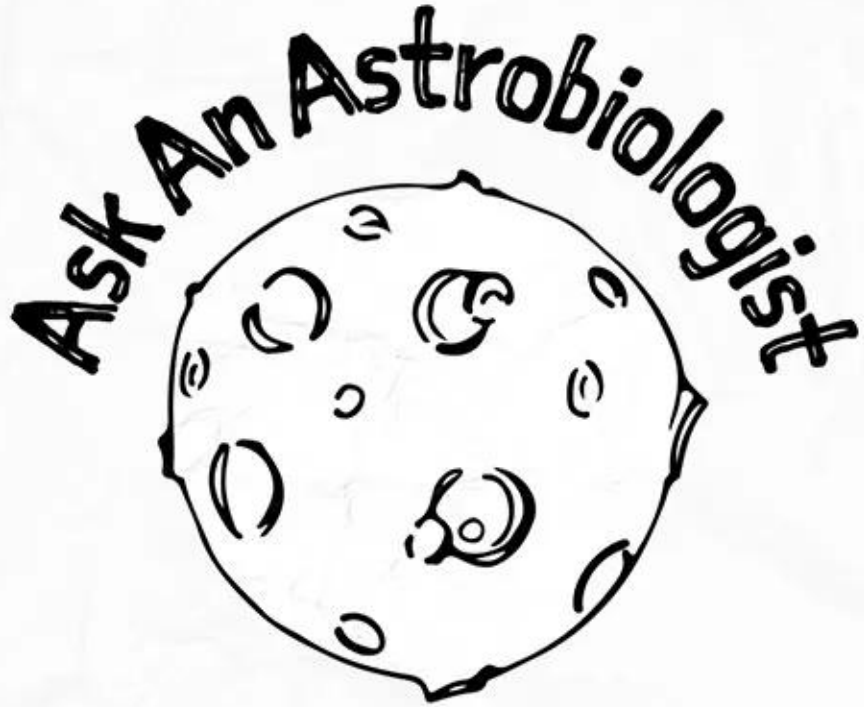


Episode 17: November 29th, 2018

# Dr. Oleg Abramov


Astrobiology Program

1
00:00:00,500 --> 00:00:29,740
[Music]

2
00:00:36,680 --> 00:00:33,889
welcome to ask an astrobiologist this is

3
00:00:38,990 --> 00:00:36,690
a show where we meet astrobiologists and

4
00:00:41,389 --> 00:00:39,000
talk to them about their careers their

5
00:00:43,910 --> 00:00:41,399
research and the things that drive them

6
00:00:45,080 --> 00:00:43,920
to want to know more about life in the

7
00:00:47,450 --> 00:00:45,090
universe

8
00:00:50,569 --> 00:00:47,460
I'm dr. Graham Lau your hosts for

9
00:00:52,760 --> 00:00:50,579
today's show before we get into the meat

10
00:00:54,410 --> 00:00:52,770
of today's ask an astrobiologist episode

11
00:00:56,209 --> 00:00:54,420
we're going to do a fun thing we do

12
00:00:58,729 --> 00:00:56,219
every month which is our photo contest

13
00:01:00,410 --> 00:00:58,739

now some of you who are regular audience

14
00:01:01,970 --> 00:01:00,420
members know that last month we had this

15
00:01:03,950 --> 00:01:01,980
really cool picture we put up and

16
00:01:05,840 --> 00:01:03,960
yesterday there was a photo competition

17
00:01:09,679 --> 00:01:05,850
on Twitter to figure out what this

18
00:01:11,660 --> 00:01:09,689
photograph showed well whoever guesses

19
00:01:13,450 --> 00:01:11,670
the right answers woman these can be a

20
00:01:15,710 --> 00:01:13,460
winner of one of the three prizes

21
00:01:18,590 --> 00:01:15,720
third-place winners get these really

22
00:01:21,560 --> 00:01:18,600
awesome NASA stickers our second-place

23
00:01:24,230 --> 00:01:21,570
winners get those plus these really cool

24
00:01:26,300 --> 00:01:24,240
graphic novels on astrobiology and our

25
00:01:28,580 --> 00:01:26,310
first-place winners get all of that plus

26
00:01:31,700 --> 00:01:28,590
a drinking glass with the second net

27
00:01:33,890 --> 00:01:31,710
logo on it well this month we actually

28
00:01:36,440 --> 00:01:33,900
have that many correct answers this was

29
00:01:38,630 --> 00:01:36,450
a hard one for everyone the picture this

30
00:01:42,440 --> 00:01:38,640
month shows a location in British

31
00:01:44,690 --> 00:01:42,450
Columbia called Yoho National Park it's

32
00:01:46,520 --> 00:01:44,700
inside of this National Park where the

33
00:01:50,330 --> 00:01:46,530
very first discovery of the Burgess

34
00:01:51,859 --> 00:01:50,340
Shale was found in 1909 some of you

35
00:01:55,039 --> 00:01:51,869
might know that Burgess Shale contains

36
00:01:57,649 --> 00:01:55,049
tens of thousands of specimens of soft

37
00:02:00,050 --> 00:01:57,659
body fossils from over 500 million years

38
00:02:03,139 --> 00:02:00,060

ago those fossils have taught us a lot

39
00:02:04,490 --> 00:02:03,149
about ancient life on Earth and and how

40
00:02:06,889 --> 00:02:04,500
that the personification of life on

41
00:02:08,130 --> 00:02:06,899
Earth occurred way long ago in the

42
00:02:10,830 --> 00:02:08,140
Cambrian

43
00:02:14,460 --> 00:02:10,840
so for this month our winners in third

44
00:02:17,160 --> 00:02:14,470
place was Hodja Effendi who gets our

45
00:02:19,560 --> 00:02:17,170
stickers our second place was Rafaela

46
00:02:21,120 --> 00:02:19,570
Shilla No who gets our second place with

47
00:02:23,490 --> 00:02:21,130
stickers and the graphics stories and

48
00:02:25,470 --> 00:02:23,500
then in 1st place is Alexi Louisa

49
00:02:27,690 --> 00:02:25,480
Hermann who gets all of those plus that

50
00:02:29,130 --> 00:02:27,700
second net drinking laughs so thanks

51
00:02:29,970 --> 00:02:29,140
everyone for competing in that photo

52
00:02:32,070 --> 00:02:29,980
competition

53
00:02:34,530 --> 00:02:32,080
you might notice behind me there is yet

54
00:02:36,210 --> 00:02:34,540
another photo and so further the next

55
00:02:38,910 --> 00:02:36,220
episode which won't be in December but

56
00:02:41,040 --> 00:02:38,920
rather in January we'll announce the day

57
00:02:42,660 --> 00:02:41,050
before the episode the photo competition

58
00:02:45,330 --> 00:02:42,670
and you'll have your chance to guess

59
00:02:48,630 --> 00:02:45,340
what's pictured here behind me and to

60
00:02:50,400 --> 00:02:48,640
potentially win some of those prizes now

61
00:02:52,290 --> 00:02:50,410
with that said let's move on to today's

62
00:02:54,449 --> 00:02:52,300
episode we have a really awesome guest

63
00:02:57,240 --> 00:02:54,459

I'm excited to chat with joining us

64
00:02:58,920 --> 00:02:57,250
today is dr. Oleg Abramov a senior

65
00:03:00,750 --> 00:02:58,930
scientist with the Planetary Science

66
00:03:04,440 --> 00:03:00,760
Institute dr. Abramov hi and thanks for

67
00:03:05,610 --> 00:03:04,450
joining us hi good to be here well it's

68
00:03:06,930 --> 00:03:05,620
great having you around I'm really

69
00:03:08,420 --> 00:03:06,940
excited for today's episode there's a

70
00:03:10,740 --> 00:03:08,430
lot of group of cool stuff to talk about

71
00:03:12,479 --> 00:03:10,750
before we get into your current research

72
00:03:14,610 --> 00:03:12,489
though and and some of the things that

73
00:03:17,100 --> 00:03:14,620
really drive you I'd love to know about

74
00:03:18,930 --> 00:03:17,110
your career path a lot of our audience

75
00:03:20,940 --> 00:03:18,940
members are high school students and

76
00:03:22,320 --> 00:03:20,950
young college students we want to know

77
00:03:24,509 --> 00:03:22,330
what they can do to become an

78
00:03:26,789 --> 00:03:24,519
astrobiologist so would you mind telling

79
00:03:27,800 --> 00:03:26,799
us the pathway you took to get to where

80
00:03:30,900 --> 00:03:27,810
you are today

81
00:03:33,120 --> 00:03:30,910
yes and I'd be happy to talk about that

82
00:03:35,640 --> 00:03:33,130
I'm not necessarily a good example to

83
00:03:39,900 --> 00:03:35,650
follow because my deathless it turned

84
00:03:45,120 --> 00:03:39,910
out a little bit convoluted and had a

85
00:03:48,150 --> 00:03:45,130
lot of full starts you would say so I

86
00:03:51,140 --> 00:03:48,160
got a degree in biology from Clarkson

87
00:03:56,250 --> 00:03:51,150
University which is in upstate New York

88
00:03:58,650 --> 00:03:56,260

in 1998 Clarkson is mostly known as an

89
00:04:02,530 --> 00:03:58,660
engineering school but I graduated with

90
00:04:04,569 --> 00:04:02,540
a Bachelor in biology and

91
00:04:06,100 --> 00:04:04,579
um a year before I graduated it was

92
00:04:08,259 --> 00:04:06,110
really inspired by the lending of

93
00:04:11,679 --> 00:04:08,269
Pathfinder Mars Pathfinder at Mars in

94
00:04:14,559 --> 00:04:11,689
the summer of 97 and that does sort of

95
00:04:16,599 --> 00:04:14,569
reignite my passion for planetary

96
00:04:19,479 --> 00:04:16,609
science that I had probably since I was

97
00:04:22,659 --> 00:04:19,489
a seven or eight and I decided that

98
00:04:26,430 --> 00:04:22,669
that's what I wanted to pursue and at

99
00:04:29,499 --> 00:04:26,440
that time the field of astrobiology was

100
00:04:33,640 --> 00:04:29,509
basically in its infancy compared to

101
00:04:35,860 --> 00:04:33,650
today and it it took quite a bit of work

102
00:04:37,870 --> 00:04:35,870
for me to get into a planetary I'm

103
00:04:41,680 --> 00:04:37,880
science PhD program with just a

104
00:04:43,320 --> 00:04:41,690
bachelor's in biology so in the meantime

105
00:04:47,499 --> 00:04:43,330
I worked at a biotech company in

106
00:04:50,200 --> 00:04:47,509
California and eventually I moved to

107
00:04:53,469 --> 00:04:50,210
Tucson to take classes non-degree at the

108
00:04:55,810 --> 00:04:53,479
University of Arizona and honestly it

109
00:04:57,790 --> 00:04:55,820
was my fourth attempt that I was finally

110
00:05:00,159 --> 00:04:57,800
admitted into the program so there was

111
00:05:01,480 --> 00:05:00,169
quite a bit of film perseverance or

112
00:05:07,990 --> 00:05:01,490
stubbornness whatever you want to call

113
00:05:11,950 --> 00:05:08,000

it and it took a little while for me to

114
00:05:14,260 --> 00:05:11,960
find the right advisor till the first

115
00:05:15,939 --> 00:05:14,270
person I want to work with left the

116
00:05:19,390 --> 00:05:15,949
university before I arrived

117
00:05:22,330 --> 00:05:19,400
and another great scientist that I

118
00:05:24,580 --> 00:05:22,340
wanted to work with I don't have funding

119
00:05:26,350 --> 00:05:24,590
for a graduate student and yet another

120
00:05:28,960 --> 00:05:26,360
potential advice are got plenty of

121
00:05:31,390 --> 00:05:28,970
funding but then really have time to

122
00:05:33,640 --> 00:05:31,400
advise graduate students so but when I

123
00:05:36,450 --> 00:05:33,650
finally found the right advisor at the

124
00:05:40,300 --> 00:05:36,460
right mentor and all the pieces clicked

125
00:05:43,629 --> 00:05:40,310
terrific PE experience at the University

126
00:05:45,490 --> 00:05:43,639
of Arizona i minored in molecular and

127
00:05:47,490 --> 00:05:45,500
cell biology so I kept you know kept

128
00:05:50,860 --> 00:05:47,500
that going and learning about that and

129
00:05:54,100 --> 00:05:50,870
then when I was ready to graduate with

130
00:05:59,010 --> 00:05:54,110
my PhD I was well equipped to do a

131
00:06:01,749 --> 00:05:59,020
research project in astrobiology and I

132
00:06:05,439 --> 00:06:01,759
applied for funding from the NASA

133
00:06:10,390 --> 00:06:05,449
Astrobiology program as a NASA

134
00:06:13,930 --> 00:06:10,400
postdoctoral scholar and that was 2006

135
00:06:16,029 --> 00:06:13,940
and astrobiology was cut in half that

136
00:06:18,339 --> 00:06:16,039
year and basically my fellowship so

137
00:06:20,260 --> 00:06:18,349
and it had to work do something else for

138
00:06:24,189 --> 00:06:20,270

a year before I couldn't do a three-year

139
00:06:27,040 --> 00:06:24,199
postdoc in astrobiology that continues

140
00:06:29,859 --> 00:06:27,050
to be a major line of research for me

141
00:06:33,100 --> 00:06:29,869
I'm very interested in how life

142
00:06:37,409 --> 00:06:33,110
originated on earth what the environment

143
00:06:40,209 --> 00:06:37,419
was like at the time how for example I'm

144
00:06:42,999 --> 00:06:40,219
impacts on early Earth may have affected

145
00:06:44,709 --> 00:06:43,009
the origins of life and I'm also of

146
00:06:46,600 --> 00:06:44,719
course interested in life on other

147
00:06:49,389 --> 00:06:46,610
planets and distribution of life in the

148
00:06:52,450 --> 00:06:49,399
universe and the future of life on this

149
00:06:53,829 --> 00:06:52,460
planet that's awesome yeah I remember

150
00:06:55,480 --> 00:06:53,839
the Pathfinder landing that really

151
00:06:57,639 --> 00:06:55,490
inspired me as a young person as well

152
00:06:59,469 --> 00:06:57,649
that was incredible and I'm glad you

153
00:07:01,689 --> 00:06:59,479
mentioned the importance of finding a

154
00:07:03,610 --> 00:07:01,699
good advisor I think a lot of young

155
00:07:06,279 --> 00:07:03,620
people are unaware of how important

156
00:07:07,689 --> 00:07:06,289
mentorship and advising is for young

157
00:07:09,730 --> 00:07:07,699
students have you had a chance to be on

158
00:07:13,510 --> 00:07:09,740
the other side of that enemy and mentor

159
00:07:16,119 --> 00:07:13,520
or advise anyone in your career yes yes

160
00:07:18,570 --> 00:07:16,129
I have a have advised several

161
00:07:21,969 --> 00:07:18,580
undergraduate students and actually a

162
00:07:24,459 --> 00:07:21,979
grant through the NASA solar system

163
00:07:27,549 --> 00:07:24,469

workings that I'm a TI on that was

164
00:07:31,149 --> 00:07:27,559
recently funded includes funding for a

165
00:07:34,389 --> 00:07:31,159
great minister and so alive me and my

166
00:07:39,790 --> 00:07:34,399
co-investigators yeah looking to recruit

167
00:07:41,409 --> 00:07:39,800
the graduates doing that's wonderful so

168
00:07:42,909 --> 00:07:41,419
by giving us an idea then about your

169
00:07:45,249 --> 00:07:42,919
current researches with the planetary

170
00:07:49,090 --> 00:07:45,259
science institute what things are really

171
00:07:57,070 --> 00:07:52,180
well so like I said probably my main

172
00:07:58,900 --> 00:07:57,080
interest is how life came about how it

173
00:08:01,960 --> 00:07:58,910
originated what kind of environment that

174
00:08:05,380 --> 00:08:01,970
originated in perhaps what planet life

175
00:08:08,050 --> 00:08:05,390
has originated on and what environmental

176
00:08:11,770 --> 00:08:08,060
influences affected the evolution of

177
00:08:14,320 --> 00:08:11,780
early life and to that end I've been

178
00:08:16,330 --> 00:08:14,330
doing a lot of a computer modeling of

179
00:08:18,250 --> 00:08:16,340
item pack bombardments in the early

180
00:08:20,260 --> 00:08:18,260
solar system we don't think about

181
00:08:22,300 --> 00:08:20,270
impacts very much now because they

182
00:08:25,180 --> 00:08:22,310
happen rarely infrequently the last big

183
00:08:27,790 --> 00:08:25,190
one killed off the dinosaurs but what

184
00:08:30,640 --> 00:08:27,800
other life happens 65 million years ago

185
00:08:32,950 --> 00:08:30,650
but if war at the time when that kind of

186
00:08:36,219 --> 00:08:32,960
impact took place every few thousand

187
00:08:38,290 --> 00:08:36,229
years ago it would be an earth would be

188
00:08:41,409 --> 00:08:38,300

a very different place and that's how it

189
00:08:45,220 --> 00:08:41,419
us 4.5 billion years ago shortly after

190
00:08:47,380 --> 00:08:45,230
its formation and so I'm modeling the

191
00:08:50,580 --> 00:08:47,390
effects of very large numbers of very

192
00:08:54,400 --> 00:08:50,590
large impacts hitting the earth and

193
00:08:57,700 --> 00:08:54,410
melting the crust ejecting large amounts

194
00:09:01,240 --> 00:08:57,710
of material into the atmosphere into

195
00:09:02,920 --> 00:09:01,250
other parts of the planet and basically

196
00:09:05,740 --> 00:09:02,930
trying to figure out when earth first

197
00:09:07,840 --> 00:09:05,750
became habitable for life as we know it

198
00:09:11,530 --> 00:09:07,850
when microbial life would have first

199
00:09:13,480 --> 00:09:11,540
originated and I'm also interested in

200
00:09:17,170 --> 00:09:13,490
the importance of credit thermal systems

201
00:09:20,740 --> 00:09:17,180
which are basically systems like

202
00:09:22,780 --> 00:09:20,750
Yellowstone's geysers and hot pools and

203
00:09:25,210 --> 00:09:22,790
so forth but the heating instead being

204
00:09:27,430 --> 00:09:25,220
magnetic would be provided by he

205
00:09:30,010 --> 00:09:27,440
delivered by a large impact and when

206
00:09:31,120 --> 00:09:30,020
those happen very frequently those kinds

207
00:09:34,870 --> 00:09:31,130
of environments would have been

208
00:09:36,010 --> 00:09:34,880
extremely common on the early Earth so

209
00:09:38,470 --> 00:09:36,020
on

210
00:09:41,410 --> 00:09:38,480
that's probably my main research

211
00:09:43,660 --> 00:09:41,420
direction I'm also involved in as a

212
00:09:46,300 --> 00:09:43,670
co-investigator in an instrument that

213
00:09:50,060 --> 00:09:46,310

will be flying to Europa old ithi m/s

214
00:09:52,939 --> 00:09:50,070
and that has a actually

215
00:09:56,540 --> 00:09:52,949
astrobiological las significance in that

216
00:09:59,180 --> 00:09:56,550
we'll be looking for places that are

217
00:10:02,900 --> 00:09:59,190
warm on the surface of Europa it might

218
00:10:05,389 --> 00:10:02,910
but that potentially indicate fractures

219
00:10:08,629 --> 00:10:05,399
or cracks in the surface or areas where

220
00:10:10,939 --> 00:10:08,639
Isis fen where if there is any life in

221
00:10:12,710 --> 00:10:10,949
the ocean below underneath the ice those

222
00:10:16,340 --> 00:10:12,720
would be in the places to look for that

223
00:10:19,009 --> 00:10:16,350
life so that's yeah yeah that's that's

224
00:10:20,360 --> 00:10:19,019
very exciting that's awesome I think

225
00:10:23,210 --> 00:10:20,370
some of our our audience members might

226
00:10:25,490 --> 00:10:23,220
know that Europa has that thin icy crust

227
00:10:27,470 --> 00:10:25,500
with a very large ocean down below it

228
00:10:29,629 --> 00:10:27,480
some recent papers have come out this

229
00:10:31,460 --> 00:10:29,639
past decade kind of showing that with

230
00:10:33,400 --> 00:10:31,470
Hubble Space Telescope observations

231
00:10:35,720 --> 00:10:33,410
we've seen what might be plumes of water

232
00:10:37,340 --> 00:10:35,730
around Europa

233
00:10:38,990 --> 00:10:37,350
so with this instrument if there are

234
00:10:40,999 --> 00:10:39,000
plumes coming out with it would see

235
00:10:42,199 --> 00:10:41,009
those plumes and the changes in the

236
00:10:45,319 --> 00:10:42,209
temperature of the surface where there's

237
00:10:48,199 --> 00:10:45,329
plumes are are erupting yes we're

238
00:10:50,809 --> 00:10:48,209

actually on Europa clipper which is a

239
00:10:53,300 --> 00:10:50,819
spacecraft that will orbit Jupiter with

240
00:10:55,220 --> 00:10:53,310
bullets fly by Europa repeatedly and it

241
00:10:57,710 --> 00:10:55,230
will obtain global coverage of most of

242
00:10:59,990 --> 00:10:57,720
Europa so we have several instruments

243
00:11:04,250 --> 00:11:00,000
that will look specifically for blooms

244
00:11:07,759 --> 00:11:04,260
and analyze tools and a Themis is one of

245
00:11:11,900 --> 00:11:07,769
them we will be basically looking forum

246
00:11:15,559 --> 00:11:11,910
warm fractures or warm spots and the

247
00:11:17,840 --> 00:11:15,569
surface and those might very well be

248
00:11:20,809 --> 00:11:17,850
places where these blooms are coming out

249
00:11:23,210 --> 00:11:20,819
of if we observe those plumes so using

250
00:11:25,730 --> 00:11:23,220
other instruments on the spacecraft will

251
00:11:28,280 --> 00:11:25,740
of course be able to analyze their

252
00:11:30,500 --> 00:11:28,290
origin area using e Themis and figure

253
00:11:36,050 --> 00:11:30,510
out exactly which temperatures are

254
00:11:37,400 --> 00:11:36,060
involved at the source Oh awesome I know

255
00:11:39,139 --> 00:11:37,410
that there's there has been a Europa

256
00:11:41,780 --> 00:11:39,149
Lander concept designed to put this

257
00:11:43,879 --> 00:11:41,790
through NASA woody Themis help us

258
00:11:47,269 --> 00:11:43,889
potentially find a good landing site on

259
00:11:50,600 --> 00:11:47,279
your Robo for such a lander oh yes yes

260
00:11:55,610 --> 00:11:50,610
absolutely on that's one of us main

261
00:11:58,699 --> 00:11:55,620
objectives in fact so I mentioned that

262
00:12:00,769 --> 00:11:58,709
it can potentially find warm spots on

263
00:12:02,610 --> 00:12:00,779

the surface of Europa and those are

264
00:12:05,880 --> 00:12:02,620
interesting and

265
00:12:09,390 --> 00:12:05,890
as potential sources for plumes or as

266
00:12:12,240 --> 00:12:09,400
potential areas where ice is thin and

267
00:12:14,010 --> 00:12:12,250
the ocean is easily accessible those are

268
00:12:17,700 --> 00:12:14,020
probably the places where you want to

269
00:12:20,100 --> 00:12:17,710
put the lander where there is recent

270
00:12:22,020 --> 00:12:20,110
contact with the ocean and that might

271
00:12:25,290 --> 00:12:22,030
allow us for example with determine if

272
00:12:28,500 --> 00:12:25,300
there are any organics in the water that

273
00:12:31,200 --> 00:12:28,510
came from the ocean no it's awesome

274
00:12:34,050 --> 00:12:31,210
and also I recall there being a proposal

275
00:12:35,760 --> 00:12:34,060
some years ago that the Kaos terrain so

276
00:12:38,580 --> 00:12:35,770
this really strange terrain on the

277
00:12:41,420 --> 00:12:38,590
surface of Europa could be indicative of

278
00:12:43,740 --> 00:12:41,430
some subsurface lakes or melt areas

279
00:12:45,900 --> 00:12:43,750
inside of that icy crust

280
00:12:49,560 --> 00:12:45,910
woody Themis have the ability this to

281
00:12:51,600 --> 00:12:49,570
see where there could be local liquid

282
00:12:55,170 --> 00:12:51,610
water reservoirs below the crust of

283
00:12:57,260 --> 00:12:55,180
Europa yeah we are actually I wrote a

284
00:13:00,180 --> 00:12:57,270
paper a few years back

285
00:13:02,700 --> 00:13:00,190
modeling exactly the circumstance

286
00:13:05,640 --> 00:13:02,710
basically looking to see if there would

287
00:13:08,670 --> 00:13:05,650
be a detectable thermal signature on the

288
00:13:10,050 --> 00:13:08,680

surface of both such lakes and indeed

289
00:13:12,750 --> 00:13:10,060
there isn't it could be resolvable

290
00:13:14,670 --> 00:13:12,760
provided that the lake is not too deep

291
00:13:18,060 --> 00:13:14,680
with us within a kilometer or two of the

292
00:13:20,490 --> 00:13:18,070
surface that's wonderful yeah I think

293
00:13:21,900 --> 00:13:20,500
Europa is a huge fan of every one I

294
00:13:24,270 --> 00:13:21,910
think they love Europa right now in

295
00:13:25,770 --> 00:13:24,280
astrobiology but another world that

296
00:13:27,690 --> 00:13:25,780
we're really interested in right now and

297
00:13:29,970 --> 00:13:27,700
keep sending spacecraft to is Mars

298
00:13:31,860 --> 00:13:29,980
and I understand you've done some work

299
00:13:33,990 --> 00:13:31,870
studying some of the processes on Mars

300
00:13:36,510 --> 00:13:34,000
and and instruments and spacecraft we

301
00:13:39,210 --> 00:13:36,520
send to Mars for instance recently we

302
00:13:41,280 --> 00:13:39,220
landed the insight Lander just the other

303
00:13:43,500 --> 00:13:41,290
day landed successfully on the surface

304
00:13:45,300 --> 00:13:43,510
of Mars I wonder if you can speak to

305
00:13:47,540 --> 00:13:45,310
that a little bit the importance of this

306
00:13:51,150 --> 00:13:47,550
spacecraft for understanding

307
00:13:52,980 --> 00:13:51,160
characteristics of Mars yes yeah

308
00:13:55,110 --> 00:13:52,990
absolutely yeah that was very exciting I

309
00:13:58,560 --> 00:13:55,120
watched it live like I have all the

310
00:14:00,570 --> 00:13:58,570
landings since Pathfinder so we

311
00:14:02,820 --> 00:14:00,580
obviously have a very successful landing

312
00:14:04,860 --> 00:14:02,830
and looking at the early pictures that

313
00:14:07,580 --> 00:14:04,870

came back it actually looks like I it

314
00:14:10,230 --> 00:14:07,590
landed in that failed an impact crater

315
00:14:12,960 --> 00:14:10,240
which would be a really good news for

316
00:14:15,730 --> 00:14:12,970
one of its instruments which is a

317
00:14:22,750 --> 00:14:15,740
thermal probe

318
00:14:25,060 --> 00:14:22,760
we'll be basically the the lender has a

319
00:14:27,220 --> 00:14:25,070
device that similar to a mole that will

320
00:14:29,920 --> 00:14:27,230
borrow into the ground about 18 feet

321
00:14:33,400 --> 00:14:29,930
deep and it will place a thermal sensor

322
00:14:35,470 --> 00:14:33,410
there that would allow us to basically

323
00:14:38,380 --> 00:14:35,480
figure out how hot Martha's on the

324
00:14:40,510 --> 00:14:38,390
inside which is a very important

325
00:14:43,120 --> 00:14:40,520
question and would be very important for

326
00:14:46,090 --> 00:14:43,130
some of the models that I have been

327
00:14:48,910 --> 00:14:46,100
doing modeling um effects of impacts on

328
00:14:50,530 --> 00:14:48,920
Mars and effects of hydrothermal systems

329
00:14:53,590 --> 00:14:50,540
that might be formed by these impacts

330
00:14:56,500 --> 00:14:53,600
and it would also let us know basically

331
00:15:00,040 --> 00:14:56,510
how likely it is that there is liquid

332
00:15:02,320 --> 00:15:00,050
water in the subsurface of Mars and how

333
00:15:04,150 --> 00:15:02,330
much it is might be there depending and

334
00:15:07,510 --> 00:15:04,160
basically how much heat there is

335
00:15:10,180 --> 00:15:07,520
available to warm up the permafrost so

336
00:15:12,310 --> 00:15:10,190
it's it will be a very very important

337
00:15:14,890 --> 00:15:12,320
very important for an astrobiology very

338
00:15:16,480 --> 00:15:14,900

important for kinds of modeling that I

339
00:15:20,500 --> 00:15:16,490
do and I know there are a lot of

340
00:15:22,180 --> 00:15:20,510
colleagues basically very happy to get

341
00:15:24,100 --> 00:15:22,190
that measurement that would allow them

342
00:15:26,590 --> 00:15:24,110
to significantly improve our

343
00:15:29,680 --> 00:15:26,600
understanding of thermal processes on

344
00:15:32,980 --> 00:15:29,690
Mars so that's that's one very exciting

345
00:15:35,080 --> 00:15:32,990
instrument another is a seismometer very

346
00:15:36,640 --> 00:15:35,090
very sensitive the seismometer that will

347
00:15:40,050 --> 00:15:36,650
allow us to detect if there any

348
00:15:43,090 --> 00:15:40,060
marsquakes it will allow us to in

349
00:15:45,070 --> 00:15:43,100
distant impacts that happen while the

350
00:15:47,250 --> 00:15:45,080
lenders on the surface and most

351
00:15:51,250 --> 00:15:47,260
importantly it would allow us to

352
00:15:54,100 --> 00:15:51,260
differentiate to basically determine the

353
00:15:57,250 --> 00:15:54,110
internal structure of Mars core mental

354
00:16:01,690 --> 00:15:57,260
crossed the boundaries between them and

355
00:16:02,910 --> 00:16:01,700
how thick each layer is for our audience

356
00:16:04,930 --> 00:16:02,920
could you say how important it is for

357
00:16:07,150 --> 00:16:04,940
understanding whether or not Mars once

358
00:16:08,440 --> 00:16:07,160
had life making those kinds of

359
00:16:11,500 --> 00:16:08,450
measurements and understanding that that

360
00:16:14,470 --> 00:16:11,510
information about Mars yeah yeah

361
00:16:17,470 --> 00:16:14,480
absolutely so for example Mars currently

362
00:16:19,690 --> 00:16:17,480
doesn't have a magnetic field and you

363
00:16:22,090 --> 00:16:19,700

did travel in a field earlier in this

364
00:16:24,760 --> 00:16:22,100
history and it's very important to

365
00:16:27,220 --> 00:16:24,770
figure out when that magnetic field went

366
00:16:29,700 --> 00:16:27,230
away because that that allowed the

367
00:16:33,540 --> 00:16:29,710
atmosphere to be a strip

368
00:16:35,590 --> 00:16:33,550
became less habitable as a result so

369
00:16:40,600 --> 00:16:35,600
understanding for example whether Mars

370
00:16:43,750 --> 00:16:40,610
as a solid or a liquid or would allow us

371
00:16:45,850 --> 00:16:43,760
to figure out when that magnetic field

372
00:16:48,820 --> 00:16:45,860
make me have disappeared early in its

373
00:16:52,060 --> 00:16:48,830
history and when Mars became maybe a

374
00:16:53,680 --> 00:16:52,070
less habitable place awesome yeah I know

375
00:16:55,690 --> 00:16:53,690
ever since I was a kid I've wondered

376
00:16:58,030 --> 00:16:55,700
what it would feel like to actually be

377
00:17:00,460 --> 00:16:58,040
one of those first human beings to to go

378
00:17:02,980 --> 00:17:00,470
to Mars in to set foot on the Red Planet

379
00:17:04,540 --> 00:17:02,990
I wonder if you can speak to that what

380
00:17:07,090 --> 00:17:04,550
do you think about humans going to Mars

381
00:17:11,260 --> 00:17:07,100
and colonizing Mars doing research on

382
00:17:13,700 --> 00:17:11,270
Mars all on our own as humans exploring

383
00:17:16,730 --> 00:17:13,710
the planet and not just using robots

384
00:17:19,940 --> 00:17:16,740
I'm I think it's a very important thing

385
00:17:21,380 --> 00:17:19,950
to do I think it's going to happen

386
00:17:24,860 --> 00:17:21,390
sooner rather than later

387
00:17:28,030 --> 00:17:24,870
at least that's have been a number of

388
00:17:31,610 --> 00:17:28,040

promising signs and developments lately

389
00:17:33,680 --> 00:17:31,620
and yeah it will be great to have a

390
00:17:39,350 --> 00:17:33,690
human scientist certainly on the surface

391
00:17:40,940 --> 00:17:39,360
of Mars so the Rovers are great but what

392
00:17:43,850 --> 00:17:40,950
happens with rural pursuits of course

393
00:17:45,620 --> 00:17:43,860
happens in excruciatingly slow motion if

394
00:17:48,200 --> 00:17:45,630
you've been following these missions and

395
00:17:51,260 --> 00:17:48,210
if they take years you know sometimes to

396
00:17:52,640 --> 00:17:51,270
move a kilometer and take the necessary

397
00:17:54,440 --> 00:17:52,650
measurements along the way and I've

398
00:17:59,330 --> 00:17:54,450
heard the number of geologists say that

399
00:18:01,160 --> 00:17:59,340
for example everything that the spirit

400
00:18:03,380 --> 00:18:01,170
or Opportunity Rovers have done over the

401
00:18:04,940 --> 00:18:03,390
course of ten years a geologists human

402
00:18:07,760 --> 00:18:04,950
geologist probably would have done in a

403
00:18:10,760 --> 00:18:07,770
couple of weeks so human humans are

404
00:18:13,700 --> 00:18:10,770
still significantly more efficient than

405
00:18:15,740 --> 00:18:13,710
machines it's important because humans

406
00:18:18,830 --> 00:18:15,750
on Mars for rather the other reasons as

407
00:18:20,360 --> 00:18:18,840
well I think it would be good human

408
00:18:23,460 --> 00:18:20,370
civilization on two planets there's

409
00:18:24,900 --> 00:18:23,470
certainly logic

410
00:18:26,430 --> 00:18:24,910
and awesome you know having a plan B

411
00:18:30,120 --> 00:18:26,440
just in case something bad happens here

412
00:18:32,280 --> 00:18:30,130
right yeah yeah for example yeah okay

413
00:18:36,480 --> 00:18:32,290

that's awesome I do understand that you

414
00:18:39,210 --> 00:18:36,490
partaken in a Mars analog study here on

415
00:18:40,140 --> 00:18:39,220
earth and Hawaii called high seas I'm

416
00:18:42,840 --> 00:18:40,150
wondering if you tell us about

417
00:18:44,310 --> 00:18:42,850
experience what high seas is and what

418
00:18:47,820 --> 00:18:44,320
that was like being involved in an

419
00:18:51,330 --> 00:18:47,830
analog human Mars study sure yes

420
00:18:53,820 --> 00:18:51,340
okay so the program crises is a stance

421
00:18:57,540 --> 00:18:53,830
for a Hawaii space exploration analog

422
00:19:01,320 --> 00:18:57,550
and simulation it is funded by the NASA

423
00:19:03,870 --> 00:19:01,330
human research program and is

424
00:19:05,460 --> 00:19:03,880
essentially an isolation experiment and

425
00:19:09,420 --> 00:19:05,470
simulated Mars mission

426
00:19:13,020 --> 00:19:09,430
it's a habitat that's self-contained and

427
00:19:16,110 --> 00:19:13,030
mostly self-sustaining located on the

428
00:19:18,000 --> 00:19:16,120
upper slopes of Mauna Lola on the Big

429
00:19:22,740 --> 00:19:18,010
Island of Hawaii at an elevation of

430
00:19:26,190 --> 00:19:22,750
about 8,000 feet and I was a member of

431
00:19:29,100 --> 00:19:26,200
the first mission their first analog

432
00:19:31,770 --> 00:19:29,110
mission in 2013 since then they've done

433
00:19:33,960 --> 00:19:31,780
four or five more missions so much long

434
00:19:37,350 --> 00:19:33,970
as a year I was there for four months

435
00:19:40,320 --> 00:19:37,360
I'm essentially a living and working as

436
00:19:44,030 --> 00:19:40,330
one with you on Mars so that basically

437
00:19:47,490 --> 00:19:44,040
is living in a dome in a confined area

438
00:19:49,620 --> 00:19:47,500

using mostly or either shelf-stable food

439
00:19:51,990 --> 00:19:49,630
or whatever food we might manage to grow

440
00:19:54,000 --> 00:19:52,000
ourselves conserving resources most

441
00:19:55,650 --> 00:19:54,010
importantly when we go outside where

442
00:19:57,690 --> 00:19:55,660
simulated space suits so we don't

443
00:20:02,130 --> 00:19:57,700
experience like fresh air and direct

444
00:20:03,990 --> 00:20:02,140
sunlight so in that way it was a fairly

445
00:20:07,500 --> 00:20:04,000
realistic simulation of course the

446
00:20:10,110 --> 00:20:07,510
isolation part there is a on Mars that

447
00:20:13,770 --> 00:20:10,120
would be a significant lag about 20

448
00:20:16,950 --> 00:20:13,780
minutes each way communicating with the

449
00:20:18,540 --> 00:20:16,960
earth and that was simulated on high

450
00:20:20,730 --> 00:20:18,550
seas so we couldn't have direct

451
00:20:23,010 --> 00:20:20,740
conversations with our friends of course

452
00:20:27,870 --> 00:20:23,020
no Skype nothing like that

453
00:20:30,120 --> 00:20:27,880
so it was it was a really a really good

454
00:20:32,100 --> 00:20:30,130
experience that learned it taught me to

455
00:20:34,530 --> 00:20:32,110
appreciate some of the things that we

456
00:20:37,000 --> 00:20:34,540
take for granted every day you know you

457
00:20:40,450 --> 00:20:37,010
might miss after years of living on Mars

458
00:20:45,280 --> 00:20:40,460
for a while but also for me personally

459
00:20:48,220 --> 00:20:45,290
um I found that I enjoyed some aspects

460
00:20:50,230 --> 00:20:48,230
of that environment you know the for

461
00:20:52,150 --> 00:20:50,240
better or worse I think I would probably

462
00:20:54,130 --> 00:20:52,160
add oh okay I'm MRSA at least at least

463
00:20:56,980 --> 00:20:54,140

for four months then well that's crazy

464
00:20:58,659 --> 00:20:56,990
here I imagine four months with a small

465
00:21:00,310 --> 00:20:58,669
group of people kind of you know stuck

466
00:21:02,650 --> 00:21:00,320
together mostly inside of the habitat

467
00:21:04,030 --> 00:21:02,660
has to be somewhat challenging you know

468
00:21:06,700 --> 00:21:04,040
psychologically and just dealing with

469
00:21:08,049 --> 00:21:06,710
social issues that pop up what was that

470
00:21:09,460 --> 00:21:08,059
like what was your crew like working

471
00:21:13,000 --> 00:21:09,470
with other people in this this small

472
00:21:16,030 --> 00:21:13,010
isolated environment we've got a great

473
00:21:19,510 --> 00:21:16,040
crew overall and we'll work together

474
00:21:22,120 --> 00:21:19,520
really really well there were some

475
00:21:24,789 --> 00:21:22,130
conflicts here and there but usually the

476
00:21:27,900 --> 00:21:24,799
offending party would apologize or we'll

477
00:21:30,130 --> 00:21:27,910
just talk it out amongst ourselves

478
00:21:33,669 --> 00:21:30,140
probably the biggest conflict

479
00:21:35,710 --> 00:21:33,679
honestly among the crew was the division

480
00:21:37,659 --> 00:21:35,720
between extroverts and introverts and

481
00:21:40,780 --> 00:21:37,669
how much time people wanted to spend

482
00:21:43,659 --> 00:21:40,790
with other people some people prefer the

483
00:21:46,510 --> 00:21:43,669
more time by themselves where other

484
00:21:48,520 --> 00:21:46,520
people felt strongly that everyone

485
00:21:50,549 --> 00:21:48,530
should be basically talking to each

486
00:21:52,840 --> 00:21:50,559
other all the time or at least be

487
00:21:55,390 --> 00:21:52,850
together on the same area all the time

488
00:22:00,310 --> 00:21:55,400

or most of the time so there were some

489
00:22:02,950 --> 00:22:00,320
conflicts around around that but we

490
00:22:04,900 --> 00:22:02,960
managed to work it out that's awesome

491
00:22:06,310 --> 00:22:04,910
imagine there's a lot of fun also just

492
00:22:09,340 --> 00:22:06,320
kind of you know simulating what would

493
00:22:12,130 --> 00:22:09,350
be like yeah yeah they think there's a

494
00:22:13,870 --> 00:22:12,140
lot of us now around the planet from a

495
00:22:16,060 --> 00:22:13,880
variety of nations and backgrounds who

496
00:22:18,430 --> 00:22:16,070
want to see humans advance forward and

497
00:22:20,200 --> 00:22:18,440
go on out into the cosmic ocean and

498
00:22:21,880 --> 00:22:20,210
explore other worlds like Mars and then

499
00:22:23,289 --> 00:22:21,890
beyond so it's it's really cool that

500
00:22:26,140 --> 00:22:23,299
we're doing some of that work right now

501
00:22:29,440 --> 00:22:26,150
here on earth - yeah absolutely well

502
00:22:31,630 --> 00:22:29,450
we're we're doing what we can and you

503
00:22:36,299 --> 00:22:31,640
know there are a lot of people for very

504
00:22:40,630 --> 00:22:36,309
I'm very passionate about humans

505
00:22:42,680 --> 00:22:40,640
colonizing Mars and expanding out

506
00:22:44,450 --> 00:22:42,690
yeah there is a lot of reason for

507
00:22:44,930 --> 00:22:44,460
optimism right that's awesome yeah it's

508
00:22:47,060 --> 00:22:44,940
great

509
00:22:48,740 --> 00:22:47,070
I do wanna remind our audience you can

510
00:22:51,409 --> 00:22:48,750
ask questions for dr. Abramov

511
00:22:52,789 --> 00:22:51,419
right now in the second net chat as well

512
00:22:54,470 --> 00:22:52,799
as on the Facebook live NASA

513
00:22:56,720 --> 00:22:54,480

Astrobiology page if you're turning in

514
00:22:59,090 --> 00:22:56,730
there you can ask questions right in the

515
00:23:01,700 --> 00:22:59,100
comment box there otherwise you can ask

516
00:23:04,730 --> 00:23:01,710
questions on twitter and instagram using

517
00:23:05,990 --> 00:23:04,740
the hashtag ask astro bio and those

518
00:23:09,169 --> 00:23:06,000
questions will come through and I can

519
00:23:10,730 --> 00:23:09,179
ask them then dr. Abramov before we

520
00:23:13,399 --> 00:23:10,740
continue on then I'd love to know more

521
00:23:15,440 --> 00:23:13,409
about things that kind of drive you what

522
00:23:16,730 --> 00:23:15,450
makes you really just want to get out

523
00:23:18,500 --> 00:23:16,740
there and explore this world I

524
00:23:20,659 --> 00:23:18,510
understand that we did go online and

525
00:23:23,060 --> 00:23:20,669
found a few pictures of you out hiking

526
00:23:24,470 --> 00:23:23,070
and enjoying the environment as being

527
00:23:29,060 --> 00:23:24,480
outdoors a really important thing for

528
00:23:31,700 --> 00:23:29,070
you oh yes yes absolutely I'm really it

529
00:23:33,710 --> 00:23:31,710
probably ever since graduate school some

530
00:23:37,580 --> 00:23:33,720
of my fellow students there were avid

531
00:23:41,779 --> 00:23:37,590
outdoorsmen and we went hiking quite a

532
00:23:44,870 --> 00:23:41,789
bit I'm near Tucson with basic explore

533
00:23:46,640 --> 00:23:44,880
all the mountain ranges we'd have quite

534
00:23:49,580 --> 00:23:46,650
a few trips to northern Arizona at

535
00:23:51,770 --> 00:23:49,590
several hikes and the Grand Canyon yeah

536
00:23:53,840 --> 00:23:51,780
I just got hooked on me on the outdoors

537
00:23:55,490 --> 00:23:53,850
when I did my postdoc at Boulder

538
00:23:58,880 --> 00:23:55,500

Colorado there were also lots of outdoor

539
00:24:01,820 --> 00:23:58,890
beautiful outdoors I took full advantage

540
00:24:04,640 --> 00:24:01,830
of that yeah I definitely am actually in

541
00:24:08,000 --> 00:24:04,650
Boulder Colorado right now a lion for

542
00:24:09,770 --> 00:24:08,010
our show and it's a great town um and I

543
00:24:12,289 --> 00:24:09,780
also do understand that you have a

544
00:24:14,720 --> 00:24:12,299
pilot's license and not just a private

545
00:24:18,440 --> 00:24:14,730
pilot's license but a commercial pilot's

546
00:24:21,649 --> 00:24:18,450
license yes so um yeah I got a private

547
00:24:24,799 --> 00:24:21,659
pilot's license back in 2010 and then a

548
00:24:26,779 --> 00:24:24,809
commercial license in 2012 and then I

549
00:24:30,649 --> 00:24:26,789
even went out for a fly instructor

550
00:24:32,659 --> 00:24:30,659
certificate well that's really cool

551
00:24:33,890 --> 00:24:32,669
what would drew you mean just just

552
00:24:36,200 --> 00:24:33,900
really enjoy flying

553
00:24:37,940 --> 00:24:36,210
uh cuz you know a lot of people who got

554
00:24:39,320 --> 00:24:37,950
in private pilot's license but I haven't

555
00:24:41,240 --> 00:24:39,330
done many you go on for commercial

556
00:24:44,120 --> 00:24:41,250
pilot's license as well

557
00:24:47,950 --> 00:24:44,130
um yeah I really enjoy flying and I

558
00:24:50,270 --> 00:24:47,960
really enjoy the challenge and just

559
00:24:53,870 --> 00:24:50,280
there is a saying that a good pilot is

560
00:24:57,320 --> 00:24:53,880
always learning and I I really enjoy

561
00:25:01,280 --> 00:24:57,330
just learning more and more and as a

562
00:25:07,860 --> 00:25:05,130
basically I could get a higher

563
00:25:11,040 --> 00:25:07,870

certificate a commercial pilot

564
00:25:14,730 --> 00:25:11,050
certificate and I I like the challenge

565
00:25:17,250 --> 00:25:14,740
for applying for that and taking

566
00:25:20,160 --> 00:25:17,260
necessary exams and check rides and

567
00:25:22,800 --> 00:25:20,170
learning everything was involved in that

568
00:25:25,590 --> 00:25:22,810
I've always been fascinated with just

569
00:25:28,560 --> 00:25:25,600
what exactly is involved with being a

570
00:25:32,610 --> 00:25:28,570
commercial pilot and I feel that now I

571
00:25:35,310 --> 00:25:32,620
know a lot more about that I I really

572
00:25:37,290 --> 00:25:35,320
enjoy a lot of aspects that's awesome

573
00:25:38,490 --> 00:25:37,300
are there any aircraft you haven't flown

574
00:25:44,100 --> 00:25:38,500
yet that you really like to get your

575
00:25:45,750 --> 00:25:44,110
hands on and take out ah yeah so I if

576
00:25:50,240 --> 00:25:45,760
there's an earplug aircraft called a

577
00:25:54,210 --> 00:25:50,250
cirrus you may have heard of it and sr

578
00:25:56,790 --> 00:25:54,220
20s or sr22 i'd love to fly those

579
00:25:58,920 --> 00:25:56,800
otherwise I'd flown most of a single

580
00:26:03,720 --> 00:25:58,930
common single-engine airplanes

581
00:26:05,700 --> 00:26:03,730
Viper's diamonds assessments of yet

582
00:26:07,380 --> 00:26:05,710
common form these heroes well that's

583
00:26:08,550 --> 00:26:07,390
awesome yeah I jumped out of a few

584
00:26:10,350 --> 00:26:08,560
airplanes but I've never actually flown

585
00:26:13,050 --> 00:26:10,360
one so I would really love to do that at

586
00:26:15,210 --> 00:26:13,060
some point of my life as well I jump out

587
00:26:17,430 --> 00:26:15,220
a few know if you are acquainted no it's

588
00:26:19,710 --> 00:26:17,440

awesome it's a great feeling right it

589
00:26:20,880 --> 00:26:19,720
changes how we experience our world is

590
00:26:22,620 --> 00:26:20,890
there any place that you haven't had a

591
00:26:24,499 --> 00:26:22,630
chance to fly yet that you'd like to see

592
00:26:27,560 --> 00:26:24,509
from above

593
00:26:29,810 --> 00:26:27,570
I yeah actually I've been living in New

594
00:26:32,930 --> 00:26:29,820
Zealand for the last couple of years and

595
00:26:34,459 --> 00:26:32,940
I haven't flown here yet just haven't

596
00:26:39,999 --> 00:26:34,469
gotten around to it but it would be a

597
00:26:45,139 --> 00:26:42,739
that's great well I think we're gonna

598
00:26:46,849 --> 00:26:45,149
start opening up the questions here soon

599
00:26:48,979 --> 00:26:46,859
so remember audience you guys can ask

600
00:26:51,709 --> 00:26:48,989
questions using ask Astro bio as a

601
00:26:53,989 --> 00:26:51,719
hashtag on Twitter or Instagram you can

602
00:26:55,939 --> 00:26:53,999
also ask questions through the second

603
00:26:59,299 --> 00:26:55,949
net chat and on the facebook chat as

604
00:27:00,709 --> 00:26:59,309
well so I think I our very first

605
00:27:03,499 --> 00:27:00,719
question is only one that comes to us

606
00:27:05,180 --> 00:27:03,509
from Twitter from user Michael Wong who

607
00:27:08,539 --> 00:27:05,190
is a longtime audience member thank you

608
00:27:11,539 --> 00:27:08,549
Michael Michael asks what one instrument

609
00:27:13,129 --> 00:27:11,549
that has not yet been flown or is being

610
00:27:15,439 --> 00:27:13,139
planned to fly on a mission in

611
00:27:17,629 --> 00:27:15,449
development would you want to send to an

612
00:27:19,479 --> 00:27:17,639
icy satellite to search for signs of

613
00:27:21,939 --> 00:27:19,489

life

614
00:27:25,939 --> 00:27:21,949
that's a great question

615
00:27:31,399 --> 00:27:25,949
so I mentioned my involvement with

616
00:27:32,839 --> 00:27:31,409
Europa clipper and I it it's a flagship

617
00:27:35,569 --> 00:27:32,849
class mission that has a lot of

618
00:27:38,839 --> 00:27:35,579
instruments on it and in terms of

619
00:27:42,109 --> 00:27:38,849
searching for signs of life from orbit

620
00:27:45,319 --> 00:27:42,119
or from repeated flybys in this case I

621
00:27:48,819 --> 00:27:45,329
think it's doing just about everything

622
00:27:54,769 --> 00:27:48,829
that can be done from orbit using

623
00:27:58,099 --> 00:27:54,779
current instruments it will as I

624
00:27:59,930 --> 00:27:58,109
mentioned figure out the data from it

625
00:28:03,019 --> 00:27:59,940
will allow us to assess potential

626
00:28:05,889 --> 00:28:03,029
landing sites and on the lander that

627
00:28:09,829 --> 00:28:05,899
would fall follow-up Europa clipper

628
00:28:14,599 --> 00:28:09,839
there should definitely be instruments

629
00:28:16,430 --> 00:28:14,609
that detect organic molecules especially

630
00:28:20,029 --> 00:28:16,440
given that that lender would likely land

631
00:28:25,579 --> 00:28:20,039
somewhere an ER event or near an area

632
00:28:29,539 --> 00:28:25,589
where ocean water recently came up so

633
00:28:32,659 --> 00:28:29,549
one potential instrument would be like a

634
00:28:34,940 --> 00:28:32,669
Raman spectrometer and it hasn't flown

635
00:28:37,260 --> 00:28:34,950
yet but it's scheduled to fly on the

636
00:28:40,320 --> 00:28:37,270
Mars 2020 there's instrument all die

637
00:28:44,760 --> 00:28:40,330
Sherlock will look for organic molecules

638
00:28:47,040 --> 00:28:44,770

on the Martian surface so that would

639
00:28:51,330 --> 00:28:47,050
probably be my first choice when this

640
00:28:53,130 --> 00:28:51,340
from Italy I see satellite hasn't flown

641
00:28:55,470 --> 00:28:53,140
yet but it will fly in a couple of years

642
00:28:57,150 --> 00:28:55,480
well that's very cool it'd be nice to

643
00:29:00,060 --> 00:28:57,160
see Rahman spectrometers then going off

644
00:29:02,880 --> 00:29:00,070
to Europa Enceladus and maybe even other

645
00:29:04,250 --> 00:29:02,890
icy worlds in our solar system yeah

646
00:29:07,260 --> 00:29:04,260
absolutely

647
00:29:08,550 --> 00:29:07,270
yeah Mars will be the testing ground for

648
00:29:11,600 --> 00:29:08,560
that kind of instrument this will be the

649
00:29:12,810 --> 00:29:11,610
first planetary Raman spectrometer ively

650
00:29:15,090 --> 00:29:12,820
awesome

651
00:29:18,720 --> 00:29:15,100
let's bring in a question from Sagan net

652
00:29:21,060 --> 00:29:18,730
this is from user Rami al Sabbagh Rami

653
00:29:22,590 --> 00:29:21,070
asks what is the best masters program

654
00:29:26,419 --> 00:29:22,600
that I could apply for to receive a

655
00:29:32,029 --> 00:29:29,539
I'm probably not the best person to

656
00:29:35,710 --> 00:29:32,039
answer that question because it has been

657
00:29:38,419 --> 00:29:35,720
a while since I have thought about that

658
00:29:41,149 --> 00:29:38,429
pretty early on I decided I wanted to go

659
00:29:43,820 --> 00:29:41,159
that ph.d route so I was looking pretty

660
00:29:47,980 --> 00:29:43,830
much almost exclusively at PhD programs

661
00:29:53,989 --> 00:29:47,990
so I'm not really a current and

662
00:29:55,519 --> 00:29:53,999
opportunities okay

663
00:29:57,769 --> 00:29:55,529

how about this one then we have another

664
00:30:01,669 --> 00:29:57,779
Twitter question this from you from user

665
00:30:03,919 --> 00:30:01,679
Seneca user Seneca asks how much physics

666
00:30:08,149 --> 00:30:03,929
is involved in your field of

667
00:30:10,480 --> 00:30:08,159
astrobiology hmm well astrobiology like

668
00:30:14,869 --> 00:30:10,490
planetary science is a very

669
00:30:16,639 --> 00:30:14,879
interdisciplinary field there is of

670
00:30:19,789 --> 00:30:16,649
course biology but there is also

671
00:30:24,499 --> 00:30:19,799
planetary science and chemistry and

672
00:30:26,480 --> 00:30:24,509
physics and geology there are many

673
00:30:29,210 --> 00:30:26,490
different parts of astrobiology that's

674
00:30:31,549 --> 00:30:29,220
what would be involved what are you do

675
00:30:35,109 --> 00:30:31,559
is actually pretty heavy on the physics

676
00:30:39,019 --> 00:30:35,119
because I write pure codes using

677
00:30:43,249 --> 00:30:39,029
equations for a heat flow and fluid

678
00:30:45,080 --> 00:30:43,259
transfer processes but there are lots of

679
00:30:48,169 --> 00:30:45,090
different ways to the westrom biology

680
00:30:51,560 --> 00:30:48,179
from my theoretical modeling to a lab

681
00:30:56,210 --> 00:30:51,570
work designing instruments that look for

682
00:30:59,330 --> 00:30:56,220
potential signs of life so there are

683
00:31:01,970 --> 00:30:59,340
it's a very very broad field yeah that's

684
00:31:03,769 --> 00:31:01,980
that's I agree entirely I myself also

685
00:31:06,230 --> 00:31:03,779
started off in biology and chemistry and

686
00:31:07,820 --> 00:31:06,240
then got a PhD in geology much as how

687
00:31:09,320 --> 00:31:07,830
you started off in biology and then kind

688
00:31:11,600 --> 00:31:09,330

of work your way into planetary science

689
00:31:13,609 --> 00:31:11,610
more yeah I think it is important for

690
00:31:15,440 --> 00:31:13,619
our audience to remember that all of us

691
00:31:17,299 --> 00:31:15,450
has two biologists have these varied

692
00:31:18,440 --> 00:31:17,309
backgrounds thoughts or abramoff has a

693
00:31:20,299 --> 00:31:18,450
varied background I have a varied

694
00:31:21,919 --> 00:31:20,309
background and we come from these very

695
00:31:24,610 --> 00:31:21,929
different fields working together to

696
00:31:26,409 --> 00:31:24,620
become astrobiologists

697
00:31:30,909 --> 00:31:26,419
so let's ask another question from

698
00:31:34,149 --> 00:31:30,919
Twitter this is from user AS 1974 this

699
00:31:36,940 --> 00:31:34,159
question says Mars used to be a warm and

700
00:31:39,159 --> 00:31:36,950
wet planet is it possible to look for

701
00:31:42,100 --> 00:31:39,169
hydrocarbon reserves as evidence of

702
00:31:45,039 --> 00:31:42,110
ancient life on Mars and does Insights

703
00:31:47,440 --> 00:31:45,049
design make it capable of detecting such

704
00:31:51,220 --> 00:31:47,450
signatures if there are these possible

705
00:32:00,220 --> 00:31:56,740
I that's a good question and based on

706
00:32:04,539 --> 00:32:00,230
our best understanding of the extent of

707
00:32:06,940 --> 00:32:04,549
possible life on Mars it's unlikely that

708
00:32:11,260 --> 00:32:06,950
there would be a large hydrocarbon

709
00:32:16,450 --> 00:32:11,270
reserves that we have on earth because

710
00:32:21,480 --> 00:32:16,460
earth of course had plant and animal

711
00:32:24,400 --> 00:32:21,490
life that was quite extensive with

712
00:32:28,390 --> 00:32:24,410
fossil record going back billions of

713
00:32:30,850 --> 00:32:28,400

years on Mars so far we found no

714
00:32:34,270 --> 00:32:30,860
evidence of life so that suggests that

715
00:32:36,370 --> 00:32:34,280
Mars was probably never covered by

716
00:32:39,970 --> 00:32:36,380
complex life to the extent that earth

717
00:32:41,380 --> 00:32:39,980
was so really the best that most people

718
00:32:45,909 --> 00:32:41,390
hope for in terms of finding life on

719
00:32:48,580 --> 00:32:45,919
Mars is a smaller either microorganisms

720
00:32:52,030 --> 00:32:48,590
or various simple complex organisms

721
00:32:53,320 --> 00:32:52,040
perhaps living deep underground where

722
00:32:57,310 --> 00:32:53,330
there might still be harder thrown

723
00:32:59,740 --> 00:32:57,320
activities of energy source but that

724
00:33:03,159 --> 00:32:59,750
would not likely to produce large

725
00:33:06,610 --> 00:33:03,169
deposits of hydrocarbons even if such

726
00:33:08,409 --> 00:33:06,620
deposits were there inside would almost

727
00:33:11,770 --> 00:33:08,419
certainly not detect them because it's

728
00:33:15,460 --> 00:33:11,780
designed to look for a large internal

729
00:33:18,130 --> 00:33:15,470
structures so it can use a seismometer

730
00:33:19,690 --> 00:33:18,140
for example to figure out the properties

731
00:33:23,890 --> 00:33:19,700
of the core or where the core-mantle

732
00:33:26,799 --> 00:33:23,900
boundary is that's those smaller

733
00:33:28,330 --> 00:33:26,809
subsurface and other carbon deposits the

734
00:33:30,970 --> 00:33:28,340
best way to look for them would actually

735
00:33:33,430 --> 00:33:30,980
be probably from orbit using a

736
00:33:36,970 --> 00:33:33,440
ground-penetrating radar and we've had

737
00:33:39,310 --> 00:33:36,980
several of those flow already and more

738
00:33:41,740 --> 00:33:39,320

should fly in the future mainly to look

739
00:33:44,409 --> 00:33:41,750
for a distribution of subsurface water

740
00:33:47,020 --> 00:33:44,419
and ice but if there are any hydrocarbon

741
00:33:48,640 --> 00:33:47,030
deposits that are there that they will

742
00:33:51,820 --> 00:33:48,650
probably also be detected by

743
00:33:53,289 --> 00:33:51,830
ground-penetrating radar very cool but

744
00:33:55,120 --> 00:33:53,299
if I ask my own question

745
00:33:58,240 --> 00:33:55,130
one thing I've wondered a lot is if

746
00:34:00,130 --> 00:33:58,250
there are lava tubes on Mars you know if

747
00:34:02,740 --> 00:34:00,140
we could detect lava tubes on Mars from

748
00:34:04,400 --> 00:34:02,750
orbit if we have already and if so if

749
00:34:09,260 --> 00:34:04,410
those would be good places to look for

750
00:34:11,650 --> 00:34:09,270
seneschal life on mars i yes i'm pretty

751
00:34:14,300 --> 00:34:11,660
sure we have detected skylights

752
00:34:18,380 --> 00:34:14,310
basically areas where lava tubes have

753
00:34:20,060 --> 00:34:18,390
collapsed on mars i remember seeing them

754
00:34:25,520 --> 00:34:20,070
on the slopes of one of the big shield

755
00:34:28,700 --> 00:34:25,530
volcanoes on Mars possibly Oh Olympus

756
00:34:31,610 --> 00:34:28,710
Mons but there in that area we have

757
00:34:34,250 --> 00:34:31,620
found lava tubes and that would be a

758
00:34:37,659 --> 00:34:34,260
very exciting places if it would go go

759
00:34:40,960 --> 00:34:37,669
inside one and and and walk around and

760
00:34:44,540 --> 00:34:40,970
it could also potentially be used as a

761
00:34:46,790 --> 00:34:44,550
habitats for future human settlements or

762
00:34:48,950 --> 00:34:46,800
at least emergency shelters for for

763
00:34:50,900 --> 00:34:48,960

humans I personally hope that humans

764
00:34:53,390 --> 00:34:50,910
don't leaven end up living in lava tube

765
00:34:57,340 --> 00:34:53,400
says doesn't sound super inspirational

766
00:34:59,960 --> 00:34:57,350
to me but certainly as a storage

767
00:35:03,620 --> 00:34:59,970
facilities or emergency emergency

768
00:35:04,790 --> 00:35:03,630
shelters I don't make your tongue yeah

769
00:35:06,230 --> 00:35:04,800
definitely having some kind of like yeah

770
00:35:09,190 --> 00:35:06,240
background storage but maybe not

771
00:35:14,720 --> 00:35:09,200
becoming cave dwellers on another world

772
00:35:17,780 --> 00:35:14,730
yeah we can probably the domes on the

773
00:35:19,070 --> 00:35:17,790
surface yeah awesome that's great let's

774
00:35:21,010 --> 00:35:19,080
bring up another question from second

775
00:35:25,700 --> 00:35:21,020
net now going back to some icy worlds

776
00:35:28,430 --> 00:35:25,710
Rahu Camargo Tom asks can I swarms like

777
00:35:30,950 --> 00:35:28,440
those that exist in ice here on earth be

778
00:35:35,510 --> 00:35:30,960
expected in icy worlds like Europa or

779
00:35:42,030 --> 00:35:39,540
well we we really don't know that's why

780
00:35:44,520 --> 00:35:42,040
we need to go and find out what's what's

781
00:35:47,740 --> 00:35:44,530
there we don't know if there's any kind

782
00:35:51,160 --> 00:35:47,750
of life on Europa or Enceladus

783
00:35:54,130 --> 00:35:51,170
intense so so far you would seen them no

784
00:35:57,970 --> 00:35:54,140
signs of life outside of Earth a life

785
00:35:59,950 --> 00:35:57,980
event originated on earth so we only

786
00:36:01,140 --> 00:35:59,960
really have day one data point in terms

787
00:36:06,310 --> 00:36:01,150
of life

788
00:36:10,080 --> 00:36:06,320

what possible life what would be like on

789
00:36:13,120 --> 00:36:10,090
Europa or Enceladus we can't really

790
00:36:16,050 --> 00:36:13,130
guess we need to we need to go there and

791
00:36:18,570 --> 00:36:16,060
find out mm-hmm absolutely

792
00:36:21,310 --> 00:36:18,580
another Europe a question then if we can

793
00:36:24,880 --> 00:36:21,320
also from second at this time from user

794
00:36:26,560 --> 00:36:24,890
Chinmayi Raj for Europa missions if we

795
00:36:28,240 --> 00:36:26,570
want to get down into that that ocean

796
00:36:31,240 --> 00:36:28,250
down below and really understand what's

797
00:36:33,510 --> 00:36:31,250
going on down there with putting robots

798
00:36:35,770 --> 00:36:33,520
down there outside of being in orbit

799
00:36:37,750 --> 00:36:35,780
would there be a requirement to have an

800
00:36:40,270 --> 00:36:37,760
impactor to break through that ice to

801
00:36:43,420 --> 00:36:40,280
access that water body down below how

802
00:36:45,460 --> 00:36:43,430
would we do that do you think yeah well

803
00:36:47,710 --> 00:36:45,470
that really underscores the importance

804
00:36:50,770 --> 00:36:47,720
of the Europa clipper mission and

805
00:36:53,620 --> 00:36:50,780
because one of us objectives is to find

806
00:36:56,310 --> 00:36:53,630
places where the ocean might be more

807
00:36:59,500 --> 00:36:56,320
easily accessible whether it's a

808
00:37:04,690 --> 00:36:59,510
fracture or just an area where the ice

809
00:37:08,740 --> 00:37:04,700
is really thin but once we figure out of

810
00:37:11,080 --> 00:37:08,750
what those places are then we can start

811
00:37:15,700 --> 00:37:11,090
working on more detailed design of how

812
00:37:17,080 --> 00:37:15,710
to get yet into the ocean one concept

813
00:37:20,140 --> 00:37:17,090

that I know has been around for a while

814
00:37:22,930 --> 00:37:20,150
is essentially using an RTG a

815
00:37:25,330 --> 00:37:22,940
radioisotope a thermally used in

816
00:37:27,190 --> 00:37:25,340
spacecraft four-bit for decades they

817
00:37:29,260 --> 00:37:27,200
generate a lot of heat so they can

818
00:37:32,380 --> 00:37:29,270
potentially be used to melt through the

819
00:37:34,750 --> 00:37:32,390
ice from I mean it's not really thick

820
00:37:37,600 --> 00:37:34,760
and there aren't really any rocks or

821
00:37:40,450 --> 00:37:37,610
anything like that in the way in space

822
00:37:42,100 --> 00:37:40,460
it's probably doable but it might be a

823
00:37:43,780 --> 00:37:42,110
little bit premature right now because

824
00:37:46,540 --> 00:37:43,790
we don't really know what we're facing

825
00:37:48,420 --> 00:37:46,550
when you're up a clipper gets there it

826
00:37:51,340 --> 00:37:48,430
will it will tell us exactly how

827
00:37:53,140 --> 00:37:51,350
difficult or easy it might be to access

828
00:37:55,120 --> 00:37:53,150
the ocean awesome

829
00:37:57,940 --> 00:37:55,130
yeah I know that you know with Galileo

830
00:37:59,800 --> 00:37:57,950
at Jupiter many years ago we got a

831
00:38:00,760 --> 00:37:59,810
somewhat of an idea of how thick that

832
00:38:02,620 --> 00:38:00,770
icy crust was

833
00:38:04,540 --> 00:38:02,630
and I know in planetary science a lot of

834
00:38:06,430 --> 00:38:04,550
us just say it it might be about 10

835
00:38:07,540 --> 00:38:06,440
kilometers thick or roughly 6 miles

836
00:38:09,340 --> 00:38:07,550
thick

837
00:38:10,990 --> 00:38:09,350
you know the e Themis instrument helped

838
00:38:13,860 --> 00:38:11,000

us to really nail down how thick that

839
00:38:17,790 --> 00:38:13,870
icy crust really is

840
00:38:19,860 --> 00:38:17,800
well we have several instruments that

841
00:38:20,160 --> 00:38:19,870
specifically address the thickness of

842
00:38:22,350 --> 00:38:20,170
the ice

843
00:38:24,570 --> 00:38:22,360
Etha --mess is one of them but it's a

844
00:38:26,010 --> 00:38:24,580
secondary of instrumental and self

845
00:38:28,080 --> 00:38:26,020
question the primary instrument will

846
00:38:30,840 --> 00:38:28,090
converse that I spent training radar

847
00:38:33,060 --> 00:38:30,850
that would obtain a direct measurement

848
00:38:36,000 --> 00:38:33,070
it would basically send the radar signal

849
00:38:39,090 --> 00:38:36,010
through the ice and have the radar

850
00:38:40,800 --> 00:38:39,100
signal balance of the liquid ocean then

851
00:38:44,250 --> 00:38:40,810
this will tell us pretty much exactly

852
00:38:48,030 --> 00:38:44,260
how all think the icy crust is and it's

853
00:38:50,100 --> 00:38:48,040
it's one of the one of the main science

854
00:38:53,310 --> 00:38:50,110
objectives of mission just figure out

855
00:38:54,630 --> 00:38:53,320
exactly how that's wonderful yeah that's

856
00:38:56,430 --> 00:38:54,640
that seems like a necessary starting

857
00:38:57,900 --> 00:38:56,440
point before we start considering a

858
00:38:58,620 --> 00:38:57,910
melting through the ice and any of that

859
00:39:01,200 --> 00:38:58,630
kind of stuff

860
00:39:04,230 --> 00:39:01,210
oh yes yes yes absolutely you're mapping

861
00:39:06,630 --> 00:39:04,240
the thickness of the ice

862
00:39:10,890 --> 00:39:06,640
and you think temperature anomalies that

863
00:39:12,150 --> 00:39:10,900

might be associated with that the ones

864
00:39:15,450 --> 00:39:12,160
you probably have heard that there was a

865
00:39:16,050 --> 00:39:15,460
concept to just attach a lender to this

866
00:39:18,720 --> 00:39:16,060
mission

867
00:39:23,250 --> 00:39:18,730
a clipper and I believe that's still on

868
00:39:25,590 --> 00:39:23,260
a table but I don't scientifically it

869
00:39:30,210 --> 00:39:25,600
might be a little bit premature Senta a

870
00:39:31,890 --> 00:39:30,220
lander before really know where - yeah

871
00:39:34,710 --> 00:39:31,900
it's good point I know the surface of

872
00:39:35,910 --> 00:39:34,720
Europa is we think very sharp and

873
00:39:37,560 --> 00:39:35,920
angular and it could be very difficult

874
00:39:39,800 --> 00:39:37,570
to land anywhere without knowing what

875
00:39:42,960 --> 00:39:39,810
we're looking at first so yeah

876
00:39:46,320 --> 00:39:42,970
absolutely be a very challenging lender

877
00:39:48,000 --> 00:39:46,330
mission without a detailed require you

878
00:39:52,050 --> 00:39:48,010
know reconnaissance ahead of time and

879
00:39:54,930 --> 00:39:52,060
data analysis it just seems of all

880
00:39:56,580 --> 00:39:54,940
premature absolutely well it's got a

881
00:40:00,240 --> 00:39:56,590
really fun question here this one from

882
00:40:02,580 --> 00:40:00,250
Richard Rowe on Facebook so if life is

883
00:40:03,920 --> 00:40:02,590
found somewhere beyond Earth in our

884
00:40:08,790 --> 00:40:03,930
solar system

885
00:40:16,440 --> 00:40:13,490
um any kind of life or intelligent life

886
00:40:20,130 --> 00:40:16,450
specifies let's say both what happens if

887
00:40:23,730 --> 00:40:20,140
either of those things happens well so

888
00:40:29,280 --> 00:40:23,740

if we find any kind of life in the solar

889
00:40:34,470 --> 00:40:29,290
system probably the first question will

890
00:40:42,790 --> 00:40:37,630
how different it is from life on earth

891
00:40:45,370 --> 00:40:42,800
and if for example oh it it's very

892
00:40:47,350 --> 00:40:45,380
similar to life on earth and that might

893
00:40:48,850 --> 00:40:47,360
be implied that it is life from Earth

894
00:40:51,850 --> 00:40:48,860
that just got transferred to another

895
00:40:56,829 --> 00:40:51,860
planet or life from another planet was

896
00:41:05,799 --> 00:41:02,529
it was transferred between planets I if

897
00:41:06,819 --> 00:41:05,809
it's a completely different kind of life

898
00:41:09,999 --> 00:41:06,829
I

899
00:41:11,650 --> 00:41:10,009
that would probably revolutionize our

900
00:41:16,269 --> 00:41:11,660
understanding of genetics and molecular

901
00:41:18,940 --> 00:41:16,279
biology and how life can be different

902
00:41:21,279 --> 00:41:18,950
from life as we know it and that will

903
00:41:25,120 --> 00:41:21,289
probably result in lots of discoveries

904
00:41:29,200 --> 00:41:25,130
that you know you can't quite predict

905
00:41:32,969 --> 00:41:29,210
but that's how science works in terms of

906
00:41:36,430 --> 00:41:32,979
why if we find signals from an

907
00:41:39,249 --> 00:41:36,440
extraterrestrial civilization I think

908
00:41:42,809 --> 00:41:39,259
that's also that would be a very

909
00:41:45,789 --> 00:41:42,819
significant moment in human history and

910
00:41:51,999 --> 00:41:45,799
depending on the nature and the

911
00:41:56,799 --> 00:41:52,009
circumstances of this detection that can

912
00:41:59,229 --> 00:41:56,809
profoundly change basically our future

913
00:42:00,849 --> 00:41:59,239

yeah it seems like something that a lot

914
00:42:03,130 --> 00:42:00,859
of us have dreamed of you know are we

915
00:42:05,440 --> 00:42:03,140
alone or not and and if we do find that

916
00:42:06,819 --> 00:42:05,450
you know what happens I did read

917
00:42:08,650 --> 00:42:06,829
recently there was this idea you know a

918
00:42:10,509 --> 00:42:08,660
lot of times we talk about finding

919
00:42:12,430 --> 00:42:10,519
extraterrestrial life and everyone kind

920
00:42:14,950 --> 00:42:12,440
of losing their minds and there being

921
00:42:16,329 --> 00:42:14,960
chaos but recently some research has

922
00:42:19,239 --> 00:42:16,339
suggested maybe that wouldn't happen

923
00:42:21,459 --> 00:42:19,249
maybe we we would actually be optimistic

924
00:42:22,930 --> 00:42:21,469
about that finding how do you think

925
00:42:26,140 --> 00:42:22,940
humans would respond how would you

926
00:42:29,349 --> 00:42:26,150
respond to that finding yourself I think

927
00:42:33,040 --> 00:42:29,359
it really depends and circumstances of

928
00:42:38,290 --> 00:42:36,130
I if there is a message the content of

929
00:42:42,250 --> 00:42:38,300
the message or if it's even something

930
00:42:43,960 --> 00:42:42,260
that can be deciphered easily so let's

931
00:42:47,730 --> 00:42:43,970
let's just say there is a detection of a

932
00:42:50,400 --> 00:42:47,740
signal that indicates

933
00:42:53,640 --> 00:42:50,410
unmistakable intelligent origin and

934
00:42:55,980 --> 00:42:53,650
nothing else if that at least answers

935
00:43:00,200 --> 00:42:55,990
the question of whether or not we're

936
00:43:04,530 --> 00:43:00,210
alone whether or not intelligent species

937
00:43:06,900 --> 00:43:04,540
and I think that would cause a lot of

938
00:43:09,420 --> 00:43:06,910

kind of fundamental rethinking of our

939
00:43:11,579 --> 00:43:09,430
own place in the universe if the husband

940
00:43:13,980 --> 00:43:11,589
brought human history that had been a

941
00:43:18,060 --> 00:43:13,990
number of what people have called the

942
00:43:20,400 --> 00:43:18,070
great devotions originally it was

943
00:43:23,700 --> 00:43:20,410
assumed that humans were in the center

944
00:43:25,500 --> 00:43:23,710
of the universe that's not the case were

945
00:43:27,780 --> 00:43:25,510
actually on a planet orbiting a star

946
00:43:30,450 --> 00:43:27,790
which itself orbits the galactic center

947
00:43:35,329 --> 00:43:30,460
and there are lots of are galaxies and

948
00:43:39,020 --> 00:43:35,339
basically we're not not that significant

949
00:43:40,980 --> 00:43:39,030
so the detection of something from

950
00:43:44,609 --> 00:43:40,990
extraterrestrial civilization I think

951
00:43:48,470 --> 00:43:44,619
would would certainly be one of those

952
00:43:55,040 --> 00:43:52,400
to understand our our space our a role

953
00:43:56,630 --> 00:43:55,050
and I wish look how how we fit into the

954
00:43:59,780 --> 00:43:56,640
grand scheme of things that gets better

955
00:44:01,310 --> 00:43:59,790
it's awesome yeah well we do have a lot

956
00:44:04,400 --> 00:44:01,320
of questions so I don't mind me just

957
00:44:08,150 --> 00:44:04,410
jumping through some more here user

958
00:44:11,000 --> 00:44:08,160
Chinmayi Raj on second net again asks in

959
00:44:13,220 --> 00:44:11,010
reference to the Mars 2020 mission how

960
00:44:15,530 --> 00:44:13,230
would the sample return mission improve

961
00:44:17,960 --> 00:44:15,540
the way we do biochemical analyses on

962
00:44:22,640 --> 00:44:17,970
Mars samples

963
00:44:27,260 --> 00:44:22,650

ah so the Mars 2020 Rover among other

964
00:44:30,349 --> 00:44:27,270
things will like cache the samples that

965
00:44:33,380 --> 00:44:30,359
it collects for Apollo for a future

966
00:44:35,870 --> 00:44:33,390
simple return mission so the idea is to

967
00:44:38,599 --> 00:44:35,880
eventually return the rocks that this

968
00:44:43,819 --> 00:44:38,609
rover will collect at its landing site

969
00:44:47,180 --> 00:44:43,829
back to earth for analysis in labs on

970
00:44:49,520 --> 00:44:47,190
earth where the capability is are

971
00:44:52,059 --> 00:44:49,530
several orders of magnitude better than

972
00:44:55,460 --> 00:44:52,069
anything potentially do on Mars

973
00:44:57,559 --> 00:44:55,470
basically you're really able to pair in

974
00:45:00,440 --> 00:44:57,569
the little samples with a

975
00:45:03,760 --> 00:45:00,450
high-resolution outrun microscopy and

976
00:45:08,030 --> 00:45:03,770
x-ray analysis all kinds of spectroscopy

977
00:45:11,180 --> 00:45:08,040
will be able to do a if there are

978
00:45:13,750 --> 00:45:11,190
organic compounds or bio signatures and

979
00:45:16,520 --> 00:45:13,760
in those samples we would be able to

980
00:45:19,040 --> 00:45:16,530
detect them with much greater certainty

981
00:45:20,960 --> 00:45:19,050
and anything that's possible to do on

982
00:45:22,609 --> 00:45:20,970
Mars right now but of course you have

983
00:45:24,079 --> 00:45:22,619
been analyzing these samples on earth

984
00:45:26,660 --> 00:45:24,089
would allow us to improve our

985
00:45:30,559 --> 00:45:26,670
methodology for analyzing samples of

986
00:45:32,390 --> 00:45:30,569
Mars and other planets awesome kind of

987
00:45:34,760 --> 00:45:32,400
maybe in a similar vein until we talked

988
00:45:36,140 --> 00:45:34,770

about insight earlier and how insights

989
00:45:38,809 --> 00:45:36,150
really kind of just measuring the

990
00:45:40,970 --> 00:45:38,819
internal structure of Mars and then how

991
00:45:42,530 --> 00:45:40,980
that might help us learn about the

992
00:45:45,859 --> 00:45:42,540
history of Mars and whether or not Mars

993
00:45:48,470 --> 00:45:45,869
was habitable but user Bruno Pavle touch

994
00:45:50,660 --> 00:45:48,480
from second net asks if insight is

995
00:45:56,210 --> 00:45:50,670
actually able to detect any specific bio

996
00:46:00,020 --> 00:45:56,220
signatures on Mars I inside is a

997
00:46:02,390 --> 00:46:00,030
relatively small mission as far as NASA

998
00:46:06,190 --> 00:46:02,400
missions go it's a discovery class

999
00:46:09,140 --> 00:46:06,200
mission as opposed to something like

1000
00:46:13,370 --> 00:46:09,150
curiosity or Mars 2020 which are flexion

1001
00:46:17,050 --> 00:46:13,380
class missions and it really has very

1002
00:46:19,609 --> 00:46:17,060
focused scientific investigations

1003
00:46:22,000 --> 00:46:19,619
they're basically focused on determining

1004
00:46:26,120 --> 00:46:22,010
the internal structure of Mars

1005
00:46:29,809 --> 00:46:26,130
what's Mars like on the inside so very

1006
00:46:31,980 --> 00:46:29,819
big geophysical questions and detection

1007
00:46:37,620 --> 00:46:31,990
of life is outside of

1008
00:46:39,300 --> 00:46:37,630
for inside but Mars 2020 will have a

1009
00:46:44,430 --> 00:46:39,310
number of instruments that would be able

1010
00:46:48,480 --> 00:46:44,440
to detect organic compounds and if there

1011
00:46:54,480 --> 00:46:48,490
are any other bio signatures that are

1012
00:46:57,089 --> 00:46:54,490
present it would be equipped to awesome

1013
00:46:59,190 --> 00:46:57,099

it's interesting let's move over to

1014
00:47:00,569 --> 00:46:59,200
Facebook now with the user Tom Caruso

1015
00:47:02,370 --> 00:47:00,579
who wants to know a bit about

1016
00:47:04,829 --> 00:47:02,380
hydrothermal venting in a deep

1017
00:47:07,829 --> 00:47:04,839
subsurface ocean like that on Enceladus

1018
00:47:09,569 --> 00:47:07,839
or Europa how would those bio critical

1019
00:47:12,540 --> 00:47:09,579
elements elements needed for life as we

1020
00:47:15,599 --> 00:47:12,550
know it be introduced into the seawater

1021
00:47:17,730 --> 00:47:15,609
and how would that plume ascend in that

1022
00:47:19,980 --> 00:47:17,740
ocean would be similar we'll see here on

1023
00:47:21,900 --> 00:47:19,990
earth would that be a different process

1024
00:47:27,480 --> 00:47:21,910
based on based on those worlds and their

1025
00:47:31,920 --> 00:47:27,490
structures so yeah let's let's talk

1026
00:47:35,880 --> 00:47:31,930
about Europa specifically is one of four

1027
00:47:38,160 --> 00:47:35,890
big satellites of Jupiter and the closer

1028
00:47:42,089 --> 00:47:38,170
the satellite is to Jupiter the more

1029
00:47:47,130 --> 00:47:42,099
tidal forces in experiences so the

1030
00:47:49,710 --> 00:47:47,140
innermost satellite big satellite has a

1031
00:47:52,559 --> 00:47:49,720
lot of volcanic activity yet the next

1032
00:47:54,540 --> 00:47:52,569
one out of zero but it probably still

1033
00:47:57,800 --> 00:47:54,550
has enough tidal heating to generate

1034
00:48:00,450 --> 00:47:57,810
volcanic activity and it's ocean floor

1035
00:48:03,960 --> 00:48:00,460
so there might very well be events

1036
00:48:08,609 --> 00:48:03,970
similar to those that we see on the

1037
00:48:11,760 --> 00:48:08,619
ocean floor earth just as a result of

1038
00:48:17,520 --> 00:48:11,770

this volcanic activity due to the tidal

1039
00:48:20,460 --> 00:48:17,530
heating of Europa and then of course the

1040
00:48:22,950 --> 00:48:20,470
physics of the plume once is generate in

1041
00:48:25,620 --> 00:48:22,960
the ocean would be quite similar to

1042
00:48:27,960 --> 00:48:25,630
those on earth of course accounting for

1043
00:48:31,600 --> 00:48:27,970
more gravity and so forth it would

1044
00:48:36,880 --> 00:48:31,610
probably be a bigger and more extensive

1045
00:48:40,120 --> 00:48:36,890
you find on earth those kinds of counter

1046
00:48:40,720 --> 00:48:40,130
thermal events and the ocean floor yep

1047
00:48:44,020 --> 00:48:40,730
terrific

1048
00:48:46,900 --> 00:48:44,030
places to look for life that's awesome

1049
00:48:48,280 --> 00:48:46,910
yeah let's jump around now go do your

1050
00:48:51,610 --> 00:48:48,290
own research and how you do your

1051
00:48:54,370 --> 00:48:51,620
research user Jonathan Joseph Durkin on

1052
00:48:56,490 --> 00:48:54,380
second net has asked what computers

1053
00:49:00,280 --> 00:48:56,500
software and maybe even computer skills

1054
00:49:01,630 --> 00:49:00,290
do you use the most in your research and

1055
00:49:03,850 --> 00:49:01,640
what technical skills would you

1056
00:49:06,340 --> 00:49:03,860
recommend to someone who's looking to

1057
00:49:09,270 --> 00:49:06,350
enter a graduate program in this kind of

1058
00:49:19,350 --> 00:49:13,080
um so I personally use computational

1059
00:49:22,080 --> 00:49:19,360
clusters which are basically a large

1060
00:49:25,680 --> 00:49:22,090
computers with large numbers of my CPUs

1061
00:49:32,220 --> 00:49:25,690
that also share memory and storage space

1062
00:49:34,830 --> 00:49:32,230
and you can schedule a simulation and

1063
00:49:37,680 --> 00:49:34,840

that's kind of a kind of a computer it

1064
00:49:40,410 --> 00:49:37,690
will automatically run it when the space

1065
00:49:43,130 --> 00:49:40,420
becomes available on it and and I

1066
00:49:47,700 --> 00:49:43,140
analyze the results of the simulation so

1067
00:49:49,440 --> 00:49:47,710
understanding computing clusters is it's

1068
00:49:55,160 --> 00:49:49,450
very important for what I do in terms of

1069
00:49:59,910 --> 00:49:55,170
my I'm the software side I use a lot of

1070
00:50:04,560 --> 00:49:59,920
programming languages python I use quite

1071
00:50:06,060 --> 00:50:04,570
a bit I use a Fortran which is of course

1072
00:50:07,710 --> 00:50:06,070
an older programming language but a lot

1073
00:50:09,300 --> 00:50:07,720
of scientific computing software is

1074
00:50:13,080 --> 00:50:09,310
still written in Fortran believe it for

1075
00:50:15,240 --> 00:50:13,090
that there is a song see there is a

1076
00:50:16,980 --> 00:50:15,250
quite a bit I have quite a bit of Perl

1077
00:50:19,470 --> 00:50:16,990
scripts that they use for viciously

1078
00:50:23,300 --> 00:50:19,480
extracting data from one place and

1079
00:50:25,350 --> 00:50:23,310
feeding data to other programs

1080
00:50:27,660 --> 00:50:25,360
understanding probably the most

1081
00:50:29,730 --> 00:50:27,670
fundamental level understanding the UNIX

1082
00:50:32,250 --> 00:50:29,740
command line understanding the basic

1083
00:50:33,990 --> 00:50:32,260
tools understanding called pipes work

1084
00:50:37,110 --> 00:50:34,000
how you couldn't be there a beta how you

1085
00:50:40,980 --> 00:50:37,120
can extract the images those are all

1086
00:50:44,820 --> 00:50:40,990
extremely useful skills the UNIX command

1087
00:50:46,440 --> 00:50:44,830
line is a very powerful tool so if

1088
00:50:51,050 --> 00:50:46,450

you're not using something like Ubuntu

1089
00:50:54,930 --> 00:50:51,060
or there are some Linux distribution or

1090
00:50:58,680 --> 00:50:54,940
other way to practice the UNIX command

1091
00:51:01,380 --> 00:50:58,690
line that'd probably be my now it's

1092
00:51:04,710 --> 00:51:01,390
wonderful maybe in a similar vein then a

1093
00:51:07,560 --> 00:51:04,720
user sunny yungshao from sega net has

1094
00:51:08,880 --> 00:51:07,570
asked how do you model hydrothermal

1095
00:51:10,800 --> 00:51:08,890
vents and how do you model these

1096
00:51:12,930 --> 00:51:10,810
terrestrial impacts then using your code

1097
00:51:14,870 --> 00:51:12,940
what goes into that process of doing

1098
00:51:18,740 --> 00:51:14,880
that modeling work

1099
00:51:20,809 --> 00:51:18,750
I so probably the first step is

1100
00:51:23,660 --> 00:51:20,819
gathering all the information from

1101
00:51:28,430 --> 00:51:23,670
literature on what is known about a

1102
00:51:32,269 --> 00:51:28,440
system I'm about simulate so I compile a

1103
00:51:34,069 --> 00:51:32,279
list of constraints and we know for

1104
00:51:36,410 --> 00:51:34,079
example what the temperature range may

1105
00:51:38,390 --> 00:51:36,420
have been in that part of the crater for

1106
00:51:41,329 --> 00:51:38,400
how long based on which minerals got

1107
00:51:43,789 --> 00:51:41,339
deposited minerals got overprinted by

1108
00:51:46,579 --> 00:51:43,799
later minerals and so forth this is all

1109
00:51:49,309 --> 00:51:46,589
in the literature the model that I come

1110
00:51:51,079 --> 00:51:49,319
up with has to fit the constraints that

1111
00:51:54,650 --> 00:51:51,089
are observed otherwise it's not like

1112
00:51:56,269 --> 00:51:54,660
something correct so then I use a

1113
00:51:59,450 --> 00:51:56,279

combination of software that I've

1114
00:52:01,999 --> 00:51:59,460
written and off-the-shelf software a

1115
00:52:04,700 --> 00:52:02,009
couple of examples of that are kind of

1116
00:52:06,519 --> 00:52:04,710
theorem which is a USGS code for

1117
00:52:09,799 --> 00:52:06,529
simulating federal thermal systems

1118
00:52:14,049 --> 00:52:09,809
heating which is an Oakridge Fortran

1119
00:52:17,960 --> 00:52:14,059
code quite old but still very useful for

1120
00:52:22,279 --> 00:52:17,970
simulating heat transfer processes basic

1121
00:52:23,749 --> 00:52:22,289
induction conduction radiation and then

1122
00:52:26,920 --> 00:52:23,759
I analyzed the results of the simulation

1123
00:52:29,450 --> 00:52:26,930
see how well they fit the constraints

1124
00:52:34,069 --> 00:52:29,460
make the necessary revisions and

1125
00:52:38,120 --> 00:52:34,079
basically the Eid is having a simulation

1126
00:52:40,789 --> 00:52:38,130
that's consistent with physics as we

1127
00:52:43,490 --> 00:52:40,799
know it of fluid and heat transfer

1128
00:52:45,019 --> 00:52:43,500
processes and all the constraints all

1129
00:52:46,819 --> 00:52:45,029
the observational constraints that we

1130
00:52:50,299 --> 00:52:46,829
have so the outcome of the simulation

1131
00:52:52,609 --> 00:52:50,309
matches what we actually see that gives

1132
00:52:56,089 --> 00:52:52,619
us a lot of insights and how these

1133
00:52:57,140 --> 00:52:56,099
systems actually work yeah it seems

1134
00:52:59,539 --> 00:52:57,150
really important then that you know

1135
00:53:00,980 --> 00:52:59,549
start from what we know build models and

1136
00:53:02,690 --> 00:53:00,990
then test those models and then figure

1137
00:53:06,470 --> 00:53:02,700
out we can learn from them it seemed

1138
00:53:07,759 --> 00:53:06,480

like a very sensible process him yep so

1139
00:53:09,170 --> 00:53:07,769
since you've been involved in

1140
00:53:10,819 --> 00:53:09,180
development of instruments for

1141
00:53:13,579 --> 00:53:10,829
spacecraft and development of

1142
00:53:16,039 --> 00:53:13,589
instruments user Norman horn from a

1143
00:53:17,509 --> 00:53:16,049
Facebook has asked how how do you

1144
00:53:20,120 --> 00:53:17,519
prevent the possibility of false

1145
00:53:21,859 --> 00:53:20,130
positives for life detection or even

1146
00:53:22,640 --> 00:53:21,869
false positives for detection of things

1147
00:53:27,430 --> 00:53:22,650
that you're looking for with these

1148
00:53:33,890 --> 00:53:30,440
so there are several ways to kava have a

1149
00:53:38,650 --> 00:53:33,900
false positive probably in the most

1150
00:53:41,150 --> 00:53:38,660
famous case was when Viking landers

1151
00:53:46,190 --> 00:53:41,160
first successful when there's on Mars

1152
00:53:49,010 --> 00:53:46,200
landed in 1976 and they had a guest

1153
00:53:52,760 --> 00:53:49,020
chromatograph basically an instrument

1154
00:53:56,270 --> 00:53:52,770
that heated up samples of the soil and

1155
00:54:00,770 --> 00:53:56,280
analyzed the gases that came off and

1156
00:54:03,980 --> 00:54:00,780
there were the results were actually

1157
00:54:06,710 --> 00:54:03,990
quite quite ambiguous some saw some

1158
00:54:08,900 --> 00:54:06,720
results for example when the Martian

1159
00:54:11,270 --> 00:54:08,910
soil was dropped into a nutrient broth

1160
00:54:14,980 --> 00:54:11,280
early and resulted in release of a lot

1161
00:54:17,240 --> 00:54:14,990
of gases including some that would be

1162
00:54:20,870 --> 00:54:17,250
expected as a result of microbial

1163
00:54:22,839 --> 00:54:20,880

metabolism but I guess chromatograph

1164
00:54:25,280 --> 00:54:22,849
then detect any organic compounds

1165
00:54:27,530 --> 00:54:25,290
suggesting that it was probably in a

1166
00:54:30,460 --> 00:54:27,540
false detection a slab detection

1167
00:54:34,010 --> 00:54:30,470
instrument basically produced results

1168
00:54:36,829 --> 00:54:34,020
consistent with life but there is no

1169
00:54:39,079 --> 00:54:36,839
organic molecules so its problem

1170
00:54:42,980 --> 00:54:39,089
probably something in a Martian

1171
00:54:44,030 --> 00:54:42,990
chemistry that resulted it so that there

1172
00:54:46,550 --> 00:54:44,040
is something if we have to be extremely

1173
00:54:48,559 --> 00:54:46,560
careful with one way to prevent false

1174
00:54:50,390 --> 00:54:48,569
positive is of course have several

1175
00:54:53,240 --> 00:54:50,400
instruments that will perform the

1176
00:54:56,359 --> 00:54:53,250
analysis in different ways and if then

1177
00:54:58,069 --> 00:54:56,369
Carl Sagan said once that extraordinary

1178
00:54:59,930 --> 00:54:58,079
claims require to require extraordinary

1179
00:55:02,420 --> 00:54:59,940
evidence if you're going to claim you

1180
00:55:04,370 --> 00:55:02,430
found life on Mars it should be several

1181
00:55:08,930 --> 00:55:04,380
different instruments that all agree

1182
00:55:14,840 --> 00:55:08,940
there is organics there is metabolic

1183
00:55:18,440 --> 00:55:14,850
activity that there is basically

1184
00:55:20,690 --> 00:55:18,450
some sort of visible structure that

1185
00:55:22,070 --> 00:55:20,700
generates this and then maybe you can

1186
00:55:23,870 --> 00:55:22,080
put together a convincing case that

1187
00:55:26,990 --> 00:55:23,880
there is some sort of microbial life on

1188
00:55:30,020 --> 00:55:27,000

Mars wonderful we're and the show here

1189
00:55:32,090 --> 00:55:30,030
soon oh that's one more question yet if

1190
00:55:34,580 --> 00:55:32,100
there was any one single piece of advice

1191
00:55:37,160 --> 00:55:34,590
that you would give young students in

1192
00:55:39,620 --> 00:55:37,170
college or high school about how they

1193
00:55:40,880 --> 00:55:39,630
might be involved in astrobiology or how

1194
00:55:43,100 --> 00:55:40,890
they can pursue more knowledge in

1195
00:55:46,850 --> 00:55:43,110
astrobiology what do you think you would

1196
00:55:52,160 --> 00:55:50,450
so for myself but probably my first step

1197
00:55:54,560 --> 00:55:52,170
was to learn as much as we can about it

1198
00:55:58,250 --> 00:55:54,570
and figure out if that's something that

1199
00:56:00,140 --> 00:55:58,260
you really want to do and if you decide

1200
00:56:04,730 --> 00:56:00,150
that's something that you really want to

1201
00:56:07,490 --> 00:56:04,740
do you persevere and you know you know

1202
00:56:11,150 --> 00:56:07,500
what what needs to be done so that you

1203
00:56:13,610 --> 00:56:11,160
can work in this field participate in

1204
00:56:18,290 --> 00:56:13,620
these amazing discoveries if this is

1205
00:56:19,940 --> 00:56:18,300
something that's awesome well thank you

1206
00:56:21,800 --> 00:56:19,950
so much dr. Aaron for being on the show

1207
00:56:25,400 --> 00:56:21,810
with us it's been a really huge pleasure

1208
00:56:27,440 --> 00:56:25,410
having you with us today thank you it

1209
00:56:29,420 --> 00:56:27,450
was great to be here yeah and thank you

1210
00:56:31,100 --> 00:56:29,430
to our audience for watching we hope you

1211
00:56:33,170 --> 00:56:31,110
can too next time we actually won't have

1212
00:56:35,150 --> 00:56:33,180
an episode in December of this year

1213
00:56:38,690 --> 00:56:35,160

we'll be back in the new year in 2019