

MAY 23

**AB
GRAD
CON
23**



1
00:00:00,000 --> 00:00:12,060
foreign

2
00:00:30,220 --> 00:00:27,130
[Music]

3
00:00:42,580 --> 00:00:30,230
foreign

4
00:01:07,020 --> 00:00:57,120
[Music]

5
00:01:27,130 --> 00:01:07,030
foreign

6
00:01:48,590 --> 00:01:42,580
[Music]

7
00:01:48,600 --> 00:01:52,000
foreign

8
00:02:18,470 --> 00:02:00,630
[Music]

9
00:02:18,480 --> 00:02:22,010
foreign

10
00:02:22,020 --> 00:02:29,630
[Music]

11
00:02:29,640 --> 00:02:37,000
foreign

12
00:03:07,030 --> 00:02:42,560
[Music]

13
00:03:27,110 --> 00:03:07,040

foreign

14

00:03:35,590 --> 00:03:33,530

[Music]

15

00:03:45,050 --> 00:03:35,600

thank you

16

00:03:45,060 --> 00:03:48,660

foreign

17

00:04:48,530 --> 00:04:00,620

[Music]

18

00:04:57,120 --> 00:04:49,140

thank you

19

00:05:00,210 --> 00:04:58,969

[Music]

20

00:05:12,570 --> 00:05:00,220

foreign

21

00:05:46,090 --> 00:05:27,120

[Music]

22

00:05:46,100 --> 00:05:57,120

thank you

23

00:06:07,010 --> 00:06:04,790

[Music]

24

00:06:12,570 --> 00:06:07,020

foreign

25

00:06:48,469 --> 00:06:17,050

[Music]

26
00:06:48,479 --> 00:06:52,010
thank you

27
00:07:21,050 --> 00:07:00,630
[Music]

28
00:07:21,060 --> 00:07:27,130
foreign

29
00:07:27,140 --> 00:07:57,650
[Music]

30
00:07:57,660 --> 00:08:00,600
thank you

31
00:09:36,980 --> 00:08:29,170
[Music]

32
00:09:57,110 --> 00:09:36,990
foreign

33
00:10:30,210 --> 00:10:12,560
[Music]

34
00:10:42,560 --> 00:10:30,220
foreign

35
00:10:59,030 --> 00:10:51,990
[Music]

36
00:11:30,060 --> 00:11:00,620
foreign

37
00:11:30,070 --> 00:11:34,790
[Music]

38
00:11:34,800 --> 00:11:40,080

foreign

39

00:12:22,250 --> 00:11:53,720

[Music]

40

00:12:22,260 --> 00:12:25,560

foreign

41

00:13:35,930 --> 00:13:05,400

[Music]

42

00:13:35,940 --> 00:14:03,410

foreign

43

00:14:03,420 --> 00:14:48,050

[Music]

44

00:14:48,060 --> 00:15:17,420

foreign

45

00:16:10,970 --> 00:15:37,050

[Music]

46

00:16:10,980 --> 00:16:17,410

foreign

47

00:16:17,420 --> 00:17:01,370

[Music]

48

00:17:01,380 --> 00:17:12,980

thank you

49

00:17:18,559 --> 00:17:16,250

[Music]

50

00:18:00,270 --> 00:17:18,569

foreign

51
00:18:00,280 --> 00:18:09,409
[Music]

52
00:18:41,410 --> 00:18:11,800
foreign

53
00:20:41,600 --> 00:18:51,020
[Music]

54
00:20:54,670 --> 00:20:41,610
foreign

55
00:20:57,410 --> 00:20:56,210
[Music]

56
00:21:28,200 --> 00:20:57,420
foreign

57
00:21:28,210 --> 00:21:33,169
[Music]

58
00:21:33,179 --> 00:21:53,410
YouTube

59
00:23:14,300 --> 00:22:00,980
[Music]

60
00:23:20,210 --> 00:23:14,310
thank you

61
00:23:21,610 --> 00:23:20,220
[Music]

62
00:23:37,370 --> 00:23:21,620
foreign

63
00:24:39,930 --> 00:23:48,560

[Music]

64

00:25:39,049 --> 00:24:39,940

foreign

65

00:25:41,160 --> 00:25:39,059

[Music]

66

00:25:51,890 --> 00:25:41,170

thank you

67

00:27:05,960 --> 00:25:51,900

[Music]

68

00:27:36,330 --> 00:27:05,970

foreign

69

00:29:33,289 --> 00:27:49,310

[Music]

70

00:29:33,299 --> 00:29:37,540

foreign

71

00:30:39,649 --> 00:30:02,210

[Music]

72

00:30:53,770 --> 00:30:41,530

foreign

73

00:31:33,769 --> 00:31:02,910

[Music]

74

00:31:33,779 --> 00:31:50,440

thank you

75

00:32:44,690 --> 00:31:53,330

[Music]

76
00:33:25,510 --> 00:33:08,750
foreign

77
00:33:25,520 --> 00:34:01,730
[Music]

78
00:34:13,030 --> 00:34:03,230
foreign

79
00:34:13,040 --> 00:34:18,710
[Music]

80
00:34:18,720 --> 00:34:39,169
foreign

81
00:35:21,890 --> 00:35:00,550
[Music]

82
00:35:38,940 --> 00:35:31,370
foreign

83
00:36:29,030 --> 00:36:14,210
[Music]

84
00:36:29,040 --> 00:36:35,600
foreign

85
00:36:35,610 --> 00:36:53,089
[Music]

86
00:37:02,040 --> 00:36:55,100
foreign

87
00:37:02,050 --> 00:37:15,050
[Music]

88
00:37:20,329 --> 00:37:18,410

we're going to start our first talk

89

00:37:22,490 --> 00:37:20,339

session

90

00:37:26,630 --> 00:37:24,550

I hope everyone had a good breakfast

91

00:37:28,010 --> 00:37:26,640

I'm putting some more announcements I

92

00:37:30,710 --> 00:37:28,020

realized there's probably some confusion

93

00:37:32,630 --> 00:37:30,720

like the Drive Lines a little crowded so

94

00:37:34,670 --> 00:37:32,640

feel free to eat in that Courtyard area

95

00:37:35,750 --> 00:37:34,680

in the morning I posted a picture I'll

96

00:37:37,130 --> 00:37:35,760

post that where like where more

97

00:37:38,390 --> 00:37:37,140

bathrooms are it's like they're all in

98

00:37:41,089 --> 00:37:38,400

the back there but there's also two

99

00:37:43,430 --> 00:37:41,099

bathrooms that are close to Surfside

100

00:37:45,349 --> 00:37:43,440

um but anyway Let's uh get started so

101
00:37:48,950 --> 00:37:45,359
our first speaker is going to be Gage

102
00:37:57,109 --> 00:37:54,530
[Applause]

103
00:37:58,849 --> 00:37:57,119
hello everyone yeah so for those you

104
00:38:00,170 --> 00:37:58,859
have who haven't met me yet yeah my name

105
00:38:02,329 --> 00:38:00,180
is Gage and I'm going to be talking

106
00:38:04,790 --> 00:38:02,339
about assembly Theory and in particular

107
00:38:06,650 --> 00:38:04,800
strings and hopefully by the end of this

108
00:38:08,270 --> 00:38:06,660
I will have convinced you that it is

109
00:38:09,710 --> 00:38:08,280
very useful for astrobiology in

110
00:38:12,589 --> 00:38:09,720
particular

111
00:38:14,270 --> 00:38:12,599
so in assembly Theory the primary

112
00:38:16,550 --> 00:38:14,280
quantity we're concerned with is called

113
00:38:18,410 --> 00:38:16,560

assembly index and it's a complexity

114

00:38:19,910 --> 00:38:18,420

measure that corresponds to the minimal

115

00:38:23,270 --> 00:38:19,920

number of joining operations that it

116

00:38:26,210 --> 00:38:23,280

takes to build an object so if my object

117

00:38:27,530 --> 00:38:26,220

is like X and I need at least three of

118

00:38:29,810 --> 00:38:27,540

these steps where I combine two things

119

00:38:32,210 --> 00:38:29,820

to make something new to get to X from

120

00:38:34,550 --> 00:38:32,220

some set of fundamental building blocks

121

00:38:35,630 --> 00:38:34,560

then we said the assembly index of X is

122

00:38:38,089 --> 00:38:35,640

three

123

00:38:39,589 --> 00:38:38,099

and so

124

00:38:41,210 --> 00:38:39,599

assembly index is kind of system

125

00:38:43,370 --> 00:38:41,220

dependent in much the same way that

126

00:38:44,870 --> 00:38:43,380

entropy is where for entropy I get to

127

00:38:47,089 --> 00:38:44,880

choose what my micro and macro states

128

00:38:49,010 --> 00:38:47,099

are and this influences exactly what it

129

00:38:50,569 --> 00:38:49,020

means and for assembly index these

130

00:38:52,430 --> 00:38:50,579

things that we get to choose are what

131

00:38:54,530 --> 00:38:52,440

our fundamental building blocks are and

132

00:38:56,930 --> 00:38:54,540

what the different joining operations

133

00:38:58,730 --> 00:38:56,940

that are allowable are

134

00:39:01,010 --> 00:38:58,740

and so

135

00:39:02,630 --> 00:39:01,020

we

136

00:39:04,790 --> 00:39:02,640

kind of philosophically what this thing

137

00:39:07,490 --> 00:39:04,800

means is that if I find some really

138

00:39:09,170 --> 00:39:07,500

complex object let's call it a and it

139

00:39:11,990 --> 00:39:09,180

has an assembly index of

140

00:39:14,150 --> 00:39:12,000

n and I find lots of copies of this

141

00:39:16,849 --> 00:39:14,160

object I can be sure that somewhere in

142

00:39:18,710 --> 00:39:16,859

the environment there's at least some

143

00:39:20,990 --> 00:39:18,720

end construction processes that exists

144

00:39:22,130 --> 00:39:21,000

there that memory is stored somewhere in

145

00:39:24,470 --> 00:39:22,140

the environment that's creating these

146

00:39:26,089 --> 00:39:24,480

objects and that just simply has to be

147

00:39:29,450 --> 00:39:26,099

true because

148

00:39:30,890 --> 00:39:29,460

for objects even as small as like modest

149

00:39:32,810 --> 00:39:30,900

size proteins there's not enough like

150

00:39:35,089 --> 00:39:32,820

matter on Earth to make all of them in

151
00:39:36,710 --> 00:39:35,099
any kind of meaningful abundance

152
00:39:39,109 --> 00:39:36,720
and so

153
00:39:41,150 --> 00:39:39,119
this approach kind of lives between two

154
00:39:43,130 --> 00:39:41,160
different worlds so one is like

155
00:39:44,750 --> 00:39:43,140
you know I might want to know the

156
00:39:46,609 --> 00:39:44,760
explicit physics or chemistry that's

157
00:39:48,050 --> 00:39:46,619
going on and know exactly how these

158
00:39:49,790 --> 00:39:48,060
things are actually built every time and

159
00:39:52,010 --> 00:39:49,800
understand those pathways

160
00:39:53,810 --> 00:39:52,020
but in assembly Theory we just take

161
00:39:55,430 --> 00:39:53,820
what's the minimal like hypothetical

162
00:39:57,230 --> 00:39:55,440
thing that we can't rule out as

163
00:39:58,490 --> 00:39:57,240

impossible and this is a massive

164

00:39:59,750 --> 00:39:58,500

simplification so we don't have to

165

00:40:01,609 --> 00:39:59,760

understand all the microphysical

166

00:40:04,130 --> 00:40:01,619

properties but we can still put lower

167

00:40:05,329 --> 00:40:04,140

bounds on how much it can take to make

168

00:40:07,910 --> 00:40:05,339

these objects

169

00:40:09,170 --> 00:40:07,920

on the other end of the spectrum it kind

170

00:40:12,650 --> 00:40:09,180

of varies from algorithmic information

171

00:40:14,329 --> 00:40:12,660

Theory where I would instead say you

172

00:40:16,550 --> 00:40:14,339

know something is so simple based off of

173

00:40:18,470 --> 00:40:16,560

how small of a program I can write that

174

00:40:19,970 --> 00:40:18,480

creates it in a computer language but in

175

00:40:21,829 --> 00:40:19,980

assembly Theory we're requiring it every

176

00:40:25,250 --> 00:40:21,839

step that that everything that's

177

00:40:26,990 --> 00:40:25,260

happening is physically possible

178

00:40:30,410 --> 00:40:27,000

and so

179

00:40:32,210 --> 00:40:30,420

strings are biologically relevant as we

180

00:40:33,470 --> 00:40:32,220

are all probably quite familiar with it

181

00:40:35,329 --> 00:40:33,480

can be encoded in like two different

182

00:40:38,569 --> 00:40:35,339

alphabets so I can write it in like

183

00:40:42,410 --> 00:40:38,579

nucleotides or in amino acids

184

00:40:44,990 --> 00:40:42,420

and like many other fields of physics

185

00:40:46,670 --> 00:40:45,000

setting strings is like studying

186

00:40:48,410 --> 00:40:46,680

symmetries and so this is kind of a

187

00:40:50,270 --> 00:40:48,420

diagram here of this top string of where

188

00:40:52,370 --> 00:40:50,280

different symmetric sub strings are

189

00:40:54,589 --> 00:40:52,380

within it and when you look at this

190

00:40:56,270 --> 00:40:54,599

these correspond to meaningful

191

00:40:58,730 --> 00:40:56,280

properties in the ways you can build it

192

00:41:01,970 --> 00:40:58,740

in the shortest paths so

193

00:41:04,430 --> 00:41:01,980

one feature I want to point out is that

194

00:41:06,650 --> 00:41:04,440

so in this bottom left bit here I have

195

00:41:08,630 --> 00:41:06,660

this one two segment that I'm doubling

196

00:41:10,730 --> 00:41:08,640

with itself into one two one two and we

197

00:41:12,109 --> 00:41:10,740

call this kind of innovation-like and

198

00:41:13,910 --> 00:41:12,119

then it's like I have the blueprints for

199

00:41:16,790 --> 00:41:13,920

it and I don't need to rebuild it from

200

00:41:19,190 --> 00:41:16,800

scratch every time

201
00:41:20,569 --> 00:41:19,200
so this has a lot of really nice

202
00:41:22,670 --> 00:41:20,579
mathematical properties and it's a

203
00:41:25,190 --> 00:41:22,680
really rich subject so like

204
00:41:26,750 --> 00:41:25,200
this thing on the bottom looks like like

205
00:41:29,210 --> 00:41:26,760
ice cream with sprinkles in it but it's

206
00:41:31,370 --> 00:41:29,220
it's it's a some kind of weird graph

207
00:41:32,870 --> 00:41:31,380
which actually corresponds to like how

208
00:41:35,329 --> 00:41:32,880
you reconcile all these symmetries

209
00:41:37,190 --> 00:41:35,339
together to calculate like what the

210
00:41:38,569 --> 00:41:37,200
shortest build path is and it has a

211
00:41:40,550 --> 00:41:38,579
really nice relation to some like really

212
00:41:42,710 --> 00:41:40,560
classic problems in computation theory

213
00:41:44,810 --> 00:41:42,720

that tell us about how complicated it is

214

00:41:47,390 --> 00:41:44,820

to calculate these things

215

00:41:50,329 --> 00:41:47,400

um but much more Salient to astrobiology

216

00:41:52,970 --> 00:41:50,339

is thinking about uh

217

00:41:55,609 --> 00:41:52,980

what we could call Prime strings or I

218

00:41:57,230 --> 00:41:55,619

would argue also materially efficient

219

00:41:59,930 --> 00:41:57,240

techno signatures

220

00:42:01,550 --> 00:41:59,940

so the example I want to kind of

221

00:42:02,930 --> 00:42:01,560

describe this as is it's just a series

222

00:42:05,450 --> 00:42:02,940

of numbers but what would it mean in

223

00:42:09,230 --> 00:42:05,460

maybe a material is if I restrict myself

224

00:42:10,910 --> 00:42:09,240

to working with polymer chains and my

225

00:42:13,130 --> 00:42:10,920

alphabet size is basically how many

226

00:42:16,130 --> 00:42:13,140

different monomers I have access to

227

00:42:18,349 --> 00:42:16,140

if I want to find how do I efficiently

228

00:42:19,490 --> 00:42:18,359

create something that demonstrates I

229

00:42:20,690 --> 00:42:19,500

know how to compute a lot of different

230

00:42:23,150 --> 00:42:20,700

reactions

231

00:42:25,190 --> 00:42:23,160

then I need something that has as few

232

00:42:26,630 --> 00:42:25,200

symmetries in it as possible and there's

233

00:42:28,010 --> 00:42:26,640

actually really explicit ways to

234

00:42:32,690 --> 00:42:28,020

construct these things such that they

235

00:42:34,310 --> 00:42:32,700

have absolutely no I I can construct

236

00:42:36,170 --> 00:42:34,320

there's many different ways to build

237

00:42:38,630 --> 00:42:36,180

these strings but none of them reuse the

238

00:42:40,069 --> 00:42:38,640

exact same reaction twice by virtue of

239

00:42:41,750 --> 00:42:40,079

just what they are

240

00:42:43,010 --> 00:42:41,760

and that's a property introduced to

241

00:42:44,569 --> 00:42:43,020

these objects and this also kind of

242

00:42:46,430 --> 00:42:44,579

highlights the difference between this

243

00:42:47,750 --> 00:42:46,440

and algorithmic information Theory

244

00:42:50,270 --> 00:42:47,760

because like

245

00:42:52,069 --> 00:42:50,280

if I asked anybody to like make the next

246

00:42:53,150 --> 00:42:52,079

one you'd probably all get it right on

247

00:42:54,589 --> 00:42:53,160

the first try there's a lot of

248

00:42:56,030 --> 00:42:54,599

regularity in what these objects look

249

00:42:57,710 --> 00:42:56,040

like and so algorithmically they're not

250

00:42:59,089 --> 00:42:57,720

that complicated but in terms of the

251
00:43:02,390 --> 00:42:59,099
physical reactions you need to make them

252
00:43:07,609 --> 00:43:03,910
so

253
00:43:09,710 --> 00:43:07,619
future and that what I'm really excited

254
00:43:12,290 --> 00:43:09,720
to do with this is have a dynamics of

255
00:43:14,450 --> 00:43:12,300
how life can explore the chemical space

256
00:43:16,490 --> 00:43:14,460
of what's possible

257
00:43:18,470 --> 00:43:16,500
and so the picture I want to illustrate

258
00:43:20,390 --> 00:43:18,480
these are not real data this is just to

259
00:43:24,109 --> 00:43:20,400
illustrate a point is I want to think

260
00:43:26,390 --> 00:43:24,119
about some space of objects and I think

261
00:43:29,089 --> 00:43:26,400
a good example is all the proteins that

262
00:43:30,890 --> 00:43:29,099
a species creates say so we take all

263
00:43:32,750 --> 00:43:30,900

these proteins and I want to assign

264

00:43:35,030 --> 00:43:32,760

distances between them all and

265

00:43:36,109 --> 00:43:35,040

qualitatively I mean there's an example

266

00:43:38,630 --> 00:43:36,119

of how to do that on the top but

267

00:43:41,870 --> 00:43:38,640

qualitatively what we should think of is

268

00:43:44,150 --> 00:43:41,880

the distance between X and Y is the

269

00:43:46,130 --> 00:43:44,160

number of joining operations that I need

270

00:43:48,050 --> 00:43:46,140

to change to go from one to the other

271

00:43:49,609 --> 00:43:48,060

and so things that are intuitively

272

00:43:53,690 --> 00:43:49,619

similar will be closer

273

00:43:55,430 --> 00:43:53,700

and just yeah as you might expect and so

274

00:43:56,290 --> 00:43:55,440

this is really useful because when we

275

00:43:59,150 --> 00:43:56,300

think about

276

00:44:01,130 --> 00:43:59,160

what we have as a generative model for

277

00:44:03,890 --> 00:44:01,140

like a null hypothesis like what should

278

00:44:05,930 --> 00:44:03,900

life be doing we know that mutations are

279

00:44:07,849 --> 00:44:05,940

things that really only change assembly

280

00:44:09,650 --> 00:44:07,859

index by one either I'm inserting some

281

00:44:10,609 --> 00:44:09,660

large segment that already existed and

282

00:44:12,290 --> 00:44:10,619

so I didn't have to build it from

283

00:44:14,990 --> 00:44:12,300

scratch or I'm making some really small

284

00:44:17,870 --> 00:44:15,000

change and in any case this is a very a

285

00:44:20,150 --> 00:44:17,880

change in assembly index of just one

286

00:44:22,250 --> 00:44:20,160

and so we have this kind of

287

00:44:24,410 --> 00:44:22,260

thick surface of the adjacent possible

288

00:44:27,050 --> 00:44:24,420

like things you can mutate into and

289

00:44:28,970 --> 00:44:27,060

because it's reasonable to imagine that

290

00:44:31,250 --> 00:44:28,980

this is happening kind of randomly

291

00:44:33,170 --> 00:44:31,260

we can have some kind of no model for

292

00:44:35,390 --> 00:44:33,180

what we expect life to look like like

293

00:44:37,130 --> 00:44:35,400

what's the shape of this object as it

294

00:44:38,630 --> 00:44:37,140

grows in time

295

00:44:40,609 --> 00:44:38,640

and

296

00:44:42,230 --> 00:44:40,619

so I like to think of it as kind of

297

00:44:44,210 --> 00:44:42,240

spherical but actually it's probably a

298

00:44:45,109 --> 00:44:44,220

little bit noisy just because it is so

299

00:44:46,790 --> 00:44:45,119

Random

300

00:44:48,650 --> 00:44:46,800

but in reality I don't think we'll

301
00:44:50,270 --> 00:44:48,660
really observe this because some

302
00:44:52,309 --> 00:44:50,280
mutations will be selected out and we'll

303
00:44:54,230 --> 00:44:52,319
never observe them and so the way I want

304
00:44:56,569 --> 00:44:54,240
to illustrate this is this you have this

305
00:44:58,970 --> 00:44:56,579
kind of noisy sphere on the left and you

306
00:45:01,730 --> 00:44:58,980
have a much noisier version of it on the

307
00:45:03,770 --> 00:45:01,740
right and you know if I observe this for

308
00:45:05,329 --> 00:45:03,780
two different things the interpretation

309
00:45:07,370 --> 00:45:05,339
of this is we're seeing something about

310
00:45:09,170 --> 00:45:07,380
like the fitness landscape like this is

311
00:45:11,809 --> 00:45:09,180
kind of the shadow that makes it through

312
00:45:13,849 --> 00:45:11,819
right so like there's lots of voids here

313
00:45:18,410 --> 00:45:13,859

of things that are either not functional

314

00:45:20,750 --> 00:45:18,420

or even hurtful to the system and

315

00:45:22,670 --> 00:45:20,760

by studying like the geometry of these

316

00:45:23,990 --> 00:45:22,680

kinds of objects and looking for the

317

00:45:27,349 --> 00:45:24,000

ways they scale we can learn things

318

00:45:29,690 --> 00:45:27,359

about the ergonicity of life meaning

319

00:45:31,030 --> 00:45:29,700

if I were to restart us from like early

320

00:45:33,050 --> 00:45:31,040

Earth times

321

00:45:35,210 --> 00:45:33,060

how similar would I expect the

322

00:45:37,490 --> 00:45:35,220

biochemistry to be today that we observe

323

00:45:38,690 --> 00:45:37,500

just by virtue of how many ways does it

324

00:45:41,210 --> 00:45:38,700

seem like there are to actually move in

325

00:45:43,130 --> 00:45:41,220

this plate in this space and by

326

00:45:45,710 --> 00:45:43,140

extension we can make inferences about

327

00:45:48,530 --> 00:45:45,720

just life in general and how

328

00:45:52,010 --> 00:45:48,540

constricted it must be and how diverse

329

00:45:55,069 --> 00:45:52,020

will potential alien biochemistries be

330

00:45:57,890 --> 00:45:55,079

so with that I'll leave you with a

331

00:46:01,170 --> 00:45:57,900

fractal that reminds me of the building

332

00:46:15,530 --> 00:46:01,180

process and I'll take any questions

333

00:46:21,430 --> 00:46:19,309

so how can this be employed to sort of

334

00:46:23,690 --> 00:46:21,440

create a Criterion for what constitutes

335

00:46:24,950 --> 00:46:23,700

abiogenesis based off the assembly

336

00:46:28,130 --> 00:46:24,960

complexes

337

00:46:29,930 --> 00:46:28,140

so there is an excellent nature comes

338

00:46:32,809 --> 00:46:29,940

paper I want to say from 2020 that's

339

00:46:34,910 --> 00:46:32,819

Marshall's the first author uh where

340

00:46:37,569 --> 00:46:34,920

they talk about so you can do this for

341

00:46:39,670 --> 00:46:37,579

molecules and they find a really big

342

00:46:41,809 --> 00:46:39,680

disparity between what kinds of things

343

00:46:44,329 --> 00:46:41,819

abiotic sources can produce versus

344

00:46:46,250 --> 00:46:44,339

biotic and this is something that you

345

00:46:48,710 --> 00:46:46,260

can measure quite accurately with like

346

00:46:51,650 --> 00:46:48,720

Mass Spec and some other methods too and

347

00:46:54,109 --> 00:46:51,660

so it just for a chemical biosignature

348

00:47:00,890 --> 00:46:54,119

way there's a concrete I think that

349

00:47:04,670 --> 00:47:03,170

hi um great talk and also just curious

350

00:47:06,890 --> 00:47:04,680

when you're evaluating the assembly

351
00:47:08,210 --> 00:47:06,900
theory is this based off of entirely the

352
00:47:11,089 --> 00:47:08,220
sequence or do you also account for

353
00:47:13,550 --> 00:47:12,710
I don't like protein folding or

354
00:47:16,730 --> 00:47:13,560
something

355
00:47:18,589 --> 00:47:16,740
ah yes so this is kind of embedded in

356
00:47:20,030 --> 00:47:18,599
like our choice of the definition of the

357
00:47:21,470 --> 00:47:20,040
joining operation right so like the

358
00:47:23,630 --> 00:47:21,480
simplest Choice doesn't count the

359
00:47:25,190 --> 00:47:23,640
protein folding but you can imagine that

360
00:47:26,870 --> 00:47:25,200
I Define the joining operations such

361
00:47:29,930 --> 00:47:26,880
that I allow myself to consider those

362
00:47:32,450 --> 00:47:29,940
like high order constructions and so

363
00:47:41,870 --> 00:47:32,460

yeah it's a choice of your

364

00:47:46,130 --> 00:47:44,270

uh yeah this is very interesting I'm

365

00:47:47,569 --> 00:47:46,140

wondering how do you consider the

366

00:47:48,829 --> 00:47:47,579

starting amino acids you have because

367

00:47:50,510 --> 00:47:48,839

there's a lot of theories on like what

368

00:47:52,190 --> 00:47:50,520

amino acids were like first or like

369

00:47:53,569 --> 00:47:52,200

which evolved later and like are you

370

00:47:55,370 --> 00:47:53,579

only using the canonical ones that we

371

00:47:57,470 --> 00:47:55,380

have in like the current genetic code or

372

00:48:00,890 --> 00:47:57,480

like they're any like theoretical amino

373

00:48:07,069 --> 00:48:02,870

I'm not uh there's someone at your table

374

00:48:10,790 --> 00:48:07,079

who does his name's Thomas

375

00:48:12,170 --> 00:48:10,800

um but I to to relate it to this I think

376

00:48:13,849 --> 00:48:12,180

this is kind of embedded in your choice

377

00:48:25,309 --> 00:48:13,859

of like what the fundamental building

378

00:48:25,319 --> 00:48:29,450

any other questions for Gage

379

00:48:39,410 --> 00:48:31,410

okay let's go around the pause

380

00:48:40,730 --> 00:48:39,420

[Applause]

381

00:48:42,470 --> 00:48:40,740

okay

382

00:48:45,530 --> 00:48:42,480

and our next speaker is going to be Alex

383

00:48:47,809 --> 00:48:45,540

Plum here from UCSD

384

00:48:49,910 --> 00:48:47,819

hi there I'm Alex Plum my talk is on

385

00:48:52,370 --> 00:48:49,920

auto catalytic chemical ecosystems in

386

00:48:53,809 --> 00:48:52,380

spatial settings uh

387

00:48:55,609 --> 00:48:53,819

so I wanted to start with this quote

388

00:48:57,470 --> 00:48:55,619

from the French nationalist George

389

00:48:58,730 --> 00:48:57,480

cuvier I don't think it's a good

390

00:49:00,530 --> 00:48:58,740

definition of life but I think it

391

00:49:02,809 --> 00:49:00,540

captures one feature of life that's very

392

00:49:04,609 --> 00:49:02,819

important uh specifically this feature

393

00:49:07,130 --> 00:49:04,619

of Auto catalysis which I think is the

394

00:49:08,630 --> 00:49:07,140

central Motif for self-propagation uh

395

00:49:10,069 --> 00:49:08,640

that we see kind of all across life and

396

00:49:12,349 --> 00:49:10,079

it may have been relevant in life's

397

00:49:14,510 --> 00:49:12,359

earliest stages so we say that a process

398

00:49:16,550 --> 00:49:14,520

is auto catalytic if the products of

399

00:49:18,410 --> 00:49:16,560

that process catalyze the process itself

400

00:49:20,329 --> 00:49:18,420

here I'm going to be talking about Auto

401

00:49:22,250 --> 00:49:20,339

catalytic Cycles where you have a

402

00:49:24,170 --> 00:49:22,260

sequence of reactions that form a cycle

403

00:49:26,450 --> 00:49:24,180

such that with every turn of the cycle

404

00:49:28,250 --> 00:49:26,460

you get a stoichiometric increase in the

405

00:49:30,530 --> 00:49:28,260

number of some set of chemicals that

406

00:49:32,270 --> 00:49:30,540

we'll call member chemicals you can take

407

00:49:34,130 --> 00:49:32,280

all of the chemicals involved in an auto

408

00:49:37,130 --> 00:49:34,140

catalytic cycle and partition them into

409

00:49:38,510 --> 00:49:37,140

food chemicals into member chemicals and

410

00:49:40,250 --> 00:49:38,520

into waste chemicals based on which

411

00:49:41,990 --> 00:49:40,260

sides of the reactions they show up in

412

00:49:44,210 --> 00:49:42,000

and so here's a simple example where you

413

00:49:46,670 --> 00:49:44,220

just have two reversible reactions you

414

00:49:48,650 --> 00:49:46,680

have two member chemicals M1 and M2 you

415

00:49:51,770 --> 00:49:48,660

have one food that's being used for both

416

00:49:53,329 --> 00:49:51,780

reactions and waste chemical and in

417

00:49:55,670 --> 00:49:53,339

principle these can be irreversible here

418

00:49:58,130 --> 00:49:55,680

I've drawn them as reversible and

419

00:50:00,650 --> 00:49:58,140

because they're reversible you can drive

420

00:50:02,210 --> 00:50:00,660

them in either direction if you have an

421

00:50:03,710 --> 00:50:02,220

abundance of food they can be driven in

422

00:50:05,450 --> 00:50:03,720

the productive direction that provides

423

00:50:06,589 --> 00:50:05,460

the stoichiometric increase in the

424

00:50:08,569 --> 00:50:06,599

member chemicals allowing them to

425

00:50:10,550 --> 00:50:08,579

self-propagate but if instead you have

426

00:50:12,109 --> 00:50:10,560

an accumulation of waste it can kind of

427

00:50:13,730 --> 00:50:12,119

wind down in the other direction and you

428

00:50:17,089 --> 00:50:13,740

can get a stoichiometric decrease in the

429

00:50:19,670 --> 00:50:17,099

number of member chemicals as well

430

00:50:21,710 --> 00:50:19,680

so we've analogized these Auto catalytic

431

00:50:22,970 --> 00:50:21,720

Cycles to biological species in part

432

00:50:24,470 --> 00:50:22,980

because they're consuming food they're

433

00:50:26,089 --> 00:50:24,480

producing waste and self-propagating

434

00:50:28,730 --> 00:50:26,099

themselves and we've demonstrated that

435

00:50:31,069 --> 00:50:28,740

they can exhibit logistic growth

436

00:50:32,569 --> 00:50:31,079

if you put them in a closed reactor some

437

00:50:34,190 --> 00:50:32,579

amount of food available some seed

438

00:50:36,050 --> 00:50:34,200

member species

439

00:50:38,390 --> 00:50:36,060

they can start growing and they can

440

00:50:40,010 --> 00:50:38,400

reach equilibrium concentrations but

441

00:50:41,510 --> 00:50:40,020

this isn't of great interest in an

442

00:50:43,309 --> 00:50:41,520

origins of Life context because life

443

00:50:44,990 --> 00:50:43,319

isn't out of equilibrium process so in

444

00:50:47,630 --> 00:50:45,000

practice we typically simulate these

445

00:50:49,970 --> 00:50:47,640

cycles and chemostats when you have an

446

00:50:51,770 --> 00:50:49,980

inflow of food from a source that drives

447

00:50:53,690 --> 00:50:51,780

them in the productive or autocatalytic

448

00:50:56,569 --> 00:50:53,700

Direction and where everything is

449

00:50:58,370 --> 00:50:56,579

diluted out of the system and this has

450

00:51:00,170 --> 00:50:58,380

two implications one it helps to offload

451
00:51:02,089 --> 00:51:00,180
the waste to kind of keep it from being

452
00:51:04,010 --> 00:51:02,099
driven in the other direction and it

453
00:51:05,809 --> 00:51:04,020
also provides a selective pressure so

454
00:51:07,609 --> 00:51:05,819
that now if the cycle doesn't replicate

455
00:51:09,530 --> 00:51:07,619
or propagate its member species quickly

456
00:51:11,089 --> 00:51:09,540
enough they'll just be diluted out of

457
00:51:12,470 --> 00:51:11,099
the reactor so it's not trivial that

458
00:51:14,829 --> 00:51:12,480
these Cycles are going to persist

459
00:51:16,730 --> 00:51:14,839
anymore persistence becomes a problem

460
00:51:17,809 --> 00:51:16,740
something that they have to kind of

461
00:51:19,370 --> 00:51:17,819
achieve

462
00:51:20,930 --> 00:51:19,380
so when you simulate these you can get

463
00:51:22,130 --> 00:51:20,940

time series that looks like this plot

464

00:51:23,569 --> 00:51:22,140

over here

465

00:51:25,250 --> 00:51:23,579

where you have a depletion of food

466

00:51:26,750 --> 00:51:25,260

through time you have logistic growth in

467

00:51:28,670 --> 00:51:26,760

the concentrations of member chemicals

468

00:51:30,049 --> 00:51:28,680

here in blue and you also have a buildup

469

00:51:32,210 --> 00:51:30,059

of waste

470

00:51:33,890 --> 00:51:32,220

you can choose to simulate them using

471

00:51:35,569 --> 00:51:33,900

ordinary differential equations if

472

00:51:37,010 --> 00:51:35,579

you're in a well-mixed reactor

473

00:51:38,450 --> 00:51:37,020

and that assumes that you have large

474

00:51:40,490 --> 00:51:38,460

enough quantities that you can treat

475

00:51:42,290 --> 00:51:40,500

continuous concentrations of chemicals

476

00:51:44,150 --> 00:51:42,300

the other approach is to simulate things

477

00:51:45,950 --> 00:51:44,160

stochastically and in kind of the large

478

00:51:47,990 --> 00:51:45,960

end limit this looks very similar to The

479

00:51:49,730 --> 00:51:48,000

Continuous case but as you go to smaller

480

00:51:51,650 --> 00:51:49,740

and smaller numbers of chemicals things

481

00:51:53,210 --> 00:51:51,660

look a lot noisier and you can start to

482

00:51:55,250 --> 00:51:53,220

have more contingency in the Dynamics

483

00:51:57,290 --> 00:51:55,260

where you can have the stochastic loss

484

00:51:59,150 --> 00:51:57,300

of a single chemical or the stochastic

485

00:52:01,549 --> 00:51:59,160

dispersal of a single chemical in a new

486

00:52:03,770 --> 00:52:01,559

location changing the dynamic somewhere

487

00:52:07,309 --> 00:52:03,780

else and so in everything I show here

488

00:52:09,049 --> 00:52:07,319

I'll be taking this stochastic approach

489

00:52:11,510 --> 00:52:09,059

so that's all the Dynamics for a single

490

00:52:13,490 --> 00:52:11,520

cycle we're ultimately interested in

491

00:52:16,430 --> 00:52:13,500

combining different cycles and seeing

492

00:52:18,410 --> 00:52:16,440

how they interact ecologically so here I

493

00:52:20,809 --> 00:52:18,420

show the the member chemical

494

00:52:23,569 --> 00:52:20,819

concentrations over time or counts over

495

00:52:25,549 --> 00:52:23,579

time for the different Auto catalytic

496

00:52:27,230 --> 00:52:25,559

Cycles shown on the left here they can

497

00:52:29,150 --> 00:52:27,240

exhibit competitive exclusion

498

00:52:31,250 --> 00:52:29,160

competitive coexistence when they share

499

00:52:33,230 --> 00:52:31,260

a common food source they can also

500

00:52:35,270 --> 00:52:33,240

exhibit mutualisms wherein the food or

501
00:52:37,970 --> 00:52:35,280
the waste of one chemical serves as food

502
00:52:39,650 --> 00:52:37,980
for another Auto catalytic cycle they

503
00:52:41,329 --> 00:52:39,660
can also exhibit predation

504
00:52:42,589 --> 00:52:41,339
where in the member chemicals of one

505
00:52:44,809 --> 00:52:42,599
cycle serve as the food for another

506
00:52:46,130 --> 00:52:44,819
cycle and the Dynamics resemble those

507
00:52:47,750 --> 00:52:46,140
that you get in the lack of ultra

508
00:52:49,309 --> 00:52:47,760
equations and ecology where you can get

509
00:52:51,410 --> 00:52:49,319
both stable and damped oscillations

510
00:52:53,990 --> 00:52:51,420
predator or prey dominance or

511
00:52:56,210 --> 00:52:54,000
coexistence of the the predator and prey

512
00:52:58,069 --> 00:52:56,220
and you can also get priority effects

513
00:53:00,049 --> 00:52:58,079

wherein two cycles might mutually

514

00:53:02,870 --> 00:53:00,059

inhibit one another so that it matters

515

00:53:05,030 --> 00:53:02,880

if one cycle gets seated in a location

516

00:53:07,849 --> 00:53:05,040

first versus the other since they'll

517

00:53:09,470 --> 00:53:07,859

suppress the growth of the other cycle

518

00:53:12,349 --> 00:53:09,480

so why is this relevant to the origin of

519

00:53:14,450 --> 00:53:12,359

life we think that these Auto catalytic

520

00:53:17,390 --> 00:53:14,460

Cycles provide one of the simplest ways

521

00:53:19,730 --> 00:53:17,400

in the absence of needing compartments

522

00:53:20,990 --> 00:53:19,740

or polymer genetics to get this sort of

523

00:53:22,190 --> 00:53:21,000

self-propagation that you see in

524

00:53:24,349 --> 00:53:22,200

metabolism

525

00:53:25,549 --> 00:53:24,359

and we think that they can provide an

526

00:53:27,829 --> 00:53:25,559

Avenue for the accumulation of

527

00:53:29,930 --> 00:53:27,839

complexity to ultimately serve as

528

00:53:31,790 --> 00:53:29,940

precursors or scaffolds for later stages

529

00:53:33,410 --> 00:53:31,800

in the origin of life so as an Avenue

530

00:53:35,450 --> 00:53:33,420

for kind of increasing the chemical

531

00:53:37,190 --> 00:53:35,460

diversity that you might need to achieve

532

00:53:38,930 --> 00:53:37,200

later stages and we think that you can

533

00:53:40,309 --> 00:53:38,940

do that by taking individual Cycles

534

00:53:42,650 --> 00:53:40,319

composing them through various

535

00:53:44,030 --> 00:53:42,660

ecological interactions and then using

536

00:53:45,470 --> 00:53:44,040

the sorts of avenues that we see in

537

00:53:46,549 --> 00:53:45,480

ecology for the accumulation of

538

00:53:50,630 --> 00:53:46,559

complexity

539

00:53:52,910 --> 00:53:50,640

ecology one way is through ecological

540

00:53:54,950 --> 00:53:52,920

succession wherein you have some species

541

00:53:56,690 --> 00:53:54,960

that lay the groundwork for others to

542

00:53:58,490 --> 00:53:56,700

later succeed them you can imagine this

543

00:54:00,410 --> 00:53:58,500

in a Chemical Context where the waste or

544

00:54:02,150 --> 00:54:00,420

member chemicals enable the activation

545

00:54:04,010 --> 00:54:02,160

of new cycles that couldn't have been

546

00:54:06,290 --> 00:54:04,020

activated into those first Cycles were

547

00:54:08,329 --> 00:54:06,300

activated you also have ideas on ecology

548

00:54:09,710 --> 00:54:08,339

about how to maximize biodiversity for

549

00:54:11,990 --> 00:54:09,720

example through the intermediate

550

00:54:13,609 --> 00:54:12,000

disturbance hypothesis and finally you

551
00:54:15,049 --> 00:54:13,619
have ideas about how spatial structure

552
00:54:17,089 --> 00:54:15,059
can be relevant to the accumulation of

553
00:54:19,130 --> 00:54:17,099
complexity in ecosystems where you have

554
00:54:21,349 --> 00:54:19,140
meta ecosystems and diversity among them

555
00:54:23,030 --> 00:54:21,359
and migration between them that allows

556
00:54:25,130 --> 00:54:23,040
for recombination in the formation of

557
00:54:26,990 --> 00:54:25,140
new ecological States

558
00:54:28,130 --> 00:54:27,000
so in an origins of Life context we

559
00:54:30,710 --> 00:54:28,140
often think about these chemical

560
00:54:32,390 --> 00:54:30,720
ecosystems as persisting and spatially

561
00:54:34,609 --> 00:54:32,400
structured environment like adsorbitive

562
00:54:36,410 --> 00:54:34,619
mineral surfaces

563
00:54:37,730 --> 00:54:36,420

moving across those surfaces where

564

00:54:39,710 --> 00:54:37,740

they're effectively concentrated where

565

00:54:41,750 --> 00:54:39,720

their diffusion is effectively lowered

566

00:54:42,770 --> 00:54:41,760

and those different ecosystems might

567

00:54:46,250 --> 00:54:42,780

interact

568

00:54:48,650 --> 00:54:46,260

they might continue to coexist they

569

00:54:51,589 --> 00:54:48,660

might fuse and modify one another and so

570

00:54:53,930 --> 00:54:51,599

we wanted to understand how

571

00:54:56,030 --> 00:54:53,940

these chemical ecosystems behave in

572

00:54:57,410 --> 00:54:56,040

space so the earlier kind of ecological

573

00:54:59,270 --> 00:54:57,420

time series that I showed you were all

574

00:55:01,430 --> 00:54:59,280

in well-mixed reactors now we're going

575

00:55:03,109 --> 00:55:01,440

to consider these systems in space so

576

00:55:04,430 --> 00:55:03,119

here's an example where a cycle is

577

00:55:05,990 --> 00:55:04,440

seated in the center and diffuses

578

00:55:07,730 --> 00:55:06,000

outwards kind of spreading to new

579

00:55:09,230 --> 00:55:07,740

sources of food and of course we know

580

00:55:10,970 --> 00:55:09,240

that spatial Dynamics are important for

581

00:55:12,530 --> 00:55:10,980

auto catalytic chemical systems we have

582

00:55:14,390 --> 00:55:12,540

classic examples like the belazov

583

00:55:15,770 --> 00:55:14,400

zabatinska reaction it's out of

584

00:55:18,049 --> 00:55:15,780

equilibrium process we know that they

585

00:55:20,809 --> 00:55:18,059

can form stable patterns

586

00:55:22,430 --> 00:55:20,819

so I want to consider cases where Cycles

587

00:55:24,530 --> 00:55:22,440

mutually inhibit one another because

588

00:55:26,030 --> 00:55:24,540

getting more complex ecosystems is easy

589

00:55:27,589 --> 00:55:26,040

when there are mutualisms between the

590

00:55:29,450 --> 00:55:27,599

Cycles it's hard when you have

591

00:55:31,010 --> 00:55:29,460

inhibition between them and there are

592

00:55:32,450 --> 00:55:31,020

various ways that Cycles can inhibit one

593

00:55:34,010 --> 00:55:32,460

another for example you can have the

594

00:55:35,690 --> 00:55:34,020

waste of one cycle interfere with the

595

00:55:37,370 --> 00:55:35,700

food of another cycle or you can have

596

00:55:38,690 --> 00:55:37,380

their member species annihilate the much

597

00:55:40,010 --> 00:55:38,700

simpler example that I show in the

598

00:55:42,349 --> 00:55:40,020

bottom this is the one that I'm going to

599

00:55:43,970 --> 00:55:42,359

be working with in the subsequent slides

600

00:55:46,130 --> 00:55:43,980

so you can put these in space here I

601
00:55:47,870 --> 00:55:46,140
have a hexagonal lattice with chemicals

602
00:55:49,250 --> 00:55:47,880
reacting within each site and diffusing

603
00:55:51,109 --> 00:55:49,260
between sites

604
00:55:52,790 --> 00:55:51,119
and I'm coloring them according to the

605
00:55:54,349 --> 00:55:52,800
fraction of member species that belong

606
00:55:57,109 --> 00:55:54,359
to one of these two mutually inhibiting

607
00:56:00,589 --> 00:55:57,119
Cycles red for cycle a B for are blue

608
00:56:02,450 --> 00:56:00,599
for cycle B and with slow diffusion they

609
00:56:04,609 --> 00:56:02,460
stop interacting and just form these

610
00:56:06,530 --> 00:56:04,619
stable patches with much higher

611
00:56:08,450 --> 00:56:06,540
diffusion you can see one cycle starts

612
00:56:09,829 --> 00:56:08,460
to crowd the other out globally and we

613
00:56:11,809 --> 00:56:09,839

can look at this more systematically

614

00:56:13,790 --> 00:56:11,819

varying the diffusion of all the

615

00:56:16,609 --> 00:56:13,800

chemicals involved kind of gradually

616

00:56:19,069 --> 00:56:16,619

increasing in the low case low diffusion

617

00:56:21,589 --> 00:56:19,079

case you end up with pretty randomly

618

00:56:22,910 --> 00:56:21,599

distributed ecological outcomes and the

619

00:56:24,890 --> 00:56:22,920

very high case you end up with one

620

00:56:27,170 --> 00:56:24,900

Global winner one cycle Drive in the

621

00:56:30,890 --> 00:56:27,180

other extinct and you can look at the

622

00:56:32,930 --> 00:56:30,900

heterogeneity of chemicals across this

623

00:56:34,370 --> 00:56:32,940

hexagonal lattice and what we find is

624

00:56:35,809 --> 00:56:34,380

that in the intermediate diffusion

625

00:56:38,210 --> 00:56:35,819

regimes

626
00:56:39,890 --> 00:56:38,220
this heterogeneity is maximized

627
00:56:41,270 --> 00:56:39,900
and insofar as these Cycles are

628
00:56:42,589 --> 00:56:41,280
inhibiting one another through these

629
00:56:45,530 --> 00:56:42,599
reactions that might produce other

630
00:56:47,030 --> 00:56:45,540
chemicals that could help to provide

631
00:56:48,109 --> 00:56:47,040
support for the activation of future

632
00:56:49,730 --> 00:56:48,119
Cycles

633
00:56:51,410 --> 00:56:49,740
you don't have that sort of interaction

634
00:56:52,730 --> 00:56:51,420
in the very very low diffusion case and

635
00:56:54,770 --> 00:56:52,740
you also lose it in the height of each

636
00:56:56,450 --> 00:56:54,780
in case when one cycle is driven extinct

637
00:56:58,609 --> 00:56:56,460
and so this suggests that some

638
00:57:00,770 --> 00:56:58,619

intermediate diffusion regimes are the

639

00:57:02,870 --> 00:57:00,780

most favorable to uh kind of this

640

00:57:05,329 --> 00:57:02,880

biodiversity so to speak of these

641

00:57:07,910 --> 00:57:05,339

chemical ecosystems

642

00:57:09,230 --> 00:57:07,920

that's all with keeping these Cycles on

643

00:57:10,670 --> 00:57:09,240

an equal playing field where they have

644

00:57:12,470 --> 00:57:10,680

the same reaction kinetics and the same

645

00:57:14,569 --> 00:57:12,480

diffusion properties what I want to show

646

00:57:16,790 --> 00:57:14,579

next is when you vary the properties of

647

00:57:19,250 --> 00:57:16,800

these two cycles asymmetrically so I'm

648

00:57:21,290 --> 00:57:19,260

showing time series here on the right of

649

00:57:23,329 --> 00:57:21,300

both Cycles being seated in some Central

650

00:57:26,690 --> 00:57:23,339

site in a three by three array and they

651
00:57:29,210 --> 00:57:26,700
can diffuse outwards I make cycle a in

652
00:57:31,790 --> 00:57:29,220
Red fiercer so that it consumes

653
00:57:33,470 --> 00:57:31,800
food more quickly than cycle B and

654
00:57:35,089 --> 00:57:33,480
because of that it starts to drive cycle

655
00:57:37,549 --> 00:57:35,099
B extinct initially

656
00:57:39,170 --> 00:57:37,559
but cycle B is made faster than cycle a

657
00:57:40,910 --> 00:57:39,180
meaning that it can diffuse outward more

658
00:57:43,069 --> 00:57:40,920
quickly and access new sources of food

659
00:57:45,470 --> 00:57:43,079
and so despite initially being driven

660
00:57:48,290 --> 00:57:45,480
down it manages to dominate in these

661
00:57:49,730 --> 00:57:48,300
outer sites and eventually reinvade so

662
00:57:52,549 --> 00:57:49,740
that in the long term it ends up driving

663
00:57:54,650 --> 00:57:52,559

cycle a extinct

664

00:57:56,030 --> 00:57:54,660

and you can kind of vary these

665

00:57:58,010 --> 00:57:56,040

properties systematically and construct

666

00:57:59,690 --> 00:57:58,020

a phase diagram here I vary the relative

667

00:58:02,089 --> 00:57:59,700

fierceness and relative fastness of the

668

00:58:03,589 --> 00:58:02,099

two cycles and you find regimes in which

669

00:58:05,690 --> 00:58:03,599

either of the Cycles can be favored

670

00:58:07,370 --> 00:58:05,700

suggesting that spatial environments can

671

00:58:08,750 --> 00:58:07,380

select for new types of traits such as

672

00:58:10,730 --> 00:58:08,760

the diffusivity of these member

673

00:58:12,410 --> 00:58:10,740

chemicals once you put them in a spatial

674

00:58:14,170 --> 00:58:12,420

environment a well-mixed reactor would

675

00:58:16,730 --> 00:58:14,180

be blind to these sorts of traits

676
00:58:18,650 --> 00:58:16,740
notably you can also look at other types

677
00:58:20,510 --> 00:58:18,660
of inhibition that don't involve

678
00:58:22,190 --> 00:58:20,520
explicit chemistry you can look at

679
00:58:24,230 --> 00:58:22,200
competition for absorption sites on

680
00:58:26,390 --> 00:58:24,240
Mineral surfaces and there we find very

681
00:58:28,609 --> 00:58:26,400
similar Dynamics and I think that this

682
00:58:30,170 --> 00:58:28,619
is suggestive that something like the

683
00:58:31,849 --> 00:58:30,180
Intermediate disturbance hypothesis

684
00:58:34,190 --> 00:58:31,859
might hold even for these chemical

685
00:58:35,390 --> 00:58:34,200
ecosystems and of course in an origins

686
00:58:37,010 --> 00:58:35,400
of Life context there are lots of

687
00:58:39,589 --> 00:58:37,020
different types of disturbances that you

688
00:58:40,730 --> 00:58:39,599

could have the noise of the spatially

689

00:58:42,829 --> 00:58:40,740

structured environment that you have

690

00:58:45,170 --> 00:58:42,839

different impacts

691

00:58:47,690 --> 00:58:45,180

and so with that I'd like to acknowledge

692

00:58:49,069 --> 00:58:47,700

David Baum my undergraduate advisor at

693

00:58:50,510 --> 00:58:49,079

the University of Wisconsin-Madison and

694

00:58:52,370 --> 00:58:50,520

Chris campus my mentor and collaborator

695

00:58:53,930 --> 00:58:52,380

at the Santa Fe Institute some excellent

696

00:58:55,430 --> 00:58:53,940

grad students and postdocs including

697

00:58:57,530 --> 00:58:55,440

profile who just defended his thesis

698

00:58:58,730 --> 00:58:57,540

last week and some excellent undergrads

699

00:59:01,130 --> 00:58:58,740

that I've had the opportunity to work

700

00:59:02,809 --> 00:59:01,140

with including Gage actually you should

701
00:59:04,370 --> 00:59:02,819
be on here

702
00:59:10,549 --> 00:59:04,380
all right with that I'll take any

703
00:59:10,559 --> 00:59:21,770
at this time

704
00:59:25,670 --> 00:59:23,690
also if everyone just wants to give you

705
00:59:27,650 --> 00:59:25,680
know their name and affiliation and ask

706
00:59:29,690 --> 00:59:27,660
a question that'd be great

707
00:59:32,030 --> 00:59:29,700
hi my name is George schaible I'm from

708
00:59:34,490 --> 00:59:32,040
Montana State University and I should

709
00:59:35,510 --> 00:59:34,500
profess I am a microbiologist so

710
00:59:36,950 --> 00:59:35,520
um but that was a great talk I thought

711
00:59:39,049 --> 00:59:36,960
you did a good job breaking down for us

712
00:59:41,450 --> 00:59:39,059
uh I'm just curious when diffusion

713
00:59:43,549 --> 00:59:41,460

happens that's I think of it in like a

714

00:59:44,990 --> 00:59:43,559

three-dimensional space so you're

715

00:59:46,130 --> 00:59:45,000

showing a lot of two-dimensional right

716

00:59:47,210 --> 00:59:46,140

crafts so what does that look like in

717

00:59:49,069 --> 00:59:47,220

three dimensions

718

00:59:50,630 --> 00:59:49,079

yeah so I didn't do simulations in

719

00:59:52,910 --> 00:59:50,640

three-dimensional space in part because

720

00:59:54,950 --> 00:59:52,920

I think the most like origins of Life

721

00:59:56,450 --> 00:59:54,960

relevant spatial structures are going to

722

00:59:57,710 --> 00:59:56,460

be these two-dimensional environments I

723

00:59:59,390 --> 00:59:57,720

think the two-dimensional environments

724

01:00:00,950 --> 00:59:59,400

can help to constrain kind of the

725

01:00:03,770 --> 01:00:00,960

effective diffusion that you would have

726

01:00:05,089 --> 01:00:03,780

they can concentrate chemistry lots of

727

01:00:07,010 --> 01:00:05,099

origins of Life theories that look at

728

01:00:08,329 --> 01:00:07,020

adsorptive Mineral surfaces already so

729

01:00:10,730 --> 01:00:08,339

we were kind of committed to that sort

730

01:00:12,530 --> 01:00:10,740

of scenario and here the idea of

731

01:00:14,270 --> 01:00:12,540

intermediate diffusion being favorable

732

01:00:16,069 --> 01:00:14,280

for chemical diversity I think that

733

01:00:17,630 --> 01:00:16,079

that's further support that that's the

734

01:00:19,370 --> 01:00:17,640

type of scenario that might be important

735

01:00:21,349 --> 01:00:19,380

I think there's a quote from Gunter

736

01:00:23,630 --> 01:00:21,359

washer who kind of pioneered some of

737

01:00:24,890 --> 01:00:23,640

these ideas that we don't build planes

738

01:00:27,289 --> 01:00:24,900

in the sky we build them on the ground

739

01:00:28,849 --> 01:00:27,299

and that's for a reason

740

01:00:31,250 --> 01:00:28,859

um I just to follow up with that what

741

01:00:32,809 --> 01:00:31,260

what kind of mineral surface would you

742

01:00:34,549 --> 01:00:32,819

like consider this yeah so that kind of

743

01:00:36,589 --> 01:00:34,559

the experimental side of my group in

744

01:00:37,670 --> 01:00:36,599

undergrad we um we were using pyrite

745

01:00:39,349 --> 01:00:37,680

surfaces

746

01:00:41,390 --> 01:00:39,359

um but here we're chemically agnostic

747

01:00:51,589 --> 01:00:41,400

and we're also agnostic to the exact

748

01:00:56,089 --> 01:00:54,530

hi I'm Ellie I'm from CU Boulder and I

749

01:00:58,250 --> 01:00:56,099

was wondering so I'm mainly a lab

750

01:01:01,490 --> 01:00:58,260

chemist and I was curious if you had any

751
01:01:03,650 --> 01:01:01,500
any like personal thoughts of how you

752
01:01:05,210 --> 01:01:03,660
would want a chemist to do some of this

753
01:01:06,950 --> 01:01:05,220
work or what kind of questions you would

754
01:01:08,690 --> 01:01:06,960
want a lab chemist to do to help ground

755
01:01:10,309 --> 01:01:08,700
truth some of the modeling that you do

756
01:01:11,630 --> 01:01:10,319
because I work a lot of like mineral

757
01:01:13,370 --> 01:01:11,640
absorption and mineral facilitated

758
01:01:15,710 --> 01:01:13,380
chemistry and of course when we do a lot

759
01:01:17,569 --> 01:01:15,720
of this stuff it is an equilibrium

760
01:01:19,789 --> 01:01:17,579
reaction because you're kind of waiting

761
01:01:21,470 --> 01:01:19,799
for it to resolve to equilibrium we're

762
01:01:23,089 --> 01:01:21,480
basing our reactions on that so like how

763
01:01:25,789 --> 01:01:23,099

would you kind of design something like

764

01:01:27,829 --> 01:01:25,799

this or like theorize or like hope for

765

01:01:29,569 --> 01:01:27,839

something right so a lot of what I

766

01:01:30,770 --> 01:01:29,579

showed that in the well-mix cases we

767

01:01:31,970 --> 01:01:30,780

were working with chemostats and

768

01:01:34,010 --> 01:01:31,980

certainly chemostats are an

769

01:01:35,809 --> 01:01:34,020

experimentally kind of realizable

770

01:01:37,370 --> 01:01:35,819

approach

771

01:01:39,589 --> 01:01:37,380

um there's another side to our group

772

01:01:42,049 --> 01:01:39,599

that looked for kind of real Auto

773

01:01:43,549 --> 01:01:42,059

catalytic cycles and known chemical

774

01:01:45,589 --> 01:01:43,559

reaction networks both biotic and

775

01:01:47,750 --> 01:01:45,599

abiotic and so I think one promising

776

01:01:49,430 --> 01:01:47,760

approach is to look at how these

777

01:01:51,049 --> 01:01:49,440

chemical ecosystems might explore that

778

01:01:53,030 --> 01:01:51,059

space where you seed with one chemical

779

01:01:54,829 --> 01:01:53,040

that activates maybe a single cycle or a

780

01:01:56,870 --> 01:01:54,839

set of cycles and then through the

781

01:01:59,270 --> 01:01:56,880

addition of subsequent seeds you might

782

01:02:00,589 --> 01:01:59,280

activate kind of new cycles and so I

783

01:02:02,930 --> 01:02:00,599

think there are kind of experimental

784

01:02:04,370 --> 01:02:02,940

approaches that can be done there and I

785

01:02:07,849 --> 01:02:04,380

think people in our group are continuing

786

01:02:11,870 --> 01:02:09,650

okay hello we have a question from

787

01:02:13,910 --> 01:02:11,880

online actually so this comes from user

788

01:02:16,490 --> 01:02:13,920

Alex he's asking can you simulate

789

01:02:17,569 --> 01:02:16,500

tipping points hysteresis spatially with

790

01:02:20,630 --> 01:02:17,579

this method

791

01:02:22,670 --> 01:02:20,640

tipping points uh it's hard to ask for a

792

01:02:25,069 --> 01:02:22,680

clarification via Zoom

793

01:02:26,510 --> 01:02:25,079

okay Alex if you can hear this um please

794

01:02:39,109 --> 01:02:26,520

clarify your question and we'll come

795

01:02:43,789 --> 01:02:41,990

hi I'm Jake from UCSD um can you clarify

796

01:02:45,589 --> 01:02:43,799

why you used a stochastic process

797

01:02:47,750 --> 01:02:45,599

instead of like just a simple solving

798

01:02:50,030 --> 01:02:47,760

differential equations analytically yeah

799

01:02:52,069 --> 01:02:50,040

so you can have cases in these chemical

800

01:02:55,010 --> 01:02:52,079

ecosystems where there's kind of some

801
01:02:56,390 --> 01:02:55,020
unstable fixed point and those unstable

802
01:02:58,069 --> 01:02:56,400
fixed points you need some degree of

803
01:02:59,329 --> 01:02:58,079
stochasticity to break out of them so

804
01:03:01,789 --> 01:02:59,339
that's one reason if I just use

805
01:03:04,370 --> 01:03:01,799
deterministic simulations you could get

806
01:03:06,650 --> 01:03:04,380
stuck in those uh it's also the case

807
01:03:09,049 --> 01:03:06,660
that in ecology we're interested in lots

808
01:03:10,549 --> 01:03:09,059
of contingency and stochasticity and

809
01:03:13,010 --> 01:03:10,559
then doing lots of replicates allows you

810
01:03:16,609 --> 01:03:13,020
to explore all those contingent outcomes

811
01:03:16,619 --> 01:03:28,190
okay we have time for one more question

812
01:03:33,410 --> 01:03:31,490
hi I'm Donna from Indiana University I'm

813
01:03:36,289 --> 01:03:33,420

an ecologist by training and it was

814

01:03:38,450 --> 01:03:36,299

really interesting to see all of those

815

01:03:40,250 --> 01:03:38,460

theories that I've been trained for in

816

01:03:43,510 --> 01:03:40,260

this context

817

01:03:46,430 --> 01:03:43,520

um a psychologist we abandoned

818

01:03:49,430 --> 01:03:46,440

intermediate disturbance hypothesis

819

01:03:51,530 --> 01:03:49,440

because we haven't observed in nature

820

01:03:54,530 --> 01:03:51,540

yeah for 20 years

821

01:03:56,870 --> 01:03:54,540

I was wondering if there are ways to

822

01:03:57,589 --> 01:03:56,880

test experimentally

823

01:04:00,289 --> 01:03:57,599

um

824

01:04:04,030 --> 01:04:00,299

what do you think about that and also

825

01:04:07,430 --> 01:04:04,040

activity in four tipping points I think

826

01:04:11,049 --> 01:04:07,440

the online person mentioned you can

827

01:04:13,670 --> 01:04:11,059

probably see the signals before

828

01:04:15,549 --> 01:04:13,680

transitions like time or took increasing

829

01:04:18,370 --> 01:04:15,559

time autocorrelation

830

01:04:20,030 --> 01:04:18,380

or coefficient of variation

831

01:04:21,589 --> 01:04:20,040

absolutely thank you for the question

832

01:04:23,390 --> 01:04:21,599

yeah so I think an ecology the

833

01:04:24,890 --> 01:04:23,400

intermediate disturbance hypothesis is

834

01:04:27,470 --> 01:04:24,900

controversial and many people have

835

01:04:29,329 --> 01:04:27,480

abandoned it I think in this kind of

836

01:04:31,430 --> 01:04:29,339

modeling context it's very easy to kind

837

01:04:34,849 --> 01:04:31,440

of look for it just because we're doing

838

01:04:36,650 --> 01:04:34,859

experiments in silico and

839

01:04:38,630 --> 01:04:36,660

I think that

840

01:04:40,190 --> 01:04:38,640

if it does hold in the biological case

841

01:04:42,170 --> 01:04:40,200

certainly it holds in the chemical case

842

01:04:43,670 --> 01:04:42,180

there's a possibility that it holds in

843

01:04:44,809 --> 01:04:43,680

the chemical case and not the biological

844

01:04:46,609 --> 01:04:44,819

case

845

01:04:47,690 --> 01:04:46,619

um I think the weak version of this is

846

01:04:49,010 --> 01:04:47,700

that there are certain types of

847

01:04:50,750 --> 01:04:49,020

disturbance regimes that can be

848

01:04:52,569 --> 01:04:50,760

beneficial for chemical diversity even

849

01:04:55,250 --> 01:04:52,579

if the intermediate disturbance

850

01:04:57,530 --> 01:04:55,260

hypothesis doesn't hold at large to the

851

01:04:59,569 --> 01:04:57,540

Tipping points question I think you do

852

01:05:01,670 --> 01:04:59,579

see sort of kind of signs in the

853

01:05:03,530 --> 01:05:01,680

diffusion cases I kind of vary it you

854

01:05:05,870 --> 01:05:03,540

end up seeing sort of power loss scaling

855

01:05:08,569 --> 01:05:05,880

in the patch size sort of like you would

856

01:05:10,190 --> 01:05:08,579

see in an icing model in physics and so

857

01:05:11,569 --> 01:05:10,200

the sort of theory that looks at

858

01:05:13,490 --> 01:05:11,579

tippling points there would also apply

859

01:05:20,390 --> 01:05:13,500

here

860

01:05:30,470 --> 01:05:23,150

okay and our next speaker is going to be

861

01:05:35,270 --> 01:05:33,230

well hello everyone first of all I'd

862

01:05:36,470 --> 01:05:35,280

like to thank for the organizers from

863

01:05:39,770 --> 01:05:36,480

having me here

864

01:05:42,049 --> 01:05:39,780

and I have already experienced how great

865

01:05:44,270 --> 01:05:42,059

this community can be I can tell that

866

01:05:45,950 --> 01:05:44,280

this is really a space for all

867

01:05:49,309 --> 01:05:45,960

so

868

01:05:50,990 --> 01:05:49,319

um how many of you like chemistry here

869

01:05:52,190 --> 01:05:51,000

in the audience

870

01:05:54,289 --> 01:05:52,200

quiet

871

01:05:55,450 --> 01:05:54,299

a few people here so

872

01:05:59,390 --> 01:05:55,460

um

873

01:06:02,089 --> 01:05:59,400

I will basically follow the logic of

874

01:06:04,190 --> 01:06:02,099

this quote throughout my whole

875

01:06:05,690 --> 01:06:04,200

presentation so probably what we're what

876

01:06:08,329 --> 01:06:05,700

I am doing and what we were doing is

877

01:06:09,710 --> 01:06:08,339

wrong but some of it might be useful in

878

01:06:10,910 --> 01:06:09,720

the future

879

01:06:11,510 --> 01:06:10,920

so

880

01:06:14,470 --> 01:06:11,520

um

881

01:06:17,690 --> 01:06:14,480

amino acids amino acids as we know

882

01:06:20,950 --> 01:06:17,700

basically looking for amino acids is one

883

01:06:23,470 --> 01:06:20,960

of the key Target for for future

884

01:06:25,849 --> 01:06:23,480

Institute life detection missions

885

01:06:27,829 --> 01:06:25,859

I'm going to talk more about the

886

01:06:29,210 --> 01:06:27,839

Practical side of astrobiology rather

887

01:06:32,329 --> 01:06:29,220

than the theory that we have heard

888

01:06:34,430 --> 01:06:32,339

before maybe we can get together after

889

01:06:36,049 --> 01:06:34,440

it and find some new solutions for the

890

01:06:38,349 --> 01:06:36,059

problems and situations that we've

891

01:06:40,789 --> 01:06:38,359

encountered during our experiments so

892

01:06:42,950 --> 01:06:40,799

there are three levels that we have to

893

01:06:46,910 --> 01:06:42,960

look at when dealing with amino acids

894

01:06:50,569 --> 01:06:46,920

the first is uh kind of a qualitative

895

01:06:54,309 --> 01:06:50,579

problem what type of amino acids can we

896

01:06:57,470 --> 01:06:54,319

detect and what do those tell us

897

01:07:00,470 --> 01:06:57,480

the second is the abundance of these

898

01:07:02,870 --> 01:07:00,480

amino acids so their ratios are they

899

01:07:05,950 --> 01:07:02,880

more similar to what things that we see

900

01:07:08,510 --> 01:07:05,960

here on Earth as the metabolic

901
01:07:10,970 --> 01:07:08,520
processes of microbes or something

902
01:07:14,210 --> 01:07:10,980
completely different and the third is

903
01:07:17,210 --> 01:07:14,220
basically what makes it a lot more

904
01:07:21,049 --> 01:07:17,220
interesting or puts the icing in the

905
01:07:25,130 --> 01:07:21,059
cake is the chirality as you well know

906
01:07:28,670 --> 01:07:25,140
amino acids are basically chiral meaning

907
01:07:30,950 --> 01:07:28,680
that they have uh they are they have two

908
01:07:32,510 --> 01:07:30,960
versions of the same molecule and

909
01:07:34,849 --> 01:07:32,520
they're non-superimposable basically

910
01:07:37,190 --> 01:07:34,859
they're mirror images of each other they

911
01:07:40,730 --> 01:07:37,200
have exactly the same amount of atoms

912
01:07:42,670 --> 01:07:40,740
bonds but they have a totally different

913
01:07:44,870 --> 01:07:42,680

um

914

01:07:45,829 --> 01:07:44,880

structure when we're talking about the

915

01:07:49,730 --> 01:07:45,839

isomers

916

01:07:52,490 --> 01:07:49,740

and getting to know the the ratio of

917

01:07:55,970 --> 01:07:52,500

these amino acids is basically like a

918

01:07:57,410 --> 01:07:55,980

Smoking Gun evidence for life if if you

919

01:07:58,190 --> 01:07:57,420

like

920

01:07:59,809 --> 01:07:58,200

um

921

01:08:03,130 --> 01:07:59,819

but what does it have to do with

922

01:08:06,529 --> 01:08:03,140

radiation well as you all know

923

01:08:07,990 --> 01:08:06,539

as we said here we are experiencing the

924

01:08:12,170 --> 01:08:08,000

effective radiation

925

01:08:14,390 --> 01:08:12,180

but in the early Universe the activity

926

01:08:17,150 --> 01:08:14,400

might have been a lot a lot bigger than

927

01:08:20,510 --> 01:08:17,160

it is today and

928

01:08:22,550 --> 01:08:20,520

there are all sorts of theories that are

929

01:08:24,950 --> 01:08:22,560

some of them are quite established some

930

01:08:27,709 --> 01:08:24,960

of their are some of them are in the

931

01:08:30,950 --> 01:08:27,719

process of proving but the point is that

932

01:08:37,490 --> 01:08:34,370

um sons and stars basically produce

933

01:08:39,410 --> 01:08:37,500

ultraviolet light and if you have this

934

01:08:42,610 --> 01:08:39,420

scattered from the surface basically you

935

01:08:45,829 --> 01:08:42,620

have a polarized light and basically

936

01:08:49,370 --> 01:08:45,839

amino acids and enantiomers which are

937

01:08:51,110 --> 01:08:49,380

which absorb a specific light better

938

01:08:53,570 --> 01:08:51,120

than their counterparts then basically

939

01:08:55,249 --> 01:08:53,580

they get destroyed in the process this

940

01:08:58,070 --> 01:08:55,259

is the same way actually as we detect

941

01:08:59,870 --> 01:08:58,080

the the their ratio but it's also their

942

01:09:01,610 --> 01:08:59,880

Doom if we are talking about high

943

01:09:03,370 --> 01:09:01,620

intensities so this is a pretty much

944

01:09:06,950 --> 01:09:03,380

established model

945

01:09:09,410 --> 01:09:06,960

we can basically replicate these using

946

01:09:12,289 --> 01:09:09,420

all sorts of accelerators and all sorts

947

01:09:16,729 --> 01:09:12,299

of sources to basically mimic this

948

01:09:19,610 --> 01:09:16,739

effect the other one is is a uh um more

949

01:09:21,890 --> 01:09:19,620

of a still about photons but but more of

950

01:09:26,590 --> 01:09:21,900

a having a

951

01:09:30,829 --> 01:09:26,600

um the magnetic effect also

952

01:09:33,590 --> 01:09:30,839

taken into account when dealing with how

953

01:09:36,490 --> 01:09:33,600

radiation affects these molecules and

954

01:09:40,249 --> 01:09:36,500

the third is basically stepping towards

955

01:09:42,890 --> 01:09:40,259

particles and subatomic particles and

956

01:09:44,510 --> 01:09:42,900

how they change the isotopic ratio and

957

01:09:46,970 --> 01:09:44,520

through the isotopic ratio how they

958

01:09:49,269 --> 01:09:46,980

change basically the composition of the

959

01:09:52,849 --> 01:09:49,279

amino acids and having them

960

01:09:55,310 --> 01:09:52,859

change a chirality so these are just the

961

01:09:57,290 --> 01:09:55,320

main theories that we know so far that

962

01:10:00,590 --> 01:09:57,300

work

963

01:10:04,689 --> 01:10:00,600

and in our Laboratories we basically set

964

01:10:07,310 --> 01:10:04,699

out to mimic some of these effects

965

01:10:10,310 --> 01:10:07,320

the accelerator atom queue we have three

966

01:10:13,310 --> 01:10:10,320

of them a small middle one and a big one

967

01:10:17,750 --> 01:10:13,320

they are all considered small in the

968

01:10:20,750 --> 01:10:17,760

field of uh Nuclear Physics but for our

969

01:10:22,430 --> 01:10:20,760

experiments we basically used a tandem

970

01:10:25,149 --> 01:10:22,440

accelerator

971

01:10:29,270 --> 01:10:25,159

which allows

972

01:10:31,430 --> 01:10:29,280

a pretty quick change of ion sources so

973

01:10:34,070 --> 01:10:31,440

basically if you want to irradiate your

974

01:10:36,590 --> 01:10:34,080

sample with hydrogen and then you want

975

01:10:38,689 --> 01:10:36,600

to see how the same scent was affected

976

01:10:41,689 --> 01:10:38,699

by a heavier ion basically you can

977

01:10:43,070 --> 01:10:41,699

change the ions in a matter of hours or

978

01:10:45,229 --> 01:10:43,080

even less if you're if you're

979

01:10:46,790 --> 01:10:45,239

experienced so it has a lot versatility

980

01:10:48,490 --> 01:10:46,800

that's that's the point of having a

981

01:10:52,850 --> 01:10:48,500

tandem accelerator

982

01:10:55,450 --> 01:10:52,860

so on the image you see probably the

983

01:10:58,550 --> 01:10:55,460

closest thing to a real lightsaber

984

01:11:01,810 --> 01:10:58,560

and what you see here on the image in

985

01:11:04,310 --> 01:11:01,820

the top right is basically how uh

986

01:11:07,189 --> 01:11:04,320

hydrogen ions look like when they're

987

01:11:10,209 --> 01:11:07,199

extracted to air from vacuum

988

01:11:14,229 --> 01:11:10,219

and basically

989

01:11:17,990 --> 01:11:14,239

this shows the ionization of the air

990

01:11:19,910 --> 01:11:18,000

that that the accelerated ions are

991

01:11:20,689 --> 01:11:19,920

hitting so

992

01:11:26,689 --> 01:11:20,699

um

993

01:11:29,870 --> 01:11:26,699

and you will connect it later but the

994

01:11:32,390 --> 01:11:29,880

point is that we use the technical

995

01:11:35,209 --> 01:11:32,400

capillary electrophoresis to basically

996

01:11:36,709 --> 01:11:35,219

see what radiation might have to do with

997

01:11:37,870 --> 01:11:36,719

the with the molecules and their

998

01:11:41,209 --> 01:11:37,880

chirality

999

01:11:44,750 --> 01:11:41,219

you see is really a very very friendly

1000

01:11:46,790 --> 01:11:44,760

technique and it's very very simple but

1001
01:11:48,709 --> 01:11:46,800
that's what people use that are

1002
01:11:51,950 --> 01:11:48,719
basically saying who are experts in the

1003
01:11:54,530 --> 01:11:51,960
field but the point is that you have a

1004
01:11:56,990 --> 01:11:54,540
tiny capillary a tiny few silica

1005
01:11:59,689 --> 01:11:57,000
capillary with an inner diameter let's

1006
01:12:01,970 --> 01:11:59,699
say 50 microns and another in another

1007
01:12:04,189 --> 01:12:01,980
diameter of let's say 400 microns and

1008
01:12:05,750 --> 01:12:04,199
when you feel this capillary with an

1009
01:12:07,970 --> 01:12:05,760
electrolyte then you

1010
01:12:10,550 --> 01:12:07,980
and you apply voltage on this system

1011
01:12:12,110 --> 01:12:10,560
basically you will see stuff migrate and

1012
01:12:14,570 --> 01:12:12,120
they will migrate according to their

1013
01:12:16,550 --> 01:12:14,580

hydrodynamic volume to charge ratio in

1014

01:12:18,850 --> 01:12:16,560

this field so what it allows you to do

1015

01:12:21,830 --> 01:12:18,860

it allows you to do to separate

1016

01:12:26,810 --> 01:12:21,840

molecules based on the hydrodynamic

1017

01:12:32,030 --> 01:12:26,820

volume to charge ratio and if you put a

1018

01:12:39,110 --> 01:12:32,040

detector in the

1019

01:12:41,350 --> 01:12:39,120

uh at the specific point of the

1020

01:12:44,870 --> 01:12:41,360

capillary basically

1021

01:12:47,510 --> 01:12:44,880

you can see the molecules migrating

1022

01:12:50,570 --> 01:12:47,520

through the capillary and the specific

1023

01:12:53,649 --> 01:12:50,580

point you get intensity versus time so

1024

01:12:55,790 --> 01:12:53,659

you you see migrating Peaks this

1025

01:12:57,470 --> 01:12:55,800

simulation on the left would like to

1026

01:12:59,510 --> 01:12:57,480

show that but unfortunately it doesn't

1027

01:13:00,649 --> 01:12:59,520

run so you have to believe me that the

1028

01:13:02,209 --> 01:13:00,659

Peaks you're seeing are actually

1029

01:13:03,950 --> 01:13:02,219

migrating through the detector window

1030

01:13:05,649 --> 01:13:03,960

that we're looking at

1031

01:13:08,330 --> 01:13:05,659

and um

1032

01:13:09,350 --> 01:13:08,340

it is using laser induced fluorescence

1033

01:13:11,689 --> 01:13:09,360

well

1034

01:13:14,510 --> 01:13:11,699

uh why are we using laser induced filter

1035

01:13:16,729 --> 01:13:14,520

since the main reason is that to achieve

1036

01:13:19,850 --> 01:13:16,739

High sensitivity it's you can imagine it

1037

01:13:23,030 --> 01:13:19,860

like going or being in a dark room uh

1038

01:13:26,510 --> 01:13:23,040

sleeping and you basically just

1039

01:13:28,010 --> 01:13:26,520

um open up or or open your phone and you

1040

01:13:30,050 --> 01:13:28,020

have a lot of bright light coming in

1041

01:13:31,430 --> 01:13:30,060

even though if you're doing it in the

1042

01:13:34,130 --> 01:13:31,440

broad daylight probably you're not

1043

01:13:36,470 --> 01:13:34,140

affected that much it allows you to

1044

01:13:39,290 --> 01:13:36,480

remove background basically have a great

1045

01:13:41,090 --> 01:13:39,300

big signal and to do that you need some

1046

01:13:43,550 --> 01:13:41,100

molecules that basically have a

1047

01:13:46,090 --> 01:13:43,560

fluorescent property meaning that you're

1048

01:13:48,709 --> 01:13:46,100

excited them over the specific

1049

01:13:52,510 --> 01:13:48,719

wavelength and they respond to you with

1050

01:13:55,370 --> 01:13:52,520

a different wavelength this is a a

1051

01:13:57,169 --> 01:13:55,380

molecule that we used to do the

1052

01:13:59,930 --> 01:13:57,179

conjugation of our amino acids to

1053

01:14:01,090 --> 01:13:59,940

basically enhance the selectivity and

1054

01:14:05,149 --> 01:14:01,100

enhance

1055

01:14:07,729 --> 01:14:05,159

separation efficiency so in order to do

1056

01:14:10,550 --> 01:14:07,739

CE what you have to do is you have to

1057

01:14:15,110 --> 01:14:10,560

have molecules that have a net charge

1058

01:14:17,750 --> 01:14:15,120

other than zero and we have to make them

1059

01:14:21,649 --> 01:14:17,760

visible this molecule here does the two

1060

01:14:24,290 --> 01:14:21,659

things at the same time so basically

1061

01:14:28,729 --> 01:14:24,300

um what what you see here is

1062

01:14:32,530 --> 01:14:28,739

uh the six centimeter from the die

1063

01:14:35,930 --> 01:14:32,540

reacting with the Mi forming a stable

1064

01:14:39,169 --> 01:14:35,940

amide conjugate and this way basically

1065

01:14:41,209 --> 01:14:39,179

you if you if you separate them uh

1066

01:14:44,270 --> 01:14:41,219

you're you're getting a pretty huge

1067

01:14:46,189 --> 01:14:44,280

resolution so what we did is basically

1068

01:14:47,450 --> 01:14:46,199

first developed the buffer system or a

1069

01:14:49,850 --> 01:14:47,460

background detector right the thing that

1070

01:14:52,310 --> 01:14:49,860

you feel the capillary with to do this

1071

01:14:54,350 --> 01:14:52,320

separation it's a pretty simple buffer

1072

01:14:57,410 --> 01:14:54,360

it contains two components and the

1073

01:15:00,649 --> 01:14:57,420

reason behind it was that we had to keep

1074

01:15:02,930 --> 01:15:00,659

in mind the restrictions that a possible

1075

01:15:04,970 --> 01:15:02,940

future Institute life detection Mission

1076

01:15:07,790 --> 01:15:04,980

would have that you're not allowed to

1077

01:15:09,890 --> 01:15:07,800

have a ton of regions you're not allowed

1078

01:15:11,870 --> 01:15:09,900

to have all sorts of mixing to to happen

1079

01:15:13,490 --> 01:15:11,880

you have to make everything simple that

1080

01:15:15,169 --> 01:15:13,500

was the mindset that we had when we were

1081

01:15:17,270 --> 01:15:15,179

doing the experiments and as you see

1082

01:15:20,510 --> 01:15:17,280

we've managed to separate actually 15

1083

01:15:23,330 --> 01:15:20,520

amino acids chirally of the 17 that we

1084

01:15:25,850 --> 01:15:23,340

had in mind

1085

01:15:28,790 --> 01:15:25,860

um why is it a promising technique like

1086

01:15:32,750 --> 01:15:28,800

just like I said suppose a few of moving

1087

01:15:35,689 --> 01:15:32,760

Parts no power consumption easy to

1088

01:15:38,930 --> 01:15:35,699

implement and it's just basically very

1089

01:15:41,570 --> 01:15:38,940

very friendly technique and guys at JP

1090

01:15:43,850 --> 01:15:41,580

are basically are developing this kind

1091

01:15:46,430 --> 01:15:43,860

of technology and what you see here on

1092

01:15:49,370 --> 01:15:46,440

the image is basically the base plate of

1093

01:15:51,290 --> 01:15:49,380

this whole setup is basically the size

1094

01:15:51,830 --> 01:15:51,300

of your laptop

1095

01:15:54,410 --> 01:15:51,840

um

1096

01:15:56,390 --> 01:15:54,420

so uh actually what we did during the

1097

01:15:58,550 --> 01:15:56,400

irradiations well we made some sample

1098

01:16:02,149 --> 01:15:58,560

holders from a drill press to kind of a

1099

01:16:06,189 --> 01:16:02,159

modified drill press and we made 100

1100

01:16:09,410 --> 01:16:06,199

Micron thick pellets of uh racemic

1101
01:16:12,530 --> 01:16:09,420
alanine and we irradiated them here you

1102
01:16:15,229 --> 01:16:12,540
see the simulation how the protein beans

1103
01:16:18,709 --> 01:16:15,239
would actually behave in the 100 Micron

1104
01:16:21,229 --> 01:16:18,719
thick alanine pellet and as you see

1105
01:16:23,570 --> 01:16:21,239
towards the end around 80 microns all

1106
01:16:25,430 --> 01:16:23,580
the ions stop and this is actually where

1107
01:16:28,090 --> 01:16:25,440
the most interesting things happen

1108
01:16:31,250 --> 01:16:28,100
during an iron B analysis or or

1109
01:16:34,310 --> 01:16:31,260
irradiation as well which you see here a

1110
01:16:36,169 --> 01:16:34,320
bit a bit in more detail so we have the

1111
01:16:38,330 --> 01:16:36,179
protons coming in the in the vacuum of

1112
01:16:41,530 --> 01:16:38,340
from the accelerator and then we have a

1113
01:16:44,630 --> 01:16:41,540

window where the protons

1114

01:16:47,270 --> 01:16:44,640

are extracted to the air and then as

1115

01:16:49,550 --> 01:16:47,280

they enter the the amino acids they

1116

01:16:53,870 --> 01:16:49,560

basically lose energy and the nice thing

1117

01:16:56,030 --> 01:16:53,880

about the ions is the that they give off

1118

01:16:58,790 --> 01:16:56,040

all their almost all the energies right

1119

01:17:01,550 --> 01:16:58,800

before they stop and this is actually

1120

01:17:04,370 --> 01:17:01,560

why it's really useful during proton

1121

01:17:07,010 --> 01:17:04,380

therapy and so we irradiated these

1122

01:17:09,110 --> 01:17:07,020

samples with these energies to basically

1123

01:17:11,630 --> 01:17:09,120

and we designed the system to basically

1124

01:17:15,050 --> 01:17:11,640

stop all the ions in the sample and see

1125

01:17:20,870 --> 01:17:15,060

how destruction or any alterations occur

1126

01:17:26,050 --> 01:17:20,880

so moving forward basically you see that

1127

01:17:32,209 --> 01:17:29,689

over D and L I mean erasmic as amino

1128

01:17:34,070 --> 01:17:32,219

acid some of you might see that these

1129

01:17:36,590 --> 01:17:34,080

are not exactly the same height and that

1130

01:17:38,510 --> 01:17:36,600

is the same area this is just the

1131

01:17:40,490 --> 01:17:38,520

control that we were using and we

1132

01:17:43,430 --> 01:17:40,500

compared all our results to these

1133

01:17:46,010 --> 01:17:43,440

control runs so basically with two big

1134

01:17:48,709 --> 01:17:46,020

Peaks and we are happy and if we go

1135

01:17:52,030 --> 01:17:48,719

further we'll be interested more in the

1136

01:17:54,470 --> 01:17:52,040

in the small Peak part of the of the

1137

01:17:56,390 --> 01:17:54,480

electrophilograms as we go with the

1138

01:17:59,630 --> 01:17:56,400

irradiation and as we go with the

1139

01:18:03,350 --> 01:17:59,640

function of those increases so what you

1140

01:18:06,530 --> 01:18:03,360

have here is basically the control that

1141

01:18:08,390 --> 01:18:06,540

I just showed and different doses that

1142

01:18:10,430 --> 01:18:08,400

have reached the sample and it's

1143

01:18:13,910 --> 01:18:10,440

apparent that some of the Peaks are

1144

01:18:16,729 --> 01:18:13,920

clearly increasing some of them show a

1145

01:18:17,570 --> 01:18:16,739

nice correlation

1146

01:18:20,510 --> 01:18:17,580

um

1147

01:18:24,050 --> 01:18:20,520

and some of these Peaks are basically

1148

01:18:27,290 --> 01:18:24,060

coming in duplets and this is what made

1149

01:18:29,950 --> 01:18:27,300

us think that actually although we were

1150

01:18:33,050 --> 01:18:29,960

irradiating wrestling

1151

01:18:36,290 --> 01:18:33,060

alanine we are basically seeing racemic

1152

01:18:39,649 --> 01:18:38,090

um so

1153

01:18:41,990 --> 01:18:39,659

um we're still in the process of

1154

01:18:44,209 --> 01:18:42,000

identifying these molecules

1155

01:18:46,550 --> 01:18:44,219

um and in these radicals that we found

1156

01:18:47,630 --> 01:18:46,560

but they seem to correlate well with the

1157

01:18:49,610 --> 01:18:47,640

dose

1158

01:18:52,010 --> 01:18:49,620

and also another interesting thing

1159

01:18:56,930 --> 01:18:52,020

happened when we were looking at the big

1160

01:18:59,270 --> 01:18:56,940

peaks of the uh amino acids and we were

1161

01:19:01,370 --> 01:18:59,280

just wondering what could this mean what

1162

01:19:04,209 --> 01:19:01,380

you see in the uh in this picture is

1163

01:19:08,930 --> 01:19:04,219

basically as we go with the dose

1164

01:19:11,750 --> 01:19:08,940

the the LD ratio is getting more and

1165

01:19:15,830 --> 01:19:11,760

more hectic which means that we're not

1166

01:19:19,030 --> 01:19:15,840

seeing it going towards one and anterior

1167

01:19:22,550 --> 01:19:19,040

or the other but kind of mixed noisy

1168

01:19:25,270 --> 01:19:22,560

version of the two as we go with those

1169

01:19:27,729 --> 01:19:25,280

higher and higher so in summary

1170

01:19:31,430 --> 01:19:27,739

basically

1171

01:19:34,669 --> 01:19:31,440

we have put together a simple setup and

1172

01:19:36,770 --> 01:19:34,679

measured some radicals that could form

1173

01:19:40,790 --> 01:19:36,780

due to your radiation and we've done it

1174

01:19:42,950 --> 01:19:40,800

in a chiral manner to basically see

1175

01:19:46,850 --> 01:19:42,960

whether our method is capable of

1176

01:19:49,370 --> 01:19:46,860

separating these chiral amino acids and

1177

01:19:52,130 --> 01:19:49,380

more importantly if you think about the

1178

01:19:54,410 --> 01:19:52,140

the next possible or the most possible

1179

01:19:58,310 --> 01:19:54,420

places in our solar system but life

1180

01:20:01,010 --> 01:19:58,320

could be actually there in a in a huge

1181

01:20:02,689 --> 01:20:01,020

radiation environment so I think it's it

1182

01:20:06,169 --> 01:20:02,699

is really necessary to basically create

1183

01:20:08,649 --> 01:20:06,179

a library of radicals simulated here in

1184

01:20:14,450 --> 01:20:08,659

the labs to basically make the work

1185

01:20:16,330 --> 01:20:14,460

easier and the unload this from the

1186

01:20:19,510 --> 01:20:16,340

scientists you will have to basically

1187

01:20:22,070 --> 01:20:19,520

figure out how

1188

01:20:23,570 --> 01:20:22,080

molecules are formed in these high

1189

01:20:25,250 --> 01:20:23,580

radiation environments and what they are

1190

01:20:27,830 --> 01:20:25,260

seeing on the the results when these

1191

01:20:31,790 --> 01:20:27,840

instruments send back the data so

1192

01:20:33,709 --> 01:20:31,800

basically we're trying to to establish a

1193

01:20:36,110 --> 01:20:33,719

big Library where all sorts of amino

1194

01:20:39,229 --> 01:20:36,120

acids mixers and single ones are

1195

01:20:42,310 --> 01:20:39,239

irradiated or with all sorts of

1196

01:20:45,950 --> 01:20:42,320

radiation sources and see

1197

01:20:48,050 --> 01:20:45,960

what products are there and what can be

1198

01:20:49,310 --> 01:20:48,060

identified using this technology so I'd

1199

01:20:49,670 --> 01:20:49,320

like to thank you very much for your

1200

01:20:54,410 --> 01:20:49,680

attention

1201

01:20:59,630 --> 01:20:57,350

foreign

1202

01:21:02,570 --> 01:20:59,640

okay we have time for two questions for

1203

01:21:04,790 --> 01:21:02,580

mate Chad

1204

01:21:07,669 --> 01:21:04,800

hi uh Chad pazoriski from Georgia Tech

1205

01:21:10,250 --> 01:21:07,679

uh I was really glad to see celif

1206

01:21:12,950 --> 01:21:10,260

because it's a method that I work with

1207

01:21:15,110 --> 01:21:12,960

as well and so uh seeing it being used

1208

01:21:16,669 --> 01:21:15,120

around is is wonderful and I have a

1209

01:21:21,050 --> 01:21:16,679

question about your chiral method which

1210

01:21:23,330 --> 01:21:21,060

seemed to work very well um so uh did

1211

01:21:25,130 --> 01:21:23,340

you develop this in its entirety or uh

1212

01:21:27,530 --> 01:21:25,140

when did you develop it where basically

1213

01:21:30,410 --> 01:21:27,540

I wanted all about the Cairo method is

1214

01:21:32,630 --> 01:21:30,420

it published and uh yeah it's not

1215

01:21:35,050 --> 01:21:32,640

published yet but we've developed it in

1216

01:21:39,590 --> 01:21:35,060

collaboration with JPL

1217

01:21:41,689 --> 01:21:39,600

basically the key thing here is that to

1218

01:21:44,090 --> 01:21:41,699

do chiro separation the way you can

1219

01:21:47,270 --> 01:21:44,100

imagine is is that when you have these

1220

01:21:49,189 --> 01:21:47,280

molecules in a solution and that they

1221

01:21:51,110 --> 01:21:49,199

migrate through the capillary if you

1222

01:21:54,410 --> 01:21:51,120

have some additional additives in your

1223

01:21:55,030 --> 01:21:54,420

buffer basically you can in

1224

01:21:58,310 --> 01:21:55,040

um

1225

01:22:00,130 --> 01:21:58,320

emphasize or or basically manipulate how

1226

01:22:04,729 --> 01:22:00,140

these

1227

01:22:05,709 --> 01:22:04,739

molecules behave but I mean that if you

1228

01:22:08,770 --> 01:22:05,719

have

1229

01:22:12,370 --> 01:22:08,780

sugars like cycle Jack strains these are

1230

01:22:15,410 --> 01:22:12,380

circular long oligomers

1231

01:22:19,070 --> 01:22:15,420

basically these amino acids are as they

1232

01:22:21,410 --> 01:22:19,080

migrate they meet with these cavities

1233

01:22:23,390 --> 01:22:21,420

and they basically form an inclusion

1234

01:22:25,310 --> 01:22:23,400

complex they go in they go out they go

1235

01:22:28,370 --> 01:22:25,320

in they go out and some of the Indian

1236

01:22:30,229 --> 01:22:28,380

tumors are staying longer in this cavity

1237

01:22:32,090 --> 01:22:30,239

and some of them are staying for a short

1238

01:22:33,950 --> 01:22:32,100

period of time and as they migrate they

1239

01:22:37,189 --> 01:22:33,960

basically separate and this is what we

1240

01:22:39,890 --> 01:22:37,199

see and in this context to basically

1241

01:22:42,050 --> 01:22:39,900

answer your question we had a lot of

1242

01:22:44,990 --> 01:22:42,060

constraints first of all we are not

1243

01:22:47,990 --> 01:22:45,000

allowed to have a ton of additives a ton

1244

01:22:49,610 --> 01:22:48,000

of stuff in the buffer because an

1245

01:22:52,490 --> 01:22:49,620

instrument has to be able to do this on

1246

01:22:55,729 --> 01:22:52,500

its own its own so we had two components

1247

01:22:57,050 --> 01:22:55,739

in it which is the habish or hippies I

1248

01:23:00,830 --> 01:22:57,060

don't know how they say it in English

1249

01:23:03,410 --> 01:23:00,840

properly AGP yes and and the other one

1250

01:23:06,610 --> 01:23:03,420

is the md40 which is basically similar

1251

01:23:10,669 --> 01:23:06,620

to cycle dextrans but it consists of

1252

01:23:14,090 --> 01:23:10,679

sugar oligomers or actually monomers and

1253

01:23:16,610 --> 01:23:14,100

as you go you have at the end at the

1254

01:23:19,490 --> 01:23:16,620

beginning one sugar one glucose unit and

1255

01:23:21,470 --> 01:23:19,500

as you go two three four Etc and these

1256

01:23:24,709 --> 01:23:21,480

after some around seven they start to

1257

01:23:27,410 --> 01:23:24,719

become helico and you have a long long

1258

01:23:30,770 --> 01:23:27,420

longer chains of these sugars and

1259

01:23:36,649 --> 01:23:30,780

basically it enhanced the effectiveness

1260

01:23:36,659 --> 01:23:44,750

last question

1261

01:23:48,470 --> 01:23:46,550

hi my name is shiv agrawal from Western

1262

01:23:49,910 --> 01:23:48,480

Michigan University so you have used

1263

01:23:52,330 --> 01:23:49,920

protons for irradiation have you

1264

01:23:55,310 --> 01:23:52,340

considered using leptons

1265

01:23:57,709 --> 01:23:55,320

we know it should be done and it should

1266

01:24:00,229 --> 01:23:57,719

be interesting but we wanted to do to

1267

01:24:03,649 --> 01:24:00,239

use the facility that we have available

1268

01:24:06,010 --> 01:24:03,659

and currently we are only are only able

1269

01:24:09,350 --> 01:24:06,020

only able to do

1270

01:24:11,630 --> 01:24:09,360

protons and heavy ions

1271

01:24:14,209 --> 01:24:11,640

it would be a nice thing to move forward

1272

01:24:16,130 --> 01:24:14,219

and do all sorts of experiments on this

1273

01:24:17,270 --> 01:24:16,140

on this field as well I'm happy to

1274

01:24:19,430 --> 01:24:17,280

collaborate

1275

01:24:21,470 --> 01:24:19,440

second thing is have you used variable

1276

01:24:23,450 --> 01:24:21,480

energies for protons at what energies

1277

01:24:25,850 --> 01:24:23,460

are you we in this experiment we used

1278

01:24:28,130 --> 01:24:25,860

only one energy we didn't want to have

1279

01:24:30,649 --> 01:24:28,140

too many variables if it's hard enough

1280

01:24:33,530 --> 01:24:30,659

to figure out whether with 100 Micron

1281

01:24:36,470 --> 01:24:33,540

thickness of a palette are we able to to

1282

01:24:38,810 --> 01:24:36,480

robustly uh do experiments and

1283

01:24:40,970 --> 01:24:38,820

unfortunately uh with a simple system

1284

01:24:44,030 --> 01:24:40,980

and with a great care we were able to

1285

01:24:45,709 --> 01:24:44,040

basically make it uh work so this was

1286

01:24:49,430 --> 01:24:45,719

the first goal that we wanted to achieve

1287

01:24:52,130 --> 01:24:49,440

and and uh of course we have all sorts

1288

01:24:55,550 --> 01:24:52,140

of experiments either already running or

1289

01:24:58,130 --> 01:24:55,560

in plan to vary energies where I

1290

01:25:00,290 --> 01:24:58,140

actually the the dose rate which is

1291

01:25:03,910 --> 01:25:00,300

actually a much more important thing it

1292

01:25:07,250 --> 01:25:03,920

looks like it is a key factor in some

1293

01:25:09,770 --> 01:25:07,260

instances and also doing everything in

1294

01:25:11,450 --> 01:25:09,780

vacuum doing everything it was in air

1295

01:25:13,250 --> 01:25:11,460

but we also would like to do it in

1296

01:25:14,090 --> 01:25:13,260

vacuum and also in cold temperatures as

1297

01:25:15,950 --> 01:25:14,100

well

1298

01:25:17,450 --> 01:25:15,960

thanks a lot

1299

01:25:18,160 --> 01:25:17,460

all right thank you very much mate

1300

01:25:26,390 --> 01:25:18,170

thanks very much

1301
01:25:28,430 --> 01:25:26,400
[Applause]

1302
01:25:32,330 --> 01:25:28,440
okay and for our next speaker we have

1303
01:25:45,330 --> 01:25:32,340
young Hua Kang from pohang University

1304
01:26:06,709 --> 01:26:02,780
[Music]

1305
01:26:18,280 --> 01:26:08,260
thank you

1306
01:26:43,189 --> 01:26:33,090
[Music]

1307
01:26:43,199 --> 01:26:48,590
foreign

1308
01:27:18,649 --> 01:27:03,410
[Music]

1309
01:27:18,659 --> 01:27:22,480
foreign

1310
01:28:28,189 --> 01:27:33,730
[Music]

1311
01:28:28,199 --> 01:28:34,360
thank you

1312
01:29:04,729 --> 01:28:39,810
[Music]

1313
01:29:17,530 --> 01:29:08,570

foreign

1314

01:29:40,430 --> 01:29:35,010

[Music]

1315

01:29:59,750 --> 01:29:40,440

foreign

1316

01:30:20,760 --> 01:30:12,320

[Music]

1317

01:31:03,729 --> 01:30:20,770

foreign

1318

01:31:29,930 --> 01:31:03,739

[Music]

1319

01:31:37,629 --> 01:31:29,940

foreign

1320

01:32:00,410 --> 01:31:37,639

[Music]

1321

01:32:30,010 --> 01:32:02,320

foreign

1322

01:32:39,210 --> 01:32:37,430

[Music]

1323

01:32:47,310 --> 01:32:39,220

foreign

1324

01:32:47,320 --> 01:33:10,910

[Music]

1325

01:33:10,920 --> 01:33:14,480

thank you

1326
01:33:48,830 --> 01:33:46,669
[Music]

1327
01:33:50,660 --> 01:33:48,840
feet

1328
01:33:58,160 --> 01:33:50,670
s

1329
01:34:19,560 --> 01:33:58,170
foreign

1330
01:34:19,570 --> 01:34:35,270
[Music]

1331
01:34:35,280 --> 01:34:39,240
foreign

1332
01:35:12,170 --> 01:35:10,430
[Music]

1333
01:35:37,370 --> 01:35:12,180
foreign

1334
01:36:07,370 --> 01:35:37,380
[Music]

1335
01:36:07,380 --> 01:36:11,530
foreign

1336
01:36:11,540 --> 01:36:26,030
[Music]

1337
01:36:53,240 --> 01:36:27,860
foreign

1338
01:37:42,200 --> 01:37:13,510

[Music]

1339

01:37:53,090 --> 01:37:42,210

foreign

1340

01:38:07,490 --> 01:37:59,720

[Music]

1341

01:38:42,370 --> 01:38:09,190

foreign

1342

01:38:44,570 --> 01:38:42,380

[Music]

1343

01:38:57,720 --> 01:38:44,580

thank you

1344

01:39:11,560 --> 01:39:10,090

[Music]

1345

01:39:26,120 --> 01:39:11,570

thank you

1346

01:39:34,580 --> 01:39:33,310

[Music]

1347

01:39:55,910 --> 01:39:34,590

thank you

1348

01:39:58,030 --> 01:39:55,920

[Music]

1349

01:40:17,080 --> 01:39:58,040

foreign

1350

01:40:46,490 --> 01:40:35,400

[Music]

1351

01:40:48,350 --> 01:40:46,500

break for about half an hour so feel

1352

01:40:50,930 --> 01:40:48,360

free to go to Surfside get coffee tea

1353

01:40:52,610 --> 01:40:50,940

snacks whatever you need we also have

1354

01:40:54,110 --> 01:40:52,620

that courtyard space you can hang out

1355

01:40:56,750 --> 01:40:54,120

out here in the lawn there's also

1356

01:40:59,149 --> 01:40:56,760

another lawn over there but yeah we'll

1357

01:41:01,250 --> 01:40:59,159

meet back at 10 30.

1358

01:41:03,470 --> 01:41:01,260

oh and also outside there's all those

1359

01:41:15,530 --> 01:41:03,480

coolers those are just full of Seltzer's

1360

01:41:19,860 --> 01:41:18,370

[Music]

1361

01:41:34,070 --> 01:41:19,870

thank you

1362

01:41:34,080 --> 01:41:36,360

foreign

1363

01:42:39,410 --> 01:42:00,570

[Music]

1364

01:42:41,629 --> 01:42:39,420

foreign

1365

01:42:44,040 --> 01:42:41,639

[Music]

1366

01:42:57,450 --> 01:42:44,050

foreign

1367

01:43:48,940 --> 01:43:17,480

[Music]

1368

01:43:56,030 --> 01:43:48,950

foreign

1369

01:43:58,640 --> 01:43:56,040

[Music]

1370

01:44:35,770 --> 01:43:58,650

foreign

1371

01:45:10,669 --> 01:45:00,380

[Music]

1372

01:45:39,020 --> 01:45:12,930

foreign

1373

01:46:25,310 --> 01:45:45,210

[Music]

1374

01:47:23,520 --> 01:46:27,380

foreign

1375

01:47:42,210 --> 01:47:39,709

[Music]

1376
01:48:19,470 --> 01:47:42,220
foreign

1377
01:48:48,109 --> 01:48:38,149
[Music]

1378
01:48:59,750 --> 01:48:50,570
detailing

1379
01:48:59,760 --> 01:49:37,910
[Music]

1380
01:49:43,130 --> 01:49:40,609
you're unusually by this time it's like

1381
01:49:49,870 --> 01:49:43,140
totally

1382
01:50:08,990 --> 01:49:52,250
[Music]

1383
01:50:23,700 --> 01:50:11,400
something

1384
01:50:34,070 --> 01:50:30,890
[Music]

1385
01:50:36,590 --> 01:50:34,080
okay yeah so I already have

1386
01:50:39,150 --> 01:50:36,600
um I only have

1387
01:50:54,770 --> 01:50:39,160
two days

1388
01:50:55,590 --> 01:50:54,780

[Music]

1389

01:51:03,960 --> 01:50:55,600

oh yeah

1390

01:51:23,380 --> 01:51:12,820

[Music]

1391

01:52:28,420 --> 01:51:23,390

foreign

1392

01:52:34,540 --> 01:52:32,990

[Music]

1393

01:53:09,050 --> 01:52:34,550

thank you

1394

01:53:38,500 --> 01:53:36,370

[Music]

1395

01:53:46,430 --> 01:53:38,510

thank you

1396

01:54:50,910 --> 01:53:46,440

[Music]

1397

01:54:58,010 --> 01:54:50,920

foreign

1398

01:54:59,920 --> 01:54:58,020

[Music]

1399

01:55:18,870 --> 01:54:59,930

foreign

1400

01:57:05,050 --> 01:55:24,860

[Music]

1401
01:57:05,060 --> 01:57:08,790
thank you

1402
01:57:37,790 --> 01:57:35,470
[Music]

1403
01:57:42,190 --> 01:57:37,800
thank you

1404
01:58:10,310 --> 01:57:59,270
[Music]

1405
01:58:22,720 --> 01:58:11,320
thank you

1406
01:58:48,530 --> 01:58:40,170
[Music]

1407
01:58:48,540 --> 01:58:55,600
foreign

1408
02:00:09,830 --> 01:59:18,950
[Music]

1409
02:00:09,840 --> 02:00:12,580
foreign

1410
02:00:42,850 --> 02:00:30,880
[Music]

1411
02:00:57,910 --> 02:00:42,860
let's see

1412
02:00:57,920 --> 02:01:01,170
thank you

1413
02:01:12,740 --> 02:01:10,010

[Music]

1414

02:01:31,140 --> 02:01:12,750

foreign

1415

02:01:50,450 --> 02:01:44,720

[Music]

1416

02:01:50,460 --> 02:01:53,630

foreign

1417

02:02:43,980 --> 02:02:01,880

[Music]

1418

02:03:04,950 --> 02:02:43,990

foreign

1419

02:03:09,780 --> 02:03:07,490

[Music]

1420

02:03:32,750 --> 02:03:09,790

foreign

1421

02:03:58,910 --> 02:03:39,830

[Music]

1422

02:03:58,920 --> 02:04:03,140

foreign

1423

02:04:03,150 --> 02:04:38,510

[Music]

1424

02:04:59,380 --> 02:04:40,790

foreign

1425

02:05:15,250 --> 02:05:09,240

[Music]

1426
02:05:15,260 --> 02:05:21,340
thank you

1427
02:05:21,350 --> 02:05:25,810
[Music]

1428
02:05:25,820 --> 02:05:37,290
thank you

1429
02:05:45,890 --> 02:05:44,089
[Music]

1430
02:05:54,500 --> 02:05:45,900
foreign

1431
02:06:14,570 --> 02:06:09,240
[Music]

1432
02:06:46,390 --> 02:06:15,900
foreign

1433
02:07:05,100 --> 02:06:47,870
thank you

1434
02:07:13,850 --> 02:07:07,370
[Music]

1435
02:07:13,860 --> 02:07:27,090
foreign

1436
02:07:46,870 --> 02:07:40,290
[Music]

1437
02:07:50,290 --> 02:07:48,510
thank you

1438
02:07:52,250 --> 02:07:50,300

[Music]

1439

02:07:54,470 --> 02:07:52,260

all right everybody we're going to start

1440

02:07:56,990 --> 02:07:54,480

the next talk session life on the edge

1441

02:08:03,649 --> 02:07:57,000

and our first presenter is Lauren Lowe

1442

02:08:08,810 --> 02:08:06,350

hi everyone so I'm Lauren and I'm from

1443

02:08:10,370 --> 02:08:08,820

Anna Lang's Lab at unsw Sydney in

1444

02:08:12,530 --> 02:08:10,380

Australia and today I'm going to tell

1445

02:08:17,089 --> 02:08:12,540

you a bit about the work I do on model

1446

02:08:20,930 --> 02:08:19,010

so I'm sure many of us here are trying

1447

02:08:23,689 --> 02:08:20,940

to answer the question of how did life

1448

02:08:26,390 --> 02:08:23,699

on earth begin now I'm focusing on a

1449

02:08:28,790 --> 02:08:26,400

very very specific point in time when

1450

02:08:30,950 --> 02:08:28,800

life had maybe begun to transition from

1451

02:08:32,810 --> 02:08:30,960

super simple primitive cells perhaps

1452

02:08:35,030 --> 02:08:32,820

composed of a fatty acid bilayer

1453

02:08:36,950 --> 02:08:35,040

membrane it's a more complex protocells

1454

02:08:39,410 --> 02:08:36,960

or primitive cells more akin to Modern

1455

02:08:41,270 --> 02:08:39,420

Biology at this point in time we'd

1456

02:08:43,729 --> 02:08:41,280

started to see the emergence of

1457

02:08:46,970 --> 02:08:43,739

phospholipids and some simple enzymes

1458

02:08:48,950 --> 02:08:46,980

but we hadn't yet thanks but we hadn't

1459

02:08:51,109 --> 02:08:48,960

yet seen the emergence of all the

1460

02:08:53,330 --> 02:08:51,119

complex cellular cellular Machinery that

1461

02:08:55,129 --> 02:08:53,340

exists in our cells so things like

1462

02:08:56,870 --> 02:08:55,139

membrane transport mechanisms for

1463

02:08:58,609 --> 02:08:56,880

example that transport nutrients and

1464

02:09:01,310 --> 02:08:58,619

waste molecules out of the cell maybe

1465

02:09:03,470 --> 02:09:01,320

they hadn't come around yet so that begs

1466

02:09:05,089 --> 02:09:03,480

the question how are these protocells

1467

02:09:06,709 --> 02:09:05,099

actually able to feed themselves how

1468

02:09:08,209 --> 02:09:06,719

were they able to grow how are they able

1469

02:09:11,149 --> 02:09:08,219

to divide

1470

02:09:13,070 --> 02:09:11,159

so I'm trying to answer this question by

1471

02:09:15,229 --> 02:09:13,080

building a propagating synthetic cell

1472

02:09:16,970 --> 02:09:15,239

what that basically means is it's an

1473

02:09:19,129 --> 02:09:16,980

artificial cell that is able to feed

1474

02:09:20,450 --> 02:09:19,139

itself can grow it can divide and I'm

1475

02:09:22,370 --> 02:09:20,460

trying to achieve this using the

1476

02:09:24,709 --> 02:09:22,380

simplest components possible to try and

1477

02:09:26,810 --> 02:09:24,719

understand how life transitioned into

1478

02:09:28,430 --> 02:09:26,820

what we know it as today

1479

02:09:31,490 --> 02:09:28,440

so this involves a pretty large

1480

02:09:33,950 --> 02:09:31,500

collaboration and with my collaborator

1481

02:09:36,589 --> 02:09:33,960

in Japan yutatsu he's been able to build

1482

02:09:39,290 --> 02:09:36,599

a preliminary synthetic cell composed of

1483

02:09:42,229 --> 02:09:39,300

a phospholipid bilayer membrane also

1484

02:09:44,990 --> 02:09:42,239

known as a vesicle and this vesicle is

1485

02:09:47,629 --> 02:09:45,000

composed of a mixture of popc and popg

1486

02:09:49,790 --> 02:09:47,639

two types of phospholipids and within

1487

02:09:51,950 --> 02:09:49,800

this vesicle we have a system that can

1488

02:09:54,669 --> 02:09:51,960

be used to actually synthesize fatty

1489

02:09:56,450 --> 02:09:54,679

acids and eventually synthesize

1490

02:09:58,550 --> 02:09:56,460

phospholipids that can then be

1491

02:10:00,770 --> 02:09:58,560

incorporated into the bilayer membrane

1492

02:10:02,750 --> 02:10:00,780

actually allowing it to grow

1493

02:10:05,629 --> 02:10:02,760

now one of the big problems with this

1494

02:10:07,490 --> 02:10:05,639

system is that you can only encapsulate

1495

02:10:09,169 --> 02:10:07,500

a small number of nutrients actually

1496

02:10:11,089 --> 02:10:09,179

within the synthetic cell within the

1497

02:10:13,490 --> 02:10:11,099

vesicle there's only room for so many

1498

02:10:15,530 --> 02:10:13,500

molecules and if you encapsulate as many

1499

02:10:17,390 --> 02:10:15,540

as you can you only really get one to

1500

02:10:19,370 --> 02:10:17,400

two percent membrane growth which isn't

1501
02:10:21,109 --> 02:10:19,380
really sustainable for a cell that we

1502
02:10:23,810 --> 02:10:21,119
want to make grow and divide

1503
02:10:26,089 --> 02:10:23,820
so what we really need is some sort of

1504
02:10:28,609 --> 02:10:26,099
regular nutrient supply so we need an

1505
02:10:31,070 --> 02:10:28,619
external feedstock of nutrients that can

1506
02:10:32,570 --> 02:10:31,080
actually permeate the lipid bilayer

1507
02:10:34,550 --> 02:10:32,580
membrane so make its way from the

1508
02:10:36,189 --> 02:10:34,560
outside of the cell into to the inside

1509
02:10:39,649 --> 02:10:36,199
of the cell that way we can actually

1510
02:10:41,510 --> 02:10:39,659
achieve continual membrane growth

1511
02:10:43,010 --> 02:10:41,520
so that's my role in this project I'm

1512
02:10:44,450 --> 02:10:43,020
trying to figure out a way that we can

1513
02:10:46,609 --> 02:10:44,460

actually get the nutrients that we need

1514

02:10:48,470 --> 02:10:46,619

for the synthetic cell to function to

1515

02:10:50,089 --> 02:10:48,480

make its way across the lipid bilayer

1516

02:10:51,950 --> 02:10:50,099

membranes the interior of the synthetic

1517

02:10:53,810 --> 02:10:51,960

cell

1518

02:10:55,370 --> 02:10:53,820

so in order to do that I've needed a

1519

02:10:57,830 --> 02:10:55,380

technique that can be used to monitor

1520

02:10:59,810 --> 02:10:57,840

solute permeability or the permeability

1521

02:11:01,609 --> 02:10:59,820

of different nutrients and to do that

1522

02:11:04,010 --> 02:11:01,619

I'm using what's known as a shrink soil

1523

02:11:06,290 --> 02:11:04,020

assay basically that involves preparing

1524

02:11:08,149 --> 02:11:06,300

vesicles encapsulating a fluorescent dye

1525

02:11:10,310 --> 02:11:08,159

known as calcine

1526

02:11:13,070 --> 02:11:10,320

when you mix these vesicles with your

1527

02:11:15,169 --> 02:11:13,080

solute or your nutrient interests the

1528

02:11:17,410 --> 02:11:15,179

difference in osmolarity actually causes

1529

02:11:20,030 --> 02:11:17,420

the vesicles to shrink because water

1530

02:11:21,890 --> 02:11:20,040

rapidly exits the vesicle and we kind of

1531

02:11:23,689 --> 02:11:21,900

see this these shriveled up sort of

1532

02:11:25,910 --> 02:11:23,699

shrunken structures

1533

02:11:27,530 --> 02:11:25,920

and because we've had water exit the

1534

02:11:29,750 --> 02:11:27,540

vesicles we've actually had an increase

1535

02:11:31,609 --> 02:11:29,760

in concentration of the diet that's on

1536

02:11:33,229 --> 02:11:31,619

the inside of these vesicles and that

1537

02:11:35,810 --> 02:11:33,239

actually causes the fluorescent signal

1538

02:11:37,010 --> 02:11:35,820

to decrease because calcium is a

1539

02:11:39,470 --> 02:11:37,020

self-quenching diet above certain

1540

02:11:41,390 --> 02:11:39,480

concentrations so at high concentrations

1541

02:11:42,890 --> 02:11:41,400

the fluorescence actually goes down

1542

02:11:44,689 --> 02:11:42,900

rather than going up so it's a little

1543

02:11:48,530 --> 02:11:44,699

bit counter-intuitive

1544

02:11:50,149 --> 02:11:48,540

but over time if we have a permeable

1545

02:11:52,129 --> 02:11:50,159

solute so a solute that does actually

1546

02:11:54,109 --> 02:11:52,139

enter the vesicle you'll start to see

1547

02:11:55,490 --> 02:11:54,119

the vesicles slowly swell up again and

1548

02:11:58,010 --> 02:11:55,500

it'll roughly get back to its original

1549

02:11:59,810 --> 02:11:58,020

size and with that we have a decrease in

1550

02:12:01,370 --> 02:11:59,820

calcium concentration so we have an

1551
02:12:03,470 --> 02:12:01,380
increase in the fluorescence roughly to

1552
02:12:05,390 --> 02:12:03,480
what it was to begin with

1553
02:12:07,669 --> 02:12:05,400
and we can basically monitor that whole

1554
02:12:08,689 --> 02:12:07,679
process using some sort of fluorimeter

1555
02:12:10,430 --> 02:12:08,699
or something that can measure

1556
02:12:12,649 --> 02:12:10,440
fluorescence and we can monitor the

1557
02:12:13,970 --> 02:12:12,659
changes intensity over the time so we

1558
02:12:15,770 --> 02:12:13,980
can see initially the intensity is

1559
02:12:17,209 --> 02:12:15,780
somewhere up here and then with the

1560
02:12:19,550 --> 02:12:17,219
addition of the solute the intensity

1561
02:12:21,530 --> 02:12:19,560
drops down and then if we have a

1562
02:12:23,570 --> 02:12:21,540
permeable solute that signal will start

1563
02:12:26,030 --> 02:12:23,580

to recover and restart to see the

1564

02:12:27,890 --> 02:12:26,040

original intensity kind of values there

1565

02:12:29,629 --> 02:12:27,900

now because these intensities are kind

1566

02:12:31,669 --> 02:12:29,639

of a direct measure of the calcium

1567

02:12:33,830 --> 02:12:31,679

concentration we can convert

1568

02:12:36,169 --> 02:12:33,840

concentration to volume so the plots

1569

02:12:39,229 --> 02:12:36,179

I'll be showing you today show the

1570

02:12:40,910 --> 02:12:39,239

changes in volume over time

1571

02:12:42,709 --> 02:12:40,920

and it's just worth noting that the

1572

02:12:44,750 --> 02:12:42,719

initial stage where the vesicles shrink

1573

02:12:46,550 --> 02:12:44,760

and swivel up shrivel up actually

1574

02:12:48,350 --> 02:12:46,560

happens very quickly and the

1575

02:12:49,490 --> 02:12:48,360

experimental setup I currently have I

1576

02:12:51,530 --> 02:12:49,500

can't actually see that because it just

1577

02:12:53,390 --> 02:12:51,540

happens too fast so the data I'll be

1578

02:12:55,729 --> 02:12:53,400

showing you is just the recovery of that

1579

02:12:59,270 --> 02:12:57,589

so the basic workflow for a lot of my

1580

02:13:01,250 --> 02:12:59,280

experiments is to First prepare the

1581

02:13:04,550 --> 02:13:01,260

vesicles composed of an eagle mixture of

1582

02:13:06,890 --> 02:13:04,560

popc popg in 50 millimolar happy so

1583

02:13:09,709 --> 02:13:06,900

that's just the buffer it's roughly

1584

02:13:11,209 --> 02:13:09,719

buffering around physiological pH and

1585

02:13:12,709 --> 02:13:11,219

these bicycles are all encap all

1586

02:13:15,290 --> 02:13:12,719

encapsulate that fluorescent diode

1587

02:13:17,629 --> 02:13:15,300

calcium and then make sure all the

1588

02:13:19,729 --> 02:13:17,639

unencapsulated calcium is removed and I

1589

02:13:21,770 --> 02:13:19,739

mix the vesicles with the solute all the

1590

02:13:24,169 --> 02:13:21,780

nutrient of interest and monitor the

1591

02:13:25,490 --> 02:13:24,179

changes in fluorescence over time and

1592

02:13:28,250 --> 02:13:25,500

then determine the changes in volume

1593

02:13:31,790 --> 02:13:30,109

so this is what some of the data looks

1594

02:13:34,790 --> 02:13:31,800

like on the left we can see some

1595

02:13:36,770 --> 02:13:34,800

examples of some permeable solutes so

1596

02:13:39,410 --> 02:13:36,780

our control here was the 50 millimolar

1597

02:13:41,149 --> 02:13:39,420

happies in the blue and all of this data

1598

02:13:43,609 --> 02:13:41,159

is normalized to the volume of that

1599

02:13:45,649 --> 02:13:43,619

control at time zero so we see in the

1600

02:13:47,450 --> 02:13:45,659

blue 50mm Heavies it's just a flat line

1601
02:13:49,250 --> 02:13:47,460
there not much is changing and that's

1602
02:13:50,990 --> 02:13:49,260
what we'd expect it's our control it's

1603
02:13:53,510 --> 02:13:51,000
what we made our vesicles in so we don't

1604
02:13:55,069 --> 02:13:53,520
expect any volume change there but when

1605
02:13:58,189 --> 02:13:55,079
we mix our vesicles with something like

1606
02:14:00,350 --> 02:13:58,199
glucose or glycine for example so the

1607
02:14:02,390 --> 02:14:00,360
red and the purple we see that

1608
02:14:04,189 --> 02:14:02,400
characteristic curve telling us that the

1609
02:14:06,169 --> 02:14:04,199
volume is actually increasing after the

1610
02:14:08,089 --> 02:14:06,179
vesicles initially kind of shriveled up

1611
02:14:09,890 --> 02:14:08,099
so that tells us that these two solutes

1612
02:14:12,109 --> 02:14:09,900
are both permeable across these lipid

1613
02:14:14,089 --> 02:14:12,119

bilayer membranes and glycine is

1614

02:14:16,970 --> 02:14:14,099

actually more permeable than the glucose

1615

02:14:19,970 --> 02:14:16,980

because it increases at a faster rate

1616

02:14:20,990 --> 02:14:19,980

on that plot I also have glycerol at

1617

02:14:23,209 --> 02:14:21,000

first glance it kind of looks like

1618

02:14:25,189 --> 02:14:23,219

nothing happens there but glycerol is

1619

02:14:27,169 --> 02:14:25,199

known to be super permeable across lipid

1620

02:14:29,149 --> 02:14:27,179

bilayers so it's likely that I just

1621

02:14:31,010 --> 02:14:29,159

actually missed that initial shrinkage

1622

02:14:32,390 --> 02:14:31,020

and swelling stage so it just looks like

1623

02:14:33,649 --> 02:14:32,400

nothing's happened right now because I

1624

02:14:35,330 --> 02:14:33,659

missed the first kind of couple minutes

1625

02:14:37,430 --> 02:14:35,340

of this process

1626

02:14:39,589 --> 02:14:37,440

now on the other plot we have some

1627

02:14:41,510 --> 02:14:39,599

examples of some impermeable sites and

1628

02:14:42,950 --> 02:14:41,520

you can see there's quite a few there so

1629

02:14:45,050 --> 02:14:42,960

a lot of the solutes I've looked at so

1630

02:14:46,790 --> 02:14:45,060

far are quite impermeable and that's we

1631

02:14:48,470 --> 02:14:46,800

can see that there's like those flat

1632

02:14:50,510 --> 02:14:48,480

lines at the bottom there there's no

1633

02:14:52,189 --> 02:14:50,520

increase in volume over time so over

1634

02:14:54,350 --> 02:14:52,199

these this time frame none of these

1635

02:14:56,089 --> 02:14:54,360

solutes are permeable which is kind of

1636

02:14:57,890 --> 02:14:56,099

disappointing because a lot of these

1637

02:15:01,310 --> 02:14:57,900

solutes would be useful nutrients for a

1638

02:15:03,050 --> 02:15:01,320

synthetic cell things like amp ATP for

1639

02:15:05,450 --> 02:15:03,060

energy and then something like sodium

1640

02:15:07,250 --> 02:15:05,460

acetate I was hoping to use as a carbon

1641

02:15:10,310 --> 02:15:07,260

source to actually synthesize fatty

1642

02:15:12,290 --> 02:15:10,320

acids and then the phospholipids

1643

02:15:13,729 --> 02:15:12,300

but it's not particularly surprising

1644

02:15:15,830 --> 02:15:13,739

that a lot of these solutes were

1645

02:15:17,270 --> 02:15:15,840

impermeable It's relatively well

1646

02:15:19,310 --> 02:15:17,280

established in literature child that

1647

02:15:21,109 --> 02:15:19,320

phospholipid bilayers aren't the most

1648

02:15:23,330 --> 02:15:21,119

permeable things especially when

1649

02:15:25,669 --> 02:15:23,340

comparing them to a fatty acid bilayer

1650

02:15:26,930 --> 02:15:25,679

for example so fatty acid bilayers are

1651

02:15:29,450 --> 02:15:26,940

kind of useful to think about because

1652

02:15:31,609 --> 02:15:29,460

they have been proposed to have made up

1653

02:15:33,950 --> 02:15:31,619

the first protocell membranes before we

1654

02:15:35,750 --> 02:15:33,960

saw the emergence of phospholipids and

1655

02:15:38,330 --> 02:15:35,760

we can see in this plot here for

1656

02:15:40,790 --> 02:15:38,340

something like glucose it's a bit less

1657

02:15:42,290 --> 02:15:40,800

permeable in phospholipids than in fatty

1658

02:15:44,450 --> 02:15:42,300

acid bilayers

1659

02:15:46,669 --> 02:15:44,460

for something like sodium potassium it's

1660

02:15:48,410 --> 02:15:46,679

significantly less permeable and like

1661

02:15:50,390 --> 02:15:48,420

over this scale that that's a really

1662

02:15:52,370 --> 02:15:50,400

significant margin there

1663

02:15:55,250 --> 02:15:52,380

and then for something like amp and

1664

02:15:57,050 --> 02:15:55,260

magnesium that's not actually on the

1665

02:15:58,850 --> 02:15:57,060

scale shown here for phospholipids so

1666

02:16:00,770 --> 02:15:58,860

it's way less permeable in phospholipid

1667

02:16:02,149 --> 02:16:00,780

membranes than it is in fatty acid

1668

02:16:03,830 --> 02:16:02,159

membranes

1669

02:16:06,530 --> 02:16:03,840

so again these results are particularly

1670

02:16:08,330 --> 02:16:06,540

surprising but I still wanted to try and

1671

02:16:10,970 --> 02:16:08,340

find a way to actually get these

1672

02:16:12,589 --> 02:16:10,980

nutrients to permeate the bilayer so

1673

02:16:14,330 --> 02:16:12,599

today I'm going to talk about a couple

1674

02:16:16,790 --> 02:16:14,340

of different strategies I've tried to

1675

02:16:18,830 --> 02:16:16,800

use to actually improve permeability the

1676

02:16:20,689 --> 02:16:18,840

first of which is modifying the membrane

1677

02:16:22,609 --> 02:16:20,699

composition

1678

02:16:25,129 --> 02:16:22,619

so as I said all the vesicles I've been

1679

02:16:28,010 --> 02:16:25,139

working with so far have been composed

1680

02:16:29,450 --> 02:16:28,020

of prbc and papg now these lipids are

1681

02:16:31,069 --> 02:16:29,460

quite nice to work with they're

1682

02:16:32,810 --> 02:16:31,079

cylindrical in shape so they're packed

1683

02:16:34,849 --> 02:16:32,820

together in these really nice bilayers

1684

02:16:37,370 --> 02:16:34,859

they're very uniform but what would

1685

02:16:38,929 --> 02:16:37,380

happen if I were to say disrupt the way

1686

02:16:41,750 --> 02:16:38,939

the lipid molecules actually pack

1687

02:16:43,969 --> 02:16:41,760

together what if I introduced a leopard

1688

02:16:46,969 --> 02:16:43,979

with a different shape something like

1689

02:16:49,190 --> 02:16:46,979

laser PC which has the single carbon

1690

02:16:51,169 --> 02:16:49,200

chain rather than two but it still has a

1691

02:16:53,389 --> 02:16:51,179

relatively bulky head group so it has

1692

02:16:55,250 --> 02:16:53,399

this more conical like shape and when

1693

02:16:57,589 --> 02:16:55,260

that gets inserted into bilayers it can

1694

02:16:59,389 --> 02:16:57,599

cause defects to form and pores which

1695

02:17:01,310 --> 02:16:59,399

would potentially allow nutrients to

1696

02:17:02,929 --> 02:17:01,320

pass through the membrane so I wanted to

1697

02:17:05,270 --> 02:17:02,939

explore what effect adding small

1698

02:17:06,830 --> 02:17:05,280

quantities of lyso PC would have on

1699

02:17:09,349 --> 02:17:06,840

permeability

1700

02:17:11,870 --> 02:17:09,359

and the other lipid I looked at is oleic

1701

02:17:14,150 --> 02:17:11,880

acid which is a fatty acid has a single

1702

02:17:16,129 --> 02:17:14,160

carbon chain and a relatively small head

1703

02:17:17,750 --> 02:17:16,139

group but because it's a fatty acid it

1704

02:17:20,150 --> 02:17:17,760

has a very different properties to what

1705

02:17:21,950 --> 02:17:20,160

phospholipids do so I wanted to explore

1706

02:17:25,910 --> 02:17:21,960

how those different properties might

1707

02:17:27,709 --> 02:17:25,920

affect the permeability of the membrane

1708

02:17:29,150 --> 02:17:27,719

and generally I found that they didn't

1709

02:17:31,969 --> 02:17:29,160

make much of a difference

1710

02:17:34,129 --> 02:17:31,979

so first of all I prepared all the

1711

02:17:37,129 --> 02:17:34,139

vesicles the same way I did before but

1712

02:17:40,070 --> 02:17:37,139

added about 10 either lyso PC or oleic

1713

02:17:42,650 --> 02:17:40,080

acid to the system and generally as I

1714

02:17:44,209 --> 02:17:42,660

said didn't make much of a difference we

1715

02:17:46,490 --> 02:17:44,219

have one of our example permeable

1716

02:17:48,709 --> 02:17:46,500

solutes there so glucose which we saw

1717

02:17:50,089 --> 02:17:48,719

was permeable earlier we can see in

1718

02:17:52,070 --> 02:17:50,099

those three curves there isn't really

1719

02:17:53,929 --> 02:17:52,080

much difference between them if anything

1720

02:17:56,150 --> 02:17:53,939

the green curve the oleic acid is

1721

02:17:57,770 --> 02:17:56,160

shifted down slightly but the shapes of

1722

02:17:59,690 --> 02:17:57,780

the curves are all very similar which is

1723

02:18:01,730 --> 02:17:59,700

telling us that the permeability hasn't

1724

02:18:03,709 --> 02:18:01,740

really changed and we see something

1725

02:18:06,469 --> 02:18:03,719

simple similar with one of the

1726

02:18:08,030 --> 02:18:06,479

impermeable solutes that being lysine I

1727

02:18:10,009 --> 02:18:08,040

still have all those flat lines so we

1728

02:18:12,709 --> 02:18:10,019

saw no improvement in permeability there

1729

02:18:13,969 --> 02:18:12,719

and this was generally the case across a

1730

02:18:15,830 --> 02:18:13,979

lot of the different solutes or

1731

02:18:17,389 --> 02:18:15,840

nutrients that I actually tried there

1732

02:18:20,150 --> 02:18:17,399

weren't any marked improvements in

1733

02:18:21,950 --> 02:18:20,160

permeability except for when I tried

1734

02:18:24,770 --> 02:18:21,960

sodium acetate

1735

02:18:27,410 --> 02:18:24,780

so when we had the presence of 10 a lake

1736

02:18:29,209 --> 02:18:27,420

acid in the system we see a significant

1737

02:18:31,730 --> 02:18:29,219

Improvement in permeability compared to

1738

02:18:34,070 --> 02:18:31,740

what it was originally with the popcpg

1739

02:18:36,530 --> 02:18:34,080

system and also compared to adding the

1740

02:18:38,270 --> 02:18:36,540

10th Cent lyso PC so we do see that

1741

02:18:39,830 --> 02:18:38,280

curve that's telling us that the vesicle

1742

02:18:41,629 --> 02:18:39,840

is swelling up again and we actually

1743

02:18:45,650 --> 02:18:41,639

have the solute molecules permeating

1744

02:18:48,230 --> 02:18:45,660

into the vesicle which is good news we

1745

02:18:50,030 --> 02:18:48,240

saw one of these uh solutes actually

1746

02:18:52,730 --> 02:18:50,040

kind of worked and actually were able to

1747

02:18:54,290 --> 02:18:52,740

permeate the membrane and as I said it

1748

02:18:55,969 --> 02:18:54,300

was great to see that it did work with

1749

02:18:58,129 --> 02:18:55,979

sodium acetate because we wanted to use

1750

02:19:00,589 --> 02:18:58,139

that as our carbon source for fatty acid

1751

02:19:02,150 --> 02:19:00,599

synthesis then phospholipid synthesis

1752

02:19:04,009 --> 02:19:02,160

and that would actually help getting the

1753

02:19:05,690 --> 02:19:04,019

membrane to grow

1754

02:19:07,429 --> 02:19:05,700

but as I said overall it didn't work for

1755

02:19:10,250 --> 02:19:07,439

a lot of the stuff I tried so I wanted

1756

02:19:12,049 --> 02:19:10,260

to try a second strategy to try and

1757

02:19:14,750 --> 02:19:12,059

improve permeability and that was

1758

02:19:16,370 --> 02:19:14,760

through the addition of divalent cations

1759

02:19:18,349 --> 02:19:16,380

so in literature it's pretty well

1760

02:19:20,330 --> 02:19:18,359

established that divalent cations also

1761

02:19:22,129 --> 02:19:20,340

affect the packing of the way of the

1762

02:19:24,169 --> 02:19:22,139

lipid molecules so the way the bilayers

1763

02:19:25,310 --> 02:19:24,179

actually packed together so I wanted to

1764

02:19:26,690 --> 02:19:25,320

see if that would make a difference to

1765

02:19:29,089 --> 02:19:26,700

permeability

1766

02:19:30,950 --> 02:19:29,099

and again generally I found it didn't

1767

02:19:34,190 --> 02:19:30,960

make that much of a difference except

1768

02:19:37,129 --> 02:19:34,200

for the presence of sodium acetate so

1769

02:19:39,169 --> 02:19:37,139

with the 10 Lake acid system and the

1770

02:19:41,270 --> 02:19:39,179

sodium acetate when I added magnesium

1771

02:19:43,429 --> 02:19:41,280

chloride which is what we see in the

1772

02:19:45,169 --> 02:19:43,439

orange there was a improvement in

1773

02:19:46,969 --> 02:19:45,179

permeability if we see that curve kind

1774

02:19:48,710 --> 02:19:46,979

of increases faster than what the the

1775

02:19:50,870 --> 02:19:48,720

blue line which is just the pure sodium

1776

02:19:53,030 --> 02:19:50,880

acetate and the green line which is just

1777

02:19:54,830 --> 02:19:53,040

the magnesium chloride so for whatever

1778

02:19:57,590 --> 02:19:54,840

reason the addition of magnesium

1779

02:19:59,690 --> 02:19:57,600

chloride with the sodium acetate and in

1780

02:20:02,210 --> 02:19:59,700

the temps in oleic acid system did

1781

02:20:04,910 --> 02:20:02,220

improve permeability overall

1782

02:20:06,469 --> 02:20:04,920

but again generally I found that this

1783

02:20:08,510 --> 02:20:06,479

was quite difficult to achieve in a lot

1784

02:20:10,190 --> 02:20:08,520

of the solutes I tried I've also tried

1785

02:20:11,389 --> 02:20:10,200

other divalent cations which I haven't

1786

02:20:14,690 --> 02:20:11,399

shown here

1787

02:20:17,870 --> 02:20:14,700

um in general it was pretty tough

1788

02:20:19,610 --> 02:20:17,880

so what does that mean overall so

1789

02:20:21,889 --> 02:20:19,620

generally I've found that permeability

1790

02:20:24,290 --> 02:20:21,899

can somewhat be modulated for specific

1791

02:20:26,990 --> 02:20:24,300

specific sites by changing the membrane

1792

02:20:29,150 --> 02:20:27,000

composition and divalent cations can

1793

02:20:31,969 --> 02:20:29,160

somewhat improve the permeability of

1794

02:20:33,889 --> 02:20:31,979

specific solutes but overall it was

1795

02:20:35,929 --> 02:20:33,899

pretty difficult to actually see any

1796

02:20:37,429 --> 02:20:35,939

marked improvements in permeability for

1797

02:20:40,190 --> 02:20:37,439

a lot of the different things I studied

1798

02:20:42,650 --> 02:20:40,200

so what does that mean for origins of

1799

02:20:44,510 --> 02:20:42,660

life well perhaps we needed protein

1800

02:20:46,790 --> 02:20:44,520

channels to actually co-evolve with

1801
02:20:48,770 --> 02:20:46,800
phospholipid synthesis as I mentioned

1802
02:20:50,450 --> 02:20:48,780
earlier fatty acid membranes are much

1803
02:20:52,190 --> 02:20:50,460
more permeable than phospholipid

1804
02:20:54,530 --> 02:20:52,200
membranes so if they were the first

1805
02:20:56,870 --> 02:20:54,540
protocell membranes they were able to

1806
02:20:58,490 --> 02:20:56,880
access nutrients a lot easier than

1807
02:20:59,870 --> 02:20:58,500
phospholipid membranes on their own

1808
02:21:01,730 --> 02:20:59,880
would be able to so we've probably

1809
02:21:04,490 --> 02:21:01,740
needed some sort of mechanism to

1810
02:21:06,469 --> 02:21:04,500
actually co-evolve with phospholipids as

1811
02:21:08,870 --> 02:21:06,479
they started to emerge

1812
02:21:10,490 --> 02:21:08,880
but this is a very much an ongoing

1813
02:21:12,050 --> 02:21:10,500

project I'm trying a lot of different

1814

02:21:14,330 --> 02:21:12,060

membrane compositions a lot of different

1815

02:21:16,190 --> 02:21:14,340

divalent cations and I'm still working

1816

02:21:18,170 --> 02:21:16,200

on other methods to kind of improve

1817

02:21:20,090 --> 02:21:18,180

permeability so hopefully in the future

1818

02:21:22,849 --> 02:21:20,100

I'll have some more definitive results

1819

02:21:25,790 --> 02:21:22,859

with some improvements in permeability

1820

02:21:28,250 --> 02:21:25,800

for a lot of other solutes too

1821

02:21:30,230 --> 02:21:28,260

so with that I'd like to acknowledge the

1822

02:21:32,330 --> 02:21:30,240

entire Land Group and my supervisor Anna

1823

02:21:33,889 --> 02:21:32,340

for all her support thank you to my

1824

02:21:35,810 --> 02:21:33,899

sources of funding and thank you to

1825

02:21:36,540 --> 02:21:35,820

everyone for listening

1826

02:21:41,590 --> 02:21:36,550

[Applause]

1827

02:21:49,550 --> 02:21:41,600

[Laughter]

1828

02:21:55,309 --> 02:21:52,849

thank you I am from Ohio University I

1829

02:21:58,550 --> 02:21:55,319

study in molecular biology I'm just

1830

02:22:01,910 --> 02:21:58,560

interested in the method that you use to

1831

02:22:04,730 --> 02:22:01,920

measure your membrane permeability is it

1832

02:22:07,969 --> 02:22:04,740

a patch clamp electrophysiology or what

1833

02:22:12,710 --> 02:22:07,979

so the technique I was using is

1834

02:22:16,910 --> 02:22:14,450

it's actually a measure of the changes

1835

02:22:19,309 --> 02:22:16,920

in volume but it's reliant on the fact

1836

02:22:21,110 --> 02:22:19,319

that with those changes in volume they

1837

02:22:23,690 --> 02:22:21,120

can only occur because the solute is

1838

02:22:25,190 --> 02:22:23,700

actually permeating the membrane so it's

1839

02:22:27,410 --> 02:22:25,200

actually a fluorescence-based technique

1840

02:22:29,030 --> 02:22:27,420

so I use a fluorine fluimeter or plate

1841

02:22:30,889 --> 02:22:29,040

radar depending on the experimental

1842

02:22:32,570 --> 02:22:30,899

setup I have going to actually measure

1843

02:22:35,030 --> 02:22:32,580

those changes in fluorescence over time

1844

02:22:37,130 --> 02:22:35,040

and from that you can calculate the

1845

02:22:39,050 --> 02:22:37,140

changes in volume which you can actually

1846

02:22:40,849 --> 02:22:39,060

then go on to work out permeability

1847

02:22:42,410 --> 02:22:40,859

coefficients from those curves which is

1848

02:22:44,570 --> 02:22:42,420

something I haven't done yet but you can

1849

02:22:46,370 --> 02:22:44,580

actually fit a model to that curve and

1850

02:22:47,090 --> 02:22:46,380

extract the permeability coefficients as

1851

02:22:50,630 --> 02:22:47,100

well

1852

02:22:53,389 --> 02:22:50,640

okay I'm I'm just actually thinking that

1853

02:22:55,610 --> 02:22:53,399

um if you can employ the patch Clump

1854

02:22:58,510 --> 02:22:55,620

electrophysiology method it can give

1855

02:23:01,010 --> 02:22:58,520

insight into like membrane polarity

1856

02:23:03,650 --> 02:23:01,020

hyperpolarization yeah which can also

1857

02:23:05,630 --> 02:23:03,660

give more insight on this yeah 100 in

1858

02:23:07,010 --> 02:23:05,640

this a few other techniques that I've

1859

02:23:09,170 --> 02:23:07,020

actually used as well that are quite

1860

02:23:10,370 --> 02:23:09,180

similar to that but I I didn't show them

1861

02:23:11,990 --> 02:23:10,380

in this presentation but I'm happy to

1862

02:23:14,690 --> 02:23:12,000

chat about

1863

02:23:17,870 --> 02:23:16,370

hi I'm Tim from University of

1864

02:23:19,969 --> 02:23:17,880

Wisconsin-Madison

1865

02:23:22,190 --> 02:23:19,979

um I was wondering uh do you think there

1866

02:23:24,770 --> 02:23:22,200

could be an effect of physical size or

1867

02:23:26,510 --> 02:23:24,780

specifically surface area on the degree

1868

02:23:28,610 --> 02:23:26,520

of permeability and if so did you like

1869

02:23:31,130 --> 02:23:28,620

control for size did you extrude your

1870

02:23:33,349 --> 02:23:31,140

vesicles I showed it good question yeah

1871

02:23:34,910 --> 02:23:33,359

so these vesicles for this system I'm

1872

02:23:36,889 --> 02:23:34,920

working with have all been extruded

1873

02:23:39,170 --> 02:23:36,899

through 50 nanometer pause

1874

02:23:41,210 --> 02:23:39,180

they're roughly

1875

02:23:44,570 --> 02:23:41,220

they're probably about 40 nanometers in

1876

02:23:47,210 --> 02:23:44,580

diameter for the most part it's a

1877

02:23:49,910 --> 02:23:47,220

relatively even distribution added to

1878

02:23:52,190 --> 02:23:49,920

DLS on pretty similar systems

1879

02:23:53,929 --> 02:23:52,200

um yeah that that's why I did extrude

1880

02:23:56,090 --> 02:23:53,939

because I would expect from the ability

1881

02:23:58,010 --> 02:23:56,100

to be affected by the size of the

1882

02:24:00,220 --> 02:23:58,020

vesicles

1883

02:24:08,270 --> 02:24:00,230

thank you very much Lauren thank you

1884

02:24:13,010 --> 02:24:09,889

thank you okay

1885

02:24:18,110 --> 02:24:13,020

our next speakers be jono abishir

1886

02:24:18,120 --> 02:24:24,670

[Music]

1887

02:24:29,809 --> 02:24:26,530

hello everyone

1888

02:24:31,730 --> 02:24:29,819

my name is jono Abshire I am a second

1889

02:24:34,070 --> 02:24:31,740

year PhD student at Portland State

1890

02:24:35,990 --> 02:24:34,080

University working in the center for

1891

02:24:37,610 --> 02:24:36,000

life in extreme environments

1892

02:24:39,950 --> 02:24:37,620

more specifically out of the extreme

1893

02:24:41,950 --> 02:24:39,960

virus lab and today I'll be giving you a

1894

02:24:44,389 --> 02:24:41,960

little bit of insight into Life In Hell

1895

02:24:46,790 --> 02:24:44,399

understanding the role of toxin

1896

02:24:48,590 --> 02:24:46,800

antitoxin systems in prokaryotic genomes

1897

02:24:52,429 --> 02:24:48,600

and their potential for virus host

1898

02:24:54,050 --> 02:24:52,439

coevolution tldr extreme organisms the

1899

02:24:55,370 --> 02:24:54,060

viruses that infect them and their

1900

02:24:57,530 --> 02:24:55,380

interactions in these extreme

1901
02:24:59,510 --> 02:24:57,540
environments and our journey kind of

1902
02:25:01,750 --> 02:24:59,520
begins right here so this is a personal

1903
02:25:04,010 --> 02:25:01,760
image of Lassen Volcanic National Park

1904
02:25:06,230 --> 02:25:04,020
it is one of the many areas on our

1905
02:25:07,790 --> 02:25:06,240
beautiful planet that is home to these

1906
02:25:09,650 --> 02:25:07,800
volcanic Hot Springs

1907
02:25:11,630 --> 02:25:09,660
this is one of the main sampling sites

1908
02:25:12,950 --> 02:25:11,640
of our a lab and while most people

1909
02:25:15,230 --> 02:25:12,960
wouldn't believe that there are things

1910
02:25:16,510 --> 02:25:15,240
living in this environment there

1911
02:25:18,710 --> 02:25:16,520
certainly are

1912
02:25:20,210 --> 02:25:18,720
specifically these microbes from hell

1913
02:25:22,250 --> 02:25:20,220

and I'll get back to these guys in just

1914

02:25:24,590 --> 02:25:22,260

a second but a little bit of background

1915

02:25:26,570 --> 02:25:24,600

about why we why we studied these

1916

02:25:28,130 --> 02:25:26,580

particular environments so these

1917

02:25:30,650 --> 02:25:28,140

volcanic Hot Springs are often

1918

02:25:32,929 --> 02:25:30,660

considered and understood to be analogs

1919

02:25:35,090 --> 02:25:32,939

for both for planets both outside and

1920

02:25:37,610 --> 02:25:35,100

inside of our solar system referring

1921

02:25:40,429 --> 02:25:37,620

back to some of the ancient Hot Springs

1922

02:25:42,410 --> 02:25:40,439

found recently on Mars which may or may

1923

02:25:44,809 --> 02:25:42,420

not have looked something like this

1924

02:25:47,630 --> 02:25:44,819

boiling Mud Pot that we find in Devil's

1925

02:25:49,670 --> 02:25:47,640

Kitchen at Lassen Volcanic National Park

1926

02:25:53,170 --> 02:25:49,680

getting back to the microbes one such

1927

02:25:55,910 --> 02:25:53,180

microbe is this micro right here

1928

02:25:57,950 --> 02:25:55,920

spherical cell known as sacralobus

1929

02:25:59,750 --> 02:25:57,960

olfactericus this is a scanning electron

1930

02:26:01,190 --> 02:25:59,760

microscope showing you the topology of

1931

02:26:04,610 --> 02:26:01,200

the cells

1932

02:26:07,370 --> 02:26:04,620

um coined s441 by our lab really thrives

1933

02:26:09,349 --> 02:26:07,380

and uh lives in these hot acidic

1934

02:26:13,610 --> 02:26:09,359

conditions with temperatures from around

1935

02:26:16,070 --> 02:26:13,620

70 to 75 to 80 degrees C and ph's of

1936

02:26:19,190 --> 02:26:16,080

around three to as low as one so these

1937

02:26:21,050 --> 02:26:19,200

really extreme environments and when we

1938

02:26:24,170 --> 02:26:21,060

think about these environments and the

1939

02:26:27,469 --> 02:26:24,180

reach ecosystems that uh and habitat

1940

02:26:30,530 --> 02:26:27,479

them we can also think about one of the

1941

02:26:32,450 --> 02:26:30,540

most abundant molecules on the planet so

1942

02:26:34,670 --> 02:26:32,460

that of viruses and yes there are these

1943

02:26:37,010 --> 02:26:34,680

extreme viruses infecting these

1944

02:26:39,050 --> 02:26:37,020

extremophiles uh the one which I work

1945

02:26:41,330 --> 02:26:39,060

with in lab is sopholobus spindle shape

1946

02:26:44,630 --> 02:26:41,340

virus one sacralobus is a natural host

1947

02:26:46,550 --> 02:26:44,640

of this particular virus this ssv1 this

1948

02:26:49,309 --> 02:26:46,560

is Stanley uses they them pronouns

1949

02:26:51,230 --> 02:26:49,319

really characterized by his lemon shape

1950

02:26:53,450 --> 02:26:51,240

so these shapes are really unique to

1951
02:26:56,450 --> 02:26:53,460
both archaeal organisms extremophiles

1952
02:26:58,429 --> 02:26:56,460
and some of these extreme viruses

1953
02:27:00,050 --> 02:26:58,439
and when we think about looking at these

1954
02:27:02,270 --> 02:27:00,060
organisms and the interactions between

1955
02:27:03,950 --> 02:27:02,280
them in these extreme environments we

1956
02:27:06,830 --> 02:27:03,960
can look at some systems currently

1957
02:27:10,309 --> 02:27:06,840
prevalent today in bacterial cells so

1958
02:27:13,010 --> 02:27:10,319
these toxin antitoxin systems usually

1959
02:27:15,469 --> 02:27:13,020
known as addiction modules found on

1960
02:27:19,370 --> 02:27:15,479
plasmids again really prevalent in

1961
02:27:22,429 --> 02:27:19,380
bacterial genomes only recently being

1962
02:27:24,050 --> 02:27:22,439
being discovered to have some viral

1963
02:27:27,349 --> 02:27:24,060

encoding

1964

02:27:30,290 --> 02:27:27,359

and what this particular system confers

1965

02:27:32,210 --> 02:27:30,300

is when you have a plasmid that has the

1966

02:27:34,790 --> 02:27:32,220

positive uh or is positive for that

1967

02:27:36,590 --> 02:27:34,800

particular addiction module that cell

1968

02:27:38,450 --> 02:27:36,600

will needs that plasmid in order to

1969

02:27:40,910 --> 02:27:38,460

continue its life in that particular

1970

02:27:42,170 --> 02:27:40,920

environment so here we have the presence

1971

02:27:44,510 --> 02:27:42,180

of the TA

1972

02:27:47,030 --> 02:27:44,520

um should that cell or progeny continue

1973

02:27:48,230 --> 02:27:47,040

with the presence of that plasmid you

1974

02:27:50,150 --> 02:27:48,240

would expect normal growth in the

1975

02:27:51,950 --> 02:27:50,160

environment whereas if it were to lose

1976

02:27:54,349 --> 02:27:51,960

that plasmid it would would have been

1977

02:27:55,910 --> 02:27:54,359

addicted to that particular genome it

1978

02:27:57,889 --> 02:27:55,920

would die off whereas in a negative

1979

02:28:00,230 --> 02:27:57,899

system you would get growth either way

1980

02:28:02,150 --> 02:28:00,240

whether or not there's plasmid loss and

1981

02:28:04,010 --> 02:28:02,160

we can further visualize this particular

1982

02:28:06,830 --> 02:28:04,020

mechanism by looking at what might

1983

02:28:08,750 --> 02:28:06,840

happen to some uncolonized cells some

1984

02:28:10,610 --> 02:28:08,760

sort of event happens in which the

1985

02:28:11,990 --> 02:28:10,620

addiction modules introduced to that

1986

02:28:13,910 --> 02:28:12,000

population

1987

02:28:16,130 --> 02:28:13,920

and you have your addicted Survivor

1988

02:28:17,750 --> 02:28:16,140

going on to make new progeny and then

1989

02:28:20,150 --> 02:28:17,760

conferring that group protection and

1990

02:28:23,030 --> 02:28:20,160

persistence so these systems are really

1991

02:28:26,389 --> 02:28:23,040

understood in bacteria to confer a

1992

02:28:29,210 --> 02:28:26,399

microbial persistence phenotype some

1993

02:28:32,389 --> 02:28:29,220

have been referred to as fate defense

1994

02:28:36,110 --> 02:28:32,399

mechanisms and largely considered as

1995

02:28:38,210 --> 02:28:36,120

plasmid stabilizers on the plasmin

1996

02:28:39,889 --> 02:28:38,220

um and we can also uh assume that

1997

02:28:41,150 --> 02:28:39,899

another group of uncolonized cells were

1998

02:28:43,070 --> 02:28:41,160

to come in here perhaps that group

1999

02:28:45,830 --> 02:28:43,080

encounter you would still get that toxic

2000

02:28:48,110 --> 02:28:45,840

culling uh from that toxin antitoxin

2001
02:28:49,910 --> 02:28:48,120
system uh one important note they are

2002
02:28:52,130 --> 02:28:49,920
characterized as two genes that are

2003
02:28:54,590 --> 02:28:52,140
typically right next to each other

2004
02:28:57,110 --> 02:28:54,600
um the toxin being just Downstream of

2005
02:28:59,929 --> 02:28:57,120
the antitoxin uh pretty stable toxin

2006
02:29:02,450 --> 02:28:59,939
pretty unstable antitoxin

2007
02:29:04,250 --> 02:29:02,460
and looking at this system with ssv1 a

2008
02:29:09,410 --> 02:29:04,260
previous student did quite a bit of work

2009
02:29:11,510 --> 02:29:09,420
in uh mutagenesis of the ssv1 genome and

2010
02:29:14,090 --> 02:29:11,520
we use this at least these mutants to

2011
02:29:15,530 --> 02:29:14,100
test whether or not some of these uh

2012
02:29:18,050 --> 02:29:15,540
genes or open reading frames are

2013
02:29:20,750 --> 02:29:18,060

essential to the virus and two genes in

2014

02:29:22,910 --> 02:29:20,760

particular this T3 and TX transcript

2015

02:29:25,969 --> 02:29:22,920

these particular two genes we can make

2016

02:29:29,690 --> 02:29:25,979

changes to what I think is the antitoxin

2017

02:29:31,910 --> 02:29:29,700

and we don't see too much difference in

2018

02:29:34,429 --> 02:29:31,920

terms of viral infection viral function

2019

02:29:36,410 --> 02:29:34,439

whereas if we were to delete this or

2020

02:29:38,150 --> 02:29:36,420

insert a sequence into this particular

2021

02:29:41,270 --> 02:29:38,160

open reading frame what I think is the

2022

02:29:42,950 --> 02:29:41,280

toxin we do see differences in infection

2023

02:29:47,450 --> 02:29:42,960

mechanisms

2024

02:29:49,370 --> 02:29:47,460

these extreme viruses and just virus

2025

02:29:51,889 --> 02:29:49,380

reproduction overall viruses can

2026

02:29:54,349 --> 02:29:51,899

typically go through two Pathways or a

2027

02:29:57,230 --> 02:29:54,359

combination of both so a lytic cycle in

2028

02:29:58,969 --> 02:29:57,240

which the viral genome the viral DNA

2029

02:30:01,190 --> 02:29:58,979

will insert itself into the cell

2030

02:30:03,889 --> 02:30:01,200

you have some replication going on

2031

02:30:06,050 --> 02:30:03,899

eventually assembly of those virions and

2032

02:30:07,969 --> 02:30:06,060

the cell will then burst die and those

2033

02:30:10,849 --> 02:30:07,979

viruses will go on to infect other cells

2034

02:30:13,130 --> 02:30:10,859

whereas in a lysogenic cycle the viral

2035

02:30:15,230 --> 02:30:13,140

genome is incorporated into the host

2036

02:30:17,510 --> 02:30:15,240

genome and there's usually a latent

2037

02:30:20,410 --> 02:30:17,520

phase in which it kind of just stays

2038

02:30:24,110 --> 02:30:20,420

there maybe some induction event happens

2039

02:30:26,690 --> 02:30:24,120

in ssv's case it actually just buds from

2040

02:30:28,429 --> 02:30:26,700

the cell without killing the cell and

2041

02:30:31,130 --> 02:30:28,439

one of the one of the two ways that we

2042

02:30:33,530 --> 02:30:31,140

use to test for this viral reproduction

2043

02:30:35,870 --> 02:30:33,540

is of course PCR so amplifying a

2044

02:30:38,469 --> 02:30:35,880

sequence that's specific to viral DNA

2045

02:30:42,110 --> 02:30:38,479

looking for its presence in cell-free

2046

02:30:44,090 --> 02:30:42,120

supernatants another way is through Halo

2047

02:30:45,590 --> 02:30:44,100

assay so very similar to a plaque assay

2048

02:30:46,550 --> 02:30:45,600

in which you look where cells are

2049

02:30:50,030 --> 02:30:46,560

bursting

2050

02:30:52,130 --> 02:30:50,040

we cultivate a lot of cells uninfected

2051

02:30:54,830 --> 02:30:52,140

sacroilobus cells like you saw in the

2052

02:30:56,870 --> 02:30:54,840

slide a while back and then we spot cell

2053

02:30:58,370 --> 02:30:56,880

free supernatants which contain these

2054

02:31:00,950 --> 02:30:58,380

mutant viruses

2055

02:31:03,830 --> 02:31:00,960

onto the plate and look for clearings

2056

02:31:06,830 --> 02:31:03,840

and this Halo assay is made possible

2057

02:31:10,070 --> 02:31:06,840

because of the fact that ssv1 buds from

2058

02:31:12,469 --> 02:31:10,080

its cell without killing the cell

2059

02:31:14,510 --> 02:31:12,479

um and the UN the infected cells grow

2060

02:31:16,910 --> 02:31:14,520

quite slower so it really converts this

2061

02:31:18,830 --> 02:31:16,920

growth stunting phenotype in the

2062

02:31:21,290 --> 02:31:18,840

sacrolobus cell

2063

02:31:23,030 --> 02:31:21,300

and looking at the toxin protein and

2064

02:31:24,469 --> 02:31:23,040

large a large majority of my work has

2065

02:31:28,370 --> 02:31:24,479

been looking at mutants that we've made

2066

02:31:30,290 --> 02:31:28,380

in this toxin protein and several uh

2067

02:31:31,910 --> 02:31:30,300

machine learning softwares have

2068

02:31:35,330 --> 02:31:31,920

indicated that there's a quite a high

2069

02:31:37,849 --> 02:31:35,340

probability of a cleavage site over here

2070

02:31:40,849 --> 02:31:37,859

behind this very hydrophobic

2071

02:31:42,469 --> 02:31:40,859

uh helicity right here and so I sought to

2072

02:31:45,710 --> 02:31:42,479

characterize at least this particular

2073

02:31:47,929 --> 02:31:45,720

mechanism in ssv1 through using some of

2074

02:31:51,530 --> 02:31:47,939

these mutants that we already have

2075

02:31:53,150 --> 02:31:51,540

um and while largely these over here are

2076

02:31:55,370 --> 02:31:53,160

our wild type so really shouldn't expect

2077

02:31:58,309 --> 02:31:55,380

any kind of change in viral function you

2078

02:32:01,130 --> 02:31:58,319

can see some really nice Halos and we

2079

02:32:03,170 --> 02:32:01,140

can confer that you know the cells are

2080

02:32:04,849 --> 02:32:03,180

not dying but they're sick

2081

02:32:08,630 --> 02:32:04,859

and in our mutants where we have

2082

02:32:10,790 --> 02:32:08,640

insertions in in that specific toxin uh

2083

02:32:12,410 --> 02:32:10,800

open reading frame we don't see any Halo

2084

02:32:15,469 --> 02:32:12,420

formation

2085

02:32:17,870 --> 02:32:15,479

um likewise I sought to substitute those

2086

02:32:20,570 --> 02:32:17,880

two uh residues at the cleavage site

2087

02:32:23,510 --> 02:32:20,580

since it's largely important for protein

2088

02:32:25,370 --> 02:32:23,520

maturation protein function and we still

2089

02:32:28,309 --> 02:32:25,380

don't see a Halo just switching those

2090

02:32:30,050 --> 02:32:28,319

two residues but the main takeaway from

2091

02:32:33,650 --> 02:32:30,060

this is that we still get virus

2092

02:32:35,450 --> 02:32:33,660

replication we still get quite a bit of

2093

02:32:37,210 --> 02:32:35,460

at least high levels of viral

2094

02:32:40,070 --> 02:32:37,220

replication from some of these mutants

2095

02:32:42,130 --> 02:32:40,080

and one of these mutants particular we

2096

02:32:43,969 --> 02:32:42,140

didn't see anything so maybe that one's

2097

02:32:46,730 --> 02:32:43,979

detrimental to that particular open

2098

02:32:49,309 --> 02:32:46,740

reading frame but we do see that there

2099

02:32:52,730 --> 02:32:49,319

is virus replication happening in the

2100

02:32:55,610 --> 02:32:52,740

cell supernatant when we screen for DNA

2101
02:32:57,830 --> 02:32:55,620
and it's important to kind of note that

2102
02:33:01,070 --> 02:32:57,840
this this protein isn't just unique to

2103
02:33:03,530 --> 02:33:01,080
ssv1 in in looking at these systems in

2104
02:33:05,570 --> 02:33:03,540
these extreme organisms uh this one in

2105
02:33:08,030 --> 02:33:05,580
particular up here is another SSV so

2106
02:33:10,070 --> 02:33:08,040
another spindle shape virus in which we

2107
02:33:13,250 --> 02:33:10,080
see really low sequence similarity

2108
02:33:15,469 --> 02:33:13,260
across these particular genes but quite

2109
02:33:17,570 --> 02:33:15,479
a hot quite a high bit of

2110
02:33:20,290 --> 02:33:17,580
um structural similarity between these

2111
02:33:23,090 --> 02:33:20,300
genes and a lot of these are

2112
02:33:25,969 --> 02:33:23,100
genomes of extremophiles while some are

2113
02:33:28,309 --> 02:33:25,979

virally encoded

2114

02:33:30,230 --> 02:33:28,319

and uh one of the main takeaways really

2115

02:33:32,030 --> 02:33:30,240

just wrapping uh wrapping it all back

2116

02:33:33,889 --> 02:33:32,040

around looking for these particular

2117

02:33:35,570 --> 02:33:33,899

mechanisms and how they confer

2118

02:33:38,389 --> 02:33:35,580

persistence with both their

2119

02:33:41,090 --> 02:33:38,399

extremophilic organism and their viruses

2120

02:33:43,389 --> 02:33:41,100

would be a really nice first start in

2121

02:33:47,570 --> 02:33:43,399

looking for these biosignatures perhaps

2122

02:33:49,670 --> 02:33:47,580

and ways that we can look into how the

2123

02:33:51,710 --> 02:33:49,680

microbes might be interacting

2124

02:33:53,870 --> 02:33:51,720

in these particular extreme environments

2125

02:33:56,270 --> 02:33:53,880

this is another sampling video

2126

02:33:58,790 --> 02:33:56,280

um just of last in volcanic Park pretty

2127

02:34:00,110 --> 02:33:58,800

pretty close to where s441 was isolated

2128

02:34:02,210 --> 02:34:00,120

from

2129

02:34:04,010 --> 02:34:02,220

uh looks pretty similar to maybe

2130

02:34:05,750 --> 02:34:04,020

something we'd see on another planet

2131

02:34:09,349 --> 02:34:05,760

that we could sample at

2132

02:34:11,330 --> 02:34:09,359

and then a Shameless plug but looking

2133

02:34:12,950 --> 02:34:11,340

for viruses in space I think is the

2134

02:34:14,950 --> 02:34:12,960

obvious next step we know that they're

2135

02:34:18,290 --> 02:34:14,960

the most abundant molecule in the planet

2136

02:34:19,910 --> 02:34:18,300

and just understanding that these

2137

02:34:22,429 --> 02:34:19,920

mechanisms and that these systems are

2138

02:34:25,130 --> 02:34:22,439

out there allowing these cells to thrive

2139

02:34:28,309 --> 02:34:25,140

in this particular environment would be

2140

02:34:30,950 --> 02:34:28,319

a great uh in starter conversation for

2141

02:34:32,090 --> 02:34:30,960

looking for these small biomolecules in

2142

02:34:34,309 --> 02:34:32,100

space

2143

02:34:35,690 --> 02:34:34,319

and with that I just want to thank my

2144

02:34:38,330 --> 02:34:35,700

loud

2145

02:34:41,450 --> 02:34:38,340

um my group over here at Boiling Springs

2146

02:34:50,929 --> 02:34:41,460

Lake when we collected samples and my Pi

2147

02:34:58,130 --> 02:34:53,090

thank you General we have a time for

2148

02:35:02,150 --> 02:35:00,230

hey my name is Pia and I'm really

2149

02:35:03,530 --> 02:35:02,160

interested in like crispr costume Unity

2150

02:35:05,030 --> 02:35:03,540

of microbes

2151
02:35:06,830 --> 02:35:05,040
um have you looked at all into the

2152
02:35:08,030 --> 02:35:06,840
interactions of other phage defense

2153
02:35:11,990 --> 02:35:08,040
systems

2154
02:35:14,330 --> 02:35:12,000
um yeah so at least in terms of uh this

2155
02:35:16,550 --> 02:35:14,340
toxin antitoxin system they're pretty

2156
02:35:18,050 --> 02:35:16,560
understood in bacterial cells to like

2157
02:35:21,530 --> 02:35:18,060
incorporate themselves into the genomic

2158
02:35:23,990 --> 02:35:21,540
crispr cas9 there are some proteins that

2159
02:35:25,790 --> 02:35:24,000
um that look pretty similar to this a291

2160
02:35:29,870 --> 02:35:25,800
and some of these other virally encoded

2161
02:35:33,410 --> 02:35:29,880
genes that do have some kind of crispr

2162
02:35:35,270 --> 02:35:33,420
casts editing mechanism so yeah I think

2163
02:35:36,710 --> 02:35:35,280

they it might be leaning towards that

2164

02:35:38,929 --> 02:35:36,720

way but they're pretty well

2165

02:35:41,630 --> 02:35:38,939

characterized in terms of like how they

2166

02:35:43,790 --> 02:35:41,640

work with proteins and mRNA so um yeah

2167

02:35:45,410 --> 02:35:43,800

not too far there yet but

2168

02:35:58,969 --> 02:35:45,420

um definitely definitely somewhere in

2169

02:36:04,670 --> 02:36:01,130

uh thank you for the talk Marshall

2170

02:36:06,290 --> 02:36:04,680

Seaton JPL and I I was curious so um

2171

02:36:08,450 --> 02:36:06,300

you're talking about looking for viruses

2172

02:36:10,070 --> 02:36:08,460

and extraterrestrial environments um do

2173

02:36:12,110 --> 02:36:10,080

you think there would be or I'm curious

2174

02:36:14,750 --> 02:36:12,120

I'm completely ignorant yeah no no I

2175

02:36:17,210 --> 02:36:14,760

dropped out of Bio too so for this

2176

02:36:20,090 --> 02:36:17,220

um for viruses specifically like would

2177

02:36:22,550 --> 02:36:20,100

small molecule biosignature classes vary

2178

02:36:25,730 --> 02:36:22,560

from viruses to like what you'd be

2179

02:36:27,950 --> 02:36:25,740

looking for with cells yeah yeah I I for

2180

02:36:29,270 --> 02:36:27,960

sure and that kind of brings me at least

2181

02:36:31,250 --> 02:36:29,280

back to a point like of looking for

2182

02:36:32,990 --> 02:36:31,260

fossils and stuff like that so viruses

2183

02:36:35,030 --> 02:36:33,000

and sediment

2184

02:36:37,309 --> 02:36:35,040

um and at least our lab there's been

2185

02:36:39,349 --> 02:36:37,319

some work in like silica and coding

2186

02:36:41,809 --> 02:36:39,359

viruses and how you know the stability

2187

02:36:43,790 --> 02:36:41,819

of them so maybe there's a pretty silica

2188

02:36:45,590 --> 02:36:43,800

Rich environment in which we might be

2189

02:36:47,750 --> 02:36:45,600

able to look for any kind of these

2190

02:36:50,389 --> 02:36:47,760

signatures so like proteins

2191

02:36:52,010 --> 02:36:50,399

um or or yeah just specific things that

2192

02:36:54,590 --> 02:36:52,020

might might have been preserved in those

2193

02:36:57,050 --> 02:36:54,600

particular environments considering that

2194

02:36:58,610 --> 02:36:57,060

these viruses live and thrive in in

2195

02:37:00,830 --> 02:36:58,620

pretty extremes

2196

02:37:02,150 --> 02:37:00,840

um you know they're they're they got to

2197

02:37:04,910 --> 02:37:02,160

be out there at least

2198

02:37:07,070 --> 02:37:04,920

and so you mentioned um uh looking at

2199

02:37:09,469 --> 02:37:07,080

like morphology and fossils and things

2200

02:37:11,690 --> 02:37:09,479

like that I know that at least for

2201

02:37:13,790 --> 02:37:11,700

um looking at cells and things

2202

02:37:16,429 --> 02:37:13,800

um they've been shown to to mimic

2203

02:37:18,469 --> 02:37:16,439

abiotic systems uh pretty well because

2204

02:37:22,190 --> 02:37:18,479

humans are very good pattern recognition

2205

02:37:23,830 --> 02:37:22,200

and so um has anything been seen like

2206

02:37:28,070 --> 02:37:23,840

that for viruses

2207

02:37:29,630 --> 02:37:28,080

yeah not that not that I'm familiar with

2208

02:37:31,550 --> 02:37:29,640

um I know it's at least a brand new

2209

02:37:33,710 --> 02:37:31,560

conversation of starting to look for

2210

02:37:36,050 --> 02:37:33,720

like viruses in space Astro virology

2211

02:37:38,150 --> 02:37:36,060

things like that so uh yeah we're just

2212

02:37:39,410 --> 02:37:38,160

kind of getting up and running oh yeah

2213

02:37:41,150 --> 02:37:39,420

yeah no sorry I don't mean to like play

2214

02:37:47,750 --> 02:37:41,160

20 Questions oh no no I just thought it

2215

02:37:52,010 --> 02:37:50,210

yeah yeah there's a there's a little

2216

02:37:54,050 --> 02:37:52,020

cure lab that like goes on right now

2217

02:37:58,910 --> 02:37:54,060

that I teach so I'm obviously not there

2218

02:37:58,920 --> 02:38:06,220

any other questions

2219

02:38:17,389 --> 02:38:13,610

[Applause]

2220

02:38:26,020 --> 02:38:17,399

our next speaker is Fatima liho from the

2221

02:39:11,650 --> 02:38:40,010

[Music]

2222

02:39:27,320 --> 02:39:13,920

thank you

2223

02:39:27,330 --> 02:39:31,010

[Music]

2224

02:39:31,020 --> 02:39:36,540

foreign

2225

02:40:23,630 --> 02:39:46,330

[Music]

2226
02:40:23,640 --> 02:40:32,200
thank you

2227
02:40:53,950 --> 02:40:40,110
[Music]

2228
02:41:03,340 --> 02:40:53,960
foreign

2229
02:41:53,330 --> 02:41:16,040
[Music]

2230
02:41:53,340 --> 02:41:57,500
thank you

2231
02:42:08,220 --> 02:42:04,530
[Music]

2232
02:42:20,770 --> 02:42:08,230
foreign

2233
02:42:51,710 --> 02:42:26,290
[Music]

2234
02:42:51,720 --> 02:42:57,190
foreign

2235
02:43:18,390 --> 02:43:13,970
[Music]

2236
02:43:33,010 --> 02:43:18,400
foreign

2237
02:44:03,490 --> 02:43:40,140
[Music]

2238
02:44:27,349 --> 02:44:05,290

thank you

2239

02:45:41,290 --> 02:44:27,359

[Music]

2240

02:45:46,849 --> 02:45:42,650

thank you

2241

02:46:08,630 --> 02:45:49,120

foreign

2242

02:46:33,250 --> 02:46:15,020

[Music]

2243

02:47:12,429 --> 02:46:34,580

thank you

2244

02:47:51,070 --> 02:47:12,439

[Music]

2245

02:47:58,850 --> 02:47:52,390

thank you

2246

02:49:01,480 --> 02:48:20,870

[Music]

2247

02:49:17,420 --> 02:49:01,490

thank you

2248

02:49:17,430 --> 02:49:38,389

[Music]

2249

02:49:38,399 --> 02:49:42,630

foreign

2250

02:50:27,490 --> 02:50:09,310

[Music]

2251
02:50:27,500 --> 02:50:35,280
thank you

2252
02:50:35,290 --> 02:50:58,190
[Music]

2253
02:51:19,920 --> 02:51:00,390
foreign

2254
02:51:42,849 --> 02:51:27,150
[Music]

2255
02:51:42,859 --> 02:51:49,510
Pena from Soma

2256
02:51:55,389 --> 02:51:53,929
hi everyone thank you for having me this

2257
02:51:58,010 --> 02:51:55,399
is a very special moment for me because

2258
02:52:00,530 --> 02:51:58,020
I am talking about going to talk about

2259
02:52:03,650 --> 02:52:00,540
hydrothermal dance so beans creeps have

2260
02:52:06,110 --> 02:52:03,660
is a very special moment so I'm happy to

2261
02:52:07,690 --> 02:52:06,120
share it with you and also about my PhD

2262
02:52:11,510 --> 02:52:07,700
Journey

2263
02:52:14,450 --> 02:52:11,520

so the link in hydrothermal veins is

2264

02:52:18,230 --> 02:52:14,460

very important between the the ocean

2265

02:52:21,950 --> 02:52:18,240

space Sciences since its Discovery in

2266

02:52:24,769 --> 02:52:21,960

the 70s the efforts to study the deep

2267

02:52:27,950 --> 02:52:24,779

ocean and these extreme environments has

2268

02:52:30,710 --> 02:52:27,960

increased a lot in these last years also

2269

02:52:32,570 --> 02:52:30,720

because of all the technology and all

2270

02:52:36,590 --> 02:52:32,580

the improvements that it has been made

2271

02:52:39,650 --> 02:52:36,600

through a study the deep sea and also

2272

02:52:42,910 --> 02:52:39,660

not only it was an outstanding Discovery

2273

02:52:45,530 --> 02:52:42,920

for your physicist geologists also for

2274

02:52:48,290 --> 02:52:45,540

biology and microbiologists that we

2275

02:52:50,809 --> 02:52:48,300

found these extreme ecosystems where we

2276

02:52:53,389 --> 02:52:50,819

are finding these extremophiles that are

2277

02:52:55,730 --> 02:52:53,399

high with high diversity not only

2278

02:52:58,490 --> 02:52:55,740

microbiology but also on microbiology

2279

02:53:01,309 --> 02:52:58,500

and in a bigger scope hydrothermal veins

2280

02:53:04,130 --> 02:53:01,319

are very important for astrobiology a

2281

02:53:06,070 --> 02:53:04,140

bigger scope is a origin of lightweight

2282

02:53:09,469 --> 02:53:06,080

is a very important thing in our planet

2283

02:53:12,110 --> 02:53:09,479

and also for looking

2284

02:53:14,389 --> 02:53:12,120

um live elsewhere also thermal van

2285

02:53:18,349 --> 02:53:14,399

systems has been proposed not only as

2286

02:53:21,910 --> 02:53:18,359

place where these structures have uh

2287

02:53:25,550 --> 02:53:21,920

have created or originated the molecules

2288

02:53:28,190 --> 02:53:25,560

for the cells but also for probably

2289

02:53:30,950 --> 02:53:28,200

there there are similar structures uh

2290

02:53:32,929 --> 02:53:30,960

existing in the icing wounds so this is

2291

02:53:36,110 --> 02:53:32,939

one of the biggest scope that we are

2292

02:53:38,450 --> 02:53:36,120

studying hydrothermal dance but a in

2293

02:53:40,250 --> 02:53:38,460

particular in this topic we are

2294

02:53:44,389 --> 02:53:40,260

exploring what is the Gulf of California

2295

02:53:46,790 --> 02:53:44,399

and Mexico so if you're will hit the

2296

02:53:49,429 --> 02:53:46,800

Gulf of California we are

2297

02:53:51,050 --> 02:53:49,439

here in Scripps out the north if you

2298

02:53:53,269 --> 02:53:51,060

cross the border here Tijuana and

2299

02:53:57,370 --> 02:53:53,279

Ensenada excellent tacos if you want to

2300

02:54:00,590 --> 02:53:57,380

stay longer you can tell me but for

2301

02:54:02,630 --> 02:54:00,600

studying the Gulf of California uh the

2302

02:54:05,050 --> 02:54:02,640

deep ocean has been studied for over a

2303

02:54:08,870 --> 02:54:05,060

decade and we have well they have found

2304

02:54:10,370 --> 02:54:08,880

that there is a series of transform

2305

02:54:11,150 --> 02:54:10,380

false

2306

02:54:14,090 --> 02:54:11,160

um

2307

02:54:15,830 --> 02:54:14,100

and spreading centers which have led to

2308

02:54:19,370 --> 02:54:15,840

the discovery of hydrothermal vent

2309

02:54:23,349 --> 02:54:19,380

systems in particular we have found here

2310

02:54:25,370 --> 02:54:23,359

it is uh impascular Basin at South

2311

02:54:27,290 --> 02:54:25,380

of the peninsula of the Gulf of

2312

02:54:29,090 --> 02:54:27,300

California we have found two

2313

02:54:32,090 --> 02:54:29,100

hydrothermaline systems I'm sorry they

2314

02:54:35,710 --> 02:54:32,100

they moved but here the yellow dot it's

2315

02:54:40,130 --> 02:54:35,720

called Alka and the Red Dot is called

2316

02:54:43,450 --> 02:54:40,140

Alka was discovered in 2015 and jagma

2317

02:54:46,790 --> 02:54:43,460

has were discovering 2018

2318

02:54:49,030 --> 02:54:46,800

these are the hierothermal band fields

2319

02:54:52,550 --> 02:54:49,040

that are at a depth of

2320

02:54:54,290 --> 02:54:52,560

3600 meters that this is the deepest

2321

02:54:56,450 --> 02:54:54,300

known halotemoral vein system in the

2322

02:54:59,349 --> 02:54:56,460

Pacific Ocean where it has levels to

2323

02:55:03,410 --> 02:54:59,359

study them as a very extreme ecosystem

2324

02:55:05,870 --> 02:55:03,420

and we have found that the the chemistry

2325

02:55:09,290 --> 02:55:05,880

of these harassment veins are it's very

2326

02:55:11,929 --> 02:55:09,300

unique they are made of calcite and they

2327

02:55:15,429 --> 02:55:11,939

have been some temperature measurements

2328

02:55:18,830 --> 02:55:15,439

of between the 20 degrees to 100 degrees

2329

02:55:20,870 --> 02:55:18,840

Celsius in around the 30 minutes but one

2330

02:55:25,670 --> 02:55:20,880

of the the highest hydrothermal veins

2331

02:55:28,610 --> 02:55:25,680

temperature goes around 300 degrees so

2332

02:55:29,990 --> 02:55:28,620

uh one of the questions that we have one

2333

02:55:31,730 --> 02:55:30,000

of the big questions that we have for

2334

02:55:34,429 --> 02:55:31,740

studying this hydrothermal vein systems

2335

02:55:36,710 --> 02:55:34,439

is who are the microbes related to the

2336

02:55:39,349 --> 02:55:36,720

hydrothermal fluids in the sediments of

2337

02:55:41,090 --> 02:55:39,359

the Alka and jagma Halo thermal band

2338

02:55:44,389 --> 02:55:41,100

feels because we don't know a lot of

2339

02:55:46,730 --> 02:55:44,399

these heart Hamilton systems so the

2340

02:55:47,570 --> 02:55:46,740

first question was who are them

2341

02:55:51,349 --> 02:55:47,580

um

2342

02:55:55,010 --> 02:55:51,359

so for this an oceanic oceanographic

2343

02:55:59,349 --> 02:55:55,020

expedition was made in 2018 about the

2344

02:56:03,410 --> 02:55:59,359

research vessel Falcor and this research

2345

02:56:07,429 --> 02:56:03,420

vessel has a ROV called Sebastian which

2346

02:56:10,010 --> 02:56:07,439

is a Rover that left us submerged and

2347

02:56:13,370 --> 02:56:10,020

with our robotic arm it had it was able

2348

02:56:15,469 --> 02:56:13,380

to take some samples of the sediments so

2349

02:56:17,150 --> 02:56:15,479

here you can see a little insight about

2350

02:56:19,429 --> 02:56:17,160

how are the sediments around this

2351

02:56:21,889 --> 02:56:19,439

hydrothermal vents all the things all

2352

02:56:26,650 --> 02:56:21,899

the white stuff that you see around is

2353

02:56:29,710 --> 02:56:26,660

microbial mat so we collected around 30

2354

02:56:35,030 --> 02:56:29,720

push core sediments

2355

02:56:37,730 --> 02:56:35,040

and all these core samples were section

2356

02:56:39,769 --> 02:56:37,740

um on the ship and it will stop

2357

02:56:44,269 --> 02:56:39,779

something with um

2358

02:56:46,730 --> 02:56:44,279

for taking DNA extraction to do poor

2359

02:56:48,590 --> 02:56:46,740

Water Analysis back in the lab we made

2360

02:56:52,370 --> 02:56:48,600

some iron chromatography DNA

2361

02:56:53,809 --> 02:56:52,380

amplification of 16s some sequencing and

2362

02:56:56,750 --> 02:56:53,819

bioinformatics and of course some

2363

02:56:58,730 --> 02:56:56,760

statistical analysis and so here I'm

2364

02:57:02,750 --> 02:56:58,740

going to present you some of the of the

2365

02:57:05,030 --> 02:57:02,760

results of of this so one of I'll the

2366

02:57:08,210 --> 02:57:05,040

questions we also have in the first

2367

02:57:10,490 --> 02:57:08,220

place it's how are Alka and Jack Maja

2368

02:57:13,190 --> 02:57:10,500

are compared how are these hydrothermal

2369

02:57:16,910 --> 02:57:13,200

vein systems related because uh our

2370

02:57:20,030 --> 02:57:16,920

contigma are like two kilometers away so

2371

02:57:23,030 --> 02:57:20,040

we wanted to compare how much are they

2372

02:57:24,950 --> 02:57:23,040

similar in terms of the geochemistry and

2373

02:57:29,769 --> 02:57:24,960

all the microbiology that we have been

2374

02:57:32,750 --> 02:57:29,779

found in so we perform this MDS analysis

2375

02:57:35,389 --> 02:57:32,760

so if you see that we have three

2376

02:57:38,330 --> 02:57:35,399

different locations Alka and jagmada are

2377

02:57:40,370 --> 02:57:38,340

the Hamilton Fields but we also have a

2378

02:57:42,349 --> 02:57:40,380

Dollar location that is called your

2379

02:57:45,290 --> 02:57:42,359

vacuum I'm sorry for the names all the

2380

02:57:48,469 --> 02:57:45,300

names are native words from the region

2381

02:57:51,889 --> 02:57:48,479

so that's how we decided Well scientists

2382

02:57:54,830 --> 02:57:51,899

have decided to to name them these both

2383

02:57:57,469 --> 02:57:54,840

are hydrothermal vein systems but all

2384

02:58:00,170 --> 02:57:57,479

the vacuum is a site between them but

2385

02:58:03,170 --> 02:58:00,180

it's a death uh hydrothermal veins site

2386

02:58:07,670 --> 02:58:03,180

so it's not active anymore so we use it

2387

02:58:10,730 --> 02:58:07,680

as an outsider to do this test so in

2388

02:58:14,690 --> 02:58:10,740

general terms you can see that they are

2389

02:58:17,630 --> 02:58:14,700

very similar okay and and jagma and here

2390

02:58:22,309 --> 02:58:17,640

is this is the outsider your vacuum that

2391

02:58:25,130 --> 02:58:22,319

it looks um not that similar to them so

2392

02:58:27,710 --> 02:58:25,140

they are sharing uh a lot of of things

2393

02:58:29,809 --> 02:58:27,720

but we are exactly we don't say we don't

2394

02:58:32,450 --> 02:58:29,819

know what if it's the geochemistry of

2395

02:58:35,090 --> 02:58:32,460

this the microbiology so

2396

02:58:36,950 --> 02:58:35,100

um we want to go further in to study the

2397

02:58:39,290 --> 02:58:36,960

microbial composition of both of them

2398

02:58:41,210 --> 02:58:39,300

and compare them and to see if they are

2399

02:58:44,090 --> 02:58:41,220

related or what are the difference

2400

02:58:44,750 --> 02:58:44,100

between them and one of the

2401

02:58:48,590 --> 02:58:44,760

um

2402

02:58:50,450 --> 02:58:48,600

a biggest surprises that we have is that

2403

02:58:52,910 --> 02:58:50,460

the microbes are related to the

2404

02:58:56,090 --> 02:58:52,920

hydrothermal fluids but between Alka and

2405

02:58:59,469 --> 02:58:56,100

jagma the well the microbes are

2406

02:59:01,929 --> 02:58:59,479

different they have we have different a

2407

02:59:06,349 --> 02:59:01,939

film composition

2408

02:59:07,929 --> 02:59:06,359

uh but the only uh film they share is

2409

02:59:10,190 --> 02:59:07,939

Thermo thermostat

2410

02:59:12,830 --> 02:59:10,200

so this is a very

2411

02:59:14,870 --> 02:59:12,840

um interesting thing to to explore that

2412

02:59:16,730 --> 02:59:14,880

we are finding different microbial

2413

02:59:18,769 --> 02:59:16,740

communities between those those are

2414

02:59:21,849 --> 02:59:18,779

thermal veins but we are they are

2415

02:59:25,730 --> 02:59:21,859

sharing one so this is telling us about

2416

02:59:28,450 --> 02:59:25,740

the thermophilic and hydrothermal flow

2417

02:59:30,830 --> 02:59:28,460

is all the ambient all the the

2418

02:59:34,309 --> 02:59:30,840

conditions extreme conditions that are

2419

02:59:35,750 --> 02:59:34,319

around and also they tell us about all

2420

02:59:38,210 --> 02:59:35,760

the um

2421

02:59:41,269 --> 02:59:38,220

your Chemistry that is happening is

2422

02:59:42,950 --> 02:59:41,279

telling us about all it's very complex I

2423

02:59:45,410 --> 02:59:42,960

think that all the metabolism that is

2424

02:59:47,990 --> 02:59:45,420

going on between these sediments around

2425

02:59:51,230 --> 02:59:48,000

Harold Hamilton events so we are trying

2426
02:59:53,530 --> 02:59:51,240
to explore furthermore about this uh

2427
02:59:55,969 --> 02:59:53,540
group the thermo togoda that they are

2428
03:00:00,410 --> 02:59:55,979
extremophiles they are adopted more than

2429
03:00:03,830 --> 03:00:00,420
50 degrees or 80 degrees Celsius so we

2430
03:00:05,269 --> 03:00:03,840
are trying to to understand if these are

2431
03:00:07,730 --> 03:00:05,279
like the same families that they are

2432
03:00:11,030 --> 03:00:07,740
sharing or not that's one of the next

2433
03:00:12,950 --> 03:00:11,040
steps for this but also the implications

2434
03:00:16,090 --> 03:00:12,960
for astrobiology in term for a

2435
03:00:19,490 --> 03:00:16,100
hypothermal veins is that we are ex

2436
03:00:21,769 --> 03:00:19,500
still exploring a lot of findings on

2437
03:00:24,050 --> 03:00:21,779
thermophilic microbial communities in

2438
03:00:26,269 --> 03:00:24,060

this hydrothermal vein systems so try to

2439

03:00:29,389 --> 03:00:26,279

understand the limits of Life on our

2440

03:00:31,190 --> 03:00:29,399

Earth as it is one of the deepest points

2441

03:00:33,830 --> 03:00:31,200

of the Pacific Ocean it is telling us a

2442

03:00:37,370 --> 03:00:33,840

lot of information about that and also

2443

03:00:39,769 --> 03:00:37,380

all another step for the investigation

2444

03:00:41,809 --> 03:00:39,779

that is going on it's applying it to the

2445

03:00:45,889 --> 03:00:41,819

icy moons with habitable habitability

2446

03:00:47,110 --> 03:00:45,899

models where we can try to add these

2447

03:00:51,170 --> 03:00:47,120

ecological

2448

03:00:54,290 --> 03:00:51,180

models and now we have data to try to

2449

03:00:56,929 --> 03:00:54,300

simulate this we have geochemistry data

2450

03:00:59,809 --> 03:00:56,939

we have microbiology data so we can try

2451
03:01:02,389 --> 03:00:59,819
to approach ecological model to the

2452
03:01:05,630 --> 03:01:02,399
isomers if someone in the isemons wants

2453
03:01:08,290 --> 03:01:05,640
to collaborate please let me know

2454
03:01:11,150 --> 03:01:08,300
um uh well the highlights of this

2455
03:01:12,710 --> 03:01:11,160
presentations to take away I want you to

2456
03:01:14,929 --> 03:01:12,720
well to

2457
03:01:16,790 --> 03:01:14,939
uh to show you some of the hydrothermal

2458
03:01:20,030 --> 03:01:16,800
veins how the hydrothermal vent system

2459
03:01:23,210 --> 03:01:20,040
looks like in pascular Basin but this is

2460
03:01:25,130 --> 03:01:23,220
the first uh insight into Jack Maja

2461
03:01:27,110 --> 03:01:25,140
ahara thermal vent field and its

2462
03:01:30,590 --> 03:01:27,120
microbiology the first time that we have

2463
03:01:32,630 --> 03:01:30,600

seen this our findings provide valuable

2464

03:01:34,849 --> 03:01:32,640

insight into the deep sea biosphere and

2465

03:01:36,830 --> 03:01:34,859

that we are learning that we there are a

2466

03:01:39,490 --> 03:01:36,840

lot of information that still need to be

2467

03:01:43,610 --> 03:01:39,500

processed and to know and to discover

2468

03:01:45,830 --> 03:01:43,620

and we have uh found a diverse range of

2469

03:01:47,929 --> 03:01:45,840

extremophiles in microbial communities

2470

03:01:50,389 --> 03:01:47,939

right now I'm just talking about the

2471

03:01:53,750 --> 03:01:50,399

thermophiles but we have methane

2472

03:01:55,969 --> 03:01:53,760

oxidizers anaerobic micro microbial

2473

03:01:58,969 --> 03:01:55,979

organisms so there are a lot of things

2474

03:02:00,889 --> 03:01:58,979

going not in the in the tab and well

2475

03:02:03,410 --> 03:02:00,899

knowing that the Pescadero Basin is the

2476
03:02:05,630 --> 03:02:03,420
deepest hydrothermal ecosystem in the

2477
03:02:07,849 --> 03:02:05,640
Pacific Ocean well it implies that we

2478
03:02:11,389 --> 03:02:07,859
are still understanding the limits of

2479
03:02:13,730 --> 03:02:11,399
life on Earth ambitions so with this I

2480
03:02:15,710 --> 03:02:13,740
want to thank you please uh if you want

2481
03:02:18,290 --> 03:02:15,720
to know a little more about the Mexican

2482
03:02:20,269 --> 03:02:18,300
astrology Society there is a link and I

2483
03:02:21,769 --> 03:02:20,279
am also from the astrobiology lab at

2484
03:02:22,920 --> 03:02:21,779
UNAM and we are happy to collaborate

2485
03:02:41,590 --> 03:02:22,930
thank you

2486
03:02:43,969 --> 03:02:41,600
um I was just curious do you find many

2487
03:02:46,070 --> 03:02:43,979
nanoprokaryotes like Nano archaea or

2488
03:02:48,650 --> 03:02:46,080

like candidate Philo radiation bacteria

2489

03:02:50,150 --> 03:02:48,660

and or do just filter them out in your

2490

03:02:52,070 --> 03:02:50,160

analyzes somehow or like are there any

2491

03:02:55,190 --> 03:02:52,080

interesting patterns

2492

03:02:57,530 --> 03:02:55,200

well Ryan well we're finding uh also

2493

03:02:59,750 --> 03:02:57,540

Archaea and bacteria well that's like

2494

03:03:02,210 --> 03:02:59,760

the further that we have like now there

2495

03:03:03,889 --> 03:03:02,220

is a lot still no information to to show

2496

03:03:05,269 --> 03:03:03,899

up but there is there's a lot of things

2497

03:03:07,550 --> 03:03:05,279

going on

2498

03:03:09,230 --> 03:03:07,560

yeah I just remember like looking

2499

03:03:11,570 --> 03:03:09,240

through various papers is there a lot of

2500

03:03:13,969 --> 03:03:11,580

them a lot of those like Nano sized

2501

03:03:16,730 --> 03:03:13,979

Clays present in the hydrogen events

2502

03:03:19,269 --> 03:03:16,740

like Nano archiora or yeah like nanarkio

2503

03:03:25,429 --> 03:03:19,279

or yeah

2504

03:03:31,910 --> 03:03:29,330

yes sorry uh just kind of curious I I'm

2505

03:03:35,150 --> 03:03:31,920

um so I'm a physics kind of background

2506

03:03:36,349 --> 03:03:35,160

person of mrsd and

2507

03:03:39,349 --> 03:03:36,359

I was wondering about temperature

2508

03:03:40,790 --> 03:03:39,359

management so like you know above above

2509

03:03:42,349 --> 03:03:40,800

certain temperatures like you're gonna

2510

03:03:44,090 --> 03:03:42,359

get denatured proteins and stuff like

2511

03:03:46,910 --> 03:03:44,100

that and I was wondering if there's

2512

03:03:49,250 --> 03:03:46,920

extremophiles that do like that cool

2513

03:03:51,290 --> 03:03:49,260

themselves somehow or any anything like

2514

03:03:54,590 --> 03:03:51,300

that sorry

2515

03:03:57,410 --> 03:03:54,600

yes uh actually well right now I'm here

2516

03:04:00,710 --> 03:03:57,420

I'm talking again as uh with

2517

03:04:02,510 --> 03:04:00,720

thermophiles but actually here in the

2518

03:04:04,550 --> 03:04:02,520

hierothermal veins well not the

2519

03:04:06,170 --> 03:04:04,560

hydrothermal vents around thermal veins

2520

03:04:08,750 --> 03:04:06,180

all these sediments there are different

2521

03:04:10,790 --> 03:04:08,760

changes in temperature so right now I am

2522

03:04:14,570 --> 03:04:10,800

talking about the highest ones that we

2523

03:04:17,150 --> 03:04:14,580

have a measure but if you go further the

2524

03:04:21,290 --> 03:04:17,160

hydrothermal bands it drops to 2 degrees

2525

03:04:23,330 --> 03:04:21,300

Centigrades so we are studying well it's

2526

03:04:25,070 --> 03:04:23,340

able to study different microbial

2527

03:04:27,230 --> 03:04:25,080

communities adapted to high temperatures

2528

03:04:31,190 --> 03:04:27,240

but also to call call these places

2529

03:04:31,200 --> 03:04:40,190

any other questions for a minute

2530

03:04:45,110 --> 03:04:42,590

hey really awesome talk this is really

2531

03:04:46,429 --> 03:04:45,120

cool I worked with hydrothem events as

2532

03:04:48,170 --> 03:04:46,439

an undergrad so this is like really

2533

03:04:50,330 --> 03:04:48,180

nostalgic for me

2534

03:04:52,610 --> 03:04:50,340

um I'm curious if anyone in your group

2535

03:04:54,050 --> 03:04:52,620

or anyone part of the the cruise is

2536

03:04:56,210 --> 03:04:54,060

doing it and

2537

03:04:58,849 --> 03:04:56,220

Karen Lloyd wouldn't wouldn't like this

2538

03:05:02,630 --> 03:04:58,859

but is doing any culturing from these

2539

03:05:04,730 --> 03:05:02,640

environments yes like specifically I'm

2540

03:05:06,530 --> 03:05:04,740

thinking at high pressure because these

2541

03:05:07,670 --> 03:05:06,540

are some of the like deeper vents in the

2542

03:05:09,290 --> 03:05:07,680

Pacific or the deepest vents in the

2543

03:05:11,630 --> 03:05:09,300

Pacific I think you said and so I'm just

2544

03:05:14,690 --> 03:05:11,640

curious if anyone's doing culturing and

2545

03:05:19,370 --> 03:05:14,700

if they're including pressure in that

2546

03:05:21,469 --> 03:05:19,380

Yes actually one of the uh here in one

2547

03:05:25,309 --> 03:05:21,479

of the collaborations that we have is in

2548

03:05:27,170 --> 03:05:25,319

Caltech in Victoria orphan's lab yes uh

2549

03:05:30,010 --> 03:05:27,180

the group are making some cultural

2550

03:05:32,690 --> 03:05:30,020

experiments with some of the different

2551

03:05:35,389 --> 03:05:32,700

sediment cores in different sites so

2552

03:05:37,490 --> 03:05:35,399

they are trying to to do that and they

2553

03:05:40,190 --> 03:05:37,500

have also published one paper about

2554

03:05:42,650 --> 03:05:40,200

culture in archaea I think so they are

2555

03:05:44,870 --> 03:05:42,660

they are doing it but of course the

2556

03:05:46,910 --> 03:05:44,880

challenging things about depression so

2557

03:05:50,090 --> 03:05:46,920

they have like this tank

2558

03:05:51,710 --> 03:05:50,100

to try to approach that yes they are

2559

03:05:53,150 --> 03:05:51,720

trying to do cultural techniques for

2560

03:05:56,809 --> 03:05:53,160

this

2561

03:05:56,819 --> 03:06:10,849

any questions here

2562

03:06:14,330 --> 03:06:13,309

I thank you for the talk

2563

03:06:18,710 --> 03:06:14,340

um

2564

03:06:21,050 --> 03:06:18,720

I have a very trivial question uh we've

2565

03:06:23,090 --> 03:06:21,060

been having issues with sediment samples

2566

03:06:26,450 --> 03:06:23,100

in our lab

2567

03:06:28,969 --> 03:06:26,460

um freaking out how not to contaminate

2568

03:06:31,730 --> 03:06:28,979

them or not being sure if they are

2569

03:06:34,849 --> 03:06:31,740

contaminated when we are taking the

2570

03:06:36,889 --> 03:06:34,859

samples I wonder how you control control

2571

03:06:40,849 --> 03:06:36,899

for that

2572

03:06:43,670 --> 03:06:40,859

yeah that's a good question so when we

2573

03:06:45,769 --> 03:06:43,680

are working on uh on the ship

2574

03:06:47,510 --> 03:06:45,779

um back in the lab there is a lot of

2575

03:06:51,650 --> 03:06:47,520

possibilities that it got contaminated

2576

03:06:54,469 --> 03:06:51,660

we will try to be as quick as possible

2577

03:06:57,830 --> 03:06:54,479

and in clean spaces but we actually

2578

03:06:59,389 --> 03:06:57,840

where we are working with salmon course

2579

03:07:01,910 --> 03:06:59,399

it's moth

2580

03:07:04,309 --> 03:07:01,920

so it gets really moved all around we

2581

03:07:07,010 --> 03:07:04,319

try to clean but we just try to be as

2582

03:07:10,670 --> 03:07:07,020

quick as possible one of the things that

2583

03:07:13,670 --> 03:07:10,680

we rely on is a bioinformatic analysis

2584

03:07:14,469 --> 03:07:13,680

so in the informatic analysis when we

2585

03:07:17,090 --> 03:07:14,479

are

2586

03:07:19,910 --> 03:07:17,100

processing all the 16s data the

2587

03:07:23,870 --> 03:07:19,920

sequences we are filtering them so we

2588

03:07:26,570 --> 03:07:23,880

have like uh we process we have also for

2589

03:07:29,809 --> 03:07:26,580

the 16s or the DNA extractions on blanks

2590

03:07:33,650 --> 03:07:29,819

and some control samples so we tried

2591

03:07:36,889 --> 03:07:33,660

like if there is a sequence uh in the

2592

03:07:39,110 --> 03:07:36,899

blank on the control we delete them so

2593

03:07:41,090 --> 03:07:39,120

we try to filter and to make the the

2594

03:07:43,910 --> 03:07:41,100

cleanest sequence possible as possible

2595

03:07:45,889 --> 03:07:43,920

but yeah of course there is some

2596

03:07:47,570 --> 03:07:45,899

contamination and we also like sometimes

2597

03:07:49,969 --> 03:07:47,580

we see like oh that's that's not from

2598

03:07:52,309 --> 03:07:49,979

the deep sea but we try to see the the

2599

03:07:54,830 --> 03:07:52,319

sequences and try to clean them that's

2600

03:07:54,840 --> 03:07:58,910

any last questions

2601
03:07:58,920 --> 03:08:08,510
okay thank you very much thank you

2602
03:08:13,429 --> 03:08:11,269
okay so lunch is served in Surfside and

2603
03:08:23,310 --> 03:08:13,439
then we'll be back for the short talk

2604
03:09:09,130 --> 03:08:42,920
[Music]

2605
03:09:09,140 --> 03:09:15,350
thank you

2606
03:09:25,660 --> 03:09:23,349
[Music]

2607
03:09:41,130 --> 03:09:25,670
thank you

2608
03:09:52,040 --> 03:09:49,929
[Music]

2609
03:10:07,990 --> 03:09:52,050
thank you

2610
03:10:08,000 --> 03:10:25,389
[Music]

2611
03:10:30,950 --> 03:10:26,710
thank you

2612
03:10:59,140 --> 03:10:33,930
foreign

2613
03:10:59,150 --> 03:11:03,410

[Music]

2614

03:11:25,840 --> 03:11:05,270

foreign

2615

03:12:35,290 --> 03:11:51,770

[Music]

2616

03:12:35,300 --> 03:12:42,930

thank you

2617

03:13:15,010 --> 03:13:09,640

[Music]

2618

03:13:31,780 --> 03:13:15,020

thank you

2619

03:13:45,570 --> 03:13:43,849

[Music]

2620

03:13:54,800 --> 03:13:45,580

thank you

2621

03:15:33,950 --> 03:14:16,170

[Music]

2622

03:15:33,960 --> 03:15:38,670

foreign

2623

03:16:20,510 --> 03:15:46,040

[Music]

2624

03:16:20,520 --> 03:16:24,610

thank you

2625

03:16:24,620 --> 03:16:47,750

[Music]

2626
03:17:19,970 --> 03:16:49,500
foreign

2627
03:17:19,980 --> 03:17:29,510
[Music]

2628
03:17:29,520 --> 03:17:36,690
thank you

2629
03:18:00,230 --> 03:17:52,430
[Music]

2630
03:18:00,240 --> 03:18:05,760
foreign

2631
03:18:41,889 --> 03:18:18,090
[Music]

2632
03:18:50,050 --> 03:18:43,470
thank you

2633
03:19:11,990 --> 03:18:59,210
[Music]

2634
03:19:30,420 --> 03:19:13,720
foreign

2635
03:19:30,430 --> 03:19:43,130
[Music]

2636
03:19:43,140 --> 03:19:50,040
foreign

2637
03:20:13,370 --> 03:20:07,320
[Music]

2638
03:20:13,380 --> 03:20:24,020

thank you

2639

03:20:35,110 --> 03:20:30,220

[Music]

2640

03:20:35,120 --> 03:20:39,390

thank you

2641

03:21:47,170 --> 03:20:48,540

[Music]

2642

03:21:55,320 --> 03:21:50,130

thank you

2643

03:22:16,190 --> 03:22:02,180

[Music]

2644

03:22:36,800 --> 03:22:16,200

foreign

2645

03:22:36,810 --> 03:22:42,230

[Music]

2646

03:22:53,850 --> 03:22:43,340

thank you

2647

03:23:38,090 --> 03:22:56,210

[Music]

2648

03:23:38,100 --> 03:23:41,830

foreign

2649

03:24:49,140 --> 03:23:52,050

[Music]

2650

03:25:06,590 --> 03:24:49,150

foreign

2651
03:25:19,940 --> 03:25:15,760
[Music]

2652
03:25:44,910 --> 03:25:19,950
foreign

2653
03:26:11,410 --> 03:26:05,240
[Music]

2654
03:26:11,420 --> 03:26:14,580
thank you

2655
03:27:15,410 --> 03:26:26,020
[Music]

2656
03:27:21,170 --> 03:27:15,420
thank you

2657
03:27:55,660 --> 03:27:35,530
[Music]

2658
03:28:04,020 --> 03:27:55,670
foreign

2659
03:28:32,230 --> 03:28:17,030
[Music]

2660
03:28:44,440 --> 03:28:32,240
thank you

2661
03:29:03,710 --> 03:28:52,970
[Music]

2662
03:29:07,190 --> 03:29:03,720
thank you

2663
03:29:38,469 --> 03:29:16,660

[Music]

2664

03:29:38,479 --> 03:29:46,510

thank you

2665

03:30:14,450 --> 03:30:10,430

[Music]

2666

03:30:14,460 --> 03:30:17,300

foreign

2667

03:30:48,240 --> 03:30:25,480

[Music]

2668

03:31:14,860 --> 03:30:48,250

foreign

2669

03:31:28,670 --> 03:31:26,120

[Music]

2670

03:31:31,849 --> 03:31:28,680

thank you

2671

03:32:07,370 --> 03:31:31,859

[Music]

2672

03:32:39,840 --> 03:32:10,010

thank you

2673

03:33:50,990 --> 03:32:42,650

[Music]

2674

03:34:28,870 --> 03:33:56,030

foreign

2675

03:35:08,090 --> 03:34:54,610

[Music]

2676
03:35:08,100 --> 03:35:12,010
foreign

2677
03:36:22,969 --> 03:35:37,010
[Music]

2678
03:36:22,979 --> 03:36:57,010
foreign

2679
03:37:39,830 --> 03:37:08,870
[Music]

2680
03:37:39,840 --> 03:38:08,010
foreign

2681
03:38:47,690 --> 03:38:17,010
[Music]

2682
03:38:47,700 --> 03:38:52,360
foreign

2683
03:39:34,730 --> 03:39:14,380
[Music]

2684
03:40:04,450 --> 03:39:34,740
foreign

2685
03:40:04,460 --> 03:40:07,870
thank you

2686
03:40:07,880 --> 03:40:29,809
[Music]

2687
03:41:08,750 --> 03:40:31,940
quickly

2688
03:41:08,760 --> 03:41:18,320

foreign

2689

03:41:18,330 --> 03:41:47,510

[Music]

2690

03:41:59,900 --> 03:41:47,890

thank you

2691

03:42:23,450 --> 03:42:11,170

[Music]

2692

03:42:52,760 --> 03:42:24,420

foreign

2693

03:42:52,770 --> 03:43:07,910

[Music]

2694

03:43:07,920 --> 03:43:10,370

thank you

2695

03:43:43,540 --> 03:43:21,620

[Music]

2696

03:44:10,309 --> 03:43:43,550

thank you

2697

03:44:10,319 --> 03:44:13,820

foreign

2698

03:44:47,210 --> 03:44:32,090

[Music]

2699

03:44:57,240 --> 03:44:47,220

foreign

2700

03:45:20,090 --> 03:45:04,840

[Music]

2701
03:45:20,100 --> 03:45:24,270
foreign

2702
03:45:53,990 --> 03:45:31,380
[Music]

2703
03:45:54,000 --> 03:45:57,670
foreign

2704
03:46:44,090 --> 03:46:13,490
[Music]

2705
03:47:15,020 --> 03:46:47,060
foreign

2706
03:48:16,870 --> 03:47:27,790
[Music]

2707
03:48:24,450 --> 03:48:19,010
thank you

2708
03:49:30,889 --> 03:48:55,580
[Music]

2709
03:49:48,020 --> 03:49:32,380
foreign

2710
03:50:37,510 --> 03:50:00,050
[Music]

2711
03:50:37,520 --> 03:50:44,450
thank you

2712
03:50:55,450 --> 03:50:46,260
foreign

2713
03:51:49,010 --> 03:51:14,070

[Music]

2714

03:52:06,020 --> 03:51:50,850

foreign

2715

03:53:05,510 --> 03:52:31,920

[Music]

2716

03:53:08,610 --> 03:53:07,429

thank you

2717

03:53:13,910 --> 03:53:08,620

foreign

2718

03:54:03,229 --> 03:53:41,630

[Music]

2719

03:54:19,450 --> 03:54:03,960

foreign

2720

03:54:19,460 --> 03:54:24,760

excuse me

2721

03:58:41,780 --> 03:54:31,650

[Music]

2722

03:58:49,969 --> 03:58:48,410

[Applause]

2723

03:58:51,349 --> 03:58:49,979

all right hello everyone how's it going

2724

03:58:53,450 --> 03:58:51,359

my name's Sean I'm from the University

2725

03:58:54,830 --> 03:58:53,460

of Maryland Baltimore County and today

2726

03:58:56,570 --> 03:58:54,840

we're going to be looking at xenoamino

2727

03:58:58,910 --> 03:58:56,580

acids a look into biochemistry as we

2728

03:59:00,229 --> 03:58:58,920

don't know it so I'm going to fly

2729

03:59:01,790 --> 03:59:00,239

through a lot of this because it's only

2730

03:59:03,530 --> 03:59:01,800

a six minute talk but please come for

2731

03:59:05,570 --> 03:59:03,540

feel free to come find me at my poster

2732

03:59:08,210 --> 03:59:05,580

outside afterwards so my project

2733

03:59:10,910 --> 03:59:08,220

attempts to merge Theory with experiment

2734

03:59:12,769 --> 03:59:10,920

in order to test if a alternative amino

2735

03:59:14,750 --> 03:59:12,779

acid set is capable of building protein

2736

03:59:16,250 --> 03:59:14,760

structure now to do this we need to

2737

03:59:18,889 --> 03:59:16,260

select a candidate alphabet from

2738

03:59:21,229 --> 03:59:18,899

plausible Alternatives and from there

2739

03:59:23,889 --> 03:59:21,239

use our collaborators over at the

2740

03:59:26,990 --> 03:59:23,899

Charles University in Prague to build

2741

03:59:28,550 --> 03:59:27,000

oligopeptides now I'm going to take a

2742

03:59:30,229 --> 03:59:28,560

step back here and go over some very

2743

03:59:33,349 --> 03:59:30,239

quick background

2744

03:59:35,450 --> 03:59:33,359

um so all life on Earth since Lucas use

2745

03:59:37,550 --> 03:59:35,460

the same set of 20 Alpha amino acids to

2746

03:59:39,110 --> 03:59:37,560

construct metabolism now multiple

2747

03:59:40,790 --> 03:59:39,120

disciplines agree that there were far

2748

03:59:43,189 --> 03:59:40,800

more than 20 available for early

2749

03:59:45,410 --> 03:59:43,199

evolution in the origins of life

2750

03:59:46,389 --> 03:59:45,420

and over the last decade or so there's

2751
03:59:48,650 --> 03:59:46,399
been

2752
03:59:51,349 --> 03:59:48,660
theoretical work that identifies as

2753
03:59:53,870 --> 03:59:51,359
simple but statistical profile that

2754
03:59:56,330 --> 03:59:53,880
distinguishes life's amino acids from

2755
03:59:58,910 --> 03:59:56,340
Alternatives and that is that the 20

2756
04:00:01,729 --> 03:59:58,920
amino acids used by life exhibit a

2757
04:00:03,950 --> 04:00:01,739
non-random coverage of size and

2758
04:00:06,110 --> 04:00:03,960
hydrophobicity when we Define coverage

2759
04:00:08,750 --> 04:00:06,120
as the range of values in a set and with

2760
04:00:11,090 --> 04:00:08,760
how and how they how evenly they

2761
04:00:12,889 --> 04:00:11,100
distribute across that range

2762
04:00:14,330 --> 04:00:12,899
so what do I mean by that exactly I want

2763
04:00:16,910 --> 04:00:14,340

you to consider a set of five amino

2764

04:00:20,030 --> 04:00:16,920

acids and pick any physical chemical

2765

04:00:22,969 --> 04:00:20,040

descriptor this could be size this could

2766

04:00:25,130 --> 04:00:22,979

be volume I'm sorry uh log P this could

2767

04:00:27,290 --> 04:00:25,140

be charge and you're going to measure

2768

04:00:30,110 --> 04:00:27,300

them rank order them and plot them on

2769

04:00:32,929 --> 04:00:30,120

that axis from here what we can do is we

2770

04:00:35,689 --> 04:00:32,939

can get the intervals between each amino

2771

04:00:37,610 --> 04:00:35,699

acid and this ties into our our idea of

2772

04:00:39,469 --> 04:00:37,620

coverage which breaks down into two

2773

04:00:42,110 --> 04:00:39,479

components which is range and evenness

2774

04:00:44,630 --> 04:00:42,120

so range is simply just the sum of these

2775

04:00:46,849 --> 04:00:44,640

intervals between each amino acid and

2776

04:00:49,309 --> 04:00:46,859

evenness is the sample variance of these

2777

04:00:51,950 --> 04:00:49,319

intervals now this ties back into what I

2778

04:00:55,490 --> 04:00:51,960

said the coded 20 amino acids are

2779

04:00:58,330 --> 04:00:55,500

statistically non-random in one in about

2780

04:01:01,309 --> 04:00:58,340

two and a half million alternative

2781

04:01:05,389 --> 04:01:01,319

alphabets would have the same or better

2782

04:01:08,630 --> 04:01:05,399

coverage in size and hydrophobicity

2783

04:01:11,450 --> 04:01:08,640

now why exactly are we looking at range

2784

04:01:13,910 --> 04:01:11,460

in evenness well range allows for a

2785

04:01:17,210 --> 04:01:13,920

broader diversity of structures and

2786

04:01:18,769 --> 04:01:17,220

functions and evenness allows for the

2787

04:01:20,450 --> 04:01:18,779

best approximation of any desired

2788

04:01:23,269 --> 04:01:20,460

physical chemistry so I like to think of

2789

04:01:25,790 --> 04:01:23,279

it as trying to recreate a black and

2790

04:01:28,490 --> 04:01:25,800

white painting using a defined set of

2791

04:01:31,309 --> 04:01:28,500

tiles and you need to pick which colors

2792

04:01:34,010 --> 04:01:31,319

you want to use to try and get that

2793

04:01:35,929 --> 04:01:34,020

painting as close as possible now range

2794

04:01:38,570 --> 04:01:35,939

is effectively the difference between

2795

04:01:40,849 --> 04:01:38,580

having black and white tiles versus just

2796

04:01:42,290 --> 04:01:40,859

different Shades of Gray and evenness is

2797

04:01:44,570 --> 04:01:42,300

among the black and white tiles having

2798

04:01:45,650 --> 04:01:44,580

an even distribution going from black to

2799

04:01:48,769 --> 04:01:45,660

white

2800

04:01:50,929 --> 04:01:48,779

now why exactly are we looking at log p

2801
04:01:53,090 --> 04:01:50,939
and volume log p is just a measure of

2802
04:01:55,729 --> 04:01:53,100
hydrophobicity and hydrophobic collapse

2803
04:01:57,229 --> 04:01:55,739
is crucial for protein folding and for

2804
04:02:00,170 --> 04:01:57,239
volume volume determines the physical

2805
04:02:01,610 --> 04:02:00,180
space that allows for protein folding

2806
04:02:03,590 --> 04:02:01,620
so now that we have this idea of

2807
04:02:06,410 --> 04:02:03,600
coverage in our mind I would like to

2808
04:02:07,490 --> 04:02:06,420
very quickly go over our workflow I'm

2809
04:02:10,729 --> 04:02:07,500
going to skip essentially everything

2810
04:02:12,229 --> 04:02:10,739
except that top right corner where all

2811
04:02:14,150 --> 04:02:12,239
we're doing is we have a heuristic

2812
04:02:16,309 --> 04:02:14,160
search protocol that searches a library

2813
04:02:18,650 --> 04:02:16,319

of purchasable amino acids

2814

04:02:20,929 --> 04:02:18,660

and from there we are in a constant

2815

04:02:22,849 --> 04:02:20,939

feedback loop with our empiricist

2816

04:02:25,910 --> 04:02:22,859

collaborators in attempting to

2817

04:02:28,670 --> 04:02:25,920

eventually get a candidate alphabet

2818

04:02:30,110 --> 04:02:28,680

now I'm sure you are all dying to see

2819

04:02:31,550 --> 04:02:30,120

what one of these alphabets look like

2820

04:02:33,830 --> 04:02:31,560

right

2821

04:02:38,090 --> 04:02:33,840

so here we go uh this is our current

2822

04:02:40,250 --> 04:02:38,100

alphabet now big emphasis on current

2823

04:02:41,689 --> 04:02:40,260

um because of that iterative feedback

2824

04:02:43,070 --> 04:02:41,699

loop this is definitely subject to

2825

04:02:45,769 --> 04:02:43,080

change and probably will change before

2826

04:02:48,889 --> 04:02:45,779

we start constructing oligopeptides from

2827

04:02:52,429 --> 04:02:48,899

a set but here is our first set um this

2828

04:02:55,610 --> 04:02:52,439

is simply just one example of around 10

2829

04:02:57,650 --> 04:02:55,620

to the 14 possible High coverage sets

2830

04:03:00,469 --> 04:02:57,660

that we could pick from so there are a

2831

04:03:04,610 --> 04:03:00,479

lot of variations that we can change and

2832

04:03:07,010 --> 04:03:04,620

play with with the empiricists now again

2833

04:03:08,870 --> 04:03:07,020

the goal here is to synthesize these

2834

04:03:10,729 --> 04:03:08,880

oligopeptides from a completely

2835

04:03:13,610 --> 04:03:10,739

non-canonical set

2836

04:03:15,469 --> 04:03:13,620

and that's hopefully what we'll be doing

2837

04:03:19,189 --> 04:03:15,479

in a few weeks

2838

04:03:22,570 --> 04:03:19,199

now I would like to very quickly end on

2839

04:03:25,189 --> 04:03:22,580

a deeper note of who cares

2840

04:03:28,309 --> 04:03:25,199

uh why would an advanced science to

2841

04:03:30,889 --> 04:03:28,319

design an alternative amino acid set and

2842

04:03:33,889 --> 04:03:30,899

I would like to kind of bring that

2843

04:03:36,110 --> 04:03:33,899

question to this idea of is there such a

2844

04:03:39,530 --> 04:03:36,120

thing as a good or bad amino acid

2845

04:03:40,969 --> 04:03:39,540

alphabet now before the empiricists and

2846

04:03:42,530 --> 04:03:40,979

the crowd jump out of their chairs and

2847

04:03:44,929 --> 04:03:42,540

strangle me

2848

04:03:47,510 --> 04:03:44,939

um yes the empiricists are saying of

2849

04:03:49,670 --> 04:03:47,520

course there are bad amino acid sets the

2850

04:03:51,290 --> 04:03:49,680

20 are very good at what they do but

2851
04:03:53,269 --> 04:03:51,300
theorists are pushing back a little bit

2852
04:03:56,689 --> 04:03:53,279
and saying well you know Evolution can

2853
04:03:58,969 --> 04:03:56,699
find any needle in any Haystack so I

2854
04:04:01,130 --> 04:03:58,979
would like to believe that the the truth

2855
04:04:03,170 --> 04:04:01,140
lies somewhere in between but what we're

2856
04:04:06,410 --> 04:04:03,180
really trying to do here is begin to

2857
04:04:09,050 --> 04:04:06,420
characterize good versus bad using an

2858
04:04:11,510 --> 04:04:09,060
adaptation of 1980s behavioral thinking

2859
04:04:15,229 --> 04:04:11,520
so optimality theory for life's amino

2860
04:04:17,330 --> 04:04:15,239
acids now I'd like to conclude just by

2861
04:04:20,889 --> 04:04:17,340
thanking our sponsors or I'm sorry our

2862
04:04:23,450 --> 04:04:20,899
sponsors our funders

2863
04:04:25,910 --> 04:04:23,460

and our collaborators over at the

2864

04:04:27,590 --> 04:04:25,920

Charles University in Prague and if you

2865

04:04:29,330 --> 04:04:27,600

would like to talk to me about this in

2866

04:04:31,670 --> 04:04:29,340

much much greater depth please find me

2867

04:04:37,340 --> 04:04:31,680

at poster 24 which is outside thank you

2868

04:04:37,350 --> 04:04:40,910

[Applause]

2869

04:04:48,710 --> 04:04:43,849

our next speakers Peter Winslow from the

2870

04:04:54,530 --> 04:04:52,429

so um my talk is in a similar vein

2871

04:04:58,910 --> 04:04:54,540

um I'm going to try to convince you all

2872

04:05:01,070 --> 04:04:58,920

that I can study the first proteins

2873

04:05:02,510 --> 04:05:01,080

um and how they might have functioned so

2874

04:05:05,630 --> 04:05:02,520

before I get to that I would like to

2875

04:05:07,550 --> 04:05:05,640

acknowledge Matilda Newton who came out

2876

04:05:10,849 --> 04:05:07,560

of my lab they did a lot of the work

2877

04:05:13,729 --> 04:05:10,859

that this is all based off of so

2878

04:05:15,650 --> 04:05:13,739

um to start off our lab is interested

2879

04:05:17,570 --> 04:05:15,660

like I said origin of the first

2880

04:05:20,330 --> 04:05:17,580

functional proteins so it's pretty well

2881

04:05:23,450 --> 04:05:20,340

established by you know chemistry that

2882

04:05:26,630 --> 04:05:23,460

you can get abiotic synthesis of amino

2883

04:05:29,150 --> 04:05:26,640

acids right so Miller experiment we find

2884

04:05:30,650 --> 04:05:29,160

them on meteorites this sort of subset

2885

04:05:34,250 --> 04:05:30,660

of the 20 amino acids we use today

2886

04:05:36,469 --> 04:05:34,260

around you know half 10 to 12. and then

2887

04:05:38,030 --> 04:05:36,479

at some point these polymerize and you

2888

04:05:40,490 --> 04:05:38,040

have polypeptides but they're not really

2889

04:05:42,050 --> 04:05:40,500

functional and then

2890

04:05:44,689 --> 04:05:42,060

um something happens and now we have

2891

04:05:46,849 --> 04:05:44,699

proteins and then you know billions of

2892

04:05:48,889 --> 04:05:46,859

years of evolution and we have modern 20

2893

04:05:51,590 --> 04:05:48,899

Amino acid-based protein what I'm

2894

04:05:53,570 --> 04:05:51,600

focused on is this this period of time

2895

04:05:56,570 --> 04:05:53,580

where we go from random chains of

2896

04:05:59,030 --> 04:05:56,580

polypeptides to functional proteins that

2897

04:06:02,269 --> 04:05:59,040

are conferring some sort of Advantage

2898

04:06:04,189 --> 04:06:02,279

right but when we look at these the the

2899

04:06:06,050 --> 04:06:04,199

key thing is they don't have all 20

2900

04:06:08,210 --> 04:06:06,060

amino acids they have

2901
04:06:10,490 --> 04:06:08,220
some sort of subset of these primordial

2902
04:06:12,349 --> 04:06:10,500
amino acids so what what are primordial

2903
04:06:14,870 --> 04:06:12,359
amino acids well

2904
04:06:17,389 --> 04:06:14,880
um we're focusing on the 20 amino acids

2905
04:06:20,510 --> 04:06:17,399
that biology uses today no Xeno amino

2906
04:06:23,750 --> 04:06:20,520
acids unfortunately but we sort of we

2907
04:06:26,689 --> 04:06:23,760
used a consensus of the addition of

2908
04:06:27,950 --> 04:06:26,699
different amino acids using more than 60

2909
04:06:29,870 --> 04:06:27,960
different theories from many different

2910
04:06:31,969 --> 04:06:29,880
fields mathematics chemistry biology

2911
04:06:33,590 --> 04:06:31,979
biochemistry

2912
04:06:36,349 --> 04:06:33,600
um and then we arbitrarily create

2913
04:06:39,050 --> 04:06:36,359

different alphabets sort of to create

2914

04:06:43,790 --> 04:06:39,060

time shots like snapshots of the this

2915

04:06:46,010 --> 04:06:43,800

timeline so 2016 9 and 5. and with this

2916

04:06:49,130 --> 04:06:46,020

we think we can answer a few big

2917

04:06:51,710 --> 04:06:49,140

questions so can you get biological

2918

04:06:54,110 --> 04:06:51,720

function from primordial alphabets

2919

04:06:56,570 --> 04:06:54,120

what is the minimum alphabet needed for

2920

04:06:59,150 --> 04:06:56,580

these proteins to function and if they

2921

04:07:02,090 --> 04:06:59,160

do function how are they similar to

2922

04:07:03,349 --> 04:07:02,100

Modern proteins so to investigate these

2923

04:07:04,929 --> 04:07:03,359

questions we

2924

04:07:07,849 --> 04:07:04,939

created

2925

04:07:10,130 --> 04:07:07,859

with these four alphabets large

2926
04:07:12,830 --> 04:07:10,140
libraries of completely random adiabino

2927
04:07:16,010 --> 04:07:12,840
acid long proteins so 10 trillion random

2928
04:07:17,570 --> 04:07:16,020
proteins in each different library and

2929
04:07:20,510 --> 04:07:17,580
we use a screen for a really simple

2930
04:07:22,429 --> 04:07:20,520
function ATP binding it's pretty you

2931
04:07:24,769 --> 04:07:22,439
know ubiquitous throughout all life

2932
04:07:28,630 --> 04:07:24,779
and we kind of just saw what we could

2933
04:07:31,189 --> 04:07:28,640
see and believe it or not every

2934
04:07:32,870 --> 04:07:31,199
Library actually yielded functional

2935
04:07:35,330 --> 04:07:32,880
proteins which we were really surprised

2936
04:07:37,910 --> 04:07:35,340
about we kind of aimed for the 20 amino

2937
04:07:39,410 --> 04:07:37,920
acid alphabet library to be sort of

2938
04:07:41,809 --> 04:07:39,420

positive control right because it's

2939

04:07:43,790 --> 04:07:41,819

modern we know those work and we sort of

2940

04:07:45,229 --> 04:07:43,800

aim for the five to be a negative

2941

04:07:48,530 --> 04:07:45,239

control because we really did not expect

2942

04:07:50,330 --> 04:07:48,540

those to bind ATP but they all do and

2943

04:07:53,630 --> 04:07:50,340

actually the five performs just as well

2944

04:07:57,290 --> 04:07:53,640

as the 20. so now we know

2945

04:08:00,010 --> 04:07:57,300

reduced amino acid proteins they

2946

04:08:02,689 --> 04:08:00,020

function but we don't know how

2947

04:08:04,729 --> 04:08:02,699

especially these really reduced ones

2948

04:08:09,229 --> 04:08:04,739

they're lacking a lot of key residues

2949

04:08:10,490 --> 04:08:09,239

that extend ATP binders use so that's

2950

04:08:12,429 --> 04:08:10,500

what I've been working on the last year

2951

04:08:15,710 --> 04:08:12,439

is trying to figure out how these work

2952

04:08:16,910 --> 04:08:15,720

and so I've been trying to characterize

2953

04:08:18,889 --> 04:08:16,920

them structurally through x-ray

2954

04:08:20,630 --> 04:08:18,899

crystallography so if you don't know

2955

04:08:22,910 --> 04:08:20,640

about extrater photography it's just you

2956

04:08:25,130 --> 04:08:22,920

crystallized protein you collect

2957

04:08:27,050 --> 04:08:25,140

diffraction data and you can extrapolate

2958

04:08:30,530 --> 04:08:27,060

that to get electron density and then

2959

04:08:32,689 --> 04:08:30,540

model that into a protein structure so

2960

04:08:34,189 --> 04:08:32,699

with this we really want to look at from

2961

04:08:35,389 --> 04:08:34,199

some of these best binders that we've

2962

04:08:37,550 --> 04:08:35,399

found

2963

04:08:40,130 --> 04:08:37,560

what is The Binding mechanism

2964

04:08:42,710 --> 04:08:40,140

how similar how different it is it to

2965

04:08:45,110 --> 04:08:42,720

Modern proteins because if it's similar

2966

04:08:47,030 --> 04:08:45,120

that's really exciting maybe this was

2967

04:08:49,610 --> 04:08:47,040

sort of always bound to happen and if

2968

04:08:51,769 --> 04:08:49,620

it's different maybe that means it's

2969

04:08:53,210 --> 04:08:51,779

sort of Frozen accident and we can see a

2970

04:08:55,910 --> 04:08:53,220

sort of sample from a completely

2971

04:08:57,710 --> 04:08:55,920

different sequence space and also how

2972

04:08:59,570 --> 04:08:57,720

dependent on alphabet complexity is

2973

04:09:01,010 --> 04:08:59,580

protein functionality which kind of goes

2974

04:09:02,689 --> 04:09:01,020

back to the last talk

2975

04:09:04,090 --> 04:09:02,699

so with that um I'd just like to thank

2976

04:09:07,250 --> 04:09:04,100

everyone in my lab

2977

04:09:08,809 --> 04:09:07,260

and our collaborators from the

2978

04:09:11,030 --> 04:09:08,819

University of Minnesota but also from

2979

04:09:12,830 --> 04:09:11,040

UCLA specifically Irene chin and Celia

2980

04:09:14,540 --> 04:09:12,840

Blanco so if you have any questions see

2981

04:09:23,090 --> 04:09:14,550

me at poster16.

2982

04:09:26,210 --> 04:09:23,100

[Applause]

2983

04:09:33,349 --> 04:09:26,220

our next speaker is Rudy gandalikar from

2984

04:09:37,250 --> 04:09:36,110

hello everyone I'm riddhi I'm a graduate

2985

04:09:38,710 --> 04:09:37,260

student at the Earth Life Science

2986

04:09:41,030 --> 04:09:38,720

Institute

2987

04:09:43,670 --> 04:09:41,040

in our study we have tried to understand

2988

04:09:46,729 --> 04:09:43,680

scaling of protein function across the

2989

04:09:49,250 --> 04:09:46,739

tree of life and the mechanisms that

2990

04:09:52,550 --> 04:09:49,260

might have led to the species diversity

2991

04:09:54,830 --> 04:09:52,560

on the tree of life right here

2992

04:09:57,050 --> 04:09:54,840

so we study scaling using power laws and

2993

04:09:58,790 --> 04:09:57,060

power laws are found everywhere if we

2994

04:10:00,590 --> 04:09:58,800

consider the number of Web Hits on a web

2995

04:10:02,689 --> 04:10:00,600

page in a given period of time or the

2996

04:10:04,910 --> 04:10:02,699

earthquake magnitude in an area over a

2997

04:10:09,290 --> 04:10:04,920

given period of time many natural and

2998

04:10:13,189 --> 04:10:11,510

so how can we help

2999

04:10:15,530 --> 04:10:13,199

um help us how can this help us

3000

04:10:17,450 --> 04:10:15,540

understand some Concepts in biology for

3001
04:10:19,370 --> 04:10:17,460
that let's consider a Lego set and

3002
04:10:21,950 --> 04:10:19,380
consider the unique pieces in relation

3003
04:10:25,130 --> 04:10:21,960
to the total pieces in the Lego set when

3004
04:10:28,610 --> 04:10:25,140
we plot this on a log log scale

3005
04:10:30,229 --> 04:10:28,620
we see the larger Lego sets use more

3006
04:10:31,910 --> 04:10:30,239
Unique Piece types but they

3007
04:10:33,349 --> 04:10:31,920
progressively go on using lesser

3008
04:10:35,750 --> 04:10:33,359
additional piece types so they're

3009
04:10:38,269 --> 04:10:35,760
becoming more efficient which means the

3010
04:10:40,189 --> 04:10:38,279
larger sets are using uh the same pieces

3011
04:10:42,590 --> 04:10:40,199
the smaller sets are using but in more

3012
04:10:44,750 --> 04:10:42,600
efficient and more complex ways so what

3013
04:10:46,790 --> 04:10:44,760

we're observing in these plots is a

3014

04:10:48,889 --> 04:10:46,800

scaling relationship and when we observe

3015

04:10:50,929 --> 04:10:48,899

a scaling relationship we could say that

3016

04:10:52,250 --> 04:10:50,939

maybe there's a set of rules that's sort

3017

04:10:54,769 --> 04:10:52,260

of governing the way something is

3018

04:10:58,550 --> 04:10:56,870

so you as a power law equation one

3019

04:11:00,889 --> 04:10:58,560

quantity varying as a power law of the

3020

04:11:02,750 --> 04:11:00,899

other and when we plot this on a log log

3021

04:11:05,090 --> 04:11:02,760

scale we get a straight line with the

3022

04:11:06,889 --> 04:11:05,100

slope Alpha so previous Studies have

3023

04:11:08,990 --> 04:11:06,899

shown that genes in a specific

3024

04:11:10,969 --> 04:11:09,000

functional category scale as a power law

3025

04:11:13,250 --> 04:11:10,979

of the total number of genes in a genome

3026

04:11:15,710 --> 04:11:13,260

so for example transcription regulation

3027

04:11:18,710 --> 04:11:15,720

is almost quadratically scaling which

3028

04:11:20,389 --> 04:11:18,720

means if the genome doubles in size the

3029

04:11:22,010 --> 04:11:20,399

genes in this specific category are

3030

04:11:24,229 --> 04:11:22,020

going to quadruple

3031

04:11:26,269 --> 04:11:24,239

so we have tried to include an expanded

3032

04:11:29,030 --> 04:11:26,279

taxonomy in our study and for that we

3033

04:11:30,889 --> 04:11:29,040

use the eggnog database so after power

3034

04:11:32,570 --> 04:11:30,899

of fitting we saw different Trends in

3035

04:11:34,309 --> 04:11:32,580

our data for the smaller and the larger

3036

04:11:36,170 --> 04:11:34,319

genomes so we carried out piecewise

3037

04:11:38,150 --> 04:11:36,180

regression to give Justice to the

3038

04:11:39,889 --> 04:11:38,160

different patterns and scaling observed

3039

04:11:42,050 --> 04:11:39,899

in the plots

3040

04:11:43,790 --> 04:11:42,060

so for example we wanted to capture the

3041

04:11:46,189 --> 04:11:43,800

slope variability for the smaller and

3042

04:11:48,170 --> 04:11:46,199

the larger genome sizes so for example

3043

04:11:50,150 --> 04:11:48,180

in category M which is cell wall and

3044

04:11:52,070 --> 04:11:50,160

cell membrane proteins

3045

04:11:54,110 --> 04:11:52,080

um so the x-axis has the total protein

3046

04:11:55,790 --> 04:11:54,120

annotations and the y-axis has the

3047

04:11:58,670 --> 04:11:55,800

category annotations for that specific

3048

04:12:00,349 --> 04:11:58,680

category so for the smaller genomes we

3049

04:12:02,090 --> 04:12:00,359

can see the proteins are scaling fast

3050

04:12:04,670 --> 04:12:02,100

which means as the genome size is

3051

04:12:06,530 --> 04:12:04,680

increasing they are incorporating

3052

04:12:08,510 --> 04:12:06,540

um more and more proteins faster than

3053

04:12:10,370 --> 04:12:08,520

the larger genomes because after a

3054

04:12:12,710 --> 04:12:10,380

statistically detected breakpoint the

3055

04:12:14,870 --> 04:12:12,720

scaling slows down and we can see a

3056

04:12:18,110 --> 04:12:14,880

similar Trend in category tree category

3057

04:12:20,929 --> 04:12:18,120

T so we saw this trend in most of the

3058

04:12:23,510 --> 04:12:20,939

breakpoints that that were supported in

3059

04:12:25,910 --> 04:12:23,520

bacteria interestingly we observed an

3060

04:12:28,010 --> 04:12:25,920

opposite Trend in archaea the scaling is

3061

04:12:31,010 --> 04:12:28,020

slow in the start but fastens up after

3062

04:12:32,630 --> 04:12:31,020

the statistically detected breakpoint so

3063

04:12:34,610 --> 04:12:32,640

a lot of categories were common between

3064

04:12:36,590 --> 04:12:34,620

archaea and bacteria

3065

04:12:38,030 --> 04:12:36,600

um but there were some categories that

3066

04:12:40,969 --> 04:12:38,040

were exclusively present either in

3067

04:12:42,349 --> 04:12:40,979

archaeon bacteria and it's also

3068

04:12:43,969 --> 04:12:42,359

interesting to observe these differences

3069

04:12:46,910 --> 04:12:43,979

in scaling pattern before and after the

3070

04:12:48,349 --> 04:12:46,920

break point in Ikea and bacteria so we

3071

04:12:50,450 --> 04:12:48,359

thought maybe these differences in

3072

04:12:52,130 --> 04:12:50,460

scaling patterns were caused by phyla

3073

04:12:54,530 --> 04:12:52,140

specific scaling so we broke these

3074

04:12:56,630 --> 04:12:54,540

domains down into specific phyla and

3075

04:12:58,790 --> 04:12:56,640

found great variation in all the phyla

3076

04:13:01,189 --> 04:12:58,800

for all the categories so for example we

3077

04:13:02,990 --> 04:13:01,199

have category 8 here which is coenzyme

3078

04:13:04,490 --> 04:13:03,000

transport proteins

3079

04:13:06,710 --> 04:13:04,500

um which also happens to be the most

3080

04:13:08,689 --> 04:13:06,720

variable across all the phyla

3081

04:13:10,610 --> 04:13:08,699

so we thought maybe this file a specific

3082

04:13:11,929 --> 04:13:10,620

scaling is causing the positioning of

3083

04:13:13,550 --> 04:13:11,939

the breakpoints that we observed

3084

04:13:14,330 --> 04:13:13,560

previously

3085

04:13:16,610 --> 04:13:14,340

um

3086

04:13:18,410 --> 04:13:16,620

so I place these breakpoints on the

3087

04:13:20,689 --> 04:13:18,420

total protein annotations to see if

3088

04:13:22,670 --> 04:13:20,699

there's any specific pattern but we can

3089

04:13:24,229 --> 04:13:22,680

see these individual phyla are spanning

3090

04:13:27,290 --> 04:13:24,239

the breakpoints and there is no specific

3091

04:13:28,910 --> 04:13:27,300

preference of for the break the Filas to

3092

04:13:31,729 --> 04:13:28,920

be present either on either sides of the

3093

04:13:33,110 --> 04:13:31,739

breakpoints so maybe taxonomy is not

3094

04:13:34,910 --> 04:13:33,120

causing the positioning of these

3095

04:13:36,710 --> 04:13:34,920

breakpoints and maybe there are some

3096

04:13:38,210 --> 04:13:36,720

other factors like physiological or

3097

04:13:40,969 --> 04:13:38,220

environmental factors that are causing

3098

04:13:42,769 --> 04:13:40,979

these fake points

3099

04:13:45,530 --> 04:13:42,779

so we were also interested in these

3100

04:13:47,689 --> 04:13:45,540

groups CPR and d-pan uh so these groups

3101

04:13:51,349 --> 04:13:47,699

have extremely small genomes and they

3102

04:13:53,570 --> 04:13:51,359

lack um major metabolic pathways so we

3103

04:13:56,030 --> 04:13:53,580

compared them with um

3104

04:13:58,429 --> 04:13:56,040

eukaryotes unicellular eukaryotes and

3105

04:14:00,229 --> 04:13:58,439

Asgard alka so for some categories we

3106

04:14:02,389 --> 04:14:00,239

can see the scaling is very similar for

3107

04:14:03,830 --> 04:14:02,399

category o but for some categories the

3108

04:14:06,349 --> 04:14:03,840

scaling is very different like in

3109

04:14:07,969 --> 04:14:06,359

category C which goes on to show there

3110

04:14:10,010 --> 04:14:07,979

are different ways in which an organism

3111

04:14:11,630 --> 04:14:10,020

can adapt while growing in their genome

3112

04:14:12,349 --> 04:14:11,640

sizes

3113

04:14:14,510 --> 04:14:12,359

um

3114

04:14:16,670 --> 04:14:14,520

I've just discussed a few key results in

3115

04:14:18,710 --> 04:14:16,680

my uh talk so if you want to discuss I

3116

04:14:21,050 --> 04:14:18,720

would be interested please come by and

3117

04:14:27,110 --> 04:14:21,060

stop at panel two for the poster thank

3118

04:14:27,120 --> 04:14:32,530

[Applause]

3119

04:14:39,170 --> 04:14:35,030

ly from the University Montana State

3120

04:14:43,250 --> 04:14:40,969

okay so we're gonna shift gears a little

3121

04:14:44,929 --> 04:14:43,260

bit here and so my project largely

3122

04:14:47,510 --> 04:14:44,939

focuses on the evolution of

3123

04:14:50,030 --> 04:14:47,520

multicellularity uh in bacteria

3124

04:14:52,070 --> 04:14:50,040

specifically so titled here cellular

3125

04:14:54,290 --> 04:14:52,080

differentiation within an obligate

3126

04:14:55,610 --> 04:14:54,300

multicellular bacteria

3127

04:14:57,050 --> 04:14:55,620

so where I like to start is just

3128

04:14:59,630 --> 04:14:57,060

generally when we think about the

3129

04:15:01,370 --> 04:14:59,640

evolution of life on Earth we can kind

3130

04:15:05,090 --> 04:15:01,380

of think of it as an increase in

3131

04:15:06,710 --> 04:15:05,100

complexity as as life continued to

3132

04:15:08,990 --> 04:15:06,720

evolve and this is yes and over

3133

04:15:10,969 --> 04:15:09,000

Simplicity but thinking of it as

3134

04:15:12,950 --> 04:15:10,979

molecules coming together to form a

3135

04:15:16,849 --> 04:15:12,960

first cell and eventually getting a

3136

04:15:18,110 --> 04:15:16,859

multi-cellular organism and then some

3137

04:15:20,809 --> 04:15:18,120

something that looks like the life that

3138

04:15:24,290 --> 04:15:20,819

we have on Earth today

3139

04:15:26,090 --> 04:15:24,300

if we look at our classic uh Tree of

3140

04:15:27,650 --> 04:15:26,100

Life where we have different domains of

3141

04:15:31,130 --> 04:15:27,660

the bacteria the archae and the

3142

04:15:32,809 --> 04:15:31,140

eukaryotes generally we tend to think of

3143

04:15:35,510 --> 04:15:32,819

all the multicellular life forms

3144

04:15:37,689 --> 04:15:35,520

belonging to the Eukarya and we think of

3145

04:15:41,809 --> 04:15:37,699

the bacteria and archae as these simple

3146

04:15:46,429 --> 04:15:44,090

um if we look at uh the Tree of Life as

3147

04:15:48,349 --> 04:15:46,439

we know it today uh multicellularity

3148

04:15:51,469 --> 04:15:48,359

actually it can be plotted across the

3149

04:15:55,010 --> 04:15:51,479

entire uh tree of life and so what I'm

3150

04:15:56,870 --> 04:15:55,020

showing here is the aggregative uh

3151
04:15:59,150 --> 04:15:56,880
evolution of multicellularity or a

3152
04:16:01,429 --> 04:15:59,160
clonal uh evolution of multicellularity

3153
04:16:03,469 --> 04:16:01,439
and we see it present in the bacteria

3154
04:16:06,830 --> 04:16:03,479
the archaea and the Eukarya of course

3155
04:16:09,229 --> 04:16:06,840
and so just focusing in on some bacteria

3156
04:16:11,469 --> 04:16:09,239
that are capable of this these are just

3157
04:16:13,729 --> 04:16:11,479
some micrographs showing different

3158
04:16:16,370 --> 04:16:13,739
cyanobacteria that are in those chains

3159
04:16:20,330 --> 04:16:16,380
up there in the upper left and then

3160
04:16:22,790 --> 04:16:20,340
mixopox mixobacteria that sporulate an

3161
04:16:25,610 --> 04:16:22,800
archaea called methanosarcina another

3162
04:16:27,530 --> 04:16:25,620
example is this uh bacteria called cable

3163
04:16:29,330 --> 04:16:27,540

bacteria that form these long centimeter

3164

04:16:31,070 --> 04:16:29,340

long filaments and can actually move

3165

04:16:33,410 --> 04:16:31,080

electrons along that

3166

04:16:35,870 --> 04:16:33,420

so the organism that I study is called

3167

04:16:37,429 --> 04:16:35,880

multicellular magnetotactic bacteria or

3168

04:16:39,229 --> 04:16:37,439

MMB for short because I just don't want

3169

04:16:41,210 --> 04:16:39,239

to say that the whole talk and so this

3170

04:16:44,150 --> 04:16:41,220

is what they look like where we have a

3171

04:16:46,610 --> 04:16:44,160

TM image showing where these cells are

3172

04:16:50,030 --> 04:16:46,620

grouped together in this kind of

3173

04:16:51,650 --> 04:16:50,040

soccer ball shape or football shape and

3174

04:16:52,910 --> 04:16:51,660

then here in the lower half just an sem

3175

04:16:55,010 --> 04:16:52,920

showing you what that structure looks

3176

04:16:57,590 --> 04:16:55,020

like so I built a cartoon kind of

3177

04:16:59,269 --> 04:16:57,600

showing what this Ultra structure looks

3178

04:17:01,389 --> 04:16:59,279

like and one of the things I want to

3179

04:17:04,250 --> 04:17:01,399

point out that pertains the name is this

3180

04:17:05,689 --> 04:17:04,260

magnetotaxis and so they make these uh

3181

04:17:08,450 --> 04:17:05,699

organelles inside the cells called

3182

04:17:10,849 --> 04:17:08,460

magnetosomes where they synthesize a

3183

04:17:12,710 --> 04:17:10,859

Paramount or ferromagnetic mineral that

3184

04:17:15,110 --> 04:17:12,720

allows them to sense Earth's geomagnetic

3185

04:17:17,929 --> 04:17:15,120

poles and then they can taxi in the

3186

04:17:20,330 --> 04:17:17,939

water column or the sediment column

3187

04:17:22,729 --> 04:17:20,340

um they also have these carbon or energy

3188

04:17:24,650 --> 04:17:22,739

storage granules inside them this

3189

04:17:26,929 --> 04:17:24,660

acellular Center so it's just one layer

3190

04:17:27,769 --> 04:17:26,939

of cells surrounding this acellular

3191

04:17:29,689 --> 04:17:27,779

Center

3192

04:17:31,610 --> 04:17:29,699

and then these actin-like filaments that

3193

04:17:35,030 --> 04:17:31,620

seem to have some something to do with

3194

04:17:39,349 --> 04:17:36,950

um I've referred to them as obligate

3195

04:17:41,210 --> 04:17:39,359

multicellular organisms and this is rare

3196

04:17:43,670 --> 04:17:41,220

in bacteria in fact the only example

3197

04:17:45,650 --> 04:17:43,680

where the hypothesized life cycle is

3198

04:17:48,290 --> 04:17:45,660

that they grow in size and then the

3199

04:17:51,410 --> 04:17:48,300

entire consortia divides and so we don't

3200

04:17:54,189 --> 04:17:51,420

typically see this in bacteria where

3201

04:17:57,290 --> 04:17:54,199

typically we see this this facultative

3202

04:17:59,510 --> 04:17:57,300

multicellularity so they can be a

3203

04:18:01,429 --> 04:17:59,520

multicellular but they can also exist as

3204

04:18:03,710 --> 04:18:01,439

a single cell that's true for all the

3205

04:18:06,110 --> 04:18:03,720

examples I showed you with the tree life

3206

04:18:08,450 --> 04:18:06,120

so here's just an image of uh one of the

3207

04:18:11,450 --> 04:18:08,460

MMB from my sample site and kind of what

3208

04:18:13,969 --> 04:18:11,460

we think it looks like uh MMB dividing

3209

04:18:16,550 --> 04:18:13,979

into possibly three

3210

04:18:18,469 --> 04:18:16,560

I also mentioned moment of truth if the

3211

04:18:23,570 --> 04:18:18,479

video works

3212

04:18:26,090 --> 04:18:23,580

um that they're magnetactic oh let me

3213

04:18:32,330 --> 04:18:26,100

see if I can get this to work

3214

04:18:38,090 --> 04:18:35,469

Okay cool so what we have here is a uh

3215

04:18:41,330 --> 04:18:38,100

tube with the MMB in the bottom of it

3216

04:18:43,189 --> 04:18:41,340

and then a magnetic stir bar next to it

3217

04:18:45,349 --> 04:18:43,199

and if you just watch it you can see

3218

04:18:48,170 --> 04:18:45,359

them swim up out of the bottom of that

3219

04:18:50,269 --> 04:18:48,180

tube and they taxi towards the the stir

3220

04:18:51,590 --> 04:18:50,279

bar these ones are going towards the

3221

04:18:54,889 --> 04:18:51,600

magnetic north

3222

04:18:57,769 --> 04:18:54,899

here in on the right is a hanging water

3223

04:18:58,990 --> 04:18:57,779

droplet just on a coverslip and there's

3224

04:19:01,550 --> 04:18:59,000

a magnet

3225

04:19:04,130 --> 04:19:01,560

to the right and then what I've done is

3226

04:19:05,689 --> 04:19:04,140

just move that magnet turns around they

3227

04:19:06,830 --> 04:19:05,699

start taxing the in the opposite

3228

04:19:08,269 --> 04:19:06,840

direction

3229

04:19:10,130 --> 04:19:08,279

so that's the just showing their

3230

04:19:11,929 --> 04:19:10,140

magnetotaxis

3231

04:19:13,790 --> 04:19:11,939

it helps when we think of

3232

04:19:15,170 --> 04:19:13,800

multicellularity to have some criteria

3233

04:19:17,269 --> 04:19:15,180

for what that is

3234

04:19:19,250 --> 04:19:17,279

and so just a list of these would be

3235

04:19:21,349 --> 04:19:19,260

built from several cells of the same

3236

04:19:23,450 --> 04:19:21,359

species a specific shape and

3237

04:19:25,490 --> 04:19:23,460

organization and synchronized growth so

3238

04:19:28,670 --> 04:19:25,500

that would exclude things like cancer

3239

04:19:30,769 --> 04:19:28,680

no competition between the cells

3240

04:19:33,710 --> 04:19:30,779

coordinated behavior in response to

3241

04:19:36,110 --> 04:19:33,720

external or internal stimuli existence

3242

04:19:38,090 --> 04:19:36,120

of cell to cell signaling and then this

3243

04:19:40,910 --> 04:19:38,100

last one that's kind of like the

3244

04:19:43,510 --> 04:19:40,920

catch-all metabolic differentiation or a

3245

04:19:46,550 --> 04:19:43,520

division of labor so with my organism

3246

04:19:48,650 --> 04:19:46,560

they fit these first four and these

3247

04:19:50,530 --> 04:19:48,660

second the last two are what we're kind

3248

04:19:52,849 --> 04:19:50,540

of looking into

3249

04:19:55,429 --> 04:19:52,859

one of the things we found with our

3250

04:19:58,010 --> 04:19:55,439

project was that the these MMB are not

3251
04:20:00,889 --> 04:19:58,020
actually clonal and how we did this was

3252
04:20:02,990 --> 04:20:00,899
we sorted whole consortias

3253
04:20:04,790 --> 04:20:03,000
did multiple displacement amplifications

3254
04:20:06,590 --> 04:20:04,800
so we Amplified their entire genome and

3255
04:20:08,809 --> 04:20:06,600
sequenced that and we were able to map

3256
04:20:10,790 --> 04:20:08,819
reads to the longest read the best

3257
04:20:13,729 --> 04:20:10,800
assembly there and look at these single

3258
04:20:16,370 --> 04:20:13,739
nucleotide polymorphism differences

3259
04:20:18,050 --> 04:20:16,380
and what we found was that they have

3260
04:20:19,969 --> 04:20:18,060
compared to controls which is a

3261
04:20:22,610 --> 04:20:19,979
pseudomonas control as well as other

3262
04:20:23,830 --> 04:20:22,620
environmental coords they have this much

3263
04:20:26,750 --> 04:20:23,840

higher

3264

04:20:28,550 --> 04:20:26,760

single nucleotide polymorphism rate than

3265

04:20:30,950 --> 04:20:28,560

than what we see with other organisms

3266

04:20:33,010 --> 04:20:30,960

which was kind of a surprise and we're

3267

04:20:36,550 --> 04:20:33,020

still scratching our heads about this

3268

04:20:38,929 --> 04:20:36,560

and that equates to 20 to 100 nucleotide

3269

04:20:40,790 --> 04:20:38,939

polymorphisms in the genome and their

3270

04:20:44,210 --> 04:20:40,800

genomes are about eight megabases which

3271

04:20:46,370 --> 04:20:44,220

is about double that of E coli

3272

04:20:48,050 --> 04:20:46,380

another thing that we looked into was

3273

04:20:50,389 --> 04:20:48,060

this metabolic differentiation or this

3274

04:20:52,490 --> 04:20:50,399

division of labor and this was done by

3275

04:20:54,050 --> 04:20:52,500

doing stable isotope incubations where

3276

04:20:57,710 --> 04:20:54,060

we incubated them in the presence of

3277

04:21:00,670 --> 04:20:57,720

these ^{13}C or deuterium oxide

3278

04:21:03,410 --> 04:21:00,680

um chemicals and then we use a

3279

04:21:07,370 --> 04:21:03,420

nanosecondary ion Mass spectroscopy to

3280

04:21:09,650 --> 04:21:07,380

look at those and map that back where we

3281

04:21:12,110 --> 04:21:09,660

found in the lower left where is the ^{13}C

3282

04:21:14,150 --> 04:21:12,120

image differences in the use of that

3283

04:21:17,030 --> 04:21:14,160

substrate indicating this division of

3284

04:21:19,969 --> 04:21:17,040

labor that we suspected

3285

04:21:22,849 --> 04:21:19,979

so with that just to kind of give

3286

04:21:24,110 --> 04:21:22,859

conclusions and takeaways the m and b

3287

04:21:26,210 --> 04:21:24,120

are the only known obligate

3288

04:21:27,429 --> 04:21:26,220

multicellular bacteria that we know of

3289

04:21:29,929 --> 04:21:27,439

yet

3290

04:21:32,630 --> 04:21:29,939

they are not clonal and do not conform

3291

04:21:35,809 --> 04:21:32,640

to these canonical ideas of what

3292

04:21:37,130 --> 04:21:35,819

multicellular multicellularity is where

3293

04:21:38,150 --> 04:21:37,140

we typically have this clonal

3294

04:21:40,670 --> 04:21:38,160

development

3295

04:21:42,889 --> 04:21:40,680

from where one cell divides into

3296

04:21:45,290 --> 04:21:42,899

daughter cells that stick together or

3297

04:21:46,250 --> 04:21:45,300

this aggregative multicellularity and

3298

04:21:48,710 --> 04:21:46,260

they seem to

3299

04:21:51,170 --> 04:21:48,720

fall somewhere in the middle there

3300

04:21:53,389 --> 04:21:51,180

they also engage in a division of labor

3301
04:21:54,950 --> 04:21:53,399
as we were looking at with the metabolic

3302
04:21:56,870 --> 04:21:54,960
differentiation

3303
04:21:58,189 --> 04:21:56,880
and then of course just to think the lab

3304
04:22:07,070 --> 04:21:58,199
and all the collaborators that help us

3305
04:22:19,130 --> 04:22:09,889
our next speaker is Claire elbon from

3306
04:22:24,590 --> 04:22:22,189
um I'm Claire and so I'm going to talk a

3307
04:22:25,910 --> 04:22:24,600
little bit about respiration oxygen

3308
04:22:28,550 --> 04:22:25,920
sensing

3309
04:22:30,910 --> 04:22:28,560
um and this idea that there might be a

3310
04:22:33,769 --> 04:22:30,920
really close relative to the ancestor of

3311
04:22:36,769 --> 04:22:33,779
protomitochondria in modern oxygen

3312
04:22:41,030 --> 04:22:38,929
um so I think a lot of people here are

3313
04:22:43,910 --> 04:22:41,040

familiar with eukaryogenesis it's this

3314

04:22:45,769 --> 04:22:43,920

idea that an archaea and a bacteria a

3315

04:22:48,710 --> 04:22:45,779

very long time ago decided to be best

3316

04:22:49,729 --> 04:22:48,720

friends forever and now we're here

3317

04:22:52,429 --> 04:22:49,739

um so there's lots of different

3318

04:22:53,630 --> 04:22:52,439

hypotheses over how this might have

3319

04:22:56,210 --> 04:22:53,640

happened

3320

04:22:58,550 --> 04:22:56,220

um and kind of the main point I want to

3321

04:23:01,309 --> 04:22:58,560

make here is that one there's always a

3322

04:23:04,610 --> 04:23:01,319

bacterial host and that's generally

3323

04:23:07,610 --> 04:23:04,620

thought of as an alpha proteobacteria

3324

04:23:10,389 --> 04:23:07,620

um and there's also a lot of or has been

3325

04:23:12,950 --> 04:23:10,399

a lot of talk historically about is this

3326

04:23:15,590 --> 04:23:12,960

obligately aerobic does it have to have

3327

04:23:18,710 --> 04:23:15,600

oxygen is it facultatively aerobic where

3328

04:23:19,610 --> 04:23:18,720

it could use oxygen or not or is it kind

3329

04:23:21,889 --> 04:23:19,620

of

3330

04:23:25,910 --> 04:23:21,899

um an anaerobic partnership that turned

3331

04:23:31,309 --> 04:23:29,030

so a lot of more quantitative Recent

3332

04:23:34,550 --> 04:23:31,319

research so kind of this triangulation

3333

04:23:37,429 --> 04:23:34,560

method suggests that this new clade of

3334

04:23:39,349 --> 04:23:37,439

marine Alpha proteobacteria from marine

3335

04:23:42,710 --> 04:23:39,359

oxiclones and these are really related

3336

04:23:46,309 --> 04:23:42,720

to a group called ioditomonas This is an

3337

04:23:47,689 --> 04:23:46,319

iodide using bacteria might be the

3338

04:23:49,870 --> 04:23:47,699

closest living relative to

3339

04:23:53,210 --> 04:23:49,880

protomitochondria

3340

04:23:55,250 --> 04:23:53,220

and so like I said Alpha proteobacteria

3341

04:23:57,130 --> 04:23:55,260

for a while have been thought of as that

3342

04:23:59,450 --> 04:23:57,140

sort of bacterial component of

3343

04:24:02,150 --> 04:23:59,460

eukaryogenesis and what I'm going to

3344

04:24:04,929 --> 04:24:02,160

showing you really quick right here is

3345

04:24:07,250 --> 04:24:04,939

that these are some anaerobic traits

3346

04:24:09,290 --> 04:24:07,260

that are thought of really essential

3347

04:24:12,650 --> 04:24:09,300

when you're looking at the criteria for

3348

04:24:14,929 --> 04:24:12,660

this ancestor and so most of these are

3349

04:24:17,450 --> 04:24:14,939

alpha proteobacteria and when we're

3350

04:24:19,849 --> 04:24:17,460

looking at the heat map what we want to

3351
04:24:22,490 --> 04:24:19,859
focus on is this green highlighted here

3352
04:24:25,610 --> 04:24:22,500
that's this new clade so they hit all of

3353
04:24:26,630 --> 04:24:25,620
these criteria for anaerobic traits when

3354
04:24:30,229 --> 04:24:26,640
we're thinking about this

3355
04:24:33,889 --> 04:24:31,849
and then when we're thinking more about

3356
04:24:35,809 --> 04:24:33,899
the aerobic side of this these

3357
04:24:38,389 --> 04:24:35,819
facultative aerobics we want to think

3358
04:24:40,309 --> 04:24:38,399
about the terminal electron chain so

3359
04:24:43,370 --> 04:24:40,319
what's interesting is that this is

3360
04:24:46,010 --> 04:24:43,380
comprised of four complexes and these

3361
04:24:48,530 --> 04:24:46,020
complexes actually have this really

3362
04:24:50,870 --> 04:24:48,540
phenomenal history of the evolution of

3363
04:24:54,050 --> 04:24:50,880

respiration inside of it so from complex

3364

04:24:58,670 --> 04:24:54,060

one to complex four we can kind of track

3365

04:25:00,889 --> 04:24:58,680

as the Earth went from anoxic to the

3366

04:25:03,590 --> 04:25:00,899

great oxidation event to kind of what we

3367

04:25:06,830 --> 04:25:03,600

experience now and so I'm really looking

3368

04:25:07,490 --> 04:25:06,840

more at complex four because

3369

04:25:13,729 --> 04:25:07,500

um

3370

04:25:16,189 --> 04:25:13,739

important reduction step so if we're

3371

04:25:18,950 --> 04:25:16,199

thinking about protomitochondria they

3372

04:25:21,410 --> 04:25:18,960

would need to have this complex for so

3373

04:25:24,530 --> 04:25:21,420

that can be divided up even more into

3374

04:25:27,229 --> 04:25:24,540

this a to c family we have an A type

3375

04:25:30,229 --> 04:25:27,239

lots of oxygen we don't have to bind it

3376

04:25:32,570 --> 04:25:30,239

super well it's there but the sea family

3377

04:25:35,750 --> 04:25:32,580

is thought of these as the oldest

3378

04:25:37,490 --> 04:25:35,760

terminal or complex four of the terminal

3379

04:25:40,070 --> 04:25:37,500

electron chain and that's because it's

3380

04:25:43,429 --> 04:25:40,080

capable of binding oxygen at very very

3381

04:25:48,349 --> 04:25:45,769

so for this new clade I had two main

3382

04:25:50,149 --> 04:25:48,359

questions looking at sort of data mining

3383

04:25:52,670 --> 04:25:50,159

which is what kind of genes do they have

3384

04:25:54,649 --> 04:25:52,680

for respiration is it

3385

04:25:56,929 --> 04:25:54,659

um entirely aerobic or is there

3386

04:25:58,849 --> 04:25:56,939

anaerobic as well are they able to sense

3387

04:26:01,250 --> 04:25:58,859

oxygen and are they moving along

3388

04:26:03,229 --> 04:26:01,260

gradients and in response to that and

3389

04:26:06,250 --> 04:26:03,239

then on top of that are these genes

3390

04:26:10,070 --> 04:26:06,260

actually being transcribed

3391

04:26:12,229 --> 04:26:10,080

so I did a lot of data mining in the uh

3392

04:26:13,670 --> 04:26:12,239

with this nice big data set from the

3393

04:26:17,689 --> 04:26:13,680

sandwich Inlet that's in British

3394

04:26:20,090 --> 04:26:17,699

Columbia it's a seasonally hypoxic area

3395

04:26:23,090 --> 04:26:20,100

but it's an oxygen minimum Zone and that

3396

04:26:26,110 --> 04:26:23,100

just means that very quickly we'll lose

3397

04:26:29,149 --> 04:26:26,120

oxygen very high up in the water column

3398

04:26:31,610 --> 04:26:29,159

and it's you can see how like seasonally

3399

04:26:35,330 --> 04:26:31,620

variable it is but overall there's a

3400

04:26:41,990 --> 04:26:38,510

and so the two really interesting points

3401

04:26:44,510 --> 04:26:42,000

I saw was one there are c-type aerobic

3402

04:26:47,750 --> 04:26:44,520

oxidases associated with this Alpha Pro

3403

04:26:49,490 --> 04:26:47,760

nucleate Alpha proteobacteria and its

3404

04:26:52,010 --> 04:26:49,500

transcription or the amount that it was

3405

04:26:54,769 --> 04:26:52,020

being used potentially increased into

3406

04:26:56,750 --> 04:26:54,779

the anoxic Depths and that there are two

3407

04:26:58,729 --> 04:26:56,760

chemotaxis proteins so that's an

3408

04:27:01,309 --> 04:26:58,739

aerotaxis protein

3409

04:27:02,809 --> 04:27:01,319

maybe maybe not it might be responding

3410

04:27:04,250 --> 04:27:02,819

to something else

3411

04:27:08,269 --> 04:27:04,260

um they were both being transcribed

3412

04:27:10,790 --> 04:27:08,279

really highly into these anoxic depths

3413

04:27:12,370 --> 04:27:10,800

um so my main takeaway is we should look

3414

04:27:14,929 --> 04:27:12,380

at omz's more we're thinking about

3415

04:27:16,910 --> 04:27:14,939

protomitochondria because there are some

3416

04:27:19,130 --> 04:27:16,920

really interesting Alphas there that

3417

04:27:20,870 --> 04:27:19,140

only exist right now as metagenomic

3418

04:27:22,969 --> 04:27:20,880

assembled genomes

3419

04:27:25,189 --> 04:27:22,979

um and it would be really interesting to

3420

04:27:28,010 --> 04:27:25,199

really look at the full genomic uh

3421

04:27:30,110 --> 04:27:28,020

capabilities of them

3422

04:27:31,790 --> 04:27:30,120

um so I'd like to thank the glass Lab at

3423

04:27:35,149 --> 04:27:31,800

Georgia Tech

3424

04:27:38,270 --> 04:27:35,159

um my funding the NSF grad and then the

3425

04:27:47,210 --> 04:27:38,280

oceans across space and time team

3426

04:27:47,220 --> 04:27:50,210

our next speaker

3427

04:27:50,220 --> 04:28:03,889

is Marisa mayor from NASA Ames

3428

04:28:07,189 --> 04:28:05,450

hi there

3429

04:28:09,170 --> 04:28:07,199

okay

3430

04:28:11,229 --> 04:28:09,180

um hi I'm Marissa I'm a postdoc

3431

04:28:14,990 --> 04:28:11,239

currently at NASA Ames Research Center

3432

04:28:17,210 --> 04:28:15,000

and I work on microbial sources of

3433

04:28:19,790 --> 04:28:17,220

hopenoid lipid biomarkers and different

3434

04:28:21,969 --> 04:28:19,800

hot spring environments uh today I'm

3435

04:28:25,130 --> 04:28:21,979

going to be excitedly sharing with you

3436

04:28:27,229 --> 04:28:25,140

some new potential microbial sources of

3437

04:28:29,649 --> 04:28:27,239

two and three methylhopenoids that we

3438

04:28:33,490 --> 04:28:29,659

were able to find in some of our anoxic

3439

04:28:36,290 --> 04:28:33,500

acidic and sulfidic hydrothermal Springs

3440

04:28:39,769 --> 04:28:36,300

I want to acknowledge my funding sources

3441

04:28:42,649 --> 04:28:39,779

which is ori NPP program National Park

3442

04:28:44,929 --> 04:28:42,659

Service NASA and finally Stanford

3443

04:28:47,570 --> 04:28:44,939

University because some of this research

3444

04:28:50,330 --> 04:28:47,580

was done back my PhD as well

3445

04:28:52,429 --> 04:28:50,340

um so yeah you might be wondering if you

3446

04:28:54,290 --> 04:28:52,439

are an astronomer or anyone but a lipid

3447

04:28:56,269 --> 04:28:54,300

chemist what are hopanoids and what do

3448

04:28:57,610 --> 04:28:56,279

they teach us in modern environments why

3449

04:29:00,950 --> 04:28:57,620

should we care

3450

04:29:02,990 --> 04:29:00,960

so hopanoids are cyclic triterpenoid

3451

04:29:04,610 --> 04:29:03,000

membrane lipids so they're complex

3452

04:29:06,229 --> 04:29:04,620

they're a little bit different from some

3453

04:29:07,929 --> 04:29:06,239

of the phospholipid membranes we've been

3454

04:29:10,729 --> 04:29:07,939

seeing today

3455

04:29:13,250 --> 04:29:10,739

hopenoids are some of the most abundant

3456

04:29:15,410 --> 04:29:13,260

bacterial lipid biomarkers on Earth so

3457

04:29:18,950 --> 04:29:15,420

they're very worthy of studying

3458

04:29:22,130 --> 04:29:18,960

they are important geologically they can

3459

04:29:24,290 --> 04:29:22,140

withstand the lithification process and

3460

04:29:27,410 --> 04:29:24,300

all the diagenetic forces that happen

3461

04:29:29,090 --> 04:29:27,420

when you are becoming a fossil and so

3462

04:29:31,250 --> 04:29:29,100

they're actually one of the few really

3463

04:29:33,670 --> 04:29:31,260

strong sources through deep time of

3464

04:29:36,830 --> 04:29:33,680

microbial inputs into the Rock record

3465

04:29:39,170 --> 04:29:36,840

and they can be detected billions of

3466

04:29:42,050 --> 04:29:39,180

years after a deposition

3467

04:29:45,050 --> 04:29:42,060

um finally in modern acidic Springs we

3468

04:29:48,469 --> 04:29:45,060

observe methylated hopenoids oh sorry

3469

04:29:51,910 --> 04:29:48,479

in in this work we in modern acidic

3470

04:29:54,530 --> 04:29:51,920

Springs observed methylated hopenoids

3471

04:29:57,710 --> 04:29:54,540

and we found these in an anoxic

3472

04:30:00,050 --> 04:29:57,720

environment where no cyanobacteria and

3473

04:30:03,590 --> 04:30:00,060

no methanotrophs were present these are

3474

04:30:06,590 --> 04:30:03,600

kind of the typified known producers of

3475

04:30:09,769 --> 04:30:06,600

these kinds of biomarkers so it was

3476

04:30:11,929 --> 04:30:09,779

exciting to find them at all and yeah

3477

04:30:14,210 --> 04:30:11,939

the work that once we found those

3478

04:30:16,849 --> 04:30:14,220

methylated hopeenoids and the follow-up

3479

04:30:18,889 --> 04:30:16,859

work was able to lead to discovery of

3480

04:30:21,290 --> 04:30:18,899

some new potential Source organisms for

3481

04:30:23,210 --> 04:30:21,300

these lipid biomarkers which if you are

3482

04:30:26,330 --> 04:30:23,220

a biomarker nerd is always exciting and

3483

04:30:28,610 --> 04:30:26,340

it's ever expanding so yeah

3484

04:30:31,370 --> 04:30:28,620

this kind of new evidence of source

3485

04:30:33,649 --> 04:30:31,380

organisms is important because uh these

3486

04:30:35,210 --> 04:30:33,659

yeah kind of inoxic environments and

3487

04:30:37,370 --> 04:30:35,220

knowing about them and the microbes that

3488

04:30:40,189 --> 04:30:37,380

live in them today can have implications

3489

04:30:41,750 --> 04:30:40,199

for us to reinterpret uh the sedimentary

3490

04:30:43,790 --> 04:30:41,760

rock record on Earth but also

3491

04:30:45,889 --> 04:30:43,800

potentially on mars or on other planets

3492

04:30:48,950 --> 04:30:45,899

where we have a sedimentary rock record

3493

04:30:51,110 --> 04:30:48,960

so my samples were taken in two sites

3494

04:30:53,889 --> 04:30:51,120

one is in Yellowstone National Park and

3495

04:30:56,809 --> 04:30:53,899

one is in Lassen Volcanic National Park

3496

04:30:58,550 --> 04:30:56,819

in both Springs you can see the mat is

3497

04:31:02,269 --> 04:30:58,560

kind of similar there's a purple layer

3498

04:31:03,830 --> 04:31:02,279

there's a like a acidic algae layer and

3499

04:31:05,929 --> 04:31:03,840

then there's this white flocculent

3500

04:31:08,710 --> 04:31:05,939

Elemental sulfur on top that's from the

3501
04:31:11,809 --> 04:31:08,720
actual hydrothermal system itself

3502
04:31:14,510 --> 04:31:11,819
so what I did is I go into these Springs

3503
04:31:17,210 --> 04:31:14,520
and I take samples and I go back to my

3504
04:31:19,729 --> 04:31:17,220
lab and I extract for both DNA and for

3505
04:31:20,630 --> 04:31:19,739
lipids and then from there I analyzed

3506
04:31:22,969 --> 04:31:20,640
them

3507
04:31:28,010 --> 04:31:22,979
so I found a bunch of different

3508
04:31:29,570 --> 04:31:28,020
hopenoids so I did a lcms analysis on

3509
04:31:31,130 --> 04:31:29,580
them and so I was able to actually look

3510
04:31:34,010 --> 04:31:31,140
at the functionalized extended

3511
04:31:36,290 --> 04:31:34,020
hopenoids and so as you can see there's

3512
04:31:38,149 --> 04:31:36,300
a lot of colors on that graph every

3513
04:31:40,130 --> 04:31:38,159

color is a different type of Hope noid

3514

04:31:43,429 --> 04:31:40,140

uh that was able to find in my Springs

3515

04:31:44,929 --> 04:31:43,439

the green overlay on some of them and

3516

04:31:47,330 --> 04:31:44,939

the pink overlays on some of them

3517

04:31:51,050 --> 04:31:47,340

indicate a 2-methyl for green or a

3518

04:31:52,910 --> 04:31:51,060

three-methyl for pink so we found a huge

3519

04:31:53,630 --> 04:31:52,920

diversity of methylated

3520

04:31:56,330 --> 04:31:53,640

um

3521

04:31:59,149 --> 04:31:56,340

yeah methylated hopeenoid compounds over

3522

04:32:01,429 --> 04:31:59,159

to the far right you can see my controls

3523

04:32:03,410 --> 04:32:01,439

we had pretty low diversity of

3524

04:32:05,090 --> 04:32:03,420

methylated compounds so

3525

04:32:06,769 --> 04:32:05,100

it was really interesting in the

3526
04:32:08,450 --> 04:32:06,779
environmental samples to see so many

3527
04:32:10,070 --> 04:32:08,460
different kinds which is what sent us on

3528
04:32:11,570 --> 04:32:10,080
our DNA work

3529
04:32:14,450 --> 04:32:11,580
um so the first thing that we did was do

3530
04:32:15,889 --> 04:32:14,460
sixness amplicon analysis of our

3531
04:32:18,110 --> 04:32:15,899
extracted DNA

3532
04:32:20,510 --> 04:32:18,120
in that we didn't see any obvious

3533
04:32:23,450 --> 04:32:20,520
sources or classical sources of those

3534
04:32:26,030 --> 04:32:23,460
methylated hopenoids which was pretty

3535
04:32:28,490 --> 04:32:26,040
exciting so that then led us to go back

3536
04:32:29,929 --> 04:32:28,500
and then do some metagenomics and then

3537
04:32:33,769 --> 04:32:29,939
when we were able to analyze that

3538
04:32:35,030 --> 04:32:33,779

metagenomic data we saw many potential

3539

04:32:35,630 --> 04:32:35,040

sources

3540

04:32:39,610 --> 04:32:35,640

um

3541

04:32:42,530 --> 04:32:39,620

of Novel yeah 2-methylhopenoid producers

3542

04:32:46,610 --> 04:32:42,540

mostly anaerobic water and soil dwelling

3543

04:32:48,349 --> 04:32:46,620

microbes but way more sources than are

3544

04:32:52,189 --> 04:32:48,359

currently understood and this is just

3545

04:32:53,990 --> 04:32:52,199

from looking in two hot springs so a

3546

04:32:57,170 --> 04:32:54,000

case for doing field work to expand our

3547

04:32:58,729 --> 04:32:57,180

knowledge in the lab we also saw a ton

3548

04:33:01,550 --> 04:32:58,739

of potential novel sources of three

3549

04:33:03,229 --> 04:33:01,560

methylhopenoids these were also so these

3550

04:33:04,910 --> 04:33:03,239

were mostly anaerobic and acidic

3551
04:33:07,970 --> 04:33:04,920
environment dwellers that we found them

3552
04:33:10,369 --> 04:33:07,980
tagging against and

3553
04:33:13,131 --> 04:33:10,379
yeah it was pretty exciting so if you

3554
04:33:17,029 --> 04:33:13,141
want to know more about either lipids or

3555
04:33:18,709 --> 04:33:17,039
DNA analyzes or a microbial Ecology of

3556
04:33:20,689 --> 04:33:18,719
these acidic Springs please come check

3557
04:33:23,570 --> 04:33:20,699
out my poster later and find me I'll be

3558
04:33:25,670 --> 04:33:23,580
at board 22 at this next session and

3559
04:33:28,789 --> 04:33:25,680
also because I am in a room full of

3560
04:33:31,970 --> 04:33:28,799
early career researchers I coordinate a

3561
04:33:33,949 --> 04:33:31,980
division seminar at NASA Ames and we

3562
04:33:35,929 --> 04:33:33,959
would love to hear you guys give talks

3563
04:33:38,869 --> 04:33:35,939

so if you would like to give a talk at

3564

04:33:40,131 --> 04:33:38,879

NASA Ames at any point please come find

3565

04:33:41,750 --> 04:33:40,141

me at my poster and I'd love to write

3566

04:33:44,269 --> 04:33:41,760

your information down and we would love

3567

04:33:47,150 --> 04:33:44,279

to have you give a talk so

3568

04:33:49,010 --> 04:33:47,970

[Applause]

3569

04:33:53,929 --> 04:33:49,020

[Music]

3570

04:33:57,230 --> 04:33:53,939

[Applause]

3571

04:34:06,590 --> 04:33:57,240

our next speaker is Colin Robinson from

3572

04:34:10,490 --> 04:34:08,631

hi everyone so I'll be talking about

3573

04:34:12,890 --> 04:34:10,500

Martian metabolism and biotic

3574

04:34:14,269 --> 04:34:12,900

perchlorate reduction in Mars analog

3575

04:34:17,570 --> 04:34:14,279

environments on Earth

3576

04:34:18,830 --> 04:34:17,580

so uh since the discovery of let's see

3577

04:34:20,570 --> 04:34:18,840

if I can get this video since the

3578

04:34:22,970 --> 04:34:20,580

discovery of perchlorate

3579

04:34:24,890 --> 04:34:22,980

on Mars by the Phoenix Lander in 2008

3580

04:34:26,810 --> 04:34:24,900

it's been a compound of interest on the

3581

04:34:29,349 --> 04:34:26,820

red planet this is due to its high

3582

04:34:32,090 --> 04:34:29,359

oxidative potential on par with oxygen

3583

04:34:35,390 --> 04:34:32,100

which means that it's a potential energy

3584

04:34:37,369 --> 04:34:35,400

source for life on the red planet uh on

3585

04:34:39,230 --> 04:34:37,379

Mars it's ubiquitous in Martian regolith

3586

04:34:40,310 --> 04:34:39,240

reaching concentrations of 0.5 weight

3587

04:34:43,010 --> 04:34:40,320

percentage

3588

04:34:44,990 --> 04:34:43,020

on Earth there are microbes that reduce

3589

04:34:46,369 --> 04:34:45,000

perchlorate in place of oxygen and

3590

04:34:48,051 --> 04:34:46,379

Metabolism using it to drive the

3591

04:34:50,869 --> 04:34:48,061

electron transport chain

3592

04:34:52,849 --> 04:34:50,879

and perchlorate accumulates in Mars

3593

04:34:54,230 --> 04:34:52,859

analog systems on Earth such as the

3594

04:34:56,869 --> 04:34:54,240

Atacama Desert where it reaches

3595

04:34:58,609 --> 04:34:56,879

concentrations up to 0.18 percent

3596

04:34:59,830 --> 04:34:58,619

as well as the Antarctic dry valleys

3597

04:35:02,929 --> 04:34:59,840

where it reaches concentrations up to

3598

04:35:04,849 --> 04:35:02,939

.0038 these are Mars analog systems that

3599

04:35:08,029 --> 04:35:04,859

are incredibly dry and accumulate

3600

04:35:11,929 --> 04:35:08,039

perchlorate via atmospheric deposition

3601

04:35:14,869 --> 04:35:11,939

over long time scales and uh

3602

04:35:16,789 --> 04:35:14,879

there are likely at looking at these

3603

04:35:19,131 --> 04:35:16,799

systems it seems reasonable that

3604

04:35:20,510 --> 04:35:19,141

reducing microbes might evolve and

3605

04:35:23,449 --> 04:35:20,520

persist in these types of environments

3606

04:35:25,609 --> 04:35:23,459

however the model organisms that we use

3607

04:35:27,650 --> 04:35:25,619

to study biotic perchlorate reduction

3608

04:35:31,310 --> 04:35:27,660

don't come from Mars analog environments

3609

04:35:34,369 --> 04:35:31,320

they come from the Potomac River in

3610

04:35:36,590 --> 04:35:34,379

Washington DC where there's very little

3611

04:35:38,689 --> 04:35:36,600

to no natural perchlorate that

3612

04:35:43,131 --> 04:35:38,699

accumulates all the pakori that we do

3613

04:35:44,631 --> 04:35:43,141

find here is um is waste from Munitions

3614

04:35:46,670 --> 04:35:44,641

factories that gets dumped into the

3615

04:35:49,010 --> 04:35:46,680

river so how did perchlorate reducing

3616

04:35:50,170 --> 04:35:49,020

microbes arrive in this type of

3617

04:35:52,789 --> 04:35:50,180

environment

3618

04:35:54,289 --> 04:35:52,799

if they likely didn't evolve here due to

3619

04:35:56,750 --> 04:35:54,299

the lack of perchloride

3620

04:35:58,131 --> 04:35:56,760

well we know that the perchlorate

3621

04:36:00,830 --> 04:35:58,141

reduction genomic island is widely

3622

04:36:02,150 --> 04:36:00,840

spread via horizontal Gene transfer we

3623

04:36:04,490 --> 04:36:02,160

know this because when we look at

3624

04:36:06,890 --> 04:36:04,500

reducing organisms uh can you see my

3625

04:36:09,650 --> 04:36:06,900

mouse yeah there we go

3626

04:36:10,910 --> 04:36:09,660

um the elements required for biotic

3627

04:36:13,070 --> 04:36:10,920

report reduction the genes that are

3628

04:36:14,990 --> 04:36:13,080

required for court reduction

3629

04:36:16,609 --> 04:36:15,000

um share a lot of homology between the

3630

04:36:20,269 --> 04:36:16,619

genes but where the genes are situated

3631

04:36:21,529 --> 04:36:20,279

in the genome is very diverse depending

3632

04:36:25,609 --> 04:36:21,539

on the organism that you're looking at

3633

04:36:27,349 --> 04:36:25,619

so it's a very chimeric metabolism so if

3634

04:36:29,150 --> 04:36:27,359

we look here the the bright green that's

3635

04:36:30,470 --> 04:36:29,160

chloride dismutates and this long dark

3636

04:36:32,090 --> 04:36:30,480

green that's perchlorate reductase

3637

04:36:34,269 --> 04:36:32,100

they're always kind of in different

3638

04:36:37,189 --> 04:36:34,279

configurations in relation to each other

3639

04:36:38,810 --> 04:36:37,199

in uh in the genomic Island and that's

3640

04:36:43,010 --> 04:36:38,820

because these individual elements are

3641

04:36:44,929 --> 04:36:43,020

getting passed uh individually and um

3642

04:36:47,269 --> 04:36:44,939

independently of one another via

3643

04:36:49,910 --> 04:36:47,279

horizontal Gene transfer so you only get

3644

04:36:53,390 --> 04:36:49,920

reducing microbes when these elements

3645

04:36:55,429 --> 04:36:53,400

come together in the same organism

3646

04:36:57,709 --> 04:36:55,439

so my research question was did

3647

04:36:59,029 --> 04:36:57,719

canonical biotic reduction arise in

3648

04:37:01,070 --> 04:36:59,039

these Mars analog environments like the

3649

04:37:02,990 --> 04:37:01,080

Atacama Desert or Antarctic dry valleys

3650

04:37:05,449 --> 04:37:03,000

and then disperse around the world via

3651
04:37:07,970 --> 04:37:05,459
acellular and microbial dispersal

3652
04:37:09,709 --> 04:37:07,980
so in order to test that I selected

3653
04:37:11,869 --> 04:37:09,719
metagenomes from sites around the world

3654
04:37:13,849 --> 04:37:11,879
the metagenome for those of you who

3655
04:37:15,529 --> 04:37:13,859
don't know is basically all the DNA in a

3656
04:37:18,890 --> 04:37:15,539
sample it comes in little

3657
04:37:21,230 --> 04:37:18,900
20 base pair of chunks and you have to

3658
04:37:22,609 --> 04:37:21,240
piece them together like a puzzle and

3659
04:37:24,949 --> 04:37:22,619
then pick out the puzzles that you're

3660
04:37:27,890 --> 04:37:24,959
interested in that maybe make a picture

3661
04:37:29,449 --> 04:37:27,900
you're interested in and then uh and

3662
04:37:31,250 --> 04:37:29,459
then analyze those independent of the

3663
04:37:33,109 --> 04:37:31,260

rest of the metagenome so basically what

3664

04:37:35,209 --> 04:37:33,119

I did is I selected metagenomes from

3665

04:37:37,189 --> 04:37:35,219

sites around the world I analyzed the

3666

04:37:39,170 --> 04:37:37,199

presence of reduction genes so basically

3667

04:37:41,209 --> 04:37:39,180

build the little puzzles and then pulled

3668

04:37:42,830 --> 04:37:41,219

out the the ones that made reducing

3669

04:37:45,590 --> 04:37:42,840

genes and then I calculated the

3670

04:37:48,349 --> 04:37:45,600

phylogenetic diversity of those genes at

3671

04:37:49,849 --> 04:37:48,359

each site this is a study that has

3672

04:37:52,670 --> 04:37:49,859

really up until this point been done

3673

04:37:55,250 --> 04:37:52,680

only in humans which is this uh type of

3674

04:37:57,109 --> 04:37:55,260

analysis where we look at diversity of a

3675

04:37:58,670 --> 04:37:57,119

species or a gene to determine the

3676

04:38:00,289 --> 04:37:58,680

likely places where it's persisted the

3677

04:38:02,269 --> 04:38:00,299

longest that's how we know that humans

3678

04:38:03,529 --> 04:38:02,279

come out of Africa is because most of

3679

04:38:05,869 --> 04:38:03,539

our phylogenetic diversity can be

3680

04:38:09,109 --> 04:38:05,879

accounted for in Africa

3681

04:38:10,429 --> 04:38:09,119

so when I did this uh so this is for

3682

04:38:12,410 --> 04:38:10,439

chloride dismutase a gene that's

3683

04:38:16,189 --> 04:38:12,420

involved in perchlorate reduction I

3684

04:38:18,650 --> 04:38:16,199

found the highest diversity to be in uh

3685

04:38:20,750 --> 04:38:18,660

in the Antarctic dry Valley so what

3686

04:38:22,849 --> 04:38:20,760

we're seeing here is these bars are are

3687

04:38:24,590 --> 04:38:22,859

a scale that's Faith's phylogenetic

3688

04:38:27,051 --> 04:38:24,600

diversity zero is basically zero

3689

04:38:29,209 --> 04:38:27,061

diversity and then up to 50 would would

3690

04:38:30,410 --> 04:38:29,219

be the maximum amount of diversity in

3691

04:38:33,529 --> 04:38:30,420

these genes that we see and each of

3692

04:38:34,730 --> 04:38:33,539

these blue dots is a separate metagenome

3693

04:38:37,551 --> 04:38:34,740

um as you can see there's a little bit

3694

04:38:39,769 --> 04:38:37,561

of sampling bias because in the anterior

3695

04:38:40,789 --> 04:38:39,779

dry valleys or Atacama Desert we have a

3696

04:38:42,051 --> 04:38:40,799

lot more sampling there's a lot more

3697

04:38:43,551 --> 04:38:42,061

research that happens in these sites

3698

04:38:45,590 --> 04:38:43,561

we've got a lot more metagenomes that I

3699

04:38:47,390 --> 04:38:45,600

can analyze whereas if I look at other

3700

04:38:49,609 --> 04:38:47,400

Mars analog sites like the Namib Desert

3701

04:38:52,609 --> 04:38:49,619

there are quite a few less or in South

3702

04:38:54,170 --> 04:38:52,619

Australian desert uh much less access to

3703

04:38:56,330 --> 04:38:54,180

that kind of data

3704

04:38:57,650 --> 04:38:56,340

when I looked at procore reductase

3705

04:39:00,650 --> 04:38:57,660

another Gene involved in biotic

3706

04:39:02,449 --> 04:39:00,660

reduction we also see that it is it

3707

04:39:04,789 --> 04:39:02,459

reaches highest levels in the Antarctic

3708

04:39:06,590 --> 04:39:04,799

dry valleys so that basically indicates

3709

04:39:08,990 --> 04:39:06,600

that these genes have persisted the

3710

04:39:11,510 --> 04:39:09,000

longest in in these in this in these in

3711

04:39:13,250 --> 04:39:11,520

these Mars analog ecosystems supporting

3712

04:39:15,170 --> 04:39:13,260

the claim that these may have evolved

3713

04:39:16,131 --> 04:39:15,180

and persisted in those Mars analog

3714

04:39:18,529 --> 04:39:16,141

systems

3715

04:39:19,849 --> 04:39:18,539

so some conclusions for court reduction

3716

04:39:21,650 --> 04:39:19,859

genes are present and diverse in Mars

3717

04:39:23,750 --> 04:39:21,660

analog systems that's really awesome

3718

04:39:25,789 --> 04:39:23,760

right before we didn't even know if they

3719

04:39:27,529 --> 04:39:25,799

could persist in Wars analog systems but

3720

04:39:29,810 --> 04:39:27,539

it looks like they both evolve and

3721

04:39:31,310 --> 04:39:29,820

persist there for long time scales

3722

04:39:33,109 --> 04:39:31,320

this metabolism may have evolved in

3723

04:39:34,369 --> 04:39:33,119

these environments and then uh prior to

3724

04:39:36,769 --> 04:39:34,379

dispersing around the world via

3725

04:39:38,330 --> 04:39:36,779

acellular and microbial dispersal and

3726
04:39:40,490 --> 04:39:38,340
studying for core reducing organisms in

3727
04:39:41,690 --> 04:39:40,500
Mars analog environments can give us

3728
04:39:43,850 --> 04:39:41,700
further insight into how life may

3729
04:39:45,830 --> 04:39:43,860
persist on the red planet when we're

3730
04:39:47,390 --> 04:39:45,840
studying life forms that do metabolisms

3731
04:39:48,530 --> 04:39:47,400
like what we expect to find on Mars we

3732
04:39:50,150 --> 04:39:48,540
shouldn't be looking at organisms that

3733
04:39:52,070 --> 04:39:50,160
come out of the Potomac River we should

3734
04:39:53,448 --> 04:39:52,080
be looking at at organisms in these Mars

3735
04:39:56,448 --> 04:39:53,458
analog systems

3736
04:39:59,030 --> 04:39:56,458
so I'd like to hear some some people I'd

3737
04:40:00,890 --> 04:39:59,040
like to thank so my funding which is the

3738
04:40:03,170 --> 04:40:00,900

the NSF grant for long-term ecological

3739

04:40:04,788 --> 04:40:03,180

research at McMurdo Station uh my

3740

04:40:06,708 --> 04:40:04,798

department at Brigham Young University

3741

04:40:09,110 --> 04:40:06,718

as well as the help and advice of Dr

3742

04:40:10,788 --> 04:40:09,120

John Coates at UC Berkeley Dr Kendall

3743

04:40:12,830 --> 04:40:10,798

Kendall Lynch at the lunar and planetary

3744

04:40:15,060 --> 04:40:12,840

Institute and Dr Jennifer glass at

3745

04:40:22,910 --> 04:40:15,070

Georgia Tech so thank you

3746

04:40:25,610 --> 04:40:22,920

[Applause]

3747

04:40:36,410 --> 04:40:25,620

and our last speaker is selesh Pandey

3748

04:40:41,208 --> 04:40:38,930

hello everyone I am Siddharth from jet

3749

04:40:42,830 --> 04:40:41,218

propulsion laboratory and I'm here to

3750

04:40:44,750 --> 04:40:42,840

talk about the work that I started

3751
04:40:46,910 --> 04:40:44,760
before joining JPL

3752
04:40:49,250 --> 04:40:46,920
um in India and for those of you in the

3753
04:40:51,708 --> 04:40:49,260
audience who are currently involved or

3754
04:40:53,868 --> 04:40:51,718
plan to do work in different parts of

3755
04:40:55,670 --> 04:40:53,878
the world where astrobiology has huge

3756
04:40:58,130 --> 04:40:55,680
potential and significance hopefully

3757
04:41:00,110 --> 04:40:58,140
with some of my experience you'll be

3758
04:41:02,208 --> 04:41:00,120
able to take things forward

3759
04:41:04,670 --> 04:41:02,218
so first of all a little bit about

3760
04:41:06,530 --> 04:41:04,680
myself so I'm originally from India and

3761
04:41:08,690 --> 04:41:06,540
before joining JPL

3762
04:41:11,090 --> 04:41:08,700
um I have an engineering background and

3763
04:41:12,590 --> 04:41:11,100

my current work is actually on Enceladus

3764

04:41:13,970 --> 04:41:12,600

on Sample collection Technologies but

3765

04:41:15,770 --> 04:41:13,980

unfortunately today I'm not going to be

3766

04:41:17,090 --> 04:41:15,780

talking about that this is primarily

3767

04:41:18,650 --> 04:41:17,100

going to be focused on that but just

3768

04:41:20,990 --> 04:41:18,660

giving a heads up people can find me

3769

04:41:23,150 --> 04:41:21,000

after the talk and maybe we can chat

3770

04:41:26,330 --> 04:41:23,160

um but here here is why we focused on

3771

04:41:27,830 --> 04:41:26,340

India well first and foremost as a

3772

04:41:29,750 --> 04:41:27,840

country India has one of the largest

3773

04:41:31,910 --> 04:41:29,760

student populations as some of you might

3774

04:41:33,650 --> 04:41:31,920

be aware every year we've got several

3775

04:41:35,390 --> 04:41:33,660

thousands of students graduating in

3776

04:41:38,090 --> 04:41:35,400

science and engineering and on a daily

3777

04:41:39,110 --> 04:41:38,100

basis we get inquiries about how do you

3778

04:41:40,970 --> 04:41:39,120

study and how do you work in

3779

04:41:42,770 --> 04:41:40,980

astrobiology so there's a huge supply

3780

04:41:45,890 --> 04:41:42,780

and demand problem and there's little to

3781

04:41:47,930 --> 04:41:45,900

no formal education or you know career

3782

04:41:49,570 --> 04:41:47,940

prospects in the country so that was the

3783

04:41:52,550 --> 04:41:49,580

first and foremost no-brainer reason

3784

04:41:54,170 --> 04:41:52,560

secondly I would like to really promote

3785

04:41:57,350 --> 04:41:54,180

the fact that we have an amazing

3786

04:41:58,970 --> 04:41:57,360

diversity of high value science analogs

3787

04:42:00,590 --> 04:41:58,980

and these are places where some of you

3788

04:42:03,230 --> 04:42:00,600

might actually find some of your work to

3789

04:42:05,330 --> 04:42:03,240

be super relevant so with this in mind

3790

04:42:06,830 --> 04:42:05,340

these sites are not even on the atlas of

3791

04:42:08,510 --> 04:42:06,840

astrobiology sites that the community

3792

04:42:11,448 --> 04:42:08,520

normally works in

3793

04:42:13,610 --> 04:42:11,458

and lastly our National Space Agency

3794

04:42:16,310 --> 04:42:13,620

Indian space research organization is

3795

04:42:18,948 --> 04:42:16,320

finally reaching a point to to involve

3796

04:42:21,170 --> 04:42:18,958

astrobiology as an important science

3797

04:42:23,030 --> 04:42:21,180

priority for its future missions it had

3798

04:42:25,368 --> 04:42:23,040

the Mars Orbiter mission in 2014

3799

04:42:26,990 --> 04:42:25,378

currently there are it's under Works to

3800

04:42:29,090 --> 04:42:27,000

work on a Surface mission that would

3801
04:42:30,830 --> 04:42:29,100
work on the progress and the success of

3802
04:42:32,990 --> 04:42:30,840
the lunar mission that will be launching

3803
04:42:34,670 --> 04:42:33,000
in a month from now and finally there is

3804
04:42:37,190 --> 04:42:34,680
the gaganyan program which is the human

3805
04:42:39,288 --> 04:42:37,200
space program which will have astronauts

3806
04:42:41,810 --> 04:42:39,298
working in low earth orbit

3807
04:42:43,610 --> 04:42:41,820
so that's with that as the basic

3808
04:42:45,650 --> 04:42:43,620
motivation of why we decided to do this

3809
04:42:47,868 --> 04:42:45,660
seven years ago let me talk quickly

3810
04:42:49,970 --> 04:42:47,878
about the background in terms of what

3811
04:42:52,368 --> 04:42:49,980
astrobiology was happening before we

3812
04:42:55,010 --> 04:42:52,378
kind of stepped in so the earliest what

3813
04:42:56,930 --> 04:42:55,020

we could find is between 97 to 2005

3814

04:42:58,788 --> 04:42:56,940

Israel was involved in scientific

3815

04:43:01,368 --> 04:42:58,798

balloon experiments where they were

3816

04:43:03,350 --> 04:43:01,378

basically working on collecting and

3817

04:43:05,628 --> 04:43:03,360

understanding microbes in the

3818

04:43:08,448 --> 04:43:05,638

stratosphere

3819

04:43:09,890 --> 04:43:08,458

um cut to 2015 whereas a grad student I

3820

04:43:12,050 --> 04:43:09,900

got an opportunity to go on an

3821

04:43:14,868 --> 04:43:12,060

astrobiology expedition to New Zealand

3822

04:43:17,270 --> 04:43:14,878

and along with a few other Indian and

3823

04:43:19,250 --> 04:43:17,280

Indian origin researchers we decided to

3824

04:43:22,330 --> 04:43:19,260

bring the program to India

3825

04:43:25,490 --> 04:43:22,340

and that's what we did as part of the

3826
04:43:27,050 --> 04:43:25,500
NASA spacer down India Expedition that

3827
04:43:28,788 --> 04:43:27,060
was the first time that a dedicated

3828
04:43:30,110 --> 04:43:28,798
astrobiology expedition was taking place

3829
04:43:32,628 --> 04:43:30,120
Gathering and bringing together

3830
04:43:34,430 --> 04:43:32,638
researchers in the country and that's

3831
04:43:36,470 --> 04:43:34,440
where ball just really started rolling

3832
04:43:38,990 --> 04:43:36,480
the momentum started building up and let

3833
04:43:40,788 --> 04:43:39,000
me tell you something that working and

3834
04:43:43,310 --> 04:43:40,798
socializing with people in uncomfortable

3835
04:43:45,170 --> 04:43:43,320
dry desert environments is way better

3836
04:43:47,090 --> 04:43:45,180
than inside an air-conditioned classroom

3837
04:43:49,368 --> 04:43:47,100
with experience

3838
04:43:50,990 --> 04:43:49,378

so some of the things that led from that

3839

04:43:52,550 --> 04:43:51,000

was the establishment of a standard of

3840

04:43:53,930 --> 04:43:52,560

Excellence in astrobiology at Amity

3841

04:43:56,150 --> 04:43:53,940

University Mumbai which was the first

3842

04:43:58,490 --> 04:43:56,160

dedicated Center that I was a part of

3843

04:43:59,990 --> 04:43:58,500

leading and also as part of Blue Marble

3844

04:44:02,570 --> 04:44:00,000

space the organization that I had been

3845

04:44:04,670 --> 04:44:02,580

affiliated with the astrobiology India

3846

04:44:07,070 --> 04:44:04,680

group has been active since then

3847

04:44:09,590 --> 04:44:07,080

working to promote coordination

3848

04:44:10,970 --> 04:44:09,600

activities between domestic researchers

3849

04:44:12,708 --> 04:44:10,980

in the country so we've been having

3850

04:44:15,288 --> 04:44:12,718

National level meetings and discussions

3851

04:44:17,090 --> 04:44:15,298

and what we want to do from here is move

3852

04:44:19,250 --> 04:44:17,100

forward towards setting up a national

3853

04:44:21,590 --> 04:44:19,260

astrobiology program closely in support

3854

04:44:23,390 --> 04:44:21,600

with the Indian government

3855

04:44:26,090 --> 04:44:23,400

I don't have enough time but I'll try to

3856

04:44:27,590 --> 04:44:26,100

do justice to this slide our efforts at

3857

04:44:30,830 --> 04:44:27,600

the center focused on three main

3858

04:44:32,810 --> 04:44:30,840

verticals the microgravity research we

3859

04:44:35,150 --> 04:44:32,820

built plant-based plant growth

3860

04:44:36,288 --> 04:44:35,160

observation experiments for ISRO we

3861

04:44:38,330 --> 04:44:36,298

worked on characterizing some of the

3862

04:44:40,910 --> 04:44:38,340

sites in Ladakh which is an early Mars

3863

04:44:43,550 --> 04:44:40,920

analog and Hardware testing for Rovers

3864

04:44:45,650 --> 04:44:43,560

and in collaboration with UC Berkeley

3865

04:44:47,090 --> 04:44:45,660

the Berkeley City Research Center we had

3866

04:44:48,770 --> 04:44:47,100

four research fellows who were working

3867

04:44:51,470 --> 04:44:48,780

to use

3868

04:44:53,750 --> 04:44:51,480

um radio telescope data from gmrt which

3869

04:44:55,070 --> 04:44:53,760

is a array facility there to set up a

3870

04:44:57,650 --> 04:44:55,080

city pipeline

3871

04:44:59,390 --> 04:44:57,660

and our research work has culminated

3872

04:45:01,250 --> 04:44:59,400

into the university finally agreeing to

3873

04:45:02,570 --> 04:45:01,260

have a master's program that is

3874

04:45:04,670 --> 04:45:02,580

dedicated for astrology and science

3875

04:45:06,170 --> 04:45:04,680

students so hopefully this year onwards

3876

04:45:09,050 --> 04:45:06,180

we'll have students in India who'll have

3877

04:45:11,090 --> 04:45:09,060

that opportunity to study there

3878

04:45:13,610 --> 04:45:11,100

um Blue Marble space has been a great

3879

04:45:14,750 --> 04:45:13,620

source of information and help and

3880

04:45:16,850 --> 04:45:14,760

network so those of you are not

3881

04:45:19,128 --> 04:45:16,860

affiliated I would say strongly

3882

04:45:21,110 --> 04:45:19,138

recommended do consider it

3883

04:45:23,510 --> 04:45:21,120

quickly talking about some of the unique

3884

04:45:25,010 --> 04:45:23,520

aspects of Astral biology in India I've

3885

04:45:27,830 --> 04:45:25,020

just highlighted some of the main sites

3886

04:45:29,690 --> 04:45:27,840

here in Ladakh up north which is a high

3887

04:45:31,310 --> 04:45:29,700

altitude code dry desert environment

3888

04:45:33,948 --> 04:45:31,320

Kutch which is one of the largest salt

3889

04:45:36,470 --> 04:45:33,958

flats in the world the only accessible

3890

04:45:37,970 --> 04:45:36,480

Basalt impact Creator in loner the

3891

04:45:39,470 --> 04:45:37,980

basalt traps and Limestone caves and

3892

04:45:41,330 --> 04:45:39,480

there are several others

3893

04:45:44,030 --> 04:45:41,340

and because we don't have a National

3894

04:45:44,930 --> 04:45:44,040

astrobiology Institute yet there have

3895

04:45:47,230 --> 04:45:44,940

been institutions that have been

3896

04:45:50,510 --> 04:45:47,240

mushrooming over the last few decades

3897

04:45:53,930 --> 04:45:50,520

and I've been very successful and

3898

04:45:56,150 --> 04:45:53,940

fortunate to be part of several senior

3899

04:45:58,490 --> 04:45:56,160

earth scientists to work towards setting

3900

04:46:00,110 --> 04:45:58,500

this up and it's only because of these

3901
04:46:02,208 --> 04:46:00,120
people who you're seeing on the screen

3902
04:46:03,590 --> 04:46:02,218
over here that we're able to do this and

3903
04:46:05,448 --> 04:46:03,600
we've been working through the pandemic

3904
04:46:07,070 --> 04:46:05,458
to make this happen they've been a

3905
04:46:08,690 --> 04:46:07,080
working group several working groups

3906
04:46:11,090 --> 04:46:08,700
that have been put in place uh we've

3907
04:46:13,070 --> 04:46:11,100
been closely following work done in

3908
04:46:14,868 --> 04:46:13,080
Europe and at uh in the United States

3909
04:46:17,030 --> 04:46:14,878
through the NASA Astra Biology Institute

3910
04:46:18,890 --> 04:46:17,040
to help form these working groups and

3911
04:46:20,990 --> 04:46:18,900
these are some names in some areas where

3912
04:46:23,750 --> 04:46:21,000
you know people have been working

3913
04:46:25,310 --> 04:46:23,760

and too much information bad slide I

3914

04:46:27,470 --> 04:46:25,320

know but I just wanted to tell you that

3915

04:46:29,090 --> 04:46:27,480

there are these sites and we have been

3916

04:46:31,610 --> 04:46:29,100

trying to map out the science objectives

3917

04:46:33,050 --> 04:46:31,620

the different Technologies what worlds

3918

04:46:34,730 --> 04:46:33,060

are they analog to and what kind of

3919

04:46:36,770 --> 04:46:34,740

missions would they be able to support

3920

04:46:38,090 --> 04:46:36,780

into the future

3921

04:46:40,190 --> 04:46:38,100

um some other ways in which we have been

3922

04:46:42,410 --> 04:46:40,200

contributing we published our first

3923

04:46:43,368 --> 04:46:42,420

advocacy paper in new space Journal uh

3924

04:46:45,948 --> 04:46:43,378

talking about the importance of

3925

04:46:47,690 --> 04:46:45,958

astrobiology for India and internally we

3926
04:46:50,090 --> 04:46:47,700
have been contributing to the science

3927
04:46:52,850 --> 04:46:50,100
roadmap for ISRO as well

3928
04:46:54,410 --> 04:46:52,860
now three main wins for us one is the

3929
04:46:56,628 --> 04:46:54,420
fact that we've got several students who

3930
04:46:57,830 --> 04:46:56,638
have gone through our uh system and

3931
04:47:00,590 --> 04:46:57,840
these are the people who in the future

3932
04:47:02,390 --> 04:47:00,600
will be taking the light forward

3933
04:47:04,850 --> 04:47:02,400
this year ISRO published its space

3934
04:47:06,770 --> 04:47:04,860
policy document and we were very happy

3935
04:47:08,990 --> 04:47:06,780
to see that they have acknowledged the

3936
04:47:10,490 --> 04:47:09,000
importance of astrobiology because

3937
04:47:11,510 --> 04:47:10,500
they've mentioned that they will be

3938
04:47:13,910 --> 04:47:11,520

looking into extraterrestrial

3939

04:47:15,830 --> 04:47:13,920

habitability so for us as a country this

3940

04:47:17,090 --> 04:47:15,840

is a huge win that finally ISRO has

3941

04:47:19,788 --> 04:47:17,100

acknowledged us

3942

04:47:22,190 --> 04:47:19,798

and the fact that there is now

3943

04:47:24,890 --> 04:47:22,200

comprehensive I would say not enough but

3944

04:47:26,750 --> 04:47:24,900

still comprehensive diversification of

3945

04:47:28,550 --> 04:47:26,760

funding for scientists in the country to

3946

04:47:29,750 --> 04:47:28,560

do this but definitely more work needs

3947

04:47:30,650 --> 04:47:29,760

to be done and more funding needs to be

3948

04:47:33,530 --> 04:47:30,660

put together

3949

04:47:35,030 --> 04:47:33,540

so my last slide um to summarize some of

3950

04:47:36,470 --> 04:47:35,040

these things if you are in your region

3951
04:47:38,390 --> 04:47:36,480
or country interested in setting things

3952
04:47:39,708 --> 04:47:38,400
up the first and foremost step is to

3953
04:47:41,930 --> 04:47:39,718
bring early and mid-career people

3954
04:47:44,448 --> 04:47:41,940
together and encourage conversations to

3955
04:47:46,190 --> 04:47:44,458
take place at a domestic level at the

3956
04:47:48,470 --> 04:47:46,200
same time leveraging International work

3957
04:47:50,868 --> 04:47:48,480
and like I said field workshops are

3958
04:47:52,970 --> 04:47:50,878
amazing for team building

3959
04:47:55,070 --> 04:47:52,980
finding an important University or a

3960
04:47:56,810 --> 04:47:55,080
host institution is critical because if

3961
04:47:58,310 --> 04:47:56,820
you're doing events logistically

3962
04:48:00,410 --> 04:47:58,320
speaking it's important to find an

3963
04:48:01,850 --> 04:48:00,420

organization that will support you and

3964

04:48:03,530 --> 04:48:01,860

beware of non-scientific and

3965

04:48:04,430 --> 04:48:03,540

exploitative groups in the in the in the

3966

04:48:06,708 --> 04:48:04,440

region

3967

04:48:08,868 --> 04:48:06,718

finally convene workshops identify

3968

04:48:11,330 --> 04:48:08,878

research interests try to tiler them

3969

04:48:12,890 --> 04:48:11,340

together into overarching themes and

3970

04:48:14,628 --> 04:48:12,900

help the group formalize themselves in

3971

04:48:16,850 --> 04:48:14,638

the form of virtual Network a non-profit

3972

04:48:18,288 --> 04:48:16,860

or a society and finally encourage the

3973

04:48:19,910 --> 04:48:18,298

group members to work closely with their

3974

04:48:22,190 --> 04:48:19,920

government for their astrology goals so

3975

04:48:23,750 --> 04:48:22,200

that's my time and you hope you can find

3976

04:48:25,380 --> 04:48:23,760

me and those of you are interested can

3977

04:48:34,788 --> 04:48:25,390

talk more on this thank you

3978

04:48:37,550 --> 04:48:34,798

[Applause]

3979

04:48:38,868 --> 04:48:37,560

okay so that concludes the first short

3980

04:48:41,690 --> 04:48:38,878

talk session so we're going to start our

3981

04:48:43,550 --> 04:48:41,700

poster session now be sure to find all

3982

04:48:45,230 --> 04:48:43,560

the speakers and others

3983

04:48:47,390 --> 04:48:45,240

um you know to talk to them at their

3984

04:48:49,788 --> 04:48:47,400

posters just a couple housekeeping

3985

04:48:51,670 --> 04:48:49,798

things our friends defense party is

3986

04:48:54,350 --> 04:48:51,680

happening in Surfside right now

3987

04:48:56,208 --> 04:48:54,360

so we've moved a lot of snacks and

3988

04:48:58,128 --> 04:48:56,218

coffee and all that just outside in the

3989

04:48:59,448 --> 04:48:58,138

courtyard so if you have a couple things

3990

04:49:01,670 --> 04:48:59,458

that you really need to grab from

3991

04:49:04,128 --> 04:49:01,680

Surfside just do it quickly and quietly

3992

04:49:05,510 --> 04:49:04,138

I think they're showing up at 1 30 but

3993

04:49:07,730 --> 04:49:05,520

for the next couple hours like really

3994

04:49:09,350 --> 04:49:07,740

we're just gonna be in the Forum we can

3995

04:49:11,090 --> 04:49:09,360

go outside on the green space but let's

3996

04:49:15,110 --> 04:49:11,100

just make sure that they can celebrate

3997

04:49:17,628 --> 04:49:15,120

and serve side and then one thing with

3998

04:49:20,330 --> 04:49:17,638

with trash we need to I guess we can't

3999

04:49:22,190 --> 04:49:20,340

put too much trash in there because I

4000

04:49:24,470 --> 04:49:22,200

guess UCSD catering usually takes care

4001
04:49:26,570 --> 04:49:24,480
of that so we've been told to just we'll

4002
04:49:28,610 --> 04:49:26,580
put out some other garbage cans but just

4003
04:49:29,628 --> 04:49:28,620
refrain from using those as much as

4004
04:49:34,060 --> 04:49:29,638
possible

4005
04:49:42,520 --> 04:49:34,070
uh yeah that's all thanks everyone

4006
04:50:22,690 --> 04:49:58,510
[Music]

4007
04:50:33,680 --> 04:50:22,700
thank you

4008
04:50:46,510 --> 04:50:44,690
[Music]

4009
04:50:59,860 --> 04:50:46,520
foreign

4010
04:51:22,500 --> 04:51:18,520
[Music]

4011
04:51:50,040 --> 04:51:22,510
thank you

4012
04:52:44,900 --> 04:51:55,730
[Music]

4013
04:52:56,100 --> 04:52:44,910

thank you

4014

04:53:10,050 --> 04:53:07,730

[Music]

4015

04:53:24,890 --> 04:53:10,060

foreign

4016

04:53:47,570 --> 04:53:39,120

[Music]

4017

04:54:26,390 --> 04:53:47,580

thank you

4018

04:54:29,390 --> 04:54:26,400

[Music]

4019

04:55:18,970 --> 04:54:29,400

foreign

4020

04:55:18,980 --> 04:55:31,710

thank you

4021

04:56:22,090 --> 04:55:36,830

[Music]

4022

04:56:22,100 --> 04:56:26,790

thank you

4023

04:56:56,448 --> 04:56:42,300

[Music]

4024

04:56:56,458 --> 04:57:01,130

foreign

4025

04:58:08,950 --> 04:57:23,220

[Music]

4026
04:58:21,700 --> 04:58:08,960
foreign

4027
04:58:57,610 --> 04:58:30,540
[Music]

4028
04:59:08,220 --> 04:58:59,350
thank you

4029
04:59:08,230 --> 04:59:34,730
[Music]

4030
04:59:34,740 --> 04:59:39,380
foreign

4031
05:00:15,420 --> 04:59:45,260
[Music]

4032
05:00:36,200 --> 05:00:15,430
thank you

4033
05:00:54,160 --> 05:00:47,020
[Music]

4034
05:01:14,640 --> 05:00:54,170
foreign

4035
05:02:06,830 --> 05:01:20,290
[Music]

4036
05:02:06,840 --> 05:02:21,180
foreign

4037
05:02:57,350 --> 05:02:33,050
[Music]

4038
05:03:09,140 --> 05:02:59,210

foreign

4039

05:04:04,208 --> 05:03:17,690

[Music]

4040

05:04:24,740 --> 05:04:06,930

thank you

4041

05:04:35,110 --> 05:04:30,390

[Music]

4042

05:04:35,120 --> 05:04:38,740

thank you

4043

05:04:38,750 --> 05:05:02,390

[Music]

4044

05:05:02,400 --> 05:05:17,670

foreign

4045

05:05:42,288 --> 05:05:33,650

[Music]

4046

05:06:04,680 --> 05:05:43,130

foreign

4047

05:06:04,690 --> 05:06:21,708

[Music]

4048

05:07:19,190 --> 05:06:23,740

foreign

4049

05:07:40,940 --> 05:07:36,640

[Music]

4050

05:07:54,140 --> 05:07:40,950

foreign

4051
05:07:54,150 --> 05:08:09,170
[Music]

4052
05:08:33,300 --> 05:08:11,550
foreign

4053
05:08:51,948 --> 05:08:46,490
[Music]

4054
05:09:02,870 --> 05:08:54,070
foreign

4055
05:09:02,880 --> 05:09:20,628
[Music]

4056
05:09:20,638 --> 05:09:25,700
foreign

4057
05:10:25,850 --> 05:09:42,660
[Music]

4058
05:10:25,860 --> 05:10:34,430
thank you

4059
05:10:48,660 --> 05:10:35,480
foreign

4060
05:11:14,590 --> 05:11:05,800
[Music]

4061
05:11:23,770 --> 05:11:14,600
thank you

4062
05:11:48,640 --> 05:11:36,740
[Music]

4063
05:12:02,780 --> 05:11:48,650

foreign

4064

05:12:30,890 --> 05:12:11,640

[Music]

4065

05:12:50,840 --> 05:12:33,390

foreign

4066

05:12:50,850 --> 05:13:03,470

[Music]

4067

05:13:03,480 --> 05:13:08,460

foreign

4068

05:13:53,990 --> 05:13:30,050

[Music]

4069

05:14:04,960 --> 05:13:56,290

foreign

4070

05:14:04,970 --> 05:14:15,590

[Music]

4071

05:14:34,490 --> 05:14:17,070

foreign

4072

05:14:34,500 --> 05:14:51,050

[Music]

4073

05:15:10,430 --> 05:14:53,020

foreign

4074

05:15:10,440 --> 05:15:27,230

[Music]

4075

05:15:45,380 --> 05:15:27,930

foreign

4076
05:16:07,170 --> 05:16:00,040
[Music]

4077
05:16:19,960 --> 05:16:07,180
thank you

4078
05:16:42,288 --> 05:16:32,380
[Music]

4079
05:17:00,060 --> 05:16:44,510
foreign

4080
05:17:00,070 --> 05:17:12,288
[Music]

4081
05:17:30,380 --> 05:17:14,830
foreign

4082
05:17:30,390 --> 05:17:38,990
[Music]

4083
05:17:39,000 --> 05:17:45,180
foreign

4084
05:17:45,190 --> 05:17:55,250
[Music]

4085
05:17:55,260 --> 05:18:00,090
foreign

4086
05:18:30,708 --> 05:18:15,460
[Music]

4087
05:18:39,810 --> 05:18:33,200
foreign

4088
05:19:10,120 --> 05:18:45,780

[Music]

4089

05:19:16,110 --> 05:19:10,130

foreign

4090

05:19:38,350 --> 05:19:33,720

[Music]

4091

05:19:46,400 --> 05:19:40,440

thank you

4092

05:19:46,410 --> 05:20:04,368

[Music]

4093

05:20:16,710 --> 05:20:05,680

foreign

4094

05:20:57,170 --> 05:20:24,410

[Music]

4095

05:21:17,340 --> 05:20:59,940

foreign

4096

05:21:30,340 --> 05:21:27,470

[Music]

4097

05:21:35,390 --> 05:21:30,350

foreign

4098

05:22:11,868 --> 05:21:35,400

[Music]

4099

05:22:11,878 --> 05:22:18,010

foreign

4100

05:23:20,090 --> 05:22:23,440

[Music]

4101
05:23:20,100 --> 05:23:23,420
foreign

4102
05:24:35,810 --> 05:23:36,250
[Music]

4103
05:24:49,600 --> 05:24:36,880
foreign

4104
05:25:07,220 --> 05:24:55,060
[Music]

4105
05:25:19,920 --> 05:25:07,230
foreign

4106
05:25:19,930 --> 05:25:24,890
[Music]

4107
05:25:24,900 --> 05:25:30,490
foreign

4108
05:25:55,250 --> 05:25:50,230
[Music]

4109
05:25:55,260 --> 05:26:00,800
foreign

4110
05:26:38,570 --> 05:26:20,550
[Music]

4111
05:26:41,060 --> 05:26:38,580
thank you

4112
05:26:50,860 --> 05:26:41,070
foreign

4113
05:27:55,430 --> 05:26:56,320

[Music]

4114

05:28:04,330 --> 05:27:56,930

foreign

4115

05:28:31,840 --> 05:28:21,810

[Music]

4116

05:28:46,560 --> 05:28:31,850

foreign

4117

05:29:17,650 --> 05:28:59,090

[Music]

4118

05:29:17,660 --> 05:29:22,090

thank you

4119

05:30:16,740 --> 05:29:45,110

[Music]

4120

05:30:22,550 --> 05:30:16,750

foreign

4121

05:31:17,330 --> 05:30:22,560

[Music]

4122

05:31:17,340 --> 05:31:21,400

foreign

4123

05:31:48,990 --> 05:31:30,530

[Music]

4124

05:32:18,070 --> 05:31:49,000

thank you

4125

05:32:19,070 --> 05:32:18,080

[Music]

4126
05:32:33,410 --> 05:32:19,080
thank you

4127
05:33:30,110 --> 05:32:33,420
[Music]

4128
05:34:10,310 --> 05:33:30,940
thank you

4129
05:34:38,000 --> 05:34:12,200
foreign

4130
05:35:12,708 --> 05:34:46,030
[Music]

4131
05:35:24,288 --> 05:35:14,720
foreign

4132
05:35:25,940 --> 05:35:24,298
[Music]

4133
05:35:59,708 --> 05:35:25,950
foreign

4134
05:36:34,208 --> 05:35:59,718
[Music]

4135
05:36:34,218 --> 05:36:40,650
thank you

4136
05:36:40,660 --> 05:36:45,730
[Music]

4137
05:36:45,740 --> 05:36:49,000
thank you

4138
05:37:24,550 --> 05:37:16,790

[Music]

4139

05:37:37,610 --> 05:37:26,060

thank you

4140

05:37:39,920 --> 05:37:37,620

[Music]

4141

05:37:49,610 --> 05:37:39,930

foreign

4142

05:37:51,410 --> 05:37:49,620

[Music]

4143

05:38:12,930 --> 05:37:51,420

foreign

4144

05:38:24,870 --> 05:38:21,890

[Music]

4145

05:39:03,910 --> 05:38:24,880

foreign

4146

05:39:07,570 --> 05:39:05,750

thank you

4147

05:39:48,490 --> 05:39:07,580

foreign

4148

05:39:48,500 --> 05:39:55,930

thank you

4149

05:39:55,940 --> 05:40:21,650

[Music]

4150

05:41:16,310 --> 05:40:23,180

foreign

4151
05:41:19,010 --> 05:41:16,320
[Music]

4152
05:41:28,430 --> 05:41:19,020
foreign

4153
05:41:30,540 --> 05:41:28,440
[Music]

4154
05:41:44,260 --> 05:41:30,550
foreign

4155
05:42:26,670 --> 05:41:58,720
[Music]

4156
05:42:40,190 --> 05:42:26,680
foreign

4157
05:42:40,800 --> 05:42:40,200
[Music]

4158
05:43:20,450 --> 05:42:40,810
foreign

4159
05:43:40,880 --> 05:43:38,930
[Music]

4160
05:43:53,628 --> 05:43:40,890
thank you

4161
05:43:55,010 --> 05:43:53,638
[Music]

4162
05:44:32,020 --> 05:43:55,020
foreign

4163
05:44:32,030 --> 05:44:58,010

[Music]

4164

05:45:07,730 --> 05:44:59,040

thank you

4165

05:45:09,940 --> 05:45:07,740

[Music]

4166

05:46:10,360 --> 05:45:09,950

foreign

4167

05:46:29,040 --> 05:46:26,510

[Music]

4168

05:47:27,530 --> 05:46:29,050

foreign

4169

05:47:29,740 --> 05:47:27,540

[Music]

4170

05:47:37,368 --> 05:47:29,750

thank you

4171

05:48:41,448 --> 05:47:37,378

[Music]

4172

05:48:46,070 --> 05:48:43,520

foreign

4173

05:48:46,470 --> 05:48:46,080

[Music]

4174

05:48:55,720 --> 05:48:46,480

foreign

4175

05:48:55,730 --> 05:49:39,650

[Music]

4176
05:49:53,960 --> 05:49:40,210
thank you

4177
05:51:04,730 --> 05:50:15,288
[Music]

4178
05:51:13,430 --> 05:51:06,270
thank you

4179
05:51:13,440 --> 05:51:24,530
[Music]

4180
05:51:24,540 --> 05:51:27,900
foreign

4181
05:52:13,910 --> 05:51:43,410
[Music]

4182
05:53:21,450 --> 05:52:13,920
foreign

4183
05:53:46,740 --> 05:53:44,690
[Music]

4184
05:53:49,010 --> 05:53:46,750
foreign

4185
05:53:51,870 --> 05:53:49,020
[Music]

4186
05:54:05,690 --> 05:53:51,880
foreign

4187
05:54:55,670 --> 05:54:18,410
[Music]

4188
05:55:17,650 --> 05:54:56,900

thank you

4189

05:55:17,660 --> 05:55:24,470

[Music]

4190

05:55:24,480 --> 05:55:32,790

thank you

4191

05:55:55,620 --> 05:55:45,790

[Music]

4192

05:56:25,070 --> 05:55:55,630

foreign

4193

05:57:26,990 --> 05:56:25,080

[Music]

4194

05:57:34,070 --> 05:57:27,000

foreign

4195

05:57:34,080 --> 05:57:51,890

[Music]

4196

05:57:51,900 --> 05:57:58,700

foreign

4197

05:59:04,700 --> 05:58:19,580

[Music]

4198

05:59:17,710 --> 05:59:04,710

foreign

4199

05:59:17,720 --> 05:59:29,570

[Music]

4200

05:59:29,580 --> 05:59:32,530

thank you

4201
05:59:59,550 --> 05:59:47,640
[Music]

4202
06:00:17,960 --> 05:59:59,560
foreign

4203
06:00:17,970 --> 06:00:30,490
[Music]

4204
06:00:48,280 --> 06:00:33,160
thank you

4205
06:00:48,290 --> 06:00:55,610
[Music]

4206
06:00:55,620 --> 06:01:01,440
foreign

4207
06:01:43,330 --> 06:01:11,340
[Music]

4208
06:01:43,340 --> 06:01:48,940
thank you

4209
06:02:50,810 --> 06:02:08,708
[Music]

4210
06:03:15,870 --> 06:02:52,860
foreign

4211
06:03:53,590 --> 06:03:27,570
[Music]

4212
06:04:02,390 --> 06:03:56,330
let's see

4213
06:04:08,160 --> 06:04:02,980

foreign

4214

06:04:32,740 --> 06:04:24,120

[Music]

4215

06:04:43,010 --> 06:04:32,750

foreign

4216

06:05:24,690 --> 06:04:50,810

[Music]

4217

06:05:45,170 --> 06:05:24,700

let's see

4218

06:06:23,030 --> 06:05:45,180

[Music]

4219

06:06:23,040 --> 06:06:29,010

foreign

4220

06:07:14,110 --> 06:06:30,948

[Music]

4221

06:07:26,740 --> 06:07:14,120

foreign

4222

06:07:49,900 --> 06:07:46,990

[Music]

4223

06:07:56,920 --> 06:07:49,910

thank you

4224

06:08:35,448 --> 06:08:05,850

[Music]

4225

06:08:53,150 --> 06:08:37,530

thank you

4226
06:08:53,160 --> 06:09:01,820
foreign

4227
06:09:49,780 --> 06:09:12,910
[Music]

4228
06:09:57,470 --> 06:09:49,790
foreign

4229
06:09:57,480 --> 06:10:03,590
[Music]

4230
06:10:03,600 --> 06:10:06,360
okay

4231
06:10:06,370 --> 06:10:16,990
[Music]

4232
06:10:17,000 --> 06:10:25,480
thank you

4233
06:11:08,940 --> 06:10:32,880
[Music]

4234
06:11:14,950 --> 06:11:08,950
thank you

4235
06:12:19,740 --> 06:11:16,850
[Music]

4236
06:13:00,880 --> 06:12:19,750
foreign

4237
06:13:00,890 --> 06:13:05,208
[Music]

4238
06:13:27,560 --> 06:13:07,010

foreign

4239

06:15:46,860 --> 06:13:46,340

[Music]

4240

06:16:02,450 --> 06:15:46,870

thank you

4241

06:17:40,208 --> 06:16:24,110

[Music]

4242

06:17:40,218 --> 06:17:47,030

thank you

4243

06:18:35,930 --> 06:18:12,230

[Music]

4244

06:18:57,670 --> 06:18:38,900

foreign

4245

06:18:57,680 --> 06:19:04,150

[Music]

4246

06:19:04,160 --> 06:19:10,460

thank you

4247

06:19:14,860 --> 06:19:13,510

[Music]

4248

06:19:30,010 --> 06:19:14,870

thank you

4249

06:19:56,048 --> 06:19:49,510

[Music]

4250

06:20:14,780 --> 06:19:57,540

thank you

4251
06:20:32,690 --> 06:20:22,700
[Music]

4252
06:20:32,700 --> 06:20:36,370
foreign

4253
06:21:07,350 --> 06:20:48,630
[Music]

4254
06:21:13,790 --> 06:21:07,360
foreign

4255
06:21:13,800 --> 06:21:20,708
[Music]

4256
06:21:20,718 --> 06:21:24,590
thank you

4257
06:21:24,600 --> 06:21:50,570
[Music]

4258
06:21:50,580 --> 06:21:54,210
foreign

4259
06:22:42,420 --> 06:22:06,480
[Music]

4260
06:22:58,360 --> 06:22:42,430
thank you

4261
06:22:58,370 --> 06:23:17,890
[Music]

4262
06:23:17,900 --> 06:23:23,570
thank you

4263
06:24:33,850 --> 06:23:50,270

[Music]

4264

06:24:41,360 --> 06:24:34,910

thank you

4265

06:25:18,090 --> 06:25:15,368

[Music]

4266

06:25:34,060 --> 06:25:18,100

thank you

4267

06:25:34,070 --> 06:25:40,570

[Music]

4268

06:25:40,580 --> 06:25:44,210

thank you

4269

06:26:10,010 --> 06:25:56,200

[Music]

4270

06:26:19,220 --> 06:26:16,430

foreign

4271

06:26:19,230 --> 06:27:04,750

[Music]

4272

06:27:04,760 --> 06:27:09,860

thank you

4273

06:27:38,708 --> 06:27:26,560

[Music]

4274

06:27:38,718 --> 06:27:43,220

thank you

4275

06:27:43,230 --> 06:27:58,368

[Music]

4276
06:28:11,570 --> 06:28:01,100
foreign

4277
06:29:08,510 --> 06:28:18,820
[Music]

4278
06:29:50,990 --> 06:29:09,870
foreign

4279
06:30:34,788 --> 06:29:53,930
[Music]

4280
06:30:34,798 --> 06:30:42,550
foreign

4281
06:31:06,048 --> 06:30:50,020
[Music]

4282
06:31:14,470 --> 06:31:07,890
foreign

4283
06:31:35,510 --> 06:31:23,630
[Music]

4284
06:31:54,840 --> 06:31:38,140
foreign

4285
06:32:04,010 --> 06:32:03,410
[Music]

4286
06:32:14,460 --> 06:32:04,020
thank you

4287
06:33:30,948 --> 06:32:18,650
[Music]

4288
06:33:30,958 --> 06:33:33,820

foreign

4289

06:34:10,128 --> 06:33:44,410

[Music]

4290

06:34:10,138 --> 06:34:19,740

foreign

4291

06:34:40,610 --> 06:34:37,620

[Music]

4292

06:35:01,240 --> 06:34:40,620

foreign

4293

06:35:25,430 --> 06:35:16,160

[Music]

4294

06:35:25,440 --> 06:35:41,610

thank you

4295

06:35:59,030 --> 06:35:50,770

[Music]

4296

06:35:59,040 --> 06:36:06,270

foreign

4297

06:37:15,288 --> 06:36:16,480

[Music]

4298

06:37:30,780 --> 06:37:18,260

foreign

4299

06:39:39,830 --> 06:37:44,570

[Music]

4300

06:39:48,100 --> 06:39:39,840

foreign

4301
06:40:52,430 --> 06:39:59,880
[Music]

4302
06:41:17,390 --> 06:40:53,800
foreign

4303
06:41:36,590 --> 06:41:32,140
[Music]

4304
06:41:36,600 --> 06:41:41,080
thank you

4305
06:42:00,650 --> 06:41:49,750
[Music]

4306
06:42:09,490 --> 06:42:01,240
thank you

4307
06:42:41,720 --> 06:42:38,240
[Music]

4308
06:42:58,440 --> 06:42:41,730
thank you

4309
06:43:49,250 --> 06:43:12,660
[Music]

4310
06:44:03,570 --> 06:43:50,540
foreign

4311
06:44:03,580 --> 06:44:26,990
[Music]

4312
06:44:30,110 --> 06:44:28,430
foreign

4313
06:44:33,708 --> 06:44:30,120

[Music]

4314

06:44:35,330 --> 06:44:33,718

everybody we're gonna start our salty

4315

06:44:37,010 --> 06:44:35,340

stuff talk session the last one of the

4316

06:44:40,210 --> 06:44:37,020

day and our first speaker will be Emily

4317

06:44:45,110 --> 06:44:40,220

Paris from Stanford University

4318

06:44:48,350 --> 06:44:45,120

[Applause]

4319

06:44:50,150 --> 06:44:48,360

hi everyone I'm Emily and I'm a PhD

4320

06:44:52,490 --> 06:44:50,160

candidate in the dica slab at Stanford

4321

06:44:56,030 --> 06:44:52,500

University and I studied the limits of

4322

06:44:58,368 --> 06:44:56,040

life in hyper saline environments

4323

06:44:59,868 --> 06:44:58,378

so as we all probably know Brian's are

4324

06:45:02,090 --> 06:44:59,878

one of the targets for a life detection

4325

06:45:04,548 --> 06:45:02,100

mission to other ocean worlds including

4326
06:45:07,310 --> 06:45:04,558
Europa and Enceladus and even past ocean

4327
06:45:10,010 --> 06:45:07,320
worlds like Mars and so by understanding

4328
06:45:12,350 --> 06:45:10,020
the limits of salty life on Earth we can

4329
06:45:15,410 --> 06:45:12,360
understand how and where to look for

4330
06:45:17,448 --> 06:45:15,420
life on these other places

4331
06:45:18,948 --> 06:45:17,458
one of the ways we can assess a brine

4332
06:45:21,590 --> 06:45:18,958
environment is through this measurement

4333
06:45:23,330 --> 06:45:21,600
called water activity and water activity

4334
06:45:25,430 --> 06:45:23,340
depends on vapor pressure but you can

4335
06:45:27,650 --> 06:45:25,440
think of it about as how many water

4336
06:45:30,048 --> 06:45:27,660
molecules are available to a cell in

4337
06:45:31,730 --> 06:45:30,058
solution so on the left is an image of

4338
06:45:33,830 --> 06:45:31,740

what pure water would be this is where

4339

06:45:35,810 --> 06:45:33,840

all the water molecules are free to

4340

06:45:38,270 --> 06:45:35,820

become Vapor move about the cabin that

4341

06:45:40,910 --> 06:45:38,280

would be a water activity of one

4342

06:45:42,830 --> 06:45:40,920

now if there's ions in solution water

4343

06:45:45,170 --> 06:45:42,840

would be attracted to those molecules

4344

06:45:46,930 --> 06:45:45,180

and a water activity would decrease so

4345

06:45:49,730 --> 06:45:46,940

the lower the water activity the more

4346

06:45:51,708 --> 06:45:49,740

uninhabitable an environment is

4347

06:45:53,868 --> 06:45:51,718

and since water is required for all Life

4348

06:45:57,048 --> 06:45:53,878

as We Know It water activity can be used

4349

06:45:59,390 --> 06:45:57,058

to assess assess habitability so some

4350

06:46:01,128 --> 06:45:59,400

common items in their water activities

4351

06:46:02,390 --> 06:46:01,138

are listed on the left including sea

4352

06:46:04,548 --> 06:46:02,400

water which has a pretty high water

4353

06:46:06,470 --> 06:46:04,558

activity and the salinity of seawater is

4354

06:46:08,270 --> 06:46:06,480

about 3.5 percent

4355

06:46:10,730 --> 06:46:08,280

and then honey has a water activity of

4356

06:46:13,190 --> 06:46:10,740

0.6 and some of Mars special regions or

4357

06:46:16,548 --> 06:46:13,200

areas where we might detect life on Mars

4358

06:46:20,510 --> 06:46:18,170

and there's been a lot of really great

4359

06:46:23,150 --> 06:46:20,520

pure culture work on the limits of life

4360

06:46:25,490 --> 06:46:23,160

and cell division at different water

4361

06:46:27,530 --> 06:46:25,500

activities and to sum it up the

4362

06:46:29,390 --> 06:46:27,540

predicted or theoretical water activity

4363

06:46:31,850 --> 06:46:29,400

limit for all life on Earth including

4364

06:46:34,190 --> 06:46:31,860

eukaryotes and prokaryotes is about 0.6

4365

06:46:36,410 --> 06:46:34,200

and this is based on pure culture so

4366

06:46:38,208 --> 06:46:36,420

like our speaker last night mentioned

4367

06:46:40,190 --> 06:46:38,218

not all the things in the world are in

4368

06:46:42,708 --> 06:46:40,200

pure culture yet so that leaves out

4369

06:46:45,048 --> 06:46:42,718

about 90 or more of the biodiversity on

4370

06:46:46,490 --> 06:46:45,058

Earth and our ability to assess what the

4371

06:46:50,390 --> 06:46:46,500

limit of life for each of those strains

4372

06:46:54,350 --> 06:46:52,070

so brine environments are really

4373

06:46:56,990 --> 06:46:54,360

widespread on Earth they're everywhere

4374

06:46:59,330 --> 06:46:57,000

um and a lot of great work has gone into

4375

06:47:01,070 --> 06:46:59,340

assessing metagenomics like the

4376

06:47:02,750 --> 06:47:01,080

taxonomic diversity the potential

4377

06:47:04,868 --> 06:47:02,760

metabolic metabolic potential of

4378

06:47:06,830 --> 06:47:04,878

microbes in these environments

4379

06:47:08,810 --> 06:47:06,840

metatranscriptomes and even some bulk

4380

06:47:10,490 --> 06:47:08,820

activity measurements but metabolic

4381

06:47:11,810 --> 06:47:10,500

activity is rarely measured at the

4382

06:47:13,490 --> 06:47:11,820

Single Cell level

4383

06:47:15,708 --> 06:47:13,500

and this can be really important because

4384

06:47:17,510 --> 06:47:15,718

when a cell is stressed out they might

4385

06:47:19,910 --> 06:47:17,520

have really low levels of activity that

4386

06:47:21,410 --> 06:47:19,920

are not detected with bulk techniques

4387

06:47:23,510 --> 06:47:21,420

so today I'll be talking a little bit

4388

06:47:25,310 --> 06:47:23,520

about my work in solar cell turns and

4389

06:47:29,448 --> 06:47:25,320

then transition into the my current work

4390

06:47:32,150 --> 06:47:29,458

in Western Australia aesthetic brands

4391

06:47:34,548 --> 06:47:32,160

so like I mentioned when life is

4392

06:47:36,830 --> 06:47:34,558

reaching its limit a metabolic activity

4393

06:47:38,868 --> 06:47:36,840

can be really low and so single cell

4394

06:47:41,150 --> 06:47:38,878

analysis can help us detect the slow

4395

06:47:44,570 --> 06:47:41,160

level of activity by lowering detection

4396

06:47:46,548 --> 06:47:44,580

limits so a cell needs to acquire 50 new

4397

06:47:49,010 --> 06:47:46,558

biomass to be able to divide into two

4398

06:47:51,230 --> 06:47:49,020

new daughter cells however with Nano

4399

06:47:53,628 --> 06:47:51,240

Sims for example we only need to detect

4400

06:47:56,090 --> 06:47:53,638

about five percent maximum we can even

4401
06:47:58,310 --> 06:47:56,100
get as low as less than one percent of

4402
06:48:00,708 --> 06:47:58,320
new biomass to detect active life in a

4403
06:48:02,448 --> 06:48:00,718
sample it also provides quantitative

4404
06:48:04,730 --> 06:48:02,458
results so we can do a law with this

4405
06:48:06,590 --> 06:48:04,740
data on a quantitative level and it also

4406
06:48:09,048 --> 06:48:06,600
reveals trends that are often obscured

4407
06:48:10,788 --> 06:48:09,058
by bulk analysis

4408
06:48:12,170 --> 06:48:10,798
and when I'm talking about metabolic

4409
06:48:14,750 --> 06:48:12,180
activity in this talk I'm talking

4410
06:48:16,548 --> 06:48:14,760
specifically about anabolic activity so

4411
06:48:18,170 --> 06:48:16,558
there's catabolic activity that produces

4412
06:48:20,270 --> 06:48:18,180
energy for a cell and then there's

4413
06:48:22,128 --> 06:48:20,280

anabolic activity where a cell can take

4414

06:48:24,468 --> 06:48:22,138

substrates from the environment like

4415

06:48:26,510 --> 06:48:24,478

amino acids and glucose and take that

4416

06:48:29,510 --> 06:48:26,520

carbon and nitrogen and then produce new

4417

06:48:32,990 --> 06:48:29,520

cell biomass which includes proteins DNA

4418

06:48:36,770 --> 06:48:34,850

so first the work that I've done at this

4419

06:48:39,770 --> 06:48:36,780

solar Sultan it's called South Bay

4420

06:48:41,750 --> 06:48:39,780

saltworks it's in here in San Diego and

4421

06:48:43,788 --> 06:48:41,760

basically they bring sea water in from

4422

06:48:46,190 --> 06:48:43,798

San Diego Bay and it goes through a

4423

06:48:47,990 --> 06:48:46,200

series of evapo concentration ponds and

4424

06:48:49,788 --> 06:48:48,000

as the water evaporates out of the sea

4425

06:48:51,890 --> 06:48:49,798

water different salts are left behind

4426
06:48:54,530 --> 06:48:51,900
producing a series of ponds that range

4427
06:48:56,570 --> 06:48:54,540
in water activity from 0.98 that of

4428
06:48:58,610 --> 06:48:56,580
seawater to that well below the known

4429
06:49:01,128 --> 06:48:58,620
limit of Life at 0.4

4430
06:49:03,708 --> 06:49:01,138
and so we measured anabolic activity of

4431
06:49:06,048 --> 06:49:03,718
over 6 000 individual cells from a

4432
06:49:08,448 --> 06:49:06,058
series of five of these brines with five

4433
06:49:10,368 --> 06:49:08,458
different isotopic substrates from amino

4434
06:49:13,128 --> 06:49:10,378
acids ammonium and bicarbonate glucose

4435
06:49:15,468 --> 06:49:13,138
and nitrate and that sort of thing

4436
06:49:17,208 --> 06:49:15,478
we measured their anabolic activity with

4437
06:49:19,610 --> 06:49:17,218
nano SIM so on the left this is what

4438
06:49:21,350 --> 06:49:19,620

this looks like cells that are circled

4439

06:49:24,110 --> 06:49:21,360

in red are considered enriched and this

4440

06:49:25,730 --> 06:49:24,120

is for carbon from amino acids and then

4441

06:49:27,770 --> 06:49:25,740

the cells that are circled in white

4442

06:49:30,230 --> 06:49:27,780

would be considered less active or less

4443

06:49:31,670 --> 06:49:30,240

enriched in the sample

4444

06:49:34,190 --> 06:49:31,680

and when you plot this with water

4445

06:49:36,288 --> 06:49:34,200

activity you see that microbial activity

4446

06:49:38,690 --> 06:49:36,298

decreases exponentially with water

4447

06:49:40,730 --> 06:49:38,700

activity however there are certain areas

4448

06:49:42,770 --> 06:49:40,740

so can we see this yeah

4449

06:49:44,810 --> 06:49:42,780

yeah certain subsets of cells are more

4450

06:49:47,270 --> 06:49:44,820

active than most of the cells in

4451
06:49:49,128 --> 06:49:47,280
seawater at a higher water activity with

4452
06:49:50,150 --> 06:49:49,138
even just low decreases in water

4453
06:49:52,850 --> 06:49:50,160
activity

4454
06:49:55,250 --> 06:49:52,860
we also detected cell biomass through

4455
06:49:57,110 --> 06:49:55,260
dappy and nanosims in this low water

4456
06:49:59,090 --> 06:49:57,120
activity magnesium chloride brine

4457
06:50:01,490 --> 06:49:59,100
however we didn't detect any activity

4458
06:50:03,230 --> 06:50:01,500
here and the incubation time was two

4459
06:50:05,090 --> 06:50:03,240
days long so there's several reasons for

4460
06:50:10,968 --> 06:50:05,100
this

4461
06:50:13,548 --> 06:50:10,978
estimate a new predicted lower limit of

4462
06:50:15,530 --> 06:50:13,558
Life at 0.54 so that's a little

4463
06:50:17,750 --> 06:50:15,540

significantly biologically significantly

4464

06:50:21,530 --> 06:50:17,760

lower than the 0.6 previous limit

4465

06:50:23,090 --> 06:50:21,540

detected sorry predicted and this data

4466

06:50:24,590 --> 06:50:23,100

I'd love to talk more about it but it's

4467

06:50:25,968 --> 06:50:24,600

been submitted and I just got word that

4468

06:50:27,830 --> 06:50:25,978

it's now in review the as of this

4469

06:50:28,730 --> 06:50:27,840

morning so it's really exciting and if

4470

06:50:31,070 --> 06:50:28,740

you'd like to hear more about that

4471

06:50:33,048 --> 06:50:31,080

please talk to me later

4472

06:50:35,090 --> 06:50:33,058

so now to kind of get into the topic of

4473

06:50:36,650 --> 06:50:35,100

this talk which is I'm talking about the

4474

06:50:38,810 --> 06:50:36,660

limits of life in acidic brine

4475

06:50:41,690 --> 06:50:38,820

environments there's a lot of things

4476
06:50:43,670 --> 06:50:41,700
that happen in brines so you can have

4477
06:50:45,708 --> 06:50:43,680
salinity as a limiting factor you can

4478
06:50:46,788 --> 06:50:45,718
have high metal concentrations you can

4479
06:50:48,830 --> 06:50:46,798
have high ionic strength and

4480
06:50:50,750 --> 06:50:48,840
chaotropicity but one thing that really

4481
06:50:52,670 --> 06:50:50,760
stood out to me about this sample set

4482
06:50:54,890 --> 06:50:52,680
was that most of the brines that had

4483
06:50:56,690 --> 06:50:54,900
high levels of activity actually had a

4484
06:50:58,750 --> 06:50:56,700
pH about seven or eight so like

4485
06:51:01,490 --> 06:50:58,760
relatively neutral to slightly basic pH

4486
06:51:04,250 --> 06:51:01,500
however this magnesium chloride brine

4487
06:51:06,708 --> 06:51:04,260
which had no detectable activity had a

4488
06:51:08,750 --> 06:51:06,718

pH of about 5.4

4489

06:51:11,090 --> 06:51:08,760

and so my question was how does pH

4490

06:51:12,708 --> 06:51:11,100

affect microbial activity in brine

4491

06:51:13,850 --> 06:51:12,718

environments and is this an important

4492

06:51:16,850 --> 06:51:13,860

factor

4493

06:51:19,490 --> 06:51:16,860

in the limits of life

4494

06:51:21,770 --> 06:51:19,500

so last summer our team went to Western

4495

06:51:24,530 --> 06:51:21,780

Australia to sample a bunch of acidic

4496

06:51:26,628 --> 06:51:24,540

brines and these brines are considered

4497

06:51:28,548 --> 06:51:26,638

Mars analogs because of the geochemistry

4498

06:51:30,890 --> 06:51:28,558

and weathering systems that created them

4499

06:51:33,770 --> 06:51:30,900

over millions of years

4500

06:51:35,628 --> 06:51:33,780

um just in short oxidation of sulfides

4501
06:51:37,968 --> 06:51:35,638
acidified the water and then evaporation

4502
06:51:40,128 --> 06:51:37,978
concentrated ions and other salts over

4503
06:51:42,410 --> 06:51:40,138
time creating these really acidic Briny

4504
06:51:43,730 --> 06:51:42,420
environments

4505
06:51:45,530 --> 06:51:43,740
um there's hundreds of these lakes and

4506
06:51:48,350 --> 06:51:45,540
we were really lucky to sample a really

4507
06:51:50,510 --> 06:51:48,360
broad spectrum of them so on the x-axis

4508
06:51:53,390 --> 06:51:50,520
is water activity and on the y-axis is

4509
06:51:56,030 --> 06:51:53,400
pH and I was really thrilled to get a

4510
06:51:58,490 --> 06:51:56,040
nice group of lakes to sample for

4511
06:52:00,890 --> 06:51:58,500
activity analysis especially these ones

4512
06:52:03,830 --> 06:52:00,900
that are boxed these are were at a water

4513
06:52:05,930 --> 06:52:03,840

activity of 0.7 and they range in PH so

4514

06:52:08,410 --> 06:52:05,940

it's a really good opportunity to kind

4515

06:52:11,750 --> 06:52:08,420

of look at how pH affects my metabolism

4516

06:52:15,948 --> 06:52:11,760

at low water activity

4517

06:52:18,110 --> 06:52:15,958

so with this uh this study I analyzed

4518

06:52:20,750 --> 06:52:18,120

metabolic activity specifically anabolic

4519

06:52:23,628 --> 06:52:20,760

activity by incubating these brines with

4520

06:52:25,850 --> 06:52:23,638

an analog amino acid called hpg

4521

06:52:28,010 --> 06:52:25,860

cells that are active in the sample will

4522

06:52:30,410 --> 06:52:28,020

take up hpg and incorporate them into

4523

06:52:33,350 --> 06:52:30,420

their new proteins that are produced and

4524

06:52:35,448 --> 06:52:33,360

then the hpg has a alkyne group on the

4525

06:52:37,368 --> 06:52:35,458

end that later on in lab you can perform

4526
06:52:39,410 --> 06:52:37,378
click chemistry on and click a four or

4527
06:52:41,150 --> 06:52:39,420
four to it so all the cells that are

4528
06:52:43,070 --> 06:52:41,160
active in the sample turn out green

4529
06:52:45,048 --> 06:52:43,080
under the microscope or in flow

4530
06:52:47,150 --> 06:52:45,058
cytometry and then that can be

4531
06:52:49,190 --> 06:52:47,160
counter-stained or compared to cells

4532
06:52:51,230 --> 06:52:49,200
that are stained blue via DNA stain of

4533
06:52:53,030 --> 06:52:51,240
doping and so with this data you can

4534
06:52:55,730 --> 06:52:53,040
calculate the percent of active cells

4535
06:52:57,650 --> 06:52:55,740
across these Lakes

4536
06:52:59,090 --> 06:52:57,660
so this is just an example of what this

4537
06:53:01,070 --> 06:52:59,100
data set looks like these are just four

4538
06:53:03,170 --> 06:53:01,080

of the 13 or 14 lakes that we were able

4539

06:53:05,930 --> 06:53:03,180

to do this with on the left the lakes

4540

06:53:07,190 --> 06:53:05,940

are ordered and decreasing pH and I

4541

06:53:09,110 --> 06:53:07,200

thought it was also kind of interesting

4542

06:53:10,430 --> 06:53:09,120

the color changes so you can admire

4543

06:53:12,288 --> 06:53:10,440

those I don't know why they do that but

4544

06:53:14,208 --> 06:53:12,298

that's the way it is and then in the

4545

06:53:16,490 --> 06:53:14,218

middle are the dappy stain cells under

4546

06:53:18,170 --> 06:53:16,500

the microscope and then on the right are

4547

06:53:20,390 --> 06:53:18,180

the active cells that are tagged with

4548

06:53:22,548 --> 06:53:20,400

the green fluorophore

4549

06:53:24,650 --> 06:53:22,558

you can also notice like the different

4550

06:53:26,510 --> 06:53:24,660

cell morphologies and abundances that

4551

06:53:29,510 --> 06:53:26,520

change with pH which is really

4552

06:53:32,090 --> 06:53:29,520

fascinating and also that pH didn't

4553

06:53:34,548 --> 06:53:32,100

affect the assay itself we do see some

4554

06:53:36,230 --> 06:53:34,558

cells that are active at these low pH's

4555

06:53:40,670 --> 06:53:36,240

and sometimes you have Brands where

4556

06:53:43,670 --> 06:53:42,170

so when you calculate the percent of

4557

06:53:45,890 --> 06:53:43,680

active cells and you put this all in a

4558

06:53:47,810 --> 06:53:45,900

plot I'll just Orient you so on the

4559

06:53:50,930 --> 06:53:47,820

x-axis here we have water activity

4560

06:53:52,788 --> 06:53:50,940

decreasing and on the y-axis is pH

4561

06:53:55,190 --> 06:53:52,798

decreasing in this direction so you

4562

06:53:58,490 --> 06:53:55,200

would expect the most extreme acidic

4563

06:54:00,288 --> 06:53:58,500

brines to be kind of in this region

4564

06:54:02,150 --> 06:54:00,298

um this dotted line is that newly

4565

06:54:04,070 --> 06:54:02,160

predicted water activity limit of life

4566

06:54:05,868 --> 06:54:04,080

that I talked about earlier and then

4567

06:54:08,930 --> 06:54:05,878

this dotted line represents the percent

4568

06:54:11,390 --> 06:54:08,940

of active cells dropping below 50 at

4569

06:54:13,910 --> 06:54:11,400

this pH so this color block each of the

4570

06:54:15,530 --> 06:54:13,920

dots is one Lake and the color bar was

4571

06:54:18,410 --> 06:54:15,540

colored on a green gradient if the

4572

06:54:20,208 --> 06:54:18,420

percent of active cells is above 50 and

4573

06:54:22,310 --> 06:54:20,218

on a gradient towards black if it was

4574

06:54:25,190 --> 06:54:22,320

below 50 so you can kind of just

4575

06:54:27,048 --> 06:54:25,200

visually see that all of the green like

4576
06:54:29,330 --> 06:54:27,058
high percentage act cells cluster up

4577
06:54:31,128 --> 06:54:29,340
here and all of the low percent of

4578
06:54:32,628 --> 06:54:31,138
active cells cluster down here

4579
06:54:34,250 --> 06:54:32,638
and when you look at it statistically

4580
06:54:36,230 --> 06:54:34,260
there is a moderately stronger

4581
06:54:38,468 --> 06:54:36,240
correlation with ph and activity

4582
06:54:40,788 --> 06:54:38,478
compared to water activity and activity

4583
06:54:43,850 --> 06:54:40,798
so so many times you can count how many

4584
06:54:46,430 --> 06:54:43,860
times I say activity in this talk

4585
06:54:49,190 --> 06:54:46,440
um and so some thoughts on this

4586
06:54:51,468 --> 06:54:49,200
a pH of six is really high for

4587
06:54:52,850 --> 06:54:51,478
environmental samples and as we've heard

4588
06:54:55,548 --> 06:54:52,860

from a lot of people and as we know

4589

06:54:57,530 --> 06:54:55,558

there's a lot of microbes that live in

4590

06:54:59,930 --> 06:54:57,540

way more acidic environments so what's

4591

06:55:01,788 --> 06:54:59,940

actually happening here I don't have an

4592

06:55:03,590 --> 06:55:01,798

answer to that yet and I'm hoping to

4593

06:55:05,628 --> 06:55:03,600

figure that out with future analyzes

4594

06:55:07,368 --> 06:55:05,638

that include nanosims work on these

4595

06:55:10,010 --> 06:55:07,378

Lakes

4596

06:55:11,690 --> 06:55:10,020

um and then if this is a true signal and

4597

06:55:14,810 --> 06:55:11,700

this is what what is going on in the

4598

06:55:16,788 --> 06:55:14,820

environment then microbial activity may

4599

06:55:20,270 --> 06:55:16,798

be detected at lower water activities

4600

06:55:22,368 --> 06:55:20,280

than we know of now as long as the pH is

4601
06:55:24,048 --> 06:55:22,378
within the seven to eight maybe like not

4602
06:55:25,910 --> 06:55:24,058
so acidic range

4603
06:55:27,468 --> 06:55:25,920
um so figuring out what that PH range is

4604
06:55:29,390 --> 06:55:27,478
and how that interacts with water

4605
06:55:33,708 --> 06:55:29,400
activity limits of life

4606
06:55:38,868 --> 06:55:36,590
so with that I'd like to acknowledge my

4607
06:55:41,510 --> 06:55:38,878
lab the DECA slab pictured up in the

4608
06:55:43,310 --> 06:55:41,520
rights all of our funding sources the

4609
06:55:44,868 --> 06:55:43,320
oceans across space and time team which

4610
06:55:46,850 --> 06:55:44,878
is a nasa-funded project you'll hear

4611
06:55:49,430 --> 06:55:46,860
about uh you'll hear from a lot of us

4612
06:55:50,990 --> 06:55:49,440
throughout this conference and all of

4613
06:55:53,270 --> 06:55:51,000

our collaborators in Western Australia

4614

06:55:54,590 --> 06:55:53,280

including Molly the dingo who of course

4615

06:55:56,810 --> 06:55:54,600

this work would not have been possible

4616

06:55:59,208 --> 06:55:57,948

all right and then I'll take any

4617

06:56:00,890 --> 06:55:59,218

questions and I'll leave this up so you

4618

06:56:02,400 --> 06:56:00,900

can stare at the dots for a little bit

4619

06:56:09,590 --> 06:56:02,410

longer

4620

06:56:22,670 --> 06:56:09,600

[Applause]

4621

06:56:26,390 --> 06:56:25,128

hi uh that was really cool talk thanks

4622

06:56:27,890 --> 06:56:26,400

so much

4623

06:56:30,048 --> 06:56:27,900

um I was just wondering if he could

4624

06:56:33,468 --> 06:56:30,058

expand a little bit on why you

4625

06:56:35,570 --> 06:56:33,478

concentrate on anabolic

4626
06:56:36,590 --> 06:56:35,580
um activity as opposed to catabolic

4627
06:56:38,930 --> 06:56:36,600
activity

4628
06:56:42,110 --> 06:56:38,940
yeah so

4629
06:56:44,150 --> 06:56:42,120
let's see scientifically the reason why

4630
06:56:45,770 --> 06:56:44,160
I would focus on anabolic activity I

4631
06:56:47,448 --> 06:56:45,780
mean both catabolic and anabolic

4632
06:56:51,288 --> 06:56:47,458
activity are essential for life right

4633
06:56:53,270 --> 06:56:51,298
life has to make energy to assimilate

4634
06:56:55,510 --> 06:56:53,280
substrates and ground divides so both

4635
06:56:58,190 --> 06:56:55,520
processes are really important

4636
06:57:00,650 --> 06:56:58,200
and they are processes that I'll be

4637
06:57:02,690 --> 06:57:00,660
combining or looking at in future field

4638
06:57:04,730 --> 06:57:02,700

sites

4639

06:57:06,770 --> 06:57:04,740

um with anabolic activity the

4640

06:57:08,208 --> 06:57:06,780

interesting thing here is that you could

4641

06:57:10,548 --> 06:57:08,218

imagine that when a cell gets really

4642

06:57:13,070 --> 06:57:10,558

stressed out it would stop dividing

4643

06:57:16,010 --> 06:57:13,080

potentially and still accumulate

4644

06:57:18,170 --> 06:57:16,020

substrates to repair DNA repair cell

4645

06:57:20,810 --> 06:57:18,180

walls do all that stuff until conditions

4646

06:57:23,930 --> 06:57:20,820

get better and so the idea was that or

4647

06:57:26,270 --> 06:57:23,940

my original hypothesis was that by

4648

06:57:28,490 --> 06:57:26,280

um that anabolic activity would extend

4649

06:57:33,110 --> 06:57:28,500

beyond the known cell division limit of

4650

06:57:34,610 --> 06:57:33,120

life because even as cells are um cells

4651
06:57:36,350 --> 06:57:34,620
would be able to survive just by taking

4652
06:57:38,030 --> 06:57:36,360
up materials and so that taking up

4653
06:57:47,330 --> 06:57:38,040
process is the anabolic Activity Part

4654
06:57:53,270 --> 06:57:48,890
sweet talk

4655
06:57:56,530 --> 06:57:53,280
I have a question so um you mentioned

4656
06:58:00,288 --> 06:57:56,540
that you guys have essentially like uh

4657
06:58:02,628 --> 06:58:00,298
extrapolated uh new

4658
06:58:04,850 --> 06:58:02,638
like limit for life like in terms of

4659
06:58:08,330 --> 06:58:04,860
water activity it's kind of a power move

4660
06:58:11,090 --> 06:58:08,340
so we're not the first ones to do this

4661
06:58:13,010 --> 06:58:11,100
okay but okay but uh could you explain

4662
06:58:14,448 --> 06:58:13,020
how you extrapolated that because I

4663
06:58:16,310 --> 06:58:14,458

think maybe I missed that or I didn't

4664

06:58:17,750 --> 06:58:16,320

understand yeah um okay we're gonna get

4665

06:58:19,548 --> 06:58:17,760

into the weeds here but let me go back

4666

06:58:22,190 --> 06:58:19,558

to that slide

4667

06:58:25,070 --> 06:58:22,200

um so this this idea or this like

4668

06:58:26,288 --> 06:58:25,080

extrapolation is based on

4669

06:58:29,208 --> 06:58:26,298

um

4670

06:58:30,590 --> 06:58:29,218

these this study here so they did the

4671

06:58:32,510 --> 06:58:30,600

same thing and this is how they got this

4672

06:58:34,548 --> 06:58:32,520

theoretical limit of life that has now

4673

06:58:36,410 --> 06:58:34,558

been cited almost 200 times from food

4674

06:58:38,150 --> 06:58:36,420

preservation fields to life detection

4675

06:58:40,030 --> 06:58:38,160

Fields so

4676

06:58:43,490 --> 06:58:40,040

um

4677

06:58:44,990 --> 06:58:43,500

hasn't been published yet

4678

06:58:46,548 --> 06:58:45,000

um so the reason so they used a

4679

06:58:49,490 --> 06:58:46,558

different technique and they based it on

4680

06:58:50,990 --> 06:58:49,500

cell division and so we're

4681

06:58:52,250 --> 06:58:51,000

um

4682

06:58:53,628 --> 06:58:52,260

so hang on let me answer your first

4683

06:58:55,128 --> 06:58:53,638

question so

4684

06:58:57,830 --> 06:58:55,138

um the way that we did this is single

4685

06:58:59,090 --> 06:58:57,840

cell analysis allows you to separate the

4686

06:59:01,070 --> 06:58:59,100

cells that are active from those that

4687

06:59:02,810 --> 06:59:01,080

are inactive and in a brine environment

4688

06:59:04,910 --> 06:59:02,820

this is really important because brines

4689

06:59:07,190 --> 06:59:04,920

are really salty and cells can fall in

4690

06:59:09,350 --> 06:59:07,200

from anywhere bird poop wind whatever

4691

06:59:11,208 --> 06:59:09,360

and get preserved and those can be

4692

06:59:13,910 --> 06:59:11,218

inactive so those can contribute to that

4693

06:59:16,368 --> 06:59:13,920

bulk analysis and not necessarily even

4694

06:59:17,990 --> 06:59:16,378

be important in that environment so a

4695

06:59:20,030 --> 06:59:18,000

single cell analysis we took out the

4696

06:59:21,530 --> 06:59:20,040

active cells average their anabolic

4697

06:59:24,230 --> 06:59:21,540

activities so we're just focusing on

4698

06:59:26,990 --> 06:59:24,240

who's contributing to metabolism in that

4699

06:59:30,410 --> 06:59:27,000

environment and then use detection

4700

06:59:32,690 --> 06:59:30,420

limits and and math to extrapolate and

4701
06:59:35,390 --> 06:59:32,700
predict or propose this new predicted

4702
06:59:37,430 --> 06:59:35,400
limit of detectable life and so this is

4703
06:59:39,468 --> 06:59:37,440
not the limit of life this is what our

4704
06:59:41,750 --> 06:59:39,478
measurements can detect and if we found

4705
06:59:43,910 --> 06:59:41,760
an environment at 0.54 Water activity

4706
06:59:45,770 --> 06:59:43,920
with similar conditions to this

4707
06:59:48,110 --> 06:59:45,780
environment that we extrapolated it from

4708
06:59:49,968 --> 06:59:48,120
we would technically be able to detect

4709
06:59:51,708 --> 06:59:49,978
life in that environment

4710
06:59:53,448 --> 06:59:51,718
and this is also a really conservative

4711
06:59:56,090 --> 06:59:53,458
limit so

4712
06:59:58,310 --> 06:59:56,100
um we even upped the number of standard

4713
07:00:00,948 --> 06:59:58,320

deviations that we would normally do for

4714

07:00:02,868 --> 07:00:00,958

our like detection limit so if we were

4715

07:00:05,208 --> 07:00:02,878

to do like our data processing in the

4716

07:00:21,170 --> 07:00:05,218

normal way it might even be lower that

4717

07:00:27,410 --> 07:00:24,468

hey George eibel from Montana State I'm

4718

07:00:29,570 --> 07:00:27,420

just curious uh you're looking at the

4719

07:00:32,150 --> 07:00:29,580

Active cells were you did you look at

4720

07:00:36,830 --> 07:00:32,160

who they were at all whether that was by

4721

07:00:39,288 --> 07:00:36,840

fish or sequencing so in this study we

4722

07:00:42,548 --> 07:00:39,298

did not look at cell identity and we

4723

07:00:46,368 --> 07:00:42,558

focused on metabolism

4724

07:00:48,590 --> 07:00:46,378

in Western Australia I don't have plans

4725

07:00:50,990 --> 07:00:48,600

to look at the actual I don't know I

4726
07:00:52,610 --> 07:00:51,000
could look at the Active fraction of

4727
07:00:53,868 --> 07:00:52,620
cells from the bond cat analysis I

4728
07:00:55,548 --> 07:00:53,878
haven't decided if I want to go down

4729
07:00:58,430 --> 07:00:55,558
that road yet but in the next field site

4730
07:00:59,030 --> 07:00:58,440
we are planning on on doing that so

4731
07:01:02,510 --> 07:00:59,040
um

4732
07:01:04,070 --> 07:01:02,520
yeah not in this not in a city

4733
07:01:04,950 --> 07:01:04,080
all right thank you very much Emily yeah

4734
07:01:06,780 --> 07:01:04,960
thank you

4735
07:01:13,010 --> 07:01:06,790
[Music]

4736
07:01:17,690 --> 07:01:15,048
okay for our next speaker we have Zoe

4737
07:01:22,910 --> 07:01:17,700
havelena from the New Mexico Institute

4738
07:01:25,610 --> 07:01:24,708

that New Mexico Tech pretty short is

4739

07:01:28,010 --> 07:01:25,620

fine

4740

07:01:30,170 --> 07:01:28,020

um so hi I'm Zoe havlina I am a PhD

4741

07:01:31,610 --> 07:01:30,180

candidate from New Mexico Tech

4742

07:01:34,010 --> 07:01:31,620

um and I would like to just jump right

4743

07:01:34,868 --> 07:01:34,020

in and introduce my field site for this

4744

07:01:38,868 --> 07:01:34,878

project

4745

07:01:40,788 --> 07:01:38,878

which are two cave systems located in

4746

07:01:41,990 --> 07:01:40,798

central Italy so pictured here they're

4747

07:01:45,170 --> 07:01:42,000

very pretty

4748

07:01:46,730 --> 07:01:45,180

and what I can hopefully show you I'm

4749

07:01:49,368 --> 07:01:46,740

going to take us on a quick field trip

4750

07:01:52,548 --> 07:01:49,378

there is why these are potentially very

4751
07:01:55,490 --> 07:01:52,558
compelling sites for astrobiology or for

4752
07:01:59,208 --> 07:01:55,500
a Geo microbiologists such as myself

4753
07:02:01,430 --> 07:01:59,218
and so these caves form through a

4754
07:02:04,430 --> 07:02:01,440
somewhat rare mechanism which is known

4755
07:02:06,890 --> 07:02:04,440
as sulfuric acid speleogenesis so this

4756
07:02:10,430 --> 07:02:06,900
is a cave building process that's seen

4757
07:02:12,410 --> 07:02:10,440
only in a handful of caves worldwide and

4758
07:02:14,448 --> 07:02:12,420
only only a fraction of those can we

4759
07:02:17,390 --> 07:02:14,458
actually access those caves and see this

4760
07:02:19,190 --> 07:02:17,400
process actively happening today and so

4761
07:02:20,628 --> 07:02:19,200
that's what I'm showing you here so

4762
07:02:22,610 --> 07:02:20,638
these are all images from one of my

4763
07:02:23,510 --> 07:02:22,620

field sites which is a fresasi Cave

4764

07:02:25,730 --> 07:02:23,520

System

4765

07:02:28,070 --> 07:02:25,740

and what you're looking at in this image

4766

07:02:30,890 --> 07:02:28,080

here on the left this is a stream this

4767

07:02:32,810 --> 07:02:30,900

is the groundwater level of the cave and

4768

07:02:35,030 --> 07:02:32,820

it's enriched in hydrogen sulfide and

4769

07:02:36,830 --> 07:02:35,040

this hydrogen sulfide degases where

4770

07:02:40,128 --> 07:02:36,840

there's voids in the host Rock of the

4771

07:02:42,948 --> 07:02:40,138

cave and this hydrogen sulfide fuels

4772

07:02:44,930 --> 07:02:42,958

very a robust microbial communities that

4773

07:02:46,910 --> 07:02:44,940

are thriving off of the energy in this

4774

07:02:49,670 --> 07:02:46,920

otherwise very leukotrophic environment

4775

07:02:52,368 --> 07:02:49,680

and this is seen kind of conspicuously

4776
07:02:56,150 --> 07:02:52,378
in the forms of these charismatically

4777
07:02:58,548 --> 07:02:56,160
named snodite biofilms which proliferate

4778
07:02:59,930 --> 07:02:58,558
in these areas of the cave here's

4779
07:03:01,910 --> 07:02:59,940
another picture of what they look like

4780
07:03:04,968 --> 07:03:01,920
and we also sometimes see if you can see

4781
07:03:07,190 --> 07:03:04,978
the yellow dots native sulfur that can

4782
07:03:09,850 --> 07:03:07,200
precipitate in these areas as well

4783
07:03:12,230 --> 07:03:09,860
and these are primarily composed of

4784
07:03:13,968 --> 07:03:12,240
citythial bacillus which is a sulfur

4785
07:03:16,010 --> 07:03:13,978
oxidizing bacteria

4786
07:03:18,350 --> 07:03:16,020
but what I'm interested in for the

4787
07:03:20,690 --> 07:03:18,360
context of my project are all of these

4788
07:03:23,690 --> 07:03:20,700

white I don't know if you can see my

4789

07:03:24,968 --> 07:03:23,700

pointer here these white clumpy minerals

4790

07:03:27,230 --> 07:03:24,978

here and this is actually

4791

07:03:29,330 --> 07:03:27,240

microcrystalline gypsum this

4792

07:03:31,190 --> 07:03:29,340

precipitates in part kind of as a

4793

07:03:33,590 --> 07:03:31,200

consequence of this microbial activity

4794

07:03:35,510 --> 07:03:33,600

because these sulfur oxidizers are

4795

07:03:38,448 --> 07:03:35,520

producing sulfuric acid which is

4796

07:03:41,150 --> 07:03:38,458

obviously highly corrosive when you have

4797

07:03:43,430 --> 07:03:41,160

a carbonate host Rock and so this gypsum

4798

07:03:46,788 --> 07:03:43,440

is precipitating as a replacement as

4799

07:03:50,510 --> 07:03:46,798

this host Rockets corroded

4800

07:03:53,750 --> 07:03:50,520

and it's highly acidic so pH is usually

4801
07:03:55,788 --> 07:03:53,760
zero to one and what happens is that

4802
07:03:58,548 --> 07:03:55,798
this gypsum can build up in these cave

4803
07:04:00,288 --> 07:03:58,558
systems and remain there essentially as

4804
07:04:01,968 --> 07:04:00,298
long as you don't have any Waters that

4805
07:04:04,010 --> 07:04:01,978
come in and wash it away and so that's

4806
07:04:05,810 --> 07:04:04,020
what I'm showing on this image on the

4807
07:04:08,810 --> 07:04:05,820
far right here this is one of these like

4808
07:04:11,390 --> 07:04:08,820
massive gypsum deposits that exists in a

4809
07:04:13,310 --> 07:04:11,400
part of the Versace cave that hasn't

4810
07:04:15,890 --> 07:04:13,320
been exposed to this active sulfide

4811
07:04:17,690 --> 07:04:15,900
degassing for maybe a hundred to two

4812
07:04:21,530 --> 07:04:17,700
hundred thousand years

4813
07:04:24,048 --> 07:04:21,540

and so we see sulfates and gypsum on

4814

07:04:26,510 --> 07:04:24,058

other locations notably the surface of

4815

07:04:28,628 --> 07:04:26,520

Mars so I'm showing you data here as it

4816

07:04:31,190 --> 07:04:28,638

relates to the Gale crater

4817

07:04:34,128 --> 07:04:31,200

and there's some evidence or some

4818

07:04:36,110 --> 07:04:34,138

thinking that this sulfates could have

4819

07:04:38,990 --> 07:04:36,120

also precipitated under acidic

4820

07:04:40,548 --> 07:04:39,000

conditions so potentially these are

4821

07:04:42,708 --> 07:04:40,558

thought of as

4822

07:04:45,650 --> 07:04:42,718

places where we might look for for

4823

07:04:48,048 --> 07:04:45,660

evidence of life and on the Earth's

4824

07:04:49,490 --> 07:04:48,058

surface the analogs that we have there

4825

07:04:50,948 --> 07:04:49,500

are several and these have been well

4826

07:04:54,530 --> 07:04:50,958

studied by other teams of

4827

07:04:56,330 --> 07:04:54,540

astrobiologists but what is novel um or

4828

07:05:00,110 --> 07:04:56,340

the argument I'm making for these caves

4829

07:05:02,150 --> 07:05:00,120

is that this is an ecosystem that as I

4830

07:05:04,788 --> 07:05:02,160

just showed you is fueled by chemo litho

4831

07:05:07,010 --> 07:05:04,798

autotrophy so these kind of alternative

4832

07:05:09,890 --> 07:05:07,020

Lifestyles and so potentially studying

4833

07:05:11,590 --> 07:05:09,900

the gypsum and its ability to preserve

4834

07:05:14,690 --> 07:05:11,600

or not preserve

4835

07:05:17,510 --> 07:05:14,700

biosignatures is is kind of a novel

4836

07:05:19,368 --> 07:05:17,520

aspect and gets away from surface world

4837

07:05:21,230 --> 07:05:19,378

where we sometimes see the signatures

4838

07:05:24,048 --> 07:05:21,240

mostly of things that are photosynthetic

4839

07:05:25,910 --> 07:05:24,058

and so in the context of this talk when

4840

07:05:27,770 --> 07:05:25,920

I'm talking about life detection or I'm

4841

07:05:30,590 --> 07:05:27,780

talking about signatures I'm talking

4842

07:05:32,628 --> 07:05:30,600

about lipid biomarkers specifically and

4843

07:05:33,890 --> 07:05:32,638

so what I'm showing you here are some

4844

07:05:36,170 --> 07:05:33,900

types of these they were kind of

4845

07:05:38,270 --> 07:05:36,180

explained earlier these ones on the left

4846

07:05:40,788 --> 07:05:38,280

which are those hopenoids so these are

4847

07:05:43,490 --> 07:05:40,798

produced by bacteria and these can be

4848

07:05:45,490 --> 07:05:43,500

functionalized and then they have this

4849

07:05:48,890 --> 07:05:45,500

very recalcitrant

4850

07:05:51,110 --> 07:05:48,900

backbone structure this hoping that is

4851
07:05:53,208 --> 07:05:51,120
this diagenetic structure that can

4852
07:05:55,610 --> 07:05:53,218
persist in some terrestrial environments

4853
07:05:58,150 --> 07:05:55,620
for potentially millions of years and

4854
07:06:00,650 --> 07:05:58,160
then on the right these are

4855
07:06:04,010 --> 07:06:00,660
gdgts from archaea so kind of a similar

4856
07:06:05,990 --> 07:06:04,020
lipid biomarker and the these specific

4857
07:06:08,330 --> 07:06:06,000
structures that I'm showing you are ones

4858
07:06:11,270 --> 07:06:08,340
that have been classified from those

4859
07:06:12,830 --> 07:06:11,280
snodite biofilms that I showed you in

4860
07:06:14,990 --> 07:06:12,840
their earlier image

4861
07:06:17,448 --> 07:06:15,000
and so knowing what we already know

4862
07:06:19,968 --> 07:06:17,458
about these cave systems which is that

4863
07:06:22,548 --> 07:06:19,978

we have gypsum that is precipitating in

4864

07:06:25,670 --> 07:06:22,558

in very close association with microbial

4865

07:06:28,368 --> 07:06:25,680

activity that's kind of these microbes

4866

07:06:31,010 --> 07:06:28,378

that are using an alternative lifestyle

4867

07:06:33,230 --> 07:06:31,020

and we know that some of these organisms

4868

07:06:34,910 --> 07:06:33,240

like that aciditythylbacillus are

4869

07:06:38,330 --> 07:06:34,920

capable of producing these lipid

4870

07:06:41,510 --> 07:06:38,340

biomarkers and this gypsum is kicking

4871

07:06:44,208 --> 07:06:41,520

around in this cave for a little bit of

4872

07:06:46,310 --> 07:06:44,218

time we sort of used what we know to

4873

07:06:47,628 --> 07:06:46,320

form these questions about things that

4874

07:06:49,610 --> 07:06:47,638

we don't know

4875

07:06:51,770 --> 07:06:49,620

um we don't actually know or going into

4876
07:06:54,170 --> 07:06:51,780
the study no one had ever looked at what

4877
07:06:55,670 --> 07:06:54,180
microbes are colonizing the surface of

4878
07:06:57,830 --> 07:06:55,680
the gypsum itself

4879
07:07:01,368 --> 07:06:57,840
and we don't know if those organisms

4880
07:07:03,708 --> 07:07:01,378
produce their own lipid biomarker Suite

4881
07:07:05,990 --> 07:07:03,718
if we'll be able to characterize that or

4882
07:07:08,750 --> 07:07:06,000
detect it in the gypsum at all and then

4883
07:07:11,150 --> 07:07:08,760
if we do does that persist in this

4884
07:07:14,270 --> 07:07:11,160
gypsum that has been existing in this

4885
07:07:17,030 --> 07:07:14,280
cave for a longer period of time

4886
07:07:18,830 --> 07:07:17,040
and so I won't go into the Weeds on

4887
07:07:20,868 --> 07:07:18,840
these methods here but I just want to

4888
07:07:22,788 --> 07:07:20,878

highlight that we're using kind of a few

4889

07:07:25,190 --> 07:07:22,798

different approaches to answer some of

4890

07:07:27,350 --> 07:07:25,200

these questions so using some sort of

4891

07:07:30,110 --> 07:07:27,360

classic molecular biology techniques

4892

07:07:31,788 --> 07:07:30,120

amplicon sequencing and metagenomics to

4893

07:07:34,548 --> 07:07:31,798

characterize those microbial communities

4894

07:07:37,070 --> 07:07:34,558

and then using some organic geochemical

4895

07:07:39,288 --> 07:07:37,080

techniques to try to characterize those

4896

07:07:42,288 --> 07:07:39,298

lipid biomarkers

4897

07:07:45,048 --> 07:07:42,298

and so some of the data that I've had

4898

07:07:47,690 --> 07:07:45,058

um is that these gypsum surfaces are in

4899

07:07:49,548 --> 07:07:47,700

fact colonized by microbes and so what

4900

07:07:52,070 --> 07:07:49,558

I'm showing you here is amplicon

4901
07:07:54,948 --> 07:07:52,080
sequencing data so that's 16sr in our

4902
07:07:57,468 --> 07:07:54,958
sequencing that tells us who's there

4903
07:07:59,150 --> 07:07:57,478
and what I want you to take away from

4904
07:08:01,730 --> 07:07:59,160
this graph is that I'm plotting two

4905
07:08:04,010 --> 07:08:01,740
things here on the left to this access

4906
07:08:06,468 --> 07:08:04,020
and the blue dots is showing the percent

4907
07:08:09,590 --> 07:08:06,478
of that acid bacillus so that's that

4908
07:08:12,350 --> 07:08:09,600
main sulfate oxidizing bacteria that we

4909
07:08:14,270 --> 07:08:12,360
see in those snodite biofilms and then

4910
07:08:17,330 --> 07:08:14,280
on the right I'm showing in this orange

4911
07:08:19,968 --> 07:08:17,340
I'm showing you the overall diversity of

4912
07:08:22,430 --> 07:08:19,978
these samples and so all these dots are

4913
07:08:24,770 --> 07:08:22,440

gypsum samples that we're taking at kind

4914

07:08:27,948 --> 07:08:24,780

of varying distances from that active

4915

07:08:30,830 --> 07:08:27,958

lead degassing sulfate extreme

4916

07:08:32,448 --> 07:08:30,840

and just a reminder so these statite

4917

07:08:35,270 --> 07:08:32,458

biofilms that have been previously

4918

07:08:37,010 --> 07:08:35,280

characterized are around 70 percent of

4919

07:08:40,070 --> 07:08:37,020

citythal bacillus and so the main

4920

07:08:42,350 --> 07:08:40,080

takeaway is that are samples of gypsum

4921

07:08:43,910 --> 07:08:42,360

are far more diverse than that you know

4922

07:08:45,948 --> 07:08:43,920

even at this kind of like best case

4923

07:08:48,350 --> 07:08:45,958

scenario where we're the closest to the

4924

07:08:50,390 --> 07:08:48,360

sulfate extreme we're really not seeing

4925

07:08:51,468 --> 07:08:50,400

anywhere near 70 percent of city-thal

4926
07:08:54,350 --> 07:08:51,478
bacillus

4927
07:08:56,448 --> 07:08:54,360
and so this is data from that other cave

4928
07:08:58,368 --> 07:08:56,458
that I've studied and I don't have that

4929
07:08:59,990 --> 07:08:58,378
nice distance gradient but again it's

4930
07:09:01,670 --> 07:09:00,000
plotting the same things and I've just

4931
07:09:03,770 --> 07:09:01,680
kind of broadly lumped these samples

4932
07:09:06,770 --> 07:09:03,780
together in terms of like high level of

4933
07:09:09,350 --> 07:09:06,780
sulfide medium level lower levels and

4934
07:09:12,110 --> 07:09:09,360
again we see a similar Trend we also see

4935
07:09:14,208 --> 07:09:12,120
low levels of acetyl bacillus and in

4936
07:09:16,910 --> 07:09:14,218
fact we see a heck of a lot of archaea

4937
07:09:19,850 --> 07:09:16,920
too so some of these samples were almost

4938
07:09:21,890 --> 07:09:19,860

entirely archaea and why I talk about

4939

07:09:24,350 --> 07:09:21,900

acetyl bacillus and I talk about the

4940

07:09:26,330 --> 07:09:24,360

diversity of these samples is that you

4941

07:09:29,330 --> 07:09:26,340

know we know acetyl bacillus is capable

4942

07:09:31,670 --> 07:09:29,340

of producing lipid biomarkers but it's

4943

07:09:33,530 --> 07:09:31,680

one of the bacteria that can and in fact

4944

07:09:35,750 --> 07:09:33,540

a lot of them can't and so this

4945

07:09:38,270 --> 07:09:35,760

potentially has implications when we

4946

07:09:40,310 --> 07:09:38,280

think about you know are there things

4947

07:09:43,010 --> 07:09:40,320

that is in this gypsum that is producing

4948

07:09:45,968 --> 07:09:43,020

lipid biomarkers or aren't there

4949

07:09:48,948 --> 07:09:45,978

and we can kind of get at this um

4950

07:09:50,930 --> 07:09:48,958

indirectly through metagenomics and so

4951
07:09:52,490 --> 07:09:50,940
again metagenomics is looking at all of

4952
07:09:55,128 --> 07:09:52,500
the genes that are present in a

4953
07:09:57,350 --> 07:09:55,138
particular environmental sample and so

4954
07:09:59,030 --> 07:09:57,360
far I have only reconstructed a single

4955
07:10:02,150 --> 07:09:59,040
metagenome and this is from a native

4956
07:10:03,530 --> 07:10:02,160
sulfur deposit but I did do some Gene

4957
07:10:05,990 --> 07:10:03,540
searching and I was looking for this

4958
07:10:08,090 --> 07:10:06,000
squally and hoping cyclase Gene which

4959
07:10:10,730 --> 07:10:08,100
forms a critical precursor to making

4960
07:10:13,310 --> 07:10:10,740
those hopenoid lipid biomarkers and I

4961
07:10:15,530 --> 07:10:13,320
did find some copies of that but again I

4962
07:10:17,930 --> 07:10:15,540
also found a ton of archaea and two of

4963
07:10:20,990 --> 07:10:17,940

the high quality bins that I was able to

4964

07:10:22,670 --> 07:10:21,000

assemble were these two kind of Novel

4965

07:10:25,250 --> 07:10:22,680

archaea that have potentially an

4966

07:10:26,868 --> 07:10:25,260

interesting symbiotic relationship and I

4967

07:10:29,090 --> 07:10:26,878

would love to talk about that more but

4968

07:10:30,530 --> 07:10:29,100

that's kind of a whole other talk so I'm

4969

07:10:33,288 --> 07:10:30,540

just going to leave it at that with this

4970

07:10:34,250 --> 07:10:33,298

complicated figure here on the right

4971

07:10:37,430 --> 07:10:34,260

um

4972

07:10:39,410 --> 07:10:37,440

so it you might be guessing or kind of

4973

07:10:42,230 --> 07:10:39,420

wondering why I've only gotten one

4974

07:10:44,270 --> 07:10:42,240

metagenome so far and really it's

4975

07:10:47,330 --> 07:10:44,280

because the overall biomass in these

4976

07:10:49,850 --> 07:10:47,340

gypsum samples is very low and so what

4977

07:10:52,070 --> 07:10:49,860

I'm showing you in this picture here so

4978

07:10:54,948 --> 07:10:52,080

this is microscopy this is dappy

4979

07:10:57,590 --> 07:10:54,958

staining so looking at cells and so you

4980

07:11:01,010 --> 07:10:57,600

see hopefully you can see just a few

4981

07:11:03,590 --> 07:11:01,020

blue dots those are cells and on the

4982

07:11:07,010 --> 07:11:03,600

right this is showing them sitting in a

4983

07:11:08,570 --> 07:11:07,020

bathtub full of gypsum micro crystals

4984

07:11:11,270 --> 07:11:08,580

and so when you just kind of

4985

07:11:13,968 --> 07:11:11,280

contextualize this low number of cells

4986

07:11:15,770 --> 07:11:13,978

in in the vast array of all of these

4987

07:11:17,810 --> 07:11:15,780

minerals

4988

07:11:19,490 --> 07:11:17,820

there's not a whole lot going on and in

4989

07:11:21,948 --> 07:11:19,500

fact some of our preliminary total

4990

07:11:24,650 --> 07:11:21,958

organic carbon measurements are less

4991

07:11:27,410 --> 07:11:24,660

than one percent or even a fraction of a

4992

07:11:29,690 --> 07:11:27,420

percent and so

4993

07:11:31,250 --> 07:11:29,700

that all leads to kind of some

4994

07:11:33,350 --> 07:11:31,260

complications with trying to actually

4995

07:11:35,628 --> 07:11:33,360

extract some of these lipid biomarkers

4996

07:11:38,150 --> 07:11:35,638

and so this side of the project is still

4997

07:11:40,310 --> 07:11:38,160

an active protocol development we

4998

07:11:41,990 --> 07:11:40,320

haven't seen anything yet

4999

07:11:44,628 --> 07:11:42,000

um and so we've had to kind of scale up

5000

07:11:47,448 --> 07:11:44,638

our extraction we're hoping to extract a

5001
07:11:48,830 --> 07:11:47,458
lot more gypsum and and I'm hoping that

5002
07:11:51,110 --> 07:11:48,840
that's something I'll be able to talk

5003
07:11:53,090 --> 07:11:51,120
about more in the future but I just want

5004
07:11:56,448 --> 07:11:53,100
to return to sort of The Guiding

5005
07:11:59,030 --> 07:11:56,458
question of this of this study which is

5006
07:12:00,530 --> 07:11:59,040
you know looking at these

5007
07:12:03,530 --> 07:12:00,540
very

5008
07:12:06,170 --> 07:12:03,540
um interesting microbial Dynamics the

5009
07:12:09,110 --> 07:12:06,180
way that the stripsum is formed we see a

5010
07:12:11,208 --> 07:12:09,120
lot of we see biofilms existing where

5011
07:12:12,350 --> 07:12:11,218
where the zone is forming but we

5012
07:12:14,930 --> 07:12:12,360
don't know

5013
07:12:17,390 --> 07:12:14,940

if there's biomarkers that are preserved

5014

07:12:19,730 --> 07:12:17,400

or not and I have to leave that question

5015

07:12:21,708 --> 07:12:19,740

open at this time

5016

07:12:22,548 --> 07:12:21,718

um but hopefully I can answer it in the

5017

07:12:25,090 --> 07:12:22,558

future

5018

07:12:28,670 --> 07:12:25,100

so I think I will just leave off there

5019

07:12:31,250 --> 07:12:28,680

and I wouldn't be able to do this work

5020

07:12:33,948 --> 07:12:31,260

without I have a lot of very fantastic

5021

07:12:35,510 --> 07:12:33,958

collaborators and funding sources and I

5022

07:12:37,788 --> 07:12:35,520

would especially like to thank all the

5023

07:12:41,570 --> 07:12:37,798

folks at the astrobiology analytical

5024

07:12:43,250 --> 07:12:41,580

laboratory at Goddard and I think that I

5025

07:12:43,960 --> 07:12:43,260

have some time for questions so thank

5026

07:12:50,810 --> 07:12:43,970

you

5027

07:13:03,830 --> 07:12:50,820

[Applause]

5028

07:13:09,468 --> 07:13:06,770

hey um I'm bunny Chase I'm from the jet

5029

07:13:11,270 --> 07:13:09,478

propulsion laboratory I really love this

5030

07:13:12,890 --> 07:13:11,280

question you're asking and like the way

5031

07:13:14,208 --> 07:13:12,900

that you're trying to attack it and I

5032

07:13:17,390 --> 07:13:14,218

was wondering

5033

07:13:20,448 --> 07:13:17,400

a lot of the lipid biomarkers that you

5034

07:13:22,310 --> 07:13:20,458

talked about looking for they as you

5035

07:13:24,530 --> 07:13:22,320

said can be preserved for a few millions

5036

07:13:26,510 --> 07:13:24,540

of years but what about the more stable

5037

07:13:28,548 --> 07:13:26,520

versions like looking for her pains

5038

07:13:31,250 --> 07:13:28,558

rather than hope Knowles are you also

5039

07:13:33,410 --> 07:13:31,260

looking for those yeah yeah we are I

5040

07:13:35,330 --> 07:13:33,420

didn't really explain that super well

5041

07:13:37,490 --> 07:13:35,340

but we are hoping to look for helping

5042

07:13:39,410 --> 07:13:37,500

hoping to look for Hope pains as well

5043

07:13:42,468 --> 07:13:39,420

yeah

5044

07:13:43,910 --> 07:13:42,478

and um what do you think like the

5045

07:13:46,070 --> 07:13:43,920

preservation

5046

07:13:48,350 --> 07:13:46,080

is in this cave would be for the

5047

07:13:51,708 --> 07:13:48,360

molecules and how similar is that to

5048

07:13:54,410 --> 07:13:51,718

Mars yeah I think that that is kind of

5049

07:13:57,350 --> 07:13:54,420

the key question for sure

5050

07:14:02,270 --> 07:13:59,288

I don't know if that's something that I

5051
07:14:03,650 --> 07:14:02,280
want to dive into right now but I think

5052
07:14:05,390 --> 07:14:03,660
we should talk about it later for sure

5053
07:14:06,530 --> 07:14:05,400
I'm curious to hear your thoughts on it

5054
07:14:08,628 --> 07:14:06,540
as well

5055
07:14:12,770 --> 07:14:08,638
um obviously this is a oxidizing

5056
07:14:15,770 --> 07:14:12,780
environment it's it's acidic it's wet so

5057
07:14:17,810 --> 07:14:15,780
it has a lot that could maybe not be

5058
07:14:19,190 --> 07:14:17,820
preserving things but

5059
07:14:21,610 --> 07:14:19,200
um you know certainly folks have done

5060
07:14:24,830 --> 07:14:21,620
similar research and and have found

5061
07:14:26,990 --> 07:14:24,840
biomarkers in in Gypsum and other

5062
07:14:33,530 --> 07:14:27,000
environments on Earth so

5063
07:14:38,810 --> 07:14:36,948

any last questions for Zoe

5064

07:14:44,330 --> 07:14:38,820

okay thank you so much oh wait there's

5065

07:14:47,930 --> 07:14:46,010

hey so I have a question about the

5066

07:14:50,510 --> 07:14:47,940

microcrystalline nature of that gypsum

5067

07:14:52,730 --> 07:14:50,520

so what do you think that might what's

5068

07:14:54,830 --> 07:14:52,740

your hypothesis for structurally how

5069

07:14:56,330 --> 07:14:54,840

that might affect preservation of Bio

5070

07:14:57,708 --> 07:14:56,340

signatures as opposed to other kinds of

5071

07:14:59,930 --> 07:14:57,718

gypsum that might happen on the surface

5072

07:15:01,310 --> 07:14:59,940

yeah I think that that's a really good

5073

07:15:03,110 --> 07:15:01,320

question

5074

07:15:05,570 --> 07:15:03,120

um

5075

07:15:07,010 --> 07:15:05,580

I guess you know off the top of my head

5076

07:15:08,750 --> 07:15:07,020

I would say that

5077

07:15:11,030 --> 07:15:08,760

I don't know if we're gonna get it like

5078

07:15:12,530 --> 07:15:11,040

doesn't really layer I think necessarily

5079

07:15:14,628 --> 07:15:12,540

in the way that we see in like

5080

07:15:16,730 --> 07:15:14,638

evaporative gypsum

5081

07:15:19,128 --> 07:15:16,740

um how that may or may not you know

5082

07:15:20,810 --> 07:15:19,138

factor into biosignature preservation I

5083

07:15:22,070 --> 07:15:20,820

don't I can't really speak to that but

5084

07:15:24,468 --> 07:15:22,080

it is I think it's definitely a really

5085

07:15:26,150 --> 07:15:24,478

interesting difference

5086

07:15:27,288 --> 07:15:26,160

um that we see in this gypsum for sure

5087

07:15:30,170 --> 07:15:27,298

and it's like

5088

07:15:31,670 --> 07:15:30,180

it's I didn't really show any of the

5089

07:15:33,708 --> 07:15:31,680

like there's that one picture that I

5090

07:15:36,170 --> 07:15:33,718

showed of the gypsum but it's it's crazy

5091

07:15:37,490 --> 07:15:36,180

it's like you know we call it Rock in

5092

07:15:39,770 --> 07:15:37,500

name only

5093

07:15:41,510 --> 07:15:39,780

um it's it's like goo

5094

07:15:43,310 --> 07:15:41,520

um you go to sample it and it's almost

5095

07:15:46,128 --> 07:15:43,320

like a non-Newtonian fluid it like just

5096

07:15:49,128 --> 07:15:46,138

kind of like oozes um which is super

5097

07:15:53,628 --> 07:15:49,138

wild and and it's kind of difficult to

5098

07:16:02,810 --> 07:15:55,710

all right thank you so much Zoe

5099

07:16:02,810 --> 07:16:02,820

[Applause]

5100

07:16:06,650 --> 07:16:04,250

okay

5101
07:16:18,948 --> 07:16:06,660
so our next speaker is Kimberly Sinclair

5102
07:16:23,510 --> 07:16:22,368
hi I'm Kimberly Sinclair I'm from the

5103
07:16:25,070 --> 07:16:23,520
University of Washington department of

5104
07:16:28,368 --> 07:16:25,080
Earth and space Sciences I'm working

5105
07:16:29,810 --> 07:16:28,378
with David catling and Tim Elam I'm

5106
07:16:31,610 --> 07:16:29,820
going to talk to you guys about this

5107
07:16:33,230 --> 07:16:31,620
project the mineralogy of evaporites and

5108
07:16:34,968 --> 07:16:33,240
sediments in the alkaline phosphate Rich

5109
07:16:36,530 --> 07:16:34,978
Lakes so the Caribou Plateau which is

5110
07:16:40,250 --> 07:16:36,540
work I've been doing with Sebastian Haas

5111
07:16:41,510 --> 07:16:40,260
and is funded by the Simons Foundation

5112
07:16:42,948 --> 07:16:41,520
okay so I want to give you a bit of

5113
07:16:44,690 --> 07:16:42,958

background about the phosphorus problem

5114

07:16:46,850 --> 07:16:44,700

in astrobiology because I know we're all

5115

07:16:48,830 --> 07:16:46,860

coming from very different backgrounds

5116

07:16:50,030 --> 07:16:48,840

uh there's a lot of biology talks this

5117

07:16:52,250 --> 07:16:50,040

morning though so I'm sure a lot of you

5118

07:16:54,548 --> 07:16:52,260

guys are caught up on this but uh so we

5119

07:16:57,770 --> 07:16:54,558

all know DNA on the right hand side here

5120

07:16:59,930 --> 07:16:57,780

has this sugar phosphate backbone and

5121

07:17:01,610 --> 07:16:59,940

then you have your base pairs or if you

5122

07:17:03,350 --> 07:17:01,620

zoom in closer you're seeing your

5123

07:17:06,650 --> 07:17:03,360

phosphate group your sugar and your

5124

07:17:08,690 --> 07:17:06,660

nuclear base here and in order to get

5125

07:17:11,150 --> 07:17:08,700

this phosphate to incorporate into the

5126
07:17:13,670 --> 07:17:11,160
nucleotide you need very high levels of

5127
07:17:15,770 --> 07:17:13,680
phosphate and this has been shown by

5128
07:17:18,110 --> 07:17:15,780
research done by powder at all in 2009

5129
07:17:19,430 --> 07:17:18,120
so this question we want to ask is how

5130
07:17:21,770 --> 07:17:19,440
much phosphorus is actually available

5131
07:17:22,670 --> 07:17:21,780
for Prebiotic phosphorylation on early

5132
07:17:24,770 --> 07:17:22,680
Earth

5133
07:17:26,628 --> 07:17:24,780
and even though we need these very high

5134
07:17:28,250 --> 07:17:26,638
concentrations of phosphate up to one

5135
07:17:30,830 --> 07:17:28,260
molar in Prebiotic phosphorylation

5136
07:17:32,750 --> 07:17:30,840
experiments we only see very low

5137
07:17:34,788 --> 07:17:32,760
concentrations of phosphate in the

5138
07:17:36,890 --> 07:17:34,798

environment close to the micromolar

5139

07:17:38,570 --> 07:17:36,900

level and that's because in natural

5140

07:17:40,490 --> 07:17:38,580

Waters phosphate will combine with

5141

07:17:43,128 --> 07:17:40,500

calcium and Fallout of solution as an

5142

07:17:45,830 --> 07:17:43,138

insoluble mineral known as appetite or

5143

07:17:48,048 --> 07:17:45,840

calcium phosphate before reaching very

5144

07:17:49,368 --> 07:17:48,058

high concentrations so there's a bit of

5145

07:17:51,530 --> 07:17:49,378

a problem here and that's what we call

5146

07:17:53,330 --> 07:17:51,540

the phosphorus problem

5147

07:17:56,330 --> 07:17:53,340

uh We've proposed a solution to the

5148

07:17:58,310 --> 07:17:56,340

phosphorus problem uh in a paper by

5149

07:18:00,770 --> 07:17:58,320

toner and catling in 2020 the hypothesis

5150

07:18:02,570 --> 07:18:00,780

was stated that abundant carbonate leads

5151
07:18:05,090 --> 07:18:02,580
to calcite formation calcite being

5152
07:18:07,910 --> 07:18:05,100
calcium carbonate thus suppressing the

5153
07:18:09,350 --> 07:18:07,920
calcium phosphate mineral formation and

5154
07:18:11,270 --> 07:18:09,360
leaving phosphorus in solution to

5155
07:18:13,010 --> 07:18:11,280
concentrate to higher levels

5156
07:18:14,930 --> 07:18:13,020
so in order to test this Theory we

5157
07:18:17,448 --> 07:18:14,940
visited the most phosphorus Rich lake in

5158
07:18:19,730 --> 07:18:17,458
the world uh this plot on the right hand

5159
07:18:21,410 --> 07:18:19,740
side is from toner and catling 2020 you

5160
07:18:23,150 --> 07:18:21,420
see a very high phosphorus

5161
07:18:25,610 --> 07:18:23,160
concentrations in these lakes on the top

5162
07:18:27,110 --> 07:18:25,620
right side which are good enough in last

5163
07:18:29,208 --> 07:18:27,120

chance Lake and so that's where we

5164

07:18:30,530 --> 07:18:29,218

wanted to visit to understand why you're

5165

07:18:32,750 --> 07:18:30,540

getting these very high concentrations

5166

07:18:34,670 --> 07:18:32,760

of phosphorus we can then apply our

5167

07:18:36,530 --> 07:18:34,680

understanding of these Lakes to possible

5168

07:18:39,590 --> 07:18:36,540

analog Lakes on Prebiotic Earth where

5169

07:18:41,208 --> 07:18:39,600

origin of life could have happened

5170

07:18:42,770 --> 07:18:41,218

so a little bit about these Lakes Last

5171

07:18:45,048 --> 07:18:42,780

Chance in good enough Lakes are

5172

07:18:46,368 --> 07:18:45,058

carbonate Rich alkaline soda lakes on

5173

07:18:49,070 --> 07:18:46,378

the Caribou plateau in British Columbia

5174

07:18:50,810 --> 07:18:49,080

Canada left hand side you see the map of

5175

07:18:53,090 --> 07:18:50,820

British Columbia here in this green

5176
07:18:55,070 --> 07:18:53,100
swath is the Caribou Plateau it's right

5177
07:18:56,868 --> 07:18:55,080
East of those coastal mountains not too

5178
07:18:58,310 --> 07:18:56,878
far north of Vancouver

5179
07:19:00,048 --> 07:18:58,320
if you were to zoom in on Google Maps

5180
07:19:03,948 --> 07:19:00,058
you would see the lakes here good enough

5181
07:19:05,810 --> 07:19:03,958
Lake here and last chance Lake here

5182
07:19:07,788 --> 07:19:05,820
um they both have very high phosphate

5183
07:19:10,368 --> 07:19:07,798
concentrations but particularly Last

5184
07:19:12,048 --> 07:19:10,378
Chance Lake gets up to 37 millimolar of

5185
07:19:14,448 --> 07:19:12,058
phosphorus which is very high in

5186
07:19:16,610 --> 07:19:14,458
comparison to that micromolar level that

5187
07:19:18,590 --> 07:19:16,620
we're usually seeing in natural Waters

5188
07:19:21,048 --> 07:19:18,600

and this is an image of Last Chance Lake

5189

07:19:22,250 --> 07:19:21,058

taken in November 2021 which is what it

5190

07:19:23,868 --> 07:19:22,260

looks like from the ground level so

5191

07:19:26,510 --> 07:19:23,878

you're seeing it form into these sort of

5192

07:19:28,190 --> 07:19:26,520

brine pools

5193

07:19:30,048 --> 07:19:28,200

so a little bit of context from these

5194

07:19:32,208 --> 07:19:30,058

Lakes they're too small less than

5195

07:19:34,610 --> 07:19:32,218

kilometer squared shallow closed Basin

5196

07:19:37,250 --> 07:19:34,620

lakes with sodium carbonate sulfate

5197

07:19:39,350 --> 07:19:37,260

chlorine brines these are typical major

5198

07:19:40,430 --> 07:19:39,360

ions of soda Lakes developed on basaltic

5199

07:19:43,070 --> 07:19:40,440

Rock

5200

07:19:45,230 --> 07:19:43,080

their sulfate potassium phosphate and

5201

07:19:47,208 --> 07:19:45,240

magnesium are abundant whereas calcium

5202

07:19:48,948 --> 07:19:47,218

iron silicon and dissolved inorganic

5203

07:19:50,270 --> 07:19:48,958

nitrogen are present at very low

5204

07:19:53,510 --> 07:19:50,280

concentrations

5205

07:19:56,330 --> 07:19:53,520

the salinity reaches up to 462 grams per

5206

07:19:58,548 --> 07:19:56,340

liter which is about 13 times seawater

5207

07:20:02,030 --> 07:19:58,558

salinity so they're very salty

5208

07:20:03,468 --> 07:20:02,040

and the pH ranges from 9.7 to 10.7 in

5209

07:20:05,208 --> 07:20:03,478

both of these Lakes depending on the

5210

07:20:07,670 --> 07:20:05,218

time of year and the location in The

5211

07:20:10,368 --> 07:20:07,680

Lakes because they do get spring in fed

5212

07:20:14,150 --> 07:20:10,378

from surrounding rivers and such

5213

07:20:15,830 --> 07:20:14,160

or sorry from groundwater not reverse

5214

07:20:18,048 --> 07:20:15,840

so we wanted to go and visit these Lakes

5215

07:20:19,910 --> 07:20:18,058

over different seasons in order to

5216

07:20:21,830 --> 07:20:19,920

understand how the mineralogy of

5217

07:20:23,930 --> 07:20:21,840

different precipitates and evaporites as

5218

07:20:25,670 --> 07:20:23,940

well as precipitates in the sediments

5219

07:20:27,530 --> 07:20:25,680

change

5220

07:20:29,090 --> 07:20:27,540

um so we went in winter summer and fall

5221

07:20:32,150 --> 07:20:29,100

and you can see the corresponding

5222

07:20:33,890 --> 07:20:32,160

pictures here in Winter 2021 you see

5223

07:20:35,390 --> 07:20:33,900

these brine pools starting to freeze

5224

07:20:38,270 --> 07:20:35,400

over

5225

07:20:40,010 --> 07:20:38,280

um and summer 22 to 2022 it enters this

5226

07:20:41,930 --> 07:20:40,020

ephemeral Lake stage where it has enough

5227

07:20:43,010 --> 07:20:41,940

water that it actually covers the entire

5228

07:20:45,770 --> 07:20:43,020

surface

5229

07:20:47,810 --> 07:20:45,780

and then in Autumn 2022 these brine

5230

07:20:49,610 --> 07:20:47,820

pools are drying out into Salt Flats and

5231

07:20:52,850 --> 07:20:49,620

so there's basically no water left in

5232

07:20:54,288 --> 07:20:52,860

this system at all it's just salt

5233

07:20:55,670 --> 07:20:54,298

so we wanted to collect lots of

5234

07:20:56,990 --> 07:20:55,680

different evaporites which are these

5235

07:20:59,690 --> 07:20:57,000

salts that are forming around the lake

5236

07:21:02,510 --> 07:20:59,700

shore as well as precipitates within the

5237

07:21:05,810 --> 07:21:02,520

lake these are different fun examples of

5238

07:21:07,430 --> 07:21:05,820

evaporites we collected so in our winter

5239

07:21:10,610 --> 07:21:07,440

trip you get a lot of these salts

5240

07:21:13,310 --> 07:21:10,620

forming on rocks Around the Lake Shores

5241

07:21:14,930 --> 07:21:13,320

around the brine pools in June this is

5242

07:21:16,548 --> 07:21:14,940

an example of a precipitate that formed

5243

07:21:18,048 --> 07:21:16,558

and fell to the bottom of the lake and

5244

07:21:18,948 --> 07:21:18,058

so you can pick it up from under the

5245

07:21:21,890 --> 07:21:18,958

water

5246

07:21:25,310 --> 07:21:21,900

it's a lot of salt mixed in with mud and

5247

07:21:28,190 --> 07:21:25,320

clay and then in September when it's in

5248

07:21:29,810 --> 07:21:28,200

that salt crust phase you can dig into

5249

07:21:31,070 --> 07:21:29,820

the salt crust and take this out and

5250

07:21:32,150 --> 07:21:31,080

that's what the cross section looks like

5251
07:21:34,310 --> 07:21:32,160
so you're getting these very white

5252
07:21:36,948 --> 07:21:34,320
opaque salts on the top that middle

5253
07:21:38,690 --> 07:21:36,958
layer of translucent Natron salt in the

5254
07:21:41,330 --> 07:21:38,700
middle and then a layer of algae right

5255
07:21:43,850 --> 07:21:41,340
above the mud

5256
07:21:45,288 --> 07:21:43,860
we also wanted to collect sediments from

5257
07:21:46,670 --> 07:21:45,298
the lake bottom and so these are

5258
07:21:49,910 --> 07:21:46,680
pictures of us collecting different

5259
07:21:51,590 --> 07:21:49,920
sediment samples with sediment cores we

5260
07:21:54,048 --> 07:21:51,600
did it both around the lake shore as

5261
07:21:55,490 --> 07:21:54,058
well as at the lake bottom and then the

5262
07:21:57,890 --> 07:21:55,500
center picture you see is us taking

5263
07:21:59,690 --> 07:21:57,900

those sudden cores and chopping off

5264

07:22:01,548 --> 07:21:59,700

different depths in order to see how the

5265

07:22:04,430 --> 07:22:01,558

mineralogy changes with depth in the

5266

07:22:08,810 --> 07:22:06,708

so we did a mineralogy analysis with

5267

07:22:10,730 --> 07:22:08,820

x-ray diffraction we used a Booker d8

5268

07:22:12,770 --> 07:22:10,740

powder x-ray diffractometer with a

5269

07:22:15,230 --> 07:22:12,780

copper anode microfocus x-ray source

5270

07:22:16,490 --> 07:22:15,240

which is the microfocus X-ray source is

5271

07:22:17,930 --> 07:22:16,500

really useful when you have very small

5272

07:22:21,110 --> 07:22:17,940

quantities of powder that you're trying

5273

07:22:22,788 --> 07:22:21,120

to analyze and plotus 100K large area 2D

5274

07:22:24,110 --> 07:22:22,798

detector is really helpful when you want

5275

07:22:27,230 --> 07:22:24,120

to increase the resolution of your

5276

07:22:30,230 --> 07:22:28,490

um just a quick note about sample

5277

07:22:31,788 --> 07:22:30,240

preparation we tried to isolate the

5278

07:22:33,650 --> 07:22:31,798

mineral phases visually as much as we

5279

07:22:36,590 --> 07:22:33,660

could from our samples in order to

5280

07:22:38,690 --> 07:22:36,600

simplify the pattern matching grind it

5281

07:22:40,010 --> 07:22:38,700

up really fine you want to have good

5282

07:22:42,110 --> 07:22:40,020

particle statistics for x-ray

5283

07:22:45,948 --> 07:22:42,120

diffraction and then dropping it onto a

5284

07:22:47,510 --> 07:22:45,958

silk zero background sample holder to

5285

07:22:49,910 --> 07:22:47,520

try and get that flat homogeneous

5286

07:22:51,350 --> 07:22:49,920

surface that's so important

5287

07:22:54,230 --> 07:22:51,360

and then for those of you who haven't

5288

07:22:56,570 --> 07:22:54,240

seen xrd Data before this is sort of

5289

07:22:58,368 --> 07:22:56,580

what it looks like uh you've got your

5290

07:23:01,310 --> 07:22:58,378

tooth Theta on the x-axis intensity and

5291

07:23:03,530 --> 07:23:01,320

the y-axis and your observed pattern is

5292

07:23:06,410 --> 07:23:03,540

in blue this is using a software called

5293

07:23:08,150 --> 07:23:06,420

gsas2 which is an open source code for

5294

07:23:10,250 --> 07:23:08,160

xrd analysis

5295

07:23:12,350 --> 07:23:10,260

and then you're trying to match uh

5296

07:23:15,590 --> 07:23:12,360

database database patterns of different

5297

07:23:18,230 --> 07:23:15,600

minerals to this observed pattern and so

5298

07:23:19,490 --> 07:23:18,240

the calculated one pattern that's a

5299

07:23:21,350 --> 07:23:19,500

conglomeration of all the different

5300

07:23:22,910 --> 07:23:21,360

mineral phases we've identified as shown

5301
07:23:24,468 --> 07:23:22,920
in green overlaid on top of that

5302
07:23:27,230 --> 07:23:24,478
observed pattern

5303
07:23:31,010 --> 07:23:27,240
so this is an example of one evaporite

5304
07:23:33,410 --> 07:23:31,020
and one sediment from these Lakes going

5305
07:23:35,030 --> 07:23:33,420
through on this evaporate here we've

5306
07:23:37,310 --> 07:23:35,040
identified multiple different sodium

5307
07:23:38,990 --> 07:23:37,320
carbonate phases so there's a lot of

5308
07:23:40,850 --> 07:23:39,000
thermonitrite which is sodium carbonate

5309
07:23:43,850 --> 07:23:40,860
with one water molecule at the 60

5310
07:23:45,590 --> 07:23:43,860
percent weight percent level and then

5311
07:23:47,930 --> 07:23:45,600
for reference in this sample here the

5312
07:23:49,910 --> 07:23:47,940
thermonitrite is this blue and so each

5313
07:23:51,730 --> 07:23:49,920

mineral you're supposed to you expect to

5314

07:23:54,468 --> 07:23:51,740

see different Peaks and

5315

07:23:55,910 --> 07:23:54,478

the two Theta range and so we're just

5316

07:23:57,830 --> 07:23:55,920

matching those Peaks

5317

07:23:59,690 --> 07:23:57,840

we're also seeing Toronto which is

5318

07:24:02,448 --> 07:23:59,700

another sodium carbonate as well as the

5319

07:24:04,548 --> 07:24:02,458

nardite sodium sulfate halide sodium

5320

07:24:06,650 --> 07:24:04,558

chloride burkite which is a sodium

5321

07:24:08,690 --> 07:24:06,660

carbonate sulfate and acolyte sodium

5322

07:24:10,368 --> 07:24:08,700

bicarbonate so these mineral phases are

5323

07:24:12,670 --> 07:24:10,378

all very common and these evaporates

5324

07:24:15,530 --> 07:24:12,680

we're finding across these Lakes

5325

07:24:18,410 --> 07:24:15,540

while in the sediment we're seeing a lot

5326

07:24:21,048 --> 07:24:18,420

of feldspars like albitgeite as well as

5327

07:24:24,230 --> 07:24:21,058

the north of Clays in a North eye and

5328

07:24:26,390 --> 07:24:24,240

other samples around the 70 to 20 to 30

5329

07:24:27,770 --> 07:24:26,400

percent range

5330

07:24:29,448 --> 07:24:27,780

um a secondary phase we're seeing a lot

5331

07:24:31,788 --> 07:24:29,458

of in the sediments is Dolomite which is

5332

07:24:32,930 --> 07:24:31,798

that calcium magnesium carbonate and

5333

07:24:34,968 --> 07:24:32,940

that's very important I'll come back to

5334

07:24:37,128 --> 07:24:34,978

that in a moment we're also seeing a lot

5335

07:24:38,750 --> 07:24:37,138

of minor phases like quartz and

5336

07:24:40,128 --> 07:24:38,760

vesuvianite and other things like that

5337

07:24:42,708 --> 07:24:40,138

that are just present in the natural

5338

07:24:44,090 --> 07:24:42,718

soil in the area

5339

07:24:45,350 --> 07:24:44,100

so then you do this a bunch more times

5340

07:24:47,570 --> 07:24:45,360

because you're a graduate student and

5341

07:24:49,490 --> 07:24:47,580

you do a lot of Labor and you take a lot

5342

07:24:51,468 --> 07:24:49,500

of samples

5343

07:24:54,650 --> 07:24:51,478

and this comes together into the

5344

07:24:56,750 --> 07:24:54,660

complete xrd results from the study so

5345

07:24:58,368 --> 07:24:56,760

I've divided this into results for last

5346

07:25:00,230 --> 07:24:58,378

chance Lake as well as good enough Lake

5347

07:25:01,910 --> 07:25:00,240

and then in each respective like the

5348

07:25:03,530 --> 07:25:01,920

sediments and the salts the salts being

5349

07:25:05,868 --> 07:25:03,540

the evaporites around the Lakeshore as

5350

07:25:07,070 --> 07:25:05,878

well as the precipitates and the lake on

5351
07:25:08,150 --> 07:25:07,080
the left hand side we have all the

5352
07:25:09,288 --> 07:25:08,160
different mineral phases we've

5353
07:25:11,990 --> 07:25:09,298
identified

5354
07:25:14,990 --> 07:25:12,000
so in the sediments the main phases of

5355
07:25:16,968 --> 07:25:15,000
Interest were these feldspars both

5356
07:25:20,090 --> 07:25:16,978
plagioclase feldspar as well as Alkali

5357
07:25:22,610 --> 07:25:20,100
or k-feld spars as well as Dolomite

5358
07:25:23,990 --> 07:25:22,620
those calcium carbonates is and Mica the

5359
07:25:25,730 --> 07:25:24,000
clay minerals

5360
07:25:27,410 --> 07:25:25,740
we're also seeing some thermonitrite

5361
07:25:29,330 --> 07:25:27,420
that sodium carbonate and the good

5362
07:25:31,310 --> 07:25:29,340
enough Lake sediments but not in the

5363
07:25:34,010 --> 07:25:31,320

last chance Lake sediments

5364

07:25:35,990 --> 07:25:34,020

and then the main mineral phases we're

5365

07:25:37,368 --> 07:25:36,000

seeing in the evaporites or the salts

5366

07:25:39,288 --> 07:25:37,378

are those sodium carbonates both

5367

07:25:42,770 --> 07:25:39,298

thermonitrite and Trona as well as

5368

07:25:46,010 --> 07:25:42,780

burkite that sodium carbonate sulfate

5369

07:25:47,690 --> 07:25:46,020

a quick word about hydrated minerals we

5370

07:25:49,310 --> 07:25:47,700

only detected thermonitrite which is

5371

07:25:50,990 --> 07:25:49,320

sodium carbonate with one water molecule

5372

07:25:52,010 --> 07:25:51,000

in the xrd patterns after sample

5373

07:25:54,590 --> 07:25:52,020

preparation

5374

07:25:56,690 --> 07:25:54,600

however previous studies of this area

5375

07:25:59,150 --> 07:25:56,700

have identified natural salts as the

5376
07:26:01,910 --> 07:25:59,160
predominant phase Natron is just sodium

5377
07:26:03,770 --> 07:26:01,920
carbonate with 10 water molecules and so

5378
07:26:05,868 --> 07:26:03,780
if the relative humidity is below 60

5379
07:26:08,570 --> 07:26:05,878
percent at zero degrees Celsius or 70

5380
07:26:09,770 --> 07:26:08,580
percent at room temperature then Natron

5381
07:26:11,208 --> 07:26:09,780
will lose its water and turn into

5382
07:26:12,650 --> 07:26:11,218
therminatrite and so we're just

5383
07:26:15,110 --> 07:26:12,660
anticipating that's what happened in our

5384
07:26:16,968 --> 07:26:15,120
samples here since the relative humidity

5385
07:26:19,128 --> 07:26:16,978
in indoor environments is around 50

5386
07:26:20,390 --> 07:26:19,138
percent so you can see this plot on the

5387
07:26:22,788 --> 07:26:20,400
right hand side from Haines at all

5388
07:26:24,890 --> 07:26:22,798

showing Natron here turning into

5389

07:26:26,150 --> 07:26:24,900

thermonitrite when you've decreased

5390

07:26:28,788 --> 07:26:26,160

relative humidity and increased

5391

07:26:33,170 --> 07:26:31,070

so in summary we found that the

5392

07:26:34,910 --> 07:26:33,180

evaporites or the salts are dominated by

5393

07:26:36,350 --> 07:26:34,920

sodium carbonates sodium carbonate

5394

07:26:38,030 --> 07:26:36,360

sulfate and sodium chloride

5395

07:26:40,670 --> 07:26:38,040

demonstrating the predominance of that

5396

07:26:42,410 --> 07:26:40,680

sodium ion in The Lakes whereas the

5397

07:26:44,030 --> 07:26:42,420

sediments are dominated by carbonates

5398

07:26:46,850 --> 07:26:44,040

both Dolomite and acry as well as

5399

07:26:50,330 --> 07:26:46,860

feldspars plagioclase and K feldspar

5400

07:26:52,910 --> 07:26:50,340

quartz peroxine and Clay minerals

5401
07:26:54,708 --> 07:26:52,920
however the big takeaway was we found no

5402
07:26:56,690 --> 07:26:54,718
calcium phosphate which is that appetite

5403
07:26:58,968 --> 07:26:56,700
I talked about earlier in any of the

5404
07:27:01,190 --> 07:26:58,978
samples and this was confirmed by icpms

5405
07:27:02,330 --> 07:27:01,200
data showing very low abundance of

5406
07:27:04,548 --> 07:27:02,340
phosphorus and all of the different

5407
07:27:06,288 --> 07:27:04,558
samples we've taken so it's not just an

5408
07:27:08,628 --> 07:27:06,298
xrd fluke it's also backed up by

5409
07:27:10,128 --> 07:27:08,638
Elemental abundances

5410
07:27:12,350 --> 07:27:10,138
um these results are consistent with the

5411
07:27:13,968 --> 07:27:12,360
hypothesis that calcium carbonates

5412
07:27:17,150 --> 07:27:13,978
precipitate early in the mineralization

5413
07:27:19,010 --> 07:27:17,160

sequence of these Lakes thus decreasing

5414

07:27:21,170 --> 07:27:19,020

the dissolved calcium concentrations and

5415

07:27:22,850 --> 07:27:21,180

allowing phosphate to accumulate to high

5416

07:27:25,128 --> 07:27:22,860

concentrations instead of precipitating

5417

07:27:27,288 --> 07:27:25,138

out as appetite which is that calcium

5418

07:27:31,010 --> 07:27:27,298

phosphate

5419

07:27:32,690 --> 07:27:31,020

concentrations in solution and that's

5420

07:27:34,670 --> 07:27:32,700

great for that Prebiotic phosphorylation

5421

07:27:37,070 --> 07:27:34,680

that you need very high phosphate

5422

07:27:40,250 --> 07:27:37,080

concentrations to get that incorporation

5423

07:27:41,510 --> 07:27:40,260

into your nucleotides and the potential

5424

07:27:44,690 --> 07:27:41,520

origin of life so these could be really

5425

07:27:47,030 --> 07:27:44,700

good environments for analogs for hidea

5426
07:27:48,960 --> 07:27:47,040
and Earth Lakes where life started

5427
07:27:55,670 --> 07:27:48,970
and that's it

5428
07:27:57,410 --> 07:27:55,680
[Applause]

5429
07:28:02,208 --> 07:27:57,420
thanks Kimberly we have plenty of time

5430
07:28:06,410 --> 07:28:04,490
I have a quick one for you yeah

5431
07:28:11,570 --> 07:28:06,420
um do you know how good enough Lake was

5432
07:28:11,580 --> 07:28:15,170
tension and when they got

5433
07:28:15,180 --> 07:28:18,708
they got back east

5434
07:28:21,890 --> 07:28:20,030
I was just curious because when we were

5435
07:28:24,490 --> 07:28:21,900
in Australia there was a lot of strange

5436
07:28:27,170 --> 07:28:24,500
Lake names out there like dead kangaroo

5437
07:28:29,330 --> 07:28:27,180
uh Peaks Piggery and we didn't really

5438
07:28:31,430 --> 07:28:29,340

understand like the history of them but

5439

07:28:33,468 --> 07:28:31,440

yeah anyway there were a lot of jokes in

5440

07:28:36,070 --> 07:28:33,478

the field uh about oh it's our last

5441

07:28:47,750 --> 07:28:36,080

chance to get our last chance sample and

5442

07:28:53,448 --> 07:28:50,868

hi I'm Ellie from CU Boulder and I was

5443

07:28:55,548 --> 07:28:53,458

wondering if the so I know you said your

5444

07:28:58,850 --> 07:28:55,558

sediments are a pledge doll Micah and

5445

07:29:00,530 --> 07:28:58,860

feldspar dominated I was curious if you

5446

07:29:02,448 --> 07:29:00,540

would think that the similar pattern

5447

07:29:03,948 --> 07:29:02,458

that you saw here would happen even if

5448

07:29:05,930 --> 07:29:03,958

your soda Lake was hosted by a different

5449

07:29:08,090 --> 07:29:05,940

type of like set like Base Rock

5450

07:29:09,708 --> 07:29:08,100

essentially like if we change instead of

5451
07:29:10,968 --> 07:29:09,718
balsaltic or things like that like do

5452
07:29:12,350 --> 07:29:10,978
you feel like the same pattern would

5453
07:29:13,670 --> 07:29:12,360
hold in terms of the precipitation of

5454
07:29:14,990 --> 07:29:13,680
the evaporites

5455
07:29:16,850 --> 07:29:15,000
yeah

5456
07:29:18,590 --> 07:29:16,860
um these Lakes are very dependent on the

5457
07:29:20,330 --> 07:29:18,600
host mineralogy and so you wouldn't

5458
07:29:22,368 --> 07:29:20,340
expect to see the same

5459
07:29:23,750 --> 07:29:22,378
um aqueous chemistry in a different host

5460
07:29:25,610 --> 07:29:23,760
environment and that's one of the

5461
07:29:27,650 --> 07:29:25,620
reasons why these uh this environment is

5462
07:29:30,288 --> 07:29:27,660
so interesting is because of that uh

5463
07:29:32,090 --> 07:29:30,298

plagi Clays Base Rock causing

5464

07:29:34,910 --> 07:29:32,100

um this very specific aqueous chemistry

5465

07:29:37,610 --> 07:29:34,920

so even just like what is it 100 miles

5466

07:29:39,830 --> 07:29:37,620

nearby is an incredibly sulfate-rich

5467

07:29:43,368 --> 07:29:39,840

Lake that people study for different

5468

07:29:51,410 --> 07:29:43,378

reasons so slight change in geology big

5469

07:29:55,310 --> 07:29:53,810

a really interesting talk uh I have kind

5470

07:29:57,708 --> 07:29:55,320

of two questions

5471

07:30:00,410 --> 07:29:57,718

um you mentioned that you collected

5472

07:30:01,548 --> 07:30:00,420

samples seasonally ended sediment by

5473

07:30:04,670 --> 07:30:01,558

death measurements do you see any

5474

07:30:06,708 --> 07:30:04,680

variability in your mineralization based

5475

07:30:08,810 --> 07:30:06,718

on like seasons and was that reflected

5476

07:30:11,868 --> 07:30:08,820

any depth transect

5477

07:30:14,690 --> 07:30:11,878

yes we hoped we would see more variation

5478

07:30:17,510 --> 07:30:14,700

but we didn't uh the only variation you

5479

07:30:19,250 --> 07:30:17,520

really saw was that you could say and

5480

07:30:21,170 --> 07:30:19,260

maybe this isn't even a statistically

5481

07:30:22,968 --> 07:30:21,180

like significant conclusion is that you

5482

07:30:25,548 --> 07:30:22,978

might see more Dolomite at the top of

5483

07:30:27,230 --> 07:30:25,558

the sediment core so like right in the

5484

07:30:28,730 --> 07:30:27,240

interaction Zone with the water you're

5485

07:30:30,650 --> 07:30:28,740

getting less Dolomite at depth which

5486

07:30:32,628 --> 07:30:30,660

makes sense for calcium carbonate

5487

07:30:34,070 --> 07:30:32,638

precipitating out of solution whereas at

5488

07:30:35,930 --> 07:30:34,080

depth in the sediment cores you're

5489

07:30:38,330 --> 07:30:35,940

getting more of those feldspars which is

5490

07:30:48,910 --> 07:30:38,340

just the host Rock but not as much in

5491

07:30:48,920 --> 07:30:52,788

two slides back

5492

07:31:01,128 --> 07:30:55,548

yeah so like you have data for I think

5493

07:31:03,170 --> 07:31:01,138

uh necklite uh and third nine diet which

5494

07:31:06,170 --> 07:31:03,180

has uncertainty higher than the data so

5495

07:31:07,610 --> 07:31:06,180

is it normal or how can you explain this

5496

07:31:09,708 --> 07:31:07,620

sorry could you say the last part again

5497

07:31:11,628 --> 07:31:09,718

so the uncertainty in the data is higher

5498

07:31:13,548 --> 07:31:11,638

than the the value so can you explain

5499

07:31:16,070 --> 07:31:13,558

this yes because a lot of these samples

5500

07:31:17,510 --> 07:31:16,080

only have these minor phases and a

5501

07:31:18,948 --> 07:31:17,520

couple of the samples

5502

07:31:20,390 --> 07:31:18,958

um and so there's just not very good

5503

07:31:21,410 --> 07:31:20,400

counting statistics we're talking about

5504

07:31:23,510 --> 07:31:21,420

maybe

5505

07:31:26,390 --> 07:31:23,520

three out of 100 samples or something

5506

07:31:29,208 --> 07:31:26,400

that have these minor phases

5507

07:31:31,670 --> 07:31:29,218

um so yeah

5508

07:31:34,610 --> 07:31:31,680

a Taylor plattner at Georgia Institute

5509

07:31:37,548 --> 07:31:34,620

of Technology this was really cool I had

5510

07:31:39,650 --> 07:31:37,558

no idea that these Lakes were so high in

5511

07:31:41,750 --> 07:31:39,660

phosphate um I know a couple of people

5512

07:31:44,510 --> 07:31:41,760

that are have studied like last chance

5513

07:31:45,230 --> 07:31:44,520

Lake and then the basket Lakes

5514

07:31:47,330 --> 07:31:45,240

um

5515

07:31:48,770 --> 07:31:47,340

I was curious

5516

07:31:50,090 --> 07:31:48,780

um because you were saying at the end

5517

07:31:52,670 --> 07:31:50,100

you know

5518

07:31:55,190 --> 07:31:52,680

interesting in terms of like the origin

5519

07:31:56,690 --> 07:31:55,200

of Life have you thought about actually

5520

07:31:58,548 --> 07:31:56,700

I have a couple questions

5521

07:32:01,968 --> 07:31:58,558

um have you thought about

5522

07:32:05,330 --> 07:32:01,978

like looking at what may be preserved in

5523

07:32:07,610 --> 07:32:05,340

in these salts or and I also have a

5524

07:32:10,190 --> 07:32:07,620

question on I know you did xrd do you

5525

07:32:10,788 --> 07:32:10,200

plan on doing any other analyzes

5526

07:32:14,150 --> 07:32:10,798

um

5527

07:32:15,708 --> 07:32:14,160

with your samples yeah so I guess your

5528

07:32:21,468 --> 07:32:15,718

first question about if we're studying

5529

07:32:25,548 --> 07:32:23,330

yeah so

5530

07:32:26,510 --> 07:32:25,558

um out of my macroscopic scale when you

5531

07:32:28,368 --> 07:32:26,520

go there it's really interesting because

5532

07:32:31,070 --> 07:32:28,378

you see all these brine flies that are

5533

07:32:32,628 --> 07:32:31,080

just encrusted in the salt which is kind

5534

07:32:34,788 --> 07:32:32,638

of it's kind of freaky because in the

5535

07:32:36,948 --> 07:32:34,798

summer you're like encompassed by flies

5536

07:32:38,448 --> 07:32:36,958

and then in the winter it's like a fly

5537

07:32:40,910 --> 07:32:38,458

cemetery and there's just a bunch of

5538

07:32:43,850 --> 07:32:40,920

dead flies in the ground but

5539

07:32:49,670 --> 07:32:43,860

um in a more astrobiology sense

5540

07:32:52,250 --> 07:32:49,680

um there are other teams at I think it's

5541

07:32:54,410 --> 07:32:52,260

shoot University in Canada who are

5542

07:32:56,930 --> 07:32:54,420

studying the current microbiology in the

5543

07:32:59,270 --> 07:32:56,940

ice because there are living microbes in

5544

07:33:00,468 --> 07:32:59,280

the ice in the winter and so we're not

5545

07:33:02,448 --> 07:33:00,478

necessarily doing that work but there

5546

07:33:07,368 --> 07:33:02,458

are colleagues who are

5547

07:33:12,468 --> 07:33:10,368

yes okay so uh my section of the work

5548

07:33:14,150 --> 07:33:12,478

was a lot about the mineralogy of the

5549

07:33:15,468 --> 07:33:14,160

sediments and the evaporites but my

5550

07:33:17,390 --> 07:33:15,478

colleagues Sebastian Haas did a lot more

5551
07:33:20,390 --> 07:33:17,400
of the water chemistry

5552
07:33:21,708 --> 07:33:20,400
um and so we're submitting a paper now

5553
07:33:24,468 --> 07:33:21,718
and hopefully you'll be able to read

5554
07:33:27,390 --> 07:33:24,478
that and hear all about his work as well

5555
07:33:33,230 --> 07:33:27,400
thank you very much Kimberly yeah

5556
07:33:36,468 --> 07:33:33,240
[Applause]

5557
07:33:40,010 --> 07:33:36,478
okay our final speaker

5558
07:33:44,448 --> 07:33:40,020
of salty stuff

5559
07:33:52,128 --> 07:33:45,468
oh

5560
07:33:57,350 --> 07:33:54,350
all right

5561
07:33:59,090 --> 07:33:57,360
so uh I'm gonna call back a little bit

5562
07:34:01,788 --> 07:33:59,100
to a couple of the sites that Emily

5563
07:34:03,350 --> 07:34:01,798

mentioned before and uh what's exciting

5564

07:34:04,968 --> 07:34:03,360

for me is that I'm in San Diego for the

5565

07:34:06,770 --> 07:34:04,978

first time so I finally might be able to

5566

07:34:08,270 --> 07:34:06,780

go see one of the field sites I'm about

5567

07:34:10,250 --> 07:34:08,280

to talk about and I had no idea that

5568

07:34:12,830 --> 07:34:10,260

they were actually palm trees down here

5569

07:34:15,890 --> 07:34:12,840

around my supposedly extreme field site

5570

07:34:17,810 --> 07:34:15,900

so that'll be a a funny dichotomy there

5571

07:34:20,330 --> 07:34:17,820

but um so yeah we're gonna be following

5572

07:34:23,510 --> 07:34:20,340

the salt uh and it's going to be a lot

5573

07:34:25,670 --> 07:34:23,520

of salt so uh uh hang tight there

5574

07:34:28,128 --> 07:34:25,680

so the first field site South Bay

5575

07:34:31,730 --> 07:34:28,138

saltworks which is down the road

5576

07:34:35,690 --> 07:34:31,740

um is a salt Farm which as water is

5577

07:34:37,730 --> 07:34:35,700

taken from the bay it is brought in and

5578

07:34:40,490 --> 07:34:37,740

um the the people there are are

5579

07:34:42,590 --> 07:34:40,500

basically taking the the hay light out

5580

07:34:44,330 --> 07:34:42,600

and using that to I believe soften the

5581

07:34:46,548 --> 07:34:44,340

water here and then the magnesium

5582

07:34:48,890 --> 07:34:46,558

chloride also gets concentrated and and

5583

07:34:51,350 --> 07:34:48,900

separated and so you get these

5584

07:34:53,868 --> 07:34:51,360

um these really sodium chloride

5585

07:34:55,368 --> 07:34:53,878

concentrated uh regions and magnesium

5586

07:34:57,410 --> 07:34:55,378

concentrated magnesium chloride

5587

07:34:59,930 --> 07:34:57,420

concentrated regions and then you also

5588

07:35:02,270 --> 07:34:59,940

have uh regions which are a lot more

5589

07:35:03,890 --> 07:35:02,280

like seawater and so

5590

07:35:05,330 --> 07:35:03,900

um that's South Bay salt works that's

5591

07:35:07,368 --> 07:35:05,340

one of the sites I'll be talking about a

5592

07:35:08,270 --> 07:35:07,378

lot today and what we're investigating

5593

07:35:10,490 --> 07:35:08,280

there

5594

07:35:12,830 --> 07:35:10,500

um with oceans across space and time uh

5595

07:35:15,350 --> 07:35:12,840

is can bioeignature molecules be

5596

07:35:18,230 --> 07:35:15,360

detected in these sites um with these

5597

07:35:20,150 --> 07:35:18,240

super high salinities and uh then how

5598

07:35:24,770 --> 07:35:20,160

does that input impact our search for

5599

07:35:26,690 --> 07:35:24,780

life elsewhere and um then how do these

5600

07:35:28,368 --> 07:35:26,700

vary with things like water activity and

5601
07:35:30,530 --> 07:35:28,378
ion concentration

5602
07:35:32,090 --> 07:35:30,540
and then here's another analog site in

5603
07:35:33,530 --> 07:35:32,100
Western Australia this is Lake Campion

5604
07:35:34,670 --> 07:35:33,540
which is a very interesting site that we

5605
07:35:36,830 --> 07:35:34,680
looked at

5606
07:35:40,250 --> 07:35:36,840
um and uh so these are transient lakes

5607
07:35:42,230 --> 07:35:40,260
and so uh they um they evaporate during

5608
07:35:44,208 --> 07:35:42,240
the drier warmer months and then they

5609
07:35:46,010 --> 07:35:44,218
fill up during the winter months and so

5610
07:35:48,890 --> 07:35:46,020
you get these salt crusts which build up

5611
07:35:50,990 --> 07:35:48,900
on the bottom of them and so uh these

5612
07:35:52,850 --> 07:35:51,000
are really interesting because uh the

5613
07:35:54,230 --> 07:35:52,860

the evaporation process is happening

5614

07:35:55,250 --> 07:35:54,240

very actively so we can get a modern

5615

07:35:57,530 --> 07:35:55,260

look

5616

07:35:58,968 --> 07:35:57,540

um at what's happening there and so in

5617

07:36:00,890 --> 07:35:58,978

general analog sites can give us

5618

07:36:02,990 --> 07:36:00,900

training grounds for robotic exploration

5619

07:36:05,628 --> 07:36:03,000

on other planets they can help us test

5620

07:36:09,350 --> 07:36:05,638

our instruments and uh particularly we

5621

07:36:13,250 --> 07:36:09,360

want to know how salt and acid acidic uh

5622

07:36:15,468 --> 07:36:13,260

um low PH environments affect our uh our

5623

07:36:17,510 --> 07:36:15,478

instruments and then it can give us

5624

07:36:19,730 --> 07:36:17,520

insight into the environmental processes

5625

07:36:22,910 --> 07:36:19,740

and the biology happening there

5626
07:36:25,490 --> 07:36:22,920
and so uh now I'm going to uh shout out

5627
07:36:26,930 --> 07:36:25,500
uh Luke Fisher's review paper in

5628
07:36:28,490 --> 07:36:26,940
environmental microbiology where he

5629
07:36:31,070 --> 07:36:28,500
talks all about the bioeignature

5630
07:36:32,990 --> 07:36:31,080
preservation in brines particularly in

5631
07:36:35,208 --> 07:36:33,000
deep hyper saline anoxic basins which I

5632
07:36:36,830 --> 07:36:35,218
won't be talking about today but when it

5633
07:36:39,110 --> 07:36:36,840
comes to brines themselves as opposed to

5634
07:36:41,990 --> 07:36:39,120
evaporates or salt crystals

5635
07:36:44,570 --> 07:36:42,000
um we know that DNA and RNA are well

5636
07:36:47,510 --> 07:36:44,580
preserved while mRNA is not as well

5637
07:36:49,910 --> 07:36:47,520
preserved and that ATP preservation has

5638
07:36:51,530 --> 07:36:49,920

been observed by uh to ovala at all in

5639

07:36:54,230 --> 07:36:51,540

1987.

5640

07:36:57,350 --> 07:36:54,240

um but not much has been done about that

5641

07:36:59,510 --> 07:36:57,360

since then and lipid preservation is

5642

07:37:01,070 --> 07:36:59,520

being studied more and more recently and

5643

07:37:03,170 --> 07:37:01,080

so that's good but but these aren't

5644

07:37:03,770 --> 07:37:03,180

nearly as well explored

5645

07:37:07,490 --> 07:37:03,780

um

5646

07:37:08,868 --> 07:37:07,500

as genetic uh compounds and so uh one

5647

07:37:10,788 --> 07:37:08,878

compound that we're looking at ATP

5648

07:37:13,430 --> 07:37:10,798

adenosine triphosphate it's a

5649

07:37:16,788 --> 07:37:13,440

short-lived molecule and it's used in

5650

07:37:18,770 --> 07:37:16,798

astrobiology and in ecology as a marker

5651
07:37:20,448 --> 07:37:18,780
of microbial activity and so if you have

5652
07:37:21,948 --> 07:37:20,458
a lot of ATP means that a lot of

5653
07:37:24,230 --> 07:37:21,958
microbial activity is happening if you

5654
07:37:25,368 --> 07:37:24,240
don't have any microbial activity then

5655
07:37:28,610 --> 07:37:25,378
you're probably not going to have much

5656
07:37:31,850 --> 07:37:28,620
ATP but it's very highly evolved so as a

5657
07:37:33,830 --> 07:37:31,860
biosignature it might be less agnostic

5658
07:37:35,810 --> 07:37:33,840
than for example amino acids and so we

5659
07:37:38,448 --> 07:37:35,820
could look at polypeptides or we could

5660
07:37:41,030 --> 07:37:38,458
look at individual amino acids and we

5661
07:37:43,670 --> 07:37:41,040
target biological amino acids in this

5662
07:37:46,190 --> 07:37:43,680
study as well as osmolite amino acids

5663
07:37:47,868 --> 07:37:46,200

which are solute compounds that are

5664

07:37:52,430 --> 07:37:47,878

accumulated by microbes when they're

5665

07:37:54,890 --> 07:37:52,440

under high stress in hyper saline sites

5666

07:37:56,150 --> 07:37:54,900

yeah so and that's well understood in

5667

07:37:57,708 --> 07:37:56,160

the literature that these osmolites

5668

07:37:59,628 --> 07:37:57,718

exist

5669

07:38:01,788 --> 07:37:59,638

and so first I'll talk about the methods

5670

07:38:03,830 --> 07:38:01,798

that we used in in the field

5671

07:38:06,830 --> 07:38:03,840

um or near the field in the motel room

5672

07:38:08,570 --> 07:38:06,840

we uh looked for ATP using a luciferase

5673

07:38:11,510 --> 07:38:08,580

assay and so say you have a beautiful

5674

07:38:13,670 --> 07:38:11,520

Crystal uh uh from the crust of a lake

5675

07:38:15,230 --> 07:38:13,680

like this from Western Australia then

5676

07:38:18,288 --> 07:38:15,240

you take it to your Western Australia

5677

07:38:20,628 --> 07:38:18,298

motel room and you do a uh you set out

5678

07:38:23,868 --> 07:38:20,638

your samples we weigh them out we

5679

07:38:26,690 --> 07:38:23,878

extract them in hot water and then we

5680

07:38:28,730 --> 07:38:26,700

add our luciferase and luciferin and we

5681

07:38:30,830 --> 07:38:28,740

have a field portable luminometer in

5682

07:38:34,430 --> 07:38:30,840

order to do our analyzes

5683

07:38:36,770 --> 07:38:34,440

and so that's how we uh quantify ATP

5684

07:38:39,230 --> 07:38:36,780

and moving on to what we do at Georgia

5685

07:38:41,570 --> 07:38:39,240

Tech when we bring the samples home so

5686

07:38:43,250 --> 07:38:41,580

uh I was so glad to hear that uh another

5687

07:38:44,750 --> 07:38:43,260

uh person here was using capillary

5688

07:38:47,090 --> 07:38:44,760

electrophoresis so I don't need to

5689

07:38:49,010 --> 07:38:47,100

explain it in its entirety again but um

5690

07:38:50,390 --> 07:38:49,020

it's a separation method that uh in our

5691

07:38:52,368 --> 07:38:50,400

lab we pair with laser-induced

5692

07:38:53,990 --> 07:38:52,378

fluorescence and so laser-induced

5693

07:38:56,330 --> 07:38:54,000

fluorescence mean means that we're

5694

07:38:59,090 --> 07:38:56,340

tagging our amino acids our compounds of

5695

07:39:01,548 --> 07:38:59,100

Interest with a fluorescent dye so we're

5696

07:39:03,708 --> 07:39:01,558

targeting specific compounds

5697

07:39:05,208 --> 07:39:03,718

um and so this is a targeted technique

5698

07:39:08,510 --> 07:39:05,218

which has very low limits of detection

5699

07:39:11,750 --> 07:39:08,520

and very high sensitivity and so

5700

07:39:13,128 --> 07:39:11,760

um we did this at South Bay saltworks on

5701

07:39:15,948 --> 07:39:13,138

one of the samples that has a water

5702

07:39:18,110 --> 07:39:15,958

activity of below 0.4 and magnesium

5703

07:39:20,448 --> 07:39:18,120

concentration of more than four molar

5704

07:39:23,090 --> 07:39:20,458

and uh this is only a one to ten

5705

07:39:26,570 --> 07:39:23,100

dilution so using a method that

5706

07:39:29,868 --> 07:39:26,580

um Marshall Seton and I developed uh we

5707

07:39:32,510 --> 07:39:29,878

got the concentration of amino acids in

5708

07:39:34,430 --> 07:39:32,520

this sample down to tens of nanomolar

5709

07:39:36,410 --> 07:39:34,440

the limits of detection for this method

5710

07:39:38,330 --> 07:39:36,420

General are in the tense of picomolar

5711

07:39:39,650 --> 07:39:38,340

and we did this using a commercial

5712

07:39:40,250 --> 07:39:39,660

instrument

5713

07:39:41,930 --> 07:39:40,260

um

5714

07:39:44,628 --> 07:39:41,940

and again it was only a one to ten

5715

07:39:46,610 --> 07:39:44,638

dilution for this uh hyper saline uh

5716

07:39:48,770 --> 07:39:46,620

sample so we were delighted that uh the

5717

07:39:51,410 --> 07:39:48,780

results came out like this and then for

5718

07:39:53,750 --> 07:39:51,420

an untargeted analysis we can use uh

5719

07:39:55,610 --> 07:39:53,760

microchip capillary electrophoresis

5720

07:39:58,610 --> 07:39:55,620

paired with uh high resolution Mass

5721

07:40:00,230 --> 07:39:58,620

spectrometry so if we take the same

5722

07:40:02,330 --> 07:40:00,240

sample and we look at it using an

5723

07:40:05,390 --> 07:40:02,340

untargeted method where we can get the

5724

07:40:07,788 --> 07:40:05,400

master charge ratio of the compounds

5725

07:40:09,530 --> 07:40:07,798

that we're interested in then uh

5726
07:40:13,310 --> 07:40:09,540
combining the zip chip commercial setup

5727
07:40:14,628 --> 07:40:13,320
with a thermal Q exactive orbitrap we

5728
07:40:18,530 --> 07:40:14,638
this is what the chip looks like it's

5729
07:40:20,990 --> 07:40:18,540
very cute uh we get a very interesting

5730
07:40:24,110 --> 07:40:21,000
set of compounds which we didn't

5731
07:40:27,110 --> 07:40:24,120
necessarily Target and so

5732
07:40:29,810 --> 07:40:27,120
uh moving back to the LIF analyzes for

5733
07:40:31,490 --> 07:40:29,820
the results what we first observed was

5734
07:40:33,530 --> 07:40:31,500
that as we increase in magnesium

5735
07:40:35,750 --> 07:40:33,540
concentration and decrease in water

5736
07:40:38,930 --> 07:40:35,760
activity and increase in chaotropicity

5737
07:40:41,448 --> 07:40:38,940
we get a significant increase in the

5738
07:40:43,730 --> 07:40:41,458

dissolved free primary amines that we

5739

07:40:45,230 --> 07:40:43,740

were targeting and so that would be our

5740

07:40:48,110 --> 07:40:45,240

biological amino acids which you've

5741

07:40:49,968 --> 07:40:48,120

identified here and as you go up you

5742

07:40:52,310 --> 07:40:49,978

have higher magnesium sites and we have

5743

07:40:54,110 --> 07:40:52,320

a lot higher Peaks and we also have a

5744

07:40:57,468 --> 07:40:54,120

lot higher values for Quantified amino

5745

07:41:00,170 --> 07:40:57,478

acids and so we attribute this to evapo

5746

07:41:01,490 --> 07:41:00,180

concentration as the sites which have a

5747

07:41:03,048 --> 07:41:01,500

lot of water and a lot of salt and then

5748

07:41:04,850 --> 07:41:03,058

evaporate and leave the salts and the

5749

07:41:07,070 --> 07:41:04,860

Organics behind the concentration is

5750

07:41:09,468 --> 07:41:07,080

higher so that's pretty straightforward

5751
07:41:11,628 --> 07:41:09,478
and simple but it is very useful in the

5752
07:41:14,150 --> 07:41:11,638
case where we're looking at very low

5753
07:41:17,090 --> 07:41:14,160
biomass regions so

5754
07:41:19,368 --> 07:41:17,100
next we then put it in micro microchip

5755
07:41:21,530 --> 07:41:19,378
cems and we looked for these same

5756
07:41:23,990 --> 07:41:21,540
compounds and we found a lot of them

5757
07:41:26,628 --> 07:41:24,000
there and so you can see histidine

5758
07:41:29,030 --> 07:41:26,638
Glycine alanine isoleucine and leucine

5759
07:41:32,030 --> 07:41:29,040
are resolved there serine

5760
07:41:34,010 --> 07:41:32,040
Etc et cetera glutamic and aspartic acid

5761
07:41:35,868 --> 07:41:34,020
um and this was only a one to four

5762
07:41:37,128 --> 07:41:35,878
dilution of that same sample so we were

5763
07:41:40,010 --> 07:41:37,138

really delighted by these results as

5764

07:41:42,110 --> 07:41:40,020

well and in the same separation just um

5765

07:41:45,230 --> 07:41:42,120

looking at different traces different M

5766

07:41:48,288 --> 07:41:45,240

over Z's we see a couple polypeptides

5767

07:41:51,110 --> 07:41:48,298

and we see some adenine and guanidine in

5768

07:41:52,850 --> 07:41:51,120

there as well uh and so these are things

5769

07:41:54,830 --> 07:41:52,860

that we didn't necessarily look for in

5770

07:41:56,868 --> 07:41:54,840

the celif but now that we're combining

5771

07:41:58,128 --> 07:41:56,878

it with an untargeted method we can we

5772

07:42:00,110 --> 07:41:58,138

can get a look at some more compounds

5773

07:42:02,208 --> 07:42:00,120

that we didn't necessarily expect

5774

07:42:04,128 --> 07:42:02,218

and then also osmolites which we did

5775

07:42:05,990 --> 07:42:04,138

expect and did want to look for we found

5776
07:42:09,230 --> 07:42:06,000
those like ornithine sarcosine and

5777
07:42:10,788 --> 07:42:09,240
betaine in our samples with very high

5778
07:42:13,128 --> 07:42:10,798
salt stress being applied to any of the

5779
07:42:15,410 --> 07:42:13,138
microbes that were alive there

5780
07:42:17,208 --> 07:42:15,420
um and and so these are there in

5781
07:42:19,850 --> 07:42:17,218
significant quantity

5782
07:42:21,170 --> 07:42:19,860
and in Western Australia uh briefly I'll

5783
07:42:23,448 --> 07:42:21,180
just show you some preliminary results

5784
07:42:25,430 --> 07:42:23,458
this is Lake Brown which has a sodium

5785
07:42:29,090 --> 07:42:25,440
concentration of near five molar and a

5786
07:42:30,770 --> 07:42:29,100
water activity of 0.89 so not nearly as

5787
07:42:32,750 --> 07:42:30,780
low water activity as the South Bay

5788
07:42:34,070 --> 07:42:32,760

saltwork sample I just showed you

5789

07:42:35,810 --> 07:42:34,080

um but it has high relative

5790

07:42:37,788 --> 07:42:35,820

concentrations of a lot of these

5791

07:42:41,510 --> 07:42:37,798

compounds including the osmolite

5792

07:42:43,010 --> 07:42:41,520

compound baiting and some lower

5793

07:42:45,110 --> 07:42:43,020

concentrations of other compounds

5794

07:42:47,990 --> 07:42:45,120

including a polypeptide

5795

07:42:50,570 --> 07:42:48,000

and then conversely at Lake Gunter which

5796

07:42:53,390 --> 07:42:50,580

has a higher water activity and a lower

5797

07:42:55,490 --> 07:42:53,400

sodium concentration we see that there

5798

07:42:57,230 --> 07:42:55,500

really isn't any easy way to detect

5799

07:42:58,548 --> 07:42:57,240

those organic compounds with with the

5800

07:43:00,890 --> 07:42:58,558

method that we're using right now so

5801
07:43:03,288 --> 07:43:00,900
just diluting these samples so perhaps

5802
07:43:04,430 --> 07:43:03,298
this indicates that the uh and of course

5803
07:43:06,468 --> 07:43:04,440
there's only two data points with

5804
07:43:07,788 --> 07:43:06,478
Western Australia but you know looking

5805
07:43:09,830 --> 07:43:07,798
at the what we found at South Bay

5806
07:43:11,930 --> 07:43:09,840
saltworks perhaps these saltier sites

5807
07:43:13,788 --> 07:43:11,940
are actually places where it might be

5808
07:43:15,350 --> 07:43:13,798
easier to detect biomolecules because of

5809
07:43:18,368 --> 07:43:15,360
evapo concentration

5810
07:43:20,690 --> 07:43:18,378
and we also want to look at the

5811
07:43:23,030 --> 07:43:20,700
normalized abundance of certain amino

5812
07:43:25,368 --> 07:43:23,040
acids just to see what sort of patterns

5813
07:43:27,530 --> 07:43:25,378

we could find and if we have water

5814

07:43:30,288 --> 07:43:27,540

activity increasing from left to right

5815

07:43:32,150 --> 07:43:30,298

here with the Magnesium sites here we

5816

07:43:35,090 --> 07:43:32,160

see that certain amino acids are upright

5817

07:43:37,910 --> 07:43:35,100

regulated in this magnesium heavy site

5818

07:43:40,430 --> 07:43:37,920

and others are down regulated

5819

07:43:43,430 --> 07:43:40,440

and with that information we decided

5820

07:43:46,070 --> 07:43:43,440

maybe we could classify our sites based

5821

07:43:48,110 --> 07:43:46,080

on the amino acid distribution so if you

5822

07:43:50,030 --> 07:43:48,120

take the distribution in you put in a

5823

07:43:52,548 --> 07:43:50,040

classifier either logistic regression or

5824

07:43:54,288 --> 07:43:52,558

random Forest you could get out one of

5825

07:43:56,150 --> 07:43:54,298

these three different site types and

5826

07:43:57,890 --> 07:43:56,160

this is a small data set and more of a

5827

07:43:59,570 --> 07:43:57,900

proof of concept than anything but it's

5828

07:44:01,788 --> 07:43:59,580

interesting to see that we have a very

5829

07:44:05,090 --> 07:44:01,798

good area under the curve of you know 1

5830

07:44:06,948 --> 07:44:05,100

or 0.83 which uh and and we also can see

5831

07:44:09,590 --> 07:44:06,958

which compounds are driving that the

5832

07:44:11,930 --> 07:44:09,600

most and so that's an interesting thing

5833

07:44:13,730 --> 07:44:11,940

to take note of that might be used in

5834

07:44:14,868 --> 07:44:13,740

the future if we have much larger data

5835

07:44:16,548 --> 07:44:14,878

sets

5836

07:44:20,570 --> 07:44:16,558

and so the last thing I wanted to talk

5837

07:44:22,430 --> 07:44:20,580

about ATP if you remember so uh on the

5838

07:44:24,468 --> 07:44:22,440

x-axis here's a magnesium concentration

5839

07:44:26,150 --> 07:44:24,478

and then we have three y axes because

5840

07:44:28,190 --> 07:44:26,160

why not and

5841

07:44:30,468 --> 07:44:28,200

um uh first of all I want to mention the

5842

07:44:33,288 --> 07:44:30,478

cell counts by microscopy which is uh

5843

07:44:35,690 --> 07:44:33,298

from Ben klempe uh showed that the

5844

07:44:37,190 --> 07:44:35,700

number of active cells in these sites go

5845

07:44:39,410 --> 07:44:37,200

down as you get to the super high

5846

07:44:40,310 --> 07:44:39,420

magnesium concentration regions which is

5847

07:44:42,530 --> 07:44:40,320

also

5848

07:44:46,070 --> 07:44:42,540

um what Emily showed in her talk and so

5849

07:44:48,530 --> 07:44:46,080

uh what we then can look at is the ATP

5850

07:44:52,190 --> 07:44:48,540

concentration which strangely goes up

5851
07:44:54,230 --> 07:44:52,200
even as the concentration of active

5852
07:44:56,090 --> 07:44:54,240
cells goes down and the expected

5853
07:44:58,910 --> 07:44:56,100
activity goes down and so we wondered

5854
07:45:01,490 --> 07:44:58,920
why is that happening because

5855
07:45:02,930 --> 07:45:01,500
um as we know the amino acids are

5856
07:45:04,490 --> 07:45:02,940
concentrating but amino acids don't

5857
07:45:06,830 --> 07:45:04,500
Decay on really short time scales

5858
07:45:10,368 --> 07:45:06,840
they're not broken up by hydrolysis or

5859
07:45:12,590 --> 07:45:10,378
by atpase enzymes but

5860
07:45:14,208 --> 07:45:12,600
we think is that something must be

5861
07:45:18,948 --> 07:45:14,218
driving this and if it's not of Apple

5862
07:45:20,930 --> 07:45:18,958
concentration uh well uh we're wondering

5863
07:45:25,070 --> 07:45:20,940

you know since the ATP hydrolysis rate

5864

07:45:27,770 --> 07:45:25,080

is uh much quicker than the evapo

5865

07:45:29,270 --> 07:45:27,780

concentration rate uh why would the ATP

5866

07:45:31,250 --> 07:45:29,280

accumulate doesn't really make much

5867

07:45:33,890 --> 07:45:31,260

sense but perhaps

5868

07:45:35,868 --> 07:45:33,900

it's being preserved so this to ovala at

5869

07:45:38,810 --> 07:45:35,878

all paper from 1987 that I mentioned way

5870

07:45:41,930 --> 07:45:38,820

earlier uh they found that ATP was

5871

07:45:44,390 --> 07:45:41,940

preserved in low water activity sites

5872

07:45:46,968 --> 07:45:44,400

and so that could be preventing the

5873

07:45:49,670 --> 07:45:46,978

enzymatic uh and natural hydrolysis of

5874

07:45:52,968 --> 07:45:49,680

ATP leaving it to uh persist in the

5875

07:45:54,770 --> 07:45:52,978

solution and additionally it could also

5876
07:45:56,868 --> 07:45:54,780
be used as an osmolite compound as well

5877
07:45:59,270 --> 07:45:56,878
and be accumulated by those

5878
07:46:02,208 --> 07:45:59,280
microorganisms before they end up in a

5879
07:46:03,948 --> 07:46:02,218
super high magnesium site and not very

5880
07:46:06,830 --> 07:46:03,958
active themselves

5881
07:46:09,830 --> 07:46:06,840
so in conclusion we can detect

5882
07:46:12,110 --> 07:46:09,840
biosignatures at micromolar

5883
07:46:15,770 --> 07:46:12,120
concentrations in near saturation brines

5884
07:46:18,230 --> 07:46:15,780
using celif and microce Ms

5885
07:46:19,968 --> 07:46:18,240
and amino acid distribution ratios can

5886
07:46:21,048 --> 07:46:19,978
be well classified based on their brine

5887
07:46:23,570 --> 07:46:21,058
type

5888
07:46:25,368 --> 07:46:23,580

and osmolites are present and detectable

5889

07:46:27,708 --> 07:46:25,378

in some but not all of the South Bay

5890

07:46:29,930 --> 07:46:27,718

saltworks in Western Australia Brines

5891

07:46:32,750 --> 07:46:29,940

and we found preservation of ATP at

5892

07:46:35,270 --> 07:46:32,760

South Bay saltworks and so

5893

07:46:37,070 --> 07:46:35,280

um basically my argument is then why

5894

07:46:38,510 --> 07:46:37,080

don't we follow the salt and see if we

5895

07:46:41,450 --> 07:46:38,520

can find biosignatures there on other

5896

07:46:47,448 --> 07:46:41,460

worlds so thanks for listening

5897

07:46:49,430 --> 07:46:47,458

[Applause]

5898

07:47:01,250 --> 07:46:49,440

thank you Chad we have time for two

5899

07:47:05,868 --> 07:47:03,468

Chad thank you for the talk um that was

5900

07:47:08,810 --> 07:47:05,878

a beautiful separation that you showed

5901
07:47:12,530 --> 07:47:08,820
uh showed earlier and so I'm I'm curious

5902
07:47:16,430 --> 07:47:12,540
uh you did a connotation of amino acids

5903
07:47:20,330 --> 07:47:16,440
using self method and it looks like

5904
07:47:22,090 --> 07:47:20,340
you've done some work using cems have

5905
07:47:26,510 --> 07:47:22,100
you tried uh

5906
07:47:29,750 --> 07:47:26,520
quantifying the amino acid content in

5907
07:47:31,610 --> 07:47:29,760
the same sites using microchip cems and

5908
07:47:33,530 --> 07:47:31,620
seeing what those look like to try and

5909
07:47:34,968 --> 07:47:33,540
like cross validate both methods and the

5910
07:47:37,010 --> 07:47:34,978
using the same sample yet or have you

5911
07:47:39,708 --> 07:47:37,020
not got to that yet nope so we just

5912
07:47:42,288 --> 07:47:39,718
started doing the micro CMS work over

5913
07:47:44,390 --> 07:47:42,298

the past month and so we're really happy

5914

07:47:46,490 --> 07:47:44,400

how it's been doing with qualitative

5915

07:47:48,410 --> 07:47:46,500

untargeted work but we haven't gone into

5916

07:47:49,448 --> 07:47:48,420

quantitative because the ion suppression

5917

07:47:52,190 --> 07:47:49,458

effects

5918

07:47:53,690 --> 07:47:52,200

might be a bit of a challenge to

5919

07:47:55,310 --> 07:47:53,700

overcome so that'll probably be a little

5920

07:47:56,930 --> 07:47:55,320

bit of a longer project what we have

5921

07:48:00,048 --> 07:47:56,940

done to try to corroborate the amino

5922

07:48:02,390 --> 07:48:00,058

acid concentrations is look at the

5923

07:48:04,610 --> 07:48:02,400

expression of um or not the expression

5924

07:48:08,810 --> 07:48:04,620

rather but the presence of certain

5925

07:48:10,968 --> 07:48:08,820

proteins in the genetic code of the

5926

07:48:13,968 --> 07:48:10,978

microbes that are were found to be

5927

07:48:16,128 --> 07:48:13,978

present here by other uh host

5928

07:48:16,730 --> 07:48:16,138

collaborators and

5929

07:48:19,070 --> 07:48:16,740

um

5930

07:48:20,750 --> 07:48:19,080

we find a moderate correlation between

5931

07:48:23,270 --> 07:48:20,760

the amino acids we see and the amino

5932

07:48:25,010 --> 07:48:23,280

acids that they see but since we don't

5933

07:48:26,810 --> 07:48:25,020

have transcriptomes from all these sites

5934

07:48:28,548 --> 07:48:26,820

we don't know exactly what proteins are

5935

07:48:31,448 --> 07:48:28,558

being made and so I think that's the

5936

07:48:33,468 --> 07:48:31,458

next step is is to connect those from

5937

07:48:35,990 --> 07:48:33,478

metabolomics to transcriptomics to

5938

07:48:43,250 --> 07:48:36,000

genomics just as the talk last night uh

5939

07:48:43,260 --> 07:48:54,288

any last question for Chad

5940

07:48:58,250 --> 07:48:56,090

um I have a two question actually oh

5941

07:49:01,310 --> 07:48:58,260

maybe I didn't really catch you what's a

5942

07:49:03,170 --> 07:49:01,320

pH of the site that you show the

5943

07:49:05,208 --> 07:49:03,180

Magnesium concentration is more than

5944

07:49:06,590 --> 07:49:05,218

four molar that's a great question I

5945

07:49:07,850 --> 07:49:06,600

don't know off the top of my head but I

5946

07:49:09,230 --> 07:49:07,860

can get back to you in a moment yeah

5947

07:49:11,750 --> 07:49:09,240

okay

5948

07:49:13,510 --> 07:49:11,760

um and also how would you determine your

5949

07:49:16,250 --> 07:49:13,520

atp's

5950

07:49:19,430 --> 07:49:16,260

accumulated or protected under high

5951

07:49:22,368 --> 07:49:19,440

selling water or like low water activity

5952

07:49:25,930 --> 07:49:22,378

how did I sorry say again how did I how

5953

07:49:28,610 --> 07:49:25,940

do you know that your ATP non-hydrolysis

5954

07:49:31,250 --> 07:49:28,620

so yeah I don't know that it's not

5955

07:49:33,590 --> 07:49:31,260

hydrolyzed necessarily but I am

5956

07:49:37,070 --> 07:49:33,600

predicting that so the the typical

5957

07:49:38,330 --> 07:49:37,080

destruction method of ATP uh either in

5958

07:49:40,730 --> 07:49:38,340

the cell or in the environment is

5959

07:49:44,570 --> 07:49:40,740

through hydrolysis either performed by

5960

07:49:47,030 --> 07:49:44,580

proteins or just um happening naturally

5961

07:49:49,548 --> 07:49:47,040

in the environment with water and so

5962

07:49:53,090 --> 07:49:49,558

those are the those are the things that

5963

07:49:54,110 --> 07:49:53,100

must uh from what I'm observing have

5964

07:49:57,468 --> 07:49:54,120

been stopped

5965

07:50:00,048 --> 07:49:57,478

if the ATP is going to persist so long

5966

07:50:01,368 --> 07:50:00,058

for it to be evapo concentrated to those

5967

07:50:03,770 --> 07:50:01,378

high of levels

5968

07:50:06,048 --> 07:50:03,780

um the huge Spike there likely wouldn't

5969

07:50:09,110 --> 07:50:06,058

have been possible if of Apple

5970

07:50:12,230 --> 07:50:09,120

concentration weren't a component and so

5971

07:50:15,230 --> 07:50:12,240

um you know unless uh the uh the

5972

07:50:17,388 --> 07:50:15,240

osmolite effect is is uh so much more

5973

07:50:19,190 --> 07:50:17,398

significant than I had thought

5974

07:50:21,948 --> 07:50:19,200

um that could be another reason but I

5975

07:50:25,250 --> 07:50:21,958

still think that uh the the preservation

5976

07:50:28,610 --> 07:50:25,260

of ATP is yeah is linked to the the lack

5977

07:50:31,670 --> 07:50:28,620

of a um a rapid breakdown mechanism uh

5978

07:50:32,650 --> 07:50:31,680

have you ever considered that ATP with

5979

07:50:35,510 --> 07:50:32,660

um

5980

07:50:37,610 --> 07:50:35,520

form some nanostructures to make the

5981

07:50:40,010 --> 07:50:37,620

things happen yeah so whether it

5982

07:50:43,190 --> 07:50:40,020

stabilizes it in some way the yeah so

5983

07:50:44,690 --> 07:50:43,200

I've I don't honestly know much about

5984

07:50:46,430 --> 07:50:44,700

how it would investigate that I've

5985

07:50:48,530 --> 07:50:46,440

spoken to someone recently about um

5986

07:50:52,310 --> 07:50:48,540

potentially modeling it uh using

5987

07:50:54,650 --> 07:50:52,320

molecular Dynamics but uh I haven't you

5988

07:50:56,388 --> 07:50:54,660

know waded into the um you know the

5989

07:50:58,548 --> 07:50:56,398

actual uh

5990

07:50:59,750 --> 07:50:58,558

the structural chemistry of whether of

5991

07:51:01,850 --> 07:50:59,760

whether that would happen but if you

5992

07:51:07,610 --> 07:51:01,860

have any ideas I'd love to hear so

5993

07:51:07,620 --> 07:51:10,670

foreign

5994

07:51:13,548 --> 07:51:12,770

okay so that concludes all the talks for

5995

07:51:16,190 --> 07:51:13,558

today

5996

07:51:17,448 --> 07:51:16,200

um we have a extended poster session so

5997

07:51:18,708 --> 07:51:17,458

it's a little bit longer than the others

5998

07:51:20,690 --> 07:51:18,718

because we have some excellent local

5999

07:51:23,570 --> 07:51:20,700

undergrads that you'll find outside in

6000

07:51:25,548 --> 07:51:23,580

the back patio and thanks to a group at

6001
07:51:27,948 --> 07:51:25,558
upper campus the cosmic tours we have an

6002
07:51:30,948 --> 07:51:27,958
indoor planetarium that's a few doors

6003
07:51:32,930 --> 07:51:30,958
down Miguel just posted a little map of

6004
07:51:34,310 --> 07:51:32,940
where it is so we encourage you like

6005
07:51:36,170 --> 07:51:34,320
throughout the poster session see if you

6006
07:51:38,510 --> 07:51:36,180
can get in there I think it's about a 20

6007
07:51:39,770 --> 07:51:38,520
minute tour or so

6008
07:51:41,388 --> 07:51:39,780
um and besides that we're all going to

6009
07:51:43,070 --> 07:51:41,398
meet at Shore Rider at seven o'clock

6010
07:51:44,930 --> 07:51:43,080
that's when we'll start serving dinner

6011
07:51:46,910 --> 07:51:44,940
and then trivia will start right at

6012
07:51:48,350 --> 07:51:46,920
eight so just feel free to relax the

6013
07:51:50,330 --> 07:51:48,360

hotel or something before

6014

07:51:51,770 --> 07:51:50,340

and then let Miguel or I know if you

6015

07:51:57,320 --> 07:51:51,780

have any any questions or concerns

6016

07:52:28,910 --> 07:52:20,860

[Music]