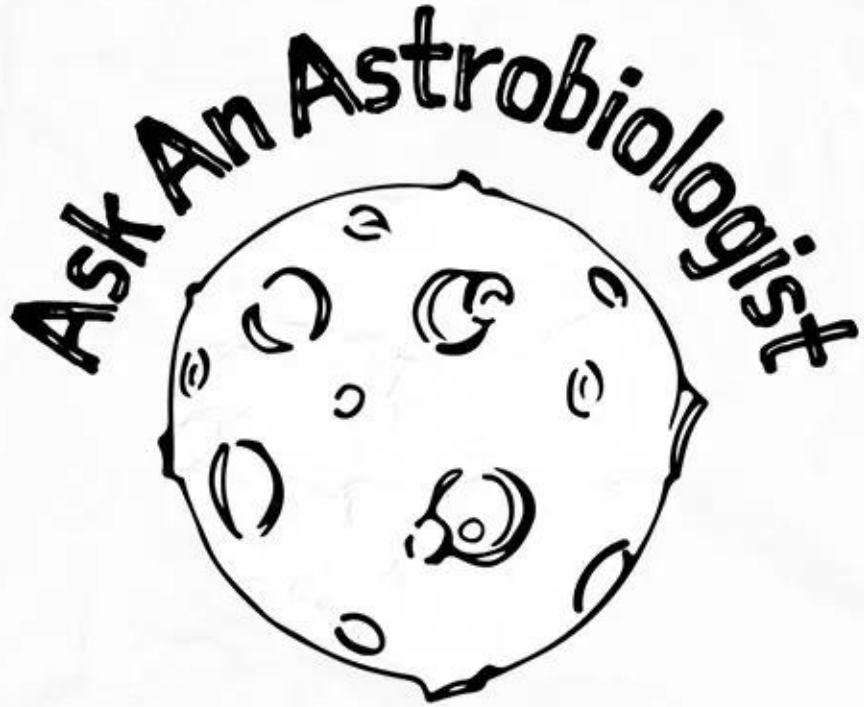

Episode 18: January 31st, 2019

Dr. Jill Tarter

NASA Astrobiology Program

1
00:00:00,500 --> 00:00:29,620
[Music]

2
00:00:35,389 --> 00:00:32,540
greetings earthlings and welcome to ask

3
00:00:37,819 --> 00:00:35,399
an astrobiologist I'm your host dr.

4
00:00:41,270 --> 00:00:37,829
Graham Lau some of you know me online as

5
00:00:43,160 --> 00:00:41,280
the Cosmo biologist and this show is

6
00:00:46,790 --> 00:00:43,170
brought to you by NASA Astrobiology

7
00:00:48,590 --> 00:00:46,800
program and second net I have an awesome

8
00:00:51,139 --> 00:00:48,600
guest for the show today so I'm kind of

9
00:00:52,760 --> 00:00:51,149
giddy super excited but before we get to

10
00:00:55,910 --> 00:00:52,770
our guests we have to do our background

11
00:00:57,889 --> 00:00:55,920
quiz as those of you who are consistent

12
00:01:01,580 --> 00:00:57,899
audience members know every month we

13
00:01:03,410 --> 00:01:01,590

have a photo behind our host and we give

14
00:01:06,350 --> 00:01:03,420
you a chance then on Twitter before the

15
00:01:09,140 --> 00:01:06,360
next episode to give us a guess at what

16
00:01:11,390 --> 00:01:09,150
that is and maybe win some prizes so for

17
00:01:13,190 --> 00:01:11,400
instance our third-place winners they

18
00:01:15,560 --> 00:01:13,200
win some of these really cool NASA

19
00:01:18,950 --> 00:01:15,570
stickers and our second-place winners

20
00:01:20,870 --> 00:01:18,960
when NASA stickers plus the astrobiology

21
00:01:22,789 --> 00:01:20,880
graphic histories and then our

22
00:01:25,039 --> 00:01:22,799
first-place winners they win both of

23
00:01:27,590 --> 00:01:25,049
those as well as a glass a drinking

24
00:01:29,960 --> 00:01:27,600
glass from second net this month's

25
00:01:32,330 --> 00:01:29,970
winners from all the right responses we

26
00:01:32,660 --> 00:01:32,340
had on Twitter yesterday are in third

27
00:01:40,609 --> 00:01:32,670
place

28
00:01:43,219 --> 00:01:40,619
tardy grata which is an incredible name

29
00:01:45,380 --> 00:01:43,229
I do have to say Arief our third place

30
00:01:48,170 --> 00:01:45,390
winner you got the right location it is

31
00:01:50,780 --> 00:01:48,180
jezero crater on Mars the next landing

32
00:01:53,090 --> 00:01:50,790
site for Mars 2020 for our next big

33
00:01:55,819 --> 00:01:53,100
Rover however there is no instrument

34
00:01:58,639 --> 00:01:55,829
called the astrological telescope we do

35
00:02:01,459 --> 00:01:58,649
astronomy and the instrument was chrism

36
00:02:04,310 --> 00:02:01,469
in the context camera onboard of the

37
00:02:06,200 --> 00:02:04,320
Mars Reconnaissance Orbiter showing that

38
00:02:08,800 --> 00:02:06,210

beautiful area around the next place

39
00:02:11,390 --> 00:02:08,810
we're landing a really big Rover on Mars

40
00:02:12,890 --> 00:02:11,400
so thank you very much for that for

41
00:02:13,580 --> 00:02:12,900
competing in our background quiz for

42
00:02:15,080 --> 00:02:13,590
this month

43
00:02:17,630 --> 00:02:15,090
the picture behind me will be the

44
00:02:19,010 --> 00:02:17,640
background quiz for next month so if you

45
00:02:20,570 --> 00:02:19,020
have an idea of what it is now that's

46
00:02:23,809 --> 00:02:20,580
great but just wait until we announce

47
00:02:25,250 --> 00:02:23,819
the day before our next episode when we

48
00:02:26,870 --> 00:02:25,260
have the background quiz and you can

49
00:02:29,809 --> 00:02:26,880
then answer and try to win some of these

50
00:02:32,540 --> 00:02:29,819
awesome prizes from NASA Astrobiology

51
00:02:34,910 --> 00:02:32,550
and from Sagan so without too much

52
00:02:37,430 --> 00:02:34,920
further ado I'd love to get into today's

53
00:02:40,550 --> 00:02:37,440
conversation with our guests today we're

54
00:02:42,259 --> 00:02:40,560
speaking with dr. Jill tarter many of

55
00:02:43,839 --> 00:02:42,269
you know her for all of her years and

56
00:02:45,440 --> 00:02:43,849
doing research with the SETI Institute

57
00:02:48,020 --> 00:02:45,450
the search for extraterrestrial

58
00:02:49,490 --> 00:02:48,030
intelligence she's been a huge proponent

59
00:02:52,370 --> 00:02:49,500
of speaking about the importance of

60
00:02:55,009 --> 00:02:52,380
asking that big question of are we alone

61
00:02:57,199 --> 00:02:55,019
and many of you also know that she was

62
00:02:59,660 --> 00:02:57,209
the basis for the character of Ellie

63
00:03:01,550 --> 00:02:59,670

Arroway and Carl Sagan's novel contact

64
00:03:03,259 --> 00:03:01,560
which was made into a film back in the

65
00:03:05,780 --> 00:03:03,269
90s starring Jodie Foster

66
00:03:08,809 --> 00:03:05,790
so Jill tarter thank you so much for

67
00:03:10,729 --> 00:03:08,819
being asking astrobiologists thanks for

68
00:03:13,039 --> 00:03:10,739
having me hopefully we won't have any

69
00:03:14,839 --> 00:03:13,049
technical difficulties yeah I know

70
00:03:16,009 --> 00:03:14,849
sometimes the connections can be a

71
00:03:17,270 --> 00:03:16,019
little weird when we're doing a show

72
00:03:19,190 --> 00:03:17,280
like this where we're connecting in from

73
00:03:21,740 --> 00:03:19,200
different places in the country and

74
00:03:23,210 --> 00:03:21,750
sometimes across the planet as much as

75
00:03:25,039 --> 00:03:23,220
we love technology it's done great

76
00:03:26,690 --> 00:03:25,049
things for us allowing us to put our ear

77
00:03:28,670 --> 00:03:26,700
to the heavens and see if there's

78
00:03:32,120 --> 00:03:28,680
neighbors out there sometimes we still

79
00:03:34,789 --> 00:03:32,130
have some issues but that's okay let's

80
00:03:36,650 --> 00:03:34,799
just start chatting be kind of cool the

81
00:03:39,050 --> 00:03:36,660
first big question I'd love to the let's

82
00:03:41,569 --> 00:03:39,060
start off with is what got you

83
00:03:45,319 --> 00:03:41,579
interested in science and that that big

84
00:03:47,990 --> 00:03:45,329
question of are we alone well it was a

85
00:03:50,539 --> 00:03:48,000
really very fortunate accident for me

86
00:03:53,240 --> 00:03:50,549
when I was a graduate student my first

87
00:03:56,270 --> 00:03:53,250
year I was supported to learn how to

88
00:04:00,590 --> 00:03:56,280

program the first desktop computer we

89
00:04:03,140 --> 00:04:00,600
ever had now this was the pdp-8 flash s

90
00:04:05,750 --> 00:04:03,150
I always thought the S was for stupid

91
00:04:08,259 --> 00:04:05,760
and it took two of us to put it up on

92
00:04:11,479 --> 00:04:08,269
the desk right but you could use it and

93
00:04:13,220 --> 00:04:11,489
there was no language so you had to

94
00:04:15,229 --> 00:04:13,230
program and then octal you had to set

95
00:04:17,319 --> 00:04:15,239
all the ones and zeros for the 11

96
00:04:20,390 --> 00:04:17,329
instructions that this machine could do

97
00:04:23,180 --> 00:04:20,400
and years later I was still a graduate

98
00:04:26,930 --> 00:04:23,190
student and this piece of equipment was

99
00:04:28,690 --> 00:04:26,940
surplus and to Stu Boyer annex

100
00:04:33,740 --> 00:04:28,700
astronomer who had a brilliant idea

101
00:04:36,290 --> 00:04:33,750
about how we could do SETI while the

102
00:04:39,260 --> 00:04:36,300
radio astronomers were using the Hat

103
00:04:41,750 --> 00:04:39,270
Creek telescope that was run by UC

104
00:04:44,680 --> 00:04:41,760
Berkeley to do their studies we could

105
00:04:48,200 --> 00:04:44,690
just make a copy of the signals being

106
00:04:51,260 --> 00:04:48,210
collected by the telescope and analyze

107
00:04:53,660 --> 00:04:51,270
them for engineered signals he hadn't

108
00:04:55,430 --> 00:04:53,670
any money he was looking for some ways

109
00:04:58,340 --> 00:04:55,440
to do it somebody gave him this old

110
00:05:02,720 --> 00:04:58,350
computer he came to me and I thought oh

111
00:05:04,670 --> 00:05:02,730
my gosh after millennia of asking

112
00:05:07,480 --> 00:05:04,680
priests and philosophers what we should

113
00:05:10,490 --> 00:05:07,490

believe about the question are we alone

114
00:05:12,770 --> 00:05:10,500
suddenly their tools there's radio

115
00:05:14,720 --> 00:05:12,780
telescopes there's computers and so

116
00:05:17,180 --> 00:05:14,730
scientists and astronomers can get

117
00:05:17,600 --> 00:05:17,190
involved to try and find out what's out

118
00:05:20,060 --> 00:05:17,610
there

119
00:05:24,170 --> 00:05:20,070
rather than accept somebody's beliefs

120
00:05:25,910 --> 00:05:24,180
and so I said I'm in and that's how it

121
00:05:29,180 --> 00:05:25,920
started and I got hooked and I've never

122
00:05:30,380 --> 00:05:29,190
gotten unhooked that's awesome yeah they

123
00:05:31,760 --> 00:05:30,390
think a lot of us you know we have those

124
00:05:33,230 --> 00:05:31,770
those ideas when we were young you know

125
00:05:35,810 --> 00:05:33,240
look at the stars at night in the

126
00:05:36,950 --> 00:05:35,820
heavens and we wonder if we're alone and

127
00:05:39,860 --> 00:05:36,960
it is really cool that we have these

128
00:05:43,100 --> 00:05:39,870
tools now I think a big question a lot

129
00:05:44,000 --> 00:05:43,110
of people have is how SETI itself has

130
00:05:46,010 --> 00:05:44,010
changed

131
00:05:48,020 --> 00:05:46,020
over these last several decades of

132
00:05:50,630 --> 00:05:48,030
really help mom's better have those

133
00:05:54,650 --> 00:05:50,640
tools gotten and what big things have

134
00:05:59,030 --> 00:05:54,660
happened in SETI during your career well

135
00:06:02,560 --> 00:05:59,040
um in terms of ideas to enormous game

136
00:06:07,060 --> 00:06:02,570
changers over my career one exoplanets

137
00:06:10,430 --> 00:06:07,070
two extremophiles and then in terms of

138
00:06:14,270 --> 00:06:10,440

instrumentation we started out purely as

139
00:06:16,940 --> 00:06:14,280
a radio source a search we've added more

140
00:06:19,159 --> 00:06:16,950
computing that's gotten better we built

141
00:06:22,970 --> 00:06:19,169
our own telescopes so we can look all

142
00:06:25,850 --> 00:06:22,980
the time and then when the technologies

143
00:06:31,060 --> 00:06:25,860
became available we started doing an

144
00:06:33,140 --> 00:06:31,070
optical search and so our current

145
00:06:35,659 --> 00:06:33,150
instrumentation threshold I would say

146
00:06:38,930 --> 00:06:35,669
now is to be able to get some

147
00:06:41,240 --> 00:06:38,940
sensitivity to transient signals

148
00:06:46,510 --> 00:06:41,250
we'd love to look at all the sky all the

149
00:06:48,170 --> 00:06:46,520
time at all wavelengths that's the next

150
00:06:51,240 --> 00:06:48,180
instrumental challenge

151
00:06:53,520 --> 00:06:51,250
whose door were trying to beat down

152
00:06:55,710 --> 00:06:53,530
okay that's interesting so so right now

153
00:06:58,050 --> 00:06:55,720
we're kind of limited to some window of

154
00:06:59,700 --> 00:06:58,060
radio a window and optical but not

155
00:07:02,700 --> 00:06:59,710
really looking through the entire AM

156
00:07:04,230 --> 00:07:02,710
spectrum yet but you did mention that we

157
00:07:05,700 --> 00:07:04,240
now have this this telescope that allows

158
00:07:07,350 --> 00:07:05,710
us to be looking all the time

159
00:07:10,140 --> 00:07:07,360
I imagine you mean the Allen telescope

160
00:07:13,500 --> 00:07:10,150
array for our audience members in the

161
00:07:15,660 --> 00:07:13,510
end we're speaking of there yeah so so

162
00:07:18,060 --> 00:07:15,670
now the Allen telescope array is my

163
00:07:21,210 --> 00:07:18,070

knowledge the very first SETI dedicated

164
00:07:23,460 --> 00:07:21,220
telescope array is that correct that's

165
00:07:28,980 --> 00:07:23,470
right it's the first time that we built

166
00:07:32,100 --> 00:07:28,990
a telescope on purpose as well as doing

167
00:07:34,800 --> 00:07:32,110
radio astronomy and it's the first time

168
00:07:38,130 --> 00:07:34,810
we built a radio telescope as a large

169
00:07:39,870 --> 00:07:38,140
number of small dishes all hooked

170
00:07:43,770 --> 00:07:39,880
together with an enormous amount of

171
00:07:46,470 --> 00:07:43,780
computing and that looks like the way in

172
00:07:48,390 --> 00:07:46,480
the future continue to build ever bigger

173
00:07:52,890 --> 00:07:48,400
radio telescopes the Square Kilometre

174
00:07:56,159 --> 00:07:52,900
Array in South Africa and Western

175
00:08:00,240 --> 00:07:56,169
Australia will be built that way the

176
00:08:03,420 --> 00:08:00,250
next generation Very Large Array will be

177
00:08:06,480 --> 00:08:03,430
built with smaller dishes and more of

178
00:08:08,760 --> 00:08:06,490
them so this is a good idea and we've

179
00:08:09,840 --> 00:08:08,770
proven that it can be done that's

180
00:08:12,659 --> 00:08:09,850
incredible that's awesome

181
00:08:15,719 --> 00:08:12,669
um I'm so glad we finally have some

182
00:08:17,159 --> 00:08:15,729
dedicated instruments just for SETI even

183
00:08:18,870 --> 00:08:17,169
though we have had other studied

184
00:08:21,930 --> 00:08:18,880
searches on things like the Arecibo

185
00:08:23,670 --> 00:08:21,940
radio telescope and also the fast

186
00:08:26,520 --> 00:08:23,680
telescope now being developed in China

187
00:08:27,600 --> 00:08:26,530
to my knowledge has a mission objective

188
00:08:30,630 --> 00:08:27,610

of the search for extraterrestrial

189
00:08:33,450 --> 00:08:30,640
intelligence if I can how do you feel

190
00:08:35,399 --> 00:08:33,460
about now other nations also getting

191
00:08:39,020 --> 00:08:35,409
interested in SETI and kind of forming

192
00:08:42,329 --> 00:08:39,030
their own SETI searches hey bring it on

193
00:08:44,130 --> 00:08:42,339
absolutely this is uh if there's a

194
00:08:45,690 --> 00:08:44,140
message out there it's coming to the

195
00:08:49,470 --> 00:08:45,700
planet right it's not coming to

196
00:08:51,810 --> 00:08:49,480
California or to China or to South

197
00:08:54,000 --> 00:08:51,820
Africa it's coming to the planet and

198
00:08:57,270 --> 00:08:54,010
that information is the property of all

199
00:08:59,940 --> 00:08:57,280
humankind um I think that's actually one

200
00:09:02,940 --> 00:08:59,950
of the very best things about study as

201
00:09:04,920 --> 00:09:02,950
we talk to people about what we're doing

202
00:09:07,019 --> 00:09:04,930
and try and get them

203
00:09:10,740 --> 00:09:07,029
stood in participating and supporting

204
00:09:14,040 --> 00:09:10,750
the work we're actually expanding their

205
00:09:15,990 --> 00:09:14,050
perspective we're making them giving

206
00:09:19,950 --> 00:09:16,000
them the opportunity to see themselves

207
00:09:25,040 --> 00:09:19,960
in a different way to see themselves as

208
00:09:27,990 --> 00:09:25,050
one species humans on one planet and

209
00:09:30,690 --> 00:09:28,000
said he kind of holds up a mirror to all

210
00:09:33,510 --> 00:09:30,700
of us on this planet and says 'i see all

211
00:09:35,850 --> 00:09:33,520
you guys you're all the same when

212
00:09:41,550 --> 00:09:35,860
compared to something else out there and

213
00:09:44,100 --> 00:09:41,560

so it it naturally reinforces this

214
00:09:46,410 --> 00:09:44,110
cosmic perspective and i think that's

215
00:09:49,350 --> 00:09:46,420
such a very important thing for our

216
00:09:52,740 --> 00:09:49,360
long-term survival we've got lots of

217
00:09:56,160 --> 00:09:52,750
challenges on this planet and those

218
00:09:58,889 --> 00:09:56,170
challenges going to respect national

219
00:10:03,630 --> 00:09:58,899
boundaries we are gonna have to solve

220
00:10:05,940 --> 00:10:03,640
them globally systemically and if we get

221
00:10:09,290 --> 00:10:05,950
into the mindset of seeing ourselves as

222
00:10:12,390 --> 00:10:09,300
earthlings because of working with Ceti

223
00:10:16,130 --> 00:10:12,400
then maybe that's the first step in

224
00:10:20,360 --> 00:10:16,140
getting together to work effectively to

225
00:10:23,780 --> 00:10:21,650
that's interesting you know having more

226
00:10:27,860 --> 00:10:23,790
of a global view through our cosmic

227
00:10:29,660 --> 00:10:27,870
perspective I love that I do have to ask

228
00:10:32,900 --> 00:10:29,670
so since you have acute files and

229
00:10:35,389 --> 00:10:32,910
exoplanets earlier you know this is

230
00:10:36,920 --> 00:10:35,399
asking astrobiologist and most of our

231
00:10:38,509 --> 00:10:36,930
guests on the show previously have done

232
00:10:41,329 --> 00:10:38,519
more work in the realm of geochemistry

233
00:10:43,210 --> 00:10:41,339
and planetary science I'm wondering if

234
00:10:46,220 --> 00:10:43,220
you can speak for our audience maybe

235
00:10:51,829 --> 00:10:46,230
about how SETI itself really fits inside

236
00:10:56,049 --> 00:10:51,839
of astrobiology well most people think

237
00:11:00,350 --> 00:10:56,059
about astrobiology as looking for

238
00:11:04,220 --> 00:11:00,360

Institue biomarkers or remotely for bio

239
00:11:07,369 --> 00:11:04,230
signatures well think about it in a

240
00:11:10,280 --> 00:11:07,379
parallel way that what we're trying to

241
00:11:14,049 --> 00:11:10,290
do is look remotely for techno

242
00:11:18,309 --> 00:11:14,059
signatures looking for evidence of

243
00:11:22,730 --> 00:11:18,319
civilizations that a lot of environments

244
00:11:25,579 --> 00:11:22,740
in ways that we might sense over the

245
00:11:27,019 --> 00:11:25,589
vast distances to the Stars sure we

246
00:11:28,999 --> 00:11:27,029
started out with electromagnetic

247
00:11:30,619 --> 00:11:29,009
radiation that's what we knew how to do

248
00:11:33,679 --> 00:11:30,629
video telescopes

249
00:11:35,720 --> 00:11:33,689
optical telescopes now think about it we

250
00:11:39,949 --> 00:11:35,730
are building or talking about building

251
00:11:44,170 --> 00:11:39,959
or wishing to build lots more large

252
00:11:46,189 --> 00:11:44,180
glass facilities on the ground and

253
00:11:50,240 --> 00:11:46,199
telescopes with lots of different

254
00:11:52,819 --> 00:11:50,250
capabilities in orbit and these are

255
00:11:57,410 --> 00:11:52,829
being built in part to look for bio

256
00:12:00,679 --> 00:11:57,420
signatures what else might they see that

257
00:12:05,569 --> 00:12:00,689
would indicate astroengineering not just

258
00:12:10,040 --> 00:12:05,579
astrobiology and so we've been trying to

259
00:12:14,449 --> 00:12:10,050
talk to the community about what might

260
00:12:20,419 --> 00:12:14,459
an engineered planet look like how might

261
00:12:23,079 --> 00:12:20,429
we tell something that is modified as

262
00:12:27,079 --> 00:12:23,089
opposed to natural out there

263
00:12:29,660 --> 00:12:27,089

big large Astro engineering project to

264
00:12:33,860 --> 00:12:29,670
capture energy might be one thing

265
00:12:36,790 --> 00:12:33,870
mirrors or Dyson spheres but we also

266
00:12:41,540 --> 00:12:36,800
when and if we get the capability to

267
00:12:45,230 --> 00:12:41,550
image these distant exoplanets we might

268
00:12:49,160 --> 00:12:45,240
find that their albedo is strange their

269
00:12:52,550 --> 00:12:49,170
temperatures are strange both of which

270
00:12:55,910 --> 00:12:52,560
could happen because of life but if we

271
00:13:01,490 --> 00:12:55,920
find that their temperatures for example

272
00:13:03,470 --> 00:13:01,500
are uniform from Paul to equator maybe

273
00:13:06,290 --> 00:13:03,480
that's an indication that somebody is

274
00:13:11,360 --> 00:13:06,300
looking to make more habitable real

275
00:13:14,390 --> 00:13:11,370
estate to manage weather do something

276
00:13:17,810 --> 00:13:14,400
that we can't do that's for sure but

277
00:13:20,390 --> 00:13:17,820
maybe another technology could suppose

278
00:13:23,510 --> 00:13:20,400
you look at the Travis one systems right

279
00:13:28,820 --> 00:13:23,520
there's seven planets all closely

280
00:13:32,720 --> 00:13:28,830
orbiting a red dwarf star and when we

281
00:13:34,770 --> 00:13:32,730
get the ability to image them we find

282
00:13:37,410 --> 00:13:34,780
out that

283
00:13:38,790 --> 00:13:37,420
they're all the same they should be

284
00:13:41,000 --> 00:13:38,800
different temperatures because of their

285
00:13:43,620 --> 00:13:41,010
are different distances from their host

286
00:13:47,250 --> 00:13:43,630
but what if we find that they're all the

287
00:13:49,830 --> 00:13:47,260
same again maybe somebody needed some

288
00:13:53,430 --> 00:13:49,840

more habitable real estate and decided

289
00:13:55,490 --> 00:13:53,440
to engineer some of those planets it's

290
00:13:57,990 --> 00:13:55,500
this kind of thing thinking broadly

291
00:14:00,930 --> 00:13:58,000
techno signatures as well as bio

292
00:14:03,090 --> 00:14:00,940
signatures interesting that makes me

293
00:14:05,100 --> 00:14:03,100
think a lot about David Grinspoon recent

294
00:14:06,960 --> 00:14:05,110
book Earth and human hands and how he

295
00:14:08,970 --> 00:14:06,970
discussed that the future humanity might

296
00:14:10,620 --> 00:14:08,980
be coming to the point of actually

297
00:14:12,600 --> 00:14:10,630
geoengineering our planet - for instance

298
00:14:14,280 --> 00:14:12,610
control our own climate around

299
00:14:15,750 --> 00:14:14,290
temperature so I find it very

300
00:14:18,150 --> 00:14:15,760
interesting that that we might look for

301
00:14:20,280 --> 00:14:18,160
other civilizations who have gotten that

302
00:14:23,520 --> 00:14:20,290
point already in controlling their own

303
00:14:25,620 --> 00:14:23,530
worlds well you know Arthur Clarke gave

304
00:14:29,150 --> 00:14:25,630
us three laws right the third of which

305
00:14:33,270 --> 00:14:29,160
was any sufficiently advanced technology

306
00:14:35,880 --> 00:14:33,280
would English will from magic right and

307
00:14:39,560 --> 00:14:35,890
we've sort of been using that as a

308
00:14:42,750 --> 00:14:39,570
backdrop for thinking but more recently

309
00:14:47,480 --> 00:14:42,760
a philosopher by the name of Karl

310
00:14:50,450 --> 00:14:47,490
Schroeder has suggested that any savants

311
00:14:56,210 --> 00:14:50,460
technology would be indistinguishable

312
00:14:59,310 --> 00:14:56,220
from nature that is that sustainability

313
00:15:01,579 --> 00:14:59,320

would require a technological

314
00:15:06,300 --> 00:15:01,589
civilization to become extraordinarily

315
00:15:10,230 --> 00:15:06,310
efficient and not put their planet out

316
00:15:11,970 --> 00:15:10,240
of kilter so scratching our heads about

317
00:15:17,220 --> 00:15:11,980
that one and thinking what would that

318
00:15:19,260 --> 00:15:17,230
imply in terms of interpreting the data

319
00:15:23,720 --> 00:15:19,270
that we're going to get back from these

320
00:15:25,250 --> 00:15:23,730
future missions mmm-hmm interesting

321
00:15:27,860 --> 00:15:25,260
so kind of in that vein I have a

322
00:15:29,449 --> 00:15:27,870
question when I ask you were on an

323
00:15:31,879 --> 00:15:29,459
interview with science Friday a couple

324
00:15:34,040 --> 00:15:31,889
of years ago and I heard a statement

325
00:15:36,920 --> 00:15:34,050
that you said that the 21st century will

326
00:15:39,590 --> 00:15:36,930
be the century of life on Earth and

327
00:15:41,569 --> 00:15:39,600
beyond I wonder if you could speak more

328
00:15:43,730 --> 00:15:41,579
to what that really means for our

329
00:15:48,050 --> 00:15:43,740
audience that this century might be the

330
00:15:52,280 --> 00:15:48,060
century for life well this is taking off

331
00:15:55,610 --> 00:15:52,290
from a quote by carl Venter and Daniel

332
00:15:57,680 --> 00:15:55,620
Cohen in 2004 they wrote a paper that

333
00:16:00,439 --> 00:15:57,690
said whereas the 20th century have been

334
00:16:02,540 --> 00:16:00,449
the century of physics 21st century was

335
00:16:04,850 --> 00:16:02,550
going to be the century of biology and

336
00:16:06,860 --> 00:16:04,860
that was a real bold prediction and they

337
00:16:10,340 --> 00:16:06,870
were talking about genomics and

338
00:16:13,210 --> 00:16:10,350

proteomics and bioengineering and all of

339
00:16:16,400 --> 00:16:13,220
this wonderful stuff which is in fact

340
00:16:20,150 --> 00:16:16,410
paying off much quicker than they might

341
00:16:23,300 --> 00:16:20,160
have anticipated but I think as bold as

342
00:16:24,920 --> 00:16:23,310
that was not really bold enough I think

343
00:16:28,639 --> 00:16:24,930
that this is going to be the century of

344
00:16:30,949 --> 00:16:28,649
biology ology not just on earth but

345
00:16:33,970 --> 00:16:30,959
beyond because I think there are a

346
00:16:38,780 --> 00:16:33,980
number of ways that we can detect

347
00:16:42,230 --> 00:16:38,790
biology this coming century

348
00:16:47,150 --> 00:16:42,240
we can find it with the the missions

349
00:16:50,300 --> 00:16:47,160
that are being proposed to look for

350
00:16:52,639 --> 00:16:50,310
microbial life to look for the chemical

351
00:16:56,750 --> 00:16:52,649
signatures of life in the atmospheres of

352
00:17:00,650 --> 00:16:56,760
exoplanets we might find evidence for

353
00:17:02,809 --> 00:17:00,660
extinct or even extant life on some of

354
00:17:05,120 --> 00:17:02,819
the bodies within our own solar system

355
00:17:08,929 --> 00:17:05,130
as we get the opportunity to explore

356
00:17:12,890 --> 00:17:08,939
those robotically or in partnership with

357
00:17:15,169 --> 00:17:12,900
with humans and we might in fact as

358
00:17:18,530 --> 00:17:15,179
we're looking for something else

359
00:17:23,350 --> 00:17:18,540
stumble across evidence of huge Astro

360
00:17:27,140 --> 00:17:23,360
engine and lastly we might take it there

361
00:17:31,730 --> 00:17:27,150
right we might by going to the moon and

362
00:17:35,170 --> 00:17:31,740
to asteroids and to Mars we in fact

363
00:17:40,810 --> 00:17:38,020

of this planet so I think this next

364
00:17:43,300 --> 00:17:40,820
century is going to be incredibly

365
00:17:45,130 --> 00:17:43,310
exciting right and I you know I wish I

366
00:17:48,130 --> 00:17:45,140
could plan to stick around to the end of

367
00:17:48,940 --> 00:17:48,140
it to see how it all works out yeah no

368
00:17:50,740 --> 00:17:48,950
kidding

369
00:17:52,150 --> 00:17:50,750
that's wonderful yeah it's kind of

370
00:17:53,920 --> 00:17:52,160
interesting just to think about what's

371
00:17:56,050 --> 00:17:53,930
coming right now

372
00:17:57,310 --> 00:17:56,060
for all of us in astrobiology there's so

373
00:17:59,800 --> 00:17:57,320
many things like you mentioned we have

374
00:18:02,440 --> 00:17:59,810
spacecraft studying our solar system we

375
00:18:04,900 --> 00:18:02,450
have telescopes on earth and in orbit

376
00:18:08,560 --> 00:18:04,910
studying exoplanets and we also have

377
00:18:10,300 --> 00:18:08,570
SETI I wonder if you could for our

378
00:18:13,240 --> 00:18:10,310
audience tell us what we all need right

379
00:18:15,220 --> 00:18:13,250
now is the most important thing not just

380
00:18:19,530 --> 00:18:15,230
for SETI right now but for the future of

381
00:18:23,850 --> 00:18:21,960
you know I missed the end of your

382
00:18:27,390 --> 00:18:23,860
question you said not just for SETI

383
00:18:31,590 --> 00:18:27,400
right now but but for the future of SETI

384
00:18:35,900 --> 00:18:31,600
as well okay well the answer to that

385
00:18:39,960 --> 00:18:35,910
question is pretty simple it's a

386
00:18:42,800 --> 00:18:39,970
sustainable funding profile right

387
00:18:46,110 --> 00:18:42,810
SETI's funding has been a roller coaster

388
00:18:48,920 --> 00:18:46,120

historically and we need to put it on a

389
00:18:52,500 --> 00:18:48,930
stable platform we need to find a way to

390
00:18:55,200 --> 00:18:52,510
fund projects that have a very long

391
00:18:58,790 --> 00:18:55,210
horizon potentially before they pay off

392
00:19:02,070 --> 00:18:58,800
the high energy physics community and

393
00:19:04,950 --> 00:19:02,080
the gravitational wave community have

394
00:19:08,340 --> 00:19:04,960
been able to do that when putting

395
00:19:10,500 --> 00:19:08,350
funding year after year after year into

396
00:19:12,120 --> 00:19:10,510
building instruments that weren't good

397
00:19:15,150 --> 00:19:12,130
enough when they were turned on and got

398
00:19:17,970 --> 00:19:15,160
made better we need to find a model for

399
00:19:21,870 --> 00:19:17,980
that hopefully at a lower price tag than

400
00:19:26,220 --> 00:19:21,880
building like OO or the the Large Hadron

401
00:19:29,430 --> 00:19:26,230
Collider but a model where because we

402
00:19:32,790 --> 00:19:29,440
have some sort of dependable funding

403
00:19:34,830 --> 00:19:32,800
base we can enact attract the best and

404
00:19:37,740 --> 00:19:34,840
the brightest you know lots of people

405
00:19:41,040 --> 00:19:37,750
are excited about this field but if you

406
00:19:44,040 --> 00:19:41,050
tell them oh come this and the other

407
00:19:45,990 --> 00:19:44,050
thing but maybe I can't pay you next

408
00:19:47,850 --> 00:19:46,000
month hmm that's a little bit close to

409
00:19:53,040 --> 00:19:47,860
home right now

410
00:19:57,150 --> 00:19:53,050
but seriously having a funding base will

411
00:20:00,930 --> 00:19:57,160
allow us to to take on very large

412
00:20:02,970 --> 00:20:00,940
projects that that provide us with huge

413
00:20:06,560 --> 00:20:02,980

improvements in our capabilities and

414
00:20:12,360 --> 00:20:06,570
will allow young people with great ideas

415
00:20:14,250 --> 00:20:12,370
to become part of this exploration yeah

416
00:20:15,960 --> 00:20:14,260
I think we have some of those best and

417
00:20:18,270 --> 00:20:15,970
brightest watching our show right now so

418
00:20:20,940 --> 00:20:18,280
you know if you're out there you know

419
00:20:22,620 --> 00:20:20,950
these are things you can do now so

420
00:20:24,570 --> 00:20:22,630
before we do open up the questions from

421
00:20:27,660 --> 00:20:24,580
the audience I do have a couple of fun

422
00:20:29,640 --> 00:20:27,670
things I want to bring up for one David

423
00:20:32,480 --> 00:20:29,650
Grinspoon had posted on Twitter last

424
00:20:35,390 --> 00:20:32,490
year some pictures of you fixing

425
00:20:36,740 --> 00:20:35,400
of the Green Bank telescope at the SETI

426
00:20:37,640 --> 00:20:36,750
Institute I wonder if you could explain

427
00:20:39,740 --> 00:20:37,650
since we're going to show the picture

428
00:20:42,040 --> 00:20:39,750
right now for our audience if you can

429
00:20:45,650 --> 00:20:42,050
explain what's happening in that picture

430
00:20:50,210 --> 00:20:45,660
well the Green Bank telescope is a

431
00:20:53,600 --> 00:20:50,220
wonderful example of an offset Gregorian

432
00:20:56,299 --> 00:20:53,610
design which means the telescope feed

433
00:20:59,270 --> 00:20:56,309
doesn't come up into from the middle of

434
00:21:02,900 --> 00:20:59,280
the telescope it actually hangs off from

435
00:21:05,930 --> 00:21:02,910
one side and now you can decide you've

436
00:21:10,190 --> 00:21:05,940
got a telescope to hang your feed up

437
00:21:13,220 --> 00:21:10,200
high or hang it off the bottom down low

438
00:21:16,010 --> 00:21:13,230

and the Allen telescope array has a feet

439
00:21:18,380 --> 00:21:16,020
low configuration but the gbt has a feed

440
00:21:20,630 --> 00:21:18,390
high configuration and we have this

441
00:21:24,950 --> 00:21:20,640
beautiful model of Seti Institute that

442
00:21:27,799 --> 00:21:24,960
with moving around and changing offices

443
00:21:30,950 --> 00:21:27,809
etc had gotten broken and it's it's

444
00:21:34,070 --> 00:21:30,960
broken position had it lying down with

445
00:21:37,700 --> 00:21:34,080
its feed on the ground and so now that

446
00:21:39,560 --> 00:21:37,710
it has become a viable SETI instrument

447
00:21:43,280 --> 00:21:39,570
being used by the breakthrough listen

448
00:21:45,980 --> 00:21:43,290
project I really felt that we needed to

449
00:21:47,960 --> 00:21:45,990
have it presented correctly so I was

450
00:21:50,090 --> 00:21:47,970
early for a science advisory board

451
00:21:53,060 --> 00:21:50,100
meeting one morning and I got out the

452
00:21:55,610 --> 00:21:53,070
super glue in the scissors and the tools

453
00:21:59,020 --> 00:21:55,620
and I fixed it so that the feed is now

454
00:22:03,169 --> 00:22:01,580
yeah it's perfect that's kind of what

455
00:22:04,880 --> 00:22:03,179
scientists do we see things you know

456
00:22:06,410 --> 00:22:04,890
that need to be fixed I mean I kind of

457
00:22:08,180 --> 00:22:06,420
messed up like that engineer to do that

458
00:22:09,410 --> 00:22:08,190
you know they may see things that aren't

459
00:22:13,190 --> 00:22:09,420
exactly the way that they are in nature

460
00:22:15,520 --> 00:22:13,200
we questioned why and I love that um I

461
00:22:18,890 --> 00:22:15,530
would be remiss if I didn't bring up

462
00:22:22,100 --> 00:22:18,900
contact and what it was like having Carl

463
00:22:23,900 --> 00:22:22,110

Sagan and Andrew and tell you that you

464
00:22:26,780 --> 00:22:23,910
were the basis in some ways for this

465
00:22:29,390 --> 00:22:26,790
character of Ellie Arroway can you tell

466
00:22:31,370 --> 00:22:29,400
us what that was like when you found out

467
00:22:34,390 --> 00:22:31,380
that you were somewhat being

468
00:22:37,520 --> 00:22:34,400
immortalized in a work by Carl Sagan

469
00:22:40,310 --> 00:22:37,530
well it was a long time ago this in the

470
00:22:42,080 --> 00:22:40,320
mid 80s Carl was a colleague and I

471
00:22:44,160 --> 00:22:42,090
actually happened to be back at Cornell

472
00:22:46,500 --> 00:22:44,170
for a meeting

473
00:22:48,870 --> 00:22:46,510
karl said come on up to the house we're

474
00:22:50,670 --> 00:22:48,880
having a cocktail party so I dutifully

475
00:22:54,270 --> 00:22:50,680
went out to their beautiful house in

476
00:22:57,810 --> 00:22:54,280
though in the hills and they took me

477
00:22:59,970 --> 00:22:57,820
aside and Karl and they said Karl's

478
00:23:02,430 --> 00:22:59,980
writing a science fiction book and I

479
00:23:04,170 --> 00:23:02,440
said oh come on the New York Times last

480
00:23:06,600 --> 00:23:04,180
weekend told us what kind of an advance

481
00:23:11,820 --> 00:23:06,610
II got and we're so bloody jealous right

482
00:23:15,520 --> 00:23:11,830
and they said well you may think you

483
00:23:18,160 --> 00:23:15,530
recognize someone in the book

484
00:23:20,730 --> 00:23:18,170
but I think you're gonna like her and

485
00:23:25,030 --> 00:23:20,740
[Laughter]

486
00:23:28,030 --> 00:23:25,040
just just make sure that she doesn't eat

487
00:23:30,310 --> 00:23:28,040
ice cream cones for lunch because that

488
00:23:33,310 --> 00:23:30,320

was something that I got teased about

489
00:23:36,430 --> 00:23:33,320
relentlessly that was my daily lunch to

490
00:23:39,430 --> 00:23:36,440
walk from our laboratories over to the

491
00:23:41,920 --> 00:23:39,440
Baskins and Robin's on the base and cone

492
00:23:45,420 --> 00:23:41,930
and walk back right so I could have my

493
00:23:48,130 --> 00:23:45,430
pleasure and get my steps simultaneously

494
00:23:49,840 --> 00:23:48,140
and I thought well as long as that

495
00:23:52,060 --> 00:23:49,850
characteristic isn't there nobody's

496
00:23:54,190 --> 00:23:52,070
think it's me well and didn't exactly

497
00:23:57,750 --> 00:23:54,200
work out that way and it I had a great

498
00:24:00,160 --> 00:23:57,760
time when this book turned into a movie

499
00:24:03,270 --> 00:24:00,170
it was a real privilege to work with

500
00:24:05,850 --> 00:24:03,280
Jodie Foster because she's a brilliant

501
00:24:08,980 --> 00:24:05,860
wonderfully good actor

502
00:24:12,940 --> 00:24:08,990
very kind person and we had a lot of fun

503
00:24:16,390 --> 00:24:12,950
and actually I was down at their Co and

504
00:24:19,930 --> 00:24:16,400
they were filming there sadly I left too

505
00:24:22,330 --> 00:24:19,940
early to prevent the huge in numerous

506
00:24:24,820 --> 00:24:22,340
that's there but while I was there I

507
00:24:28,060 --> 00:24:24,830
just was fascinated by all their gear

508
00:24:30,790 --> 00:24:28,070
they've got really good technology and I

509
00:24:33,490 --> 00:24:30,800
was thinking oh maybe I'd like to make

510
00:24:37,870 --> 00:24:33,500
movies if I can't make it in in SETI

511
00:24:39,330 --> 00:24:37,880
right absolutely I think a lot of people

512
00:24:41,650 --> 00:24:39,340
who are interested in astrobiology

513
00:24:44,280 --> 00:24:41,660

interested in this idea of are we alone

514
00:24:47,740 --> 00:24:44,290
are also huge fans of science fiction

515
00:24:53,770 --> 00:24:47,750
and so things like context inspired so

516
00:24:57,460 --> 00:24:53,780
many of us because I think science

517
00:25:00,970 --> 00:24:57,470
fiction is great because it gives us an

518
00:25:03,310 --> 00:25:00,980
opportunity to think about things that

519
00:25:06,220 --> 00:25:03,320
we can't conceive of I mean one of my

520
00:25:10,000 --> 00:25:06,230
favorite science fiction stories is Fred

521
00:25:13,920 --> 00:25:10,010
Hoyle cosmologists wrote a story about a

522
00:25:18,230 --> 00:25:13,930
plasma cloud that was intelligent and

523
00:25:20,840 --> 00:25:18,240
causing us unintel

524
00:25:26,390 --> 00:25:20,850
the Sun as it came to visit us

525
00:25:29,120 --> 00:25:26,400
um that's a type of intelligence I might

526
00:25:31,910 --> 00:25:29,130
not have known but now that I've read

527
00:25:35,530 --> 00:25:31,920
that book there's some little piece of

528
00:25:37,910 --> 00:25:35,540
my mind that's open to that idea

529
00:25:39,620 --> 00:25:37,920
interesting yeah it's interesting how a

530
00:25:42,380 --> 00:25:39,630
science fiction kind of gives us a way

531
00:25:45,350 --> 00:25:42,390
of seeing ourselves in settings in

532
00:25:48,590 --> 00:25:45,360
different time periods I do have to ask

533
00:25:50,930 --> 00:25:48,600
if if Carl Sagan was here right now and

534
00:25:52,970 --> 00:25:50,940
was writing the novel contact right now

535
00:25:56,090 --> 00:25:52,980
or or if the film contact were being

536
00:25:58,190 --> 00:25:56,100
made right now how do you think it would

537
00:26:00,320 --> 00:25:58,200
be different from the way it was was

538
00:26:04,400 --> 00:26:00,330

made back in 1985 when the novel was

539
00:26:07,910 --> 00:26:04,410
first published well Carl was prophetic

540
00:26:09,080 --> 00:26:07,920
unfortunately in terms of understanding

541
00:26:11,450 --> 00:26:09,090
that whereas we were a government

542
00:26:15,590 --> 00:26:11,460
program in fat dumb and happy in some

543
00:26:17,830 --> 00:26:15,600
sense we would face a termination of the

544
00:26:19,880 --> 00:26:17,840
funds and then be struck with the

545
00:26:21,980 --> 00:26:19,890
difficulty of going out and raising

546
00:26:27,860 --> 00:26:21,990
money I wish he hadn't been right about

547
00:26:32,240 --> 00:26:27,870
that piece I think that what would be

548
00:26:38,170 --> 00:26:32,250
different now would be a larger

549
00:26:41,420 --> 00:26:38,180
concentration on private funding being

550
00:26:44,990 --> 00:26:41,430
sufficient or at least maybe just

551
00:26:48,550 --> 00:26:45,000
adequate to take on the challenges of

552
00:26:53,090 --> 00:26:48,560
space flight so I think he would be

553
00:26:57,280 --> 00:26:53,100
having a lot to say about SpaceX and LU

554
00:27:01,130 --> 00:26:57,290
origin and all of the other

555
00:27:05,210 --> 00:27:01,140
opportunities for access to space that

556
00:27:07,250 --> 00:27:05,220
aren't directly related to the federal

557
00:27:10,250 --> 00:27:07,260
government of course they're funded in

558
00:27:13,910 --> 00:27:10,260
the end by federal funds are these

559
00:27:16,370 --> 00:27:13,920
contracts that the private companies get

560
00:27:18,960 --> 00:27:16,380
from the government but still it's a

561
00:27:20,970 --> 00:27:18,970
different way of doing it

562
00:27:22,529 --> 00:27:20,980
and I think Carl would be fascinated to

563
00:27:24,870 --> 00:27:22,539

see where that was going

564
00:27:26,399 --> 00:27:24,880
you know that things have changed a lot

565
00:27:28,500 --> 00:27:26,409
I mean for the generation coming up

566
00:27:30,899 --> 00:27:28,510
right now you know for them we've always

567
00:27:32,159 --> 00:27:30,909
had people in space in orbit and we live

568
00:27:34,289 --> 00:27:32,169
in a time where we have private

569
00:27:36,390 --> 00:27:34,299
companies developing rockets and we have

570
00:27:38,039 --> 00:27:36,400
you know breakthrough and SETI and these

571
00:27:39,870 --> 00:27:38,049
different companies these organizations

572
00:27:42,659 --> 00:27:39,880
kind of you know taking on some of these

573
00:27:44,610 --> 00:27:42,669
tasks themselves I think it is a good

574
00:27:46,169 --> 00:27:44,620
time now to change up the conversation

575
00:27:50,430 --> 00:27:46,179
and open up some questions from the

576
00:27:53,850 --> 00:27:50,440
audience if we can so on this idea of

577
00:27:56,130 --> 00:27:53,860
science-fiction Michael Wong writing on

578
00:27:57,600 --> 00:27:56,140
Twitter has asked that he'd love to hear

579
00:27:58,770 --> 00:27:57,610
your thoughts on the 2016

580
00:28:03,510 --> 00:27:58,780
science-fiction film

581
00:28:04,200 --> 00:28:03,520
arrival if you saw that I saw it and I

582
00:28:07,409 --> 00:28:04,210
loved it

583
00:28:09,990 --> 00:28:07,419
I just might was keep trying to wrap my

584
00:28:12,899 --> 00:28:10,000
head around the fact that if you're

585
00:28:15,659 --> 00:28:12,909
going to write in circles you have to

586
00:28:20,580 --> 00:28:15,669
know the future and I think that's such

587
00:28:22,380 --> 00:28:20,590
on a mind exploding concept I thought

588
00:28:25,049 --> 00:28:22,390

that was that was beautiful and I

589
00:28:28,140 --> 00:28:25,059
thought the actors and it was all great

590
00:28:30,750 --> 00:28:28,150
I really liked it me too

591
00:28:32,070 --> 00:28:30,760
it seems like SETI and people you know

592
00:28:33,840 --> 00:28:32,080
who are really thinking about SETI

593
00:28:35,700 --> 00:28:33,850
deeply are also people who are

594
00:28:37,080 --> 00:28:35,710
considering what language would be like

595
00:28:39,149 --> 00:28:37,090
if it were different from the way that

596
00:28:40,560 --> 00:28:39,159
we use language and so it kind of makes

597
00:28:43,110 --> 00:28:40,570
sense you know the question what happens

598
00:28:44,820 --> 00:28:43,120
if we right circularly are there people

599
00:28:46,980 --> 00:28:44,830
actively working with city who are

600
00:28:48,930 --> 00:28:46,990
linguists who are trying to figure out

601
00:28:53,039 --> 00:28:48,940
how an alien language might actually

602
00:28:56,390 --> 00:28:53,049
look there are there this has been a

603
00:29:01,020 --> 00:28:56,400
topic of interest for quite a while and

604
00:29:03,149 --> 00:29:01,030
at first I think the easy solution to

605
00:29:07,260 --> 00:29:03,159
that was well it'll be based on

606
00:29:09,419 --> 00:29:07,270
mathematics right and certainly bring

607
00:29:12,330 --> 00:29:09,429
Paul developed this whole language

608
00:29:18,680 --> 00:29:12,340
called Linc O's that was supposed to

609
00:29:23,220 --> 00:29:18,690
allow communication of complex emotional

610
00:29:26,029 --> 00:29:23,230
concepts but starting with very very

611
00:29:31,630 --> 00:29:26,039
precise rules sort of mathematical rules

612
00:29:40,030 --> 00:29:35,590
it seems to us now that the actual

613
00:29:48,370 --> 00:29:44,830

ah dictates how we think about

614
00:29:52,720 --> 00:29:48,380
mathematics perhaps so we might be

615
00:29:57,150 --> 00:29:52,730
correct that something like the periodic

616
00:29:59,080 --> 00:29:57,160
table or simple rules of addition

617
00:30:06,330 --> 00:29:59,090
subtraction and that sort of thing that

618
00:30:09,610 --> 00:30:06,340
they're all correct but even to

619
00:30:13,680 --> 00:30:09,620
technological civilizations trying to

620
00:30:17,290 --> 00:30:13,690
describe the same phenomenon using their

621
00:30:22,810 --> 00:30:17,300
intrinsic math it might not look

622
00:30:25,510 --> 00:30:22,820
anything like the same thing so we're

623
00:30:27,370 --> 00:30:25,520
getting a bit we're going beyond the

624
00:30:31,180 --> 00:30:27,380
back of the envelope in our thinking

625
00:30:34,450 --> 00:30:31,190
here trying to understand what if

626
00:30:37,570 --> 00:30:34,460
anything is universal what is

627
00:30:39,790 --> 00:30:37,580
fundamental and what is contingent upon

628
00:30:43,740 --> 00:30:39,800
the fact that we have a three-pound

629
00:30:46,930 --> 00:30:43,750
brain that is structured the way it is

630
00:30:49,360 --> 00:30:46,940
all right that leads really well into

631
00:30:53,610 --> 00:30:49,370
our next question then from dr. Jim past

632
00:30:56,800 --> 00:30:53,620
from Twitter chicken runs the Astro

633
00:30:58,780 --> 00:30:56,810
sociology Research Institute and he's

634
00:31:01,570 --> 00:30:58,790
really interested in how social science

635
00:31:04,080 --> 00:31:01,580
linguistics how these other parts of the

636
00:31:06,670 --> 00:31:04,090
humanities and those study here you I

637
00:31:09,970 --> 00:31:06,680
apologize the next question comes from

638
00:31:12,480 --> 00:31:09,980

Twitter from Jim Paz and he wants to

639
00:31:15,240 --> 00:31:12,490
know how social scientists and humanists

640
00:31:17,830 --> 00:31:15,250
they're often overlooked sometimes

641
00:31:20,260 --> 00:31:17,840
astrobiology he wants to know what the

642
00:31:22,240 --> 00:31:20,270
future collaborations could be with the

643
00:31:25,300 --> 00:31:22,250
social sciences and things like

644
00:31:28,280 --> 00:31:25,310
astrobiology and SETI

645
00:31:30,920 --> 00:31:28,290
he's right in the fact that in the past

646
00:31:35,060 --> 00:31:30,930
they haven't been included or not well

647
00:31:38,090 --> 00:31:35,070
included right to get smarter and so now

648
00:31:42,950 --> 00:31:38,100
we are looking for opportunities to work

649
00:31:45,910 --> 00:31:42,960
with these other disciplines it's

650
00:31:50,960 --> 00:31:45,920
difficult well we all have our own

651
00:31:54,590 --> 00:31:50,970
methodologies and it's more than just

652
00:31:58,010 --> 00:31:54,600
writing an astrobiology primer with the

653
00:32:03,260 --> 00:31:58,020
glossary to explain to a geologists what

654
00:32:06,590 --> 00:32:03,270
a chemist means there's some more bold

655
00:32:09,350 --> 00:32:06,600
difference in the way that some of the

656
00:32:11,500 --> 00:32:09,360
social scientists and some of Vettii

657
00:32:14,000 --> 00:32:11,510
scientists approach the same question

658
00:32:19,360 --> 00:32:14,010
but nevertheless we realize that there's

659
00:32:26,800 --> 00:32:23,440
what a terrible decades ago called

660
00:32:30,810 --> 00:32:26,810
Chariots of the Gods which was totally

661
00:32:35,020 --> 00:32:30,820
disrespectful to civilizations from

662
00:32:38,460 --> 00:32:35,030
millennia ago because he said oh you

663
00:32:42,010 --> 00:32:38,470

couldn't have done this or built this or

664
00:32:43,960 --> 00:32:42,020
created this unless there was some super

665
00:32:46,450 --> 00:32:43,970
intelligence that came down from a

666
00:32:49,390 --> 00:32:46,460
spaceship and guided you to do it well

667
00:32:53,980 --> 00:32:49,400
totally totally disrespectful to those

668
00:32:58,960 --> 00:32:53,990
civilizations and has a very very first

669
00:33:03,280 --> 00:32:58,970
step it really makes sense to go back

670
00:33:07,200 --> 00:33:03,290
with folks that are trained and digging

671
00:33:11,760 --> 00:33:07,210
into the past of different ethnic and

672
00:33:16,270 --> 00:33:11,770
cultural groups and seeing are there any

673
00:33:18,220 --> 00:33:16,280
anomaly buried deep in history that

674
00:33:21,070 --> 00:33:18,230
might in fact turn out to be techno

675
00:33:23,140 --> 00:33:21,080
signatures who knows I mean it

676
00:33:25,630 --> 00:33:23,150
unfortunately the whole thing hasn't he

677
00:33:28,300 --> 00:33:25,640
pets has a bad taste because of how

678
00:33:31,660 --> 00:33:28,310
poorly it was done with chariots in

679
00:33:36,670 --> 00:33:31,670
there God but it is a project that could

680
00:33:41,170 --> 00:33:36,680
be well done by cooperating with experts

681
00:33:42,640 --> 00:33:41,180
in those fields absolutely yeah and I

682
00:33:44,740 --> 00:33:42,650
think myself and others have written

683
00:33:46,780 --> 00:33:44,750
about Erich von Daniken and Chariots of

684
00:33:48,640 --> 00:33:46,790
the Gods and the issues with you know

685
00:33:50,710 --> 00:33:48,650
the inherent racism and culturalism

686
00:33:53,380 --> 00:33:50,720
involved in that so I'm glad you brought

687
00:33:55,900 --> 00:33:53,390
that up we have another question this

688
00:33:58,060 --> 00:33:55,910

one kind of often comes to lots of us in

689
00:33:59,980 --> 00:33:58,070
the realm of astrobiology and and even

690
00:34:02,200 --> 00:33:59,990
space science in general when people say

691
00:34:05,080 --> 00:34:02,210
you know why go spend money on going to

692
00:34:07,090 --> 00:34:05,090
space we have these problems here our

693
00:34:10,300 --> 00:34:07,100
next question comes from Mary Ann Denton

694
00:34:12,850 --> 00:34:10,310
on Twitter she says when I speak with

695
00:34:14,590 --> 00:34:12,860
others about exploration or astrobiology

696
00:34:15,970 --> 00:34:14,600
there's always somebody who wants to

697
00:34:19,210 --> 00:34:15,980
know what the return on the investment

698
00:34:22,330 --> 00:34:19,220
is so her question is how can I best

699
00:34:23,890 --> 00:34:22,340
share that this is a valid pursuit and I

700
00:34:27,210 --> 00:34:23,900
assume by this she means

701
00:34:31,079 --> 00:34:27,220
how is SETI a Vallon pursuit

702
00:34:34,740 --> 00:34:31,089
okay I've got a really simple answer for

703
00:34:42,629 --> 00:34:34,750
her which is that SETI may turn out to

704
00:34:46,889 --> 00:34:42,639
be absolutely critical to humans and

705
00:34:50,129 --> 00:34:46,899
life on Earth having a long future it's

706
00:34:50,909 --> 00:34:50,139
a statistical answer so sometimes it

707
00:34:54,450 --> 00:34:50,919
does not

708
00:34:56,339 --> 00:34:54,460
please Westerners but it's the deal if

709
00:35:00,210 --> 00:34:56,349
there are any two technological

710
00:35:03,030 --> 00:35:00,220
civilizations are capable of contacting

711
00:35:05,520 --> 00:35:03,040
one another and we succeed in that

712
00:35:08,760 --> 00:35:05,530
contact it means that that other

713
00:35:12,240 --> 00:35:08,770

civilization has to be close by that's

714
00:35:15,450 --> 00:35:12,250
close in space so that we are sensitive

715
00:35:20,430 --> 00:35:15,460
enough to detect them but also close in

716
00:35:25,170 --> 00:35:20,440
time we have to be overlapping in this

717
00:35:28,680 --> 00:35:25,180
10 billion year history our galaxy and

718
00:35:36,480 --> 00:35:28,690
if technological civilizations as a rule

719
00:35:40,079 --> 00:35:36,490
rule start up grow up expand and either

720
00:35:42,569 --> 00:35:40,089
turn themselves off themselves in in

721
00:35:45,480 --> 00:35:42,579
timescales that we can measure in human

722
00:35:50,099 --> 00:35:45,490
times there will never be a successful

723
00:35:53,250 --> 00:35:50,109
contact but turn it around around if we

724
00:35:57,390 --> 00:35:53,260
succeed with settings we know well that

725
00:36:01,079 --> 00:35:57,400
on average technological civilizations

726
00:36:05,609 --> 00:36:01,089
must be long-lived somebody else has

727
00:36:09,750 --> 00:36:05,619
figured out how to do it how to have a

728
00:36:14,880 --> 00:36:09,760
sustainable technological civilization

729
00:36:18,150 --> 00:36:14,890
for millennia for hundreds of thousands

730
00:36:21,690 --> 00:36:18,160
millions of years something that we

731
00:36:24,690 --> 00:36:21,700
don't necessarily speak as a possibility

732
00:36:28,020 --> 00:36:24,700
for us today we see lots of ways it

733
00:36:31,920 --> 00:36:28,030
could go wrong but you know even a

734
00:36:36,210 --> 00:36:31,930
cosmic dial tone no information but just

735
00:36:39,210 --> 00:36:36,220
proof of existence tells us that we can

736
00:36:40,710 --> 00:36:39,220
have a long future and I think would be

737
00:36:44,010 --> 00:36:40,720
hugely motivational

738
00:36:48,480 --> 00:36:44,020

for us to try and get our act together

739
00:36:49,230 --> 00:36:48,490
to figure out how to get there yeah

740
00:36:51,120 --> 00:36:49,240
absolutely

741
00:36:53,430 --> 00:36:51,130
and it seems like you know even though

742
00:36:55,230 --> 00:36:53,440
right now I think so many of us we we

743
00:36:57,270 --> 00:36:55,240
tend to focus so much on the bad things

744
00:36:59,700 --> 00:36:57,280
sometimes going on around the world we

745
00:37:01,140 --> 00:36:59,710
see war and we see poverty we see a lot

746
00:37:03,450 --> 00:37:01,150
of these problems caused by climate

747
00:37:06,089 --> 00:37:03,460
change and caused by governments not

748
00:37:08,310 --> 00:37:06,099
functioning or not working together

749
00:37:11,220 --> 00:37:08,320
but some of us also see a lot of promise

750
00:37:13,830 --> 00:37:11,230
in how people from different backgrounds

751
00:37:16,530 --> 00:37:13,840
different genders different ideas are

752
00:37:19,380 --> 00:37:16,540
starting to work together more and in

753
00:37:21,660 --> 00:37:19,390
many ways astrobiology SETI and the

754
00:37:24,540 --> 00:37:21,670
sciences and engineering in general are

755
00:37:27,210 --> 00:37:24,550
opening up to so many more people right

756
00:37:29,670 --> 00:37:27,220
now on the globe which kind of leads to

757
00:37:33,180 --> 00:37:29,680
our next question then yeah it's that

758
00:37:35,550 --> 00:37:33,190
cosmic perspective yeah absolutely this

759
00:37:38,370 --> 00:37:35,560
one comes from tarda Greta on Twitter

760
00:37:40,430 --> 00:37:38,380
she wants to know then from you what's

761
00:37:43,740 --> 00:37:40,440
the best advice you can give to girls

762
00:37:46,710 --> 00:37:43,750
who want to dive into any field of

763
00:37:50,910 --> 00:37:46,720

astrobiology right now

764
00:37:54,430 --> 00:37:50,920
find out what you really love to do and

765
00:37:58,240 --> 00:37:54,440
then learn how to use some tools and

766
00:38:01,299 --> 00:37:58,250
become better at using those tools than

767
00:38:04,900 --> 00:38:01,309
anybody else because then with this

768
00:38:08,559 --> 00:38:04,910
toolset you can go look around for

769
00:38:13,690 --> 00:38:08,569
projects that might yield to your skills

770
00:38:17,400 --> 00:38:13,700
and you can essentially drive your own

771
00:38:20,200 --> 00:38:17,410
boat right so have skills will travel

772
00:38:22,089 --> 00:38:20,210
let's find the interesting problems and

773
00:38:26,290 --> 00:38:22,099
you won't be able to solve them without

774
00:38:28,540 --> 00:38:26,300
me so I want on board and you'll you'll

775
00:38:32,620 --> 00:38:28,550
turn out to be much better served by

776
00:38:34,420 --> 00:38:32,630
including absolutely you know that

777
00:38:35,880 --> 00:38:34,430
applies to so many people who want to

778
00:38:38,440 --> 00:38:35,890
get involved in these things as well I

779
00:38:40,270 --> 00:38:38,450
don't mind our audience you can always

780
00:38:42,819 --> 00:38:40,280
tweet your question using using hashtag

781
00:38:45,339 --> 00:38:42,829
ask Astro bio on Twitter you can also

782
00:38:48,130 --> 00:38:45,349
ask questions on Facebook and on Sagan

783
00:38:52,329 --> 00:38:48,140
net so our next question actually comes

784
00:38:54,190 --> 00:38:52,339
from Facebook now from Tom Caruso Tom

785
00:38:56,470 --> 00:38:54,200
wants to know he says can you please

786
00:38:59,430 --> 00:38:56,480
tell us what you think about listening

787
00:39:01,690 --> 00:38:59,440
for life deep in remote ocean worlds

788
00:39:02,500 --> 00:39:01,700

possibly using like seismometers and

789
00:39:04,750 --> 00:39:02,510
hydrophones

790
00:39:07,980 --> 00:39:04,760
so kind of like doing SETI but looking

791
00:39:12,670 --> 00:39:07,990
downwards inside of worlds

792
00:39:16,599 --> 00:39:12,680
right so we use those deep hydrophones

793
00:39:20,349 --> 00:39:16,609
to study humpback whales to try and

794
00:39:24,640 --> 00:39:20,359
understand their social engineering as

795
00:39:26,770 --> 00:39:24,650
they recruit members to cooperate in

796
00:39:31,690 --> 00:39:26,780
bubble netting members who aren't

797
00:39:33,789 --> 00:39:31,700
relatives as it turns out that's the

798
00:39:36,150 --> 00:39:33,799
technology we're beginning to understand

799
00:39:38,920 --> 00:39:36,160
we also know that when you're trying to

800
00:39:42,549 --> 00:39:38,930
figure this all out it helps us if you

801
00:39:45,849 --> 00:39:42,559
have video as well as the audio so that

802
00:39:50,319 --> 00:39:45,859
you can see their actions and tie them

803
00:39:54,720 --> 00:39:50,329
to audio sounds in your recording that's

804
00:40:07,480 --> 00:40:01,480
what size creature gets to vocalize at

805
00:40:11,500 --> 00:40:07,490
depth in water probably microbes aren't

806
00:40:14,950 --> 00:40:11,510
really very chatty at least in terms of

807
00:40:17,349 --> 00:40:14,960
oral all kinds of communication large

808
00:40:21,579 --> 00:40:17,359
structures like the humpback who

809
00:40:25,589 --> 00:40:21,589
understand the structure of the ocean go

810
00:40:28,839 --> 00:40:25,599
and find that the level in a thermocline

811
00:40:30,970 --> 00:40:28,849
that will allow their songs and their

812
00:40:35,430 --> 00:40:30,980
messages to travel the longest distance

813
00:40:38,289 --> 00:40:35,440

such very large creatures are

814
00:40:41,799 --> 00:40:38,299
well-suited to that kind of

815
00:40:46,750 --> 00:40:41,809
communication in a liquid world

816
00:40:50,530 --> 00:40:46,760
I don't know I'm very very eager to see

817
00:40:52,960 --> 00:40:50,540
how we solve the problems of sampling

818
00:40:57,420 --> 00:40:52,970
the ocean worlds within our own solar

819
00:41:01,059 --> 00:40:57,430
system what can we do with plumes and

820
00:41:04,260 --> 00:41:01,069
how can we concentrate what it is that

821
00:41:10,120 --> 00:41:04,270
we collect and how can we avoid

822
00:41:13,089 --> 00:41:10,130
contamination the material that we are

823
00:41:15,220 --> 00:41:13,099
trying to collect as me if we have to

824
00:41:17,980 --> 00:41:15,230
melt through or drill through kilometers

825
00:41:22,000 --> 00:41:17,990
of ice to get there all fascinating

826
00:41:30,520 --> 00:41:26,349
I thought if you're really going to tie

827
00:41:33,400 --> 00:41:30,530
it to intelligent communication I think

828
00:41:42,390 --> 00:41:33,410
you're going to need some visual cues as

829
00:41:46,349 --> 00:41:42,400
well some strange ramekin of vents

830
00:41:49,680 --> 00:41:46,359
creaking and stretching and and

831
00:41:53,470 --> 00:41:52,180
interesting yeah your mom since we since

832
00:41:55,690 --> 00:41:53,480
you brought up though this idea of

833
00:41:58,960 --> 00:41:55,700
contamination I do wonder what you think

834
00:42:01,809 --> 00:41:58,970
of planetary protection right now when

835
00:42:03,609 --> 00:42:01,819
we launch missions through NASA we have

836
00:42:06,039 --> 00:42:03,619
a planetary protection officer their job

837
00:42:07,809 --> 00:42:06,049
is to try to make sure that we're being

838
00:42:08,650 --> 00:42:07,819

as clean as possible and launching our

839
00:42:11,049 --> 00:42:08,660
spacecraft

840
00:42:13,509 --> 00:42:11,059
we're also weary of bringing potential

841
00:42:15,819 --> 00:42:13,519
alien life back to earth what do you

842
00:42:17,589 --> 00:42:15,829
think about planetary protection and

843
00:42:24,099 --> 00:42:17,599
then including that in our mission

844
00:42:26,109 --> 00:42:24,109
designs okay Graham I lost you all of

845
00:42:28,690 --> 00:42:26,119
that after what do I think about

846
00:42:35,349 --> 00:42:28,700
planetary protection and I vote for it

847
00:42:38,620 --> 00:42:35,359
yes extremely thoughtful about how we do

848
00:42:43,880 --> 00:42:38,630
our research we're only gonna get in

849
00:42:49,809 --> 00:42:43,890
most cases one chance and it would be

850
00:42:53,569 --> 00:42:49,819
they disappointed if we didn't do our

851
00:42:56,900 --> 00:42:53,579
exploration in the most appropriate way

852
00:42:59,109 --> 00:42:56,910
so that we don't end up with ambiguous

853
00:43:03,249 --> 00:42:59,119
results

854
00:43:07,569 --> 00:43:03,259
hmm okay awesome our next question comes

855
00:43:10,269 --> 00:43:07,579
from the user JC on Twitter JC says if

856
00:43:12,099 --> 00:43:10,279
life developed on a planet orbiting a

857
00:43:14,380 --> 00:43:12,109
star with a different luminosity than

858
00:43:16,390 --> 00:43:14,390
our Sun do you think photosynthesis

859
00:43:19,269 --> 00:43:16,400
photosynthesis that may evolve there

860
00:43:22,390 --> 00:43:19,279
will still reflect primarily green light

861
00:43:23,769 --> 00:43:22,400
or would we see a change in what they're

862
00:43:26,170 --> 00:43:23,779
using taking advantage of the most

863
00:43:28,150 --> 00:43:26,180

abundant wavelengths of light yeah you

864
00:43:30,219 --> 00:43:28,160
mentioned something earlier which leads

865
00:43:32,829 --> 00:43:30,229
me to believe I think the fact that we

866
00:43:36,099 --> 00:43:32,839
do this the fact that astrobiology is a

867
00:43:37,599 --> 00:43:36,109
young science and wasn't a science that

868
00:43:40,569 --> 00:43:37,609
was all stove-piped

869
00:43:46,390 --> 00:43:40,579
and stumped up with excuse me old white

870
00:43:49,019 --> 00:43:46,400
males has opened up the field young

871
00:43:52,959 --> 00:43:49,029
scientists of all persuasions and

872
00:43:57,309 --> 00:43:52,969
globally right I think it's great this

873
00:43:59,859 --> 00:43:57,319
is just the way we need to go so if

874
00:44:05,259 --> 00:43:59,869
you'll allow me to give your audience a

875
00:44:08,859 --> 00:44:05,269
homework assignment please I would like

876
00:44:11,349 --> 00:44:08,869
to challenge them to go to all of their

877
00:44:15,729 --> 00:44:11,359
social media devices each of which has a

878
00:44:18,729 --> 00:44:15,739
profile and suggest to them that they

879
00:44:20,049 --> 00:44:18,739
might want to say in that profile the

880
00:44:23,289 --> 00:44:20,059
very first thing they say about

881
00:44:24,209 --> 00:44:23,299
themselves is that they're an Earthling

882
00:44:27,309 --> 00:44:24,219
earthling

883
00:44:29,469 --> 00:44:27,319
because I think ultimately that's what's

884
00:44:34,319 --> 00:44:29,479
going to matter we're gonna find a

885
00:44:37,900 --> 00:44:36,309
yeah absolutely

886
00:44:39,640 --> 00:44:37,910
it's interesting manager that you

887
00:44:42,160 --> 00:44:39,650
mentioned you know how we are connecting

888
00:44:44,319 --> 00:44:42,170

with all these people and there are so

889
00:44:46,569 --> 00:44:44,329
many awesome audience members of our

890
00:44:49,839 --> 00:44:46,579
show from around the globe from Turkey

891
00:44:51,999 --> 00:44:49,849
and the UK and India and Egypt and other

892
00:44:54,219 --> 00:44:52,009
nations who are tuning in because there

893
00:44:56,019 --> 00:44:54,229
are so many young people now across the

894
00:44:58,209 --> 00:44:56,029
globe who want to get involved in

895
00:44:59,950 --> 00:44:58,219
astrobiology I speak with young women

896
00:45:02,469 --> 00:44:59,960
and young men from various countries

897
00:45:05,440 --> 00:45:02,479
from various backgrounds on a weekly

898
00:45:08,200 --> 00:45:05,450
basis these days about what they can do

899
00:45:10,719 --> 00:45:08,210
to get involved in astrobiology and so I

900
00:45:12,530 --> 00:45:10,729
think so many of us are humbled to see

901
00:45:13,970 --> 00:45:12,540
how enthusiastic

902
00:45:15,860 --> 00:45:13,980
all these young people are from all

903
00:45:19,010 --> 00:45:15,870
these different backgrounds about these

904
00:45:21,080 --> 00:45:19,020
big questions of are we alone and if not

905
00:45:23,690 --> 00:45:21,090
how do we find out and I absolutely love

906
00:45:26,840 --> 00:45:23,700
that all right and you know because

907
00:45:28,070 --> 00:45:26,850
because we're now engaging globally with

908
00:45:32,210 --> 00:45:28,080
different cultures and different

909
00:45:34,580 --> 00:45:32,220
traditions as well as being more

910
00:45:38,570 --> 00:45:34,590
inclusive as far as gender is concerned

911
00:45:41,150 --> 00:45:38,580
I think that it's inevitable that we're

912
00:45:42,980 --> 00:45:41,160
going to stub our toes right that we're

913
00:45:46,580 --> 00:45:42,990

going to make mistakes

914
00:45:50,090 --> 00:45:46,590
I'll not not intentionally not with bad

915
00:45:53,330 --> 00:45:50,100
will but just out of ignorance not

916
00:45:56,240 --> 00:45:53,340
understanding and I think that we all

917
00:45:59,240 --> 00:45:56,250
have to be prepared for that and be

918
00:46:03,290 --> 00:45:59,250
willing to say hey whoops that wasn't

919
00:46:03,890 --> 00:46:03,300
appropriate and then we all move on and

920
00:46:07,970 --> 00:46:03,900
get over it

921
00:46:10,160 --> 00:46:07,980
and it's only bad if you don't learn

922
00:46:15,890 --> 00:46:10,170
from them and repeat the action taxes

923
00:46:19,430 --> 00:46:15,900
and then we should appropriate controls

924
00:46:26,260 --> 00:46:19,440
our reactions but yeah people are gonna

925
00:46:34,330 --> 00:46:32,260
and move on but if I repeat no yes

926
00:46:36,220 --> 00:46:34,340
come on that idea of us making mistakes

927
00:46:39,040 --> 00:46:36,230
I'm gonna bring it back around to

928
00:46:43,180 --> 00:46:39,050
science fiction for a moment our user

929
00:46:44,590 --> 00:46:43,190
Suraj Kumar saw who on Sagan net wants

930
00:46:47,980 --> 00:46:44,600
to know what you think of the film

931
00:46:50,020 --> 00:46:47,990
interstellar a film where it starts off

932
00:46:52,600 --> 00:46:50,030
with the idea that humans have made a

933
00:46:55,359 --> 00:46:52,610
very bad mistake have made Earth's

934
00:46:58,330 --> 00:46:55,369
climate so unlivable that they want to

935
00:47:00,970 --> 00:46:58,340
go somewhere else to live what you think

936
00:47:03,910 --> 00:47:00,980
about the story in interstellar either

937
00:47:07,570 --> 00:47:03,920
didn't do their calculations correctly

938
00:47:14,710 --> 00:47:10,510

my Mirza did not give us enough

939
00:47:20,170 --> 00:47:14,720
information to make the case that it was

940
00:47:25,320 --> 00:47:20,180
totally unaffordable of all things at

941
00:47:28,830 --> 00:47:25,330
home because the cost of taking a

942
00:47:34,450 --> 00:47:28,840
population of the planet is really

943
00:47:39,040 --> 00:47:34,460
horrendously large and I think a lot

944
00:47:42,850 --> 00:47:39,050
less money we probably used wisely and

945
00:47:46,170 --> 00:47:42,860
in a very targeted fashion could

946
00:47:49,950 --> 00:47:46,180
probably solve the problems at home and

947
00:47:52,240 --> 00:47:49,960
bottom line why if you don't solve them

948
00:47:54,040 --> 00:47:52,250
you're just gonna get them with you with

949
00:47:56,260 --> 00:47:54,050
you and you're going to be facing the

950
00:48:00,790 --> 00:47:56,270
same problem in the future in an

951
00:48:04,480 --> 00:48:00,800
location so I think that I'm really

952
00:48:09,360 --> 00:48:04,490
really excited about exploration and I

953
00:48:13,690 --> 00:48:09,370
think humans will be occupying other

954
00:48:15,640 --> 00:48:13,700
bodies in the future I think it won't be

955
00:48:18,750 --> 00:48:15,650
all humans I think it will be the

956
00:48:23,260 --> 00:48:18,760
Explorers the scientists the engineers

957
00:48:27,160 --> 00:48:23,270
at the frontiers and that's good but

958
00:48:32,710 --> 00:48:27,170
hopefully they have a well shepherded

959
00:48:33,700 --> 00:48:32,720
planet to come home mmm absolutely yeah

960
00:48:36,060 --> 00:48:33,710
so there's so the scientists the

961
00:48:38,890 --> 00:48:36,070
engineers be the next pioneers basically

962
00:48:42,430 --> 00:48:38,900
yeah we have another question here from

963
00:48:44,650 --> 00:48:42,440

Rami al Sabbagh from second net Rami

964
00:48:46,720 --> 00:48:44,660
asks do you think there's another form

965
00:48:49,540 --> 00:48:46,730
of life on another planet where their

966
00:48:50,950 --> 00:48:49,550
building blocks are in organic matter so

967
00:48:57,180 --> 00:48:50,960
perhaps something like the silicon life

968
00:49:02,020 --> 00:48:59,380
you know that's really one of these

969
00:49:04,900 --> 00:49:02,030
these things it's so hard to puzzle are

970
00:49:08,950 --> 00:49:04,910
we telling ourselves a just-so story

971
00:49:11,950 --> 00:49:08,960
when we make the arguments for the

972
00:49:16,450 --> 00:49:11,960
greater efficiency of carbon versus

973
00:49:23,050 --> 00:49:16,460
silicon you know with one example it's

974
00:49:26,680 --> 00:49:23,060
damn near impossible to decide what's

975
00:49:30,130 --> 00:49:26,690
necessary and what's contingent I often

976
00:49:32,440 --> 00:49:30,140
think if I had a prehensile tail which

977
00:49:35,290 --> 00:49:32,450
would be a lot of fun I think I would

978
00:49:38,470 --> 00:49:35,300
have a really good story to tell you

979
00:49:40,600 --> 00:49:38,480
about why I couldn't be a scientist why

980
00:49:43,030 --> 00:49:40,610
I couldn't be an engineer why I couldn't

981
00:49:47,950 --> 00:49:43,040
try to answer this question if I didn't

982
00:49:50,320 --> 00:49:47,960
happen to so yeah there are lots of

983
00:49:52,140 --> 00:49:50,330
stories that we can tell and it's based

984
00:49:56,920 --> 00:49:52,150
in in the science that we currently

985
00:50:00,250 --> 00:49:56,930
understand that says carbon is gonna win

986
00:50:04,690 --> 00:50:00,260
out over silicon I mean if you want to

987
00:50:10,420 --> 00:50:04,700
get gross kind of hard to eliminate sand

988
00:50:12,430 --> 00:50:10,430

I just think about about phase and the

989
00:50:17,980 --> 00:50:12,440
sea side and the sand inside my bathing

990
00:50:23,410 --> 00:50:17,990
suit right so carbon dioxide gas is a

991
00:50:26,500 --> 00:50:23,420
lot easier to deal with um but we just

992
00:50:29,350 --> 00:50:26,510
there's so much we don't know and with

993
00:50:31,450 --> 00:50:29,360
all of these questions as a physicist do

994
00:50:33,610 --> 00:50:31,460
you want to say okay here are all the

995
00:50:36,100 --> 00:50:33,620
options option and let's figure out what

996
00:50:38,050 --> 00:50:36,110
the branching ratios are you know how

997
00:50:40,150 --> 00:50:38,060
much what percentage of the time did

998
00:50:43,570 --> 00:50:40,160
things go in that direction versus that

999
00:50:46,300 --> 00:50:43,580
direction versus that direct and then we

1000
00:50:48,820 --> 00:50:46,310
could begin to make reasonable

1001
00:50:51,760 --> 00:50:48,830
statements about these kinds of very

1002
00:50:53,680 --> 00:50:51,770
good questions at the moment you just

1003
00:50:55,500 --> 00:50:53,690
got an example of one how many have to

1004
00:50:58,570 --> 00:50:55,510
see what we give you with that

1005
00:51:02,200 --> 00:50:58,580
absolutely so one more question then

1006
00:51:04,000 --> 00:51:02,210
hear from our audience and it kind of

1007
00:51:06,660 --> 00:51:04,010
follows off of that so rather than being

1008
00:51:08,800 --> 00:51:06,670
based in inorganic life whether or not

1009
00:51:09,240 --> 00:51:08,810
biological life as we know it here on

1010
00:51:12,270 --> 00:51:09,250
earth

1011
00:51:15,990 --> 00:51:12,280
could evolve into a form of inorganic

1012
00:51:19,860 --> 00:51:16,000
life so penny Boston on livestream has

1013
00:51:22,020 --> 00:51:19,870

asked she asked what's your personal

1014
00:51:24,360 --> 00:51:22,030
opinion as to whether civilizations that

1015
00:51:27,270 --> 00:51:24,370
we may discover or that may discover us

1016
00:51:29,370 --> 00:51:27,280
are more likely to still be organic life

1017
00:51:32,000 --> 00:51:29,380
or that have transitioned to some sort

1018
00:51:36,890 --> 00:51:32,010
of cyber race

1019
00:51:43,690 --> 00:51:40,130
I think I've seen some of Kenny's

1020
00:51:47,799 --> 00:51:43,700
cartoons and I think she's got some very

1021
00:51:53,529 --> 00:51:47,809
interesting ideas about a future

1022
00:51:58,009 --> 00:51:53,539
evolution that takes us to be more a

1023
00:52:01,640 --> 00:51:58,019
cooperative partnership with silicon

1024
00:52:03,559 --> 00:52:01,650
based intelligence I mean some people go

1025
00:52:06,109 --> 00:52:03,569
the other way and say once the silicon

1026
00:52:07,960 --> 00:52:06,119
based intelligence shows up we don't

1027
00:52:12,799 --> 00:52:07,970
really need the biologicals anymore

1028
00:52:16,400 --> 00:52:12,809
maybe it will make good pets I actually

1029
00:52:21,769 --> 00:52:16,410
think is going to be a cooperative or

1030
00:52:25,660 --> 00:52:21,779
coevolution such as we've had on it for

1031
00:52:28,220 --> 00:52:25,670
billions of years and we ultimately

1032
00:52:32,569 --> 00:52:28,230
probably will not be the smartest kid on

1033
00:52:34,069 --> 00:52:32,579
the whole interesting so the future

1034
00:52:36,289 --> 00:52:34,079
might not just be just us but our

1035
00:52:40,039 --> 00:52:36,299
sharing our world and our future with

1036
00:52:41,390 --> 00:52:40,049
with another thing I like that oh well

1037
00:52:43,609 --> 00:52:41,400
that's all the time we had for today's

1038
00:52:46,299 --> 00:52:43,619

episode Jill thank you so much for

1039
00:52:48,559 --> 00:52:46,309
joining us for asking astrobiologists

1040
00:52:50,809 --> 00:52:48,569
it's been my pleasure and I'm sorry we

1041
00:52:54,769 --> 00:52:50,819
had these hiccups and technological

1042
00:52:59,749 --> 00:52:54,779
freezes and Caleb reminds us that on a

1043
00:53:02,380 --> 00:52:59,759
finite world a cosmic perspective is a

1044
00:53:06,650 --> 00:53:02,390
necessity and not a luxury

1045
00:53:09,170 --> 00:53:06,660
so Caleb I think we'll leave it right

1046
00:53:10,110 --> 00:53:09,180
there thanks everyone for joining us and