Ask An Astrobiologist

Episode 40: April 20th, 2021

Dr. Jen Blank

NASA Astrobiology Program

1
00:00:00,680 --> 00:00:30,070
[Music]

2
00:00:33,830 --> 00:00:30,870
greetings

3
00:00:35,590 --> 00:00:33,840
friends fellow explorers and perhaps

4
00:00:37,830 --> 00:00:35,600
avid spelunkers

5
00:00:40,229 --> 00:00:37,840
welcome to ask anthro biologists the

6
00:00:42,630 --> 00:00:40,239
show that celebrates the science

7
00:00:45,190 --> 00:00:42,640
and celebrates the scientists involved

8
00:00:47,029 --> 00:00:45,200
in our quest to understand the nature of

9
00:00:49,430 --> 00:00:47,039
life in the cosmos

10
00:00:51,750 --> 00:00:49,440
i'm your host dr graham lau and our show

11
00:00:54,709 --> 00:00:51,760
is brought to you by saginet.org

12
00:00:56,310 --> 00:00:54,719
and the nasa astrobiology program and

13
00:00:58,790 --> 00:00:56,320

this month's episode is going to be

14
00:01:00,069 --> 00:00:58,800
a lot of fun our special featured guest

15
00:01:02,470 --> 00:01:00,079
this month is going to take us

16
00:01:04,310 --> 00:01:02,480
some really cool places around the world

17
00:01:05,789 --> 00:01:04,320
to think about how we use analog

18
00:01:08,149 --> 00:01:05,799
environments for

19
00:01:09,429 --> 00:01:08,159
astrobiology including some places that

20
00:01:13,030 --> 00:01:09,439
will take us deep into

21
00:01:14,789 --> 00:01:13,040
caves and lava tubes of course as usual

22
00:01:17,350 --> 00:01:14,799
before we get there we like to

23
00:01:19,270 --> 00:01:17,360
say a huge thanks to folks out there

24
00:01:21,990 --> 00:01:19,280
online on twitter and facebook

25
00:01:23,429 --> 00:01:22,000
instagram linkedin all the fun places

26
00:01:25,429 --> 00:01:23,439
who are sharing

27
00:01:27,510 --> 00:01:25,439
our show with others especially those of

28
00:01:29,429 --> 00:01:27,520
you on twitter who are retweeting all of

29
00:01:30,550 --> 00:01:29,439
the posts from nasa astrobiology and

30
00:01:32,550 --> 00:01:30,560
from saginet

31
00:01:33,830 --> 00:01:32,560
we really appreciate all the support we

32
00:01:36,069 --> 00:01:33,840
like to think of you as

33
00:01:37,190 --> 00:01:36,079
our ambassadors and this month we'd love

34
00:01:40,710 --> 00:01:37,200
to highlight

35
00:01:43,749 --> 00:01:40,720
denise at astrobio dnz

36
00:01:44,389 --> 00:01:43,759
and anna root mohanty at strayologist

37
00:01:46,789 --> 00:01:44,399
for being

38
00:01:47,990 --> 00:01:46,799

ambassadors for the show for sharing

39
00:01:49,510 --> 00:01:48,000
information about

40
00:01:51,190 --> 00:01:49,520
all of the things that we're doing for

41
00:01:52,069 --> 00:01:51,200
getting involved and asking questions of

42
00:01:54,950 --> 00:01:52,079
our guests

43
00:01:56,870 --> 00:01:54,960
and for just being really cool people so

44
00:01:58,789 --> 00:01:56,880
that said i get to now introduce our

45
00:02:01,350 --> 00:01:58,799
featured guest for this month

46
00:02:03,350 --> 00:02:01,360
and i have a lot to say about her

47
00:02:06,389 --> 00:02:03,360
joining us is dr jen blank

48
00:02:08,949 --> 00:02:06,399
she's a geochemist and astrobiologist

49
00:02:10,630 --> 00:02:08,959
at both nasa's ames research center and

50
00:02:11,670 --> 00:02:10,640
with the blue marble space institute of

51
00:02:14,150 --> 00:02:11,680
science

52
00:02:16,470 --> 00:02:14,160
she studies mars analog environments on

53
00:02:18,470 --> 00:02:16,480
earth focusing on the potential for

54
00:02:19,910 --> 00:02:18,480
water rock interactions to support

55
00:02:21,589 --> 00:02:19,920
microbial life and

56
00:02:23,350 --> 00:02:21,599
trying to understand the geochemical

57
00:02:24,949 --> 00:02:23,360
signatures of that life

58
00:02:27,270 --> 00:02:24,959
and how we could use those signatures

59
00:02:29,270 --> 00:02:27,280
and looking for life elsewhere

60
00:02:31,110 --> 00:02:29,280
she's done field work in all kinds of

61
00:02:32,790 --> 00:02:31,120
places around our planet

62
00:02:34,309 --> 00:02:32,800
places like looking at carbonates

63
00:02:37,350 --> 00:02:34,319

associated with cold springs and

64
00:02:39,910 --> 00:02:37,360
ultramafic terrain in del puerto

65
00:02:42,150 --> 00:02:39,920
ophelite in california she studied

66
00:02:44,470 --> 00:02:42,160
centers in warm springs in the ante

67
00:02:46,949 --> 00:02:44,480
the andes in chile she studied hot

68
00:02:48,229 --> 00:02:46,959
springs in the indian himalaya in ladakh

69
00:02:49,910 --> 00:02:48,239
in india

70
00:02:51,270 --> 00:02:49,920
she's been around the world to do some

71
00:02:52,949 --> 00:02:51,280
really cool stuff and now she's the

72
00:02:54,949 --> 00:02:52,959
principal investigator

73
00:02:57,509 --> 00:02:54,959
of the project funded by nasa called

74
00:02:59,509 --> 00:02:57,519
braille or the biologic and resource

75
00:03:00,949 --> 00:02:59,519
analog investigations and low light

76
00:03:03,589 --> 00:03:00,959
environments project

77
00:03:05,190 --> 00:03:03,599
where they're actively exploring caves

78
00:03:07,589 --> 00:03:05,200
and lava tubes including

79
00:03:08,229 --> 00:03:07,599
using robots uh and so without further

80
00:03:10,229 --> 00:03:08,239
ado

81
00:03:11,990 --> 00:03:10,239
uh dr jen blank thank you for joining us

82
00:03:13,110 --> 00:03:12,000
for ask an astrobiologist and welcome to

83
00:03:14,390 --> 00:03:13,120
the show

84
00:03:16,630 --> 00:03:14,400
thanks fran then thanks for that

85
00:03:17,990 --> 00:03:16,640
introduction i mean there's

86
00:03:19,750 --> 00:03:18,000
cool stuff to say about the places

87
00:03:21,670 --> 00:03:19,760
you've been the things that you've done

88
00:03:23,110 --> 00:03:21,680

uh before our start our show we had a

89
00:03:25,110 --> 00:03:23,120
chance to chat you and i and

90
00:03:26,470 --> 00:03:25,120
i'm just blown away by how much awesome

91
00:03:29,830 --> 00:03:26,480
research you've done

92
00:03:30,149 --> 00:03:29,840
uh throughout your career uh now for our

93
00:03:31,509 --> 00:03:30,159
show

94
00:03:32,869 --> 00:03:31,519
you know you and i will chat for roughly

95
00:03:34,470 --> 00:03:32,879
a half an hour and then we'll open it up

96
00:03:36,390 --> 00:03:34,480
to audience questions

97
00:03:38,710 --> 00:03:36,400
so for those watching if you have any

98
00:03:40,390 --> 00:03:38,720
questions for dr blank along the way

99
00:03:42,229 --> 00:03:40,400
feel free to drop those in the chat in

100
00:03:43,750 --> 00:03:42,239
saginet and on facebook

101
00:03:46,149 --> 00:03:43,760
and we'll get those over to me to ask

102
00:03:47,670 --> 00:03:46,159
for for dr blank here shortly

103
00:03:49,030 --> 00:03:47,680
but the first thing i love to do with

104
00:03:50,149 --> 00:03:49,040
all of our guests when they join us for

105
00:03:51,910 --> 00:03:50,159
the show is

106
00:03:53,750 --> 00:03:51,920
to kind of figure out a little bit about

107
00:03:54,789 --> 00:03:53,760
what really got you into the science

108
00:03:57,990 --> 00:03:54,799
that you do

109
00:03:59,190 --> 00:03:58,000
what your science origin story was and i

110
00:04:01,110 --> 00:03:59,200
understand that you're a third

111
00:04:02,630 --> 00:04:01,120
generation geoscientist

112
00:04:04,390 --> 00:04:02,640
so i wonder if you could explain a bit

113
00:04:05,830 --> 00:04:04,400

to us about what that was like and and

114
00:04:08,149 --> 00:04:05,840
how that inspired you to become a

115
00:04:10,869 --> 00:04:08,159
geoscientist yourself

116
00:04:11,750 --> 00:04:10,879
okay well um yes my dad is a

117
00:04:14,229 --> 00:04:11,760
geophysicist

118
00:04:15,429 --> 00:04:14,239
and he's still working on his maps in

119
00:04:16,390 --> 00:04:15,439
the basement of their house up in

120
00:04:18,229 --> 00:04:16,400
washington state

121
00:04:21,509 --> 00:04:18,239
and my grandfather was a mineralogist

122
00:04:24,790 --> 00:04:21,519
who was a professor for many years at

123
00:04:27,350 --> 00:04:24,800
texas a m college and

124
00:04:28,390 --> 00:04:27,360
um anyway i think what got mentioned in

125
00:04:31,110 --> 00:04:28,400
science

126
00:04:32,070 --> 00:04:31,120
well i guess following my dad and also

127
00:04:34,310 --> 00:04:32,080
growing up

128
00:04:36,790 --> 00:04:34,320
camping and traveling all over the world

129
00:04:39,510 --> 00:04:36,800
uh and always to places that were

130
00:04:41,030 --> 00:04:39,520
in new environments whether it was in uh

131
00:04:43,030 --> 00:04:41,040
in the west coast of u.s

132
00:04:45,830 --> 00:04:43,040
or in europe where there weren't any

133
00:04:47,110 --> 00:04:45,840
towns or in africa

134
00:04:48,790 --> 00:04:47,120
or in the middle east where we ended up

135
00:04:50,390 --> 00:04:48,800
living for many years my dad worked for

136
00:04:53,990 --> 00:04:50,400
the survey abroad

137
00:04:55,350 --> 00:04:54,000
um yeah yeah and so

138
00:04:56,870 --> 00:04:55,360

i think you had told me you know you had

139
00:04:58,550 --> 00:04:56,880
the experience of being a young person

140
00:04:59,830 --> 00:04:58,560
in saudi arabia with your dad driving

141
00:05:01,430 --> 00:04:59,840
around in a vehicle and like

142
00:05:03,909 --> 00:05:01,440
you hanging out and pointing out cool

143
00:05:05,510 --> 00:05:03,919
rocks um which is kind of funny

144
00:05:06,790 --> 00:05:05,520
like you're still doing that now you

145
00:05:08,310 --> 00:05:06,800
know in your career like you're pointing

146
00:05:10,230 --> 00:05:08,320
out cool rocks right

147
00:05:12,629 --> 00:05:10,240
yeah what's funny is that i grew up

148
00:05:14,150 --> 00:05:12,639
spending a lot of time outside and

149
00:05:15,830 --> 00:05:14,160
especially with my dad and i think since

150
00:05:18,310 --> 00:05:15,840
i was the oldest kid

151
00:05:19,430 --> 00:05:18,320
i was the you know most able to tap talk

152
00:05:21,670 --> 00:05:19,440
back with him

153
00:05:23,350 --> 00:05:21,680
so he'd point me to things and then test

154
00:05:25,510 --> 00:05:23,360
me he was a professor for some years

155
00:05:27,909 --> 00:05:25,520
and i think i was you know a victim or

156
00:05:29,590 --> 00:05:27,919
whatever i was a captive audience

157
00:05:31,749 --> 00:05:29,600
but it was turned out to be pretty fun

158
00:05:33,110 --> 00:05:31,759
and then when i went to graduate school

159
00:05:36,150 --> 00:05:33,120
i did an experiment a thesis on

160
00:05:38,790 --> 00:05:36,160
experimental metrology and

161
00:05:39,990 --> 00:05:38,800
while i i really um found it challenging

162
00:05:42,629 --> 00:05:40,000
i learned so much

163
00:05:43,670 --> 00:05:42,639

i really missed being outside so little

164
00:05:45,510 --> 00:05:43,680
by little

165
00:05:47,430 --> 00:05:45,520
i've been working my way to work my way

166
00:05:48,790 --> 00:05:47,440
to be able to do this analog research

167
00:05:51,110 --> 00:05:48,800
which is a nice fit

168
00:05:51,990 --> 00:05:51,120
of the more rigorous science and also

169
00:05:55,029 --> 00:05:52,000
field work

170
00:05:57,270 --> 00:05:55,039
and also with a focus on astrobiology

171
00:05:59,270 --> 00:05:57,280
and planetary science

172
00:06:00,790 --> 00:05:59,280
yeah and then a lot of our audience

173
00:06:01,990 --> 00:06:00,800
watching right now are mostly going to

174
00:06:03,830 --> 00:06:02,000
be high school students

175
00:06:06,070 --> 00:06:03,840
undergraduate students early graduate

176
00:06:07,510 --> 00:06:06,080
students i wonder what advice you might

177
00:06:08,390 --> 00:06:07,520
give for someone like that who wants to

178
00:06:10,469 --> 00:06:08,400
pursue

179
00:06:12,469 --> 00:06:10,479
a career similar to yours and do similar

180
00:06:13,029 --> 00:06:12,479
research uh what direction might you

181
00:06:14,710 --> 00:06:13,039
give them

182
00:06:16,230 --> 00:06:14,720
if they wanted to follow kind of in your

183
00:06:18,070 --> 00:06:16,240
in your path

184
00:06:20,150 --> 00:06:18,080
well um i think i mentioned to you

185
00:06:23,990 --> 00:06:20,160
earlier but i've sort of had a

186
00:06:25,270 --> 00:06:24,000
circuitous path so i guess

187
00:06:27,430 --> 00:06:25,280
the biggest thing is find something you

188
00:06:28,790 --> 00:06:27,440

like and that you like enough to work

189
00:06:31,430 --> 00:06:28,800
hard when it's you know when it's not

190
00:06:32,469 --> 00:06:31,440
fun and you know persist with it and

191
00:06:34,790 --> 00:06:32,479
then also

192
00:06:35,590 --> 00:06:34,800
find people who are like-minded so find

193
00:06:39,029 --> 00:06:35,600
a tribe

194
00:06:41,110 --> 00:06:39,039
when things are good and things are bad

195
00:06:42,390 --> 00:06:41,120
and also um you know keep finding

196
00:06:44,870 --> 00:06:42,400
something you like even though it takes

197
00:06:47,670 --> 00:06:44,880
a lot of work i think that's advice

198
00:06:48,230 --> 00:06:47,680
awesome yeah and then uh so you mean

199
00:06:49,670 --> 00:06:48,240
your career

200
00:06:51,350 --> 00:06:49,680
you've done so many cool things you

201
00:06:52,550 --> 00:06:51,360
traveled to so many cool places

202
00:06:53,830 --> 00:06:52,560
i understand that when you've kind of

203
00:06:55,189 --> 00:06:53,840
first started you were kind of looking

204
00:06:57,029 --> 00:06:55,199
at impact craters

205
00:06:59,189 --> 00:06:57,039
and understanding the interactions of

206
00:07:00,870 --> 00:06:59,199
water and and chemistry there

207
00:07:02,710 --> 00:07:00,880
i wonder if you tell us a bit about that

208
00:07:03,909 --> 00:07:02,720
early work that you had done

209
00:07:06,070 --> 00:07:03,919
right well i was working on some

210
00:07:08,070 --> 00:07:06,080
hydrothermal experiments and i went on a

211
00:07:09,350 --> 00:07:08,080
i was actually invited to help a field

212
00:07:10,629 --> 00:07:09,360
trip to iceland

213
00:07:12,950 --> 00:07:10,639

and that's something you don't usually

214
00:07:14,070 --> 00:07:12,960
turn down so i went with the group from

215
00:07:15,990 --> 00:07:14,080
the university of chicago

216
00:07:17,830 --> 00:07:16,000
including one including one of my um

217
00:07:18,550 --> 00:07:17,840
caltech grad school colleagues greg

218
00:07:20,710 --> 00:07:18,560
miller

219
00:07:21,830 --> 00:07:20,720
and he had a big gas gun in the basement

220
00:07:24,870 --> 00:07:21,840
of the university

221
00:07:25,589 --> 00:07:24,880
and he was smashing metal on metal and i

222
00:07:27,270 --> 00:07:25,599
was like wow

223
00:07:29,029 --> 00:07:27,280
i don't really get that but you have

224
00:07:30,629 --> 00:07:29,039
this incredible setup why don't we

225
00:07:31,830 --> 00:07:30,639
simulate a comet hitting the earth or

226
00:07:33,350 --> 00:07:31,840
something like that we can do

227
00:07:35,909 --> 00:07:33,360
astrobiology science

228
00:07:37,749 --> 00:07:35,919
little did i know it'd be really hard

229
00:07:39,430 --> 00:07:37,759
but a lot of experiments are really hard

230
00:07:41,110 --> 00:07:39,440
and so we spent the next several years

231
00:07:43,749 --> 00:07:41,120
trying to make a container

232
00:07:45,390 --> 00:07:43,759
that could withstand sort of a comet

233
00:07:46,550 --> 00:07:45,400
scale impact without blowing up

234
00:07:48,150 --> 00:07:46,560
[Music]

235
00:07:50,230 --> 00:07:48,160
so anyway so i sort of fell into that

236
00:07:51,830 --> 00:07:50,240
right with a colleague who had the tools

237
00:07:54,230 --> 00:07:51,840
and then we both work together for the

238
00:07:56,629 --> 00:07:54,240

next several years to

239
00:07:58,150 --> 00:07:56,639
generate peptides in these impact

240
00:07:59,189 --> 00:07:58,160
experiments simulating common earth

241
00:08:01,270 --> 00:07:59,199
impact

242
00:08:02,629 --> 00:08:01,280
that's so cool yeah and then you know

243
00:08:04,150 --> 00:08:02,639
your research then has taken you

244
00:08:05,670 --> 00:08:04,160
to places like iceland all these other

245
00:08:07,909 --> 00:08:05,680
places around the world

246
00:08:09,189 --> 00:08:07,919
uh we did ask our twitter audience uh

247
00:08:10,869 --> 00:08:09,199
four of the places you've been which

248
00:08:13,270 --> 00:08:10,879
they would prefer to travel to

249
00:08:14,230 --> 00:08:13,280
we offered them the choices of iceland

250
00:08:15,909 --> 00:08:14,240
india

251
00:08:18,710 --> 00:08:15,919
new zealand or going down to south

252
00:08:21,510 --> 00:08:18,720
america and going to the patagonia

253
00:08:24,070 --> 00:08:21,520
and it's kind of a tie between iceland

254
00:08:25,909 --> 00:08:24,080
and new zealand it was pretty close

255
00:08:28,150 --> 00:08:25,919
but i think all four places are are

256
00:08:29,510 --> 00:08:28,160
pretty awesome uh do you have a favorite

257
00:08:30,790 --> 00:08:29,520
place out of those places that you've

258
00:08:34,630 --> 00:08:30,800
been so far

259
00:08:37,990 --> 00:08:34,640
oh um no i like them all

260
00:08:40,709 --> 00:08:38,000
um i have to say that cool things about

261
00:08:42,149 --> 00:08:40,719
india and new zealand and south america

262
00:08:43,990 --> 00:08:42,159
is that without driving

263
00:08:45,190 --> 00:08:44,000

too much well maybe not in the case of

264
00:08:47,190 --> 00:08:45,200
india but you can

265
00:08:48,389 --> 00:08:47,200
find these different different extreme

266
00:08:51,269 --> 00:08:48,399
environments

267
00:08:52,550 --> 00:08:51,279
so whereas iceland i just i love basalt

268
00:08:54,470 --> 00:08:52,560
i'm a fan of basalt

269
00:08:55,670 --> 00:08:54,480
the most common rock on earth i just i

270
00:08:57,509 --> 00:08:55,680
just love it um

271
00:08:59,670 --> 00:08:57,519
but it's iceland's mostly basalt with a

272
00:09:00,630 --> 00:08:59,680
little bit of fun more high silica rock

273
00:09:03,350 --> 00:09:00,640
thrown in

274
00:09:04,630 --> 00:09:03,360
so yeah it'd be hard to choose awesome

275
00:09:05,430 --> 00:09:04,640
yeah i mean i'd have a hard time

276
00:09:06,949 --> 00:09:05,440
choosing

277
00:09:08,470 --> 00:09:06,959
i've only been to iceland on that list

278
00:09:09,590 --> 00:09:08,480
myself so far i'd love to visit those

279
00:09:11,269 --> 00:09:09,600
other places but

280
00:09:13,509 --> 00:09:11,279
still there's so many cool things around

281
00:09:16,310 --> 00:09:13,519
our world for us to see

282
00:09:17,509 --> 00:09:16,320
uh to explore and so one thing that you

283
00:09:18,710 --> 00:09:17,519
mentioned to me when we were preparing

284
00:09:20,150 --> 00:09:18,720
for the episode

285
00:09:22,630 --> 00:09:20,160
is that you like visiting these places

286
00:09:24,230 --> 00:09:22,640
that make you feel small i wonder if you

287
00:09:26,070 --> 00:09:24,240
could speak to that for our audience

288
00:09:27,670 --> 00:09:26,080

what did you mean by places where you

289
00:09:30,870 --> 00:09:27,680
feel small

290
00:09:33,269 --> 00:09:30,880
oh i love being an open space where you

291
00:09:35,509 --> 00:09:33,279
can see the landscape and see

292
00:09:36,310 --> 00:09:35,519
see what folds in the earth so for

293
00:09:38,150 --> 00:09:36,320
example

294
00:09:39,430 --> 00:09:38,160
going to the mars desert research

295
00:09:41,269 --> 00:09:39,440
station where you run the one of the

296
00:09:42,230 --> 00:09:41,279
rover university river challenges

297
00:09:44,230 --> 00:09:42,240
about half an hour away there's

298
00:09:46,310 --> 00:09:44,240
something called the san rafael swell

299
00:09:47,670 --> 00:09:46,320
you see this giant sink line of folded

300
00:09:49,990 --> 00:09:47,680
earth layers and that's

301
00:09:50,790 --> 00:09:50,000
that's amazing we're going to india and

302
00:09:52,550 --> 00:09:50,800
flying in

303
00:09:54,470 --> 00:09:52,560
through the himalayas in tallay which is

304
00:09:57,110 --> 00:09:54,480
the biggest town in ladakh

305
00:09:58,870 --> 00:09:57,120
region of india and seeing the giant

306
00:09:59,590 --> 00:09:58,880
mountains and just thinking wow i'm so

307
00:10:01,190 --> 00:09:59,600
tiny here

308
00:10:03,509 --> 00:10:01,200
or the all the features actually in the

309
00:10:05,030 --> 00:10:03,519
dark are super sized

310
00:10:06,550 --> 00:10:05,040
um you know we're just being able to out

311
00:10:08,630 --> 00:10:06,560
look over the

312
00:10:10,550 --> 00:10:08,640
ocean rift in iceland and see well i'm

313
00:10:13,190 --> 00:10:10,560

standing i'm straddling

314
00:10:14,230 --> 00:10:13,200
place a place where the world is being

315
00:10:16,069 --> 00:10:14,240
rifted apart

316
00:10:18,150 --> 00:10:16,079
this really inspires me and makes me

317
00:10:19,829 --> 00:10:18,160
think about bigger scale processes than

318
00:10:23,110 --> 00:10:19,839
my daily problems

319
00:10:24,550 --> 00:10:23,120
or challenges yes so i mean

320
00:10:26,630 --> 00:10:24,560
that kind of also then kind of is a good

321
00:10:28,150 --> 00:10:26,640
abstraction to astrobiology and

322
00:10:29,590 --> 00:10:28,160
applying what you're doing all these you

323
00:10:30,630 --> 00:10:29,600
know unique environments and unique

324
00:10:32,470 --> 00:10:30,640
systems around the planet for

325
00:10:34,310 --> 00:10:32,480
understanding life elsewhere

326
00:10:36,150 --> 00:10:34,320
did you always want to be involved in

327
00:10:37,910 --> 00:10:36,160
that that exploration of using these

328
00:10:38,790 --> 00:10:37,920
places to understand potential for life

329
00:10:40,310 --> 00:10:38,800
out there or

330
00:10:43,030 --> 00:10:40,320
what was the thing that really got you

331
00:10:45,590 --> 00:10:43,040
inspired to start applying geochemistry

332
00:10:46,389 --> 00:10:45,600
in earth systems to other worlds well i

333
00:10:47,990 --> 00:10:46,399
mean i grew up

334
00:10:49,750 --> 00:10:48,000
like many of us i grew up reading

335
00:10:51,829 --> 00:10:49,760
science fiction and so

336
00:10:53,509 --> 00:10:51,839
um starting from pulpy science fiction

337
00:10:54,630 --> 00:10:53,519
of robert heinlein where he had teenage

338
00:10:56,150 --> 00:10:54,640

explorers

339
00:10:58,389 --> 00:10:56,160
exploring the using of the solar system

340
00:11:01,430 --> 00:10:58,399
of the universe to more

341
00:11:02,310 --> 00:11:01,440
scientific work or more like eon by greg

342
00:11:04,230 --> 00:11:02,320
bear

343
00:11:06,150 --> 00:11:04,240
when the protagonist was a woman grad

344
00:11:07,430 --> 00:11:06,160
student from celtic

345
00:11:09,750 --> 00:11:07,440
um so i thought that that's pretty

346
00:11:11,110 --> 00:11:09,760
awesome um but you know what it what

347
00:11:12,230 --> 00:11:11,120
inspired me i guess you know i started

348
00:11:15,269 --> 00:11:12,240
out doing a thesis

349
00:11:17,030 --> 00:11:15,279
a phd thesis in the laboratory to try to

350
00:11:18,710 --> 00:11:17,040
help constrain our understanding of how

351
00:11:20,870 --> 00:11:18,720
volcanoes do gas

352
00:11:22,150 --> 00:11:20,880
and um but i was i was i was sponsored

353
00:11:24,949 --> 00:11:22,160
by nasa so there was

354
00:11:26,630 --> 00:11:24,959
uh annual meetings to see how we

355
00:11:29,509 --> 00:11:26,640
finished with the nasa programs

356
00:11:30,389 --> 00:11:29,519
and then i always like you know i liked

357
00:11:33,829 --> 00:11:30,399
black smokers

358
00:11:35,310 --> 00:11:33,839
how

359
00:11:37,269 --> 00:11:35,320
why they supported life through

360
00:11:39,430 --> 00:11:37,279
chemolithotrophy and

361
00:11:40,790 --> 00:11:39,440
i thought well i'm a geochemist how can

362
00:11:42,389 --> 00:11:40,800
i apply that

363
00:11:44,150 --> 00:11:42,399

that well okay what's the food that the

364
00:11:45,670 --> 00:11:44,160
geology or the rocks can

365
00:11:47,110 --> 00:11:45,680
help feed that life and help support

366
00:11:47,590 --> 00:11:47,120
that life and then so little by little i

367
00:11:50,629 --> 00:11:47,600
sort of

368
00:11:52,629 --> 00:11:50,639
moved into more um astrobiology science

369
00:11:53,910 --> 00:11:52,639
and in fact astrobiology was you know

370
00:11:56,949 --> 00:11:53,920
it just sort of came into being in the

371
00:11:59,910 --> 00:11:56,959
90s it was exobiology for a long time

372
00:12:01,829 --> 00:11:59,920
so i was there during that transition

373
00:12:03,590 --> 00:12:01,839
yeah i mean it really was you know in 96

374
00:12:05,509 --> 00:12:03,600
with david mckay's paper

375
00:12:07,110 --> 00:12:05,519
and colleagues uh showing that there

376
00:12:08,629 --> 00:12:07,120
could have been potential signs of life

377
00:12:10,470 --> 00:12:08,639
in the allen hills meteorite that really

378
00:12:11,670 --> 00:12:10,480
had launched astrobiology

379
00:12:13,430 --> 00:12:11,680
um and it's cool that you know you had a

380
00:12:14,310 --> 00:12:13,440
chance to be be involved you know at

381
00:12:17,030 --> 00:12:14,320
that time when

382
00:12:18,790 --> 00:12:17,040
exobiology and xenobiology became

383
00:12:19,590 --> 00:12:18,800
astrobiology for a lot of people in the

384
00:12:21,590 --> 00:12:19,600
community

385
00:12:22,870 --> 00:12:21,600
i know i i am i was there and i had

386
00:12:23,590 --> 00:12:22,880
friends who were editors at science

387
00:12:25,430 --> 00:12:23,600
magazine

388
00:12:27,269 --> 00:12:25,440

and so they shared with some of the

389
00:12:28,870 --> 00:12:27,279
dilemmas do we do we

390
00:12:31,030 --> 00:12:28,880
have the press release for this

391
00:12:31,910 --> 00:12:31,040
potential finding of life from mars or

392
00:12:33,430 --> 00:12:31,920
do we

393
00:12:36,150 --> 00:12:33,440
wait because the democratic national

394
00:12:37,430 --> 00:12:36,160
conventions meeting you know it just

395
00:12:39,430 --> 00:12:37,440
real life got in the way so anyway

396
00:12:40,470 --> 00:12:39,440
that's so interesting yeah i mean that

397
00:12:41,910 --> 00:12:40,480
happens you know sometimes

398
00:12:43,430 --> 00:12:41,920
there are some politics and things that

399
00:12:45,269 --> 00:12:43,440
come into it and when these things get

400
00:12:46,949 --> 00:12:45,279
released and how we release them

401
00:12:49,030 --> 00:12:46,959
um i do want to switch over now just to

402
00:12:51,190 --> 00:12:49,040
talking about braille

403
00:12:52,550 --> 00:12:51,200
um you know and and what your work has

404
00:12:55,030 --> 00:12:52,560
been has been doing here

405
00:12:56,790 --> 00:12:55,040
trying to understand you know life and

406
00:12:57,590 --> 00:12:56,800
these potential geochemical signatures

407
00:13:00,389 --> 00:12:57,600
of life

408
00:13:01,750 --> 00:13:00,399
inside of caves and lava tubes um could

409
00:13:04,310 --> 00:13:01,760
would you mind just giving everyone like

410
00:13:06,710 --> 00:13:04,320
a synopsis of what braille is doing

411
00:13:08,150 --> 00:13:06,720
all right um thanks uh braille and i

412
00:13:08,550 --> 00:13:08,160
thank you for remembering the acronym

413
00:13:10,550 --> 00:13:08,560

because i

414
00:13:12,310 --> 00:13:10,560
would often forget myself but basically

415
00:13:14,790 --> 00:13:12,320
i remember we're working in the dark

416
00:13:15,509 --> 00:13:14,800
and nasa as nasa's science mission

417
00:13:17,829 --> 00:13:15,519
directorate

418
00:13:19,030 --> 00:13:17,839
funds research programs and this is a

419
00:13:21,430 --> 00:13:19,040
particular instrument development

420
00:13:24,069 --> 00:13:21,440
programs and really just one that

421
00:13:25,990 --> 00:13:24,079
um does uh analog work or focus on

422
00:13:29,110 --> 00:13:26,000
analog work where you have to

423
00:13:31,190 --> 00:13:29,120
unite the science effort and

424
00:13:32,949 --> 00:13:31,200
either the instrument or or human

425
00:13:34,550 --> 00:13:32,959
activities that would simulate

426
00:13:36,310 --> 00:13:34,560
something that could be a potential

427
00:13:38,069 --> 00:13:36,320
future mission so braille is one of

428
00:13:40,069 --> 00:13:38,079
these projects it's an analog project

429
00:13:42,069 --> 00:13:40,079
that has to unite science and mission

430
00:13:43,750 --> 00:13:42,079
activities in our case we're

431
00:13:45,910 --> 00:13:43,760
working in lava tubes they've been

432
00:13:48,470 --> 00:13:45,920
identified as one of the potential

433
00:13:49,509 --> 00:13:48,480
targets in the search for even extant

434
00:13:52,710 --> 00:13:49,519
extant or

435
00:13:54,710 --> 00:13:52,720
current life or past life because of

436
00:13:55,910 --> 00:13:54,720
their access they're accessible since

437
00:13:58,710 --> 00:13:55,920
they're near the surface

438
00:13:59,990 --> 00:13:58,720

and also um they've been things and

439
00:14:01,110 --> 00:14:00,000
things in life but caves could be

440
00:14:02,470 --> 00:14:01,120
protected from that

441
00:14:04,550 --> 00:14:02,480
of the harsh conditions of the martian

442
00:14:06,389 --> 00:14:04,560
surface so that serves our

443
00:14:08,150 --> 00:14:06,399
target inspiration and then we're

444
00:14:10,069 --> 00:14:08,160
thinking gosh how could we

445
00:14:11,750 --> 00:14:10,079
what what would if there is no life in

446
00:14:12,230 --> 00:14:11,760
the lava caves on mars but there was

447
00:14:13,990 --> 00:14:12,240
life

448
00:14:15,430 --> 00:14:14,000
how can we find it what would be the

449
00:14:17,110 --> 00:14:15,440
geochemical evidence

450
00:14:18,790 --> 00:14:17,120
of that so braille essentially has a

451
00:14:20,389 --> 00:14:18,800
science part where we

452
00:14:21,829 --> 00:14:20,399
try to characterize the living life and

453
00:14:23,509 --> 00:14:21,839
lava tubes and

454
00:14:25,110 --> 00:14:23,519
the chemical signatures and

455
00:14:26,949 --> 00:14:25,120
mineralogical signatures that life

456
00:14:28,790 --> 00:14:26,959
leaves behind and then couple that with

457
00:14:30,870 --> 00:14:28,800
robotic activities where we see

458
00:14:32,710 --> 00:14:30,880
robots can either detect lives

459
00:14:35,509 --> 00:14:32,720
themselves autonomously or

460
00:14:35,829 --> 00:14:35,519
send data back to a surface team that

461
00:14:39,030 --> 00:14:35,839
could

462
00:14:40,629 --> 00:14:39,040
of life

463
00:14:42,389 --> 00:14:40,639

you know i want to talk about robots so

464
00:14:44,310 --> 00:14:42,399
much more first

465
00:14:45,990 --> 00:14:44,320
for our audience so so lava tubes are

466
00:14:47,590 --> 00:14:46,000
caves that are created when lava

467
00:14:49,350 --> 00:14:47,600
lava when it flows along can actually

468
00:14:50,710 --> 00:14:49,360
form these really long cool caves i've

469
00:14:52,310 --> 00:14:50,720
been in a few of myself in

470
00:14:54,550 --> 00:14:52,320
hawaii and arizona and they're the

471
00:14:56,870 --> 00:14:54,560
really cool places to hike through these

472
00:14:58,550 --> 00:14:56,880
these caves uh and and jen we've

473
00:14:59,590 --> 00:14:58,560
discovered these on the moon and mars

474
00:15:01,910 --> 00:14:59,600
now right

475
00:15:03,430 --> 00:15:01,920
well yes and they're i guess it's better

476
00:15:05,110 --> 00:15:03,440
to say candidate caves

477
00:15:06,550 --> 00:15:05,120
because we won't know until we go there

478
00:15:07,590 --> 00:15:06,560
but there's definitely an indication of

479
00:15:11,350 --> 00:15:07,600
void space

480
00:15:13,269 --> 00:15:11,360
and in fact investigators have used

481
00:15:14,870 --> 00:15:13,279
machine learning tools to look at

482
00:15:15,509 --> 00:15:14,880
satellite data from both the moon and

483
00:15:18,310 --> 00:15:15,519
mars

484
00:15:20,069 --> 00:15:18,320
and found the case the moon over 1500

485
00:15:21,590 --> 00:15:20,079
candidate cave entrances and in mars

486
00:15:24,310 --> 00:15:21,600
over 1200 caves

487
00:15:25,110 --> 00:15:24,320
so we think there are many of them and

488
00:15:27,110 --> 00:15:25,120

basalt is

489
00:15:28,949 --> 00:15:27,120
that you have to have a basaltic lava to

490
00:15:30,550 --> 00:15:28,959
form a cave it has to have that right

491
00:15:33,590 --> 00:15:30,560
sort of consistency and fluid

492
00:15:35,189 --> 00:15:33,600
or flowiness or viscosity and uh we

493
00:15:36,949 --> 00:15:35,199
think also when there's lower gravity

494
00:15:39,990 --> 00:15:36,959
the caves will be much much bigger

495
00:15:41,509 --> 00:15:40,000
so expect that people i guess possibly

496
00:15:43,670 --> 00:15:41,519
that caves on the moon could be

497
00:15:44,550 --> 00:15:43,680
hundreds and hundreds of meters uh in

498
00:15:45,910 --> 00:15:44,560
diameter

499
00:15:47,829 --> 00:15:45,920
whereas on the earth they're not quite

500
00:15:48,629 --> 00:15:47,839
that big usually tens of meters and the

501
00:15:51,670 --> 00:15:48,639
mars somewhere

502
00:15:52,550 --> 00:15:51,680
in between oh i i never heard that

503
00:15:54,870 --> 00:15:52,560
before that but

504
00:15:56,310 --> 00:15:54,880
in my mind i start instantly thinking of

505
00:15:57,990 --> 00:15:56,320
humans you know exploring

506
00:16:00,230 --> 00:15:58,000
these tubes and what that would be like

507
00:16:01,590 --> 00:16:00,240
to walk around in a cathedral of a lava

508
00:16:03,430 --> 00:16:01,600
tube like that

509
00:16:04,949 --> 00:16:03,440
i i know that's that's really inspiring

510
00:16:07,749 --> 00:16:04,959
in fact there even films

511
00:16:09,430 --> 00:16:07,759
i know of a film from the 1950s called

512
00:16:10,870 --> 00:16:09,440
robin crusoe on mars

513
00:16:12,790 --> 00:16:10,880

when uh strapped an astronaut on the

514
00:16:14,230 --> 00:16:12,800
crusade and his monkey

515
00:16:16,230 --> 00:16:14,240
i think his monkeys did friday or

516
00:16:18,710 --> 00:16:16,240
something but anyway he said suck on

517
00:16:21,590 --> 00:16:18,720
mars and end up surviving in a cave

518
00:16:22,150 --> 00:16:21,600
so i think you can find it on youtube so

519
00:16:23,990 --> 00:16:22,160
cool

520
00:16:25,189 --> 00:16:24,000
i mean it has to be really fun for you

521
00:16:27,350 --> 00:16:25,199
and for your team

522
00:16:28,710 --> 00:16:27,360
to travel into these lava tubes i know

523
00:16:31,350 --> 00:16:28,720
we have a video

524
00:16:32,069 --> 00:16:31,360
of lidar kind of showing yes you know

525
00:16:33,269 --> 00:16:32,079
the structure

526
00:16:35,269 --> 00:16:33,279
of one of these tubes i wonder if you

527
00:16:36,710 --> 00:16:35,279
can explain what that process is like

528
00:16:38,870 --> 00:16:36,720
using something like lidar and the

529
00:16:40,710 --> 00:16:38,880
mapping that you're doing sure so we

530
00:16:42,550 --> 00:16:40,720
i mentioned braille several parts the

531
00:16:43,509 --> 00:16:42,560
scientists worked in a whole slurry of

532
00:16:45,189 --> 00:16:43,519
caves up at

533
00:16:47,670 --> 00:16:45,199
lava beds national monument northern

534
00:16:49,269 --> 00:16:47,680
california and for the robotic work

535
00:16:51,110 --> 00:16:49,279
we picked one cave that would be you

536
00:16:52,949 --> 00:16:51,120
know easiest to work in and so this is a

537
00:16:53,590 --> 00:16:52,959
visitor cave so people come in and watch

538
00:16:55,670 --> 00:16:53,600

us

539
00:16:57,269 --> 00:16:55,680
and we we have a lighter instrument that

540
00:16:59,030 --> 00:16:57,279
we map the cave

541
00:17:00,629 --> 00:16:59,040
we're mapping in two ways one with the

542
00:17:02,949 --> 00:17:00,639
robot but

543
00:17:04,150 --> 00:17:02,959
also another way with the handheld lidar

544
00:17:05,510 --> 00:17:04,160
instrument and i think you might have a

545
00:17:07,189 --> 00:17:05,520
video do you want to show that

546
00:17:09,429 --> 00:17:07,199
now yeah i think it's showing in the

547
00:17:10,789 --> 00:17:09,439
background right now oh really okay cool

548
00:17:12,549 --> 00:17:10,799
well this is valentine cave and it's

549
00:17:13,829 --> 00:17:12,559
about a half a kilometer point six

550
00:17:16,470 --> 00:17:13,839
kilometers long

551
00:17:17,110 --> 00:17:16,480
and um it's it's you can walk through it

552
00:17:18,549 --> 00:17:17,120
it's actually

553
00:17:20,870 --> 00:17:18,559
my favorite cave in the park i just love

554
00:17:23,829 --> 00:17:20,880
this cave i would live in this cave

555
00:17:24,549 --> 00:17:23,839
and there's one bat that we know of um a

556
00:17:26,870 --> 00:17:24,559
few crickets

557
00:17:28,150 --> 00:17:26,880
anyway it's a lovely lovely cave and uh

558
00:17:29,990 --> 00:17:28,160
that that's a

559
00:17:31,190 --> 00:17:30,000
video that was made by just a little

560
00:17:34,070 --> 00:17:31,200
small handheld uh

561
00:17:35,270 --> 00:17:34,080
looks like a size of a yoga block um

562
00:17:37,430 --> 00:17:35,280
walking in the cave

563
00:17:38,870 --> 00:17:37,440

with a help held by a human and then

564
00:17:40,789 --> 00:17:38,880
processed afterwards

565
00:17:42,470 --> 00:17:40,799
that's so cool so so the team is you

566
00:17:43,350 --> 00:17:42,480
know you're mapping the cave to

567
00:17:45,110 --> 00:17:43,360
understand

568
00:17:46,789 --> 00:17:45,120
its structure you're also going in i

569
00:17:47,669 --> 00:17:46,799
imagine doing biological kind of

570
00:17:51,510 --> 00:17:47,679
sampling

571
00:17:52,950 --> 00:17:51,520
pairing those things together

572
00:17:54,710 --> 00:17:52,960
uh what kinds of things are you finding

573
00:17:55,510 --> 00:17:54,720
so far in these waves through these

574
00:17:57,190 --> 00:17:55,520
analyses well

575
00:17:58,710 --> 00:17:57,200
we're finding that first of all a lot of

576
00:18:01,750 --> 00:17:58,720
events is uh

577
00:18:03,029 --> 00:18:01,760
known it has gosh it's um has this is a

578
00:18:05,669 --> 00:18:03,039
monument that's a

579
00:18:07,590 --> 00:18:05,679
part of the medicine um medicine like

580
00:18:10,390 --> 00:18:07,600
volcano and it's about

581
00:18:11,750 --> 00:18:10,400
one tenth of that land about twenty two

582
00:18:14,070 --> 00:18:11,760
thousand square kilometers

583
00:18:14,870 --> 00:18:14,080
and um there are over 900 caves there so

584
00:18:16,230 --> 00:18:14,880
it's amazing

585
00:18:17,990 --> 00:18:16,240
sort of it's the highest concentration

586
00:18:19,909 --> 00:18:18,000
of caves in north america and

587
00:18:21,430 --> 00:18:19,919
what are we finding we're finding both

588
00:18:23,110 --> 00:18:21,440

you know soft soft

589
00:18:24,789 --> 00:18:23,120
microbiology and it's in the form of

590
00:18:26,950 --> 00:18:24,799
many microbial films

591
00:18:27,990 --> 00:18:26,960
and also speleothems or little

592
00:18:30,470 --> 00:18:28,000
concretions

593
00:18:31,830 --> 00:18:30,480
that um are up to maybe one or two

594
00:18:32,549 --> 00:18:31,840
centimeters long but usually smaller

595
00:18:34,549 --> 00:18:32,559
than that

596
00:18:35,510 --> 00:18:34,559
and they look like small stromatolites

597
00:18:37,510 --> 00:18:35,520
one one thing that was a little

598
00:18:39,750 --> 00:18:37,520
surprising to me in hindsight

599
00:18:41,270 --> 00:18:39,760
shouldn't have been is that these little

600
00:18:43,990 --> 00:18:41,280
features in the caves

601
00:18:45,270 --> 00:18:44,000
are actually predominantly silicon so

602
00:18:47,190 --> 00:18:45,280
that means they it's good for

603
00:18:48,630 --> 00:18:47,200
good for geologists because they could

604
00:18:49,990 --> 00:18:48,640
that means they could persist over long

605
00:18:52,310 --> 00:18:50,000
periods of time if they were carbonated

606
00:18:54,310 --> 00:18:52,320
maybe it might be more

607
00:18:55,909 --> 00:18:54,320
open or vulnerable to weathering but

608
00:18:56,950 --> 00:18:55,919
these things look like miniature cave

609
00:18:58,549 --> 00:18:56,960
stromatolites

610
00:19:00,470 --> 00:18:58,559
and in fact they look like guys right or

611
00:19:02,230 --> 00:19:00,480
things that are formed in hot springs

612
00:19:03,830 --> 00:19:02,240
which i've studied in the past so sort

613
00:19:05,350 --> 00:19:03,840

of like coming around full circle to see

614
00:19:07,669 --> 00:19:05,360
these features in the caves

615
00:19:08,950 --> 00:19:07,679
and you know and try to correlate the

616
00:19:12,390 --> 00:19:08,960
microbiology

617
00:19:13,909 --> 00:19:12,400
and other geochemistry factors into

618
00:19:15,669 --> 00:19:13,919
how they're formed and where they where

619
00:19:17,830 --> 00:19:15,679
they exist in the caves

620
00:19:19,510 --> 00:19:17,840
that's so groovy uh i understand this so

621
00:19:20,789 --> 00:19:19,520
so now i'd love to hear about the robots

622
00:19:22,630 --> 00:19:20,799
that you're using so you're

623
00:19:25,029 --> 00:19:22,640
you're also taking robots into these

624
00:19:27,350 --> 00:19:25,039
caves and using them for exploration

625
00:19:28,230 --> 00:19:27,360
uh and i know that we have a video uh

626
00:19:29,590 --> 00:19:28,240
that you gave us

627
00:19:31,590 --> 00:19:29,600
of one of these robots exploring i

628
00:19:33,830 --> 00:19:31,600
wonder if you explain what's going on

629
00:19:36,150 --> 00:19:33,840
uh with these robots for us okay well we

630
00:19:39,430 --> 00:19:36,160
started in 2018 we started out with

631
00:19:41,510 --> 00:19:39,440
one of the training robots at nasa ames

632
00:19:43,190 --> 00:19:41,520
and that was just that was rolling down

633
00:19:44,789 --> 00:19:43,200
inside the cave and looking at one side

634
00:19:46,310 --> 00:19:44,799
of the cave wall

635
00:19:48,230 --> 00:19:46,320
but more recently we started

636
00:19:49,190 --> 00:19:48,240
collaborating with the co-star team at

637
00:19:50,950 --> 00:19:49,200
jpl

638
00:19:52,710 --> 00:19:50,960

and they're competing in the current

639
00:19:55,110 --> 00:19:52,720
darpa subterranean challenge

640
00:19:57,350 --> 00:19:55,120
so co-star stands for collaborative

641
00:20:00,150 --> 00:19:57,360
subterranean autonomous robots

642
00:20:00,870 --> 00:20:00,160
so we went from trying worrying about

643
00:20:03,590 --> 00:20:00,880
sending

644
00:20:04,789 --> 00:20:03,600
information from the robot that was

645
00:20:07,750 --> 00:20:04,799
wheeling down the cave

646
00:20:09,590 --> 00:20:07,760
up to a surface group that was trying to

647
00:20:11,669 --> 00:20:09,600
interpret and then direct the robot

648
00:20:13,590 --> 00:20:11,679
to these fully autonomous robots that

649
00:20:15,270 --> 00:20:13,600
jpl has developed

650
00:20:16,950 --> 00:20:15,280
and they're the spot the boston dynamics

651
00:20:19,110 --> 00:20:16,960
yellow spot dog robots

652
00:20:20,549 --> 00:20:19,120
and so we sort of had a step up in our

653
00:20:21,430 --> 00:20:20,559
autonomy and that's really exciting i

654
00:20:24,630 --> 00:20:21,440
think this video

655
00:20:26,630 --> 00:20:24,640
shows um the spot robot in action

656
00:20:27,990 --> 00:20:26,640
that's so cool and i i think a lot of

657
00:20:29,909 --> 00:20:28,000
folks at home have probably seen boston

658
00:20:31,669 --> 00:20:29,919
dynamics videos of their robots

659
00:20:33,430 --> 00:20:31,679
like the walking ones doing backflips

660
00:20:35,110 --> 00:20:33,440
and stuff like that are they've most

661
00:20:38,070 --> 00:20:35,120
likely also have seen you know

662
00:20:38,549 --> 00:20:38,080
the robot dogs as well um i wonder if

663
00:20:40,870 --> 00:20:38,559

you could

664
00:20:43,190 --> 00:20:40,880
you know share with us why why should we

665
00:20:44,950 --> 00:20:43,200
be using a robot dog as compared to like

666
00:20:45,990 --> 00:20:44,960
a track robot or whatever you know a

667
00:20:48,149 --> 00:20:46,000
rover

668
00:20:49,430 --> 00:20:48,159
ah well this is thank you for the pitch

669
00:20:52,070 --> 00:20:49,440
of the opportunity to pitch

670
00:20:52,710 --> 00:20:52,080
legged robots for planetary exploration

671
00:20:56,950 --> 00:20:52,720
um

672
00:20:58,950 --> 00:20:56,960
excited about how well these robots

673
00:21:00,789 --> 00:20:58,960
perform in the cave so with the wheeling

674
00:21:02,470 --> 00:21:00,799
robot we had to carry it in

675
00:21:04,549 --> 00:21:02,480
and then with a smaller wheel and robot

676
00:21:06,149 --> 00:21:04,559
that jpl uses it actually had a hard

677
00:21:07,510 --> 00:21:06,159
time traversing inside the cave in fact

678
00:21:09,750 --> 00:21:07,520
it went down the slope and did a

679
00:21:10,789 --> 00:21:09,760
front flip but with the leggett robots

680
00:21:12,390 --> 00:21:10,799
they weigh a lot less

681
00:21:14,230 --> 00:21:12,400
you know this these robots with

682
00:21:16,149 --> 00:21:14,240
instruments weigh about 35 kilos

683
00:21:18,230 --> 00:21:16,159
supposed to say curiosity that weighs

684
00:21:20,470 --> 00:21:18,240
about a ton metric ton

685
00:21:21,909 --> 00:21:20,480
and they walk they dance you might have

686
00:21:23,110 --> 00:21:21,919
seen them on youtube dancing but they

687
00:21:24,630 --> 00:21:23,120
can walk down the

688
00:21:26,950 --> 00:21:24,640

you know in you'll see it in the video

689
00:21:29,909 --> 00:21:26,960
they can walk down inside the lava cave

690
00:21:31,830 --> 00:21:29,919
and the thought is we're thinking that

691
00:21:32,390 --> 00:21:31,840
we could use multiple robots working in

692
00:21:34,710 --> 00:21:32,400
tandem

693
00:21:36,070 --> 00:21:34,720
so not a swarm but maybe a pack of these

694
00:21:39,750 --> 00:21:36,080
robot dogs

695
00:21:43,270 --> 00:21:39,760
they can work together and also minimize

696
00:21:46,149 --> 00:21:43,280
risk in case one one gets hurt

697
00:21:48,710 --> 00:21:46,159
and so say we we send a swarm of these

698
00:21:50,710 --> 00:21:48,720
robot dogs to the moon

699
00:21:53,190 --> 00:21:50,720
or a pack it's a pack of robot dogs so

700
00:21:54,230 --> 00:21:53,200
say we sent a pack of robot dogs to mars

701
00:21:56,310 --> 00:21:54,240
for instance to

702
00:21:58,390 --> 00:21:56,320
to examine some of these lava tubes

703
00:21:59,510 --> 00:21:58,400
these potential caves on mars

704
00:22:01,669 --> 00:21:59,520
what kinds of instruments do you think

705
00:22:03,430 --> 00:22:01,679
that they should take along uh

706
00:22:06,149 --> 00:22:03,440
not just understand the geology but also

707
00:22:07,430 --> 00:22:06,159
maybe to look for signs of life

708
00:22:09,190 --> 00:22:07,440
well first of all like you mentioned the

709
00:22:10,630 --> 00:22:09,200
geology so we'd have in fact these

710
00:22:13,990 --> 00:22:10,640
robots working with

711
00:22:16,390 --> 00:22:14,000
spots they do have lidar on on them so

712
00:22:17,909 --> 00:22:16,400
in in the case of our current team they

713
00:22:21,190 --> 00:22:17,919

are mapping in real time

714
00:22:23,750 --> 00:22:21,200
and they can even send back to uh for

715
00:22:25,750 --> 00:22:23,760
rear located robots and then essentially

716
00:22:27,270 --> 00:22:25,760
just do a little tag team of transfer

717
00:22:29,909 --> 00:22:27,280
data so that's pretty cool

718
00:22:31,029 --> 00:22:29,919
but in terms of autonomous features or

719
00:22:32,230 --> 00:22:31,039
instrumentation

720
00:22:33,990 --> 00:22:32,240
we want to have some spectral

721
00:22:34,630 --> 00:22:34,000
information about the size of a wall so

722
00:22:37,190 --> 00:22:34,640
something would

723
00:22:38,710 --> 00:22:37,200
detect either a certain mineral or maybe

724
00:22:41,029 --> 00:22:38,720
a water

725
00:22:42,230 --> 00:22:41,039
water signal and that would give us

726
00:22:44,149 --> 00:22:42,240
indications of where to go

727
00:22:45,669 --> 00:22:44,159
in particular one thing i didn't have a

728
00:22:46,310 --> 00:22:45,679
chance to mention i forgot to mention is

729
00:22:48,390 --> 00:22:46,320
that

730
00:22:49,750 --> 00:22:48,400
we're taking a lot of the photographs so

731
00:22:50,870 --> 00:22:49,760
almost ten thousand photos that the

732
00:22:51,430 --> 00:22:50,880
science that scientists have been

733
00:22:53,830 --> 00:22:51,440
collecting

734
00:22:54,950 --> 00:22:53,840
in the caves over three years and

735
00:22:56,870 --> 00:22:54,960
folding them into

736
00:22:58,549 --> 00:22:56,880
algorithm development development for

737
00:23:00,230 --> 00:22:58,559
autonomous life detection

738
00:23:02,149 --> 00:23:00,240

by the robots and we'll be testing that

739
00:23:03,909 --> 00:23:02,159
this summer in 2021

740
00:23:05,270 --> 00:23:03,919
oh man that's so cool yeah and you know

741
00:23:06,789 --> 00:23:05,280
you mentioned earlier i'm involved with

742
00:23:08,230 --> 00:23:06,799
the university river challenge

743
00:23:09,990 --> 00:23:08,240
which takes place every year at the mars

744
00:23:11,909 --> 00:23:10,000
desert research station and i've seen

745
00:23:14,149 --> 00:23:11,919
some really cool things over the years

746
00:23:15,190 --> 00:23:14,159
uh our students now are using autonomy

747
00:23:16,630 --> 00:23:15,200
on their rovers

748
00:23:18,549 --> 00:23:16,640
on their robots some of them are lagged

749
00:23:19,750 --> 00:23:18,559
most of them are track or or wheeled

750
00:23:21,590 --> 00:23:19,760
rovers

751
00:23:23,190 --> 00:23:21,600
some of them are now learning how to do

752
00:23:24,710 --> 00:23:23,200
autonomous navigation and things like

753
00:23:27,190 --> 00:23:24,720
that and how to collect data

754
00:23:28,710 --> 00:23:27,200
autonomously uh they also we've had in

755
00:23:29,510 --> 00:23:28,720
the past some students have launched

756
00:23:31,029 --> 00:23:29,520
drones

757
00:23:32,870 --> 00:23:31,039
off the back of their rovers to fly

758
00:23:34,630 --> 00:23:32,880
around and i know that we have a very

759
00:23:37,190 --> 00:23:34,640
short video of the very recent

760
00:23:38,710 --> 00:23:37,200
first powered controlled flight on mars

761
00:23:41,269 --> 00:23:38,720
from the ingenuity

762
00:23:42,470 --> 00:23:41,279
uh aircraft helicopter i know people

763
00:23:44,390 --> 00:23:42,480

have been freaking out about it because

764
00:23:45,190 --> 00:23:44,400
it is so very cool to see this little

765
00:23:47,590 --> 00:23:45,200
drone

766
00:23:48,630 --> 00:23:47,600
uh testing powered flight on the surface

767
00:23:50,950 --> 00:23:48,640
of mars

768
00:23:53,029 --> 00:23:50,960
um it was so cool and it makes me think

769
00:23:55,750 --> 00:23:53,039
about you know what does the future hold

770
00:23:57,590 --> 00:23:55,760
for robotic exploration and you know dr

771
00:23:59,510 --> 00:23:57,600
blank since you are an expert of

772
00:24:01,909 --> 00:23:59,520
robotic exploration in caves and lava

773
00:24:03,510 --> 00:24:01,919
tubes i wonder what your vision is what

774
00:24:05,350 --> 00:24:03,520
do you think the future is for missions

775
00:24:06,950 --> 00:24:05,360
that we will be sending to mars

776
00:24:08,789 --> 00:24:06,960
oh thanks yeah thanks for bringing up

777
00:24:10,070 --> 00:24:08,799
the ingenuity which i like to spell with

778
00:24:12,789 --> 00:24:10,080
the jay

779
00:24:13,909 --> 00:24:12,799
ingenuity but um shout out to that team

780
00:24:16,149 --> 00:24:13,919
it was so exciting

781
00:24:17,510 --> 00:24:16,159
and um also i was so impressed with the

782
00:24:20,070 --> 00:24:17,520
way the perseverance

783
00:24:21,110 --> 00:24:20,080
rover mastercam z team was able to catch

784
00:24:24,310 --> 00:24:21,120
frame

785
00:24:25,990 --> 00:24:24,320
the ingenuity when it was elevated

786
00:24:27,350 --> 00:24:26,000
with just sand in the background no rock

787
00:24:28,950 --> 00:24:27,360
so it was really beautifully framed by

788
00:24:31,269 --> 00:24:28,960

that you know great job all around

789
00:24:32,390 --> 00:24:31,279
very exciting and what if um well i

790
00:24:35,269 --> 00:24:32,400
think you know i was talking with a

791
00:24:36,710 --> 00:24:35,279
friend of mine uh lucinda offer who's um

792
00:24:38,630 --> 00:24:36,720
executive director for the mars society

793
00:24:40,789 --> 00:24:38,640
and she said oh i i hate

794
00:24:42,630 --> 00:24:40,799
i hate this autonomy because it's it's

795
00:24:43,909 --> 00:24:42,640
supporting the argument against human

796
00:24:45,590 --> 00:24:43,919
exploration

797
00:24:47,430 --> 00:24:45,600
and i still believe that they should be

798
00:24:50,149 --> 00:24:47,440
in tandem right um

799
00:24:51,110 --> 00:24:50,159
but uh it is exciting to think what else

800
00:24:53,909 --> 00:24:51,120
we could do

801
00:24:54,230 --> 00:24:53,919
potentially for much less money um you

802
00:24:57,190 --> 00:24:54,240
know

803
00:24:57,590 --> 00:24:57,200
in the autonomous robotic exploration

804
00:24:58,950 --> 00:24:57,600
yeah

805
00:25:00,630 --> 00:24:58,960
and that kind of makes me wonder too

806
00:25:02,310 --> 00:25:00,640
what you think then about humans going

807
00:25:04,070 --> 00:25:02,320
to mars and exploring

808
00:25:05,350 --> 00:25:04,080
um what we'll see humans doing do you

809
00:25:07,110 --> 00:25:05,360
think we'll see humans

810
00:25:08,789 --> 00:25:07,120
building habitats in martian caves in

811
00:25:12,230 --> 00:25:08,799
the not too distant future

812
00:25:14,789 --> 00:25:12,240
well this is my hope this is my hope and

813
00:25:15,269 --> 00:25:14,799

and one of the challenges with uh uh the

814
00:25:17,830 --> 00:25:15,279
caves

815
00:25:19,110 --> 00:25:17,840
at mars is that they're they're most

816
00:25:21,590 --> 00:25:19,120
frequently discovered in

817
00:25:22,149 --> 00:25:21,600
parts of mars that are higher evolvation

818
00:25:23,909 --> 00:25:22,159
so

819
00:25:25,750 --> 00:25:23,919
um it means you know our all of our

820
00:25:27,590 --> 00:25:25,760
landing sites so far for the rovers and

821
00:25:28,789 --> 00:25:27,600
landers have been in lower elevation

822
00:25:30,870 --> 00:25:28,799
sites on mars

823
00:25:32,230 --> 00:25:30,880
and so we have a little bit of scouting

824
00:25:33,909 --> 00:25:32,240
to do and also a little bit of

825
00:25:35,590 --> 00:25:33,919
technology development to do

826
00:25:37,510 --> 00:25:35,600
but the cool thing is we can have

827
00:25:39,669 --> 00:25:37,520
ministry helicopters that could

828
00:25:40,870 --> 00:25:39,679
fly around and report back that would

829
00:25:43,190 --> 00:25:40,880
save us a lot of

830
00:25:45,190 --> 00:25:43,200
having to bring the bigger or smaller

831
00:25:46,230 --> 00:25:45,200
robots but the ground-based robots

832
00:25:47,430 --> 00:25:46,240
and that would help with our near

833
00:25:48,549 --> 00:25:47,440
surface exploration i think they're

834
00:25:50,149 --> 00:25:48,559
really exciting

835
00:25:52,390 --> 00:25:50,159
so but in terms of when this is going to

836
00:25:55,269 --> 00:25:52,400
happen i think a few years is too soon

837
00:25:56,789 --> 00:25:55,279
i think for uh for nasa's focus we have

838
00:25:58,710 --> 00:25:56,799

mars sample return

839
00:26:00,710 --> 00:25:58,720
in front of us that'll take the next 10

840
00:26:02,149 --> 00:26:00,720
years so it'll be after that but in the

841
00:26:03,909 --> 00:26:02,159
meanwhile i think we should uh

842
00:26:06,070 --> 00:26:03,919
hone our skills in terms of entrance

843
00:26:09,990 --> 00:26:06,080
into caves and exploration of caves

844
00:26:12,070 --> 00:26:10,000
by practicing on the moon um yeah

845
00:26:13,510 --> 00:26:12,080
so uh i am going to open up our audience

846
00:26:14,230 --> 00:26:13,520
questions here very soon for everyone

847
00:26:15,669 --> 00:26:14,240
watching

848
00:26:18,710 --> 00:26:15,679
please do ask your questions for dr

849
00:26:21,590 --> 00:26:18,720
blank on the chats and segonet.org or

850
00:26:22,710 --> 00:26:21,600
nasa astrobiology's facebook page um i'm

851
00:26:26,070 --> 00:26:22,720
curious

852
00:26:26,950 --> 00:26:26,080
uh so if there was another world in our

853
00:26:29,029 --> 00:26:26,960
solar system

854
00:26:30,310 --> 00:26:29,039
that you could explore yourself or send

855
00:26:32,310 --> 00:26:30,320
a pack of robot dogs

856
00:26:34,710 --> 00:26:32,320
or whatever um to go look at for

857
00:26:36,630 --> 00:26:34,720
astrobiology for geology

858
00:26:39,590 --> 00:26:36,640
what other place beyond mars would you

859
00:26:42,470 --> 00:26:39,600
want to go explore in our solar system

860
00:26:43,510 --> 00:26:42,480
uh good question if time time wasn't a

861
00:26:46,390 --> 00:26:43,520
issue in terms of

862
00:26:47,990 --> 00:26:46,400
time to get there i think uh some of the

863
00:26:49,669 --> 00:26:48,000

icing rooms

864
00:26:51,590 --> 00:26:49,679
certainly and i think we haven't looked

865
00:26:53,269 --> 00:26:51,600
at ganymede growing up i was obsessed

866
00:26:55,590 --> 00:26:53,279
with ganymede

867
00:26:56,950 --> 00:26:55,600
which is the biggest of the jovian moons

868
00:26:58,630 --> 00:26:56,960
um but no and

869
00:27:01,590 --> 00:26:58,640
and i guess for robotic exploration

870
00:27:04,070 --> 00:27:01,600
maybe titan so because it's so different

871
00:27:04,870 --> 00:27:04,080
um especially if there is a subsurface

872
00:27:06,710 --> 00:27:04,880
ocean

873
00:27:09,190 --> 00:27:06,720
or so there is you know other substance

874
00:27:11,830 --> 00:27:09,200
voids too and what's what's there

875
00:27:13,029 --> 00:27:11,840
yeah there's so much to explore yeah so

876
00:27:15,350 --> 00:27:13,039
how about you how about you

877
00:27:16,230 --> 00:27:15,360
dr lau where would you go you know i

878
00:27:17,990 --> 00:27:16,240
love europa

879
00:27:19,909 --> 00:27:18,000
and i can't help it i'm a huge fan of

880
00:27:21,110 --> 00:27:19,919
venus too i do think we should explore

881
00:27:23,110 --> 00:27:21,120
venus more

882
00:27:24,789 --> 00:27:23,120
not just for astrobiology but there's a

883
00:27:26,789 --> 00:27:24,799
lot that we can learn from venus just

884
00:27:29,269 --> 00:27:26,799
from a planetary geology

885
00:27:31,110 --> 00:27:29,279
uh you know point of view understanding

886
00:27:32,950 --> 00:27:31,120
what happened in venus's past to lead to

887
00:27:35,029 --> 00:27:32,960
this runaway greenhouse but

888
00:27:36,230 --> 00:27:35,039

as an astrobiologist i'm a huge huge

889
00:27:38,549 --> 00:27:36,240
nerd for europa

890
00:27:40,310 --> 00:27:38,559
uh i'm looking forward to clipper and to

891
00:27:41,269 --> 00:27:40,320
the juice mission and anything else we

892
00:27:42,630 --> 00:27:41,279
can send there

893
00:27:45,029 --> 00:27:42,640
i'd love to see us drill through that

894
00:27:46,630 --> 00:27:45,039
ice one day i think i think it's

895
00:27:48,149 --> 00:27:46,640
fantastic and i think also how lucky

896
00:27:49,750 --> 00:27:48,159
that we have this

897
00:27:51,190 --> 00:27:49,760
clipper mission coming so that's really

898
00:27:51,909 --> 00:27:51,200
exciting it's gonna be such a cool

899
00:27:53,590 --> 00:27:51,919
mission

900
00:27:55,190 --> 00:27:53,600
um and hopefully we'll get a lambo not

901
00:27:57,750 --> 00:27:55,200
too long afterward we'll see

902
00:27:58,870 --> 00:27:57,760
uh how that all pans out uh so before i

903
00:28:00,549 --> 00:27:58,880
go to the audience

904
00:28:02,789 --> 00:28:00,559
uh we had one more thing we shared on

905
00:28:04,310 --> 00:28:02,799
twitter through nasa astrobiology

906
00:28:06,149 --> 00:28:04,320
we asked for people to send in some

907
00:28:07,590 --> 00:28:06,159
pictures of their favorite field work

908
00:28:08,630 --> 00:28:07,600
that they've done

909
00:28:10,789 --> 00:28:08,640
and we actually have a couple of

910
00:28:12,149 --> 00:28:10,799
pictures popping up in the screen here

911
00:28:14,389 --> 00:28:12,159
for us to see

912
00:28:15,990 --> 00:28:14,399
um showing a few of our audience members

913
00:28:17,909 --> 00:28:16,000

and some field work they've done as well

914
00:28:19,430 --> 00:28:17,919
as a few of us and some of the field

915
00:28:20,950 --> 00:28:19,440
work that we've done

916
00:28:23,190 --> 00:28:20,960
and it is really fun especially for

917
00:28:25,029 --> 00:28:23,200
those of us involved in astrobiology

918
00:28:26,310 --> 00:28:25,039
and geoscience to have a chance to

919
00:28:28,710 --> 00:28:26,320
travel to these really

920
00:28:29,750 --> 00:28:28,720
unique places around our planet and to

921
00:28:31,590 --> 00:28:29,760
learn more about

922
00:28:33,590 --> 00:28:31,600
the biology and geology and the

923
00:28:34,789 --> 00:28:33,600
chemistry and even you know for some of

924
00:28:37,029 --> 00:28:34,799
us who like exploring

925
00:28:38,470 --> 00:28:37,039
learning about human history and culture

926
00:28:40,070 --> 00:28:38,480
around our planet as well there's so

927
00:28:41,990 --> 00:28:40,080
many cool things to see

928
00:28:43,590 --> 00:28:42,000
um so for everyone out there watching i

929
00:28:45,510 --> 00:28:43,600
highly recommend get out there

930
00:28:47,510 --> 00:28:45,520
go out in your backyard go for a hike

931
00:28:50,470 --> 00:28:47,520
and just see the world around you

932
00:28:51,750 --> 00:28:50,480
there's so much to learn out there now

933
00:28:53,110 --> 00:28:51,760
that said i think we are going to start

934
00:28:54,549 --> 00:28:53,120
now taking some of our audience

935
00:28:56,470 --> 00:28:54,559
questions i know we have a few that came

936
00:28:58,389 --> 00:28:56,480
in early from facebook

937
00:29:00,070 --> 00:28:58,399
so the first one comes from emergent

938
00:29:01,510 --> 00:29:00,080

chemical evolution

939
00:29:03,190 --> 00:29:01,520
uh they want to know if you've done any

940
00:29:04,950 --> 00:29:03,200
more research into high impact amino

941
00:29:05,830 --> 00:29:04,960
acid survivability experiments like you

942
00:29:09,029 --> 00:29:05,840
had before

943
00:29:11,110 --> 00:29:09,039
uh back in the early 2000s

944
00:29:12,149 --> 00:29:11,120
good question um no i'm not doing those

945
00:29:15,909 --> 00:29:12,159
experiments now

946
00:29:16,630 --> 00:29:15,919
i um i i'm not but i'm still asked to

947
00:29:19,909 --> 00:29:16,640
review

948
00:29:21,990 --> 00:29:19,919
proposals and papers about them so um

949
00:29:23,110 --> 00:29:22,000
and i i really encourage that work i

950
00:29:25,590 --> 00:29:23,120
think it's really exciting

951
00:29:26,870 --> 00:29:25,600
um and we have more and more

952
00:29:29,190 --> 00:29:26,880
computational power

953
00:29:30,389 --> 00:29:29,200
to explore that computationally yeah

954
00:29:31,990 --> 00:29:30,399
that's a really good point i mean i mean

955
00:29:33,510 --> 00:29:32,000
we're talking about autonomy and data

956
00:29:35,029 --> 00:29:33,520
collection things like that but

957
00:29:37,510 --> 00:29:35,039
i mean we're definitely moving into this

958
00:29:39,510 --> 00:29:37,520
age of big data where we can collect

959
00:29:39,990 --> 00:29:39,520
humongous data sets from some of these

960
00:29:42,149 --> 00:29:40,000
instruments

961
00:29:44,470 --> 00:29:42,159
on mars and other worlds and on earth as

962
00:29:46,149 --> 00:29:44,480
well and you know having some way to

963
00:29:47,990 --> 00:29:46,159

actually analyze those data sets without

964
00:29:49,190 --> 00:29:48,000
having a single graduate student spend

965
00:29:50,870 --> 00:29:49,200
six years just

966
00:29:53,510 --> 00:29:50,880
slowly clicking through each piece of

967
00:29:54,630 --> 00:29:53,520
data is a really huge advancement for us

968
00:29:56,230 --> 00:29:54,640
so that's really important for us to

969
00:29:58,149 --> 00:29:56,240
remember i know and if you're one of

970
00:30:00,389 --> 00:29:58,159
those people who has spent time

971
00:30:01,909 --> 00:30:00,399
you know i mean i think when i first

972
00:30:03,750 --> 00:30:01,919
started with an instrument it was so

973
00:30:05,029 --> 00:30:03,760
it was one of the first stable isotope

974
00:30:08,149 --> 00:30:05,039
mass spectrometers

975
00:30:09,590 --> 00:30:08,159
from the 1950s and actually i was i was

976
00:30:11,269 --> 00:30:09,600
at caltech when we

977
00:30:13,110 --> 00:30:11,279
convinced that it was time for the new

978
00:30:15,029 --> 00:30:13,120
one but this was such a

979
00:30:16,710 --> 00:30:15,039
workhorse but it was you know red ink

980
00:30:19,990 --> 00:30:16,720
and drawing with a protractor

981
00:30:20,950 --> 00:30:20,000
and i was like oh my gosh but the data

982
00:30:24,389 --> 00:30:20,960
were um

983
00:30:25,430 --> 00:30:24,399
very valid right well validated

984
00:30:27,430 --> 00:30:25,440
and i had to actually end up going

985
00:30:30,710 --> 00:30:27,440
somewhere else with the micro capillary

986
00:30:31,669 --> 00:30:30,720
inlet system but anyway but the thing is

987
00:30:32,870 --> 00:30:31,679
you have to recognize or

988
00:30:34,549 --> 00:30:32,880

even if you're doing something that

989
00:30:36,310 --> 00:30:34,559
seems you know that it'll be outdated in

990
00:30:37,430 --> 00:30:36,320
five years or ten years you're playing

991
00:30:39,510 --> 00:30:37,440
an important piece of

992
00:30:40,870 --> 00:30:39,520
the development path yeah i mean we

993
00:30:42,549 --> 00:30:40,880
absolutely are you know standing on the

994
00:30:44,470 --> 00:30:42,559
shoulders of giants all of us

995
00:30:46,230 --> 00:30:44,480
you know every scientist every engineer

996
00:30:47,990 --> 00:30:46,240
every person taking a part in

997
00:30:49,269 --> 00:30:48,000
in this journey of astrobiology and the

998
00:30:51,029 --> 00:30:49,279
journey of sciences

999
00:30:52,389 --> 00:30:51,039
is standing on top of all the other work

1000
00:30:54,230 --> 00:30:52,399
that came before us and

1001
00:30:55,750 --> 00:30:54,240
it feels like for every other generation

1002
00:30:57,269 --> 00:30:55,760
every generation we have

1003
00:30:59,830 --> 00:30:57,279
that there's like the earlier generation

1004
00:31:00,470 --> 00:30:59,840
did all this long back-breaking arduous

1005
00:31:02,230 --> 00:31:00,480
work

1006
00:31:04,549 --> 00:31:02,240
of trying to figure out how to collect

1007
00:31:05,909 --> 00:31:04,559
the data and then analyzing it by hand

1008
00:31:07,750 --> 00:31:05,919
and then like each generation gets

1009
00:31:09,350 --> 00:31:07,760
better and better ways of analyzing it

1010
00:31:11,029 --> 00:31:09,360
but then they also get other problems to

1011
00:31:15,190 --> 00:31:11,039
deal with that keep them very busy in

1012
00:31:18,870 --> 00:31:16,789
so our next question comes from user

1013
00:31:21,190 --> 00:31:18,880

michael blank on facebook

1014
00:31:22,789 --> 00:31:21,200
uh michael says that he's seen photos of

1015
00:31:24,870 --> 00:31:22,799
subsurface liquid

1016
00:31:27,190 --> 00:31:24,880
presumably the water flowing down crater

1017
00:31:29,509 --> 00:31:27,200
hills i imagine this is in mars

1018
00:31:31,830 --> 00:31:29,519
uh if any life exists below the surface

1019
00:31:33,430 --> 00:31:31,840
wouldn't this be the best place to look

1020
00:31:35,190 --> 00:31:33,440
perhaps he's talking about the recurring

1021
00:31:36,630 --> 00:31:35,200
slope linear maybe

1022
00:31:38,470 --> 00:31:36,640
so crater walls especially ones that

1023
00:31:40,310 --> 00:31:38,480
might spew a mudslide are

1024
00:31:42,230 --> 00:31:40,320
probably too dangerous for an astronaut

1025
00:31:44,149 --> 00:31:42,240
and maybe too steep for a rover

1026
00:31:45,909 --> 00:31:44,159
but maybe a larger version of ingenuity

1027
00:31:47,590 --> 00:31:45,919
or maybe in this case a pack of robot

1028
00:31:50,230 --> 00:31:47,600
dogs could walk down to it

1029
00:31:51,509 --> 00:31:50,240
uh so what do you think about that uh

1030
00:31:54,149 --> 00:31:51,519
you know um people have

1031
00:31:55,990 --> 00:31:54,159
as long as i guess postulated that that

1032
00:31:58,710 --> 00:31:56,000
those we could place or rather this

1033
00:32:00,230 --> 00:31:58,720
surface expression of subsurface fluids

1034
00:32:01,190 --> 00:32:00,240
might be a good entry point but as you

1035
00:32:03,350 --> 00:32:01,200
as you mentioned graham

1036
00:32:04,950 --> 00:32:03,360
um how do you how to get there right so

1037
00:32:07,509 --> 00:32:04,960
the helicopter might be one way

1038
00:32:08,870 --> 00:32:07,519

jpl another jpl team has a concept

1039
00:32:11,110 --> 00:32:08,880
called moon diver

1040
00:32:13,190 --> 00:32:11,120
um that is being developed for the moon

1041
00:32:13,750 --> 00:32:13,200
but it involves a tether so essentially

1042
00:32:16,870 --> 00:32:13,760
a road

1043
00:32:17,350 --> 00:32:16,880
wheeled robot that comes up and then the

1044
00:32:21,110 --> 00:32:17,360
front

1045
00:32:23,190 --> 00:32:21,120
released and powers on

1046
00:32:25,029 --> 00:32:23,200
it's on and goes down into a crater on

1047
00:32:26,630 --> 00:32:25,039
the moon so maybe something like that

1048
00:32:28,630 --> 00:32:26,640
would be useful but i think you're right

1049
00:32:31,990 --> 00:32:28,640
it is very dangerous we have no idea

1050
00:32:33,350 --> 00:32:32,000
um how what the what the how solid that

1051
00:32:34,950 --> 00:32:33,360
slope would be

1052
00:32:36,630 --> 00:32:34,960
yeah in our in our river challenge we've

1053
00:32:38,149 --> 00:32:36,640
been discussing for some years

1054
00:32:40,389 --> 00:32:38,159
having the students have to connect a

1055
00:32:42,070 --> 00:32:40,399
cable and like lower themselves down the

1056
00:32:43,590 --> 00:32:42,080
side of a hill

1057
00:32:45,190 --> 00:32:43,600
and i know the students you know these

1058
00:32:46,389 --> 00:32:45,200
young undergraduate engineering

1059
00:32:48,070 --> 00:32:46,399
and science students from around the

1060
00:32:48,789 --> 00:32:48,080
world they would love to be given a

1061
00:32:51,029 --> 00:32:48,799
problem like that

1062
00:32:52,310 --> 00:32:51,039
to work around uh and so i think we're

1063
00:32:53,990 --> 00:32:52,320

gonna see things like that you know

1064
00:32:55,830 --> 00:32:54,000
unique engineering solutions

1065
00:32:57,669 --> 00:32:55,840
getting into these really tricky areas

1066
00:32:59,669 --> 00:32:57,679
in the future i i'm so

1067
00:33:01,190 --> 00:32:59,679
i mean i'm so in it of all of the

1068
00:33:04,549 --> 00:33:01,200
robotic things that you can do

1069
00:33:06,950 --> 00:33:04,559
on low budget and there's low budget at

1070
00:33:08,310 --> 00:33:06,960
home and then there's low budget like

1071
00:33:09,509 --> 00:33:08,320
the relatively low about

1072
00:33:11,350 --> 00:33:09,519
the rover challenge when you have like a

1073
00:33:12,870 --> 00:33:11,360
twenty thousand dollar cap which is

1074
00:33:14,789 --> 00:33:12,880
harder for an individual it's expensive

1075
00:33:16,149 --> 00:33:14,799
for ninja for you know compared to a

1076
00:33:18,310 --> 00:33:16,159
million dollar price tag

1077
00:33:20,389 --> 00:33:18,320
for or a billion dollar price tag to get

1078
00:33:23,669 --> 00:33:20,399
curiosity or perseverance to mars

1079
00:33:24,789 --> 00:33:23,679
um it's it's it's amazing absolutely

1080
00:33:26,230 --> 00:33:24,799
and it's getting better all the time

1081
00:33:27,830 --> 00:33:26,240
there's so many ways for young children

1082
00:33:28,789 --> 00:33:27,840
too now to get involved in robotics and

1083
00:33:30,549 --> 00:33:28,799
engineering there's

1084
00:33:31,990 --> 00:33:30,559
really simple robotics kits and lots of

1085
00:33:33,190 --> 00:33:32,000
great websites out there

1086
00:33:37,110 --> 00:33:33,200
and ways for young people to get

1087
00:33:38,870 --> 00:33:37,120
involved in in this future of robotics

1088
00:33:40,149 --> 00:33:38,880

so our next question comes from ana

1089
00:33:42,389 --> 00:33:40,159
rupanti uh

1090
00:33:43,669 --> 00:33:42,399
at strayologist one of our ambassadors

1091
00:33:44,710 --> 00:33:43,679
for this month and someone who i

1092
00:33:47,029 --> 00:33:44,720
personally argued

1093
00:33:49,430 --> 00:33:47,039
will be like the president of the the

1094
00:33:51,350 --> 00:33:49,440
astrobiology organization of india

1095
00:33:53,110 --> 00:33:51,360
once it's formed uh i think he has a

1096
00:33:55,269 --> 00:33:53,120
very bright future

1097
00:33:57,830 --> 00:33:55,279
honor wants to know a bit more about how

1098
00:33:59,269 --> 00:33:57,840
different martian lava tubes are

1099
00:34:01,590 --> 00:33:59,279
you mentioned earlier the difference in

1100
00:34:03,430 --> 00:34:01,600
sizes but to you know the gravity

1101
00:34:05,430 --> 00:34:03,440
atmospheric pressure temperature do they

1102
00:34:09,109 --> 00:34:05,440
also alter these caves in other ways

1103
00:34:10,950 --> 00:34:09,119
that we think could be important hi hi

1104
00:34:12,629 --> 00:34:10,960
um yeah that's a great question and

1105
00:34:13,270 --> 00:34:12,639
actually the short answer is we don't

1106
00:34:15,750 --> 00:34:13,280
know

1107
00:34:17,430 --> 00:34:15,760
right so we have uh chemistry right the

1108
00:34:18,149 --> 00:34:17,440
chemical composition of the basalts on

1109
00:34:19,990 --> 00:34:18,159
mars

1110
00:34:22,069 --> 00:34:20,000
and so we can model that you know based

1111
00:34:23,829 --> 00:34:22,079
on the rheology we assume

1112
00:34:25,909 --> 00:34:23,839
but would these uh one thing that

1113
00:34:26,950 --> 00:34:25,919

affects how the case will flow and where

1114
00:34:30,550 --> 00:34:26,960
the tubes will

1115
00:34:31,750 --> 00:34:30,560
form it has to how much water is in the

1116
00:34:33,669 --> 00:34:31,760
initial magma

1117
00:34:35,909 --> 00:34:33,679
and so that affects the viscosity and

1118
00:34:38,470 --> 00:34:35,919
whether or not it'll flow long distances

1119
00:34:39,030 --> 00:34:38,480
things on mars we see we see what

1120
00:34:40,629 --> 00:34:39,040
appears

1121
00:34:42,149 --> 00:34:40,639
and on the moon we see tubes that appear

1122
00:34:44,470 --> 00:34:42,159
to have flowed or

1123
00:34:47,349 --> 00:34:44,480
formed over hundreds of kilometers so

1124
00:34:49,990 --> 00:34:47,359
they would be much longer also on earth

1125
00:34:52,629 --> 00:34:50,000
and um and as i mentioned because of low

1126
00:34:54,310 --> 00:34:52,639
gravity bigger

1127
00:34:55,270 --> 00:34:54,320
yeah in my mind i keep going to this

1128
00:34:57,030 --> 00:34:55,280
weird place where it's kind of like

1129
00:34:58,710 --> 00:34:57,040
science fiction kind of imagine an

1130
00:35:00,150 --> 00:34:58,720
underground network of lava tubes and

1131
00:35:01,030 --> 00:35:00,160
stuff that humans could connect to each

1132
00:35:05,430 --> 00:35:01,040
other if we had

1133
00:35:08,710 --> 00:35:07,030
that'd be very exciting yeah it seems

1134
00:35:10,710 --> 00:35:08,720
like too much possibility

1135
00:35:12,950 --> 00:35:10,720
um so our next question is coming in

1136
00:35:14,150 --> 00:35:12,960
from saginet from user stephanie colon

1137
00:35:16,310 --> 00:35:14,160
santos

1138
00:35:17,430 --> 00:35:16,320

uh stephanie says once she said amazing

1139
00:35:19,990 --> 00:35:17,440
talk um

1140
00:35:20,710 --> 00:35:20,000
and now she's curious if you were to

1141
00:35:23,750 --> 00:35:20,720
imagine

1142
00:35:25,510 --> 00:35:23,760
life on mars um or or any alternative

1143
00:35:28,550 --> 00:35:25,520
environment but life out there

1144
00:35:31,589 --> 00:35:28,560
uh what does it look like to you

1145
00:35:33,109 --> 00:35:31,599
uh well you know i guess i'm not

1146
00:35:35,589 --> 00:35:33,119
in this regard i'm sort of conservative

1147
00:35:38,950 --> 00:35:35,599
i think it'll be microbial life

1148
00:35:39,829 --> 00:35:38,960
and uh we know from models that it seems

1149
00:35:42,630 --> 00:35:39,839
it was possible

1150
00:35:44,230 --> 00:35:42,640
to have a pens when we like trans

1151
00:35:46,470 --> 00:35:44,240
transportation between

1152
00:35:48,069 --> 00:35:46,480
planets within our solar system so there

1153
00:35:49,990 --> 00:35:48,079
are some people who propose that

1154
00:35:52,069 --> 00:35:50,000
life actually began on mars and then

1155
00:35:53,829 --> 00:35:52,079
came to earth but i think there's a

1156
00:35:55,430 --> 00:35:53,839
life on mars it would be a residual life

1157
00:35:58,310 --> 00:35:55,440
from an older time

1158
00:35:59,109 --> 00:35:58,320
billions of years older and it will be

1159
00:36:00,790 --> 00:35:59,119
um

1160
00:36:02,310 --> 00:36:00,800
very we'll have the diversity we see on

1161
00:36:05,030 --> 00:36:02,320
earth and it will be

1162
00:36:05,430 --> 00:36:05,040
in the microbial form yeah that's very

1163
00:36:07,990 --> 00:36:05,440

cool

1164
00:36:09,349 --> 00:36:08,000
so i have another question for myself um

1165
00:36:10,630 --> 00:36:09,359
in trying to understand whether or not

1166
00:36:11,829 --> 00:36:10,640
there could have been microbial life or

1167
00:36:13,430 --> 00:36:11,839
especially ancient life

1168
00:36:15,750 --> 00:36:13,440
you know signs of ancient life from long

1169
00:36:18,150 --> 00:36:15,760
ago on mars with with perseverance

1170
00:36:19,750 --> 00:36:18,160
we're going to be caching samples and

1171
00:36:21,030 --> 00:36:19,760
dropping samples and these tubes on the

1172
00:36:21,829 --> 00:36:21,040
surface and then sending a mission to

1173
00:36:23,109 --> 00:36:21,839
pick them up and

1174
00:36:24,390 --> 00:36:23,119
and bring them back to earth and it's

1175
00:36:26,230 --> 00:36:24,400
going to be a very large undertaking

1176
00:36:29,510 --> 00:36:26,240
it's going to take many years before

1177
00:36:32,069 --> 00:36:29,520
we get those samples back if you had a

1178
00:36:33,270 --> 00:36:32,079
chance to work on one of these samples

1179
00:36:36,390 --> 00:36:33,280
what would you want to look for

1180
00:36:38,470 --> 00:36:36,400
specifically from your expertise

1181
00:36:41,670 --> 00:36:38,480
well i guess oh that's a good question

1182
00:36:43,589 --> 00:36:41,680
what i want to look for i would probably

1183
00:36:45,109 --> 00:36:43,599
as as we all want we want to use many

1184
00:36:46,950 --> 00:36:45,119
lines of evidence to

1185
00:36:49,430 --> 00:36:46,960
address the question of is it life or is

1186
00:36:49,750 --> 00:36:49,440
it not so for my background i would use

1187
00:36:54,310 --> 00:36:49,760
a

1188
00:36:55,910 --> 00:36:54,320

geochemistry um

1189
00:36:58,310 --> 00:36:55,920
life has a slightly different isotope

1190
00:37:00,069 --> 00:36:58,320
signature than non-life

1191
00:37:01,589 --> 00:37:00,079
and then i think what one thing we've

1192
00:37:02,310 --> 00:37:01,599
learned from working in the lava caves

1193
00:37:06,550 --> 00:37:02,320
is

1194
00:37:09,750 --> 00:37:06,560
dominated by our

1195
00:37:12,710 --> 00:37:09,760
visual perceptions so uh you can never

1196
00:37:13,750 --> 00:37:12,720
get enough of the images so images tell

1197
00:37:15,589 --> 00:37:13,760
you where to look and then you have to

1198
00:37:17,349 --> 00:37:15,599
probe deeper

1199
00:37:19,270 --> 00:37:17,359
yeah so it's so important that we put

1200
00:37:21,190 --> 00:37:19,280
cameras on all of our our spacecraft to

1201
00:37:23,190 --> 00:37:21,200
like let us see

1202
00:37:24,870 --> 00:37:23,200
i know the idea of sending any probe

1203
00:37:29,109 --> 00:37:24,880
anywhere without a camera

1204
00:37:30,710 --> 00:37:29,119
to me is um will be a no-go

1205
00:37:32,069 --> 00:37:30,720
and yet in the early history of space

1206
00:37:33,750 --> 00:37:32,079
exploration a lot of people are like why

1207
00:37:35,750 --> 00:37:33,760
would we send a camera along

1208
00:37:37,109 --> 00:37:35,760
um you know it really took some forward

1209
00:37:38,630 --> 00:37:37,119
thinking to take a long camera to get

1210
00:37:40,310 --> 00:37:38,640
all these wonderful pictures for

1211
00:37:42,390 --> 00:37:40,320
everyone on earth to feel like part of

1212
00:37:43,990 --> 00:37:42,400
the process uh as well as getting

1213
00:37:45,829 --> 00:37:44,000

getting great data

1214
00:37:47,829 --> 00:37:45,839
um our next question now for you dr

1215
00:37:48,870 --> 00:37:47,839
blank comes from candy rodriguez on

1216
00:37:51,910 --> 00:37:48,880
facebook

1217
00:37:54,470 --> 00:37:51,920
kandee wants to know um if you can oh

1218
00:37:57,589 --> 00:37:54,480
this is an interesting question

1219
00:37:58,550 --> 00:37:57,599
they are they're all interested so do

1220
00:38:00,550 --> 00:37:58,560
you think it's more

1221
00:38:01,589 --> 00:38:00,560
common to find a physicist working in

1222
00:38:03,510 --> 00:38:01,599
biology

1223
00:38:05,430 --> 00:38:03,520
or to find a biologist working in

1224
00:38:07,750 --> 00:38:05,440
physics

1225
00:38:09,109 --> 00:38:07,760
i think that's actually an easy one in

1226
00:38:10,950 --> 00:38:09,119
terms of i think it's more common to

1227
00:38:14,150 --> 00:38:10,960
find a physicist working in biology

1228
00:38:14,950 --> 00:38:14,160
especially today because physicists

1229
00:38:17,109 --> 00:38:14,960
often have

1230
00:38:18,470 --> 00:38:17,119
strong computational skills and strong

1231
00:38:20,790 --> 00:38:18,480
mathematical skills

1232
00:38:22,790 --> 00:38:20,800
and today more and more um whether

1233
00:38:23,270 --> 00:38:22,800
you're in synthetic biology but more

1234
00:38:26,230 --> 00:38:23,280
more

1235
00:38:27,990 --> 00:38:26,240
important i guess in bioinformatics it's

1236
00:38:30,310 --> 00:38:28,000
really a data mining exercise

1237
00:38:32,790 --> 00:38:30,320
right you need the context of the

1238
00:38:33,270 --> 00:38:32,800

genetics or microbial ecology background

1239
00:38:34,950 --> 00:38:33,280
to

1240
00:38:37,270 --> 00:38:34,960
understand the value of what you're

1241
00:38:40,630 --> 00:38:37,280
finding but to find patterns and define

1242
00:38:42,390 --> 00:38:40,640
features in the data it's you know you

1243
00:38:45,510 --> 00:38:42,400
really have to have strong

1244
00:38:48,310 --> 00:38:45,520
data data analysis skills

1245
00:38:48,870 --> 00:38:48,320
and that's common among physicists

1246
00:38:50,710 --> 00:38:48,880
whereas

1247
00:38:51,910 --> 00:38:50,720
there's still i mean the many biologists

1248
00:38:54,950 --> 00:38:51,920
whose expertise

1249
00:38:56,470 --> 00:38:54,960
is in the field or with a microscope or

1250
00:38:59,190 --> 00:38:56,480
with culture in the laboratory who might

1251
00:39:00,790 --> 00:38:59,200
not have those other skills

1252
00:39:02,550 --> 00:39:00,800
so it's a great collaboration great

1253
00:39:04,550 --> 00:39:02,560
collaboration yeah i mean

1254
00:39:06,150 --> 00:39:04,560
the reason why we have astrobiology we

1255
00:39:07,510 --> 00:39:06,160
are coming together across

1256
00:39:09,750 --> 00:39:07,520
all of our disciplines and sub

1257
00:39:10,470 --> 00:39:09,760
disciplines to answer these larger

1258
00:39:12,630 --> 00:39:10,480
questions

1259
00:39:14,230 --> 00:39:12,640
about you know life how it started how

1260
00:39:16,310 --> 00:39:14,240
it evolved and where it might be out

1261
00:39:18,470 --> 00:39:16,320
there for us to go find so

1262
00:39:20,470 --> 00:39:18,480
that's really cool we have another

1263
00:39:21,510 --> 00:39:20,480

facebook question here from user kelly

1264
00:39:24,470 --> 00:39:21,520
lars

1265
00:39:25,190 --> 00:39:24,480
kelly asks if you use physics and they

1266
00:39:26,390 --> 00:39:25,200
want

1267
00:39:28,310 --> 00:39:26,400
it sounds they won't know more about

1268
00:39:31,670 --> 00:39:28,320
math they won't know if you use calculus

1269
00:39:32,790 --> 00:39:31,680
and maths in your day to day work um

1270
00:39:35,829 --> 00:39:32,800
and i think the question they want to

1271
00:39:36,710 --> 00:39:35,839
ask is is how much math is important for

1272
00:39:38,310 --> 00:39:36,720
your work

1273
00:39:39,670 --> 00:39:38,320
um they said that the most direct path

1274
00:39:40,870 --> 00:39:39,680
to astrobiology appears like

1275
00:39:43,109 --> 00:39:40,880
astrophysics

1276
00:39:45,430 --> 00:39:43,119
for them but there's a lot of math that

1277
00:39:46,550 --> 00:39:45,440
doesn't seem to be used from day to day

1278
00:39:48,550 --> 00:39:46,560
and we've gotten this question from

1279
00:39:50,230 --> 00:39:48,560
other people before for the show

1280
00:39:52,550 --> 00:39:50,240
they really want to know and you know

1281
00:39:53,670 --> 00:39:52,560
how much do you use mathematics in your

1282
00:39:55,270 --> 00:39:53,680
own research

1283
00:39:57,270 --> 00:39:55,280
how important was it for you in your

1284
00:39:58,630 --> 00:39:57,280
learning to have a base of mathematics

1285
00:40:00,310 --> 00:39:58,640
first

1286
00:40:01,430 --> 00:40:00,320
that's a good question so i know people

1287
00:40:02,390 --> 00:40:01,440
said i can't do this because i don't

1288
00:40:05,030 --> 00:40:02,400

have math

1289
00:40:06,309 --> 00:40:05,040
but i think math gives you a framework

1290
00:40:08,470 --> 00:40:06,319
for interpretation

1291
00:40:10,630 --> 00:40:08,480
so and having to solve problems or

1292
00:40:12,550 --> 00:40:10,640
mathematical problems helps you develop

1293
00:40:14,150 --> 00:40:12,560
a thinking you know thinking ability

1294
00:40:15,190 --> 00:40:14,160
right a whole new thinking ability but

1295
00:40:18,550 --> 00:40:15,200
in terms of do i

1296
00:40:21,190 --> 00:40:18,560
i took um three years of math in college

1297
00:40:24,230 --> 00:40:21,200
and then a year of math at caltech but

1298
00:40:25,910 --> 00:40:24,240
but it was complex analysis again

1299
00:40:27,670 --> 00:40:25,920
and i really haven't had to think about

1300
00:40:30,309 --> 00:40:27,680
imaginary numbers but um

1301
00:40:31,270 --> 00:40:30,319
what has been valuable is linear algebra

1302
00:40:32,870 --> 00:40:31,280
and i did

1303
00:40:34,470 --> 00:40:32,880
take that as an undergraduate and then i

1304
00:40:37,750 --> 00:40:34,480
took that on my own

1305
00:40:39,190 --> 00:40:37,760
um uh that's in

1306
00:40:40,790 --> 00:40:39,200
in grad school one summer i thought oh i

1307
00:40:41,990 --> 00:40:40,800
need to you know learn this better

1308
00:40:43,510 --> 00:40:42,000
because we do

1309
00:40:45,270 --> 00:40:43,520
once again when we're processing big

1310
00:40:48,630 --> 00:40:45,280
data sets to understand

1311
00:40:50,069 --> 00:40:48,640
uh statistics um and then how it's

1312
00:40:52,150 --> 00:40:50,079
how it's performed and how we can

1313
00:40:54,870 --> 00:40:52,160

transpose our

1314
00:40:55,750 --> 00:40:54,880
number matrices to extract patterns

1315
00:40:58,470 --> 00:40:55,760
that's important

1316
00:40:59,910 --> 00:40:58,480
but that said i think you can do very

1317
00:41:01,589 --> 00:40:59,920
well with the software

1318
00:41:03,270 --> 00:41:01,599
even if you can't derive the mathematics

1319
00:41:04,710 --> 00:41:03,280
right so in fact

1320
00:41:06,470 --> 00:41:04,720
people ask me to derive mathematical

1321
00:41:07,109 --> 00:41:06,480
equations i guess i would say i'm not

1322
00:41:08,630 --> 00:41:07,119
afraid

1323
00:41:11,190 --> 00:41:08,640
but i'd have to go back and relearn or

1324
00:41:12,710 --> 00:41:11,200
revisit so i think that helps you in

1325
00:41:13,510 --> 00:41:12,720
your ability to think and pose new

1326
00:41:15,750 --> 00:41:13,520
questions

1327
00:41:16,550 --> 00:41:15,760
if you have have some sort of grounding

1328
00:41:20,150 --> 00:41:16,560
in mathematics but

1329
00:41:22,230 --> 00:41:20,160
it's not essential that's a good point

1330
00:41:24,710 --> 00:41:22,240
um our next question comes from a

1331
00:41:26,870 --> 00:41:24,720
twitter user at redbrook42

1332
00:41:28,069 --> 00:41:26,880
who is brooke carothers an alumnus of

1333
00:41:29,430 --> 00:41:28,079
our young scientist program at blue

1334
00:41:32,150 --> 00:41:29,440
marble space

1335
00:41:33,109 --> 00:41:32,160
uh brook first off says hi um and then

1336
00:41:35,270 --> 00:41:33,119
she wants to know

1337
00:41:36,550 --> 00:41:35,280
uh what is your favorite and least

1338
00:41:39,670 --> 00:41:36,560

favorite thing

1339
00:41:43,190 --> 00:41:39,680
about being an astrobiologist

1340
00:41:46,710 --> 00:41:43,200
favorite thing i guess is uh

1341
00:41:48,470 --> 00:41:46,720
two things i i love the fieldwork part

1342
00:41:50,390 --> 00:41:48,480
especially when i'm working with people

1343
00:41:51,589 --> 00:41:50,400
who also love the field work so a good

1344
00:41:53,510 --> 00:41:51,599
group of people

1345
00:41:54,790 --> 00:41:53,520
and also i love those tiny moments that

1346
00:41:56,230 --> 00:41:54,800
are very few and far between of

1347
00:41:58,230 --> 00:41:56,240
discovery

1348
00:41:59,510 --> 00:41:58,240
now we can break it down and say every

1349
00:42:00,550 --> 00:41:59,520
day is something you need to discover

1350
00:42:02,230 --> 00:42:00,560
right but i mean

1351
00:42:03,589 --> 00:42:02,240
like a sort of step change in discovery

1352
00:42:07,030 --> 00:42:03,599
that's that's exciting

1353
00:42:09,030 --> 00:42:07,040
the hardest thing um for me is of course

1354
00:42:11,430 --> 00:42:09,040
the resources we have to spend a lot of

1355
00:42:15,349 --> 00:42:11,440
time generating resources

1356
00:42:16,630 --> 00:42:15,359
um ie funding to do our crazy work

1357
00:42:18,710 --> 00:42:16,640
and then i guess another thing that's

1358
00:42:19,510 --> 00:42:18,720
challenging is is sometimes politics but

1359
00:42:22,150 --> 00:42:19,520
you know

1360
00:42:23,349 --> 00:42:22,160
and seeing how politics affect the basic

1361
00:42:24,790 --> 00:42:23,359
science

1362
00:42:26,069 --> 00:42:24,800
and you mentioned to us earlier that you

1363
00:42:27,030 --> 00:42:26,079

know you've been in the field for some

1364
00:42:28,950 --> 00:42:27,040
time now

1365
00:42:30,630 --> 00:42:28,960
i wonder how how have those things

1366
00:42:31,829 --> 00:42:30,640
changed for you over time have you seen

1367
00:42:33,990 --> 00:42:31,839
a large change in

1368
00:42:35,670 --> 00:42:34,000
the demographics of our field in the

1369
00:42:37,270 --> 00:42:35,680
politics of our field have things gotten

1370
00:42:39,030 --> 00:42:37,280
better or worse

1371
00:42:40,950 --> 00:42:39,040
what would you say is kind of the scope

1372
00:42:42,630 --> 00:42:40,960
of the trajectory of astrobiology

1373
00:42:44,630 --> 00:42:42,640
that's a good question well um i think

1374
00:42:46,150 --> 00:42:44,640
even in the 90s when astrology

1375
00:42:47,670 --> 00:42:46,160
was sort of recognized as its own

1376
00:42:49,910 --> 00:42:47,680
discipline

1377
00:42:51,510 --> 00:42:49,920
it automatically maybe because of the

1378
00:42:53,910 --> 00:42:51,520
biology aspect

1379
00:42:55,829 --> 00:42:53,920
there were a lot more women in

1380
00:42:56,630 --> 00:42:55,839
astrobiology than say in geology or

1381
00:42:58,069 --> 00:42:56,640
physics

1382
00:42:59,510 --> 00:42:58,079
and even though my training is in

1383
00:43:01,670 --> 00:42:59,520
geochemistry i haven't been hired as a

1384
00:43:03,030 --> 00:43:01,680
geophysicist or as a physicist so

1385
00:43:05,109 --> 00:43:03,040
i worked for example in one of the

1386
00:43:06,630 --> 00:43:05,119
national laboratories in a division

1387
00:43:07,670 --> 00:43:06,640
where there are 200 scientists and i was

1388
00:43:09,349 --> 00:43:07,680

the other woman

1389
00:43:11,190 --> 00:43:09,359
this is very lonely so i've seen that

1390
00:43:14,470 --> 00:43:11,200
change and also going back to visit

1391
00:43:16,309 --> 00:43:14,480
my alma mater for graduate school

1392
00:43:17,670 --> 00:43:16,319
we actually now have women faculty in my

1393
00:43:19,109 --> 00:43:17,680
division and there were no

1394
00:43:21,910 --> 00:43:19,119
there are no role models when i was

1395
00:43:23,990 --> 00:43:21,920
going through school who are women

1396
00:43:25,109 --> 00:43:24,000
and there's such more of an emphasis on

1397
00:43:28,230 --> 00:43:25,119
speaking up

1398
00:43:29,990 --> 00:43:28,240
and uh if if you are in the i guess a

1399
00:43:31,270 --> 00:43:30,000
what's considered to be a inferior

1400
00:43:33,430 --> 00:43:31,280
position whether if you have

1401
00:43:35,349 --> 00:43:33,440
if you have less power in your in your

1402
00:43:38,390 --> 00:43:35,359
position there's much more protection

1403
00:43:39,430 --> 00:43:38,400
for that and and also opportunities for

1404
00:43:41,270 --> 00:43:39,440
students

1405
00:43:42,550 --> 00:43:41,280
they're fantastic so i'm saying to any

1406
00:43:43,990 --> 00:43:42,560
students this week

1407
00:43:46,710 --> 00:43:44,000
there are so many more opportunities for

1408
00:43:48,470 --> 00:43:46,720
students in early career than there are

1409
00:43:50,309 --> 00:43:48,480
small opportunities that there are later

1410
00:43:51,190 --> 00:43:50,319
in your career so take advantage of all

1411
00:43:52,950 --> 00:43:51,200
of them that you can

1412
00:43:54,309 --> 00:43:52,960
so it's pretty great that's a great

1413
00:43:55,750 --> 00:43:54,319

message i love that yeah

1414
00:43:57,589 --> 00:43:55,760
take advantage of the opportunities

1415
00:43:57,990 --> 00:43:57,599
apply for things reach out to people

1416
00:43:59,910 --> 00:43:58,000
that's

1417
00:44:01,670 --> 00:43:59,920
a really great message right and don't i

1418
00:44:03,990 --> 00:44:01,680
mean if you get rejected

1419
00:44:04,710 --> 00:44:04,000
try to take it as a learning lesson

1420
00:44:07,990 --> 00:44:04,720
rather than

1421
00:44:10,069 --> 00:44:08,000
oh woe is me i'm a failure because in

1422
00:44:12,950 --> 00:44:10,079
this business we get rejections it's not

1423
00:44:13,430 --> 00:44:12,960
as bad as acting but um you know we have

1424
00:44:15,589 --> 00:44:13,440
to and

1425
00:44:16,790 --> 00:44:15,599
and part of i guess when i get rejected

1426
00:44:19,030 --> 00:44:16,800
of course i feel horrible

1427
00:44:20,470 --> 00:44:19,040
but then i think okay did i get any

1428
00:44:21,990 --> 00:44:20,480
constructive criticism that can make my

1429
00:44:25,030 --> 00:44:22,000
next try better

1430
00:44:27,750 --> 00:44:25,040
or you know whatever and that

1431
00:44:28,230 --> 00:44:27,760
and then i go play with my horse but um

1432
00:44:29,750 --> 00:44:28,240
so

1433
00:44:31,270 --> 00:44:29,760
you know it's not it you need a little

1434
00:44:32,870 --> 00:44:31,280
recovery time but it happens to

1435
00:44:33,829 --> 00:44:32,880
everybody even the people who are at the

1436
00:44:35,589 --> 00:44:33,839
top of the game

1437
00:44:36,710 --> 00:44:35,599
yeah we haven't discussed your voice yet

1438
00:44:37,430 --> 00:44:36,720

i wonder if you might just tell our

1439
00:44:39,030 --> 00:44:37,440
audience

1440
00:44:41,430 --> 00:44:39,040
um about your horse what what i mean is

1441
00:44:42,550 --> 00:44:41,440
this so uh equestrian as a hobby then or

1442
00:44:43,829 --> 00:44:42,560
is this something you've been doing for

1443
00:44:46,069 --> 00:44:43,839
a long time in your life

1444
00:44:47,910 --> 00:44:46,079
you know it's funny yeah thanks i i have

1445
00:44:50,390 --> 00:44:47,920
had a horse for 10 years and

1446
00:44:50,950 --> 00:44:50,400
i wanted to ride as a girl and didn't uh

1447
00:44:53,750 --> 00:44:50,960
for

1448
00:44:55,109 --> 00:44:53,760
various reasons and so at some point i

1449
00:44:57,270 --> 00:44:55,119
thought i'm not getting any younger

1450
00:44:59,589 --> 00:44:57,280
i'll start taking lessons and i'm in a

1451
00:45:01,750 --> 00:44:59,599
place in california where

1452
00:45:02,630 --> 00:45:01,760
there are ranches nearby so through a

1453
00:45:04,470 --> 00:45:02,640
friend got

1454
00:45:06,390 --> 00:45:04,480
got involved and after five years i was

1455
00:45:09,030 --> 00:45:06,400
still really excited

1456
00:45:10,470 --> 00:45:09,040
so then i got my own horse and uh i've

1457
00:45:13,190 --> 00:45:10,480
had quite adventures about

1458
00:45:14,390 --> 00:45:13,200
with my horse including um many broken

1459
00:45:16,069 --> 00:45:14,400
bones

1460
00:45:18,470 --> 00:45:16,079
he's off the track thoroughbred who was

1461
00:45:20,069 --> 00:45:18,480
quite quite feisty and probably too

1462
00:45:21,990 --> 00:45:20,079
feisty for me

1463
00:45:23,270 --> 00:45:22,000

at the time but the biggest thing i've

1464
00:45:24,230 --> 00:45:23,280
learned so much about myself through

1465
00:45:26,870 --> 00:45:24,240
having a horse

1466
00:45:27,589 --> 00:45:26,880
because here's a thousand pound animal

1467
00:45:29,750 --> 00:45:27,599
who

1468
00:45:30,710 --> 00:45:29,760
can and has hurt me through no male

1469
00:45:32,550 --> 00:45:30,720
intent

1470
00:45:34,550 --> 00:45:32,560
but just also trying to communicate or

1471
00:45:36,870 --> 00:45:34,560
understand it's helped me with uh

1472
00:45:37,829 --> 00:45:36,880
interacting with people but mostly it's

1473
00:45:40,230 --> 00:45:37,839
to help me

1474
00:45:41,349 --> 00:45:40,240
learn about who i am so i find that to

1475
00:45:43,349 --> 00:45:41,359
be great therapy

1476
00:45:44,390 --> 00:45:43,359
and also it's sort of like doing yoga

1477
00:45:46,309 --> 00:45:44,400
you're always on a path

1478
00:45:48,390 --> 00:45:46,319
or doing astrobiology science you're

1479
00:45:50,069 --> 00:45:48,400
always on a path to discovery

1480
00:45:52,069 --> 00:45:50,079
and uh you know you never know where

1481
00:45:53,430 --> 00:45:52,079
it's going to take you i love that so

1482
00:45:54,870 --> 00:45:53,440
much right i feel like i need to go ride

1483
00:45:57,510 --> 00:45:54,880
a horse now

1484
00:45:59,670 --> 00:45:57,520
um our next question comes from user

1485
00:46:02,630 --> 00:45:59,680
paige cincio on facebook

1486
00:46:04,309 --> 00:46:02,640
first off page says hi and then she says

1487
00:46:06,150 --> 00:46:04,319
i'm starting my phd this fall

1488
00:46:08,390 --> 00:46:06,160

studying hydrothermal development in

1489
00:46:09,589 --> 00:46:08,400
impact craters with astrobiological

1490
00:46:11,270 --> 00:46:09,599
significance

1491
00:46:12,630 --> 00:46:11,280
how can hydrothermal systems within

1492
00:46:14,630 --> 00:46:12,640
earth analogs

1493
00:46:16,630 --> 00:46:14,640
assist in detecting bio signatures of

1494
00:46:17,910 --> 00:46:16,640
life on mars

1495
00:46:19,109 --> 00:46:17,920
ah that's you know that's a really good

1496
00:46:20,309 --> 00:46:19,119
question and i'd actually like to know

1497
00:46:21,990 --> 00:46:20,319
what she thinks if she's gonna be

1498
00:46:24,950 --> 00:46:22,000
starting her thesis on this

1499
00:46:26,390 --> 00:46:24,960
um but uh hydrothermal systems are a

1500
00:46:28,630 --> 00:46:26,400
fascination of mine and

1501
00:46:30,470 --> 00:46:28,640
one thing is they you know they they're

1502
00:46:32,390 --> 00:46:30,480
different kinds of signatures when

1503
00:46:34,790 --> 00:46:32,400
the water picks up the flavor of the

1504
00:46:35,990 --> 00:46:34,800
rock and sometimes in um

1505
00:46:38,309 --> 00:46:36,000
essentially especially when it's hot

1506
00:46:39,910 --> 00:46:38,319
water it promotes um alteration

1507
00:46:41,750 --> 00:46:39,920
chemistry or mineralogy

1508
00:46:43,349 --> 00:46:41,760
and sometimes that will leave behind

1509
00:46:44,470 --> 00:46:43,359
different chemical signatures whether

1510
00:46:46,550 --> 00:46:44,480
it's a hydrated rock

1511
00:46:47,670 --> 00:46:46,560
like some sort of circuitingized mineral

1512
00:46:49,589 --> 00:46:47,680
and then if you know the

1513
00:46:51,510 --> 00:46:49,599

chemical formula of that rock we can

1514
00:46:53,750 --> 00:46:51,520
essentially estimate

1515
00:46:54,710 --> 00:46:53,760
the types of energy that that reaction

1516
00:46:58,550 --> 00:46:54,720
can provide

1517
00:46:59,910 --> 00:46:58,560
and to support microbial metabolisms

1518
00:47:01,190 --> 00:46:59,920
that's very cool yeah and i mean maybe

1519
00:47:02,150 --> 00:47:01,200
paige should reach out you know and then

1520
00:47:05,030 --> 00:47:02,160
have yeah

1521
00:47:05,430 --> 00:47:05,040
hey you know i'm so excited to hear

1522
00:47:07,270 --> 00:47:05,440
about

1523
00:47:09,030 --> 00:47:07,280
what you know new graduate students and

1524
00:47:10,550 --> 00:47:09,040
new postdocs are doing for their work

1525
00:47:11,829 --> 00:47:10,560
because um

1526
00:47:12,950 --> 00:47:11,839
they're at a great you know beginning

1527
00:47:14,550 --> 00:47:12,960
point and i'm just like oh there's

1528
00:47:17,430 --> 00:47:14,560
there's so much to do so little time

1529
00:47:18,550 --> 00:47:17,440
what are you doing absolutely i i'm

1530
00:47:19,750 --> 00:47:18,560
still involved in the early career

1531
00:47:21,270 --> 00:47:19,760
community a lot but i feel like i'm

1532
00:47:22,069 --> 00:47:21,280
moving kind of more in my mid-career

1533
00:47:23,430 --> 00:47:22,079
right now

1534
00:47:25,349 --> 00:47:23,440
and it's been really fun for me lately

1535
00:47:26,870 --> 00:47:25,359
i've been i've been talking to various

1536
00:47:28,069 --> 00:47:26,880
undergraduate students and graduate

1537
00:47:29,430 --> 00:47:28,079
students about where they're going to go

1538
00:47:31,030 --> 00:47:29,440

with her and research and

1539
00:47:32,630 --> 00:47:31,040
offered my own advice here and there for

1540
00:47:33,990 --> 00:47:32,640
them offering you know advice on

1541
00:47:35,990 --> 00:47:34,000
programs to take and it's been really

1542
00:47:37,829 --> 00:47:36,000
cool at this point in my career to see

1543
00:47:39,349 --> 00:47:37,839
what young people are working on in the

1544
00:47:41,190 --> 00:47:39,359
field and where they're taking

1545
00:47:43,190 --> 00:47:41,200
astrobiology right now

1546
00:47:44,470 --> 00:47:43,200
right and what sort of uh in-situ

1547
00:47:46,230 --> 00:47:44,480
instrumentation or

1548
00:47:47,829 --> 00:47:46,240
laboratory information can they use that

1549
00:47:49,270 --> 00:47:47,839
would you know essentially take a

1550
00:47:51,109 --> 00:47:49,280
fraction of the time it took me to do my

1551
00:47:54,790 --> 00:47:51,119
phd and how much more can they learn

1552
00:47:57,710 --> 00:47:54,800
it's great absolutely our next question

1553
00:48:01,270 --> 00:47:57,720
comes from a twitter user uh at

1554
00:48:02,870 --> 00:48:01,280
arunava2512 the name is arunava podar

1555
00:48:05,270 --> 00:48:02,880
first off aaron nava says really cool

1556
00:48:06,950 --> 00:48:05,280
talk and then has a question

1557
00:48:09,349 --> 00:48:06,960
they want to know about field studies

1558
00:48:11,750 --> 00:48:09,359
for origins of life research

1559
00:48:13,750 --> 00:48:11,760
and how experiments conducted out there

1560
00:48:14,150 --> 00:48:13,760
when origin of life processes might have

1561
00:48:16,470 --> 00:48:14,160
taken

1562
00:48:18,150 --> 00:48:16,480
millions of years it kind of goes to the

1563
00:48:21,510 --> 00:48:18,160

question of you know how can we simulate

1564
00:48:22,630 --> 00:48:21,520
life the origin of life in a test tube

1565
00:48:24,230 --> 00:48:22,640
in the laboratory

1566
00:48:26,470 --> 00:48:24,240
without having that that you know many

1567
00:48:28,390 --> 00:48:26,480
millions of years process

1568
00:48:29,910 --> 00:48:28,400
wow well i heard sort of two questions

1569
00:48:30,390 --> 00:48:29,920
here and that's a that's really that's a

1570
00:48:32,870 --> 00:48:30,400
really

1571
00:48:33,510 --> 00:48:32,880
useful comment i think one when we go to

1572
00:48:34,950 --> 00:48:33,520
the field

1573
00:48:36,630 --> 00:48:34,960
we have to remember that earth is

1574
00:48:39,109 --> 00:48:36,640
contaminated

1575
00:48:40,470 --> 00:48:39,119
so the natural environment has life

1576
00:48:43,430 --> 00:48:40,480
everywhere we look there's life so it's

1577
00:48:44,309 --> 00:48:43,440
very hard to find a pristine pre-life

1578
00:48:45,910 --> 00:48:44,319
environment

1579
00:48:48,309 --> 00:48:45,920
and that's one of the advantages of the

1580
00:48:51,430 --> 00:48:48,319
lab but as you know the

1581
00:48:53,190 --> 00:48:51,440
person mentioned um it's it's hard to

1582
00:48:54,630 --> 00:48:53,200
account for time in the laboratory we

1583
00:48:55,670 --> 00:48:54,640
find this with every type of experiment

1584
00:48:58,630 --> 00:48:55,680
we do pretty much

1585
00:48:59,349 --> 00:48:58,640
um but one thing we can do to increase

1586
00:49:01,829 --> 00:48:59,359
or rather to

1587
00:49:03,510 --> 00:49:01,839
diminish the time that needed for a

1588
00:49:04,549 --> 00:49:03,520

reaction take place is to change the

1589
00:49:06,630 --> 00:49:04,559
gradient

1590
00:49:08,390 --> 00:49:06,640
so if we have an interface we have one

1591
00:49:10,069 --> 00:49:08,400
chemical constituent

1592
00:49:12,309 --> 00:49:10,079
flowing to another that's being consumed

1593
00:49:13,349 --> 00:49:12,319
or making making a cell or whatever it's

1594
00:49:15,430 --> 00:49:13,359
doing

1595
00:49:17,349 --> 00:49:15,440
if we increase the concentration of

1596
00:49:18,790 --> 00:49:17,359
something uh increase the temperature or

1597
00:49:19,829 --> 00:49:18,800
something these are things that that can

1598
00:49:20,870 --> 00:49:19,839
speed up reactions

1599
00:49:23,510 --> 00:49:20,880
and so we try to do that in the

1600
00:49:24,549 --> 00:49:23,520
laboratory yeah it's really important

1601
00:49:25,910 --> 00:49:24,559
for us to know

1602
00:49:27,670 --> 00:49:25,920
what can we actually do in the

1603
00:49:28,870 --> 00:49:27,680
laboratory what can we model

1604
00:49:30,790 --> 00:49:28,880
using all of you know our wonderful

1605
00:49:32,309 --> 00:49:30,800
computer systems and stuff now versus

1606
00:49:34,069 --> 00:49:32,319
what can we actually find in the field

1607
00:49:35,190 --> 00:49:34,079
to actually test you know our hypotheses

1608
00:49:36,790 --> 00:49:35,200
and our models

1609
00:49:37,990 --> 00:49:36,800
um we have a few more questions yet i'm

1610
00:49:39,349 --> 00:49:38,000
going to try my hardest to get to as

1611
00:49:40,710 --> 00:49:39,359
many as i can but we are

1612
00:49:42,549 --> 00:49:40,720
starting to run down time for the

1613
00:49:44,790 --> 00:49:42,559

episode uh so if i do miss anyone's

1614
00:49:46,150 --> 00:49:44,800
questions i apologize to our audience

1615
00:49:48,790 --> 00:49:46,160
um but there's been so many wonderful

1616
00:49:50,150 --> 00:49:48,800
questions already um our next question

1617
00:49:51,829 --> 00:49:50,160
actually comes from an ask an

1618
00:49:54,790 --> 00:49:51,839
astrobiologist co-host

1619
00:49:55,349 --> 00:49:54,800
dr sanjoy sam a good friend of ours on

1620
00:49:58,470 --> 00:49:55,359
twitter

1621
00:50:00,710 --> 00:49:58,480
sanjoy marcel sanjoy says

1622
00:50:03,190 --> 00:50:00,720
you mentioned this incredible feeling of

1623
00:50:05,829 --> 00:50:03,200
feeling small and large landscapes

1624
00:50:07,990 --> 00:50:05,839
uh oh this is fun how does this feeling

1625
00:50:11,109 --> 00:50:08,000
translate to working in caves

1626
00:50:12,470 --> 00:50:11,119
oh you know that's a great question

1627
00:50:14,549 --> 00:50:12,480
sanjoy and

1628
00:50:16,470 --> 00:50:14,559
um i i don't think i don't know if you

1629
00:50:18,230 --> 00:50:16,480
showed any one of these pictures but one

1630
00:50:19,750 --> 00:50:18,240
tool we use in the caves is we change

1631
00:50:21,670 --> 00:50:19,760
the light wavelength

1632
00:50:23,430 --> 00:50:21,680
and we found that if we take a sort of

1633
00:50:26,870 --> 00:50:23,440
common i call it pp light

1634
00:50:29,030 --> 00:50:26,880
or 365 nanometers that um you might use

1635
00:50:31,349 --> 00:50:29,040
to inspect your carpets at home

1636
00:50:32,790 --> 00:50:31,359
um if you shine that on the wall and

1637
00:50:34,630 --> 00:50:32,800
turn on all the light you see

1638
00:50:36,710 --> 00:50:34,640

a whole different color spectrum of

1639
00:50:39,030 --> 00:50:36,720
microbes and so one thing i'd like to do

1640
00:50:40,790 --> 00:50:39,040
in the caves is turn out all the light

1641
00:50:42,390 --> 00:50:40,800
and i think if you're claustrophobic

1642
00:50:44,790 --> 00:50:42,400
that wouldn't work so well but

1643
00:50:46,790 --> 00:50:44,800
i when i turn on lights or when i'm in

1644
00:50:48,069 --> 00:50:46,800
an arm of a cave or by myself in a cave

1645
00:50:50,069 --> 00:50:48,079
and turn on the lights

1646
00:50:51,510 --> 00:50:50,079
i feel very small and i feel as though

1647
00:50:54,470 --> 00:50:51,520
it's just a huge

1648
00:50:55,829 --> 00:50:54,480
universe of microbial life you know

1649
00:50:57,670 --> 00:50:55,839
almost within arm's reach

1650
00:50:58,710 --> 00:50:57,680
but that that's i don't know i just i

1651
00:51:00,309 --> 00:50:58,720
love that feeling or when you're

1652
00:51:02,390 --> 00:51:00,319
underground and you're not the lights

1653
00:51:03,990 --> 00:51:02,400
or even when i'm stuck you know trying

1654
00:51:06,230 --> 00:51:04,000
to squeeze between one

1655
00:51:07,030 --> 00:51:06,240
opening another if i turn on the lights

1656
00:51:10,470 --> 00:51:07,040
i just

1657
00:51:12,950 --> 00:51:10,480
small i'd recommend you try it

1658
00:51:15,030 --> 00:51:12,960
awesome i mean so for myself i meditate

1659
00:51:15,430 --> 00:51:15,040
a lot i have a daily meditation practice

1660
00:51:16,549 --> 00:51:15,440
and

1661
00:51:17,910 --> 00:51:16,559
i know there's a lot of like you know

1662
00:51:19,990 --> 00:51:17,920
people right now getting to the trend of

1663
00:51:21,510 --> 00:51:20,000

using these float tanks where it's like

1664
00:51:23,270 --> 00:51:21,520
isolation of your senses and you're

1665
00:51:24,230 --> 00:51:23,280
floating on a salt water

1666
00:51:26,549 --> 00:51:24,240
and they're kind of trying to like

1667
00:51:28,150 --> 00:51:26,559
recreate that feeling almost they're

1668
00:51:29,910 --> 00:51:28,160
making it very dark and trying to take

1669
00:51:31,270 --> 00:51:29,920
away everything around them but what i

1670
00:51:32,309 --> 00:51:31,280
love that you mentioned is that you know

1671
00:51:34,309 --> 00:51:32,319
you're in the cave and it's

1672
00:51:35,750 --> 00:51:34,319
it's pitch black you know it's dark but

1673
00:51:37,589 --> 00:51:35,760
you also sense that

1674
00:51:38,950 --> 00:51:37,599
microbial world around you the life

1675
00:51:40,470 --> 00:51:38,960
around you in the cave

1676
00:51:41,750 --> 00:51:40,480
um it sounds like a really cool place to

1677
00:51:43,990 --> 00:51:41,760
like go turn off your lights and maybe

1678
00:51:45,190 --> 00:51:44,000
just meditate for a minute on

1679
00:51:47,270 --> 00:51:45,200
i bet it would be because it's you know

1680
00:51:48,630 --> 00:51:47,280
it's it's um the caves have a really

1681
00:51:51,109 --> 00:51:48,640
constant temperature

1682
00:51:52,309 --> 00:51:51,119
of about uh like quickly in celsius but

1683
00:51:54,390 --> 00:51:52,319
it's about somewhere between

1684
00:51:55,829 --> 00:51:54,400
you know around 60 degrees so that's

1685
00:51:59,030 --> 00:51:55,839
always like

1686
00:52:01,990 --> 00:51:59,040
20. something like that to 15 15 maybe

1687
00:52:03,270 --> 00:52:02,000
15 degrees um see but yeah it's just so

1688
00:52:06,390 --> 00:52:03,280

if you have a little bit of a

1689
00:52:08,549 --> 00:52:06,400
like a sweatshirt or some jacket on you

1690
00:52:10,230 --> 00:52:08,559
can feel really comfortable and just

1691
00:52:11,750 --> 00:52:10,240
stay out there have you tried an

1692
00:52:13,670 --> 00:52:11,760
isolation tank i

1693
00:52:15,190 --> 00:52:13,680
have yeah i've done the float tank thing

1694
00:52:16,230 --> 00:52:15,200
i think it's a lot of fun

1695
00:52:18,069 --> 00:52:16,240
there's also a bunch of people doing

1696
00:52:19,670 --> 00:52:18,079
like virtual reality in float tanks now

1697
00:52:20,630 --> 00:52:19,680
where you have the goggles on

1698
00:52:22,630 --> 00:52:20,640
and you're going into virtual

1699
00:52:24,470 --> 00:52:22,640
environments um there are some folks

1700
00:52:25,910 --> 00:52:24,480
using virtual reality overview effect

1701
00:52:27,270 --> 00:52:25,920
experiences where you

1702
00:52:29,670 --> 00:52:27,280
feel like you're an astronaut looking

1703
00:52:31,030 --> 00:52:29,680
down at the earth while in a float tank

1704
00:52:31,510 --> 00:52:31,040
and taking away the rest of your senses

1705
00:52:34,549 --> 00:52:31,520
so there's

1706
00:52:38,230 --> 00:52:36,549
um let's get to maybe just two more

1707
00:52:41,030 --> 00:52:38,240
questions if we have time here

1708
00:52:42,230 --> 00:52:41,040
um first from tom caruso a long time

1709
00:52:44,549 --> 00:52:42,240
viewer of the show

1710
00:52:46,309 --> 00:52:44,559
on facebook tom wants to know are there

1711
00:52:48,470 --> 00:52:46,319
any specific wavelengths

1712
00:52:51,109 --> 00:52:48,480
that differentiate biosignatures in

1713
00:52:53,829 --> 00:52:51,119

these dark low-light environments

1714
00:52:56,309 --> 00:52:53,839
um yeah tom that's a great question and

1715
00:52:58,630 --> 00:52:56,319
i think it requires

1716
00:53:01,190 --> 00:52:58,640
good for future study so we tried a

1717
00:53:01,910 --> 00:53:01,200
little bit um to explore into the deep

1718
00:53:03,990 --> 00:53:01,920
uv

1719
00:53:05,750 --> 00:53:04,000
and and that's the you know if you we

1720
00:53:07,910 --> 00:53:05,760
know from like a cafeteria if you use

1721
00:53:09,349 --> 00:53:07,920
dpv you can clean the surface right

1722
00:53:10,950 --> 00:53:09,359
and in fact we had to discuss for the

1723
00:53:11,589 --> 00:53:10,960
park we don't want to kill the life

1724
00:53:13,430 --> 00:53:11,599
right

1725
00:53:14,790 --> 00:53:13,440
but we um so we were sparing with that

1726
00:53:17,589 --> 00:53:14,800
approach but we didn't see

1727
00:53:18,549 --> 00:53:17,599
our visual our eyes couldn't detect uh

1728
00:53:21,910 --> 00:53:18,559
much

1729
00:53:23,589 --> 00:53:21,920
so because of the

1730
00:53:25,349 --> 00:53:23,599
potential hazard to the to the cave

1731
00:53:26,470 --> 00:53:25,359
walls and also um

1732
00:53:28,710 --> 00:53:26,480
the fact that we weren't really well

1733
00:53:30,069 --> 00:53:28,720
equipped to study that um

1734
00:53:32,069 --> 00:53:30,079
we haven't really pursued it but it'd be

1735
00:53:33,990 --> 00:53:32,079
a great great thing to pursue the future

1736
00:53:35,510 --> 00:53:34,000
so we are limited i mentioned that we

1737
00:53:37,589 --> 00:53:35,520
are driven by

1738
00:53:38,549 --> 00:53:37,599

our essentially visual perception but

1739
00:53:40,230 --> 00:53:38,559
how does it limit us

1740
00:53:41,990 --> 00:53:40,240
it's another question we can ask

1741
00:53:43,670 --> 00:53:42,000
absolutely and okay we have one more

1742
00:53:46,230 --> 00:53:43,680
question i'd love to get to here

1743
00:53:48,230 --> 00:53:46,240
uh this is from satyam tawari uh also a

1744
00:53:49,750 --> 00:53:48,240
past young scientist program participant

1745
00:53:52,230 --> 00:53:49,760
from blue marble space

1746
00:53:53,510 --> 00:53:52,240
uh and i know uh satyam shared recently

1747
00:53:55,510 --> 00:53:53,520
with our community

1748
00:53:57,910 --> 00:53:55,520
that he was reading about budgets in

1749
00:54:00,710 --> 00:53:57,920
astrobiology and he found this old

1750
00:54:03,430 --> 00:54:00,720
fact from when the astrobiology budget

1751
00:54:04,150 --> 00:54:03,440
was facing a budget cut back in 2006 now

1752
00:54:06,950 --> 00:54:04,160
i think it wasn't

1753
00:54:08,950 --> 00:54:06,960
six yeah and he saw that the

1754
00:54:10,790 --> 00:54:08,960
astrobiology budget was much bigger than

1755
00:54:13,349 --> 00:54:10,800
the astrophysics budget

1756
00:54:15,670 --> 00:54:13,359
at that time and so his question for you

1757
00:54:16,470 --> 00:54:15,680
is what do you think about astrobiology

1758
00:54:18,230 --> 00:54:16,480
budgets

1759
00:54:19,750 --> 00:54:18,240
should they be relatively equal to other

1760
00:54:23,190 --> 00:54:19,760
disciplines or should there be

1761
00:54:24,870 --> 00:54:23,200
more put into astrobiology um

1762
00:54:27,190 --> 00:54:24,880
okay well that's a question really for

1763
00:54:29,829 --> 00:54:27,200

people above my pay grade

1764
00:54:30,230 --> 00:54:29,839
i mean i have obviously have a bias um

1765
00:54:33,750 --> 00:54:30,240
and

1766
00:54:35,510 --> 00:54:33,760
um i do remember when we we lost

1767
00:54:37,670 --> 00:54:35,520
essentially the astrobiology budget was

1768
00:54:39,589 --> 00:54:37,680
decimated in 2006 and many of us simply

1769
00:54:42,549 --> 00:54:39,599
needed to send it to washington dc

1770
00:54:43,750 --> 00:54:42,559
and went and talked to our congressman

1771
00:54:45,510 --> 00:54:43,760
um to advocate

1772
00:54:47,109 --> 00:54:45,520
to bring back that budget and it was

1773
00:54:49,270 --> 00:54:47,119
sort of ironic because the money was

1774
00:54:51,589 --> 00:54:49,280
going to support the moon at that time

1775
00:54:52,630 --> 00:54:51,599
and human human return to the moon right

1776
00:54:54,470 --> 00:54:52,640
human strength

1777
00:54:55,910 --> 00:54:54,480
but in terms of different programs one

1778
00:54:58,150 --> 00:54:55,920
versus another

1779
00:54:59,750 --> 00:54:58,160
that's a really hard question and i um

1780
00:55:01,589 --> 00:54:59,760
well i mean we ought to support what we

1781
00:55:03,109 --> 00:55:01,599
like so

1782
00:55:04,630 --> 00:55:03,119
so no i think the astrology budget

1783
00:55:07,190 --> 00:55:04,640
should be bigger if anything

1784
00:55:08,870 --> 00:55:07,200
yeah they should all be bigger right

1785
00:55:10,789 --> 00:55:08,880
let's make them all much much bigger

1786
00:55:12,069 --> 00:55:10,799
um that's a really good point i'm very

1787
00:55:13,990 --> 00:55:12,079
glad you shared that

1788
00:55:15,990 --> 00:55:14,000

many of us the sciences also get

1789
00:55:17,109 --> 00:55:16,000
involved in policy we also get involved

1790
00:55:19,109 --> 00:55:17,119
in advocacy

1791
00:55:21,190 --> 00:55:19,119
for the young people watching if you

1792
00:55:22,549 --> 00:55:21,200
want to see more money put into science

1793
00:55:24,150 --> 00:55:22,559
if you want to see more opportunities

1794
00:55:25,670 --> 00:55:24,160
available for young students

1795
00:55:27,589 --> 00:55:25,680
it's important that you talk to your

1796
00:55:30,309 --> 00:55:27,599
representatives your legislators

1797
00:55:31,270 --> 00:55:30,319
people in authority and power lawmakers

1798
00:55:32,710 --> 00:55:31,280
and let them know

1799
00:55:34,069 --> 00:55:32,720
about your interests let them know that

1800
00:55:35,430 --> 00:55:34,079
you want to go to space let them know

1801
00:55:37,430 --> 00:55:35,440
that you want to see a pack of robot

1802
00:55:38,549 --> 00:55:37,440
dogs exploring caves on mars

1803
00:55:41,270 --> 00:55:38,559
let them know that these things are

1804
00:55:43,589 --> 00:55:41,280
important to you because they their job

1805
00:55:45,270 --> 00:55:43,599
is supposed to be representing you and

1806
00:55:47,750 --> 00:55:45,280
doing things for you

1807
00:55:49,190 --> 00:55:47,760
as politicians right and let us let them

1808
00:55:51,750 --> 00:55:49,200
know how

1809
00:55:52,870 --> 00:55:51,760
supporting science efforts or astrology

1810
00:55:55,589 --> 00:55:52,880
science efforts

1811
00:55:56,309 --> 00:55:55,599
not only you know expands interest in

1812
00:56:00,230 --> 00:55:56,319
technical

1813
00:56:02,230 --> 00:56:00,240

but also

1814
00:56:03,589 --> 00:56:02,240
there's technology transfer that could

1815
00:56:06,710 --> 00:56:03,599
potentially um

1816
00:56:08,710 --> 00:56:06,720
benefit us here on earth oh yeah

1817
00:56:09,190 --> 00:56:08,720
absolutely i love when people nasa spin

1818
00:56:11,109 --> 00:56:09,200
off

1819
00:56:13,349 --> 00:56:11,119
there's just so much stuff we've gotten

1820
00:56:15,030 --> 00:56:13,359
from nasa from going to space it's come

1821
00:56:16,069 --> 00:56:15,040
back to us in so many ways in our

1822
00:56:18,069 --> 00:56:16,079
households and

1823
00:56:20,549 --> 00:56:18,079
in our daily lives so definitely worth

1824
00:56:23,829 --> 00:56:20,559
checking velcro i think i'm broke

1825
00:56:25,349 --> 00:56:23,839
exactly all right dr jen blank thank you

1826
00:56:26,710 --> 00:56:25,359
so much for joining us for this show

1827
00:56:27,829 --> 00:56:26,720
it's been such a huge pleasure having

1828
00:56:30,069 --> 00:56:27,839
you on

1829
00:56:31,270 --> 00:56:30,079
thanks graham all right and for everyone

1830
00:56:32,630 --> 00:56:31,280
watching um

1831
00:56:34,470 --> 00:56:32,640
you know we mentioned a lot of different

1832
00:56:35,750 --> 00:56:34,480
field sites that dr blank has visited

1833
00:56:37,430 --> 00:56:35,760
that we're interested in and doing

1834
00:56:39,510 --> 00:56:37,440
various kinds of science

1835
00:56:41,349 --> 00:56:39,520
uh if you had a choice and that you had

1836
00:56:43,750 --> 00:56:41,359
you know some money to support you

1837
00:56:45,109 --> 00:56:43,760
where would you want to go on the earth

1838
00:56:46,470 --> 00:56:45,119

many of us have been you know very

1839
00:56:47,910 --> 00:56:46,480
isolated we haven't been traveling

1840
00:56:49,270 --> 00:56:47,920
because of the pandemic

1841
00:56:51,670 --> 00:56:49,280
when we do get through this thing

1842
00:56:54,069 --> 00:56:51,680
together where do you want to go

1843
00:56:55,990 --> 00:56:54,079
let us know uh go on twitter or anywhere

1844
00:56:58,309 --> 00:56:56,000
on social media let us know using

1845
00:56:59,829 --> 00:56:58,319
ask astro bio tell us about it we'd love

1846
00:57:01,109 --> 00:56:59,839
to hear your stories about where you

1847
00:57:03,190 --> 00:57:01,119
want to explore

1848
00:57:05,030 --> 00:57:03,200
in the world and if you'd like to stay

1849
00:57:06,870 --> 00:57:05,040
in the loop about our episodes of ask an

1850
00:57:08,069 --> 00:57:06,880
astrobiologist or to find out more

1851
00:57:09,990 --> 00:57:08,079
information about

1852
00:57:11,829 --> 00:57:10,000
various events and opportunities from

1853
00:57:13,750 --> 00:57:11,839
nasa astrobiology

1854
00:57:15,750 --> 00:57:13,760
you can also sign up for the newsletter

1855
00:57:17,510 --> 00:57:15,760
from nasa astrobiology

1856
00:57:19,670 --> 00:57:17,520
using the link popping up in your screen

1857
00:57:20,549 --> 00:57:19,680
right now that'll allow you to sign up

1858
00:57:22,069 --> 00:57:20,559
to receive

1859
00:57:23,589 --> 00:57:22,079
newsletters emails from nasa

1860
00:57:25,910 --> 00:57:23,599
astrobiology

1861
00:57:27,589 --> 00:57:25,920
to learn more about our show and so much

1862
00:57:28,950 --> 00:57:27,599
more going on in the realm of

1863
00:57:30,870 --> 00:57:28,960

astrobiology

1864
00:57:32,870 --> 00:57:30,880
so thank you to all of you for joining

1865
00:57:41,400 --> 00:57:32,880
us and until next time