
AbSciCon
2019

1
00:00:00,790 --> 00:00:07,320
[Music]

2
00:00:12,500 --> 00:00:09,040
[Applause]

3
00:00:15,740 --> 00:00:12,510
well welcome to the second session of

4
00:00:19,640 --> 00:00:15,750
the NAI 20th anniversary of discipline

5
00:00:22,220 --> 00:00:19,650
reaches maturity session and we have a

6
00:00:23,929 --> 00:00:22,230
little bit more time this morning you

7
00:00:25,640 --> 00:00:23,939
may notice that at the end of the

8
00:00:27,859 --> 00:00:25,650
session there appears to be some free

9
00:00:30,800 --> 00:00:27,869
time and the program but we are going to

10
00:00:34,310 --> 00:00:30,810
have lightning talks by the poster

11
00:00:38,030 --> 00:00:34,320
presenters and so we will have some

12
00:00:40,910 --> 00:00:38,040
additional short talks at the end and I

13
00:00:43,670 --> 00:00:40,920

think we do have time for one or two

14
00:00:46,250 --> 00:00:43,680
minutes of questions per paper we'll

15
00:00:49,220 --> 00:00:46,260
stick with the 10 minute presentations

16
00:00:55,340 --> 00:00:49,230
with a warning at 8 minutes so let's get

17
00:00:57,500 --> 00:00:55,350
started with Natalie Cabral great

18
00:00:59,810 --> 00:00:57,510
pleasure to be here this afternoon and

19
00:01:03,110 --> 00:00:59,820
my perspective is going to be a very

20
00:01:07,130 --> 00:01:03,120
personal perspective on Ani NII and what

21
00:01:09,350 --> 00:01:07,140
it did for me but maybe as as a case

22
00:01:11,120 --> 00:01:09,360
study of what he did for a number of

23
00:01:14,690 --> 00:01:11,130
young scientists the getting started

24
00:01:16,640 --> 00:01:14,700
thing is really about the NAI when it

25
00:01:18,980 --> 00:01:16,650
started but it's also me becoming a

26
00:01:21,560 --> 00:01:18,990
principal investigator exactly the same

27
00:01:23,390 --> 00:01:21,570
year at the SETI Institute so what that

28
00:01:25,670 --> 00:01:23,400
says exactly like Tory said this morning

29
00:01:28,039 --> 00:01:25,680
I've never known anything else in my

30
00:01:30,590 --> 00:01:28,049
intellectual life as a scientist you

31
00:01:32,620 --> 00:01:30,600
know as as DNA I and and definitely that

32
00:01:36,590 --> 00:01:32,630
has shaped my mind the way I'm thinking

33
00:01:39,139 --> 00:01:36,600
as a young scientist but now as still

34
00:01:42,980 --> 00:01:39,149
you're very young scientists I dye my

35
00:01:45,830 --> 00:01:42,990
hair gray and so I would like to you

36
00:01:47,780 --> 00:01:45,840
know get you through this because it's a

37
00:01:49,819 --> 00:01:47,790
personal journey but I think it talks a

38
00:01:52,700 --> 00:01:49,829

lot about what is happening to young

39
00:01:55,429 --> 00:01:52,710
scientists within the NAI so getting

40
00:01:56,959 --> 00:01:55,439
started I came to the nei I was invited

41
00:02:00,440 --> 00:01:56,969
by Christian Bale for the first SETI

42
00:02:01,850 --> 00:02:00,450
Institute team and I came from the

43
00:02:04,010 --> 00:02:01,860
standpoint of being involved with the

44
00:02:06,800 --> 00:02:04,020
Mars Exploration Rover team and in

45
00:02:08,510 --> 00:02:06,810
thinking ahead what is the next step we

46
00:02:12,380 --> 00:02:08,520
demonstrated that there is habitability

47
00:02:14,300 --> 00:02:12,390
on those on the side and Mars so if life

48
00:02:16,340 --> 00:02:14,310
was there how does it look like and in

49
00:02:19,430 --> 00:02:16,350
DNA I seem to be the perfect Avenue to

50
00:02:20,990 --> 00:02:19,440
get into a multidisciplinary team and

51
00:02:23,360 --> 00:02:21,000
ask this question and goes to those

52
00:02:27,410 --> 00:02:23,370
places to start to figure out those

53
00:02:30,470 --> 00:02:27,420
those things and so I was a co I on

54
00:02:33,290 --> 00:02:30,480
Chris's team and with my four people

55
00:02:37,940 --> 00:02:33,300
strong task and I think something like

56
00:02:42,760 --> 00:02:37,950
75 K we decided to tackle these

57
00:02:45,080 --> 00:02:42,770
questions but I think that what I I did

58
00:02:49,970 --> 00:02:45,090
especially at the very beginning was

59
00:02:53,420 --> 00:02:49,980
more to test the system and the patience

60
00:02:55,700 --> 00:02:53,430
of a number of program directors because

61
00:02:58,100 --> 00:02:55,710
I I came to them and saying well you

62
00:03:00,740 --> 00:02:58,110
know there is this very very big volcano

63
00:03:03,620 --> 00:03:00,750

in ear knees and it's a really good

64
00:03:06,080 --> 00:03:03,630
analog to to Mars it's about 6,000 meter

65
00:03:09,380 --> 00:03:06,090
high I want to go there so they started

66
00:03:11,000 --> 00:03:09,390
to raise eyebrows say okay and say you

67
00:03:13,430 --> 00:03:11,010
know I've made a reconnaissance over

68
00:03:15,410 --> 00:03:13,440
there there is this lake inside that

69
00:03:19,700 --> 00:03:15,420
volcano by the way the volcano is not

70
00:03:23,300 --> 00:03:19,710
exactly extinct and I'd like to dive in

71
00:03:25,670 --> 00:03:23,310
there so you can thank me today if there

72
00:03:28,430 --> 00:03:25,680
is a safety redo panel for extreme

73
00:03:29,150 --> 00:03:28,440
environment because this is how it got

74
00:03:31,670 --> 00:03:29,160
started

75
00:03:35,810 --> 00:03:31,680
basically even before the NAI with with

76
00:03:38,420 --> 00:03:35,820
the DDF in 2002 so III tested that part

77
00:03:40,640 --> 00:03:38,430
of the system but III thank NASA for

78
00:03:42,230 --> 00:03:40,650
that because today we can make safe

79
00:03:46,280 --> 00:03:42,240
science in very extreme environment

80
00:03:50,930 --> 00:03:46,290
thanks to you that and the patient of

81
00:03:52,520 --> 00:03:50,940
some directors because of Administration

82
00:03:56,180 --> 00:03:52,530
in South America and some time

83
00:04:00,350 --> 00:03:56,190
boundaries that are a little flexible so

84
00:04:02,990 --> 00:04:00,360
I had a few phone calls from Mike Mike

85
00:04:04,400 --> 00:04:03,000
Meyer calling me and say Nellie I sign

86
00:04:06,380 --> 00:04:04,410
the paperwork for Bolivia what were you

87
00:04:08,540 --> 00:04:06,390
doing in Chile I said I'm sorry I was

88
00:04:11,120 --> 00:04:08,550

diving in that leg and then it's not my

89
00:04:12,590 --> 00:04:11,130
fault if the boundary runs across but

90
00:04:16,970 --> 00:04:12,600
nobody asked me for my passport didn't

91
00:04:20,840 --> 00:04:16,980
like so but oh what was fixed but the

92
00:04:23,120 --> 00:04:20,850
point is that I was within a team and I

93
00:04:25,400 --> 00:04:23,130
could put my samples into perspective I

94
00:04:27,050 --> 00:04:25,410
was not on my own I was not especially

95
00:04:28,940 --> 00:04:27,060
when we arrived I said that will be the

96
00:04:30,550 --> 00:04:28,950
fastest project ever because the

97
00:04:31,990 --> 00:04:30,560
environment is going to soon to be

98
00:04:34,780 --> 00:04:32,000
nasty we're not going to find anything

99
00:04:37,980 --> 00:04:34,790
my task was put you video similars over

100
00:04:40,270 --> 00:04:37,990
there take the data see what happens and

101
00:04:41,800 --> 00:04:40,280
when we arrive over there

102
00:04:43,750 --> 00:04:41,810
the first morning I realized I was

103
00:04:46,480 --> 00:04:43,760
sitting in a 100 square kilometres

104
00:04:48,400 --> 00:04:46,490
Philips to my delight they were pleased

105
00:04:51,060 --> 00:04:48,410
to since one and and then they were more

106
00:04:54,129 --> 00:04:51,070
growing in in the current like so

107
00:04:56,500 --> 00:04:54,139
immediately the team in itself started

108
00:04:58,659 --> 00:04:56,510
to talk they wanted more more samples

109
00:05:00,520 --> 00:04:58,669
and it's not necessarily the people in

110
00:05:02,950 --> 00:05:00,530
the team but also the people they knew

111
00:05:05,710 --> 00:05:02,960
and this started a network as a

112
00:05:07,629 --> 00:05:05,720
scientist for me and then many of those

113
00:05:09,430 --> 00:05:07,639

people I'm still working with today so

114
00:05:12,010 --> 00:05:09,440
we started as I said with little money

115
00:05:14,730 --> 00:05:12,020
for people the project five years later

116
00:05:17,650 --> 00:05:14,740
was 50 scientists involved from 26

117
00:05:20,590 --> 00:05:17,660
institution nine countries and we had

118
00:05:23,710 --> 00:05:20,600
reach out thousands of children in

119
00:05:25,960 --> 00:05:23,720
schools including some events with the

120
00:05:30,700 --> 00:05:25,970
Exploratorium that were facilitated by

121
00:05:34,030 --> 00:05:30,710
the NAI in many ways we also had thanks

122
00:05:37,600 --> 00:05:34,040
to the the DD FN and and other things

123
00:05:39,520 --> 00:05:37,610
though the recent Clark funds as well we

124
00:05:43,870 --> 00:05:39,530
had students every single year with us

125
00:05:48,730 --> 00:05:43,880
in the field so always always helpful

126
00:05:49,900 --> 00:05:48,740
and help get the project bigger also the

127
00:05:52,029 --> 00:05:49,910
the name of the NAI

128
00:05:54,070 --> 00:05:52,039
has opened many doors for me as a

129
00:05:55,360 --> 00:05:54,080
scientist and even when the

130
00:05:57,940 --> 00:05:55,370
administration was very difficult

131
00:06:00,370 --> 00:05:57,950
sometimes in South America you would be

132
00:06:01,960 --> 00:06:00,380
surprised that it seemed that people

133
00:06:04,060 --> 00:06:01,970
make a difference between NASA and nei

134
00:06:07,440 --> 00:06:04,070
and when we're talking about any I

135
00:06:10,029 --> 00:06:07,450
actually facilitated the paperwork so

136
00:06:12,760 --> 00:06:10,039
for me it became the NA I became a

137
00:06:15,040 --> 00:06:12,770
professional family and also a place

138
00:06:18,430 --> 00:06:15,050

where I couldn't network once again with

139
00:06:21,250 --> 00:06:18,440
people I'm still working today and also

140
00:06:23,170 --> 00:06:21,260
it's a holistic approach to science I am

141
00:06:25,690 --> 00:06:23,180
a firm believer that we go through

142
00:06:28,629 --> 00:06:25,700
science like in life and in respiration

143
00:06:30,640 --> 00:06:28,639
through moments where you have to go and

144
00:06:33,010 --> 00:06:30,650
take the reductionist approach and look

145
00:06:34,870 --> 00:06:33,020
at the tiny window of your science and

146
00:06:36,760 --> 00:06:34,880
sometimes you have to step back and look

147
00:06:38,529 --> 00:06:36,770
at the bigger perspective and this is

148
00:06:40,659 --> 00:06:38,539
what any I did for me put everything

149
00:06:42,080 --> 00:06:40,669
into bigger perspective and especially

150
00:06:44,570 --> 00:06:42,090
keep me in check in

151
00:06:46,010 --> 00:06:44,580
intellectually I remember at the very

152
00:06:48,140 --> 00:06:46,020
beginning of my career I was writing a

153
00:06:50,450 --> 00:06:48,150
lot writing a pair a lots of papers and

154
00:06:52,220 --> 00:06:50,460
I was joking with my mother a few months

155
00:06:53,990 --> 00:06:52,230
ago because I was whining I couldn't

156
00:06:55,700 --> 00:06:54,000
write a paragraph and she was very

157
00:06:57,320 --> 00:06:55,710
surprised to say well you seem to have

158
00:07:01,490 --> 00:06:57,330
more difficulty now I said no I just

159
00:07:06,230 --> 00:07:01,500
know what I'm talking about now and also

160
00:07:07,940 --> 00:07:06,240
the societal impact of the work that we

161
00:07:11,780 --> 00:07:07,950
were doing that probably would never had

162
00:07:14,510 --> 00:07:11,790
happened if I was not with the NAI

163
00:07:16,969 --> 00:07:14,520

going to those places having high UV

164
00:07:18,980 --> 00:07:16,979
environment finding life that resists to

165
00:07:21,740 --> 00:07:18,990
to those things all of a sudden the

166
00:07:23,060 --> 00:07:21,750
oncology department at UCSC I got

167
00:07:25,010 --> 00:07:23,070
involved with us and they are still

168
00:07:27,469 --> 00:07:25,020
working with us so many years later

169
00:07:32,390 --> 00:07:27,479
because they might this might provide

170
00:07:35,360 --> 00:07:32,400
avenues for cancer research so this is

171
00:07:38,510 --> 00:07:35,370
how this this happened it started there

172
00:07:41,500 --> 00:07:38,520
in 2003 and then I made the conscious

173
00:07:44,510 --> 00:07:41,510
decision to leave the NAI

174
00:07:47,180 --> 00:07:44,520
whilst Eddie was trying to renew and go

175
00:07:48,560 --> 00:07:47,190
to the more reductionist pursue this is

176
00:07:51,080 --> 00:07:48,570
what I learned whether they nai now I'm

177
00:07:52,670 --> 00:07:51,090
going to try to apply it to to Mission

178
00:07:55,430 --> 00:07:52,680
because this is what I do I I really

179
00:07:58,520 --> 00:07:55,440
want to apply that knowledge to missions

180
00:08:02,690 --> 00:07:58,530
so I went through a number of P stars

181
00:08:06,950 --> 00:08:02,700
and deployed Rovers in the field and try

182
00:08:08,719 --> 00:08:06,960
to write a nei proposal in 2012 that was

183
00:08:11,719 --> 00:08:08,729
not selected so I went back to P star

184
00:08:14,300 --> 00:08:11,729
and lakes on Titan that we discovered so

185
00:08:16,310 --> 00:08:14,310
I applied some of that knowledge to

186
00:08:19,580 --> 00:08:16,320
missions on for Titans

187
00:08:21,740 --> 00:08:19,590
but then in 2015 there was the changing

188
00:08:23,360 --> 00:08:21,750

planetary environment and the

189
00:08:27,050 --> 00:08:23,370
fingerprints of light project we started

190
00:08:28,790 --> 00:08:27,060
a new SETI Institute team we started

191
00:08:31,760 --> 00:08:28,800
with 20 scientists were about double

192
00:08:33,469 --> 00:08:31,770
today there was a constant I heard the

193
00:08:36,110 --> 00:08:33,479
representative of cab this morning

194
00:08:39,260 --> 00:08:36,120
talking about their involvement with the

195
00:08:40,459 --> 00:08:39,270
NAI where a Victoria are here and and

196
00:08:42,199 --> 00:08:40,469
you know for a fact that we have been

197
00:08:43,730 --> 00:08:42,209
working together for 15 years that

198
00:08:46,610 --> 00:08:43,740
started there too and that continued

199
00:08:49,550 --> 00:08:46,620
onto with a piece start so right now

200
00:08:51,800 --> 00:08:49,560
what we are doing with our project is to

201
00:08:54,210 --> 00:08:51,810
come in support of Mars mission and to

202
00:08:57,470 --> 00:08:54,220
bring the astrobiology in the BIOS

203
00:09:00,389 --> 00:08:57,480
expiration of the Mars 2020 mission and

204
00:09:04,139 --> 00:09:00,399
think about how we can use the payroll

205
00:09:05,519 --> 00:09:04,149
that they have to actually explore for

206
00:09:07,199 --> 00:09:05,529
for bio signature we are developing

207
00:09:09,480 --> 00:09:07,209
mission and mission concept I'll talk

208
00:09:13,189 --> 00:09:09,490
about that tomorrow

209
00:09:16,710 --> 00:09:13,199
and also the teaming with icy world

210
00:09:19,170 --> 00:09:16,720
nai team has led to a winning pistol

211
00:09:22,259 --> 00:09:19,180
proposal for the exploration of Europa

212
00:09:24,600 --> 00:09:22,269
so we talk we mix we match and and we

213
00:09:26,400 --> 00:09:24,610

come from our different perspective also

214
00:09:30,090 --> 00:09:26,410
what I appreciated very much is the

215
00:09:32,449 --> 00:09:30,100
possibility of giving my opinion on how

216
00:09:36,689 --> 00:09:32,459
I think astrobiology should move forward

217
00:09:40,530 --> 00:09:36,699
and have an impact at the academy of

218
00:09:43,019 --> 00:09:40,540
science for now in terms of research

219
00:09:45,509 --> 00:09:43,029
what comes next is this application how

220
00:09:49,110 --> 00:09:45,519
do like III transfer the knowledge that

221
00:09:50,309 --> 00:09:49,120
we we are acquiring with the NAI project

222
00:09:52,199 --> 00:09:50,319
into mission and this is what I'm

223
00:09:55,439 --> 00:09:52,209
planning to do in the in the coming

224
00:09:58,110 --> 00:09:55,449
years one way or another this is well my

225
00:09:59,819 --> 00:09:58,120
task and we'll see how that happens

226
00:10:03,150 --> 00:09:59,829
probably going back to a more mission

227
00:10:05,160 --> 00:10:03,160
oriented view of things before we go

228
00:10:08,970 --> 00:10:05,170
back to multidisciplinary project well

229
00:10:10,619 --> 00:10:08,980
see that I have no clear vision yet but

230
00:10:12,780 --> 00:10:10,629
something that I want to conclude a now

231
00:10:15,480 --> 00:10:12,790
is that at the same time that I became

232
00:10:17,340 --> 00:10:15,490
the PI of the SETI Institute team the

233
00:10:18,960 --> 00:10:17,350
same year abundance of goods

234
00:10:21,389 --> 00:10:18,970
I became also the head of science of the

235
00:10:23,280 --> 00:10:21,399
SETI Institute and it happens that we

236
00:10:25,019 --> 00:10:23,290
have six research division going across

237
00:10:27,900 --> 00:10:25,029
pretty much the program that you see at

238
00:10:30,960 --> 00:10:27,910

NASA and definitely the way that the NAI

239
00:10:33,780 --> 00:10:30,970
has shaped my mind and have me think

240
00:10:35,519 --> 00:10:33,790
over the years is very much applied to

241
00:10:38,910 --> 00:10:35,529
the SETI Institute where we are creating

242
00:10:41,220 --> 00:10:38,920
bridges among disciplines and see how

243
00:10:45,360 --> 00:10:41,230
you know what are the new ways we can do

244
00:10:48,509 --> 00:10:45,370
more science better science so I am

245
00:10:51,079 --> 00:10:48,519
going to leave that here what I wanted

246
00:10:54,090 --> 00:10:51,089
to say is that of course we can you know

247
00:10:55,650 --> 00:10:54,100
look back and at the science but it

248
00:10:58,049 --> 00:10:55,660
would never happen with with other

249
00:11:00,960 --> 00:10:58,059
people with first created DNA like but I

250
00:11:04,019 --> 00:11:00,970
have a special soft button in my heart

251
00:11:05,579 --> 00:11:04,029
for the NAI central you guys are every

252
00:11:06,310 --> 00:11:05,589
single day day in day out making it

253
00:11:09,070 --> 00:11:06,320
happen

254
00:11:11,680 --> 00:11:09,080
and you'll go really you know the extra

255
00:11:20,800 --> 00:11:11,690
mile to help us so thank you very much

256
00:11:22,990 --> 00:11:20,810
very very much for everything we do have

257
00:11:28,900 --> 00:11:23,000
time for for perhaps one quick question

258
00:11:32,080 --> 00:11:28,910
for Natalie if anyone has one then thank

259
00:11:47,429 --> 00:11:32,090
you very much Natalie okay let us move

260
00:11:52,059 --> 00:11:49,899
alright hey there my name is Laurie

261
00:11:54,999 --> 00:11:52,069
barge and I am an investigation lead for

262
00:11:56,589 --> 00:11:55,009
the NAIC worlds team at JPL and I'm here

263
00:11:58,449 --> 00:11:56,599

representing the whole team but most of

264
00:12:00,639 --> 00:11:58,459
all our PI issue Kanak he is on

265
00:12:02,769 --> 00:12:00,649
sabbatical right now in Italy and so

266
00:12:04,389 --> 00:12:02,779
partly I'm gonna talk about how our team

267
00:12:06,579 --> 00:12:04,399
has really benefited from the nei

268
00:12:08,649 --> 00:12:06,589
support and you know in terms of science

269
00:12:09,939 --> 00:12:08,659
and the whole team at JPL but also Carl

270
00:12:11,589 --> 00:12:09,949
had asked me to speak about some of the

271
00:12:13,869 --> 00:12:11,599
early career benefits that I personally

272
00:12:16,989 --> 00:12:13,879
have experienced so we'll have a little

273
00:12:18,399 --> 00:12:16,999
bit of both of that and so our RC Worlds

274
00:12:20,169 --> 00:12:18,409
team has actually been part of the NAI

275
00:12:22,119 --> 00:12:20,179
for two separate cycles that we were

276
00:12:24,639 --> 00:12:22,129
part of the can five and also part of

277
00:12:28,149 --> 00:12:24,649
the can seven and so there can five

278
00:12:29,979 --> 00:12:28,159
started in I guess 2009 and so I was

279
00:12:32,289 --> 00:12:29,989
actually part of the team as a postdoc

280
00:12:34,359 --> 00:12:32,299
in the cam 5 and then we wrote the Kant

281
00:12:36,339 --> 00:12:34,369
7 proposal and I was in that one as a co

282
00:12:37,899 --> 00:12:36,349
I and then when that got funded it was a

283
00:12:39,419 --> 00:12:37,909
large part of helping me get hired at

284
00:12:41,619 --> 00:12:39,429
JPL so that was one of the major

285
00:12:43,599 --> 00:12:41,629
advances of these types of teams is that

286
00:12:45,489 --> 00:12:43,609
you can sort of be in them as an early

287
00:12:47,859 --> 00:12:45,499
career person for a long period of time

288
00:12:50,199 --> 00:12:47,869

enough to sort of grow up and you know

289
00:12:51,819 --> 00:12:50,209
be able to contribute as a co I and then

290
00:12:53,769 --> 00:12:51,829
you can write the next versions of these

291
00:12:55,059 --> 00:12:53,779
things and actually this will help a lot

292
00:12:57,549 --> 00:12:55,069
for early career people to become

293
00:12:59,589 --> 00:12:57,559
established at their institutions and so

294
00:13:01,299 --> 00:12:59,599
the focus of the team evolved and

295
00:13:04,689 --> 00:13:01,309
changed a little bit over the 10 years

296
00:13:06,669 --> 00:13:04,699
and in the can 7 team which I am most

297
00:13:08,769 --> 00:13:06,679
familiar with we did we were looking at

298
00:13:10,449 --> 00:13:08,779
in general the icy worlds which are now

299
00:13:12,429 --> 00:13:10,459
called the ocean worlds and where we're

300
00:13:13,929 --> 00:13:12,439
interested in how you could determine

301
00:13:15,909 --> 00:13:13,939
whether these worlds that have the ice

302
00:13:17,859 --> 00:13:15,919
shell with the ocean with the rocky sea

303
00:13:19,719 --> 00:13:17,869
floor beneath how you could determine if

304
00:13:21,279 --> 00:13:19,729
those are habitable and how you might

305
00:13:24,309 --> 00:13:21,289
approach looking for life on these

306
00:13:26,259 --> 00:13:24,319
worlds and so one of the big questions

307
00:13:27,909 --> 00:13:26,269
that we focused on as part of this was

308
00:13:30,069 --> 00:13:27,919
not just you know understanding the

309
00:13:32,319 --> 00:13:30,079
moons themselves and how to detect stuff

310
00:13:33,759 --> 00:13:32,329
but also trying to understand how life

311
00:13:35,319 --> 00:13:33,769
can begin on these worlds in the first

312
00:13:37,059 --> 00:13:35,329
place because it's possible that you

313
00:13:38,439 --> 00:13:37,069

have things that are habitable but where

314
00:13:41,559 --> 00:13:38,449
life does not exist because it never

315
00:13:43,539 --> 00:13:41,569
emerged right and so one of the one of

316
00:13:46,179 --> 00:13:43,549
the nice things about our team is in the

317
00:13:48,009 --> 00:13:46,189
canned 7 round was that we had this big

318
00:13:50,199 --> 00:13:48,019
origin of life contingent that was also

319
00:13:51,909 --> 00:13:50,209
working together very well with the you

320
00:13:53,590 --> 00:13:51,919
know studying the interiors of the icy

321
00:13:55,449 --> 00:13:53,600
worlds and finding out what types of

322
00:13:56,610 --> 00:13:55,459
environments exist but then also

323
00:13:58,890 --> 00:13:56,620
understanding how

324
00:14:00,600 --> 00:13:58,900
begin how it could evolve and change and

325
00:14:01,980 --> 00:14:00,610
how that might be represented in these

326
00:14:04,350 --> 00:14:01,990
worlds in a way that you could detect

327
00:14:05,340 --> 00:14:04,360
from the surface and so we had four

328
00:14:07,530 --> 00:14:05,350
investigations

329
00:14:09,240 --> 00:14:07,540
um investigation one was about looking

330
00:14:10,400 --> 00:14:09,250
at how water and rock interact in the

331
00:14:12,330 --> 00:14:10,410
chemistry that happens there

332
00:14:14,640 --> 00:14:12,340
investigation two which is the one that

333
00:14:16,260 --> 00:14:14,650
I was leading is how geo electrochemical

334
00:14:18,600 --> 00:14:16,270
systems can lead to the origin of life

335
00:14:20,370 --> 00:14:18,610
so this is a hydrothermal origin of life

336
00:14:21,840 --> 00:14:20,380
work which is for an ocean world if

337
00:14:23,760 --> 00:14:21,850
there's no land this is one of the main

338
00:14:26,220 --> 00:14:23,770

ways that you may have origin of life on

339
00:14:27,960 --> 00:14:26,230
these planets investigation 3 was

340
00:14:29,880 --> 00:14:27,970
looking at the structure of these moons

341
00:14:32,340 --> 00:14:29,890
and where the disequilibrium exists an

342
00:14:34,470 --> 00:14:32,350
investigation for was looking about how

343
00:14:36,180 --> 00:14:34,480
we can understand the surface signatures

344
00:14:37,800 --> 00:14:36,190
that might come on the surface based on

345
00:14:40,500 --> 00:14:37,810
the stuff that's happening below the in

346
00:14:41,910 --> 00:14:40,510
the ocean and so there were lots and

347
00:14:43,470 --> 00:14:41,920
lots of different you know science

348
00:14:45,540 --> 00:14:43,480
accomplishments over the years from all

349
00:14:47,760 --> 00:14:45,550
of our Co eyes we had a large team that

350
00:14:49,320 --> 00:14:47,770
was spread not just at JPL but also in

351
00:14:51,180 --> 00:14:49,330
outside institutions we had

352
00:14:52,980 --> 00:14:51,190
international collaborators and lots of

353
00:14:55,290 --> 00:14:52,990
different involvement with other nei

354
00:14:57,300 --> 00:14:55,300
teams as well and so you know not to go

355
00:14:59,610 --> 00:14:57,310
into any particular research project but

356
00:15:00,810 --> 00:14:59,620
there were a lot of things that could

357
00:15:03,030 --> 00:15:00,820
come out of the fact that there was

358
00:15:04,290 --> 00:15:03,040
meaningful and long-term support and so

359
00:15:05,730 --> 00:15:04,300
a lot of the stuff that we were

360
00:15:07,730 --> 00:15:05,740
publishing was things that had taken

361
00:15:09,690 --> 00:15:07,740
several years to sort of germinate and

362
00:15:11,670 --> 00:15:09,700
you know being able to do field work

363
00:15:14,010 --> 00:15:11,680

multiple seasons in a row or being able

364
00:15:15,420 --> 00:15:14,020
to do lab experiments that go on for two

365
00:15:17,280 --> 00:15:15,430
or three years before you can figure out

366
00:15:19,050 --> 00:15:17,290
a good method and this sort of thing it

367
00:15:20,850 --> 00:15:19,060
was a really valuable way to be able to

368
00:15:24,720 --> 00:15:20,860
make high-impact contributions to the

369
00:15:26,340 --> 00:15:24,730
field and so one of the things that was

370
00:15:28,260 --> 00:15:26,350
very important for me is an early career

371
00:15:30,150 --> 00:15:28,270
a member of Nai even before I joined I

372
00:15:32,250 --> 00:15:30,160
SeaWorld's actually was although all the

373
00:15:34,050 --> 00:15:32,260
programs that Nai supported so this

374
00:15:35,760 --> 00:15:34,060
range is from there were the AB grad

375
00:15:37,230 --> 00:15:35,770
cons the astrobiology graduate

376
00:15:38,130 --> 00:15:37,240
conferences which I think many of you

377
00:15:40,230 --> 00:15:38,140
have also attended

378
00:15:42,000 --> 00:15:40,240
actually many people who are now you

379
00:15:43,110 --> 00:15:42,010
know pis or Co eyes and the NA I have

380
00:15:45,660 --> 00:15:43,120
have been attending these to have grad

381
00:15:47,730 --> 00:15:45,670
cons as well and it was a it was a

382
00:15:49,710 --> 00:15:47,740
graduate student only conference also

383
00:15:51,300 --> 00:15:49,720
postdocs could attend but it was a

384
00:15:52,860 --> 00:15:51,310
conference where you could give like

385
00:15:54,510 --> 00:15:52,870
your first conference talk and get to

386
00:15:57,210 --> 00:15:54,520
make you know new collaborations with

387
00:16:00,510 --> 00:15:57,220
people and so I attended AB grad con

388
00:16:02,790 --> 00:16:00,520

actually I think 2005 onward and so I

389
00:16:04,770 --> 00:16:02,800
was a PhD student at an earth science

390
00:16:06,900 --> 00:16:04,780
but I didn't have a planetary science or

391
00:16:08,910 --> 00:16:06,910
astrobiology thesis and but I wanted to

392
00:16:09,879 --> 00:16:08,920
be an astrobiologist so I would attend

393
00:16:11,739 --> 00:16:09,889
the AB grad Cana

394
00:16:13,269 --> 00:16:11,749
a way to build the professional network

395
00:16:15,489 --> 00:16:13,279
that I wanted that I didn't really have

396
00:16:16,960 --> 00:16:15,499
from my institution so this was really

397
00:16:18,819 --> 00:16:16,970
great and then there was also all these

398
00:16:21,669 --> 00:16:18,829
astrobiology summer and winter schools

399
00:16:23,679 --> 00:16:21,679
so I had to go for these too I could

400
00:16:27,639 --> 00:16:23,689
find them online this is the Santander

401
00:16:29,679 --> 00:16:27,649
summer school in 2007 17 and 2018 for

402
00:16:30,819 --> 00:16:29,689
2006 which was the one that I attended I

403
00:16:32,559 --> 00:16:30,829
had to actually pull out a physical

404
00:16:35,349 --> 00:16:32,569
photo and scan this because I couldn't

405
00:16:36,789 --> 00:16:35,359
find it online so I mean this 2006

406
00:16:38,499 --> 00:16:36,799
school is where I met a lot of the

407
00:16:40,900 --> 00:16:38,509
collaborators who I still work with

408
00:16:42,699 --> 00:16:40,910
today and then this kind of continued

409
00:16:45,039 --> 00:16:42,709
throughout the there was a Hawaii summer

410
00:16:47,069 --> 00:16:45,049
or a Hawaii winter school and Iceland

411
00:16:49,269 --> 00:16:47,079
summer school there was actually a

412
00:16:51,400 --> 00:16:49,279
University of Arizona winter school as I

413
00:16:53,679 --> 00:16:51,410

recall as well and so I went to all of

414
00:16:54,819 --> 00:16:53,689
these and you would see these people

415
00:16:56,799 --> 00:16:54,829
that were kind of building their own

416
00:16:58,449 --> 00:16:56,809
early career network that was

417
00:17:00,369 --> 00:16:58,459
transcending what they might be doing in

418
00:17:01,989 --> 00:17:00,379
their particular thesis program that

419
00:17:05,019 --> 00:17:01,999
allowed them to build a career in

420
00:17:06,789 --> 00:17:05,029
astrobiology and so that is actually

421
00:17:08,710 --> 00:17:06,799
what led to me being involved with icy

422
00:17:11,980 --> 00:17:08,720
worlds was I was a tap grad con I think

423
00:17:13,689 --> 00:17:11,990
in 2000 and maybe eight or seven and I

424
00:17:15,159 --> 00:17:13,699
met somebody who knew ishik and they

425
00:17:17,079 --> 00:17:15,169
introduced me and one thing led to

426
00:17:19,360 --> 00:17:17,089
another and then I was a postdoc at JPL

427
00:17:21,159 --> 00:17:19,370
so the abbé grad con was also a pathway

428
00:17:23,139 --> 00:17:21,169
for people to get into the teams and

429
00:17:25,240 --> 00:17:23,149
actually become then later co eyes and

430
00:17:27,250 --> 00:17:25,250
the other another thing that was really

431
00:17:29,889 --> 00:17:27,260
beneficial for the early careers was the

432
00:17:32,169 --> 00:17:29,899
NAI director's discretionary fund so

433
00:17:34,000 --> 00:17:32,179
this was a a small grant that you could

434
00:17:35,620 --> 00:17:34,010
apply for where would be a couple tens

435
00:17:37,870 --> 00:17:35,630
of thousands of dollars to do a research

436
00:17:39,519 --> 00:17:37,880
project with another team or to go visit

437
00:17:41,980 --> 00:17:39,529
some other collaborator maybe that

438
00:17:43,810 --> 00:17:41,990

wasn't yet in the NAI and so that was

439
00:17:45,940 --> 00:17:43,820
actually a really valuable way for a

440
00:17:48,009 --> 00:17:45,950
younger person on the team to sort of

441
00:17:49,539 --> 00:17:48,019
have their own idea and get funding to

442
00:17:50,769 --> 00:17:49,549
do it and it's something that may not

443
00:17:53,799 --> 00:17:50,779
have been included in the original

444
00:17:55,509 --> 00:17:53,809
proposal and so we had I had one of

445
00:17:57,370 --> 00:17:55,519
these along with pavlo sue Brown from

446
00:17:59,620 --> 00:17:57,380
the SETI team and this was a really big

447
00:18:01,029 --> 00:17:59,630
deal for us because we got to go to LC

448
00:18:03,549 --> 00:18:01,039
whose the earth Life Science Institute

449
00:18:05,529 --> 00:18:03,559
in Tokyo and we were developing a laser

450
00:18:07,659 --> 00:18:05,539
spectroscopy project along with Elsi

451
00:18:09,250 --> 00:18:07,669
researchers and we also had a student

452
00:18:11,500 --> 00:18:09,260
exchange where we had an undergrad come

453
00:18:13,720 --> 00:18:11,510
to Japan and then later on as someone

454
00:18:16,180 --> 00:18:13,730
from Japan visited our lab and then

455
00:18:18,070 --> 00:18:16,190
that's actually over a couple years

456
00:18:19,750 --> 00:18:18,080
later it led to Pablo and I getting

457
00:18:22,149 --> 00:18:19,760
funded by a P star which I think Natalie

458
00:18:23,080 --> 00:18:22,159
just mentioned and so we we were able to

459
00:18:24,550 --> 00:18:23,090
get a

460
00:18:26,050 --> 00:18:24,560
a project going and start doing

461
00:18:28,240 --> 00:18:26,060
preliminary stuff and start gathering

462
00:18:29,620 --> 00:18:28,250
team and thinking about things so that

463
00:18:32,320 --> 00:18:29,630

we could learn how to apply for these

464
00:18:34,060 --> 00:18:32,330
much larger programs and so I this was a

465
00:18:35,740 --> 00:18:34,070
really valuable thing for us to be able

466
00:18:38,370 --> 00:18:35,750
to work together and a lot of that also

467
00:18:40,810 --> 00:18:38,380
came out of the app grad cons as well

468
00:18:42,580 --> 00:18:40,820
another thing that was very valuable

469
00:18:44,050 --> 00:18:42,590
it's kind of a smaller version of this

470
00:18:46,630 --> 00:18:44,060
it was the NAI early career

471
00:18:48,160 --> 00:18:46,640
collaboration award and this was about I

472
00:18:49,690 --> 00:18:48,170
think three to five thousand dollars

473
00:18:52,420 --> 00:18:49,700
where you could get this and then go

474
00:18:54,160 --> 00:18:52,430
visit another lab and so this was where

475
00:18:56,320 --> 00:18:54,170
you could do a little pilot study or try

476
00:18:59,110 --> 00:18:56,330
out a new experiment or something and I

477
00:19:01,420 --> 00:18:59,120
had one of these in 2012 where Bradley

478
00:19:03,220 --> 00:19:01,430
Burke are from the RPI team and I wrote

479
00:19:05,560 --> 00:19:03,230
up a project to test RNA and a

480
00:19:07,540 --> 00:19:05,570
hydrothermal vent and so I visited RPI

481
00:19:09,790 --> 00:19:07,550
for two or three weeks we did a project

482
00:19:11,590 --> 00:19:09,800
and then Bradley finished a lot of it

483
00:19:13,840 --> 00:19:11,600
and then we had a paper in astrobiology

484
00:19:15,430 --> 00:19:13,850
that came from this and it was it was a

485
00:19:17,140 --> 00:19:15,440
sort of collaboration that it would have

486
00:19:19,150 --> 00:19:17,150
been really hard to do otherwise because

487
00:19:20,440 --> 00:19:19,160
these you know this isn't the sort of

488
00:19:23,080 --> 00:19:20,450

thing that will get funded right away

489
00:19:24,910 --> 00:19:23,090
you need preliminary data but also it

490
00:19:26,650 --> 00:19:24,920
came directly out of have grad con again

491
00:19:28,780 --> 00:19:26,660
because Bradley and I had met at at grad

492
00:19:30,790 --> 00:19:28,790
Con had this idea who wrote this thing

493
00:19:32,200 --> 00:19:30,800
with the support of our two PI's and

494
00:19:35,380 --> 00:19:32,210
then ended up getting this collaboration

495
00:19:36,880 --> 00:19:35,390
going and then like later on we ended up

496
00:19:38,530 --> 00:19:36,890
hosting several of these and I think

497
00:19:40,060 --> 00:19:38,540
many of the teams have hosted early

498
00:19:42,640 --> 00:19:40,070
career researchers through this program

499
00:19:45,220 --> 00:19:42,650
so if an icy world's recently we hosted

500
00:19:46,840 --> 00:19:45,230
a student from University of Tulsa who

501
00:19:48,760 --> 00:19:46,850
came out to look at different ways we

502
00:19:51,520 --> 00:19:48,770
could analyze reactive minerals and

503
00:19:53,590 --> 00:19:51,530
early Earth systems and then in 2018 we

504
00:19:55,710 --> 00:19:53,600
had another one come from Penn State to

505
00:19:57,100 --> 00:19:55,720
look at how we could have vesicles and

506
00:19:59,470 --> 00:19:57,110
compartmentalization and hydrothermal

507
00:20:02,410 --> 00:19:59,480
vents so this has been really really

508
00:20:04,150 --> 00:20:02,420
exciting to be able to have new people

509
00:20:05,650 --> 00:20:04,160
come and visit and actually get to work

510
00:20:07,030 --> 00:20:05,660
for several weeks in the lab which is

511
00:20:08,980 --> 00:20:07,040
really a lot better than just you know

512
00:20:10,420 --> 00:20:08,990
chatting at a conference but you need

513
00:20:12,040 --> 00:20:10,430

that preliminary data in order to move

514
00:20:14,260 --> 00:20:12,050
forward with things like the graduate

515
00:20:15,940 --> 00:20:14,270
student fellowship proposals or even

516
00:20:19,150 --> 00:20:15,950
things like exobiology or habitable

517
00:20:21,040 --> 00:20:19,160
worlds so the other one that was

518
00:20:23,170 --> 00:20:21,050
important for me in particular this is a

519
00:20:25,690 --> 00:20:23,180
slide Ishika made kind of about the

520
00:20:28,270 --> 00:20:25,700
recent postdocs of our team was the NPP

521
00:20:31,000 --> 00:20:28,280
program so like many of the astrobiology

522
00:20:33,280 --> 00:20:31,010
programs and na I could have NPP's it

523
00:20:34,930 --> 00:20:33,290
with the teams and you could also have

524
00:20:36,820 --> 00:20:34,940
postdocs that were affiliated with the

525
00:20:40,660 --> 00:20:36,830
teams funded just directly from the

526
00:20:42,850 --> 00:20:40,670
and so I was an NAIA MPP from 2013 to

527
00:20:44,590 --> 00:20:42,860
2015 and before that I was a postdoc

528
00:20:48,550 --> 00:20:44,600
with icy worlds for two more years

529
00:20:50,130 --> 00:20:48,560
funded as a JPL postdoc and so this was

530
00:20:51,850 --> 00:20:50,140
a very it was a really excellent

531
00:20:53,680 --> 00:20:51,860
opportunity to be able to have

532
00:20:55,360 --> 00:20:53,690
essentially my own fellowship money to

533
00:20:57,190 --> 00:20:55,370
do a project that was kind of a

534
00:20:58,990 --> 00:20:57,200
high-risk high-reward type of project

535
00:21:00,370 --> 00:20:59,000
that wasn't you know the sort of thing

536
00:21:02,460 --> 00:21:00,380
that you would get funded necessarily

537
00:21:04,390 --> 00:21:02,470
with one of the traditional programs and

538
00:21:06,160 --> 00:21:04,400

throughout the years we've had a lot of

539
00:21:08,470 --> 00:21:06,170
really excellent post talks with icy

540
00:21:10,480 --> 00:21:08,480
worlds team JPL has a very vigorous

541
00:21:12,550 --> 00:21:10,490
postdoc program and so some of those

542
00:21:14,650 --> 00:21:12,560
individuals are shown here and there's

543
00:21:16,390 --> 00:21:14,660
also others I think from the earlier kin

544
00:21:20,080 --> 00:21:16,400
that I had not included in this slide

545
00:21:21,730 --> 00:21:20,090
and then finally we have so many

546
00:21:24,760 --> 00:21:21,740
excellent students that have benefited

547
00:21:26,260 --> 00:21:24,770
from the NAI and at JPL people often ask

548
00:21:28,270 --> 00:21:26,270
so all your students must come from

549
00:21:29,920 --> 00:21:28,280
Caltech right and it's like no now they

550
00:21:31,630 --> 00:21:29,930
come from all over because you have

551
00:21:33,790 --> 00:21:31,640
these NASA internship programs where

552
00:21:35,890 --> 00:21:33,800
students can come from anywhere in the

553
00:21:37,660 --> 00:21:35,900
US or locally in California or even

554
00:21:39,790 --> 00:21:37,670
internationally and they can work with

555
00:21:41,430 --> 00:21:39,800
our team for the summer the spring the

556
00:21:44,650 --> 00:21:41,440
fall you know multiple semesters

557
00:21:46,720 --> 00:21:44,660
anything goes and so we've received

558
00:21:48,880 --> 00:21:46,730
support over these many years in order

559
00:21:50,380 --> 00:21:48,890
to really grow different students

560
00:21:52,090 --> 00:21:50,390
careers and have them do research that

561
00:21:53,500 --> 00:21:52,100
became part of their thesis projects

562
00:21:57,040 --> 00:21:53,510
they publish papers they go to

563
00:21:59,260 --> 00:21:57,050

conferences here's an example of ishik

564
00:22:00,760 --> 00:21:59,270
and I and two students were filming an

565
00:22:02,410 --> 00:22:00,770
article for The Journal of visualized

566
00:22:04,870 --> 00:22:02,420
experiments which is a chemistry video

567
00:22:07,510 --> 00:22:04,880
journal initiated lab work and was in a

568
00:22:09,010 --> 00:22:07,520
small movie there so we had a lot of

569
00:22:12,550 --> 00:22:09,020
excellent students doing great stuff

570
00:22:15,220 --> 00:22:12,560
with this team and I think that is it

571
00:22:17,230 --> 00:22:15,230
oh one more focus groups were a big deal

572
00:22:19,680 --> 00:22:17,240
too and we had a lot of involvement with

573
00:22:21,370 --> 00:22:19,690
the TDE focus group and this really

574
00:22:22,810 --> 00:22:21,380
enhanced our international

575
00:22:24,160 --> 00:22:22,820
collaborations in a big way because

576
00:22:26,500 --> 00:22:24,170
we're able to have meetings at these

577
00:22:28,810 --> 00:22:26,510
Institute's like LC and cab and so on

578
00:22:30,820 --> 00:22:28,820
and this was a major major part of my

579
00:22:33,070 --> 00:22:30,830
networking throughout my postdoc years

580
00:22:41,210 --> 00:22:33,080
and also has been hugely beneficial to

581
00:22:45,860 --> 00:22:43,540
[Applause]

582
00:22:50,660 --> 00:22:45,870
thank you all I think in the interest of

583
00:23:08,510 --> 00:22:50,670
time we will move on to Frank Rosen

584
00:23:10,610 --> 00:23:08,520
spike all right good afternoon thank you

585
00:23:12,410 --> 00:23:10,620
very much for inviting me to speak at

586
00:23:13,010 --> 00:23:12,420
apps icon it's always an honor to be

587
00:23:16,940 --> 00:23:13,020
here

588
00:23:19,100 --> 00:23:16,950

so my point of departure is this beyond

589
00:23:20,890 --> 00:23:19,110
the Darwinian threshold major

590
00:23:23,570 --> 00:23:20,900
transitions viewed through the lens of

591
00:23:26,060 --> 00:23:23,580
astrobiology and what I'd like to do in

592
00:23:28,550 --> 00:23:26,070
the next few minutes is is pose and try

593
00:23:30,530 --> 00:23:28,560
to begin to answer these questions what

594
00:23:33,530 --> 00:23:30,540
is the Darwinian threshold what are

595
00:23:35,270 --> 00:23:33,540
major evolutionary transitions why

596
00:23:38,060 --> 00:23:35,280
should after biologists care about

597
00:23:42,350 --> 00:23:38,070
either and how has the NAI advanced our

598
00:23:44,420 --> 00:23:42,360
understanding of these processes so both

599
00:23:45,950 --> 00:23:44,430
concepts originate with two of the most

600
00:23:49,340 --> 00:23:45,960
original thinkers in the history of

601
00:23:51,800 --> 00:23:49,350
science namely Darwin arguably the

602
00:23:55,160 --> 00:23:51,810
preeminent biologist of the 19th century

603
00:23:57,530 --> 00:23:55,170
and Karl was arguably the preeminent

604
00:24:00,080 --> 00:23:57,540
biologist of the 20th century and of

605
00:24:02,630 --> 00:24:00,090
course Darwin's revolutionary idea is

606
00:24:05,090 --> 00:24:02,640
that all of life can be explained by

607
00:24:09,040 --> 00:24:05,100
natural processes and his other

608
00:24:12,290 --> 00:24:09,050
revolutionary idea is that these

609
00:24:15,770 --> 00:24:12,300
relationships amongst all organisms

610
00:24:18,610 --> 00:24:15,780
extant and extinct can be explained in

611
00:24:20,380 --> 00:24:18,620
terms of ancestor descendant

612
00:24:23,870 --> 00:24:20,390
relationships

613
00:24:28,340 --> 00:24:23,880

now just as Darwin was an astute

614
00:24:32,540 --> 00:24:28,350
observer an obscure historian of visible

615
00:24:34,790 --> 00:24:32,550
forms namely morphology whoas was an

616
00:24:38,330 --> 00:24:34,800
astute natural historian of the

617
00:24:41,480 --> 00:24:38,340
invisible forms in biochemistry and his

618
00:24:44,240 --> 00:24:41,490
revolutionary ideas were that you could

619
00:24:47,810 --> 00:24:44,250
study universal biomolecules and in

620
00:24:52,009 --> 00:24:47,820
particular ribosomal RNAs and establish

621
00:24:54,349 --> 00:24:52,019
these ancestor descendant relationships

622
00:24:57,649 --> 00:24:54,359
and not only established them but

623
00:25:00,079 --> 00:24:57,659
provide evidence conclusive evidence

624
00:25:04,599 --> 00:25:00,089
that all of life is descended from a

625
00:25:07,849 --> 00:25:04,609
common ancestor so in this this cartoon

626
00:25:10,219 --> 00:25:07,859
from a paper by Eugene Koonin he has

627
00:25:12,889 --> 00:25:10,229
another interesting idea and that is the

628
00:25:14,989 --> 00:25:12,899
notion of genetic temperature and that

629
00:25:17,690 --> 00:25:14,999
genetic temperature represents how

630
00:25:20,060 --> 00:25:17,700
information flows amongst repla cons

631
00:25:22,549 --> 00:25:20,070
whether those are populations of

632
00:25:26,979 --> 00:25:22,559
molecules or populations of organisms

633
00:25:30,709 --> 00:25:26,989
and was made the distinction between

634
00:25:34,609 --> 00:25:30,719
information flow before the origin of

635
00:25:37,129 --> 00:25:34,619
cellular life where you had free flow of

636
00:25:39,859 --> 00:25:37,139
information and a constraint on that

637
00:25:42,379 --> 00:25:39,869
information above the point where

638
00:25:47,119 --> 00:25:42,389

cellular life arose and this is what he

639
00:25:49,459 --> 00:25:47,129
refers to as the Darwinian threshold so

640
00:25:51,769 --> 00:25:49,469
taking stock of astrobiologist

641
00:25:54,289 --> 00:25:51,779
traditional themes of prebiotic

642
00:25:56,359 --> 00:25:54,299
chemistry of origin of life life and

643
00:25:58,789 --> 00:25:56,369
extreme environments and bio signatures

644
00:26:01,459 --> 00:25:58,799
a group of us and the evolution

645
00:26:04,789 --> 00:26:01,469
community decided that perhaps there was

646
00:26:07,729 --> 00:26:04,799
an unfilled niche in the astrobiology

647
00:26:10,430 --> 00:26:07,739
portfolio and that is the post cellular

648
00:26:13,339 --> 00:26:10,440
evolution of complexity and specifically

649
00:26:15,979 --> 00:26:13,349
major evolutionary transitions these

650
00:26:20,180 --> 00:26:15,989
increases in complexity that followed

651
00:26:23,149 --> 00:26:20,190
the advent of the Darwinian threshold so

652
00:26:26,749 --> 00:26:23,159
these major transitions can be viewed as

653
00:26:30,169 --> 00:26:26,759
transitions amongst from simple units to

654
00:26:32,509 --> 00:26:30,179
more complex wholes and the assumption

655
00:26:35,810 --> 00:26:32,519
over time of inter interdependence and

656
00:26:38,509 --> 00:26:35,820
autonomy amongst those more complex

657
00:26:41,930 --> 00:26:38,519
wholes which opens the possibility for

658
00:26:44,599 --> 00:26:41,940
division of labor and of course as this

659
00:26:46,839 --> 00:26:44,609
relationship becomes enforced amongst

660
00:26:49,969 --> 00:26:46,849
these subunits the levels of selection

661
00:26:54,799 --> 00:26:49,979
change from this individual to this new

662
00:26:57,019 --> 00:26:54,809
individual and so this is the clearly

663
00:26:59,209 --> 00:26:57,029

while we think of a lot of the tree of

664
00:27:01,729 --> 00:26:59,219
life and natural selection is occurring

665
00:27:04,500 --> 00:27:01,739
by competitive interactions it's clear

666
00:27:07,049 --> 00:27:04,510
that many of life's major transitions in

667
00:27:10,500 --> 00:27:07,059
of cooperative ones including the origin

668
00:27:12,570 --> 00:27:10,510
of stamp metabolism organelles the

669
00:27:14,700 --> 00:27:12,580
various symbiosis across the Tree of

670
00:27:19,549 --> 00:27:14,710
Life as well as the advent of

671
00:27:22,560 --> 00:27:19,559
multicellularity so all of these are

672
00:27:26,960 --> 00:27:22,570
involved microorganisms and as such

673
00:27:30,810 --> 00:27:26,970
these processes are open to the study of

674
00:27:33,630 --> 00:27:30,820
to study using microorganisms and of

675
00:27:35,520 --> 00:27:33,640
doing experimental evolution where you

676
00:27:37,650 --> 00:27:35,530
can control the type and the intensity

677
00:27:41,250 --> 00:27:37,660
of selection population size and

678
00:27:43,460 --> 00:27:41,260
structure and in Stephen Jay Gould nice

679
00:27:46,409 --> 00:27:43,470
metaphor it gives us the possibility of

680
00:27:49,560 --> 00:27:46,419
replaying the tape of our twice history

681
00:27:52,470 --> 00:27:49,570
and examining the ecological and genetic

682
00:27:55,710 --> 00:27:52,480
forces that led in these cases to major

683
00:27:59,480 --> 00:27:55,720
evolutionary transitions and so thus was

684
00:28:01,409 --> 00:27:59,490
born the can seventeen reliving the past

685
00:28:04,680 --> 00:28:01,419
experimental evolution of major

686
00:28:06,419 --> 00:28:04,690
transitions and it's been my honor over

687
00:28:08,549 --> 00:28:06,429
the last four years to help coordinate

688
00:28:11,370 --> 00:28:08,559

the research efforts of this team of

689
00:28:13,409 --> 00:28:11,380
young investigators and so some of the

690
00:28:15,210 --> 00:28:13,419
contributions that we've made over the

691
00:28:17,520 --> 00:28:15,220
last few years we're interested in

692
00:28:20,400 --> 00:28:17,530
evolution of metabolism and how new

693
00:28:23,159 --> 00:28:20,410
genes and new proteins active protein

694
00:28:26,880 --> 00:28:23,169
activities arise and here are some of

695
00:28:29,280 --> 00:28:26,890
the recent papers by some of our team

696
00:28:32,340 --> 00:28:29,290
members and I went in particular I would

697
00:28:34,560 --> 00:28:32,350
call attention to efforts by Shelley

698
00:28:37,860 --> 00:28:34,570
Copley and her associates including von

699
00:28:40,260 --> 00:28:37,870
Cooper who have demonstrated that enzyme

700
00:28:43,169 --> 00:28:40,270
promiscuity which is an intrinsic

701
00:28:46,490 --> 00:28:43,179
property of all enzymes is one of the

702
00:28:49,470 --> 00:28:46,500
major substrates for evolutionary change

703
00:28:52,650 --> 00:28:49,480
so in terms of evolution of symbiosis

704
00:28:55,200 --> 00:28:52,660
how two or more species come to behave

705
00:28:58,500 --> 00:28:55,210
as one John mcCutchan has established

706
00:29:01,280 --> 00:28:58,510
himself as perhaps the preeminent young

707
00:29:03,510 --> 00:29:01,290
investigator walking the earth today

708
00:29:07,200 --> 00:29:03,520
papers showing that the lichen

709
00:29:09,270 --> 00:29:07,210
excuse me the lichen symbiosis which has

710
00:29:11,940 --> 00:29:09,280
been viewed as a simple two member

711
00:29:15,120 --> 00:29:11,950
partnership for 150 years is actually

712
00:29:17,670 --> 00:29:15,130
genomically much more complex a recent

713
00:29:21,240 --> 00:29:17,680

paper in Nature showing that al

714
00:29:23,700 --> 00:29:21,250
symbiosis with with corals are also more

715
00:29:26,130 --> 00:29:23,710
genomically complex and of course the

716
00:29:28,680 --> 00:29:26,140
elegant work joined that insect

717
00:29:31,500 --> 00:29:28,690
endosymbiosis are these wonderful

718
00:29:33,900 --> 00:29:31,510
matreshka doll-like cell within cell

719
00:29:37,740 --> 00:29:33,910
within cell genome within genome within

720
00:29:39,030 --> 00:29:37,750
genome organizations and of course we're

721
00:29:40,860 --> 00:29:39,040
interested in the evolution of

722
00:29:43,640 --> 00:29:40,870
multicellularity and how you get

723
00:29:46,950 --> 00:29:43,650
unicellular forms evolving from

724
00:29:50,460 --> 00:29:46,960
multicellular forms and in this research

725
00:29:54,090 --> 00:29:50,470
a couple of people Matt heron a former

726
00:29:57,270 --> 00:29:54,100
NPP fellow and an NA ICO I and will

727
00:30:00,360 --> 00:29:57,280
Ratcliffe also an nai Co I have made

728
00:30:02,430 --> 00:30:00,370
great strides and so I'll give you just

729
00:30:06,440 --> 00:30:02,440
a little peek into some of their recent

730
00:30:08,940 --> 00:30:06,450
discoveries well first of all

731
00:30:11,190 --> 00:30:08,950
multicellularity has arisen many times

732
00:30:13,020 --> 00:30:11,200
in the history of life at least a couple

733
00:30:15,900 --> 00:30:13,030
of dozen times and this is within the

734
00:30:18,810 --> 00:30:15,910
Eukarya but it's arisen also amongst

735
00:30:20,760 --> 00:30:18,820
prokaryotes how can we study the

736
00:30:23,430 --> 00:30:20,770
evolution of cellulite multicellularity

737
00:30:25,800 --> 00:30:23,440
well we can study the fossil record but

738
00:30:29,490 --> 00:30:25,810

the fossil record is relatively scant

739
00:30:33,420 --> 00:30:29,500
with respect to the early major

740
00:30:35,640 --> 00:30:33,430
transition to multicellularity we can

741
00:30:38,790 --> 00:30:35,650
compare multicellular forms to their

742
00:30:40,560 --> 00:30:38,800
extant unicellular relatives but of

743
00:30:44,220 --> 00:30:40,570
course there's a problem there and that

744
00:30:46,200 --> 00:30:44,230
each of these presumptive that these two

745
00:30:48,870 --> 00:30:46,210
forms have common ancestors but they've

746
00:30:52,290 --> 00:30:48,880
been pursuing their own in evolutionary

747
00:30:55,170 --> 00:30:52,300
trajectories for millions of years for

748
00:30:57,390 --> 00:30:55,180
those groups where you have within a

749
00:30:59,550 --> 00:30:57,400
clade intermediate forms such as you

750
00:31:02,160 --> 00:30:59,560
have within the clarified algae within

751
00:31:04,800 --> 00:31:02,170
the vulva seen algal clay you have the

752
00:31:07,710 --> 00:31:04,810
possibility of you have single-cell

753
00:31:11,870 --> 00:31:07,720
forms you have transitional forms you

754
00:31:14,610 --> 00:31:11,880
have fully formed differentiated

755
00:31:16,860 --> 00:31:14,620
multicellularity with germline in soma

756
00:31:20,220 --> 00:31:16,870
and so what you can do in these cases

757
00:31:22,680 --> 00:31:20,230
then is to take this group organize

758
00:31:25,350 --> 00:31:22,690
their cell biology in relationship to

759
00:31:30,870 --> 00:31:25,360
their phylogeny and generate in this

760
00:31:33,360 --> 00:31:30,880
case by Kirk in 2005 a 12-step program

761
00:31:35,970 --> 00:31:33,370
in relationship to the evolution of

762
00:31:38,610 --> 00:31:35,980
multicellularity or you can try to

763
00:31:41,150 --> 00:31:38,620

evolve in the lab a multicellular form

764
00:31:43,710 --> 00:31:41,160
that looks like one that's becoming

765
00:31:46,710 --> 00:31:43,720
multicellular and this is what Matt and

766
00:31:48,510 --> 00:31:46,720
will have done in a paper that was

767
00:31:51,660 --> 00:31:48,520
carried out in collaboration with Mike

768
00:31:54,240 --> 00:31:51,670
travisano back in 2013 they showed that

769
00:31:56,340 --> 00:31:54,250
you could select for larger size just by

770
00:31:58,590 --> 00:31:56,350
increasing their settling through

771
00:32:00,960 --> 00:31:58,600
centrifugation and come up with a

772
00:32:03,270 --> 00:32:00,970
multicellular form that has its own life

773
00:32:06,330 --> 00:32:03,280
history in a single-cell dispersal phase

774
00:32:09,060 --> 00:32:06,340
and more recently they published a paper

775
00:32:12,270 --> 00:32:09,070
in scientific reports showing that you

776
00:32:14,240 --> 00:32:12,280
can do continuous selection in the

777
00:32:17,030 --> 00:32:14,250
presence of a unicellular predator

778
00:32:19,110 --> 00:32:17,040
Paramecium and come up with these

779
00:32:23,490 --> 00:32:19,120
multicellular forms where you have a

780
00:32:27,539 --> 00:32:23,500
primitive control of cell number within

781
00:32:29,580 --> 00:32:27,549
the multicellular cluster so this is

782
00:32:32,250 --> 00:32:29,590
what you got out of the predation

783
00:32:34,289 --> 00:32:32,260
experiments this is what you get out of

784
00:32:36,450 --> 00:32:34,299
the predation experiments on top here

785
00:32:38,250 --> 00:32:36,460
and while I'm not suggesting that they

786
00:32:41,190 --> 00:32:38,260
have evolved new species in the

787
00:32:43,169 --> 00:32:41,200
laboratory it is true that these forms

788
00:32:45,930 --> 00:32:43,179

that they got in experimental evolution

789
00:32:50,010 --> 00:32:45,940
are quite reminiscent of actual bona

790
00:32:52,230 --> 00:32:50,020
fide species in nature so you have

791
00:32:54,990 --> 00:32:52,240
differentiated multicellularity that can

792
00:32:57,510 --> 00:32:55,000
be evolved in the laboratory these arise

793
00:33:00,090 --> 00:32:57,520
clonally and are therefore new units of

794
00:33:02,789 --> 00:33:00,100
selection and the genetic basis of these

795
00:33:06,570 --> 00:33:02,799
de novo origins of multicellularity are

796
00:33:09,990 --> 00:33:06,580
now within our grasp so in terms of

797
00:33:12,539 --> 00:33:10,000
broader impacts the sort of the

798
00:33:15,330 --> 00:33:12,549
culmination of this work and perhaps the

799
00:33:18,299 --> 00:33:15,340
influence of this work was a recent

800
00:33:21,659 --> 00:33:18,309
conference at Georgia Tech which was

801
00:33:24,600 --> 00:33:21,669
organized by Peter Conlon and NPP

802
00:33:28,140 --> 00:33:24,610
fellows at Georgia Tech as well as will

803
00:33:32,190 --> 00:33:28,150
rackleff and Chris Reinhart who RNA Aiko

804
00:33:34,680 --> 00:33:32,200
is and I would expect that going forward

805
00:33:36,750 --> 00:33:34,690
many of the people who came from all

806
00:33:39,180 --> 00:33:36,760
over the world to this conference will

807
00:33:43,830 --> 00:33:39,190
be submitting proposals that populate

808
00:33:45,870 --> 00:33:43,840
the new RCN the Marcion from early

809
00:33:48,330 --> 00:33:45,880
sales to multicellularity and so with

810
00:33:51,480 --> 00:33:48,340
that I thank the NASA Astrobiology

811
00:33:53,850 --> 00:33:51,490
Institute and I thank it for its funding

812
00:33:56,399 --> 00:33:53,860
for this high-risk high payoff research

813
00:34:05,220 --> 00:33:56,409

that has enabled us to attract a lot of

814
00:34:07,680 --> 00:34:05,230
other funding thank you very much thank

815
00:34:09,599 --> 00:34:07,690
you very much Frank I there's something

816
00:34:11,310 --> 00:34:09,609
that I had meant to say at the end

817
00:34:13,109 --> 00:34:11,320
actually of Laurie's talk so I'm just

818
00:34:15,570 --> 00:34:13,119
gonna go back a little bit but your very

819
00:34:17,550 --> 00:34:15,580
last slide showing your leadership as a

820
00:34:19,230 --> 00:34:17,560
TDE focus group and I always forget what

821
00:34:21,419 --> 00:34:19,240
TD stands for but the T is

822
00:34:24,240 --> 00:34:21,429
thermodynamics and disequilibrium and

823
00:34:27,470 --> 00:34:24,250
entropy may be in there as well but was

824
00:34:30,780 --> 00:34:27,480
just a wonderful example of somebody who

825
00:34:35,609 --> 00:34:30,790
basically had their career development

826
00:34:37,320 --> 00:34:35,619
occur within the astrobiology ecosystem

827
00:34:39,389 --> 00:34:37,330
if you like then becoming an

828
00:34:41,550 --> 00:34:39,399
international leader because this focus

829
00:34:44,339 --> 00:34:41,560
group met internationally on a variety

830
00:34:46,980 --> 00:34:44,349
of continents and lorries developed

831
00:34:49,440 --> 00:34:46,990
collaborations really across the globe

832
00:34:52,619 --> 00:34:49,450
particularly with folks at LC so just I

833
00:34:55,169 --> 00:34:52,629
think a really wonderful example of how

834
00:34:57,170 --> 00:34:55,179
somebody can both benefit and then

835
00:34:59,370 --> 00:34:57,180
really contribute not just

836
00:35:02,730 --> 00:34:59,380
scientifically but to the community

837
00:35:04,530 --> 00:35:02,740
development as well so with that I would

838
00:35:14,170 --> 00:35:04,540

like to turn the podium over to Lauren

839
00:35:17,980 --> 00:35:16,210
Thank You Karl thank you guys very much

840
00:35:24,839 --> 00:35:17,990
for inviting me here thanks for coming

841
00:35:32,470 --> 00:35:24,849
to hear me this will confuse me probably

842
00:35:34,539 --> 00:35:32,480
okay good job Frank um I'm gonna talk a

843
00:35:36,450 --> 00:35:34,549
little bit about I've had to overcome

844
00:35:40,510 --> 00:35:36,460
some barriers to becoming an

845
00:35:43,950 --> 00:35:40,520
astrobiologist I never met Carl Sagan

846
00:35:47,950 --> 00:35:43,960
and I never held moon rocks in my hand

847
00:35:49,440 --> 00:35:47,960
and I was trained as a biochemist

848
00:35:52,120 --> 00:35:49,450
actually a biophysicist and

849
00:35:53,859 --> 00:35:52,130
biophysicists don't think about time you

850
00:35:57,099 --> 00:35:53,869
know we study hemoglobin we teach about

851
00:36:00,430 --> 00:35:57,109
hemoglobin as if it always was and and

852
00:36:02,589 --> 00:36:00,440
as if everything has it and myosin and

853
00:36:05,710 --> 00:36:02,599
things like that so that's that's the

854
00:36:07,029 --> 00:36:05,720
world I come from but I was able to

855
00:36:09,609 --> 00:36:07,039
overcome this and I made a really

856
00:36:12,279 --> 00:36:09,619
important contribution to astrobiology

857
00:36:22,900 --> 00:36:12,289
which is I gave the Heimlich maneuver to

858
00:36:25,870 --> 00:36:22,910
bill shop a lot of people have questions

859
00:36:29,319 --> 00:36:25,880
by judgment on that but I did it it was

860
00:36:40,599 --> 00:36:29,329
just that impulse and so I do have that

861
00:36:42,819 --> 00:36:40,609
I put on my resume okay so so I started

862
00:36:45,099 --> 00:36:42,829
as a biochemist and I had a long career

863
00:36:48,130 --> 00:36:45,109

studying ions and I really thought I

864
00:36:51,700 --> 00:36:48,140
knew more than anyone in the world about

865
00:36:53,410 --> 00:36:51,710
how ions interact with nucleic acids I

866
00:36:56,500 --> 00:36:53,420
studied the ribosome but I also studied

867
00:37:00,309 --> 00:36:56,510
DNA DNA bending RNA folding not a long

868
00:37:01,960 --> 00:37:00,319
career studying ions and then the

869
00:37:05,019 --> 00:37:01,970
ribosome structures came out and I

870
00:37:06,430 --> 00:37:05,029
looked at them as databases so you could

871
00:37:09,010 --> 00:37:06,440
study ions even better

872
00:37:11,950 --> 00:37:09,020
that was what I saw in the ribosome was

873
00:37:13,660 --> 00:37:11,960
a lot of ions and a couple things

874
00:37:15,519 --> 00:37:13,670
happened to me that sort of changed my

875
00:37:17,829 --> 00:37:15,529
life number one is I have a very good

876
00:37:19,269 --> 00:37:17,839
friend in Nicholas HUD who's probably

877
00:37:20,830 --> 00:37:19,279
not here because he never comes to my

878
00:37:31,600 --> 00:37:20,840
talks

879
00:37:32,920 --> 00:37:31,610
oh wait okay okay okay but anyway Nick

880
00:37:34,810 --> 00:37:32,930
was my friend for a lot of years and we

881
00:37:37,090 --> 00:37:34,820
have a lot of scientific overlap amazing

882
00:37:38,470 --> 00:37:37,100
kind of ways we look at things but he

883
00:37:39,790 --> 00:37:38,480
was been very interested in the origin

884
00:37:42,520 --> 00:37:39,800
of life for a long time

885
00:37:47,140 --> 00:37:42,530
and we talked about it a lot and he kind

886
00:37:49,420 --> 00:37:47,150
of pulled me in and and he talked to me

887
00:37:51,970 --> 00:37:49,430
about this ma I and things like that and

888
00:37:52,960 --> 00:37:51,980

kind of educated me that was one of the

889
00:37:54,790 --> 00:37:52,970
things that happened the other thing

890
00:37:57,400 --> 00:37:54,800
that happened is that one time I

891
00:37:58,870 --> 00:37:57,410
actually I had ACL surgery and I was

892
00:38:00,520 --> 00:37:58,880
lying on my couch I had a long time on

893
00:38:03,370 --> 00:38:00,530
my couch and I was just like looking at

894
00:38:05,320 --> 00:38:03,380
the ribosome and looking at the ions in

895
00:38:06,910 --> 00:38:05,330
the ribosome and just like you know I

896
00:38:10,600 --> 00:38:06,920
would just spend like days and days

897
00:38:12,880 --> 00:38:10,610
looking at these ions and I all of a

898
00:38:15,190 --> 00:38:12,890
sudden I was also taking some narcotics

899
00:38:17,890 --> 00:38:15,200
at the time because of my surgery but

900
00:38:18,790 --> 00:38:17,900
anyway I thought these ions have been

901
00:38:22,030 --> 00:38:18,800
here a long time

902
00:38:24,550 --> 00:38:22,040
yeah and I just got this idea that the

903
00:38:28,690 --> 00:38:24,560
ions in the ribosome might tell us a

904
00:38:31,120 --> 00:38:28,700
story and so I and Nick encouraged me I

905
00:38:33,790 --> 00:38:31,130
wrote up and got some ideas I had on how

906
00:38:35,950 --> 00:38:33,800
to think about this and submitted an an

907
00:38:38,170 --> 00:38:35,960
AI proposal a can and I really was an

908
00:38:40,510 --> 00:38:38,180
outsider I didn't I didn't know I'd

909
00:38:43,600 --> 00:38:40,520
never met Carl I'd never met Ed or

910
00:38:45,610 --> 00:38:43,610
anybody in the NI and so I said actually

911
00:38:47,680 --> 00:38:45,620
I remember I was I was walking across

912
00:38:50,950 --> 00:38:47,690
campus and my knee was still really bad

913
00:38:52,930 --> 00:38:50,960

and I had this big box and I just at one

914
00:38:55,210 --> 00:38:52,940
point I just said I cannot get to the

915
00:38:56,950 --> 00:38:55,220
FedEx office and I just I'm not that was

916
00:38:58,330 --> 00:38:56,960
in the old days it was a big box right

917
00:38:59,950 --> 00:38:58,340
it was a heavy box it's not this

918
00:39:04,150 --> 00:38:59,960
electronic thing right you had to submit

919
00:39:06,190 --> 00:39:04,160
like 20 copies of a 200 page proposal

920
00:39:08,410 --> 00:39:06,200
and it weighed a lot and my knee hurt

921
00:39:10,330 --> 00:39:08,420
and I called my wife I said I'm not

922
00:39:12,490 --> 00:39:10,340
submitting this proposal I've just and

923
00:39:13,510 --> 00:39:12,500
she just said stop being a baby and she

924
00:39:17,740 --> 00:39:13,520
came and got me and drove me to the

925
00:39:21,430 --> 00:39:17,750
FedEx so I submitted it so then I forgot

926
00:39:24,670 --> 00:39:21,440
about it and I went on with my life and

927
00:39:28,480 --> 00:39:24,680
a long time later a city my house and my

928
00:39:33,430 --> 00:39:28,490
phone rang and this guy says hi I'm Carl

929
00:39:34,390 --> 00:39:33,440
pillar from the NAI and you know we've

930
00:39:38,800 --> 00:39:34,400
awarded you

931
00:39:41,800 --> 00:39:38,810
this camp this center nei Center and my

932
00:39:46,380 --> 00:39:41,810
wife is right there and I said I think I

933
00:39:50,770 --> 00:39:46,390
got that and she said no you didn't and

934
00:39:54,190 --> 00:39:50,780
and in fact she said that's Nick playing

935
00:39:56,050 --> 00:39:54,200
a joke on you that's what she said she

936
00:39:59,280 --> 00:39:56,060
really said that and then I said I

937
00:40:01,900 --> 00:39:59,290
doesn't sound like Nick you know and so

938
00:40:03,970 --> 00:40:01,910

and then she ate Carl's talking to me

939
00:40:05,530 --> 00:40:03,980
and she starts googly and she's and she

940
00:40:08,020 --> 00:40:05,540
shows me the web page with NASA had been

941
00:40:10,030 --> 00:40:08,030
announced it and she said you caught it

942
00:40:11,860 --> 00:40:10,040
all right so then she believed me and

943
00:40:15,730 --> 00:40:11,870
Carl said you know can you come up to

944
00:40:17,860 --> 00:40:15,740
Washington DC tomorrow for an Emmy I'm

945
00:40:20,710 --> 00:40:17,870
eating and I was like yes I'm coming

946
00:40:23,770 --> 00:40:20,720
and so that's when I went up and I met

947
00:40:25,870 --> 00:40:23,780
all the I met Ed and Estelle and Melissa

948
00:40:28,600 --> 00:40:25,880
and I meant all the NAI staff and I

949
00:40:29,950 --> 00:40:28,610
learned that I didn't know I'd learned

950
00:40:32,890 --> 00:40:29,960
that I needed to know the moons of

951
00:40:34,330 --> 00:40:32,900
Saturn and Jupiter I knew and I learned

952
00:40:39,550 --> 00:40:34,340
I needed to know a lot of things that I

953
00:40:41,230 --> 00:40:39,560
did not know so I went up there and you

954
00:40:44,470 --> 00:40:41,240
know I've been studying these ions and

955
00:40:47,410 --> 00:40:44,480
so then I think 2009 there was this

956
00:40:49,360 --> 00:40:47,420
meeting in Phoenix sort of a strategy

957
00:40:51,610 --> 00:40:49,370
meeting for the NAI and I went to that

958
00:40:52,960 --> 00:40:51,620
meeting and I gave a talk on ions in the

959
00:40:55,180 --> 00:40:52,970
ribosome and what I thought I could

960
00:40:57,360 --> 00:40:55,190
learn about ions in the ribosome and I

961
00:40:59,440 --> 00:40:57,370
was talking about magnesium and the

962
00:41:02,380 --> 00:40:59,450
magnesium's in the ribosome are really

963
00:41:04,360 --> 00:41:02,390

remarkable ok so this is this is a

964
00:41:06,640 --> 00:41:04,370
bacterial in our Caleb ribosome ok so

965
00:41:08,740 --> 00:41:06,650
this is going back before Luca this is

966
00:41:10,810 --> 00:41:08,750
these are magnesium ions that have been

967
00:41:11,770 --> 00:41:10,820
sitting here without moving for about 4

968
00:41:13,960 --> 00:41:11,780
billion years

969
00:41:15,430 --> 00:41:13,970
ok so these are this is just incredible

970
00:41:17,290 --> 00:41:15,440
and they're hydrated there's waters

971
00:41:19,090 --> 00:41:17,300
around them and those waters have not

972
00:41:21,430 --> 00:41:19,100
moved in fact the protons on the waters

973
00:41:23,470 --> 00:41:21,440
have not moved so this is like you know

974
00:41:27,190 --> 00:41:23,480
this is the most permanent thing in the

975
00:41:29,290 --> 00:41:27,200
universe that is not cold I think maybe

976
00:41:31,570 --> 00:41:29,300
somebody can argue with me but I think

977
00:41:33,610 --> 00:41:31,580
that's true anyway so I was talking

978
00:41:35,680 --> 00:41:33,620
about these magnesium ions and all the

979
00:41:39,250 --> 00:41:35,690
things we could learn about evolution

980
00:41:41,380 --> 00:41:39,260
deep deep evolution and and I and I

981
00:41:44,380 --> 00:41:41,390
considered myself an expert I've been

982
00:41:45,910 --> 00:41:44,390
studying ions and nucleic acids for 20

983
00:41:48,240 --> 00:41:45,920
years I'd done a lot of crystallography

984
00:41:52,200 --> 00:41:48,250
all sorts of stuff and after my talk is

985
00:41:53,990 --> 00:41:52,210
comes up to me and this I didn't know

986
00:41:56,550 --> 00:41:54,000
this guy I didn't know anybody actually

987
00:41:59,850 --> 00:41:56,560
and he said I think you're wrong about

988
00:42:03,600 --> 00:41:59,860

magnesium he said those magnesium ions

989
00:42:07,830 --> 00:42:03,610
are probably replacements of a previous

990
00:42:11,040 --> 00:42:07,840
ion and they were originally iron and I

991
00:42:14,720 --> 00:42:11,050
scoffed at him and I said iron degrades

992
00:42:18,840 --> 00:42:14,730
RNA you cannot have iron in RNA together

993
00:42:20,930 --> 00:42:18,850
and I felt a little smug and he said you

994
00:42:24,510 --> 00:42:20,940
know that ancient earth was an toxic

995
00:42:25,950 --> 00:42:24,520
don't you and I said yes even though I'm

996
00:42:28,620 --> 00:42:25,960
not sure I can't remember if I really

997
00:42:30,930 --> 00:42:28,630
did I may not have I may not have know

998
00:42:36,960 --> 00:42:30,940
now in my mind I think I did but I'm not

999
00:42:40,290 --> 00:42:36,970
really sure so that guy of course I

1000
00:42:41,940 --> 00:42:40,300
should have known who he was but anyway

1001
00:42:44,010 --> 00:42:41,950
I thought about what he said for a long

1002
00:42:46,410 --> 00:42:44,020
time and this wasn't not really part of

1003
00:42:48,420 --> 00:42:46,420
our nai project or Center to look at

1004
00:42:52,200 --> 00:42:48,430
iron but I just kept thinking it was

1005
00:42:54,780 --> 00:42:52,210
kind of haunting me and really for I

1006
00:42:58,800 --> 00:42:54,790
think maybe a year and actually we

1007
00:43:00,720 --> 00:42:58,810
submitted Laurie talked about this this

1008
00:43:02,370 --> 00:43:00,730
little director's grab and we submitted

1009
00:43:04,650 --> 00:43:02,380
a little proposal two minutes okay I

1010
00:43:07,410 --> 00:43:04,660
gotta go fast and Carl sent it out for

1011
00:43:09,090 --> 00:43:07,420
review and it was horribly reviewed that

1012
00:43:11,760 --> 00:43:09,100
we were gonna like look at RNA and iron

1013
00:43:13,200 --> 00:43:11,770

and it came back and he was like Lauren

1014
00:43:14,940 --> 00:43:13,210
I want to give this to you but I can't

1015
00:43:21,630 --> 00:43:14,950
because people don't like your proposal

1016
00:43:23,700 --> 00:43:21,640
so we didn't get it but ultimately we we

1017
00:43:25,170 --> 00:43:23,710
did start working on this and we and in

1018
00:43:27,330 --> 00:43:25,180
fact we wrote a paper where we showed

1019
00:43:30,600 --> 00:43:27,340
that RNA folds beautifully with iron and

1020
00:43:31,890 --> 00:43:30,610
RNA works really well in fact and we

1021
00:43:33,780 --> 00:43:31,900
submit it and we had a very hard time

1022
00:43:35,190 --> 00:43:33,790
publishing this paper okay if you look

1023
00:43:37,470 --> 00:43:35,200
it's in PLoS this is like the fifth

1024
00:43:42,510 --> 00:43:37,480
journal we submitted it to it was

1025
00:43:44,820 --> 00:43:42,520
rejected everywhere and finally we sort

1026
00:43:46,830 --> 00:43:44,830
of established this whole thing and I'll

1027
00:43:51,270 --> 00:43:46,840
just say that actually there's a Marcus

1028
00:43:53,130 --> 00:43:51,280
it has a presentation 245 on Thursday or

1029
00:43:54,840 --> 00:43:53,140
he's talking about our iron project we

1030
00:43:55,800 --> 00:43:54,850
have an ongoing iron project it turns

1031
00:43:59,280 --> 00:43:55,810
out we were right they should have

1032
00:44:01,200 --> 00:43:59,290
accepted our paper and I just want to

1033
00:44:01,599 --> 00:44:01,210
show you this is our ancient earth I

1034
00:44:04,150 --> 00:44:01,609
think we

1035
00:44:06,549 --> 00:44:04,160
the only dedicated facility in the world

1036
00:44:09,160 --> 00:44:06,559
where you can study RNA and iron in the

1037
00:44:12,519 --> 00:44:09,170
absence of oxygen so this is our our

1038
00:44:14,170 --> 00:44:12,529

glovebox devoted to iron in the absence

1039
00:44:16,809 --> 00:44:14,180
of oxygen and the presence of iron and

1040
00:44:18,309 --> 00:44:16,819
that I should say that's Jennifer glass

1041
00:44:21,460 --> 00:44:18,319
over there and she is my close

1042
00:44:24,549 --> 00:44:21,470
collaborator on this project and in the

1043
00:44:26,019 --> 00:44:24,559
very back is Marcus and he's talking

1044
00:44:28,029 --> 00:44:26,029
about he's basically we can do

1045
00:44:30,460 --> 00:44:28,039
translation all the enzymes involved in

1046
00:44:32,049 --> 00:44:30,470
translation the ribosome it works with

1047
00:44:34,359 --> 00:44:32,059
iron we can take the ribosome now and

1048
00:44:36,970 --> 00:44:34,369
put it back to its ancient roots it's

1049
00:44:38,710 --> 00:44:36,980
it's anoxic root roots and make it work

1050
00:44:41,470 --> 00:44:38,720
in the presence of iron so all of that

1051
00:44:43,920 --> 00:44:41,480
is a story I'd like to thank Carl he

1052
00:44:46,779 --> 00:44:43,930
just raised up the science I could do

1053
00:44:48,700 --> 00:44:46,789
and he just you know such a good guy and

1054
00:44:50,999 --> 00:44:48,710
I'd like to thank the nei and all the

1055
00:44:54,420 --> 00:44:51,009
mostella and all the NIH staff Melissa

1056
00:44:58,920 --> 00:44:54,790
[Music]

1057
00:45:05,940 --> 00:45:03,990
I love that story of Lawrence

1058
00:45:08,010 --> 00:45:05,950
not because I deserve any personal

1059
00:45:10,309 --> 00:45:08,020
credit for it but because we had a

1060
00:45:17,760 --> 00:45:10,319
process in place that brought together

1061
00:45:20,160 --> 00:45:17,770
investigators that that brought together

1062
00:45:22,230 --> 00:45:20,170
investigators who didn't know each other

1063
00:45:23,819 --> 00:45:22,240

who had never worked together and who

1064
00:45:27,359 --> 00:45:23,829
would never have been talking to each

1065
00:45:29,039 --> 00:45:27,369
other and Lauren and Bob Hazen were two

1066
00:45:31,950 --> 00:45:29,049
such investigators and they came

1067
00:45:35,819 --> 00:45:31,960
together at a meeting that we had

1068
00:45:37,529 --> 00:45:35,829
organized for that purpose and this is

1069
00:45:41,400 --> 00:45:37,539
what emerged a whole new understanding

1070
00:45:44,370 --> 00:45:41,410
of the nature of the ribosome so thank

1071
00:45:47,460 --> 00:45:44,380
you very much Lauren for for being there

1072
00:45:50,210 --> 00:45:47,470
and for contributing that and now I'd

1073
00:46:04,140 --> 00:45:50,220
like to call up Jen eigen Broad for a

1074
00:46:07,289 --> 00:46:04,150
personal perspective so uh Carl when you

1075
00:46:09,180 --> 00:46:07,299
emailed me to invite me to give this

1076
00:46:12,390 --> 00:46:09,190
I couldn't believe twenty years had gone

1077
00:46:15,480 --> 00:46:12,400
by and and still I'm having a bit

1078
00:46:18,029 --> 00:46:15,490
trouble grasping all of that I am a

1079
00:46:20,250 --> 00:46:18,039
project scientist for two mission

1080
00:46:22,529 --> 00:46:20,260
concepts both of them are searching for

1081
00:46:24,049 --> 00:46:22,539
evidence of life on other places in our

1082
00:46:29,730 --> 00:46:24,059
solar system

1083
00:46:31,890 --> 00:46:29,740
more importantly 20-some years ago I was

1084
00:46:35,130 --> 00:46:31,900
one of the first PhD students that came

1085
00:46:39,150 --> 00:46:35,140
out of the NAI program out of an EMI

1086
00:46:42,559 --> 00:46:39,160
program meaning the first wave of us it

1087
00:46:45,420 --> 00:46:42,569
was astrobiology it was NASA

1088
00:46:48,480 --> 00:46:45,430

Astrobiology Institute they got me to

1089
00:46:51,120 --> 00:46:48,490
where I am today and so the perspective

1090
00:46:53,700 --> 00:46:51,130
that I want to share is what that path

1091
00:46:55,620 --> 00:46:53,710
was as a representation of all the

1092
00:46:58,859 --> 00:46:55,630
richness that we have gone from this and

1093
00:47:02,250 --> 00:46:58,869
what any eye really means to the student

1094
00:47:06,319 --> 00:47:02,260
side of those who have benefited the

1095
00:47:09,180 --> 00:47:06,329
most I think from all of this because

1096
00:47:11,760 --> 00:47:09,190
what we have what we have gained from

1097
00:47:13,560 --> 00:47:11,770
any eye is still happening

1098
00:47:17,849 --> 00:47:13,570
it's still going affect the future and

1099
00:47:19,730 --> 00:47:17,859
the next generations so of before I get

1100
00:47:23,430 --> 00:47:19,740
started really all those details

1101
00:47:25,440 --> 00:47:23,440
yesterday three terms came up and I was

1102
00:47:27,510 --> 00:47:25,450
kind of shocked that I never really

1103
00:47:30,450 --> 00:47:27,520
reflected on what they meant

1104
00:47:32,880 --> 00:47:30,460
there's multidisciplinary so here's one

1105
00:47:35,579 --> 00:47:32,890
of my favorite paintings by Roth kook

1106
00:47:37,440 --> 00:47:35,589
it's um you know it's he just likes to

1107
00:47:40,349 --> 00:47:37,450
put in different splotches of color and

1108
00:47:42,630 --> 00:47:40,359
these to me represent the two different

1109
00:47:45,060 --> 00:47:42,640
disciplines they're put together and

1110
00:47:47,970 --> 00:47:45,070
they work together you know it's it's

1111
00:47:51,180 --> 00:47:47,980
just a representation but this is

1112
00:47:52,920 --> 00:47:51,190
interdisciplinary and imagine all of

1113
00:47:54,960 --> 00:47:52,930

these colors up here all these little

1114
00:47:57,510 --> 00:47:54,970
spots being different disciplines and

1115
00:48:00,120 --> 00:47:57,520
they merge together and when they merge

1116
00:48:02,579 --> 00:48:00,130
together you can do different things and

1117
00:48:06,329 --> 00:48:02,589
so for instance biology chemistry

1118
00:48:09,240 --> 00:48:06,339
geology physics start bringing in

1119
00:48:11,670 --> 00:48:09,250
planetary stuff all of that stuff starts

1120
00:48:14,070 --> 00:48:11,680
to blend together and what you end up

1121
00:48:17,099 --> 00:48:14,080
with is something bigger it's a bigger

1122
00:48:20,099 --> 00:48:17,109
picture and it's these bigger pictures

1123
00:48:24,000 --> 00:48:20,109
that we couldn't really address until we

1124
00:48:27,540 --> 00:48:24,010
had the tools and the programs and the

1125
00:48:30,680 --> 00:48:27,550
structures to an infrastructure to help

1126
00:48:33,599 --> 00:48:30,690
make this science more or less

1127
00:48:35,490 --> 00:48:33,609
transdisciplinary and what we mean by

1128
00:48:37,890 --> 00:48:35,500
that is all of these disciplines

1129
00:48:41,339 --> 00:48:37,900
integrating together in such a way that

1130
00:48:42,660 --> 00:48:41,349
they become more or less holistic it's a

1131
00:48:45,030 --> 00:48:42,670
single strategy going forward

1132
00:48:49,589 --> 00:48:45,040
but they're all blended together we draw

1133
00:48:52,859 --> 00:48:49,599
up the walls so let's go back to me now

1134
00:48:55,980 --> 00:48:52,869
where I started this is me up in British

1135
00:48:57,390 --> 00:48:55,990
Columbia I love the wilderness I was in

1136
00:48:58,940 --> 00:48:57,400
the one in the last of the old school

1137
00:49:03,390 --> 00:48:58,950
geology field Kansas were out there

1138
00:49:06,599 --> 00:49:03,400

mapping geology in Tagish Lake area so

1139
00:49:08,310 --> 00:49:06,609
I'm over here on the side here and I was

1140
00:49:10,710 --> 00:49:08,320
a hardcore geologist I mean this is the

1141
00:49:12,180 --> 00:49:10,720
things I did I even went into geophysics

1142
00:49:14,640 --> 00:49:12,190
for a little while I went the bird

1143
00:49:17,760 --> 00:49:14,650
station flew around for two months over

1144
00:49:19,470 --> 00:49:17,770
the ice looking at whether or not there

1145
00:49:22,500 --> 00:49:19,480
were volcanoes under the ice where the

1146
00:49:24,150 --> 00:49:22,510
ice flowing all these cool interesting

1147
00:49:25,080 --> 00:49:24,160
things but you know what geophysics just

1148
00:49:28,070 --> 00:49:25,090
wasn't quite my

1149
00:49:31,560 --> 00:49:28,080
thing so I moved on and I studied

1150
00:49:33,380 --> 00:49:31,570
paleoclimatology paleoclimatology to me

1151
00:49:36,510 --> 00:49:33,390
as an example of this multidisciplinary

1152
00:49:38,040 --> 00:49:36,520
approach at least at that time it was I

1153
00:49:39,750 --> 00:49:38,050
brought edited chemistry and I did

1154
00:49:41,370 --> 00:49:39,760
geology it's a mineralogy in there I

1155
00:49:43,560 --> 00:49:41,380
kind of brought those things together

1156
00:49:46,170 --> 00:49:43,570
trying to understand things but there

1157
00:49:48,960 --> 00:49:46,180
were things missing it was like there

1158
00:49:52,230 --> 00:49:48,970
were gaps and how everything connected

1159
00:49:54,300 --> 00:49:52,240
and it didn't make sense to me there was

1160
00:49:56,490 --> 00:49:54,310
something missing there so that's when I

1161
00:49:59,480 --> 00:49:56,500
went after what we would call Earth

1162
00:50:02,730 --> 00:49:59,490
System science and trying to understand

1163
00:50:04,680 --> 00:50:02,740

how everything gets connected that took

1164
00:50:08,460 --> 00:50:04,690
me to Penn State so again I'm still

1165
00:50:10,950 --> 00:50:08,470
geologist at this point Here I am on on

1166
00:50:12,690 --> 00:50:10,960
the roadside with Lee come over in the

1167
00:50:14,790 --> 00:50:12,700
book cliffs when the classic places we

1168
00:50:17,880 --> 00:50:14,800
look at sure trigger fee I'm trying to

1169
00:50:19,680 --> 00:50:17,890
understand all of this trying to like

1170
00:50:20,910 --> 00:50:19,690
they're just really absorbing everything

1171
00:50:22,680 --> 00:50:20,920
that's being thrown at me from the

1172
00:50:25,770 --> 00:50:22,690
geology side but still seeking the Earth

1173
00:50:29,250 --> 00:50:25,780
System science side and I was at this

1174
00:50:33,930 --> 00:50:29,260
time that I got is simulated into Nai as

1175
00:50:35,940 --> 00:50:33,940
a PhD student and talk about opening

1176
00:50:37,560 --> 00:50:35,950
doors when we talk about it's not I'm

1177
00:50:40,080 --> 00:50:37,570
not talking about my career I'm talking

1178
00:50:42,480 --> 00:50:40,090
about how I think about everything

1179
00:50:45,960 --> 00:50:42,490
around me as a scientist the questions

1180
00:50:47,910 --> 00:50:45,970
that I ask as a geologist I was asking

1181
00:50:49,410 --> 00:50:47,920
questions about biology that's named odd

1182
00:50:52,170 --> 00:50:49,420
that there weren't a lot other people

1183
00:50:54,720 --> 00:50:52,180
doing it and here's what here's were a

1184
00:50:57,740 --> 00:50:54,730
classic picture for my PhD type work I

1185
00:51:00,780 --> 00:50:57,750
went to the Hamersley Basin in Australia

1186
00:51:03,990 --> 00:51:00,790
investigated the the geology this there

1187
00:51:05,640 --> 00:51:04,000
the biogeochemistry here I have on the

1188
00:51:08,730 --> 00:51:05,650

bottom here if you can barely see it

1189
00:51:10,770 --> 00:51:08,740
this was might like the the the category

1190
00:51:14,130 --> 00:51:10,780
of discipline that I was in paleo

1191
00:51:19,760 --> 00:51:14,140
isotope organic biogeochemistry and

1192
00:51:23,310 --> 00:51:19,770
stratigraphy that is interdisciplinary

1193
00:51:26,430 --> 00:51:23,320
that is it I mean like I don't ask me to

1194
00:51:28,980 --> 00:51:26,440
repeat it and in the craziest on top of

1195
00:51:32,030 --> 00:51:28,990
all that when it came time to take my

1196
00:51:34,590 --> 00:51:32,040
comprehensive exam for future the ph.d

1197
00:51:38,120 --> 00:51:34,600
katefreeman kind of find images like

1198
00:51:39,800 --> 00:51:38,130
well we don't really know how to do this

1199
00:51:42,410 --> 00:51:39,810
there was only a few of us that who had

1200
00:51:45,020 --> 00:51:42,420
gotten to this point so we're gonna make

1201
00:51:47,030 --> 00:51:45,030
you get tested on all of these topics so

1202
00:51:50,030 --> 00:51:47,040
I had analytical chemistry isotope

1203
00:51:53,839 --> 00:51:50,040
geochemistry microbial biogeochemistry

1204
00:51:55,700 --> 00:51:53,849
and stratigraphy and then one of those

1205
00:51:57,250 --> 00:51:55,710
questions I said this is open book test

1206
00:51:59,690 --> 00:51:57,260
you had two hours answer each question

1207
00:52:03,500 --> 00:51:59,700
one of those questions was how would you

1208
00:52:05,230 --> 00:52:03,510
do should sugar free on Mars how ironic

1209
00:52:08,240 --> 00:52:05,240
it is that I'm working on Mars now

1210
00:52:10,940 --> 00:52:08,250
because at that time we weren't sure if

1211
00:52:14,809 --> 00:52:10,950
the river channels that were there were

1212
00:52:15,589 --> 00:52:14,819
formed by water or maybe liquid co2 we

1213
00:52:17,510 --> 00:52:15,599

just didn't know

1214
00:52:22,120 --> 00:52:17,520
so things have come a long way since

1215
00:52:25,790 --> 00:52:22,130
then as I progressed through my career

1216
00:52:29,150 --> 00:52:25,800
so did the science and and the breadth

1217
00:52:31,579 --> 00:52:29,160
of that so he just kind of you know spin

1218
00:52:33,470 --> 00:52:31,589
through a few of these Here I am up in

1219
00:52:37,790 --> 00:52:33,480
small barred Merced murchison fjord

1220
00:52:40,069 --> 00:52:37,800
trying to understand that paleo isotope

1221
00:52:42,710 --> 00:52:40,079
organic biochemistry in a different

1222
00:52:44,720 --> 00:52:42,720
place but also the continuum of that

1223
00:52:46,670 --> 00:52:44,730
record the whole way through today where

1224
00:52:49,839 --> 00:52:46,680
the modern organisms that are there what

1225
00:52:52,579 --> 00:52:49,849
are they doing and can we decipher that

1226
00:52:54,770 --> 00:52:52,589
we wanted to look at that life what is

1227
00:52:57,050 --> 00:52:54,780
it well in extreme environments it's

1228
00:52:58,849 --> 00:52:57,060
hard to get to it when you've got so

1229
00:53:02,210 --> 00:52:58,859
much contamination around you we are

1230
00:53:04,490 --> 00:53:02,220
walking clouds of microbiome we alone

1231
00:53:06,829 --> 00:53:04,500
contaminate things so we spent two years

1232
00:53:08,210 --> 00:53:06,839
trying to figure out how to clean things

1233
00:53:10,220 --> 00:53:08,220
this is a picture of Leonov bending

1234
00:53:12,260 --> 00:53:10,230
swabbing the inside of a core barrel and

1235
00:53:14,329 --> 00:53:12,270
then when we finally figured out how to

1236
00:53:16,130 --> 00:53:14,339
clean things we actually went out to the

1237
00:53:19,220 --> 00:53:16,140
glaciers and we started looking for

1238
00:53:22,819 --> 00:53:19,230

signatures of life okay we want to do

1239
00:53:25,609 --> 00:53:22,829
that on other ocean worlds now back then

1240
00:53:30,319 --> 00:53:25,619
when we did this most of the stuff that

1241
00:53:32,390 --> 00:53:30,329
we got was contaminated still and we

1242
00:53:34,220 --> 00:53:32,400
didn't have techniques that worked very

1243
00:53:38,750 --> 00:53:34,230
well I'm a a lot of the approaches that

1244
00:53:41,240 --> 00:53:38,760
we use while transdisciplinary in nature

1245
00:53:43,730 --> 00:53:41,250
and how we want to do it the techniques

1246
00:53:45,800 --> 00:53:43,740
themselves didn't work so we're back to

1247
00:53:47,880 --> 00:53:45,810
the lab Here I am with Melissa Trainor

1248
00:53:49,980 --> 00:53:47,890
were working in the lab together

1249
00:53:52,380 --> 00:53:49,990
and technology developments how do we

1250
00:53:56,190 --> 00:53:52,390
make the measurements we need on another

1251
00:53:59,730 --> 00:53:56,200
planet this is an another shift okay so

1252
00:54:02,420 --> 00:53:59,740
here I am the the breadth of what I love

1253
00:54:04,940 --> 00:54:02,430
what I am doing as an interdisciplinary

1254
00:54:08,190 --> 00:54:04,950
transdisciplinary scientist is expanding

1255
00:54:09,599 --> 00:54:08,200
meanwhile all along NASA Astrobiology

1256
00:54:11,460 --> 00:54:09,609
Institute has been fundamental and

1257
00:54:12,660 --> 00:54:11,470
making all of this stuff happen in this

1258
00:54:16,589 --> 00:54:12,670
case it was Goddard Center of

1259
00:54:17,970 --> 00:54:16,599
astrobiology Atacama Desert

1260
00:54:20,819 --> 00:54:17,980
ok-hee it will finally figured out how

1261
00:54:23,400 --> 00:54:20,829
to do things cleanly and look at this

1262
00:54:27,960 --> 00:54:23,410
we've got a new technology it's called a

1263
00:54:30,809 --> 00:54:27,970

kitchen spoon so this is how we're

1264
00:54:32,819 --> 00:54:30,819
sampling in the Atacama Desert looking

1265
00:54:35,789 --> 00:54:32,829
for signs of extreme life that's living

1266
00:54:37,109 --> 00:54:35,799
there and we did indeed find that but

1267
00:54:39,809 --> 00:54:37,119
when we go to apply that kind of

1268
00:54:41,339 --> 00:54:39,819
knowledge to a place like Mars or other

1269
00:54:43,079 --> 00:54:41,349
places in the solar system we had be

1270
00:54:46,140 --> 00:54:43,089
cognizant of the things that were not

1271
00:54:49,650 --> 00:54:46,150
familiar with like radiation so here's a

1272
00:54:54,269 --> 00:54:49,660
picture of a synchro cyclotron where we

1273
00:54:57,660 --> 00:54:54,279
were exposing analog materials to eight

1274
00:55:00,650 --> 00:54:57,670
million years worth of 200 mega electron

1275
00:55:03,509 --> 00:55:00,660
volts of protons there's a lot of

1276
00:55:06,839 --> 00:55:03,519
radiation but that's what you get on

1277
00:55:08,099 --> 00:55:06,849
places like Mars or in route from here

1278
00:55:09,630 --> 00:55:08,109
to Mars or something like that

1279
00:55:11,279 --> 00:55:09,640
so we were trying to understand well

1280
00:55:12,499 --> 00:55:11,289
what happens to this type of stuff if it

1281
00:55:16,289 --> 00:55:12,509
was ever there

1282
00:55:18,420 --> 00:55:16,299
again the transdisciplinary the bubble

1283
00:55:21,870 --> 00:55:18,430
the cloud of all the stuff that we take

1284
00:55:23,549 --> 00:55:21,880
in is growing this is just my two cents

1285
00:55:26,549 --> 00:55:23,559
on this but there's a whole communities

1286
00:55:28,170 --> 00:55:26,559
working on this a la this culminates in

1287
00:55:30,299 --> 00:55:28,180
something like a mission here is a

1288
00:55:32,640 --> 00:55:30,309

picture of Sam as the gold box it's

1289
00:55:35,819 --> 00:55:32,650
going into the base of the Curiosity

1290
00:55:39,779 --> 00:55:35,829
rover and we've been on Mars now forever

1291
00:55:41,249 --> 00:55:39,789
six years exploring all the types of

1292
00:55:45,509 --> 00:55:41,259
stuff that I was exploring as a

1293
00:55:47,249 --> 00:55:45,519
geologist as a annek biogeochemist I

1294
00:55:50,130 --> 00:55:47,259
said hope biogeochemist

1295
00:55:52,109 --> 00:55:50,140
all this stuff is going on I'm a

1296
00:55:54,089 --> 00:55:52,119
geologist again but I'm also an

1297
00:55:59,130 --> 00:55:54,099
astrobiologist through the eyes and

1298
00:56:01,180 --> 00:55:59,140
tools of a rover it's come full circle

1299
00:56:02,589 --> 00:56:01,190
to some degree

1300
00:56:04,660 --> 00:56:02,599
in that you know I started off as a

1301
00:56:07,540 --> 00:56:04,670
geologist I ended up here doing Mars

1302
00:56:12,220 --> 00:56:07,550
geology but it carried with me all of

1303
00:56:14,650 --> 00:56:12,230
the astrobiology with it and now I moved

1304
00:56:18,010 --> 00:56:14,660
on to other places I've gone back to the

1305
00:56:19,720 --> 00:56:18,020
ice here it's Enceladus Enceladus is one

1306
00:56:23,140 --> 00:56:19,730
of the places where I am project

1307
00:56:25,540 --> 00:56:23,150
scientists for a mission concept so I

1308
00:56:27,460 --> 00:56:25,550
want to kind of end this with um just

1309
00:56:30,910 --> 00:56:27,470
the one of those nice little concluding

1310
00:56:33,280 --> 00:56:30,920
remarks when I was first asked to do

1311
00:56:39,069 --> 00:56:33,290
this talk I wasn't sure what I was going

1312
00:56:42,550 --> 00:56:39,079
to say but and and then reflecting after

1313
00:56:44,440 --> 00:56:42,560

yesterday's conversation at the the Town

1314
00:56:45,280 --> 00:56:44,450
Hall on the multidisciplinary versus

1315
00:56:48,510 --> 00:56:45,290
interdisciplinary versus

1316
00:56:53,069 --> 00:56:48,520
transdisciplinary made me realize that

1317
00:56:57,069 --> 00:56:53,079
nei has really enabled me and

1318
00:57:00,609 --> 00:56:57,079
generations of scientists to think

1319
00:57:02,740 --> 00:57:00,619
broader than disciplines their

1320
00:57:06,880 --> 00:57:02,750
disciplines can be like walls of some

1321
00:57:11,859 --> 00:57:06,890
degree or buckets and an nai has allowed

1322
00:57:13,900 --> 00:57:11,869
us to not even see them anymore I was

1323
00:57:18,069 --> 00:57:13,910
talking to Alex Pavlov yesterday he is

1324
00:57:21,390 --> 00:57:18,079
an atmospheric modeler and that's what

1325
00:57:23,920 --> 00:57:21,400
his training us and he's actually doing

1326
00:57:26,950 --> 00:57:23,930
microbial simulations like he's doing

1327
00:57:31,420 --> 00:57:26,960
Mars simulations with microbes in the

1328
00:57:33,370 --> 00:57:31,430
lab he's on biology at all to feed back

1329
00:57:36,130 --> 00:57:33,380
into his atmospheric studies but it's

1330
00:57:38,410 --> 00:57:36,140
another example of how we kind of broken

1331
00:57:41,170 --> 00:57:38,420
through what used to be walls they're

1332
00:57:43,930 --> 00:57:41,180
not disciplines anymore nei has really

1333
00:57:47,920 --> 00:57:43,940
allowed the science of understanding

1334
00:57:49,540 --> 00:57:47,930
life to evolve into something uniquely

1335
00:57:53,069 --> 00:57:49,550
different than it ever was previously

1336
00:57:57,460 --> 00:57:53,079
and it's hard to explain what that is

1337
00:58:00,940 --> 00:57:57,470
but it's it's sorry Mary you're looking

1338
00:58:02,530 --> 00:58:00,950

at her shot it's something uniquely

1339
00:58:04,480 --> 00:58:02,540
different than what we had previously

1340
00:58:07,180 --> 00:58:04,490
thought and I'm saying life I'm saying

1341
00:58:10,270 --> 00:58:07,190
life as the search for how we think of

1342
00:58:11,950 --> 00:58:10,280
it how we study it and in doing so we

1343
00:58:13,900 --> 00:58:11,960
really are turning the next chapter in

1344
00:58:14,830 --> 00:58:13,910
astrobiology and searching for life

1345
00:58:17,110 --> 00:58:14,840
beyond Earth

1346
00:58:19,630 --> 00:58:17,120
and I think that all of us here may

1347
00:58:22,300 --> 00:58:19,640
actually get to see that search start up

1348
00:58:23,350 --> 00:58:22,310
again and take place and I'm sure we are

1349
00:58:37,480 --> 00:58:23,360
looking forward to it

1350
00:58:39,760 --> 00:58:37,490
so with that I'll in Jen thank you so

1351
00:58:41,650 --> 00:58:39,770
much when I when I sent that email to

1352
00:58:47,530 --> 00:58:41,660
you I knew you would come up with

1353
00:58:50,830 --> 00:58:47,540
something perfect as you did okay

1354
00:58:53,320 --> 00:58:50,840
the let me just say while Karen meetcha

1355
00:58:57,820 --> 00:58:53,330
is coming up Aaron is the is the next

1356
00:59:02,460 --> 00:58:57,830
speaker I just like to say that we it's

1357
00:59:05,050 --> 00:59:02,470
really wonderful to have a few

1358
00:59:08,650 --> 00:59:05,060
representative stories such as Laurie

1359
00:59:12,610 --> 00:59:08,660
such as Jen's we're going to hear at

1360
00:59:15,220 --> 00:59:12,620
least one more today but it's just been

1361
00:59:17,770 --> 00:59:15,230
so gratifying over the years to see so

1362
00:59:20,230 --> 00:59:17,780
many young researchers come up through

1363
00:59:23,500 --> 00:59:20,240

this this ecosystem and it's been one of

1364
00:59:35,070 --> 00:59:23,510
the things that I feel really privileged

1365
00:59:45,600 --> 00:59:42,930
and forgetting to do my job thank you

1366
00:59:48,420 --> 00:59:45,610
very much for the invitation so I want

1367
00:59:51,000 --> 00:59:48,430
to give a perspective on the University

1368
00:59:53,790 --> 00:59:51,010
of Hawaii astrobiology Institute and

1369
00:59:56,250 --> 00:59:53,800
some of the lessons learned and I'd like

1370
00:59:58,560 --> 00:59:56,260
to start with when we first proposed

1371
01:00:01,350 --> 00:59:58,570
there was actually a failed proposal I

1372
01:00:03,420 --> 01:00:01,360
think either can one or can too in part

1373
01:00:06,360 --> 01:00:03,430
because it was too narrowly focused so

1374
01:00:08,490 --> 01:00:06,370
when cam 3 came around we started to

1375
01:00:10,770 --> 01:00:08,500
look at the existing teams and saw that

1376
01:00:13,950 --> 01:00:10,780
many of them were multidisciplinary

1377
01:00:15,780 --> 01:00:13,960
covering a whole range of topics and to

1378
01:00:18,990 --> 01:00:15,790
me that seemed like it's the wrong way

1379
01:00:21,900 --> 01:00:19,000
to go and I really liked the VPL model

1380
01:00:23,580 --> 01:00:21,910
of a single focus question where you

1381
01:00:26,250 --> 01:00:23,590
address it from many different

1382
01:00:29,460 --> 01:00:26,260
disciplines so our team came up with the

1383
01:00:32,040 --> 01:00:29,470
idea of having a watery Drake equation

1384
01:00:34,050 --> 01:00:32,050
or exploring the formation of habitable

1385
01:00:35,820 --> 01:00:34,060
worlds through the story of water

1386
01:00:39,290 --> 01:00:35,830
bringing in disciplines such as

1387
01:00:41,580 --> 01:00:39,300
cosmochemistry astronomy geochemistry

1388
01:00:45,180 --> 01:00:41,590

disc chemistry and even in the early

1389
01:00:46,830 --> 01:00:45,190
years then looking at extremophiles but

1390
01:00:48,710 --> 01:00:46,840
I'd like to start with some of the ways

1391
01:00:51,810 --> 01:00:48,720
in which we fostered this

1392
01:00:55,680 --> 01:00:51,820
interdisciplinarity and how its resulted

1393
01:00:57,720 --> 01:00:55,690
in some activities most of our funding

1394
01:00:59,790 --> 01:00:57,730
like many of the teams went into funding

1395
01:01:02,370 --> 01:00:59,800
the early career scientists postdocs and

1396
01:01:03,810 --> 01:01:02,380
graduate students and we decided that it

1397
01:01:05,730 --> 01:01:03,820
was very important to have them

1398
01:01:07,620 --> 01:01:05,740
co-located so they could talk to each

1399
01:01:09,630 --> 01:01:07,630
other and I think someone this morning

1400
01:01:12,870 --> 01:01:09,640
said it's not just about putting people

1401
01:01:15,450 --> 01:01:12,880
together well sometimes it is you have

1402
01:01:17,580 --> 01:01:15,460
to learn each other's language you have

1403
01:01:19,590 --> 01:01:17,590
to understand what you don't know and

1404
01:01:21,630 --> 01:01:19,600
that's what happened by throwing our

1405
01:01:23,790 --> 01:01:21,640
scientists together they started to

1406
01:01:26,670 --> 01:01:23,800
learn about other disciplines this

1407
01:01:29,220 --> 01:01:26,680
resulted in a lot of interdisciplinary

1408
01:01:31,290 --> 01:01:29,230
collaborations that spread further with

1409
01:01:33,360 --> 01:01:31,300
some of our senior scientists looking at

1410
01:01:35,190 --> 01:01:33,370
how disciplines interact with each

1411
01:01:37,310 --> 01:01:35,200
others you can see in the graphic in the

1412
01:01:39,690 --> 01:01:37,320
lower right and it spread to

1413
01:01:42,480 --> 01:01:39,700

investigating how teams across na l

1414
01:01:44,610 --> 01:01:42,490
started to talk to each other I think

1415
01:01:47,160 --> 01:01:44,620
one of the big really important

1416
01:01:48,339 --> 01:01:47,170
fundamental programs that we had was the

1417
01:01:50,859 --> 01:01:48,349
development of

1418
01:01:53,589 --> 01:01:50,869
summer and winter astrobiology schools

1419
01:01:55,509 --> 01:01:53,599
this was a brainchild of Bo riper if he

1420
01:01:58,120 --> 01:01:55,519
said you're never going to build a

1421
01:02:00,190 --> 01:01:58,130
network of scientists unless they start

1422
01:02:02,710 --> 01:02:00,200
to get to know each other and the best

1423
01:02:04,269 --> 01:02:02,720
way to do this is in a focused

1424
01:02:06,759 --> 01:02:04,279
environment not just where they're

1425
01:02:09,460 --> 01:02:06,769
teaching them different Sciences but you

1426
01:02:12,249 --> 01:02:09,470
have the opportunity to network to learn

1427
01:02:14,700 --> 01:02:12,259
about each other in social environments

1428
01:02:17,469 --> 01:02:14,710
and so this started the two-week-long

1429
01:02:19,839 --> 01:02:17,479
schools we began to collaborate with

1430
01:02:22,569 --> 01:02:19,849
will get wolfg a part at the Nordic

1431
01:02:26,739 --> 01:02:22,579
astrobiology Institute and this has

1432
01:02:29,140 --> 01:02:26,749
resulted in 135 alumni that I now see

1433
01:02:31,479 --> 01:02:29,150
very proudly are leaders in the field of

1434
01:02:34,089 --> 01:02:31,489
astrobiology and I'd like to thank this

1435
01:02:36,700 --> 01:02:34,099
also helped play a role in the Europeans

1436
01:02:40,469 --> 01:02:36,710
really ramping up and they're now

1437
01:02:42,969 --> 01:02:40,479
forming their own astrobiology Institute

1438
01:02:45,130 --> 01:02:42,979

so I want to give you two examples of

1439
01:02:47,650 --> 01:02:45,140
why stuffing the postdocs into the same

1440
01:02:49,359 --> 01:02:47,660
office was useful one day James

1441
01:02:52,569 --> 01:02:49,369
Stevenson who was a bioinformatics

1442
01:02:54,880 --> 01:02:52,579
worked in microbial environments turned

1443
01:02:56,799 --> 01:02:54,890
to lydia hallice who's a Cosmo chemist

1444
01:02:59,079 --> 01:02:56,809
working on Mars meteorites and just

1445
01:03:01,120 --> 01:02:59,089
asked how much boron is there on Mars

1446
01:03:03,489 --> 01:03:01,130
and she said why on earth would I care

1447
01:03:05,109 --> 01:03:03,499
he said well it's kind of important for

1448
01:03:06,969 --> 01:03:05,119
life and it you know they had a long

1449
01:03:09,339 --> 01:03:06,979
discussion she said well you know what

1450
01:03:12,400 --> 01:03:09,349
I've got meteorites in the lab from Mars

1451
01:03:14,890 --> 01:03:12,410
and I have ion probe time tomorrow

1452
01:03:16,479 --> 01:03:14,900
why don't we measure something and so

1453
01:03:19,209 --> 01:03:16,489
they did and it became a wonderful

1454
01:03:21,670 --> 01:03:19,219
collaboration that led to a very high

1455
01:03:24,700 --> 01:03:21,680
profile paper looking at the possibility

1456
01:03:27,509 --> 01:03:24,710
of formation of ribose and an

1457
01:03:30,700 --> 01:03:27,519
environment conducive to life on Mars

1458
01:03:33,279 --> 01:03:30,710
another area was tracing the origin of

1459
01:03:37,120 --> 01:03:33,289
Earth's water many people for many years

1460
01:03:40,839 --> 01:03:37,130
since the missions to comets Halley's

1461
01:03:43,089 --> 01:03:40,849
Comet had thought about d2h isotopes as

1462
01:03:45,219 --> 01:03:43,099
a tracer of the origin of water on earth

1463
01:03:46,509 --> 01:03:45,229

but everybody was looking at this from

1464
01:03:49,239 --> 01:03:46,519
the point of view of comparing it to

1465
01:03:51,099 --> 01:03:49,249
earth ocean water and a bunch of the

1466
01:03:52,930 --> 01:03:51,109
team started to get together and think

1467
01:03:55,150 --> 01:03:52,940
well you know the geologist said there's

1468
01:03:56,890 --> 01:03:55,160
more water inside the earth than on the

1469
01:03:58,100 --> 01:03:56,900
earth the astronomers said there's water

1470
01:04:00,020 --> 01:03:58,110
in the earth

1471
01:04:01,700 --> 01:04:00,030
and everyone started to think about it

1472
01:04:03,680 --> 01:04:01,710
and said you know what maybe the water

1473
01:04:06,800 --> 01:04:03,690
on the earth isn't what we should be

1474
01:04:09,350 --> 01:04:06,810
measuring and so that led to geology

1475
01:04:11,600 --> 01:04:09,360
expeditions baffin island iceland and

1476
01:04:14,120 --> 01:04:11,610
the discovery that probably the water in

1477
01:04:16,430 --> 01:04:14,130
the earth is very different and this has

1478
01:04:18,710 --> 01:04:16,440
led to some remarkable questions about

1479
01:04:23,090 --> 01:04:18,720
how we really would trace the origin of

1480
01:04:25,130 --> 01:04:23,100
water in the solar system so many years

1481
01:04:28,520 --> 01:04:25,140
of work with the team has led to some

1482
01:04:30,530 --> 01:04:28,530
ideas developing a mission and many of

1483
01:04:33,770 --> 01:04:30,540
you have seen these marvelous pictures

1484
01:04:36,170 --> 01:04:33,780
from Alma showing you know nowadays that

1485
01:04:38,200 --> 01:04:36,180
we can actually look at the process of

1486
01:04:43,400 --> 01:04:38,210
birth of planets and other star systems

1487
01:04:45,410 --> 01:04:43,410
you see these dark lanes of gas gas and

1488
01:04:48,080 --> 01:04:45,420

dust where maybe planets have cleared

1489
01:04:49,670 --> 01:04:48,090
out gaps we're looking at the process of

1490
01:04:51,950 --> 01:04:49,680
planet formation but what we're not

1491
01:04:54,080 --> 01:04:51,960
seeing is the formation of planets in

1492
01:04:55,670 --> 01:04:54,090
the habitable zone what we really want

1493
01:04:57,790 --> 01:04:55,680
to understand is how you build a world

1494
01:05:00,440 --> 01:04:57,800
that has the right ingredients for life

1495
01:05:02,960 --> 01:05:00,450
people are proposing now for the decadal

1496
01:05:05,570 --> 01:05:02,970
survey the next generation of these very

1497
01:05:08,270 --> 01:05:05,580
large arrays which will have the ability

1498
01:05:11,560 --> 01:05:08,280
now the resolution and the sensitivity

1499
01:05:14,210 --> 01:05:11,570
to watch this process unfold in

1500
01:05:16,040 --> 01:05:14,220
extrasolar planetary systems we will

1501
01:05:18,110 --> 01:05:16,050
watch the formation of planets and

1502
01:05:20,630 --> 01:05:18,120
habitable zones and look at their

1503
01:05:23,900 --> 01:05:20,640
chemistry but the question is how would

1504
01:05:26,060 --> 01:05:23,910
you do this in our solar system we can't

1505
01:05:28,220 --> 01:05:26,070
go back in time so what we have to do is

1506
01:05:30,950 --> 01:05:28,230
look at the leftover remnants of the

1507
01:05:33,500 --> 01:05:30,960
process here namely we want to trace the

1508
01:05:35,840 --> 01:05:33,510
isotopes in the young solar system and

1509
01:05:39,140 --> 01:05:35,850
that's best done with primitive objects

1510
01:05:40,550 --> 01:05:39,150
that haven't been altered before Cosmo

1511
01:05:42,710 --> 01:05:40,560
chemists have been looking at meteorites

1512
01:05:45,560 --> 01:05:42,720
for years they've been thermally altered

1513
01:05:48,860 --> 01:05:45,570

we've had spectacular measurements from

1514
01:05:51,590 --> 01:05:48,870
comet missions their pristine preserved

1515
01:05:53,360 --> 01:05:51,600
remnants of the early solar system but

1516
01:05:55,700 --> 01:05:53,370
we don't really know the dynamical

1517
01:05:57,620 --> 01:05:55,710
history of particular objects we've

1518
01:05:59,780 --> 01:05:57,630
explored icy satellites which have

1519
01:06:02,090 --> 01:05:59,790
thermally evolved and I won't even bring

1520
01:06:05,510 --> 01:06:02,100
up the interstellar objects because we

1521
01:06:07,880 --> 01:06:05,520
only have one so far however we have icy

1522
01:06:10,420 --> 01:06:07,890
asteroids that are preserving this

1523
01:06:11,920 --> 01:06:10,430
primitive signature

1524
01:06:14,170 --> 01:06:11,930
and I think one lesson to be learned

1525
01:06:17,319 --> 01:06:14,180
from bringing the disciplines together

1526
01:06:19,240 --> 01:06:17,329
as this is not an easy question you get

1527
01:06:20,799 --> 01:06:19,250
a chemical fingerprint in all the

1528
01:06:23,109 --> 01:06:20,809
building blocks that make up a solar

1529
01:06:26,349 --> 01:06:23,119
system and that chemical fingerprint

1530
01:06:29,020 --> 01:06:26,359
depends on a gradient and temperature it

1531
01:06:31,450 --> 01:06:29,030
depends on the physics and each isotope

1532
01:06:34,299 --> 01:06:31,460
will behave in a different manner so you

1533
01:06:36,520 --> 01:06:34,309
have different tracers but then it all

1534
01:06:39,579 --> 01:06:36,530
gets scrambled up as the plant planets

1535
01:06:42,910 --> 01:06:39,589
are assembling so if we imagine that in

1536
01:06:45,280 --> 01:06:42,920
our solar system as the current paradigm

1537
01:06:48,130 --> 01:06:45,290
now thinks Jupiter formed early Oh

1538
01:06:50,319 --> 01:06:48,140

probably opened a gap in the disk this

1539
01:06:53,079 --> 01:06:50,329
impedes the inward flow of icy material

1540
01:06:55,390 --> 01:06:53,089
such that the habitable worlds in our

1541
01:06:57,370 --> 01:06:55,400
solar system formed in the hot inner

1542
01:06:58,660 --> 01:06:57,380
disk where it's harder to get volatile

1543
01:07:01,540 --> 01:06:58,670
and organics

1544
01:07:03,790 --> 01:07:01,550
but then as Jupiter grows its gaseous

1545
01:07:05,940 --> 01:07:03,800
envelope gives it a lot of mass and it

1546
01:07:07,950 --> 01:07:05,950
starts to toss around the planetesimals

1547
01:07:10,630 --> 01:07:07,960
where they come from

1548
01:07:13,270 --> 01:07:10,640
depends on whether Jupiter formed and

1549
01:07:15,910 --> 01:07:13,280
didn't move or whether it migrated so

1550
01:07:19,059 --> 01:07:15,920
the key I think is to actually sample

1551
01:07:21,280 --> 01:07:19,069
the region where Jupiter tossed material

1552
01:07:23,620 --> 01:07:21,290
and that's in the outer asteroid belt

1553
01:07:26,430 --> 01:07:23,630
so in fact by combining different

1554
01:07:28,900 --> 01:07:26,440
disciplines cosmochemistry disk dynamics

1555
01:07:32,200 --> 01:07:28,910
interstellar medium chemistry and earth

1556
01:07:34,780 --> 01:07:32,210
geology you can begin to look at where

1557
01:07:38,049 --> 01:07:34,790
did the material come from in our solar

1558
01:07:40,180 --> 01:07:38,059
system that brings habitable ingredients

1559
01:07:41,829 --> 01:07:40,190
or ingredients to a habitable world and

1560
01:07:44,049 --> 01:07:41,839
we can compare that to extrasolar

1561
01:07:46,809 --> 01:07:44,059
systems and so I think the way to do

1562
01:07:49,120 --> 01:07:46,819
that is with a discovery class mission

1563
01:07:51,250 --> 01:07:49,130

and so that's where combining the

1564
01:07:54,400 --> 01:07:51,260
disciplines with our team has been

1565
01:07:57,220 --> 01:07:54,410
leading I just want to finish off with

1566
01:07:59,319 --> 01:07:57,230
where it started and I think again one

1567
01:08:01,210 --> 01:07:59,329
of the really fundamental things aside

1568
01:08:03,970 --> 01:08:01,220
from allowing different disciplines to

1569
01:08:06,250 --> 01:08:03,980
talk to each other with Nai has been the

1570
01:08:08,890 --> 01:08:06,260
remarkable ability to train the next

1571
01:08:10,660 --> 01:08:08,900
generation and form those critical

1572
01:08:13,480 --> 01:08:10,670
networks where you actually think

1573
01:08:15,280 --> 01:08:13,490
outside the box ask that stupid

1574
01:08:17,110 --> 01:08:15,290
kindergartner question I mean I'm sure

1575
01:08:19,450 --> 01:08:17,120
all of you have done outreach with

1576
01:08:21,640 --> 01:08:19,460
kindergartners they are not afraid to

1577
01:08:23,439 --> 01:08:21,650
ask that stupid question and it's

1578
01:08:24,039 --> 01:08:23,449
remarkable when you get adults together

1579
01:08:25,749 --> 01:08:24,049
they're not

1580
01:08:27,459 --> 01:08:25,759
afraid to ask the stupid question if

1581
01:08:30,039 --> 01:08:27,469
it's not in their field because they're

1582
01:08:32,499 --> 01:08:30,049
not supposed to know that answer so by

1583
01:08:34,780 --> 01:08:32,509
having these astrobiology summer in

1584
01:08:37,419 --> 01:08:34,790
winter schools we've given the people

1585
01:08:39,370 --> 01:08:37,429
the environment and the conditions to

1586
01:08:41,499 --> 01:08:39,380
start that discussion and so now we have

1587
01:08:43,720 --> 01:08:41,509
a generation of people ready to ask

1588
01:08:53,049 --> 01:08:43,730

these questions across different

1589
01:08:55,329 --> 01:08:53,059
disciplines thank you thank you very

1590
01:08:57,970 --> 01:08:55,339
much Karen Karen's work really has been

1591
01:09:00,129 --> 01:08:57,980
so instrumental in that ecosystem that

1592
01:09:03,269 --> 01:09:00,139
I've referred to of training and

1593
01:09:06,669 --> 01:09:03,279
educating the next generation of

1594
01:09:09,970 --> 01:09:06,679
astrobiologists and now I turned the

1595
01:09:16,149 --> 01:09:09,980
podium over to our co convener Dave D

1596
01:09:18,099 --> 01:09:16,159
Marais so before lunch Karl said now

1597
01:09:19,599 --> 01:09:18,109
with Tori holers talk were transitioning

1598
01:09:21,700 --> 01:09:19,609
into the afternoon where you're going to

1599
01:09:26,589 --> 01:09:21,710
hear from early career investigators and

1600
01:09:28,599 --> 01:09:26,599
mid-career and I said oh god but that

1601
01:09:31,510 --> 01:09:28,609
actually as I was eating lunch I thought

1602
01:09:33,609 --> 01:09:31,520
of Bill Schulz talk and that my early

1603
01:09:36,099 --> 01:09:33,619
career experience actually was with PPR

1604
01:09:37,899 --> 01:09:36,109
G and everything that bill said about

1605
01:09:40,329 --> 01:09:37,909
teamwork and having a good time and

1606
01:09:42,069 --> 01:09:40,339
everything just totally applied and in

1607
01:09:44,229 --> 01:09:42,079
many ways that was the sort of the

1608
01:09:46,479 --> 01:09:44,239
forerunner spirit of what we're talking

1609
01:09:48,490 --> 01:09:46,489
about today so you know this is the

1610
01:09:51,430 --> 01:09:48,500
longer view I guess going back a few

1611
01:09:53,680 --> 01:09:51,440
decades on that same topic microbial

1612
01:09:55,660 --> 01:09:53,690
mats again it was bill that introduced

1613
01:09:58,390 --> 01:09:55,670

me to going to Baja and seeing these

1614
01:10:00,780 --> 01:09:58,400
wonderful mats down there and the

1615
01:10:03,490 --> 01:10:00,790
perspective in my life had changed was

1616
01:10:04,990 --> 01:10:03,500
that I thought of biofilms is something

1617
01:10:08,049 --> 01:10:05,000
that you brush off your teeth twice a

1618
01:10:10,990 --> 01:10:08,059
day and an outcome of bad housekeeping

1619
01:10:13,149 --> 01:10:11,000
in your bathroom but actually found that

1620
01:10:14,560 --> 01:10:13,159
there's a lot more to biofilms as you

1621
01:10:16,959 --> 01:10:14,570
will see shortly and I'm sure you

1622
01:10:18,700 --> 01:10:16,969
already know so here's the connection

1623
01:10:20,530 --> 01:10:18,710
here and I guess to get to the details

1624
01:10:22,839 --> 01:10:20,540
of it there's just a number of reasons

1625
01:10:24,700 --> 01:10:22,849
why these photosynthetic microbial mats

1626
01:10:26,350 --> 01:10:24,710
are really important in astrobiology I

1627
01:10:28,870 --> 01:10:26,360
think they're one of the central nodes

1628
01:10:31,569 --> 01:10:28,880
of what it is that we're doing first of

1629
01:10:33,819 --> 01:10:31,579
all they're the oldest most widespread

1630
01:10:35,890 --> 01:10:33,829
ecosystems that we have documented so

1631
01:10:37,660 --> 01:10:35,900
far the remarkably complete

1632
01:10:39,280 --> 01:10:37,670
self-contained ecosystems

1633
01:10:40,689 --> 01:10:39,290
it's everything you want to know just in

1634
01:10:42,430 --> 01:10:40,699
your hand

1635
01:10:44,020 --> 01:10:42,440
they're probably hosted several key

1636
01:10:46,120 --> 01:10:44,030
evolutionary events given their

1637
01:10:49,840 --> 01:10:46,130
antiquity and their importance in

1638
01:10:51,310 --> 01:10:49,850

ecology and the key thing for physiology

1639
01:10:53,919 --> 01:10:51,320
is that the micro environments within

1640
01:10:56,200 --> 01:10:53,929
mats differ markedly from the external

1641
01:10:57,780 --> 01:10:56,210
environment steep changing chemical and

1642
01:11:00,220 --> 01:10:57,790
light gradients mean that the physiology

1643
01:11:02,890 --> 01:11:00,230
that's relevant is not something you

1644
01:11:05,439 --> 01:11:02,900
measure in a culture medium in a pure

1645
01:11:06,850 --> 01:11:05,449
solution you know pure culture and of

1646
01:11:08,590 --> 01:11:06,860
course the punch line again for

1647
01:11:10,689 --> 01:11:08,600
understanding the early rock record is

1648
01:11:12,130 --> 01:11:10,699
mats create abundant and diverse bio

1649
01:11:14,520 --> 01:11:12,140
signature so there's all kinds of

1650
01:11:17,470 --> 01:11:14,530
incentives for studying these things

1651
01:11:20,110 --> 01:11:17,480
this wiring diagram which is sort of the

1652
01:11:22,300 --> 01:11:20,120
ecosystem of the mat starting oh yeah

1653
01:11:26,590 --> 01:11:22,310
you push the back button it goes back

1654
01:11:29,110 --> 01:11:26,600
amazing pushing the this is the button I

1655
01:11:31,810 --> 01:11:29,120
want to push ah this is basically an

1656
01:11:33,459 --> 01:11:31,820
entire ecosystem rather like a forest

1657
01:11:35,830 --> 01:11:33,469
with the canopy organisms the

1658
01:11:37,240 --> 01:11:35,840
cyanobacteria and the carbon flowing

1659
01:11:39,209 --> 01:11:37,250
down through all these other organisms

1660
01:11:42,459 --> 01:11:39,219
creates this incredibly diverse

1661
01:11:43,840 --> 01:11:42,469
ecosystem but the in the theme of this

1662
01:11:45,939 --> 01:11:43,850
session what I really want to highlight

1663
01:11:48,610 --> 01:11:45,949

is that it this is a fundamentally

1664
01:11:50,800 --> 01:11:48,620
interdisciplinary topic of study and

1665
01:11:52,570 --> 01:11:50,810
that is to say that you've always got

1666
01:11:53,939 --> 01:11:52,580
the microbiology in here but you have

1667
01:11:56,110 --> 01:11:53,949
the chemistry because you have a lot of

1668
01:11:59,229 --> 01:11:56,120
photochemistry that's actually happening

1669
01:12:01,030 --> 01:11:59,239
with the chemical intermediates that are

1670
01:12:02,590 --> 01:12:01,040
here there's a lot of physics in this

1671
01:12:04,780 --> 01:12:02,600
because we're talking about the light

1672
01:12:07,150 --> 01:12:04,790
regime and how scattering and other

1673
01:12:09,100 --> 01:12:07,160
optical effects really determine that

1674
01:12:10,720 --> 01:12:09,110
micro environment that is so important

1675
01:12:12,430 --> 01:12:10,730
for shaping the physiology do these

1676
01:12:14,229 --> 01:12:12,440
things and then of course you have the

1677
01:12:15,970 --> 01:12:14,239
geologic aspect and that is that the

1678
01:12:18,310 --> 01:12:15,980
products that could potentially go into

1679
01:12:20,380 --> 01:12:18,320
the geologic record are subject to a

1680
01:12:21,930 --> 01:12:20,390
bunch of processes of very of great

1681
01:12:25,240 --> 01:12:21,940
interest to sedimentology stand

1682
01:12:28,030 --> 01:12:25,250
geologists so you know it's really an

1683
01:12:31,209 --> 01:12:28,040
argument right here for a it really

1684
01:12:33,250 --> 01:12:31,219
takes a team an ecosystem of scientists

1685
01:12:35,979 --> 01:12:33,260
of diverse capabilities to study this

1686
01:12:37,450 --> 01:12:35,989
kind of ecosystem and the shaming aspect

1687
01:12:39,669 --> 01:12:37,460
of it is that once you realize how

1688
01:12:41,200 --> 01:12:39,679

exquisite the system is you figure of

1689
01:12:43,120 --> 01:12:41,210
Jesus my team had better be at least

1690
01:12:45,729 --> 01:12:43,130
half as efficient as this community is

1691
01:12:48,060 --> 01:12:45,739
that we're trying to study and so it

1692
01:12:50,290 --> 01:12:48,070
does motivate you given the incredible

1693
01:12:51,280 --> 01:12:50,300
fine-tuning that has been done in this

1694
01:12:55,270 --> 01:12:51,290
ecosystem over

1695
01:12:57,130 --> 01:12:55,280
time one key example of this is that the

1696
01:12:59,110 --> 01:12:57,140
rates of oxygen 'ok photosynthesis that

1697
01:13:00,400 --> 01:12:59,120
we measured our hide the highest rates

1698
01:13:02,830 --> 01:13:00,410
that have ever been measured on earth

1699
01:13:05,260 --> 01:13:02,840
compared even either to a coastal

1700
01:13:07,600 --> 01:13:05,270
ecosystem or a rainforest so these

1701
01:13:09,250 --> 01:13:07,610
things are incredibly productive part of

1702
01:13:11,680 --> 01:13:09,260
the reason for that which we discovered

1703
01:13:13,690 --> 01:13:11,690
by making these rate measurements is

1704
01:13:16,060 --> 01:13:13,700
that all the major processes within the

1705
01:13:19,300 --> 01:13:16,070
mats oxygen production sulfate reduction

1706
01:13:22,630 --> 01:13:19,310
oxic respiration and so forth are all

1707
01:13:24,550 --> 01:13:22,640
finely tuned to match to each other and

1708
01:13:27,040 --> 01:13:24,560
when you change the temperature they all

1709
01:13:28,780 --> 01:13:27,050
change in concert if you took each of

1710
01:13:30,130 --> 01:13:28,790
these processes independently they would

1711
01:13:31,090 --> 01:13:30,140
change differently as a function of

1712
01:13:33,130 --> 01:13:31,100
temperature you put them in the

1713
01:13:35,260 --> 01:13:33,140

ecosystem they are lockstep with each

1714
01:13:37,810 --> 01:13:35,270
other and this high coupling efficiency

1715
01:13:39,340 --> 01:13:37,820
is part of the reason they can drive

1716
01:13:41,920 --> 01:13:39,350
these very high rates of primary

1717
01:13:44,680 --> 01:13:41,930
production and for to understand that

1718
01:13:46,240 --> 01:13:44,690
you have to understand the ecosystem so

1719
01:13:48,280 --> 01:13:46,250
that's just another example of how the

1720
01:13:51,160 --> 01:13:48,290
whole being greater than the sum of the

1721
01:13:53,020 --> 01:13:51,170
parts one of the big benefits then was

1722
01:13:54,670 --> 01:13:53,030
being involved with nei I mean we had

1723
01:13:57,400 --> 01:13:54,680
done this work for a number of years but

1724
01:13:59,620 --> 01:13:57,410
then nei just a nihilist to scale up big

1725
01:14:01,450 --> 01:13:59,630
time to get a number of people to

1726
01:14:03,490 --> 01:14:01,460
collaborate with and just to approach it

1727
01:14:06,850 --> 01:14:03,500
at the proper scale to really begin to

1728
01:14:08,410 --> 01:14:06,860
drill into this a great collaboration

1729
01:14:09,700 --> 01:14:08,420
with the University of Colorado John

1730
01:14:12,790 --> 01:14:09,710
spirit and mentioned this I think

1731
01:14:14,680 --> 01:14:12,800
earlier this key paper by Ruth ley this

1732
01:14:16,750 --> 01:14:14,690
was one of the first real demonstrations

1733
01:14:20,080 --> 01:14:16,760
of norm paces environmental sort of

1734
01:14:22,120 --> 01:14:20,090
genomics capability that just an

1735
01:14:23,860 --> 01:14:22,130
incredible diversity in fact you know we

1736
01:14:26,830 --> 01:14:23,870
never could really converge on what the

1737
01:14:28,900 --> 01:14:26,840
total number of so-called species were

1738
01:14:30,700 --> 01:14:28,910

in these things and just really looked

1739
01:14:32,560 --> 01:14:30,710
into a big dark room with a very dim

1740
01:14:35,470 --> 01:14:32,570
flashlight saying oh man there's more to

1741
01:14:36,850 --> 01:14:35,480
these mats than we we had figured and it

1742
01:14:38,920 --> 01:14:36,860
was through the nei with this

1743
01:14:41,050 --> 01:14:38,930
collaboration that we were able to make

1744
01:14:42,790 --> 01:14:41,060
that revelation of course now that's

1745
01:14:44,230 --> 01:14:42,800
common people have done this a number of

1746
01:14:45,970 --> 01:14:44,240
ecosystems yeah of course it's

1747
01:14:47,890 --> 01:14:45,980
incredibly complex out there but this is

1748
01:14:50,320 --> 01:14:47,900
really one of the first times that we

1749
01:14:52,380 --> 01:14:50,330
were able to demonstrate that we took

1750
01:14:56,230 --> 01:14:52,390
that forward looking into gypsum crusts

1751
01:14:58,480 --> 01:14:56,240
later on with nai support we were

1752
01:15:00,550 --> 01:14:58,490
actually able to map the different types

1753
01:15:03,100 --> 01:15:00,560
of phototrophic organisms down through

1754
01:15:04,380 --> 01:15:03,110
the gypsum mat these are course the sign

1755
01:15:06,330 --> 01:15:04,390
of bacteria in the diet

1756
01:15:09,600 --> 01:15:06,340
at the top and the purple photosynthetic

1757
01:15:12,630 --> 01:15:09,610
bacteria basically and oxygenic photos

1758
01:15:14,850 --> 01:15:12,640
tropes further down and this is where we

1759
01:15:16,500 --> 01:15:14,860
began to really couple the populations

1760
01:15:18,510 --> 01:15:16,510
and their distribution with depth with

1761
01:15:20,130 --> 01:15:18,520
the actual functions that are going on

1762
01:15:22,590 --> 01:15:20,140
that we could measure with other

1763
01:15:24,960 --> 01:15:22,600

methodologies and really this is now I

1764
01:15:26,550 --> 01:15:24,970
think where microbial ecology is going

1765
01:15:28,710 --> 01:15:26,560
right now you have this ability to map

1766
01:15:30,720 --> 01:15:28,720
these populations and understand their

1767
01:15:32,880 --> 01:15:30,730
physiologies but now in the context of

1768
01:15:35,760 --> 01:15:32,890
how they work together in a physiologic

1769
01:15:37,860 --> 01:15:35,770
sense within the ecosystem and this was

1770
01:15:40,620 --> 01:15:37,870
again a direct outcome of the ability to

1771
01:15:42,690 --> 01:15:40,630
incorporate specialists who can do the

1772
01:15:45,420 --> 01:15:42,700
genetic work people actually making the

1773
01:15:46,980 --> 01:15:45,430
physiologic measurements and of course

1774
01:15:48,780 --> 01:15:46,990
just a beautiful a visually beautiful

1775
01:15:51,540 --> 01:15:48,790
demonstration of this is when Victoria

1776
01:15:53,610 --> 01:15:51,550
Orphan George joined our group again

1777
01:15:56,610 --> 01:15:53,620
during the time we had the nai support

1778
01:15:58,200 --> 01:15:56,620
and she was just she she's a genius in a

1779
01:16:00,990 --> 01:15:58,210
number of ways but one of the ways is

1780
01:16:03,300 --> 01:16:01,000
adapting staining techniques to the some

1781
01:16:05,490 --> 01:16:03,310
really challenging environments and here

1782
01:16:07,290 --> 01:16:05,500
you're looking at trying to do

1783
01:16:09,150 --> 01:16:07,300
fluorescent tags in a community that

1784
01:16:10,830 --> 01:16:09,160
just glows in the dark when you hit it

1785
01:16:12,360 --> 01:16:10,840
with light because of all the photo

1786
01:16:15,660 --> 01:16:12,370
pigments that are in there and yet she

1787
01:16:17,700 --> 01:16:15,670
figured out a way to make a probes for

1788
01:16:20,510 --> 01:16:17,710

methanogens actually but also later on

1789
01:16:23,280 --> 01:16:20,520
working with David fight now probes for

1790
01:16:25,020 --> 01:16:23,290
sulfate-reducing bacteria so when you

1791
01:16:26,490 --> 01:16:25,030
look at this is like a millimeter here

1792
01:16:29,130 --> 01:16:26,500
and you're looking down through the mat

1793
01:16:31,800 --> 01:16:29,140
you see the photo pigments are glowing

1794
01:16:33,330 --> 01:16:31,810
here in red the DNA stain course is all

1795
01:16:34,830 --> 01:16:33,340
over the place and so when you put those

1796
01:16:37,170 --> 01:16:34,840
two together you get purple so you're

1797
01:16:38,940 --> 01:16:37,180
looking at cyanobacteria here but the

1798
01:16:42,180 --> 01:16:38,950
thing that's amazing about this is the

1799
01:16:43,950 --> 01:16:42,190
SRB you have sulfate reducers right up

1800
01:16:46,350 --> 01:16:43,960
in there in the in the oxygen-rich zone

1801
01:16:48,000 --> 01:16:46,360
and yet and as you go deeper in the mat

1802
01:16:49,830 --> 01:16:48,010
you see different types of sulfate

1803
01:16:51,870 --> 01:16:49,840
reducing bacteria as indicated by the

1804
01:16:54,480 --> 01:16:51,880
fluorescent tags now one of the

1805
01:16:56,730 --> 01:16:54,490
measurements we made early on was that

1806
01:17:00,000 --> 01:16:56,740
sulfate reduction which is an anaerobic

1807
01:17:01,680 --> 01:17:00,010
process is poisoned by oxygen and yet we

1808
01:17:03,360 --> 01:17:01,690
measured the highest rates of sulfate

1809
01:17:05,520 --> 01:17:03,370
reduction ever measured in nature in the

1810
01:17:07,980 --> 01:17:05,530
oxygen of these mats now if you want to

1811
01:17:09,510 --> 01:17:07,990
get you want to get a slap across the

1812
01:17:11,190 --> 01:17:09,520
face thing you really don't know what's

1813
01:17:12,930 --> 01:17:11,200

going on in these things just try

1814
01:17:14,820 --> 01:17:12,940
understanding why an obligate lee

1815
01:17:17,680 --> 01:17:14,830
anaerobic process is happening in the

1816
01:17:19,540 --> 01:17:17,690
presence of 100% oxygen saturation

1817
01:17:21,670 --> 01:17:19,550
and we made that measurement earlier and

1818
01:17:23,380 --> 01:17:21,680
with Victoria working with David FICA

1819
01:17:25,030 --> 01:17:23,390
actually started putting some names and

1820
01:17:27,550 --> 01:17:25,040
faces on the characters that are capable

1821
01:17:28,750 --> 01:17:27,560
of doing that and yet as you go deeper

1822
01:17:31,300 --> 01:17:28,760
within the mat you're seeing different

1823
01:17:33,459 --> 01:17:31,310
types of SRB indicating again

1824
01:17:35,920 --> 01:17:33,469
adaptations to different environments in

1825
01:17:37,660 --> 01:17:35,930
this one group of bacteria so we're

1826
01:17:40,209 --> 01:17:37,670
really getting closer to understanding

1827
01:17:43,209 --> 01:17:40,219
the machinery inside the engine room

1828
01:17:45,010 --> 01:17:43,219
with these with these communities and

1829
01:17:48,070 --> 01:17:45,020
then of course as we go to biomarkers

1830
01:17:50,560 --> 01:17:48,080
and this is a slide that Nikki paronto

1831
01:17:52,750 --> 01:17:50,570
showed yesterday done by Linda janky we

1832
01:17:54,910 --> 01:17:52,760
ultimately want to get this complexity

1833
01:17:57,550 --> 01:17:54,920
and diversity of this community and see

1834
01:18:00,400 --> 01:17:57,560
how it maps into the geologic record few

1835
01:18:02,680 --> 01:18:00,410
minutes great and and as a result of

1836
01:18:05,110 --> 01:18:02,690
that Linda is course been the real

1837
01:18:08,020 --> 01:18:05,120
genius in this whole thing is just

1838
01:18:09,760 --> 01:18:08,030

really done catalogs and catalogs of

1839
01:18:12,880 --> 01:18:09,770
different types of lipids which types of

1840
01:18:15,010 --> 01:18:12,890
organisms they map to just an incredible

1841
01:18:17,590 --> 01:18:15,020
detailed study of the literature

1842
01:18:19,600 --> 01:18:17,600
followed by lab work to where we really

1843
01:18:21,990 --> 01:18:19,610
now see an enormous diversity of of

1844
01:18:24,400 --> 01:18:22,000
lipids that these mats are generating

1845
01:18:25,720 --> 01:18:24,410
one of the real opportunities of these

1846
01:18:28,450 --> 01:18:25,730
mats and something that we haven't

1847
01:18:30,850 --> 01:18:28,460
realized until recently is that by

1848
01:18:33,880 --> 01:18:30,860
looking at these modern examples of

1849
01:18:35,860 --> 01:18:33,890
cyanobacteria mats and also studying

1850
01:18:38,770 --> 01:18:35,870
ancient stromatolite such as this one

1851
01:18:40,780 --> 01:18:38,780
from the Sibley group in Ontario we can

1852
01:18:42,340 --> 01:18:40,790
begin to correlate the dye Jetix fates

1853
01:18:45,490 --> 01:18:42,350
of the fabrics of these stromatolites

1854
01:18:47,920 --> 01:18:45,500
with the dye genetic fates of organic

1855
01:18:49,990 --> 01:18:47,930
bio signatures and how how the or the

1856
01:18:51,459 --> 01:18:50,000
lipids are actually preserved and into

1857
01:18:54,070 --> 01:18:51,469
these stromatolites and how there's a

1858
01:18:55,720 --> 01:18:54,080
potentially great record there one of

1859
01:18:57,790 --> 01:18:55,730
the things we realize is a lot of these

1860
01:19:00,430 --> 01:18:57,800
beautiful ancient stromatolite s-- must

1861
01:19:01,990 --> 01:19:00,440
have lithified early when the organisms

1862
01:19:04,750 --> 01:19:02,000
are still alive in order for those

1863
01:19:07,060 --> 01:19:04,760

fabrics to be preserved and this is just

1864
01:19:09,010 --> 01:19:07,070
demonstrated by the fact that we can we

1865
01:19:11,380 --> 01:19:09,020
have a timescale on these mats we see

1866
01:19:14,700 --> 01:19:11,390
how the fiber fabrics are changing and

1867
01:19:16,810 --> 01:19:14,710
it's it's just a great rosetta stone for

1868
01:19:19,930 --> 01:19:16,820
correlating two types of biosignatures

1869
01:19:23,220 --> 01:19:19,940
the fabric bio signature as well as the

1870
01:19:26,229 --> 01:19:23,230
organic bio signatures and so with that

1871
01:19:28,090 --> 01:19:26,239
i just want to mention of course that on

1872
01:19:29,259 --> 01:19:28,100
Curiosity rover we're driving up the

1873
01:19:31,509 --> 01:19:29,269
hill here and there's a

1874
01:19:33,099 --> 01:19:31,519
lights up ahead on the road we're

1875
01:19:37,000 --> 01:19:33,109
actually going to be able to look at

1876
01:19:39,489 --> 01:19:37,010
sulfate deposits on Mars and these two

1877
01:19:41,439 --> 01:19:39,499
images just show that when you look at

1878
01:19:43,689 --> 01:19:41,449
the scale of observation in Baja a

1879
01:19:45,279 --> 01:19:43,699
centimeter scale here we're already at

1880
01:19:47,079 --> 01:19:45,289
that's an irrelevant scale of

1881
01:19:50,289 --> 01:19:47,089
observation on Mars this happens to be

1882
01:19:51,609 --> 01:19:50,299
Meridiani Planum here of course the

1883
01:19:53,529 --> 01:19:51,619
tip-off is if we haven't found the

1884
01:19:55,719 --> 01:19:53,539
stromatolites yet but the point is we

1885
01:19:57,429 --> 01:19:55,729
are at the scale of observation where

1886
01:19:59,709 --> 01:19:57,439
you could actually begin to seriously

1887
01:20:03,579 --> 01:19:59,719
interrogate Mars that it a scale

1888
01:20:06,250 --> 01:20:03,589

relevant of object observation with that

1889
01:20:07,509 --> 01:20:06,260
I just like to thanks for support and I

1890
01:20:11,019 --> 01:20:07,519
just want to make this general point

1891
01:20:13,929 --> 01:20:11,029
that NASA and exobiology and

1892
01:20:16,000 --> 01:20:13,939
astrobiology supportive team research

1893
01:20:18,639 --> 01:20:16,010
goes way back actually before nai

1894
01:20:21,609 --> 01:20:18,649
ruinous with Ed bill told us earlier and

1895
01:20:23,379 --> 01:20:21,619
that's the key thing you know maybe the

1896
01:20:24,879 --> 01:20:23,389
names of the organization's change over

1897
01:20:26,439 --> 01:20:24,889
time Institute to may be now

1898
01:20:28,779 --> 01:20:26,449
transitioning to something else but

1899
01:20:30,489 --> 01:20:28,789
what's important is this long term NASA

1900
01:20:33,279 --> 01:20:30,499
commitment to team oriented

1901
01:20:35,349 --> 01:20:33,289
interdisciplinary search research and I

1902
01:20:36,939 --> 01:20:35,359
think what we've seen today with these

1903
01:20:41,510 --> 01:20:36,949
talks is demonstrates the incredible

1904
01:20:41,520 --> 01:20:45,190
[Applause]

1905
01:20:51,890 --> 01:20:49,130
thank you very much Dave just one bit of

1906
01:20:54,020 --> 01:20:51,900
housekeeping before I call up Chris and

1907
01:20:55,550 --> 01:20:54,030
that is could I just have a show of

1908
01:20:57,770 --> 01:20:55,560
hands so I can get a count of how many

1909
01:21:05,240 --> 01:20:57,780
of our poster presenters are here in the

1910
01:21:12,040 --> 01:21:05,250
room okay there are more hands than we

1911
01:21:13,790 --> 01:21:12,050
had poster presenters so okay we will

1912
01:21:16,250 --> 01:21:13,800
because there were there were six

1913
01:21:18,470 --> 01:21:16,260

posters associated with with this

1914
01:21:20,420 --> 01:21:18,480
session yes so so could I have another

1915
01:21:23,600 --> 01:21:20,430
show of hands of the people who had

1916
01:21:27,500 --> 01:21:23,610
posters associated with this session who

1917
01:21:30,290 --> 01:21:27,510
are in the room so there's one two three

1918
01:21:32,330 --> 01:21:30,300
and you would all like to and and so

1919
01:21:36,050 --> 01:21:32,340
you're all going to be invited to come

1920
01:21:36,800 --> 01:21:36,060
on up and if you have illustrations on a

1921
01:21:38,840 --> 01:21:36,810
stick

1922
01:21:40,340 --> 01:21:38,850
we can should be able to accommodate it

1923
01:21:42,860 --> 01:21:40,350
and if you need to show it from your

1924
01:21:44,390 --> 01:21:42,870
computer we probably can accommodate

1925
01:21:48,710 --> 01:21:44,400
even that but a stick would be better

1926
01:21:59,800 --> 01:21:48,720
and easier and with that Chris Chris

1927
01:22:07,010 --> 01:22:02,660
all right thank you I wanna thank Carl

1928
01:22:10,100 --> 01:22:07,020
and NASA and bust penny for this

1929
01:22:12,110 --> 01:22:10,110
opportunity I'll like many people who

1930
01:22:15,070 --> 01:22:12,120
have talked before there are some common

1931
01:22:17,560 --> 01:22:15,080
themes the the careers diverted

1932
01:22:20,600 --> 01:22:17,570
opportunities to collaborate enabled

1933
01:22:22,820 --> 01:22:20,610
opportunities within one's own career to

1934
01:22:24,830 --> 01:22:22,830
be enabled so my story is slightly

1935
01:22:27,140 --> 01:22:24,840
different in this in the end in the

1936
01:22:30,560 --> 01:22:27,150
essence that my career got diverted

1937
01:22:33,080 --> 01:22:30,570
partly partly before any I got started

1938
01:22:35,570 --> 01:22:33,090

so I wanted to start you can basically

1939
01:22:38,600 --> 01:22:35,580
see the bottom all these acknowledgments

1940
01:22:40,100 --> 01:22:38,610
is is my road map if you will and the

1941
01:22:42,680 --> 01:22:40,110
far left I want to start without the

1942
01:22:46,670 --> 01:22:42,690
actually the NASA and escort program

1943
01:22:50,450 --> 01:22:46,680
which was a predecessor a predecessor to

1944
01:22:52,970 --> 01:22:50,460
nei there was an nasa n squirts in

1945
01:22:57,020 --> 01:22:52,980
exobiology at UC san diego and there was

1946
01:22:58,850 --> 01:22:57,030
a nasa and scorn exobiology at RPI and I

1947
01:23:01,880 --> 01:22:58,860
was part of the of the UC San Diego one

1948
01:23:04,010 --> 01:23:01,890
and then I'll go through my like

1949
01:23:06,350 --> 01:23:04,020
somewhat like like John eigen bro Duke

1950
01:23:08,960 --> 01:23:06,360
did go through the career but I won't

1951
01:23:12,320 --> 01:23:08,970
talk about her comps which I was also

1952
01:23:15,950 --> 01:23:12,330
part of on the other side of that so

1953
01:23:18,640 --> 01:23:15,960
here here I am as a sophomore and this

1954
01:23:21,920 --> 01:23:18,650
is me as a sophomore not that picture

1955
01:23:24,320 --> 01:23:21,930
and I I didn't go to UCSD for

1956
01:23:26,900 --> 01:23:24,330
astrobiology in fact I'd never heard of

1957
01:23:29,600 --> 01:23:26,910
that word but I did know from my high

1958
01:23:33,710 --> 01:23:29,610
suppose high school textbook who Stanley

1959
01:23:36,350 --> 01:23:33,720
Miller was and I very much idolized his

1960
01:23:39,290 --> 01:23:36,360
work had no idea he was at UC San Diego

1961
01:23:42,920 --> 01:23:39,300
and one one time as actually at midnight

1962
01:23:46,160 --> 01:23:42,930
I called a the coke or the captain of

1963
01:23:47,450 --> 01:23:46,170

the UC San Diego sailing team to tell

1964
01:23:49,760 --> 01:23:47,460
them that I wasn't going to be able to

1965
01:23:52,370 --> 01:23:49,770
do practices in the spring because I've

1966
01:23:54,650 --> 01:23:52,380
had to take o chem and which was going

1967
01:23:55,910 --> 01:23:54,660
to be in the afternoon and she said well

1968
01:23:57,320 --> 01:23:55,920
if you're gonna miss the practices you

1969
01:24:00,580 --> 01:23:57,330
might as well take Stanley Millers class

1970
01:24:03,980 --> 01:24:00,590
I said oh really

1971
01:24:05,330 --> 01:24:03,990
ok so the very next day I went to Stan

1972
01:24:07,760 --> 01:24:05,340
Lee Miller's office and knocked on his

1973
01:24:09,830 --> 01:24:07,770
door and he let me in and I sat down and

1974
01:24:12,589 --> 01:24:09,840
this is my confession to everyone

1975
01:24:14,299 --> 01:24:12,599
there's been some confessions he

1976
01:24:16,729 --> 01:24:14,309
I said I really like to take your class

1977
01:24:19,429 --> 01:24:16,739
in the spring and I don't have their

1978
01:24:21,919 --> 01:24:19,439
prerequisites I'm not a chem major I'm

1979
01:24:24,049 --> 01:24:21,929
you know I'm sort of maybe a bio major I

1980
01:24:26,419 --> 01:24:24,059
think I'm officially a anthropology if

1981
01:24:30,189 --> 01:24:26,429
you look at my yeah anyway well he said

1982
01:24:32,989 --> 01:24:30,199
do you know that glycolysis is I kind of

1983
01:24:36,020 --> 01:24:32,999
exaggerated and he said okay you can

1984
01:24:38,689 --> 01:24:36,030
take the class so so I took his class

1985
01:24:41,089 --> 01:24:38,699
and and and then I joined his lab and

1986
01:24:43,669 --> 01:24:41,099
that and that was did summer research

1987
01:24:47,020 --> 01:24:43,679
with the unscored in exobiology and it

1988
01:24:50,060 --> 01:24:47,030

was fantastic so that that that's the my

1989
01:24:52,189 --> 01:24:50,070
career diverted into astrobiology this

1990
01:24:53,359 --> 01:24:52,199
is a lab meeting by it with Stanley

1991
01:24:54,379 --> 01:24:53,369
there Stanley Miller I'm in the middle

1992
01:24:56,149 --> 01:24:54,389
there

1993
01:25:01,869 --> 01:24:56,159
Jason Dworkin is sitting on the lab

1994
01:25:07,250 --> 01:25:05,270
there's Jason Dworkin and so he's

1995
01:25:10,429 --> 01:25:07,260
project scientists of osiris-rex if you

1996
01:25:14,389 --> 01:25:10,439
don't recognize the name Tony Keith Mike

1997
01:25:16,729 --> 01:25:14,399
Robertson papito Loretta and Michael

1998
01:25:24,169 --> 01:25:16,739
Robinson sorry

1999
01:25:27,379 --> 01:25:24,179
shoot anyway that was anyway I'll think

2000
01:25:30,830 --> 01:25:27,389
of it so next I went to grad school and

2001
01:25:33,739 --> 01:25:30,840
and Bill shop was kind enough to let me

2002
01:25:36,319 --> 01:25:33,749
in his lab and did a wonderful job

2003
01:25:38,299 --> 01:25:36,329
training me but this is this was prior

2004
01:25:40,909 --> 01:25:38,309
to nai and so you know you've heard

2005
01:25:42,469 --> 01:25:40,919
about that all these summer schools you

2006
01:25:44,209 --> 01:25:42,479
go to every single summer you went to

2007
01:25:46,520 --> 01:25:44,219
all five of them or whatever know that

2008
01:25:48,500 --> 01:25:46,530
without that was not you know part of

2009
01:25:50,060 --> 01:25:48,510
there were a few summer schools well

2010
01:25:52,279 --> 01:25:50,070
there was the Woods Hole microbial

2011
01:25:53,739 --> 01:25:52,289
diversity one goes way way back but but

2012
01:25:56,239 --> 01:25:53,749
there was a small community

2013
01:25:58,299 --> 01:25:56,249

astrobiology was a community but as a

2014
01:26:01,279 --> 01:25:58,309
very small convenient of grad students

2015
01:26:02,810 --> 01:26:01,289
mainly it was the Gordon Gordon research

2016
01:26:08,389 --> 01:26:02,820
conference they worked in life where

2017
01:26:11,389 --> 01:26:08,399
we'd see each other but then UCLA was a

2018
01:26:14,899 --> 01:26:11,399
founding member of nai in 1998 so I

2019
01:26:20,149 --> 01:26:14,909
helped with that proposal and we we got

2020
01:26:24,169 --> 01:26:20,159
funded and then I graduated by the way

2021
01:26:26,300 --> 01:26:24,179
it's the Grand Canyon and and I went to

2022
01:26:28,790 --> 01:26:26,310
Penn State and this is really

2023
01:26:30,620 --> 01:26:28,800
think that the main in terms of the

2024
01:26:34,880 --> 01:26:30,630
history of Nai this kind of celebration

2025
01:26:38,330 --> 01:26:34,890
we're having our role has been to to

2026
01:26:40,280 --> 01:26:38,340
train a high number of excellent

2027
01:26:41,930 --> 01:26:40,290
graduate students and I think Penn State

2028
01:26:45,320 --> 01:26:41,940
does attract excellent graduate students

2029
01:26:48,080 --> 01:26:45,330
jen is a good example so we've had 90

2030
01:26:50,000 --> 01:26:48,090
astrobiology related PhDs and in the

2031
01:26:51,440 --> 01:26:50,010
interest of time I decided not to go

2032
01:26:55,280 --> 01:26:51,450
through every one of those dissertations

2033
01:26:57,110 --> 01:26:55,290
today but instead just to say you know

2034
01:26:59,960 --> 01:26:57,120
that many of them are in the room many

2035
01:27:02,800 --> 01:26:59,970
of them are this conference and and and

2036
01:27:05,990 --> 01:27:02,810
it went through basically we had can one

2037
01:27:09,770 --> 01:27:06,000
which @ken one and can three Kuroshio

2038
01:27:13,430 --> 01:27:09,780

modo SP I can't can five iowa's P I and

2039
01:27:18,170 --> 01:27:13,440
then now can eight katefreeman is is P I

2040
01:27:22,580 --> 01:27:18,180
so a Penn State has back in in any I for

2041
01:27:24,380 --> 01:27:22,590
a I guess that's a fourth time alright

2042
01:27:27,290 --> 01:27:24,390
so we train to train the next generation

2043
01:27:29,510 --> 01:27:27,300
that's large that we did if you look

2044
01:27:31,700 --> 01:27:29,520
around apps icon I've currently run into

2045
01:27:33,650 --> 01:27:31,710
about a dozen of our former students

2046
01:27:35,930 --> 01:27:33,660
it's probably more like two dozen I just

2047
01:27:37,400 --> 01:27:35,940
didn't run into them all and and one

2048
01:27:40,220 --> 01:27:37,410
example that just to really illustrate

2049
01:27:44,510 --> 01:27:40,230
it is it's a really nice example is

2050
01:27:48,080 --> 01:27:44,520
Goddard at NASA Goddard you have one two

2051
01:27:51,710 --> 01:27:48,090
three four five and across the street

2052
01:27:54,200 --> 01:27:51,720
six six pi6 Penn State former Penn State

2053
01:27:55,850 --> 01:27:54,210
pH cheese there may be more i might miss

2054
01:27:57,920 --> 01:27:55,860
them i think they must have an alumni

2055
01:28:03,410 --> 01:27:57,930
lunch they go to everyday i don't know

2056
01:28:04,850 --> 01:28:03,420
they should but but in terms of

2057
01:28:06,230 --> 01:28:04,860
opportunities opportunities to

2058
01:28:08,960 --> 01:28:06,240
collaborate has been another common

2059
01:28:10,160 --> 01:28:08,970
theme and for me i think this example i

2060
01:28:11,720 --> 01:28:10,170
tried to think of an example that was

2061
01:28:15,320 --> 01:28:11,730
really dramatic and totally changed my

2062
01:28:18,080 --> 01:28:15,330
career and that was as a assistant

2063
01:28:20,990 --> 01:28:18,090

professor having any i membership and

2064
01:28:23,210 --> 01:28:21,000
having naf funding provided me the

2065
01:28:26,060 --> 01:28:23,220
opportunity to to meet and to then

2066
01:28:27,860 --> 01:28:26,070
launch a project right of the blue with

2067
01:28:32,180 --> 01:28:27,870
then graduate student victoria orphan

2068
01:28:34,790 --> 01:28:32,190
and then postdoc kendricks so three very

2069
01:28:38,090 --> 01:28:34,800
junior people at the time we're not

2070
01:28:40,129 --> 01:28:38,100
junior anymore thinking we've aged but

2071
01:28:42,649 --> 01:28:40,139
but together we we launched a

2072
01:28:47,270 --> 01:28:42,659
a productive research project on on

2073
01:28:49,310 --> 01:28:47,280
namme cells in methane seeps and that

2074
01:28:52,220 --> 01:28:49,320
led to many trips out to see with

2075
01:28:54,140 --> 01:28:52,230
Victoria then that also led to IO DP

2076
01:28:56,959 --> 01:28:54,150
cruises and that's another thing that

2077
01:28:58,700 --> 01:28:56,969
nei enabled is that in a while the

2078
01:29:02,479 --> 01:28:58,710
internet in the international ocean

2079
01:29:03,919 --> 01:29:02,489
drilling program provides a ship and

2080
01:29:07,669 --> 01:29:03,929
provides sediment and provides an

2081
01:29:09,950 --> 01:29:07,679
opportunity you don't necessarily have a

2082
01:29:12,050 --> 01:29:09,960
lot of research funding to do anything

2083
01:29:14,479 --> 01:29:12,060
with that opportunity and so having the

2084
01:29:17,359 --> 01:29:14,489
funding in place and and to do

2085
01:29:21,800 --> 01:29:17,369
astrobiology out at sea the combination

2086
01:29:23,750 --> 01:29:21,810
is is excellent in terms of enabling -

2087
01:29:26,600 --> 01:29:23,760
I'll just say that this continues and

2088
01:29:29,870 --> 01:29:26,610

and with and somewhere around six days

2089
01:29:32,359 --> 01:29:29,880
from now between now and six days I will

2090
01:29:35,149 --> 01:29:32,369
push the submit button on a NASA

2091
01:29:36,919 --> 01:29:35,159
discovery proposal so that so it's

2092
01:29:38,689 --> 01:29:36,929
really just gonna be excellent we'll see

2093
01:29:40,550 --> 01:29:38,699
what happens it's just a proposal but

2094
01:29:42,229 --> 01:29:40,560
it's a really great one an astrobiology

2095
01:29:46,450 --> 01:29:42,239
Lander two series if you want to see

2096
01:29:51,830 --> 01:29:46,460
that that's tomorrow any lightning talk

2097
01:29:53,419 --> 01:29:51,840
okay so it's provide whoops provided

2098
01:29:55,160 --> 01:29:53,429
unique opportunities especially for

2099
01:29:57,140 --> 01:29:55,170
junior scientists it's allowed for

2100
01:29:59,030 --> 01:29:57,150
high-risk high-reward science and

2101
01:30:01,580 --> 01:29:59,040
there's been a tremendous community

2102
01:30:04,820 --> 01:30:01,590
created through the critical mass that's

2103
01:30:08,419 --> 01:30:04,830
created in turn activates and the cob

2104
01:30:12,530 --> 01:30:08,429
randomness of Nai and and it's related

2105
01:30:14,780 --> 01:30:12,540
organizations we are moving ahead so

2106
01:30:17,120 --> 01:30:14,790
we've gone from n score to nai to the

2107
01:30:18,560 --> 01:30:17,130
future and so I think I just wanted end

2108
01:30:21,770 --> 01:30:18,570
by saying that I that I'm optimistic

2109
01:30:24,169 --> 01:30:21,780
that this will be really be a similarly

2110
01:30:26,149 --> 01:30:24,179
great program as n scored and nai and

2111
01:30:28,840 --> 01:30:26,159
that it really will be what we make it

2112
01:30:31,399 --> 01:30:28,850
because it has a grassroots sort of

2113
01:30:33,740 --> 01:30:31,409

flavor to it that we can populate these

2114
01:30:36,590 --> 01:30:33,750
nodes and we can interact and we can do

2115
01:30:39,200 --> 01:30:36,600
it if we choose to and and then there

2116
01:30:42,800 --> 01:30:39,210
still be the alternative that I car

2117
01:30:44,930 --> 01:30:42,810
provides a great longer multi Co I grant

2118
01:30:46,609 --> 01:30:44,940
opportunity so I think all the framework

2119
01:30:50,550 --> 01:30:46,619
is there if the community accepts it and

2120
01:31:00,720 --> 01:30:58,680
I just want to particularly thank Chris

2121
01:31:03,270 --> 01:31:00,730
for for telling his story

2122
01:31:05,780 --> 01:31:03,280
I've told Chris on more than one

2123
01:31:08,970 --> 01:31:05,790
occasion that he was my poster child for

2124
01:31:10,710 --> 01:31:08,980
illustrating the whole process and I

2125
01:31:14,720 --> 01:31:10,720
think it's an important part of that

2126
01:31:17,430 --> 01:31:14,730
process that that Chris began before the

2127
01:31:21,630 --> 01:31:17,440
origins program which is what emerged

2128
01:31:23,460 --> 01:31:21,640
from the alh84001 announcement in 1996

2129
01:31:25,410 --> 01:31:23,470
and that origins program included the

2130
01:31:29,610 --> 01:31:25,420
NAI but it included many many other

2131
01:31:33,050 --> 01:31:29,620
things as well because the astrobiology

2132
01:31:36,450 --> 01:31:33,060
program as it developed following

2133
01:31:39,140 --> 01:31:36,460
alh84001 was in turn built on the

2134
01:31:42,030 --> 01:31:39,150
foundation provided by decades of

2135
01:31:46,200 --> 01:31:42,040
exobiology program funding to this

2136
01:31:50,070 --> 01:31:46,210
community from NASA and the end skorts

2137
01:31:53,340 --> 01:31:50,080
and P P RG and a variety of things and

2138
01:31:56,670 --> 01:31:53,350

so again it's we continually stand on

2139
01:31:59,430 --> 01:31:56,680
the shoulders of those and what came

2140
01:32:02,730 --> 01:31:59,440
before and we benefit from it and see

2141
01:32:06,690 --> 01:32:02,740
farther and go farther because of it so

2142
01:32:08,670 --> 01:32:06,700
now we have time for I think three

2143
01:32:12,570 --> 01:32:08,680
lightning talks and we'll do it in the

2144
01:32:16,530 --> 01:32:12,580
order that it was in the poster session

2145
01:32:23,820 --> 01:32:16,540
and so Sanjoy would you like to come up

2146
01:32:25,470 --> 01:32:23,830
and we may have to do a little bit of

2147
01:32:31,410 --> 01:32:25,480
shuffling do you have anything you want

2148
01:32:39,980 --> 01:32:31,420
to show okay in that case I'm just gonna

2149
01:32:44,250 --> 01:32:42,630
okay I'll try to be quite be relaxed

2150
01:32:46,830 --> 01:32:44,260
my name is Sandra um please come check

2151
01:32:50,130 --> 01:32:46,840
out a poster number 17 the idea behind

2152
01:32:52,050 --> 01:32:50,140
our poster is that during graduate

2153
01:32:54,440 --> 01:32:52,060
school I founded a non-profit to do

2154
01:32:56,670 --> 01:32:54,450
build community around doing science and

2155
01:32:58,080 --> 01:32:56,680
we've been around for 10 years and

2156
01:32:59,850 --> 01:32:58,090
believe it or not this is the third apps

2157
01:33:02,010 --> 01:32:59,860
icon where we've been co-sponsoring the

2158
01:33:03,720 --> 01:33:02,020
meeting and feeding you coffee so

2159
01:33:04,279 --> 01:33:03,730
indirectly taking credit for all the

2160
01:33:11,000 --> 01:33:04,289
amazing I

2161
01:33:12,500 --> 01:33:11,010
you guys are definitely and supporting

2162
01:33:14,000 --> 01:33:12,510
the community has been incredibly

2163
01:33:17,239 --> 01:33:14,010

incredibly important for Blue Marble

2164
01:33:19,309 --> 01:33:17,249
space because the NAI has been

2165
01:33:22,009 --> 01:33:19,319
instrumental first particularly on a

2166
01:33:24,469 --> 01:33:22,019
personal story in helping me develop my

2167
01:33:25,989 --> 01:33:24,479
scientific growth but also on the

2168
01:33:27,859 --> 01:33:25,999
personal side my personal growth

2169
01:33:29,839 --> 01:33:27,869
scientifically of course I was lucky

2170
01:33:31,429 --> 01:33:29,849
enough to to come to the University of

2171
01:33:33,500 --> 01:33:31,439
Washington and join their astrobiology

2172
01:33:35,329 --> 01:33:33,510
program although when I came to the

2173
01:33:36,919 --> 01:33:35,339
University of Washington it was for

2174
01:33:39,259 --> 01:33:36,929
plasma physics in the aerospace

2175
01:33:41,509 --> 01:33:39,269
engineering department and then my first

2176
01:33:43,399 --> 01:33:41,519
year of my Master's I took planetary

2177
01:33:46,399 --> 01:33:43,409
atmospheres from David ketling and then

2178
01:33:48,109 --> 01:33:46,409
I had a quarter life crisis here I was

2179
01:33:49,609 --> 01:33:48,119
six years into engineering school and

2180
01:33:51,409 --> 01:33:49,619
decided to start grad school all over

2181
01:33:54,889 --> 01:33:51,419
again in Earth and Space Sciences and

2182
01:33:56,270 --> 01:33:54,899
astrobiology and I start grad school in

2183
01:33:58,429 --> 01:33:56,280
Earth and space science and then David

2184
01:34:01,369 --> 01:33:58,439
Catlin get its prestigious position in

2185
01:34:03,079 --> 01:34:01,379
the UK and I'm like comma and supposed

2186
01:34:05,509 --> 01:34:03,089
to be my wingman but I was very lucky

2187
01:34:07,189 --> 01:34:05,519
that David Montgomery and Roger Buick

2188
01:34:10,429 --> 01:34:07,199

took me under their wing and having

2189
01:34:12,799 --> 01:34:10,439
Roger Buick as a graduate advisor is an

2190
01:34:14,270 --> 01:34:12,809
incredible adventure because the places

2191
01:34:16,549 --> 01:34:14,280
he takes you to Western Australia the

2192
01:34:20,239 --> 01:34:16,559
stories he says really grabs you into

2193
01:34:22,219 --> 01:34:20,249
the field but on more important who

2194
01:34:23,869 --> 01:34:22,229
growth I think is a personal kind I

2195
01:34:25,309 --> 01:34:23,879
can't think of any other organization

2196
01:34:26,629 --> 01:34:25,319
that has existed

2197
01:34:29,109 --> 01:34:26,639
other than the NAI and there's

2198
01:34:32,299 --> 01:34:29,119
incredible support of the early career

2199
01:34:34,189 --> 01:34:32,309
community particularly you two important

2200
01:34:37,609 --> 01:34:34,199
things one is the ab grad con conference

2201
01:34:39,049 --> 01:34:37,619
and the summer schools so I was actually

2202
01:34:41,419 --> 01:34:39,059
this year is actually the 10-year

2203
01:34:43,159 --> 01:34:41,429
anniversary of AB grad con 2009 which

2204
01:34:45,529 --> 01:34:43,169
was held in the Seattle at the

2205
01:34:47,329 --> 01:34:45,539
University of Washington and I was a

2206
01:34:49,429 --> 01:34:47,339
lead organizer among two grad student

2207
01:34:53,059 --> 01:34:49,439
misfits for that for that conference and

2208
01:34:54,589 --> 01:34:53,069
little did I know that I working with

2209
01:34:56,719 --> 01:34:54,599
friends you could build something that's

2210
01:35:01,279 --> 01:34:56,729
bigger than yourself so really building

2211
01:35:02,869 --> 01:35:01,289
is this this confidence of being the

2212
01:35:05,029 --> 01:35:02,879
leading voice in believing in something

2213
01:35:07,819 --> 01:35:05,039

you're passionate about was something I

2214
01:35:10,219 --> 01:35:07,829
could not have done without Carl's and

2215
01:35:11,839 --> 01:35:10,229
Enya's vision of supporting grad

2216
01:35:14,929 --> 01:35:11,849
students organize a conference you know

2217
01:35:16,819 --> 01:35:14,939
here's some funds hang out build

2218
01:35:17,870 --> 01:35:16,829
community build support and I can say

2219
01:35:19,910 --> 01:35:17,880
today you know

2220
01:35:22,010 --> 01:35:19,920
last week I was mid-career but they

2221
01:35:24,440 --> 01:35:22,020
changed the transition from seven-year

2222
01:35:29,600 --> 01:35:24,450
to ten-year post PhD so now I qualify as

2223
01:35:32,030 --> 01:35:29,610
an early career so so I really can say

2224
01:35:33,980 --> 01:35:32,040
that now in my early career I've my

2225
01:35:36,530 --> 01:35:33,990
collaborators and best friends come from

2226
01:35:38,510 --> 01:35:36,540
these bonds that we've made as grad

2227
01:35:43,220 --> 01:35:38,520
students and through the the summer

2228
01:35:45,640 --> 01:35:43,230
schools but also in AB grad Khan in 2011

2229
01:35:48,260 --> 01:35:45,650
we wanted to kind of formalize our

2230
01:35:50,510 --> 01:35:48,270
outreach community of community

2231
01:35:51,890 --> 01:35:50,520
engagement efforts through Signet orgs

2232
01:35:53,420 --> 01:35:51,900
and oh maybe maybe of some of you have

2233
01:35:56,270 --> 01:35:53,430
heard it is our public engagement

2234
01:35:58,580 --> 01:35:56,280
platform and but we didn't know how to

2235
01:36:00,440 --> 01:35:58,590
be how to be how to be science

2236
01:36:01,820 --> 01:36:00,450
communicators how to be have to support

2237
01:36:03,680 --> 01:36:01,830
the next generation of scientists we

2238
01:36:06,320 --> 01:36:03,690

were after all early carriers ourselves

2239
01:36:08,030 --> 01:36:06,330
and myself and some of our few

2240
01:36:10,820 --> 01:36:08,040
co-founders Sarah Walker would

2241
01:36:13,160 --> 01:36:10,830
Casa grasshopper Ellen Kuhn and Julia

2242
01:36:15,530 --> 01:36:13,170
Damaris were like well we should go to a

2243
01:36:18,560 --> 01:36:15,540
mentoring conference to learn what what

2244
01:36:20,810 --> 01:36:18,570
it's about to to support to learn the

2245
01:36:22,400 --> 01:36:20,820
skills to mentor students who are

2246
01:36:25,130 --> 01:36:22,410
interested because astrobiology brings

2247
01:36:27,260 --> 01:36:25,140
interest from all over the world and so

2248
01:36:28,880 --> 01:36:27,270
we asked Carlin nai hey would you be we

2249
01:36:31,790 --> 01:36:28,890
like to go to this mentoring conference

2250
01:36:33,650 --> 01:36:31,800
in Albuquerque to help support us with

2251
01:36:36,610 --> 01:36:33,660
our vision for for Signet and they were

2252
01:36:40,400 --> 01:36:38,540
and we did and it's been an amazing

2253
01:36:42,770 --> 01:36:40,410
experience in in in in learning how to

2254
01:36:44,450 --> 01:36:42,780
become a mentor as I think the growth of

2255
01:36:45,890 --> 01:36:44,460
that has been a young scientist program

2256
01:36:47,830 --> 01:36:45,900
that's been an offshoot of our Institute

2257
01:36:51,710 --> 01:36:47,840
of science and now we are we are

2258
01:36:53,120 --> 01:36:51,720
supporting 25 interns at NASA Ames who

2259
01:36:55,220 --> 01:36:53,130
are through our program where we bring

2260
01:36:56,570 --> 01:36:55,230
in faculty from the Stanford School of

2261
01:36:58,910 --> 01:36:56,580
Business to teach them how to give a

2262
01:37:00,740 --> 01:36:58,920
presentation and we give them a training

2263
01:37:03,800 --> 01:37:00,750

in ethics and in science and then they

2264
01:37:05,600 --> 01:37:03,810
build a community themselves as an

2265
01:37:08,000 --> 01:37:05,610
offshoot of the the mentoring skills

2266
01:37:11,540 --> 01:37:08,010
that I was able to learn through the

2267
01:37:13,400 --> 01:37:11,550
support of Nai so I could talk for a

2268
01:37:14,420 --> 01:37:13,410
long time about how Nai is release has

2269
01:37:16,550 --> 01:37:14,430
changed my life

2270
01:37:18,290 --> 01:37:16,560
Budda mentally change I was going to be

2271
01:37:20,570 --> 01:37:18,300
an engineer and then I've you know

2272
01:37:22,130 --> 01:37:20,580
starting a PhD looking at plasma physics

2273
01:37:24,710 --> 01:37:22,140
and finishing it with looking at

2274
01:37:26,150 --> 01:37:24,720
Precambrian rocks it's kind of the story

2275
01:37:28,010 --> 01:37:26,160
of all of us I think none of us have

2276
01:37:29,450 --> 01:37:28,020
ever had a linear path in our career

2277
01:37:29,990 --> 01:37:29,460
because of astrobiology and that's a

2278
01:37:31,940 --> 01:37:30,000
beauty of it

2279
01:37:34,160 --> 01:37:31,950
so I we're excited too

2280
01:37:36,230 --> 01:37:34,170
to support the to keep continuing

2281
01:37:37,940 --> 01:37:36,240
supporting the community through our

2282
01:37:40,850 --> 01:37:37,950
nonprofit activities particularly at

2283
01:37:43,040 --> 01:37:40,860
NASA Ames and I encourage you to come

2284
01:37:53,600 --> 01:37:43,050
visit our booth number two downstairs

2285
01:37:55,580 --> 01:37:53,610
and poster number 17 so thank you my

2286
01:38:05,240 --> 01:37:55,590
only complaint about the morning session

2287
01:38:06,800 --> 01:38:05,250
was that penny got all the hugs well

2288
01:38:52,430 --> 01:38:06,810

that's okay

2289
01:38:57,770 --> 01:38:53,650
[Music]

2290
01:39:00,110 --> 01:38:57,780
hello my name is our cell I'm the

2291
01:39:03,620 --> 01:39:00,120
oddball I'm a social scientist I used to

2292
01:39:09,710 --> 01:39:03,630
be an MPP at nai central between 2012

2293
01:39:12,440 --> 01:39:09,720
and 2014 15 I was brought in to study

2294
01:39:17,030 --> 01:39:12,450
actually you so you study everything

2295
01:39:19,490 --> 01:39:17,040
else I study you my unit of analysis was

2296
01:39:23,590 --> 01:39:19,500
of course the Ken teams can fork and

2297
01:39:26,420 --> 01:39:23,600
five and ten six but you know I straight

2298
01:39:29,810 --> 01:39:26,430
gastro village was so interesting I

2299
01:39:38,930 --> 01:39:29,820
study concept of astrobiology early

2300
01:39:41,570 --> 01:39:38,940
career folks there's a fly and today I

2301
01:39:42,860 --> 01:39:41,580
would like to talk about my posture and

2302
01:39:47,600 --> 01:39:42,870
the impact

2303
01:39:50,990 --> 01:39:47,610
astrobiology of course you can't see

2304
01:39:53,360 --> 01:39:51,000
anything because this is quite small I'm

2305
01:39:56,510 --> 01:39:53,370
a social scientist but I do cult ativ

2306
01:39:58,610 --> 01:39:56,520
research and quantitative research and

2307
01:40:01,220 --> 01:39:58,620
qualitative research is what your

2308
01:40:03,740 --> 01:40:01,230
prejudices are you know we are flying on

2309
01:40:06,200 --> 01:40:03,750
the walls I visited more than twenty

2310
01:40:09,190 --> 01:40:06,210
laps all over the US for Ken teams

2311
01:40:11,660 --> 01:40:09,200
watched how people work together I

2312
01:40:14,120 --> 01:40:11,670
interviewed them I interviewed 150

2313
01:40:16,490 --> 01:40:14,130

people but I also looked at the

2314
01:40:19,280 --> 01:40:16,500
publications and project reports you

2315
01:40:23,270 --> 01:40:19,290
wrote and published and stuff and I want

2316
01:40:28,610 --> 01:40:23,280
to show you the first one you can see on

2317
01:40:30,610 --> 01:40:28,620
the right you have a laser you have a

2318
01:40:33,830 --> 01:40:30,620
laser right there the small green button

2319
01:40:38,210 --> 01:40:33,840
so you see the spike therefore this red

2320
01:40:40,040 --> 01:40:38,220
one that's 1997 1998 and that's the

2321
01:40:43,340 --> 01:40:40,050
number of astrobiology and origins of

2322
01:40:45,980 --> 01:40:43,350
life related papers so after the

2323
01:40:50,630 --> 01:40:45,990
establishment of nai it's skyrockets

2324
01:40:53,630 --> 01:40:50,640
before that it is three five at best ten

2325
01:40:58,340 --> 01:40:53,640
papers per year but now we have close to

2326
01:41:00,140 --> 01:40:58,350
500 publications related to astrobiology

2327
01:41:04,010 --> 01:41:00,150
and origins of life that includes

2328
01:41:06,260 --> 01:41:04,020
exoplanets as well so na IRA literally

2329
01:41:09,230 --> 01:41:06,270
gave some structure

2330
01:41:14,450 --> 01:41:09,240
and in one of the interviews on top

2331
01:41:15,380 --> 01:41:14,460
which I am going to I don't know it's

2332
01:41:20,240 --> 01:41:15,390
readable now

2333
01:41:23,060 --> 01:41:20,250
oh it's readable excellent so this is an

2334
01:41:24,590 --> 01:41:23,070
early Korean folk I interviewed some

2335
01:41:26,570 --> 01:41:24,600
years ago the names are not real by the

2336
01:41:29,750 --> 01:41:26,580
way I changed it

2337
01:41:32,270 --> 01:41:29,760
so by San Jose definition that person is

2338
01:41:36,830 --> 01:41:32,280

still early career but actually he is or

2339
01:41:38,900 --> 01:41:36,840
she is now mid-career he says that nei

2340
01:41:41,480 --> 01:41:38,910
has done a really good job of getting a

2341
01:41:45,680 --> 01:41:41,490
brand out there for astrobiology because

2342
01:41:48,230 --> 01:41:45,690
as you already lived in it as even ten

2343
01:41:50,630 --> 01:41:48,240
years ago in some of the interviews it

2344
01:41:54,620 --> 01:41:50,640
was obvious that a serve elegy is it

2345
01:41:57,980 --> 01:41:54,630
real and I remember some students saying

2346
01:42:00,740 --> 01:41:57,990
that their advisers trying to redirect

2347
01:42:03,290 --> 01:42:00,750
them to more mainstream careers and

2348
01:42:06,250 --> 01:42:03,300
stuff thank God

2349
01:42:11,030 --> 01:42:06,260
they failed and thank God we prevailed

2350
01:42:13,490 --> 01:42:11,040
so and nai really has given more of a

2351
01:42:16,540 --> 01:42:13,500
pedigree and more of a reputation to

2352
01:42:19,660 --> 01:42:16,550
astrobiology which is really really cool

2353
01:42:26,510 --> 01:42:19,670
the second thing I want to mention is

2354
01:42:30,770 --> 01:42:26,520
let's see this one okay you've seen this

2355
01:42:33,650 --> 01:42:30,780
one so this is bigger now this is the

2356
01:42:35,360 --> 01:42:33,660
first one I wanted to mention this is

2357
01:42:38,620 --> 01:42:35,370
about the interdisciplinarity of

2358
01:42:42,440 --> 01:42:38,630
astrobiology so this is a network map

2359
01:42:46,520 --> 01:42:42,450
these words come from the abstracts

2360
01:42:50,030 --> 01:42:46,530
titles and the keywords of astrobiology

2361
01:42:51,730 --> 01:42:50,040
Norwich ins of life related papers so

2362
01:42:55,160 --> 01:42:51,740
you're talking here about you know

2363
01:42:58,070 --> 01:42:55,170

geosciences biology astronomy these

2364
01:43:01,190 --> 01:42:58,080
disciplines are socially constructed but

2365
01:43:05,300 --> 01:43:01,200
these keywords are the real deal you're

2366
01:43:08,030 --> 01:43:05,310
researching about and you can it you

2367
01:43:10,820 --> 01:43:08,040
know I showed it to astrobiologists so

2368
01:43:12,860 --> 01:43:10,830
it makes sense I cannot fully interpret

2369
01:43:17,120 --> 01:43:12,870
this because I'm a social scientist but

2370
01:43:19,440 --> 01:43:17,130
you can see the bigger domains bigger

2371
01:43:23,070 --> 01:43:19,450
subdomains within a Surabaya

2372
01:43:25,260 --> 01:43:23,080
here it will tell you more you know the

2373
01:43:28,520 --> 01:43:25,270
yellow stuff yellow cluster is about

2374
01:43:30,860 --> 01:43:28,530
evolution self-organization emergence or

2375
01:43:33,540 --> 01:43:30,870
the blue stuff astrochemistry

2376
01:43:36,720 --> 01:43:33,550
cosmochemistry space dust and things

2377
01:43:40,610 --> 01:43:36,730
like that so we can see where your

2378
01:43:42,600 --> 01:43:40,620
research rules we can identify potential

2379
01:43:47,760 --> 01:43:42,610
collaboration opportunities that you

2380
01:43:53,220 --> 01:43:47,770
haven't discovered yet and the last one

2381
01:43:56,070 --> 01:43:53,230
is the people it's not all of you

2382
01:43:59,580 --> 01:43:56,080
because the resolution is really low in

2383
01:44:04,320 --> 01:43:59,590
this one there are you know in na eyes I

2384
01:44:06,930 --> 01:44:04,330
did this for 10 for and can 5 I have two

2385
01:44:12,510 --> 01:44:06,940
minutes excellent fork and fork and 5

2386
01:44:14,370 --> 01:44:12,520
there are close to 1200 1200 scientists

2387
01:44:17,370 --> 01:44:14,380
so you cannot see all the names here and

2388
01:44:29,270 --> 01:44:17,380

this is you know names for 50 years and

2389
01:44:38,790 --> 01:44:35,250
okay but also you know I don't want to

2390
01:44:42,300 --> 01:44:38,800
say the term modern but recent names now

2391
01:44:45,330 --> 01:44:42,310
Jim please or Chris McKay and you can

2392
01:44:52,930 --> 01:44:45,340
see and each color represents actually a

2393
01:45:04,570 --> 01:44:57,830
the final thing I want to say about nari

2394
01:45:18,490 --> 01:45:04,580
is getting back to this poster and these

2395
01:45:24,550 --> 01:45:21,730
so hey I really I studied many

2396
01:45:27,640 --> 01:45:24,560
communities as so village is not the

2397
01:45:29,350 --> 01:45:27,650
only community I studied but the amount

2398
01:45:33,070 --> 01:45:29,360
the attention given to early career

2399
01:45:33,700 --> 01:45:33,080
folks here is very different than the

2400
01:45:35,800 --> 01:45:33,710
other ones

2401
01:45:37,840 --> 01:45:35,810
you know chemists have been trained the

2402
01:45:42,070 --> 01:45:37,850
same way maybe for the last two

2403
01:45:43,540 --> 01:45:42,080
centuries astrobiologists it's someone

2404
01:45:46,780 --> 01:45:43,550
people actually mentioned that we are

2405
01:45:50,080 --> 01:45:46,790
the misfits people who do not fall into

2406
01:45:52,900 --> 01:45:50,090
the traditional academic career paths

2407
01:45:56,260 --> 01:45:52,910
that is true they take initiative they

2408
01:46:00,160 --> 01:45:56,270
do lots of stuff but because you more

2409
01:46:02,290 --> 01:46:00,170
senior folks are open-minded and provide

2410
01:46:05,200 --> 01:46:02,300
them with opportunities and stuff and

2411
01:46:08,200 --> 01:46:05,210
you are doing your best to capture their

2412
01:46:11,530 --> 01:46:08,210
inspiration and they are reaching up to

2413
01:46:13,600 --> 01:46:11,540

the plate so in order to capture the

2414
01:46:16,450 --> 01:46:13,610
next generation we need not only to

2415
01:46:18,310 --> 01:46:16,460
inform as multidisciplinary seminar is

2416
01:46:21,580 --> 01:46:18,320
do back then multidisciplinary was a

2417
01:46:23,740 --> 01:46:21,590
buzzword now it's interdisciplinary but

2418
01:46:25,720 --> 01:46:23,750
also to inspire them to do the historic

2419
01:46:28,810 --> 01:46:25,730
nature of the question that astrobiology

2420
01:46:30,880 --> 01:46:28,820
poses great nations do great things and

2421
01:46:33,850 --> 01:46:30,890
NASA took it upon itself as a great

2422
01:46:35,710 --> 01:46:33,860
agency of a great nation to embark on

2423
01:46:39,040 --> 01:46:35,720
one of the most profound questions in

2424
01:46:42,370 --> 01:46:39,050
human history astrobiologists dare to

2425
01:46:45,760 --> 01:46:42,380
ask these big questions that's a huge

2426
01:46:50,110 --> 01:46:45,770
huge difference compared to most of the

2427
01:46:52,540 --> 01:46:50,120
other disciplines and tackle that

2428
01:46:55,660 --> 01:46:52,550
question in the scientific way in a

2429
01:47:00,070 --> 01:46:55,670
rigorous way you know so it makes it a

2430
01:47:04,090 --> 01:47:00,080
real science so I I cannot judge if any

2431
01:47:09,570 --> 01:47:04,100
I completed its mission or not but I can

2432
01:47:13,690 --> 01:47:09,580
say that in AI achieved its objectives

2433
01:47:18,880 --> 01:47:13,700
introducing an interdisciplinary science

2434
01:47:22,020 --> 01:47:18,890
and creating a community that is

2435
01:47:29,050 --> 01:47:22,030
sustainable thank you

2436
01:47:36,560 --> 01:47:29,060
[Applause]

2437
01:47:39,320 --> 01:47:36,570
thank you thank you our civ and I think

2438
01:47:42,920 --> 01:47:39,330

that it is very fitting that we finish

2439
01:47:45,200 --> 01:47:42,930
this session with Ken Steadman who

2440
01:47:47,030 --> 01:47:45,210
worked very closely as you are going to

2441
01:47:50,630 --> 01:47:47,040
hear with our founding director Barry

2442
01:47:53,860 --> 01:47:50,640
Bloomberg on a subject that is near and

2443
01:48:03,010 --> 01:47:53,870
dear to both Ken and Barry's hearts and

2444
01:48:06,500 --> 01:48:03,020
so Ken so basically I'm the virus guy

2445
01:48:09,530 --> 01:48:06,510
except that unlike Barry I'm not really

2446
01:48:11,900 --> 01:48:09,540
a virologist I just play one on TV which

2447
01:48:19,340 --> 01:48:11,910
is actually the CBC a few years ago as

2448
01:48:23,150 --> 01:48:19,350
you may hear in fact that is something

2449
01:48:25,670 --> 01:48:23,160
that I have to agree with you on here I

2450
01:48:27,710 --> 01:48:25,680
don't think that any viral adjust is

2451
01:48:30,940 --> 01:48:27,720
really a virologist sort of by

2452
01:48:33,530 --> 01:48:30,950
definition virally is interdisciplinary

2453
01:48:34,850 --> 01:48:33,540
because you're talking about structures

2454
01:48:36,920 --> 01:48:34,860
or thinking about evolution or thinking

2455
01:48:38,420 --> 01:48:36,930
about ecology etc so I think it's a

2456
01:48:42,590 --> 01:48:38,430
really good match here so how do I get

2457
01:48:47,990 --> 01:48:42,600
this to actually work that's why I'm a

2458
01:48:50,060 --> 01:48:48,000
Mac person I never a me to this our

2459
01:48:51,830 --> 01:48:50,070
sieve we may need you back up here yes

2460
01:48:55,130 --> 01:48:51,840
yeah you got it

2461
01:48:59,960 --> 01:48:55,140
okay here we are so I also need to I

2462
01:49:04,130 --> 01:48:59,970
think thank our serve with to the goal

2463
01:49:05,930 --> 01:49:04,140

that we actually have now as far as what

2464
01:49:07,550 --> 01:49:05,940
I'm going to be talking about here for

2465
01:49:12,770 --> 01:49:07,560
the next what three and a half minutes I

2466
01:49:16,070 --> 01:49:12,780
have left so that I didn't see a ball

2467
01:49:19,130 --> 01:49:16,080
with viruses on it in your analysis and

2468
01:49:21,410 --> 01:49:19,140
so the next time in ten years when all

2469
01:49:23,030 --> 01:49:21,420
of these you know next presentations

2470
01:49:26,120 --> 01:49:23,040
come up hopefully there'll be a really

2471
01:49:29,030 --> 01:49:26,130
big blob in that particular aspect but

2472
01:49:31,760 --> 01:49:29,040
yeah this is really the virus focus

2473
01:49:35,180 --> 01:49:31,770
group is really the brainchild of Barry

2474
01:49:35,860 --> 01:49:35,190
Bloomberg and to hark back to some of

2475
01:49:40,120 --> 01:49:35,870
the talks we

2476
01:49:43,150 --> 01:49:40,130
this morning I wasn't a baby professor I

2477
01:49:45,340 --> 01:49:43,160
think I was actually in utero as far as

2478
01:49:46,810 --> 01:49:45,350
professors were concerned when Barry

2479
01:49:49,540 --> 01:49:46,820
first talked to me about this cuz I was

2480
01:49:51,700 --> 01:49:49,550
still postdoc and just about to start my

2481
01:49:53,440 --> 01:49:51,710
permanent position at Porton State

2482
01:49:54,880 --> 01:49:53,450
University where I've been you know ever

2483
01:49:58,900 --> 01:49:54,890
since so it's been a few years since

2484
01:50:03,250 --> 01:49:58,910
then but when a Nobel laureate asks you

2485
01:50:05,590 --> 01:50:03,260
to be co-chair of a focus group first

2486
01:50:08,680 --> 01:50:05,600
your arm gets twisted a lot and you say

2487
01:50:11,380 --> 01:50:08,690
well yeah how high do I jump but at the

2488
01:50:13,000 --> 01:50:11,390

same time realizing that yes I was

2489
01:50:16,470 --> 01:50:13,010
co-chair but basically I was gonna have

2490
01:50:18,520 --> 01:50:16,480
to do all the work so what was that work

2491
01:50:20,260 --> 01:50:18,530
basically again based on a lot of

2492
01:50:22,240 --> 01:50:20,270
Barry's ideas was just putting together

2493
01:50:25,030 --> 01:50:22,250
workshops and meetings particularly

2494
01:50:27,550 --> 01:50:25,040
again going back to Barry not really

2495
01:50:30,310 --> 01:50:27,560
being a virologist getting out in the

2496
01:50:32,470 --> 01:50:30,320
field and that was really central to the

2497
01:50:35,590 --> 01:50:32,480
way that Barry thought about doing

2498
01:50:38,710 --> 01:50:35,600
science even from a viral adjust point

2499
01:50:41,290 --> 01:50:38,720
of view and what was the virus focus

2500
01:50:42,850 --> 01:50:41,300
groups supposed to do basically think

2501
01:50:46,150 --> 01:50:42,860
about the origin and evolution of

2502
01:50:49,960 --> 01:50:46,160
viruses but also thinking about how

2503
01:50:52,960 --> 01:50:49,970
viruses then are involved in evolution

2504
01:50:55,150 --> 01:50:52,970
in multicellularity as we heard about a

2505
01:50:56,620 --> 01:50:55,160
little bit earlier this afternoon I

2506
01:50:59,800 --> 01:50:56,630
think these are really really critical

2507
01:51:02,350 --> 01:50:59,810
kinds of aspects about what viruses do

2508
01:51:03,790 --> 01:51:02,360
what we know they do and potentially

2509
01:51:06,850 --> 01:51:03,800
could be involved in all kinds of other

2510
01:51:08,700 --> 01:51:06,860
things so my multidisciplinarity thing

2511
01:51:11,140 --> 01:51:08,710
here at the bottom is about ecology

2512
01:51:13,810 --> 01:51:11,150
diversity that there are beneficial

2513
01:51:16,570 --> 01:51:13,820

viruses I like to say viruses have a bad

2514
01:51:18,100 --> 01:51:16,580
rap in many cases and also thinking

2515
01:51:21,310 --> 01:51:18,110
about viruses in the space environment

2516
01:51:22,990 --> 01:51:21,320
so again we had a number of workshops

2517
01:51:26,350 --> 01:51:23,000
this is the very first one that we had

2518
01:51:27,880 --> 01:51:26,360
was in Portland in 2003 hopefully most

2519
01:51:29,680 --> 01:51:27,890
of you recognize bury in the middle some

2520
01:51:31,420 --> 01:51:29,690
of you may see sherry Katie hiding at

2521
01:51:34,630 --> 01:51:31,430
the back here and also hiding at the

2522
01:51:36,250 --> 01:51:34,640
back in the room today so I'll just

2523
01:51:37,810 --> 01:51:36,260
going to quickly screen through some of

2524
01:51:40,810 --> 01:51:37,820
these things then we had the first ever

2525
01:51:43,840 --> 01:51:40,820
as far as I know astrobiology session at

2526
01:51:46,540 --> 01:51:43,850
apps icon in 2004 and one of the things

2527
01:51:48,580 --> 01:51:46,550
that was presented there by the late

2528
01:51:49,460 --> 01:51:48,590
Roger Hendricks was if you take all of

2529
01:51:52,460 --> 01:51:49,470
the virus

2530
01:51:59,110 --> 01:51:52,470
on this planet and line them up end to

2531
01:52:02,540 --> 01:51:59,120
end there about 200 million light years

2532
01:52:05,540 --> 01:52:02,550
just ridiculous astronomical numbers of

2533
01:52:07,400 --> 01:52:05,550
viruses which we have on our planet one

2534
01:52:07,820 --> 01:52:07,410
place that we went to look again with

2535
01:52:11,690 --> 01:52:07,830
Barry

2536
01:52:13,310 --> 01:52:11,700
it was Mono Lake which is as if far as

2537
01:52:16,010 --> 01:52:13,320
I'm concerned like most environments

2538
01:52:19,760 --> 01:52:16,020

really understudied as far as viruses

2539
01:52:21,260 --> 01:52:19,770
are concerned and also was a very large

2540
01:52:23,960 --> 01:52:21,270
group with multiple different

2541
01:52:25,700 --> 01:52:23,970
participants many students involved as

2542
01:52:27,800 --> 01:52:25,710
we also heard the NII has been really

2543
01:52:30,020 --> 01:52:27,810
wonderful about supporting students

2544
01:52:33,230 --> 01:52:30,030
supporting young researchers this has

2545
01:52:35,390 --> 01:52:33,240
also been published then we also had a

2546
01:52:37,100 --> 01:52:35,400
field trip to my main stomping ground

2547
01:52:39,620 --> 01:52:37,110
which is in Lassen Volcanic National

2548
01:52:41,330 --> 01:52:39,630
Park in Northern California if you've

2549
01:52:42,830 --> 01:52:41,340
seen that volcano here

2550
01:52:44,060 --> 01:52:42,840
Mount Rainier if you keep going all the

2551
01:52:46,550 --> 01:52:44,070
way south to the southernmost of the

2552
01:52:50,720 --> 01:52:46,560
Cascade volcanoes that's Mount lassen

2553
01:52:53,180 --> 01:52:50,730
and has a wonderful area of all kinds of

2554
01:52:55,640 --> 01:52:53,190
great geothermal areas but also right

2555
01:52:58,610 --> 01:52:55,650
next to that is the SETI Allen array and

2556
01:53:01,070 --> 01:52:58,620
so we also visited there at the time we

2557
01:53:03,650 --> 01:53:01,080
have been very involved in trying to do

2558
01:53:06,470 --> 01:53:03,660
public outreach and as I mentioned here

2559
01:53:08,510 --> 01:53:06,480
I play a viral adjust on television in

2560
01:53:10,430 --> 01:53:08,520
fact that last group where we were in

2561
01:53:13,550 --> 01:53:10,440
lassen it was the Canadian Broadcasting

2562
01:53:16,940 --> 01:53:13,560
Corporation that came with us and I and

2563
01:53:20,030 --> 01:53:16,950

a few real biologists were then on

2564
01:53:21,830 --> 01:53:20,040
television with the CBC and that's

2565
01:53:24,130 --> 01:53:21,840
available have also been involved with

2566
01:53:27,010 --> 01:53:24,140
the astrobiology training program

2567
01:53:29,710 --> 01:53:27,020
Canadian and then as we saw before also

2568
01:53:33,740 --> 01:53:29,720
the California Academy of Sciences

2569
01:53:34,280 --> 01:53:33,750
looking for aliens on earth our viruses

2570
01:53:35,990 --> 01:53:34,290
aliens

2571
01:53:37,970 --> 01:53:36,000
I like the viruses are actually really

2572
01:53:40,700 --> 01:53:37,980
important for the development of all

2573
01:53:42,500 --> 01:53:40,710
life rather than aliens per se and then

2574
01:53:45,320 --> 01:53:42,510
just wanted to finish up in terms of

2575
01:53:47,240 --> 01:53:45,330
where the virus focus group is gone one

2576
01:53:48,890 --> 01:53:47,250
thing you have to do these days if you

2577
01:53:50,420 --> 01:53:48,900
ever end up on the cover of a journal is

2578
01:53:52,580 --> 01:53:50,430
to show the picture of that cover

2579
01:53:55,550 --> 01:53:52,590
because who looks at the actual you know

2580
01:53:58,750 --> 01:53:55,560
printing journals anymore so this was

2581
01:54:03,090 --> 01:53:58,760
our review article in astrobiology

2582
01:54:05,550 --> 01:54:03,100
astrobiology excuse me the beginning of

2583
01:54:07,110 --> 01:54:05,560
a year where we basically synthesized a

2584
01:54:09,240 --> 01:54:07,120
lot of the things that have come out of

2585
01:54:12,390 --> 01:54:09,250
those field trips and workshops and

2586
01:54:14,580 --> 01:54:12,400
tried to put it into one semi

2587
01:54:16,950 --> 01:54:14,590
comprehensive but of course we've missed

2588
01:54:20,550 --> 01:54:16,960

out on many things as well as far as

2589
01:54:23,880 --> 01:54:20,560
where we think astro virology should go

2590
01:54:26,880 --> 01:54:23,890
and then that leads to where we have

2591
01:54:29,910 --> 01:54:26,890
Astro virology today there were a couple

2592
01:54:33,450 --> 01:54:29,920
of posters including this one presented

2593
01:54:35,520 --> 01:54:33,460
on Monday Wednesday there will be four

2594
01:54:38,880 --> 01:54:35,530
more presentations with viruses and

2595
01:54:40,290 --> 01:54:38,890
we'll also have a couple of talks both

2596
01:54:42,360 --> 01:54:40,300
Wednesday and Thursday

2597
01:54:45,750 --> 01:54:42,370
on viruses so please come and check

2598
01:54:49,250 --> 01:54:45,760
those out but most importantly is we

2599
01:54:52,770 --> 01:54:49,260
need contributions from you in terms of

2600
01:54:54,810 --> 01:54:52,780
how we can get the next time that we

2601
01:54:55,860 --> 01:54:54,820
have a nice bubble plot and have viruses

2602
01:54:58,470 --> 01:54:55,870
all over it

2603
01:55:00,900 --> 01:54:58,480
and that we'll be meeting tomorrow 12:15

2604
01:55:02,430 --> 01:55:00,910
to 1:30 in the Balsam room we're setting

2605
01:55:04,350 --> 01:55:02,440
up a workshop without walls we don't

2606
01:55:06,120 --> 01:55:04,360
have the exact dates yet we'll be in

2607
01:55:09,630 --> 01:55:06,130
September probably the week of September

2608
01:55:11,730 --> 01:55:09,640
16th so stay tuned as far as all that is

2609
01:55:14,040 --> 01:55:11,740
concerned otherwise you can come and

2610
01:55:15,660 --> 01:55:14,050
find me I will be heading to my post or

2611
01:55:17,880 --> 01:55:15,670
even though the poster session was

2612
01:55:22,260 --> 01:55:17,890
yesterday and without how many minutes

2613
01:55:24,630 --> 01:55:22,270

we have left there's something is this

2614
01:55:28,050 --> 01:55:24,640
Europe well this just leads me to thank

2615
01:55:32,430 --> 01:55:28,060
not only Barry and his memory as far as

2616
01:55:34,410 --> 01:55:32,440
the founder of the NII but also some of

2617
01:55:37,190 --> 01:55:34,420
the directors discretionary fund that we

2618
01:55:39,930 --> 01:55:37,200
got from Carl just as a quick spin off

2619
01:55:42,720 --> 01:55:39,940
they funding we got from that turned

2620
01:55:44,640 --> 01:55:42,730
into a patent which has now been issued

2621
01:55:46,710 --> 01:55:44,650
in five different countries the

2622
01:55:48,980 --> 01:55:46,720
foundation of a company which I started

2623
01:55:51,960 --> 01:55:48,990
about five years ago that may actually

2624
01:55:53,610 --> 01:55:51,970
revolutionize getting vaccines to the

2625
01:55:55,730 --> 01:55:53,620
developing world so if we're more

2626
01:56:03,140 --> 01:55:55,740
interested in that come find me later

2627
01:56:11,370 --> 01:56:07,440
thank you very much can I really just in

2628
01:56:13,200 --> 01:56:11,380
closing I'd like to thank can thank all

2629
01:56:15,930 --> 01:56:13,210
the speakers of course but thank Ken for

2630
01:56:18,120 --> 01:56:15,940
reminding us of the importance of a part

2631
01:56:20,610 --> 01:56:18,130
of the biosphere that frequently gets

2632
01:56:23,700 --> 01:56:20,620
ignored or at least not given the

2633
01:56:25,980 --> 01:56:23,710
respect that it deserves and it was a

2634
01:56:28,800 --> 01:56:25,990
part of the biosphere that was very dear

2635
01:56:30,150 --> 01:56:28,810
to Barry Bloomberg's heart I'm sure most

2636
01:56:33,660 --> 01:56:30,160
people in this room but maybe not

2637
01:56:36,150 --> 01:56:33,670
everybody knows that Barry Bloomberg who

2638
01:56:39,510 --> 01:56:36,160

was the founding director of the NASA

2639
01:56:42,150 --> 01:56:39,520
Astrobiology Institute had a long career

2640
01:56:45,180 --> 01:56:42,160
in medicine he was 72 years old when he

2641
01:56:48,630 --> 01:56:45,190
became the NAI director and he had won

2642
01:56:51,930 --> 01:56:48,640
the Nobel Prize in 1976 for discovering

2643
01:56:56,070 --> 01:56:51,940
the hepatitis B virus and developing the

2644
01:56:58,470 --> 01:56:56,080
vaccine which is still used today as the

2645
01:57:00,690 --> 01:56:58,480
primary vaccine against hepatitis B it's

2646
01:57:02,760 --> 01:57:00,700
now made it's manufactured in a

2647
01:57:06,480 --> 01:57:02,770
different way than the way Barry made it

2648
01:57:09,420 --> 01:57:06,490
but it's the same vaccine and if you

2649
01:57:13,800 --> 01:57:09,430
don't know about Barry's life history

2650
01:57:15,540 --> 01:57:13,810
and his story I recommend that you read

2651
01:57:20,250 --> 01:57:15,550
an article that appeared in astrobiology

2652
01:57:25,980 --> 01:57:20,260
oh I forget how many years ago maybe

2653
01:57:28,770 --> 01:57:25,990
sherry remembers it was maybe 2015 and

2654
01:57:30,600 --> 01:57:28,780
at any rate I wrote it and I'm not

2655
01:57:32,970 --> 01:57:30,610
recommending it because I wrote it I'm

2656
01:57:34,440 --> 01:57:32,980
recommending it so that if you don't

2657
01:57:37,680 --> 01:57:34,450
know about Barry you can learn about him

2658
01:57:39,510 --> 01:57:37,690
he was a remarkable human being with

2659
01:57:42,360 --> 01:57:39,520
that I would like to thank my co

2660
01:57:44,850 --> 01:57:42,370
convenors penny and Dave I would like to

2661
01:57:47,370 --> 01:57:44,860
thank again all of the speakers morning

2662
01:57:49,680 --> 01:57:47,380
and afternoon and especially thank all

2663
01:57:51,330 --> 01:57:49,690

of you for spending your precious time

2664
01:57:53,810 --> 01:57:51,340
here at apps icon with us in this

2665
01:57:53,900 --> 01:57:53,820
session thanks