
NASA
SILICON
VALLEY
AMES RESEARCH CENTER

1
00:00:00,000 --> 00:00:05,000
four three two

2
00:00:24,970 --> 00:00:18,580
[Music]

3
00:00:27,609 --> 00:00:24,980
what's up everybody you are watching

4
00:00:29,350 --> 00:00:27,619
NASA in Silicon Valley live for August

5
00:00:32,319 --> 00:00:29,360
30th 2018

6
00:00:35,650 --> 00:00:32,329
I'm your host Matt Buffington and I'm

7
00:00:37,360 --> 00:00:35,660
Abbie Tabor and today I'm happy to

8
00:00:39,400 --> 00:00:37,370
introduce a very special guest we have

9
00:00:40,540 --> 00:00:39,410
NASA's administrator Jim brightenstein

10
00:00:42,160 --> 00:00:40,550
with us hi Jim

11
00:00:47,920 --> 00:00:42,170
well hello I keep telling people I'm

12
00:00:49,780 --> 00:00:47,930
special your mother isn't the chat and

13
00:00:57,450 --> 00:00:49,790

she confirmed your various yes indeed

14
00:01:04,149 --> 00:01:00,780
on Twitter all the time these days nice

15
00:01:06,100 --> 00:01:04,159
at Jim bridenstine you got it all right

16
00:01:08,289 --> 00:01:06,110
Jim Bryden Stein exact everybody out

17
00:01:11,020 --> 00:01:08,299
there go to action Bryce don't forget to

18
00:01:13,179 --> 00:01:11,030
Like share and subscribe there you go if

19
00:01:15,969 --> 00:01:13,189
you didn't know this is NASA in Silicon

20
00:01:18,280 --> 00:01:15,979
Valley live a conversational show out of

21
00:01:20,260 --> 00:01:18,290
NASA's Ames Research Center with all the

22
00:01:23,380 --> 00:01:20,270
various scientists researchers engineers

23
00:01:25,149 --> 00:01:23,390
and all-around cool people at NASA where

24
00:01:26,919 --> 00:01:25,159
we talk about all the nerdy NASA news

25
00:01:27,310 --> 00:01:26,929
you need to know about now if you like

26
00:01:29,169 --> 00:01:27,320
that

27
00:01:32,380 --> 00:01:29,179
we were simultaneously live on twitch

28
00:01:34,660 --> 00:01:32,390
YouTube and Facebook but if you want to

29
00:01:38,080 --> 00:01:34,670
participate in the chat then you need to

30
00:01:40,300 --> 00:01:38,090
go to twitch.tv slash NASA we're doing

31
00:01:42,429 --> 00:01:40,310
the chat on Twitch not over on YouTube

32
00:01:44,169 --> 00:01:42,439
and Facebook if you want so participate

33
00:01:45,669 --> 00:01:44,179
go to twitch if you want us to go on

34
00:01:48,010 --> 00:01:45,679
YouTube and Facebook then let us know in

35
00:01:49,809 --> 00:01:48,020
those comments but if you can't catch us

36
00:01:51,609 --> 00:01:49,819
live that is no big deal we'll have the

37
00:01:55,090 --> 00:01:51,619
video on demand after the show is over

38
00:01:57,609 --> 00:01:55,100

including on NASA TV you can also catch

39
00:02:00,809 --> 00:01:57,619
the audio version on podcast services

40
00:02:03,550 --> 00:02:00,819
throughout the solar system and beyond

41
00:02:05,889 --> 00:02:03,560
alright so should we get to it

42
00:02:07,680 --> 00:02:05,899
let's do this alright so later in the

43
00:02:10,270 --> 00:02:07,690
show we are going to have NASA

44
00:02:12,160 --> 00:02:10,280
astrobiologist penny Boston on to talk

45
00:02:13,870 --> 00:02:12,170
about her work as well as some friends

46
00:02:15,730 --> 00:02:13,880
of hers who are right now are off the

47
00:02:18,160 --> 00:02:15,740
coast of Hawaii doing research along

48
00:02:19,360 --> 00:02:18,170
those lines astrobiology this so

49
00:02:22,420 --> 00:02:19,370
everybody knows there's some really

50
00:02:25,090 --> 00:02:22,430
nasty test tube's am i right that honey

51
00:02:26,400 --> 00:02:25,100
is gonna bring into the mix glad I will

52
00:02:28,590 --> 00:02:26,410
be gone when that comes in

53
00:02:30,720 --> 00:02:28,600
I tried to warn him it is not your water

54
00:02:33,810 --> 00:02:30,730
bottle no I think not want to drink you

55
00:02:36,210 --> 00:02:33,820
not mix those two up exactly so before

56
00:02:38,040 --> 00:02:36,220
we get to all that exciting stuff let's

57
00:02:41,040 --> 00:02:38,050
talk to Jim tell us what have you been

58
00:02:42,660 --> 00:02:41,050
up to in Silicon Valley really I've just

59
00:02:44,340 --> 00:02:42,670
kind of been going through all the

60
00:02:48,750 --> 00:02:44,350
different buildings here at Ames and

61
00:02:50,130 --> 00:02:48,760
checking out the aliens I saw that

62
00:02:52,470 --> 00:02:50,140
dropped in the chat where people are

63
00:02:54,660 --> 00:02:52,480

thinking they announced aliens yeah well

64
00:02:56,280 --> 00:02:54,670
these aliens are the ones from Mars and

65
00:02:57,120 --> 00:02:56,290
sometimes they're a little more hostile

66
00:02:59,370 --> 00:02:57,130
than the other ones

67
00:03:00,680 --> 00:02:59,380
but but no it's it's actually been a lot

68
00:03:03,120 --> 00:03:00,690
of fun of course

69
00:03:04,770 --> 00:03:03,130
traveling around we we have looked at

70
00:03:07,050 --> 00:03:04,780
some of the robotics capabilities of

71
00:03:08,780 --> 00:03:07,060
Ames which have been done in cooperation

72
00:03:10,770 --> 00:03:08,790
with some of the really impressive

73
00:03:15,240 --> 00:03:10,780
technological capabilities here in the

74
00:03:18,270 --> 00:03:15,250
Silicon Valley we walked through the two

75
00:03:20,940 --> 00:03:18,280
largest wind tunnels on the planet which

76
00:03:24,060 --> 00:03:20,950
are right here at Ames which again

77
00:03:25,740 --> 00:03:24,070
really impressive I've seen pictures but

78
00:03:27,780 --> 00:03:25,750
when you stand inside a wind tunnel

79
00:03:30,620 --> 00:03:27,790
that's massive it really changes your

80
00:03:32,760 --> 00:03:30,630
perspective which has been good

81
00:03:35,220 --> 00:03:32,770
certainly looking at some of the lunar

82
00:03:39,360 --> 00:03:35,230
capabilities a lot of people might not

83
00:03:41,220 --> 00:03:39,370
be aware that most of our moon missions

84
00:03:42,870 --> 00:03:41,230
robotically have been done they've been

85
00:03:45,060 --> 00:03:42,880
managed right you know right here at

86
00:03:47,400 --> 00:03:45,070
Ames you know speaking of moon there's

87
00:03:56,880 --> 00:03:47,410
Greg les and the chat said 3d printing

88
00:03:59,280 --> 00:03:56,890

with moon dust yes no it's it's a very

89
00:04:00,840 --> 00:03:59,290
serious kind of capability we need to

90
00:04:04,250 --> 00:04:00,850
develop which is how do we use the

91
00:04:06,750 --> 00:04:04,260
regolith how do we use in situ resources

92
00:04:09,420 --> 00:04:06,760
resources of the moon to actually build

93
00:04:12,540 --> 00:04:09,430
and live and work on the surface of the

94
00:04:15,180 --> 00:04:12,550
moon and 3d printing of objects using

95
00:04:17,280 --> 00:04:15,190
the regolith would be a capability

96
00:04:19,349 --> 00:04:17,290
that's important for us alright so

97
00:04:21,270 --> 00:04:19,359
before we get too far into the weeds

98
00:04:23,790 --> 00:04:21,280
with Jim because we don't have them the

99
00:04:25,380 --> 00:04:23,800
entire hour but you know you should have

100
00:04:27,570 --> 00:04:25,390
me for the entire do you want to say I

101
00:04:29,480 --> 00:04:27,580
mean you are the NASA Administrator over

102
00:04:31,249 --> 00:04:29,490
here with her little test tubes or

103
00:04:34,700 --> 00:04:31,259
chase you out or you're gonna have to

104
00:04:37,040 --> 00:04:34,710
grow a third arm so anyway so we're

105
00:04:46,730 --> 00:04:37,050
gonna jump into our first segment if you

106
00:04:48,950 --> 00:04:46,740
have bill we're ready to roll that so

107
00:04:50,990 --> 00:04:48,960
with that fancy music and graphic it's

108
00:04:53,120 --> 00:04:51,000
time for a let's play now this may

109
00:04:55,309 --> 00:04:53,130
include game controllers 12 sided dice

110
00:04:57,110 --> 00:04:55,319
or a pop o matic bubble it's all an

111
00:04:59,300 --> 00:04:57,120
excuse to play games and talk about

112
00:05:03,230 --> 00:04:59,310
science and today we're gonna go

113
00:05:04,939 --> 00:05:03,240

jeopardy style so Jim are you ready for

114
00:05:07,189 --> 00:05:04,949
the for your jeopardy court well it's

115
00:05:09,140 --> 00:05:07,199
not really questions or answers this is

116
00:05:11,960 --> 00:05:09,150
very do just basically you're gonna take

117
00:05:13,820 --> 00:05:11,970
the NASA Administrator and put them in a

118
00:05:16,100 --> 00:05:13,830
position to show everybody how dummy is

119
00:05:18,860 --> 00:05:16,110
that's a brilliant well it's not just

120
00:05:23,270 --> 00:05:18,870
for you remember you you ultimately work

121
00:05:24,499 --> 00:05:23,280
for me I do so both for Jim and for the

122
00:05:25,730 --> 00:05:24,509
chat because you know what let's test

123
00:05:27,439 --> 00:05:25,740
test the knowledge of the chat because

124
00:05:29,659 --> 00:05:27,449
they didn't get the advantage of touring

125
00:05:32,560 --> 00:05:29,669
Ames abilities all right so you may have

126
00:05:34,490 --> 00:05:32,570
heard of these things on other episodes

127
00:05:36,290 --> 00:05:34,500
let's see if you guys can do the answer

128
00:05:38,390 --> 00:05:36,300
but we had it up there briefly let's go

129
00:05:39,020 --> 00:05:38,400
back to it builds throw that question up

130
00:05:41,180 --> 00:05:39,030
ooh

131
00:05:43,790 --> 00:05:41,190
this plasma wind tunnel is used to

132
00:05:47,120 --> 00:05:43,800
simulate the extreme heat experienced by

133
00:05:50,860 --> 00:05:47,130
spacecraft during atmospheric entry is

134
00:05:54,980 --> 00:05:50,870
that for me do I have a hit a buzzer oh

135
00:05:56,990 --> 00:05:54,990
that would be the arc jet Alex in Z that

136
00:06:08,629 --> 00:05:57,000
is what is the arc jet I got asked the

137
00:06:11,300 --> 00:06:08,639
question people are familiar with wind

138
00:06:13,100 --> 00:06:11,310

tunnels you you take basically a really

139
00:06:15,350 --> 00:06:13,110
fast stream of air and you're able to

140
00:06:16,879 --> 00:06:15,360
check the aerodynamics of different air

141
00:06:18,830 --> 00:06:16,889
foils and air foil is really nothing

142
00:06:20,320 --> 00:06:18,840
nothing more than a wing and you can put

143
00:06:22,610 --> 00:06:20,330
them in the vertical or the horizontal

144
00:06:24,439 --> 00:06:22,620
and that's that's what a wind tunnel is

145
00:06:27,230 --> 00:06:24,449
well one of the things that we have to

146
00:06:30,189 --> 00:06:27,240
do as an agency is understand when we

147
00:06:32,450 --> 00:06:30,199
re-enter the atmosphere at you know

148
00:06:35,029 --> 00:06:32,460
17,000 miles per hour when you're in low

149
00:06:38,149 --> 00:06:35,039
Earth orbit or in some cases it could be

150
00:06:39,980 --> 00:06:38,159
you know 25,000 miles per hour or I

151
00:06:42,219 --> 00:06:39,990
should say yeah 25,000 miles per hour if

152
00:06:44,439 --> 00:06:42,229
you're coming back from from the moon

153
00:06:47,320 --> 00:06:44,449
we have to be able to test our

154
00:06:50,739 --> 00:06:47,330
capabilities at those velocities it's

155
00:06:53,320 --> 00:06:50,749
really difficult to accelerate a wind

156
00:06:55,480 --> 00:06:53,330
tunnel to 25,000 miles per hour while

157
00:06:57,159 --> 00:06:55,490
the arc jet actually does yeah get

158
00:07:00,219 --> 00:06:57,169
pretty darn close and it's not perfect

159
00:07:03,189 --> 00:07:00,229
but it gets to about five kilometers per

160
00:07:05,860 --> 00:07:03,199
second which is very very very fast air

161
00:07:07,230 --> 00:07:05,870
and in fact they call the plasma plasma

162
00:07:09,760 --> 00:07:07,240
that's exactly right

163
00:07:12,580 --> 00:07:09,770

and what we're able to do is take that

164
00:07:14,800 --> 00:07:12,590
five kilometers per second speed and

165
00:07:16,269 --> 00:07:14,810
combine it with heat and create an

166
00:07:18,640 --> 00:07:16,279
energy scenario that would be equivalent

167
00:07:21,730 --> 00:07:18,650
to entering the atmosphere at say 200

168
00:07:24,519 --> 00:07:21,740
thousand feet and you know 25,000 miles

169
00:07:27,309 --> 00:07:24,529
per hour so it's um it's a pretty

170
00:07:30,610 --> 00:07:27,319
impressive capability there's a lot of

171
00:07:32,769 --> 00:07:30,620
really smart people over there that know

172
00:07:35,409 --> 00:07:32,779
how to make that happen and they tried

173
00:07:37,329 --> 00:07:35,419
their best to explain it to me and they

174
00:07:40,390 --> 00:07:37,339
can they can explain it very well but

175
00:07:42,730 --> 00:07:40,400
they can't understand it for me um but

176
00:07:44,140 --> 00:07:42,740
certainly it is an impressive capability

177
00:07:49,420 --> 00:07:44,150
that nASA has an important for our

178
00:07:50,920 --> 00:07:49,430
agency and the country understand things

179
00:07:55,480 --> 00:07:50,930
like heat shields right I think that's

180
00:07:56,890 --> 00:07:55,490
what we just the heart shields from the

181
00:07:58,420 --> 00:07:56,900
bottom but then there's also working on

182
00:08:00,969 --> 00:07:58,430
ones that are deployable that's right

183
00:08:03,219 --> 00:08:00,979
like an umbrella that's right a retarder

184
00:08:06,070 --> 00:08:03,229
if you will to the the accept the

185
00:08:07,629 --> 00:08:06,080
speed of the vehicle all right so I

186
00:08:10,869 --> 00:08:07,639
think we've talked all about ArcGIS

187
00:08:12,969 --> 00:08:10,879
jumping to the next answer you don't get

188
00:08:15,639 --> 00:08:12,979

to choose your categories I know it's a

189
00:08:18,490 --> 00:08:15,649
wager either but remember it's a

190
00:08:20,350 --> 00:08:18,500
question yes so NASA is working with the

191
00:08:22,240 --> 00:08:20,360
Federal Aviation Administration and

192
00:08:25,629 --> 00:08:22,250
industry partners to develop this system

193
00:08:27,639 --> 00:08:25,639
for managing drone traffic oh great

194
00:08:29,200 --> 00:08:27,649
great great answer I'll give you the

195
00:08:30,550 --> 00:08:29,210
question well let me see I'm wondering

196
00:08:31,480 --> 00:08:30,560
if anybody in the chat or any of you

197
00:08:32,949 --> 00:08:31,490
guys are gonna be able to get this

198
00:08:35,500 --> 00:08:32,959
because I'm not seeing them popping up

199
00:08:41,589 --> 00:08:35,510
Facebook live about this recently we

200
00:08:42,670 --> 00:08:41,599
sure do so it's it's quite a mouthful

201
00:08:44,560 --> 00:08:42,680
but go for it

202
00:08:46,720 --> 00:08:44,570
why I probably don't have it right

203
00:08:49,720 --> 00:08:46,730
unmanned aerial systems traffic

204
00:08:51,630 --> 00:08:49,730
management UTM which is the way we

205
00:08:54,389 --> 00:08:51,640
integrate

206
00:08:57,180 --> 00:08:54,399
basically unmanned or uncrewed aircraft

207
00:08:59,970 --> 00:08:57,190
into the National Airspace System which

208
00:09:01,620 --> 00:08:59,980
is going to be transformative for really

209
00:09:04,740 --> 00:09:01,630
our country for transformative for our

210
00:09:08,130 --> 00:09:04,750
economy the idea that you know I was

211
00:09:11,639 --> 00:09:08,140
talking this morning on my on my Twitter

212
00:09:15,420 --> 00:09:11,649
Twitter live by the way at Jim Bryan is

213
00:09:17,160 --> 00:09:15,430

interested and and in in the Twitter the

214
00:09:20,370 --> 00:09:17,170
live stream I did there on Twitter it

215
00:09:22,530 --> 00:09:20,380
you know I talked about how one of the

216
00:09:24,420 --> 00:09:22,540
things that I like most about visiting

217
00:09:26,100 --> 00:09:24,430
California and this is important if

218
00:09:28,259 --> 00:09:26,110
everybody pays very close attention to

219
00:09:30,840 --> 00:09:28,269
this but the thing I like most about

220
00:09:34,079 --> 00:09:30,850
visiting California is in an out burger

221
00:09:38,160 --> 00:09:34,089
of course and the speed at which you can

222
00:09:40,740 --> 00:09:38,170
get a very very delicious burger animal

223
00:09:42,509 --> 00:09:40,750
stuff yes impressive and we don't have

224
00:09:44,639 --> 00:09:42,519
those on the East Coast but here on the

225
00:09:46,680 --> 00:09:44,649
west coast we're able to get that will

226
00:09:51,120 --> 00:09:46,690
imagine being able to have an in-and-out

227
00:09:53,880 --> 00:09:51,130
burger delivered from an unmanned aerial

228
00:09:55,620 --> 00:09:53,890
vehicle nice to see your doorstep in a

229
00:09:57,000 --> 00:09:55,630
matter of minutes from a phone call now

230
00:09:58,380 --> 00:09:57,010
I'm not saying in and out its gonna do

231
00:10:06,600 --> 00:09:58,390
any of this stuff I'm just saying in my

232
00:10:09,540 --> 00:10:06,610
dream world that would be well in and

233
00:10:11,100 --> 00:10:09,550
out is top notch but Taco Bell is really

234
00:10:15,740 --> 00:10:11,110
one of my favorite is you know so I got

235
00:10:18,689 --> 00:10:15,750
to throw the love around but a supreme

236
00:10:24,689 --> 00:10:18,699
and Long John Silver's chicken have you

237
00:10:26,550 --> 00:10:24,699
had that we're big fans of chain

238
00:10:28,500 --> 00:10:26,560

restaurants yes so there's no reason we

239
00:10:30,180 --> 00:10:28,510
shouldn't be just eating all the fast

240
00:10:36,030 --> 00:10:30,190
food available to us brought to us by

241
00:10:37,769 --> 00:10:36,040
drug a system in a way that doesn't

242
00:10:39,660 --> 00:10:37,779
clobber the air traffic control

243
00:10:42,449 --> 00:10:39,670
capabilities of this country so that's

244
00:10:45,410 --> 00:10:42,459
what it really is it's all about the

245
00:10:48,750 --> 00:10:45,420
food as fast as you can get it exactly

246
00:10:51,540 --> 00:10:48,760
let's jump into the third the third

247
00:10:54,509 --> 00:10:51,550
answer I suppose let's jump on over into

248
00:10:55,610 --> 00:10:54,519
that alright so here's a fun one and I

249
00:10:58,860 --> 00:10:55,620
heard you talking about this earlier

250
00:11:01,889 --> 00:10:58,870
NASA's LCROSS spacecraft discovered

251
00:11:05,390 --> 00:11:01,899
buckets of water on this astronomical

252
00:11:07,880 --> 00:11:05,400
body which humans plan to revisit

253
00:11:09,800 --> 00:11:07,890
now come on now the chat you can't do us

254
00:11:10,910 --> 00:11:09,810
wrong on this while I'm on folks but

255
00:11:15,500 --> 00:11:10,920
they're still talking about like

256
00:11:18,290 --> 00:11:15,510
McDonald's oh I got sore sore Oh X says

257
00:11:19,660 --> 00:11:18,300
in before McDonald's take the fund I

258
00:11:22,760 --> 00:11:19,670
don't even know what you're doing dude

259
00:11:25,640 --> 00:11:22,770
so but yeah so this job oh yeah here we

260
00:11:28,250 --> 00:11:25,650
got we got Frankie ranked uses moon nom

261
00:11:30,290 --> 00:11:28,260
so a lot of people I don't know a lot of

262
00:11:31,940 --> 00:11:30,300
moon references in there man and the

263
00:11:34,430 --> 00:11:31,950

chat is going completely insane like

264
00:11:37,490 --> 00:11:34,440
fuzzy Steve 88 where to go dude you got

265
00:11:41,600 --> 00:11:37,500
them can we see the questions we see the

266
00:11:45,680 --> 00:11:41,610
answer again okay I think the answer is

267
00:11:47,780 --> 00:11:45,690
incorrect go on yeah so it wasn't

268
00:11:57,640 --> 00:11:47,790
buckets of water we discovered that the

269
00:12:03,080 --> 00:12:00,350
made of barbecue spareribs would you eat

270
00:12:06,800 --> 00:12:03,090
it and the answer of course well is yes

271
00:12:09,200 --> 00:12:06,810
that's like a difference making

272
00:12:10,460 --> 00:12:09,210
discoveries every day and that's one of

273
00:12:12,320 --> 00:12:10,470
them and I'm here as a NASA

274
00:12:14,450 --> 00:12:12,330
Administrator to encourage everybody to

275
00:12:17,090 --> 00:12:14,460
get their share of the moon which is

276
00:12:18,800 --> 00:12:17,100
actually made of barbecue spirits you're

277
00:12:20,420 --> 00:12:18,810
gonna need some water to wash that down

278
00:12:24,080 --> 00:12:20,430
Yeah right yes

279
00:12:25,850 --> 00:12:24,090
no but we have as you alluded to in the

280
00:12:28,310 --> 00:12:25,860
answer there we have discovered hundreds

281
00:12:30,140 --> 00:12:28,320
of billions of tons of water ice on the

282
00:12:32,510 --> 00:12:30,150
surface of the Moon and that's important

283
00:12:36,350 --> 00:12:32,520
for our agency and for the country

284
00:12:38,290 --> 00:12:36,360
imagine this from 1969 the first time we

285
00:12:42,740 --> 00:12:38,300
landed on the moon all the way up until

286
00:12:44,510 --> 00:12:42,750
I guess it was 2008 we believed that the

287
00:12:47,720 --> 00:12:44,520
moon was bone-dry yeah

288
00:12:49,850 --> 00:12:47,730

bone-dry yeah that's 39 years and and

289
00:12:52,490 --> 00:12:49,860
and and then all of a sudden we had a

290
00:12:54,950 --> 00:12:52,500
couple of missions that demonstrated

291
00:12:56,870 --> 00:12:54,960
that there could be water ice on the

292
00:12:58,250 --> 00:12:56,880
surface of the moon at the poles and now

293
00:12:59,750 --> 00:12:58,260
we know that there's hundreds of

294
00:13:01,250 --> 00:12:59,760
billions of tons of water ice so what

295
00:13:03,830 --> 00:13:01,260
does that mean to us water ice

296
00:13:06,200 --> 00:13:03,840
represents water to drink so we talked

297
00:13:08,060 --> 00:13:06,210
about in situ resource utilization using

298
00:13:09,950 --> 00:13:08,070
the regolith of the moon for 3d printing

299
00:13:12,260 --> 00:13:09,960
to make things that we can live and work

300
00:13:13,640 --> 00:13:12,270
on the surface of the Moon but water ice

301
00:13:16,190 --> 00:13:13,650
is even more important because it

302
00:13:18,590 --> 00:13:16,200
represents life support water to drink

303
00:13:19,040 --> 00:13:18,600
air to breathe if you crack it into

304
00:13:21,740 --> 00:13:19,050
hydrogen

305
00:13:23,420 --> 00:13:21,750
oxygen that's the same propulsion that

306
00:13:26,720 --> 00:13:23,430
powered the space shuttles for example

307
00:13:29,060 --> 00:13:26,730
so we have resources on the moon and the

308
00:13:31,940 --> 00:13:29,070
president's space policy directive gives

309
00:13:33,650 --> 00:13:31,950
me as the NASA Administrator a a

310
00:13:36,680 --> 00:13:33,660
direction and it says that we as a

311
00:13:39,259 --> 00:13:36,690
nation and this is brand-new we will use

312
00:13:41,389 --> 00:13:39,269
the resources of the moon as we return

313
00:13:43,550 --> 00:13:41,399

to the moon so that is that is a new

314
00:13:46,069 --> 00:13:43,560
space policy directive for the United

315
00:13:47,900 --> 00:13:46,079
States of America and of course a lot of

316
00:13:49,759 --> 00:13:47,910
people all around the world are excited

317
00:13:52,040 --> 00:13:49,769
about it and the reason it's important

318
00:13:54,139 --> 00:13:52,050
it's because that gives us an ability to

319
00:13:56,449 --> 00:13:54,149
prove capabilities to prove technologies

320
00:13:59,810 --> 00:13:56,459
and then ultimately with that in situ

321
00:14:01,880 --> 00:13:59,820
resource utilization go to Mars and if

322
00:14:03,860 --> 00:14:01,890
we can prove out that it's possible with

323
00:14:05,420 --> 00:14:03,870
the moon then we can actually achieve it

324
00:14:07,040 --> 00:14:05,430
on Mars as well hence the moon to Mars

325
00:14:08,240 --> 00:14:07,050
moon to Mars that's exactly right

326
00:14:09,590 --> 00:14:08,250
excellent

327
00:14:11,389 --> 00:14:09,600
earlier you were even talking about like

328
00:14:13,699 --> 00:14:11,399
how it was like we're not going the same

329
00:14:15,860 --> 00:14:13,709
way we went last time that's right we we

330
00:14:17,780 --> 00:14:15,870
are doing it entirely but that the

331
00:14:21,079 --> 00:14:17,790
president space policy director says

332
00:14:23,060 --> 00:14:21,089
this time we're going sustainably we're

333
00:14:25,250 --> 00:14:23,070
not gonna we're not leaving flags and

334
00:14:26,780 --> 00:14:25,260
footprints which is what we did with the

335
00:14:28,699 --> 00:14:26,790
Apollo program would be really clear we

336
00:14:31,069 --> 00:14:28,709
love the Apollo program critically

337
00:14:34,510 --> 00:14:31,079
important for establishing the United

338
00:14:38,420 --> 00:14:34,520

States of America as a technological

339
00:14:40,760 --> 00:14:38,430
technologically superior you know nation

340
00:14:42,380 --> 00:14:40,770
on the planet back in the 60s and 70s

341
00:14:45,949 --> 00:14:42,390
but also it established the United

342
00:14:47,840 --> 00:14:45,959
States as a as a political system and an

343
00:14:50,600 --> 00:14:47,850
economic system that was superior to the

344
00:14:52,340 --> 00:14:50,610
former Soviet Union so as a critically

345
00:14:54,319 --> 00:14:52,350
important mission but this time when we

346
00:14:56,420 --> 00:14:54,329
do it it's not just about demonstrating

347
00:14:58,940 --> 00:14:56,430
those capabilities it's about staying

348
00:15:01,010 --> 00:14:58,950
right so how do we stay well we're gonna

349
00:15:03,380 --> 00:15:01,020
take advantage of the fact that we have

350
00:15:05,060 --> 00:15:03,390
international partners that historically

351
00:15:06,560 --> 00:15:05,070
we haven't had before don't get me wrong

352
00:15:08,600 --> 00:15:06,570
the International Space Station has been

353
00:15:10,130 --> 00:15:08,610
a great proving ground absolutely for

354
00:15:13,040 --> 00:15:10,140
all kinds of international cooperation

355
00:15:15,920 --> 00:15:13,050
which has been critically important but

356
00:15:17,630 --> 00:15:15,930
now we have an opportunity to partner

357
00:15:19,100 --> 00:15:17,640
with more nations than ever before there

358
00:15:22,639 --> 00:15:19,110
are more nations on the face of the

359
00:15:24,199 --> 00:15:22,649
planet right now today that have space

360
00:15:27,470 --> 00:15:24,209
agencies than ever before in human

361
00:15:30,350 --> 00:15:27,480
history and we have commercial partners

362
00:15:31,200 --> 00:15:30,360
we're talking about you look at the you

363
00:15:32,850 --> 00:15:31,210

know come the the

364
00:15:34,530 --> 00:15:32,860
we do commercial crew to the

365
00:15:36,750 --> 00:15:34,540
International Space Station starting

366
00:15:38,880 --> 00:15:36,760
next year NASA is not going to purchase

367
00:15:41,550 --> 00:15:38,890
own and operate rockets we're gonna buy

368
00:15:43,290 --> 00:15:41,560
a service and and our partners are gonna

369
00:15:44,910 --> 00:15:43,300
carry our astronauts to the

370
00:15:47,570 --> 00:15:44,920
International Space Station just like

371
00:15:50,340 --> 00:15:47,580
right now our partners are carrying

372
00:15:53,220 --> 00:15:50,350
resupply to the International Space

373
00:15:55,080 --> 00:15:53,230
Station so this is a this is a great

374
00:15:57,450 --> 00:15:55,090
opportunity for us to go back to the

375
00:15:59,640 --> 00:15:57,460
moon in a sustainable way where the

376
00:16:01,500 --> 00:15:59,650
entire architecture is reusable

377
00:16:04,020 --> 00:16:01,510
when I say reusable we know what happens

378
00:16:04,950 --> 00:16:04,030
with reusable rockets access goes up

379
00:16:07,560 --> 00:16:04,960
cost goes down

380
00:16:09,510 --> 00:16:07,570
NASA's one customer of many customers

381
00:16:12,150 --> 00:16:09,520
and we have multiple providers that are

382
00:16:13,560 --> 00:16:12,160
competing on cost and innovation giving

383
00:16:14,100 --> 00:16:13,570
us more access than we've ever had

384
00:16:15,750 --> 00:16:14,110
before

385
00:16:17,220 --> 00:16:15,760
well we want every part of the

386
00:16:19,770 --> 00:16:17,230
architecture between the earth and the

387
00:16:21,600 --> 00:16:19,780
moon to be reusable not just launch so

388
00:16:23,820 --> 00:16:21,610

we want tugs from Earth orbit to lunar

389
00:16:25,500 --> 00:16:23,830
orbit to be reusable we want Landers

390
00:16:27,870 --> 00:16:25,510
from lunar orbit to the surface of the

391
00:16:29,520 --> 00:16:27,880
Moon to be reusable we want commercial

392
00:16:31,920 --> 00:16:29,530
partners and international partners so

393
00:16:33,330 --> 00:16:31,930
all of our standards or all of our our

394
00:16:35,580 --> 00:16:33,340
capabilities the standards will be

395
00:16:37,530 --> 00:16:35,590
published so that anybody who wants to

396
00:16:39,120 --> 00:16:37,540
build a lander can can work into the

397
00:16:41,640 --> 00:16:39,130
architecture the the critical

398
00:16:42,810 --> 00:16:41,650
infrastructure that we develop so that

399
00:16:46,320 --> 00:16:42,820
we can have a sustainable architecture

400
00:16:48,720 --> 00:16:46,330
we retire the risk and then we take all

401
00:16:51,540 --> 00:16:48,730
those capabilities to Mars so that's the

402
00:16:53,640 --> 00:16:51,550
goal but so I know you've I mean you've

403
00:16:55,320 --> 00:16:53,650
been bouncing around Ames checking out

404
00:16:57,660 --> 00:16:55,330
all these different like tours that have

405
00:17:00,720 --> 00:16:57,670
been prepared I know as a pilot you're

406
00:17:02,820 --> 00:17:00,730
pretty hype for your next visit that's

407
00:17:04,770 --> 00:17:02,830
coming up is this your way of telling me

408
00:17:05,940 --> 00:17:04,780
I need to leave the show not yet oh no

409
00:17:08,550 --> 00:17:05,950
we still got a couple more minutes

410
00:17:10,650 --> 00:17:08,560
before they come in and usher you out so

411
00:17:18,240 --> 00:17:10,660
you want to talk about we want as a

412
00:17:24,210 --> 00:17:18,250
pilot here they're gonna assure me we

413
00:17:25,920 --> 00:17:24,220

need you to have fun right now as a

414
00:17:28,170 --> 00:17:25,930
pilot this is what we're talking about

415
00:17:30,270 --> 00:17:28,180
is the vertical motion simulator and you

416
00:17:31,560 --> 00:17:30,280
think we have some b-roll of that but

417
00:17:34,770 --> 00:17:31,570
it's like what you're actually gonna go

418
00:17:37,440 --> 00:17:34,780
fly is one of the supersonic or though

419
00:17:39,030 --> 00:17:37,450
it's a below sonic boom demonstration

420
00:17:42,060 --> 00:17:39,040
this is the biggest flight simulator in

421
00:17:44,490 --> 00:17:42,070
the world I think right so yeah so the

422
00:17:47,070 --> 00:17:44,500
set up for your flight absolutely so

423
00:17:49,230 --> 00:17:47,080
when we think about the history of NASA

424
00:17:51,480 --> 00:17:49,240
a lot of people forget that the first

425
00:17:54,510 --> 00:17:51,490
day in NASA is for Aeronautics mm-hmm

426
00:17:56,640 --> 00:17:54,520
and I'm getting ready when I leave this

427
00:17:57,900 --> 00:17:56,650
show which I'm sad that you guys are

428
00:17:59,750 --> 00:17:57,910
kicking me out early and you don't give

429
00:18:04,080 --> 00:17:59,760
me the full hour but I'll get past it

430
00:18:06,450 --> 00:18:04,090
when I leave here I'm gonna go fly the

431
00:18:08,670 --> 00:18:06,460
what's called the ex-59 which is a low

432
00:18:10,920 --> 00:18:08,680
boom flight demonstrator the idea being

433
00:18:12,780 --> 00:18:10,930
that in the United States you know we've

434
00:18:15,840 --> 00:18:12,790
been flying through the atmosphere at

435
00:18:17,400 --> 00:18:15,850
0.7 Mach for 50 or 60 years well we want

436
00:18:19,770 --> 00:18:17,410
to fly faster than the speed of sound

437
00:18:22,470 --> 00:18:19,780
the problem is when you do that it

438
00:18:24,390 --> 00:18:22,480

creates this sonic boom that can

439
00:18:27,360 --> 00:18:24,400
sometimes be very disturbing to people

440
00:18:30,540 --> 00:18:27,370
on the ground and very damaging in fact

441
00:18:32,310 --> 00:18:30,550
for livestock and other kinds of you

442
00:18:34,350 --> 00:18:32,320
know live animals in fact there's a plug

443
00:18:36,240 --> 00:18:34,360
on at Jim bridenstine where you over at

444
00:18:38,310 --> 00:18:36,250
NASA Armstrong sitting in a plane

445
00:18:40,350 --> 00:18:38,320
talking about this very thing what that

446
00:18:48,080 --> 00:18:40,360
was we're now pretty sure was at

447
00:18:54,240 --> 00:18:50,910
Jim Brian Stein while you are located

448
00:19:00,930 --> 00:18:54,250
physically at NASA Armstrong so that's

449
00:19:03,240 --> 00:19:00,940
that's at Jim bridenstine T ine so

450
00:19:05,070 --> 00:19:03,250
anyway so you're right so yeah I'm gonna

451
00:19:07,020 --> 00:19:05,080
jump into that simulator over there as

452
00:19:08,970 --> 00:19:07,030
you can see that's a full motion sensor

453
00:19:11,330 --> 00:19:08,980
and a lot of motion there so hopefully I

454
00:19:13,920 --> 00:19:11,340
won't get sick but at the end of the day

455
00:19:16,050 --> 00:19:13,930
yeah so we're gonna fly across the

456
00:19:18,570 --> 00:19:16,060
United States faster than the speed of

457
00:19:19,730 --> 00:19:18,580
sound decreasing the time it takes to

458
00:19:23,190 --> 00:19:19,740
fly from New York to Los Angeles

459
00:19:25,200 --> 00:19:23,200
decreasing that time by half Wow and do

460
00:19:28,560 --> 00:19:25,210
it in a way because of the aerodynamics

461
00:19:30,570 --> 00:19:28,570
capabilities of Ames and Armstrong and

462
00:19:32,880 --> 00:19:30,580
other other great researchers throughout

463
00:19:36,180 --> 00:19:32,890

NASA we're gonna be able to do it in a

464
00:19:38,310 --> 00:19:36,190
way where the sonic boom is really a

465
00:19:40,710 --> 00:19:38,320
fraction of a normal sonic boom in other

466
00:19:44,300 --> 00:19:40,720
words it could even be imperceptible on

467
00:19:46,950 --> 00:19:44,310
on earth so if we can do that it will

468
00:19:49,380 --> 00:19:46,960
transform the way we fly across the

469
00:19:52,520 --> 00:19:49,390
United States even better it will enable

470
00:19:55,680 --> 00:19:52,530
the United States of America to keep its

471
00:19:58,830 --> 00:19:55,690
export which is aviation we have a

472
00:20:01,110 --> 00:19:58,840
massive trade surplus when it comes to

473
00:20:02,879 --> 00:20:01,120
aviation now I know a lot of people hear

474
00:20:04,409 --> 00:20:02,889
about the you know the president talks a

475
00:20:06,090 --> 00:20:04,419
lot about the trade deficit which is a

476
00:20:08,580 --> 00:20:06,100
big problem but in this particular case

477
00:20:09,899 --> 00:20:08,590
aviation is a trade surplus for the

478
00:20:12,180 --> 00:20:09,909
United States and the question is why

479
00:20:13,830 --> 00:20:12,190
well it's because NASA has been making

480
00:20:16,549 --> 00:20:13,840
amazing investments into these

481
00:20:22,110 --> 00:20:16,559
capabilities whether it's Aeronautics or

482
00:20:24,509 --> 00:20:22,120
aerodynamics or engines or avionics

483
00:20:26,879 --> 00:20:24,519
there's a lot of capabilities that are

484
00:20:28,889 --> 00:20:26,889
you know resident in the United States

485
00:20:31,409 --> 00:20:28,899
because of investments made by NASA that

486
00:20:33,720 --> 00:20:31,419
keep America very competitive and in

487
00:20:36,539 --> 00:20:33,730
fact keep aviation and export for our

488
00:20:37,560 --> 00:20:36,549

country can I ask one question that's

489
00:20:39,210 --> 00:20:37,570
59a

490
00:20:42,119 --> 00:20:39,220
ok this experimental aircraft you've got

491
00:20:43,619 --> 00:20:42,129
I'm not a pilot what I hear is because

492
00:20:45,869 --> 00:20:43,629
of the way it's built it has a really

493
00:20:47,700 --> 00:20:45,879
really long nose I guess it does it

494
00:20:48,990 --> 00:20:47,710
doesn't work to have windows for the

495
00:20:51,210 --> 00:20:49,000
pilot to look out of and you're gonna be

496
00:20:53,840 --> 00:20:51,220
looking at screens yes does that sound

497
00:20:56,490 --> 00:20:53,850
weird and disturbing for a pilot

498
00:20:58,740 --> 00:20:56,500
everything again these are investments

499
00:21:00,840 --> 00:20:58,750
made by NASA for the purpose of retiring

500
00:21:03,930 --> 00:21:00,850
risk to do to do kind of really

501
00:21:06,090 --> 00:21:03,940
important work now this is not really

502
00:21:08,009 --> 00:21:06,100
it's not actually new we've done this

503
00:21:10,769 --> 00:21:08,019
kind of work before and at the end of

504
00:21:13,560 --> 00:21:10,779
the day you're looking at images from

505
00:21:15,149 --> 00:21:13,570
you know and I think on the x-15 I don't

506
00:21:16,590 --> 00:21:15,159
know how they do it on the ex-59 but on

507
00:21:19,289 --> 00:21:16,600
other aircraft you're looking at images

508
00:21:22,110 --> 00:21:19,299
from cameras huh to ultimately know know

509
00:21:24,299 --> 00:21:22,120
your trajectory but but the the last

510
00:21:26,070 --> 00:21:24,309
time I flew an X 59 simulator it wasn't

511
00:21:28,139 --> 00:21:26,080
a simulator anywhere near as nice as the

512
00:21:31,889 --> 00:21:28,149
one about to get in but the last time I

513
00:21:35,369 --> 00:21:31,899

flew one I can tell you this it's it's

514
00:21:39,210 --> 00:21:35,379
built to go fast it is not built to turn

515
00:21:41,970 --> 00:21:39,220
oh it turns like a pig you try spinning

516
00:21:45,930 --> 00:21:41,980
a joint this thing would not turn it was

517
00:21:48,600 --> 00:21:45,940
a it was a yeah it was difficult to turn

518
00:21:50,430 --> 00:21:48,610
it now it's also true that it'll it can

519
00:21:52,799 --> 00:21:50,440
depart pretty easily as well as an

520
00:21:54,570 --> 00:21:52,809
aircraft which is why flight control

521
00:21:56,100 --> 00:21:54,580
computers are an important part of it by

522
00:21:59,369 --> 00:21:56,110
the way those flight control computers

523
00:22:02,580 --> 00:21:59,379
going back to the 1970s originated at

524
00:22:04,139 --> 00:22:02,590
NASA nice and of course I flew those

525
00:22:06,720 --> 00:22:04,149
same flight control computers that were

526
00:22:07,740 --> 00:22:06,730
in the x-29 at the time in the f-18

527
00:22:10,529 --> 00:22:07,750
Hornet when I was a PI

528
00:22:12,390 --> 00:22:10,539
the Navy so we are coming up on all the

529
00:22:14,610 --> 00:22:12,400
time that we have left with Jim you have

530
00:22:16,880 --> 00:22:14,620
a flight to catch you do a simulated

531
00:22:19,350 --> 00:22:16,890
flight but yet a flight nonetheless

532
00:22:22,080 --> 00:22:19,360
touch it I'm gonna fly it we're gonna

533
00:22:23,549 --> 00:22:22,090
fly it indeed and so there's a ton of

534
00:22:25,140 --> 00:22:23,559
questions in the chat a bunch of

535
00:22:29,270 --> 00:22:25,150
comments in there but I'm sure that they

536
00:22:36,299 --> 00:22:33,810
absolutely and that's Bri and STI MD

537
00:22:38,640 --> 00:22:36,309
thank you so much everybody that's been

538
00:22:45,419 --> 00:22:38,650

fun always we'll do it again maybe maybe

539
00:22:47,399 --> 00:22:45,429
next time I'll get a whole hour very

540
00:22:52,140 --> 00:22:47,409
important for your audience to see these

541
00:22:53,880 --> 00:22:52,150
I guess these test tubes with it looks

542
00:22:56,370 --> 00:22:53,890
like everybody urinated in a tube and

543
00:22:57,120 --> 00:22:56,380
now we're gonna talk about it we are but

544
00:22:58,740 --> 00:22:57,130
I'll be gone

545
00:23:00,659 --> 00:22:58,750
I love the name a science lab that I'll

546
00:23:03,060 --> 00:23:00,669
be gone penny I'll look forward to

547
00:23:09,060 --> 00:23:03,070
watching this later though all right all

548
00:23:10,860 --> 00:23:09,070
right appreciate it thank you as we say

549
00:23:13,140 --> 00:23:10,870
goodbye to Jim and we're gonna welcome

550
00:23:15,750 --> 00:23:13,150
our new guest penny I'm gonna sort

551
00:23:17,279 --> 00:23:15,760
through some housekeeping and don't Jim

552
00:23:19,020 --> 00:23:17,289
you didn't head on out the back and

553
00:23:20,610 --> 00:23:19,030
Penny's gonna come on up it's okay

554
00:23:23,279 --> 00:23:20,620
everybody on the show everybody who's

555
00:23:26,159 --> 00:23:23,289
watching it knows this is how the set

556
00:23:28,140 --> 00:23:26,169
goes so okay um just a little bit of

557
00:23:30,649 --> 00:23:28,150
housekeeping if you are just joining us

558
00:23:32,880 --> 00:23:30,659
this is NASA and Silicon Valley live a

559
00:23:35,520 --> 00:23:32,890
conversational show out of NASA's Ames

560
00:23:37,590 --> 00:23:35,530
Research Center with the various reached

561
00:23:40,020 --> 00:23:37,600
researchers scientists engineers and

562
00:23:42,210 --> 00:23:40,030
all-around cool people here at NASA

563
00:23:44,580 --> 00:23:42,220

where we talk about all the nerdy NASA

564
00:23:47,340 --> 00:23:44,590
news that you need to know about so if

565
00:23:50,010 --> 00:23:47,350
you like that we are simultaneously live

566
00:23:51,240 --> 00:23:50,020
on twitch YouTube and Facebook but if

567
00:23:52,620 --> 00:23:51,250
you want to participate in the chat

568
00:23:57,270 --> 00:23:52,630
you're gonna have to go on over to

569
00:23:59,490 --> 00:23:57,280
twitch.tv slash NASA so um we're getting

570
00:24:02,730 --> 00:23:59,500
everything set up I figured while we're

571
00:24:04,649 --> 00:24:02,740
at it we can this I know bill is looking

572
00:24:06,390 --> 00:24:04,659
to set up some of the stuff with our

573
00:24:08,070 --> 00:24:06,400
friends over in Hawaii we can introduce

574
00:24:12,330 --> 00:24:08,080
the crew I don't know if crew cam is

575
00:24:14,549 --> 00:24:12,340
working marked we have the oh hey Bill's

576
00:24:16,190 --> 00:24:14,559
in place Hey all right so that's bill

577
00:24:17,930 --> 00:24:16,200
and mark bill are we all ready

578
00:24:19,279 --> 00:24:17,940
you did what you need to do to connect

579
00:24:21,830 --> 00:24:19,289
to Hawaii or he's going to do it now

580
00:24:23,720 --> 00:24:21,840
okay he's good to go shoot all right

581
00:24:25,970 --> 00:24:23,730
and also if you're over here in the

582
00:24:30,320 --> 00:24:25,980
studio Dave we didn't even go to the

583
00:24:31,310 --> 00:24:30,330
cloud cam go to class hey Dave so these

584
00:24:32,840 --> 00:24:31,320
are all the people who are sitting

585
00:24:33,889 --> 00:24:32,850
behind the scenes it's like you know

586
00:24:35,930 --> 00:24:33,899
every time there's like a launch

587
00:24:37,460 --> 00:24:35,940
everything there's a NASA event you

588
00:24:38,899 --> 00:24:37,470

always have like a crew of people who

589
00:24:40,669 --> 00:24:38,909
are sitting here you know doing all of

590
00:24:42,980 --> 00:24:40,679
the audio-visual stuff to make this

591
00:24:44,930 --> 00:24:42,990
stuff work it's somebody behind it so I

592
00:24:46,639 --> 00:24:44,940
wanted to give them a shout out and also

593
00:24:49,399 --> 00:24:46,649
gonna say so all right we're following

594
00:24:52,279 --> 00:24:49,409
the twitch chat and just as your heads

595
00:24:54,620 --> 00:24:52,289
up I'm looking at the chat live but it

596
00:24:57,289 --> 00:24:54,630
does going way faster than I can even

597
00:24:59,360 --> 00:24:57,299
possibly read it but we have give a

598
00:25:01,460 --> 00:24:59,370
shout-out to my friend Kavon he's

599
00:25:03,769 --> 00:25:01,470
actually moderating the chat so he's the

600
00:25:05,720 --> 00:25:03,779
human being behind the nasa username in

601
00:25:07,730 --> 00:25:05,730
the chat so just as a heads up we love

602
00:25:09,200 --> 00:25:07,740
the emotes we love the shout outs but if

603
00:25:11,299 --> 00:25:09,210
you want us to actually read what you

604
00:25:13,190 --> 00:25:11,309
say you need to add a real question and

605
00:25:15,080 --> 00:25:13,200
so what Kavon is doing is grabbing and

606
00:25:17,389 --> 00:25:15,090
compiling all those questions for me and

607
00:25:19,879 --> 00:25:17,399
so in case I didn't get something in

608
00:25:23,960 --> 00:25:19,889
real time like just don't be surprised

609
00:25:26,990 --> 00:25:23,970
if we grab an old question but with that

610
00:25:31,700 --> 00:25:27,000
Abbie with that Matt look who it is it's

611
00:25:33,860 --> 00:25:31,710
penny Boston yeah great to see you guys

612
00:25:36,019 --> 00:25:33,870
honey is a scientist here and the

613
00:25:39,620 --> 00:25:36,029

director of the NASA Astrobiology

614
00:25:42,259 --> 00:25:39,630
Institute and we're going to get into

615
00:25:44,690 --> 00:25:42,269
that and we're going to go live to a

616
00:25:47,750 --> 00:25:44,700
ship off the coast of Hawaii where some

617
00:25:52,159 --> 00:25:47,760
researchers are working and they're

618
00:25:53,899 --> 00:25:52,169
figuring out ways to to search for life

619
00:25:56,240 --> 00:25:53,909
they're trying to understand how we

620
00:25:56,750 --> 00:25:56,250
might be able to find life in the solar

621
00:25:59,000 --> 00:25:56,760
system

622
00:26:01,430 --> 00:25:59,010
so we're gonna get into all that but

623
00:26:03,950 --> 00:26:01,440
first of all penny is an astrobiologist

624
00:26:05,690 --> 00:26:03,960
I don't think that existed when I was in

625
00:26:08,269 --> 00:26:05,700
high school and taking biology and

626
00:26:10,820 --> 00:26:08,279
chemistry so what is it exactly what are

627
00:26:16,250 --> 00:26:10,830
you turn answer astrobiology is a huge

628
00:26:18,740 --> 00:26:16,260
field and it really focuses on life in

629
00:26:21,500 --> 00:26:18,750
the universe so we have one example

630
00:26:24,649 --> 00:26:21,510
right now which is us yeah not just us

631
00:26:26,629 --> 00:26:24,659
humans but us earth life right

632
00:26:30,440 --> 00:26:26,639
and we're trying to figure out how to

633
00:26:34,310 --> 00:26:30,450
look for life-forms of some sort on

634
00:26:37,849 --> 00:26:34,320
other planets and or even other bodies

635
00:26:40,009 --> 00:26:37,859
so moons moons or maybe even small

636
00:26:44,229 --> 00:26:40,019
bodies might have something to to teach

637
00:26:47,089 --> 00:26:44,239
us about that okay is that all no no no

638
00:26:49,879 --> 00:26:47,099

never all that the only challenge are

639
00:26:53,210 --> 00:26:49,889
trying to tackle no we're really trying

640
00:26:56,570 --> 00:26:53,220
to even understand life on this planet

641
00:26:58,039 --> 00:26:56,580
yeah it's origin and evolution and then

642
00:26:59,659 --> 00:26:58,049
what we won't learn from that of course

643
00:27:01,789 --> 00:26:59,669
enriches our understanding of our own

644
00:27:04,310 --> 00:27:01,799
planet but then we can generalize that

645
00:27:06,680 --> 00:27:04,320
out to these other bodies tell us what

646
00:27:08,529 --> 00:27:06,690
we might look for right yeah and one of

647
00:27:11,659 --> 00:27:08,539
the important implications of course is

648
00:27:13,639 --> 00:27:11,669
I think most of us are convinced that

649
00:27:16,609 --> 00:27:13,649
there's life elsewhere in our galaxy and

650
00:27:22,729 --> 00:27:16,619
beyond but it's a really darn big place

651
00:27:25,399 --> 00:27:22,739
the galaxy is enormous and many other

652
00:27:27,649 --> 00:27:25,409
solar systems are light-years away right

653
00:27:31,279 --> 00:27:27,659
and so how do we figure out how to look

654
00:27:34,279 --> 00:27:31,289
for that what are the signals that life

655
00:27:35,960 --> 00:27:34,289
might be showing us there and what are

656
00:27:38,269 --> 00:27:35,970
the signals that we can find right here

657
00:27:40,549 --> 00:27:38,279
in our own solar system so how do we

658
00:27:42,619 --> 00:27:40,559
figure out how to look for life how do

659
00:27:45,139 --> 00:27:42,629
we know when we've detected it if it's

660
00:27:47,930 --> 00:27:45,149
really different from here yeah and and

661
00:27:50,749 --> 00:27:47,940
then you know one of the third classic

662
00:27:52,879 --> 00:27:50,759
questions that NASA has in its in its

663
00:27:56,299 --> 00:27:52,889

science plan is what is the future of

664
00:27:59,989 --> 00:27:56,309
life on Earth and beyond so how do

665
00:28:02,479 --> 00:27:59,999
planets not only give rise to life but

666
00:28:04,690 --> 00:28:02,489
how does that life develop through the

667
00:28:07,669 --> 00:28:04,700
course of a solar system's history

668
00:28:09,529 --> 00:28:07,679
including our own so before we get too

669
00:28:10,639 --> 00:28:09,539
far in the weeds this is a shout out I'm

670
00:28:24,039 --> 00:28:10,649
getting the sign that they want you to

671
00:28:29,060 --> 00:28:27,259
but before we go in the weeds you think

672
00:28:32,500 --> 00:28:29,070
penny brought a lot of fun stuff for us

673
00:28:36,070 --> 00:28:32,510
to ask yeah but before we go into that

674
00:28:37,930 --> 00:28:36,080
start rolling our next segment which I'm

675
00:28:44,860 --> 00:28:37,940
sure bill has gonna get ready to cue on

676
00:28:48,760 --> 00:28:44,870
up for science there should be a voice

677
00:28:50,470 --> 00:28:48,770
exactly maybe we'll add a voice over the

678
00:28:52,900 --> 00:28:50,480
part of the show that we call weird

679
00:28:54,940 --> 00:28:52,910
science and yes we want to hear from our

680
00:28:57,340 --> 00:28:54,950
guests about the craziest things that

681
00:29:00,520 --> 00:28:57,350
they've had to do in the name of science

682
00:29:03,909 --> 00:29:00,530
so we know you got stories I got stories

683
00:29:06,280 --> 00:29:03,919
yeah they were on us well my own

684
00:29:11,380 --> 00:29:06,290
personal area of research besides my

685
00:29:14,500 --> 00:29:11,390
work managing science is in the

686
00:29:16,840 --> 00:29:14,510
subsurface caves and mines mm-hmm and

687
00:29:19,210 --> 00:29:16,850
the case that we pick are the ones that

688
00:29:21,640 --> 00:29:19,220

are the most poisonous the most likely

689
00:29:22,810 --> 00:29:21,650
to kill you naturally yeah and that's

690
00:29:25,690 --> 00:29:22,820
not just because we want to be on

691
00:29:28,260 --> 00:29:25,700
reality TV it's because those are the

692
00:29:31,960 --> 00:29:28,270
places where the really unusual

693
00:29:33,850 --> 00:29:31,970
microorganisms will be yeah and so we're

694
00:29:35,890 --> 00:29:33,860
looking for guys that can make their

695
00:29:39,159 --> 00:29:35,900
living in high temperatures low

696
00:29:41,950 --> 00:29:39,169
temperatures environments that to us are

697
00:29:44,860 --> 00:29:41,960
poisonous but to them it's home sweet

698
00:29:47,890 --> 00:29:44,870
home and so that means that we have to

699
00:29:50,440 --> 00:29:47,900
go into these dangerous environments and

700
00:29:52,650 --> 00:29:50,450
so we've been in places where things

701
00:29:55,180 --> 00:29:52,660
have collapsed on us from places where

702
00:29:57,669 --> 00:29:55,190
we couldn't breathe the air because it's

703
00:30:00,549 --> 00:29:57,679
so full of carbon dioxide carbon

704
00:30:02,860 --> 00:30:00,559
monoxide and hydrogen sulfide so we have

705
00:30:03,909 --> 00:30:02,870
to we're breathing gas so I'm gonna jump

706
00:30:06,280 --> 00:30:03,919
in real quick because we have a question

707
00:30:07,840 --> 00:30:06,290
from echo Atlas as asked he's like can

708
00:30:10,030 --> 00:30:07,850
you ask penny I think what is the most

709
00:30:12,490 --> 00:30:10,040
common life form and astrobiologist is

710
00:30:16,450 --> 00:30:12,500
looking for something that's tough as

711
00:30:18,250 --> 00:30:16,460
nails and will fit a particular place

712
00:30:20,620 --> 00:30:18,260
that we're looking at so if we're

713
00:30:22,060 --> 00:30:20,630

looking at Mars my favorite place on

714
00:30:25,870 --> 00:30:22,070
Mars is going to be in the subsurface

715
00:30:29,470 --> 00:30:25,880
okay and that's not just because I'm a

716
00:30:31,120 --> 00:30:29,480
cave dude it's because that in the

717
00:30:33,159 --> 00:30:31,130
Martian subsurface things are going to

718
00:30:35,650 --> 00:30:33,169
be more protected and they are on the

719
00:30:41,740 --> 00:30:35,660
surface and so we know that modern Mars

720
00:30:44,260 --> 00:30:41,750
is a really dry really cold place with a

721
00:30:45,690 --> 00:30:44,270
lot of radiation hitting the surface but

722
00:30:47,310 --> 00:30:45,700
the subsurface we

723
00:30:49,799 --> 00:30:47,320
beginning to get more and more evidence

724
00:30:52,649 --> 00:30:49,809
that it's a much cozier place especially

725
00:30:54,269 --> 00:30:52,659
for these tough little dudes or these

726
00:31:00,570 --> 00:30:54,279
little dudes you talk about microbes is

727
00:31:04,620 --> 00:31:00,580
back - yeah we which is another group of

728
00:31:07,409 --> 00:31:04,630
tiny organisms if people may know you're

729
00:31:09,000 --> 00:31:07,419
with but they're bacteria sighs there

730
00:31:11,340 --> 00:31:09,010
are things called protists if you ever

731
00:31:13,799 --> 00:31:11,350
looked at an amoeba in high school

732
00:31:17,250 --> 00:31:13,809
biology class you would have seen things

733
00:31:19,980 --> 00:31:17,260
like that maybe fungi we don't know

734
00:31:21,840 --> 00:31:19,990
viruses maybe even maybe yeah getting

735
00:31:23,700 --> 00:31:21,850
back to the cave exploration I didn't

736
00:31:31,860 --> 00:31:23,710
want them to miss we have a photo of you

737
00:31:33,870 --> 00:31:31,870
in the gear that's required you might

738
00:31:35,970 --> 00:31:33,880

think that I'm all duded up like that to

739
00:31:39,360 --> 00:31:35,980
try to stay warm but the truth is that

740
00:31:42,330 --> 00:31:39,370
I'm actually packed in ice ice fest on

741
00:31:45,570 --> 00:31:42,340
underneath I've got an ice pack under my

742
00:31:48,090 --> 00:31:45,580
caving helmet and I'm breathing cooled

743
00:31:51,590 --> 00:31:48,100
air from a backpack on my back and this

744
00:31:54,659 --> 00:31:51,600
was to go into the night cave system in

745
00:31:55,710 --> 00:31:54,669
Chihuahua in Mexico which is a super hot

746
00:31:57,960 --> 00:31:55,720
system yeah

747
00:32:00,779 --> 00:31:57,970
it's about 130 to 140 degrees Fahrenheit

748
00:32:03,450 --> 00:32:00,789
Wow and humans can't really tolerate

749
00:32:06,269 --> 00:32:03,460
that so we did the best we could cool

750
00:32:08,669 --> 00:32:06,279
ourselves down to get in there so the

751
00:32:11,129 --> 00:32:08,679
punchline is that it's a beautiful set

752
00:32:13,769 --> 00:32:11,139
of caves with no natural openings

753
00:32:16,590 --> 00:32:13,779
I was only discovered by mining

754
00:32:19,470 --> 00:32:16,600
activities and those organisms in there

755
00:32:21,659 --> 00:32:19,480
it's home sweet home for them so we are

756
00:32:23,159 --> 00:32:21,669
completely inundated with questions and

757
00:32:26,930 --> 00:32:23,169
we may want to do a rapid-fire thing but

758
00:32:33,060 --> 00:32:29,639
choices took planner tell me what you

759
00:32:34,769 --> 00:32:33,070
want me to grab over here well you know

760
00:32:37,500 --> 00:32:34,779
let me start with the oldest thing that

761
00:32:41,610 --> 00:32:37,510
I had yeah the oldest thing that I have

762
00:32:43,500 --> 00:32:41,620
and place a bearing on it polished so

763
00:32:46,379 --> 00:32:43,510

you can see layers let me see if I got

764
00:32:49,980 --> 00:32:46,389
it the right way this way okay so these

765
00:32:53,519 --> 00:32:49,990
layers are horizontal here and this

766
00:32:56,810 --> 00:32:53,529
represents a time when microorganisms

767
00:32:59,100 --> 00:32:56,820
had just invented the type of

768
00:33:01,169 --> 00:32:59,110
photosynthesis that produces free

769
00:33:04,530 --> 00:33:01,179
oxygen and we are indebted to them

770
00:33:06,630 --> 00:33:04,540
because they make life for our kinds of

771
00:33:09,600 --> 00:33:06,640
large energy-requiring creatures like

772
00:33:15,780 --> 00:33:09,610
humans and Canaries and you know potted

773
00:33:19,740 --> 00:33:15,790
plants possible so they started to

774
00:33:21,840 --> 00:33:19,750
produce oxygen and that would react with

775
00:33:23,910 --> 00:33:21,850
the iron in the ocean and then that

776
00:33:26,400 --> 00:33:23,920
would precipitate out into a layer and

777
00:33:28,289 --> 00:33:26,410
then that would sort of take all the

778
00:33:31,470 --> 00:33:28,299
oxygen away for a while and then they

779
00:33:34,680 --> 00:33:31,480
had to build up again so this is a 3.2

780
00:33:38,100 --> 00:33:34,690
billion year old rock and so we know

781
00:33:40,770 --> 00:33:38,110
that this is an indirect evidence of the

782
00:33:43,230 --> 00:33:40,780
very very very early life so is it like

783
00:33:45,000 --> 00:33:43,240
so iron reacting with oxygen is like

784
00:33:48,690 --> 00:33:45,010
rust right yes so is that what I'm

785
00:33:50,820 --> 00:33:48,700
saying that's right when the iron hasn't

786
00:33:52,770 --> 00:33:50,830
reacted when it's in a different

787
00:33:55,470 --> 00:33:52,780
chemical state where it doesn't have so

788
00:33:58,049 --> 00:33:55,480

many oxygens glued on to it then it's

789
00:34:00,210 --> 00:33:58,059
the dark color okay so find that in the

790
00:34:01,409 --> 00:34:00,220
earliest history of the planet okay so

791
00:34:05,100 --> 00:34:01,419
what you're saying is that this rock

792
00:34:06,870 --> 00:34:05,110
holds evidence of life and we sure like

793
00:34:08,490 --> 00:34:06,880
there's something like that on Mars but

794
00:34:09,690 --> 00:34:08,500
we don't know yet okay we don't know

795
00:34:11,669 --> 00:34:09,700
yeah but that's the kind of thing a rock

796
00:34:14,490 --> 00:34:11,679
can tell you yes search for life rocks

797
00:34:31,440 --> 00:34:14,500
are amazing because they can tell us so

798
00:34:32,430 --> 00:34:31,450
much so you mentioned the photosynthesis

799
00:34:35,340 --> 00:34:32,440
yes

800
00:34:37,560 --> 00:34:35,350
plants do I it yeah they do microbes did

801
00:34:39,899 --> 00:34:37,570
it before before okay yeah microbes did

802
00:34:42,629 --> 00:34:39,909
it first yeah what about in your caves

803
00:34:44,879 --> 00:34:42,639
you're studying organisms that seem to

804
00:34:47,399 --> 00:34:44,889
live without something yes yes and they

805
00:34:50,970 --> 00:34:47,409
do and so the guys that I'm particularly

806
00:34:52,980 --> 00:34:50,980
interested in don't use sunlight uh-huh

807
00:34:56,369 --> 00:34:52,990
because there isn't any in there yeah

808
00:34:58,620 --> 00:34:56,379
and so the ones that are really care

809
00:34:59,640 --> 00:34:58,630
about are guys that essentially eat rock

810
00:35:02,910 --> 00:34:59,650
Wow

811
00:35:05,400 --> 00:35:02,920
they rock they dissolve the rock and

812
00:35:09,210 --> 00:35:05,410
they get minerals out of the rock that

813
00:35:11,040 --> 00:35:09,220

they then react with chemically so and

814
00:35:12,000 --> 00:35:11,050
they get their energy instead of from

815
00:35:14,490 --> 00:35:12,010
photosynthesis

816
00:35:15,960 --> 00:35:14,500
or burning food like we do animals we

817
00:35:18,900 --> 00:35:15,970
think that's the only way that I can

818
00:35:21,210 --> 00:35:18,910
live and and we thought that until in

819
00:35:23,820 --> 00:35:21,220
the late 1970s we understood about these

820
00:35:25,380 --> 00:35:23,830
deep sea hydrothermal vents and that

821
00:35:27,210 --> 00:35:25,390
there were stuff going on in the deep

822
00:35:29,580 --> 00:35:27,220
ocean that was really different from

823
00:35:31,830 --> 00:35:29,590
here and then we started looking other

824
00:35:33,210 --> 00:35:31,840
places so at a certain point we're gonna

825
00:35:34,680 --> 00:35:33,220
need to jump over to our friends in

826
00:35:35,849 --> 00:35:34,690
Hawaii but I do want to do a quick

827
00:35:38,340 --> 00:35:35,859
rapid-fire because there's a bunch of

828
00:35:42,450 --> 00:35:38,350
questions about cat about caves penny

829
00:35:44,880 --> 00:35:42,460
this is a Kazu Mirai is asking if you've

830
00:35:55,890 --> 00:35:44,890
ever been to Carlsbad Caverns well you

831
00:35:57,630 --> 00:35:55,900
know I was just there have you ever been

832
00:35:59,940 --> 00:35:57,640
to the Natural Bridge Caverns in Texas

833
00:36:02,430 --> 00:35:59,950
this isn't good no I have not been there

834
00:36:04,320 --> 00:36:02,440
and then what's the best technological

835
00:36:06,000 --> 00:36:04,330
advancements in astrobiology ever since

836
00:36:09,359 --> 00:36:06,010
penny started her research this is for

837
00:36:11,940 --> 00:36:09,369
me Emil oh well gosh just about

838
00:36:13,620 --> 00:36:11,950

everything we do the field has

839
00:36:15,380 --> 00:36:13,630
revolutionized you have to understand

840
00:36:18,030 --> 00:36:15,390
that I've been doing this for 40 years

841
00:36:20,700 --> 00:36:18,040
before we even called an astrobiology

842
00:36:22,560 --> 00:36:20,710
cool looking for exotic organisms and

843
00:36:25,050 --> 00:36:22,570
here's an interesting one it's kind of

844
00:36:26,280 --> 00:36:25,060
similar but like to the ice idea it's

845
00:36:28,080 --> 00:36:26,290
like like how are we getting this is

846
00:36:30,090 --> 00:36:28,090
from Clarissa I'm like how are we gonna

847
00:36:33,060 --> 00:36:30,100
check for life on Europa when the ice is

848
00:36:35,070 --> 00:36:33,070
like ten miles thick well you know we

849
00:36:36,960 --> 00:36:35,080
want to get into the ocean on the inside

850
00:36:39,359 --> 00:36:36,970
but I think that there are lots of other

851
00:36:41,520 --> 00:36:39,369
possible habitats that organisms could

852
00:36:44,010 --> 00:36:41,530
be living that are much closer to the

853
00:36:46,830 --> 00:36:44,020
surface and when we look at Antarctica

854
00:36:48,990 --> 00:36:46,840
we see you know fracture habitats we see

855
00:36:52,650 --> 00:36:49,000
shallow caves and the ice that are

856
00:36:55,530 --> 00:36:52,660
created by you know warmer spots that

857
00:36:57,359 --> 00:36:55,540
are coming from volcanic activity and so

858
00:36:59,160 --> 00:36:57,369
forth says a lot of places too and then

859
00:37:00,780 --> 00:36:59,170
I'm jumping it one more time just

860
00:37:02,099 --> 00:37:00,790
because this is a good question and it's

861
00:37:04,800 --> 00:37:02,109
one of the topics I know the Abby wants

862
00:37:07,140 --> 00:37:04,810
to talk about so this is this comes from

863
00:37:09,750 --> 00:37:07,150

Higgs bacon awesome

864
00:37:14,430 --> 00:37:09,760
between Enceladus Titan which moon seems

865
00:37:16,950 --> 00:37:14,440
more promising for life for a NASA

866
00:37:21,570 --> 00:37:16,960
mission and so honest versus Titan yeah

867
00:37:23,950 --> 00:37:21,580
oh it can be only one and so this is

868
00:37:26,650 --> 00:37:23,960
wonderful because it's going

869
00:37:30,690 --> 00:37:26,660
and giving us sample that's coming out

870
00:37:37,750 --> 00:37:34,510
look at Titan it looks so earth-like it

871
00:37:40,360 --> 00:37:37,760
looks so familiar so Titan certainly at

872
00:37:42,580 --> 00:37:40,370
least has prebiotic chemistry going on

873
00:37:45,370 --> 00:37:42,590
and maybe there's some kind of lifelike

874
00:37:48,030 --> 00:37:45,380
process we have no idea so I want to go

875
00:37:52,120 --> 00:37:48,040
to both 3d and I want to go everywhere

876
00:37:54,460 --> 00:37:52,130
refuse to choose refuse to choose yeah

877
00:37:56,380 --> 00:37:54,470
do you have well I have so many

878
00:38:06,700 --> 00:37:56,390
questions it's quite insane but I don't

879
00:38:11,680 --> 00:38:06,710
know keep going what the files the vials

880
00:38:14,050 --> 00:38:11,690
are interesting might let you tell us

881
00:38:16,180 --> 00:38:14,060
what's the deal with hydrothermal vents

882
00:38:20,620 --> 00:38:16,190
you just keep it very Dave we'll zoom in

883
00:38:22,780 --> 00:38:20,630
on it right and your caves and right why

884
00:38:24,910 --> 00:38:22,790
is it my why do we talk to our buddies

885
00:38:26,230 --> 00:38:24,920
who work in the oceans yeah I think the

886
00:38:29,730 --> 00:38:26,240
essence of the question is and it's

887
00:38:33,250 --> 00:38:29,740
because amazingly enough the

888
00:38:36,130 --> 00:38:33,260

microorganisms that live in the bottom

889
00:38:39,400 --> 00:38:36,140
of the ocean are doing amazing things

890
00:38:43,690 --> 00:38:39,410
they're tunneling through volcanic

891
00:38:45,250 --> 00:38:43,700
glasses and other rock types and a lot

892
00:38:47,800 --> 00:38:45,260
of the organisms that we have in caves

893
00:38:50,170 --> 00:38:47,810
are also doing something like that okay

894
00:38:51,910 --> 00:38:50,180
so even though they live in what we from

895
00:38:54,220 --> 00:38:51,920
our human perspective think are wildly

896
00:38:57,400 --> 00:38:54,230
different environments but man their

897
00:39:00,550 --> 00:38:57,410
lifestyle is very similar huh and we

898
00:39:03,220 --> 00:39:00,560
even see genetic relatedness between

899
00:39:05,200 --> 00:39:03,230
some of our cave organisms and deep sea

900
00:39:07,510 --> 00:39:05,210
hydrothermal vents and we've known that

901
00:39:10,180 --> 00:39:07,520
within our research group for the last

902
00:39:12,220 --> 00:39:10,190
20 or more years so we think they're

903
00:39:14,500 --> 00:39:12,230
deeply connected in the history of life

904
00:39:17,260 --> 00:39:14,510
so the things you study on land in crazy

905
00:39:22,840 --> 00:39:17,270
caves right those crazy microbes and it

906
00:39:25,210 --> 00:39:22,850
was crazy right all right we can compare

907
00:39:27,640 --> 00:39:25,220
these different habitats and then that

908
00:39:31,090 --> 00:39:27,650
sort of thing tells you sorry what you

909
00:39:33,280 --> 00:39:31,100
might look for in the moons people were

910
00:39:35,620 --> 00:39:33,290
just asking about obviously obviously

911
00:39:37,200 --> 00:39:35,630
really interested in how life did all of

912
00:39:39,900 --> 00:39:37,210
its stuff on her

913
00:39:43,530 --> 00:39:39,910

yeah but we use this as a template as a

914
00:39:46,140 --> 00:39:43,540
pattern for hmm how do we figure out

915
00:39:47,400 --> 00:39:46,150
where to look on these other amazing

916
00:39:51,210 --> 00:39:47,410
places because when you look at our

917
00:39:53,940 --> 00:39:51,220
solar system we got one of everything of

918
00:39:58,110 --> 00:39:53,950
every kind of body okay we got hot we

919
00:40:00,270 --> 00:39:58,120
gotta get big we got small yeah yeah

920
00:40:02,650 --> 00:40:00,280
they shout out for Dave from TD waffle

921
00:40:04,070 --> 00:40:02,660
he's saying Dave zoom in on the vials

922
00:40:06,990 --> 00:40:04,080
[Laughter]

923
00:40:08,670 --> 00:40:07,000
LeBron James headband is like saying let

924
00:40:12,810 --> 00:40:08,680
the man speak because I got questions

925
00:40:15,450 --> 00:40:12,820
for example my question Fox

926
00:40:17,190 --> 00:40:15,460
tango typed in the chat just like you

927
00:40:19,230 --> 00:40:17,200
can it was asking penny what are the

928
00:40:22,290 --> 00:40:19,240
chances of finding dna-based life

929
00:40:24,420 --> 00:40:22,300
elsewhere and oh man that thing is going

930
00:40:26,310 --> 00:40:24,430
too fast and I completely lost the chain

931
00:40:28,260 --> 00:40:26,320
because the chats moving too fast

932
00:40:34,080 --> 00:40:28,270
so anyways well just kind of go with

933
00:40:37,530 --> 00:40:34,090
that like DNA is one sort of way of

934
00:40:39,810 --> 00:40:37,540
coding living information I can imagine

935
00:40:43,320 --> 00:40:39,820
a whole lot of other different ways so

936
00:40:47,040 --> 00:40:43,330
since we already understand quite a bit

937
00:40:51,500 --> 00:40:47,050
about how DNA works here we for sure are

938
00:40:55,260 --> 00:40:51,510

gonna look for that but I know that

939
00:40:56,910 --> 00:40:55,270
nature is amazing and may have great

940
00:40:59,460 --> 00:40:56,920
ways to make living things out of other

941
00:41:02,040 --> 00:40:59,470
stuff so we're not just hedging our bets

942
00:41:04,110 --> 00:41:02,050
on one chemical system mm-hmm

943
00:41:06,810 --> 00:41:04,120
people have done work on alternative

944
00:41:08,490 --> 00:41:06,820
DNA's where they're sort of similar but

945
00:41:12,690 --> 00:41:08,500
you know the details are different yeah

946
00:41:15,120 --> 00:41:12,700
and we know that maybe there are ways to

947
00:41:16,920 --> 00:41:15,130
put carbon together in different ways of

948
00:41:18,990 --> 00:41:16,930
course people have long suggested

949
00:41:23,790 --> 00:41:19,000
silicon and we're right here in Silicon

950
00:41:27,000 --> 00:41:23,800
Valley so let's go with it speaking of

951
00:41:30,210 --> 00:41:27,010
nature is amazing let's leave bacon

952
00:41:31,650 --> 00:41:30,220
Valley I know this department the nice

953
00:41:34,470 --> 00:41:31,660
warm temperature of Silicon Valley and

954
00:41:36,270 --> 00:41:34,480
let's head to Hawaii we're gonna see if

955
00:41:38,320 --> 00:41:36,280
we can get this Skype up and working

956
00:41:45,469 --> 00:41:38,330
yeah

957
00:41:49,199 --> 00:41:45,479
[Music]

958
00:41:51,779 --> 00:41:49,209
hey let me introduce you to our viewers

959
00:41:54,719 --> 00:41:51,789
here we have Darlene Lim she is a

960
00:41:56,069 --> 00:41:54,729
scientist here at NASA Ames and she is

961
00:41:58,079 --> 00:41:56,079
leading this project we're gonna hear

962
00:42:00,299 --> 00:41:58,089
more about and next to her is Chris

963
00:42:03,239 --> 00:42:00,309

German he's a senior scientist at Woods

964
00:42:07,589 --> 00:42:03,249
Hole Oceanographic Institution hey so

965
00:42:09,359 --> 00:42:07,599
where are you tell us we are we're on

966
00:42:11,849 --> 00:42:09,369
we're in between the studio of the

967
00:42:14,909 --> 00:42:11,859
amazing Nautilus which is the ship that

968
00:42:16,919 --> 00:42:14,919
we're all on and the ship's about 64

969
00:42:19,380 --> 00:42:16,929
meters I think in length that's about

970
00:42:21,779 --> 00:42:19,390
right and there's got a crew of just shy

971
00:42:25,169 --> 00:42:21,789
at 50 so we're kind of tucked away on

972
00:42:27,809 --> 00:42:25,179
the second level sub kind of main level

973
00:42:34,589 --> 00:42:27,819
and we're not sick which is a good thing

974
00:42:36,689 --> 00:42:34,599
pretty sick for a little while and yeah

975
00:42:49,349 --> 00:42:36,699
this this whole ship was not smelling

976
00:42:50,459 --> 00:42:49,359
too good ye know nice well I can see the

977
00:42:58,189 --> 00:42:50,469
ocean a little bit and through the

978
00:43:01,620 --> 00:42:58,199
window behind you yeah okay we're lucky

979
00:43:04,259 --> 00:43:01,630
better sea state right now good alright

980
00:43:06,449 --> 00:43:04,269
so we're gonna talk about your project

981
00:43:09,509 --> 00:43:06,459
which conveniently are appropriately is

982
00:43:12,809 --> 00:43:09,519
called subsea because you are going so

983
00:43:15,029 --> 00:43:12,819
straight but I suspect that's an acronym

984
00:43:17,579 --> 00:43:15,039
no subsea that's very fortuitous it

985
00:43:19,140 --> 00:43:17,589
feels like it's an acronym right yeah

986
00:43:22,589 --> 00:43:19,150
what does it stand for and in a nutshell

987
00:43:24,599 --> 00:43:22,599
what are you doing out there okay let's

988
00:43:26,549 --> 00:43:24,609

let's make sure we remember cuz you see

989
00:43:29,069 --> 00:43:26,559
the way that Suzy knew real excited cuz

990
00:43:30,569 --> 00:43:29,079
just a little secret but the we put our

991
00:43:36,029 --> 00:43:30,579
project names together one of the time

992
00:43:37,799 --> 00:43:36,039
as we take a word and say who can

993
00:43:39,449 --> 00:43:37,809
actually add some words to this word

994
00:43:41,719 --> 00:43:39,459
that sort of makes sense and so I think

995
00:43:57,780 --> 00:43:41,729
maybe I make sense but it's like

996
00:44:06,730 --> 00:44:00,040
yeah well write a proposal if you got a

997
00:44:08,820 --> 00:44:06,740
better so what does all that mean we're

998
00:44:13,570 --> 00:44:08,830
doing science you're doing exploration

999
00:44:14,830 --> 00:44:13,580
it's an analog we are yeah it's actually

1000
00:44:16,630 --> 00:44:14,840
a really fun analog and it's a

1001
00:44:18,940 --> 00:44:16,640
partnership between NASA and Nagoya

1002
00:44:21,730 --> 00:44:18,950
ocean exploration trust and it's an

1003
00:44:23,910 --> 00:44:21,740
analog that allows us to explore our

1004
00:44:26,440 --> 00:44:23,920
Earth's ocean as a point of comparison

1005
00:44:28,960 --> 00:44:26,450
to ocean world systems such as Enceladus

1006
00:44:32,109 --> 00:44:28,970
but the other cool thing is that its

1007
00:44:35,050 --> 00:44:32,119
entire operational setup that we use to

1008
00:44:36,640 --> 00:44:35,060
do our science on the ship and from

1009
00:44:37,840 --> 00:44:36,650
shore where we actually have a whole but

1010
00:44:39,910 --> 00:44:37,850
scientists tucked away in Rhode Island

1011
00:44:41,859 --> 00:44:39,920
that are interacting with us while we

1012
00:44:43,300 --> 00:44:41,869
actually do you are taught that's called

1013
00:44:45,790 --> 00:44:43,310

telepresence and that's an amazing

1014
00:44:47,710 --> 00:44:45,800
analog as well for future mission

1015
00:44:50,109 --> 00:44:47,720
concepts for human spaceflight called

1016
00:44:52,270 --> 00:44:50,119
low latency telerobotics so there's kind

1017
00:44:53,380 --> 00:44:52,280
of multiple levels of and multiple

1018
00:44:55,990 --> 00:44:53,390
different things going on in this

1019
00:44:57,580 --> 00:44:56,000
project which are geared at being

1020
00:45:00,790 --> 00:44:57,590
analogous to different operational and

1021
00:45:01,780 --> 00:45:00,800
physical environments and so in terms of

1022
00:45:03,280 --> 00:45:01,790
science actually this is why I wanted

1023
00:45:06,010 --> 00:45:03,290
there Chris storm and he's like our

1024
00:45:08,980 --> 00:45:06,020
deputy and amazing Chiefs just give you

1025
00:45:23,680 --> 00:45:08,990
a really nice overview and deep dive for

1026
00:45:24,760 --> 00:45:23,690
the better term yes right right okay so

1027
00:45:27,280 --> 00:45:24,770
first I just wanted to say we keep

1028
00:45:28,990 --> 00:45:27,290
saying analog and that means it mean for

1029
00:45:30,790 --> 00:45:29,000
people yeah do you want to explain

1030
00:45:33,790 --> 00:45:30,800
there's a similar situation on earth

1031
00:45:37,770 --> 00:45:33,800
it's a it's a an environment on earth

1032
00:45:40,390 --> 00:45:37,780
that we think has some similarities to

1033
00:45:42,280 --> 00:45:40,400
some kind of planetary environment that

1034
00:45:45,340 --> 00:45:42,290
we're interested in so when we're

1035
00:45:47,230 --> 00:45:45,350
looking at the ocean worlds these icy

1036
00:45:52,540 --> 00:45:47,240
moons with a whole lot of liquid on the

1037
00:45:55,630 --> 00:45:52,550
inside then the sea environment is one

1038
00:45:57,220 --> 00:45:55,640

of our closest analogs to that yeah yeah

1039
00:45:59,170 --> 00:45:57,230
that's right but it's a fancier name

1040
00:46:02,799 --> 00:45:59,180
it's a fancy name

1041
00:46:06,010 --> 00:46:02,809
you have long words is a scientific way

1042
00:46:07,599 --> 00:46:06,020
so as Darlene just said there are a lot

1043
00:46:08,770 --> 00:46:07,609
of different elements to subsea right so

1044
00:46:10,270 --> 00:46:08,780
darling the way I think of it as

1045
00:46:12,069 --> 00:46:10,280
different storylines and it's like

1046
00:46:14,589 --> 00:46:12,079
choose your own adventure when you're

1047
00:46:16,930 --> 00:46:14,599
talking about subsea so first of all

1048
00:46:21,250 --> 00:46:16,940
yeah you want to talk about the science

1049
00:46:26,109 --> 00:46:21,260
storyline tell us what is the object of

1050
00:46:29,260 --> 00:46:26,119
your exploration the volcano I'll give

1051
00:46:31,960 --> 00:46:29,270
you a quick high-level and then I'm have

1052
00:46:34,240 --> 00:46:31,970
Chris like do magic but basically as he

1053
00:46:36,849 --> 00:46:34,250
mentioned we're sitting on top of Loihi

1054
00:46:39,339 --> 00:46:36,859
seamount which is the next Hawaii Island

1055
00:46:41,349 --> 00:46:39,349
well next if you have some way of like

1056
00:46:43,120 --> 00:46:41,359
moving forward 48 hours you know and

1057
00:46:44,859 --> 00:46:43,130
staying alive that long it's about how

1058
00:46:47,290 --> 00:46:44,869
long it'll take before kind of popular

1059
00:46:49,630 --> 00:46:47,300
surface but um we're here because this

1060
00:46:51,910 --> 00:46:49,640
volcanic environment really interesting

1061
00:46:53,740 --> 00:46:51,920
intra plates two plates meeting it's

1062
00:46:55,930 --> 00:46:53,750
rather frightening it's a really neat

1063
00:46:58,359 --> 00:46:55,940

environment where we can study it not

1064
00:47:01,210 --> 00:46:58,369
only for its you know value as a place

1065
00:47:02,589 --> 00:47:01,220
to studies as an ocean exploration spot

1066
00:47:04,900 --> 00:47:02,599
but also because it's a wonderful

1067
00:47:06,430 --> 00:47:04,910
opportunity for us to study and an

1068
00:47:10,140 --> 00:47:06,440
analog as a point of comparison to

1069
00:47:12,720 --> 00:47:10,150
Enceladus and so with that PO - Chris

1070
00:47:14,710 --> 00:47:12,730
yes I think the key thing is that

1071
00:47:16,150 --> 00:47:14,720
there's lots of different places on our

1072
00:47:18,670 --> 00:47:16,160
own planet but have hydrothermal

1073
00:47:22,329 --> 00:47:18,680
activity but the ones we care about most

1074
00:47:24,130 --> 00:47:22,339
in from this panel you with me now we

1075
00:47:25,599 --> 00:47:24,140
know what an analogue is we know we

1076
00:47:26,950 --> 00:47:25,609
don't know that they tectonics on other

1077
00:47:29,500 --> 00:47:26,960
planets but we know there are volcanoes

1078
00:47:31,539 --> 00:47:29,510
on these other planets and for example

1079
00:47:34,000 --> 00:47:31,549
like on Io they're about Kapinos today

1080
00:47:35,799 --> 00:47:34,010
on Mars they're extinct volcanoes but so

1081
00:47:37,839 --> 00:47:35,809
they've been active in the past so when

1082
00:47:39,280 --> 00:47:37,849
it comes to Enceladus in Europa there's

1083
00:47:41,140 --> 00:47:39,290
no reason why there will be similar

1084
00:47:43,990 --> 00:47:41,150
kinds of geologic activity on their

1085
00:47:46,210 --> 00:47:44,000
seafloor so those places are too far

1086
00:47:47,170 --> 00:47:46,220
from the side effect to have much energy

1087
00:47:49,960 --> 00:47:47,180
coming that's available for

1088
00:47:51,250 --> 00:47:49,970

photosynthesis but like pointing out the

1089
00:47:53,440 --> 00:47:51,260
first half of Earth history didn't have

1090
00:47:55,630 --> 00:47:53,450
much photosynthesis there if you come

1091
00:47:58,210 --> 00:47:55,640
here at the wrong time we have found was

1092
00:48:01,089 --> 00:47:58,220
a bunch of rock chomping slime at the

1093
00:48:02,109 --> 00:48:01,099
bottom of the ocean maybe and that's the

1094
00:48:04,260 --> 00:48:02,119
kind of thing we're working on now

1095
00:48:07,210 --> 00:48:04,270
because it may well be sitting elsewhere

1096
00:48:08,349 --> 00:48:07,220
in the universe and actually much closer

1097
00:48:10,359 --> 00:48:08,359
to home you know we don't have to worry

1098
00:48:11,470 --> 00:48:10,369
about extra plaque necessarily but

1099
00:48:12,710 --> 00:48:11,480
there's ways that we could have life

1100
00:48:14,300 --> 00:48:12,720
much

1101
00:48:18,350 --> 00:48:14,310
like closer in than we've even been to

1102
00:48:20,300 --> 00:48:18,360
so far with our own spacecraft so so as

1103
00:48:21,890 --> 00:48:20,310
you guys were talking and you don't I

1104
00:48:24,440 --> 00:48:21,900
know you can't see it on your side in

1105
00:48:27,110 --> 00:48:24,450
Hawaii they're playing b-roll of the

1106
00:48:29,120 --> 00:48:27,120
robotic the robotics traveling through

1107
00:48:31,100 --> 00:48:29,130
the ocean going through those caves in

1108
00:48:35,030 --> 00:48:31,110
Hawaii and so that actually is a perfect

1109
00:48:37,670 --> 00:48:35,040
time to segue to the next segment that

1110
00:48:40,080 --> 00:48:37,680
we're gonna roll on up as soon as it's

1111
00:48:49,820 --> 00:48:46,510
[Music]

1112
00:48:52,940 --> 00:48:49,830
now's the time now's the time where our

1113
00:48:55,510 --> 00:48:52,950

guests take a complex scientific concept

1114
00:48:59,270 --> 00:48:55,520
and as the saying on the internet goes

1115
00:49:01,760 --> 00:48:59,280
explain it like I'm five so the we're

1116
00:49:05,720 --> 00:49:01,770
talking about like robotics time delay

1117
00:49:08,210 --> 00:49:05,730
so I say four darling and Chris um I've

1118
00:49:09,920 --> 00:49:08,220
heard the terms like low latency tella

1119
00:49:12,740 --> 00:49:09,930
operations highly and see teller

1120
00:49:14,990 --> 00:49:12,750
operations so explain it like I'm five

1121
00:49:20,380 --> 00:49:15,000
what does that mean what are you talking

1122
00:49:25,010 --> 00:49:20,390
about when you say those words okay so

1123
00:49:27,380 --> 00:49:25,020
what it means is that so when we talking

1124
00:49:30,350 --> 00:49:27,390
buddy on the telephone for example or if

1125
00:49:33,470 --> 00:49:30,360
we FaceTime with them get to be such

1126
00:49:35,420 --> 00:49:33,480
that it like instantaneous yeah so if

1127
00:49:36,890 --> 00:49:35,430
you're talking on the phone right now

1128
00:49:40,400 --> 00:49:36,900
yeah exactly like what we're doing right

1129
00:49:43,520 --> 00:49:40,410
now there's no delay and so when we talk

1130
00:49:46,610 --> 00:49:43,530
about time delay between two planets if

1131
00:49:48,650 --> 00:49:46,620
you can imagine say something and then I

1132
00:49:50,240 --> 00:49:48,660
got wait five minutes until I hear it

1133
00:49:52,070 --> 00:49:50,250
and then I gotta think about what I want

1134
00:49:54,410 --> 00:49:52,080
to stay back to and then you got to wait

1135
00:49:57,050 --> 00:49:54,420
at least five minutes for out to travel

1136
00:49:59,300 --> 00:49:57,060
back that's what we encounter when we

1137
00:50:01,490 --> 00:49:59,310
have time delay community or

1138
00:50:03,860 --> 00:50:01,500

communications that's delayed between

1139
00:50:05,780 --> 00:50:03,870
for example the Earth and Mars because

1140
00:50:08,410 --> 00:50:05,790
the planets are long houses they're in

1141
00:50:11,330 --> 00:50:08,420
orbit around the Sun in such a way that

1142
00:50:13,460 --> 00:50:11,340
that space and time between the two

1143
00:50:15,950 --> 00:50:13,470
planets varies anywhere from four

1144
00:50:18,620 --> 00:50:15,960
minutes to 22 minutes one way so it's

1145
00:50:20,810 --> 00:50:18,630
already really huh you have even just a

1146
00:50:22,250 --> 00:50:20,820
few seconds delay between yourself and

1147
00:50:23,840 --> 00:50:22,260
the other person that you're speaking to

1148
00:50:25,860 --> 00:50:23,850
for example if I had to talk to my

1149
00:50:28,680 --> 00:50:25,870
grandma and she was alive beside of the

1150
00:50:30,930 --> 00:50:28,690
of the world and there was a delay I

1151
00:50:32,520 --> 00:50:30,940
mean answering her question when she's

1152
00:50:34,290 --> 00:50:32,530
asking you another question in your like

1153
00:50:35,930 --> 00:50:34,300
wait so I just another question and so

1154
00:50:38,400 --> 00:50:35,940
if there's a there's a compounding

1155
00:50:40,320 --> 00:50:38,410
confusion ovens if you're not prepared

1156
00:50:42,240 --> 00:50:40,330
for that connotation so that's what

1157
00:50:43,410 --> 00:50:42,250
timezone those are some of the issues

1158
00:50:45,060 --> 00:50:43,420
that we're trying to deal with when it

1159
00:50:47,490 --> 00:50:45,070
comes to time delay because when you

1160
00:50:48,660 --> 00:50:47,500
suman's out into deep space regardless

1161
00:50:49,860 --> 00:50:48,670
you're probably gonna want to talk to

1162
00:50:52,260 --> 00:50:49,870
them it's something they're gonna want

1163
00:50:54,780 --> 00:50:52,270

to call home and so they have to be able

1164
00:50:55,650 --> 00:50:54,790
to deal with that delayed situation and

1165
00:50:56,790 --> 00:50:55,660
we gotta figure out how to do that

1166
00:50:59,360 --> 00:50:56,800
that's the kind of devil in the detail

1167
00:51:02,940 --> 00:50:59,370
work that we're we're involved with

1168
00:51:17,670 --> 00:51:02,950
right on it's pretty good it might be

1169
00:51:23,940 --> 00:51:17,680
explaining like in 15 very smart like

1170
00:51:25,890 --> 00:51:23,950
clever five your own candy so tell us a

1171
00:51:28,560 --> 00:51:25,900
little bit about how you are acting out

1172
00:51:30,060 --> 00:51:28,570
that kind of space exploration right now

1173
00:51:32,180 --> 00:51:30,070
because you have robots that are

1174
00:51:34,940 --> 00:51:32,190
exploring for you under the sea right

1175
00:51:38,460 --> 00:51:34,950
tell us a little bit about exactly's

1176
00:51:40,560 --> 00:51:38,470
yeah so we have an ROV actually the two

1177
00:51:42,570 --> 00:51:40,570
are Ovie's that are exploring on our

1178
00:51:44,730 --> 00:51:42,580
behalf essentially we can't go down a

1179
00:51:46,680 --> 00:51:44,740
thousand meters but we can send these

1180
00:51:49,110 --> 00:51:46,690
credible robots down what is called

1181
00:51:52,910 --> 00:51:49,120
Argus and Argus actually float about

1182
00:51:54,990 --> 00:51:52,920
fifteen meters or 50 meters above

1183
00:51:58,740 --> 00:51:55,000
Hercules which is the larger working

1184
00:52:00,780 --> 00:51:58,750
horse the Barley's and Argos is really

1185
00:52:02,730 --> 00:52:00,790
cool it basically provides a whole bunch

1186
00:52:04,470 --> 00:52:02,740
light gives you situational awareness it

1187
00:52:06,600 --> 00:52:04,480
tells you kind of roughly where this big

1188
00:52:08,640 --> 00:52:06,610

Hercules is you know relative to the

1189
00:52:10,290 --> 00:52:08,650
rock face and so forth and then Hercules

1190
00:52:12,410 --> 00:52:10,300
is totally tricked out so it's like this

1191
00:52:14,790 --> 00:52:12,420
ginormous minivan that can get submerged

1192
00:52:15,900 --> 00:52:14,800
and I'll get squished by the pressures

1193
00:52:19,440 --> 00:52:15,910
that we're dealing with in the deep

1194
00:52:21,720 --> 00:52:19,450
ocean it's got arms and it's got bottles

1195
00:52:24,300 --> 00:52:21,730
it's got you know tubes that duct water

1196
00:52:26,250 --> 00:52:24,310
from things like that and boxes where we

1197
00:52:28,170 --> 00:52:26,260
can store rocks so it's pretty epic and

1198
00:52:30,240 --> 00:52:28,180
it's all controlled from the surface

1199
00:52:32,550 --> 00:52:30,250
from this ship which we have some

1200
00:52:34,710 --> 00:52:32,560
amazing ROV pilots I don't know how they

1201
00:52:36,300 --> 00:52:34,720
do it because they are under so much

1202
00:52:38,250 --> 00:52:36,310
pressure you know like it's the

1203
00:52:38,970 --> 00:52:38,260
scientists work up the fitting bag it's

1204
00:52:39,569 --> 00:52:38,980
just a video game

1205
00:52:42,779 --> 00:52:39,579
yeah we're just

1206
00:52:44,579 --> 00:52:42,789
no pressure it's not nobodies graduate

1207
00:52:47,309 --> 00:52:44,589
thesis or anything but somehow

1208
00:52:49,009 --> 00:52:47,319
completely chill and they just go at it

1209
00:52:52,410 --> 00:52:49,019
you know and they're just focused and

1210
00:52:55,019 --> 00:52:52,420
hazing and they operate the equipment as

1211
00:52:56,699 --> 00:52:55,029
you know as a complete pros so you're

1212
00:52:58,769 --> 00:52:56,709
right there we have robots we're

1213
00:53:00,599 --> 00:52:58,779

operating them the ship down on the

1214
00:53:02,699 --> 00:53:00,609
surface but then we've got this whole

1215
00:53:04,199 --> 00:53:02,709
other part of our mission which are our

1216
00:53:04,890 --> 00:53:04,209
friends that are sitting on shore in

1217
00:53:08,729 --> 00:53:04,900
Rhode Island

1218
00:53:12,150 --> 00:53:08,739
so our six hours ahead of us in terms of

1219
00:53:13,829 --> 00:53:12,160
the time zone change and we have to work

1220
00:53:16,309 --> 00:53:13,839
with them they've got a feed back into

1221
00:53:18,809 --> 00:53:16,319
our day to day mission as we're diving

1222
00:53:21,089 --> 00:53:18,819
in but what do they want us to do turn

1223
00:53:22,979 --> 00:53:21,099
left turn right pick up this rock up

1224
00:53:26,819 --> 00:53:22,989
tighter thermal vent suck up that water

1225
00:53:30,150 --> 00:53:26,829
for how long and and step back and forth

1226
00:53:31,799 --> 00:53:30,160
and it's it's hard did you were showing

1227
00:53:34,259 --> 00:53:31,809
earlier from the caves is actually

1228
00:53:36,209 --> 00:53:34,269
inside the volcanic crater years ago oh

1229
00:53:38,249 --> 00:53:36,219
the world we were driving around there

1230
00:53:39,479 --> 00:53:38,259
so Darlene and I were actually directing

1231
00:53:41,640 --> 00:53:39,489
what the pilots were doing where they

1232
00:53:43,319 --> 00:53:41,650
were flying on the seafloor but all the

1233
00:53:44,459 --> 00:53:43,329
time in the same headset we had people

1234
00:53:46,199 --> 00:53:44,469
talking in just like you have in a

1235
00:53:47,729 --> 00:53:46,209
studio we had people from Rhode Island

1236
00:53:49,380 --> 00:53:47,739
telling us what they wanted to do next

1237
00:53:51,120 --> 00:53:49,390
making observations where they wanted to

1238
00:53:53,309 --> 00:53:51,130

go samples and so they were really

1239
00:53:54,900 --> 00:53:53,319
relaying that information to us

1240
00:53:56,609 --> 00:53:54,910
Tinh like the astronauts on a future

1241
00:53:58,529 --> 00:53:56,619
space mission right and then actually

1242
00:54:00,359 --> 00:53:58,539
directing in where we would go what

1243
00:54:01,709 --> 00:54:00,369
samples we collect what measurements

1244
00:54:03,660 --> 00:54:01,719
we'd make and then sending that

1245
00:54:05,189 --> 00:54:03,670
information streaming it live to shore

1246
00:54:07,469 --> 00:54:05,199
so they could actually be seeing it in

1247
00:54:08,789 --> 00:54:07,479
Mission Control just like a future space

1248
00:54:11,009 --> 00:54:08,799
mission that's awesome you know I

1249
00:54:12,599 --> 00:54:11,019
actually saw that because we haven't

1250
00:54:14,729 --> 00:54:12,609
mentioned I don't think that everybody

1251
00:54:16,949 --> 00:54:14,739
can watch this live online no the whole

1252
00:54:20,069 --> 00:54:16,959
mission is live streams and I saw this I

1253
00:54:22,499 --> 00:54:20,079
heard Darlene telling the the pilot

1254
00:54:24,269 --> 00:54:22,509
where to send the sampling or you know

1255
00:54:26,819 --> 00:54:24,279
thermometer or whatever it was into a

1256
00:54:28,650 --> 00:54:26,829
crevasse in the volcano to get the

1257
00:54:30,209 --> 00:54:28,660
readings she needed in fact I think a

1258
00:54:32,099 --> 00:54:30,219
Vaughn who's doing the moderating in the

1259
00:54:34,499 --> 00:54:32,109
chat I can help be able to add the link

1260
00:54:36,630 --> 00:54:34,509
so people chat can see it it's like it's

1261
00:54:38,699 --> 00:54:36,640
on a YouTube it's on YouTube yeah they

1262
00:54:41,130 --> 00:54:38,709
can be Nautilus see all of Darlene and

1263
00:54:42,420 --> 00:54:41,140

Chris's words like in real time I'm

1264
00:54:44,400 --> 00:54:42,430
doing it go into some of the chat

1265
00:54:46,799 --> 00:54:44,410
questions that we had of there's a

1266
00:54:48,539 --> 00:54:46,809
person but I per kid was asking how long

1267
00:54:52,620 --> 00:54:48,549
do you spend on the ship and how often

1268
00:54:53,309 --> 00:54:52,630
do you restock hmm that's a great

1269
00:54:55,789 --> 00:54:53,319
question

1270
00:54:59,689 --> 00:54:55,799
don't restock once we're out the city

1271
00:55:02,969 --> 00:54:59,699
and we were supposed to be at sea for

1272
00:55:04,979 --> 00:55:02,979
actually I think about four days but

1273
00:55:06,749 --> 00:55:04,989
because of hurricane lane we ended up

1274
00:55:07,949 --> 00:55:06,759
having to the ship but fortunately we

1275
00:55:11,609 --> 00:55:07,959
had all gotten on we had to get off

1276
00:55:13,199 --> 00:55:11,619
hunker down in Honolulu and then once

1277
00:55:15,329 --> 00:55:13,209
the you know it was pretty much cleared

1278
00:55:18,449 --> 00:55:15,339
up then we were able to get back on the

1279
00:55:21,779 --> 00:55:18,459
ship and head out to whoo which is just

1280
00:55:24,299 --> 00:55:21,789
in the south eastern end of a Big Island

1281
00:55:26,910 --> 00:55:24,309
of Hawaii so the oceans have been still

1282
00:55:28,559 --> 00:55:26,920
pretty angry about happened and there

1283
00:55:31,559 --> 00:55:28,569
are other hurricanes in the area so

1284
00:55:34,049 --> 00:55:31,569
gonna turn the bend last night and hook

1285
00:55:35,640 --> 00:55:34,059
her down in the little Michelle Cove so

1286
00:55:37,949 --> 00:55:35,650
to speak on the other side of the island

1287
00:55:39,949 --> 00:55:37,959
so that we could make sure we were safe

1288
00:55:42,390 --> 00:55:39,959

through through the evening

1289
00:55:43,620 --> 00:55:42,400
normally asleep you have three to four

1290
00:55:45,599 --> 00:55:43,630
weeks at the time and you're just out

1291
00:55:47,339 --> 00:55:45,609
there yeah whatever you remember to put

1292
00:55:49,130 --> 00:55:47,349
out whatever you forgot the back well

1293
00:55:51,180 --> 00:55:49,140
sounds a little stressed out because

1294
00:55:52,949 --> 00:55:51,190
some of the people that flew on my

1295
00:55:54,120 --> 00:55:52,959
flight they only had carry-on and I had

1296
00:55:56,729 --> 00:55:54,130
checked in the back and they said

1297
00:55:58,529 --> 00:55:56,739
Darlene word on the street is you know

1298
00:56:01,580 --> 00:55:58,539
the needs whether or not you have your

1299
00:56:10,609 --> 00:56:01,590
underwear and so I was like oh my god

1300
00:56:10,619 --> 00:56:18,620
like penny if you have any questions for

1301
00:56:24,359 --> 00:56:23,430
dry on this a good friend and one of the

1302
00:56:26,430 --> 00:56:24,369
things that we were talking about

1303
00:56:29,249 --> 00:56:26,440
earlier Darlene before you got on was

1304
00:56:33,019 --> 00:56:29,259
the relationship between the kind of

1305
00:56:35,819 --> 00:56:33,029
work that you guys are doing exploring

1306
00:56:38,219 --> 00:56:35,829
that environment and the similarities

1307
00:56:41,009 --> 00:56:38,229
between that and those of us who study

1308
00:56:43,469 --> 00:56:41,019
terrestrial systems and that even though

1309
00:56:47,249 --> 00:56:43,479
there's really really different seeming

1310
00:56:49,439 --> 00:56:47,259
environments but they are you know many

1311
00:56:54,079 --> 00:56:49,449
scientific connections many similarities

1312
00:56:56,430 --> 00:56:54,089
in the habitats and then yes similarly I

1313
00:56:57,930 --> 00:56:56,440

said you know what else it's it's

1314
00:57:00,509 --> 00:56:57,940
amazing Curtin I were having this

1315
00:57:02,729 --> 00:57:00,519
conversation about the need to as Earth

1316
00:57:05,280 --> 00:57:02,739
Science this who happened to extrapolate

1317
00:57:08,490 --> 00:57:05,290
our knowledge to Planetary application

1318
00:57:10,200 --> 00:57:08,500
to be as diverse as possible and because

1319
00:57:11,790 --> 00:57:10,210
never know what you're going to

1320
00:57:14,970 --> 00:57:11,800
encounter once you get off this planet

1321
00:57:17,370 --> 00:57:14,980
so I think having earth-based as well as

1322
00:57:19,590 --> 00:57:17,380
you know deep subsea and any for that

1323
00:57:21,690 --> 00:57:19,600
matter any ocean sciences look at

1324
00:57:22,620 --> 00:57:21,700
problems look at the same problems in

1325
00:57:24,990 --> 00:57:22,630
different ways in different environments

1326
00:57:26,250 --> 00:57:25,000
it's going to be beneficial to planetary

1327
00:57:28,260 --> 00:57:26,260
sciences and of course the earth

1328
00:57:30,030 --> 00:57:28,270
sciences in general and so it makes a

1329
00:57:32,250 --> 00:57:30,040
lot of sense that there are so many

1330
00:57:34,290 --> 00:57:32,260
different astrobiology projects that

1331
00:57:36,990 --> 00:57:34,300
work in extreme environments you know in

1332
00:57:38,970 --> 00:57:37,000
the deep subsurface as you have on lands

1333
00:57:40,410 --> 00:57:38,980
in the deep ocean you know and in the

1334
00:57:42,540 --> 00:57:40,420
shallower parts of the ocean all over

1335
00:57:44,310 --> 00:57:42,550
and high altitude and so forth we need

1336
00:57:45,720 --> 00:57:44,320
that diversity and there's also that

1337
00:57:47,940 --> 00:57:45,730
commonality of how do you actually get

1338
00:57:50,130 --> 00:57:47,950

explorations right yes it does a lot of

1339
00:57:51,690 --> 00:57:50,140
her time working on land and think about

1340
00:57:53,700 --> 00:57:51,700
what would happen if you suddenly went

1341
00:57:55,050 --> 00:57:53,710
to the same kind of rocky environment on

1342
00:57:56,160 --> 00:57:55,060
another planet and somebody takes your

1343
00:57:58,350 --> 00:57:56,170
smartphone away you don't have Google

1344
00:58:01,410 --> 00:57:58,360
Maps I don't know where you are anymore

1345
00:58:03,960 --> 00:58:01,420
how do you how do you not get lost it's

1346
00:58:04,890 --> 00:58:03,970
this bewildering builder interval when I

1347
00:58:05,880 --> 00:58:04,900
dive down to the bottom of the ocean

1348
00:58:07,500 --> 00:58:05,890
with a robot and I'm driving around in

1349
00:58:09,660 --> 00:58:07,510
the dark down there we have the same

1350
00:58:11,340 --> 00:58:09,670
challenges so comparing what space

1351
00:58:12,810 --> 00:58:11,350
technology is come up with and what

1352
00:58:14,310 --> 00:58:12,820
underwater technologies can't with and

1353
00:58:16,530 --> 00:58:14,320
doing that mind meld as well the

1354
00:58:19,410 --> 00:58:16,540
technology yeah just as important as the

1355
00:58:20,580 --> 00:58:19,420
science as well it's a really rich area

1356
00:58:25,080 --> 00:58:20,590
of cross-fertilization

1357
00:58:26,490 --> 00:58:25,090
yeah yeah and so I mean I mean I

1358
00:58:27,960 --> 00:58:26,500
unfortunately feel like we could

1359
00:58:31,680 --> 00:58:27,970
literally just sit here and just talk

1360
00:58:33,150 --> 00:58:31,690
all day going through but in the course

1361
00:58:35,010 --> 00:58:33,160
of chatting with you guys and all the

1362
00:58:36,780 --> 00:58:35,020
different segments inside I'm looking

1363
00:58:38,600 --> 00:58:36,790

and we're like counting down from like

1364
00:58:41,640 --> 00:58:38,610
less than two minutes left in the show

1365
00:58:44,670 --> 00:58:41,650
so it's about that time we're gonna have

1366
00:58:46,410 --> 00:58:44,680
to wrap things up but a huge thanks to

1367
00:58:50,130 --> 00:58:46,420
everybody but I wanted to let everybody

1368
00:58:52,020 --> 00:58:50,140
know this has been actually the premiere

1369
00:58:54,930 --> 00:58:52,030
episode for this season of NASA in

1370
00:58:56,670 --> 00:58:54,940
Silicon Valley live a conversational

1371
00:58:59,070 --> 00:58:56,680
show out of NASA's Ames Research Center

1372
00:59:01,920 --> 00:58:59,080
with the various researchers scientists

1373
00:59:04,110 --> 00:59:01,930
engineers and all-around cool people at

1374
00:59:06,030 --> 00:59:04,120
NASA where we talk about all the nerdy

1375
00:59:07,740 --> 00:59:06,040
NASA news that you need to know about so

1376
00:59:10,470 --> 00:59:07,750
if you like that you can find us on

1377
00:59:12,180 --> 00:59:10,480
twitch YouTube I heard you had some

1378
00:59:13,470 --> 00:59:12,190
problems getting up on Facebook today

1379
00:59:17,040 --> 00:59:13,480
but hopefully they'll be working in the

1380
00:59:18,980 --> 00:59:17,050
future including NASA TV if you can't

1381
00:59:21,020 --> 00:59:18,990
catch us live that is No

1382
00:59:23,180 --> 00:59:21,030
we will have video-on-demand after the

1383
00:59:25,099 --> 00:59:23,190
show is over you can also catch the

1384
00:59:27,500 --> 00:59:25,109
audio version on podcast services

1385
00:59:29,660 --> 00:59:27,510
throughout the solar system and beyond

1386
00:59:32,450 --> 00:59:29,670
so at Jim Brighton Stein isn't here

1387
00:59:35,120 --> 00:59:32,460
anymore so a big thanks to Jim huge

1388
00:59:37,400 --> 00:59:35,130

thanks to Darlene Chris and penny and

1389
00:59:39,650 --> 00:59:37,410
especially everybody's sitting in the

1390
00:59:41,930 --> 00:59:39,660
twitch chat we're very well behaved

1391
00:59:43,970 --> 00:59:41,940
asked very wonderful questions sorry we

1392
00:59:46,730 --> 00:59:43,980
couldn't get to them all but we're gonna

1393
00:59:51,700 --> 00:59:46,740
be back on September 13th when we talk

1394
00:59:54,260 --> 00:59:51,710
about biology research in space but