Ask An Astrobiologist

Episode 35: September 29th, 2020

Ravi Kopparapu

NASA Astrobiology Program

1
00:00:00,680 --> 00:00:28,830
[Music]

2
00:00:36,950 --> 00:00:30,520
my

3
00:00:39,270 --> 00:00:36,960
minds

4
00:00:40,549 --> 00:00:39,280
and welcome to ask an astrobiologist the

5
00:00:43,590 --> 00:00:40,559
show where we

6
00:00:45,990 --> 00:00:43,600
honor the science and the scientists

7
00:00:47,830 --> 00:00:46,000
involved in the study of the origins the

8
00:00:49,350 --> 00:00:47,840
evolution and the distribution of life

9
00:00:52,029 --> 00:00:49,360
in the universe

10
00:00:53,590 --> 00:00:52,039
i'm graham lau also known online as the

11
00:00:56,389 --> 00:00:53,600
cosmobiologists

12
00:00:58,709 --> 00:00:56,399
and we are sponsored by saginet.org and

13
00:01:00,709 --> 00:00:58,719

the nasa astrobiology program

14
00:01:03,430 --> 00:01:00,719
and i'm super stoked for today's program

15
00:01:06,070 --> 00:01:03,440
guys uh today's guest is an

16
00:01:07,190 --> 00:01:06,080
expert in exoplanets uh modeling their

17
00:01:08,789 --> 00:01:07,200
habitability

18
00:01:10,789 --> 00:01:08,799
looking for techno signatures and so

19
00:01:11,270 --> 00:01:10,799
much more it's going to be a really

20
00:01:14,310 --> 00:01:11,280
awesome

21
00:01:16,550 --> 00:01:14,320
show but before i introduce him we have

22
00:01:17,749 --> 00:01:16,560
a few people we'd like to recognize

23
00:01:20,310 --> 00:01:17,759
those people who

24
00:01:22,789 --> 00:01:20,320
have supported the show by sharing

25
00:01:24,950 --> 00:01:22,799
retweeting commenting all over twitter

26
00:01:25,990 --> 00:01:24,960
and other places on social media in the

27
00:01:28,630 --> 00:01:26,000
interwebs

28
00:01:29,590 --> 00:01:28,640
so this month we'd like to say a huge

29
00:01:33,830 --> 00:01:29,600
thank you

30
00:01:37,670 --> 00:01:33,840
to kashish gupta delara kylie charslin

31
00:01:39,190 --> 00:01:37,680
anna root mahanti and fernando salazar

32
00:01:40,710 --> 00:01:39,200
thanks to all four of you and to

33
00:01:43,190 --> 00:01:40,720
everyone else who's out there

34
00:01:44,469 --> 00:01:43,200
sharing our show engaging with the

35
00:01:45,749 --> 00:01:44,479
experts who come on ask an

36
00:01:49,350 --> 00:01:45,759
astrobiologist

37
00:01:51,270 --> 00:01:49,360
we really appreciate it now that said

38
00:01:52,710 --> 00:01:51,280

i'd like to introduce our guest for this

39
00:01:55,109 --> 00:01:52,720
month our guest

40
00:01:56,630 --> 00:01:55,119
is a research scientist at nada nasa's

41
00:01:59,510 --> 00:01:56,640
goddard space flight center

42
00:02:00,709 --> 00:01:59,520
his name is dr ravi koparapu uh ravi

43
00:02:02,069 --> 00:02:00,719
thank you very much for joining us and

44
00:02:04,230 --> 00:02:02,079
welcome to the show

45
00:02:05,510 --> 00:02:04,240
thank you grant thank you for having me

46
00:02:06,310 --> 00:02:05,520
yeah i'm definitely glad we could have

47
00:02:08,150 --> 00:02:06,320
you on

48
00:02:09,669 --> 00:02:08,160
uh we recently had jacob hawk mister on

49
00:02:11,670 --> 00:02:09,679
i know the two of you worked together

50
00:02:13,830 --> 00:02:11,680
a lot in the past uh you recently both

51
00:02:16,150 --> 00:02:13,840
worked together on the techno climbs

52
00:02:16,869 --> 00:02:16,160
workshop which we might talk about later

53
00:02:18,229 --> 00:02:16,879
um

54
00:02:20,070 --> 00:02:18,239
one thing i love to have our guests do

55
00:02:21,990 --> 00:02:20,080
when they first come on the show

56
00:02:24,550 --> 00:02:22,000
is to share with us their science

57
00:02:27,030 --> 00:02:24,560
journey uh what really got them into the

58
00:02:28,949 --> 00:02:27,040
sciences and got them into astrobiology

59
00:02:30,470 --> 00:02:28,959
uh what was it for you ravi that brought

60
00:02:32,150 --> 00:02:30,480
you to this place in your life in

61
00:02:35,190 --> 00:02:32,160
astrobiology

62
00:02:38,229 --> 00:02:35,200
so i came to united states in 2000

63
00:02:41,509 --> 00:02:38,239

20 years ago as a phd students to work

64
00:02:44,869 --> 00:02:41,519
on gravitational waves uh with the ligo

65
00:02:46,229 --> 00:02:44,879
observatory and now i guess many of you

66
00:02:49,750 --> 00:02:46,239
probably heard of these

67
00:02:51,190 --> 00:02:49,760
you know lego detections of binary black

68
00:02:54,390 --> 00:02:51,200
holes so

69
00:02:57,270 --> 00:02:54,400
i started my phd with that uh

70
00:02:58,630 --> 00:02:57,280
and i did a postdoc three years after my

71
00:03:00,550 --> 00:02:58,640
um

72
00:03:02,550 --> 00:03:00,560
a phd on the gravitational waves in

73
00:03:05,589 --> 00:03:02,560
gravitational waves as well

74
00:03:09,030 --> 00:03:05,599
during that time i was at penn state

75
00:03:10,550 --> 00:03:09,040
and just after my phd at louisiana state

76
00:03:12,869 --> 00:03:10,560
university which is where one of the

77
00:03:16,830 --> 00:03:12,879
ligo observatories located

78
00:03:18,869 --> 00:03:16,840
um i started getting interested in

79
00:03:20,630 --> 00:03:18,879
exoplanets there was a good reason for

80
00:03:22,949 --> 00:03:20,640
that one

81
00:03:23,990 --> 00:03:22,959
was that you know it was when my mom

82
00:03:26,309 --> 00:03:24,000
asked me hey

83
00:03:27,190 --> 00:03:26,319
what do you do there and it was hard for

84
00:03:30,550 --> 00:03:27,200
me to explain

85
00:03:32,869 --> 00:03:30,560
general relativity for her and you know

86
00:03:33,589 --> 00:03:32,879
so i thought you know i should i should

87
00:03:35,589 --> 00:03:33,599
probably

88
00:03:37,830 --> 00:03:35,599

be able to explain to my mom and then i

89
00:03:40,630 --> 00:03:37,840
would be able to do my work properly

90
00:03:42,390 --> 00:03:40,640
and so it was a great experience working

91
00:03:43,110 --> 00:03:42,400
for ligo and one of the fundamental

92
00:03:46,149 --> 00:03:43,120
things

93
00:03:47,430 --> 00:03:46,159
uh that we can uh observe with these

94
00:03:50,149 --> 00:03:47,440
observatories

95
00:03:51,190 --> 00:03:50,159
to test the gravity and all um but at

96
00:03:53,670 --> 00:03:51,200
that time

97
00:03:54,869 --> 00:03:53,680
i thought that i was so much interested

98
00:03:58,070 --> 00:03:54,879
in exoplanets

99
00:04:01,190 --> 00:03:58,080
than gravitational waves and

100
00:04:03,270 --> 00:04:01,200
my inner trekkie i'm a star trek fan

101
00:04:04,949 --> 00:04:03,280
was pushing out and saying hey you know

102
00:04:05,589 --> 00:04:04,959
there is something out there you can do

103
00:04:08,390 --> 00:04:05,599
better

104
00:04:08,949 --> 00:04:08,400
so then i started i contacted professor

105
00:04:12,149 --> 00:04:08,959
jim

106
00:04:12,550 --> 00:04:12,159
uh casting at penn state and while i was

107
00:04:20,469 --> 00:04:12,560
at

108
00:04:23,189 --> 00:04:20,479
castling

109
00:04:25,030 --> 00:04:23,199
how can i get involved in my research in

110
00:04:26,310 --> 00:04:25,040
your research for the exoplanets he said

111
00:04:27,110 --> 00:04:26,320
you know just come and attend the group

112
00:04:29,670 --> 00:04:27,120
meeting so for

113
00:04:32,230 --> 00:04:29,680

three years of my postdoc i just sat in

114
00:04:35,510 --> 00:04:32,240
the group meetings listening to things

115
00:04:36,390 --> 00:04:35,520
um related exoplanets and started slowly

116
00:04:39,110 --> 00:04:36,400
working up

117
00:04:40,070 --> 00:04:39,120
on on the exoplanet field at the end of

118
00:04:43,030 --> 00:04:40,080
my post talk

119
00:04:44,150 --> 00:04:43,040
uh at penn state uh in the gravitational

120
00:04:46,310 --> 00:04:44,160
wave group

121
00:04:47,189 --> 00:04:46,320
i ran out of funding and i was this

122
00:04:49,189 --> 00:04:47,199
close to

123
00:04:51,110 --> 00:04:49,199
going out of the country because i'm

124
00:04:53,110 --> 00:04:51,120
gonna be i was on a visa then

125
00:04:54,469 --> 00:04:53,120
and so jim said you know what why don't

126
00:04:57,909 --> 00:04:54,479
you just come and join us

127
00:05:00,310 --> 00:04:57,919
and see you know what you can do and

128
00:05:01,830 --> 00:05:00,320
and you know from then onwards i started

129
00:05:05,110 --> 00:05:01,840
working on exoplanets

130
00:05:07,430 --> 00:05:05,120
uh yeah that was how it started wow it's

131
00:05:08,629 --> 00:05:07,440
incredible i love that story so much

132
00:05:10,550 --> 00:05:08,639
that you were just intrigued enough to

133
00:05:11,990 --> 00:05:10,560
keep going to the lab meetings and then

134
00:05:13,110 --> 00:05:12,000
it led you into your career where you

135
00:05:14,310 --> 00:05:13,120
are now i think that's a good thing for

136
00:05:16,150 --> 00:05:14,320
our listeners who are

137
00:05:17,909 --> 00:05:16,160
interested in various areas of research

138
00:05:18,629 --> 00:05:17,919

just just go sit on lab meetings if you

139
00:05:20,230 --> 00:05:18,639
can

140
00:05:22,070 --> 00:05:20,240
go talk to people it might be the next

141
00:05:24,070 --> 00:05:22,080
big thing in your career

142
00:05:26,629 --> 00:05:24,080
and so a lot of your career now if i'm

143
00:05:28,550 --> 00:05:26,639
correct is in modeling the habitability

144
00:05:29,189 --> 00:05:28,560
of of exoplanets can you speak a bit

145
00:05:30,950 --> 00:05:29,199
about

146
00:05:32,469 --> 00:05:30,960
maybe like a day in the life of dr

147
00:05:34,150 --> 00:05:32,479
koparapu and what kind of research

148
00:05:37,189 --> 00:05:34,160
you're currently doing

149
00:05:39,749 --> 00:05:37,199
so yes so um we work on

150
00:05:40,950 --> 00:05:39,759
right now i'm i have several projects on

151
00:05:43,189 --> 00:05:40,960
the habitability not just the

152
00:05:43,510 --> 00:05:43,199
habitability of exoplanets also to find

153
00:05:44,950 --> 00:05:43,520
out

154
00:05:47,110 --> 00:05:44,960
you know what kind of atmospheres

155
00:05:50,950 --> 00:05:47,120
exoplanets may have

156
00:05:53,510 --> 00:05:50,960
uh and so in the in the mornings i

157
00:05:55,110 --> 00:05:53,520
uh you know i start with uh trying to

158
00:05:57,029 --> 00:05:55,120
catch up with my email trying to get

159
00:05:58,550 --> 00:05:57,039
them you know answer some questions from

160
00:06:01,590 --> 00:05:58,560
students in postdocs

161
00:06:04,629 --> 00:06:01,600
uh and uh work that i usually

162
00:06:08,550 --> 00:06:04,639
uh i usually keep some time for

163
00:06:09,189 --> 00:06:08,560

my own signs and so i block my calendar

164
00:06:10,710 --> 00:06:09,199
so and

165
00:06:12,390 --> 00:06:10,720
saying that you know i'm busy during

166
00:06:13,990 --> 00:06:12,400
that time to focus on the

167
00:06:15,830 --> 00:06:14,000
science that i want to do one of the

168
00:06:19,110 --> 00:06:15,840
things that i'm currently working on

169
00:06:21,990 --> 00:06:19,120
is on trying to see

170
00:06:22,309 --> 00:06:22,000
what kind of atmospheric uh compositions

171
00:06:25,270 --> 00:06:22,319
uh

172
00:06:26,150 --> 00:06:25,280
planets around cool stars m dwarf stars

173
00:06:28,790 --> 00:06:26,160
um

174
00:06:30,070 --> 00:06:28,800
may have and uh i'm writing a paper

175
00:06:32,870 --> 00:06:30,080
right now with jacob

176
00:06:36,150 --> 00:06:32,880
by the way on techno signatures how

177
00:06:38,230 --> 00:06:36,160
nitrogen dioxide can be used as a

178
00:06:39,830 --> 00:06:38,240
signature for a industrialized

179
00:06:42,150 --> 00:06:39,840
technological civilization

180
00:06:43,909 --> 00:06:42,160
and how future observatories are coming

181
00:06:46,390 --> 00:06:43,919
up observatories can

182
00:06:48,390 --> 00:06:46,400
use we can use them and figure out if

183
00:06:49,189 --> 00:06:48,400
there is a alien civilization out there

184
00:06:52,070 --> 00:06:49,199
so

185
00:06:53,110 --> 00:06:52,080
that's uh that's uh that's how i we keep

186
00:06:54,870 --> 00:06:53,120
working on

187
00:06:56,710 --> 00:06:54,880
that's excellent yeah and we'll talk

188
00:06:58,309 --> 00:06:56,720

about techno signatures a bunch here in

189
00:07:00,150 --> 00:06:58,319
a short bit but you did mention

190
00:07:01,749 --> 00:07:00,160
uh upcoming telescopes so i think it's

191
00:07:03,270 --> 00:07:01,759
important that we really have an idea of

192
00:07:04,790 --> 00:07:03,280
what the future looks like

193
00:07:06,070 --> 00:07:04,800
for this research and i know you've done

194
00:07:07,029 --> 00:07:06,080
some work with the origin space

195
00:07:08,150 --> 00:07:07,039
telescope

196
00:07:09,990 --> 00:07:08,160
i wonder if you can just give us a

197
00:07:11,270 --> 00:07:10,000
little view of that space telescope and

198
00:07:13,270 --> 00:07:11,280
maybe some of these other

199
00:07:15,110 --> 00:07:13,280
potential upcoming space telescopes and

200
00:07:17,589 --> 00:07:15,120
what they mean for this research

201
00:07:19,270 --> 00:07:17,599
right so i'm actually involved in two i

202
00:07:22,309 --> 00:07:19,280
was involved in the two

203
00:07:24,390 --> 00:07:22,319
uh mission concepts one was luar which i

204
00:07:27,029 --> 00:07:24,400
was heavily a little bit more involved

205
00:07:30,070 --> 00:07:27,039
than the origin space telescopes

206
00:07:32,309 --> 00:07:30,080
um so the luad space telescope

207
00:07:33,350 --> 00:07:32,319
again these are the there are four

208
00:07:37,990 --> 00:07:33,360
decadal missions

209
00:07:42,309 --> 00:07:38,000
uh concept studies so every 10 years

210
00:07:45,350 --> 00:07:42,319
nasa commissions a community-led

211
00:07:48,629 --> 00:07:45,360
group that will uh

212
00:07:52,150 --> 00:07:48,639
read in uh the community recommended uh

213
00:07:54,309 --> 00:07:52,160

science cases and mission uh proposals

214
00:07:56,469 --> 00:07:54,319
to see which one they would uh

215
00:07:57,110 --> 00:07:56,479
prioritize nasa should prioritize for

216
00:07:59,430 --> 00:07:57,120
the next

217
00:08:00,869 --> 00:07:59,440
coming decade so james webb space

218
00:08:03,749 --> 00:08:00,879
telescope was one of that

219
00:08:06,070 --> 00:08:03,759
hubble was one of that back in the 70s

220
00:08:08,550 --> 00:08:06,080
uh switzer space telescope and so on

221
00:08:09,990 --> 00:08:08,560
and and for this decade uh the roman

222
00:08:10,869 --> 00:08:10,000
space telescope by the way was uh

223
00:08:14,070 --> 00:08:10,879
recommended

224
00:08:16,869 --> 00:08:14,080
for um which is a w4e pass

225
00:08:17,270 --> 00:08:16,879
you you used to call that w first and

226
00:08:20,550 --> 00:08:17,280
which

227
00:08:22,309 --> 00:08:20,560
is supposed to be launched in 2025 or so

228
00:08:23,990 --> 00:08:22,319
so for this decade there are four

229
00:08:27,830 --> 00:08:24,000
mission concepts that

230
00:08:30,550 --> 00:08:27,840
uh were proposed one of them was luar

231
00:08:31,350 --> 00:08:30,560
and habex habitable uh exoplanet

232
00:08:34,550 --> 00:08:31,360
emission

233
00:08:37,509 --> 00:08:34,560
luart's full form is large uv

234
00:08:40,070 --> 00:08:37,519
uh ultraviolet uh infrared optical of

235
00:08:42,630 --> 00:08:40,080
optical infrared telescope uh

236
00:08:43,670 --> 00:08:42,640
and then the other one is havex

237
00:08:46,389 --> 00:08:43,680
habitable exoplanet

238
00:08:48,310 --> 00:08:46,399

imaging mission the third one is the ost

239
00:08:49,990 --> 00:08:48,320
that's the origin space telescope

240
00:08:51,350 --> 00:08:50,000
and the fourth one is called lynx which

241
00:08:53,110 --> 00:08:51,360
is an x-ray telescope

242
00:08:54,630 --> 00:08:53,120
so the first three missions are the ones

243
00:08:57,910 --> 00:08:54,640
that are more relevant

244
00:09:00,710 --> 00:08:57,920
for um intense uh

245
00:09:01,190 --> 00:09:00,720
exoplanet observations links also does

246
00:09:03,990 --> 00:09:01,200
some

247
00:09:04,949 --> 00:09:04,000
but we will focus mostly on these three

248
00:09:08,150 --> 00:09:04,959
telescopes

249
00:09:10,389 --> 00:09:08,160
so i was involved more in luvar and

250
00:09:11,509 --> 00:09:10,399
origin space telescope i was in the

251
00:09:14,630 --> 00:09:11,519
working groups and

252
00:09:17,670 --> 00:09:14,640
science analyzing teams and

253
00:09:19,509 --> 00:09:17,680
luar is a 15 meter class telescope there

254
00:09:21,509 --> 00:09:19,519
are two mission concepts for that

255
00:09:22,949 --> 00:09:21,519
again i'm calling them as concepts

256
00:09:25,670 --> 00:09:22,959
because the decadal

257
00:09:26,389 --> 00:09:25,680
process is still going on we will know

258
00:09:29,750 --> 00:09:26,399
which one

259
00:09:33,910 --> 00:09:29,760
they will prioritize next year and so

260
00:09:35,670 --> 00:09:33,920
luwar is has two concepts one is a 15

261
00:09:35,990 --> 00:09:35,680
meter class telescope one is an eight

262
00:09:38,550 --> 00:09:36,000
meter

263
00:09:41,350 --> 00:09:38,560

class telescope just to give you an idea

264
00:09:44,230 --> 00:09:41,360
hubble is a 2.4 meter class telescope

265
00:09:45,430 --> 00:09:44,240
and james webb is a 6.4 meter so we are

266
00:09:48,870 --> 00:09:45,440
talking you know

267
00:09:51,269 --> 00:09:48,880
five times however double the size of uh

268
00:09:53,110 --> 00:09:51,279
james webb space telescope because in

269
00:09:55,030 --> 00:09:53,120
astronomy we need a light bucket

270
00:09:56,870 --> 00:09:55,040
we need to collect everything we know is

271
00:09:58,790 --> 00:09:56,880
through the light coming from the stars

272
00:10:01,110 --> 00:09:58,800
and so we need a bigger bucket and

273
00:10:03,190 --> 00:10:01,120
that's why we were trying to do this

274
00:10:04,470 --> 00:10:03,200
with origin space telescope it's also

275
00:10:07,350 --> 00:10:04,480
about um

276
00:10:08,150 --> 00:10:07,360
i think around nine meter class

277
00:10:09,670 --> 00:10:08,160
telescope

278
00:10:12,230 --> 00:10:09,680
which is uh which operates in the

279
00:10:13,990 --> 00:10:12,240
infrared part of the spectrum more than

280
00:10:15,750 --> 00:10:14,000
a luar which operates in the u

281
00:10:18,470 --> 00:10:15,760
ultraviolet invisible

282
00:10:19,990 --> 00:10:18,480
and so i you know we worked on trying to

283
00:10:22,069 --> 00:10:20,000
see what kind of atmospheres you can

284
00:10:24,710 --> 00:10:22,079
detect with what signal to noise ratio

285
00:10:26,389 --> 00:10:24,720
and things like that well that brings me

286
00:10:27,670 --> 00:10:26,399
a good point then too

287
00:10:29,190 --> 00:10:27,680
a lot of people have heard that we're

288
00:10:31,350 --> 00:10:29,200

looking for signs of life looking for

289
00:10:32,790 --> 00:10:31,360
biosignatures on exoplanets

290
00:10:34,150 --> 00:10:32,800
but i think a lot of people don't really

291
00:10:35,269 --> 00:10:34,160
realize that what we're looking at is

292
00:10:37,590 --> 00:10:35,279
that little bit of light

293
00:10:39,430 --> 00:10:37,600
passing through the atmosphere of the

294
00:10:41,190 --> 00:10:39,440
exit planet and coming to us

295
00:10:43,110 --> 00:10:41,200
uh so so what does the future look like

296
00:10:43,990 --> 00:10:43,120
for actually understanding atmospheric

297
00:10:45,509 --> 00:10:44,000
chemistry

298
00:10:47,190 --> 00:10:45,519
are these space telescopes really going

299
00:10:49,110 --> 00:10:47,200
to open up a whole new world of looking

300
00:10:50,949 --> 00:10:49,120
for signs of life in these worlds and

301
00:10:52,310 --> 00:10:50,959
what's that look like for you an

302
00:10:54,470 --> 00:10:52,320
excellent question because

303
00:10:55,509 --> 00:10:54,480
uh that is exactly what these telescopes

304
00:10:57,509 --> 00:10:55,519
are designed to do

305
00:10:59,110 --> 00:10:57,519
to detect the light coming reflected

306
00:11:00,949 --> 00:10:59,120
light or the emitted light

307
00:11:02,150 --> 00:11:00,959
from the planet the heat coming from the

308
00:11:03,590 --> 00:11:02,160
planet also

309
00:11:05,670 --> 00:11:03,600
will be in the infrared part of the

310
00:11:08,790 --> 00:11:05,680
spectrum just like our body heats if you

311
00:11:11,910 --> 00:11:08,800
you know use an infrared instrument

312
00:11:14,710 --> 00:11:11,920
and so in the future lure

313
00:11:14,949 --> 00:11:14,720

havocs can operate in the ultraviolet

314
00:11:17,110 --> 00:11:14,959
and

315
00:11:18,230 --> 00:11:17,120
visual part origin space telescope can

316
00:11:19,590 --> 00:11:18,240
do that in the infrared part of the

317
00:11:21,509 --> 00:11:19,600
spectrum james webb

318
00:11:22,870 --> 00:11:21,519
is coming up by the way and then

319
00:11:24,870 --> 00:11:22,880
hopefully next year

320
00:11:25,910 --> 00:11:24,880
uh that's also in the infrared part of

321
00:11:28,790 --> 00:11:25,920
the spectrum

322
00:11:30,550 --> 00:11:28,800
uh and and we will be able to figure out

323
00:11:31,990 --> 00:11:30,560
look at the atmospheres of these planets

324
00:11:32,470 --> 00:11:32,000
like coming through the atmospheres of

325
00:11:34,230 --> 00:11:32,480
planets

326
00:11:35,750 --> 00:11:34,240
to see what kind of chemical uh

327
00:11:39,190 --> 00:11:35,760
fingerprints are there

328
00:11:42,230 --> 00:11:39,200
one thing i would say is um um

329
00:11:45,430 --> 00:11:42,240
we have to be ready for a surprise

330
00:11:48,949 --> 00:11:45,440
whenever we point any new instrument

331
00:11:51,829 --> 00:11:48,959
into the universe and we look in there

332
00:11:54,150 --> 00:11:51,839
we always are surprised to find things

333
00:11:54,949 --> 00:11:54,160
that we have no idea how they came out

334
00:11:57,110 --> 00:11:54,959
to be

335
00:11:59,030 --> 00:11:57,120
but i'll just to give you an example the

336
00:12:02,150 --> 00:11:59,040
cosmic microwave background

337
00:12:03,590 --> 00:12:02,160
you know how big bang was uh became the

338
00:12:05,829 --> 00:12:03,600

evidence for a big bang

339
00:12:07,910 --> 00:12:05,839
you know they were trying to you know

340
00:12:08,550 --> 00:12:07,920
remove the noise background noise coming

341
00:12:10,470 --> 00:12:08,560
from these

342
00:12:11,590 --> 00:12:10,480
pensions and wilson they were the ones

343
00:12:13,670 --> 00:12:11,600
who detected this

344
00:12:14,870 --> 00:12:13,680
trying to remove the noise and and they

345
00:12:16,710 --> 00:12:14,880
slowly figured out

346
00:12:17,990 --> 00:12:16,720
you know we can't remove this this is

347
00:12:19,430 --> 00:12:18,000
something else

348
00:12:21,990 --> 00:12:19,440
and so basically they were trying to

349
00:12:24,230 --> 00:12:22,000
like clear bird poo

350
00:12:25,990 --> 00:12:24,240
antenna right yeah so so when you are

351
00:12:27,269 --> 00:12:26,000
pointing a new instrument to the

352
00:12:28,870 --> 00:12:27,279
universe

353
00:12:30,389 --> 00:12:28,880
you have to get ready for something

354
00:12:32,230 --> 00:12:30,399
unusual to

355
00:12:33,750 --> 00:12:32,240
uh to be discovered the same thing

356
00:12:35,269 --> 00:12:33,760
happened with the pulsars

357
00:12:37,990 --> 00:12:35,279
you know they were they they got this

358
00:12:39,269 --> 00:12:38,000
periodic pulses from some part in the

359
00:12:40,949 --> 00:12:39,279
sky and they thought they're coming from

360
00:12:43,269 --> 00:12:40,959
alien civilization who

361
00:12:44,870 --> 00:12:43,279
sense you know regular pulses in the

362
00:12:46,870 --> 00:12:44,880
nature right so

363
00:12:49,269 --> 00:12:46,880

so we have to be ready for a decent

364
00:12:50,949 --> 00:12:49,279
surprise i would say with uh james webb

365
00:12:52,389 --> 00:12:50,959
yeah i love that point i mean i think

366
00:12:53,110 --> 00:12:52,399
it's important for everyone to remember

367
00:12:54,949 --> 00:12:53,120
that we've

368
00:12:56,470 --> 00:12:54,959
we've learned so much about the cosmos

369
00:12:57,350 --> 00:12:56,480
already but there's still so much we

370
00:12:59,030 --> 00:12:57,360
don't know

371
00:13:01,350 --> 00:12:59,040
and yeah we're always open to surprises

372
00:13:03,350 --> 00:13:01,360
i mean in our lifetimes alone we've now

373
00:13:04,310 --> 00:13:03,360
discovered that exoplanets do exist that

374
00:13:05,990 --> 00:13:04,320
we actually can

375
00:13:07,990 --> 00:13:06,000
confirm their presence as a kid you know

376
00:13:09,590 --> 00:13:08,000
we didn't have that information

377
00:13:11,110 --> 00:13:09,600
um but you also you also bring up that

378
00:13:12,949 --> 00:13:11,120
point i'd like to actually get to we

379
00:13:14,949 --> 00:13:12,959
actually had a twitter poll yesterday

380
00:13:17,030 --> 00:13:14,959
from nasa astrobiology i'd like to bring

381
00:13:20,710 --> 00:13:17,040
up uh we asked everyone

382
00:13:22,230 --> 00:13:20,720
uh online uh which kind of worlds might

383
00:13:24,629 --> 00:13:22,240
be the most likely to be

384
00:13:26,389 --> 00:13:24,639
inhabited and currently we hear a lot

385
00:13:28,230 --> 00:13:26,399
about planets in this

386
00:13:29,750 --> 00:13:28,240
uh some call it a habitable zone i

387
00:13:31,190 --> 00:13:29,760
personally prefer goldilocks zone for

388
00:13:32,949 --> 00:13:31,200

liquid water

389
00:13:35,430 --> 00:13:32,959
but in this region around a star where

390
00:13:37,269 --> 00:13:35,440
liquid water could potentially be

391
00:13:39,670 --> 00:13:37,279
stable at the surface of a terrestrial

392
00:13:40,389 --> 00:13:39,680
world i'm curious before we share the

393
00:13:41,910 --> 00:13:40,399
poll

394
00:13:43,990 --> 00:13:41,920
uh what your answer might be what kind

395
00:13:46,230 --> 00:13:44,000
of worlds do you think we'll discover

396
00:13:47,670 --> 00:13:46,240
are most likely to be inhabited if there

397
00:13:49,350 --> 00:13:47,680
is life out there

398
00:13:51,350 --> 00:13:49,360
okay i'm going to give you a very short

399
00:13:54,870 --> 00:13:51,360
answer and i'm going to give you a very

400
00:13:57,430 --> 00:13:54,880
um um not long answer okay it's

401
00:13:59,590 --> 00:13:57,440
so the very short answer personally i

402
00:14:02,629 --> 00:13:59,600
think because of our instruments

403
00:14:04,790 --> 00:14:02,639
uh if you're asking how which

404
00:14:06,949 --> 00:14:04,800
objects we would be able to detect i

405
00:14:08,710 --> 00:14:06,959
would probably say

406
00:14:10,310 --> 00:14:08,720
habitable zone planets because those

407
00:14:11,030 --> 00:14:10,320
those are the kind of instruments we are

408
00:14:14,389 --> 00:14:11,040
building

409
00:14:16,790 --> 00:14:14,399
to be sensitive to if you are asking

410
00:14:17,910 --> 00:14:16,800
forget the detectability what are the

411
00:14:20,389 --> 00:14:17,920
locations you think

412
00:14:22,470 --> 00:14:20,399
are the have most likely to be habitable

413
00:14:23,670 --> 00:14:22,480

i'd say any place where there is a

414
00:14:27,670 --> 00:14:23,680
decent

415
00:14:31,350 --> 00:14:27,680
pressure range

416
00:14:33,509 --> 00:14:31,360
and have a you know a stable environment

417
00:14:34,870 --> 00:14:33,519
that's where it you know life is very

418
00:14:37,430 --> 00:14:34,880
resilient it

419
00:14:38,230 --> 00:14:37,440
you know it might uh occur on comets

420
00:14:40,870 --> 00:14:38,240
going

421
00:14:42,550 --> 00:14:40,880
uh orbiting the sun so my first priority

422
00:14:45,590 --> 00:14:42,560
would be the habitable zone

423
00:14:46,389 --> 00:14:45,600
uh earth-like planets and the other

424
00:14:49,990 --> 00:14:46,399
thing is that

425
00:14:52,949 --> 00:14:50,000
um the a little bit short answer is a

426
00:14:53,269 --> 00:14:52,959
little bit longer answer is uh we have

427
00:14:57,990 --> 00:14:53,279
to

428
00:14:59,990 --> 00:14:58,000
astronomy or in science

429
00:15:01,509 --> 00:15:00,000
there was always the case many many

430
00:15:04,150 --> 00:15:01,519
times it happened

431
00:15:05,430 --> 00:15:04,160
that we detect the most weirdest things

432
00:15:07,509 --> 00:15:05,440
first

433
00:15:09,509 --> 00:15:07,519
and because they are the most loudest

434
00:15:12,389 --> 00:15:09,519
things that you will notice

435
00:15:13,590 --> 00:15:12,399
and so when we are going to find life

436
00:15:15,509 --> 00:15:13,600
for the first time

437
00:15:17,590 --> 00:15:15,519
i bet it's going to be one of the

438
00:15:18,150 --> 00:15:17,600

weirdest things we probably not imagined

439
00:15:19,670 --> 00:15:18,160
at the

440
00:15:21,990 --> 00:15:19,680
in the location that we have never

441
00:15:24,230 --> 00:15:22,000
thought should i should be there

442
00:15:26,710 --> 00:15:24,240
and so for example that the first

443
00:15:28,710 --> 00:15:26,720
exoplanets discovered around pulsars

444
00:15:30,389 --> 00:15:28,720
and alex wilsham from penn state who

445
00:15:30,710 --> 00:15:30,399
discovered them he was not even looking

446
00:15:32,949 --> 00:15:30,720
for

447
00:15:34,550 --> 00:15:32,959
planets he was he's a radio astronomer

448
00:15:35,030 --> 00:15:34,560
he was looking at pulsars and he found

449
00:15:36,870 --> 00:15:35,040
these

450
00:15:38,310 --> 00:15:36,880
planets orbiting them now who would

451
00:15:41,430 --> 00:15:38,320
expect planets

452
00:15:42,949 --> 00:15:41,440
around a dead exploding star right and

453
00:15:45,110 --> 00:15:42,959
so the same thing with the

454
00:15:47,269 --> 00:15:45,120
you know um i was telling about the

455
00:15:50,230 --> 00:15:47,279
cosmic microwave background radiation

456
00:15:50,550 --> 00:15:50,240
we would find that so the most weirdest

457
00:15:55,030 --> 00:15:50,560
one

458
00:15:56,790 --> 00:15:55,040
will find so

459
00:15:58,629 --> 00:15:56,800
i bet that's where we were going to find

460
00:16:00,150 --> 00:15:58,639
the surprises for life

461
00:16:01,670 --> 00:16:00,160
nice i love that idea i'm going to hold

462
00:16:02,790 --> 00:16:01,680
you to that too um

463
00:16:04,310 --> 00:16:02,800

it'd be kind of cool though right like

464
00:16:05,110 --> 00:16:04,320
maybe there's a whole party of life

465
00:16:07,110 --> 00:16:05,120
going on

466
00:16:08,790 --> 00:16:07,120
but we'll first see like the party clown

467
00:16:10,230 --> 00:16:08,800
doing all the doing all the cool stuff

468
00:16:12,790 --> 00:16:10,240
but then there's this whole other other

469
00:16:14,710 --> 00:16:12,800
thing of life going on i love that idea

470
00:16:16,230 --> 00:16:14,720
real quick to share for our audience for

471
00:16:17,990 --> 00:16:16,240
those who did fill out the poll on the

472
00:16:19,269 --> 00:16:18,000
nasa astrobiology twitter account

473
00:16:22,629 --> 00:16:19,279
yesterday

474
00:16:24,790 --> 00:16:22,639
we had 34 said planets within this this

475
00:16:28,069 --> 00:16:24,800
goldilocks zone for liquid water

476
00:16:31,590 --> 00:16:28,079
uh but actually the winner by 42 percent

477
00:16:34,069 --> 00:16:31,600
were ocean moons of planets uh and so

478
00:16:37,910 --> 00:16:34,079
user juan nunez esposito

479
00:16:40,629 --> 00:16:37,920
uh at january sb uh said enceladus

480
00:16:41,509 --> 00:16:40,639
europa titan maybe ganymede triton and

481
00:16:44,150 --> 00:16:41,519
ceres

482
00:16:45,910 --> 00:16:44,160
uh and so a lot of potential moons which

483
00:16:47,269 --> 00:16:45,920
is intriguing right if those worlds are

484
00:16:48,069 --> 00:16:47,279
inhabited maybe they're just harder to

485
00:16:49,829 --> 00:16:48,079
find

486
00:16:51,189 --> 00:16:49,839
and so maybe yeah maybe you're right

487
00:16:53,350 --> 00:16:51,199
maybe we'll find

488
00:16:54,470 --> 00:16:53,360

life in in this habitable zone or in the

489
00:16:55,829 --> 00:16:54,480
goldilocks zone

490
00:16:58,550 --> 00:16:55,839
or as some have called it the temperate

491
00:17:00,389 --> 00:16:58,560
zone um but that won't be the primary

492
00:17:03,030 --> 00:17:00,399
form of life out there that's really

493
00:17:04,390 --> 00:17:03,040
intriguing to think about and also so

494
00:17:05,110 --> 00:17:04,400
your answer also kind of makes me think

495
00:17:06,630 --> 00:17:05,120
then and

496
00:17:08,870 --> 00:17:06,640
and it's a good time now to talk about

497
00:17:10,710 --> 00:17:08,880
techno signatures uh these signs of

498
00:17:11,429 --> 00:17:10,720
technological activity that we see out

499
00:17:13,029 --> 00:17:11,439
there

500
00:17:14,630 --> 00:17:13,039
uh in the universe because maybe we'll

501
00:17:15,909 --> 00:17:14,640
find that first then if you're right

502
00:17:18,309 --> 00:17:15,919
maybe that's the weird

503
00:17:19,429 --> 00:17:18,319
the weird stuff we'll find first uh i

504
00:17:20,870 --> 00:17:19,439
wonder if you can just just for our

505
00:17:22,789 --> 00:17:20,880
audience give us like

506
00:17:24,309 --> 00:17:22,799
your view of what the search for techno

507
00:17:27,029 --> 00:17:24,319
signatures uh is and

508
00:17:27,429 --> 00:17:27,039
where that research is right now right

509
00:17:30,549 --> 00:17:27,439
so

510
00:17:32,710 --> 00:17:30,559
just uh like you know how uh

511
00:17:34,710 --> 00:17:32,720
earth's history earth was not the same

512
00:17:36,870 --> 00:17:34,720
had did not have the same composition of

513
00:17:39,029 --> 00:17:36,880

atmosphere we didn't have oxygen 2.7

514
00:17:42,070 --> 00:17:39,039
billion years ago it was all methane

515
00:17:44,070 --> 00:17:42,080
and carbon dioxide and now we have

516
00:17:46,390 --> 00:17:44,080
oxygen in the atmosphere the oxygen

517
00:17:48,870 --> 00:17:46,400
dominated atmosphere similarly

518
00:17:49,669 --> 00:17:48,880
uh techno signatures technical

519
00:17:51,830 --> 00:17:49,679
signatures

520
00:17:53,590 --> 00:17:51,840
from technological civilizations when i

521
00:17:55,669 --> 00:17:53,600
say technological civilizations

522
00:17:58,070 --> 00:17:55,679
it could be anything you know it doesn't

523
00:18:00,390 --> 00:17:58,080
need to be the hollywood fantasies of

524
00:18:01,669 --> 00:18:00,400
uh highly advanced civilization it need

525
00:18:04,470 --> 00:18:01,679
not be just them

526
00:18:05,190 --> 00:18:04,480
it could also be our level of technology

527
00:18:08,549 --> 00:18:05,200
or maybe

528
00:18:11,669 --> 00:18:08,559
less advanced technology as well and so

529
00:18:12,070 --> 00:18:11,679
when these are they emit in they could

530
00:18:13,669 --> 00:18:12,080
be

531
00:18:15,669 --> 00:18:13,679
signatures of these low-level

532
00:18:19,110 --> 00:18:15,679
technological civilizations as well

533
00:18:21,029 --> 00:18:19,120
and so there is a community now uh

534
00:18:23,350 --> 00:18:21,039
that we are trying to build and it's

535
00:18:24,789 --> 00:18:23,360
already there uh city which is a service

536
00:18:25,750 --> 00:18:24,799
for extraterrestrial intelligence the

537
00:18:27,270 --> 00:18:25,760
radio city

538
00:18:28,789 --> 00:18:27,280

have already been doing this for the

539
00:18:31,110 --> 00:18:28,799
past many decades

540
00:18:32,870 --> 00:18:31,120
but now we can expand it into other

541
00:18:35,029 --> 00:18:32,880
areas of our city not just

542
00:18:37,110 --> 00:18:35,039
radio city we can look in the optical

543
00:18:37,909 --> 00:18:37,120
city we can look in the atmospheric

544
00:18:40,630 --> 00:18:37,919
setting

545
00:18:41,669 --> 00:18:40,640
uh and then you know things like that we

546
00:18:43,510 --> 00:18:41,679
have more options

547
00:18:44,950 --> 00:18:43,520
so we have to look everywhere because we

548
00:18:47,029 --> 00:18:44,960
don't know

549
00:18:49,430 --> 00:18:47,039
what we will find when we try to look

550
00:18:51,750 --> 00:18:49,440
them like as you know like you mentioned

551
00:18:53,430 --> 00:18:51,760
when we point something we might uh

552
00:18:55,750 --> 00:18:53,440
discard a technological civilization

553
00:18:57,510 --> 00:18:55,760
first before a biosignature detection

554
00:18:59,029 --> 00:18:57,520
now how cool is that i would love to do

555
00:19:01,750 --> 00:18:59,039
you know to have that

556
00:19:02,390 --> 00:19:01,760
but you know we should be ready for that

557
00:19:04,630 --> 00:19:02,400
yeah

558
00:19:06,549 --> 00:19:04,640
uh so a fun question then do you think

559
00:19:09,029 --> 00:19:06,559
that that because there could be an

560
00:19:10,789 --> 00:19:09,039
existential risk to our species

561
00:19:12,789 --> 00:19:10,799
if if we end up having some

562
00:19:14,310 --> 00:19:12,799
technologically advanced neighbors

563
00:19:16,549 --> 00:19:14,320

uh do you think we all should also

564
00:19:19,590 --> 00:19:16,559
should start preparing ourselves

565
00:19:20,870 --> 00:19:19,600
uh around the world internationally for

566
00:19:22,310 --> 00:19:20,880
you know what to do if we find

567
00:19:23,750 --> 00:19:22,320
extraterrestrial life or if

568
00:19:25,110 --> 00:19:23,760
extraterrestrial life arrives on our

569
00:19:27,830 --> 00:19:25,120
doorstep

570
00:19:29,830 --> 00:19:27,840
i think uh there are some groups who are

571
00:19:32,310 --> 00:19:29,840
uh devising protocols

572
00:19:33,909 --> 00:19:32,320
what if we have uh contact with an

573
00:19:35,830 --> 00:19:33,919
extraterrestrial civilization

574
00:19:37,110 --> 00:19:35,840
what should we do it depends upon what

575
00:19:39,750 --> 00:19:37,120
kind of

576
00:19:41,430 --> 00:19:39,760
contact it would be until now it was all

577
00:19:43,190 --> 00:19:41,440
radio city let's say if we receive a

578
00:19:45,510 --> 00:19:43,200
communication from someone how do we

579
00:19:48,549 --> 00:19:45,520
respond or if we have to respond that's

580
00:19:50,789 --> 00:19:48,559
that was the idea but what if we

581
00:19:53,029 --> 00:19:50,799
discover something if they are doing

582
00:19:53,350 --> 00:19:53,039
their own thing but we just discovered

583
00:19:55,750 --> 00:19:53,360
that

584
00:19:57,270 --> 00:19:55,760
they are over there based on some you

585
00:19:59,029 --> 00:19:57,280
know atmospheric signatures or maybe

586
00:20:00,630 --> 00:19:59,039
they build a mega structure and so we

587
00:20:01,430 --> 00:20:00,640
can see that structure going around the

588
00:20:04,149 --> 00:20:01,440

star

589
00:20:04,789 --> 00:20:04,159
uh in transit observations or something

590
00:20:06,870 --> 00:20:04,799
so

591
00:20:09,830 --> 00:20:06,880
we should have those kind of protocols

592
00:20:11,830 --> 00:20:09,840
so i'm i i think i'm pretty sure

593
00:20:12,950 --> 00:20:11,840
there are some groups who are devising

594
00:20:14,630 --> 00:20:12,960
these protocols

595
00:20:16,630 --> 00:20:14,640
and trying to see how to communicate

596
00:20:19,990 --> 00:20:16,640
with the public if we discover

597
00:20:22,549 --> 00:20:20,000
such uh you know completely existential

598
00:20:23,669 --> 00:20:22,559
uh answering a question like you know

599
00:20:26,470 --> 00:20:23,679
are we alone

600
00:20:28,070 --> 00:20:26,480
we probably are not and so it would be

601
00:20:31,270 --> 00:20:28,080
good to have that discussion

602
00:20:33,190 --> 00:20:31,280
and have this idea that you know much

603
00:20:34,390 --> 00:20:33,200
more prevalent and spreading to the

604
00:20:36,789 --> 00:20:34,400
public that

605
00:20:38,390 --> 00:20:36,799
even if we discover what we would do and

606
00:20:41,590 --> 00:20:38,400
what it means to

607
00:20:43,750 --> 00:20:41,600
our you know belief systems and our

608
00:20:44,950 --> 00:20:43,760
societal systems our sociological

609
00:20:47,190 --> 00:20:44,960
systems how do we

610
00:20:48,390 --> 00:20:47,200
change and what impact it has so it

611
00:20:49,590 --> 00:20:48,400
would be good to have that kind of a

612
00:20:52,789 --> 00:20:49,600
conversation with uh

613
00:20:53,990 --> 00:20:52,799

with a lot of people yeah awesome yeah i

614
00:20:55,430 --> 00:20:54,000
mean i agree i think it's important to

615
00:20:57,990 --> 00:20:55,440
have these conversations

616
00:20:59,110 --> 00:20:58,000
uh real quick for our audience uh ravi

617
00:21:01,909 --> 00:20:59,120
is also hosting

618
00:21:03,510 --> 00:21:01,919
a workshop right now at nasa goddard on

619
00:21:05,029 --> 00:21:03,520
techno signatures so if you're

620
00:21:06,789 --> 00:21:05,039
interested in learning more and being

621
00:21:08,950 --> 00:21:06,799
involved if you're a young researcher

622
00:21:10,950 --> 00:21:08,960
and you like to get into this field you

623
00:21:11,510 --> 00:21:10,960
can reach out to myself or to ravi

624
00:21:13,350 --> 00:21:11,520
online

625
00:21:15,750 --> 00:21:13,360
after the show and we'll get the

626
00:21:17,669 --> 00:21:15,760
information to you for how to register

627
00:21:18,549 --> 00:21:17,679
uh to join these workshops on techno

628
00:21:20,149 --> 00:21:18,559
signatures

629
00:21:21,990 --> 00:21:20,159
lots of great talks coming in the coming

630
00:21:24,070 --> 00:21:22,000
months uh in this room

631
00:21:25,350 --> 00:21:24,080
it's a seminar series so you can hear

632
00:21:28,470 --> 00:21:25,360
it's online so you can

633
00:21:30,710 --> 00:21:28,480
listen it online yeah wonderful

634
00:21:32,470 --> 00:21:30,720
and so kind of on this idea then of like

635
00:21:33,190 --> 00:21:32,480
you know culture and what it means you

636
00:21:35,350 --> 00:21:33,200
know if

637
00:21:37,750 --> 00:21:35,360
these existential questions uh you're

638
00:21:39,590 --> 00:21:37,760

also a fan of science fiction

639
00:21:41,350 --> 00:21:39,600
um and we know that you you write

640
00:21:42,950 --> 00:21:41,360
science fiction stories

641
00:21:44,870 --> 00:21:42,960
um but you don't write them in english i

642
00:21:47,430 --> 00:21:44,880
wonder if you could explain to us

643
00:21:49,270 --> 00:21:47,440
uh your science fiction writing and and

644
00:21:50,710 --> 00:21:49,280
and the audience that you're sharing

645
00:21:53,510 --> 00:21:50,720
your stories with

646
00:21:55,750 --> 00:21:53,520
yeah so i mean i'm i've started writing

647
00:21:59,669 --> 00:21:55,760
sci-fi stories in my native language

648
00:22:02,549 --> 00:21:59,679
more uh directed towards the

649
00:22:03,590 --> 00:22:02,559
uh the cultural concepts of uh indian

650
00:22:07,350 --> 00:22:03,600
mythology and

651
00:22:10,470 --> 00:22:07,360
uh or you know to references to

652
00:22:11,909 --> 00:22:10,480
the indian um population uh the reason

653
00:22:12,310 --> 00:22:11,919
is that you know there are already a lot

654
00:22:14,390 --> 00:22:12,320
of

655
00:22:16,549 --> 00:22:14,400
people who are writing uh in the western

656
00:22:19,830 --> 00:22:16,559
literature in science fiction

657
00:22:22,870 --> 00:22:19,840
uh and you know there's there's not much

658
00:22:24,470 --> 00:22:22,880
i have more i i thought i could do uh in

659
00:22:26,310 --> 00:22:24,480
in that on that friend

660
00:22:29,190 --> 00:22:26,320
uh so i started writing these i wrote

661
00:22:32,230 --> 00:22:29,200
about maybe 15 to 20 stories on that one

662
00:22:34,310 --> 00:22:32,240
and i published on a website and my wife

663
00:22:35,830 --> 00:22:34,320

uh translated some in different other

664
00:22:38,070 --> 00:22:35,840
indian languages

665
00:22:39,270 --> 00:22:38,080
um many of my stories have twisted the

666
00:22:42,470 --> 00:22:39,280
end

667
00:22:45,110 --> 00:22:42,480
as i mentioned and so uh this is some

668
00:22:45,990 --> 00:22:45,120
this is a way for me to get my creative

669
00:22:49,830 --> 00:22:46,000
side out

670
00:22:53,110 --> 00:22:49,840
uh and and not not just do my work

671
00:22:54,149 --> 00:22:53,120
but you know try to see how it gives me

672
00:22:56,710 --> 00:22:54,159
more freedom

673
00:22:58,710 --> 00:22:56,720
to explore my ideas than my what my work

674
00:23:01,190 --> 00:22:58,720
is a little bit more conservative side

675
00:23:02,310 --> 00:23:01,200
naturally scientists are conservative in

676
00:23:04,870 --> 00:23:02,320
their thinking

677
00:23:05,990 --> 00:23:04,880
more cautious so that's uh that's how i

678
00:23:08,710 --> 00:23:06,000
try to balance my

679
00:23:09,830 --> 00:23:08,720
uh my creative side and my worksite at

680
00:23:11,270 --> 00:23:09,840
the same time

681
00:23:12,390 --> 00:23:11,280
it's good to have that creative outlet

682
00:23:13,830 --> 00:23:12,400
for all of us you know to have these

683
00:23:15,430 --> 00:23:13,840
other passions that kind of

684
00:23:16,870 --> 00:23:15,440
you know help justify the you know this

685
00:23:19,110 --> 00:23:16,880
this life that we're living

686
00:23:21,029 --> 00:23:19,120
uh i personally right now am rereading

687
00:23:23,350 --> 00:23:21,039
for the umpteenth time

688
00:23:24,950 --> 00:23:23,360

frank herbert's dune uh are there any

689
00:23:26,070 --> 00:23:24,960
science fiction authors who like really

690
00:23:28,149 --> 00:23:26,080
who really reach you

691
00:23:29,669 --> 00:23:28,159
any stories that really have impacted

692
00:23:33,029 --> 00:23:29,679
your life greatly

693
00:23:34,390 --> 00:23:33,039
i i like you know the first thing

694
00:23:36,630 --> 00:23:34,400
the first person that comes to my mind

695
00:23:39,590 --> 00:23:36,640
because i've read most of his stories

696
00:23:41,029 --> 00:23:39,600
isaac asimov his writing is so

697
00:23:43,990 --> 00:23:41,039
phenomenally

698
00:23:44,789 --> 00:23:44,000
clear and simple but at the same time it

699
00:23:48,470 --> 00:23:44,799
reaches

700
00:23:50,549 --> 00:23:48,480
your imagination in a way that you know

701
00:23:51,669 --> 00:23:50,559
that makes you think and a little bit

702
00:23:54,149 --> 00:23:51,679
more deeper than

703
00:23:55,590 --> 00:23:54,159
you would uh you could anticipate so

704
00:23:58,789 --> 00:23:55,600
isaac asimov would say

705
00:24:01,110 --> 00:23:58,799
is my primary you know one of my best

706
00:24:02,149 --> 00:24:01,120
uh science fair science fiction writer

707
00:24:05,190 --> 00:24:02,159
uh in terms of

708
00:24:08,070 --> 00:24:05,200
who other you know who

709
00:24:09,350 --> 00:24:08,080
else influenced my writings or my

710
00:24:10,789 --> 00:24:09,360
thinking in terms of science fiction

711
00:24:14,470 --> 00:24:10,799
stories is uh

712
00:24:17,590 --> 00:24:14,480
uh is not you know mano chamblin from um

713
00:24:19,190 --> 00:24:17,600

from hollywood because of his um you

714
00:24:22,230 --> 00:24:19,200
know twist at the end so it

715
00:24:25,269 --> 00:24:22,240
forces me to think you know what is

716
00:24:27,590 --> 00:24:25,279
how can you entice the audience to

717
00:24:28,549 --> 00:24:27,600
uh lead them to one conclusion and

718
00:24:30,830 --> 00:24:28,559
suddenly

719
00:24:33,269 --> 00:24:30,840
you change everything and change their

720
00:24:33,830 --> 00:24:33,279
perspective and so that's uh that i

721
00:24:35,830 --> 00:24:33,840
would say

722
00:24:37,909 --> 00:24:35,840
is one of the other influencer i could

723
00:24:39,110 --> 00:24:37,919
uh i could think about

724
00:24:40,390 --> 00:24:39,120
that kind of that kind of goes back to

725
00:24:41,029 --> 00:24:40,400
what you were saying earlier too about

726
00:24:42,549 --> 00:24:41,039
you know

727
00:24:43,990 --> 00:24:42,559
we have our minds kind of focused on

728
00:24:45,510 --> 00:24:44,000
this one thing because of what we can do

729
00:24:46,950 --> 00:24:45,520
and then maybe we'll find out

730
00:24:50,390 --> 00:24:46,960
it's not quite that maybe there'll be a

731
00:24:52,630 --> 00:24:50,400
twist an m night shyamalanian twist

732
00:24:54,149 --> 00:24:52,640
uh in in the search for for life out

733
00:24:56,310 --> 00:24:54,159
there in the universe

734
00:24:57,909 --> 00:24:56,320
right uh finally uh uh so our producer

735
00:25:00,230 --> 00:24:57,919
mike toyon found out that you were

736
00:25:01,029 --> 00:25:00,240
involved in a star trek player or series

737
00:25:02,470 --> 00:25:01,039
of plays

738
00:25:04,230 --> 00:25:02,480

i wonder if you could speak to that for

739
00:25:07,430 --> 00:25:04,240
our audience for a minute

740
00:25:09,190 --> 00:25:07,440
yes so i was at penn state and um

741
00:25:11,029 --> 00:25:09,200
every year at penn state in summer

742
00:25:13,350 --> 00:25:11,039
during july

743
00:25:15,830 --> 00:25:13,360
they organized something called an astro

744
00:25:16,950 --> 00:25:15,840
fest it's a public outreach program for

745
00:25:19,430 --> 00:25:16,960
four days

746
00:25:21,269 --> 00:25:19,440
and there are talks and events and

747
00:25:23,190 --> 00:25:21,279
people can come there are about

748
00:25:25,590 --> 00:25:23,200
seven hundred thousand people out of

749
00:25:27,990 --> 00:25:25,600
those four days

750
00:25:29,430 --> 00:25:28,000
and i wanted to do something different

751
00:25:31,350 --> 00:25:29,440
and something new

752
00:25:32,549 --> 00:25:31,360
um you know every year we are giving

753
00:25:34,149 --> 00:25:32,559
talks every year we are showing

754
00:25:35,909 --> 00:25:34,159
telescopes but what is something

755
00:25:38,230 --> 00:25:35,919
different that we can do that you know

756
00:25:40,230 --> 00:25:38,240
is fun but it also gives the same time

757
00:25:43,909 --> 00:25:40,240
uh some information about exoplanets

758
00:25:46,789 --> 00:25:43,919
so what i did was um i wrote a play

759
00:25:47,669 --> 00:25:46,799
based on star trek and recruited i would

760
00:25:49,430 --> 00:25:47,679
say

761
00:25:51,830 --> 00:25:49,440
twisted their arms some of the grad

762
00:25:55,110 --> 00:25:51,840
students and

763
00:25:56,390 --> 00:25:55,120

undergraduates to act in my play i acted

764
00:25:59,430 --> 00:25:56,400
as one of the red shirt

765
00:26:00,470 --> 00:25:59,440
guy who unfortunately does not make it

766
00:26:03,830 --> 00:26:00,480
back to the

767
00:26:06,390 --> 00:26:03,840
spaceship um and we

768
00:26:08,470 --> 00:26:06,400
we did that for uh two years and it was

769
00:26:11,510 --> 00:26:08,480
it was very well received in fact

770
00:26:12,390 --> 00:26:11,520
there is a trailer also we made uh for

771
00:26:14,789 --> 00:26:12,400
that show

772
00:26:15,669 --> 00:26:14,799
uh for that play i think it's on my penn

773
00:26:18,310 --> 00:26:15,679
state website

774
00:26:20,549 --> 00:26:18,320
uh if anybody is interested you can see

775
00:26:21,350 --> 00:26:20,559
uh the trailer for that uh play that's

776
00:26:23,990 --> 00:26:21,360
coming up

777
00:26:25,669 --> 00:26:24,000
so yeah that was that was really fun

778
00:26:26,870 --> 00:26:25,679
awesome yeah i'm sure if it's not being

779
00:26:29,029 --> 00:26:26,880
shared out there right now it's

780
00:26:30,549 --> 00:26:29,039
it'll be shared soon from our audience

781
00:26:31,350 --> 00:26:30,559
um yeah those are all also awesome

782
00:26:33,350 --> 00:26:31,360
answers so

783
00:26:34,470 --> 00:26:33,360
one more personal uh question before we

784
00:26:36,070 --> 00:26:34,480
get into

785
00:26:37,510 --> 00:26:36,080
the questions from our audience and for

786
00:26:39,110 --> 00:26:37,520
our audience watching

787
00:26:41,029 --> 00:26:39,120
just a friendly reminder you can start

788
00:26:43,830 --> 00:26:41,039

asking questions now for ravi

789
00:26:46,070 --> 00:26:43,840
uh using the saginet chat using the chat

790
00:26:47,510 --> 00:26:46,080
on the nasa astrobiology facebook page

791
00:26:50,470 --> 00:26:47,520
if you're watching there

792
00:26:51,269 --> 00:26:50,480
or on twitter with hashtag askgastrobio

793
00:26:53,750 --> 00:26:51,279
we'll open up

794
00:26:54,390 --> 00:26:53,760
those questions here soon so i have a

795
00:26:56,310 --> 00:26:54,400
non

796
00:26:58,070 --> 00:26:56,320
not necessarily astrobiology question

797
00:27:01,590 --> 00:26:58,080
from star trek then

798
00:27:05,350 --> 00:27:01,600
since you are a fan so am i i wonder

799
00:27:08,070 --> 00:27:05,360
which star trek technology do you think

800
00:27:10,470 --> 00:27:08,080
could actually happen in our lifetimes

801
00:27:12,390 --> 00:27:10,480
that would be revolutionary for us

802
00:27:13,669 --> 00:27:12,400
it's already happened several times

803
00:27:17,510 --> 00:27:13,679
there is actually a

804
00:27:18,149 --> 00:27:17,520
webpage where they have a list of star

805
00:27:20,549 --> 00:27:18,159
trek

806
00:27:22,789 --> 00:27:20,559
technology that has already occurred you

807
00:27:23,510 --> 00:27:22,799
know for example ipads and you know flip

808
00:27:27,269 --> 00:27:23,520
phones

809
00:27:29,350 --> 00:27:27,279
floppy disks uh you communicators

810
00:27:31,510 --> 00:27:29,360
these things the only the one technology

811
00:27:34,630 --> 00:27:31,520
i would really really hope

812
00:27:37,430 --> 00:27:34,640
uh can happen is a transporter

813
00:27:38,870 --> 00:27:37,440

that will reduce my travel time a lot my

814
00:27:41,830 --> 00:27:38,880
conference times a lot

815
00:27:42,630 --> 00:27:41,840
and so if anybody out there is trying to

816
00:27:46,870 --> 00:27:42,640
figure this out

817
00:27:49,669 --> 00:27:46,880
please let's uh let's do this

818
00:27:50,630 --> 00:27:49,679
just for the sound effects i like that

819
00:27:53,269 --> 00:27:50,640
nice

820
00:27:54,789 --> 00:27:53,279
um so i i did live one more question so

821
00:27:55,830 --> 00:27:54,799
you work you have worked a lot on

822
00:27:57,750 --> 00:27:55,840
modeling

823
00:27:59,269 --> 00:27:57,760
uh the positions of these various worlds

824
00:28:00,549 --> 00:27:59,279
around other stars

825
00:28:02,549 --> 00:28:00,559
um you've done a lot of work on this

826
00:28:04,310 --> 00:28:02,559
goldilocks zone for liquid water

827
00:28:05,990 --> 00:28:04,320
um i know that we have some some images

828
00:28:07,350 --> 00:28:06,000
that you've compiled um

829
00:28:09,110 --> 00:28:07,360
showing this region different kinds of

830
00:28:10,789 --> 00:28:09,120
worlds in this region um

831
00:28:12,710 --> 00:28:10,799
do we expect there will be a lot of

832
00:28:13,350 --> 00:28:12,720
worlds like earth a lot of worlds like

833
00:28:15,830 --> 00:28:13,360
venus

834
00:28:17,669 --> 00:28:15,840
more worlds like mars what's our current

835
00:28:19,190 --> 00:28:17,679
understanding of the kinds of worlds we

836
00:28:20,789 --> 00:28:19,200
expect to find

837
00:28:22,549 --> 00:28:20,799
inside of this this region called the

838
00:28:25,350 --> 00:28:22,559

habitable zone by some

839
00:28:25,750 --> 00:28:25,360
very very good question right now from

840
00:28:28,710 --> 00:28:25,760
just

841
00:28:29,510 --> 00:28:28,720
based on the kepler mission data we see

842
00:28:32,710 --> 00:28:29,520
that uh

843
00:28:36,230 --> 00:28:32,720
the most common occur occurring

844
00:28:37,190 --> 00:28:36,240
worlds are um uh subneptunes or mini

845
00:28:40,789 --> 00:28:37,200
neptunes

846
00:28:42,549 --> 00:28:40,799
larger than the earth-sized

847
00:28:44,070 --> 00:28:42,559
planets we don't have those kind of

848
00:28:46,389 --> 00:28:44,080
planets in our solar system

849
00:28:47,190 --> 00:28:46,399
we have you know the inner four planets

850
00:28:51,430 --> 00:28:47,200
earth

851
00:28:54,470 --> 00:28:51,440
biggest planet is neptune

852
00:28:55,430 --> 00:28:54,480
but several of these uh extrasolar

853
00:28:57,430 --> 00:28:55,440
planets are

854
00:28:59,510 --> 00:28:57,440
mini neptunes between the earth and

855
00:29:01,750 --> 00:28:59,520
neptune size so

856
00:29:03,430 --> 00:29:01,760
apparently they are the most common ones

857
00:29:05,510 --> 00:29:03,440
in in our galaxy

858
00:29:06,710 --> 00:29:05,520
but i'd say that you know that is

859
00:29:08,149 --> 00:29:06,720
probably something called an

860
00:29:09,830 --> 00:29:08,159
observational bias because they are a

861
00:29:11,110 --> 00:29:09,840
little bit larger and so easier to

862
00:29:12,310 --> 00:29:11,120
detect just like you know we were

863
00:29:14,630 --> 00:29:12,320

talking about the most

864
00:29:16,230 --> 00:29:14,640
uh sensitive and most weirdest planet is

865
00:29:16,789 --> 00:29:16,240
the one that you would be able to detect

866
00:29:18,710 --> 00:29:16,799
first

867
00:29:19,909 --> 00:29:18,720
no surprise there see you know universe

868
00:29:21,430 --> 00:29:19,919
is telling us

869
00:29:22,870 --> 00:29:21,440
pointing us in the direction saying that

870
00:29:24,470 --> 00:29:22,880
you know whenever you see something you

871
00:29:27,269 --> 00:29:24,480
would find the weird ones first

872
00:29:28,789 --> 00:29:27,279
so so there are theories of if we if we

873
00:29:31,909 --> 00:29:28,799
compensate for how many

874
00:29:33,830 --> 00:29:31,919
planets we are missing uh it looks like

875
00:29:36,070 --> 00:29:33,840
majority of the planets in our galaxy

876
00:29:38,310 --> 00:29:36,080
are smaller terrestrial size planets

877
00:29:40,389 --> 00:29:38,320
and so there are several habitable zone

878
00:29:41,269 --> 00:29:40,399
planets and the venus zone planets out

879
00:29:43,750 --> 00:29:41,279
there

880
00:29:44,389 --> 00:29:43,760
uh um you know we can't that we can't

881
00:29:46,549 --> 00:29:44,399
see

882
00:29:47,510 --> 00:29:46,559
so there are therefore we have an

883
00:29:50,789 --> 00:29:47,520
upcoming paper

884
00:29:52,310 --> 00:29:50,799
and um on how common it would be the

885
00:29:54,149 --> 00:29:52,320
earth like planets our own sun like

886
00:29:56,389 --> 00:29:54,159
stars and you know

887
00:29:57,750 --> 00:29:56,399
the estimate we would come out we even

888
00:30:00,789 --> 00:29:57,760

the previous estimates

889
00:30:01,430 --> 00:30:00,799
came out to be uh just you know billions

890
00:30:03,590 --> 00:30:01,440
of planets

891
00:30:05,029 --> 00:30:03,600
earth earth-like planets but size

892
00:30:08,149 --> 00:30:05,039
planets inhabitable zones

893
00:30:10,070 --> 00:30:08,159
so yeah so we we have way many of them

894
00:30:12,310 --> 00:30:10,080
nice yeah i often have to remind people

895
00:30:13,669 --> 00:30:12,320
that logically we have to admit that we

896
00:30:14,950 --> 00:30:13,679
could be alone

897
00:30:16,149 --> 00:30:14,960
in the universe but when you start

898
00:30:17,669 --> 00:30:16,159
throwing out numbers and you start

899
00:30:19,190 --> 00:30:17,679
looking at how many earth-like worlds

900
00:30:21,029 --> 00:30:19,200
could be out there it just

901
00:30:22,630 --> 00:30:21,039
it feels like there has to be something

902
00:30:24,549 --> 00:30:22,640
else there has to be

903
00:30:26,310 --> 00:30:24,559
the one thing i quickly will point out

904
00:30:29,350 --> 00:30:26,320
is that habitable doesn't

905
00:30:30,630 --> 00:30:29,360
does not mean inhabitants just because a

906
00:30:32,389 --> 00:30:30,640
planet is habitable

907
00:30:34,710 --> 00:30:32,399
which means it can have liquid water on

908
00:30:38,310 --> 00:30:34,720
the surface flowing on it nicely

909
00:30:41,110 --> 00:30:38,320
doesn't mean the planet must be have

910
00:30:42,710 --> 00:30:41,120
inhabited by organisms or anything and

911
00:30:45,110 --> 00:30:42,720
so we may have billions of

912
00:30:46,149 --> 00:30:45,120
habitable planets we do not know how

913
00:30:48,630 --> 00:30:46,159

many of them

914
00:30:49,510 --> 00:30:48,640
are inhabited and that is where lua and

915
00:30:51,190 --> 00:30:49,520
havoc's like

916
00:30:53,029 --> 00:30:51,200
and the origin space telescope coming to

917
00:30:55,750 --> 00:30:53,039
picture they will figure out

918
00:30:57,909 --> 00:30:55,760
how common are inhabited planets and how

919
00:30:59,110 --> 00:30:57,919
common potentially life uh technological

920
00:31:01,110 --> 00:30:59,120
life would be

921
00:31:03,350 --> 00:31:01,120
and so yeah those are the telescopes

922
00:31:05,269 --> 00:31:03,360
that we should be looking forward for

923
00:31:08,230 --> 00:31:05,279
oh absolutely yeah these coming decades

924
00:31:10,470 --> 00:31:08,240
look pretty exciting for astrobiology

925
00:31:11,990 --> 00:31:10,480
uh in many ways um i am going to open it

926
00:31:13,909 --> 00:31:12,000
up now to the audience questions

927
00:31:15,350 --> 00:31:13,919
since i know we have a few already uh

928
00:31:17,029 --> 00:31:15,360
again to the audience please ask your

929
00:31:17,590 --> 00:31:17,039
questions in the chat we're monitoring

930
00:31:19,190 --> 00:31:17,600
them

931
00:31:20,710 --> 00:31:19,200
uh they'll get into my cues so i can ask

932
00:31:22,710 --> 00:31:20,720
ravi your questions

933
00:31:23,750 --> 00:31:22,720
uh the first question comes from uh

934
00:31:27,269 --> 00:31:23,760
astro kid

935
00:31:28,389 --> 00:31:27,279
on twitter uh user at kid 11 underscore

936
00:31:30,310 --> 00:31:28,399
astro

937
00:31:31,430 --> 00:31:30,320
i'm going to modify his question since i

938
00:31:32,470 --> 00:31:31,440

think he meant something a little bit

939
00:31:34,149 --> 00:31:32,480
different

940
00:31:36,230 --> 00:31:34,159
he wants to know are all techno

941
00:31:40,710 --> 00:31:36,240
signatures we look for related to

942
00:31:46,389 --> 00:31:44,389
so we now have a methodology

943
00:31:48,149 --> 00:31:46,399
to detect um we are developing

944
00:31:51,990 --> 00:31:48,159
methodology to detect

945
00:31:55,110 --> 00:31:52,000
uh techno signatures that uh

946
00:31:57,430 --> 00:31:55,120
uses electromagnetic observations

947
00:31:58,789 --> 00:31:57,440
so if you look at james webb telescope

948
00:32:00,230 --> 00:31:58,799
it looks in the infrared part of the

949
00:32:00,789 --> 00:32:00,240
spectrum so that's an electromagnetic

950
00:32:02,789 --> 00:32:00,799
spectrum

951
00:32:04,789 --> 00:32:02,799
if you look at luva or have x they are

952
00:32:07,190 --> 00:32:04,799
looking in ultraviolet and optical

953
00:32:07,990 --> 00:32:07,200
so that's an electromagnetic spectrum so

954
00:32:11,750 --> 00:32:08,000
we are

955
00:32:15,029 --> 00:32:11,760
electromagnetic spectrum

956
00:32:15,669 --> 00:32:15,039
there is a an interesting idea here that

957
00:32:17,590 --> 00:32:15,679
you know

958
00:32:18,950 --> 00:32:17,600
some way advanced technological

959
00:32:21,990 --> 00:32:18,960
civilizations can use

960
00:32:22,950 --> 00:32:22,000
gravitational waves as their you know

961
00:32:26,549 --> 00:32:22,960
technological

962
00:32:28,310 --> 00:32:26,559
uh ability and so there if we

963
00:32:29,909 --> 00:32:28,320

there might be a possibility that we may

964
00:32:32,389 --> 00:32:29,919
be able to detect a

965
00:32:33,509 --> 00:32:32,399
super advanced like god like uh

966
00:32:36,630 --> 00:32:33,519
civilizations

967
00:32:38,870 --> 00:32:36,640
who can modify the you know very massive

968
00:32:39,830 --> 00:32:38,880
neutron stars and black holes in such a

969
00:32:41,590 --> 00:32:39,840
way that

970
00:32:43,110 --> 00:32:41,600
their signatures techno technological

971
00:32:43,669 --> 00:32:43,120
signature will be in the gravitational

972
00:32:46,549 --> 00:32:43,679
waves

973
00:32:48,950 --> 00:32:46,559
so that's one area we could uh look at

974
00:32:50,870 --> 00:32:48,960
that's both stunning and terrifying

975
00:32:52,710 --> 00:32:50,880
at the same time this really advanced

976
00:32:54,070 --> 00:32:52,720
like high kardashev scale

977
00:32:55,669 --> 00:32:54,080
civilization but yeah gravitational

978
00:32:56,310 --> 00:32:55,679
waves have done a lot they've shown us

979
00:32:57,750 --> 00:32:56,320
you know

980
00:32:59,430 --> 00:32:57,760
so much more about like neutron star

981
00:33:01,509 --> 00:32:59,440
mergers that are happening and

982
00:33:02,630 --> 00:33:01,519
potential for nuclear synthesis in these

983
00:33:03,990 --> 00:33:02,640
processes for

984
00:33:05,669 --> 00:33:04,000
creating other elements but it'd be

985
00:33:07,669 --> 00:33:05,679
really cool if we saw some signs of

986
00:33:10,310 --> 00:33:07,679
alien activity in that as well

987
00:33:11,029 --> 00:33:10,320
um i like that that idea a lot uh this

988
00:33:13,430 --> 00:33:11,039

next question

989
00:33:15,430 --> 00:33:13,440
question comes from connor on twitter uh

990
00:33:18,389 --> 00:33:15,440
user at connor underscore

991
00:33:19,509 --> 00:33:18,399
mick underscore ivor and connor so this

992
00:33:19,990 --> 00:33:19,519
might be a little bit outside of your

993
00:33:22,470 --> 00:33:20,000
range

994
00:33:23,909 --> 00:33:22,480
um you know welcome to speak to it uh do

995
00:33:26,149 --> 00:33:23,919
you think there's a possibility of

996
00:33:28,870 --> 00:33:26,159
finding evidence of life from long ago

997
00:33:31,750 --> 00:33:28,880
like fossils uh own celestial bodies

998
00:33:34,389 --> 00:33:31,760
like mars or europa

999
00:33:37,190 --> 00:33:34,399
so very interesting question you asked

1000
00:33:40,549 --> 00:33:37,200
because there was a paper last year

1001
00:33:43,590 --> 00:33:40,559
or year before 2018 by

1002
00:33:46,310 --> 00:33:43,600
nasa scientist gavin schmidt from nasa

1003
00:33:47,669 --> 00:33:46,320
guests in new york and also from adam

1004
00:33:49,590 --> 00:33:47,679
frank

1005
00:33:50,710 --> 00:33:49,600
from university of rochester both of

1006
00:33:53,990 --> 00:33:50,720
them wrote a paper

1007
00:33:56,870 --> 00:33:54,000
two years ago on finding uh

1008
00:33:58,310 --> 00:33:56,880
the you know trying to figure out what

1009
00:34:01,830 --> 00:33:58,320
if there was

1010
00:34:04,549 --> 00:34:01,840
an advanced civilization on earth

1011
00:34:06,149 --> 00:34:04,559
millions of years ago if we would be

1012
00:34:09,909 --> 00:34:06,159
able to find

1013
00:34:12,470 --> 00:34:09,919

them in the archaeological data

1014
00:34:13,510 --> 00:34:12,480
and so the conclusion if i remember

1015
00:34:16,710 --> 00:34:13,520
correctly

1016
00:34:19,349 --> 00:34:16,720
is that there is a possibility

1017
00:34:21,109 --> 00:34:19,359
that if they existed we would not be

1018
00:34:24,629 --> 00:34:21,119
able to distinguish it from

1019
00:34:26,869 --> 00:34:24,639
the geological features uh on earth

1020
00:34:27,990 --> 00:34:26,879
so we don't even have to go to mars or

1021
00:34:30,790 --> 00:34:28,000
venus or anywhere

1022
00:34:32,950 --> 00:34:30,800
on earth itself imagine 50 million years

1023
00:34:33,349 --> 00:34:32,960
our civilization's lifetime is now what

1024
00:34:35,030 --> 00:34:33,359
the

1025
00:34:37,589 --> 00:34:35,040
starting of agricultural civilization is

1026
00:34:39,750 --> 00:34:37,599
10 000 years with 10 000 years we are

1027
00:34:42,069 --> 00:34:39,760
up to here if our technological

1028
00:34:45,270 --> 00:34:42,079
civilization is probably 200 years

1029
00:34:46,869 --> 00:34:45,280
old and and consider that with the time

1030
00:34:48,629 --> 00:34:46,879
scale of the civilization

1031
00:34:50,149 --> 00:34:48,639
time scale of the earth for different

1032
00:34:52,710 --> 00:34:50,159
species evolution

1033
00:34:54,069 --> 00:34:52,720
you know 50 million years ago you would

1034
00:34:56,629 --> 00:34:54,079
have many of them

1035
00:34:57,190 --> 00:34:56,639
uh come up and gone and uh you know

1036
00:34:59,910 --> 00:34:57,200
gavin

1037
00:35:00,710 --> 00:34:59,920
and adam they propose that if they

1038
00:35:02,790 --> 00:35:00,720

existed

1039
00:35:03,990 --> 00:35:02,800
we would not be able to likely

1040
00:35:07,670 --> 00:35:04,000
distinguish them from

1041
00:35:09,270 --> 00:35:07,680
the geological features so there you go

1042
00:35:11,510 --> 00:35:09,280
yeah i recall that paper is pretty

1043
00:35:13,109 --> 00:35:11,520
intriguing it's a fun thought experiment

1044
00:35:15,349 --> 00:35:13,119
uh to question what we actually can know

1045
00:35:17,349 --> 00:35:15,359
of our own world let alone searching for

1046
00:35:19,190 --> 00:35:17,359
life potentially elsewhere

1047
00:35:21,270 --> 00:35:19,200
uh my next question i have in my list

1048
00:35:22,710 --> 00:35:21,280
here i'm going to answer myself

1049
00:35:24,150 --> 00:35:22,720
first and then i'm going to ask you a

1050
00:35:25,349 --> 00:35:24,160
slightly modified uh version of the

1051
00:35:28,310 --> 00:35:25,359
question from me

1052
00:35:30,069 --> 00:35:28,320
uh so amal bijou on facebook wants to

1053
00:35:31,750 --> 00:35:30,079
know why phosphine

1054
00:35:33,910 --> 00:35:31,760
is considered to be a sign of life or

1055
00:35:36,150 --> 00:35:33,920
potential sign of life on venus

1056
00:35:37,190 --> 00:35:36,160
and i think i'll start with this one

1057
00:35:38,790 --> 00:35:37,200
because it's a really

1058
00:35:42,069 --> 00:35:38,800
interesting potential detection that we

1059
00:35:43,670 --> 00:35:42,079
just had of the molecule false being

1060
00:35:45,349 --> 00:35:43,680
in the atmosphere of venus and some

1061
00:35:47,670 --> 00:35:45,359
researchers i just saw a pre

1062
00:35:49,910 --> 00:35:47,680
a pre-print article uh suggesting that

1063
00:35:51,270 --> 00:35:49,920

old spacecraft data may actually confirm

1064
00:35:53,270 --> 00:35:51,280
this false beam

1065
00:35:55,430 --> 00:35:53,280
uh and we might have a flyby so we have

1066
00:35:58,790 --> 00:35:55,440
a flyby of beppy columbo

1067
00:36:00,310 --> 00:35:58,800
next month around venus but it's also

1068
00:36:02,150 --> 00:36:00,320
it won't have enough time to change much

1069
00:36:03,030 --> 00:36:02,160
but it's also flying by next year in

1070
00:36:04,550 --> 00:36:03,040
august

1071
00:36:06,390 --> 00:36:04,560
and some have suggested that we could

1072
00:36:07,270 --> 00:36:06,400
actually use becky colombo to look for

1073
00:36:08,790 --> 00:36:07,280
phosphine

1074
00:36:10,870 --> 00:36:08,800
and confirm it in venus's atmosphere

1075
00:36:12,710 --> 00:36:10,880
next year so that's huge

1076
00:36:14,390 --> 00:36:12,720
however everyone should know we have

1077
00:36:16,710 --> 00:36:14,400
detected phosphine

1078
00:36:17,990 --> 00:36:16,720
in jupiter and saturn previously so we

1079
00:36:20,630 --> 00:36:18,000
know it can form

1080
00:36:21,750 --> 00:36:20,640
without life in other worlds or at least

1081
00:36:23,349 --> 00:36:21,760
we have models for how it can form

1082
00:36:25,109 --> 00:36:23,359
without life in other worlds

1083
00:36:26,550 --> 00:36:25,119
the reason why it was so interesting for

1084
00:36:28,790 --> 00:36:26,560
for so many of us

1085
00:36:30,710 --> 00:36:28,800
is that on earth phosphine forms

1086
00:36:31,589 --> 00:36:30,720
naturally only through biological

1087
00:36:33,670 --> 00:36:31,599
processes

1088
00:36:34,870 --> 00:36:33,680

through these organisms in oxygen free

1089
00:36:36,950 --> 00:36:34,880
environments

1090
00:36:38,870 --> 00:36:36,960
and the finding on venus currently we

1091
00:36:40,390 --> 00:36:38,880
don't have a good model to explain how

1092
00:36:42,310 --> 00:36:40,400
it could be there

1093
00:36:44,470 --> 00:36:42,320
that said i saw another pre-print paper

1094
00:36:46,230 --> 00:36:44,480
that's out suggesting that maybe

1095
00:36:48,069 --> 00:36:46,240
uh volcanism could be a very good

1096
00:36:49,589 --> 00:36:48,079
explanation because you know we just

1097
00:36:50,150 --> 00:36:49,599
don't know enough about the surface of

1098
00:36:52,550 --> 00:36:50,160
venus

1099
00:36:53,190 --> 00:36:52,560
yet we need more missions and so i think

1100
00:36:55,109 --> 00:36:53,200
if anything

1101
00:36:57,109 --> 00:36:55,119
this this this phosphine finding will

1102
00:36:58,069 --> 00:36:57,119
definitely make us get to venus to study

1103
00:37:00,230 --> 00:36:58,079
more

1104
00:37:01,750 --> 00:37:00,240
uh however one of my colleagues uh

1105
00:37:03,349 --> 00:37:01,760
sukrit ranjan

1106
00:37:04,870 --> 00:37:03,359
uh i had a chance to speak with him and

1107
00:37:06,550 --> 00:37:04,880
he was on this paper

1108
00:37:08,470 --> 00:37:06,560
and he brought up the interesting fact

1109
00:37:11,670 --> 00:37:08,480
that this is now giving us a test bed

1110
00:37:12,790 --> 00:37:11,680
for exoplanets and so ravi i want to ask

1111
00:37:14,470 --> 00:37:12,800
you

1112
00:37:16,950 --> 00:37:14,480
what this phosphene detection

1113
00:37:19,190 --> 00:37:16,960

potentially means for you

1114
00:37:21,270 --> 00:37:19,200
for the search for life and maybe even

1115
00:37:23,510 --> 00:37:21,280
industrial technological activity

1116
00:37:25,510 --> 00:37:23,520
on exoplanets uh as well as having a

1117
00:37:26,790 --> 00:37:25,520
test bed here for venus

1118
00:37:29,589 --> 00:37:26,800
okay that's a good that's a good

1119
00:37:31,829 --> 00:37:29,599
question um so i agree with what you

1120
00:37:33,670 --> 00:37:31,839
said completely and that's there are

1121
00:37:35,910 --> 00:37:33,680
natural sources of

1122
00:37:36,710 --> 00:37:35,920
biological sources of phosphene on earth

1123
00:37:39,190 --> 00:37:36,720
and so that's

1124
00:37:41,750 --> 00:37:39,200
that's the reason why this was uh a bit

1125
00:37:45,109 --> 00:37:41,760
one uh interesting for uh venus life

1126
00:37:48,870 --> 00:37:45,119
in the clouds of venus and and um so

1127
00:37:50,069 --> 00:37:48,880
we i would say that this is one

1128
00:37:53,670 --> 00:37:50,079
observation that

1129
00:37:56,310 --> 00:37:53,680
uh the study others got from their

1130
00:37:57,430 --> 00:37:56,320
whatever the data that they took i would

1131
00:38:00,870 --> 00:37:57,440
uh

1132
00:38:04,069 --> 00:38:00,880
be cautiously optimistic on this one let

1133
00:38:06,950 --> 00:38:04,079
the follow-up observations confirm

1134
00:38:08,150 --> 00:38:06,960
and you know or try to get more data and

1135
00:38:09,829 --> 00:38:08,160
verify

1136
00:38:11,270 --> 00:38:09,839
that indeed there is phosphine over

1137
00:38:13,829 --> 00:38:11,280
there but

1138
00:38:14,710 --> 00:38:13,839

and go through the peer review uh and

1139
00:38:16,710 --> 00:38:14,720
and it's it's

1140
00:38:17,910 --> 00:38:16,720
great that this has generated so much

1141
00:38:20,069 --> 00:38:17,920
interest in life

1142
00:38:21,510 --> 00:38:20,079
on venus i mean we were just talking

1143
00:38:24,470 --> 00:38:21,520
about weird life so yeah

1144
00:38:25,910 --> 00:38:24,480
i mean tell me about that now so we have

1145
00:38:26,630 --> 00:38:25,920
next door neighbor have potentially

1146
00:38:29,030 --> 00:38:26,640
having this

1147
00:38:30,710 --> 00:38:29,040
life in the clouds but i would i would

1148
00:38:33,190 --> 00:38:30,720
still say that you know let

1149
00:38:34,150 --> 00:38:33,200
the science do its job let people

1150
00:38:37,510 --> 00:38:34,160
confirm

1151
00:38:40,710 --> 00:38:37,520
more on this one as for the exoplanets

1152
00:38:41,750 --> 00:38:40,720
uh for uh you know again if we find this

1153
00:38:45,030 --> 00:38:41,760
uh

1154
00:38:48,550 --> 00:38:45,040
we should be

1155
00:38:51,990 --> 00:38:48,560
really really uh be able to

1156
00:38:55,190 --> 00:38:52,000
rule out every other abiotic sources

1157
00:38:55,670 --> 00:38:55,200
that uh that may not cannot be produced

1158
00:39:03,030 --> 00:38:55,680
uh

1159
00:39:03,910 --> 00:39:03,040
have to completely rule out or have a

1160
00:39:06,870 --> 00:39:03,920
very low

1161
00:39:07,589 --> 00:39:06,880
low probability of having uh abiotic

1162
00:39:10,069 --> 00:39:07,599
sources and

1163
00:39:11,510 --> 00:39:10,079

completely it's coming from biology only

1164
00:39:12,550 --> 00:39:11,520
and so that's one of the critical things

1165
00:39:14,390 --> 00:39:12,560
that we need to do

1166
00:39:16,870 --> 00:39:14,400
so we have a luxury of sending a mission

1167
00:39:19,510 --> 00:39:16,880
to venus we don't have that luxury to

1168
00:39:20,470 --> 00:39:19,520
send it to an exoplanet yet of course

1169
00:39:22,630 --> 00:39:20,480
and so

1170
00:39:24,310 --> 00:39:22,640
as for technological uh aspects of

1171
00:39:25,990 --> 00:39:24,320
civilization aspects this is a fun

1172
00:39:26,710 --> 00:39:26,000
thought experiment i'm not saying this

1173
00:39:29,750 --> 00:39:26,720
is the case

1174
00:39:32,950 --> 00:39:29,760
so um you know phosphine is uh

1175
00:39:35,829 --> 00:39:32,960
produced by various things on earth uh

1176
00:39:36,470 --> 00:39:35,839
uh you know uh industrial processes and

1177
00:39:40,550 --> 00:39:36,480
uh

1178
00:39:42,550 --> 00:39:40,560
breaking bad

1179
00:39:44,230 --> 00:39:42,560
you know phosphine can be generated

1180
00:39:46,790 --> 00:39:44,240
through that process as well

1181
00:39:48,550 --> 00:39:46,800
and so yeah there is a there is a

1182
00:39:49,750 --> 00:39:48,560
possibility for them too but we have to

1183
00:39:50,790 --> 00:39:49,760
be really careful about these

1184
00:39:53,430 --> 00:39:50,800
observations and

1185
00:39:55,190 --> 00:39:53,440
make sure this is absolutely reconfirmed

1186
00:39:57,190 --> 00:39:55,200
this is how science works

1187
00:39:58,790 --> 00:39:57,200
so in the end the truth will prevail

1188
00:39:59,670 --> 00:39:58,800

universe the shortest part for the

1189
00:40:02,790 --> 00:39:59,680
universe

1190
00:40:04,390 --> 00:40:02,800
is truth so we will have to wait and see

1191
00:40:06,069 --> 00:40:04,400
i love that answer yeah so i think it's

1192
00:40:08,230 --> 00:40:06,079
important for everyone to remember

1193
00:40:09,750 --> 00:40:08,240
uh you can be too optimistic you can be

1194
00:40:09,990 --> 00:40:09,760
too pessimistic but somewhere in the

1195
00:40:12,390 --> 00:40:10,000
middle

1196
00:40:13,750 --> 00:40:12,400
is kind of a nice place to be uh to

1197
00:40:14,870 --> 00:40:13,760
think through the potential that's if

1198
00:40:17,190 --> 00:40:14,880
that's out there

1199
00:40:19,109 --> 00:40:17,200
uh our next question comes from guarev

1200
00:40:21,750 --> 00:40:19,119
yadav on facebook

1201
00:40:23,109 --> 00:40:21,760
uh which has a small build in guara says

1202
00:40:25,990 --> 00:40:23,119
since old and complex

1203
00:40:27,589 --> 00:40:26,000
galaxies have high potential to provide

1204
00:40:29,030 --> 00:40:27,599
the ingredients for the building blocks

1205
00:40:31,349 --> 00:40:29,040
of life like the milky way

1206
00:40:33,349 --> 00:40:31,359
or at least as we know it they also have

1207
00:40:35,190 --> 00:40:33,359
a high emission rate of gamma rays

1208
00:40:36,710 --> 00:40:35,200
while dwarf galaxies with very thin

1209
00:40:38,390 --> 00:40:36,720
concentrations of stars have a low

1210
00:40:40,630 --> 00:40:38,400
emission of gamma rays

1211
00:40:42,230 --> 00:40:40,640
based on this scenario can we consider

1212
00:40:44,230 --> 00:40:42,240
high gamma ray detection

1213
00:40:47,829 --> 00:40:44,240

from a distant galaxy as a possible

1214
00:40:51,990 --> 00:40:50,829
we will not be able to determine either

1215
00:40:53,430 --> 00:40:52,000
way

1216
00:40:55,990 --> 00:40:53,440
just like i was talking about the

1217
00:40:57,670 --> 00:40:56,000
fossilized past civilization on earth

1218
00:41:00,150 --> 00:40:57,680
we would not be able to distinguish

1219
00:41:03,270 --> 00:41:00,160
between whether it's a natural process

1220
00:41:05,190 --> 00:41:03,280
or whether it's if it's coming from

1221
00:41:06,470 --> 00:41:05,200
an artificial one unless there is a

1222
00:41:10,069 --> 00:41:06,480
repeatability

1223
00:41:12,950 --> 00:41:10,079
or of the of that signal or

1224
00:41:13,910 --> 00:41:12,960
maybe there is a long-lived signal that

1225
00:41:17,030 --> 00:41:13,920
does not match

1226
00:41:19,670 --> 00:41:17,040
any known natural emission

1227
00:41:20,150 --> 00:41:19,680
then you know you can potentially say

1228
00:41:23,030 --> 00:41:20,160
how

1229
00:41:24,790 --> 00:41:23,040
you know it's not happening naturally so

1230
00:41:28,710 --> 00:41:24,800
we don't know what it is

1231
00:41:31,510 --> 00:41:28,720
but i i would say that at that such

1232
00:41:33,349 --> 00:41:31,520
long distances if some technological

1233
00:41:37,589 --> 00:41:33,359
civilization is emitting

1234
00:41:39,750 --> 00:41:37,599
that amount of gamma rays boy they are

1235
00:41:41,990 --> 00:41:39,760
they are super advanced and um you know

1236
00:41:44,150 --> 00:41:42,000
i'm glad they are that far

1237
00:41:45,430 --> 00:41:44,160
yeah i keep coming back to that right it

1238
00:41:48,069 --> 00:41:45,440

could be terrifying

1239
00:41:50,150 --> 00:41:48,079
it could be awesome and we don't know uh

1240
00:41:52,790 --> 00:41:50,160
we have another question here from hana

1241
00:41:54,150 --> 00:41:52,800
ahmed on facebook uh i'm going to answer

1242
00:41:55,510 --> 00:41:54,160
the first part and then i'll present on

1243
00:41:57,430 --> 00:41:55,520
the second part for you so

1244
00:41:59,109 --> 00:41:57,440
hana wants to know how bioinformatics

1245
00:42:00,550 --> 00:41:59,119
might help in discovering life in other

1246
00:42:02,150 --> 00:42:00,560
planets

1247
00:42:04,309 --> 00:42:02,160
since this isn't quite in the exoplanet

1248
00:42:06,550 --> 00:42:04,319
and physics astrophysics realm

1249
00:42:08,470 --> 00:42:06,560
uh bioinformatics for those listening

1250
00:42:11,349 --> 00:42:08,480
are the tools that we use

1251
00:42:11,829 --> 00:42:11,359
uh to disentangle all the biological

1252
00:42:13,670 --> 00:42:11,839
data

1253
00:42:14,950 --> 00:42:13,680
that we can get uh specifically a lot of

1254
00:42:16,069 --> 00:42:14,960
times we're looking at things like

1255
00:42:18,790 --> 00:42:16,079
genomes

1256
00:42:20,630 --> 00:42:18,800
metagenomics and stuff like that those

1257
00:42:22,230 --> 00:42:20,640
tools are extremely powerful

1258
00:42:24,790 --> 00:42:22,240
in trying to understand life on other

1259
00:42:27,270 --> 00:42:24,800
worlds we might expect that we won't

1260
00:42:29,270 --> 00:42:27,280
find dna elsewhere if we find dna from

1261
00:42:30,550 --> 00:42:29,280
the alien life form on mars

1262
00:42:32,710 --> 00:42:30,560
we might have good reason to think that

1263
00:42:34,470 --> 00:42:32,720

we have a shared history so in that case

1264
00:42:37,589 --> 00:42:34,480
that bioinformatics will help us

1265
00:42:39,270 --> 00:42:37,599
untangle that potentially shared history

1266
00:42:41,349 --> 00:42:39,280
but say we find other kinds of

1267
00:42:43,030 --> 00:42:41,359
information molecules out there

1268
00:42:45,510 --> 00:42:43,040
the exact same tools that you're going

1269
00:42:47,270 --> 00:42:45,520
to learn how to use in bioinformatics

1270
00:42:49,109 --> 00:42:47,280
can then be applied to these other

1271
00:42:51,430 --> 00:42:49,119
information storage systems

1272
00:42:52,230 --> 00:42:51,440
and so i think having bio bioinformatics

1273
00:42:53,670 --> 00:42:52,240
prepared

1274
00:42:56,870 --> 00:42:53,680
and being ready for what that could that

1275
00:42:58,550 --> 00:42:56,880
could do for us is a huge place to be

1276
00:43:00,630 --> 00:42:58,560
and then hana kind of wanted to know

1277
00:43:02,470 --> 00:43:00,640
then what kinds of requirements there

1278
00:43:03,190 --> 00:43:02,480
might be for for biologists to work at

1279
00:43:04,790 --> 00:43:03,200
nasa

1280
00:43:06,309 --> 00:43:04,800
and so so ravi and i'd like to change

1281
00:43:07,990 --> 00:43:06,319
that a little bit uh

1282
00:43:10,230 --> 00:43:08,000
what would be the needed requirements

1283
00:43:11,990 --> 00:43:10,240
for maybe a young biologist

1284
00:43:14,630 --> 00:43:12,000
to get involved in doing research with

1285
00:43:16,069 --> 00:43:14,640
you in exoplanets and things like this

1286
00:43:18,950 --> 00:43:16,079
this is another this is a very good

1287
00:43:22,150 --> 00:43:18,960
question because um this fear is that

1288
00:43:25,990 --> 00:43:22,160

we are on a nasa astrobiology program

1289
00:43:28,390 --> 00:43:26,000
uh and so the uh the biologists are

1290
00:43:29,670 --> 00:43:28,400
so immensely helpful in in this uh in

1291
00:43:32,150 --> 00:43:29,680
this new field

1292
00:43:33,109 --> 00:43:32,160
because when we try to find life and

1293
00:43:37,990 --> 00:43:33,119
when we are

1294
00:43:40,309 --> 00:43:38,000
they can help us at several stages

1295
00:43:41,109 --> 00:43:40,319
one even to look for life remote life

1296
00:43:43,670 --> 00:43:41,119
for example

1297
00:43:45,030 --> 00:43:43,680
uh for exoplanets we need to know how

1298
00:43:47,510 --> 00:43:45,040
biology works

1299
00:43:49,109 --> 00:43:47,520
and what kind of uh end products

1300
00:43:51,430 --> 00:43:49,119
byproducts the

1301
00:43:53,670 --> 00:43:51,440
biology can create so that we can uh

1302
00:43:54,069 --> 00:43:53,680
look at it for example the phosphine one

1303
00:43:56,390 --> 00:43:54,079
so

1304
00:43:57,990 --> 00:43:56,400
you know how biology uh you know

1305
00:43:59,750 --> 00:43:58,000
decaying matter actually

1306
00:44:01,510 --> 00:43:59,760
can emit fast and so we need to

1307
00:44:03,270 --> 00:44:01,520
understand we need to have experts in

1308
00:44:05,829 --> 00:44:03,280
biology for the years so yes

1309
00:44:07,270 --> 00:44:05,839
this is really not important to have a

1310
00:44:09,270 --> 00:44:07,280
biologist and at least

1311
00:44:10,630 --> 00:44:09,280
trying to figure out what kind of

1312
00:44:13,109 --> 00:44:10,640
features we want to look at

1313
00:44:13,990 --> 00:44:13,119

the next thing is what if we find

1314
00:44:17,109 --> 00:44:14,000
something

1315
00:44:19,670 --> 00:44:17,119
uh and how do we uh try to

1316
00:44:21,030 --> 00:44:19,680
figure out or how do we identify if that

1317
00:44:22,870 --> 00:44:21,040
is life or not

1318
00:44:24,950 --> 00:44:22,880
and that's where the data analysis comes

1319
00:44:26,470 --> 00:44:24,960
and that's where biologists are also

1320
00:44:28,710 --> 00:44:26,480
quite important we have really good

1321
00:44:32,870 --> 00:44:28,720
biologists at various nasa centers

1322
00:44:36,390 --> 00:44:35,030
you know colleagues of mine here at nasa

1323
00:44:37,270 --> 00:44:36,400
goddard also we have very good

1324
00:44:39,829 --> 00:44:37,280
colleagues

1325
00:44:40,470 --> 00:44:39,839
who can you know help in uh getting

1326
00:44:43,750 --> 00:44:40,480
people

1327
00:44:45,670 --> 00:44:43,760
uh interested uh you know young one as

1328
00:44:47,109 --> 00:44:45,680
astrobiologists or biologists to come

1329
00:44:48,710 --> 00:44:47,119
and work for us we have summer intern

1330
00:44:50,230 --> 00:44:48,720
program if you're interested in so you

1331
00:44:51,510 --> 00:44:50,240
can apply through that and see you know

1332
00:44:54,309 --> 00:44:51,520
who would be interested in

1333
00:44:55,670 --> 00:44:54,319
you know for you to work with that's

1334
00:44:57,030 --> 00:44:55,680
awesome yeah absolutely for all of our

1335
00:44:58,470 --> 00:44:57,040
young scientists watching there's so

1336
00:44:59,750 --> 00:44:58,480
many ways to get involved

1337
00:45:01,589 --> 00:44:59,760
and if you're if you're still unsure

1338
00:45:02,870 --> 00:45:01,599

reach out to us many of us are always

1339
00:45:04,950 --> 00:45:02,880
happy to help point you

1340
00:45:06,069 --> 00:45:04,960
in the right direction uh another

1341
00:45:07,270 --> 00:45:06,079
question kind of from what we were just

1342
00:45:10,309 --> 00:45:07,280
talking about then

1343
00:45:12,950 --> 00:45:10,319
from sangeet daemon on sega net uh

1344
00:45:14,630 --> 00:45:12,960
if we get a signal from space how might

1345
00:45:16,150 --> 00:45:14,640
we confirm that it could be a real

1346
00:45:17,589 --> 00:45:16,160
biological signal versus something

1347
00:45:20,230 --> 00:45:17,599
abiotic

1348
00:45:21,910 --> 00:45:20,240
so this is where uh the false positive

1349
00:45:24,870 --> 00:45:21,920
mechanisms come in

1350
00:45:26,630 --> 00:45:24,880
right so we need to on we it's not we we

1351
00:45:28,870 --> 00:45:26,640
can't just look at the signal we need to

1352
00:45:32,069 --> 00:45:28,880
understand the context of the

1353
00:45:34,150 --> 00:45:32,079
uh planetary system uh if if

1354
00:45:35,589 --> 00:45:34,160
if it's coming from an exoplanet we need

1355
00:45:37,750 --> 00:45:35,599
to understand its size

1356
00:45:39,430 --> 00:45:37,760
radius what kind of a star it is is it

1357
00:45:41,589 --> 00:45:39,440
in the hydro zone or if it is

1358
00:45:42,870 --> 00:45:41,599
somewhere else what kind of a potential

1359
00:45:45,109 --> 00:45:42,880
atmosphere it has

1360
00:45:46,069 --> 00:45:45,119
can biology sustain in that kind of an

1361
00:45:48,950 --> 00:45:46,079
atmosphere

1362
00:45:50,390 --> 00:45:48,960
or we can use our normal usual thinking

1363
00:45:51,910 --> 00:45:50,400

that biology cannot sustain the

1364
00:45:54,150 --> 00:45:51,920
atmosphere is it wrong

1365
00:45:54,950 --> 00:45:54,160
so is there a mechanism where biology

1366
00:45:57,270 --> 00:45:54,960
can sustain

1367
00:45:58,230 --> 00:45:57,280
that atmosphere and so we have to verify

1368
00:46:00,710 --> 00:45:58,240
all these things get

1369
00:46:02,790 --> 00:46:00,720
all the pictures together and make sure

1370
00:46:05,510 --> 00:46:02,800
we understand the context first

1371
00:46:06,230 --> 00:46:05,520
without context we cannot say for sure

1372
00:46:07,990 --> 00:46:06,240
if this

1373
00:46:10,230 --> 00:46:08,000
uh planet if the signal that you're

1374
00:46:14,069 --> 00:46:10,240
receiving is biology or not it is

1375
00:46:16,150 --> 00:46:14,079
it is simply i would say is um

1376
00:46:17,829 --> 00:46:16,160
would be a pitfall to just look at the

1377
00:46:20,230 --> 00:46:17,839
signal and say it's biology

1378
00:46:22,069 --> 00:46:20,240
you need to know the history of at least

1379
00:46:23,829 --> 00:46:22,079
you need to know the context and the

1380
00:46:24,550 --> 00:46:23,839
environment where the signal is coming

1381
00:46:26,069 --> 00:46:24,560
from

1382
00:46:27,510 --> 00:46:26,079
just like the phosphine in venus people

1383
00:46:29,109 --> 00:46:27,520
are trying to figure out same

1384
00:46:30,950 --> 00:46:29,119
methodology you following

1385
00:46:33,109 --> 00:46:30,960
for uh extraterrestrial signature

1386
00:46:34,790 --> 00:46:33,119
signatures as well

1387
00:46:36,870 --> 00:46:34,800
yeah that's a good point you know when

1388
00:46:38,470 --> 00:46:36,880

we find something even if it seems

1389
00:46:39,990 --> 00:46:38,480
biological we still won't jump to that

1390
00:46:41,510 --> 00:46:40,000
conclusion we will try to figure out

1391
00:46:42,950 --> 00:46:41,520
what else it could be first

1392
00:46:44,550 --> 00:46:42,960
that's important for everyone watching

1393
00:46:46,710 --> 00:46:44,560
to remember as well

1394
00:46:49,349 --> 00:46:46,720
uh so this is a really fun question uh

1395
00:46:51,589 --> 00:46:49,359
from satyam tawari on sagonet

1396
00:46:53,589 --> 00:46:51,599
uh satyam wants to know and and being a

1397
00:46:54,710 --> 00:46:53,599
huge sci-fi nerd i love this question

1398
00:46:57,550 --> 00:46:54,720
satyam

1399
00:46:59,430 --> 00:46:57,560
uh is there a possibility that there are

1400
00:47:01,349 --> 00:46:59,440
extraterrestrial artifacts

1401
00:47:04,069 --> 00:47:01,359
lurking right now within our own solar

1402
00:47:09,430 --> 00:47:07,990
e are you asking is that a possibility

1403
00:47:11,030 --> 00:47:09,440
he says is there a possibility do you

1404
00:47:12,230 --> 00:47:11,040
think there are extraterrestrial

1405
00:47:15,270 --> 00:47:12,240
artifacts

1406
00:47:16,550 --> 00:47:15,280
i would say there could be there is

1407
00:47:18,550 --> 00:47:16,560
there could be extraterrestrial

1408
00:47:19,030 --> 00:47:18,560
artifacts without any evidence without

1409
00:47:21,990 --> 00:47:19,040
any

1410
00:47:22,710 --> 00:47:22,000
observations that i could think about or

1411
00:47:25,190 --> 00:47:22,720
i would say

1412
00:47:26,470 --> 00:47:25,200
if yeah i mean there could be a

1413
00:47:28,630 --> 00:47:26,480

possibility

1414
00:47:29,910 --> 00:47:28,640
if they are extraterrestrial i don't

1415
00:47:32,390 --> 00:47:29,920
know yeah

1416
00:47:33,430 --> 00:47:32,400
you know that's one thing there could be

1417
00:47:35,430 --> 00:47:33,440
you know just like we are sending

1418
00:47:37,109 --> 00:47:35,440
voyager probes pioneer probes to

1419
00:47:39,190 --> 00:47:37,119
interstellar space to other solar

1420
00:47:41,349 --> 00:47:39,200
systems other planetary systems

1421
00:47:42,710 --> 00:47:41,359
there could be extraterrestrial probes

1422
00:47:44,950 --> 00:47:42,720
in our system as well

1423
00:47:46,950 --> 00:47:44,960
yeah yeah i mean it's an intriguing

1424
00:47:47,910 --> 00:47:46,960
question reminds me of like 2001 a space

1425
00:47:49,829 --> 00:47:47,920
odyssey

1426
00:47:51,270 --> 00:47:49,839
and this idea of the cosmic zoo maybe

1427
00:47:52,630 --> 00:47:51,280
there are intelligent aliens out there

1428
00:47:54,470 --> 00:47:52,640
just waiting for us

1429
00:47:55,910 --> 00:47:54,480
to become intelligent enough to have a

1430
00:47:58,790 --> 00:47:55,920
conversation with

1431
00:48:00,630 --> 00:47:58,800
um and i love that idea um our next

1432
00:48:03,910 --> 00:48:00,640
question comes from preetha jaipal

1433
00:48:05,430 --> 00:48:03,920
on segednet preetha says to what extent

1434
00:48:06,630 --> 00:48:05,440
would the launch of the james webb space

1435
00:48:09,349 --> 00:48:06,640
telescope

1436
00:48:11,109 --> 00:48:09,359
accelerate our search for life and do

1437
00:48:12,549 --> 00:48:11,119
you think studying planetary systems

1438
00:48:13,910 --> 00:48:12,559

around white dwarfs

1439
00:48:15,349 --> 00:48:13,920
would increase our chances of coming

1440
00:48:17,349 --> 00:48:15,359
across exciting and significant

1441
00:48:19,190 --> 00:48:17,359
discoveries in the near future

1442
00:48:20,630 --> 00:48:19,200
so i'll answer the first question first

1443
00:48:21,349 --> 00:48:20,640
about james webb and then i'll come to

1444
00:48:24,390 --> 00:48:21,359
the whiteboard

1445
00:48:26,870 --> 00:48:24,400
one so with james webb um

1446
00:48:28,470 --> 00:48:26,880
if we are lucky and if the life is

1447
00:48:30,950 --> 00:48:28,480
really weird and

1448
00:48:31,829 --> 00:48:30,960
produces high signal in the in the most

1449
00:48:35,829 --> 00:48:31,839
unusual

1450
00:48:36,630 --> 00:48:35,839
part of the um you know on a planetary

1451
00:48:38,150 --> 00:48:36,640
system

1452
00:48:39,910 --> 00:48:38,160
like you know if the planet is very

1453
00:48:43,270 --> 00:48:39,920
close to the star in

1454
00:48:44,390 --> 00:48:43,280
hydrogen dominated gas super hot and if

1455
00:48:47,190 --> 00:48:44,400
we find something

1456
00:48:48,309 --> 00:48:47,200
strange over there you know yeah that is

1457
00:48:50,710 --> 00:48:48,319
a possibility

1458
00:48:51,750 --> 00:48:50,720
but for habitable zone planets around uh

1459
00:48:55,270 --> 00:48:51,760
cool stars

1460
00:48:56,309 --> 00:48:55,280
um you know james webb we have to get

1461
00:48:59,109 --> 00:48:56,319
lucky on that one

1462
00:49:00,870 --> 00:48:59,119
and we it needs a bit of time for that

1463
00:49:03,270 --> 00:49:00,880

it's not impossible

1464
00:49:04,150 --> 00:49:03,280
but there is a confluence of several

1465
00:49:06,390 --> 00:49:04,160
factors that

1466
00:49:07,670 --> 00:49:06,400
have to work for us to detect a

1467
00:49:10,950 --> 00:49:07,680
habitable zone

1468
00:49:14,630 --> 00:49:10,960
planet

1469
00:49:16,230 --> 00:49:14,640
atmosphere with james webb okay so

1470
00:49:17,589 --> 00:49:16,240
okay so that the second question is

1471
00:49:20,549 --> 00:49:17,599
about the white orange should we look at

1472
00:49:23,829 --> 00:49:20,559
white was for potential life signatures

1473
00:49:27,030 --> 00:49:23,839
uh again you know my traditional

1474
00:49:28,549 --> 00:49:27,040
conservative scientists think that what

1475
00:49:30,150 --> 00:49:28,559
white wars are dead stars

1476
00:49:31,670 --> 00:49:30,160
why should we look for life around

1477
00:49:33,109 --> 00:49:31,680
planets around dead stars

1478
00:49:34,790 --> 00:49:33,119
you can ask the same question to me

1479
00:49:36,630 --> 00:49:34,800
about pulsar planets why should you look

1480
00:49:39,910 --> 00:49:36,640
for planets around pulsars

1481
00:49:42,470 --> 00:49:39,920
right okay so so i would say

1482
00:49:43,030 --> 00:49:42,480
my traditional scientists thinking cap i

1483
00:49:46,069 --> 00:49:43,040
would say

1484
00:49:47,030 --> 00:49:46,079
probably yeah no but my technological

1485
00:49:48,950 --> 00:49:47,040
civilization

1486
00:49:50,710 --> 00:49:48,960
side of the guy says that no no no no

1487
00:49:52,230 --> 00:49:50,720
you wait a minute you know you never

1488
00:49:55,270 --> 00:49:52,240

know what will happen so

1489
00:49:57,030 --> 00:49:55,280
i would say yes you you don't know units

1490
00:49:59,829 --> 00:49:57,040
is far more clever than you

1491
00:50:01,349 --> 00:49:59,839
so don't dismiss this possibility i love

1492
00:50:01,910 --> 00:50:01,359
it the universe is far more clever than

1493
00:50:03,990 --> 00:50:01,920
you

1494
00:50:05,750 --> 00:50:04,000
uh and this feeds really well into our

1495
00:50:06,950 --> 00:50:05,760
next question which is also a really

1496
00:50:10,230 --> 00:50:06,960
wonderful question

1497
00:50:13,430 --> 00:50:10,240
from azul of pinoba uh

1498
00:50:16,230 --> 00:50:13,440
azulpinoba on twitter azul wants to know

1499
00:50:17,990 --> 00:50:16,240
what feelings run through you every time

1500
00:50:19,109 --> 00:50:18,000
you look at these different systems of

1501
00:50:21,589 --> 00:50:19,119
the universe

1502
00:50:22,870 --> 00:50:21,599
and you notice some unexpected patterns

1503
00:50:26,790 --> 00:50:22,880
or results

1504
00:50:29,190 --> 00:50:26,800
versus what we expect to find

1505
00:50:31,589 --> 00:50:29,200
what my my feelings my feelings are that

1506
00:50:34,630 --> 00:50:31,599
i feel small

1507
00:50:39,030 --> 00:50:34,640
because i feel like we

1508
00:50:40,630 --> 00:50:39,040
we have we don't know so many things

1509
00:50:42,150 --> 00:50:40,640
compared to what the universe is

1510
00:50:43,829 --> 00:50:42,160
offering or just

1511
00:50:45,270 --> 00:50:43,839
show you know it's not even an offering

1512
00:50:47,510 --> 00:50:45,280
it doesn't care if we

1513
00:50:49,510 --> 00:50:47,520

are looking at or not we are trying to

1514
00:50:51,589 --> 00:50:49,520
look at this part of the

1515
00:50:53,190 --> 00:50:51,599
spa you know area of the universe and

1516
00:50:53,670 --> 00:50:53,200
the universe is giving us the whole

1517
00:50:55,829 --> 00:50:53,680
thing

1518
00:50:57,910 --> 00:50:55,839
and we are not even able to see it so

1519
00:51:00,390 --> 00:50:57,920
when when i see some unusual patterns

1520
00:51:01,349 --> 00:51:00,400
it feels like a new window has opened a

1521
00:51:03,109 --> 00:51:01,359
small window

1522
00:51:05,190 --> 00:51:03,119
so there are several such windows that

1523
00:51:08,470 --> 00:51:05,200
we need to open to understand the whole

1524
00:51:10,950 --> 00:51:08,480
whole universe so i feel i feel small

1525
00:51:12,870 --> 00:51:10,960
and i feel humbled that you know i need

1526
00:51:15,349 --> 00:51:12,880
to learn a lot from the universe

1527
00:51:16,870 --> 00:51:15,359
yeah astrobiology and astronomy in

1528
00:51:18,790 --> 00:51:16,880
general are very humbling

1529
00:51:20,470 --> 00:51:18,800
experiences as carl sagan once remarked

1530
00:51:22,470 --> 00:51:20,480
and as andrew and once

1531
00:51:24,150 --> 00:51:22,480
for small creatures such as we this this

1532
00:51:26,549 --> 00:51:24,160
universe this vastness

1533
00:51:27,829 --> 00:51:26,559
is bearable only through love and and i

1534
00:51:29,510 --> 00:51:27,839
love that idea

1535
00:51:31,109 --> 00:51:29,520
um we have an interesting question here

1536
00:51:33,510 --> 00:51:31,119
that could be really important

1537
00:51:35,430 --> 00:51:33,520
um for the future for indian students

1538
00:51:37,510 --> 00:51:35,440

who are interested in astrobiology and

1539
00:51:39,109 --> 00:51:37,520
for myself recently i i've given several

1540
00:51:42,630 --> 00:51:39,119
talks to students

1541
00:51:44,549 --> 00:51:42,640
in india in pakistan in morocco and iran

1542
00:51:45,670 --> 00:51:44,559
and all through south america and chile

1543
00:51:47,510 --> 00:51:45,680
and colombia

1544
00:51:49,270 --> 00:51:47,520
australia just all around the world i'm

1545
00:51:50,230 --> 00:51:49,280
really impressed right now by how many

1546
00:51:51,990 --> 00:51:50,240
people

1547
00:51:53,349 --> 00:51:52,000
around the world want to be involved in

1548
00:51:55,030 --> 00:51:53,359
astrobiology

1549
00:51:56,710 --> 00:51:55,040
uh and so our next question comes from

1550
00:52:00,630 --> 00:51:56,720
shivang kondaweli

1551
00:52:03,030 --> 00:52:00,640
a user at rabbi alcoon on twitter

1552
00:52:04,470 --> 00:52:03,040
shivang wants to know what do you think

1553
00:52:06,710 --> 00:52:04,480
are the career scopes

1554
00:52:08,790 --> 00:52:06,720
in astrobiology for indian residents who

1555
00:52:11,030 --> 00:52:08,800
want to be involved in this field

1556
00:52:13,349 --> 00:52:11,040
um so if there are i'm i'm not sure

1557
00:52:14,870 --> 00:52:13,359
there are so i was uh in india this

1558
00:52:16,549 --> 00:52:14,880
january past january and gave a couple

1559
00:52:18,549 --> 00:52:16,559
of talks that

1560
00:52:20,390 --> 00:52:18,559
there is an institute called icer in

1561
00:52:23,589 --> 00:52:20,400
pune uh city

1562
00:52:24,630 --> 00:52:23,599
uh and also in ayuka where i did my

1563
00:52:27,829 --> 00:52:24,640

masters

1564
00:52:29,990 --> 00:52:27,839
uh and so i recently gave a talk at

1565
00:52:33,670 --> 00:52:30,000
bangalore university as well

1566
00:52:37,270 --> 00:52:33,680
uh just last month so i i

1567
00:52:39,109 --> 00:52:37,280
my feeling is that they may in the major

1568
00:52:41,589 --> 00:52:39,119
institutes or in the ones that are

1569
00:52:44,230 --> 00:52:41,599
traditional institutes there is a

1570
00:52:45,990 --> 00:52:44,240
not yet an astrobiology program or an

1571
00:52:47,990 --> 00:52:46,000
exoplanet program

1572
00:52:50,150 --> 00:52:48,000
uh if you are interested in that then

1573
00:52:52,470 --> 00:52:50,160
you would you know it would be good to

1574
00:52:53,510 --> 00:52:52,480
communicate with people who are working

1575
00:52:55,510 --> 00:52:53,520
around the world

1576
00:52:56,870 --> 00:52:55,520
to do a project i have a student who's

1577
00:52:59,270 --> 00:52:56,880
working um

1578
00:53:01,270 --> 00:52:59,280
with me who work with me who did his

1579
00:53:02,150 --> 00:53:01,280
master's thesis from the icer institute

1580
00:53:06,069 --> 00:53:02,160
at pune on

1581
00:53:08,309 --> 00:53:06,079
exoplanet uh exoplanets so yeah so

1582
00:53:09,510 --> 00:53:08,319
one i would say i mean i'm going to go

1583
00:53:11,510 --> 00:53:09,520
back to my

1584
00:53:13,589 --> 00:53:11,520
introduction you know how did i get

1585
00:53:16,549 --> 00:53:13,599
started it's networking

1586
00:53:17,910 --> 00:53:16,559
networking is i would say fundamental

1587
00:53:20,710 --> 00:53:17,920
thing that you should

1588
00:53:22,390 --> 00:53:20,720

keep doing so that you can get to more

1589
00:53:24,790 --> 00:53:22,400
and more opportunities

1590
00:53:25,589 --> 00:53:24,800
in the interested field you want so do

1591
00:53:30,950 --> 00:53:25,599
not

1592
00:53:32,870 --> 00:53:30,960
shyness come in between because

1593
00:53:35,510 --> 00:53:32,880
networking will take you

1594
00:53:37,430 --> 00:53:35,520
you know a long way so try to network as

1595
00:53:38,870 --> 00:53:37,440
much as possible

1596
00:53:40,470 --> 00:53:38,880
yeah absolutely i agree and like i

1597
00:53:41,190 --> 00:53:40,480
mentioned i've been in contact with so

1598
00:53:44,470 --> 00:53:41,200
many

1599
00:53:45,910 --> 00:53:44,480
other places uh

1600
00:53:47,990 --> 00:53:45,920
many of you who are from india and are

1601
00:53:50,309 --> 00:53:48,000
interested might even be taking the

1602
00:53:52,309 --> 00:53:50,319
online introductory astrobiology course

1603
00:53:54,309 --> 00:53:52,319
from amity university currently

1604
00:53:55,589 --> 00:53:54,319
uh several hundred people signed up for

1605
00:53:57,510 --> 00:53:55,599
that course

1606
00:53:59,430 --> 00:53:57,520
there's a really cool graphic out there

1607
00:54:00,549 --> 00:53:59,440
made by a student from guatemala named

1608
00:54:02,790 --> 00:54:00,559
kat herrera

1609
00:54:04,870 --> 00:54:02,800
where she took all the languages of the

1610
00:54:06,950 --> 00:54:04,880
attendees of this online course

1611
00:54:08,790 --> 00:54:06,960
in 36 different languages and has the

1612
00:54:11,190 --> 00:54:08,800
word astrobiology written and

1613
00:54:13,109 --> 00:54:11,200

that's really powerful um again you know

1614
00:54:14,150 --> 00:54:13,119
astrobiology it's not just a humbling

1615
00:54:16,790 --> 00:54:14,160
experience

1616
00:54:17,910 --> 00:54:16,800
but it's also an international a human

1617
00:54:19,270 --> 00:54:17,920
experience too

1618
00:54:21,910 --> 00:54:19,280
that's bringing us together now from

1619
00:54:23,589 --> 00:54:21,920
around the world we have about five more

1620
00:54:25,829 --> 00:54:23,599
minutes here and so i have a few more

1621
00:54:29,829 --> 00:54:25,839
questions i'd like to get to if we can

1622
00:54:31,750 --> 00:54:29,839
uh user dan haller on segonnet has asked

1623
00:54:33,829 --> 00:54:31,760
as we look for microbial life in the

1624
00:54:36,150 --> 00:54:33,839
clouds of planets

1625
00:54:37,670 --> 00:54:36,160
is there any effort to examine periodic

1626
00:54:40,950 --> 00:54:37,680
comets for life

1627
00:54:44,230 --> 00:54:40,960
when they enter the habitable zone

1628
00:54:46,630 --> 00:54:44,240
um so there are there is

1629
00:54:47,750 --> 00:54:46,640
i wouldn't call the comet entering into

1630
00:54:50,710 --> 00:54:47,760
a habitable zone

1631
00:54:52,950 --> 00:54:50,720
uh as this comet comes near the sun it

1632
00:54:55,430 --> 00:54:52,960
becomes you know it generally creates a

1633
00:54:58,950 --> 00:54:55,440
tail because of the solar bin pressure

1634
00:55:01,190 --> 00:54:58,960
um there we maybe we can sample send a

1635
00:55:02,150 --> 00:55:01,200
spacecraft and sample the tail of the

1636
00:55:05,430 --> 00:55:02,160
comet to

1637
00:55:08,470 --> 00:55:05,440
find organics for example and to see if

1638
00:55:10,390 --> 00:55:08,480

any rudimentary life

1639
00:55:13,270 --> 00:55:10,400
molecules are available so yeah i mean

1640
00:55:16,630 --> 00:55:13,280
that that could be possible

1641
00:55:20,150 --> 00:55:16,640
awesome yeah so another one uh from user

1642
00:55:21,750 --> 00:55:20,160
lord n644 on twitter going by the name

1643
00:55:23,589 --> 00:55:21,760
nawang sherpa

1644
00:55:29,990 --> 00:55:23,599
wants to know what do you think is

1645
00:55:34,069 --> 00:55:32,150
we won't know until we actually find

1646
00:55:35,030 --> 00:55:34,079
something and then we say hey we missed

1647
00:55:39,109 --> 00:55:35,040
that

1648
00:55:41,589 --> 00:55:39,119
you know more collaboration more

1649
00:55:44,710 --> 00:55:41,599
interdisciplinary collaboration with um

1650
00:55:45,829 --> 00:55:44,720
different fields uh of uh research at

1651
00:55:48,950 --> 00:55:45,839
geologists

1652
00:55:52,309 --> 00:55:48,960
uh as biologists i would say

1653
00:55:54,150 --> 00:55:52,319
physi physicists and also astronomers

1654
00:55:55,829 --> 00:55:54,160
more promoting more collaboration with

1655
00:55:57,430 --> 00:55:55,839
them because we will all have different

1656
00:55:58,549 --> 00:55:57,440
perspectives so that's what it's not

1657
00:56:01,670 --> 00:55:58,559
missing i would say

1658
00:56:05,030 --> 00:56:01,680
i'd say you know a more strengthened

1659
00:56:06,950 --> 00:56:05,040
cooperation would mean awesome and

1660
00:56:08,309 --> 00:56:06,960
if you don't mind just one more question

1661
00:56:09,030 --> 00:56:08,319
and then i think we'll wrap our episode

1662
00:56:11,230 --> 00:56:09,040
here

1663
00:56:13,030 --> 00:56:11,240

uh this next one comes from user at

1664
00:56:15,910 --> 00:56:13,040
cronenberg211

1665
00:56:17,670 --> 00:56:15,920
by the name miriam cronenberg on twitter

1666
00:56:20,069 --> 00:56:17,680
miriam would like to know that if you

1667
00:56:21,829 --> 00:56:20,079
if if you feel uh is there enough

1668
00:56:24,390 --> 00:56:21,839
invested in technology

1669
00:56:26,230 --> 00:56:24,400
in your opinion for example to ever

1670
00:56:27,109 --> 00:56:26,240
reach exoplanets ourselves with our

1671
00:56:29,910 --> 00:56:27,119
robots

1672
00:56:31,109 --> 00:56:29,920
we have to go a lot faster so i i think

1673
00:56:32,069 --> 00:56:31,119
miriam wants to know like what your

1674
00:56:34,390 --> 00:56:32,079
opinion is on

1675
00:56:35,510 --> 00:56:34,400
our current investments uh in future

1676
00:56:37,270 --> 00:56:35,520
technologies like

1677
00:56:38,870 --> 00:56:37,280
getting out to these actual exoplanets

1678
00:56:42,069 --> 00:56:38,880
ourselves

1679
00:56:44,710 --> 00:56:42,079
um so we have um

1680
00:56:45,670 --> 00:56:44,720
uh so there is the technology has to be

1681
00:56:47,910 --> 00:56:45,680
significantly

1682
00:56:50,069 --> 00:56:47,920
uh improved uh the breakthrough

1683
00:56:51,670 --> 00:56:50,079
initiative is uh starting this solar

1684
00:56:53,589 --> 00:56:51,680
sail project i think uh

1685
00:56:54,870 --> 00:56:53,599
you know to reach proxima centauri which

1686
00:56:57,510 --> 00:56:54,880
is the nearest star

1687
00:56:58,630 --> 00:56:57,520
uh in about two or three decade decades

1688
00:57:00,470 --> 00:56:58,640

also otherwise

1689
00:57:01,829 --> 00:57:00,480
with the common rocket technology that

1690
00:57:05,109 --> 00:57:01,839
we have it would take 70

1691
00:57:07,670 --> 00:57:05,119
000 years and so you know

1692
00:57:09,670 --> 00:57:07,680
uh propulsion technique technology is

1693
00:57:12,710 --> 00:57:09,680
the most important thing and

1694
00:57:14,710 --> 00:57:12,720
and then try to avoid uh you know

1695
00:57:15,910 --> 00:57:14,720
how to navigate through the interstellar

1696
00:57:19,750 --> 00:57:15,920
space at that high speeds

1697
00:57:22,069 --> 00:57:19,760
is one area we would have to focus on

1698
00:57:23,589 --> 00:57:22,079
yeah i agree entirely and i i think i

1699
00:57:25,990 --> 00:57:23,599
think you know you've given us here some

1700
00:57:27,750 --> 00:57:26,000
hope for the future of astrobiology just

1701
00:57:29,190 --> 00:57:27,760
by having these you know these new space

1702
00:57:29,589 --> 00:57:29,200
telescopes and by the research that

1703
00:57:31,990 --> 00:57:29,599
you're

1704
00:57:33,109 --> 00:57:32,000
currently working on uh and who knows

1705
00:57:34,390 --> 00:57:33,119
folks it might be right around the

1706
00:57:36,789 --> 00:57:34,400
corner that we find

1707
00:57:38,870 --> 00:57:36,799
uh techno signatures out there or signs

1708
00:57:40,069 --> 00:57:38,880
of an alien civilization or just alien

1709
00:57:41,270 --> 00:57:40,079
life uh

1710
00:57:43,270 --> 00:57:41,280
i think we're gonna wrap it here though

1711
00:57:44,630 --> 00:57:43,280
so so dr ravi kaparapu

1712
00:57:46,309 --> 00:57:44,640
thank you so much for joining us for

1713
00:57:48,150 --> 00:57:46,319

asking astrobiology

1714
00:57:50,069 --> 00:57:48,160
thank you for having me it was great

1715
00:57:51,829 --> 00:57:50,079
yeah we really appreciate having you on

1716
00:57:53,270 --> 00:57:51,839
uh to all of our viewers uh we like to

1717
00:57:54,069 --> 00:57:53,280
always have a little call for action for

1718
00:57:55,990 --> 00:57:54,079
all of you to stay

1719
00:57:57,349 --> 00:57:56,000
engaged during the month while we're

1720
00:57:58,870 --> 00:57:57,359
away from the show

1721
00:58:01,190 --> 00:57:58,880
so here's a question for all of you

1722
00:58:03,990 --> 00:58:01,200
watching you can answer on twitter using

1723
00:58:05,990 --> 00:58:04,000
ask astrobio if you like do you think

1724
00:58:07,430 --> 00:58:06,000
we'll discover signs of intelligent

1725
00:58:09,510 --> 00:58:07,440
biological life

1726
00:58:11,270 --> 00:58:09,520
before we ever find any actual life

1727
00:58:12,870 --> 00:58:11,280
forms on other worlds

1728
00:58:15,030 --> 00:58:12,880
uh so feel free to let us know you can

1729
00:58:17,510 --> 00:58:15,040
let us know on facebook on saggingnet

1730
00:58:18,069 --> 00:58:17,520
and also on twitter as i mentioned uh

1731
00:58:20,150 --> 00:58:18,079
and so

1732
00:58:21,510 --> 00:58:20,160
thanks for joining us and as usual until

1733
00:58:37,870 --> 00:58:21,520
next time remember