Ask An Astrobiologist

Episode 37: November 24th, 2020

Dr. Melissa Trainer

NASA Astrobiology Program

1
00:00:00,680 --> 00:00:29,910
[Music]

2
00:00:34,110 --> 00:00:31,509
greetings my friends and

3
00:00:35,670 --> 00:00:34,120
fellow earthlings and welcome to ask an

4
00:00:37,670 --> 00:00:35,680
astrobiologist

5
00:00:39,910 --> 00:00:37,680
the show where we celebrate the science

6
00:00:41,670 --> 00:00:39,920
and celebrate the scientists

7
00:00:43,750 --> 00:00:41,680
involved in our quest to understand the

8
00:00:46,069 --> 00:00:43,760
nature of life in the cosmos

9
00:00:48,150 --> 00:00:46,079
i'm dr graham lau also known online as

10
00:00:48,869 --> 00:00:48,160
the cosmo biologist your host for the

11
00:00:50,229 --> 00:00:48,879
show

12
00:00:53,270 --> 00:00:50,239
and we're brought to you by nasa

13
00:00:55,189 --> 00:00:53,280

astrobiology and saginet.org

14
00:00:57,110 --> 00:00:55,199
and this is going to be the last episode

15
00:00:58,389 --> 00:00:57,120
for 2020 but i promise it's going to be

16
00:01:00,549 --> 00:00:58,399
really groovy

17
00:01:02,310 --> 00:01:00,559
i'm so excited we talking about titan

18
00:01:04,070 --> 00:01:02,320
about the upcoming dragonfly mission and

19
00:01:05,109 --> 00:01:04,080
a bunch of other stuff when we ask an

20
00:01:07,429 --> 00:01:05,119
astrobiologist

21
00:01:08,950 --> 00:01:07,439
all about that but first we have a few

22
00:01:11,910 --> 00:01:08,960
of our fun things to get through

23
00:01:13,030 --> 00:01:11,920
like our contest earlier in the week

24
00:01:15,350 --> 00:01:13,040
last week

25
00:01:17,109 --> 00:01:15,360
nasa astrobiology sent out a tweet

26
00:01:20,550 --> 00:01:17,119
asking who discovered

27
00:01:22,550 --> 00:01:20,560
that strange moon of saturn called titan

28
00:01:23,990 --> 00:01:22,560
and we had a whole lot of correct

29
00:01:25,749 --> 00:01:24,000
answers it's pretty easy to google

30
00:01:28,670 --> 00:01:25,759
search that i guess

31
00:01:30,710 --> 00:01:28,680
but our winner is john beal at

32
00:01:32,630 --> 00:01:30,720
darkwalker168 on twitter

33
00:01:35,429 --> 00:01:32,640
who not only said huygens which is

34
00:01:37,429 --> 00:01:35,439
correct but also said also can i go to

35
00:01:39,749 --> 00:01:37,439
titan too it's my favorite moon

36
00:01:40,630 --> 00:01:39,759
and it is a really cool moon uh for

37
00:01:42,230 --> 00:01:40,640
those uh

38
00:01:44,710 --> 00:01:42,240

history buffs out there you might know

39
00:01:45,670 --> 00:01:44,720
that titan is the sixth moon we

40
00:01:47,990 --> 00:01:45,680
discovered

41
00:01:48,950 --> 00:01:48,000
in the universe outside of our own moon

42
00:01:50,710 --> 00:01:48,960
which was one

43
00:01:52,310 --> 00:01:50,720
and then the four galilean satellites of

44
00:01:54,469 --> 00:01:52,320
jupiter that galileo found

45
00:01:57,109 --> 00:01:54,479
huygens was the next person to find a

46
00:02:00,149 --> 00:01:57,119
moon and at first titan was just called

47
00:02:01,749 --> 00:02:00,159
saturn moon uh saturni luna it was the

48
00:02:03,270 --> 00:02:01,759
only other moon that we knew of and so

49
00:02:03,749 --> 00:02:03,280
it was just saturn moon eventually we

50
00:02:06,149 --> 00:02:03,759
found

51
00:02:08,469 --> 00:02:06,159
many many many more and so we had to

52
00:02:10,389 --> 00:02:08,479
have a better name for it

53
00:02:12,390 --> 00:02:10,399
also as usual we love to point out the

54
00:02:15,670 --> 00:02:12,400
people who take the time

55
00:02:18,070 --> 00:02:15,680
to share about our show to share

56
00:02:19,990 --> 00:02:18,080
about our featured guests for the month

57
00:02:22,150 --> 00:02:20,000
to share information about the topic

58
00:02:23,270 --> 00:02:22,160
and just get involved in everything ask

59
00:02:25,190 --> 00:02:23,280
astro bio

60
00:02:27,430 --> 00:02:25,200
and so this month our ambassadors that

61
00:02:30,070 --> 00:02:27,440
we want to just give a huge shout out to

62
00:02:30,949 --> 00:02:30,080
our anna root mahanti at strayologist on

63
00:02:41,509 --> 00:02:30,959

twitter

64
00:02:42,309 --> 00:02:41,519
and then someone called t at tiramari

65
00:02:44,869 --> 00:02:42,319
underscore

66
00:02:46,790 --> 00:02:44,879
on twitter uh thank you all so much for

67
00:02:48,830 --> 00:02:46,800
sharing the show for getting involved

68
00:02:50,229 --> 00:02:48,840
and as always for asking an

69
00:02:51,910 --> 00:02:50,239
astrobiologist

70
00:02:54,630 --> 00:02:51,920
now i'm going to introduce our guests

71
00:02:56,630 --> 00:02:54,640
for this month uh dr melissa traynor is

72
00:02:57,830 --> 00:02:56,640
a research scientist at nasa's goddard

73
00:02:59,430 --> 00:02:57,840
space flight center

74
00:03:01,270 --> 00:02:59,440
and she's also the deputy principal

75
00:03:02,550 --> 00:03:01,280
investigator for the upcoming dragonfly

76
00:03:04,869 --> 00:03:02,560
mission to titan

77
00:03:06,869 --> 00:03:04,879
uh so dr traynor uh hello and welcome to

78
00:03:09,190 --> 00:03:06,879
ask an astrobiologist

79
00:03:10,550 --> 00:03:09,200
hi really happy to be here yeah it's so

80
00:03:12,550 --> 00:03:10,560
great to have you on

81
00:03:14,630 --> 00:03:12,560
uh i'm really excited just to nerd out

82
00:03:16,949 --> 00:03:14,640
over titan and dragonfly

83
00:03:18,869 --> 00:03:16,959
a little bit uh and learn more about

84
00:03:19,350 --> 00:03:18,879
this mission what your role is with the

85
00:03:20,790 --> 00:03:19,360
mission

86
00:03:22,790 --> 00:03:20,800
and and the science that we're going to

87
00:03:24,550 --> 00:03:22,800
learn from it uh i do want to remind the

88
00:03:27,509 --> 00:03:24,560

audience to ask your questions

89
00:03:29,750 --> 00:03:27,519
uh in the chat at saginet.org or on the

90
00:03:31,030 --> 00:03:29,760
nasa astrobiology facebook page

91
00:03:32,630 --> 00:03:31,040
we'll get those into the queue then for

92
00:03:34,550 --> 00:03:32,640
dr traynor after she and i have a small

93
00:03:36,630 --> 00:03:34,560
conversation here first

94
00:03:37,589 --> 00:03:36,640
uh and dr traynor i always love with our

95
00:03:39,190 --> 00:03:37,599
guests

96
00:03:41,670 --> 00:03:39,200
since a lot of our audience are

97
00:03:43,830 --> 00:03:41,680
undergraduate maybe high school students

98
00:03:45,990 --> 00:03:43,840
maybe recent graduates they want to know

99
00:03:47,509 --> 00:03:46,000
how to become astrobiologists what you

100
00:03:49,110 --> 00:03:47,519
know what our pathways are to get to

101
00:03:50,630 --> 00:03:49,120
where we are in our careers

102
00:03:52,869 --> 00:03:50,640
and so i'm wondering if you can share

103
00:03:55,270 --> 00:03:52,879
with us maybe your science story

104
00:03:56,309 --> 00:03:55,280
you know your superhero science origin

105
00:03:57,830 --> 00:03:56,319
story for

106
00:04:00,229 --> 00:03:57,840
for what really brought you to where you

107
00:04:03,589 --> 00:04:00,239
are currently in your career sure

108
00:04:05,750 --> 00:04:03,599
happy too um so i

109
00:04:07,190 --> 00:04:05,760
it wasn't a plan i should say i wasn't

110
00:04:08,550 --> 00:04:07,200
one of those kids who said i'm gonna

111
00:04:12,149 --> 00:04:08,560
work at nasa someday

112
00:04:15,509 --> 00:04:12,159
um i always love nasa and love planets

113
00:04:18,150 --> 00:04:15,519

um but probably like a lot of

114
00:04:19,909 --> 00:04:18,160
uh young people maybe especially in the

115
00:04:22,069 --> 00:04:19,919
80s i was mostly only aware of

116
00:04:23,909 --> 00:04:22,079
astronauts and the space shuttle program

117
00:04:25,270 --> 00:04:23,919
uh and that probably made the biggest

118
00:04:28,469 --> 00:04:25,280
impact um

119
00:04:30,310 --> 00:04:28,479
on me when i was a kid and but i always

120
00:04:33,510 --> 00:04:30,320
love math and i love science

121
00:04:35,749 --> 00:04:33,520
and so i followed those interests uh

122
00:04:36,550 --> 00:04:35,759
for example through college i majored in

123
00:04:38,310 --> 00:04:36,560
chemistry

124
00:04:39,909 --> 00:04:38,320
partly because i also loved being in the

125
00:04:43,030 --> 00:04:39,919
laboratory and i loved like

126
00:04:43,830 --> 00:04:43,040
mixing things up and so as beautiful as

127
00:04:45,670 --> 00:04:43,840
the night sky

128
00:04:46,870 --> 00:04:45,680
is i was really a lot more drawn to

129
00:04:49,189 --> 00:04:46,880
hands-on

130
00:04:52,150 --> 00:04:49,199
laboratory work than necessarily um

131
00:04:55,270 --> 00:04:52,160
observational astronomy for example

132
00:04:55,749 --> 00:04:55,280
so i was graduating chemistry i knew i

133
00:04:57,590 --> 00:04:55,759
didn't

134
00:04:59,350 --> 00:04:57,600
want to get a job yet i knew i wanted to

135
00:05:01,909 --> 00:04:59,360
keep going to school

136
00:05:02,469 --> 00:05:01,919
and so i started trying to figure out

137
00:05:05,270 --> 00:05:02,479
what

138
00:05:05,670 --> 00:05:05,280

kind of research really um interested me

139
00:05:09,430 --> 00:05:05,680
and

140
00:05:13,189 --> 00:05:09,440
graduate school

141
00:05:15,270 --> 00:05:13,199
and i ended up uh really drawn to

142
00:05:16,469 --> 00:05:15,280
the study of atmosphere and atmospheric

143
00:05:18,469 --> 00:05:16,479
chemistry

144
00:05:19,830 --> 00:05:18,479
but more so for earth right that was my

145
00:05:21,670 --> 00:05:19,840
my original thought i had these like

146
00:05:23,110 --> 00:05:21,680
visions on like climb mountains and

147
00:05:24,629 --> 00:05:23,120
measure ozone and

148
00:05:27,350 --> 00:05:24,639
do all those kinds of those kind of

149
00:05:29,670 --> 00:05:27,360
measurements um and so that brought me

150
00:05:32,550 --> 00:05:29,680
to the grad program i went to which is

151
00:05:35,189 --> 00:05:32,560
at the university of colorado boulder

152
00:05:38,550 --> 00:05:35,199
but when i started looking for projects

153
00:05:40,629 --> 00:05:38,560
and and people i wanted to work with the

154
00:05:42,070 --> 00:05:40,639
professor and the group i was most drawn

155
00:05:45,110 --> 00:05:42,080
to the

156
00:05:46,469 --> 00:05:45,120
available project um that also really

157
00:05:48,070 --> 00:05:46,479
suited i thought my

158
00:05:49,590 --> 00:05:48,080
my interests and my strengths was

159
00:05:51,430 --> 00:05:49,600
studying the

160
00:05:53,430 --> 00:05:51,440
chemistry not of the earth's atmosphere

161
00:05:55,670 --> 00:05:53,440
but of titan's atmosphere

162
00:05:58,309 --> 00:05:55,680
so sort of a little bit of a just

163
00:06:00,150 --> 00:05:58,319

grabbing an opportunity that i had

164
00:06:01,990 --> 00:06:00,160
to do something i hadn't necessarily

165
00:06:04,870 --> 00:06:02,000
planned on but still found

166
00:06:05,749 --> 00:06:04,880
found really interesting and that's sort

167
00:06:07,350 --> 00:06:05,759
of the theme

168
00:06:09,990 --> 00:06:07,360
when i think about how i got to where i

169
00:06:12,950 --> 00:06:10,000
am today that's sort of the theme

170
00:06:13,510 --> 00:06:12,960
um so i did all my graduate thesis work

171
00:06:15,029 --> 00:06:13,520
studying

172
00:06:17,189 --> 00:06:15,039
titan as well as the early earth and

173
00:06:19,270 --> 00:06:17,199
kind of the connections in

174
00:06:21,189 --> 00:06:19,280
atmospheric synthesis and the role that

175
00:06:21,990 --> 00:06:21,199
might play in distributing complex

176
00:06:24,469 --> 00:06:22,000
organics

177
00:06:25,189 --> 00:06:24,479
kind of all around a planetary system

178
00:06:27,670 --> 00:06:25,199
and

179
00:06:29,350 --> 00:06:27,680
i did a little postdoc work studying uh

180
00:06:31,270 --> 00:06:29,360
mars polar caps

181
00:06:33,430 --> 00:06:31,280
and um that was right around the time

182
00:06:34,629 --> 00:06:33,440
that methane observations of mars were

183
00:06:36,230 --> 00:06:34,639
just starting and there was a lot of

184
00:06:38,309 --> 00:06:36,240
interest in that so

185
00:06:39,830 --> 00:06:38,319
uh again just tried to do some lab work

186
00:06:41,990 --> 00:06:39,840
um thinking through what are some

187
00:06:43,510 --> 00:06:42,000
possible mechanisms of trapping and

188
00:06:45,430 --> 00:06:43,520

re-releasing methane

189
00:06:47,430 --> 00:06:45,440
um the spoiler alert is we didn't find

190
00:06:48,070 --> 00:06:47,440
any i didn't find any in that particular

191
00:06:49,830 --> 00:06:48,080
project

192
00:06:51,589 --> 00:06:49,840
but sometimes a null result is still

193
00:06:55,029 --> 00:06:51,599
really really valuable

194
00:06:56,390 --> 00:06:55,039
um and then um i was

195
00:06:57,589 --> 00:06:56,400
we're kind of ready for the next step

196
00:06:58,550 --> 00:06:57,599
and trying to figure out what i was

197
00:07:01,110 --> 00:06:58,560
gonna do and

198
00:07:02,790 --> 00:07:01,120
and i think i had sort of always assumed

199
00:07:05,110 --> 00:07:02,800
i would um

200
00:07:07,110 --> 00:07:05,120
you know go into academia and and try to

201
00:07:10,230 --> 00:07:07,120
get a professorship

202
00:07:12,550 --> 00:07:10,240
but uh again like sort of out of

203
00:07:13,589 --> 00:07:12,560
cycle from that before i could even do

204
00:07:15,749 --> 00:07:13,599
all that work

205
00:07:17,430 --> 00:07:15,759
this job opportunity at goddard popped

206
00:07:20,550 --> 00:07:17,440
up and

207
00:07:22,710 --> 00:07:20,560
i ended up meeting with the people who

208
00:07:23,510 --> 00:07:22,720
were hiring coming out to visit giving a

209
00:07:25,670 --> 00:07:23,520
seminar

210
00:07:26,950 --> 00:07:25,680
and it was yet another one of those this

211
00:07:29,029 --> 00:07:26,960
is not necessarily

212
00:07:30,469 --> 00:07:29,039
the thing i plan to do but this is

213
00:07:31,670 --> 00:07:30,479

really exciting and this is really

214
00:07:32,390 --> 00:07:31,680
interesting so i'm going to give it a

215
00:07:36,309 --> 00:07:32,400
try

216
00:07:38,230 --> 00:07:36,319
and uh and see how it goes and um

217
00:07:40,469 --> 00:07:38,240
that is how i got to goddard and then

218
00:07:41,909 --> 00:07:40,479
the group i joined is one that is very

219
00:07:43,029 --> 00:07:41,919
involved in missions and in building

220
00:07:45,510 --> 00:07:43,039
instrumentation

221
00:07:47,110 --> 00:07:45,520
permissions such as the sam instrument

222
00:07:49,909 --> 00:07:47,120
on curiosity

223
00:07:50,309 --> 00:07:49,919
and through working in that group and

224
00:07:51,990 --> 00:07:50,319
and

225
00:07:53,670 --> 00:07:52,000
working at an institution especially

226
00:07:56,150 --> 00:07:53,680
that's

227
00:07:57,589 --> 00:07:56,160
really based in mission work i'm

228
00:08:00,550 --> 00:07:57,599
proposing

229
00:08:01,670 --> 00:08:00,560
and executing planetary missions is sort

230
00:08:04,950 --> 00:08:01,680
of what led me kind of

231
00:08:06,950 --> 00:08:04,960
in the business and and set me up to

232
00:08:08,150 --> 00:08:06,960
to be part of the dragonfly team oh

233
00:08:09,830 --> 00:08:08,160
that's wonderful

234
00:08:11,110 --> 00:08:09,840
uh i'm super jealous it sounds you've

235
00:08:12,309 --> 00:08:11,120
had your hands on so many different

236
00:08:14,070 --> 00:08:12,319
awesome missions

237
00:08:15,430 --> 00:08:14,080
and concepts as well including the titan

238
00:08:17,029 --> 00:08:15,440

mario explorer and

239
00:08:18,550 --> 00:08:17,039
um all these things are kind of coming

240
00:08:19,350 --> 00:08:18,560
up to this culmination of exploring

241
00:08:21,110 --> 00:08:19,360
titan

242
00:08:23,589 --> 00:08:21,120
uh one really cool thing i learned from

243
00:08:25,990 --> 00:08:23,599
you in preparation for this episode

244
00:08:27,350 --> 00:08:26,000
uh was actually going to lead into our

245
00:08:28,710 --> 00:08:27,360
current field site challenge we just

246
00:08:31,029 --> 00:08:28,720
released yesterday

247
00:08:32,870 --> 00:08:31,039
uh on twitter we asked people to guess

248
00:08:35,509 --> 00:08:32,880
the location of a certain picture

249
00:08:36,790 --> 00:08:35,519
relevant to the exploration of titan uh

250
00:08:40,310 --> 00:08:36,800
and that picture was an

251
00:08:42,709 --> 00:08:40,320
image of linear dunes in the namib cnc

252
00:08:44,230 --> 00:08:42,719
uh in namibia and i can't help but hear

253
00:08:44,949 --> 00:08:44,240
david attenborough's voice going the

254
00:08:46,389 --> 00:08:44,959
namib

255
00:08:47,750 --> 00:08:46,399
you know the way that he would say it so

256
00:08:49,269 --> 00:08:47,760
poetically and beautifully when we talk

257
00:08:51,590 --> 00:08:49,279
about in the mid

258
00:08:57,910 --> 00:08:51,600
our winners for that contest are lloyd

259
00:09:01,269 --> 00:08:59,430
so thanks thank you to all of you who

260
00:09:04,230 --> 00:09:01,279
competed in that challenge as well

261
00:09:05,509 --> 00:09:04,240
and realized this was namibia um i

262
00:09:07,190 --> 00:09:05,519
wonder if you can speak to that why

263
00:09:10,949 --> 00:09:07,200

namibia is so important for

264
00:09:13,990 --> 00:09:10,959
our explorations of titan sure so

265
00:09:17,030 --> 00:09:14,000
one of the features of titan

266
00:09:18,150 --> 00:09:17,040
that is really fascinating and

267
00:09:20,710 --> 00:09:18,160
compelling to think about

268
00:09:21,590 --> 00:09:20,720
has become is part of our target when we

269
00:09:24,630 --> 00:09:21,600
go

270
00:09:29,990 --> 00:09:24,640
fields

271
00:09:31,590 --> 00:09:30,000
are present and sort of wrap around the

272
00:09:33,670 --> 00:09:31,600
moon they're really

273
00:09:34,710 --> 00:09:33,680
noticeable from the images that we have

274
00:09:38,150 --> 00:09:34,720
of the surface

275
00:09:40,230 --> 00:09:38,160
from cassini and the

276
00:09:41,910 --> 00:09:40,240
formation and the processes that that

277
00:09:43,110 --> 00:09:41,920
lead to those dune fields and kind of

278
00:09:45,750 --> 00:09:43,120
the shaping

279
00:09:47,030 --> 00:09:45,760
um and the spacing with these wide inter

280
00:09:48,470 --> 00:09:47,040
dune flats where

281
00:09:50,949 --> 00:09:48,480
where we think you have access to the

282
00:09:51,910 --> 00:09:50,959
the bedrock uh which on titan would be

283
00:09:54,310 --> 00:09:51,920
water ice

284
00:09:55,910 --> 00:09:54,320
um as well as then and then the sort of

285
00:09:58,790 --> 00:09:55,920
pile up of doom particles

286
00:10:00,070 --> 00:09:58,800
the way those are formed uh we said it

287
00:10:02,389 --> 00:10:00,080
would be very similar

288
00:10:03,430 --> 00:10:02,399

to how the doing some of the gene fields

289
00:10:06,949 --> 00:10:03,440
on earth form and so

290
00:10:10,150 --> 00:10:06,959
that image that you showed and that um

291
00:10:13,110 --> 00:10:10,160
namibia sam see is an analog

292
00:10:14,389 --> 00:10:13,120
uh for that that region on titan but

293
00:10:16,630 --> 00:10:14,399
what's so cool about

294
00:10:17,990 --> 00:10:16,640
titan is that it's totally different

295
00:10:19,190 --> 00:10:18,000
materials i sort of hinted at that

296
00:10:21,269 --> 00:10:19,200
already right instead of

297
00:10:23,190 --> 00:10:21,279
having your exposed bedrock be some kind

298
00:10:25,829 --> 00:10:23,200
of you know silicate-based rock

299
00:10:26,550 --> 00:10:25,839
uh it's water ice which is the crust of

300
00:10:29,350 --> 00:10:26,560
titan

301
00:10:31,829 --> 00:10:29,360
and the dune particles that are piled up

302
00:10:33,670 --> 00:10:31,839
are expected to be made up of organic

303
00:10:36,710 --> 00:10:33,680
carbon organic molecules

304
00:10:37,269 --> 00:10:36,720
uh and exactly how those particles form

305
00:10:39,670 --> 00:10:37,279
or not

306
00:10:41,190 --> 00:10:39,680
we're not entirely sure um but that's

307
00:10:42,550 --> 00:10:41,200
part of what we we want to learn more

308
00:10:44,389 --> 00:10:42,560
about

309
00:10:45,990 --> 00:10:44,399
that's great and that leads me then to

310
00:10:47,990 --> 00:10:46,000
to dragonfly and learning more about

311
00:10:49,269 --> 00:10:48,000
it uh so i mentioned earlier titan was

312
00:10:50,790 --> 00:10:49,279
the first moon of saturn we found that

313
00:10:53,590 --> 00:10:50,800

we now know of lots more

314
00:10:53,910 --> 00:10:53,600
uh titan's surface is very cold it's

315
00:10:56,790 --> 00:10:53,920
like

316
00:10:57,269 --> 00:10:56,800
20 kelvin warmer than liquid nitrogen so

317
00:11:00,470 --> 00:10:57,279
it's

318
00:11:01,829 --> 00:11:00,480
methodological cycle

319
00:11:03,430 --> 00:11:01,839
instead of a hydrological cycle and

320
00:11:03,750 --> 00:11:03,440
there's methane going to the atmosphere

321
00:11:08,470 --> 00:11:03,760
and

322
00:11:09,990 --> 00:11:08,480
there's like this raining gunk coming

323
00:11:10,949 --> 00:11:10,000
down to the surface of titan which is

324
00:11:12,630 --> 00:11:10,959
very cool

325
00:11:14,310 --> 00:11:12,640
uh i wonder if you could then sit up for

326
00:11:15,350 --> 00:11:14,320
us maybe the brief history of

327
00:11:17,590 --> 00:11:15,360
exploration

328
00:11:18,790 --> 00:11:17,600
of titan i know we had one mission land

329
00:11:20,710 --> 00:11:18,800
on titan

330
00:11:21,990 --> 00:11:20,720
and what really leads us now to want to

331
00:11:24,710 --> 00:11:22,000
send dragonfly there

332
00:11:27,030 --> 00:11:24,720
i've heard this question a lot why are

333
00:11:29,430 --> 00:11:27,040
we sending dragonfly to titan

334
00:11:31,590 --> 00:11:29,440
sure sure so you've talked a little bit

335
00:11:33,350 --> 00:11:31,600
about the original discovery of the moon

336
00:11:34,790 --> 00:11:33,360
um you know just looking from earth

337
00:11:36,710 --> 00:11:34,800
through telescopes and

338
00:11:38,230 --> 00:11:36,720

and that's probably just because it's

339
00:11:40,230 --> 00:11:38,240
it's large

340
00:11:43,350 --> 00:11:40,240
right so it was one of the earlier moons

341
00:11:46,470 --> 00:11:43,360
that was was able to be observed

342
00:11:48,710 --> 00:11:46,480
and there were studies from again from

343
00:11:49,590 --> 00:11:48,720
more advanced um studies earlier last

344
00:11:52,389 --> 00:11:49,600
century

345
00:11:53,590 --> 00:11:52,399
we're using telescopes uh that led to

346
00:11:56,069 --> 00:11:53,600
the discovery

347
00:11:57,590 --> 00:11:56,079
that titan has an atmosphere and in

348
00:11:59,670 --> 00:11:57,600
particular that there's there's methane

349
00:12:01,350 --> 00:11:59,680
in the atmosphere and so that sort of

350
00:12:03,350 --> 00:12:01,360
already kind of pulls titan out as

351
00:12:06,629 --> 00:12:03,360
unique among all the other moons

352
00:12:10,870 --> 00:12:06,639
in that it has a substantial atmosphere

353
00:12:13,110 --> 00:12:10,880
at all and then with flybys from

354
00:12:15,430 --> 00:12:13,120
uh you know for example voyager we got

355
00:12:17,829 --> 00:12:15,440
some some really good images

356
00:12:18,949 --> 00:12:17,839
of what titan looks like kind of from

357
00:12:20,790 --> 00:12:18,959
the outside

358
00:12:23,269 --> 00:12:20,800
in the visible it's like this hazy

359
00:12:25,670 --> 00:12:23,279
orange bowl ball it looks kind of like

360
00:12:26,550 --> 00:12:25,680
like a marble or like this this fuzzy

361
00:12:28,870 --> 00:12:26,560
ball

362
00:12:29,910 --> 00:12:28,880
um but spectroscopy we see that's

363
00:12:31,350 --> 00:12:29,920

related to

364
00:12:33,190 --> 00:12:31,360
the as you said the methane in the

365
00:12:35,269 --> 00:12:33,200
atmosphere but uh

366
00:12:37,269 --> 00:12:35,279
energy coming into the atmosphere and

367
00:12:39,590 --> 00:12:37,279
fertilizing that methane leads to

368
00:12:41,829 --> 00:12:39,600
very complex chemistry and so the

369
00:12:43,350 --> 00:12:41,839
particulates that that give it that hazy

370
00:12:44,550 --> 00:12:43,360
orange look

371
00:12:46,150 --> 00:12:44,560
that right there is sort of the first

372
00:12:47,430 --> 00:12:46,160
clue titan's got something really

373
00:12:48,069 --> 00:12:47,440
interesting going on these are these are

374
00:12:51,670 --> 00:12:48,079
organic

375
00:12:53,509 --> 00:12:51,680
particulates uh made up of chemicals

376
00:12:54,230 --> 00:12:53,519
that are formed through that process and

377
00:12:56,389 --> 00:12:54,240
they condense

378
00:12:58,150 --> 00:12:56,399
out and they make us haze and that

379
00:12:59,910 --> 00:12:58,160
completely obscured the view of the

380
00:13:02,389 --> 00:12:59,920
surface

381
00:13:03,269 --> 00:13:02,399
but uh was the first hint that there's

382
00:13:05,190 --> 00:13:03,279
some really

383
00:13:06,310 --> 00:13:05,200
really interesting carbon cycling going

384
00:13:08,629 --> 00:13:06,320
on um and

385
00:13:11,269 --> 00:13:08,639
and the potential for those organics to

386
00:13:12,389 --> 00:13:11,279
to be very complex organic species

387
00:13:14,949 --> 00:13:12,399
so it wasn't until we got there with

388
00:13:16,230 --> 00:13:14,959

cassini uh the casino huygens mission

389
00:13:18,550 --> 00:13:16,240
that we were able to actually see

390
00:13:20,069 --> 00:13:18,560
through uh that haze layer

391
00:13:21,990 --> 00:13:20,079
and and get an idea of what the surface

392
00:13:23,269 --> 00:13:22,000
was like before that there were a couple

393
00:13:25,430 --> 00:13:23,279
different hypotheses

394
00:13:26,870 --> 00:13:25,440
uh one was that maybe the surface was

395
00:13:29,430 --> 00:13:26,880
covered in just a whole

396
00:13:30,790 --> 00:13:29,440
ocean of liquid ethane with the thought

397
00:13:32,389 --> 00:13:30,800
that ethane would be a major product

398
00:13:33,190 --> 00:13:32,399
from the photosys you get enough of it

399
00:13:34,949 --> 00:13:33,200
it's all going to just

400
00:13:36,310 --> 00:13:34,959
condense out and maybe there's liquid

401
00:13:38,949 --> 00:13:36,320
ethane everywhere

402
00:13:41,030 --> 00:13:38,959
they're not totally sure until we got

403
00:13:45,030 --> 00:13:41,040
there with cassini huygens um

404
00:13:47,269 --> 00:13:45,040
and so uh cassini was the saturn orbiter

405
00:13:49,350 --> 00:13:47,279
but i dropped the huygens pro off uh

406
00:13:51,670 --> 00:13:49,360
huygens fell through the atmosphere

407
00:13:53,269 --> 00:13:51,680
for several hours and then it lived on

408
00:13:54,870 --> 00:13:53,279
the surface actually which wasn't

409
00:13:55,910 --> 00:13:54,880
necessarily expected or planned for

410
00:13:56,790 --> 00:13:55,920
because we didn't know what it would

411
00:13:58,629 --> 00:13:56,800
land on

412
00:14:00,230 --> 00:13:58,639
um but it survived on the surface for

413
00:14:01,509 --> 00:14:00,240

about 70 minutes

414
00:14:03,430 --> 00:14:01,519
but what it did while it fell through

415
00:14:04,389 --> 00:14:03,440
the atmosphere took images of the

416
00:14:06,470 --> 00:14:04,399
surface and

417
00:14:08,310 --> 00:14:06,480
as it descended down from those images

418
00:14:11,350 --> 00:14:08,320
we could see sort of evidence of

419
00:14:13,829 --> 00:14:11,360
uh a really interesting topography uh

420
00:14:17,430 --> 00:14:13,839
river channels i landed in what looks

421
00:14:19,990 --> 00:14:17,440
like a plains sort of a planes area

422
00:14:20,710 --> 00:14:20,000
and it also took measurements of the

423
00:14:22,550 --> 00:14:20,720
composition

424
00:14:25,430 --> 00:14:22,560
of the atmosphere while it fell down so

425
00:14:28,870 --> 00:14:25,440
the methane and the nitrogen

426
00:14:31,750 --> 00:14:28,880
as well as some of the trace species and

427
00:14:33,110 --> 00:14:31,760
isotopic ratios of uh some of the major

428
00:14:35,030 --> 00:14:33,120
species

429
00:14:36,389 --> 00:14:35,040
and also things like pressure and

430
00:14:38,870 --> 00:14:36,399
temperature kind of giving us

431
00:14:39,990 --> 00:14:38,880
the profile winds uh all the way down so

432
00:14:41,750 --> 00:14:40,000
that's sort of our one

433
00:14:43,509 --> 00:14:41,760
our one point data point of really

434
00:14:44,710 --> 00:14:43,519
understanding what titan is like all the

435
00:14:47,670 --> 00:14:44,720
way down to the surface

436
00:14:50,150 --> 00:14:47,680
also looking back up at the haze at all

437
00:14:51,670 --> 00:14:50,160
those particles to get an idea of um

438
00:14:53,509 --> 00:14:51,680

sort of what are they made of what shape

439
00:14:54,389 --> 00:14:53,519
they are how dense are they down to the

440
00:14:55,509 --> 00:14:54,399
surface

441
00:14:57,189 --> 00:14:55,519
and then since it survived on the

442
00:14:58,310 --> 00:14:57,199
surface we have we have really great

443
00:15:00,949 --> 00:14:58,320
images

444
00:15:02,230 --> 00:15:00,959
taken from huygens sitting of what that

445
00:15:04,629 --> 00:15:02,240
area of the titan surface

446
00:15:05,430 --> 00:15:04,639
looks like so that those you know three

447
00:15:08,870 --> 00:15:05,440
hours

448
00:15:09,670 --> 00:15:08,880
um it was an immense uh leap in our

449
00:15:12,069 --> 00:15:09,680
understanding

450
00:15:12,870 --> 00:15:12,079
of of what titan's like but luckily

451
00:15:15,030 --> 00:15:12,880
cassini

452
00:15:17,350 --> 00:15:15,040
kept coming by titan over and over right

453
00:15:20,389 --> 00:15:17,360
so over 100 flybys of titan

454
00:15:22,150 --> 00:15:20,399
um and from that we have learned so much

455
00:15:24,389 --> 00:15:22,160
too about about titan you know as a

456
00:15:26,389 --> 00:15:24,399
planetary system basically right as

457
00:15:28,150 --> 00:15:26,399
um i always refer to it often as a

458
00:15:29,430 --> 00:15:28,160
planet because

459
00:15:31,990 --> 00:15:29,440
other than the fact that it orbits on a

460
00:15:35,670 --> 00:15:32,000
different planet it acts like a planet

461
00:15:37,829 --> 00:15:35,680
um so the cassini orbiter gave us views

462
00:15:40,230 --> 00:15:37,839
of the surface

463
00:15:42,150 --> 00:15:40,240

in different you know channels of light

464
00:15:43,829 --> 00:15:42,160
that could get through the haze

465
00:15:46,230 --> 00:15:43,839
the absorption of the methane or the

466
00:15:46,870 --> 00:15:46,240
haze different visible and infrared

467
00:15:49,749 --> 00:15:46,880
lines

468
00:15:51,430 --> 00:15:49,759
um as well as using radar to get ideas

469
00:15:52,710 --> 00:15:51,440
about the topography what the what the

470
00:15:54,230 --> 00:15:52,720
surface is like

471
00:15:55,990 --> 00:15:54,240
and from that we can see i mean time is

472
00:15:57,910 --> 00:15:56,000
a fascinating place uh

473
00:15:59,509 --> 00:15:57,920
you've already hinted at a lot of the

474
00:16:01,670 --> 00:15:59,519
cool features things

475
00:16:03,590 --> 00:16:01,680
like the methane cycle that acts like

476
00:16:05,590 --> 00:16:03,600
the hydrological cycle on earth

477
00:16:08,310 --> 00:16:05,600
we have observed clouds we've seen

478
00:16:10,870 --> 00:16:08,320
evidence that it does rain

479
00:16:12,069 --> 00:16:10,880
sometimes on titan uh except there's

480
00:16:14,870 --> 00:16:12,079
river channels

481
00:16:15,749 --> 00:16:14,880
uh cassini discovered near the north

482
00:16:18,470 --> 00:16:15,759
pole a whole

483
00:16:19,749 --> 00:16:18,480
region of seas that are primarily

484
00:16:21,910 --> 00:16:19,759
methane and ethane

485
00:16:23,430 --> 00:16:21,920
seas so it's titan's the only place in

486
00:16:24,310 --> 00:16:23,440
the solar system you could go sailing

487
00:16:26,870 --> 00:16:24,320
other than earth

488
00:16:28,150 --> 00:16:26,880

um if you could stay in the cold that's

489
00:16:31,910 --> 00:16:28,160
awesome

490
00:16:34,629 --> 00:16:31,920
and there's you mentioned mountains

491
00:16:36,629 --> 00:16:34,639
uh there's uh it's been speculated that

492
00:16:39,829 --> 00:16:36,639
there might be cryovolcanism

493
00:16:42,470 --> 00:16:39,839
so the ice shell acts

494
00:16:43,030 --> 00:16:42,480
sort of like bedrock does on earth and

495
00:16:45,430 --> 00:16:43,040
then

496
00:16:47,990 --> 00:16:45,440
for titan underneath that there's a

497
00:16:49,910 --> 00:16:48,000
subsurface liquid water ocean

498
00:16:51,350 --> 00:16:49,920
and so it's thought that it's possible

499
00:16:52,150 --> 00:16:51,360
that you could get eruptions of this

500
00:16:54,389 --> 00:16:52,160
liquid water

501
00:16:55,910 --> 00:16:54,399
out onto the surface and despite the

502
00:16:58,949 --> 00:16:55,920
fact that titan

503
00:17:01,030 --> 00:16:58,959
is so cold at the surface uh if you have

504
00:17:04,549 --> 00:17:01,040
enough energy either in that kind of

505
00:17:05,909 --> 00:17:04,559
uh eruption of cryolava or for example a

506
00:17:07,590 --> 00:17:05,919
big impactor comes in a

507
00:17:09,029 --> 00:17:07,600
big impact crater if you get enough

508
00:17:11,350 --> 00:17:09,039
energy in the system

509
00:17:13,029 --> 00:17:11,360
and you melt the the water you have some

510
00:17:14,309 --> 00:17:13,039
liquid water present on the surface it

511
00:17:17,270 --> 00:17:14,319
could last for

512
00:17:18,230 --> 00:17:17,280
100 a thousand maybe even 10 000 years

513
00:17:19,829 --> 00:17:18,240

depending on

514
00:17:21,909 --> 00:17:19,839
on how much energy it takes it still

515
00:17:24,870 --> 00:17:21,919
takes long time to cool off

516
00:17:26,150 --> 00:17:24,880
so when you put this all together uh

517
00:17:28,950 --> 00:17:26,160
what we've learned

518
00:17:30,710 --> 00:17:28,960
from exploring titan is that you've got

519
00:17:32,470 --> 00:17:30,720
this location where we have

520
00:17:33,909 --> 00:17:32,480
we have sunlight coming in uh

521
00:17:34,470 --> 00:17:33,919
potentially other you know energy

522
00:17:37,590 --> 00:17:34,480
sources

523
00:17:39,270 --> 00:17:37,600
we have uh water definitely liquid water

524
00:17:40,710 --> 00:17:39,280
below the surface and sometimes on the

525
00:17:44,310 --> 00:17:40,720
surface and we have

526
00:17:46,150 --> 00:17:44,320
more you know organic carbon than

527
00:17:47,590 --> 00:17:46,160
than you could possibly need right it's

528
00:17:49,750 --> 00:17:47,600
sort of the opposite of what we're doing

529
00:17:52,470 --> 00:17:49,760
on mars where we're we're looking for

530
00:17:54,470 --> 00:17:52,480
you know uh just a few molecules you

531
00:17:56,230 --> 00:17:54,480
know uh preserved in rocks right and

532
00:17:57,750 --> 00:17:56,240
titan it's like you're it's organic

533
00:18:01,110 --> 00:17:57,760
carbon everywhere um

534
00:18:03,510 --> 00:18:01,120
we have complex organics so

535
00:18:04,950 --> 00:18:03,520
what happens right when you have all of

536
00:18:06,789 --> 00:18:04,960
those things together

537
00:18:08,950 --> 00:18:06,799
so what happens when you've got the

538
00:18:10,070 --> 00:18:08,960

super rich organic chemistry taking

539
00:18:11,669 --> 00:18:10,080
place in the atmosphere and

540
00:18:14,070 --> 00:18:11,679
it's it's depositing everywhere

541
00:18:15,990 --> 00:18:14,080
supposing all over the surface you

542
00:18:18,470 --> 00:18:16,000
suddenly have an impactor come in

543
00:18:20,070 --> 00:18:18,480
you create a melt pool now we have all

544
00:18:21,190 --> 00:18:20,080
this organic molecules and they're

545
00:18:22,150 --> 00:18:21,200
sitting in water

546
00:18:24,470 --> 00:18:22,160
and they're sitting in there for

547
00:18:26,549 --> 00:18:24,480
thousands of years you have a lot of

548
00:18:27,510 --> 00:18:26,559
hydrolysis reactions other reactions can

549
00:18:29,430 --> 00:18:27,520
take place

550
00:18:31,029 --> 00:18:29,440
can you start to make the types of

551
00:18:33,830 --> 00:18:31,039
molecules that we think of

552
00:18:35,510 --> 00:18:33,840
as important for biochemistry can you

553
00:18:36,950 --> 00:18:35,520
start to make things like amino acids

554
00:18:38,470 --> 00:18:36,960
and nucleobases

555
00:18:40,150 --> 00:18:38,480
and if you are able to make them in a

556
00:18:42,470 --> 00:18:40,160
synthesis step

557
00:18:44,390 --> 00:18:42,480
do they continue going on do you do you

558
00:18:45,110 --> 00:18:44,400
make any you know oligomers of those

559
00:18:48,630 --> 00:18:45,120
things

560
00:18:50,390 --> 00:18:48,640
um what kind of you know how far can

561
00:18:52,070 --> 00:18:50,400
an abiotic synthesis or this kind of

562
00:18:54,470 --> 00:18:52,080
process take you in terms

563
00:18:55,190 --> 00:18:54,480

of complex chemistry you know sort of on

564
00:18:56,630 --> 00:18:55,200
the root

565
00:18:58,470 --> 00:18:56,640
uh like what we think of as prebiotic

566
00:18:59,110 --> 00:18:58,480
chemistry so those are some of the big

567
00:19:01,350 --> 00:18:59,120
questions

568
00:19:03,350 --> 00:19:01,360
uh that are part of the dragonfly

569
00:19:06,630 --> 00:19:03,360
mission those are the because i have

570
00:19:09,990 --> 00:19:06,640
uh in going to titan and exploring titan

571
00:19:12,549 --> 00:19:10,000
um and then in addition uh we're able

572
00:19:13,750 --> 00:19:12,559
to make like very specific measurements

573
00:19:14,950 --> 00:19:13,760
maybe about some of the chemical

574
00:19:17,029 --> 00:19:14,960
composition

575
00:19:18,710 --> 00:19:17,039
of uh some of the surface materials that

576
00:19:20,789 --> 00:19:18,720
we encounter but we can do so

577
00:19:21,830 --> 00:19:20,799
putting it in the context of the whole

578
00:19:24,310 --> 00:19:21,840
area

579
00:19:25,190 --> 00:19:24,320
that that we're exploring in right so

580
00:19:27,590 --> 00:19:25,200
also

581
00:19:28,630 --> 00:19:27,600
uh spending time on the surface and

582
00:19:30,150 --> 00:19:28,640
making

583
00:19:31,669 --> 00:19:30,160
measurements understanding the

584
00:19:33,190 --> 00:19:31,679
environment understanding sort of the

585
00:19:35,510 --> 00:19:33,200
meteorology

586
00:19:37,110 --> 00:19:35,520
um and and and kind of piecing it all

587
00:19:39,830 --> 00:19:37,120
together you know

588
00:19:41,350 --> 00:19:39,840

what does it mean to to have a place

589
00:19:43,110 --> 00:19:41,360
like titan that has all the ingredients

590
00:19:45,750 --> 00:19:43,120
we think of are important for life

591
00:19:46,870 --> 00:19:45,760
um and and how does that all kind of

592
00:19:49,350 --> 00:19:46,880
come together as a system

593
00:19:50,150 --> 00:19:49,360
and what can we say about uh what that

594
00:19:51,830 --> 00:19:50,160
means for

595
00:19:53,510 --> 00:19:51,840
what we think about habitability you

596
00:19:53,990 --> 00:19:53,520
know what makes the place habitable for

597
00:19:55,270 --> 00:19:54,000
example

598
00:19:56,470 --> 00:19:55,280
interesting yeah so it seems like

599
00:19:58,070 --> 00:19:56,480
there's there's a lot to learn just

600
00:20:00,630 --> 00:19:58,080
about planetary processes

601
00:20:02,789 --> 00:20:00,640
in general and atmospheric processes by

602
00:20:04,710 --> 00:20:02,799
by going to titan and exploring

603
00:20:06,149 --> 00:20:04,720
uh i'd not read before but the potential

604
00:20:08,230 --> 00:20:06,159
for for liquid water to come

605
00:20:09,510 --> 00:20:08,240
up to the surface or an impact or to

606
00:20:10,710 --> 00:20:09,520
leave it on the surface for a long

607
00:20:11,990 --> 00:20:10,720
period of time

608
00:20:14,710 --> 00:20:12,000
so that presents a really interesting

609
00:20:15,510 --> 00:20:14,720
potential for an oasis or a refuge if

610
00:20:18,630 --> 00:20:15,520
you will for

611
00:20:20,630 --> 00:20:18,640
for a potential life if it's there so so

612
00:20:21,510 --> 00:20:20,640
how would dragonfly then specifically as

613
00:20:23,669 --> 00:20:21,520

a mission

614
00:20:25,029 --> 00:20:23,679
uh help us to understand this what kinds

615
00:20:26,549 --> 00:20:25,039
of instruments will be taking

616
00:20:28,950 --> 00:20:26,559
uh what kinds of measurements will it

617
00:20:31,190 --> 00:20:28,960
give us yeah so

618
00:20:32,310 --> 00:20:31,200
um one of the big features and i'm gonna

619
00:20:35,909 --> 00:20:32,320
point to the

620
00:20:39,110 --> 00:20:35,919
dragonfly in my background

621
00:20:40,149 --> 00:20:39,120
since i'm broadcasting from titan um the

622
00:20:41,830 --> 00:20:40,159
you know of course one of the key

623
00:20:43,430 --> 00:20:41,840
features of dragonfly is that it can go

624
00:20:45,590 --> 00:20:43,440
to more than one location

625
00:20:47,669 --> 00:20:45,600
uh so they we call it a relocatable

626
00:20:50,390 --> 00:20:47,679
lander so we're able to visit

627
00:20:52,630 --> 00:20:50,400
multiple types of locations i've talked

628
00:20:54,950 --> 00:20:52,640
about dunes and organic dune fields

629
00:20:56,390 --> 00:20:54,960
and now i've talked about this potential

630
00:20:58,470 --> 00:20:56,400
for there to be

631
00:21:00,230 --> 00:20:58,480
we know there are impact craters and

632
00:21:01,350 --> 00:21:00,240
that at some point in their history they

633
00:21:03,750 --> 00:21:01,360
would have been liquid water

634
00:21:04,870 --> 00:21:03,760
frozen over now but our plan is to visit

635
00:21:08,310 --> 00:21:04,880
one of these um

636
00:21:10,390 --> 00:21:08,320
impact craters and and look for evidence

637
00:21:12,950 --> 00:21:10,400
of this type of chemistry

638
00:21:14,789 --> 00:21:12,960

so the way that we'll do that we'll

639
00:21:16,310 --> 00:21:14,799
measure the composition of the surface

640
00:21:17,750 --> 00:21:16,320
in several locations

641
00:21:19,590 --> 00:21:17,760
and and be able to compare it and kind

642
00:21:21,590 --> 00:21:19,600
of understanding a processing history

643
00:21:23,990 --> 00:21:21,600
we do that a lot of the way very similar

644
00:21:25,510 --> 00:21:24,000
to how uh curiosity rover

645
00:21:27,590 --> 00:21:25,520
makes similar measurements on mars and

646
00:21:30,070 --> 00:21:27,600
looks for organic materials on mars

647
00:21:31,909 --> 00:21:30,080
so we'll drill into the surface we have

648
00:21:34,310 --> 00:21:31,919
a cryogenic drill

649
00:21:35,270 --> 00:21:34,320
and that delivers the sample to a mass

650
00:21:39,190 --> 00:21:35,280
spectrometer

651
00:21:42,070 --> 00:21:39,200
look for

652
00:21:44,310 --> 00:21:42,080
different types of organic molecules

653
00:21:46,630 --> 00:21:44,320
identify different compound classes

654
00:21:48,390 --> 00:21:46,640
by comparing like what we find in the

655
00:21:50,470 --> 00:21:48,400
doom sands to what we might find

656
00:21:51,750 --> 00:21:50,480
in sort of this frozen over impact

657
00:21:53,590 --> 00:21:51,760
deposits

658
00:21:55,110 --> 00:21:53,600
we can make some inferences again about

659
00:21:57,029 --> 00:21:55,120
the type of processing that may have

660
00:21:58,630 --> 00:21:57,039
taken place

661
00:22:00,070 --> 00:21:58,640
we have two different ways to measure

662
00:22:01,669 --> 00:22:00,080
surface samples with the

663
00:22:03,510 --> 00:22:01,679

mass spectrometer one involves uh

664
00:22:04,549 --> 00:22:03,520
shooting in the laser which is sort of

665
00:22:05,909 --> 00:22:04,559
our first look

666
00:22:07,750 --> 00:22:05,919
and and that helps us get you know some

667
00:22:10,390 --> 00:22:07,760
of the larger molecular weight uh

668
00:22:11,669 --> 00:22:10,400
molecules but then we also have a gas

669
00:22:13,909 --> 00:22:11,679
chromatograph

670
00:22:16,070 --> 00:22:13,919
and using that approach and again this

671
00:22:18,710 --> 00:22:16,080
is something that has been done on mars

672
00:22:20,390 --> 00:22:18,720
we do what's called derivatization so

673
00:22:22,230 --> 00:22:20,400
use a chemical reagent

674
00:22:23,909 --> 00:22:22,240
and mix it with some of the molecules

675
00:22:26,470 --> 00:22:23,919
that normally might not

676
00:22:28,149 --> 00:22:26,480
if you heated them go into a gas flow

677
00:22:29,430 --> 00:22:28,159
but we make them more volatile

678
00:22:31,669 --> 00:22:29,440
and then we can send them through our

679
00:22:33,270 --> 00:22:31,679
our system and measure them in the mass

680
00:22:34,470 --> 00:22:33,280
spec and that includes things like amino

681
00:22:36,549 --> 00:22:34,480
acids

682
00:22:37,510 --> 00:22:36,559
and it also gives us the capability

683
00:22:39,990 --> 00:22:37,520
we're carrying

684
00:22:41,990 --> 00:22:40,000
a special separation column with our gas

685
00:22:43,750 --> 00:22:42,000
chromatograph that lets us look at uh

686
00:22:45,029 --> 00:22:43,760
chirality so that's sort of the

687
00:22:47,029 --> 00:22:45,039
handedness

688
00:22:48,789 --> 00:22:47,039

of molecules that's really really

689
00:22:51,350 --> 00:22:48,799
important biosignature

690
00:22:52,149 --> 00:22:51,360
for our biochemistry as we know it on

691
00:22:54,149 --> 00:22:52,159
earth

692
00:22:55,990 --> 00:22:54,159
and so that's something that we have the

693
00:22:58,470 --> 00:22:56,000
ability to look and see there's a

694
00:22:59,350 --> 00:22:58,480
big enhancement in in one chirality or

695
00:23:02,070 --> 00:22:59,360
another

696
00:23:03,669 --> 00:23:02,080
so that's very focused on just sorry the

697
00:23:05,190 --> 00:23:03,679
chemistry measurements

698
00:23:06,710 --> 00:23:05,200
uh but we're making tons of other

699
00:23:09,510 --> 00:23:06,720
measurements as well

700
00:23:10,789 --> 00:23:09,520
uh again to really understand this this

701
00:23:12,630 --> 00:23:10,799
whole planetary system and learn

702
00:23:14,070 --> 00:23:12,640
more about planetary processes as well

703
00:23:15,190 --> 00:23:14,080
and put the chemical measurements in

704
00:23:17,990 --> 00:23:15,200
context

705
00:23:18,630 --> 00:23:18,000
uh so of course imaging lots and lots of

706
00:23:20,630 --> 00:23:18,640
imaging

707
00:23:22,149 --> 00:23:20,640
right we couldn't go to titan and fly

708
00:23:22,390 --> 00:23:22,159
around titan without sending back lots

709
00:23:30,870 --> 00:23:22,400
of

710
00:23:33,990 --> 00:23:30,880
you know uh forward and down looking

711
00:23:36,070 --> 00:23:34,000
views we have a microscopic imager

712
00:23:38,549 --> 00:23:36,080
that'll let us see in a lot in in much

713
00:23:40,710 --> 00:23:38,559

finer detail that the types of surfaces

714
00:23:43,830 --> 00:23:40,720
the types of materials that are there

715
00:23:44,630 --> 00:23:43,840
uh as including the area where we um uh

716
00:23:47,110 --> 00:23:44,640
will drill

717
00:23:47,909 --> 00:23:47,120
if if we decide to take a drill sample

718
00:23:49,990 --> 00:23:47,919
and so

719
00:23:51,590 --> 00:23:50,000
from uh piecing together all of those we

720
00:23:53,269 --> 00:23:51,600
can learn a lot about the geologic

721
00:23:53,990 --> 00:23:53,279
history of the different landing sites

722
00:23:56,230 --> 00:23:54,000
that we're in

723
00:23:57,830 --> 00:23:56,240
for example uh to learn a lot more about

724
00:24:01,510 --> 00:23:57,840
how those doom fields

725
00:24:02,870 --> 00:24:01,520
are formed and and transformed over time

726
00:24:05,190 --> 00:24:02,880
we're also making meteorological

727
00:24:08,390 --> 00:24:05,200
measurements so things like temperature

728
00:24:11,750 --> 00:24:08,400
pressure wind looking at methane

729
00:24:14,549 --> 00:24:11,760
humidity we have

730
00:24:14,870 --> 00:24:14,559
the ability to make seismic measurements

731
00:24:28,549 --> 00:24:14,880
a

732
00:24:31,269 --> 00:24:28,559
interior structure

733
00:24:32,870 --> 00:24:31,279
and how that interior might connect with

734
00:24:33,510 --> 00:24:32,880
the surface and what implications that

735
00:24:35,669 --> 00:24:33,520
could have

736
00:24:37,510 --> 00:24:35,679
for for you know were there let's say

737
00:24:38,870 --> 00:24:37,520
potential life in that deep subsurface

738
00:24:41,110 --> 00:24:38,880

ocean

739
00:24:42,710 --> 00:24:41,120
uh we also have uh gamma-ray neutron

740
00:24:45,830 --> 00:24:42,720
spectrometer measurements which

741
00:24:47,830 --> 00:24:45,840
are uh spectroscopy sorry which are uh

742
00:24:50,230 --> 00:24:47,840
really useful they do we are able to get

743
00:24:52,230 --> 00:24:50,240
a bulk elemental composition of every

744
00:24:53,350 --> 00:24:52,240
landing site that we're at so it sort of

745
00:24:56,789 --> 00:24:53,360
tells us

746
00:24:58,470 --> 00:24:56,799
um you know what what major elements uh

747
00:25:01,190 --> 00:24:58,480
approach carbon and

748
00:25:02,470 --> 00:25:01,200
hydrogen and oxygen uh will be important

749
00:25:03,909 --> 00:25:02,480
ones as we're

750
00:25:06,630 --> 00:25:03,919
landing on sites that have different

751
00:25:09,029 --> 00:25:06,640
amounts of uh water ice or maybe

752
00:25:10,870 --> 00:25:09,039
organic molecules sort of layered on top

753
00:25:13,750 --> 00:25:10,880
almost like a like a soil

754
00:25:15,750 --> 00:25:13,760
or a layering on top uh but if we land

755
00:25:17,510 --> 00:25:15,760
in an icy spot we might also see

756
00:25:21,510 --> 00:25:17,520
evidence that there's a lot of salts

757
00:25:24,070 --> 00:25:21,520
uh you know chlorine and and sodium and

758
00:25:25,750 --> 00:25:24,080
different cations and anions if if they

759
00:25:27,430 --> 00:25:25,760
kind of pop up in those measurements too

760
00:25:29,190 --> 00:25:27,440
that could tell us a lot about the

761
00:25:30,390 --> 00:25:29,200
history of that area and again potential

762
00:25:32,390 --> 00:25:30,400
connection maybe

763
00:25:34,470 --> 00:25:32,400

from the interior ocean and that also

764
00:25:37,029 --> 00:25:34,480
helps us classify

765
00:25:38,630 --> 00:25:37,039
site to site um our is where we're

766
00:25:41,590 --> 00:25:38,640
sitting now very similar

767
00:25:42,470 --> 00:25:41,600
to where we were last time and if so do

768
00:25:44,950 --> 00:25:42,480
we want to

769
00:25:46,070 --> 00:25:44,960
you know is it worth drilling and taking

770
00:25:48,390 --> 00:25:46,080
another sample or should we

771
00:25:51,269 --> 00:25:48,400
keep continuing on to find um kind of a

772
00:25:53,350 --> 00:25:51,279
new geologic unit

773
00:25:54,789 --> 00:25:53,360
so very cool yeah i'm just like smiling

774
00:25:56,710 --> 00:25:54,799
widely over here just thinking about

775
00:25:58,470 --> 00:25:56,720
dragonfly and what's possible

776
00:25:59,990 --> 00:25:58,480
i do have a couple rapid fire questions

777
00:26:01,909 --> 00:26:00,000
for you actually too

778
00:26:03,510 --> 00:26:01,919
uh i gave a talk last week at the denver

779
00:26:03,990 --> 00:26:03,520
museum of nature and science and of

780
00:26:06,149 --> 00:26:04,000
course

781
00:26:07,669 --> 00:26:06,159
children always ask the best questions

782
00:26:09,590 --> 00:26:07,679
and i had a bunch of kids ask questions

783
00:26:12,230 --> 00:26:09,600
that i had no answers to

784
00:26:14,310 --> 00:26:12,240
uh so a quick one uh how big is

785
00:26:16,390 --> 00:26:14,320
dragonfly going to be

786
00:26:18,070 --> 00:26:16,400
okay so dragonfly you want to picture

787
00:26:20,070 --> 00:26:18,080
the scale is like

788
00:26:21,510 --> 00:26:20,080

kind of like a mars rover right so this

789
00:26:24,149 --> 00:26:21,520
is not a teeny

790
00:26:25,110 --> 00:26:24,159
little little drone this is a this is a

791
00:26:30,310 --> 00:26:25,120
serious

792
00:26:31,750 --> 00:26:30,320
got to carry that that whole payload

793
00:26:33,590 --> 00:26:31,760
okay so like maybe like a small like a

794
00:26:35,669 --> 00:26:33,600
mini cooper kind of size

795
00:26:36,630 --> 00:26:35,679
yeah something like that maybe maybe i

796
00:26:38,710 --> 00:26:36,640
mean it'll have its own

797
00:26:40,470 --> 00:26:38,720
little dimensions but you know it's you

798
00:26:42,789 --> 00:26:40,480
know hundreds of kilograms

799
00:26:45,029 --> 00:26:42,799
very cool uh another question that i i

800
00:26:46,230 --> 00:26:45,039
had why did we choose to put on eight

801
00:26:48,230 --> 00:26:46,240
propellers

802
00:26:49,909 --> 00:26:48,240
um on the spacecraft why not why not

803
00:26:52,149 --> 00:26:49,919
four or just two

804
00:26:53,510 --> 00:26:52,159
well by having eight and having them

805
00:26:56,630 --> 00:26:53,520
arranged the way we have them

806
00:26:58,390 --> 00:26:56,640
where there's it's really um uh two

807
00:27:01,110 --> 00:26:58,400
four locations with two each that gives

808
00:27:02,310 --> 00:27:01,120
us a little bit of redundancy so if one

809
00:27:05,110 --> 00:27:02,320
of those

810
00:27:06,549 --> 00:27:05,120
um rotors were to go out for example we

811
00:27:07,110 --> 00:27:06,559
could we could keep flying and keep

812
00:27:09,110 --> 00:27:07,120
flying

813
00:27:11,590 --> 00:27:09,120

in a very balanced and controlled way oh

814
00:27:12,870 --> 00:27:11,600
very cool then another question so

815
00:27:15,510 --> 00:27:12,880
uh obviously there'll be there'll be a

816
00:27:16,390 --> 00:27:15,520
nuclear fuel source um for powering the

817
00:27:18,870 --> 00:27:16,400
spacecraft

818
00:27:21,110 --> 00:27:18,880
or powering the craft on titan uh but

819
00:27:23,750 --> 00:27:21,120
how long do we expect that it might live

820
00:27:25,269 --> 00:27:23,760
what's the optimal time for the mission

821
00:27:28,870 --> 00:27:25,279
as of now

822
00:27:30,389 --> 00:27:28,880
so the um the plan is to use an mmrpg

823
00:27:32,070 --> 00:27:30,399
right so that's how we propose and

824
00:27:36,070 --> 00:27:32,080
that's what the architecture um

825
00:27:38,710 --> 00:27:36,080
is dependent on uh and it will depend

826
00:27:40,149 --> 00:27:38,720
um right now based on the cruise time

827
00:27:44,470 --> 00:27:40,159
that we're looking at

828
00:27:46,549 --> 00:27:44,480
uh and we land and we have a three-year

829
00:27:48,149 --> 00:27:46,559
prime mission right and throughout the

830
00:27:49,590 --> 00:27:48,159
whole prime mission we have enough power

831
00:27:51,590 --> 00:27:49,600
certainly to do everything that we need

832
00:27:53,990 --> 00:27:51,600
to do um but

833
00:27:55,110 --> 00:27:54,000
we should keep getting enough energy out

834
00:27:57,669 --> 00:27:55,120
of the power source

835
00:27:59,669 --> 00:27:57,679
uh to keep going and then over time

836
00:28:02,149 --> 00:27:59,679
ultimately it will start to

837
00:28:04,149 --> 00:28:02,159
degrade but you know we're looking at

838
00:28:05,990 --> 00:28:04,159

several years on the surface okay and

839
00:28:07,430 --> 00:28:06,000
even hopefully beyond the prime mission

840
00:28:09,110 --> 00:28:07,440
even yeah i mean we're still learning

841
00:28:11,669 --> 00:28:09,120
right what we can do with these nuclear

842
00:28:12,710 --> 00:28:11,679
sources for spacecraft on planetary

843
00:28:14,389 --> 00:28:12,720
surfaces

844
00:28:16,710 --> 00:28:14,399
obviously with the voyager spacecraft

845
00:28:18,470 --> 00:28:16,720
they've been going for decades now

846
00:28:20,070 --> 00:28:18,480
you know using a nuclear fuel source and

847
00:28:21,750 --> 00:28:20,080
so it'd be cool if it could last for

848
00:28:22,950 --> 00:28:21,760
that long and really give us many years

849
00:28:24,630 --> 00:28:22,960
of measurements

850
00:28:25,909 --> 00:28:24,640
from the surface of titan and lots of

851
00:28:26,870 --> 00:28:25,919
really cool pictures and lots of really

852
00:28:29,430 --> 00:28:26,880
cool chemistry for

853
00:28:30,549 --> 00:28:29,440
all of us back here i do want to change

854
00:28:32,549 --> 00:28:30,559
topics just a little bit

855
00:28:34,230 --> 00:28:32,559
uh before that though uh just remember

856
00:28:36,710 --> 00:28:34,240
remember for the audience uh you can ask

857
00:28:38,549 --> 00:28:36,720
questions right now in second nets chat

858
00:28:40,710 --> 00:28:38,559
uh feature at secondnet.org or in the

859
00:28:42,950 --> 00:28:40,720
nasa astrobiology facebook page

860
00:28:44,870 --> 00:28:42,960
uh i see questions coming in right now

861
00:28:45,190 --> 00:28:44,880
uh for doctor trainer and so i'll get to

862
00:28:48,710 --> 00:28:45,200
your

863
00:28:50,789 --> 00:28:48,720

few other questions

864
00:28:52,470 --> 00:28:50,799
i have first so uh you've done a lot of

865
00:28:54,549 --> 00:28:52,480
other work not just you know looking at

866
00:28:56,310 --> 00:28:54,559
titan and its atmospheric chemistry and

867
00:28:57,990 --> 00:28:56,320
and some of these things uh you've also

868
00:28:59,190 --> 00:28:58,000
been involved with the sam instrument on

869
00:29:01,110 --> 00:28:59,200
curiosity

870
00:29:03,269 --> 00:29:01,120
uh and you mentioned earlier like the

871
00:29:04,870 --> 00:29:03,279
methane detections on mars

872
00:29:06,470 --> 00:29:04,880
i remember when those those first

873
00:29:08,230 --> 00:29:06,480
started coming out like mike mama was

874
00:29:09,830 --> 00:29:08,240
using a telescope here at earth

875
00:29:11,990 --> 00:29:09,840
and looking at mars and seeing methane

876
00:29:14,389 --> 00:29:12,000
and a lot of people didn't believe it

877
00:29:15,990 --> 00:29:14,399
i was skeptical of methane on mars at

878
00:29:17,110 --> 00:29:16,000
first as well but now we've had repeat

879
00:29:19,350 --> 00:29:17,120
measurements

880
00:29:20,789 --> 00:29:19,360
uh but recently you were also involved

881
00:29:23,110 --> 00:29:20,799
in an announcement of finding

882
00:29:25,029 --> 00:29:23,120
oxygen on mars and i wonder if you could

883
00:29:27,110 --> 00:29:25,039
just like tell our audience about that

884
00:29:28,630 --> 00:29:27,120
about that detection and what we think

885
00:29:30,230 --> 00:29:28,640
might be going on to be

886
00:29:32,710 --> 00:29:30,240
putting both methane and oxygen

887
00:29:36,149 --> 00:29:32,720
potentially into mars atmosphere

888
00:29:37,909 --> 00:29:36,159

sure so we expected to find oxygen

889
00:29:40,549 --> 00:29:37,919
oxygen was measured

890
00:29:41,510 --> 00:29:40,559
by certainly by the viking landers as as

891
00:29:44,630 --> 00:29:41,520
well as other

892
00:29:45,990 --> 00:29:44,640
um uh you know spacecraft or other

893
00:29:48,470 --> 00:29:46,000
observations of mars

894
00:29:50,070 --> 00:29:48,480
uh so we knew that oxygen was there uh

895
00:29:52,470 --> 00:29:50,080
what we were able to

896
00:29:54,149 --> 00:29:52,480
see with the sand measurements that that

897
00:29:57,430 --> 00:29:54,159
couldn't be seen before

898
00:29:58,950 --> 00:29:57,440
was how it changed over time seasonally

899
00:30:00,950 --> 00:29:58,960
and how it changed compared to the other

900
00:30:03,909 --> 00:30:00,960
major gases in the atmosphere

901
00:30:04,789 --> 00:30:03,919
so with uh the sam instrument on

902
00:30:07,590 --> 00:30:04,799
curiosity

903
00:30:08,630 --> 00:30:07,600
you know we've been on mars for over

904
00:30:11,510 --> 00:30:08,640
seven

905
00:30:12,950 --> 00:30:11,520
over eight years um i have to pause

906
00:30:14,710 --> 00:30:12,960
because my daughter was born right after

907
00:30:17,430 --> 00:30:14,720
we landed so i can always remember how

908
00:30:20,389 --> 00:30:17,440
long we've been there by how old she is

909
00:30:21,029 --> 00:30:20,399
um so uh we've been on the surface for a

910
00:30:22,950 --> 00:30:21,039
long time

911
00:30:24,310 --> 00:30:22,960
we're not making daily measurements of

912
00:30:27,269 --> 00:30:24,320
the atmosphere with

913
00:30:28,789 --> 00:30:27,279

the mass spectrometer but we're making

914
00:30:31,830 --> 00:30:28,799
frequent measurements and we were able

915
00:30:34,470 --> 00:30:31,840
to kind of build up over time

916
00:30:36,070 --> 00:30:34,480
coverage that then spanned all the

917
00:30:39,430 --> 00:30:36,080
seasons and had lots of points

918
00:30:40,789 --> 00:30:39,440
over over repeated mars years

919
00:30:42,230 --> 00:30:40,799
and that was sort of that was a big

920
00:30:43,269 --> 00:30:42,240
first right so all the other

921
00:30:44,310 --> 00:30:43,279
measurements had either been

922
00:30:47,190 --> 00:30:44,320
observations

923
00:30:48,789 --> 00:30:47,200
um you know from from orbit or from

924
00:30:49,669 --> 00:30:48,799
telescope or for example the viking

925
00:30:51,830 --> 00:30:49,679
landers

926
00:30:53,190 --> 00:30:51,840
which made that kind of comprehensive

927
00:30:55,190 --> 00:30:53,200
measurement of

928
00:30:56,710 --> 00:30:55,200
all the composition of the atmosphere

929
00:30:59,110 --> 00:30:56,720
but only for a few

930
00:31:01,509 --> 00:30:59,120
souls only for a few mars days so we

931
00:31:05,110 --> 00:31:01,519
sort of built up this first data set

932
00:31:07,669 --> 00:31:05,120
and uh things like argon and nitrogen

933
00:31:08,710 --> 00:31:07,679
which we know are inert they don't they

934
00:31:11,190 --> 00:31:08,720
don't chemically

935
00:31:12,470 --> 00:31:11,200
uh react to other species they don't

936
00:31:15,909 --> 00:31:12,480
really interact very much

937
00:31:19,110 --> 00:31:15,919
uh with the surface um they behave very

938
00:31:20,630 --> 00:31:19,120

well like it's a weird way to emphasize

939
00:31:22,070 --> 00:31:20,640
them but they they have a very repeated

940
00:31:23,830 --> 00:31:22,080
cycle that we expected to see

941
00:31:25,350 --> 00:31:23,840
and every year you know we could fill in

942
00:31:27,990 --> 00:31:25,360
the points and and it would make this

943
00:31:29,110 --> 00:31:28,000
you know put together this nice curve

944
00:31:33,590 --> 00:31:29,120
but the oxygen was

945
00:31:37,430 --> 00:31:33,600
was uh not following the same patterns

946
00:31:37,830 --> 00:31:37,440
uh it had it would rise a lot earlier in

947
00:31:45,269 --> 00:31:37,840
the

948
00:31:47,350 --> 00:31:45,279
down really fast and both of both of

949
00:31:48,389 --> 00:31:47,360
those aspects of the oxygen cycle were

950
00:31:51,430 --> 00:31:48,399
unexpected

951
00:31:53,430 --> 00:31:51,440
uh based on what we know about

952
00:31:54,789 --> 00:31:53,440
oxygen photochemistry and the cycles in

953
00:31:57,110 --> 00:31:54,799
the atmosphere

954
00:31:58,470 --> 00:31:57,120
you uh would expect it to actually

955
00:32:01,590 --> 00:31:58,480
mostly look like argon

956
00:32:03,590 --> 00:32:01,600
behave like argon so what it tells us

957
00:32:05,269 --> 00:32:03,600
whenever we get to make a measurement

958
00:32:06,789 --> 00:32:05,279
that hasn't been made before hasn't been

959
00:32:08,070 --> 00:32:06,799
made with the same resolution that it's

960
00:32:10,310 --> 00:32:08,080
been made before

961
00:32:12,549 --> 00:32:10,320
and you don't see what you expect it

962
00:32:14,149 --> 00:32:12,559
just means it's time to go back and and

963
00:32:17,990 --> 00:32:14,159

question the assumptions

964
00:32:21,029 --> 00:32:18,000
so we had an expectation based on

965
00:32:22,310 --> 00:32:21,039
only one real process of controlling

966
00:32:23,509 --> 00:32:22,320
oxygen in the atmosphere which related

967
00:32:25,269 --> 00:32:23,519
to photochemistry

968
00:32:26,950 --> 00:32:25,279
and by seeing different behavior it's

969
00:32:28,070 --> 00:32:26,960
telling us there's something going else

970
00:32:31,509 --> 00:32:28,080
going on

971
00:32:33,669 --> 00:32:31,519
and our we don't have an answer yet so

972
00:32:34,950 --> 00:32:33,679
so these results were uh took years and

973
00:32:36,389 --> 00:32:34,960
years to build up

974
00:32:38,149 --> 00:32:36,399
uh and we published them about a year

975
00:32:40,389 --> 00:32:38,159
ago and

976
00:32:42,230 --> 00:32:40,399
and part of the idea was to say hey this

977
00:32:43,909 --> 00:32:42,240
is an unprecedented data set this is

978
00:32:45,669 --> 00:32:43,919
something interesting and new and and it

979
00:32:47,029 --> 00:32:45,679
was a little bit out to the community

980
00:32:49,350 --> 00:32:47,039
the science community you know maybe

981
00:32:51,669 --> 00:32:49,360
some of the people on this call uh

982
00:32:53,350 --> 00:32:51,679
see what you can think about you know um

983
00:32:55,110 --> 00:32:53,360
i think that there's probably a really

984
00:32:56,870 --> 00:32:55,120
strong connection to the surface

985
00:32:59,350 --> 00:32:56,880
to processes that are going on in the

986
00:33:02,870 --> 00:32:59,360
surface heterogeneous chemistry

987
00:33:04,470 --> 00:33:02,880
there may be a reservoir where oxygen

988
00:33:06,630 --> 00:33:04,480

gets converted into another

989
00:33:07,509 --> 00:33:06,640
species temporarily and then it could be

990
00:33:09,190 --> 00:33:07,519
re-released

991
00:33:10,950 --> 00:33:09,200
that's one way to potentially explain

992
00:33:12,470 --> 00:33:10,960
how it can kind of come out fast and

993
00:33:14,310 --> 00:33:12,480
then go back away fast

994
00:33:15,590 --> 00:33:14,320
but we haven't found a smoking gun in

995
00:33:18,149 --> 00:33:15,600
terms of what would

996
00:33:18,950 --> 00:33:18,159
that reservoir be and and what would

997
00:33:21,509 --> 00:33:18,960
trigger

998
00:33:22,950 --> 00:33:21,519
kind of release or or reabsorption you

999
00:33:25,750 --> 00:33:22,960
know we compared

1000
00:33:27,269 --> 00:33:25,760
our results to everything else that we

1001
00:33:30,310 --> 00:33:27,279
were measuring at the time

1002
00:33:32,710 --> 00:33:30,320
uh whether it was a uv incidence

1003
00:33:34,470 --> 00:33:32,720
or you know temperature pressure surface

1004
00:33:36,389 --> 00:33:34,480
ground temperature

1005
00:33:38,230 --> 00:33:36,399
dust loading the methane you measure so

1006
00:33:39,590 --> 00:33:38,240
we compared it as best as we could to

1007
00:33:40,230 --> 00:33:39,600
the measurements of methane that were

1008
00:33:41,750 --> 00:33:40,240
made

1009
00:33:43,909 --> 00:33:41,760
and the methane and oxygen it's

1010
00:33:44,549 --> 00:33:43,919
interesting they sometimes follow each

1011
00:33:48,389 --> 00:33:44,559
other

1012
00:33:50,230 --> 00:33:48,399
and sometimes not so

1013
00:33:52,230 --> 00:33:50,240

there's parts of the year where they

1014
00:33:53,750 --> 00:33:52,240
seem like they might be tracking

1015
00:33:55,190 --> 00:33:53,760
and then other parts where they're not

1016
00:33:57,190 --> 00:33:55,200
so that seems like another really

1017
00:33:59,110 --> 00:33:57,200
important clue too

1018
00:34:01,029 --> 00:33:59,120
interesting that's because it's really

1019
00:34:01,669 --> 00:34:01,039
groovy and so you guys you guys heard it

1020
00:34:03,909 --> 00:34:01,679
uh uh

1021
00:34:05,590 --> 00:34:03,919
dr traynor has said it's a challenge

1022
00:34:05,990 --> 00:34:05,600
help us figure out what's going on maybe

1023
00:34:06,950 --> 00:34:06,000
someone

1024
00:34:08,310 --> 00:34:06,960
listening right now maybe an

1025
00:34:09,909 --> 00:34:08,320
undergraduate student or high school

1026
00:34:11,270 --> 00:34:09,919
student listening right now might be

1027
00:34:14,149 --> 00:34:11,280
involved in helping us to

1028
00:34:15,430 --> 00:34:14,159
to solve these these puzzles um and as

1029
00:34:17,349 --> 00:34:15,440
always in science you know it's not

1030
00:34:20,470 --> 00:34:17,359
always a case of eureka it's a case of

1031
00:34:22,230 --> 00:34:20,480
huh you know why is that happening

1032
00:34:23,589 --> 00:34:22,240
uh so dr traynor before i open it up to

1033
00:34:25,589 --> 00:34:23,599
our audience questions

1034
00:34:26,950 --> 00:34:25,599
i do love for all of our guests just to

1035
00:34:28,790 --> 00:34:26,960
chat a bit about

1036
00:34:30,310 --> 00:34:28,800
uh what it is outside of science that

1037
00:34:32,230 --> 00:34:30,320
drives your life forward

1038
00:34:34,069 --> 00:34:32,240

uh so you mentioned to me before that

1039
00:34:35,829 --> 00:34:34,079
you're really into your family life and

1040
00:34:37,190 --> 00:34:35,839
you guys have a lot of hobbies together

1041
00:34:38,950 --> 00:34:37,200
uh you like to get outdoors with your

1042
00:34:40,550 --> 00:34:38,960
family i wonder if you just let us know

1043
00:34:42,629 --> 00:34:40,560
what kinds of adventures have you and

1044
00:34:44,550 --> 00:34:42,639
your family been on lately

1045
00:34:50,230 --> 00:34:44,560
sure well this has not been a normal

1046
00:34:53,589 --> 00:34:52,629
a few years ago we got really into

1047
00:34:56,950 --> 00:34:53,599
trying to visit

1048
00:34:58,710 --> 00:34:56,960
different national parks um i i love

1049
00:35:00,390 --> 00:34:58,720
the outdoors i love the natural

1050
00:35:03,270 --> 00:35:00,400
environment i probably don't

1051
00:35:03,990 --> 00:35:03,280
get into it as often as i would like um

1052
00:35:07,750 --> 00:35:04,000
living in

1053
00:35:10,950 --> 00:35:07,760
you know suburban washington dc area

1054
00:35:11,510 --> 00:35:10,960
but we started trying to visit uh

1055
00:35:14,790 --> 00:35:11,520
different

1056
00:35:18,630 --> 00:35:14,800
summer we had gone to

1057
00:35:21,829 --> 00:35:18,640
shenandoah we've been to some in

1058
00:35:23,589 --> 00:35:21,839
hawaii like haleakala and i used to live

1059
00:35:25,030 --> 00:35:23,599
in colorado so i've been to many many of

1060
00:35:28,150 --> 00:35:25,040
the parks in colorado

1061
00:35:29,349 --> 00:35:28,160
um but now my son who's 11 now

1062
00:35:30,710 --> 00:35:29,359
he's like really into it you know he

1063
00:35:31,349 --> 00:35:30,720

wants to like be able to check some of

1064
00:35:34,150 --> 00:35:31,359
these places

1065
00:35:34,550 --> 00:35:34,160
off of his list uh so this past summer

1066
00:35:35,829 --> 00:35:34,560
um

1067
00:35:37,990 --> 00:35:35,839
we were supposed to go to yellowstone we

1068
00:35:40,870 --> 00:35:38,000
had to curtail those plans

1069
00:35:42,870 --> 00:35:40,880
um but we decided to stay semi-local and

1070
00:35:43,430 --> 00:35:42,880
we made a visit down to a great smoky

1071
00:35:47,349 --> 00:35:43,440
mountain

1072
00:35:48,390 --> 00:35:47,359
national park and that was a first for

1073
00:35:51,589 --> 00:35:48,400
all of us it was

1074
00:35:53,430 --> 00:35:51,599
amazing it's beautiful we loved it um we

1075
00:35:55,190 --> 00:35:53,440
got to see some really cool wildlife and

1076
00:35:55,990 --> 00:35:55,200
it's just far away enough from where we

1077
00:35:59,270 --> 00:35:56,000
are now

1078
00:35:59,990 --> 00:35:59,280
we really like uh birds my kids like to

1079
00:36:02,710 --> 00:36:00,000
do

1080
00:36:04,790 --> 00:36:02,720
they're you know um not the most patient

1081
00:36:06,630 --> 00:36:04,800
quiet bird watchers but

1082
00:36:08,310 --> 00:36:06,640
when we do see new birds we like to

1083
00:36:10,150 --> 00:36:08,320
figure out what they are and

1084
00:36:11,670 --> 00:36:10,160
and um kind of keep track you know in a

1085
00:36:15,030 --> 00:36:11,680
little book um

1086
00:36:15,589 --> 00:36:15,040
and we saw some elk uh again park elk

1087
00:36:17,829 --> 00:36:15,599
that were

1088
00:36:19,670 --> 00:36:17,839

very blase about the people and could

1089
00:36:20,230 --> 00:36:19,680
care less about us there not in any way

1090
00:36:22,630 --> 00:36:20,240
afraid

1091
00:36:23,990 --> 00:36:22,640
or or interested uh so that was really

1092
00:36:26,069 --> 00:36:24,000
cool um

1093
00:36:27,030 --> 00:36:26,079
we also just tried to do i think like a

1094
00:36:28,550 --> 00:36:27,040
lot of people

1095
00:36:30,069 --> 00:36:28,560
uh we just tried to do some outdoor

1096
00:36:32,710 --> 00:36:30,079
activities that seemed safe

1097
00:36:33,349 --> 00:36:32,720
um you know given uh trying to be

1098
00:36:35,910 --> 00:36:33,359
careful

1099
00:36:37,670 --> 00:36:35,920
uh with coronavirus so we uh did

1100
00:36:40,470 --> 00:36:37,680
horseback riding through the forest

1101
00:36:42,550 --> 00:36:40,480
um my i took my son's zip lining through

1102
00:36:44,710 --> 00:36:42,560
the trees you know just lots of

1103
00:36:46,390 --> 00:36:44,720
just lots of fun out outdoorsy stuff so

1104
00:36:48,230 --> 00:36:46,400
a lot of what i do

1105
00:36:49,990 --> 00:36:48,240
the adventures i have are different than

1106
00:36:51,270 --> 00:36:50,000
the ones i had before i had kids but

1107
00:36:54,870 --> 00:36:51,280
it's so fun as they get

1108
00:36:57,349 --> 00:36:54,880
older we can do more and more um

1109
00:36:58,950 --> 00:36:57,359
and i can do fun things like uh

1110
00:36:59,670 --> 00:36:58,960
ziplining by conning my kid into doing

1111
00:37:01,910 --> 00:36:59,680
it with me

1112
00:37:03,430 --> 00:37:01,920
that's awesome yeah my son's only 16

1113
00:37:04,870 --> 00:37:03,440

months old right now and so

1114
00:37:06,470 --> 00:37:04,880
i'm at that phase where he can't really

1115
00:37:07,670 --> 00:37:06,480
do all the cool things i want to go do

1116
00:37:09,349 --> 00:37:07,680
just yet but

1117
00:37:10,950 --> 00:37:09,359
so so there is a hope that down the road

1118
00:37:11,829 --> 00:37:10,960
we'll be doing some ziplining together i

1119
00:37:13,750 --> 00:37:11,839
love it

1120
00:37:15,190 --> 00:37:13,760
um so i'm gonna open it up now to the

1121
00:37:16,550 --> 00:37:15,200
audience q a um

1122
00:37:17,910 --> 00:37:16,560
we have a bunch of questions coming in

1123
00:37:18,950 --> 00:37:17,920
from the audience keep those questions

1124
00:37:20,230 --> 00:37:18,960
coming folks

1125
00:37:22,630 --> 00:37:20,240
uh we'll try to get to all of them if we

1126
00:37:23,270 --> 00:37:22,640
can uh the first one is a question that

1127
00:37:25,270 --> 00:37:23,280
came to us

1128
00:37:28,150 --> 00:37:25,280
through twitter uh from a long time

1129
00:37:31,670 --> 00:37:28,160
watcher of the show uh dr jim pass

1130
00:37:33,270 --> 00:37:31,680
uh as an astro sociologist he says

1131
00:37:34,550 --> 00:37:33,280
uh he's interested in hearing your

1132
00:37:35,990 --> 00:37:34,560
thoughts about the search for

1133
00:37:39,190 --> 00:37:36,000
extraterrestrial life

1134
00:37:42,790 --> 00:37:39,200
and how it affects societies even uh

1135
00:37:44,310 --> 00:37:42,800
without uh ambiguous evidence uh and how

1136
00:37:48,630 --> 00:37:44,320
things might change if we do

1137
00:37:51,109 --> 00:37:48,640
find such evidence wow

1138
00:37:51,910 --> 00:37:51,119

that's a dude that's a great question um

1139
00:37:53,670 --> 00:37:51,920
i'm very much

1140
00:37:57,829 --> 00:37:53,680
out of my expertise and i'm speaking

1141
00:38:01,910 --> 00:37:57,839
only this is this opinion is only my own

1142
00:38:03,910 --> 00:38:01,920
type answer um i think there i think it

1143
00:38:05,190 --> 00:38:03,920
personally i think that if we are to

1144
00:38:08,550 --> 00:38:05,200
discover life

1145
00:38:10,230 --> 00:38:08,560
off of earth um whether it's like some

1146
00:38:12,150 --> 00:38:10,240
something that presents itself to us or

1147
00:38:13,750 --> 00:38:12,160
something even just as simple as a micro

1148
00:38:14,470 --> 00:38:13,760
that we discover on another planet i

1149
00:38:15,910 --> 00:38:14,480
mean i

1150
00:38:18,230 --> 00:38:15,920
to me i'm hoping that will be very

1151
00:38:19,750 --> 00:38:18,240
unifying for our society

1152
00:38:21,270 --> 00:38:19,760
um it's a little bit of like the star

1153
00:38:25,270 --> 00:38:21,280
trek view i think

1154
00:38:27,990 --> 00:38:25,280
um you know uh it really

1155
00:38:28,390 --> 00:38:28,000
helping us remind ourselves as humans

1156
00:38:30,470 --> 00:38:28,400
and as

1157
00:38:31,750 --> 00:38:30,480
earthlings uh how we're so much more

1158
00:38:34,550 --> 00:38:31,760
similar

1159
00:38:36,069 --> 00:38:34,560
than we are different um and and i would

1160
00:38:38,790 --> 00:38:36,079
like to think that that that would

1161
00:38:39,910 --> 00:38:38,800
kind of bring us together um as you know

1162
00:38:43,990 --> 00:38:39,920
as a species

1163
00:38:47,109 --> 00:38:44,000

um on earth um and i think even

1164
00:38:48,630 --> 00:38:47,119
uh for those who do search for life

1165
00:38:50,310 --> 00:38:48,640
off of earth we have to think really

1166
00:38:52,230 --> 00:38:50,320
hard about what could it look like

1167
00:38:53,510 --> 00:38:52,240
should we expect it to be similar

1168
00:38:56,069 --> 00:38:53,520
to life on earth and that already kind

1169
00:38:57,270 --> 00:38:56,079
of put you in in that mindset and really

1170
00:39:00,630 --> 00:38:57,280
thinking about

1171
00:39:02,069 --> 00:39:00,640
um what does it mean to be

1172
00:39:03,190 --> 00:39:02,079
you know to be life on earth what does

1173
00:39:05,109 --> 00:39:03,200
it mean to be an earthling what does it

1174
00:39:07,510 --> 00:39:05,119
mean to be a citizen of this planet

1175
00:39:08,630 --> 00:39:07,520
versus what could it be like um uh for

1176
00:39:11,670 --> 00:39:08,640
someone on another

1177
00:39:12,829 --> 00:39:11,680
another planet um so uh that is based on

1178
00:39:15,670 --> 00:39:12,839
zero research

1179
00:39:18,550 --> 00:39:15,680
uh but my hopes

1180
00:39:19,670 --> 00:39:18,560
i think of um why uh part of why the

1181
00:39:22,230 --> 00:39:19,680
search for life i think is

1182
00:39:23,109 --> 00:39:22,240
an important endeavor for humanity and

1183
00:39:26,710 --> 00:39:23,119
and

1184
00:39:29,109 --> 00:39:26,720
that's great yeah

1185
00:39:30,470 --> 00:39:29,119
i agree i love that response and you

1186
00:39:31,670 --> 00:39:30,480
know our questions coming from our

1187
00:39:33,109 --> 00:39:31,680
audience can be about all kinds of

1188
00:39:34,150 --> 00:39:33,119

topics that they want to ask an answer

1189
00:39:35,670 --> 00:39:34,160
biologist

1190
00:39:38,310 --> 00:39:35,680
uh the next two questions are titan

1191
00:39:41,030 --> 00:39:38,320
related though uh so the first is from

1192
00:39:43,270 --> 00:39:41,040
andrew planet uh he asked on twitter uh

1193
00:39:46,310 --> 00:39:43,280
was that very short active lifespan

1194
00:39:47,750 --> 00:39:46,320
of the huygens spacecraft intentional um

1195
00:39:49,670 --> 00:39:47,760
did they know it was going to last for

1196
00:39:51,670 --> 00:39:49,680
such a short period of time yes

1197
00:39:52,870 --> 00:39:51,680
absolutely so it was designed to be a

1198
00:39:55,270 --> 00:39:52,880
descent probe

1199
00:39:56,310 --> 00:39:55,280
so the the whole mission for that

1200
00:39:58,230 --> 00:39:56,320
huygens probe was

1201
00:40:00,150 --> 00:39:58,240
to fall through the atmosphere and it

1202
00:40:02,870 --> 00:40:00,160
did exactly what it was supposed to do

1203
00:40:04,470 --> 00:40:02,880
and in fact uh the 70 minutes it

1204
00:40:05,190 --> 00:40:04,480
survived on the surface was complete

1205
00:40:07,109 --> 00:40:05,200
bonus

1206
00:40:08,829 --> 00:40:07,119
science right so that wasn't even

1207
00:40:10,390 --> 00:40:08,839
originally planned because they couldn't

1208
00:40:12,790 --> 00:40:10,400
guarantee um

1209
00:40:14,230 --> 00:40:12,800
what it would land in so one thing you

1210
00:40:15,430 --> 00:40:14,240
learned what i'm learning

1211
00:40:16,870 --> 00:40:15,440
right so this is the first time i've

1212
00:40:17,829 --> 00:40:16,880
ever sat on a mission from the

1213
00:40:19,190 --> 00:40:17,839

conception

1214
00:40:20,470 --> 00:40:19,200
you know all the way through development

1215
00:40:22,150 --> 00:40:20,480
and what i'm learning is you want to be

1216
00:40:25,430 --> 00:40:22,160
really careful you can't

1217
00:40:26,390 --> 00:40:25,440
put requirements on the planet so i

1218
00:40:29,190 --> 00:40:26,400
can't guarantee

1219
00:40:30,390 --> 00:40:29,200
titan is going to cooperate i can only

1220
00:40:32,710 --> 00:40:30,400
plan for what i

1221
00:40:33,670 --> 00:40:32,720
what i can constrain properly and what i

1222
00:40:34,630 --> 00:40:33,680
can expect

1223
00:40:36,870 --> 00:40:34,640
and then there's some things where

1224
00:40:38,950 --> 00:40:36,880
you're like well if titan cooperates

1225
00:40:40,230 --> 00:40:38,960
we'll get this or this will happen but

1226
00:40:41,670 --> 00:40:40,240
we don't know

1227
00:40:44,390 --> 00:40:41,680
awesome yeah so it could have just like

1228
00:40:45,030 --> 00:40:44,400
sunk down into a group of hydrocarbons

1229
00:40:47,829 --> 00:40:45,040
and

1230
00:40:49,750 --> 00:40:47,839
that could have been it or hit a harder

1231
00:40:52,470 --> 00:40:49,760
surface than we expected maybe and

1232
00:40:53,190 --> 00:40:52,480
broke broke something you know

1233
00:40:55,750 --> 00:40:53,200
interesting

1234
00:40:56,790 --> 00:40:55,760
yeah um so another question uh from uh

1235
00:40:59,829 --> 00:40:56,800
azul pinoba

1236
00:41:01,190 --> 00:40:59,839
on twitter um azul wants to know uh is

1237
00:41:03,109 --> 00:41:01,200
it known how titan's

1238
00:41:05,109 --> 00:41:03,119

seasons influence the methodological

1239
00:41:08,069 --> 00:41:05,119
cycle

1240
00:41:08,630 --> 00:41:08,079
it is yeah so one thing to keep in mind

1241
00:41:13,670 --> 00:41:08,640
is

1242
00:41:17,030 --> 00:41:13,680
half

1243
00:41:18,309 --> 00:41:17,040
earth years so cassini was able to

1244
00:41:21,750 --> 00:41:18,319
observe

1245
00:41:25,190 --> 00:41:21,760
saturn and titan kind of going through

1246
00:41:29,510 --> 00:41:25,200
um a a big seasonal change

1247
00:41:32,870 --> 00:41:29,520
right but um not even a whole year

1248
00:41:34,710 --> 00:41:32,880
only a half of a year and so we

1249
00:41:36,230 --> 00:41:34,720
were able to make a lots of observations

1250
00:41:39,510 --> 00:41:36,240
with cassini flybys

1251
00:41:42,550 --> 00:41:39,520
about how the seasons can shift

1252
00:41:43,190 --> 00:41:42,560
uh some of the chemical species um we

1253
00:41:46,630 --> 00:41:43,200
think it can

1254
00:41:48,230 --> 00:41:46,640
influence uh perhaps there's lakes near

1255
00:41:50,390 --> 00:41:48,240
the sort of dried out what look like

1256
00:41:52,950 --> 00:41:50,400
dried out lake beds that may get filled

1257
00:41:53,910 --> 00:41:52,960
um if there's some rain in in other

1258
00:41:55,829 --> 00:41:53,920
seasons

1259
00:41:57,910 --> 00:41:55,839
uh and then just the rain in general is

1260
00:42:01,030 --> 00:41:57,920
expected you know we can see clouds

1261
00:42:02,870 --> 00:42:01,040
that formed uh in uh sort of certain

1262
00:42:04,069 --> 00:42:02,880
seasons in certain locations uh but then

1263
00:42:05,750 --> 00:42:04,079

not in others

1264
00:42:08,150 --> 00:42:05,760
so there's definitely expected to be an

1265
00:42:10,870 --> 00:42:08,160
influence it's very slow moving

1266
00:42:11,430 --> 00:42:10,880
compared to earth not just because of

1267
00:42:14,870 --> 00:42:11,440
that

1268
00:42:17,190 --> 00:42:14,880
seasons but also because it's very

1269
00:42:18,470 --> 00:42:17,200
cold and so in general the the

1270
00:42:19,670 --> 00:42:18,480
atmosphere is going to be a lot slower

1271
00:42:21,910 --> 00:42:19,680
and a lot more sluggish

1272
00:42:23,109 --> 00:42:21,920
than what we experience on earth right

1273
00:42:24,630 --> 00:42:23,119
the the

1274
00:42:26,550 --> 00:42:24,640
huge temperature gradients you can get

1275
00:42:28,150 --> 00:42:26,560
from solar insulation on earth

1276
00:42:30,309 --> 00:42:28,160
you know you're very far out there the

1277
00:42:31,910 --> 00:42:30,319
sunlight is going to just influence

1278
00:42:34,390 --> 00:42:31,920
things in a smaller

1279
00:42:35,910 --> 00:42:34,400
and and slower way um and i should also

1280
00:42:37,670 --> 00:42:35,920
say it's not just cassini that helps us

1281
00:42:39,190 --> 00:42:37,680
observe how titan is evolving through

1282
00:42:41,030 --> 00:42:39,200
the seasons of course there's uh

1283
00:42:42,710 --> 00:42:41,040
still ground-based or other telescope

1284
00:42:44,870 --> 00:42:42,720
space telescope measurements that can

1285
00:42:45,750 --> 00:42:44,880
be made as well that help us track all

1286
00:42:47,670 --> 00:42:45,760
those things

1287
00:42:50,069 --> 00:42:47,680
um but so i would say i think we have a

1288
00:42:51,109 --> 00:42:50,079

good we have a beginning understanding

1289
00:42:53,670 --> 00:42:51,119
of how that works

1290
00:42:55,910 --> 00:42:53,680
um and that supported ongoing work on

1291
00:42:57,990 --> 00:42:55,920
that also gets supported by

1292
00:42:59,349 --> 00:42:58,000
models that we can do sort of global

1293
00:43:01,190 --> 00:42:59,359
circulation models

1294
00:43:03,030 --> 00:43:01,200
that help us try to understand it and

1295
00:43:05,270 --> 00:43:03,040
and match the data um

1296
00:43:06,470 --> 00:43:05,280
but dragonfly sort of will be uh you

1297
00:43:09,270 --> 00:43:06,480
know ground truth

1298
00:43:11,349 --> 00:43:09,280
for at least this one one area of titan

1299
00:43:12,630 --> 00:43:11,359
making observations and and

1300
00:43:14,309 --> 00:43:12,640
really help us understand that even

1301
00:43:15,109 --> 00:43:14,319
better and that's a great point too

1302
00:43:17,270 --> 00:43:15,119
actually there's there's another

1303
00:43:20,390 --> 00:43:17,280
question right now from anaru mahanti

1304
00:43:21,589 --> 00:43:20,400
uh at strayala just on twitter um he

1305
00:43:22,710 --> 00:43:21,599
wants to know about the landing site

1306
00:43:23,430 --> 00:43:22,720
selection which we didn't even talk

1307
00:43:25,109 --> 00:43:23,440
about yet

1308
00:43:26,630 --> 00:43:25,119
uh he says for nasa's perseverance

1309
00:43:28,550 --> 00:43:26,640
wherever we used remote sensing data of

1310
00:43:30,230 --> 00:43:28,560
mars to select the site

1311
00:43:31,829 --> 00:43:30,240
of scientific interest but also you know

1312
00:43:33,750 --> 00:43:31,839
the engineering had to allow us to

1313
00:43:35,349 --> 00:43:33,760

actually have a landing site

1314
00:43:36,790 --> 00:43:35,359
so can you speak to what we currently

1315
00:43:39,430 --> 00:43:36,800
have for a landing site

1316
00:43:40,630 --> 00:43:39,440
for dragonfly and how we selected it

1317
00:43:43,829 --> 00:43:40,640
sure absolutely

1318
00:43:45,990 --> 00:43:43,839
um so we have all the data that

1319
00:43:47,910 --> 00:43:46,000
was accumulated from cassini so i

1320
00:43:51,270 --> 00:43:47,920
mentioned sort of between the visual

1321
00:43:53,670 --> 00:43:51,280
spectroscopy and radar data

1322
00:43:54,470 --> 00:43:53,680
we actually have a good set and we

1323
00:43:57,670 --> 00:43:54,480
picked

1324
00:43:59,270 --> 00:43:57,680
uh locations on titan where there was a

1325
00:44:00,550 --> 00:43:59,280
good data coverage so that we had the

1326
00:44:01,349 --> 00:44:00,560
best data that we could have about what

1327
00:44:03,829 --> 00:44:01,359
the surface

1328
00:44:05,109 --> 00:44:03,839
uh was like we have what we know from

1329
00:44:06,870 --> 00:44:05,119
the huygens probe

1330
00:44:08,950 --> 00:44:06,880
uh coming in and taking up close images

1331
00:44:11,670 --> 00:44:08,960
of the surface

1332
00:44:12,630 --> 00:44:11,680
and uh then we so we took that

1333
00:44:14,150 --> 00:44:12,640
information

1334
00:44:15,670 --> 00:44:14,160
and then we also thought about well what

1335
00:44:17,270 --> 00:44:15,680
do we want the mission to do right one

1336
00:44:20,470 --> 00:44:17,280
of the biggest goals

1337
00:44:22,069 --> 00:44:20,480
is to visit more than one type of

1338
00:44:23,990 --> 00:44:22,079

compositional area

1339
00:44:25,430 --> 00:44:24,000
so one thing that we can see with the

1340
00:44:27,270 --> 00:44:25,440
measurements we've been able to make of

1341
00:44:29,270 --> 00:44:27,280
the whole titan globe

1342
00:44:31,589 --> 00:44:29,280
is we can't tell exactly what the

1343
00:44:33,910 --> 00:44:31,599
service composition is in every location

1344
00:44:36,150 --> 00:44:33,920
um but we can classify it right so we

1345
00:44:38,630 --> 00:44:36,160
can classify they're sort of like it's

1346
00:44:39,349 --> 00:44:38,640
dark areas and then there's these we got

1347
00:44:41,349 --> 00:44:39,359
like blue

1348
00:44:42,710 --> 00:44:41,359
areas where we know there's water ice

1349
00:44:44,950 --> 00:44:42,720
included um

1350
00:44:46,630 --> 00:44:44,960
and maybe some brownish or greenish you

1351
00:44:48,550 --> 00:44:46,640
know classifying it all

1352
00:44:50,950 --> 00:44:48,560
and and looking at that you can see how

1353
00:44:52,630 --> 00:44:50,960
diverse the surface is

1354
00:44:54,309 --> 00:44:52,640
and so i talked a little bit about dunes

1355
00:44:55,430 --> 00:44:54,319
and i talked about impact craters so in

1356
00:44:57,990 --> 00:44:55,440
addition to being

1357
00:44:59,750 --> 00:44:58,000
you know topographically diverse uh

1358
00:45:01,430 --> 00:44:59,760
geographically diverse these are also

1359
00:45:03,670 --> 00:45:01,440
chemically diverse areas right they have

1360
00:45:05,430 --> 00:45:03,680
different provenances so the materials

1361
00:45:07,430 --> 00:45:05,440
are likely made of different things and

1362
00:45:09,349 --> 00:45:07,440
so we wanted to be able to visit as many

1363
00:45:12,550 --> 00:45:09,359

of those places as possible

1364
00:45:14,150 --> 00:45:12,560
and to include one of these frozen over

1365
00:45:15,589 --> 00:45:14,160
impact areas where we know there used to

1366
00:45:18,309 --> 00:45:15,599
be liquid water because that sort of

1367
00:45:21,510 --> 00:45:18,319
gets at our prebiotic chemistry goals

1368
00:45:21,910 --> 00:45:21,520
and so we found this location um uh near

1369
00:45:25,109 --> 00:45:21,920
silk

1370
00:45:27,910 --> 00:45:25,119
crater sulk is a you know known

1371
00:45:29,510 --> 00:45:27,920
impact crater and it's right near this

1372
00:45:30,150 --> 00:45:29,520
this shangri-la area right with the

1373
00:45:32,630 --> 00:45:30,160
dunes

1374
00:45:33,670 --> 00:45:32,640
and so by going to this location we're

1375
00:45:36,150 --> 00:45:33,680
able to visit

1376
00:45:37,589 --> 00:45:36,160
uh the dune fields understand those

1377
00:45:38,790 --> 00:45:37,599
understand the organic sands that

1378
00:45:41,589 --> 00:45:38,800
comprise them

1379
00:45:43,109 --> 00:45:41,599
uh where they come from but then also

1380
00:45:44,150 --> 00:45:43,119
look at an impact crater where there

1381
00:45:45,190 --> 00:45:44,160
might have been this more advanced

1382
00:45:48,309 --> 00:45:45,200
synthesis

1383
00:45:51,510 --> 00:45:48,319
and the data that we have

1384
00:45:52,069 --> 00:45:51,520
isn't as high resolution as the type

1385
00:45:54,309 --> 00:45:52,079
that we

1386
00:45:56,150 --> 00:45:54,319
have for mars certainly especially for

1387
00:45:58,150 --> 00:45:56,160
you know like a perseverance

1388
00:45:59,750 --> 00:45:58,160

uh you know we have very high resolution

1389
00:46:00,150 --> 00:45:59,760
uh data for mars we have to remember we

1390
00:46:03,589 --> 00:46:00,160
don't

1391
00:46:05,910 --> 00:46:03,599
have to um drive across the surface and

1392
00:46:07,030 --> 00:46:05,920
another cool thing is that when we come

1393
00:46:10,150 --> 00:46:07,040
in

1394
00:46:10,950 --> 00:46:10,160
the craft itself um comes out of the the

1395
00:46:13,030 --> 00:46:10,960
back shell and

1396
00:46:14,470 --> 00:46:13,040
and transitions to its own powered

1397
00:46:16,630 --> 00:46:14,480
flight and so

1398
00:46:18,790 --> 00:46:16,640
it can pick its landing site its initial

1399
00:46:21,670 --> 00:46:18,800
landing site and it and it does so

1400
00:46:23,510 --> 00:46:21,680
with you know using imagery and and

1401
00:46:25,109 --> 00:46:23,520
light iron like terrain navigation

1402
00:46:26,950 --> 00:46:25,119
to select a safe landing site so it's

1403
00:46:29,030 --> 00:46:26,960
okay that we don't know the exact

1404
00:46:30,470 --> 00:46:29,040
precise you know

1405
00:46:32,710 --> 00:46:30,480
really really high resolution areas we

1406
00:46:33,510 --> 00:46:32,720
know enough to know that there are big

1407
00:46:35,670 --> 00:46:33,520
flats

1408
00:46:37,589 --> 00:46:35,680
uh big flat areas in these dunes and

1409
00:46:39,510 --> 00:46:37,599
there's a lot of potential landing sites

1410
00:46:41,109 --> 00:46:39,520
and then as we go we'll always be doing

1411
00:46:43,430 --> 00:46:41,119
reconnaissance we call leap frog we'll

1412
00:46:45,430 --> 00:46:43,440
always be flying over a new area

1413
00:46:46,710 --> 00:46:45,440

making really high detail making our own

1414
00:46:48,950 --> 00:46:46,720
maps right

1415
00:46:50,710 --> 00:46:48,960
coming back to the original landing site

1416
00:46:53,670 --> 00:46:50,720
deciding where the next target is

1417
00:46:54,230 --> 00:46:53,680
and then moving over to that awesome and

1418
00:46:56,550 --> 00:46:54,240
you kind of

1419
00:46:57,750 --> 00:46:56,560
alluded to this earlier a good bit but

1420
00:46:59,829 --> 00:46:57,760
uh miriam nassim

1421
00:47:01,750 --> 00:46:59,839
on segonnet wants to know from an

1422
00:47:03,990 --> 00:47:01,760
astrobiology perspective

1423
00:47:05,270 --> 00:47:04,000
if you think titan may be habitable or

1424
00:47:06,790 --> 00:47:05,280
could be inhabited

1425
00:47:09,270 --> 00:47:06,800
and what kind of life you think might

1426
00:47:12,870 --> 00:47:09,280
actually be able to survive on titan

1427
00:47:16,710 --> 00:47:12,880
yeah so this is such a fun question um

1428
00:47:19,190 --> 00:47:16,720
the in the subsurface ocean right that's

1429
00:47:20,710 --> 00:47:19,200
often thought about as probably the most

1430
00:47:23,990 --> 00:47:20,720
likely long-term

1431
00:47:26,150 --> 00:47:24,000
habitat for life water-based life right

1432
00:47:27,510 --> 00:47:26,160
because if it's maintained for a long

1433
00:47:30,309 --> 00:47:27,520
period of time

1434
00:47:30,630 --> 00:47:30,319
and if there's uh sufficient nutrients

1435
00:47:35,589 --> 00:47:30,640
and

1436
00:47:37,030 --> 00:47:35,599
then uh that would be the place that

1437
00:47:40,230 --> 00:47:37,040
would be most likely to

1438
00:47:41,829 --> 00:47:40,240

harbor life that's one reason we think

1439
00:47:42,950 --> 00:47:41,839
about connection between that ocean and

1440
00:47:45,190 --> 00:47:42,960
the surface is as

1441
00:47:46,630 --> 00:47:45,200
as being really critical um but the

1442
00:47:50,390 --> 00:47:46,640
truth is we don't really know how

1443
00:47:52,230 --> 00:47:50,400
life evolved on earth right so maybe

1444
00:47:54,069 --> 00:47:52,240
those some of those surface environments

1445
00:47:55,030 --> 00:47:54,079
even if they're transient surface

1446
00:47:56,710 --> 00:47:55,040
environments

1447
00:47:58,950 --> 00:47:56,720
of liquid water or if they're fed from

1448
00:48:01,829 --> 00:47:58,960
the anterior um

1449
00:48:02,230 --> 00:48:01,839
you know it's possible that life could

1450
00:48:04,470 --> 00:48:02,240
have

1451
00:48:05,589 --> 00:48:04,480
uh at least persisted for brief periods

1452
00:48:07,109 --> 00:48:05,599
of time

1453
00:48:08,549 --> 00:48:07,119
in those environments and and i think

1454
00:48:09,270 --> 00:48:08,559
you grant me use the word um like

1455
00:48:11,270 --> 00:48:09,280
refuges

1456
00:48:12,630 --> 00:48:11,280
or oasis maybe and so maybe they would

1457
00:48:13,750 --> 00:48:12,640
have been temporary but a thousand years

1458
00:48:15,030 --> 00:48:13,760
doesn't seem temporary to like a

1459
00:48:17,990 --> 00:48:15,040
bacteria right so

1460
00:48:19,109 --> 00:48:18,000
uh it doesn't even seem temporary to me

1461
00:48:21,750 --> 00:48:19,119
um

1462
00:48:22,470 --> 00:48:21,760
so uh you know that's a potential maybe

1463
00:48:25,109 --> 00:48:22,480

it was just this

1464
00:48:26,710 --> 00:48:25,119
this very brief amount of time um and

1465
00:48:28,150 --> 00:48:26,720
then if you want to get really exciting

1466
00:48:30,549 --> 00:48:28,160
then we can think about okay well we

1467
00:48:34,230 --> 00:48:30,559
know there's these methane and ethane

1468
00:48:37,430 --> 00:48:34,240
seas at the poles uh we know there's

1469
00:48:38,950 --> 00:48:37,440
um you know maybe methane soaked sands

1470
00:48:39,349 --> 00:48:38,960
in other places and and then we can

1471
00:48:41,510 --> 00:48:39,359
start

1472
00:48:42,790 --> 00:48:41,520
you know having fun thinking about like

1473
00:48:45,510 --> 00:48:42,800
weird life and and

1474
00:48:47,670 --> 00:48:45,520
what potential you know other other

1475
00:48:48,870 --> 00:48:47,680
biochemistries could be supported

1476
00:48:50,790 --> 00:48:48,880
in that type of environment i know

1477
00:48:51,910 --> 00:48:50,800
there's some good you know some people

1478
00:48:53,510 --> 00:48:51,920
started looking into

1479
00:48:55,510 --> 00:48:53,520
into that type of that type of

1480
00:48:57,430 --> 00:48:55,520
possibility that's so groovy

1481
00:48:59,829 --> 00:48:57,440
i remember a few years ago uh the folks

1482
00:49:02,630 --> 00:48:59,839
at goddard's visualization studio

1483
00:49:04,390 --> 00:49:02,640
released like this video of a submarine

1484
00:49:05,510 --> 00:49:04,400
going down into one of titan's lakes and

1485
00:49:07,190 --> 00:49:05,520
looking around

1486
00:49:09,750 --> 00:49:07,200
um made me wonder if there could be some

1487
00:49:11,589 --> 00:49:09,760
weird alien octopus that lives in

1488
00:49:12,950 --> 00:49:11,599

in methane and ethane lakes and super

1489
00:49:14,829 --> 00:49:12,960
cold temperatures down there to grab

1490
00:49:17,589 --> 00:49:14,839
that submarine

1491
00:49:18,950 --> 00:49:17,599
yeah i think i think we all hope if we

1492
00:49:20,549 --> 00:49:18,960
send a submarine anywhere

1493
00:49:22,710 --> 00:49:20,559
whether it's titan or europa i think we

1494
00:49:25,990 --> 00:49:22,720
all hope it'll get eaten by an octopus

1495
00:49:27,109 --> 00:49:26,000
exactly yeah from jules verne like

1496
00:49:28,710 --> 00:49:27,119
it's just in all of our heads it's

1497
00:49:30,470 --> 00:49:28,720
ingrained in the culture of science

1498
00:49:33,109 --> 00:49:30,480
fiction and all these things so

1499
00:49:35,349 --> 00:49:33,119
um let's jump ship a little bit our next

1500
00:49:36,470 --> 00:49:35,359
question comes from blake overbay on

1501
00:49:38,309 --> 00:49:36,480
facebook

1502
00:49:40,150 --> 00:49:38,319
uh blake is majoring right now in

1503
00:49:41,670 --> 00:49:40,160
environmental chemistry and has interest

1504
00:49:44,790 --> 00:49:41,680
in abiogenesis and

1505
00:49:45,510 --> 00:49:44,800
the origin of life uh and so blake wants

1506
00:49:47,190 --> 00:49:45,520
to know

1507
00:49:48,309 --> 00:49:47,200
and you may not have the best answer for

1508
00:49:49,510 --> 00:49:48,319
this it's up to you how you wanna how

1509
00:49:51,990 --> 00:49:49,520
you wanna answer it

1510
00:49:53,349 --> 00:49:52,000
um if astrobiologists right now are

1511
00:49:56,150 --> 00:49:53,359
trying to answer these questions

1512
00:49:56,870 --> 00:49:56,160
of the origin of life um is there a lot

1513
00:49:59,190 --> 00:49:56,880

of call

1514
00:50:00,309 --> 00:49:59,200
for origin of life research and do you

1515
00:50:00,950 --> 00:50:00,319
think that we're getting closer to

1516
00:50:04,230 --> 00:50:00,960
finding

1517
00:50:07,109 --> 00:50:04,240
life from non-life

1518
00:50:07,910 --> 00:50:07,119
um we're closer than we ever were that's

1519
00:50:10,390 --> 00:50:07,920
so that's answering

1520
00:50:12,390 --> 00:50:10,400
no there's actually there's a huge

1521
00:50:15,829 --> 00:50:12,400
community of people in origin of life

1522
00:50:16,309 --> 00:50:15,839
research absolutely um i luckily before

1523
00:50:19,750 --> 00:50:16,319
the

1524
00:50:22,309 --> 00:50:19,760
in person to um

1525
00:50:23,910 --> 00:50:22,319
a really great meeting on original life

1526
00:50:27,589 --> 00:50:23,920
research earlier this year

1527
00:50:29,510 --> 00:50:27,599
um and there are so many different ways

1528
00:50:32,710 --> 00:50:29,520
that that question is being approached

1529
00:50:34,790 --> 00:50:32,720
it's very multidisciplinary um

1530
00:50:36,470 --> 00:50:34,800
philosophically just you know like a

1531
00:50:37,670 --> 00:50:36,480
wide range of sort of philosophies of

1532
00:50:40,230 --> 00:50:37,680
how to think about it

1533
00:50:42,950 --> 00:50:40,240
um we're thinking about what happens if

1534
00:50:44,710 --> 00:50:42,960
you bring in material from outside

1535
00:50:46,549 --> 00:50:44,720
uh to a planet what happens if the

1536
00:50:48,150 --> 00:50:46,559
planet sort of makes its own

1537
00:50:49,589 --> 00:50:48,160
um you know chemistry kind of like i've

1538
00:50:51,589 --> 00:50:49,599

been talking about with like the titan

1539
00:50:53,750 --> 00:50:51,599
like prebiotic chemistry um

1540
00:50:55,829 --> 00:50:53,760
there's so many different ways to to

1541
00:50:57,750 --> 00:50:55,839
think about it and to understand

1542
00:50:59,190 --> 00:50:57,760
what are the controlling parameters of

1543
00:51:00,710 --> 00:50:59,200
an environment um

1544
00:51:02,549 --> 00:51:00,720
and people are making a ton of progress

1545
00:51:05,109 --> 00:51:02,559
and understanding what are those first

1546
00:51:05,910 --> 00:51:05,119
critical steps of synthesis at least for

1547
00:51:08,549 --> 00:51:05,920
the early earth

1548
00:51:10,150 --> 00:51:08,559
um and so in that case you know we we

1549
00:51:11,510 --> 00:51:10,160
have minimal constraints

1550
00:51:12,950 --> 00:51:11,520
and and so it's good that so many people

1551
00:51:14,309 --> 00:51:12,960
are kind of approaching it and thinking

1552
00:51:16,390 --> 00:51:14,319
about it in different ways because you

1553
00:51:17,910 --> 00:51:16,400
have to explore all these potential

1554
00:51:19,670 --> 00:51:17,920
pathways for for how it might have

1555
00:51:21,510 --> 00:51:19,680
happened on earth you know we can't we

1556
00:51:23,109 --> 00:51:21,520
have very little evidence of of

1557
00:51:25,030 --> 00:51:23,119
what happened back then all we have is

1558
00:51:25,910 --> 00:51:25,040
the end point right the life we see

1559
00:51:27,270 --> 00:51:25,920
around us

1560
00:51:28,950 --> 00:51:27,280
um but that's one thing why we think

1561
00:51:31,270 --> 00:51:28,960
it's so cool to go to titan

1562
00:51:32,390 --> 00:51:31,280
too because that's a place where you

1563
00:51:34,390 --> 00:51:32,400

don't have life all over

1564
00:51:35,990 --> 00:51:34,400
everywhere right biology hasn't just

1565
00:51:38,470 --> 00:51:36,000
over printed on all of

1566
00:51:39,030 --> 00:51:38,480
the chemical processes that are going on

1567
00:51:42,150 --> 00:51:39,040
and and

1568
00:51:43,670 --> 00:51:42,160
and that's part of helping us you know

1569
00:51:45,430 --> 00:51:43,680
ultimately go back and think about what

1570
00:51:47,190 --> 00:51:45,440
happened on earth billions of years ago

1571
00:51:48,230 --> 00:51:47,200
that that led to the formation of life

1572
00:51:49,829 --> 00:51:48,240
there

1573
00:51:50,870 --> 00:51:49,839
yeah you know i often tell people that

1574
00:51:52,470 --> 00:51:50,880
there's there's a good chance we'll

1575
00:51:54,150 --> 00:51:52,480
never know for sure

1576
00:51:55,510 --> 00:51:54,160
how life started here on earth because

1577
00:51:56,470 --> 00:51:55,520
we might have lost that record

1578
00:51:58,309 --> 00:51:56,480
chemically

1579
00:51:59,829 --> 00:51:58,319
um but with titan there's a chance we

1580
00:52:02,150 --> 00:51:59,839
could actually see the process

1581
00:52:03,510 --> 00:52:02,160
in action um even if that process does

1582
00:52:05,030 --> 00:52:03,520
take a very long time so that's that's

1583
00:52:06,630 --> 00:52:05,040
really cool to think about

1584
00:52:09,270 --> 00:52:06,640
uh another question from another

1585
00:52:10,470 --> 00:52:09,280
undergraduate uh kennedy marthaler

1586
00:52:11,990 --> 00:52:10,480
uh has said that they're an

1587
00:52:12,790 --> 00:52:12,000
undergraduate majoring in physical

1588
00:52:14,870 --> 00:52:12,800

sciences

1589
00:52:16,309 --> 00:52:14,880
math and physics and are determined to

1590
00:52:18,710 --> 00:52:16,319
go to graduate school

1591
00:52:20,069 --> 00:52:18,720
uh for either astronomy or looking into

1592
00:52:21,109 --> 00:52:20,079
astrobiology

1593
00:52:23,430 --> 00:52:21,119
and they want to know if you have any

1594
00:52:25,270 --> 00:52:23,440
tips in how to get started in such

1595
00:52:26,710 --> 00:52:25,280
programs um they are you know

1596
00:52:27,510 --> 00:52:26,720
competitive sometimes to get into these

1597
00:52:28,710 --> 00:52:27,520
programs

1598
00:52:30,470 --> 00:52:28,720
and so we can also go a little bit

1599
00:52:32,069 --> 00:52:30,480
broader if you don't mind what would

1600
00:52:33,589 --> 00:52:32,079
your advice be to any of our

1601
00:52:35,589 --> 00:52:33,599
undergraduates right now who

1602
00:52:37,430 --> 00:52:35,599
are watching and might be interested in

1603
00:52:40,630 --> 00:52:37,440
pursuing astrobiology

1604
00:52:43,510 --> 00:52:40,640
sure so i can i'll speak specifically to

1605
00:52:45,109 --> 00:52:43,520
to how i got into astrobiology and what

1606
00:52:48,150 --> 00:52:45,119
i think was really helpful for me

1607
00:52:51,270 --> 00:52:48,160
um and what it was was to

1608
00:52:51,990 --> 00:52:51,280
stay in a primary discipline so instead

1609
00:52:55,349 --> 00:52:52,000
of

1610
00:52:59,109 --> 00:52:55,359
pursuing maybe a a degree

1611
00:53:00,790 --> 00:52:59,119
a phd that was just astrobiology or

1612
00:53:02,710 --> 00:53:00,800
you know what i did is i i stuck with

1613
00:53:04,549 --> 00:53:02,720

chemistry which i really liked

1614
00:53:05,990 --> 00:53:04,559
um but that could be physics it could be

1615
00:53:07,829 --> 00:53:06,000
geology it could be any of

1616
00:53:09,670 --> 00:53:07,839
those things so i so i kind of stayed in

1617
00:53:11,190 --> 00:53:09,680
a core discipline

1618
00:53:13,030 --> 00:53:11,200
uh so more traditional i should say

1619
00:53:16,470 --> 00:53:13,040
that's what i'm saying um

1620
00:53:18,549 --> 00:53:16,480
discipline and and then got involved

1621
00:53:20,230 --> 00:53:18,559
in you know taking classes that were

1622
00:53:22,309 --> 00:53:20,240
related to astrobiology

1623
00:53:23,589 --> 00:53:22,319
or um or having research or

1624
00:53:25,589 --> 00:53:23,599
participating in

1625
00:53:27,670 --> 00:53:25,599
um meetings and seminars that were

1626
00:53:29,510 --> 00:53:27,680
focused around astrobiology but

1627
00:53:31,349 --> 00:53:29,520
i i was really glad that i maintained

1628
00:53:33,750 --> 00:53:31,359
sort of that grounding

1629
00:53:34,470 --> 00:53:33,760
in in in that other discipline so i

1630
00:53:37,829 --> 00:53:34,480
recommend

1631
00:53:39,589 --> 00:53:37,839
thinking about which uh types of science

1632
00:53:42,870 --> 00:53:39,599
you're really passionate about

1633
00:53:44,950 --> 00:53:42,880
um and so many of them

1634
00:53:46,710 --> 00:53:44,960
have a link to astro bad like that's

1635
00:53:48,309 --> 00:53:46,720
what i love about astrobiology it's so

1636
00:53:48,790 --> 00:53:48,319
multidisciplinary and that's what makes

1637
00:53:50,470 --> 00:53:48,800
it

1638
00:53:52,870 --> 00:53:50,480

a so fascinating and that's what helps

1639
00:53:55,109 --> 00:53:52,880
us make progress right like i'm the only

1640
00:53:56,790 --> 00:53:55,119
uh i may be the only chemist that like

1641
00:54:00,390 --> 00:53:56,800
works around me at all and my

1642
00:54:01,430 --> 00:54:00,400
my group at nasa um and i you know i so

1643
00:54:02,870 --> 00:54:01,440
i work with a bunch of people who all

1644
00:54:05,109 --> 00:54:02,880
bring some other

1645
00:54:06,390 --> 00:54:05,119
you know sort of expertise in terms of

1646
00:54:07,430 --> 00:54:06,400
their training

1647
00:54:09,750 --> 00:54:07,440
but then together we can make

1648
00:54:10,790 --> 00:54:09,760
connections and we can and we can come

1649
00:54:13,670 --> 00:54:10,800
together and

1650
00:54:14,630 --> 00:54:13,680
and kind of build um something like that

1651
00:54:16,870 --> 00:54:14,640
so

1652
00:54:17,750 --> 00:54:16,880
that's my that's the advice i usually

1653
00:54:20,790 --> 00:54:17,760
give

1654
00:54:24,309 --> 00:54:20,800
awesome yeah i i noticed in your bio

1655
00:54:26,630 --> 00:54:24,319
uh so i'm a past ab grad con of when we

1656
00:54:28,790 --> 00:54:26,640
had at cu boulder in 2016

1657
00:54:30,790 --> 00:54:28,800
uh we just had our last episode of ask

1658
00:54:33,670 --> 00:54:30,800
an astrobiologist was focused

1659
00:54:35,270 --> 00:54:33,680
on ab grad con and the importance of

1660
00:54:35,670 --> 00:54:35,280
things like this like you know meetings

1661
00:54:37,349 --> 00:54:35,680
and

1662
00:54:38,950 --> 00:54:37,359
you know conferences where you know

1663
00:54:40,789 --> 00:54:38,960

undergraduates and graduate students and

1664
00:54:42,390 --> 00:54:40,799
postdocs can come together and share

1665
00:54:44,630 --> 00:54:42,400
their research

1666
00:54:46,069 --> 00:54:44,640
and you were a past organizer of grad

1667
00:54:47,270 --> 00:54:46,079
con i saw

1668
00:54:49,190 --> 00:54:47,280
i wonder if you can speak to the

1669
00:54:50,069 --> 00:54:49,200
importance of ab grad con and other

1670
00:54:52,710 --> 00:54:50,079
meetings

1671
00:54:55,030 --> 00:54:52,720
and networking uh in your career oh

1672
00:54:57,829 --> 00:54:55,040
absolutely i would not have my job

1673
00:54:59,510 --> 00:54:57,839
if it weren't for astrobiology meetings

1674
00:55:02,789 --> 00:54:59,520
actually

1675
00:55:06,309 --> 00:55:02,799
when i think about it um one

1676
00:55:09,109 --> 00:55:06,319
uh meeting sort of um apps icon uh

1677
00:55:09,990 --> 00:55:09,119
meetings i would go to uh every time

1678
00:55:11,750 --> 00:55:10,000
they happened

1679
00:55:13,270 --> 00:55:11,760
um when i was a graduate student i was

1680
00:55:15,750 --> 00:55:13,280
very lucky i had an advisor who

1681
00:55:16,390 --> 00:55:15,760
who really pushed me uh pushed all of

1682
00:55:18,710 --> 00:55:16,400
her students

1683
00:55:20,870 --> 00:55:18,720
to present at meetings um and get out

1684
00:55:21,990 --> 00:55:20,880
there and by presenting my research sort

1685
00:55:24,069 --> 00:55:22,000
of on titan

1686
00:55:26,390 --> 00:55:24,079
you know aerosols and early earth

1687
00:55:29,430 --> 00:55:26,400
aerosols i made uh connections

1688
00:55:31,430 --> 00:55:29,440

um with one scientist who

1689
00:55:32,710 --> 00:55:31,440
was uh very interested in working at

1690
00:55:36,309 --> 00:55:32,720
penn state at the time

1691
00:55:39,349 --> 00:55:36,319
um and then remembered that discussion

1692
00:55:41,190 --> 00:55:39,359
years later when she was in a group at

1693
00:55:42,069 --> 00:55:41,200
goddard that was about wanted to hire

1694
00:55:44,309 --> 00:55:42,079
somebody new

1695
00:55:45,349 --> 00:55:44,319
and that's who passed my name for

1696
00:55:47,109 --> 00:55:45,359
example to

1697
00:55:48,549 --> 00:55:47,119
the person who ended up hiring me in my

1698
00:55:50,309 --> 00:55:48,559
current job

1699
00:55:52,309 --> 00:55:50,319
and in addition to that when i organized

1700
00:55:55,190 --> 00:55:52,319
avira khan i did so

1701
00:55:56,390 --> 00:55:55,200
um with two other people one of whom was

1702
00:55:58,069 --> 00:55:56,400
a postdoc at goddard

1703
00:55:59,990 --> 00:55:58,079
so when the job opportunity came up i

1704
00:56:02,630 --> 00:56:00,000
was like oh hey avi

1705
00:56:03,109 --> 00:56:02,640
um there's a job opening do you think i

1706
00:56:05,270 --> 00:56:03,119
should

1707
00:56:06,950 --> 00:56:05,280
try you know and if i come out to

1708
00:56:07,589 --> 00:56:06,960
give a seminar can i visit you and see

1709
00:56:11,030 --> 00:56:07,599
what

1710
00:56:14,549 --> 00:56:11,040
like at goddard um

1711
00:56:19,190 --> 00:56:17,430
um and and now it turns out the both of

1712
00:56:20,950 --> 00:56:19,200
the people i organize every con with

1713
00:56:22,870 --> 00:56:20,960

both we all work at goddard all three of

1714
00:56:24,549 --> 00:56:22,880
us awesome yeah so

1715
00:56:26,069 --> 00:56:24,559
i mean i became the host of this show

1716
00:56:28,309 --> 00:56:26,079
because because of ab grad khan and

1717
00:56:29,910 --> 00:56:28,319
meeting sanjoy sam and the folks who run

1718
00:56:31,349 --> 00:56:29,920
blue marble space and sega net and

1719
00:56:33,990 --> 00:56:31,359
becoming friends and

1720
00:56:35,109 --> 00:56:34,000
it led to me being here now too um so

1721
00:56:36,470 --> 00:56:35,119
that's wonderful

1722
00:56:37,829 --> 00:56:36,480
uh there's one more question that just

1723
00:56:39,589 --> 00:56:37,839
came in that i really want to ask

1724
00:56:42,870 --> 00:56:39,599
because it's a really cool question

1725
00:56:44,789 --> 00:56:42,880
um going back to titan um ken

1726
00:56:46,789 --> 00:56:44,799
titan so you mentioned how titan has

1727
00:56:48,069 --> 00:56:46,799
this bedrock of water ice

1728
00:56:51,430 --> 00:56:48,079
and and we've discussed you know like

1729
00:56:54,549 --> 00:56:51,440
this sand particles of organic material

1730
00:56:57,270 --> 00:56:54,559
uh so user at rogue zebra tmr

1731
00:56:57,670 --> 00:56:57,280
on twitter wants to know can titan have

1732
00:56:59,990 --> 00:56:57,680
different

1733
00:57:01,670 --> 00:57:00,000
types of rocks could it be like you know

1734
00:57:02,309 --> 00:57:01,680
we have igneous metamorphic sedimentary

1735
00:57:05,670 --> 00:57:02,319
rocks

1736
00:57:09,589 --> 00:57:05,680
you know that this this

1737
00:57:12,789 --> 00:57:09,599
icy material on titan in the same way so

1738
00:57:13,270 --> 00:57:12,799

we will i think i i really believe we

1739
00:57:14,630 --> 00:57:13,280
will we

1740
00:57:16,150 --> 00:57:14,640
at one of our earliest science team

1741
00:57:16,870 --> 00:57:16,160
meetings we talked about how we're going

1742
00:57:19,109 --> 00:57:16,880
to be

1743
00:57:21,190 --> 00:57:19,119
sort of writing the mineralogy of titan

1744
00:57:24,390 --> 00:57:21,200
with the kind of studies that we can do

1745
00:57:27,670 --> 00:57:24,400
uh with dragonfly and um

1746
00:57:29,670 --> 00:57:27,680
i i think knowing what we do know now i

1747
00:57:32,630 --> 00:57:29,680
have every expectation that we'll find

1748
00:57:33,030 --> 00:57:32,640
evidence right of sedimentary formations

1749
00:57:35,109 --> 00:57:33,040
but

1750
00:57:36,950 --> 00:57:35,119
it'll be made of things that are

1751
00:57:38,710 --> 00:57:36,960
affected by liquid methane flowing over

1752
00:57:41,030 --> 00:57:38,720
them instead of liquid water flowing

1753
00:57:43,510 --> 00:57:41,040
over them right we expect to find

1754
00:57:44,150 --> 00:57:43,520
um maybe even conglomerates of like

1755
00:57:45,670 --> 00:57:44,160
water ice

1756
00:57:47,270 --> 00:57:45,680
chunks but maybe they're an organic

1757
00:57:49,589 --> 00:57:47,280
matrix or vice versa

1758
00:57:50,630 --> 00:57:49,599
um and we know we have like these impact

1759
00:57:53,109 --> 00:57:50,640
melts and

1760
00:57:54,470 --> 00:57:53,119
and and so i think absolutely we're

1761
00:57:55,349 --> 00:57:54,480
going to be classifying all the

1762
00:57:58,069 --> 00:57:55,359
materials

1763
00:57:59,670 --> 00:57:58,079

that we find and it's going to be it's

1764
00:58:02,230 --> 00:57:59,680
going to be um

1765
00:58:02,789 --> 00:58:02,240
you know a lot of parallels because you

1766
00:58:04,710 --> 00:58:02,799
know

1767
00:58:06,069 --> 00:58:04,720
that's how we study other planets right

1768
00:58:09,030 --> 00:58:06,079
we take what we know from earth

1769
00:58:09,670 --> 00:58:09,040
and we apply it to those other systems

1770
00:58:10,789 --> 00:58:09,680
awesome

1771
00:58:13,030 --> 00:58:10,799
uh do you have time for one more

1772
00:58:15,109 --> 00:58:13,040
question dr training yeah okay awesome

1773
00:58:16,470 --> 00:58:15,119
uh so one more question uh and to all of

1774
00:58:18,150 --> 00:58:16,480
those asking questions thank you very

1775
00:58:19,990 --> 00:58:18,160
much we're not gonna get to all of them

1776
00:58:21,510 --> 00:58:20,000
obviously but i do appreciate uh

1777
00:58:22,230 --> 00:58:21,520
everyone asking your questions for dr

1778
00:58:24,309 --> 00:58:22,240
traynor

1779
00:58:27,030 --> 00:58:24,319
uh our last question comes from azul

1780
00:58:28,390 --> 00:58:27,040
again uh she wants to know in terms of

1781
00:58:30,470 --> 00:58:28,400
resistance design

1782
00:58:31,510 --> 00:58:30,480
how does the dragonfly spacecraft differ

1783
00:58:33,750 --> 00:58:31,520
from the huygens

1784
00:58:36,150 --> 00:58:33,760
spacecraft uh allowing it to have that

1785
00:58:39,270 --> 00:58:36,160
much longer of a lifespan

1786
00:58:41,349 --> 00:58:39,280
oh it's it's power it's 100

1787
00:58:42,549 --> 00:58:41,359
power so the huygens probe was powered

1788
00:58:44,789 --> 00:58:42,559

with a battery

1789
00:58:46,230 --> 00:58:44,799
and so eventually the battery just runs

1790
00:58:48,630 --> 00:58:46,240
out

1791
00:58:49,990 --> 00:58:48,640
whereas as we talked before the idea is

1792
00:58:51,910 --> 00:58:50,000
that um

1793
00:58:53,510 --> 00:58:51,920
uh dragonfly was designed to be powered

1794
00:58:54,230 --> 00:58:53,520
with a nuclear energy source that can

1795
00:58:55,910 --> 00:58:54,240
last much

1796
00:58:57,910 --> 00:58:55,920
much much longer for years years and

1797
00:58:59,670 --> 00:58:57,920
years well that's wonderful

1798
00:59:01,670 --> 00:58:59,680
well dr traynor thank you so much for

1799
00:59:03,430 --> 00:59:01,680
joining us for asking master biologists

1800
00:59:05,030 --> 00:59:03,440
i'm just i'm way more hopeful now about

1801
00:59:05,750 --> 00:59:05,040
dragonfly i'm so excited for this

1802
00:59:08,069 --> 00:59:05,760
mission

1803
00:59:09,349 --> 00:59:08,079
um there's so much more to learn uh so

1804
00:59:10,470 --> 00:59:09,359
hopefully folks can reach out to you if

1805
00:59:12,710 --> 00:59:10,480
you're okay with that

1806
00:59:14,230 --> 00:59:12,720
uh you are at planet underscore trainer

1807
00:59:15,190 --> 00:59:14,240
on twitter and i think folks can find

1808
00:59:17,270 --> 00:59:15,200
you there

1809
00:59:19,589 --> 00:59:17,280
and ask more questions and thank you for

1810
00:59:21,990 --> 00:59:19,599
joining us for ask an astrobiologist

1811
00:59:23,109 --> 00:59:22,000
thank you so much this is so fun oh it

1812
00:59:25,109 --> 00:59:23,119
was great having you

1813
00:59:26,710 --> 00:59:25,119

uh for everyone watching uh if you're

1814
00:59:28,630 --> 00:59:26,720
interested right now our producer and

1815
00:59:29,510 --> 00:59:28,640
director mike tyan is going to put up a

1816
00:59:32,549 --> 00:59:29,520
poster

1817
00:59:34,390 --> 00:59:32,559
from nasa of the dragonfly mission

1818
00:59:36,230 --> 00:59:34,400
and you can download and print this

1819
00:59:37,109 --> 00:59:36,240
special dragonfly mission poster for

1820
00:59:39,270 --> 00:59:37,119
yourself

1821
00:59:40,950 --> 00:59:39,280
uh the link is now available at the nasa

1822
00:59:43,990 --> 00:59:40,960
astrobiology twitter account

1823
00:59:45,430 --> 00:59:44,000
uh that's at nasa astro bio no space

1824
00:59:47,030 --> 00:59:45,440
obviously

1825
00:59:48,710 --> 00:59:47,040
and so for everyone watching everyone

1826
00:59:50,230 --> 00:59:48,720
asking questions getting involved

1827
00:59:52,390 --> 00:59:50,240
thank you so much for asking an astro

1828
01:00:01,060 --> 00:59:52,400
biologist and as always