



Ask An Astrobiologist



EPISODE 39: MARCH 25TH, 2021

DR. CYNTHIA PHILLIPS



Astrobiology Program

1
00:00:00,680 --> 00:00:29,669

[Music]

2
00:00:34,630 --> 00:00:31,269

greetings my friends and

3
00:00:36,790 --> 00:00:34,640

perhaps fellow fans of icy worlds

4
00:00:39,030 --> 00:00:36,800

uh welcome to ask an astrobiologist the

5
00:00:41,670 --> 00:00:39,040

show that celebrates the science

6
00:00:43,670 --> 00:00:41,680

and celebrates the scientists involved

7
00:00:44,549 --> 00:00:43,680

in our quest to understand the nature of

8
00:00:46,790 --> 00:00:44,559

life

9
00:00:48,470 --> 00:00:46,800

i'm dr graham lau also known online as

10
00:00:50,790 --> 00:00:48,480

the cosmobiologist and

11
00:00:51,750 --> 00:00:50,800

perhaps more recently as astro beef for

12
00:00:52,950 --> 00:00:51,760

some reason

13
00:00:55,750 --> 00:00:52,960

uh and we're brought to you by

14

00:00:56,869 --> 00:00:55,760

seganet.org and the nasa astrobiology

15

00:00:58,790 --> 00:00:56,879

program

16

00:00:59,990 --> 00:00:58,800

and i'm really really excited about

17

00:01:02,229 --> 00:01:00,000

today's episode

18

00:01:04,630 --> 00:01:02,239

uh there's been a lot of love for mars

19

00:01:06,630 --> 00:01:04,640

in the news lately in astrobiology

20

00:01:07,990 --> 00:01:06,640

but you know we have to have our dose of

21

00:01:10,390 --> 00:01:08,000

good icy worlds

22

00:01:11,429 --> 00:01:10,400

ocean worlds and some europa to talk

23

00:01:13,670 --> 00:01:11,439

about

24

00:01:15,350 --> 00:01:13,680

but first we have to do our usual house

25

00:01:17,670 --> 00:01:15,360

cleaning activity of

26
00:01:18,469 --> 00:01:17,680
sending out a huge shout out and thanks

27
00:01:21,510 --> 00:01:18,479
to those of you

28
00:01:23,350 --> 00:01:21,520
who share about our show online

29
00:01:25,590 --> 00:01:23,360
uh who talk about the show who engage

30
00:01:27,109 --> 00:01:25,600
with our guests through social media by

31
00:01:28,469 --> 00:01:27,119
emailing them by learning more about

32
00:01:30,310 --> 00:01:28,479
their research

33
00:01:32,149 --> 00:01:30,320
we have some ambassadors from twitter

34
00:01:33,910 --> 00:01:32,159
we'd like to mention for this month

35
00:01:36,310 --> 00:01:33,920
uh we'd like to say give a huge shout

36
00:01:39,590 --> 00:01:36,320
out to jason gilchrist

37
00:01:42,789 --> 00:01:39,600
origin center netherland denise

38
00:01:45,190 --> 00:01:42,799

and navino saranji on twitter uh these

39

00:01:47,109 --> 00:01:45,200

users have shared about our show

40

00:01:48,950 --> 00:01:47,119

have helped us to get the word out about

41

00:01:51,429 --> 00:01:48,960

ask an astrobiologist and all the

42

00:01:53,270 --> 00:01:51,439

awesome work of those who are joining us

43

00:01:54,630 --> 00:01:53,280

now like i mentioned i'm super excited

44

00:01:57,590 --> 00:01:54,640

for this episode

45

00:02:00,149 --> 00:01:57,600

joining me today is dr cynthia phillips

46

00:02:02,469 --> 00:02:00,159

of nasa's jet propulsion laboratory

47

00:02:04,550 --> 00:02:02,479

dr phillips is an expert in the

48

00:02:05,590 --> 00:02:04,560

geological processes that are occurring

49

00:02:07,590 --> 00:02:05,600

on moons

50

00:02:09,109 --> 00:02:07,600

like the icy worlds and the ocean worlds

51
00:02:11,510 --> 00:02:09,119
of our solar system

52
00:02:12,710 --> 00:02:11,520
she's also a project staff scientist on

53
00:02:14,790 --> 00:02:12,720
the europa clipper

54
00:02:17,110 --> 00:02:14,800
and the deputy project scientist for the

55
00:02:18,710 --> 00:02:17,120
europa lander concept design

56
00:02:20,790 --> 00:02:18,720
and so i'm super excited to narrow out

57
00:02:21,430 --> 00:02:20,800
with her about everything europa and icy

58
00:02:22,949 --> 00:02:21,440
worlds

59
00:02:24,949 --> 00:02:22,959
uh dr phillips welcome to ask an

60
00:02:27,030 --> 00:02:24,959
astrobiologist awesome thanks so much

61
00:02:28,229 --> 00:02:27,040
for having me here i'm super excited

62
00:02:30,949 --> 00:02:28,239
awesome yeah i mean it's just so much

63
00:02:32,869 --> 00:02:30,959

fun stuff to talk about with europa

64

00:02:34,869 --> 00:02:32,879

but i usually with our guests i love to

65

00:02:36,470 --> 00:02:34,879

first just since we have a lot of young

66

00:02:38,150 --> 00:02:36,480

people we have high school students and

67

00:02:39,750 --> 00:02:38,160

undergraduate students who

68

00:02:41,589 --> 00:02:39,760

are getting into science maybe for the

69

00:02:43,190 --> 00:02:41,599

first time maybe they're just finding

70

00:02:44,710 --> 00:02:43,200

out about astrobiology

71

00:02:46,949 --> 00:02:44,720

and so we like to tell them about the

72

00:02:47,910 --> 00:02:46,959

careers of of the the scientists who

73

00:02:49,350 --> 00:02:47,920

join us

74

00:02:51,509 --> 00:02:49,360

and so i'd love if you wouldn't mind

75

00:02:52,790 --> 00:02:51,519

just sharing with us maybe your science

76

00:02:54,470 --> 00:02:52,800

origin story

77

00:02:57,030 --> 00:02:54,480

the thing that really kicked you off uh

78

00:02:59,350 --> 00:02:57,040

towards your career that you have now

79

00:03:00,070 --> 00:02:59,360

sure yeah so i grew up in a in a suburb

80

00:03:02,710 --> 00:03:00,080

of boston

81

00:03:03,990 --> 00:03:02,720

and so i i came from a family a proud

82

00:03:05,670 --> 00:03:04,000

family of science nerds

83

00:03:07,270 --> 00:03:05,680

and so you know we were all into math

84

00:03:07,990 --> 00:03:07,280

and science and reading and all that

85

00:03:10,229 --> 00:03:08,000

stuff

86

00:03:12,309 --> 00:03:10,239

and my dad was a was this amateur

87

00:03:14,229 --> 00:03:12,319

astronomer and so he had a telescope

88

00:03:15,910 --> 00:03:14,239

and he would always you know he'd be

89

00:03:18,070 --> 00:03:15,920

he'd be trying to find

90

00:03:19,589 --> 00:03:18,080

some you know nebula or galaxy or

91

00:03:21,910 --> 00:03:19,599

something and so he'd spend hours

92

00:03:23,990 --> 00:03:21,920

setting up his telescope in our backyard

93

00:03:25,190 --> 00:03:24,000

and he'd drag us out and somehow it was

94

00:03:26,630 --> 00:03:25,200

always the middle of the night

95

00:03:28,789 --> 00:03:26,640

it was always like the middle of winter

96

00:03:30,309 --> 00:03:28,799

it was freezing cold we'd go out there

97

00:03:31,830 --> 00:03:30,319

we'd look and he was you know he was so

98

00:03:33,509 --> 00:03:31,840

proud that he'd managed to find this

99

00:03:34,229 --> 00:03:33,519

nebula in his telescope we'd go out and

100

00:03:36,390 --> 00:03:34,239

look

101
00:03:38,070 --> 00:03:36,400
and it was always so disappointing for

102
00:03:38,869 --> 00:03:38,080
me because it was like this little fuzzy

103
00:03:41,350 --> 00:03:38,879
blob

104
00:03:42,229 --> 00:03:41,360
right and so you know my dad's amazing i

105
00:03:44,630 --> 00:03:42,239
love him but

106
00:03:46,229 --> 00:03:44,640
i was just i was so unimpressed right i

107
00:03:47,430 --> 00:03:46,239
was like i loved astronomy i loved the

108
00:03:49,190 --> 00:03:47,440
whole idea

109
00:03:50,869 --> 00:03:49,200
of there being something out there you

110
00:03:52,630 --> 00:03:50,879
know beyond the earth but

111
00:03:53,990 --> 00:03:52,640
i was just you know i wasn't impressed

112
00:03:56,949 --> 00:03:54,000
with these galaxies

113
00:03:57,350 --> 00:03:56,959

and so i was in um high school when the

114

00:03:59,190 --> 00:03:57,360

um

115

00:04:01,190 --> 00:03:59,200

when the voyager spacecraft flew past

116

00:04:01,670 --> 00:04:01,200

neptune and this is back you know there

117

00:04:03,589 --> 00:04:01,680

was no

118

00:04:05,270 --> 00:04:03,599

internet right it was you know it wasn't

119

00:04:08,309 --> 00:04:05,280

the dark ages but

120

00:04:08,949 --> 00:04:08,319

the only way that we could see the

121

00:04:10,229 --> 00:04:08,959

pictures

122

00:04:12,470 --> 00:04:10,239

that were taken by the voyager

123

00:04:14,550 --> 00:04:12,480

spacecraft was the scientists who were

124

00:04:16,390 --> 00:04:14,560

on the team actually had to go to jpl

125

00:04:18,310 --> 00:04:16,400

and i had no idea what a jpl was back

126
00:04:20,069 --> 00:04:18,320
then but you know to me it was like this

127
00:04:22,710 --> 00:04:20,079
mystical place and so

128
00:04:23,110 --> 00:04:22,720
on tv like on pbs they had basically a

129
00:04:25,510 --> 00:04:23,120
live

130
00:04:27,030 --> 00:04:25,520
feed from the jpl control room of all

131
00:04:27,990 --> 00:04:27,040
these scientists like sitting around

132
00:04:30,150 --> 00:04:28,000
these big tv

133
00:04:32,150 --> 00:04:30,160
monitors waiting for the pictures to

134
00:04:34,870 --> 00:04:32,160
come in from neptune and

135
00:04:36,710 --> 00:04:34,880
this is the first time that humans had

136
00:04:38,070 --> 00:04:36,720
ever seen neptune or any of its

137
00:04:39,670 --> 00:04:38,080
satellites up close

138
00:04:41,189 --> 00:04:39,680

we'd never seen them right it was just

139

00:04:42,950 --> 00:04:41,199

this little point of light this really

140

00:04:45,350 --> 00:04:42,960

faint point of light in the sky

141

00:04:47,350 --> 00:04:45,360

and so suddenly as these pictures came

142

00:04:48,950 --> 00:04:47,360

in these little kind of dots of light

143

00:04:50,310 --> 00:04:48,960

they turned into worlds like they turned

144

00:04:52,390 --> 00:04:50,320

into places

145

00:04:53,909 --> 00:04:52,400

and i remember just watching this i

146

00:04:55,030 --> 00:04:53,919

managed to persuade my parents let me

147

00:04:56,310 --> 00:04:55,040

stay up

148

00:04:57,990 --> 00:04:56,320

they had something called neptune all

149

00:04:59,670 --> 00:04:58,000

night so basically they just had a live

150

00:05:00,629 --> 00:04:59,680

feed that went all night on pbs from the

151
00:05:02,070 --> 00:05:00,639
control room

152
00:05:03,909 --> 00:05:02,080
and you know we didn't have a vcr or

153
00:05:05,670 --> 00:05:03,919
anything so you know i was a persuasive

154
00:05:07,029 --> 00:05:05,680
kid and i and i persuaded my parents let

155
00:05:08,230 --> 00:05:07,039
me stay up and watch this thing so i

156
00:05:08,710 --> 00:05:08,240
remember it's like the middle of the

157
00:05:10,550 --> 00:05:08,720
night

158
00:05:12,710 --> 00:05:10,560
carl sagan is there and you know carl

159
00:05:14,230 --> 00:05:12,720
sagan right he's on the science team

160
00:05:16,150 --> 00:05:14,240
he's watching these pictures come in and

161
00:05:18,150 --> 00:05:16,160
one of these like crazy looking pictures

162
00:05:20,150 --> 00:05:18,160
of one of the moons of neptune

163
00:05:21,830 --> 00:05:20,160

comes up on this tv screen and i

164

00:05:22,870 --> 00:05:21,840

remember carl sagan looking at and

165

00:05:25,670 --> 00:05:22,880

saying wow

166

00:05:27,670 --> 00:05:25,680

i have no idea what that is and to me

167

00:05:30,790 --> 00:05:27,680

that was like my eureka moment okay

168

00:05:32,230 --> 00:05:30,800

i was like if carl sagan

169

00:05:33,670 --> 00:05:32,240

the best you know the most amazing

170

00:05:34,950 --> 00:05:33,680

scientist in the world you know in my

171

00:05:37,909 --> 00:05:34,960

opinion then

172

00:05:38,710 --> 00:05:37,919

um if he doesn't know what's going on in

173

00:05:41,510 --> 00:05:38,720

this moon

174

00:05:41,909 --> 00:05:41,520

there are still things left undiscovered

175

00:05:44,150 --> 00:05:41,919

right

176
00:05:45,510 --> 00:05:44,160
there are still places that humans have

177
00:05:48,070 --> 00:05:45,520
never seen before

178
00:05:48,950 --> 00:05:48,080
and i was just hooked i was like i want

179
00:05:51,749 --> 00:05:48,960
to do that

180
00:05:53,189 --> 00:05:51,759
i want to be in the control room at jpl

181
00:05:54,950 --> 00:05:53,199
watching the pictures come in for the

182
00:05:56,230 --> 00:05:54,960
first time the first time that we see a

183
00:05:58,309 --> 00:05:56,240
new world

184
00:06:00,390 --> 00:05:58,319
and you know with a bunch of twists and

185
00:06:01,350 --> 00:06:00,400
turns it's still amazing to me as an

186
00:06:03,029 --> 00:06:01,360
adult now i

187
00:06:04,550 --> 00:06:03,039
look back at that starry eyed high

188
00:06:06,790 --> 00:06:04,560

school student and i'm like

189

00:06:08,550 --> 00:06:06,800

i made it right i work at jbl i still

190

00:06:10,629 --> 00:06:08,560

have to pinch myself sometimes

191

00:06:11,830 --> 00:06:10,639

when i think about the fact that i'm

192

00:06:14,309 --> 00:06:11,840

there

193

00:06:15,830 --> 00:06:14,319

i love that so much um and how

194

00:06:16,309 --> 00:06:15,840

incredible you know that that thing that

195

00:06:17,749 --> 00:06:16,319

kind of

196

00:06:20,629 --> 00:06:17,759

got you into it really in the first

197

00:06:22,469 --> 00:06:20,639

place um i also so we often tell

198

00:06:23,990 --> 00:06:22,479

young students who are interested in

199

00:06:25,270 --> 00:06:24,000

being involved in astrobiology who have

200

00:06:27,270 --> 00:06:25,280

those kinds of eureka moments of their

201
00:06:28,629 --> 00:06:27,280
own where they realize that science is

202
00:06:30,469 --> 00:06:28,639
we're still discovering things we're

203
00:06:32,070 --> 00:06:30,479
still asking big questions and

204
00:06:33,590 --> 00:06:32,080
trying to understand the answers that

205
00:06:35,270 --> 00:06:33,600
we're getting um

206
00:06:36,950 --> 00:06:35,280
we understand that when you were younger

207
00:06:39,189 --> 00:06:36,960
you were very motivated to reach out to

208
00:06:40,469 --> 00:06:39,199
scientists to ask more questions

209
00:06:42,390 --> 00:06:40,479
and that you even had a chance to go to

210
00:06:43,189 --> 00:06:42,400
greenland on a trip once when you're in

211
00:06:44,390 --> 00:06:43,199
high school

212
00:06:46,629 --> 00:06:44,400
would you mind talking about that for

213
00:06:48,550 --> 00:06:46,639

our audience yeah sure so so

214

00:06:49,749 --> 00:06:48,560

you know again i was a pretty persuasive

215

00:06:52,790 --> 00:06:49,759

kid when i was in high school

216

00:06:54,230 --> 00:06:52,800

and so um i knew that

217

00:06:55,749 --> 00:06:54,240

i knew that i wanted to like i was

218

00:06:57,270 --> 00:06:55,759

obsessed with science i knew that i

219

00:06:59,589 --> 00:06:57,280

wanted to do science but

220

00:07:01,430 --> 00:06:59,599

to me i didn't really know what science

221

00:07:02,070 --> 00:07:01,440

was right is science looking through a

222

00:07:03,510 --> 00:07:02,080

telescope

223

00:07:05,589 --> 00:07:03,520

is science looking at this picture that

224

00:07:06,390 --> 00:07:05,599

comes in you know what does it mean to

225

00:07:10,629 --> 00:07:06,400

do science

226

00:07:11,029 --> 00:07:10,639

and so i i saved up all of my batman's

227

00:07:12,550 --> 00:07:11,039

money

228

00:07:14,469 --> 00:07:12,560

right and so this was the you know like

229

00:07:15,909 --> 00:07:14,479

the 1980s right and so

230

00:07:17,670 --> 00:07:15,919

you know you could you could put you

231

00:07:19,029 --> 00:07:17,680

could put money in a bank account and it

232

00:07:20,710 --> 00:07:19,039

you know interest rates were high right

233

00:07:23,430 --> 00:07:20,720

so you know you could do pretty well

234

00:07:24,870 --> 00:07:23,440

so a couple years later um i was looking

235

00:07:27,110 --> 00:07:24,880

at something called earthwatch which is

236

00:07:28,390 --> 00:07:27,120

this program that basically lets like

237

00:07:30,150 --> 00:07:28,400

it was sort of one of the first citizen

238

00:07:30,870 --> 00:07:30,160

scientist programs back before that was

239

00:07:32,950 --> 00:07:30,880

a thing

240

00:07:33,990 --> 00:07:32,960

the idea was basically you know like you

241

00:07:35,350 --> 00:07:34,000

could just

242

00:07:37,029 --> 00:07:35,360

random members of the public could go

243

00:07:38,230 --> 00:07:37,039

along and help scientists on some kind

244

00:07:40,309 --> 00:07:38,240

of expedition

245

00:07:41,749 --> 00:07:40,319

and so i got this catalog like i wrote

246

00:07:43,270 --> 00:07:41,759

away you know i got this catalog that

247

00:07:44,309 --> 00:07:43,280

came again pre-internet i can just

248

00:07:45,990 --> 00:07:44,319

google things

249

00:07:48,070 --> 00:07:46,000

um but i got this catalog and i spent

250

00:07:50,390 --> 00:07:48,080

like weeks just pouring over it

251
00:07:52,710 --> 00:07:50,400
and i was like okay where's a place that

252
00:07:54,710 --> 00:07:52,720
i probably will never get to go

253
00:07:56,790 --> 00:07:54,720
in my life right and so you know i

254
00:07:58,790 --> 00:07:56,800
looked at like the jungles of borneo to

255
00:08:00,230 --> 00:07:58,800
go work with like you know gorillas or

256
00:08:01,909 --> 00:08:00,240
chimpanzees or something

257
00:08:04,150 --> 00:08:01,919
and then i saw this one that was looking

258
00:08:06,869 --> 00:08:04,160
for plant fossils in greenland

259
00:08:09,350 --> 00:08:06,879
and i don't know it just it completely

260
00:08:12,469 --> 00:08:09,360
just grabbed my mind that i was like wow

261
00:08:14,150 --> 00:08:12,479
i could go to greenland and you know

262
00:08:15,990 --> 00:08:14,160
i figured that green i mean greenland's

263
00:08:18,150 --> 00:08:16,000

pretty safe right there's like you know

264

00:08:19,029 --> 00:08:18,160

a few tens of thousands of people there

265

00:08:20,550 --> 00:08:19,039

right there's no

266

00:08:22,309 --> 00:08:20,560

you know i figured that that would be an

267

00:08:23,670 --> 00:08:22,319

easier sell with my parents than going

268

00:08:25,909 --> 00:08:23,680

to the jungle somewhere

269

00:08:27,670 --> 00:08:25,919

so and and and yeah and so is this

270

00:08:28,150 --> 00:08:27,680

expedition where basically you could go

271

00:08:30,150 --> 00:08:28,160

and

272

00:08:31,909 --> 00:08:30,160

look for you know you're digging up

273

00:08:33,589 --> 00:08:31,919

rocks um you're looking for these late

274

00:08:35,190 --> 00:08:33,599

cretaceous plant fossils and

275

00:08:37,110 --> 00:08:35,200

you know i was led by the scientists who

276

00:08:39,110 --> 00:08:37,120

basically had an idea that you could

277

00:08:40,550 --> 00:08:39,120

use like the size of the leaves and the

278

00:08:41,670 --> 00:08:40,560

serrations of them to figure out the

279

00:08:43,029 --> 00:08:41,680

light levels which you can

280

00:08:44,710 --> 00:08:43,039

be tracked the fact that greenland was

281

00:08:46,470 --> 00:08:44,720

much closer to the equator

282

00:08:48,230 --> 00:08:46,480

when in the late cretaceous than it is

283

00:08:49,990 --> 00:08:48,240

now like there's this tropical basically

284

00:08:52,070 --> 00:08:50,000

foliage we were finding

285

00:08:53,509 --> 00:08:52,080

so yeah so i somehow persuaded my

286

00:08:55,829 --> 00:08:53,519

parents and now you know

287

00:08:56,630 --> 00:08:55,839

i i'm a parent right so i mean i have

288

00:08:58,470 --> 00:08:56,640

kids who are

289

00:08:59,910 --> 00:08:58,480

you know my oldest is 22 now right so i

290

00:09:00,870 --> 00:08:59,920

mean i have kids who've gone through the

291

00:09:02,949 --> 00:09:00,880

teenage years

292

00:09:04,389 --> 00:09:02,959

and looking back i'm like how did my

293

00:09:06,389 --> 00:09:04,399

parents how did i

294

00:09:08,070 --> 00:09:06,399

how did they agree to this right how did

295

00:09:09,910 --> 00:09:08,080

they agree to send me to the middle of

296

00:09:11,670 --> 00:09:09,920

nowhere in greenland for

297

00:09:13,190 --> 00:09:11,680

you know two months in the summer when i

298

00:09:15,110 --> 00:09:13,200

was 16. but

299

00:09:16,470 --> 00:09:15,120

everything was great and i had a really

300

00:09:18,630 --> 00:09:16,480

good time and that was really my first

301
00:09:19,350 --> 00:09:18,640
taste of doing science right doing field

302
00:09:21,590 --> 00:09:19,360
work

303
00:09:23,110 --> 00:09:21,600
right having a having a scientific goal

304
00:09:24,710 --> 00:09:23,120
and trying to find evidence to to

305
00:09:26,790 --> 00:09:24,720
support that hypothesis

306
00:09:28,710 --> 00:09:26,800
so it was really fun that's wonderful

307
00:09:29,910 --> 00:09:28,720
yeah i'm i'm super jealous i've been to

308
00:09:31,590 --> 00:09:29,920
the high arctic but

309
00:09:33,190 --> 00:09:31,600
never to greenland and so that's really

310
00:09:34,630 --> 00:09:33,200
cool uh and i think you know

311
00:09:36,710 --> 00:09:34,640
there's a lot more these days too for

312
00:09:38,550 --> 00:09:36,720
citizen signs and ways for

313
00:09:40,389 --> 00:09:38,560

people from all around to get involved

314

00:09:41,269 --> 00:09:40,399

in various scientific expeditions and

315

00:09:42,630 --> 00:09:41,279

endeavors

316

00:09:43,990 --> 00:09:42,640

um so for everyone watching if you're

317

00:09:45,030 --> 00:09:44,000

interested in doing something similar i

318

00:09:47,190 --> 00:09:45,040

highly recommend it

319

00:09:48,870 --> 00:09:47,200

be motivated get out there ask the

320

00:09:50,870 --> 00:09:48,880

questions save up your money

321

00:09:52,949 --> 00:09:50,880

and and go do these things because they

322

00:09:55,509 --> 00:09:52,959

might you know change your future

323

00:09:57,190 --> 00:09:55,519

um and that's really cool uh so dr

324

00:09:58,470 --> 00:09:57,200

phillips you did your undergraduate uh

325

00:10:01,030 --> 00:09:58,480

in physics and astronomy

326

00:10:03,030 --> 00:10:01,040

at harvard you then went on to uh your

327

00:10:05,030 --> 00:10:03,040

graduate studies in planetary science at

328

00:10:07,670 --> 00:10:05,040

university of arizona

329

00:10:08,069 --> 00:10:07,680

what things along the way really drove

330

00:10:10,710 --> 00:10:08,079

you

331

00:10:12,550 --> 00:10:10,720

to become an expert in understanding the

332

00:10:13,829 --> 00:10:12,560

icy worlds and the moons of our solar

333

00:10:15,190 --> 00:10:13,839

system

334

00:10:16,470 --> 00:10:15,200

is there any advice you would give for

335

00:10:17,590 --> 00:10:16,480

instance young undergraduates or

336

00:10:19,590 --> 00:10:17,600

graduate students who might want to

337

00:10:22,630 --> 00:10:19,600

pursue a similar career

338

00:10:23,910 --> 00:10:22,640

yeah so so a lot of a lot of my career

339

00:10:25,670 --> 00:10:23,920

has been

340

00:10:27,350 --> 00:10:25,680

strategic planning and a lot of it has

341

00:10:28,870 --> 00:10:27,360

been luck right so it's really a

342

00:10:30,870 --> 00:10:28,880

combination of the two

343

00:10:32,069 --> 00:10:30,880

um you know i went to college and i was

344

00:10:34,790 --> 00:10:32,079

like i'm going to be a physics major

345

00:10:36,389 --> 00:10:34,800

because you know i i had seen these move

346

00:10:37,750 --> 00:10:36,399

i'd seen these voyager images right i'd

347

00:10:40,310 --> 00:10:37,760

seen these moons of neptune

348

00:10:42,069 --> 00:10:40,320

but i had no idea how to get from where

349

00:10:43,430 --> 00:10:42,079

i was which was like a smart high school

350

00:10:45,829 --> 00:10:43,440

student who was good at physics

351

00:10:47,190 --> 00:10:45,839

to that jpl control room so that was

352

00:10:49,350 --> 00:10:47,200

always in the back of my mind

353

00:10:50,630 --> 00:10:49,360

but i had no idea how to get there right

354

00:10:51,910 --> 00:10:50,640

so i went to college i was like okay i'm

355

00:10:54,310 --> 00:10:51,920

gonna be a physics major

356

00:10:54,949 --> 00:10:54,320

so i go and i major in physics and man

357

00:10:57,190 --> 00:10:54,959

it was

358

00:10:58,949 --> 00:10:57,200

i i'd been like i've been great at

359

00:11:00,550 --> 00:10:58,959

physics i did physics really intuitively

360

00:11:01,750 --> 00:11:00,560

and i got to college and i hit quantum

361

00:11:04,150 --> 00:11:01,760

physics and suddenly

362

00:11:04,949 --> 00:11:04,160

my brain no longer worked right like i

363

00:11:07,269 --> 00:11:04,959

could not

364

00:11:08,230 --> 00:11:07,279

get an intuitive grip of of quantum

365

00:11:10,710 --> 00:11:08,240

physics

366

00:11:12,069 --> 00:11:10,720

and you know quantum mechanics and you

367

00:11:13,590 --> 00:11:12,079

know i didn't really know how

368

00:11:15,110 --> 00:11:13,600

because i'd always just kind of

369

00:11:16,150 --> 00:11:15,120

understood it i didn't really know how

370

00:11:18,150 --> 00:11:16,160

to teach myself

371

00:11:20,230 --> 00:11:18,160

how to do it right so i hit this brick

372

00:11:21,750 --> 00:11:20,240

wall and you know i was like one of the

373

00:11:23,190 --> 00:11:21,760

few women in the physics department and

374

00:11:24,470 --> 00:11:23,200

it was just it was not a very supportive

375

00:11:26,470 --> 00:11:24,480

department at the time

376

00:11:28,069 --> 00:11:26,480

and so i found the astronomy department

377

00:11:29,910 --> 00:11:28,079

and the astronomy department was

378

00:11:31,590 --> 00:11:29,920

like they were friendly and they were

379

00:11:33,350 --> 00:11:31,600

nice and they had telescopes i was like

380

00:11:34,550 --> 00:11:33,360

okay so i'll do a joint astronomy and

381

00:11:36,069 --> 00:11:34,560

physics major

382

00:11:38,150 --> 00:11:36,079

and then i'll be able to look at the

383

00:11:39,350 --> 00:11:38,160

solar system so you know i'm taking

384

00:11:41,430 --> 00:11:39,360

astronomy classes

385

00:11:43,030 --> 00:11:41,440

and i remember i'm like you know we're

386

00:11:44,630 --> 00:11:43,040

studying galaxies and debbie is like all

387

00:11:46,389 --> 00:11:44,640

of those like faint fuzzy

388

00:11:47,670 --> 00:11:46,399

disappointing looking things and i'm

389

00:11:48,470 --> 00:11:47,680

like okay when are we gonna get to the

390

00:11:50,710 --> 00:11:48,480

planets

391

00:11:51,750 --> 00:11:50,720

and so finally you know i asked i was

392

00:11:53,030 --> 00:11:51,760

like okay you know

393

00:11:54,389 --> 00:11:53,040

when when are we gonna study the planets

394

00:11:56,389 --> 00:11:54,399

and they're oh well that's planetary

395

00:11:58,629 --> 00:11:56,399

science that's not astronomy right

396

00:12:00,310 --> 00:11:58,639

so it was this whole like other thing

397

00:12:01,910 --> 00:12:00,320

right and so planetary science like the

398

00:12:04,150 --> 00:12:01,920

study of the solar system

399

00:12:06,470 --> 00:12:04,160

it's a pretty young field because we've

400

00:12:07,030 --> 00:12:06,480

really only in the last like 50 years or

401

00:12:09,030 --> 00:12:07,040

so

402

00:12:10,790 --> 00:12:09,040

we've had spacecraft that have been able

403

00:12:13,190 --> 00:12:10,800

to go out and take pictures of these of

404

00:12:16,389 --> 00:12:13,200

these other worlds in our solar system

405

00:12:18,150 --> 00:12:16,399

and so at least at the time um you know

406

00:12:19,670 --> 00:12:18,160

so planetary science sometimes it's part

407

00:12:21,509 --> 00:12:19,680

of like the earth and planetary science

408

00:12:23,110 --> 00:12:21,519

like a geology department sometimes it's

409

00:12:26,150 --> 00:12:23,120

part of the astronomy department

410

00:12:27,990 --> 00:12:26,160

sometimes it's its own department um

411

00:12:29,190 --> 00:12:28,000

so it was really just kind of confusing

412

00:12:31,269 --> 00:12:29,200

trying to figure out okay

413

00:12:33,110 --> 00:12:31,279

what should i be studying and who do i

414

00:12:36,150 --> 00:12:33,120

work with and who do i do research with

415

00:12:38,150 --> 00:12:36,160

if i want to be a planetary scientist

416

00:12:40,069 --> 00:12:38,160

and so i started you know i found like

417

00:12:41,590 --> 00:12:40,079

the one planetary science person

418

00:12:42,790 --> 00:12:41,600

who was there who was in the astronomy

419

00:12:44,470 --> 00:12:42,800

department and you know i worked with

420

00:12:44,949 --> 00:12:44,480

him looking at pictures of venus that

421

00:12:46,629 --> 00:12:44,959

had been

422

00:12:48,310 --> 00:12:46,639

taken by the magellan spacecraft because

423

00:12:51,030 --> 00:12:48,320

that was that's what was going on

424

00:12:52,069 --> 00:12:51,040

when i was in college and i started

425

00:12:53,430 --> 00:12:52,079

thinking about okay

426

00:12:55,030 --> 00:12:53,440

you know i'm remembering back to my

427

00:12:55,910 --> 00:12:55,040

dream and i'm like okay what mission is

428

00:12:57,910 --> 00:12:55,920

coming up next

429

00:12:59,829 --> 00:12:57,920

it's going to have new pictures and so

430

00:13:00,710 --> 00:12:59,839

the galileo mission was about to reach

431

00:13:02,870 --> 00:13:00,720

jupiter

432

00:13:04,150 --> 00:13:02,880

and so i you know found a journal

433

00:13:04,949 --> 00:13:04,160

article again there's like i couldn't

434

00:13:07,430 --> 00:13:04,959

just google

435

00:13:09,030 --> 00:13:07,440

galileo science team right so i found a

436

00:13:10,550 --> 00:13:09,040

journal article that had a list of all

437

00:13:11,269 --> 00:13:10,560

of the members of the galileo science

438

00:13:13,110 --> 00:13:11,279

team

439

00:13:14,629 --> 00:13:13,120

and i figured out what universities

440

00:13:16,790 --> 00:13:14,639

they're at and then i went to

441

00:13:17,430 --> 00:13:16,800

conferences as an undergrad and i talked

442

00:13:19,030 --> 00:13:17,440

to

443

00:13:20,710 --> 00:13:19,040

every grad student i could find i had

444

00:13:22,069 --> 00:13:20,720

this little notebook i kept in my pocket

445

00:13:23,110 --> 00:13:22,079

of like all the planetary science

446

00:13:24,949 --> 00:13:23,120

departments

447

00:13:26,790 --> 00:13:24,959

and i talked to them and i talked to

448

00:13:28,389 --> 00:13:26,800

them about you know the members of the

449

00:13:30,150 --> 00:13:28,399

galileo imaging team

450

00:13:31,670 --> 00:13:30,160

and so basically those were the

451
00:13:32,949 --> 00:13:31,680
departments i applied to like i figured

452
00:13:34,470 --> 00:13:32,959
out what schools they were in i figured

453
00:13:36,069 --> 00:13:34,480
out what departments they're in

454
00:13:37,590 --> 00:13:36,079
that's where i applied because i knew

455
00:13:38,310 --> 00:13:37,600
that i wanted to work with one of those

456
00:13:40,069 --> 00:13:38,320
people

457
00:13:41,269 --> 00:13:40,079
and so i was lucky enough to you know

458
00:13:42,710 --> 00:13:41,279
get accepted at the university of

459
00:13:44,710 --> 00:13:42,720
arizona and i worked with someone who

460
00:13:46,949 --> 00:13:44,720
was on the galileo imaging team

461
00:13:47,990 --> 00:13:46,959
and i got to be there i got to be the

462
00:13:49,670 --> 00:13:48,000
one you know

463
00:13:51,590 --> 00:13:49,680

i was like this lowly you know first

464

00:13:53,430 --> 00:13:51,600

year grad student when galileo

465

00:13:55,030 --> 00:13:53,440

reached the jupiter system right so

466

00:13:56,389 --> 00:13:55,040

that's the luck right that's the timing

467

00:13:57,670 --> 00:13:56,399

i was just i was in the right place at

468

00:14:00,230 --> 00:13:57,680

the right time

469

00:14:01,910 --> 00:14:00,240

um and so since i was like the youngest

470

00:14:03,269 --> 00:14:01,920

one the youngest grad student and i was

471

00:14:05,110 --> 00:14:03,279

good with computers

472

00:14:06,710 --> 00:14:05,120

i got to be the one who could you know

473

00:14:08,150 --> 00:14:06,720

the images were released and there was

474

00:14:10,389 --> 00:14:08,160

the internet by then right and so

475

00:14:12,150 --> 00:14:10,399

we didn't actually get to physically go

476
00:14:13,829 --> 00:14:12,160
to the jpl control room and look at the

477
00:14:15,990 --> 00:14:13,839
pictures on the big screens

478
00:14:17,590 --> 00:14:16,000
they were put on an ftp site but i was

479
00:14:19,430 --> 00:14:17,600
the one who was very good at you know i

480
00:14:20,949 --> 00:14:19,440
could ftp the images over really quickly

481
00:14:22,949 --> 00:14:20,959
and get them up and stretch them and get

482
00:14:24,870 --> 00:14:22,959
them on my big monitor on my computer

483
00:14:26,230 --> 00:14:24,880
and all of the you know the scientists

484
00:14:27,910 --> 00:14:26,240
in the department the professors would

485
00:14:28,710 --> 00:14:27,920
gather around behind me and we'd look at

486
00:14:31,750 --> 00:14:28,720
those pictures

487
00:14:33,590 --> 00:14:31,760
and say wow i have no idea what that is

488
00:14:34,790 --> 00:14:33,600

right i got to do it and it was just

489

00:14:36,310 --> 00:14:34,800

amazing

490

00:14:38,069 --> 00:14:36,320

and that's when i fell in love with the

491

00:14:39,430 --> 00:14:38,079

with the satellites of jupiter with with

492

00:14:42,069 --> 00:14:39,440

i worked on io

493

00:14:42,710 --> 00:14:42,079

you know ganymede callisto but really

494

00:14:46,389 --> 00:14:42,720

europa

495

00:14:48,790 --> 00:14:46,399

became obsessed with it

496

00:14:49,590 --> 00:14:48,800

so i've worked on europa ever since oh

497

00:14:51,269 --> 00:14:49,600

that's wonderful

498

00:14:52,949 --> 00:14:51,279

i love your connection there of you know

499

00:14:53,590 --> 00:14:52,959

as a young person seeing carl sagan

500

00:14:55,590 --> 00:14:53,600

looking at

501
00:14:56,790 --> 00:14:55,600
the moons of neptune and being like i

502
00:14:58,310 --> 00:14:56,800
don't know what that is and then as a

503
00:14:59,670 --> 00:14:58,320
graduate student you're involved in

504
00:15:01,110 --> 00:14:59,680
downloading these images and

505
00:15:03,829 --> 00:15:01,120
and scientists are like i don't know

506
00:15:06,389 --> 00:15:03,839
what that is and i was i was so lucky

507
00:15:07,509 --> 00:15:06,399
right it was amazing yeah and i love you

508
00:15:09,350 --> 00:15:07,519
know the mixture of you know your

509
00:15:10,069 --> 00:15:09,360
motivation hard work and a bit of luck

510
00:15:12,150 --> 00:15:10,079
too i mean

511
00:15:13,670 --> 00:15:12,160
that does happen along the way and it is

512
00:15:15,269 --> 00:15:13,680
interesting there always are you know

513
00:15:17,030 --> 00:15:15,279

upcoming missions that young people can

514

00:15:19,110 --> 00:15:17,040

get involved in right now

515

00:15:20,629 --> 00:15:19,120

uh the dragonfly mission to titan won't

516

00:15:22,069 --> 00:15:20,639

launch for quite some time but

517

00:15:24,069 --> 00:15:22,079

you can get involved now as a young

518

00:15:26,550 --> 00:15:24,079

student uh there are ways to be involved

519

00:15:28,150 --> 00:15:26,560

with upcoming europa missions

520

00:15:30,069 --> 00:15:28,160

and a lot of people are very interested

521

00:15:32,310 --> 00:15:30,079

in icy worlds in our solar system we

522

00:15:33,430 --> 00:15:32,320

actually asked on the nasa astrobiology

523

00:15:35,670 --> 00:15:33,440

twitter account

524

00:15:38,230 --> 00:15:35,680

uh what people's favorite icy worlds

525

00:15:40,710 --> 00:15:38,240

were we gave them the options of europa

526

00:15:42,150 --> 00:15:40,720

enceladus titan or other now i

527

00:15:43,990 --> 00:15:42,160

personally also recommended triton

528

00:15:47,110 --> 00:15:44,000

because that's one of my favorites

529

00:15:49,269 --> 00:15:47,120

uh but the polling showed us that 41

530

00:15:50,550 --> 00:15:49,279

of the audience who responded chose

531

00:15:54,230 --> 00:15:50,560

europa

532

00:15:55,749 --> 00:15:54,240

excellent good choice everyone and so

533

00:15:58,069 --> 00:15:55,759

you know let's talk a bit about

534

00:15:59,749 --> 00:15:58,079

europa uh and maybe specifically

535

00:16:02,069 --> 00:15:59,759

focusing on the upcoming mission

536

00:16:03,269 --> 00:16:02,079

europa clipper and europa lander um i

537

00:16:04,310 --> 00:16:03,279

wonder if you can give us you know kind

538

00:16:05,829 --> 00:16:04,320

of a

539

00:16:06,949 --> 00:16:05,839

really quick synopsis of what we're

540

00:16:08,069 --> 00:16:06,959

going to be doing with the clipper

541

00:16:10,710 --> 00:16:08,079

mission

542

00:16:11,189 --> 00:16:10,720

sure yeah so so after the galileo

543

00:16:13,110 --> 00:16:11,199

mission

544

00:16:14,949 --> 00:16:13,120

studied jupiter and satellites you know

545

00:16:15,829 --> 00:16:14,959

we discovered that europa was really

546

00:16:17,590 --> 00:16:15,839

fascinating

547

00:16:19,509 --> 00:16:17,600

right so it's it the surface is covered

548

00:16:21,749 --> 00:16:19,519

with ice it's really bright

549

00:16:23,189 --> 00:16:21,759

it has all these cracks and ridges and

550

00:16:24,629 --> 00:16:23,199

places on the surface where

551

00:16:26,870 --> 00:16:24,639

it almost looks like icebergs like

552

00:16:28,710 --> 00:16:26,880

something's like rotated and translated

553

00:16:29,749 --> 00:16:28,720

and broken up and then frozen into a new

554

00:16:32,629 --> 00:16:29,759

position

555

00:16:33,350 --> 00:16:32,639

it's just this crazy looking world and

556

00:16:35,430 --> 00:16:33,360

we're

557

00:16:36,710 --> 00:16:35,440

pretty sure with evidence from all the

558

00:16:37,829 --> 00:16:36,720

different instruments on the galileo

559

00:16:39,749 --> 00:16:37,839

spacecraft that

560

00:16:40,949 --> 00:16:39,759

there's this layer of ice at the surface

561

00:16:43,350 --> 00:16:40,959

but under that ice

562

00:16:45,590 --> 00:16:43,360

is an ocean of liquid water and there's

563

00:16:47,829 --> 00:16:45,600

actually more water on europa

564

00:16:50,150 --> 00:16:47,839

than all of earth's oceans combined

565

00:16:53,269 --> 00:16:50,160

right so it's a lot of water it's this

566

00:16:54,790 --> 00:16:53,279

global subsurface ocean and so

567

00:16:56,710 --> 00:16:54,800

when we start thinking about that we

568

00:16:58,389 --> 00:16:56,720

start thinking about how wow

569

00:17:00,470 --> 00:16:58,399

that could be one of the best places to

570

00:17:01,590 --> 00:17:00,480

look for life in the solar system life

571

00:17:03,350 --> 00:17:01,600

beyond the earth

572

00:17:05,189 --> 00:17:03,360

um you know forget mars right nothing

573

00:17:06,710 --> 00:17:05,199

against mars mars is nice it's pretty in

574

00:17:09,750 --> 00:17:06,720

red it matches my shirt but

575

00:17:12,069 --> 00:17:09,760

you know there's no oceans on mars today

576

00:17:14,549 --> 00:17:12,079

right if we find life on mars it's going

577

00:17:15,990 --> 00:17:14,559

to be kind of old fossilized microbes or

578

00:17:18,069 --> 00:17:16,000

you know maybe something hiding in a

579

00:17:20,549 --> 00:17:18,079

little ice pocket under the surface but

580

00:17:21,350 --> 00:17:20,559

on europa we have this ocean there could

581

00:17:24,390 --> 00:17:21,360

be life

582

00:17:26,309 --> 00:17:24,400

in that ocean and so we started working

583

00:17:28,069 --> 00:17:26,319

on a new mission called europa clipper

584

00:17:29,350 --> 00:17:28,079

and you know after galileo we thought

585

00:17:31,190 --> 00:17:29,360

okay this will be the next mission

586

00:17:33,190 --> 00:17:31,200

it's going to get going and it took a

587

00:17:35,669 --> 00:17:33,200

long time to get this mission

588

00:17:36,390 --> 00:17:35,679

you know really approved and so now

589

00:17:37,590 --> 00:17:36,400

finally

590

00:17:40,230 --> 00:17:37,600

we have this mission it's going to

591

00:17:42,630 --> 00:17:40,240

launch in a couple years um

592

00:17:44,230 --> 00:17:42,640

and it's going to study europa it's

593

00:17:45,029 --> 00:17:44,240

going to have that detailed close-up

594

00:17:47,510 --> 00:17:45,039

lurk with

595

00:17:48,230 --> 00:17:47,520

resolution images with a radar

596

00:17:49,510 --> 00:17:48,240

instrument with

597

00:17:51,430 --> 00:17:49,520

all sorts of instruments that will

598

00:17:54,549 --> 00:17:51,440

really be able to study europa

599

00:17:56,950 --> 00:17:54,559

um and its ocean um and so the top level

600

00:17:59,270 --> 00:17:56,960

science goal of europa clipper is to

601
00:18:00,470 --> 00:17:59,280
explore europa to investigate its

602
00:18:02,470 --> 00:18:00,480
habitability

603
00:18:04,150 --> 00:18:02,480
so europa clipper is not a life

604
00:18:06,230 --> 00:18:04,160
detection mission per se

605
00:18:07,350 --> 00:18:06,240
it's a habitability mission it's kind of

606
00:18:10,310 --> 00:18:07,360
the next step

607
00:18:12,230 --> 00:18:10,320
in understanding europa and so what it's

608
00:18:14,390 --> 00:18:12,240
going to do is look for

609
00:18:15,270 --> 00:18:14,400
are there places on europa that are

610
00:18:17,590 --> 00:18:15,280
habitable

611
00:18:19,270 --> 00:18:17,600
that we think that life and again this

612
00:18:20,549 --> 00:18:19,280
is life as we know it right

613
00:18:22,070 --> 00:18:20,559

you know there's all sorts of crazy

614

00:18:23,029 --> 00:18:22,080

ideas of what kinds of crazy life there

615

00:18:24,710 --> 00:18:23,039

could be but

616

00:18:26,549 --> 00:18:24,720

you know you can't really base a mission

617

00:18:29,029 --> 00:18:26,559

on that you have to base a mission on

618

00:18:30,390 --> 00:18:29,039

you know our best knowledge of what life

619

00:18:33,190 --> 00:18:30,400

on earth looks like

620

00:18:34,950 --> 00:18:33,200

and how we think that life could survive

621

00:18:36,390 --> 00:18:34,960

in an environment like europa

622

00:18:37,990 --> 00:18:36,400

and so that's what europa clipper will

623

00:18:39,029 --> 00:18:38,000

do is it's going to study the surface

624

00:18:40,870 --> 00:18:39,039

composition

625

00:18:42,150 --> 00:18:40,880

it's going to try to probe the

626

00:18:44,150 --> 00:18:42,160

subsurface structure

627

00:18:45,510 --> 00:18:44,160

maybe even get down to tell us like how

628

00:18:47,430 --> 00:18:45,520

deep that ocean is

629

00:18:48,630 --> 00:18:47,440

whether there's ice pockets maybe in the

630

00:18:50,230 --> 00:18:48,640

ice crest

631

00:18:52,070 --> 00:18:50,240

um and it'll also look for the

632

00:18:54,630 --> 00:18:52,080

composition of material that's that's

633

00:18:56,470 --> 00:18:54,640

ejected from europa's surface into space

634

00:18:58,310 --> 00:18:56,480

the off and kind of stick out its tongue

635

00:19:01,350 --> 00:18:58,320

and you know taste that material and

636

00:19:03,669 --> 00:19:01,360

figure out what it's made of and so all

637

00:19:05,909 --> 00:19:03,679

of these instruments working together

638

00:19:07,029 --> 00:19:05,919

will be able to give us an amazing idea

639

00:19:09,029 --> 00:19:07,039

of

640

00:19:11,190 --> 00:19:09,039

whether there are places on europa that

641

00:19:12,950 --> 00:19:11,200

we think life could live

642

00:19:14,310 --> 00:19:12,960

yeah that's a good point too and also

643

00:19:15,750 --> 00:19:14,320

like picking out things that could be

644

00:19:17,909 --> 00:19:15,760

orbiting around europa as it's flying

645

00:19:19,350 --> 00:19:17,919

through we got very lucky with cassini

646

00:19:21,110 --> 00:19:19,360

that you know we could fly through the

647

00:19:22,710 --> 00:19:21,120

plumes of enceladus

648

00:19:24,230 --> 00:19:22,720

i remember there was a workshop at nasa

649

00:19:26,070 --> 00:19:24,240

ames some years ago

650

00:19:27,669 --> 00:19:26,080

uh proposing how would we actually look

651

00:19:30,070 --> 00:19:27,679

at the chemistry of material if there

652

00:19:31,909 --> 00:19:30,080

are plumes coming out of europa as well

653

00:19:33,430 --> 00:19:31,919

uh there are there are some data to

654

00:19:35,830 --> 00:19:33,440

suggest there could be plumes

655

00:19:36,870 --> 00:19:35,840

that intermittently come out of europa

656

00:19:38,390 --> 00:19:36,880

but i think it's good for people to

657

00:19:39,669 --> 00:19:38,400

remember that that clipper is going to

658

00:19:41,110 --> 00:19:39,679

be an orbiting mission

659

00:19:43,830 --> 00:19:41,120

that will orbit around jupiter and

660

00:19:45,590 --> 00:19:43,840

europa together and study the surface

661

00:19:47,669 --> 00:19:45,600

um and so we also have the concept

662

00:19:48,950 --> 00:19:47,679

design of the europa lander

663

00:19:51,350 --> 00:19:48,960

um and so would you mind just telling

664

00:19:51,990 --> 00:19:51,360

our audience about this idea of landing

665

00:19:53,750 --> 00:19:52,000

a spacecraft

666

00:19:55,750 --> 00:19:53,760

on europa as well and what we might do

667

00:19:58,310 --> 00:19:55,760

if we actually send that there

668

00:19:59,909 --> 00:19:58,320

yeah so once we've studied europa from

669

00:20:01,510 --> 00:19:59,919

orbit and so europa clipper it's going

670

00:20:04,070 --> 00:20:01,520

to be in orbit around jupiter

671

00:20:06,310 --> 00:20:04,080

with multiple close flybys like 40 or 50

672

00:20:08,549 --> 00:20:06,320

close flybys of europa

673

00:20:10,149 --> 00:20:08,559

but if you really want to study the

674

00:20:10,870 --> 00:20:10,159

composition of europa and if you really

675

00:20:13,909 --> 00:20:10,880

want to do an

676
00:20:15,990 --> 00:20:13,919
actual search for biosignatures so bio

677
00:20:19,430 --> 00:20:16,000
signatures are basically signs of life

678
00:20:21,590 --> 00:20:19,440
so materials that were

679
00:20:23,750 --> 00:20:21,600
that that must have been made in the

680
00:20:25,510 --> 00:20:23,760
presence of life or made by life

681
00:20:27,510 --> 00:20:25,520
right so if you really want to look for

682
00:20:29,350 --> 00:20:27,520
bio signatures you've got to land

683
00:20:30,870 --> 00:20:29,360
you've got to touch the surface and so

684
00:20:31,750 --> 00:20:30,880
the the picture in back of me so this is

685
00:20:32,950 --> 00:20:31,760
the europa lander

686
00:20:34,870 --> 00:20:32,960
i'm moving because i'm blocking the

687
00:20:37,750 --> 00:20:34,880
lander but so the idea is that

688
00:20:39,190 --> 00:20:37,760

you land on the surface of europa and so

689

00:20:40,950 --> 00:20:39,200

i've been working with this europa

690

00:20:42,950 --> 00:20:40,960

lander mission concept so

691

00:20:45,110 --> 00:20:42,960

this is not an approved nasa mission yet

692

00:20:47,110 --> 00:20:45,120

right it's a concept it's a study

693

00:20:48,470 --> 00:20:47,120

but it's a very high fidelity you know

694

00:20:50,470 --> 00:20:48,480

mature concept

695

00:20:52,390 --> 00:20:50,480

so if you know somebody arrived with a

696

00:20:54,070 --> 00:20:52,400

big bucket of dollars and said hey build

697

00:20:54,950 --> 00:20:54,080

me a mission to europa i'd say okay and

698

00:20:56,390 --> 00:20:54,960

i'd push the button

699

00:20:58,630 --> 00:20:56,400

and we'd start building this thing that

700

00:20:59,510 --> 00:20:58,640

would land on the surface um and so the

701
00:21:02,070 --> 00:20:59,520

idea is that

702
00:21:04,230 --> 00:21:02,080

you land and then you have like a like a

703
00:21:06,070 --> 00:21:04,240

saw or some other kind of sampling

704
00:21:08,549 --> 00:21:06,080

or you know instrument on the end of an

705
00:21:09,669 --> 00:21:08,559

arm you dig below the surface so you

706
00:21:10,950 --> 00:21:09,679

you don't want to sample the stuff

707
00:21:13,190 --> 00:21:10,960

that's right at the surface because

708
00:21:14,630 --> 00:21:13,200

that's just been fried by radiation

709
00:21:16,710 --> 00:21:14,640

so you want to go down a little bit

710
00:21:18,070 --> 00:21:16,720

deeper so where the ice can protect

711
00:21:19,909 --> 00:21:18,080

any of these materials from that

712
00:21:20,950 --> 00:21:19,919

radiation you want to scoop up some of

713
00:21:22,630 --> 00:21:20,960

that material

714

00:21:24,310 --> 00:21:22,640

you want to get it into your spacecraft

715

00:21:25,750 --> 00:21:24,320

and then you have these onboard chemical

716

00:21:28,149 --> 00:21:25,760

analysis instruments

717

00:21:29,669 --> 00:21:28,159

that will be able to tell you what's in

718

00:21:30,070 --> 00:21:29,679

that material and that will be able to

719

00:21:32,230 --> 00:21:30,080

look

720

00:21:33,190 --> 00:21:32,240

for these bio signatures these signs of

721

00:21:35,909 --> 00:21:33,200

life

722

00:21:37,350 --> 00:21:35,919

and so this would just be an amazing

723

00:21:38,470 --> 00:21:37,360

mission because it would really be one

724

00:21:40,470 --> 00:21:38,480

of our first

725

00:21:42,230 --> 00:21:40,480

you know since the viking missions the

726
00:21:43,590 --> 00:21:42,240
viking landers that went to mars back in

727
00:21:45,430 --> 00:21:43,600
the 1970s

728
00:21:47,110 --> 00:21:45,440
those were explicit you know

729
00:21:49,110 --> 00:21:47,120
astrobiology we didn't even have the

730
00:21:51,669 --> 00:21:49,120
word astrobiology back then but

731
00:21:52,789 --> 00:21:51,679
those were life detection missions and

732
00:21:54,630 --> 00:21:52,799
what we could do

733
00:21:56,310 --> 00:21:54,640
on europa with this europa lander

734
00:21:58,390 --> 00:21:56,320
mission concept is

735
00:22:01,590 --> 00:21:58,400
look for bio signatures look for signs

736
00:22:03,590 --> 00:22:01,600
of life and it would just be amazing

737
00:22:05,029 --> 00:22:03,600
awesome yeah i was super fortunate in

738
00:22:05,750 --> 00:22:05,039

graduate school to do research at a

739

00:22:07,830 --> 00:22:05,760

place called

740

00:22:09,750 --> 00:22:07,840

fjord pass up in the canadian high

741

00:22:10,470 --> 00:22:09,760

arctic which is one of our analogs on

742

00:22:12,310 --> 00:22:10,480

earth

743

00:22:13,669 --> 00:22:12,320

for europa and specifically for the

744

00:22:14,549 --> 00:22:13,679

kinds of instruments that we might

745

00:22:17,029 --> 00:22:14,559

employ

746

00:22:18,470 --> 00:22:17,039

on a lander mission and so i'm super

747

00:22:20,149 --> 00:22:18,480

hopeful that the lander will eventually

748

00:22:23,270 --> 00:22:20,159

be funded and that we'll see

749

00:22:24,710 --> 00:22:23,280

a lander going to europa as well i do

750

00:22:26,630 --> 00:22:24,720

want to mine the audience watching

751
00:22:28,710 --> 00:22:26,640
on segonnet on the nasa astrobiology

752
00:22:29,909 --> 00:22:28,720
facebook page if you have questions for

753
00:22:32,789 --> 00:22:29,919
dr phillips about

754
00:22:34,470 --> 00:22:32,799
europa or other icy worlds about her

755
00:22:36,230 --> 00:22:34,480
research and studying the geology of

756
00:22:37,669 --> 00:22:36,240
these moons of our solar system

757
00:22:38,950 --> 00:22:37,679
feel free to drop those in the chat and

758
00:22:40,630 --> 00:22:38,960
we'll start adding those to our

759
00:22:43,190 --> 00:22:40,640
teleprompter for me then

760
00:22:44,789 --> 00:22:43,200
to ask dr phillips here shortly i do

761
00:22:47,029 --> 00:22:44,799
want to chat just for a moment

762
00:22:48,789 --> 00:22:47,039
i know you've done a lot of public

763
00:22:50,470 --> 00:22:48,799

engagement community engagement in the

764

00:22:51,590 --> 00:22:50,480

sciences as well

765

00:22:54,070 --> 00:22:51,600

you've done things like going to

766

00:22:55,590 --> 00:22:54,080

comic-con and south by southwest and and

767

00:22:57,190 --> 00:22:55,600

shared science i wonder if you could

768

00:22:59,350 --> 00:22:57,200

speak to our audience

769

00:23:00,310 --> 00:22:59,360

about your vision of the importance of

770

00:23:01,990 --> 00:23:00,320

sharing science

771

00:23:03,430 --> 00:23:02,000

and and maybe what that has meant for

772

00:23:05,830 --> 00:23:03,440

you in your own career to have a chance

773

00:23:08,630 --> 00:23:05,840

to speak to others about your work

774

00:23:10,470 --> 00:23:08,640

yeah absolutely um one of the one of the

775

00:23:11,990 --> 00:23:10,480

most amazing things about my job is that

776

00:23:14,630 --> 00:23:12,000

you know it's just that i get to do it

777

00:23:17,590 --> 00:23:14,640

right and i love sharing that excitement

778

00:23:19,669 --> 00:23:17,600

about about europa about what i do about

779

00:23:21,350 --> 00:23:19,679

you know this little ice covered world

780

00:23:21,990 --> 00:23:21,360

that's like the size of our moon but it

781

00:23:24,390 --> 00:23:22,000

looks so

782

00:23:26,470 --> 00:23:24,400

totally different like i love talking to

783

00:23:27,430 --> 00:23:26,480

students to classes to the general

784

00:23:29,430 --> 00:23:27,440

public

785

00:23:30,630 --> 00:23:29,440

um and so so yeah when i get the

786

00:23:32,230 --> 00:23:30,640

opportunity to do these

787

00:23:34,230 --> 00:23:32,240

bigger like higher profile kind of

788

00:23:35,990 --> 00:23:34,240

science communications events

789

00:23:37,750 --> 00:23:36,000

it's just fabulous it's fabulous to go

790

00:23:39,750 --> 00:23:37,760

to somewhere like you know san diego

791

00:23:41,350 --> 00:23:39,760

comic-con or south by southwest

792

00:23:43,669 --> 00:23:41,360

where you know you'll have panels with

793

00:23:45,590 --> 00:23:43,679

like actors from these amazing tv shows

794

00:23:47,350 --> 00:23:45,600

and you know comic book artists and

795

00:23:48,950 --> 00:23:47,360

you know all of the all of the you know

796

00:23:50,630 --> 00:23:48,960

the cosplay and the amazing

797

00:23:53,110 --> 00:23:50,640

people that are there and then you have

798

00:23:55,269 --> 00:23:53,120

like a nasa track or a science track

799

00:23:57,269 --> 00:23:55,279

and you have a couple of nasa panels and

800

00:23:58,710 --> 00:23:57,279

you know they're hugely popular like we

801
00:24:00,710 --> 00:23:58,720
get huge audiences okay

802
00:24:02,149 --> 00:24:00,720
maybe not as much as the cast of the

803
00:24:03,830 --> 00:24:02,159
latest avengers movie but

804
00:24:05,909 --> 00:24:03,840
you know still like there's a lot of

805
00:24:06,549 --> 00:24:05,919
interest and i think what that shows is

806
00:24:15,029 --> 00:24:06,559
that

807
00:24:16,470 --> 00:24:15,039
it's about you know what can you dream

808
00:24:18,230 --> 00:24:16,480
and how can you make those dreams

809
00:24:19,350 --> 00:24:18,240
reality and whether you're making them

810
00:24:21,830 --> 00:24:19,360
reality through

811
00:24:22,870 --> 00:24:21,840
a movie or through a comic book or you

812
00:24:24,870 --> 00:24:22,880
know through actually building a

813
00:24:26,710 --> 00:24:24,880

spacecraft and going there and seeing

814

00:24:28,870 --> 00:24:26,720

what would it look like on europa right

815

00:24:29,669 --> 00:24:28,880

the ties between science and science

816

00:24:31,990 --> 00:24:29,679

fiction

817

00:24:33,510 --> 00:24:32,000

um they're so close right so many of us

818

00:24:35,029 --> 00:24:33,520

who went into science i mean i watched

819

00:24:36,630 --> 00:24:35,039

star trek as a kid right i mean

820

00:24:38,230 --> 00:24:36,640

you know we're we're obsessed with

821

00:24:40,950 --> 00:24:38,240

science fiction because

822

00:24:42,710 --> 00:24:40,960

that's sort of a view of the future and

823

00:24:44,950 --> 00:24:42,720

we get the privilege of trying to figure

824

00:24:47,669 --> 00:24:44,960

out how to make that view reality

825

00:24:48,549 --> 00:24:47,679

awesome uh before we move on and in our

826

00:24:50,950 --> 00:24:48,559

discussion here

827

00:24:52,870 --> 00:24:50,960

dr phillips we asked another question

828

00:24:54,149 --> 00:24:52,880

through the nasa astrobiology twitter

829

00:24:56,390 --> 00:24:54,159

profile

830

00:24:58,310 --> 00:24:56,400

we shared one of your favorite pictures

831

00:25:00,310 --> 00:24:58,320

from the solar system

832

00:25:02,950 --> 00:25:00,320

and we asked folks online if they could

833

00:25:04,630 --> 00:25:02,960

actually tell us where that location was

834

00:25:07,029 --> 00:25:04,640

uh and so that image is popping up right

835

00:25:07,909 --> 00:25:07,039

now on our screens for everyone at home

836

00:25:10,630 --> 00:25:07,919

to see

837

00:25:11,269 --> 00:25:10,640

uh it's a beautiful colored image from

838

00:25:14,870 --> 00:25:11,279

the moon

839

00:25:17,590 --> 00:25:14,880

io or eo depending on your pronunciation

840

00:25:19,110 --> 00:25:17,600

it's a region called coulomb patera on

841

00:25:21,430 --> 00:25:19,120

io and io is

842

00:25:23,350 --> 00:25:21,440

a very volcanically active world it's

843

00:25:26,390 --> 00:25:23,360

spewing volcanic material including

844

00:25:27,190 --> 00:25:26,400

lots of sulfur out into orbit around

845

00:25:29,350 --> 00:25:27,200

jupiter

846

00:25:30,230 --> 00:25:29,360

uh and so we want to mention uh marianne

847

00:25:33,029 --> 00:25:30,240

denton at

848

00:25:33,390 --> 00:25:33,039

astro underscore limno and matt thompson

849

00:25:36,390 --> 00:25:33,400

at

850

00:25:38,630 --> 00:25:36,400

mftomster on twitter for

851
00:25:39,510 --> 00:25:38,640
getting it right that it was on io and

852
00:25:41,110 --> 00:25:39,520
then the winner

853
00:25:42,789 --> 00:25:41,120
who actually got the right location of

854
00:25:45,909 --> 00:25:42,799
coulomb patera as well

855
00:25:47,510 --> 00:25:45,919
is ana route mohanty at strayologist

856
00:25:49,510 --> 00:25:47,520
so thanks everyone for all of your

857
00:25:51,350 --> 00:25:49,520
wonderful answers for getting involved

858
00:25:52,710 --> 00:25:51,360
um with us there and a reminder for the

859
00:25:54,789 --> 00:25:52,720
audience i am going to jump over to our

860
00:25:55,669 --> 00:25:54,799
q a and start asking your questions very

861
00:25:57,269 --> 00:25:55,679
soon so

862
00:25:59,110 --> 00:25:57,279
feel free to drop any questions you have

863
00:25:59,430 --> 00:25:59,120

for dr phillips in the chats right now

864

00:26:00,870 --> 00:25:59,440

and

865

00:26:02,630 --> 00:26:00,880

we'll do our best to get to as many of

866

00:26:04,789 --> 00:26:02,640

those as we possibly can

867

00:26:07,430 --> 00:26:04,799

um just before we move on i do want to

868

00:26:09,430 --> 00:26:07,440

know uh for all of us in the sciences we

869

00:26:11,350 --> 00:26:09,440

also have many other things that are

870

00:26:12,549 --> 00:26:11,360

are driving us you know our hobbies and

871

00:26:14,710 --> 00:26:12,559

other activities

872

00:26:15,990 --> 00:26:14,720

things that kind of keep us going i

873

00:26:17,669 --> 00:26:16,000

understand that you're a big fan of

874

00:26:19,190 --> 00:26:17,679

science fiction for instance

875

00:26:21,029 --> 00:26:19,200

um i wonder if you could talk to us

876

00:26:22,310 --> 00:26:21,039

about the things that that can inspire

877

00:26:25,269 --> 00:26:22,320

you and keep you going

878

00:26:26,070 --> 00:26:25,279

outside of the science that you do yeah

879

00:26:28,230 --> 00:26:26,080

sure i mean

880

00:26:29,909 --> 00:26:28,240

i have five kids and so honestly you

881

00:26:31,110 --> 00:26:29,919

know i don't have time between work and

882

00:26:32,149 --> 00:26:31,120

kids i don't have that much time for

883

00:26:33,909 --> 00:26:32,159

hobbies but

884

00:26:36,149 --> 00:26:33,919

i'm a huge science fiction fan and so

885

00:26:37,750 --> 00:26:36,159

i've been really you know i grew up on

886

00:26:39,110 --> 00:26:37,760

star trek on star trek the next

887

00:26:40,630 --> 00:26:39,120

generation and then i went back and

888

00:26:41,990 --> 00:26:40,640

watched the original series which was

889

00:26:43,669 --> 00:26:42,000

you know before my time but of course

890

00:26:45,990 --> 00:26:43,679

within reruns so

891

00:26:48,230 --> 00:26:46,000

yeah i'm a big fan of sort of like that

892

00:26:50,070 --> 00:26:48,240

the the positive but the sort of

893

00:26:51,350 --> 00:26:50,080

realistic views of what a future might

894

00:26:53,750 --> 00:26:51,360

be like and so

895

00:26:55,430 --> 00:26:53,760

recently i've been enjoying um shows

896

00:26:56,710 --> 00:26:55,440

like the expanse you know the books but

897

00:26:58,549 --> 00:26:56,720

also the show is just they're they're

898

00:27:01,830 --> 00:26:58,559

amazing they're probably the most like

899

00:27:03,590 --> 00:27:01,840

scientifically accurate um depictions of

900

00:27:05,590 --> 00:27:03,600

you know a near future where we've

901
00:27:07,590 --> 00:27:05,600
inhabited and you know we're living in

902
00:27:09,110 --> 00:27:07,600
the solar system that i've seen um

903
00:27:10,630 --> 00:27:09,120
i keep waiting for them to go to europa

904
00:27:13,029 --> 00:27:10,640
and they haven't yet but you know

905
00:27:14,230 --> 00:27:13,039
i'm watching for it yeah i i really hope

906
00:27:15,669 --> 00:27:14,240
so it'd be awesome

907
00:27:17,269 --> 00:27:15,679
yeah i've read the books as well and i'm

908
00:27:19,029 --> 00:27:17,279
kind of sad that they only have one more

909
00:27:20,710 --> 00:27:19,039
season now of the show because

910
00:27:22,230 --> 00:27:20,720
books seven and eight kind of go into a

911
00:27:24,149 --> 00:27:22,240
much bigger place

912
00:27:26,310 --> 00:27:24,159
um cosmically speaking for science

913
00:27:27,750 --> 00:27:26,320

fiction um which is pretty awesome so

914

00:27:29,510 --> 00:27:27,760

hopefully they'll do europa eventually

915

00:27:31,669 --> 00:27:29,520

that would be pretty cool um

916

00:27:33,350 --> 00:27:31,679

if they did that i think we will move

917

00:27:34,950 --> 00:27:33,360

now to our audience q a

918

00:27:36,470 --> 00:27:34,960

uh we do have a bunch of questions

919

00:27:38,470 --> 00:27:36,480

rolling in already

920

00:27:39,750 --> 00:27:38,480

um so let's start off with a question

921

00:27:41,430 --> 00:27:39,760

from facebook

922

00:27:42,870 --> 00:27:41,440

from rebecca jennifer jennifer

923

00:27:44,630 --> 00:27:42,880

elderbrock

924

00:27:46,470 --> 00:27:44,640

rebecca wants to know what is the most

925

00:27:48,149 --> 00:27:46,480

important physics or astronomy class

926
00:27:49,990 --> 00:27:48,159
that you took in undergrad

927
00:27:51,190 --> 00:27:50,000
that prepared you to get accepted into

928
00:27:53,510 --> 00:27:51,200
graduate school

929
00:27:54,230 --> 00:27:53,520
um that's a really that's a really good

930
00:27:56,149 --> 00:27:54,240
question

931
00:27:57,430 --> 00:27:56,159
and i would say that probably the most

932
00:28:00,230 --> 00:27:57,440
important thing that i did as an

933
00:28:03,269 --> 00:28:00,240
undergrad was to do research

934
00:28:05,269 --> 00:28:03,279
so we had we had a couple of different

935
00:28:07,350 --> 00:28:05,279
um they were called tutorial sessions

936
00:28:09,669 --> 00:28:07,360
but basically you sort of like

937
00:28:11,029 --> 00:28:09,679
you met with various members of the

938
00:28:12,470 --> 00:28:11,039

astronomy department

939

00:28:13,909 --> 00:28:12,480

and then you kind of picked one of them

940

00:28:15,669 --> 00:28:13,919

as a sophomore to like write a little

941

00:28:17,269 --> 00:28:15,679

research paper with and then

942

00:28:19,350 --> 00:28:17,279

you could you know kind of move on and

943

00:28:21,269 --> 00:28:19,360

do a different one in your junior year

944

00:28:23,190 --> 00:28:21,279

um and then and then i did you know a

945

00:28:25,190 --> 00:28:23,200

senior thesis as a senior

946

00:28:27,269 --> 00:28:25,200

um and so getting involved with with

947

00:28:29,029 --> 00:28:27,279

research as an undergraduate

948

00:28:30,470 --> 00:28:29,039

i think that that was really one of the

949

00:28:33,029 --> 00:28:30,480

key things i mean obviously you want to

950

00:28:34,950 --> 00:28:33,039

do well in your core classes

951
00:28:36,630 --> 00:28:34,960
but you want to really you know worry

952
00:28:38,710 --> 00:28:36,640
about grades but really also worry about

953
00:28:40,389 --> 00:28:38,720
just having a deep understanding of the

954
00:28:42,710 --> 00:28:40,399
fundamentals of you know whether you're

955
00:28:45,269 --> 00:28:42,720
in physics or chemistry or geology

956
00:28:46,789 --> 00:28:45,279
or you know astronomy um but really it's

957
00:28:47,990 --> 00:28:46,799
the opportunity to sort of get your feet

958
00:28:49,510 --> 00:28:48,000
wet with research and

959
00:28:51,110 --> 00:28:49,520
you know do one of these there's these

960
00:28:52,389 --> 00:28:51,120
research experience or undergraduate

961
00:28:53,590 --> 00:28:52,399
summer programs you can do where you

962
00:28:55,350 --> 00:28:53,600
actually get paid

963
00:28:57,350 --> 00:28:55,360

you know to go somewhere for a summer

964

00:28:59,190 --> 00:28:57,360

and do research right and with coveted

965

00:29:01,190 --> 00:28:59,200

times that's harder these days but

966

00:29:02,630 --> 00:29:01,200

it's such a great opportunity to see if

967

00:29:04,470 --> 00:29:02,640

you like it right before you get to

968

00:29:06,389 --> 00:29:04,480

graduate school

969

00:29:07,590 --> 00:29:06,399

yeah i agree entirely i was very lucky i

970

00:29:09,430 --> 00:29:07,600

did an reu

971

00:29:10,950 --> 00:29:09,440

at the graduate school of oceanography

972

00:29:11,750 --> 00:29:10,960

as well as an internship at the nasa

973

00:29:13,430 --> 00:29:11,760

academy

974

00:29:15,590 --> 00:29:13,440

at ames and those things as undergrads

975

00:29:16,070 --> 00:29:15,600

were really important in my future

976
00:29:17,590 --> 00:29:16,080
career

977
00:29:19,590 --> 00:29:17,600
and kind of helping me figure out what i

978
00:29:21,590 --> 00:29:19,600
wanted to do as well

979
00:29:23,029 --> 00:29:21,600
now you are working now at nasa's jet

980
00:29:24,870 --> 00:29:23,039
propulsion laboratory

981
00:29:26,310 --> 00:29:24,880
we have another question from facebook

982
00:29:27,750 --> 00:29:26,320
from stephanie carr

983
00:29:30,789 --> 00:29:27,760
uh stephanie wants to know what your

984
00:29:33,190 --> 00:29:30,799
typical work day actually looks like

985
00:29:33,990 --> 00:29:33,200
that's a great question and um you know

986
00:29:35,669 --> 00:29:34,000
you've seen those

987
00:29:37,269 --> 00:29:35,679
those little internet memes where it's

988
00:29:38,630 --> 00:29:37,279

like you know what i think i do and what

989

00:29:40,389 --> 00:29:38,640

my parents think i do and what i

990

00:29:41,510 --> 00:29:40,399

actually do right so you know if you

991

00:29:42,950 --> 00:29:41,520

apply one of those there's one of those

992

00:29:44,389 --> 00:29:42,960

about working at nasa where it's like

993

00:29:45,909 --> 00:29:44,399

what i think i do and it's like you know

994

00:29:47,430 --> 00:29:45,919

you're in a spacesuit and

995

00:29:48,789 --> 00:29:47,440

what my parents think i do and you're

996

00:29:49,430 --> 00:29:48,799

like flying the millennium falcon or

997

00:29:51,029 --> 00:29:49,440

something and then

998

00:29:52,549 --> 00:29:51,039

what i actually do and it's a picture of

999

00:29:54,389 --> 00:29:52,559

people at a conference room and

1000

00:29:56,710 --> 00:29:54,399

you're having a meeting and you know

1001

00:29:59,669 --> 00:29:56,720

honestly it's a lot of meetings

1002

00:30:01,190 --> 00:29:59,679

but you know that said some of those

1003

00:30:03,110 --> 00:30:01,200

meetings are amazing right so

1004

00:30:04,789 --> 00:30:03,120

we'll be we'll be talking we'll be in

1005

00:30:06,230 --> 00:30:04,799

one meeting where we're talking about

1006

00:30:07,510 --> 00:30:06,240

okay how are we going to get these two

1007

00:30:08,070 --> 00:30:07,520

instruments on the europa clipper

1008

00:30:09,990 --> 00:30:08,080

spacecraft

1009

00:30:11,110 --> 00:30:10,000

to work together is there a conflict or

1010

00:30:13,110 --> 00:30:11,120

you know can they both take

1011

00:30:14,789 --> 00:30:13,120

observations at the same time and then

1012

00:30:16,389 --> 00:30:14,799

it'll be in another meeting where it's

1013

00:30:17,909 --> 00:30:16,399

you know we're talking about a future

1014

00:30:20,149 --> 00:30:17,919

you know a mission concept we're

1015

00:30:21,430 --> 00:30:20,159

like wow could we actually like drive

1016

00:30:21,990 --> 00:30:21,440

something around on the surface of

1017

00:30:23,590 --> 00:30:22,000

enceladus

1018

00:30:25,510 --> 00:30:23,600

or is the gravity too low so i'll be in

1019

00:30:26,950 --> 00:30:25,520

a meeting like that and then i'll be in

1020

00:30:29,029 --> 00:30:26,960

a meeting so i'm also the science

1021

00:30:30,789 --> 00:30:29,039

communications lead for europa clipper

1022

00:30:32,310 --> 00:30:30,799

so i'll be in a meeting where we're like

1023

00:30:34,310 --> 00:30:32,320

wow you know we're working on our new

1024

00:30:35,750 --> 00:30:34,320

graphic identifier design and you know

1025

00:30:36,230 --> 00:30:35,760

what should it look like and how are we

1026
00:30:38,710 --> 00:30:36,240
gonna get

1027
00:30:40,230 --> 00:30:38,720
get across the whole spirit of europa to

1028
00:30:41,830 --> 00:30:40,240
the general public

1029
00:30:43,350 --> 00:30:41,840
um and then i'll be in another meeting

1030
00:30:46,149 --> 00:30:43,360
where we're like okay

1031
00:30:47,029 --> 00:30:46,159
we're gonna plan a conference to talk

1032
00:30:49,190 --> 00:30:47,039
about

1033
00:30:51,269 --> 00:30:49,200
how we're gonna how we're gonna study

1034
00:30:52,870 --> 00:30:51,279
the surface of europa with instruments

1035
00:30:54,549 --> 00:30:52,880
that are on a landed spacecraft so

1036
00:30:56,310 --> 00:30:54,559
you know it's really it's a lot of these

1037
00:30:58,950 --> 00:30:56,320
working with different teams of people

1038
00:31:01,590 --> 00:30:58,960

in a very collaborative way

1039

00:31:03,110 --> 00:31:01,600

awesome uh that i mean it's so important

1040

00:31:03,509 --> 00:31:03,120

the science to know how to work in teams

1041

00:31:04,710 --> 00:31:03,519

i mean

1042

00:31:06,789 --> 00:31:04,720

that's a really important thing for us

1043

00:31:08,470 --> 00:31:06,799

all to remember uh our next question

1044

00:31:11,350 --> 00:31:08,480

comes from segon net uh

1045

00:31:12,549 --> 00:31:11,360

a user named omar a lady uh wants to

1046

00:31:14,549 --> 00:31:12,559

know for the landing

1047

00:31:15,909 --> 00:31:14,559

uh for for a lander mission if a landing

1048

00:31:17,430 --> 00:31:15,919

site has been chosen

1049

00:31:19,430 --> 00:31:17,440

and what reasons would be for choosing

1050

00:31:20,149 --> 00:31:19,440

that site um and i think it's pretty

1051
00:31:21,990 --> 00:31:20,159
important for

1052
00:31:23,830 --> 00:31:22,000
for uh him and for others to know you

1053
00:31:25,029 --> 00:31:23,840
know that the lander is still a concept

1054
00:31:26,630 --> 00:31:25,039
and the important thing you mentioned

1055
00:31:27,269 --> 00:31:26,640
earlier is that clipper is going there

1056
00:31:28,630 --> 00:31:27,279
first

1057
00:31:30,470 --> 00:31:28,640
so i wonder if you could speak about the

1058
00:31:31,990 --> 00:31:30,480
importance of using clipper to find a

1059
00:31:34,310 --> 00:31:32,000
landing site

1060
00:31:35,909 --> 00:31:34,320
yeah sure so i actually am and one of

1061
00:31:37,669 --> 00:31:35,919
the the co-chairs of what's called the

1062
00:31:39,830 --> 00:31:37,679
reconnaissance focus group

1063
00:31:41,750 --> 00:31:39,840

and so this is a group that that it's

1064

00:31:43,029 --> 00:31:41,760

sort of in between europa clipper

1065

00:31:45,029 --> 00:31:43,039

which is you know again it's like an

1066

00:31:46,310 --> 00:31:45,039

approved mission it's going and europa

1067

00:31:47,110 --> 00:31:46,320

lander which is still this mission

1068

00:31:49,509 --> 00:31:47,120

concept

1069

00:31:50,549 --> 00:31:49,519

so what we want to do is make sure that

1070

00:31:53,269 --> 00:31:50,559

europa clipper

1071

00:31:55,110 --> 00:31:53,279

takes the right data set so that a

1072

00:31:56,710 --> 00:31:55,120

future follow-up whether it's you know

1073

00:31:57,669 --> 00:31:56,720

the europa lander mission concept that

1074

00:32:00,070 --> 00:31:57,679

i've been working on

1075

00:32:01,110 --> 00:32:00,080

or some other mission it's going to need

1076

00:32:03,269 --> 00:32:01,120

to use the data

1077

00:32:04,389 --> 00:32:03,279

taken by europa clipper to find a

1078

00:32:06,389 --> 00:32:04,399

landing site

1079

00:32:07,590 --> 00:32:06,399

and so when you're looking for a landing

1080

00:32:09,509 --> 00:32:07,600

site in europa

1081

00:32:11,350 --> 00:32:09,519

there's sort of two categories of

1082

00:32:13,430 --> 00:32:11,360

information you need the first

1083

00:32:15,190 --> 00:32:13,440

is you want to find some place that's

1084

00:32:16,870 --> 00:32:15,200

scientifically interesting

1085

00:32:18,549 --> 00:32:16,880

right the last thing you want to do is

1086

00:32:19,830 --> 00:32:18,559

land in europa and you pick like this

1087

00:32:20,549 --> 00:32:19,840

place you're like oh it looks amazing

1088

00:32:22,310 --> 00:32:20,559

you land there

1089

00:32:23,509 --> 00:32:22,320

and all there is is ice there's nothing

1090

00:32:25,190 --> 00:32:23,519

else right that would be really

1091

00:32:26,470 --> 00:32:25,200

disappointing because we're going there

1092

00:32:27,990 --> 00:32:26,480

you know we know there's ice on your

1093

00:32:28,789 --> 00:32:28,000

upper right we don't need to go there to

1094

00:32:30,389 --> 00:32:28,799

know there's eyes

1095

00:32:32,389 --> 00:32:30,399

we want to look for the good stuff the

1096

00:32:32,950 --> 00:32:32,399

other stuff right other biosignatures

1097

00:32:35,190 --> 00:32:32,960

are there

1098

00:32:37,110 --> 00:32:35,200

interesting chemicals on the surface

1099

00:32:38,950 --> 00:32:37,120

right so you want to pick a place that's

1100

00:32:41,990 --> 00:32:38,960

scientifically interesting

1101

00:32:45,029 --> 00:32:42,000

but you also have to pick a place that's

1102

00:32:47,269 --> 00:32:45,039

safe engineering-wise to land on and so

1103

00:32:48,549 --> 00:32:47,279

this is always the the tension when

1104

00:32:49,909 --> 00:32:48,559

you're choosing a landing site

1105

00:32:51,509 --> 00:32:49,919

because the scientists are like oh if we

1106

00:32:52,950 --> 00:32:51,519

could only land halfway up that cliff

1107

00:32:54,549 --> 00:32:52,960

look there's this amazing thing there

1108

00:32:56,710 --> 00:32:54,559

and then the engineer's like no you're

1109

00:32:58,230 --> 00:32:56,720

landing on this completely flat plane i

1110

00:32:59,990 --> 00:32:58,240

don't care how boring it is this is

1111

00:33:01,830 --> 00:33:00,000

where we can put our spacecraft

1112

00:33:03,590 --> 00:33:01,840

and so this is what we're working on is

1113

00:33:04,389 --> 00:33:03,600

how can we make sure that europa clipper

1114

00:33:06,389 --> 00:33:04,399

collects

1115

00:33:08,470 --> 00:33:06,399

the right data sets all the information

1116

00:33:10,149 --> 00:33:08,480

we need not just from the cameras but

1117

00:33:12,149 --> 00:33:10,159

with all the other instruments so that

1118

00:33:14,789 --> 00:33:12,159

we can choose a place to land that's

1119

00:33:16,630 --> 00:33:14,799

scientifically interesting but is also

1120

00:33:18,950 --> 00:33:16,640

satisfies these engineering safety

1121

00:33:20,470 --> 00:33:18,960

criteria

1122

00:33:21,990 --> 00:33:20,480

yeah and so for people you know for

1123

00:33:23,430 --> 00:33:22,000

instance when we see you know mars and

1124

00:33:24,470 --> 00:33:23,440

we're landing there people see that big

1125

00:33:25,669 --> 00:33:24,480

ellipse where

1126
00:33:27,269 --> 00:33:25,679
we're landing inside and there's these

1127
00:33:27,990 --> 00:33:27,279
landing site selection committees that

1128
00:33:30,310 --> 00:33:28,000
go through

1129
00:33:31,669 --> 00:33:30,320
a huge process of finding the site and

1130
00:33:33,669 --> 00:33:31,679
and for me myself like i mentioned

1131
00:33:34,870 --> 00:33:33,679
i've done research relevant to analogues

1132
00:33:37,190 --> 00:33:34,880
for for

1133
00:33:38,789 --> 00:33:37,200
europa and the landing mission and so

1134
00:33:40,630 --> 00:33:38,799
i'm super excited about the potential

1135
00:33:41,990 --> 00:33:40,640
for finding that right landing site and

1136
00:33:42,870 --> 00:33:42,000
for all of us in the community working

1137
00:33:44,870 --> 00:33:42,880
together

1138
00:33:46,310 --> 00:33:44,880

um especially you know under the

1139

00:33:47,909 --> 00:33:46,320

leadership of the clipper team to make

1140

00:33:49,029 --> 00:33:47,919

that work the best way we could possibly

1141

00:33:51,830 --> 00:33:49,039

can

1142

00:33:52,389 --> 00:33:51,840

let's jump into the ocean of europa now

1143

00:33:55,430 --> 00:33:52,399

uh

1144

00:33:57,830 --> 00:33:55,440

user at malik minorinjin

1145

00:33:59,509 --> 00:33:57,840

on twitter has a couple of questions

1146

00:34:02,470 --> 00:33:59,519

together about the water

1147

00:34:03,909 --> 00:34:02,480

inside of europa so they say yes europa

1148

00:34:06,470 --> 00:34:03,919

is a significant moon

1149

00:34:07,110 --> 00:34:06,480

but is the water really drinkable and

1150

00:34:10,310 --> 00:34:07,120

could we make

1151
00:34:11,349 --> 00:34:10,320
oxygen from that water so those are

1152
00:34:15,030 --> 00:34:11,359
really good questions

1153
00:34:16,550 --> 00:34:15,040
um so we know that we know that there's

1154
00:34:18,629 --> 00:34:16,560
water in europa from

1155
00:34:20,230 --> 00:34:18,639
these gravity measurements and also

1156
00:34:22,230 --> 00:34:20,240
these magnetic field measurements that

1157
00:34:23,190 --> 00:34:22,240
were made by the galileo spacecraft so

1158
00:34:25,829 --> 00:34:23,200
back in the

1159
00:34:27,510 --> 00:34:25,839
in the 1990s um so we know that there's

1160
00:34:29,669 --> 00:34:27,520
this layer on europa

1161
00:34:30,710 --> 00:34:29,679
that has a solid layer at the surface

1162
00:34:33,349 --> 00:34:30,720
with a density of

1163
00:34:34,790 --> 00:34:33,359

of water ice and then below that is this

1164

00:34:38,069 --> 00:34:34,800

layer of liquid water

1165

00:34:39,990 --> 00:34:38,079

and unfortunately the the density of

1166

00:34:41,190 --> 00:34:40,000

solid ice and liquid water they're so

1167

00:34:43,109 --> 00:34:41,200

close to each other that

1168

00:34:44,310 --> 00:34:43,119

the galileo spacecraft couldn't

1169

00:34:46,149 --> 00:34:44,320

completely determine

1170

00:34:47,349 --> 00:34:46,159

how much is frozen ice and how much is

1171

00:34:49,109 --> 00:34:47,359

liquid water

1172

00:34:50,470 --> 00:34:49,119

but we were able to use the magnetic

1173

00:34:53,349 --> 00:34:50,480

field measurements

1174

00:34:55,349 --> 00:34:53,359

to determine that there's this weird

1175

00:34:56,389 --> 00:34:55,359

induced magnetic field signal coming

1176

00:34:58,150 --> 00:34:56,399

from europa

1177

00:35:00,710 --> 00:34:58,160

and you know if you go through all the

1178

00:35:03,589 --> 00:35:00,720

calculations you realize that really

1179

00:35:05,190 --> 00:35:03,599

a global layer of salt water would give

1180

00:35:07,270 --> 00:35:05,200

us that conducting signature

1181

00:35:08,470 --> 00:35:07,280

so that's how we know it's salty and it

1182

00:35:09,349 --> 00:35:08,480

turns out it doesn't even have to be

1183

00:35:11,670 --> 00:35:09,359

that salty

1184

00:35:14,630 --> 00:35:11,680

it's actually less salty probably than

1185

00:35:16,310 --> 00:35:14,640

the sea water the ocean water on earth

1186

00:35:17,910 --> 00:35:16,320

and so you know you probably wouldn't

1187

00:35:19,430 --> 00:35:17,920

want to drink ocean water like if you're

1188

00:35:20,950 --> 00:35:19,440

a human because we're you know

1189

00:35:23,190 --> 00:35:20,960

we're used to drinking fresh water on

1190

00:35:24,390 --> 00:35:23,200

the land but there's plenty of creatures

1191

00:35:26,310 --> 00:35:24,400

that live in our ocean that are

1192

00:35:27,670 --> 00:35:26,320

perfectly happy living in that kind of

1193

00:35:30,069 --> 00:35:27,680

salty water

1194

00:35:31,589 --> 00:35:30,079

um so so i would say that yeah you know

1195

00:35:32,790 --> 00:35:31,599

maybe you personally wouldn't want to

1196

00:35:34,069 --> 00:35:32,800

drink it maybe it's good to like gargle

1197

00:35:35,349 --> 00:35:34,079

with and clean out your throat with

1198

00:35:37,349 --> 00:35:35,359

right but you probably wouldn't want to

1199

00:35:39,349 --> 00:35:37,359

drink it but it's not going to kill you

1200

00:35:40,950 --> 00:35:39,359

um but if you're a fish you'd be totally

1201

00:35:44,310 --> 00:35:40,960

happy to live in it

1202

00:35:47,589 --> 00:35:44,320

um in terms of making oxygen um

1203

00:35:50,069 --> 00:35:47,599

yeah you know so that's a possibility um

1204

00:35:51,190 --> 00:35:50,079

but you know i mean you if you do have

1205

00:35:53,270 --> 00:35:51,200

water or ice

1206

00:35:55,349 --> 00:35:53,280

um you know it's possible to to you know

1207

00:35:56,950 --> 00:35:55,359

to modify it to use it to try to do you

1208

00:35:59,349 --> 00:35:56,960

know do electrolysis and get some

1209

00:36:00,790 --> 00:35:59,359

oxygens off of it

1210

00:36:03,030 --> 00:36:00,800

but there's you know there's no

1211

00:36:05,190 --> 00:36:03,040

atmosphere on europa and so

1212

00:36:07,109 --> 00:36:05,200

that would probably be something where

1213

00:36:08,150 --> 00:36:07,119

way way in the future if we had a base

1214

00:36:09,990 --> 00:36:08,160

on europa

1215

00:36:12,069 --> 00:36:10,000

um maybe we could use either some of the

1216

00:36:13,589 --> 00:36:12,079

ice or the water to make oxygen that we

1217

00:36:15,190 --> 00:36:13,599

could breathe

1218

00:36:16,630 --> 00:36:15,200

awesome yeah i mean it's an interesting

1219

00:36:18,870 --> 00:36:16,640

question right like will we ever send

1220

00:36:20,310 --> 00:36:18,880

humans to europa and have a little

1221

00:36:22,390 --> 00:36:20,320

colony or habitat or

1222

00:36:23,910 --> 00:36:22,400

or you know there was a europa report

1223

00:36:25,589 --> 00:36:23,920

movie that came out some years ago

1224

00:36:26,069 --> 00:36:25,599

showing humans exploring europa with

1225

00:36:28,870 --> 00:36:26,079

some

1226

00:36:30,470 --> 00:36:28,880

creatures right under the ice and our

1227

00:36:32,710 --> 00:36:30,480

next question actually comes

1228

00:36:34,150 --> 00:36:32,720

from tom caruso from facebook who wants

1229

00:36:35,829 --> 00:36:34,160

to know a bit about that environment

1230

00:36:36,950 --> 00:36:35,839

that could be possible just under the

1231

00:36:38,870 --> 00:36:36,960

ice

1232

00:36:39,990 --> 00:36:38,880

so tom wants to know about these

1233

00:36:41,910 --> 00:36:40,000

possible environments in

1234

00:36:43,829 --> 00:36:41,920

inner ocean worlds just under the ice

1235

00:36:45,829 --> 00:36:43,839

could it be a brine channel

1236

00:36:46,950 --> 00:36:45,839

brine rejection or injection into the

1237

00:36:48,390 --> 00:36:46,960

channel

1238

00:36:50,150 --> 00:36:48,400

and what kind of communication do you

1239

00:36:52,550 --> 00:36:50,160

think exists between the surface and the

1240

00:36:53,750 --> 00:36:52,560

subsurface oceans in these worlds

1241

00:36:55,750 --> 00:36:53,760

yeah those are really excellent

1242

00:36:58,390 --> 00:36:55,760

questions um so

1243

00:36:59,670 --> 00:36:58,400

when we think about life or when we

1244

00:37:01,589 --> 00:36:59,680

think about environments

1245

00:37:04,230 --> 00:37:01,599

in the in the in an ocean layer on an

1246

00:37:06,790 --> 00:37:04,240

icy world one of the reasons why

1247

00:37:07,990 --> 00:37:06,800

europa is really at the top of our list

1248

00:37:10,310 --> 00:37:08,000

of places to go look

1249

00:37:11,750 --> 00:37:10,320

for a habitable environment it's not

1250

00:37:13,190 --> 00:37:11,760

just that europa is awesome but you know

1251
00:37:14,950 --> 00:37:13,200
i mean i'll stipulate to it just being

1252
00:37:16,950 --> 00:37:14,960
intrinsically awesome right but there

1253
00:37:18,710 --> 00:37:16,960
are good scientific reasons right and so

1254
00:37:20,310 --> 00:37:18,720
one of those reasons is actually so you

1255
00:37:20,630 --> 00:37:20,320
have this ice layer at the surface you

1256
00:37:22,550 --> 00:37:20,640
have an

1257
00:37:23,670 --> 00:37:22,560
ocean layer under it but then under that

1258
00:37:26,790 --> 00:37:23,680
ocean layer is

1259
00:37:28,950 --> 00:37:26,800
rock right so the rocky core of europa

1260
00:37:30,950 --> 00:37:28,960
um just like at the bottom of earth's

1261
00:37:31,750 --> 00:37:30,960
oceans there's a rocky layer at the

1262
00:37:34,150 --> 00:37:31,760
bottom

1263
00:37:34,950 --> 00:37:34,160

and so the reason why that's important

1264

00:37:37,750 --> 00:37:34,960

is that

1265

00:37:39,670 --> 00:37:37,760

on the earth if you go to the sea floor

1266

00:37:40,230 --> 00:37:39,680

you find these hydrothermal systems that

1267

00:37:42,790 --> 00:37:40,240

are at the

1268

00:37:43,270 --> 00:37:42,800

at the base of the ocean where you know

1269

00:37:47,430 --> 00:37:43,280

you have

1270

00:37:49,589 --> 00:37:47,440

almost like you know little volcanoes

1271

00:37:51,270 --> 00:37:49,599

and you have circulation between the

1272

00:37:53,349 --> 00:37:51,280

ocean the water layer

1273

00:37:54,950 --> 00:37:53,359

it circulates into the rock it picks up

1274

00:37:55,910 --> 00:37:54,960

all sorts of interesting minerals and

1275

00:37:57,910 --> 00:37:55,920

nutrients

1276

00:38:00,150 --> 00:37:57,920

and you have whole ecosystems that

1277

00:38:03,270 --> 00:38:00,160

survive and thrive down there

1278

00:38:04,069 --> 00:38:03,280

largely independent from the sun so when

1279

00:38:06,630 --> 00:38:04,079

we're thinking about

1280

00:38:07,510 --> 00:38:06,640

places on europa that maybe could be

1281

00:38:09,349 --> 00:38:07,520

habitable

1282

00:38:10,790 --> 00:38:09,359

the bottom of the ocean is actually one

1283

00:38:12,550 --> 00:38:10,800

of them and then

1284

00:38:14,550 --> 00:38:12,560

the other one is sort of the top of the

1285

00:38:16,230 --> 00:38:14,560

ocean so so the the questioner was

1286

00:38:18,150 --> 00:38:16,240

asking about what's going on at that

1287

00:38:20,150 --> 00:38:18,160

the ice water interface so at the bottom

1288

00:38:22,150 --> 00:38:20,160

of the ice layer at the top of the ocean

1289

00:38:24,069 --> 00:38:22,160

um and so there yeah we think that we

1290

00:38:25,670 --> 00:38:24,079

see all these cracks on the surface

1291

00:38:27,190 --> 00:38:25,680

and so really one of the unanswered

1292

00:38:29,349 --> 00:38:27,200

questions is

1293

00:38:30,630 --> 00:38:29,359

can a crack that goes all the way from

1294

00:38:32,390 --> 00:38:30,640

the ocean layer make it

1295

00:38:34,150 --> 00:38:32,400

up close to the surface or you know

1296

00:38:36,390 --> 00:38:34,160

almost all the way to the surface

1297

00:38:39,030 --> 00:38:36,400

if that's it's hard to hold a crack open

1298

00:38:41,349 --> 00:38:39,040

through you know 10-15 kilometers of ice

1299

00:38:42,310 --> 00:38:41,359

right that's that's pretty deep um and

1300

00:38:44,150 --> 00:38:42,320

so

1301

00:38:46,310 --> 00:38:44,160

that's really a question could you get

1302

00:38:46,870 --> 00:38:46,320

some of the brine some of the the salty

1303

00:38:48,870 --> 00:38:46,880

water

1304

00:38:50,069 --> 00:38:48,880

could you get it up could you pressurize

1305

00:38:52,630 --> 00:38:50,079

it could you you know

1306

00:38:53,349 --> 00:38:52,640

have a thermal plume you know some

1307

00:38:56,470 --> 00:38:53,359

mechanism

1308

00:38:58,550 --> 00:38:56,480

to to help that liquid rise up you have

1309

00:38:58,870 --> 00:38:58,560

a buoyancy problem right so ice is weird

1310

00:39:02,630 --> 00:38:58,880

so

1311

00:39:04,310 --> 00:39:02,640

it's not like with a lava flow with

1312

00:39:05,910 --> 00:39:04,320

magma in a volcano where

1313

00:39:08,310 --> 00:39:05,920

you know you melt it it gets lighter and

1314

00:39:09,430 --> 00:39:08,320

it wants to come out on europa the water

1315

00:39:10,630 --> 00:39:09,440

doesn't want to come out it wants to

1316

00:39:12,230 --> 00:39:10,640

stay down in the ocean

1317

00:39:13,910 --> 00:39:12,240

and the ice wants to stay floating on

1318

00:39:15,510 --> 00:39:13,920

top so if you have any kind of

1319

00:39:17,270 --> 00:39:15,520

communication you have to think about

1320

00:39:18,870 --> 00:39:17,280

yeah is it pressurized are there

1321

00:39:20,710 --> 00:39:18,880

you know interesting volatiles that are

1322

00:39:21,910 --> 00:39:20,720

dissolved in the water like ammonia that

1323

00:39:23,670 --> 00:39:21,920

could help make it up

1324

00:39:25,750 --> 00:39:23,680

um so it's a really it's a good

1325

00:39:27,990 --> 00:39:25,760

unanswered question as to how

1326
00:39:30,310 --> 00:39:28,000
material from the ocean could get at or

1327
00:39:31,750 --> 00:39:30,320
near the surface of europa

1328
00:39:33,430 --> 00:39:31,760
that's a really good question too for

1329
00:39:34,310 --> 00:39:33,440
for leading into our next audience

1330
00:39:36,230 --> 00:39:34,320
question

1331
00:39:38,630 --> 00:39:36,240
um of what we're actually looking for

1332
00:39:41,349 --> 00:39:38,640
for potential evidences of life

1333
00:39:41,990 --> 00:39:41,359
for the astrobiology side of of using

1334
00:39:43,829 --> 00:39:42,000
clipper could

1335
00:39:45,990 --> 00:39:43,839
clipper actually detect something at the

1336
00:39:48,310 --> 00:39:46,000
surface that shows that communication

1337
00:39:49,990 --> 00:39:48,320
and even more so with a lander what

1338
00:39:51,430 --> 00:39:50,000

kinds of materials might have might

1339

00:39:52,790 --> 00:39:51,440

actually be near the surface for the

1340

00:39:55,349 --> 00:39:52,800

landing mission

1341

00:39:56,069 --> 00:39:55,359

for us to look at yeah those are really

1342

00:39:58,870 --> 00:39:56,079

great questions

1343

00:39:59,190 --> 00:39:58,880

um so with europa clipper so again we're

1344

00:40:01,670 --> 00:39:59,200

not

1345

00:40:02,470 --> 00:40:01,680

expecting to detect life with europa

1346

00:40:04,150 --> 00:40:02,480

clipper you know

1347

00:40:05,750 --> 00:40:04,160

i mean if a fish gets thrown out of the

1348

00:40:07,430 --> 00:40:05,760

surface and whacks into europa clipper

1349

00:40:08,630 --> 00:40:07,440

then okay we've found life right

1350

00:40:10,309 --> 00:40:08,640

you know no one's going to argue with

1351
00:40:11,430 --> 00:40:10,319
that but the chances of that are really

1352
00:40:12,710 --> 00:40:11,440
small right there's probably not going

1353
00:40:15,430 --> 00:40:12,720
to be any flying fish

1354
00:40:17,190 --> 00:40:15,440
so really with europa clipper we'll be

1355
00:40:18,470 --> 00:40:17,200
able to measure the composition of

1356
00:40:20,309 --> 00:40:18,480
particles that are thrown off the

1357
00:40:22,309 --> 00:40:20,319
surface so with

1358
00:40:23,589 --> 00:40:22,319
with a mass spectrometer and a dust

1359
00:40:25,589 --> 00:40:23,599
analyzer

1360
00:40:27,109 --> 00:40:25,599
if there are plumes we'll be able to fly

1361
00:40:28,150 --> 00:40:27,119
through them and measure the composition

1362
00:40:29,510 --> 00:40:28,160
of those plumes

1363
00:40:31,270 --> 00:40:29,520

but even if there aren't plumes there's

1364

00:40:32,870 --> 00:40:31,280

enough material just ejected off the

1365

00:40:33,670 --> 00:40:32,880

surface just you know single particles

1366

00:40:36,309 --> 00:40:33,680

of material

1367

00:40:37,990 --> 00:40:36,319

that we will be able to measure those um

1368

00:40:39,670 --> 00:40:38,000

but what europa clipper will also do

1369

00:40:41,589 --> 00:40:39,680

is it'll study the composition of the

1370

00:40:42,950 --> 00:40:41,599

surface using a there's a near-infrared

1371

00:40:44,470 --> 00:40:42,960

mapping spectrometer

1372

00:40:46,150 --> 00:40:44,480

that will be able to tell us you know

1373

00:40:48,630 --> 00:40:46,160

surface composition

1374

00:40:50,390 --> 00:40:48,640

there's a thermal mapper that will be

1375

00:40:52,390 --> 00:40:50,400

able to look for places maybe in the

1376

00:40:53,990 --> 00:40:52,400

near subsurface that are warmer and that

1377

00:40:57,190 --> 00:40:54,000

could be places maybe where

1378

00:40:58,790 --> 00:40:57,200

liquid is closer to the surface there's

1379

00:40:59,750 --> 00:40:58,800

this radar instrument that again it'll

1380

00:41:01,190 --> 00:40:59,760

help us to map

1381

00:41:02,950 --> 00:41:01,200

out the subsurface it'll be able to

1382

00:41:04,790 --> 00:41:02,960

sound through the ice layer

1383

00:41:06,710 --> 00:41:04,800

maybe to find these sort of melt pockets

1384

00:41:09,109 --> 00:41:06,720

or maybe even all the way through

1385

00:41:10,790 --> 00:41:09,119

awesome our next question comes from the

1386

00:41:13,349 --> 00:41:10,800

same user on sega net

1387

00:41:14,630 --> 00:41:13,359

uh prithai jaipal uh pritha wants to

1388

00:41:16,069 --> 00:41:14,640

know and you already discussed this a

1389

00:41:16,950 --> 00:41:16,079

bit uh you were talking about

1390

00:41:18,950 --> 00:41:16,960

the potential for things like

1391

00:41:20,309 --> 00:41:18,960

hydrothermal vents and how here on earth

1392

00:41:22,630 --> 00:41:20,319

they can be entirely

1393

00:41:24,390 --> 00:41:22,640

uh disconnected from the solar

1394

00:41:26,150 --> 00:41:24,400

environment from the sun's energy

1395

00:41:28,470 --> 00:41:26,160

uh and so preetha really wants to know

1396

00:41:30,150 --> 00:41:28,480

about uh since there is so little solar

1397

00:41:32,309 --> 00:41:30,160

energy reaching europa and if there is

1398

00:41:32,950 --> 00:41:32,319

life it most likely is down below such a

1399

00:41:35,750 --> 00:41:32,960

thick

1400

00:41:37,589 --> 00:41:35,760

uh crust of ice so maybe you just

1401

00:41:39,990 --> 00:41:37,599

hypothesize with us

1402

00:41:41,109 --> 00:41:40,000

what the the forms of energy might be

1403

00:41:43,670 --> 00:41:41,119

for a life

1404

00:41:44,470 --> 00:41:43,680

in the european ocean that's a really

1405

00:41:47,270 --> 00:41:44,480

good question

1406

00:41:49,990 --> 00:41:47,280

um so so yeah life on europa it's going

1407

00:41:52,390 --> 00:41:50,000

to have to be completely independent of

1408

00:41:53,109 --> 00:41:52,400

solar energy so if we look at life on

1409

00:41:56,710 --> 00:41:53,119

earth

1410

00:41:58,790 --> 00:41:56,720

close to the sun

1411

00:42:00,710 --> 00:41:58,800

the energy from the sun is such a huge

1412

00:42:02,390 --> 00:42:00,720

energy source that basically

1413

00:42:04,550 --> 00:42:02,400

life that takes advantage of solar

1414

00:42:05,990 --> 00:42:04,560

energy just it dominates over any other

1415

00:42:07,910 --> 00:42:06,000

kind of energy source

1416

00:42:10,069 --> 00:42:07,920

but out at europa we're five times

1417

00:42:11,990 --> 00:42:10,079

further away from the sun we're at 5au

1418

00:42:15,109 --> 00:42:12,000

instead of 1au here on earth so that

1419

00:42:17,270 --> 00:42:15,119

means there's 25 times less solar energy

1420

00:42:18,470 --> 00:42:17,280

um and so because of that you know the

1421

00:42:20,309 --> 00:42:18,480

sun i mean it looks kind of like a

1422

00:42:21,349 --> 00:42:20,319

bright star in the sky but it's not like

1423

00:42:23,190 --> 00:42:21,359

it is here on earth

1424

00:42:25,109 --> 00:42:23,200

so yeah life on europa is going to have

1425

00:42:26,870 --> 00:42:25,119

to use other energy sources

1426
00:42:28,710 --> 00:42:26,880
and so one of those potential energy

1427
00:42:30,950 --> 00:42:28,720
sources is chemical energy

1428
00:42:32,790 --> 00:42:30,960
and so this is where we we start

1429
00:42:33,670 --> 00:42:32,800
thinking about sort of those exchange

1430
00:42:36,150 --> 00:42:33,680
processes

1431
00:42:37,910 --> 00:42:36,160
so they there could be interesting stuff

1432
00:42:39,589 --> 00:42:37,920
going on at the bottom of the ocean so

1433
00:42:40,710 --> 00:42:39,599
if we have hydrothermal systems if we

1434
00:42:42,630 --> 00:42:40,720
have places where

1435
00:42:45,030 --> 00:42:42,640
the ocean water can circulate through

1436
00:42:46,470 --> 00:42:45,040
the crust and can pick up interesting

1437
00:42:48,150 --> 00:42:46,480
materials and then

1438
00:42:49,589 --> 00:42:48,160

then bring those dissolve those and

1439

00:42:51,190 --> 00:42:49,599

bring them into the ocean

1440

00:42:54,150 --> 00:42:51,200

that could serve as chemical energy

1441

00:42:55,750 --> 00:42:54,160

maybe for for an ecosystem

1442

00:42:57,589 --> 00:42:55,760

and then the other possibility is stuff

1443

00:43:01,030 --> 00:42:57,599

that comes in from the surface

1444

00:43:03,109 --> 00:43:01,040

so the surface of europa is bathed in

1445

00:43:04,550 --> 00:43:03,119

radiation high energy radiation that

1446

00:43:07,190 --> 00:43:04,560

comes from jupiter

1447

00:43:08,870 --> 00:43:07,200

and so the that you can create all of

1448

00:43:09,589 --> 00:43:08,880

these oxidants and organics at the

1449

00:43:11,990 --> 00:43:09,599

surface by

1450

00:43:13,910 --> 00:43:12,000

processing not just the ice but by

1451
00:43:15,430 --> 00:43:13,920
processing the other materials that have

1452
00:43:16,470 --> 00:43:15,440
you know kind of like drifted out onto

1453
00:43:18,790 --> 00:43:16,480
the surface like

1454
00:43:20,950 --> 00:43:18,800
sulfur that comes from io for example

1455
00:43:22,630 --> 00:43:20,960
like micrometeorites that come in

1456
00:43:24,390 --> 00:43:22,640
so you can create these interesting

1457
00:43:25,270 --> 00:43:24,400
oxidants and organics at the surface of

1458
00:43:27,190 --> 00:43:25,280
europa

1459
00:43:28,710 --> 00:43:27,200
and then if you have a way to mix them

1460
00:43:29,589 --> 00:43:28,720
from the surface all the way through the

1461
00:43:31,990 --> 00:43:29,599
ice layer

1462
00:43:32,870 --> 00:43:32,000
down into the ocean that can also serve

1463
00:43:35,349 --> 00:43:32,880

as as

1464

00:43:37,349 --> 00:43:35,359

fuel basically as food for a biosphere

1465

00:43:39,109 --> 00:43:37,359

that's that's living in the ocean

1466

00:43:40,390 --> 00:43:39,119

so yeah when we're thinking about life

1467

00:43:42,390 --> 00:43:40,400

on europa

1468

00:43:44,230 --> 00:43:42,400

it's very very unlikely that anything

1469

00:43:45,589 --> 00:43:44,240

could survive right at the surface just

1470

00:43:47,430 --> 00:43:45,599

because we're at you know there's no

1471

00:43:49,510 --> 00:43:47,440

atmosphere you're in a vacuum you're at

1472

00:43:51,670 --> 00:43:49,520

100 kelvin so it's really cold

1473

00:43:53,589 --> 00:43:51,680

and you're fried by radiation right so

1474

00:43:55,589 --> 00:43:53,599

it's not a good place to live

1475

00:43:57,349 --> 00:43:55,599

but fortunately ice is a pretty good

1476

00:43:58,870 --> 00:43:57,359

shield like it'll block out a lot of

1477

00:44:00,790 --> 00:43:58,880

that radiation so

1478

00:44:02,230 --> 00:44:00,800

you know once you get down even you know

1479

00:44:04,550 --> 00:44:02,240

a meter or so in the ice

1480

00:44:06,069 --> 00:44:04,560

it's a much safer place for life not to

1481

00:44:07,990 --> 00:44:06,079

get fried by radiation

1482

00:44:09,510 --> 00:44:08,000

but again we're probably unless there's

1483

00:44:11,270 --> 00:44:09,520

kind of pockets of water

1484

00:44:13,589 --> 00:44:11,280

closer to the surface we're probably

1485

00:44:15,510 --> 00:44:13,599

talking about life you know maybe at the

1486

00:44:16,710 --> 00:44:15,520

bottom of the ice layer or in the ocean

1487

00:44:17,990 --> 00:44:16,720

itself

1488

00:44:19,829 --> 00:44:18,000

yeah and that's important for people to

1489

00:44:21,349 --> 00:44:19,839

remember too is that this this life

1490

00:44:22,390 --> 00:44:21,359

could be very deep down there and well

1491

00:44:23,910 --> 00:44:22,400

protected i mean

1492

00:44:25,109 --> 00:44:23,920

we talk about sending humans out into

1493

00:44:26,950 --> 00:44:25,119

space and how we might mitigate

1494

00:44:27,349 --> 00:44:26,960

radiation and we talk about using water

1495

00:44:28,790 --> 00:44:27,359

and

1496

00:44:31,270 --> 00:44:28,800

other forms of shielding to help break

1497

00:44:33,109 --> 00:44:31,280

down that radiation so it won't harm us

1498

00:44:34,829 --> 00:44:33,119

um let's talk a bit about the surface of

1499

00:44:36,870 --> 00:44:34,839

europa then and that radiation

1500

00:44:37,990 --> 00:44:36,880

environment uh our next question comes

1501
00:44:40,550 --> 00:44:38,000
from garrett campion

1502
00:44:42,309 --> 00:44:40,560
uh on twitter garrett wants to know

1503
00:44:44,309 --> 00:44:42,319
about the color differences we've seen

1504
00:44:46,069 --> 00:44:44,319
in images of europa you see the

1505
00:44:47,750 --> 00:44:46,079
the linea they have these you know

1506
00:44:49,910 --> 00:44:47,760
really beautiful red colorations and a

1507
00:44:51,910 --> 00:44:49,920
lot of the images that were shown

1508
00:44:54,150 --> 00:44:51,920
does that coloration and the potential

1509
00:44:55,670 --> 00:44:54,160
source of these differences that cause

1510
00:44:58,710 --> 00:44:55,680
those colorations that we see

1511
00:45:00,790 --> 00:44:58,720
in images of the moon does that give us

1512
00:45:02,630 --> 00:45:00,800
prospects of finding bio signatures most

1513
00:45:05,510 --> 00:45:02,640

likely in the cracks

1514

00:45:07,190 --> 00:45:05,520

um it does actually so this is actually

1515

00:45:08,710 --> 00:45:07,200

a lot of the pictures you see of europa

1516

00:45:10,390 --> 00:45:08,720

especially the color ones they're ones

1517

00:45:11,990 --> 00:45:10,400

that i made personally actually so

1518

00:45:13,510 --> 00:45:12,000

that was one of my jobs back when i was

1519

00:45:15,829 --> 00:45:13,520

in grad school was

1520

00:45:16,870 --> 00:45:15,839

to make mosaics of the surface of images

1521

00:45:18,550 --> 00:45:16,880

as they came in

1522

00:45:20,390 --> 00:45:18,560

um and so i developed these techniques

1523

00:45:22,150 --> 00:45:20,400

to process the color data

1524

00:45:23,430 --> 00:45:22,160

into what we call these enhanced color

1525

00:45:25,030 --> 00:45:23,440

images so

1526

00:45:27,109 --> 00:45:25,040

first off most of the pictures you see

1527

00:45:27,829 --> 00:45:27,119

of europa unfortunately they're very

1528

00:45:29,990 --> 00:45:27,839

they're what we call

1529

00:45:30,950 --> 00:45:30,000

color enhanced right so that's a they're

1530

00:45:33,589 --> 00:45:30,960

very stretched

1531

00:45:35,589 --> 00:45:33,599

right so europa is not really anywhere

1532

00:45:37,030 --> 00:45:35,599

near as bright red and bright blue as

1533

00:45:38,710 --> 00:45:37,040

you see in those pictures

1534

00:45:41,430 --> 00:45:38,720

the surface is really kind of more like

1535

00:45:43,430 --> 00:45:41,440

a yellowish brownish kind of color

1536

00:45:44,870 --> 00:45:43,440

but the reason that we enhance them is

1537

00:45:46,069 --> 00:45:44,880

not just because they're beautiful which

1538

00:45:48,150 --> 00:45:46,079

you know i think they're pretty

1539

00:45:50,309 --> 00:45:48,160

but there you can also do science with

1540

00:45:51,190 --> 00:45:50,319

them and so basically the places on the

1541

00:45:53,829 --> 00:45:51,200

surface that have

1542

00:45:55,349 --> 00:45:53,839

more of like a whitish bluish color

1543

00:45:57,510 --> 00:45:55,359

those are the places that have more of a

1544

00:45:59,510 --> 00:45:57,520

pure water ice composition

1545

00:46:00,550 --> 00:45:59,520

the places that are more kind of reddish

1546

00:46:02,150 --> 00:46:00,560

and brownish

1547

00:46:04,550 --> 00:46:02,160

those are the areas that have a higher

1548

00:46:06,470 --> 00:46:04,560

concentration of non-ice materials

1549

00:46:07,829 --> 00:46:06,480

and so we're still debating based on the

1550

00:46:09,990 --> 00:46:07,839

galileo material

1551

00:46:11,270 --> 00:46:10,000

is this you know sulfuric acid is it

1552

00:46:12,950 --> 00:46:11,280

magnesium sulfate

1553

00:46:14,790 --> 00:46:12,960

like there's a variety of like highly

1554

00:46:15,589 --> 00:46:14,800

hydrated kind of salts and other

1555

00:46:17,349 --> 00:46:15,599

minerals

1556

00:46:19,190 --> 00:46:17,359

that could be responsible for this

1557

00:46:22,069 --> 00:46:19,200

coloration

1558

00:46:23,510 --> 00:46:22,079

but what we do see is that this reddish

1559

00:46:26,870 --> 00:46:23,520

brownish-yellowish stuff

1560

00:46:28,950 --> 00:46:26,880

it's associated with places where their

1561

00:46:30,230 --> 00:46:28,960

younger geologic features and their

1562

00:46:32,630 --> 00:46:30,240

features that we think

1563

00:46:34,390 --> 00:46:32,640

might be connected to bringing up

1564

00:46:36,710 --> 00:46:34,400

material from the subsurface

1565

00:46:38,870 --> 00:46:36,720

so yeah we see these reddish these long

1566

00:46:40,390 --> 00:46:38,880

linear features these giant cracks and

1567

00:46:42,069 --> 00:46:40,400

ridges that can go for thousands of

1568

00:46:44,069 --> 00:46:42,079

kilometers across the surface

1569

00:46:45,910 --> 00:46:44,079

those look kind of reddish and then we

1570

00:46:47,589 --> 00:46:45,920

see this disrupted what we call chaos

1571

00:46:48,950 --> 00:46:47,599

terrain that's where these icebergs have

1572

00:46:50,790 --> 00:46:48,960

broken up the surface

1573

00:46:52,470 --> 00:46:50,800

and those also generally look kind of

1574

00:46:54,790 --> 00:46:52,480

reddish and so

1575

00:46:56,230 --> 00:46:54,800

that tells us that there must be when

1576
00:46:58,309 --> 00:46:56,240
those features are formed and we don't

1577
00:47:00,230 --> 00:46:58,319
know for sure how they're formed yet

1578
00:47:02,069 --> 00:47:00,240
but we're pretty sure that those are

1579
00:47:02,550 --> 00:47:02,079
bringing up material that comes from

1580
00:47:06,710 --> 00:47:02,560
this

1581
00:47:07,750 --> 00:47:06,720
we're talking about places to look for

1582
00:47:09,510 --> 00:47:07,760
signs of life

1583
00:47:11,030 --> 00:47:09,520
since we think the life is in the ocean

1584
00:47:13,270 --> 00:47:11,040
we want to go to places

1585
00:47:14,550 --> 00:47:13,280
we want to study places that could have

1586
00:47:16,390 --> 00:47:14,560
brought ocean material

1587
00:47:17,990 --> 00:47:16,400
up to you know to the surface or close

1588
00:47:19,510 --> 00:47:18,000

to the surface

1589

00:47:21,589 --> 00:47:19,520

yeah and those cracks just seem so

1590

00:47:22,790 --> 00:47:21,599

appealing for astrobiologists just

1591

00:47:24,150 --> 00:47:22,800

looking at that and thinking about the

1592

00:47:25,910 --> 00:47:24,160

potential there

1593

00:47:27,829 --> 00:47:25,920

we do have a time for just a couple of

1594

00:47:29,109 --> 00:47:27,839

more questions i i do apologize to our

1595

00:47:31,430 --> 00:47:29,119

audience for those who've

1596

00:47:32,790 --> 00:47:31,440

asked so many questions as you know

1597

00:47:34,230 --> 00:47:32,800

within the half an hour that we have for

1598

00:47:35,109 --> 00:47:34,240

our q a it's always so hard to get to

1599

00:47:36,630 --> 00:47:35,119

all of them

1600

00:47:38,630 --> 00:47:36,640

but we do our best to try to get to your

1601
00:47:40,150 --> 00:47:38,640
questions if you do have more questions

1602
00:47:41,109 --> 00:47:40,160
for after the show that i can't get to

1603
00:47:42,630 --> 00:47:41,119
right now

1604
00:47:44,309 --> 00:47:42,640
feel free to reach out on twitter and

1605
00:47:45,109 --> 00:47:44,319
other places on social media send us

1606
00:47:47,910 --> 00:47:45,119
emails

1607
00:47:49,829 --> 00:47:47,920
um you know astrobiologists love talking

1608
00:47:51,270 --> 00:47:49,839
about all the things that we do

1609
00:47:53,990 --> 00:47:51,280
and so feel free to reach out and

1610
00:47:56,950 --> 00:47:54,000
connect um but we have two questions now

1611
00:47:58,390 --> 00:47:56,960
about the lander mission itself uh first

1612
00:47:59,349 --> 00:47:58,400
off marianne denton is watching on

1613
00:48:01,589 --> 00:47:59,359

facebook

1614

00:48:03,589 --> 00:48:01,599

and marianne wants to know what kinds of

1615

00:48:04,549 --> 00:48:03,599

planetary protection measures are being

1616

00:48:07,349 --> 00:48:04,559

considered

1617

00:48:07,750 --> 00:48:07,359

in the lander concept right now that's a

1618

00:48:09,190 --> 00:48:07,760

really

1619

00:48:10,630 --> 00:48:09,200

important question and it's something

1620

00:48:11,430 --> 00:48:10,640

we're definitely thinking about for the

1621

00:48:13,270 --> 00:48:11,440

lander

1622

00:48:14,790 --> 00:48:13,280

um because yeah the last thing we want

1623

00:48:17,349 --> 00:48:14,800

to do is land on the surface

1624

00:48:18,230 --> 00:48:17,359

and then destroy the life on europa in

1625

00:48:20,069 --> 00:48:18,240

the act of

1626
00:48:21,750 --> 00:48:20,079
looking for it right that's that's like

1627
00:48:23,750 --> 00:48:21,760
the worst possible case

1628
00:48:24,950 --> 00:48:23,760
and so yeah we take planetary protection

1629
00:48:27,589 --> 00:48:24,960
very seriously

1630
00:48:29,349 --> 00:48:27,599
um we would need to sterilize the

1631
00:48:31,349 --> 00:48:29,359
spacecraft like really clean it like

1632
00:48:33,829 --> 00:48:31,359
like we do with missions to mars

1633
00:48:36,390 --> 00:48:33,839
um where every inch of that spacecraft

1634
00:48:38,069 --> 00:48:36,400
is just scrubbed and cleaned and studied

1635
00:48:39,670 --> 00:48:38,079
so we want to get off make sure that

1636
00:48:41,589 --> 00:48:39,680
there aren't microbes from earth that

1637
00:48:43,510 --> 00:48:41,599
are hitching a ride

1638
00:48:44,790 --> 00:48:43,520

and then you also want to characterize

1639

00:48:46,630 --> 00:48:44,800

so you say okay

1640

00:48:48,069 --> 00:48:46,640

i'm going to clean this as well as i can

1641

00:48:49,910 --> 00:48:48,079

but i understand that i can't

1642

00:48:51,109 --> 00:48:49,920

clean every single nook and cranny of

1643

00:48:52,790 --> 00:48:51,119

the spacecraft so

1644

00:48:54,069 --> 00:48:52,800

in addition to cleaning it they also do

1645

00:48:54,870 --> 00:48:54,079

what's called like a biological

1646

00:48:56,790 --> 00:48:54,880

inventory

1647

00:48:58,150 --> 00:48:56,800

where they actually study the spacecraft

1648

00:49:00,470 --> 00:48:58,160

and they measure

1649

00:49:01,270 --> 00:49:00,480

all of the species that are on it and so

1650

00:49:03,430 --> 00:49:01,280

that way

1651
00:49:05,109 --> 00:49:03,440
so when say like a mars rover goes to

1652
00:49:07,430 --> 00:49:05,119
mars and if it

1653
00:49:09,430 --> 00:49:07,440
found something that looks like life

1654
00:49:11,030 --> 00:49:09,440
right they could compare it to

1655
00:49:12,309 --> 00:49:11,040
okay we know these are the contaminants

1656
00:49:12,790 --> 00:49:12,319
that were on the spacecraft to start

1657
00:49:15,109 --> 00:49:12,800
with

1658
00:49:17,109 --> 00:49:15,119
and oh look we just found e coli well

1659
00:49:18,790 --> 00:49:17,119
it's pretty unlikely that e coli evolved

1660
00:49:19,589 --> 00:49:18,800
independently on mars it probably just

1661
00:49:21,190 --> 00:49:19,599
hits the ride

1662
00:49:23,030 --> 00:49:21,200
right so having that sort of biological

1663
00:49:24,630 --> 00:49:23,040

inventory is another really important

1664

00:49:26,790 --> 00:49:24,640

part of planetary protection

1665

00:49:27,990 --> 00:49:26,800

so we would probably use those to use

1666

00:49:30,069 --> 00:49:28,000

some of those techniques

1667

00:49:31,829 --> 00:49:30,079

to land on europa um you'd have the

1668

00:49:33,270 --> 00:49:31,839

spacecraft in what's called like a bio

1669

00:49:35,270 --> 00:49:33,280

barrier probably where

1670

00:49:36,309 --> 00:49:35,280

it's sort of like sealed until it gets

1671

00:49:37,829 --> 00:49:36,319

close to europa

1672

00:49:39,589 --> 00:49:37,839

when you're in space obviously you don't

1673

00:49:40,870 --> 00:49:39,599

have to worry so much about it picking

1674

00:49:41,829 --> 00:49:40,880

up but you know microbes that are

1675

00:49:43,670 --> 00:49:41,839

hanging around

1676
00:49:45,270 --> 00:49:43,680
um so when you're in space it's pretty

1677
00:49:47,750 --> 00:49:45,280
safe um

1678
00:49:49,270 --> 00:49:47,760
you would probably say you'd clean it

1679
00:49:49,990 --> 00:49:49,280
fortunately on europa all of this

1680
00:49:51,430 --> 00:49:50,000
radiation

1681
00:49:53,750 --> 00:49:51,440
does help to sort of sterilize your

1682
00:49:56,069 --> 00:49:53,760
spacecraft so that can help as well

1683
00:49:57,990 --> 00:49:56,079
um and then a final thing we're looking

1684
00:49:59,910 --> 00:49:58,000
into is having what's called a

1685
00:50:01,190 --> 00:49:59,920
terminal sterilization system where you

1686
00:50:02,950 --> 00:50:01,200
basically like

1687
00:50:04,790 --> 00:50:02,960
you have you sort of like set off a mini

1688
00:50:06,390 --> 00:50:04,800

bomb inside of your your instrument

1689

00:50:08,069 --> 00:50:06,400

vault where all the instruments are

1690

00:50:09,750 --> 00:50:08,079

that that would be like a last-ditch

1691

00:50:10,549 --> 00:50:09,760

effort to basically like at the end of

1692

00:50:12,870 --> 00:50:10,559

your mission

1693

00:50:14,470 --> 00:50:12,880

you want to sterilize everything inside

1694

00:50:15,510 --> 00:50:14,480

just so there aren't any remnants lying

1695

00:50:16,790 --> 00:50:15,520

around

1696

00:50:18,710 --> 00:50:16,800

so so those are all things that we're

1697

00:50:19,670 --> 00:50:18,720

thinking of um for a land admission on

1698

00:50:21,109 --> 00:50:19,680

europa

1699

00:50:22,549 --> 00:50:21,119

that's awesome yeah and it's really

1700

00:50:22,950 --> 00:50:22,559

important for us to think about you know

1701

00:50:26,390 --> 00:50:22,960

and

1702

00:50:27,349 --> 00:50:26,400

told me before we started the show that

1703

00:50:29,270 --> 00:50:27,359

you actually have

1704

00:50:31,109 --> 00:50:29,280

an interesting anecdote about arthur c

1705

00:50:34,309 --> 00:50:31,119

clarke i think a lot of us who

1706

00:50:36,870 --> 00:50:34,319

are our 2001 space odyssey 2010 uh

1707

00:50:38,069 --> 00:50:36,880

fans of science fiction know this very

1708

00:50:39,430 --> 00:50:38,079

famous quote about

1709

00:50:41,270 --> 00:50:39,440

you know all of these worlds are yours

1710

00:50:41,829 --> 00:50:41,280

except for europa they're landing there

1711

00:50:43,109 --> 00:50:41,839

right

1712

00:50:44,390 --> 00:50:43,119

um i wonder if you could share that

1713

00:50:45,829 --> 00:50:44,400

story with our audience in the last

1714

00:50:48,150 --> 00:50:45,839

minute that we have here

1715

00:50:50,470 --> 00:50:48,160

sure so so that's whenever i talk about

1716

00:50:52,069 --> 00:50:50,480

landing on europa invariably someone

1717

00:50:53,510 --> 00:50:52,079

will post that quote or they'll post a

1718

00:50:55,510 --> 00:50:53,520

screenshot from the movie

1719

00:50:57,270 --> 00:50:55,520

it's embedded in kind of our cultural

1720

00:50:57,589 --> 00:50:57,280

consciousness that we have to be you

1721

00:50:59,430 --> 00:50:57,599

know

1722

00:51:02,150 --> 00:50:59,440

we have this we're forbidden to land on

1723

00:51:03,829 --> 00:51:02,160

europa and so back in the 1990s

1724

00:51:05,829 --> 00:51:03,839

during the galileo mission we had the

1725

00:51:06,870 --> 00:51:05,839

first europa ocean conference and these

1726

00:51:08,549 --> 00:51:06,880

were scientists

1727

00:51:09,910 --> 00:51:08,559

who were first starting to put together

1728

00:51:11,109 --> 00:51:09,920

all the clues that there could be an

1729

00:51:12,710 --> 00:51:11,119

ocean on europa

1730

00:51:14,390 --> 00:51:12,720

and so arthur c clarke actually

1731

00:51:16,069 --> 00:51:14,400

addressed the banquet at this conference

1732

00:51:16,549 --> 00:51:16,079

and i was there as you know a lowly grad

1733

00:51:18,150 --> 00:51:16,559

student

1734

00:51:20,230 --> 00:51:18,160

so i got to go to the banquet so arthur

1735

00:51:22,309 --> 00:51:20,240

c clarke addressed this banquet

1736

00:51:23,829 --> 00:51:22,319

via videophone and this is you know okay

1737

00:51:25,910 --> 00:51:23,839

it's the 1990s

1738

00:51:27,430 --> 00:51:25,920

having a video call from arthur c clark

1739

00:51:29,190 --> 00:51:27,440

in sri lanka it was a

1740

00:51:30,630 --> 00:51:29,200

big deal okay it's not like you know

1741

00:51:31,990 --> 00:51:30,640

today we take it for granted you can

1742

00:51:33,270 --> 00:51:32,000

hold up your phone and talk to someone

1743

00:51:35,270 --> 00:51:33,280

anywhere in the world but

1744

00:51:36,870 --> 00:51:35,280

back then it was like it was a really

1745

00:51:38,630 --> 00:51:36,880

big deal and you know he didn't travel

1746

00:51:40,309 --> 00:51:38,640

from sri lanka so basically he had this

1747

00:51:41,670 --> 00:51:40,319

whole satellite set up and so

1748

00:51:43,670 --> 00:51:41,680

you know so he addressed us at the

1749

00:51:45,349 --> 00:51:43,680

banquet and so you know he gave this

1750

00:51:47,109 --> 00:51:45,359

nice talk and i remember at the end of

1751

00:51:49,510 --> 00:51:47,119

it the the project scientist

1752

00:51:51,589 --> 00:51:49,520

on the on the galileo mission got up and

1753

00:51:53,750 --> 00:51:51,599

said you know sir arthur you know

1754

00:51:54,710 --> 00:51:53,760

in 2010 you said all these worlds are

1755

00:51:56,390 --> 00:51:54,720

yours except

1756

00:51:58,790 --> 00:51:56,400

you know except europa attempt no

1757

00:52:00,069 --> 00:51:58,800

landings there may we have permission to

1758

00:52:01,589 --> 00:52:00,079

explore europa

1759

00:52:03,109 --> 00:52:01,599

and arthur c clarke thought it was the

1760

00:52:05,990 --> 00:52:03,119

most hilarious thing

1761

00:52:07,750 --> 00:52:06,000

ever that nasa was asking him a science

1762

00:52:08,549 --> 00:52:07,760

fiction writer for permission to explore

1763

00:52:10,549 --> 00:52:08,559

europa

1764

00:52:12,069 --> 00:52:10,559

but he was very gracious and he granted

1765

00:52:13,750 --> 00:52:12,079

he said yes you know

1766

00:52:15,510 --> 00:52:13,760

don't worry about the prohibition you

1767

00:52:16,710 --> 00:52:15,520

have my permission and my blessing to

1768

00:52:19,349 --> 00:52:16,720

explore europa

1769

00:52:19,990 --> 00:52:19,359

so for anyone who's worried that you

1770

00:52:23,430 --> 00:52:20,000

know that

1771

00:52:25,109 --> 00:52:23,440

the aliens from the the 2001 2010

1772

00:52:27,270 --> 00:52:25,119

series are going to get angry at us for

1773

00:52:27,829 --> 00:52:27,280

exploring europa we're okay we have it

1774

00:52:30,390 --> 00:52:27,839

covered

1775

00:52:31,670 --> 00:52:30,400

we have permission i love that so much

1776

00:52:32,549 --> 00:52:31,680

we have we have arthur c clarke

1777

00:52:34,230 --> 00:52:32,559

permission

1778

00:52:35,910 --> 00:52:34,240

um so we are going to start wrapping our

1779

00:52:38,069 --> 00:52:35,920

episode uh right now

1780

00:52:40,390 --> 00:52:38,079

uh dr cynthia phillips thank you so much

1781

00:52:41,670 --> 00:52:40,400

for joining us for ask an astrobiologist

1782

00:52:43,510 --> 00:52:41,680

uh it's been great to have you on the

1783

00:52:44,230 --> 00:52:43,520

show oh it's been great to be here thank

1784

00:52:45,750 --> 00:52:44,240

you

1785

00:52:47,589 --> 00:52:45,760

and thanks to all everyone who has such

1786

00:52:49,670 --> 00:52:47,599

great questions this was really fun

1787

00:52:51,349 --> 00:52:49,680

yeah and as i said i mean we had so many

1788

00:52:52,790 --> 00:52:51,359

questions i do apologize to our audience

1789

00:52:53,510 --> 00:52:52,800

for some technical issues we had during

1790

00:52:54,870 --> 00:52:53,520

the show

1791

00:52:56,549 --> 00:52:54,880

uh during the live stream we'll try to

1792

00:52:57,589 --> 00:52:56,559

clean those up for the recorded version

1793

00:52:59,750 --> 00:52:57,599

for everyone

1794

00:53:00,870 --> 00:52:59,760

uh and yeah so many questions i can't

1795

00:53:03,109 --> 00:53:00,880

always get to

1796

00:53:04,069 --> 00:53:03,119

uh so so please you know reach out to us

1797

00:53:06,790 --> 00:53:04,079

in any way you can

1798

00:53:08,390 --> 00:53:06,800

online um and we're more than happy to

1799

00:53:10,069 --> 00:53:08,400

try to interact with whatever time we do

1800

00:53:11,990 --> 00:53:10,079

have available to us

1801
00:53:13,910 --> 00:53:12,000
um we do want to ask our viewers so we

1802
00:53:15,109 --> 00:53:13,920
talked about europa and icy worlds we

1803
00:53:16,470 --> 00:53:15,119
asked you on twitter through nasa

1804
00:53:19,109 --> 00:53:16,480
astrobiology

1805
00:53:22,150 --> 00:53:19,119
um about things like your favorite icy

1806
00:53:23,589 --> 00:53:22,160
world and to identify a feature on io

1807
00:53:25,349 --> 00:53:23,599
but we also talked about science fiction

1808
00:53:26,790 --> 00:53:25,359
a bit so what is your favorite science

1809
00:53:28,870 --> 00:53:26,800
fiction or art or

1810
00:53:30,230 --> 00:53:28,880
other media that inspires you to ask

1811
00:53:32,710 --> 00:53:30,240
questions about the nature

1812
00:53:33,270 --> 00:53:32,720
of life in the universe so feel free to

1813
00:53:36,470 --> 00:53:33,280

reach out

1814

00:53:39,589 --> 00:53:36,480

out to us at nasa astrobiology or

1815

00:53:41,190 --> 00:53:39,599

nasa astrobio at saganorg on twitter

1816

00:53:43,430 --> 00:53:41,200

and we're more than happy to engage with

1817

00:53:44,710 --> 00:53:43,440

you in conversations about this

1818

00:53:46,470 --> 00:53:44,720

and also if you want to know more about

1819

00:53:48,390 --> 00:53:46,480

the europa clipper mission um the

1820

00:53:51,510 --> 00:53:48,400

upcoming lander concept

1821

00:53:53,270 --> 00:53:51,520

go to europa.nasa.gov

1822

00:53:54,630 --> 00:53:53,280

and you can learn a whole bunch more

1823

00:53:57,270 --> 00:53:54,640

about all the things going on

1824

00:53:58,630 --> 00:53:57,280

at nasa with europa right now and if you

1825

00:54:00,230 --> 00:53:58,640

want to stay in the loop on upcoming

1826
00:54:02,790 --> 00:54:00,240
episodes of our show

1827
00:54:04,309 --> 00:54:02,800
or find out more about nasa astrobiology

1828
00:54:05,670 --> 00:54:04,319
about opportunities

1829
00:54:08,150 --> 00:54:05,680
for young students for instance in

1830
00:54:09,510 --> 00:54:08,160
astrobiology we're going to also pop up

1831
00:54:12,150 --> 00:54:09,520
a sign up link

1832
00:54:13,990 --> 00:54:12,160
uh for joining uh the the newsletter the

1833
00:54:15,430 --> 00:54:14,000
from nasa astrobiology

1834
00:54:16,710 --> 00:54:15,440
to get that in your email whenever there

1835
00:54:17,589 --> 00:54:16,720
are opportunities and other things

1836
00:54:19,750 --> 00:54:17,599
happening

1837
00:54:22,710 --> 00:54:19,760
uh and so on behalf of our team for mike

1838
00:54:24,390 --> 00:54:22,720

toyon miriam nassim sarah treadwell

1839

00:54:26,630 --> 00:54:24,400

on behalf of saginet and nasa

1840

00:54:28,470 --> 00:54:26,640

astrobiology and myself

1841

00:54:29,670 --> 00:54:28,480

thank you all for joining and remember

1842

00:54:38,170 --> 00:54:29,680

until next time to