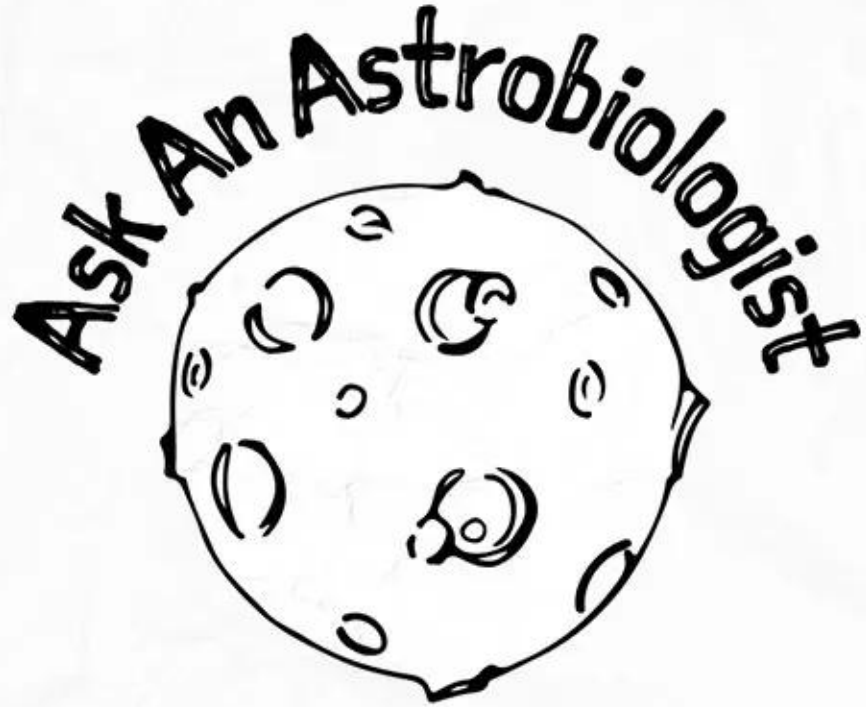

Episode 23: July 16th, 2019

Dr. Lucianne Walkowicz

NASA Astrobiology Program

1
00:00:00,500 --> 00:00:29,259
[Music]

2
00:00:33,560 --> 00:00:31,310
greetings friends of astrobiology

3
00:00:35,479 --> 00:00:33,570
welcome to a brand-new episode of ask an

4
00:00:38,270 --> 00:00:35,489
astrobiologist a show where we celebrate

5
00:00:39,619 --> 00:00:38,280
science and celebrate scientists my name

6
00:00:41,240 --> 00:00:39,629
is Sanjay Amin this program is made

7
00:00:43,580 --> 00:00:41,250
possible by contributions from the NASA

8
00:00:46,850 --> 00:00:43,590
Astrobiology program and the non profit

9
00:00:49,100 --> 00:00:46,860
blue marble space last month all of us

10
00:00:50,959 --> 00:00:49,110
astrobiologists were at the astrobiology

11
00:00:51,500 --> 00:00:50,969
Science Conference in Bellevue

12
00:00:53,290 --> 00:00:51,510
Washington

13
00:00:55,310 --> 00:00:53,300

across the lake from Seattle in the

14
00:00:57,130 --> 00:00:55,320
northwest corner of the United States

15
00:00:59,270 --> 00:00:57,140
where we had a week of intense

16
00:01:01,760 --> 00:00:59,280
multidisciplinarity and to celebrate

17
00:01:02,869 --> 00:01:01,770
this multidisciplinarity who else then

18
00:01:05,000 --> 00:01:02,879
to invite to the show then

19
00:01:07,880 --> 00:01:05,010
astrobiologists extraordinaire dr.

20
00:01:10,120 --> 00:01:07,890
lucien waka wits with who is an

21
00:01:13,280 --> 00:01:10,130
astronomer at the Adler Planetarium in

22
00:01:15,560 --> 00:01:13,290
Chicago as well as the fifth bearish

23
00:01:17,149 --> 00:01:15,570
bloomberg chair of astrobiology at the

24
00:01:18,499 --> 00:01:17,159
Library of Congress and we're really

25
00:01:19,999 --> 00:01:18,509
excited by this show we're going to talk

26
00:01:22,550 --> 00:01:20,009
about a lot of different exciting things

27
00:01:25,550 --> 00:01:22,560
but first it's time for your favorite

28
00:01:27,620 --> 00:01:25,560
background quiz last month Mike if you

29
00:01:30,560 --> 00:01:27,630
could put up our background from last

30
00:01:34,190 --> 00:01:30,570
month several of you got it right it is

31
00:01:36,289 --> 00:01:34,200
of course fly geyser in Nevada purchased

32
00:01:39,350 --> 00:01:36,299
recently by the Burning Man foundation

33
00:01:40,789 --> 00:01:39,360
and it is a geyser that's very rich in

34
00:01:43,460 --> 00:01:40,799
silica the water coming out is around

35
00:01:45,590 --> 00:01:43,470
200 degrees Fahrenheit roughly thirty 93

36
00:01:48,499 --> 00:01:45,600
degrees Celsius and the geyser you see

37
00:01:50,480 --> 00:01:48,509
is about about let's see five feet tall

38
00:01:52,429 --> 00:01:50,490

one and a half meters so that's it's

39
00:01:54,469 --> 00:01:52,439
really really beautiful sight and I was

40
00:01:57,380 --> 00:01:54,479
a background from last month and several

41
00:01:58,999 --> 00:01:57,390
you got it right so as usual we have

42
00:02:01,310 --> 00:01:59,009
some really exciting prize the

43
00:02:04,249 --> 00:02:01,320
third-place winner is

44
00:02:05,660 --> 00:02:04,259
roshni Biswas congratulations roshni you

45
00:02:09,619 --> 00:02:05,670
get the very cool

46
00:02:12,260 --> 00:02:09,629
NASA stickers in second place is Rosie

47
00:02:13,589 --> 00:02:12,270
Caine congratulation Rosie who gets the

48
00:02:15,780 --> 00:02:13,599
NASA stickers

49
00:02:17,729 --> 00:02:15,790
and the astrobiology graphic novels

50
00:02:22,789 --> 00:02:17,739
which are a super fun read and our

51
00:02:25,830 --> 00:02:22,799
winner this month is Neil tweeting as

52
00:02:27,750 --> 00:02:25,840
NPS USA congratulations you get the

53
00:02:29,879 --> 00:02:27,760
stickers you get the graphic novels and

54
00:02:32,190 --> 00:02:29,889
you get the Magnificent Sagan a dork

55
00:02:33,959 --> 00:02:32,200
points thank you very much and thank you

56
00:02:35,369 --> 00:02:33,969
all of you who have been active on

57
00:02:36,899 --> 00:02:35,379
social media spreading the word about

58
00:02:38,039 --> 00:02:36,909
our show we're really excited about it

59
00:02:41,429 --> 00:02:38,049
and hope you are too and yet you're

60
00:02:42,750 --> 00:02:41,439
enjoying it and then - thank you all of

61
00:02:44,339 --> 00:02:42,760
you who are really tweeting and being

62
00:02:45,899 --> 00:02:44,349
active on social media we have our new

63
00:02:49,319 --> 00:02:45,909

program or ambassador of the month and

64
00:02:52,080 --> 00:02:49,329
this month the Ambassador is Cashner

65
00:02:54,420 --> 00:02:52,090
who's tweeting as Astro bio

66
00:02:56,429 --> 00:02:54,430
cache congratulations and happy birthday

67
00:03:00,030 --> 00:02:56,439
thank you again for all your efforts in

68
00:03:01,679 --> 00:03:00,040
sharing our show and and yeah what we do

69
00:03:02,789 --> 00:03:01,689
we think is awesome we have some great

70
00:03:04,470 --> 00:03:02,799
guests and I hope you enjoyed the

71
00:03:06,479 --> 00:03:04,480
program and do let us know who you want

72
00:03:08,459 --> 00:03:06,489
to see on the program add your comments

73
00:03:11,879 --> 00:03:08,469
down below on Twitter social and

74
00:03:13,800 --> 00:03:11,889
Facebook and on saying that of course so

75
00:03:15,449 --> 00:03:13,810
with that let's get our show started dr.

76
00:03:17,099 --> 00:03:15,459
Lucy and walk of its thank you so much

77
00:03:19,920 --> 00:03:17,109
for taking the time with us today

78
00:03:23,249 --> 00:03:19,930
oh my pleasure thanks for having me on

79
00:03:24,839 --> 00:03:23,259
the show so you do so many things I we

80
00:03:25,979 --> 00:03:24,849
have going to be speaking about half an

81
00:03:27,240 --> 00:03:25,989
hour and then we'll open it up to the

82
00:03:29,039 --> 00:03:27,250
questions because I'm sure we're gonna

83
00:03:30,869 --> 00:03:29,049
fill it up with with all the questions

84
00:03:32,069 --> 00:03:30,879
from our audience um but to begin with

85
00:03:34,319 --> 00:03:32,079
could you tell us a little bit about

86
00:03:36,149 --> 00:03:34,329
your path as a you're now an astronomer

87
00:03:37,679 --> 00:03:36,159
and astrobiologist wasn't it was this a

88
00:03:39,449 --> 00:03:37,689

linear path through school and then

89
00:03:41,099 --> 00:03:39,459
later on as a postdoc and later on so

90
00:03:44,520 --> 00:03:41,109
tell us a little bit about your s-curve

91
00:03:48,360 --> 00:03:44,530
perhaps as a career sure yeah I you know

92
00:03:50,460 --> 00:03:48,370
I started wanting a career in astronomy

93
00:03:53,819 --> 00:03:50,470
when I was actually in high school and

94
00:03:55,559 --> 00:03:53,829
it was really because you know I we

95
00:03:57,360 --> 00:03:55,569
talked a little bit before the show like

96
00:03:59,699 --> 00:03:57,370
yeah many of our colleagues have these

97
00:04:01,559 --> 00:03:59,709
stories about like how they star games

98
00:04:03,479 --> 00:04:01,569
as a child or all of those sort of

99
00:04:05,670 --> 00:04:03,489
things like I am from New York City I

100
00:04:08,429 --> 00:04:05,680
have never owned a telescope personally

101
00:04:10,140 --> 00:04:08,439
although I've used many telescopes and

102
00:04:12,689 --> 00:04:10,150
so you know my interest in astronomy

103
00:04:15,050 --> 00:04:12,699
really came from being interested in

104
00:04:17,670 --> 00:04:15,060
physics and chemistry and wanting to

105
00:04:22,110 --> 00:04:17,680
find a way to combine all the sciences

106
00:04:23,689 --> 00:04:22,120
and so I think astrobiology despite

107
00:04:26,279 --> 00:04:23,699
having astronomy and biology

108
00:04:27,270 --> 00:04:26,289
specifically in its name is like the

109
00:04:30,720 --> 00:04:27,280
ultimate intern

110
00:04:33,300 --> 00:04:30,730
disciplinary science in many ways so you

111
00:04:35,310 --> 00:04:33,310
know I started out life as a physics

112
00:04:37,980 --> 00:04:35,320
major and went on to grad school in

113
00:04:40,710 --> 00:04:37,990

astronomy with the intention of studying

114
00:04:42,570 --> 00:04:40,720
magnetic activity and stars so I was

115
00:04:45,540 --> 00:04:42,580
very much just a straight-up astronomer

116
00:04:47,400 --> 00:04:45,550
for a long time and it was actually an

117
00:04:47,970 --> 00:04:47,410
astrobiologist at University of

118
00:04:50,760 --> 00:04:47,980
Washington

119
00:04:52,770 --> 00:04:50,770
what do you Sullivan who kind of pulled

120
00:04:54,360 --> 00:04:52,780
me aside like midway through my grad

121
00:04:57,060 --> 00:04:54,370
career like maybe three years into grad

122
00:04:58,890 --> 00:04:57,070
school and was like hey the SETI

123
00:05:01,590 --> 00:04:58,900
Institute is having this like

124
00:05:03,240 --> 00:05:01,600
invitation-only workshop where they're

125
00:05:06,390 --> 00:05:03,250
gonna talk about whether the stars you

126
00:05:08,550 --> 00:05:06,400
study these little red stars are good or

127
00:05:10,860 --> 00:05:08,560
bad hosts for potentially habitable

128
00:05:12,780 --> 00:05:10,870
planets and it was like you should go to

129
00:05:15,990 --> 00:05:12,790
that and I was like yeah I should go to

130
00:05:18,780 --> 00:05:16,000
that so that was kind of like my first

131
00:05:20,760 --> 00:05:18,790
introduction into astrobiology and and

132
00:05:22,560 --> 00:05:20,770
from there I was like totally hooked

133
00:05:24,630 --> 00:05:22,570
because of course who doesn't want to

134
00:05:28,230 --> 00:05:24,640
know more about life in the universe and

135
00:05:31,140 --> 00:05:28,240
where we might find it so yeah after

136
00:05:33,659 --> 00:05:31,150
grad school I did postdoc

137
00:05:35,880 --> 00:05:33,669
first at Berkeley for three years which

138
00:05:38,640 --> 00:05:35,890

was a really exciting time because I

139
00:05:40,800 --> 00:05:38,650
joined the Kepler team just before the

140
00:05:43,740 --> 00:05:40,810
Kepler mission launched and got to be

141
00:05:47,250 --> 00:05:43,750
part of that mission from day day zero

142
00:05:49,260 --> 00:05:47,260
and then after that went on to postdoc

143
00:05:50,640 --> 00:05:49,270
at Princeton where I continued a lot of

144
00:05:51,960 --> 00:05:50,650
the work that I was doing with Kepler

145
00:05:53,430 --> 00:05:51,970
and also broadened it to some of the

146
00:05:55,980 --> 00:05:53,440
stuff that we'll talk about today and

147
00:05:59,420 --> 00:05:55,990
I've been at the Adler the planetarium

148
00:06:01,650 --> 00:05:59,430
at the planetarium in Chicago since 2014

149
00:06:03,630 --> 00:06:01,660
very cool very cool yeah I've been to

150
00:06:05,940 --> 00:06:03,640
the Adler Planetarium once and it's just

151
00:06:07,440 --> 00:06:05,950
a very mesmerizing place great exhibits

152
00:06:09,719 --> 00:06:07,450
and really interesting people to talk to

153
00:06:11,070 --> 00:06:09,729
there so if any of you are watching go

154
00:06:15,390 --> 00:06:11,080
do check out the Adler Planetarium in

155
00:06:17,490 --> 00:06:15,400
Chicago it's amazing and so you're those

156
00:06:18,960 --> 00:06:17,500
little red stars that I thought we can

157
00:06:21,000 --> 00:06:18,970
talk about it a little bit are our own

158
00:06:22,440 --> 00:06:21,010
Sun is the G star I'm but those little

159
00:06:25,440 --> 00:06:22,450
red star those M dwarfs are actually

160
00:06:26,940 --> 00:06:25,450
much more common in in a galaxy than the

161
00:06:28,800 --> 00:06:26,950
G stars can you tell us a little bit

162
00:06:31,440 --> 00:06:28,810
about the potential habitability of

163
00:06:35,250 --> 00:06:31,450

these of these of planets around those

164
00:06:38,760 --> 00:06:35,260
small M dwarf stars sure yeah so these

165
00:06:41,020 --> 00:06:38,770
little red stars M dwarfs make up about

166
00:06:45,190 --> 00:06:41,030
70 to 75% of all

167
00:06:48,070 --> 00:06:45,200
the stars in our galaxy and they're very

168
00:06:50,020 --> 00:06:48,080
faint compared to our sons so they you

169
00:06:54,100 --> 00:06:50,030
know they're not made of very much fuel

170
00:06:56,860 --> 00:06:54,110
to begin with but they're also very very

171
00:07:00,100 --> 00:06:56,870
thrifty with their fuels so they burn

172
00:07:02,980 --> 00:07:00,110
very low luminosity over a very long

173
00:07:04,450 --> 00:07:02,990
period of time and actually they're so

174
00:07:06,160 --> 00:07:04,460
faint that even if you were in the

175
00:07:08,760 --> 00:07:06,170
darkest place on earth you would never

176
00:07:12,130 --> 00:07:08,770
be able to see one with your naked eye

177
00:07:14,920 --> 00:07:12,140
but the stars above you are just like a

178
00:07:16,120 --> 00:07:14,930
tiny fraction of what there's and there

179
00:07:19,390 --> 00:07:16,130
is out there and most of them are these

180
00:07:21,400 --> 00:07:19,400
little Reds worse so the the reason that

181
00:07:23,350 --> 00:07:21,410
even though they're so plentiful they

182
00:07:25,630 --> 00:07:23,360
had been discounted for many years by

183
00:07:28,420 --> 00:07:25,640
astrobiologists as potential hosts for

184
00:07:30,370 --> 00:07:28,430
habitable planets is that they don't

185
00:07:32,560 --> 00:07:30,380
give off very much light and that means

186
00:07:34,510 --> 00:07:32,570
that planets that are around them in

187
00:07:36,820 --> 00:07:34,520
order to get that same kind of work that

188
00:07:39,820 --> 00:07:36,830

we get from our Sun have to be cuddled

189
00:07:41,800 --> 00:07:39,830
in pretty close to the start so that

190
00:07:43,870 --> 00:07:41,810
would be fine if it wasn't for the fact

191
00:07:46,510 --> 00:07:43,880
that they also have what we call

192
00:07:49,270 --> 00:07:46,520
magnetic activity so in the same way

193
00:07:51,460 --> 00:07:49,280
that our Sun has solar flares these big

194
00:07:54,730 --> 00:07:51,470
bursts of high-energy radiation and

195
00:07:56,380 --> 00:07:54,740
ultraviolet and x-rays that come off of

196
00:07:58,990 --> 00:07:56,390
our star and you know influence our

197
00:08:01,390 --> 00:07:59,000
planet along with you know actual like

198
00:08:03,670 --> 00:08:01,400
particles from the Sun that stream into

199
00:08:05,680 --> 00:08:03,680
our planet create you know occasionally

200
00:08:07,780 --> 00:08:05,690
like disturbances in our technology or

201
00:08:12,670 --> 00:08:07,790
just beautiful you know northern and

202
00:08:15,400 --> 00:08:12,680
southern lights the stars M dwarfs that

203
00:08:16,720 --> 00:08:15,410
would be hosting these planets they'd

204
00:08:19,060 --> 00:08:16,730
have to be super close to them but then

205
00:08:21,000 --> 00:08:19,070
they also have these huge flares and

206
00:08:23,230 --> 00:08:21,010
that makes the planets very vulnerable

207
00:08:26,170 --> 00:08:23,240
to the effects of this high-energy

208
00:08:29,410 --> 00:08:26,180
radiation so for a long time people just

209
00:08:31,990 --> 00:08:29,420
assumed like oh well if you're a planet

210
00:08:33,100 --> 00:08:32,000
that that that close to the star you

211
00:08:35,380 --> 00:08:33,110
know you're gonna be completely

212
00:08:37,090 --> 00:08:35,390
irradiated and like anything on the

213
00:08:40,360 --> 00:08:37,100

surface would be just you know like

214
00:08:42,040 --> 00:08:40,370
wiped out immediately that radiation and

215
00:08:44,710 --> 00:08:42,050
the particles that come off the star can

216
00:08:46,210 --> 00:08:44,720
also erode the planetary atmosphere as

217
00:08:49,140 --> 00:08:46,220
well so it could even scrape the

218
00:08:51,220 --> 00:08:49,150
atmosphere off a planet completely

219
00:08:53,560 --> 00:08:51,230
because of the gravitational interaction

220
00:08:54,370 --> 00:08:53,570
between the planet and the star people

221
00:08:56,710 --> 00:08:54,380
were also were

222
00:08:58,690 --> 00:08:56,720
read that the the planet could be locked

223
00:09:00,520 --> 00:08:58,700
to the star so you only had one day side

224
00:09:02,110 --> 00:09:00,530
of one night side and people were

225
00:09:05,260 --> 00:09:02,120
worried about what would happen to your

226
00:09:08,560 --> 00:09:05,270
planet planet's atmosphere so back about

227
00:09:10,360 --> 00:09:08,570
15 years ago or so there was this

228
00:09:12,670 --> 00:09:10,370
meeting that I mentioned that was all

229
00:09:14,430 --> 00:09:12,680
about reevaluating them and it turns out

230
00:09:18,160 --> 00:09:14,440
that none of those things are really

231
00:09:20,080 --> 00:09:18,170
showstoppers you know even though it is

232
00:09:22,000 --> 00:09:20,090
definitely something for us to take into

233
00:09:24,670 --> 00:09:22,010
account that they are subject to this

234
00:09:27,280 --> 00:09:24,680
high-energy radiation it also could be

235
00:09:29,890 --> 00:09:27,290
beneficial in certain ways so maybe you

236
00:09:31,510 --> 00:09:29,900
have a very massive planet or with a

237
00:09:33,490 --> 00:09:31,520
very thick atmosphere that wouldn't be

238
00:09:35,230 --> 00:09:33,500

habitable in the way that we think of it

239
00:09:37,420 --> 00:09:35,240
and maybe that stellar activity actually

240
00:09:39,010 --> 00:09:37,430
erodes some of it often leaves you with

241
00:09:41,020 --> 00:09:39,020
a potentially happen habitable

242
00:09:44,230 --> 00:09:41,030
atmosphere afterwards so there's all

243
00:09:46,240 --> 00:09:44,240
this like open questions about how

244
00:09:48,310 --> 00:09:46,250
exactly the stars influence the planets

245
00:09:50,980 --> 00:09:48,320
and I kind of look into that by studying

246
00:09:52,270 --> 00:09:50,990
the stars themselves very cool I mean if

247
00:09:53,860 --> 00:09:52,280
there's any lesson that we can learn

248
00:09:56,230 --> 00:09:53,870
from life on earth is that life is

249
00:09:57,940 --> 00:09:56,240
extremely adaptable it can find any

250
00:10:00,040 --> 00:09:57,950
place to garner energy from the

251
00:10:01,300 --> 00:10:00,050
environment it will we find life on

252
00:10:01,960 --> 00:10:01,310
Earth and some of the most extreme

253
00:10:05,650 --> 00:10:01,970
conditions

254
00:10:08,320 --> 00:10:05,660
sure watching please don't forget to ask

255
00:10:10,750 --> 00:10:08,330
questions on cigarettes on Facebook and

256
00:10:12,100 --> 00:10:10,760
on Twitter use hash tag ask astrobiology

257
00:10:14,500 --> 00:10:12,110
on Twitter so you're sure to find you

258
00:10:16,900 --> 00:10:14,510
and yeah yeah keep them coming we have a

259
00:10:18,190 --> 00:10:16,910
nice list going on now which is great so

260
00:10:20,950 --> 00:10:18,200
you mentioned Kepler is a really

261
00:10:23,950 --> 00:10:20,960
exciting mission that was launched in

262
00:10:26,110 --> 00:10:23,960
early in mid-2000s to detect the

263
00:10:27,790 --> 00:10:26,120

presence of these extrasolar planets so

264
00:10:29,560 --> 00:10:27,800
planets are orbiting stars that are not

265
00:10:30,850 --> 00:10:29,570
our Sun can you tell us that had been

266
00:10:33,400 --> 00:10:30,860
involved with the entire mission how

267
00:10:34,930 --> 00:10:33,410
successful how successful it was and

268
00:10:37,180 --> 00:10:34,940
perhaps do we have a sense of how many

269
00:10:38,830 --> 00:10:37,190
planets out there that are that could

270
00:10:40,330 --> 00:10:38,840
potentially host life that are within

271
00:10:44,230 --> 00:10:40,340
that habitable zone you were talking

272
00:10:47,470 --> 00:10:44,240
about yeah I think Kepler has been a

273
00:10:49,330 --> 00:10:47,480
greater success than anyone ever thought

274
00:10:51,460 --> 00:10:49,340
it would be with the possible exception

275
00:10:54,040 --> 00:10:51,470
of its principal investigator bill

276
00:10:55,950 --> 00:10:54,050
Baruch II who I often like to tell

277
00:11:00,850 --> 00:10:55,960
people as kind of a lesson about

278
00:11:02,980 --> 00:11:00,860
resilience that bill Borucki posted like

279
00:11:06,340 --> 00:11:02,990
a wrote a paper that had the initial

280
00:11:08,230 --> 00:11:06,350
idea for Kepler 25 years almost to the

281
00:11:11,079 --> 00:11:08,240
day prior to Kepler launch

282
00:11:13,090 --> 00:11:11,089
and he was convinced that it was a good

283
00:11:16,750 --> 00:11:13,100
idea and you know like back in the mid

284
00:11:18,310 --> 00:11:16,760
80s when he wrote the paper people were

285
00:11:19,870 --> 00:11:18,320
right that like the technology wasn't

286
00:11:23,079 --> 00:11:19,880
good enough but the technology caught up

287
00:11:25,600 --> 00:11:23,089
so you know being part of Kepler was

288
00:11:27,130 --> 00:11:25,610

really incredible because of the you

289
00:11:28,840 --> 00:11:27,140
know many thousands of planets that we

290
00:11:30,790 --> 00:11:28,850
now know around other stars I think

291
00:11:33,820 --> 00:11:30,800
we're at you know ballpark four thousand

292
00:11:36,160 --> 00:11:33,830
planets or so in the previous 22 years

293
00:11:38,889 --> 00:11:36,170
to Kepler there were only about 400 of

294
00:11:42,460 --> 00:11:38,899
them known and they tended to be these

295
00:11:45,400 --> 00:11:42,470
like larger usually like a gas giant or

296
00:11:47,350 --> 00:11:45,410
icy giant planets you know but often

297
00:11:50,320 --> 00:11:47,360
very not icy because they were often

298
00:11:52,930 --> 00:11:50,330
very close to their star places that you

299
00:11:54,730 --> 00:11:52,940
know are interesting to find but we're

300
00:11:57,610 --> 00:11:54,740
not necessarily the places we might look

301
00:12:00,850 --> 00:11:57,620
for life not the small rocky worlds like

302
00:12:03,699 --> 00:12:00,860
the Mars's and Venus's and earths of of

303
00:12:06,400 --> 00:12:03,709
the universe so you know Kepler was

304
00:12:09,340 --> 00:12:06,410
revolutionary because it not only found

305
00:12:12,250 --> 00:12:09,350
lots of planets but it was our first way

306
00:12:15,010 --> 00:12:12,260
of looking into how common these smaller

307
00:12:17,170 --> 00:12:15,020
potentially habitable worlds are around

308
00:12:20,130 --> 00:12:17,180
other stars and what we find is that

309
00:12:24,040 --> 00:12:20,140
they're incredibly common you know a

310
00:12:27,340 --> 00:12:24,050
very large fraction of the stars that we

311
00:12:29,139 --> 00:12:27,350
have searched so far you know Kepler was

312
00:12:31,030 --> 00:12:29,149
sort of like taking a little mini census

313
00:12:33,730 --> 00:12:31,040

so it only looked at one patch of the

314
00:12:36,490 --> 00:12:33,740
sky about the size of your palm held out

315
00:12:38,050 --> 00:12:36,500
at arm's length and it counted up all

316
00:12:40,600 --> 00:12:38,060
the planets they could find in that one

317
00:12:42,850 --> 00:12:40,610
patch of sky and then because that Patra

318
00:12:45,579 --> 00:12:42,860
sky is not any you know particularly

319
00:12:47,560 --> 00:12:45,589
special patch of sky it allows us to

320
00:12:50,380 --> 00:12:47,570
extrapolate how many planets we would

321
00:12:52,360 --> 00:12:50,390
expect over the sky as a whole so if you

322
00:12:53,710 --> 00:12:52,370
want to go you know make your neighbors

323
00:12:55,660 --> 00:12:53,720
think you're weird but also have some

324
00:12:59,170 --> 00:12:55,670
fun tonight you can try paneling the

325
00:13:00,760 --> 00:12:59,180
entire night sky with your palm because

326
00:13:02,230 --> 00:13:00,770
it's the thousands of planets that we

327
00:13:03,880 --> 00:13:02,240
found from Kepler are just in that one

328
00:13:07,690 --> 00:13:03,890
patch and that tells us that there must

329
00:13:09,880 --> 00:13:07,700
be billions of planets in the galaxy

330
00:13:11,680 --> 00:13:09,890
itself and I'll point out that one of

331
00:13:13,900 --> 00:13:11,690
even though Kepler was focused on

332
00:13:16,600 --> 00:13:13,910
looking at stars that were more massive

333
00:13:19,240 --> 00:13:16,610
like our Sun one of Kepler's main

334
00:13:22,060 --> 00:13:19,250
results is that it is actually the low

335
00:13:23,740 --> 00:13:22,070
mass stars that seem to

336
00:13:27,610 --> 00:13:23,750
least frequent more frequently have

337
00:13:30,250 --> 00:13:27,620
small rocky worlds that are in this

338
00:13:33,100 --> 00:13:30,260

potential habitable zone so that tells

339
00:13:35,760 --> 00:13:33,110
us that by the numbers the small red

340
00:13:38,140 --> 00:13:35,770
stars are really the place to look very

341
00:13:39,730 --> 00:13:38,150
cool so it's just them the numbers alone

342
00:13:42,070 --> 00:13:39,740
like billions of stars in our galaxy

343
00:13:43,840 --> 00:13:42,080
each have several planets you know it

344
00:13:46,570 --> 00:13:43,850
means perhaps tens of billions of

345
00:13:47,890 --> 00:13:46,580
planets in our own galaxy alone it seems

346
00:13:50,530 --> 00:13:47,900
very difficult to think that we're the

347
00:13:54,280 --> 00:13:50,540
only life in this in this in this world

348
00:13:56,470 --> 00:13:54,290
wow just mind-blowing numbers and what's

349
00:13:57,250 --> 00:13:56,480
cool also is that like even in our own

350
00:14:00,040 --> 00:13:57,260
solar system

351
00:14:01,660 --> 00:14:00,050
humans are searching for life beyond the

352
00:14:04,270 --> 00:14:01,670
habitable zone right the I have the

353
00:14:06,670 --> 00:14:04,280
moons of Saturn and Jupiter who have

354
00:14:08,320 --> 00:14:06,680
sort of moon Enceladus for example is

355
00:14:10,240 --> 00:14:08,330
the moon of Saturn and Europe moon of

356
00:14:11,740 --> 00:14:10,250
Jupiter are thought to potentially

357
00:14:14,020 --> 00:14:11,750
Harbor environments that could sustain

358
00:14:16,060 --> 00:14:14,030
life right under the ice shelves where

359
00:14:19,240 --> 00:14:16,070
water is interacting with rocks so our

360
00:14:20,860 --> 00:14:19,250
own solar system hosts environments that

361
00:14:22,360 --> 00:14:20,870
could host life beyond the traditional

362
00:14:23,890 --> 00:14:22,370
concept of our habitable zone so

363
00:14:26,620 --> 00:14:23,900

jester's increases the numbers of

364
00:14:30,370 --> 00:14:26,630
potential habitable worlds to are

365
00:14:31,780 --> 00:14:30,380
stagnant absolutely and you know I as a

366
00:14:33,730 --> 00:14:31,790
person who kind of came into

367
00:14:36,850 --> 00:14:33,740
astrobiology from an astronomy

368
00:14:39,910 --> 00:14:36,860
perspective I think my thinking in

369
00:14:41,680 --> 00:14:39,920
recent years has shifted about where we

370
00:14:43,420 --> 00:14:41,690
might find the and this is like one of

371
00:14:46,810 --> 00:14:43,430
my favorite questions to ask people so

372
00:14:49,570 --> 00:14:46,820
they'll ask you a question but you know

373
00:14:52,570 --> 00:14:49,580
I often like asking people do you think

374
00:14:55,120 --> 00:14:52,580
that we'll find the first unambiguous

375
00:14:57,930 --> 00:14:55,130
sign of life you know the thing that

376
00:15:00,010 --> 00:14:57,940
people kind of come together and accept

377
00:15:02,250 --> 00:15:00,020
rather than arguing over although

378
00:15:04,690 --> 00:15:02,260
scientists always argue over a results

379
00:15:06,640 --> 00:15:04,700
you know do you think that will be in

380
00:15:08,680 --> 00:15:06,650
the solar system or outside the solar

381
00:15:11,410 --> 00:15:08,690
system because I think I used to think

382
00:15:13,240 --> 00:15:11,420
it would be from some of the atmospheric

383
00:15:15,580 --> 00:15:13,250
characterization of exoplanets that

384
00:15:17,860 --> 00:15:15,590
we've been you know working towards and

385
00:15:19,900 --> 00:15:17,870
trying to understand what those signs

386
00:15:21,550 --> 00:15:19,910
those global signs of life that we might

387
00:15:24,430 --> 00:15:21,560
measure in the atmospheres of planets

388
00:15:27,070 --> 00:15:24,440

are but the more I think about it

389
00:15:29,410 --> 00:15:27,080
because there are so many potentially

390
00:15:31,780 --> 00:15:29,420
habitable places in our own solar system

391
00:15:33,520 --> 00:15:31,790
that are not amenable to that kind of

392
00:15:35,770 --> 00:15:33,530
characterization at all you know

393
00:15:37,210 --> 00:15:35,780
Europa's ocean being a great one

394
00:15:38,740 --> 00:15:37,220
you know like there's no there's no

395
00:15:40,210 --> 00:15:38,750
atmosphere you're like you can't use any

396
00:15:42,940 --> 00:15:40,220
of the techniques that you would use on

397
00:15:46,350 --> 00:15:42,950
an exoplanet on something like Europa or

398
00:15:49,600 --> 00:15:46,360
even like Titan or even subsurface Mars

399
00:15:52,240 --> 00:15:49,610
so you know I I think my thinking has

400
00:15:53,890 --> 00:15:52,250
actually kind of changed over to being

401
00:15:56,770 --> 00:15:53,900
like well I think we should look in all

402
00:15:58,540 --> 00:15:56,780
places maybe the first unambiguous thing

403
00:16:00,820 --> 00:15:58,550
the thing that really like we're like oh

404
00:16:02,170 --> 00:16:00,830
yeah no that's a sign of life might

405
00:16:05,110 --> 00:16:02,180
actually just be here in our solar

406
00:16:06,880 --> 00:16:05,120
system yeah and you know frankly the

407
00:16:08,710 --> 00:16:06,890
first few astrobiologists are going to

408
00:16:10,720 --> 00:16:08,720
be landing on Mars in the in the next

409
00:16:13,150 --> 00:16:10,730
few decades might be the ones with the

410
00:16:15,070 --> 00:16:13,160
help of robots actually detect that kind

411
00:16:17,140 --> 00:16:15,080
of potential life-forms who knows

412
00:16:19,090 --> 00:16:17,150
although the Martian surface is pretty

413
00:16:21,700 --> 00:16:19,100

deadly for life as we know it but as we

414
00:16:24,100 --> 00:16:21,710
know life is very very flexible in ways

415
00:16:25,870 --> 00:16:24,110
to to find hiding spots and ways to

416
00:16:27,040 --> 00:16:25,880
extract energy from the environments so

417
00:16:27,910 --> 00:16:27,050
let's talk about Mars a little bit

418
00:16:29,500 --> 00:16:27,920
that's something I know you've been

419
00:16:31,990 --> 00:16:29,510
talking about especially with human

420
00:16:33,580 --> 00:16:32,000
explorers you hosted a workshop not too

421
00:16:34,960 --> 00:16:33,590
long ago about thinking about the kind

422
00:16:38,170 --> 00:16:34,970
of the longer-term questions about

423
00:16:39,910 --> 00:16:38,180
Humanity on Mars of arguments I've seen

424
00:16:43,450 --> 00:16:39,920
the press is that human humanity should

425
00:16:46,390 --> 00:16:43,460
learn how to explore and conquer almost

426
00:16:48,340 --> 00:16:46,400
settle Mars as a backup in case we screw

427
00:16:49,960 --> 00:16:48,350
up our own planet that's something I

428
00:16:51,700 --> 00:16:49,970
personally feel strongly against and

429
00:16:53,620 --> 00:16:51,710
that kind of philosophy and I think you

430
00:16:55,600 --> 00:16:53,630
have some similar viewpoints you tell us

431
00:16:58,329 --> 00:16:55,610
more but but how you approach the human

432
00:17:01,030 --> 00:16:58,339
settlement of Mars yeah you know for the

433
00:17:03,160 --> 00:17:01,040
past for the past several years I've

434
00:17:05,470 --> 00:17:03,170
really been very interested in some of

435
00:17:08,500 --> 00:17:05,480
these like sociological questions about

436
00:17:10,720 --> 00:17:08,510
not just you know how we plan for space

437
00:17:12,579 --> 00:17:10,730
missions but also like how we talk about

438
00:17:14,319 --> 00:17:12,589

what it is that we're doing like the

439
00:17:17,140 --> 00:17:14,329
narratives that we tell in the way that

440
00:17:18,490 --> 00:17:17,150
we frame space exploration particularly

441
00:17:20,890 --> 00:17:18,500
when we're talking about human beings

442
00:17:23,410 --> 00:17:20,900
going into space and what you know

443
00:17:26,380 --> 00:17:23,420
projects they might do they're you know

444
00:17:29,410 --> 00:17:26,390
my my interest in the topic was really

445
00:17:35,080 --> 00:17:29,420
in some ways sparked by being very

446
00:17:36,670 --> 00:17:35,090
annoyed by those those what I think are

447
00:17:38,680 --> 00:17:36,680
really like marketing narratives that

448
00:17:42,820 --> 00:17:38,690
come out of a lot of private space

449
00:17:46,390 --> 00:17:42,830
industry about how going to Mars will

450
00:17:49,270 --> 00:17:46,400
somehow like back up humanity or you

451
00:17:52,780 --> 00:17:49,280
know allow us as some sort of like you

452
00:17:54,340 --> 00:17:52,790
get out of jail free card for the kinds

453
00:17:57,160 --> 00:17:54,350
of things that we're wreaking on our own

454
00:18:00,630 --> 00:17:57,170
environment here and you know I think

455
00:18:05,830 --> 00:18:00,640
like as much as I love space exploration

456
00:18:09,040 --> 00:18:05,840
the the nicest day on Mars it's still an

457
00:18:12,820 --> 00:18:09,050
extremely inhospitable environment and

458
00:18:14,680 --> 00:18:12,830
not only that you know the fact that we

459
00:18:18,340 --> 00:18:14,690
have the planet that we do and that we

460
00:18:20,560 --> 00:18:18,350
have resources to the point where we can

461
00:18:22,720 --> 00:18:20,570
think about literally blasting those

462
00:18:25,210 --> 00:18:22,730
resources using those resources to send

463
00:18:27,040 --> 00:18:25,220

things off of space now off of the you

464
00:18:30,580 --> 00:18:27,050
know the rock that we live on into space

465
00:18:33,190 --> 00:18:30,590
you know a lot of our even ability to

466
00:18:35,350 --> 00:18:33,200
consider thinking about the way the

467
00:18:37,510 --> 00:18:35,360
universe works and space exploration is

468
00:18:40,870 --> 00:18:37,520
given to us by having a planet that

469
00:18:44,460 --> 00:18:40,880
supports at least our basic needs in a

470
00:18:47,770 --> 00:18:44,470
variety of ways so you know I think that

471
00:18:50,950 --> 00:18:47,780
these sort of invocations of existential

472
00:18:54,570 --> 00:18:50,960
dread about like asteroid impacts you

473
00:18:58,630 --> 00:18:54,580
know going to like dinosaurus basically

474
00:19:01,090 --> 00:18:58,640
are are a little disingenuous especially

475
00:19:04,000 --> 00:19:01,100
because you know many of those companies

476
00:19:06,790 --> 00:19:04,010
that have been I think most responsible

477
00:19:08,890 --> 00:19:06,800
for forwarding that narrative never

478
00:19:11,200 --> 00:19:08,900
bring up climate change because it in in

479
00:19:13,120 --> 00:19:11,210
it actually implies like a personal

480
00:19:14,710 --> 00:19:13,130
responsibility to deal with stuff here

481
00:19:16,600 --> 00:19:14,720
on earth whereas if you say it's an

482
00:19:18,340 --> 00:19:16,610
asteroid impact you're you're predicting

483
00:19:21,460 --> 00:19:18,350
protecting yourself from wealth and

484
00:19:23,290 --> 00:19:21,470
that's nobody's fault right so you know

485
00:19:26,890 --> 00:19:23,300
I think out of that I became very

486
00:19:28,840 --> 00:19:26,900
interested in you know not only like the

487
00:19:31,780 --> 00:19:28,850
ways we justify going to space but then

488
00:19:34,810 --> 00:19:31,790

also the ways that we invoke narratives

489
00:19:38,050 --> 00:19:34,820
from human history so you know even the

490
00:19:42,970 --> 00:19:38,060
choice of the word like colonization you

491
00:19:46,150 --> 00:19:42,980
know conquering settling you know broad

492
00:19:49,240 --> 00:19:46,160
declarations of like what what humans do

493
00:19:52,060 --> 00:19:49,250
and like you know humans need to leave

494
00:19:54,750 --> 00:19:52,070
their territory etc a lot of those come

495
00:19:57,850 --> 00:19:54,760
from you know the history of

496
00:19:59,620 --> 00:19:57,860
predominantly European colonization and

497
00:20:01,030 --> 00:19:59,630
a lot of those narratives are drawn like

498
00:20:02,070 --> 00:20:01,040
specifically tied to things like

499
00:20:05,149 --> 00:20:02,080
Columbus

500
00:20:08,070 --> 00:20:05,159
and you know to me that is a symptom of

501
00:20:12,659 --> 00:20:08,080
a broader lack of inclusion in the

502
00:20:14,399 --> 00:20:12,669
fields you know I think for those of us

503
00:20:16,529 --> 00:20:14,409
who are within the field who are like of

504
00:20:19,049 --> 00:20:16,539
your European descent

505
00:20:21,570 --> 00:20:19,059
we don't necessarily hear the name

506
00:20:23,310 --> 00:20:21,580
Columbus and think about genocide but

507
00:20:25,860 --> 00:20:23,320
that is the historical narrative that

508
00:20:28,649 --> 00:20:25,870
we're drawing on and so you know I would

509
00:20:31,740 --> 00:20:28,659
like us to ask what are the ways in

510
00:20:33,810 --> 00:20:31,750
which we use these narratives and you

511
00:20:36,080 --> 00:20:33,820
know like are they a what we want to do

512
00:20:39,899 --> 00:20:36,090
what we want to use to frame the future

513
00:20:42,570 --> 00:20:39,909

and also you know what rewriting of

514
00:20:45,509 --> 00:20:42,580
Earth's history are we implying by

515
00:20:49,740 --> 00:20:45,519
casting them in this supposedly neutral

516
00:20:52,100 --> 00:20:49,750
or and/or positive light so over the

517
00:20:54,090 --> 00:20:52,110
past year or several years and

518
00:20:56,009 --> 00:20:54,100
specifically at the Library of Congress

519
00:20:59,009 --> 00:20:56,019
what I was doing was looking at a lot of

520
00:21:01,529 --> 00:20:59,019
the intersections of things we explore

521
00:21:04,139 --> 00:21:01,539
here on earth and you know art history

522
00:21:07,289 --> 00:21:04,149
so not just for example colonization but

523
00:21:10,470 --> 00:21:07,299
also environmental law the way that we

524
00:21:12,539 --> 00:21:10,480
think about environments and whether

525
00:21:14,120 --> 00:21:12,549
they are for the use of humanity whether

526
00:21:16,200 --> 00:21:14,130
they have sovereignty unto themselves

527
00:21:18,120 --> 00:21:16,210
whether their sovereignty or their

528
00:21:19,470 --> 00:21:18,130
autonomy has tied to the presence of

529
00:21:21,450 --> 00:21:19,480
life which i think is a really

530
00:21:23,129 --> 00:21:21,460
interesting question too and the way

531
00:21:25,230 --> 00:21:23,139
that that interfaces with things like

532
00:21:28,379 --> 00:21:25,240
our laws you know like our planetary

533
00:21:30,450 --> 00:21:28,389
protection policies for example the way

534
00:21:32,879 --> 00:21:30,460
we clean our spacecraft when we go to

535
00:21:35,490 --> 00:21:32,889
try and find life so yeah I've been

536
00:21:36,840 --> 00:21:35,500
thinking about all of that and it's

537
00:21:38,610 --> 00:21:36,850
really valuable cause I mean clearly

538
00:21:41,370 --> 00:21:38,620

Humanity is more advanced in the

539
00:21:43,680 --> 00:21:41,380
engineering and in technology of landing

540
00:21:46,080 --> 00:21:43,690
a craft on another planet then we are

541
00:21:48,360 --> 00:21:46,090
about the environmental science about

542
00:21:50,879 --> 00:21:48,370
the ethics about the the legal about the

543
00:21:54,360 --> 00:21:50,889
economics so I wonder if there's value

544
00:21:57,210 --> 00:21:54,370
in and just like slowing down the human

545
00:21:59,580 --> 00:21:57,220
push to put humans on Mars until we're

546
00:22:02,279 --> 00:21:59,590
able to put as much financial resources

547
00:22:04,440 --> 00:22:02,289
into these soft Sciences to to really

548
00:22:06,360 --> 00:22:04,450
not screw up when we settle another

549
00:22:08,700 --> 00:22:06,370
world and not make the mistakes of our

550
00:22:11,370 --> 00:22:08,710
past yeah well and I think that one of

551
00:22:13,200 --> 00:22:11,380
the things that I I personally have

552
00:22:15,840 --> 00:22:13,210
really enjoyed about doing some of this

553
00:22:18,359 --> 00:22:15,850
work is the way that it's allowed me to

554
00:22:21,659 --> 00:22:18,369
reach out to and to learn from scholars

555
00:22:24,210 --> 00:22:21,669
so for example scholars who are you know

556
00:22:25,940 --> 00:22:24,220
in indigenous history who could talk

557
00:22:29,969 --> 00:22:25,950
about treaty making and the ways

558
00:22:32,639 --> 00:22:29,979
treaties tend to become violated or be

559
00:22:34,950 --> 00:22:32,649
violated by nations and private actors

560
00:22:37,919 --> 00:22:34,960
when resources come into play which is

561
00:22:40,139 --> 00:22:37,929
exactly what we are seeing starting to

562
00:22:43,289 --> 00:22:40,149
happen with talk about you know like

563
00:22:44,700 --> 00:22:43,299

mining in space and like the treaties

564
00:22:47,700 --> 00:22:44,710
that we have like the Outer Space Treaty

565
00:22:50,009 --> 00:22:47,710
of 1967 we can learn a lot by talking

566
00:22:53,190 --> 00:22:50,019
with people who have studied these same

567
00:22:55,320 --> 00:22:53,200
kinds of cases in fields that are

568
00:22:57,690 --> 00:22:55,330
seemingly disparate from science and so

569
00:23:01,379 --> 00:22:57,700
you know this is again another way in

570
00:23:03,029 --> 00:23:01,389
which astrobiology is a wonderful

571
00:23:04,979 --> 00:23:03,039
conduit for being a truly

572
00:23:07,169 --> 00:23:04,989
interdisciplinary not just science but

573
00:23:09,269 --> 00:23:07,179
an interdisciplinary field and I've

574
00:23:12,659 --> 00:23:09,279
really learned a lot from you know folks

575
00:23:14,909 --> 00:23:12,669
who are in sociology or ethicists who

576
00:23:17,389 --> 00:23:14,919
are now even you know people in animal

577
00:23:20,639 --> 00:23:17,399
behavior who are now like working with

578
00:23:22,710 --> 00:23:20,649
you know people within astrobiology

579
00:23:25,919 --> 00:23:22,720
to try and understand what some of these

580
00:23:27,409 --> 00:23:25,929
issues are and and really broaden our

581
00:23:29,729 --> 00:23:27,419
thinking you know I think having more

582
00:23:32,909 --> 00:23:29,739
voices in the room has been really

583
00:23:34,799 --> 00:23:32,919
helpful you know coming out of my year

584
00:23:36,989 --> 00:23:34,809
at the Library of Congress one of the

585
00:23:40,200 --> 00:23:36,999
the things that I've been engaged in

586
00:23:42,570 --> 00:23:40,210
over the past about half a year or so I

587
00:23:45,210 --> 00:23:42,580
guess just at the end of 2018 is that I

588
00:23:47,519 --> 00:23:45,220

and another astronomer Erica ness fold

589
00:23:50,549 --> 00:23:47,529
who is now also a developer for universe

590
00:23:52,889 --> 00:23:50,559
sandbox co-founded space ethics

591
00:23:56,279 --> 00:23:52,899
nonprofit called the just space Alliance

592
00:23:59,190 --> 00:23:56,289
and essentially what we are here to do

593
00:24:02,369 --> 00:23:59,200
is to help advocate for a more inclusive

594
00:24:04,379 --> 00:24:02,379
and ethical future in space a more

595
00:24:07,289 --> 00:24:04,389
inclusive approach to space exploration

596
00:24:09,839 --> 00:24:07,299
and also to use some of the excitement

597
00:24:11,940 --> 00:24:09,849
that people have to talk about how we

598
00:24:14,940 --> 00:24:11,950
might create more equitable equitable

599
00:24:16,799 --> 00:24:14,950
futures here on earth today because a

600
00:24:18,719 --> 00:24:16,809
lot of times when we talk about what

601
00:24:20,639 --> 00:24:18,729
humans might do in space what we're

602
00:24:23,729 --> 00:24:20,649
really talking about is the ways in

603
00:24:26,099 --> 00:24:23,739
which we hope or fear that we might live

604
00:24:29,279 --> 00:24:26,109
on earth and so I think it's a really

605
00:24:29,580 --> 00:24:29,289
fertile ground for creating some visions

606
00:24:31,730 --> 00:24:29,590
of the

607
00:24:35,130 --> 00:24:31,740
future that are maybe a little more

608
00:24:37,620 --> 00:24:35,140
inclusive than they have been I really

609
00:24:39,960 --> 00:24:37,630
hope that this vision of it comes comes

610
00:24:41,880 --> 00:24:39,970
comes through like even even the

611
00:24:44,430 --> 00:24:41,890
diversity of scientists needed to

612
00:24:45,960 --> 00:24:44,440
advance as questions is coupled to the

613
00:24:49,320 --> 00:24:45,970

diversity of the scientists themselves

614
00:24:50,190 --> 00:24:49,330
in the discipline to advance on because

615
00:24:52,279 --> 00:24:50,200
we gain a lot from different

616
00:24:55,680 --> 00:24:52,289
perspectives and from different culture

617
00:25:01,740 --> 00:24:55,690
absolutely um so as far as I can tell

618
00:25:04,590 --> 00:25:01,750
you've given to TED talks and I think

619
00:25:06,389 --> 00:25:04,600
your second one you ended on about you

620
00:25:08,399 --> 00:25:06,399
ended the talk talking about the the

621
00:25:11,430 --> 00:25:08,409
Fermi paradox thinking about the

622
00:25:12,539 --> 00:25:11,440
long-term survivability of humans you

623
00:25:14,460 --> 00:25:12,549
know it's something we need to be very

624
00:25:16,580 --> 00:25:14,470
attentive to because you know our

625
00:25:18,419 --> 00:25:16,590
civilization has been listening through

626
00:25:20,399 --> 00:25:18,429
efforts like SETI the search for

627
00:25:22,799 --> 00:25:20,409
extraterrestrial intelligence for radio

628
00:25:25,350 --> 00:25:22,809
signals coming from space for 50 years

629
00:25:27,570 --> 00:25:25,360
and we have we have heard nothing right

630
00:25:29,370 --> 00:25:27,580
so one of the resolutions of these Fermi

631
00:25:31,769 --> 00:25:29,380
paradox is that civilizations once it

632
00:25:33,779 --> 00:25:31,779
become advanced enough miss the

633
00:25:35,850 --> 00:25:33,789
opportunity to see themselves from space

634
00:25:38,730 --> 00:25:35,860
and realize the fragility you end up you

635
00:25:40,289 --> 00:25:38,740
know killing their civilization so

636
00:25:42,720 --> 00:25:40,299
that's not a destiny I hope for our

637
00:25:44,610 --> 00:25:42,730
society and so let's talk a little bit

638
00:25:45,539 --> 00:25:44,620

more about this these SETI efforts

639
00:25:47,820 --> 00:25:45,549
because it's something that I know

640
00:25:50,760 --> 00:25:47,830
you've been involved with as well and

641
00:25:53,130 --> 00:25:50,770
the efforts up to date have been trying

642
00:25:56,159 --> 00:25:53,140
to figure out how to characterize the

643
00:25:57,529 --> 00:25:56,169
signals based on what we think the

644
00:25:59,519 --> 00:25:57,539
expressive as extraterrestrial

645
00:26:01,169 --> 00:25:59,529
civilizations could be sending in terms

646
00:26:02,610 --> 00:26:01,179
of information but you're changing that

647
00:26:06,570 --> 00:26:02,620
paradigm a little bit with your research

648
00:26:09,419 --> 00:26:06,580
right yeah so I been very interested in

649
00:26:12,570 --> 00:26:09,429
SETI kind of as I you know a

650
00:26:14,310 --> 00:26:12,580
complementary fork to what-what I you

651
00:26:16,169 --> 00:26:14,320
know sometimes will call like vanilla

652
00:26:17,669 --> 00:26:16,179
astrobiology you know that the

653
00:26:20,399 --> 00:26:17,679
understanding of the underlying physics

654
00:26:22,830 --> 00:26:20,409
and chemistry and biology is wonderful

655
00:26:25,049 --> 00:26:22,840
and it's it's I think complementary to

656
00:26:26,730 --> 00:26:25,059
doing something like what is now called

657
00:26:28,470 --> 00:26:26,740
like the search for techno signatures

658
00:26:30,060 --> 00:26:28,480
you know the signs of technologically

659
00:26:33,930 --> 00:26:30,070
advanced life that sends signals out

660
00:26:36,360 --> 00:26:33,940
into the universe and you know SETI

661
00:26:39,060 --> 00:26:36,370
it said he is really sociologically

662
00:26:41,370 --> 00:26:39,070
interesting too because while it is true

663
00:26:43,350 --> 00:26:41,380

that efforts have been going on for like

664
00:26:47,940 --> 00:26:43,360
50 some-odd here

665
00:26:51,650 --> 00:26:47,950
study has I think suffered a lack of

666
00:26:54,840 --> 00:26:51,660
support where you know in many ways

667
00:26:57,270 --> 00:26:54,850
doing something like studying extreme

668
00:26:59,370 --> 00:26:57,280
life that lives in acidic pools in

669
00:27:02,400 --> 00:26:59,380
Yellowstone is considered like

670
00:27:04,350 --> 00:27:02,410
legitimate science but looking for radio

671
00:27:06,480 --> 00:27:04,360
signals from space from you know

672
00:27:09,780 --> 00:27:06,490
technologically advanced life has been

673
00:27:12,210 --> 00:27:09,790
considered kind of fringy and so it

674
00:27:15,299 --> 00:27:12,220
hasn't typically enjoyed the same kind

675
00:27:17,610 --> 00:27:15,309
of financial support in terms of ability

676
00:27:19,560 --> 00:27:17,620
to access research funding and support

677
00:27:22,380 --> 00:27:19,570
graduate students or postdocs or even

678
00:27:24,630 --> 00:27:22,390
faculty to work full-time on those

679
00:27:27,450 --> 00:27:24,640
questions and so it is true that we've

680
00:27:30,030 --> 00:27:27,460
been looking for a long time but you

681
00:27:32,010 --> 00:27:30,040
know I think I think it's Jill tarter

682
00:27:34,020 --> 00:27:32,020
who likes to say you know the amount

683
00:27:37,860 --> 00:27:34,030
that we have looked as equivalent to a

684
00:27:40,470 --> 00:27:37,870
cup of water in the ocean you know it it

685
00:27:44,160 --> 00:27:40,480
isn't much of a paradox to me that we

686
00:27:46,710 --> 00:27:44,170
haven't found anything with the efforts

687
00:27:52,500 --> 00:27:46,720
that we've been able to make you know so

688
00:27:55,799 --> 00:27:52,510

I also question our our approach you

689
00:27:58,590 --> 00:27:55,809
know I think many many study efforts for

690
00:28:00,600 --> 00:27:58,600
a very long time work focused on what my

691
00:28:03,200 --> 00:28:00,610
my colleague Jeff Scargill who was at

692
00:28:05,640 --> 00:28:03,210
NASA Ames called psychoanalyzing et

693
00:28:08,100 --> 00:28:05,650
thinking about you know like well if you

694
00:28:09,750 --> 00:28:08,110
were another intelligence like what kind

695
00:28:12,060 --> 00:28:09,760
of signal would you send out that

696
00:28:13,980 --> 00:28:12,070
someone else might be able to detect it

697
00:28:15,900 --> 00:28:13,990
and then also decode it and then what

698
00:28:18,570 --> 00:28:15,910
information would you include in it and

699
00:28:19,830 --> 00:28:18,580
how would you make it different from you

700
00:28:22,080 --> 00:28:19,840
know and astronomically like

701
00:28:25,770 --> 00:28:22,090
naturally-occurring Astrophysical signal

702
00:28:27,270 --> 00:28:25,780
these are all great questions but one of

703
00:28:30,000 --> 00:28:27,280
the things that I'm really interested in

704
00:28:32,210 --> 00:28:30,010
is applications of something called

705
00:28:36,120 --> 00:28:32,220
machine learning to astronomy that

706
00:28:38,549 --> 00:28:36,130
allows you to deal with large large

707
00:28:40,890 --> 00:28:38,559
piles of data data that is of a volume

708
00:28:44,040 --> 00:28:40,900
or complexity that I a human would have

709
00:28:46,950 --> 00:28:44,050
a hard time looking through it I machine

710
00:28:49,919 --> 00:28:46,960
learning is used for a broad variety of

711
00:28:51,780 --> 00:28:49,929
applications in astronomy of which I am

712
00:28:54,810 --> 00:28:51,790
focused on study but that's not the only

713
00:28:56,280 --> 00:28:54,820

thing and I've been very interested in

714
00:28:59,300 --> 00:28:56,290
the ability to look

715
00:29:01,830 --> 00:28:59,310
or signals that are unusual without

716
00:29:04,260 --> 00:29:01,840
having to say how they are unusual

717
00:29:05,730 --> 00:29:04,270
before them because the only thing we

718
00:29:09,630 --> 00:29:05,740
know is that we don't know what we're

719
00:29:11,490 --> 00:29:09,640
looking for you know we don't know if

720
00:29:13,590 --> 00:29:11,500
it's in the data we don't know what it

721
00:29:16,320 --> 00:29:13,600
looks like we don't know anything about

722
00:29:18,690 --> 00:29:16,330
like who might be sending it you know

723
00:29:21,660 --> 00:29:18,700
how they communicate etc like we can't

724
00:29:24,090 --> 00:29:21,670
even talk to wheels okay Whipple's are

725
00:29:25,380 --> 00:29:24,100
are organisms that we understand a lot

726
00:29:26,970 --> 00:29:25,390
about who have like advanced

727
00:29:29,220 --> 00:29:26,980
communications and we cannot communicate

728
00:29:31,140 --> 00:29:29,230
with them so you know we have all of

729
00:29:34,290 --> 00:29:31,150
these things kind of hindering us in the

730
00:29:36,390 --> 00:29:34,300
search for life however what we do have

731
00:29:38,430 --> 00:29:36,400
is a lot of astronomical data now you

732
00:29:41,010 --> 00:29:38,440
know Kepler is an example of an

733
00:29:43,140 --> 00:29:41,020
astronomical survey where instead of you

734
00:29:43,890 --> 00:29:43,150
know like taking data on like one thing

735
00:29:46,710 --> 00:29:43,900
at a time

736
00:29:50,130 --> 00:29:46,720
you take vast amounts of data on many

737
00:29:52,320 --> 00:29:50,140
many objects all at once and that gives

738
00:29:56,310 --> 00:29:52,330

you a big data base in Kepler's case of

739
00:29:58,050 --> 00:29:56,320
how stars vary in brightness and in

740
00:30:00,090 --> 00:29:58,060
Kepler's case like there's been a couple

741
00:30:02,790 --> 00:30:00,100
examples of things that have popped up

742
00:30:05,220 --> 00:30:02,800
in the course of you know Kepler just

743
00:30:07,830 --> 00:30:05,230
doing its planet-hunting job that have

744
00:30:09,840 --> 00:30:07,840
been unusual so Boyajian star is kind of

745
00:30:11,790 --> 00:30:09,850
like the big one of this has made a big

746
00:30:13,770 --> 00:30:11,800
splash a couple of years ago as being

747
00:30:17,730 --> 00:30:13,780
like potential alien mega-structure

748
00:30:20,070 --> 00:30:17,740
found found by citizen scientists

749
00:30:22,380 --> 00:30:20,080
actually looking through the light

750
00:30:23,940 --> 00:30:22,390
curves from Kepler these measurements of

751
00:30:26,280 --> 00:30:23,950
how the brightness of stars are changing

752
00:30:28,140 --> 00:30:26,290
over time and seeing that there was this

753
00:30:32,010 --> 00:30:28,150
unusual one that didn't look like the

754
00:30:33,840 --> 00:30:32,020
rest so that's great but also like what

755
00:30:36,840 --> 00:30:33,850
happens then if you have so much data

756
00:30:39,180 --> 00:30:36,850
that a person would never accidentally

757
00:30:41,160 --> 00:30:39,190
come across that so what I've been

758
00:30:43,230 --> 00:30:41,170
working on with my graduate student

759
00:30:45,420 --> 00:30:43,240
Daniel Giles who is at the Illinois

760
00:30:47,150 --> 00:30:45,430
Institute of Technology is just wrapping

761
00:30:50,760 --> 00:30:47,160
up his thesis work on this actually

762
00:30:53,700 --> 00:30:50,770
using a machine learning to sift the

763
00:30:55,350 --> 00:30:53,710

Kepler data into categories of stars

764
00:30:57,540 --> 00:30:55,360
that resemble each other in their

765
00:31:01,350 --> 00:30:57,550
behavior and what this allows us to do

766
00:31:02,580 --> 00:31:01,360
is find things that are unusual so you

767
00:31:05,520 --> 00:31:02,590
know kind of the end of this we have

768
00:31:07,470 --> 00:31:05,530
like a ranked weirdness score for

769
00:31:07,930 --> 00:31:07,480
everything in the database and we are

770
00:31:09,909 --> 00:31:07,940
able to

771
00:31:13,419 --> 00:31:09,919
pick out the most unusual like herbs

772
00:31:16,779 --> 00:31:13,429
that Kepler has observed and our plan is

773
00:31:21,100 --> 00:31:16,789
to identify those you know finding

774
00:31:24,009 --> 00:31:21,110
something unusual in a database stuff

775
00:31:26,830 --> 00:31:24,019
does not mean it's aliens there's a lot

776
00:31:29,769 --> 00:31:26,840
more work to do to figure out like is it

777
00:31:32,499 --> 00:31:29,779
you know some telescope hiccup is it

778
00:31:35,499 --> 00:31:32,509
like you know you're super interesting

779
00:31:36,999 --> 00:31:35,509
study signal is it like new astrophysics

780
00:31:39,249 --> 00:31:37,009
is a known astrophysics that just

781
00:31:42,340 --> 00:31:39,259
doesn't happen very often but to me all

782
00:31:44,499 --> 00:31:42,350
of those things are interesting so where

783
00:31:45,970 --> 00:31:44,509
as trying to figure out what kind of

784
00:31:47,379 --> 00:31:45,980
signal and alien might send and then

785
00:31:49,029 --> 00:31:47,389
detecting that is kind of like oh you

786
00:31:51,159 --> 00:31:49,039
have a smoking gun

787
00:31:53,019 --> 00:31:51,169
this is just a way of making that

788
00:31:57,279 --> 00:31:53,029

serendipity of finding something truly

789
00:31:59,139 --> 00:31:57,289
truly unusual much more efficient so I'm

790
00:32:01,810 --> 00:31:59,149
I've been really excited to see the

791
00:32:04,180 --> 00:32:01,820
progress over the past couple years here

792
00:32:07,149 --> 00:32:04,190
and Daniel just presented some of his

793
00:32:09,549 --> 00:32:07,159
work at apps icon but yeah it's it's

794
00:32:11,169 --> 00:32:09,559
been really fun to work on very cool

795
00:32:13,060 --> 00:32:11,179
very cool I'm excited to see those

796
00:32:14,980 --> 00:32:13,070
results myself I wouldn't be mindful of

797
00:32:16,240 --> 00:32:14,990
time because we definitely wanna give

798
00:32:18,100 --> 00:32:16,250
some time to our audience to ask

799
00:32:20,169 --> 00:32:18,110
questions I'm gonna ask you one last

800
00:32:21,700 --> 00:32:20,179
questions before we open it up and that

801
00:32:23,049 --> 00:32:21,710
is I know you're very accomplished

802
00:32:24,340 --> 00:32:23,059
artist as well could you tell us a

803
00:32:25,869 --> 00:32:24,350
little bit how your art influences

804
00:32:29,289 --> 00:32:25,879
influences your science and perhaps our

805
00:32:31,450 --> 00:32:29,299
your science influences uark sure the

806
00:32:35,019 --> 00:32:31,460
the short answer is that sometimes it

807
00:32:38,710 --> 00:32:35,029
does and sometimes it doesn't so I I do

808
00:32:40,360 --> 00:32:38,720
a pretty wide variety of art work some

809
00:32:43,990 --> 00:32:40,370
of the the things that I've done that

810
00:32:47,320 --> 00:32:44,000
have been more focused on science I I

811
00:32:51,190 --> 00:32:47,330
drew a lot of inspiration from friends

812
00:32:52,840 --> 00:32:51,200
who work with data as a medium so in

813
00:32:55,029 --> 00:32:52,850

particular an artist named Julie

814
00:32:58,299 --> 00:32:55,039
Friedman whose website is translating

815
00:33:00,430 --> 00:32:58,309
nature has a lot of work that she does

816
00:33:02,950 --> 00:33:00,440
in which she takes data and turns it

817
00:33:05,860 --> 00:33:02,960
into you know either in some cases

818
00:33:09,610 --> 00:33:05,870
sculptures in some kind of cases you

819
00:33:11,350 --> 00:33:09,620
know visualizations and also an artist

820
00:33:13,509 --> 00:33:11,360
named Natalie me Bach who uses their

821
00:33:16,119 --> 00:33:13,519
data to create like giant woven

822
00:33:18,100 --> 00:33:16,129
sculptures I encountering a couple of

823
00:33:19,690 --> 00:33:18,110
people like that maybe think about some

824
00:33:22,100 --> 00:33:19,700
of the things that I might do with my

825
00:33:24,380 --> 00:33:22,110
data artistically

826
00:33:27,530 --> 00:33:24,390
several years ago I made a sound

827
00:33:30,530 --> 00:33:27,540
installation where I was taking at the

828
00:33:33,110 --> 00:33:30,540
time I was studying the rotations of

829
00:33:36,740 --> 00:33:33,120
stars and Kepler so stars spin on their

830
00:33:38,540 --> 00:33:36,750
axes like tops and as light and dark

831
00:33:40,910 --> 00:33:38,550
patches on the surface of the star

832
00:33:43,670 --> 00:33:40,920
rotate into and out of you it makes the

833
00:33:45,680 --> 00:33:43,680
light from the star change you can

834
00:33:47,810 --> 00:33:45,690
actually take that measurement that's

835
00:33:50,150 --> 00:33:47,820
actually you know brightness of the star

836
00:33:53,180 --> 00:33:50,160
over time and turn it into sound and it

837
00:33:55,430 --> 00:33:53,190
helps you identify like subtle shifts in

838
00:33:57,620 --> 00:33:55,440

the periodicity that are telling you

839
00:33:59,440 --> 00:33:57,630
something about like where the spots on

840
00:34:02,810 --> 00:33:59,450
the star or peeling are appearing so

841
00:34:05,240 --> 00:34:02,820
that sort of started as Lumi seeing if I

842
00:34:09,080 --> 00:34:05,250
could use sound actually as a way of

843
00:34:10,730 --> 00:34:09,090
exploring my data and then I eventually

844
00:34:14,540 --> 00:34:10,740
ended up deciding that like as an

845
00:34:17,150 --> 00:34:14,550
analysis tool it it wasn't quite what I

846
00:34:19,790 --> 00:34:17,160
wanted it to be and so I ended up making

847
00:34:21,920 --> 00:34:19,800
a sound installation out of it because

848
00:34:23,090 --> 00:34:21,930
you know when we you know if you come to

849
00:34:25,070 --> 00:34:23,100
somewhere like the Adler Planetarium

850
00:34:29,030 --> 00:34:25,080
like we have a lot of like really

851
00:34:31,460 --> 00:34:29,040
beautiful engaging exhibits here but

852
00:34:32,690 --> 00:34:31,470
we're definitely focused also on like

853
00:34:34,910 --> 00:34:32,700
helping you understand like the

854
00:34:37,490 --> 00:34:34,920
underlying science that's happening but

855
00:34:40,610 --> 00:34:37,500
for me one of the powers I think that

856
00:34:42,880 --> 00:34:40,620
art has is of giving people sort of a

857
00:34:45,950 --> 00:34:42,890
more primary emotional experience with

858
00:34:47,960 --> 00:34:45,960
with the work and so you know for me as

859
00:34:50,180 --> 00:34:47,970
a scientist like the exciting part is

860
00:34:51,590 --> 00:34:50,190
when I see that there might be a pattern

861
00:34:54,110 --> 00:34:51,600
in my data and I don't know what it

862
00:34:55,970 --> 00:34:54,120
means yet and like nobody can come to me

863
00:34:59,270 --> 00:34:55,980

and like it read the explanatory plaque

864
00:35:01,310 --> 00:34:59,280
because there isn't one so I really

865
00:35:03,590 --> 00:35:01,320
wanted people to be able to have this

866
00:35:05,330 --> 00:35:03,600
like direct experience with the Kepler

867
00:35:07,910 --> 00:35:05,340
data and just sort of like hear that

868
00:35:09,650 --> 00:35:07,920
there are patterns but not necessarily

869
00:35:11,260 --> 00:35:09,660
to know what they mean but to think

870
00:35:15,110 --> 00:35:11,270
about like what they might mean

871
00:35:16,460 --> 00:35:15,120
so I created a originally it was like a

872
00:35:18,350 --> 00:35:16,470
little installation like a dome

873
00:35:21,760 --> 00:35:18,360
meditation room that you could go into

874
00:35:25,280 --> 00:35:21,770
and then eventually it was up as part of

875
00:35:27,350 --> 00:35:25,290
a group sound exhibit at a gallery

876
00:35:29,570 --> 00:35:27,360
called artists fear outside of

877
00:35:33,290 --> 00:35:29,580
Washington DC called firmata

878
00:35:35,640 --> 00:35:33,300
back I guess in like 2014 or so and yeah

879
00:35:38,819 --> 00:35:35,650
that was really satisfying to

880
00:35:43,319 --> 00:35:38,829
to work on I mean more recently I also

881
00:35:47,099 --> 00:35:43,329
do aerial circus so like I do basically

882
00:35:48,839 --> 00:35:47,109
like performance stuff and I more

883
00:35:50,999 --> 00:35:48,849
recently did something that was only

884
00:35:54,210 --> 00:35:51,009
sort of inspired by astronomy that was

885
00:35:55,829 --> 00:35:54,220
called 40 orbits that was like a kind of

886
00:35:59,670 --> 00:35:55,839
like life story I was my 40th birthday

887
00:36:02,309 --> 00:35:59,680
and January so I asked my partner who is

888
00:36:04,470 --> 00:36:02,319

an artist to compose like a piece of

889
00:36:07,859 --> 00:36:04,480
music like we kind of talked about like

890
00:36:09,180 --> 00:36:07,869
different decades of life and I was

891
00:36:12,239 --> 00:36:09,190
really interested in doing that because

892
00:36:16,019 --> 00:36:12,249
I think the idea that the way we humans

893
00:36:18,799 --> 00:36:16,029
map out time is physically tied to like

894
00:36:21,089 --> 00:36:18,809
the path of our planet around the Sun

895
00:36:23,279 --> 00:36:21,099
you know we have this like actual

896
00:36:25,349 --> 00:36:23,289
physical markers that is tied very much

897
00:36:28,380 --> 00:36:25,359
to like the structure of our solar

898
00:36:31,680 --> 00:36:28,390
system that is how we like map out all

899
00:36:34,529 --> 00:36:31,690
of the sort of non-physical you know

900
00:36:37,950 --> 00:36:34,539
like life things that happen to us

901
00:36:39,569 --> 00:36:37,960
and so maybe I'll tweet that YouTube

902
00:36:40,950 --> 00:36:39,579
video afterwards so I created a

903
00:36:43,799 --> 00:36:40,960
performance and there's like you know

904
00:36:46,650 --> 00:36:43,809
it's pretty pretty fun I'm pretty happy

905
00:36:49,680 --> 00:36:46,660
with how it turned out awesome awesome

906
00:36:52,019 --> 00:36:49,690
yes so all of you are watching dr. Lucy

907
00:36:57,569 --> 00:36:52,029
and Waka wits tweets as at shaka

908
00:36:59,839 --> 00:36:57,579
underscore lulu right okay so now it's

909
00:37:02,400 --> 00:36:59,849
time for questions I'm so excited so

910
00:37:06,120 --> 00:37:02,410
let's go ahead the first question is

911
00:37:08,160 --> 00:37:06,130
from Jim Paz who asks on Twitter I am

912
00:37:09,650 --> 00:37:08,170
curious about your thoughts concerning

913
00:37:11,910 --> 00:37:09,660

the future relationship between

914
00:37:13,349 --> 00:37:11,920
astrobiologists and potential settlers

915
00:37:14,910 --> 00:37:13,359
or miners on the Moon and Mars

916
00:37:18,329 --> 00:37:14,920
can they get along well do you think

917
00:37:21,599 --> 00:37:18,339
there will be a conflict well actually

918
00:37:23,910 --> 00:37:21,609
if you haven't watched it yet NatGeo

919
00:37:27,450 --> 00:37:23,920
channel had it has a show called Mars

920
00:37:30,329 --> 00:37:27,460
that I got to participate in season two

921
00:37:33,059 --> 00:37:30,339
of it's sort of divided between

922
00:37:36,359 --> 00:37:33,069
interviews with folks here on earth like

923
00:37:39,749 --> 00:37:36,369
myself and then the other half of it is

924
00:37:41,849 --> 00:37:39,759
a drama that focuses on a scientific

925
00:37:43,589 --> 00:37:41,859
base on Mars in which miners from

926
00:37:45,900 --> 00:37:43,599
industry show up and the conflicts that

927
00:37:49,460 --> 00:37:45,910
arise from the two of them you know I

928
00:37:54,240 --> 00:37:49,470
think that I don't think that

929
00:37:56,820 --> 00:37:54,250
it's necessarily going to be like all

930
00:37:59,310 --> 00:37:56,830
conflict all the time but I do think

931
00:38:03,480 --> 00:37:59,320
that there are some particular areas of

932
00:38:05,730 --> 00:38:03,490
friction between the motivations of you

933
00:38:08,460 --> 00:38:05,740
know trying to make profit off of a

934
00:38:10,680 --> 00:38:08,470
planet and the motivations of scientists

935
00:38:12,950 --> 00:38:10,690
wanting to study that planet and the way

936
00:38:15,510 --> 00:38:12,960
that this plays out I think most keenly

937
00:38:18,450 --> 00:38:15,520
is when we look at issues of planetary

938
00:38:19,800 --> 00:38:18,460

protection you know the so the Outer

939
00:38:22,980 --> 00:38:19,810
Space Treaty which goes all the way back

940
00:38:25,230 --> 00:38:22,990
to 1967 has this clause in it that says

941
00:38:27,630 --> 00:38:25,240
that you can't contaminate another world

942
00:38:31,230 --> 00:38:27,640
for any reason so you can't make it

943
00:38:33,630 --> 00:38:31,240
unusable to other people and that no

944
00:38:37,350 --> 00:38:33,640
single actor no nation no individual

945
00:38:38,970 --> 00:38:37,360
actor can do that so you know that has

946
00:38:40,770 --> 00:38:38,980
been the law of the land for a very long

947
00:38:43,320 --> 00:38:40,780
time it's like why we clean our

948
00:38:45,020 --> 00:38:43,330
spacecraft when we go to other worlds

949
00:38:47,940 --> 00:38:45,030
and why we're very careful not to

950
00:38:49,760 --> 00:38:47,950
transfer earth bacteria to other

951
00:38:54,300 --> 00:38:49,770
environments within the solar system

952
00:38:55,730 --> 00:38:54,310
however back in 2015 there was something

953
00:38:58,890 --> 00:38:55,740
called the Space Act that was passed

954
00:39:00,780 --> 00:38:58,900
that was motivated largely by the

955
00:39:03,420 --> 00:39:00,790
lobbying efforts of asteroid mining

956
00:39:06,900 --> 00:39:03,430
companies and what the Space Act says is

957
00:39:08,370 --> 00:39:06,910
that you can you can't own a celestial

958
00:39:09,930 --> 00:39:08,380
body so that's another thing that's in

959
00:39:12,960 --> 00:39:09,940
the Outer Space Treaty is that you can't

960
00:39:15,720 --> 00:39:12,970
own another world and you can't own part

961
00:39:17,910 --> 00:39:15,730
of another world so you know like we can

962
00:39:19,680 --> 00:39:17,920
leave all our exploration junk all over

963
00:39:23,130 --> 00:39:19,690

the Moon and Mars but we don't own the

964
00:39:27,300 --> 00:39:23,140
land that that stuff is on even if you

965
00:39:29,430 --> 00:39:27,310
plant a flag in it so you know you can't

966
00:39:32,310 --> 00:39:29,440
own other world still according to the

967
00:39:35,370 --> 00:39:32,320
Space Act however you can own resources

968
00:39:37,920 --> 00:39:35,380
so now space resources are defined as

969
00:39:41,550 --> 00:39:37,930
anything that is not biological

970
00:39:44,430 --> 00:39:41,560
including water that somebody might

971
00:39:46,830 --> 00:39:44,440
extract from another world so this is

972
00:39:49,950 --> 00:39:46,840
very interesting right because the sort

973
00:39:53,490 --> 00:39:49,960
of a casual slogan for astrobiology just

974
00:39:55,020 --> 00:39:53,500
follow the water because you know here

975
00:39:56,640 --> 00:39:55,030
in astrobiology at least than what we've

976
00:39:58,110 --> 00:39:56,650
learned from Earth is that while life

977
00:40:01,080 --> 00:39:58,120
exists in a wide variety of environments

978
00:40:02,910 --> 00:40:01,090
water is a really good sign of like a

979
00:40:04,099 --> 00:40:02,920
place that might be good for life to

980
00:40:06,859 --> 00:40:04,109
throw

981
00:40:08,660 --> 00:40:06,869
for the most part so you know that

982
00:40:11,000 --> 00:40:08,670
brings up like some interesting ethical

983
00:40:14,750 --> 00:40:11,010
questions let's say that what you wanted

984
00:40:17,599 --> 00:40:14,760
to do was create you know a luxury hotel

985
00:40:19,460 --> 00:40:17,609
on Mars and what you'd like to do is

986
00:40:21,800 --> 00:40:19,470
create a waterpark

987
00:40:23,870 --> 00:40:21,810
you know therefore like if you extract

988
00:40:27,079 --> 00:40:23,880

the water for your guests to go to your

989
00:40:29,810 --> 00:40:27,089
luxury hotel on Mars does that mean it's

990
00:40:33,500 --> 00:40:29,820
okay for you to sterilize some water if

991
00:40:35,060 --> 00:40:33,510
there's biology in it do you leave the

992
00:40:38,150 --> 00:40:35,070
biology on the water and just say that

993
00:40:41,510 --> 00:40:38,160
you don't own it you know remember that

994
00:40:42,980 --> 00:40:41,520
we we don't see like giraffes running

995
00:40:44,810 --> 00:40:42,990
across the surface of Mars but that

996
00:40:46,609 --> 00:40:44,820
doesn't mean that there isn't life under

997
00:40:48,440 --> 00:40:46,619
the surface and it doesn't mean that we

998
00:40:51,530 --> 00:40:48,450
might not make some other additional

999
00:40:53,660 --> 00:40:51,540
surprising discoveries so you know I

1000
00:40:57,320 --> 00:40:53,670
think when we play out these scenarios

1001
00:40:59,570 --> 00:40:57,330
of like how private industry versus

1002
00:41:01,760 --> 00:40:59,580
scientific exploration versus like

1003
00:41:05,000 --> 00:41:01,770
nationalistic exploration play out there

1004
00:41:07,550 --> 00:41:05,010
are some obvious errors of areas of

1005
00:41:08,420 --> 00:41:07,560
friction that that come up so these are

1006
00:41:12,079 --> 00:41:08,430
things that we should start thinking

1007
00:41:16,420 --> 00:41:12,089
about now because we are rapidly

1008
00:41:19,070 --> 00:41:16,430
outpacing our treaties and existing laws

1009
00:41:20,660 --> 00:41:19,080
just again to show that the ethic still

1010
00:41:23,359 --> 00:41:20,670
has a ways to go to catch up with the

1011
00:41:25,910 --> 00:41:23,369
engineering of settlement yeah the next

1012
00:41:28,970 --> 00:41:25,920
question is by Andrew Planet who asks on

1013
00:41:32,660 --> 00:41:28,980

Twitter is space exploit is the language

1014
00:41:34,760 --> 00:41:32,670
of space exploration biased to our still

1015
00:41:37,430 --> 00:41:34,770
earthbound existence or will it change

1016
00:41:41,570 --> 00:41:37,440
once we settle a long term beyond our

1017
00:41:44,050 --> 00:41:41,580
planet that's an interesting question I

1018
00:41:48,290 --> 00:41:44,060
am not totally sure I understand it I

1019
00:41:50,420 --> 00:41:48,300
think I think that it's very much biased

1020
00:41:53,329 --> 00:41:50,430
towards earthbound existence at the

1021
00:41:57,800 --> 00:41:53,339
moment in part because like that's where

1022
00:42:00,650 --> 00:41:57,810
we live you know so I think if you're

1023
00:42:02,900 --> 00:42:00,660
asking about like Earth's history then

1024
00:42:06,349 --> 00:42:02,910
for sure you know like we draw on

1025
00:42:07,910 --> 00:42:06,359
Earth's history in part because you know

1026
00:42:10,970 --> 00:42:07,920
like it's the history that we're

1027
00:42:13,339 --> 00:42:10,980
familiar with as I said earlier in the

1028
00:42:15,770 --> 00:42:13,349
program you know I think the histories

1029
00:42:17,120 --> 00:42:15,780
that we tend to draw from where I'm

1030
00:42:19,609 --> 00:42:17,130
using weed to me and Astra

1031
00:42:22,339 --> 00:42:19,619
just also reflect the lack of diversity

1032
00:42:23,870 --> 00:42:22,349
in the field in that you know people

1033
00:42:27,230 --> 00:42:23,880
tend to draw on European history

1034
00:42:29,240 --> 00:42:27,240
particularly that's why you see you know

1035
00:42:31,099 --> 00:42:29,250
these examples of like European

1036
00:42:33,440 --> 00:42:31,109
colonization of the Americas pop up

1037
00:42:35,269 --> 00:42:33,450
again and again whereas there are there

1038
00:42:37,309 --> 00:42:35,279

are a lot of examples of people leaving

1039
00:42:38,990 --> 00:42:37,319
their home territories and exploring

1040
00:42:42,950 --> 00:42:39,000
other areas that aren't necessarily

1041
00:42:45,620 --> 00:42:42,960
those so you know I think we tend to

1042
00:42:47,779 --> 00:42:45,630
always draw on examples that we're

1043
00:42:49,999 --> 00:42:47,789
familiar with whether that is drawn from

1044
00:42:51,620 --> 00:42:50,009
a particular earth culture or whether

1045
00:42:53,839 --> 00:42:51,630
it's drawn from the history of the

1046
00:42:56,269 --> 00:42:53,849
entire earth itself you know as long as

1047
00:42:58,700 --> 00:42:56,279
we are you know terrestrial beings

1048
00:43:00,470 --> 00:42:58,710
I think that'll probably continue to be

1049
00:43:02,210 --> 00:43:00,480
the case but you know who knows what's

1050
00:43:04,759 --> 00:43:02,220
possible I I personally have been

1051
00:43:08,180 --> 00:43:04,769
recently watching the expanse and I've

1052
00:43:10,609 --> 00:43:08,190
been really interested to see how things

1053
00:43:11,630 --> 00:43:10,619
are framed in this sort of those who

1054
00:43:12,589 --> 00:43:11,640
haven't watched it without giving

1055
00:43:14,299 --> 00:43:12,599
anything away

1056
00:43:17,120 --> 00:43:14,309
you know it's world in which people live

1057
00:43:18,559 --> 00:43:17,130
the asteroid belt Earth and Mars and

1058
00:43:20,900 --> 00:43:18,569
there's all these like you know

1059
00:43:23,269 --> 00:43:20,910
conflicts and competition between these

1060
00:43:25,670 --> 00:43:23,279
three groups of folks having these

1061
00:43:28,370 --> 00:43:25,680
different like physical locations within

1062
00:43:30,589 --> 00:43:28,380
the system and the cultural identities

1063
00:43:33,740 --> 00:43:30,599

that come from those so that's been

1064
00:43:36,680 --> 00:43:33,750
really fun to see it sounds like an

1065
00:43:38,390 --> 00:43:36,690
awesome talking about diversity the next

1066
00:43:41,390 --> 00:43:38,400
question is by Rashmi

1067
00:43:43,099 --> 00:43:41,400
Shiv nee who asks on Twitter miss fields

1068
00:43:44,990 --> 00:43:43,109
astrobiology is so welcoming of many

1069
00:43:46,789 --> 00:43:45,000
people with diverse backgrounds Thank

1070
00:43:49,519 --> 00:43:46,799
You ash me I think so too we could do

1071
00:43:51,349 --> 00:43:49,529
better across multiple fields and are

1072
00:43:53,630 --> 00:43:51,359
there any other disciplines you hope

1073
00:43:55,160 --> 00:43:53,640
will jump on board in the effort to

1074
00:43:58,880 --> 00:43:55,170
search for life in the universe ie

1075
00:44:00,230 --> 00:43:58,890
linguists artists and so on yeah you

1076
00:44:02,269 --> 00:44:00,240
know one of the things that I think is

1077
00:44:04,279 --> 00:44:02,279
really interesting about astrobiology is

1078
00:44:07,940 --> 00:44:04,289
you know the we do talk a lot about like

1079
00:44:10,460 --> 00:44:07,950
the mix of fields in the sciences that

1080
00:44:13,009 --> 00:44:10,470
are in like the physical sciences that

1081
00:44:14,569 --> 00:44:13,019
are within the field but also like

1082
00:44:17,240 --> 00:44:14,579
astrobiology has a long history of

1083
00:44:21,069 --> 00:44:17,250
engagement with sociologists Ephesus

1084
00:44:24,319 --> 00:44:21,079
artists linguists as well and I think

1085
00:44:26,539 --> 00:44:24,329
you know just recently I so viewers may

1086
00:44:28,279 --> 00:44:26,549
or may not be aware that astronomy as a

1087
00:44:30,350 --> 00:44:28,289
field has very interesting practice

1088
00:44:32,590 --> 00:44:30,360

called the decadal survey

1089
00:44:35,720 --> 00:44:32,600
we're like every 10 years astronomers

1090
00:44:38,240 --> 00:44:35,730
from like all over the US get together

1091
00:44:41,060 --> 00:44:38,250
and you know in many cases like all over

1092
00:44:42,980 --> 00:44:41,070
the world get together and write these

1093
00:44:44,540 --> 00:44:42,990
papers about what they think the high

1094
00:44:46,640 --> 00:44:44,550
priorities should be for like the next

1095
00:44:49,970 --> 00:44:46,650
decade so it's sort of like this whole

1096
00:44:52,010 --> 00:44:49,980
community-wide vision setting exercise

1097
00:44:54,650 --> 00:44:52,020
though that we lots of us participate

1098
00:44:56,420 --> 00:44:54,660
it's all totally voluntary this

1099
00:44:58,370 --> 00:44:56,430
eventually ends up in like a big report

1100
00:45:00,740 --> 00:44:58,380
that helps guide decisions about like

1101
00:45:02,360 --> 00:45:00,750
funding going forward and I've been very

1102
00:45:04,610 --> 00:45:02,370
happy to see that in this decade all

1103
00:45:07,280 --> 00:45:04,620
survey there have been papers about the

1104
00:45:09,830 --> 00:45:07,290
importance of interdisciplinarity to

1105
00:45:12,980 --> 00:45:09,840
astrobiology and also specifically in

1106
00:45:14,930 --> 00:45:12,990
the context of SETI searches as well so

1107
00:45:16,430 --> 00:45:14,940
understanding you know like not only how

1108
00:45:18,800 --> 00:45:16,440
to guide our searches but also what the

1109
00:45:21,170 --> 00:45:18,810
implications of like contact with

1110
00:45:23,780 --> 00:45:21,180
another species from off of this world

1111
00:45:26,150 --> 00:45:23,790
might actually be so you know I think

1112
00:45:28,400 --> 00:45:26,160
that I this has been one of the areas in

1113
00:45:30,320 --> 00:45:28,410

which astrobiology is very

1114
00:45:32,930 --> 00:45:30,330
forward-thinking I think it could always

1115
00:45:36,080 --> 00:45:32,940
do well to interface more with the

1116
00:45:38,120 --> 00:45:36,090
humanities you know and again the more

1117
00:45:39,830 --> 00:45:38,130
like the more voices in the conversation

1118
00:45:42,890 --> 00:45:39,840
I think often the richer the

1119
00:45:44,600 --> 00:45:42,900
conversation but I think that it's it's

1120
00:45:46,220 --> 00:45:44,610
even broader than you think it is and

1121
00:45:48,770 --> 00:45:46,230
getting more so all the time and that's

1122
00:45:51,080 --> 00:45:48,780
really great I would love to see more

1123
00:45:53,570 --> 00:45:51,090
humanitarian more sessions at apps icon

1124
00:45:56,420 --> 00:45:53,580
on the humanities of astrobiology w

1125
00:45:59,360 --> 00:45:56,430
really fascinating the next question is

1126
00:46:02,030 --> 00:45:59,370
by Laura from Twitter who asks as a

1127
00:46:04,220 --> 00:46:02,040
Columbian I love the way how Shaka Lulu

1128
00:46:06,470 --> 00:46:04,230
described the similarities between space

1129
00:46:08,480 --> 00:46:06,480
settlement and colonization there should

1130
00:46:09,260 --> 00:46:08,490
be more talk about inclusion related to

1131
00:46:11,360 --> 00:46:09,270
space exploration

1132
00:46:13,580 --> 00:46:11,370
are there any authors or texts you would

1133
00:46:15,730 --> 00:46:13,590
recommend to read more about these views

1134
00:46:19,940 --> 00:46:15,740
oh goodness

1135
00:46:22,280 --> 00:46:19,950
yeah so there's it depends where you

1136
00:46:26,240 --> 00:46:22,290
want to start so I think there's been

1137
00:46:29,450 --> 00:46:26,250
quite a lot of really good just popular

1138
00:46:33,650 --> 00:46:29,460

articles in the in the press recently so

1139
00:46:34,820 --> 00:46:33,660
certainly a lot of like for example in

1140
00:46:37,460 --> 00:46:34,830
the past year

1141
00:46:39,770 --> 00:46:37,470
Gizmodo and Newsweek have both an NGO

1142
00:46:43,370 --> 00:46:39,780
have all written about some of the

1143
00:46:45,230 --> 00:46:43,380
conversations that are ongoing about the

1144
00:46:47,330 --> 00:46:45,240
language that we use around space

1145
00:46:49,580 --> 00:46:47,340
exploration and those are good places to

1146
00:46:52,160 --> 00:46:49,590
start one of the people that I have

1147
00:46:53,900 --> 00:46:52,170
really learned a lot from from is Shonda

1148
00:46:55,730 --> 00:46:53,910
prescott weinstein who's a theoretical

1149
00:46:58,310 --> 00:46:55,740
astrophysicist at the university of new

1150
00:47:00,410 --> 00:46:58,320
hampshire Shonda maintains a

1151
00:47:03,110 --> 00:47:00,420
decolonizing science reading list that

1152
00:47:04,970 --> 00:47:03,120
is not specifically focused necessarily

1153
00:47:07,760 --> 00:47:04,980
on space exploration but I think is a

1154
00:47:10,900 --> 00:47:07,770
really strong place to start

1155
00:47:16,160 --> 00:47:10,910
you know I think particularly a lot of

1156
00:47:19,160 --> 00:47:16,170
rethinking how how we frame and and

1157
00:47:21,320 --> 00:47:19,170
actually conduct this kind of like

1158
00:47:24,590 --> 00:47:21,330
scientific enterprise that we're all

1159
00:47:27,050 --> 00:47:24,600
engaged in you know a lot of the reading

1160
00:47:30,080 --> 00:47:27,060
is not necessarily even specific to

1161
00:47:31,790 --> 00:47:30,090
space it's really understanding the

1162
00:47:35,270 --> 00:47:31,800
history of science and the ways in which

1163
00:47:37,790 --> 00:47:35,280

like science has has functioned within

1164
00:47:39,890 --> 00:47:37,800
these larger colonial structures because

1165
00:47:41,360 --> 00:47:39,900
I think a lot of times you know even we

1166
00:47:43,880 --> 00:47:41,370
scientists and I'm sure that I do this

1167
00:47:46,760 --> 00:47:43,890
as well have a way of like posing like

1168
00:47:48,920 --> 00:47:46,770
science as this kind of like completely

1169
00:47:52,160 --> 00:47:48,930
value neutral thing which it has

1170
00:47:54,140 --> 00:47:52,170
historically not been at all so I you

1171
00:47:56,990 --> 00:47:54,150
know I would certainly recommend reading

1172
00:47:59,570 --> 00:47:57,000
some of the articles you can find them

1173
00:48:02,030 --> 00:47:59,580
as many of them linked actually from my

1174
00:48:04,370 --> 00:48:02,040
website tangled fields com

1175
00:48:06,590 --> 00:48:04,380
but you you should start there but then

1176
00:48:07,400 --> 00:48:06,600
I would also check out dr. Prescott

1177
00:48:09,920 --> 00:48:07,410
Weinstein's

1178
00:48:11,360 --> 00:48:09,930
decolonizing science reading list for

1179
00:48:15,200 --> 00:48:11,370
some other really excellent places to

1180
00:48:18,230 --> 00:48:15,210
start thank you the next question is by

1181
00:48:21,020 --> 00:48:18,240
Genova and Barassi on cygnets who asks

1182
00:48:26,480 --> 00:48:21,030
is habitability ever changing in our own

1183
00:48:28,850 --> 00:48:26,490
solar system oh yes so you know one of

1184
00:48:33,380 --> 00:48:28,860
the one of the things that i think is so

1185
00:48:35,390 --> 00:48:33,390
fascinating about Mars in particular but

1186
00:48:38,420 --> 00:48:35,400
I often like thinking about like Mars

1187
00:48:40,010 --> 00:48:38,430
Venus on earth as sort of like you know

1188
00:48:41,900 --> 00:48:40,020

in a in a Christmas Carol there's like

1189
00:48:44,300 --> 00:48:41,910
the ghost of Christmas past in future

1190
00:48:46,670 --> 00:48:44,310
and the ghost of Christmas present and

1191
00:48:49,760 --> 00:48:46,680
you know they're all like different

1192
00:48:53,210 --> 00:48:49,770
possible outcomes of you know the same

1193
00:48:55,130 --> 00:48:53,220
Syrian series of events right so I when

1194
00:48:55,630 --> 00:48:55,140
we look at Mars for example one of the

1195
00:48:57,280 --> 00:48:55,640
reasons

1196
00:48:59,890 --> 00:48:57,290
that Mars is such an interesting place

1197
00:49:02,350 --> 00:48:59,900
to study is that it's a world where we

1198
00:49:03,870 --> 00:49:02,360
have pretty good evidence now it was a

1199
00:49:06,250 --> 00:49:03,880
much more hospitable environment

1200
00:49:08,770 --> 00:49:06,260
potentially for life in the past than it

1201
00:49:11,380 --> 00:49:08,780
is today and you know the reasons for

1202
00:49:13,870 --> 00:49:11,390
that are many one of the primary reasons

1203
00:49:16,510 --> 00:49:13,880
is that you know Mars no longer really

1204
00:49:19,060 --> 00:49:16,520
has a robust emmonak magnetic field and

1205
00:49:21,370 --> 00:49:19,070
that its atmosphere has changed a lot

1206
00:49:23,770 --> 00:49:21,380
over time so you know we now know that

1207
00:49:26,080 --> 00:49:23,780
there was at some point like standing

1208
00:49:29,050 --> 00:49:26,090
water on the surface of Mars and lots of

1209
00:49:31,750 --> 00:49:29,060
it for a long amount of time but today

1210
00:49:34,690 --> 00:49:31,760
the atmosphere is very thin extremely

1211
00:49:36,310 --> 00:49:34,700
dry you know largely carbon dioxide

1212
00:49:40,000 --> 00:49:36,320
there's not really like a whole lot of

1213
00:49:42,940 --> 00:49:40,010

like chemical cycling happening on the

1214
00:49:44,290 --> 00:49:42,950
on the planet there's like leftover

1215
00:49:46,270 --> 00:49:44,300
magnetic fields but not a lot of

1216
00:49:49,150 --> 00:49:46,280
shielding from the radiation from the

1217
00:49:51,820 --> 00:49:49,160
Sun and so by studying Mars we can look

1218
00:49:54,190 --> 00:49:51,830
at an environment that we see today as

1219
00:49:56,470 --> 00:49:54,200
being not what we would think of as

1220
00:49:59,380 --> 00:49:56,480
traditionally habitable and not even

1221
00:50:02,290 --> 00:49:59,390
particularly hospitable at all but we

1222
00:50:05,530 --> 00:50:02,300
can study its past and learn about how

1223
00:50:08,470 --> 00:50:05,540
the how this world at least in Mars case

1224
00:50:11,920 --> 00:50:08,480
might have lost its habitability you

1225
00:50:14,200 --> 00:50:11,930
know when we look at our own planets you

1226
00:50:17,290 --> 00:50:14,210
know we see the changes that are

1227
00:50:19,840 --> 00:50:17,300
happening in our climate and one of the

1228
00:50:22,570 --> 00:50:19,850
worries for us right is that we might

1229
00:50:25,570 --> 00:50:22,580
lose our habitability you know the

1230
00:50:27,310 --> 00:50:25,580
planet will still be there like if you

1231
00:50:29,830 --> 00:50:27,320
look at Venus Venus is trucking along

1232
00:50:33,070 --> 00:50:29,840
just fine but there's a reason that you

1233
00:50:35,440 --> 00:50:33,080
don't hear about Venus rovers and that's

1234
00:50:38,140 --> 00:50:35,450
because Venus is you know very very very

1235
00:50:40,060 --> 00:50:38,150
very very hot not very hospitable

1236
00:50:41,590 --> 00:50:40,070
environment for totally different

1237
00:50:43,780 --> 00:50:41,600
reasons than Mars is an inhospitable

1238
00:50:46,360 --> 00:50:43,790

environment right so we have this

1239
00:50:48,940 --> 00:50:46,370
wonderful diversity of worlds within our

1240
00:50:50,920 --> 00:50:48,950
own solar system including our own that

1241
00:50:54,010 --> 00:50:50,930
I think can really help us understand

1242
00:50:55,200 --> 00:50:54,020
you know not only what it means to be a

1243
00:50:57,790 --> 00:50:55,210
planet that is

1244
00:51:01,240 --> 00:50:57,800
hospitable to life and actually has life

1245
00:51:03,880 --> 00:51:01,250
but also what possible pathways forward

1246
00:51:06,760 --> 00:51:03,890
might cause you know like us or other

1247
00:51:07,770 --> 00:51:06,770
worlds to lose that that habitability

1248
00:51:10,560 --> 00:51:07,780
and

1249
00:51:12,330 --> 00:51:10,570
you know I think habitability is is very

1250
00:51:14,220 --> 00:51:12,340
much you know we often talk about it as

1251
00:51:16,140 --> 00:51:14,230
just like how far is a planet from the

1252
00:51:18,780 --> 00:51:16,150
Sun but it has all of these

1253
00:51:22,230 --> 00:51:18,790
complications and wonderful details that

1254
00:51:25,740 --> 00:51:22,240
make it a very shifting and evolving

1255
00:51:27,150 --> 00:51:25,750
thing with time yeah I think that's one

1256
00:51:29,330 --> 00:51:27,160
of the beauties of astrobiology is that

1257
00:51:32,310 --> 00:51:29,340
it brings you a new sense of

1258
00:51:34,710 --> 00:51:32,320
appreciation and wonder of our own world

1259
00:51:36,420 --> 00:51:34,720
seen from far away appreciate of the

1260
00:51:38,760 --> 00:51:36,430
evolution of Earth through time how has

1261
00:51:40,200 --> 00:51:38,770
this changed or the impacts of human and

1262
00:51:42,540 --> 00:51:40,210
how does that reflect in other worlds in

1263
00:51:44,339 --> 00:51:42,550

our solar system makes you much more

1264
00:51:46,970 --> 00:51:44,349
appreciative about what we have on our

1265
00:51:49,980 --> 00:51:46,980
own planet yeah absolutely

1266
00:51:53,849 --> 00:51:49,990
the next question is from Graham Lau my

1267
00:51:56,040 --> 00:51:53,859
fiercely bearded co-host he asks can you

1268
00:51:58,020 --> 00:51:56,050
name a piece of art writing film or

1269
00:52:05,720 --> 00:51:58,030
other media that most inspired you to

1270
00:52:12,990 --> 00:52:09,900
you know I actually think it might be so

1271
00:52:15,839 --> 00:52:13,000
I I will caveat this with the fact that

1272
00:52:17,640 --> 00:52:15,849
like I read like you know old science

1273
00:52:19,710 --> 00:52:17,650
fiction like Ray Bradbury story is when

1274
00:52:22,500 --> 00:52:19,720
I was like in junior high but I'm not

1275
00:52:24,300 --> 00:52:22,510
generally like a great consumer of like

1276
00:52:27,180 --> 00:52:24,310
science fiction specifically which is

1277
00:52:28,829 --> 00:52:27,190
usually what people are asking about you

1278
00:52:31,500 --> 00:52:28,839
know as far as like being inspired to

1279
00:52:34,859 --> 00:52:31,510
study astrobiology or science more

1280
00:52:36,900 --> 00:52:34,869
broadly I actually have a answer to this

1281
00:52:39,630 --> 00:52:36,910
that I think is fairly unusual which is

1282
00:52:41,849 --> 00:52:39,640
that I read a book by a woman named

1283
00:52:45,540 --> 00:52:41,859
Donna Shirley called managing Martians

1284
00:52:49,980 --> 00:52:45,550
that so she was the I believe project

1285
00:52:52,710 --> 00:52:49,990
manager for the surgery rover and it was

1286
00:52:54,720 --> 00:52:52,720
about her career so that would have come

1287
00:52:56,160 --> 00:52:54,730
out you know in the late 90s or

1288
00:52:58,410 --> 00:52:56,170

something so it must have been like

1289
00:53:00,530 --> 00:52:58,420
right within my last year of high school

1290
00:53:02,970 --> 00:53:00,540
or first year of college that I read it

1291
00:53:06,240 --> 00:53:02,980
but it was a very fascinating book

1292
00:53:08,310 --> 00:53:06,250
because it was about her career and you

1293
00:53:10,200 --> 00:53:08,320
know her being like the generation

1294
00:53:13,349 --> 00:53:10,210
before me as like a woman in science and

1295
00:53:15,990 --> 00:53:13,359
engineering she you know really didn't

1296
00:53:18,150 --> 00:53:16,000
have a ton of opportunities in in many

1297
00:53:19,680 --> 00:53:18,160
ways the beginning of her career was not

1298
00:53:20,960 --> 00:53:19,690
very illustrious she had like a really

1299
00:53:23,450 --> 00:53:20,970
hard time and I think

1300
00:53:25,820 --> 00:53:23,460
actually ended up if I remember

1301
00:53:27,080 --> 00:53:25,830
correctly and it's been a long time but

1302
00:53:30,230 --> 00:53:27,090
if I remember correctly she actually

1303
00:53:33,290 --> 00:53:30,240
ended up working at NASA after just

1304
00:53:36,770 --> 00:53:33,300
working as like a drafts person for an

1305
00:53:39,109 --> 00:53:36,780
engineering company and gradually ended

1306
00:53:42,170 --> 00:53:39,119
up managing this incredible like the

1307
00:53:45,800 --> 00:53:42,180
first Mars rover mission and I think

1308
00:53:49,280 --> 00:53:45,810
that kind of gave me some early exposure

1309
00:53:51,830 --> 00:53:49,290
to the sort of what I would call like

1310
00:53:53,420 --> 00:53:51,840
the project aspect of science so you

1311
00:53:55,160 --> 00:53:53,430
know like we think about like scientists

1312
00:53:56,540 --> 00:53:55,170
doing their work but then you know these

1313
00:54:00,170 --> 00:53:56,550

missions that we talk about like Kepler

1314
00:54:01,790 --> 00:54:00,180
are these huge collaborations of people

1315
00:54:04,609 --> 00:54:01,800
that have like very specific knowledge

1316
00:54:06,290 --> 00:54:04,619
that combine it all to create this like

1317
00:54:08,120 --> 00:54:06,300
piece of technology that then is like

1318
00:54:10,160 --> 00:54:08,130
able to answer all these science

1319
00:54:12,530 --> 00:54:10,170
questions it's really like as far as

1320
00:54:15,560 --> 00:54:12,540
like the human side of it it's a very

1321
00:54:17,810 --> 00:54:15,570
interesting thing to me and I've always

1322
00:54:19,550 --> 00:54:17,820
found like the ways in which scientists

1323
00:54:22,550 --> 00:54:19,560
do their work and like the ways in which

1324
00:54:25,520 --> 00:54:22,560
we organize ourselves and the the myriad

1325
00:54:28,460 --> 00:54:25,530
skills beyond just being good like math

1326
00:54:30,710 --> 00:54:28,470
or lab science you know your ability to

1327
00:54:33,589 --> 00:54:30,720
like keep up on your email and like

1328
00:54:34,880 --> 00:54:33,599
manage your time and write things you

1329
00:54:37,310 --> 00:54:34,890
know all these things that people don't

1330
00:54:39,770 --> 00:54:37,320
think of as being specific science

1331
00:54:41,720 --> 00:54:39,780
skills but that really are I think that

1332
00:54:43,250 --> 00:54:41,730
was one of the things that I found

1333
00:54:46,089 --> 00:54:43,260
really interesting about that book that

1334
00:54:48,230 --> 00:54:46,099
I had this interaction with early on

1335
00:54:50,500 --> 00:54:48,240
cool thank you thank you for that I have

1336
00:54:54,079 --> 00:54:50,510
to read that the next question is by

1337
00:54:56,690 --> 00:54:54,089
Ashish Nath who asks on Twitter is

1338
00:54:59,000 --> 00:54:56,700

interpolated is interplanetary

1339
00:55:05,900 --> 00:54:59,010
colonization really in need of this hour

1340
00:55:08,120 --> 00:55:05,910
or not so I would say not you know I

1341
00:55:10,970 --> 00:55:08,130
think a lot of times and you touched on

1342
00:55:14,390 --> 00:55:10,980
this century a little while ago I the

1343
00:55:17,660 --> 00:55:14,400
kind of urgency that is often posed

1344
00:55:21,740 --> 00:55:17,670
behind you know humans like needing to

1345
00:55:25,490 --> 00:55:21,750
go and live off of offworld is to me

1346
00:55:27,920 --> 00:55:25,500
often largely artificially induced you

1347
00:55:29,990 --> 00:55:27,930
know I think we do have like urgent

1348
00:55:32,630 --> 00:55:30,000
issues and challenges in living on our

1349
00:55:34,220 --> 00:55:32,640
world but none of them are really

1350
00:55:38,420 --> 00:55:34,230
directly address

1351
00:55:39,800 --> 00:55:38,430
by going and sending humans to live on

1352
00:55:43,760 --> 00:55:39,810
another world in which their resources

1353
00:55:46,310 --> 00:55:43,770
are not met you know I think that space

1354
00:55:47,930 --> 00:55:46,320
exploration and you know like you

1355
00:55:50,270 --> 00:55:47,940
specifically like the challenges of

1356
00:55:52,820 --> 00:55:50,280
sending humans into space offers us many

1357
00:55:55,460 --> 00:55:52,830
scientific opportunities it offers us

1358
00:55:57,260 --> 00:55:55,470
opportunities to learn about living in

1359
00:55:59,510 --> 00:55:57,270
inhospitable environments that could be

1360
00:56:02,890 --> 00:55:59,520
very helpful for our understanding of

1361
00:56:06,260 --> 00:56:02,900
how we might live as our earth changes

1362
00:56:09,590 --> 00:56:06,270
you know I think that a lot of times

1363
00:56:11,630 --> 00:56:09,600

though the kind of urgency you know even

1364
00:56:13,790 --> 00:56:11,640
for example when you look at like we're

1365
00:56:16,280 --> 00:56:13,800
going to put people on them the most

1366
00:56:20,230 --> 00:56:16,290
recent like NASA effort of we're going

1367
00:56:26,090 --> 00:56:22,460
there's no reason the moon's going to be

1368
00:56:29,180 --> 00:56:26,100
there in 2025 you know a lot of these

1369
00:56:32,150 --> 00:56:29,190
things are driven out of either politics

1370
00:56:33,590 --> 00:56:32,160
or eco you know a lot of times when

1371
00:56:35,270 --> 00:56:33,600
people are like we have to do it now

1372
00:56:38,450 --> 00:56:35,280
what they really mean is like I want to

1373
00:56:40,640 --> 00:56:38,460
do it to do it my lifetime and I I

1374
00:56:43,460 --> 00:56:40,650
totally understand that you know like I

1375
00:56:48,020 --> 00:56:43,470
understand that like human need like I

1376
00:56:50,210 --> 00:56:48,030
am I am constantly berating myself that

1377
00:56:53,720 --> 00:56:50,220
like everything takes about like five to

1378
00:56:54,980 --> 00:56:53,730
10 times longer than I wish it did you

1379
00:56:56,450 --> 00:56:54,990
know and so I'm constantly very

1380
00:56:58,790 --> 00:56:56,460
impatient but I always have to remind

1381
00:57:02,030 --> 00:56:58,800
myself that that impatience like comes

1382
00:57:03,800 --> 00:57:02,040
from me and so I think you know when we

1383
00:57:05,240 --> 00:57:03,810
look at the the scope of the things that

1384
00:57:08,000 --> 00:57:05,250
we're trying to do and the challenges

1385
00:57:11,510 --> 00:57:08,010
that we have that we you know we don't

1386
00:57:14,150 --> 00:57:11,520
have to do it tomorrow and you know I

1387
00:57:16,190 --> 00:57:14,160
think it's worth thinking about how we

1388
00:57:18,340 --> 00:57:16,200

would want to do it and maybe taking our

1389
00:57:20,870 --> 00:57:18,350
ego a little bit out of the equation

1390
00:57:24,740 --> 00:57:20,880
when we think about what that timescale

1391
00:57:26,359 --> 00:57:24,750
should really be oh yeah um so we're

1392
00:57:28,910 --> 00:57:26,369
running you're low on time so we'll have

1393
00:57:31,670 --> 00:57:28,920
one more question and that is by M Flynn

1394
00:57:33,710 --> 00:57:31,680
who acts on Twitter what advice do you

1395
00:57:35,240 --> 00:57:33,720
have for a college-bound person who is

1396
00:57:37,490 --> 00:57:35,250
interested in both a scientific field

1397
00:57:39,740 --> 00:57:37,500
like astronomy biology or physics as

1398
00:57:42,920 --> 00:57:39,750
well as the arts what's the best way to

1399
00:57:44,630 --> 00:57:42,930
find a balance between the two yeah

1400
00:57:46,570 --> 00:57:44,640
that's a great question it's one that I

1401
00:57:51,100 --> 00:57:46,580
have definitely had

1402
00:57:53,020 --> 00:57:51,110
address myself you know i so i majored

1403
00:57:54,430 --> 00:57:53,030
in physics i originally actually was

1404
00:57:56,440 --> 00:57:54,440
planning to major in chemistry and

1405
00:57:58,420 --> 00:57:56,450
physics double and then I realized that

1406
00:58:00,390 --> 00:57:58,430
also I needed to eat and sleep during

1407
00:58:03,850 --> 00:58:00,400
the course of you know individual days

1408
00:58:05,590 --> 00:58:03,860
so I ended up just majoring in physics

1409
00:58:07,510 --> 00:58:05,600
and I've always had a like a

1410
00:58:09,520 --> 00:58:07,520
long-standing interest in art and so a

1411
00:58:12,250 --> 00:58:09,530
lot of my for example in college a lot

1412
00:58:13,810 --> 00:58:12,260
of my electives were in painting which

1413
00:58:15,940 --> 00:58:13,820

was the primary art that I was

1414
00:58:18,580 --> 00:58:15,950
practicing during that time you know but

1415
00:58:21,390 --> 00:58:18,590
I would say that because there are a

1416
00:58:24,550 --> 00:58:21,400
limited number of hours in the day that

1417
00:58:26,740 --> 00:58:24,560
making sure to prioritize maintaining an

1418
00:58:28,630 --> 00:58:26,750
artistic practice in whatever way you

1419
00:58:30,730 --> 00:58:28,640
know feels good and important to you

1420
00:58:32,650 --> 00:58:30,740
whether it's you know like it could be

1421
00:58:34,630 --> 00:58:32,660
dance or performance it could be music

1422
00:58:38,590 --> 00:58:34,640
it could be visual art whatever it

1423
00:58:41,230 --> 00:58:38,600
happens to be that maintaining that that

1424
00:58:43,120 --> 00:58:41,240
priority being important to you makes it

1425
00:58:45,640 --> 00:58:43,130
worth making time for but also

1426
00:58:48,700 --> 00:58:45,650
understanding that time management is

1427
00:58:52,900 --> 00:58:48,710
always breathable so you know when I was

1428
00:58:54,730 --> 00:58:52,910
in grad school I actually like was kind

1429
00:58:56,410 --> 00:58:54,740
of midway through grad school was

1430
00:58:58,000 --> 00:58:56,420
approached for I was drawing comics at

1431
00:59:00,370 --> 00:58:58,010
the time and I was like approached for a

1432
00:59:02,650 --> 00:59:00,380
couple potential publishing gigs

1433
00:59:04,570 --> 00:59:02,660
none of which actually panned out which

1434
00:59:06,700 --> 00:59:04,580
in retrospect like I don't know how I

1435
00:59:10,810 --> 00:59:06,710
was thinking I would be in grad school

1436
00:59:12,700 --> 00:59:10,820
and like write a comic full-time also so

1437
00:59:15,670 --> 00:59:12,710
you know like and then when that didn't

1438
00:59:17,170 --> 00:59:15,680

pan out I ended up like redoubling my

1439
00:59:19,210 --> 00:59:17,180
efforts and like having to write my

1440
00:59:20,620 --> 00:59:19,220
thesis and stuff which was completely

1441
00:59:22,810 --> 00:59:20,630
consuming and there were a couple of

1442
00:59:24,640 --> 00:59:22,820
years where I just like wasn't really I

1443
00:59:27,760 --> 00:59:24,650
didn't have any time to do things like

1444
00:59:29,350 --> 00:59:27,770
play music or make art and that didn't

1445
00:59:32,410 --> 00:59:29,360
mean that I like would never do them

1446
00:59:35,140 --> 00:59:32,420
again you know like now I have a much

1447
00:59:37,720 --> 00:59:35,150
more like balanced ability to like

1448
00:59:39,280 --> 00:59:37,730
manage those things in my life but it's

1449
00:59:40,570 --> 00:59:39,290
it has to be flexible you know like

1450
00:59:43,120 --> 00:59:40,580
sometimes you're not going to be able to

1451
00:59:45,070 --> 00:59:43,130
do both you know but as long as you're

1452
00:59:46,780 --> 00:59:45,080
constantly trying to kind of keep it on

1453
00:59:50,200 --> 00:59:46,790
an even keel you'll probably get some

1454
00:59:51,610 --> 00:59:50,210
mix that is satisfying for you wonderful

1455
00:59:53,470 --> 00:59:51,620
wonderful that's a great advice to see

1456
00:59:58,170 --> 00:59:53,480
and you have some perhaps final words of

1457
01:00:02,499 --> 01:00:00,039
don't know stick with

1458
01:00:05,439 --> 01:00:02,509
whatever you're interested in don't let

1459
01:00:08,829 --> 01:00:05,449
anybody pigeonhole you Interdisciplinary

1460
01:00:11,620 --> 01:00:08,839
is great we always end our show as our

1461
01:00:13,509 --> 01:00:11,630
as our moto of staying curious dr.

1462
01:00:14,919 --> 01:00:13,519
Lucien well Kuwait's thank you so much

1463
01:00:16,179 --> 01:00:14,929

for your time

1464
01:00:18,579 --> 01:00:16,189
with being with us today it's been

1465
01:00:19,989 --> 01:00:18,589
absolutely wonderful conversation my

1466
01:00:21,789 --> 01:00:19,999
pleasure thank you so much for having me

1467
01:00:24,279 --> 01:00:21,799
on the show those of you who are

1468
01:00:26,019 --> 01:00:24,289
watching so what science-fiction art and

1469
01:00:28,029 --> 01:00:26,029
other media inspires you to ask

1470
01:00:31,660 --> 01:00:28,039
questions about the universe let us know

1471
01:00:33,309 --> 01:00:31,670
on social media tweet us hashtag us ask

1472
01:00:35,410 --> 01:00:33,319
Esther bio we'd love to hear from you

1473
01:00:37,209 --> 01:00:35,420
thank you all for sharing the show to

1474
01:00:38,709 --> 01:00:37,219
your friends and families we love what

1475
01:00:39,969 --> 01:00:38,719
we do and we hope you enjoyed to let us

1476
01:00:42,729 --> 01:00:39,979
know who you want to have on the show

1477
01:00:44,529 --> 01:00:42,739
and please stay curious since you next

1478
01:00:45,939 --> 01:00:44,539
week and before I end the show I want to

1479
01:00:48,219 --> 01:00:45,949
remind all of you about the background

1480
01:00:50,169 --> 01:00:48,229
quiz there's a new picture every month

1481
01:00:52,359 --> 01:00:50,179
behind myself for either Graham what is

1482
01:00:55,239 --> 01:00:52,369
behind me today will give the answer

1483
01:00:57,820 --> 01:00:55,249
next month on ask ask an astrobiologists