



1  
00:00:00,790 --> 00:00:07,320

[Music]

2  
00:00:12,920 --> 00:00:09,580

[Applause]

3  
00:00:15,410 --> 00:00:12,930

time and again we have been bowled over

4  
00:00:17,900 --> 00:00:15,420

by the indescribable foreignness of

5  
00:00:19,430 --> 00:00:17,910

other worlds and I wanted to take a few

6  
00:00:22,609 --> 00:00:19,440

minutes this morning just to talk about

7  
00:00:26,359 --> 00:00:22,619

the idea of looking for life as we don't

8  
00:00:28,819 --> 00:00:26,369

know it so picking up where Dave left

9  
00:00:30,700 --> 00:00:28,829

off I would argue that looking for life

10  
00:00:33,140 --> 00:00:30,710

as we do know it has been a terrific

11  
00:00:36,050 --> 00:00:33,150

starting point as we've gotten our feet

12  
00:00:38,030 --> 00:00:36,060

wet with astrobiology especially for a

13  
00:00:40,250 --> 00:00:38,040

planet like Mars we're never gonna find

14

00:00:42,349 --> 00:00:40,260

another planet more similar to earth in

15

00:00:44,510 --> 00:00:42,359

the solar system Mars and Earth had

16

00:00:46,819 --> 00:00:44,520

these thick carbon dioxide atmospheres

17

00:00:49,819 --> 00:00:46,829

protective magnetic fields silicate

18

00:00:51,830 --> 00:00:49,829

crust at least some episodic water early

19

00:00:54,410 --> 00:00:51,840

in their histories around the time life

20

00:00:56,779 --> 00:00:54,420

was getting started here on earth and we

21

00:00:59,000 --> 00:00:56,789

know that up to a billion tons of rocks

22

00:01:00,619 --> 00:00:59,010

were likely exchanged early in the

23

00:01:02,060 --> 00:01:00,629

histories and there's a possibility that

24

00:01:04,610 --> 00:01:02,070

we could have just kind of caught life

25

00:01:06,520 --> 00:01:04,620

from the next planet over that life on

26

00:01:10,640 --> 00:01:06,530

earth and life on Mars might be

27

00:01:12,740 --> 00:01:10,650

ancestrally related and we've developed

28

00:01:15,200 --> 00:01:12,750

as Dave mentioned these really robust

29

00:01:16,249 --> 00:01:15,210

approaches for Terran life detection we

30

00:01:18,880 --> 00:01:16,259

know how to look for these

31

00:01:21,679 --> 00:01:18,890

well-established widely accepted

32

00:01:23,870 --> 00:01:21,689

identified NT fires of biologic

33

00:01:26,179 --> 00:01:23,880

processes and because we're starting

34

00:01:28,580 --> 00:01:26,189

with what we know it's a lot easier to

35

00:01:31,010 --> 00:01:28,590

interpret the data we've got signals

36

00:01:32,780 --> 00:01:31,020

that can be very rich and information

37

00:01:34,999 --> 00:01:32,790

and importantly I think we have much

38

00:01:37,850 --> 00:01:35,009

stronger understanding of taphonomy what

39

00:01:39,590 --> 00:01:37,860

happens when an organism dies you know

40

00:01:41,030 --> 00:01:39,600

we might not find a dinosaur in the

41

00:01:43,580 --> 00:01:41,040

rocky mountains but we don't have to

42

00:01:45,730 --> 00:01:43,590

because we can find a dinosaur bone and

43

00:01:48,260 --> 00:01:45,740

the same thing is true with molecular

44

00:01:50,359 --> 00:01:48,270

fossilization we can even if we lose a

45

00:01:55,039 --> 00:01:50,369

bunch of functional groups we can still

46

00:01:58,100 --> 00:01:55,049

identify what was once there but as we

47

00:01:59,569 --> 00:01:58,110

expand deeper into the solar system I

48

00:02:01,819 --> 00:01:59,579

think it's really important that we're

49

00:02:04,100 --> 00:02:01,829

thinking about these new targets and the

50

00:02:06,289 --> 00:02:04,110

possibilities for life there and the

51  
00:02:08,600 --> 00:02:06,299  
ideas of developing tools and techniques

52  
00:02:09,740 --> 00:02:08,610  
that that go beyond just life as we know

53  
00:02:12,620 --> 00:02:09,750  
it I think are gonna be especially

54  
00:02:14,660 --> 00:02:12,630  
important we've got a whole bevy of new

55  
00:02:16,610 --> 00:02:14,670  
moons that we are suddenly able to

56  
00:02:19,040 --> 00:02:16,620  
target much more sophisticated ly with

57  
00:02:20,220 --> 00:02:19,050  
these new solar propulsion technologies

58  
00:02:23,400 --> 00:02:20,230  
huge rockets

59  
00:02:25,949 --> 00:02:23,410  
the SLS and when we think about you know

60  
00:02:28,320 --> 00:02:25,959  
what might the same molecular building

61  
00:02:30,509 --> 00:02:28,330  
blocks of life in a world like Titan

62  
00:02:31,860 --> 00:02:30,519  
look like where water's not even your

63  
00:02:33,839 --> 00:02:31,870

solvent you know you've got these

64

00:02:37,410 --> 00:02:33,849

hydrocarbon lakes as seen in this

65

00:02:41,220 --> 00:02:37,420

Cassini radar image we just need to

66

00:02:43,380 --> 00:02:41,230

think broader so NASA is recently funded

67

00:02:45,509 --> 00:02:43,390

through its astrobiology program a team

68

00:02:48,600 --> 00:02:45,519

of investigators called the laboratory

69

00:02:50,190 --> 00:02:48,610

for agnostic bio signatures or a lab and

70

00:02:52,110 --> 00:02:50,200

I just wanted to talk through a few

71

00:02:55,440 --> 00:02:52,120

examples of the things that we're

72

00:02:57,780 --> 00:02:55,450

working on to target these agnostic bio

73

00:02:59,309 --> 00:02:57,790

signatures and just to be clear when I

74

00:03:00,839 --> 00:02:59,319

say agnostic what what I'm really

75

00:03:04,979 --> 00:03:00,849

talking about is without presupposing

76

00:03:07,559 --> 00:03:04,989

any underlying biochemistry any

77

00:03:08,789 --> 00:03:07,569

particular molecular framework so not

78

00:03:11,009 --> 00:03:08,799

necessarily life that's even

79

00:03:14,130 --> 00:03:11,019

carbon-based just thinking as broadly as

80

00:03:16,170 --> 00:03:14,140

possible and and it comes at an exciting

81

00:03:18,449 --> 00:03:16,180

time this is a report from the NASA

82

00:03:19,860 --> 00:03:18,459

Astrobiology strategy was out a few

83

00:03:22,289 --> 00:03:19,870

months ago saying you know this is a

84

00:03:25,770 --> 00:03:22,299

great time to think about research on

85

00:03:27,720 --> 00:03:25,780

novel and agnostic bio signatures kind

86

00:03:29,970 --> 00:03:27,730

of how it is we look for life as we

87

00:03:33,559 --> 00:03:29,980

don't know it how we can contend with

88

00:03:36,780 --> 00:03:33,569

the truly alien so just the doctor a few

89

00:03:40,050 --> 00:03:36,790

examples so so one idea is the safety of

90

00:03:42,300 --> 00:03:40,060

chemical complexity and as my colleague

91

00:03:44,970 --> 00:03:42,310

and lab Kelly Cronin likes to say if you

92

00:03:46,710 --> 00:03:44,980

find a 747 on the surface of Mars you

93

00:03:49,860 --> 00:03:46,720

may not know how I got there but it

94

00:03:51,660 --> 00:03:49,870

probably wasn't random and so a neat

95

00:03:53,430 --> 00:03:51,670

paper then you put out I have about a

96

00:03:55,860 --> 00:03:53,440

year and a half ago was really asking

97

00:03:58,379 --> 00:03:55,870

what's the simplest way we can instruct

98

00:04:00,569 --> 00:03:58,389

a molecule from its parts taking with

99

00:04:02,009 --> 00:04:00,579

the simplifying feature duplication

100

00:04:04,129 --> 00:04:02,019

because you can get high molecular

101  
00:04:06,390 --> 00:04:04,139  
weight polymers that aren't necessarily

102  
00:04:08,550 --> 00:04:06,400  
complex they're just repeating small

103  
00:04:13,199 --> 00:04:08,560  
subunits and so as you can see with this

104  
00:04:15,030 --> 00:04:13,209  
example biphenyl you could simplify that

105  
00:04:17,129 --> 00:04:15,040  
into a construction process that just

106  
00:04:19,199 --> 00:04:17,139  
requires six steps and you can start to

107  
00:04:21,509 --> 00:04:19,209  
explore chemical space and you can see

108  
00:04:23,850 --> 00:04:21,519  
that simple molecules like glycine can

109  
00:04:26,430 --> 00:04:23,860  
be assigned an index of four much more

110  
00:04:28,710 --> 00:04:26,440  
complicated molecules like ATP can be

111  
00:04:30,300 --> 00:04:28,720  
assigned an index of 21 so this is

112  
00:04:32,390 --> 00:04:30,310  
adding a new element or a new type of

113  
00:04:34,730 --> 00:04:32,400

bond a new feature

114

00:04:36,530 --> 00:04:34,740

um and what leads found is that there

115

00:04:39,370 --> 00:04:36,540

appears to be this threshold above which

116

00:04:42,020 --> 00:04:39,380

it's very unlikely that you don't have

117

00:04:44,150 --> 00:04:42,030

machinery biological machinery

118

00:04:46,279 --> 00:04:44,160

associated with creating that molecule

119

00:04:48,620 --> 00:04:46,289

and so that's not taking into account

120

00:04:50,810 --> 00:04:48,630

anything about what the actual chemical

121

00:04:52,189 --> 00:04:50,820

constituents of that molecule are so

122

00:04:54,529 --> 00:04:52,199

Lee's got a terrific talk about this

123

00:04:56,420 --> 00:04:54,539

Thursday morning at 11:30 for folks that

124

00:05:00,650 --> 00:04:56,430

are interested in how his algorithms are

125

00:05:03,040 --> 00:05:00,660

coming along along similar lines we're

126  
00:05:05,330 --> 00:05:03,050  
also working on this idea of molecular

127  
00:05:06,890 --> 00:05:05,340  
complementarity so one of the most

128  
00:05:08,680 --> 00:05:06,900  
exciting things I think that's happened

129  
00:05:10,670 --> 00:05:08,690  
in the world of genomics is we've had

130  
00:05:12,140 --> 00:05:10,680  
miniaturization and sequencing

131  
00:05:14,450 --> 00:05:12,150  
technologies so now we have these

132  
00:05:17,360 --> 00:05:14,460  
handheld sequencers that can only wait

133  
00:05:19,010 --> 00:05:17,370  
85 grams and draw a lot of power and you

134  
00:05:20,750 --> 00:05:19,020  
know for folks that create instruments

135  
00:05:22,909 --> 00:05:20,760  
for spacecraft this is half the battle

136  
00:05:25,700 --> 00:05:22,919  
just getting something down this small

137  
00:05:28,129 --> 00:05:25,710  
so NASA is currently funding two teams

138  
00:05:30,529 --> 00:05:28,139

through matisse and cold tech to develop

139

00:05:32,659 --> 00:05:30,539

nanopore sequencers to send into space

140

00:05:34,700 --> 00:05:32,669

they've been tested in extreme

141

00:05:36,860 --> 00:05:34,710

environments down here in Antarctica as

142

00:05:37,730 --> 00:05:36,870

well as off at the International Space

143

00:05:40,670 --> 00:05:37,740

Station

144

00:05:42,320 --> 00:05:40,680

and one thing you might say well

145

00:05:44,659 --> 00:05:42,330

sequencing that's looking for nucleic

146

00:05:45,950 --> 00:05:44,669

acids that's not agnostic you know and

147

00:05:47,540 --> 00:05:45,960

and so even though these kinds of

148

00:05:49,939 --> 00:05:47,550

technologies might be able to be used

149

00:05:52,189 --> 00:05:49,949

for non-standard bases prints you'll

150

00:05:54,589 --> 00:05:52,199

even informational polymers what we've

151

00:05:56,950 --> 00:05:54,599

been most excited on my team is about

152

00:06:00,070 --> 00:05:56,960

this idea of harnessing the power of

153

00:06:03,290 --> 00:06:00,080

sequencing to explore complexity of

154

00:06:05,420 --> 00:06:03,300

surfaces and so this is not necessarily

155

00:06:08,000 --> 00:06:05,430

looking for any life that has nucleic

156

00:06:11,149 --> 00:06:08,010

acids involved but the idea is that you

157

00:06:13,550 --> 00:06:11,159

could take libraries of millions of

158

00:06:15,529 --> 00:06:13,560

randomly generated short oligos so

159

00:06:18,170 --> 00:06:15,539

strands of DNA and RNA there were just

160

00:06:20,450 --> 00:06:18,180

3050 base pairs in length and they'll

161

00:06:22,670 --> 00:06:20,460

naturally curl up and have secondary and

162

00:06:26,600 --> 00:06:22,680

tertiary structures and they'll bind to

163

00:06:28,159 --> 00:06:26,610

a wide variety of analytes and so we're

164

00:06:31,460 --> 00:06:28,169

talking about peptides and proteins

165

00:06:33,469 --> 00:06:31,470

small organics inorganics like mineral

166

00:06:35,480 --> 00:06:33,479

surfaces of course from the RNA world we

167

00:06:38,330 --> 00:06:35,490

know RNAi sticks to montmorillonite and

168

00:06:39,830 --> 00:06:38,340

even metals and they'll bind with the

169

00:06:43,670 --> 00:06:39,840

same sort of specificities and

170

00:06:45,110 --> 00:06:43,680

affinities as antibodies and so the idea

171

00:06:48,140 --> 00:06:45,120

if you can just imagine

172

00:06:50,840 --> 00:06:48,150

simple sort of end member say you have a

173

00:06:53,150 --> 00:06:50,850

simple little mineral grain versus a

174

00:06:54,980 --> 00:06:53,160

cell and even the most primitive cell on

175

00:06:57,409 --> 00:06:54,990

earth contains a vast amount of

176

00:06:59,570 --> 00:06:57,419

information patterned on its surface if

177

00:07:02,090 --> 00:06:59,580

you were to incubate with libraries of

178

00:07:04,730 --> 00:07:02,100

millions randomly generated oligos some

179

00:07:07,250 --> 00:07:04,740

very very small proportion of those

180

00:07:09,290 --> 00:07:07,260

would bind and they bind again with

181

00:07:11,270 --> 00:07:09,300

these very high specificities and and

182

00:07:12,920 --> 00:07:11,280

affinities and if you've got a surface

183

00:07:14,659 --> 00:07:12,930

with a lot of binding sites a lot of

184

00:07:17,270 --> 00:07:14,669

different analytes they could bind to

185

00:07:19,430 --> 00:07:17,280

you'll have many more diverse sequences

186

00:07:21,490 --> 00:07:19,440

detected versus something simple like a

187

00:07:24,260 --> 00:07:21,500

repeating crystalline structure and

188

00:07:26,060 --> 00:07:24,270

because these reporters that we'd be

189

00:07:28,100 --> 00:07:26,070

using are nucleic acids instead of

190

00:07:31,159 --> 00:07:28,110

proteins we could amplify them up using

191

00:07:32,810 --> 00:07:31,169

the PCR polymerase chain reaction and we

192

00:07:35,480 --> 00:07:32,820

think this could have a lot of potential

193

00:07:37,909 --> 00:07:35,490

especially for ocean worlds where key

194

00:07:40,340 --> 00:07:37,919

Melissa trophic life might be much much

195

00:07:41,750 --> 00:07:40,350

lower biomass than we're expecting here

196

00:07:45,290 --> 00:07:41,760

on earth where we have photosynthetic

197

00:07:47,300 --> 00:07:45,300

life so related talks exciting ones just

198

00:07:49,730 --> 00:07:47,310

following this session in the agnostic

199

00:07:51,830 --> 00:07:49,740

bio signatures session by M lab coli

200

00:07:53,300 --> 00:07:51,840

sandy Ellington and Eric Hanson at UT

201  
00:07:57,590 --> 00:07:53,310  
those are going to be in the Cedar

202  
00:07:59,990 --> 00:07:57,600  
Ballroom this morning we also have just

203  
00:08:02,240 --> 00:08:00,000  
this idea of compartmentalization and

204  
00:08:04,490 --> 00:08:02,250  
chemical fractionation can we find

205  
00:08:07,279 --> 00:08:04,500  
separation from an environment as an

206  
00:08:09,650 --> 00:08:07,289  
agnostic bio signature so here are just

207  
00:08:12,770 --> 00:08:09,660  
some nano Sims images or you can see

208  
00:08:14,719 --> 00:08:12,780  
really different compartments can can

209  
00:08:16,190 --> 00:08:14,729  
light up and we might be able to look at

210  
00:08:18,170 --> 00:08:16,200  
this and these are the kinds of things

211  
00:08:20,089 --> 00:08:18,180  
that Chris house has been working on in

212  
00:08:22,640 --> 00:08:20,099  
his laboratory at Penn State but we have

213  
00:08:26,659 --> 00:08:22,650

lots of excitement about where this

214

00:08:29,120 --> 00:08:26,669

might take us and then also energy

215

00:08:30,980 --> 00:08:29,130

transfer for extant life this is this

216

00:08:33,380 --> 00:08:30,990

wonderful quote life is nothing but an

217

00:08:35,719 --> 00:08:33,390

electron looking for a place to rest

218

00:08:38,060 --> 00:08:35,729

so we've long known that microbes can

219

00:08:40,730 --> 00:08:38,070

utilize minerals as electron acceptors

220

00:08:43,490 --> 00:08:40,740

you can use insoluble ferric oxide for

221

00:08:45,829 --> 00:08:43,500

example and what turns out is that the

222

00:08:48,230 --> 00:08:45,839

electrochemical properties of abiotic

223

00:08:50,030 --> 00:08:48,240

and biotic oxidation actually look

224

00:08:52,160 --> 00:08:50,040

different and it's apparent and even the

225

00:08:54,829 --> 00:08:52,170

simplest of setups as shown here you get

226

00:08:56,540 --> 00:08:54,839

this market and sustained increase in

227

00:08:58,290 --> 00:08:56,550

voltage and these little reactors that

228

00:09:00,450 --> 00:08:58,300

have microbial communities that

229

00:09:02,400 --> 00:09:00,460

been inoculated this is every time iron

230

00:09:04,530 --> 00:09:02,410

sulfide tailings are added in this

231

00:09:06,120 --> 00:09:04,540

simple setup so this is something Pete

232

00:09:09,030 --> 00:09:06,130

Girgis has been working on and we'll be

233

00:09:10,920 --> 00:09:09,040

talking more about Friday morning and in

234

00:09:13,590 --> 00:09:10,930

collaboration with Jana DOE and other co

235

00:09:16,020 --> 00:09:13,600

I on our team also this possibility of

236

00:09:18,960 --> 00:09:16,030

setting these specific potentials so

237

00:09:21,750 --> 00:09:18,970

this last image is it's these glass

238

00:09:23,220 --> 00:09:21,760

lithographically etched glass slides and

239

00:09:25,410 --> 00:09:23,230

you can look at these chips and you can

240

00:09:26,970 --> 00:09:25,420

set these very specific potentials and

241

00:09:30,050 --> 00:09:26,980

you could cycle through looking to

242

00:09:33,750 --> 00:09:30,060

discover possible energetic niches for

243

00:09:36,660 --> 00:09:33,760

extraterrestrial microbes so now some of

244

00:09:38,790 --> 00:09:36,670

these techniques we need some time these

245

00:09:40,500 --> 00:09:38,800

are very low TRL some of them are more

246

00:09:43,920 --> 00:09:40,510

at the concept stage that needs to be

247

00:09:46,350 --> 00:09:43,930

developed but others are higher heritage

248

00:09:48,510 --> 00:09:46,360

and so trying to think about how we can

249

00:09:50,100 --> 00:09:48,520

translate these concepts to actual

250

00:09:53,130 --> 00:09:50,110

missions I think is where the rubber

251  
00:09:54,540 --> 00:09:53,140  
hits the road the one opportunity that I

252  
00:09:57,570 --> 00:09:54,550  
wanted to talk about that's pretty

253  
00:09:59,850 --> 00:09:57,580  
immediate is this idea of translating to

254  
00:10:03,930 --> 00:09:59,860  
say Mars mission so MoMA the Mars

255  
00:10:05,670 --> 00:10:03,940  
organic molecule analyzer is um is an

256  
00:10:08,010 --> 00:10:05,680  
instrument that's gonna be sent on the

257  
00:10:10,890 --> 00:10:08,020  
ExoMars Rover that launches next summer

258  
00:10:13,290 --> 00:10:10,900  
will land the following spring MoMA is a

259  
00:10:14,790 --> 00:10:13,300  
really fantastic instrument it's a grass

260  
00:10:16,800 --> 00:10:14,800  
come out of grass mass spectrometer

261  
00:10:18,750 --> 00:10:16,810  
coupled to a laser desorption mass

262  
00:10:20,940 --> 00:10:18,760  
spectrometer it's got this incredible

263  
00:10:22,770 --> 00:10:20,950

range not only for high molecular weight

264

00:10:27,540 --> 00:10:22,780

stuff but also things that aren't easily

265

00:10:29,610 --> 00:10:27,550

volatilized to big advantage is moma and

266

00:10:31,680 --> 00:10:29,620

LDL smoking actually detect these heavy

267

00:10:34,020 --> 00:10:31,690

organic compounds even in the presence

268

00:10:36,480 --> 00:10:34,030

of perchlorates which has been really

269

00:10:38,820 --> 00:10:36,490

steaming every time we heat samples

270

00:10:40,890 --> 00:10:38,830

above 200 degrees celsius with pyrolysis

271

00:10:43,470 --> 00:10:40,900

perchlorates released these reactive

272

00:10:45,840 --> 00:10:43,480

gases that make it hard to that obscure

273

00:10:48,210 --> 00:10:45,850

the signals but MoMA can avoid this

274

00:10:51,210 --> 00:10:48,220

problem and it also can analyze

275

00:10:53,370 --> 00:10:51,220

structure using its ms/ms mode so if

276  
00:10:55,230 --> 00:10:53,380  
you've got a peak that's of interest a

277  
00:10:57,770 --> 00:10:55,240  
particularly interesting peak you can

278  
00:11:01,620 --> 00:10:57,780  
zoom in on it and create its own

279  
00:11:03,930 --> 00:11:01,630  
fragmentation pattern and so we've been

280  
00:11:05,190 --> 00:11:03,940  
doing ongoing work at Goddard Space

281  
00:11:07,980 --> 00:11:05,200  
Flight Center which has been responsible

282  
00:11:10,530 --> 00:11:07,990  
for building MoMA building this whole

283  
00:11:12,280 --> 00:11:10,540  
training set using these flight capable

284  
00:11:14,319 --> 00:11:12,290  
instrument bed boards and flight

285  
00:11:16,629 --> 00:11:14,329  
prototypes see if we can start pulling

286  
00:11:18,730 --> 00:11:16,639  
out complexity information working in

287  
00:11:21,310 --> 00:11:18,740  
close collaboration with lea and his

288  
00:11:23,110 --> 00:11:21,320

complexity work as well but um this is

289

00:11:25,840 --> 00:11:23,120

just one example say here's this really

290

00:11:27,910 --> 00:11:25,850

interesting peak at 825 Dalton's we

291

00:11:30,340 --> 00:11:27,920

isolate it and we look at the ms/ms

292

00:11:32,410 --> 00:11:30,350

pattern we see these mass units that are

293

00:11:34,030 --> 00:11:32,420

repeating they're separated by the same

294

00:11:36,340 --> 00:11:34,040

mass units and so what this actually is

295

00:11:38,139 --> 00:11:36,350

indicative indicating is that this is a

296

00:11:40,150 --> 00:11:38,149

polymer which indeed it is and if you

297

00:11:42,670 --> 00:11:40,160

saw a pattern like this you would not

298

00:11:44,710 --> 00:11:42,680

think this is a complex molecule but

299

00:11:46,389 --> 00:11:44,720

we're trying to explore chemical space

300

00:11:48,670 --> 00:11:46,399

and do this for lots of different things

301  
00:11:50,499 --> 00:11:48,680  
to build this training set so that we

302  
00:11:52,449 --> 00:11:50,509  
can work with colleagues at the Santa Fe

303  
00:11:53,970 --> 00:11:52,459  
Institute on our project trying to

304  
00:11:56,410 --> 00:11:53,980  
develop these machine learning

305  
00:11:59,470 --> 00:11:56,420  
capabilities where we can take this data

306  
00:12:03,189 --> 00:11:59,480  
and translate it into to you know data

307  
00:12:05,379 --> 00:12:03,199  
processing techniques so one thing I

308  
00:12:07,449 --> 00:12:05,389  
will say that's important to note is

309  
00:12:10,620 --> 00:12:07,459  
that these agnostic techniques are gonna

310  
00:12:13,059 --> 00:12:10,630  
trade definitiveness for inclusivity

311  
00:12:14,949 --> 00:12:13,069  
it's never going to be as definitive as

312  
00:12:17,470 --> 00:12:14,959  
say finding a whole pane or a DNA

313  
00:12:19,689 --> 00:12:17,480

sequence but one thing that we're

314

00:12:21,129 --> 00:12:19,699

fortunate is when we send missions off

315

00:12:22,920 --> 00:12:21,139

into space we usually get to send a

316

00:12:25,569 --> 00:12:22,930

package of instruments not just one

317

00:12:27,759 --> 00:12:25,579

instrument and so we've got a whole wing

318

00:12:29,439 --> 00:12:27,769

of our project thinking along the lines

319

00:12:31,389 --> 00:12:29,449

of computation and theoretical

320

00:12:34,600 --> 00:12:31,399

approaches how we can start combining

321

00:12:36,790 --> 00:12:34,610

multiple techniques data streams from

322

00:12:38,889 --> 00:12:36,800

that maybe lots of different bio hints

323

00:12:40,540 --> 00:12:38,899

together and using Bayesian networks

324

00:12:43,090 --> 00:12:40,550

trying to convert these measurements

325

00:12:44,559 --> 00:12:43,100

into thresholds and likelihoods trying

326

00:12:47,439 --> 00:12:44,569

to push away from this life for a

327

00:12:49,629 --> 00:12:47,449

no-life binary into okay this is three

328

00:12:52,180 --> 00:12:49,639

sigma away from what we might expect

329

00:12:53,290 --> 00:12:52,190

with abiotic processes and I think

330

00:12:55,240 --> 00:12:53,300

Sarah's going to touch on some of these

331

00:12:57,790 --> 00:12:55,250

cool data interpretation strategies as

332

00:12:59,350 --> 00:12:57,800

well so I'll leave it there but I just

333

00:13:01,509 --> 00:12:59,360

want to say thank you so much to NASA

334

00:13:04,000 --> 00:13:01,519

for this tremendous opportunity and and

335

00:13:06,759 --> 00:13:04,010

we're proud of net enfold the network

336

00:13:08,050 --> 00:13:06,769

for life detection which is um you know

337

00:13:09,579 --> 00:13:08,060

I think Nikki's gonna tell you about

338

00:13:11,650 --> 00:13:09,589

some events we have within fold this

339

00:13:14,090 --> 00:13:11,660

week that you're all welcome to join for

340

00:13:15,290 --> 00:13:14,100

and so I'll leave it there