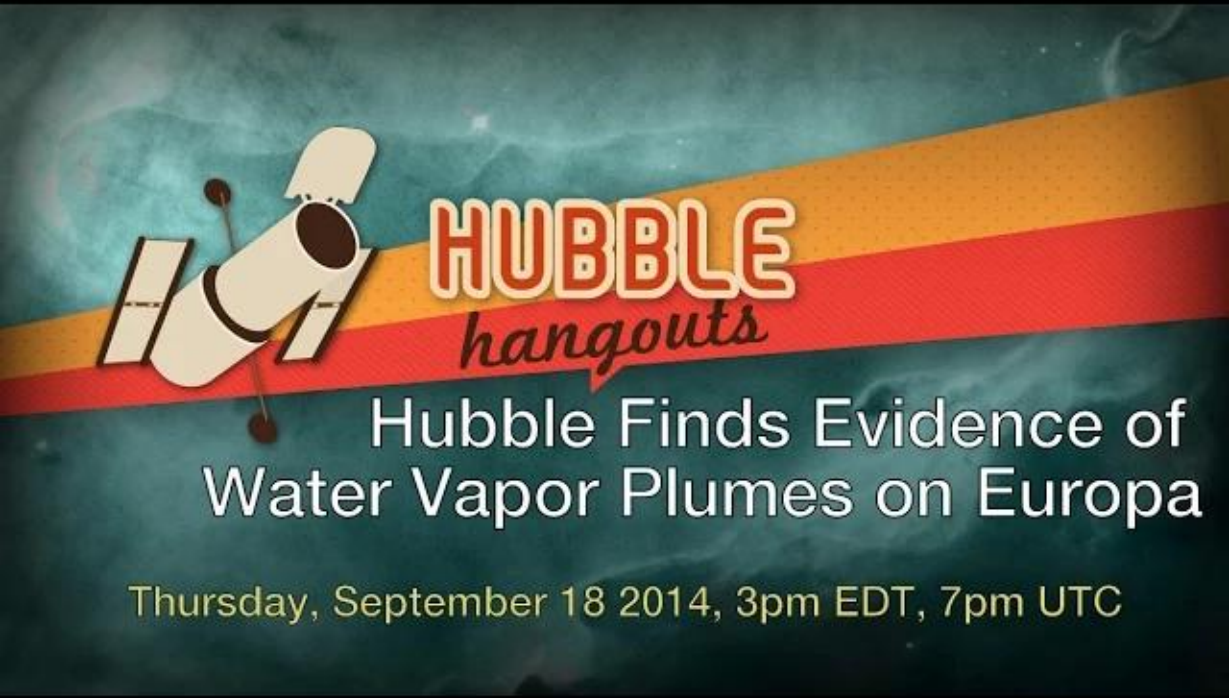
HUBBLE
hangouts
Hubble Finds Evidence of
Water Vapor Plumes on Europa
Thursday, September 18 2014, 3pm EDT, 7pm UTC

1
00:00:12,430 --> 00:00:10,299
hello everybody and welcome to our

2
00:00:14,320 --> 00:00:12,440
latest Hubble hang out my name is Tony

3
00:00:16,660 --> 00:00:14,330
Darnell I work heavy Space Telescope

4
00:00:18,250 --> 00:00:16,670
Science Institute and today we've got a

5
00:00:20,410 --> 00:00:18,260
great hangout plan for you we're going

6
00:00:23,140 --> 00:00:20,420
to be talking about water vapor plumes

7
00:00:24,460 --> 00:00:23,150
seen on Europa but before I get started

8
00:00:27,519 --> 00:00:24,470
I want to make a quick little

9
00:00:29,320 --> 00:00:27,529
programming announcement tonight we have

10
00:00:32,050 --> 00:00:29,330
a special Hubble public lecture series

11
00:00:33,819 --> 00:00:32,060
which is going to be from a renowned

12
00:00:37,869 --> 00:00:33,829
astrophysicist and an award-winning

13
00:00:40,299 --> 00:00:37,879

writer dr. ray jayawardana and he's

14
00:00:42,880 --> 00:00:40,309
going to be talking about neutrinos in

15
00:00:44,950 --> 00:00:42,890
the title is neutrino hunters chasing a

16
00:00:46,900 --> 00:00:44,960
ghostly particle to unlock cosmic

17
00:00:49,450 --> 00:00:46,910
secrets he's going to give us a look

18
00:00:51,580 --> 00:00:49,460
into the shadowy world of neutrinos and

19
00:00:54,490 --> 00:00:51,590
the colorful lives those who seek them

20
00:00:58,660 --> 00:00:54,500
so that's tonight at eight pm eastern uh

21
00:01:00,819 --> 00:00:58,670
I believe that's midnight in the

22
00:01:02,889 --> 00:01:00,829
universal time so hopefully you guys can

23
00:01:06,100 --> 00:01:02,899
catch alive you can also watch it at

24
00:01:07,570 --> 00:01:06,110
webcast I ftse I edu so I wanted to give

25
00:01:11,520 --> 00:01:07,580
that little programming note out there

26
00:01:14,230 --> 00:01:11,530
before we get too far into it um today

27
00:01:17,590 --> 00:01:14,240
we as i mentioned we're going to be

28
00:01:19,570 --> 00:01:17,600
talking about neutrinos and no or not no

29
00:01:21,340 --> 00:01:19,580
or not what about water vapor pick you

30
00:01:24,340 --> 00:01:21,350
can talk about neutrinos the weighted

31
00:01:26,080 --> 00:01:24,350
robot yeah we're out Europa and water

32
00:01:27,790 --> 00:01:26,090
vapor plumes that we've seen there and

33
00:01:30,370 --> 00:01:27,800
with me to help just help me with this

34
00:01:31,780 --> 00:01:30,380
discussion as they just did dr. carol

35
00:01:33,040 --> 00:01:31,790
christian she's the Hubble outreach

36
00:01:35,650 --> 00:01:33,050
scientist for the Space Telescope

37
00:01:38,170 --> 00:01:35,660
Science Institute and got Louis from

38
00:01:41,350 --> 00:01:38,180

know the cosmos calm and the internet

39
00:01:43,630 --> 00:01:41,360
driver extraordinary welcome guys it's

40
00:01:45,820 --> 00:01:43,640
good to see you again Ellen yeah so

41
00:01:49,050 --> 00:01:45,830
what's going with those neutrinos Tony

42
00:01:52,510 --> 00:01:49,060
okay I've got a tuna tonight okay okay

43
00:01:54,419 --> 00:01:52,520
that's the deal sorry I got all too too

44
00:01:57,580 --> 00:01:54,429
many things cooking

45
00:02:00,219 --> 00:01:57,590
so with me to discuss this ABS these

46
00:02:06,160 --> 00:02:00,229
observations that have just that have

47
00:02:08,350 --> 00:02:06,170
just recently is dr. rents room what dr.

48
00:02:11,800 --> 00:02:08,360
Lorenz let me slow down from these

49
00:02:14,850 --> 00:02:11,810
Research Institute I dr. Kurt rather 40

50
00:02:18,490 --> 00:02:14,860
from us the southwest research institute

51
00:02:20,800 --> 00:02:18,500
and dr. yo Joaquin star from the

52
00:02:25,210 --> 00:02:20,810
University of Cologne and Germany so

53
00:02:28,809 --> 00:02:25,220
welcome guys yeah thank you hello thank

54
00:02:30,280 --> 00:02:28,819
you Anchorage uh so let's go so let's go

55
00:02:32,410 --> 00:02:30,290
ahead and get started i'll be talking

56
00:02:34,690 --> 00:02:32,420
about others let's let's get everyone

57
00:02:37,449 --> 00:02:34,700
knowing on how they can ah thank you

58
00:02:40,089 --> 00:02:37,459
yeah internets let me drive you for a

59
00:02:44,140 --> 00:02:40,099
moment if you have any questions or

60
00:02:46,720 --> 00:02:44,150
comments for our panel you can tweet at

61
00:02:49,059 --> 00:02:46,730
us using the hashtag hubble hang out we

62
00:02:51,190 --> 00:02:49,069
also have the Q&A app installed right

63
00:02:54,280 --> 00:02:51,200

now so whether you're on youtube or on

64
00:02:56,020 --> 00:02:54,290
Google+ you can open that up there leave

65
00:02:57,849 --> 00:02:56,030
questions in there and we will be able

66
00:02:59,590 --> 00:02:57,859
to choose that during the show and we'll

67
00:03:01,360 --> 00:02:59,600
still be checking comments on YouTube

68
00:03:03,610 --> 00:03:01,370
and the Google+ event page there's many

69
00:03:05,590 --> 00:03:03,620
different ways that you can get in touch

70
00:03:07,780 --> 00:03:05,600
with us and we'll be monitoring them

71
00:03:12,819 --> 00:03:07,790
throughout the show great thank you

72
00:03:14,949 --> 00:03:12,829
Scott so this these observations as let

73
00:03:17,440 --> 00:03:14,959
me get a little background here Europa

74
00:03:20,110 --> 00:03:17,450
as many of you hopefully know is a moon

75
00:03:22,089 --> 00:03:20,120
that is in orbit around Jupiter one of

76
00:03:24,640 --> 00:03:22,099
the largest planet in our solar system

77
00:03:27,129 --> 00:03:24,650
and we've long known or at least I think

78
00:03:32,080 --> 00:03:27,139
observations have strongly suggested

79
00:03:34,030 --> 00:03:32,090
that there is water uh around the on the

80
00:03:39,069 --> 00:03:34,040
surface of or underneath the frozen

81
00:03:41,620 --> 00:03:39,079
surface of the moon but Hubble was that

82
00:03:43,210 --> 00:03:41,630
was able to detect some water vapor

83
00:03:45,490 --> 00:03:43,220
plumes what you think with some water

84
00:03:46,960 --> 00:03:45,500
water vapor plumes and so Lorenz let me

85
00:03:49,360 --> 00:03:46,970
start with you can use can you give us

86
00:03:51,520 --> 00:03:49,370
some idea of what you observed and and

87
00:03:55,809 --> 00:03:51,530
with the Hubble when you first pointed

88
00:03:58,089 --> 00:03:55,819

it at Europa so and we observe for your

89
00:04:01,330 --> 00:03:58,099
surface auroral emissions so we observe

90
00:04:04,059 --> 00:04:01,340
the neutral gas in the environment of

91
00:04:06,010 --> 00:04:04,069
Europa this is excited by charged

92
00:04:08,620 --> 00:04:06,020
particles by M

93
00:04:11,140 --> 00:04:08,630
runs in this case and in the particular

94
00:04:13,600 --> 00:04:11,150
case of the observations that led to the

95
00:04:16,350 --> 00:04:13,610
discovery of the water vapor we observed

96
00:04:19,300 --> 00:04:16,360
emissions from hydrogen and oxygen and

97
00:04:21,130 --> 00:04:19,310
these emissions kind of point to the

98
00:04:25,180 --> 00:04:21,140
existence of these water with Weber

99
00:04:28,660 --> 00:04:25,190
booms at Europa and when did you did you

100
00:04:32,260 --> 00:04:28,670
do this and the detection we have like

101
00:04:34,060 --> 00:04:32,270
one set of observations where we see the

102
00:04:38,500 --> 00:04:34,070
water vapor plumes and these were taken

103
00:04:43,420 --> 00:04:38,510
in December 2012 so um yeah not quite

104
00:04:46,030 --> 00:04:43,430
two years ago yes and then n the and so

105
00:04:47,680 --> 00:04:46,040
these were not as you point out these

106
00:04:51,880 --> 00:04:47,690
were not images right that you took

107
00:04:55,060 --> 00:04:51,890
these were yet it said the Methodist

108
00:04:57,040 --> 00:04:55,070
imaging spectroscopy so and we use the

109
00:04:59,410 --> 00:04:57,050
Disqus camera the space telescope

110
00:05:02,470 --> 00:04:59,420
imaging spectrograph on hubble and the

111
00:05:04,930 --> 00:05:02,480
two arcsecond white slid and the moons

112
00:05:08,170 --> 00:05:04,940
of jupiter they fit into this to our

113
00:05:12,550 --> 00:05:08,180

second wide slate so we can em we have

114
00:05:18,070 --> 00:05:12,560
the entire moon within the slit and then

115
00:05:20,680 --> 00:05:18,080
we spectrally disperse the signal from

116
00:05:23,740 --> 00:05:20,690
the moon and so we have both spatial

117
00:05:26,050 --> 00:05:23,750
information and also the spectral

118
00:05:28,990 --> 00:05:26,060
information so we have a spectrum of

119
00:05:30,070 --> 00:05:29,000
images so to say okay so yeah I wondered

120
00:05:32,830 --> 00:05:30,080
if I wanted to make that point because

121
00:05:34,720 --> 00:05:32,840
these are according to what I've read

122
00:05:37,270 --> 00:05:34,730
about the research this is a pretty

123
00:05:40,570 --> 00:05:37,280
these are pretty faint plumes right they

124
00:05:44,350 --> 00:05:40,580
may not even be visible to in visual or

125
00:05:47,290 --> 00:05:44,360
in visible light right yeah always I

126
00:05:50,470 --> 00:05:47,300
mean it's a matter of definition of a

127
00:05:58,870 --> 00:05:50,480
faint and here but I'm sorry it's my

128
00:06:01,960 --> 00:05:58,880
phone and and they are they can be like

129
00:06:04,180 --> 00:06:01,970
invisible light almost yeah undetectable

130
00:06:07,090 --> 00:06:04,190
and but we observed in the in the

131
00:06:11,170 --> 00:06:07,100
ultraviolet and a two distinct

132
00:06:13,300 --> 00:06:11,180
wavelength here and and I mean it's the

133
00:06:16,420 --> 00:06:13,310
emissions are relatively feigned so we

134
00:06:18,820 --> 00:06:16,430
need more exposure time to really

135
00:06:21,320 --> 00:06:18,830
observe them but

136
00:06:23,149 --> 00:06:21,330
alright lutely you can hard to say if

137
00:06:25,519 --> 00:06:23,159
they they are faint I mean always a

138
00:06:27,320 --> 00:06:25,529

matter of what you compare compare it to

139
00:06:28,610 --> 00:06:27,330
yeah I want to remind people that a lot

140
00:06:31,519 --> 00:06:28,620
of people associate Hubble observations

141
00:06:33,499 --> 00:06:31,529
with deep space stuff you know very

142
00:06:35,869 --> 00:06:33,509
distant galaxies and that sort of thing

143
00:06:37,760 --> 00:06:35,879
but who actually does do quite a bit of

144
00:06:40,839 --> 00:06:37,770
observing within our own solar system I

145
00:06:45,260 --> 00:06:40,849
mean just recently we've looked at the

146
00:06:47,149 --> 00:06:45,270
at comet ison last year and we also I

147
00:06:49,820 --> 00:06:47,159
think Carol don't we have plans for a

148
00:06:51,439 --> 00:06:49,830
hangout on some more common observations

149
00:06:53,989 --> 00:06:51,449
may be a little bit difference months so

150
00:06:56,269 --> 00:06:53,999
how's actually be within the solar

151
00:06:58,459 --> 00:06:56,279
system and and what are the advantages

152
00:07:01,850 --> 00:06:58,469
when you use Hubble what does hub will

153
00:07:03,499 --> 00:07:01,860
give you when you look at these it will

154
00:07:05,089 --> 00:07:03,509
at Europa for example or for anything

155
00:07:07,010 --> 00:07:05,099
that might be within the solar system

156
00:07:09,829 --> 00:07:07,020
that you wouldn't or necessarily get

157
00:07:11,050 --> 00:07:09,839
from a ground-based telescope kurt is

158
00:07:14,809 --> 00:07:11,060
that something you can answer for us

159
00:07:17,869 --> 00:07:14,819
yeah sure our group our thoughts bar

160
00:07:21,019 --> 00:07:17,879
tonight did are feasting on some

161
00:07:27,619 --> 00:07:21,029
observations of i owed volcanic inside

162
00:07:29,510 --> 00:07:27,629
your absorbent and very similar of the

163
00:07:31,579 --> 00:07:29,520

related space from volcanic instead of

164
00:07:33,679 --> 00:07:31,589
going off on i'll light of it

165
00:07:38,119 --> 00:07:33,689
ultraviolet wavelengths a community

166
00:07:41,079 --> 00:07:38,129
functions and some other things on

167
00:07:42,920 --> 00:07:41,089
Jupiter's Roura but give spectacular

168
00:07:45,769 --> 00:07:42,930
okay we're starting to lose a little

169
00:07:48,050 --> 00:07:45,779
above your sound I think um I was just a

170
00:07:50,749 --> 00:07:48,060
really powerful tool for magic sorry

171
00:07:56,089 --> 00:07:50,759
that's what oh okay okay so yeah so uh

172
00:07:59,239 --> 00:07:56,099
oh the so the lorenz was telling us that

173
00:08:01,550 --> 00:07:59,249
the you looked at the Europa for quite a

174
00:08:03,170 --> 00:08:01,560
while any sense of how long what what

175
00:08:04,519 --> 00:08:03,180
the exposure times are honey how many

176
00:08:08,449 --> 00:08:04,529
orbits did you use to make these

177
00:08:09,889 --> 00:08:08,459
observations and so the visit or this

178
00:08:12,739 --> 00:08:09,899
set of observations with the detection

179
00:08:14,839 --> 00:08:12,749
had five double orbits so it was like

180
00:08:17,449 --> 00:08:14,849
five times more or less 40 minutes of

181
00:08:20,230 --> 00:08:17,459
exposure time and that gave us the

182
00:08:24,170 --> 00:08:20,240
signal we needed to do to take the poems

183
00:08:25,699 --> 00:08:24,180
okay i don't like Scott I don't know if

184
00:08:27,350 --> 00:08:25,709
you have it handy but from the press

185
00:08:29,089 --> 00:08:27,360
release that we did on this which by the

186
00:08:31,820 --> 00:08:29,099
way is in the link to that is in the

187
00:08:34,430 --> 00:08:31,830
Google+ event there is

188
00:08:36,830 --> 00:08:34,440

there's an image that shows your oppa

189
00:08:39,320 --> 00:08:36,840
with overlaid on top of it it's an

190
00:08:40,940 --> 00:08:39,330
illustration with overlaid on top of it

191
00:08:42,650 --> 00:08:40,950
with the locations of where these plumes

192
00:08:45,710 --> 00:08:42,660
were do you happen to have that image

193
00:08:47,900 --> 00:08:45,720
handy let me pull it up here if not it I

194
00:08:49,670 --> 00:08:47,910
I added it to the Google+ event page

195
00:08:51,260 --> 00:08:49,680
itself and I can see and I can share the

196
00:08:52,730 --> 00:08:51,270
screen we had some technical

197
00:08:54,530 --> 00:08:52,740
difficulties before we started I was

198
00:08:56,480 --> 00:08:54,540
going to have Elena have that handy but

199
00:09:00,440 --> 00:08:56,490
I didn't get a chance to ask her on that

200
00:09:02,090 --> 00:09:00,450
but it's well while Scott's looking for

201
00:09:05,420 --> 00:09:02,100
that um can you give us some sense of

202
00:09:11,060 --> 00:09:05,430
how where these were on Europa where did

203
00:09:16,640 --> 00:09:11,070
you find them are you asking oh sorry

204
00:09:19,190 --> 00:09:16,650
I'm space in spicy snack yeah there's no

205
00:09:20,960 --> 00:09:19,200
utterance oh yeah well okay yaki let me

206
00:09:23,180 --> 00:09:20,970
get you into this uh what do you have

207
00:09:27,140 --> 00:09:23,190
where were these things on on Europa

208
00:09:30,620 --> 00:09:27,150
they were located around the South Pole

209
00:09:33,590 --> 00:09:30,630
of Europa and thought of that was very

210
00:09:36,970 --> 00:09:33,600
similar to plumes recently discovered

211
00:09:39,590 --> 00:09:36,980
with the Cassini spacecraft at Enceladus

212
00:09:41,570 --> 00:09:39,600
so originally I mean they were always

213
00:09:45,830 --> 00:09:41,580

taught around that Europa could have

214
00:09:48,620 --> 00:09:45,840
plumes and then after similar blooms

215
00:09:51,110 --> 00:09:48,630
head teen have been seen on Enceladus it

216
00:09:53,660 --> 00:09:51,120
really sort of fell into place that we

217
00:09:56,990 --> 00:09:53,670
saw something similar on a body like

218
00:09:58,310 --> 00:09:57,000
with Alta has an icy surface and Scott

219
00:10:00,950 --> 00:09:58,320
has it up now I just wanted to say that

220
00:10:07,550 --> 00:10:00,960
real quick so Elena would know so yet so

221
00:10:09,380 --> 00:10:07,560
here so here we see we we see the sort

222
00:10:14,420 --> 00:10:09,390
of blue areas down and down at the

223
00:10:16,910 --> 00:10:14,430
bottom so what you can can I say

224
00:10:19,040 --> 00:10:16,920
something about it yeah go ahead I made

225
00:10:21,230 --> 00:10:19,050
it's just yeah it's it's like that the

226
00:10:24,290 --> 00:10:21,240
Hubble data and the blue thing is to

227
00:10:27,350 --> 00:10:24,300
double and double daters of smooth then

228
00:10:29,750 --> 00:10:27,360
the pixel spin together and they just

229
00:10:33,230 --> 00:10:29,760
laid on top of a image taken by Galileo

230
00:10:35,270 --> 00:10:33,240
and of Europa or mosaic of images of

231
00:10:38,090 --> 00:10:35,280
that the surface we actually or the

232
00:10:40,010 --> 00:10:38,100
hemisphere we actually observe and the

233
00:10:42,740 --> 00:10:40,020
structure of the thing is not really

234
00:10:45,290 --> 00:10:42,750
it's not a real structure or physical

235
00:10:47,870 --> 00:10:45,300
structure in a sense and more shows like

236
00:10:50,180 --> 00:10:47,880
the statistic variability and the signal

237
00:10:52,280 --> 00:10:50,190
is rather low we see so we the kind of

238
00:10:55,070 --> 00:10:52,290

structure is is created to through

239
00:10:58,940 --> 00:10:55,080
statistics of after detector count as a

240
00:11:00,949 --> 00:10:58,950
telescope and I only like cut out this

241
00:11:02,420 --> 00:11:00,959
signal from the South Pole or we see the

242
00:11:04,160 --> 00:11:02,430
plumes and put it on top and all the

243
00:11:06,680 --> 00:11:04,170
rest is it's not in this image here so

244
00:11:08,210 --> 00:11:06,690
so if you seen anything anywhere else or

245
00:11:09,650 --> 00:11:08,220
is it all pretty much been I guess it

246
00:11:11,449 --> 00:11:09,660
with these observations it's only in the

247
00:11:14,449 --> 00:11:11,459
south but you do think there might be

248
00:11:17,090 --> 00:11:14,459
some plumes that might appear elsewhere

249
00:11:18,650 --> 00:11:17,100
on Europa or is this a is there

250
00:11:19,910 --> 00:11:18,660
something about Europa that makes them

251
00:11:22,579 --> 00:11:19,920
appear mostly here do you have any

252
00:11:24,800 --> 00:11:22,589
conjecture or thoughts on that on where

253
00:11:29,540 --> 00:11:24,810
they might be Kurt maybe I'll ask you

254
00:11:31,250 --> 00:11:29,550
that yeah sure wherever you see a linear

255
00:11:32,720 --> 00:11:31,260
feature one of these small cracks that

256
00:11:34,850 --> 00:11:32,730
you can see running across the surface

257
00:11:36,350 --> 00:11:34,860
of Europa that's those dark lines that

258
00:11:38,449 --> 00:11:36,360
you see you across those dark lines yeah

259
00:11:40,370 --> 00:11:38,459
the question is how deep do those go

260
00:11:41,660 --> 00:11:40,380
that's something that we just really

261
00:11:44,720 --> 00:11:41,670
don't know after the Galileo mission

262
00:11:47,449 --> 00:11:44,730
took all these great imageries and but

263
00:11:50,329 --> 00:11:47,459

we do know that Europa is totally forced

264
00:11:52,910 --> 00:11:50,339
by Jupiter very very strong gravity and

265
00:11:54,710 --> 00:11:52,920
it's your boat orbits around its ice

266
00:11:56,750 --> 00:11:54,720
shell gets compressed stretched and

267
00:11:58,579 --> 00:11:56,760
pulled and twisted in all sorts of

268
00:12:00,949 --> 00:11:58,589
different ways and there are all sorts

269
00:12:03,410 --> 00:12:00,959
of geophysical geophysical models out

270
00:12:06,980 --> 00:12:03,420
there that can try to sort of estimate

271
00:12:08,780 --> 00:12:06,990
where along these a linear features the

272
00:12:13,090 --> 00:12:08,790
tensile stresses would add up to

273
00:12:17,180 --> 00:12:13,100
possibly given enough energy to let some

274
00:12:19,220 --> 00:12:17,190
auto paper out into space and we're

275
00:12:21,110 --> 00:12:19,230
probably seeing you know just one of the

276
00:12:23,120 --> 00:12:21,120
biggest plumes that are on Europa

277
00:12:24,889 --> 00:12:23,130
whether there are smaller ones that I'm

278
00:12:26,690 --> 00:12:24,899
about two kilometers and said 200

279
00:12:28,189 --> 00:12:26,700
commerce and I is really an open

280
00:12:30,380 --> 00:12:28,199
question that we can only speculate

281
00:12:32,090 --> 00:12:30,390
about right now but if possible I'm glad

282
00:12:34,360 --> 00:12:32,100
you brought that up at the title the

283
00:12:38,210 --> 00:12:34,370
tidal forces that are acting on this so

284
00:12:41,420 --> 00:12:38,220
but the the surface I look at this

285
00:12:42,650 --> 00:12:41,430
picture of Europa what the we're looking

286
00:12:46,639 --> 00:12:42,660
at here and correct me if I'm wrong

287
00:12:48,980 --> 00:12:46,649
anybody uh the this is an ice-covered

288
00:12:51,490 --> 00:12:48,990

world correct this is all ice we're

289
00:12:54,110 --> 00:12:51,500
looking at on the surface right and

290
00:12:55,579 --> 00:12:54,120
these little cracks and stuff are these

291
00:12:58,430 --> 00:12:55,589
those dark lines that you were talking

292
00:12:59,060 --> 00:12:58,440
about give us those are those are faults

293
00:13:01,820 --> 00:12:59,070
or some

294
00:13:05,180 --> 00:13:01,830
sort of imperfections in the indie in

295
00:13:08,270 --> 00:13:05,190
the surface what is Europa's orbit like

296
00:13:10,010 --> 00:13:08,280
income in relation to into relation to

297
00:13:12,620 --> 00:13:10,020
do better is it highly elliptical is a

298
00:13:17,480 --> 00:13:12,630
more or less circular y'all keep I'll

299
00:13:21,020 --> 00:13:17,490
ask you that oh yeah it's it's it's only

300
00:13:23,180 --> 00:13:21,030
a little bit and non circular but that's

301
00:13:28,760 --> 00:13:23,190
already sufficient does somebody know

302
00:13:32,210 --> 00:13:28,770
the eccentricity by heart um go ahead

303
00:13:35,750 --> 00:13:32,220
yeah I don't know what the point 0 0 3

304
00:13:38,150 --> 00:13:35,760
okay so it's a stupid kind of deviation

305
00:13:40,100 --> 00:13:38,160
from being circular but that's already

306
00:13:43,130 --> 00:13:40,110
sufficient because it's so close to that

307
00:13:45,650 --> 00:13:43,140
very massive planet that it still

308
00:13:46,970 --> 00:13:45,660
experienced heights on the surface okay

309
00:13:49,280 --> 00:13:46,980
that's the point I was trying to get to

310
00:13:51,650 --> 00:13:49,290
so there's got to be there's a there's a

311
00:13:53,480 --> 00:13:51,660
point in its orbit around Jupiter where

312
00:13:59,300 --> 00:13:53,490
their forces are stronger than it others

313
00:14:03,380 --> 00:13:59,310

correct okay so correct okay so so given

314
00:14:04,610 --> 00:14:03,390
that I are that one would expect at

315
00:14:06,950 --> 00:14:04,620
certain times of the orbit that there

316
00:14:08,630 --> 00:14:06,960
are these plumes would be present and

317
00:14:09,980 --> 00:14:08,640
one spot and maybe they'd be President

318
00:14:12,010 --> 00:14:09,990
and other depending on the forces acting

319
00:14:15,740 --> 00:14:12,020
on their boat is there ever a time when

320
00:14:17,330 --> 00:14:15,750
you know they might be more active than

321
00:14:19,400 --> 00:14:17,340
not is there any speculation on that

322
00:14:22,700 --> 00:14:19,410
make Lorenz do you have any any thoughts

323
00:14:26,060 --> 00:14:22,710
on that yeah that was we had a kind of

324
00:14:27,890 --> 00:14:26,070
suggestion after like the first three

325
00:14:30,110 --> 00:14:27,900
setups of observations we had we had

326
00:14:32,270 --> 00:14:30,120
this one detection and like i said from

327
00:14:35,330 --> 00:14:32,280
december two thousand twelve then we had

328
00:14:36,890 --> 00:14:35,340
the same kind of observations just from

329
00:14:40,250 --> 00:14:36,900
one month earlier in november two

330
00:14:42,020 --> 00:14:40,260
thousand twelve and we had very similar

331
00:14:45,650 --> 00:14:42,030
observations are also the same and from

332
00:14:48,140 --> 00:14:45,660
october 99s over 13 years ago and and

333
00:14:51,140 --> 00:14:48,150
the other two sets of observations and

334
00:14:53,600 --> 00:14:51,150
for taking mini ROK bar was closed

335
00:14:55,370 --> 00:14:53,610
Jupiter whereas in december two thousand

336
00:14:58,160 --> 00:14:55,380
twelve where the detection was made

337
00:15:01,070 --> 00:14:58,170
europa was further away from Jupiter so

338
00:15:03,140 --> 00:15:01,080

we had this idea that did the relative

339
00:15:05,920 --> 00:15:03,150
distance or the position of European its

340
00:15:08,840 --> 00:15:05,930
elliptical orbit and is connected to the

341
00:15:11,720 --> 00:15:08,850
m2 these two the existence or to the

342
00:15:12,560 --> 00:15:11,730
activity of the plumes based on these

343
00:15:14,540 --> 00:15:12,570
three

344
00:15:18,440 --> 00:15:14,550
observations that's not a good statistic

345
00:15:21,590 --> 00:15:18,450
with three data points but another clue

346
00:15:23,630 --> 00:15:21,600
was that the plumes of this saturn's

347
00:15:27,050 --> 00:15:23,640
moon enceladus you haven't mentioned

348
00:15:28,970 --> 00:15:27,060
earlier and there and we have seen so

349
00:15:30,470 --> 00:15:28,980
Cassini has taken a lot of images and we

350
00:15:32,960 --> 00:15:30,480
know that there is this connection that

351
00:15:35,420 --> 00:15:32,970
when telus is further away from say turn

352
00:15:38,570 --> 00:15:35,430
the plumes are more active and when it's

353
00:15:40,340 --> 00:15:38,580
closer to say turn and then they are

354
00:15:42,560 --> 00:15:40,350
less active so we had the idea that the

355
00:15:44,900 --> 00:15:42,570
same thing is happening it at Europa

356
00:15:48,050 --> 00:15:44,910
there and what we don't have any proof

357
00:15:51,530 --> 00:15:48,060
and for the Adsense and we only had two

358
00:15:54,500 --> 00:15:51,540
three data points okay you are kima how

359
00:15:59,780 --> 00:15:54,510
how did you know when you took this data

360
00:16:03,550 --> 00:15:59,790
that you were looking at water vapor the

361
00:16:06,590 --> 00:16:03,560
like we saw oxygen lines and we saw

362
00:16:10,220 --> 00:16:06,600
hydrogen line to the hype one the

363
00:16:13,670 --> 00:16:10,230

lyman-alpha of hydrogen and the emission

364
00:16:17,540 --> 00:16:13,680
was in a race you such as that electron

365
00:16:21,160 --> 00:16:17,550
break water molecules apart and because

366
00:16:23,990 --> 00:16:21,170
the service anyway consists out of water

367
00:16:27,830 --> 00:16:24,000
so what is the primary molecule that's

368
00:16:30,230 --> 00:16:27,840
around and and because we only saw it as

369
00:16:32,060 --> 00:16:30,240
a Pecha the South Pole needed to be blue

370
00:16:35,540 --> 00:16:32,070
but the ratio of the hydrogen and the

371
00:16:38,750 --> 00:16:35,550
oxygen emission lines that told us it

372
00:16:42,560 --> 00:16:38,760
needs to be watered it and broken up can

373
00:16:44,600 --> 00:16:42,570
you tell us how in in particular

374
00:16:46,940 --> 00:16:44,610
observations and you can pick you know

375
00:16:51,650 --> 00:16:46,950
whether December or the other the other

376
00:16:55,970 --> 00:16:51,660
time how high are these things how big

377
00:16:58,760 --> 00:16:55,980
were they it it's based on our

378
00:17:01,100 --> 00:16:58,770
calculation day of roughly 200 they rise

379
00:17:05,810 --> 00:17:01,110
up 200 kilometers above the surface oh

380
00:17:08,510 --> 00:17:05,820
wow ah nice uh well that's not so

381
00:17:10,490 --> 00:17:08,520
surprising it Europa because because

382
00:17:12,650 --> 00:17:10,500
gravity is much smaller stand up guys

383
00:17:14,660 --> 00:17:12,660
here on the earth doesn't make it 200

384
00:17:17,060 --> 00:17:14,670
kilometers because gravity on the earth

385
00:17:19,429 --> 00:17:17,070
is much stronger than gravity on Europa

386
00:17:21,470 --> 00:17:19,439
and I'm sure the tidal forces with

387
00:17:24,380 --> 00:17:21,480
Jupiter they're much stronger on that

388
00:17:25,429 --> 00:17:24,390

less massive planetary body too so that

389
00:17:28,100 --> 00:17:25,439
I would have a

390
00:17:30,230 --> 00:17:28,110
larger effect on it right yes that's to

391
00:17:32,269 --> 00:17:30,240
end anyway the moon is so much closer to

392
00:17:34,759 --> 00:17:32,279
Jupiter there and like for example like

393
00:17:36,529 --> 00:17:34,769
the earth-moon that creates the the

394
00:17:39,110 --> 00:17:36,539
tidal forces on the earth is even like

395
00:17:41,539 --> 00:17:39,120
the distance and the mazes are so much

396
00:17:46,070 --> 00:17:41,549
more in favor of being strong at Europa

397
00:17:47,600 --> 00:17:46,080
and the and I i was reading the press

398
00:17:49,669 --> 00:17:47,610
release earlier and i was and it was

399
00:17:54,310 --> 00:17:49,679
being compared to the plumes around

400
00:17:56,899 --> 00:17:54,320
Saturn's moon Enceladus do you are they

401
00:18:00,129 --> 00:17:56,909
are they roughly the same the roughly

402
00:18:02,919 --> 00:18:00,139
the same size and characteristics as

403
00:18:09,200 --> 00:18:02,929
what was seen in as what was seen on

404
00:18:10,580 --> 00:18:09,210
Enceladus yep into to some extent yeah

405
00:18:12,200 --> 00:18:10,590
roughly they are roughly the same size

406
00:18:14,779 --> 00:18:12,210
that's correct but there's a key

407
00:18:17,360 --> 00:18:14,789
difference intelligence is even less

408
00:18:19,999 --> 00:18:17,370
messy than you Europa so so the glooms

409
00:18:22,279 --> 00:18:20,009
actually at Enceladus are not really

410
00:18:25,369 --> 00:18:22,289
stopped by the gravity so they just keep

411
00:18:27,169 --> 00:18:25,379
going and they they leave a lot of the

412
00:18:29,360 --> 00:18:27,179
mayors of Enceladus just leaves

413
00:18:32,450 --> 00:18:29,370

intelligence because gravity cannot hold

414
00:18:35,060 --> 00:18:32,460
it well on Europa that's more massive

415
00:18:41,720 --> 00:18:35,070
body so the border plumes the stock

416
00:18:44,180 --> 00:18:41,730
falls back on Europa okay uh Kurt when

417
00:18:46,460 --> 00:18:44,190
you first saw this come on now this had

418
00:18:47,539 --> 00:18:46,470
to be in a big deal I mean I i I've when

419
00:18:49,460 --> 00:18:47,549
I first read about the press release

420
00:18:53,419 --> 00:18:49,470
earlier the earlier I guess is late last

421
00:18:55,039 --> 00:18:53,429
year the thought this was huge new so

422
00:18:58,190 --> 00:18:55,049
what did you think when you saw these

423
00:19:00,169 --> 00:18:58,200
planes coming up well we had hints of

424
00:19:03,110 --> 00:19:00,179
something interesting going on and some

425
00:19:05,360 --> 00:19:03,120
data that document published using a

426
00:19:07,700 --> 00:19:05,370
different instrument on Ebola called the

427
00:19:09,649 --> 00:19:07,710
ACS and solely enhance camera for

428
00:19:12,129 --> 00:19:09,659
surveys the fans camper service yes and

429
00:19:15,019 --> 00:19:12,139
we use the other ultraviolet wavelengths

430
00:19:16,730 --> 00:19:15,029
again to look for oxygen emissions and

431
00:19:17,840 --> 00:19:16,740
we thought we saw a little bump a hint

432
00:19:20,779 --> 00:19:17,850
or something that wasn't really well

433
00:19:23,749 --> 00:19:20,789
explained by I things on but so we

434
00:19:25,100 --> 00:19:23,759
really did dedicate a observing proposal

435
00:19:27,799 --> 00:19:25,110
to hobble to look for something

436
00:19:30,409 --> 00:19:27,809
specifically but we thought we'd see the

437
00:19:33,830 --> 00:19:30,419
plume maybe on the disk of Europa book

438
00:19:36,409 --> 00:19:33,840

when Lauren's show me the data that he

439
00:19:39,410 --> 00:19:36,419
published you know and there was this

440
00:19:43,100 --> 00:19:39,420
awful inhibition of this hydrogen

441
00:19:44,690 --> 00:19:43,110
Adam brightness it was just very bright

442
00:19:46,820 --> 00:19:44,700
compared to things that we've seen a tie

443
00:19:50,060 --> 00:19:46,830
on Ganymede before six hundred raley's

444
00:19:52,160 --> 00:19:50,070
versus of two hundred raleys or 100

445
00:19:53,720 --> 00:19:52,170
raley's of the oxygen show but that's

446
00:19:55,610 --> 00:19:53,730
just a science unit for brightness the

447
00:19:57,980 --> 00:19:55,620
higher the number the brighter so in

448
00:19:59,540 --> 00:19:57,990
your thin rate we had a good feel for

449
00:20:04,100 --> 00:19:59,550
what the brightness is told this in

450
00:20:06,650 --> 00:20:04,110
terms of a sort of how big this was and

451
00:20:08,810 --> 00:20:06,660
yeah that was a big deal and I sort of

452
00:20:11,150 --> 00:20:08,820
blinked twice and said boy yeah Lawrence

453
00:20:12,830 --> 00:20:11,160
we gotta sit down jackman really work

454
00:20:14,450 --> 00:20:12,840
out the statistics on this make sure

455
00:20:18,350 --> 00:20:14,460
this is right because this really would

456
00:20:19,910 --> 00:20:18,360
have big implications and turn off every

457
00:20:21,860 --> 00:20:19,920
explanation that we came up with in our

458
00:20:23,240 --> 00:20:21,870
own mind for how this data worked kept

459
00:20:26,480 --> 00:20:23,250
pointing back to plumes made the best

460
00:20:29,660 --> 00:20:26,490
explanation so I did have a question um

461
00:20:32,030 --> 00:20:29,670
I wanted to eat you to clarify exactly

462
00:20:35,900 --> 00:20:32,040
how the observation was taken so how

463
00:20:40,070 --> 00:20:35,910

much of the disk did you get in a single

464
00:20:42,020 --> 00:20:40,080
observation okay so Lawrence briefly

465
00:20:43,910 --> 00:20:42,030
described how we use a long slit

466
00:20:46,270 --> 00:20:43,920
spectrograph right to attend

467
00:20:48,440 --> 00:20:46,280
observations in Europa's disk filled up

468
00:20:51,140 --> 00:20:48,450
half of that slip with so we basically

469
00:20:53,360 --> 00:20:51,150
had to Europa radii from the center of

470
00:20:55,340 --> 00:20:53,370
that slit great event that you saw on

471
00:20:56,960 --> 00:20:55,350
the website maybe can bring it up again

472
00:20:59,480 --> 00:20:56,970
what you see is pretty much what we got

473
00:21:00,830 --> 00:20:59,490
or we have other slides too and all the

474
00:21:02,840 --> 00:21:00,840
pixels that you see on these images

475
00:21:05,120 --> 00:21:02,850
showed with the full extent of what

476
00:21:06,380 --> 00:21:05,130
we're looking at um that's pretty much

477
00:21:08,840 --> 00:21:06,390
the view that Hubble had right there

478
00:21:10,460 --> 00:21:08,850
that width across Europe okay so we

479
00:21:14,780 --> 00:21:10,470
didn't have to scan across it anything

480
00:21:17,870 --> 00:21:14,790
like that we got it all in one view we

481
00:21:21,350 --> 00:21:17,880
had to to do five hub orbits in a row to

482
00:21:26,690 --> 00:21:21,360
build up our signals noise but uh yeah

483
00:21:28,430 --> 00:21:26,700
we do have that same time so I see some

484
00:21:31,460 --> 00:21:28,440
other data up here maybe Lawrence wants

485
00:21:35,200 --> 00:21:31,470
to talk us through this one at a time

486
00:21:37,310 --> 00:21:35,210
when you go one slide or back to the

487
00:21:43,550 --> 00:21:37,320
spectral image it's a couple of flights

488
00:21:46,280 --> 00:21:43,560

earlier and Sonia it even one more yeah

489
00:21:49,510 --> 00:21:46,290
this one so that's if you probably need

490
00:21:53,360 --> 00:21:49,520
to zoom in here that's you can see like

491
00:21:56,360 --> 00:21:53,370
it's an image of Europa and in these

492
00:21:59,210 --> 00:21:56,370
yellow boxes here and we do get an image

493
00:22:01,880 --> 00:21:59,220
at the hydrogen lyman-alpha line that's

494
00:22:03,590 --> 00:22:01,890
the leftmost box here and at a sign at

495
00:22:06,890 --> 00:22:03,600
the same time we do get an image to

496
00:22:09,350 --> 00:22:06,900
oxygen lines to different wavelengths

497
00:22:11,630 --> 00:22:09,360
and so we have three images taken at the

498
00:22:13,850 --> 00:22:11,640
same time and then we compared the

499
00:22:16,130 --> 00:22:13,860
brightness and did this spatial

500
00:22:19,070 --> 00:22:16,140
distribution of the emissions in these

501
00:22:23,120 --> 00:22:19,080
images and what we did see is that the

502
00:22:25,970 --> 00:22:23,130
same location emissions showed up in the

503
00:22:27,380 --> 00:22:25,980
hydrogen image and in the one of one of

504
00:22:29,690 --> 00:22:27,390
the oxygen images but not in the other

505
00:22:32,930 --> 00:22:29,700
one and this is this particular ratio

506
00:22:35,530 --> 00:22:32,940
and it's kind of an indication for and

507
00:22:38,960 --> 00:22:35,540
that water isn't involved in the process

508
00:22:42,740 --> 00:22:38,970
so the way the spectrum works for an

509
00:22:46,700 --> 00:22:42,750
imaging spectrograph is if the object in

510
00:22:49,640 --> 00:22:46,710
Europa in this case was emitting sort of

511
00:22:52,130 --> 00:22:49,650
uniformly or in a continuous manner you

512
00:22:55,190 --> 00:22:52,140
would just see a smear like you do off

513
00:22:58,700 --> 00:22:55,200

to the right of the blue band but

514
00:23:01,100 --> 00:22:58,710
because it's specifically emitting or

515
00:23:04,580 --> 00:23:01,110
oxygen and hydrogen are then you get a

516
00:23:07,040 --> 00:23:04,590
brighter disk and so that is the picture

517
00:23:09,799 --> 00:23:07,050
if you will of Europa and hydrogen and

518
00:23:12,500 --> 00:23:09,809
then in oxygen and then the other smooth

519
00:23:22,700 --> 00:23:12,510
emission that it has as it shines

520
00:23:29,750 --> 00:23:26,210
in my back can you hear me yes I'm

521
00:23:31,820 --> 00:23:29,760
really sorry folks I am having isp

522
00:23:34,130 --> 00:23:31,830
problems I can't apologize enough I

523
00:23:36,139 --> 00:23:34,140
really I'm a dropout I don't I can't

524
00:23:37,760 --> 00:23:36,149
understand what the stability issues of

525
00:23:41,810 --> 00:23:37,770
are here but they're not great so my

526
00:23:43,430 --> 00:23:41,820
apologies so I'm not quite sure I saw

527
00:23:45,710 --> 00:23:43,440
the spectra there and I guess I was that

528
00:23:47,090 --> 00:23:45,720
was explaining a little bit about how

529
00:23:53,120 --> 00:23:47,100
you do what you were looking at was

530
00:23:55,399 --> 00:23:53,130
water vapor and it was the water is are

531
00:23:58,970 --> 00:23:55,409
we sure that there is water underneath

532
00:24:01,010 --> 00:23:58,980
the crust anybody anybody have any I

533
00:24:03,080 --> 00:24:01,020
mean how sure are we that there are

534
00:24:05,529 --> 00:24:03,090
there there's water vapor or water

535
00:24:11,330 --> 00:24:05,539
liquid water underneath the cross there

536
00:24:13,220 --> 00:24:11,340
Kurt well I'm no expert on the internal

537
00:24:14,480 --> 00:24:13,230
geophysics of things but the Galileo

538
00:24:18,110 --> 00:24:14,490

mission really did give us a lot of

539
00:24:20,600 --> 00:24:18,120
insights into both the inner workings of

540
00:24:23,299 --> 00:24:20,610
the satellite and also surface features

541
00:24:25,279 --> 00:24:23,309
that hinted to his previous activity

542
00:24:26,899 --> 00:24:25,289
whether its current activity or not just

543
00:24:29,269 --> 00:24:26,909
the way the terrain looks like it just

544
00:24:31,610 --> 00:24:29,279
one features stood out from other

545
00:24:33,710 --> 00:24:31,620
features and having sort of a liquid a

546
00:24:35,750 --> 00:24:33,720
sort of process underneath I shall

547
00:24:39,950 --> 00:24:35,760
provide a good explanations for that and

548
00:24:42,799 --> 00:24:39,960
so I think everyone had really good

549
00:24:44,269 --> 00:24:42,809
circumstantial evidence for a subsurface

550
00:24:47,210 --> 00:24:44,279
ocean there was also a magnetometer

551
00:24:50,840 --> 00:24:47,220
experiment that saw the induced field

552
00:24:53,810 --> 00:24:50,850
change around Europa based on internal

553
00:24:57,110 --> 00:24:53,820
currents of salty water as magnetic

554
00:24:58,850 --> 00:24:57,120
field around Jupiter around so lots of

555
00:25:01,549 --> 00:24:58,860
things that working director to get into

556
00:25:03,440 --> 00:25:01,559
the subsurface but these plumes I think

557
00:25:06,370 --> 00:25:03,450
really excited everybody and maybe

558
00:25:09,320 --> 00:25:06,380
crystallized this idea of subsurface of

559
00:25:11,600 --> 00:25:09,330
liquid regions on Europa people's minds

560
00:25:13,010 --> 00:25:11,610
and you know if and when these plumes

561
00:25:16,639 --> 00:25:13,020
are confirmed by subsequent observations

562
00:25:20,180 --> 00:25:16,649
I think that'll be a real confirming

563
00:25:21,430 --> 00:25:20,190

aspect of global ocean ideas now whether

564
00:25:23,419 --> 00:25:21,440
the water we're seeing is actually

565
00:25:25,310 --> 00:25:23,429
connected all the way down to some

566
00:25:27,799 --> 00:25:25,320
subsurface ocean kilometers down or

567
00:25:29,600 --> 00:25:27,809
maybe just in a little subsurface lake

568
00:25:31,580 --> 00:25:29,610
trapped within an ice layer a little

569
00:25:33,799 --> 00:25:31,590
build lens within the ice shell or not

570
00:25:36,440 --> 00:25:33,809
something that will really only get to

571
00:25:38,480 --> 00:25:36,450
know what's future mission well what

572
00:25:41,900 --> 00:25:38,490
are there any are there any plans to

573
00:25:44,630 --> 00:25:41,910
send something out to to look at this to

574
00:25:47,570 --> 00:25:44,640
investigate this closer yes there are

575
00:25:49,790 --> 00:25:47,580
one mission called chuse the jupiter icy

576
00:25:52,280 --> 00:25:49,800
moon Explorer mission is being led by

577
00:25:54,290 --> 00:25:52,290
isa its alternate destiny is order on

578
00:25:56,480 --> 00:25:54,300
Ganymede but it will do to fly bys

579
00:25:58,850 --> 00:25:56,490
around Europa and try to address some of

580
00:26:01,430 --> 00:25:58,860
these goals but just very recently if

581
00:26:03,830 --> 00:26:01,440
winds not going to happen uh it's going

582
00:26:06,440 --> 00:26:03,840
to launch in 2020 you know won't really

583
00:26:10,040 --> 00:26:06,450
get till to Jupiter until 2030 so this

584
00:26:12,050 --> 00:26:10,050
is a long-duration mission a long time

585
00:26:16,430 --> 00:26:12,060
delayed gratification type of process

586
00:26:18,050 --> 00:26:16,440
here thank you son but also some of this

587
00:26:21,320 --> 00:26:18,060
excitement about the plume discovery we

588
00:26:24,710 --> 00:26:21,330

have has helped take an idea to put a

589
00:26:28,040 --> 00:26:24,720
real fluid mission for NASA back on to

590
00:26:30,440 --> 00:26:28,050
the budget books and we've had de kado

591
00:26:32,030 --> 00:26:30,450
survey after taquito survey I they make

592
00:26:33,710 --> 00:26:32,040
this meal for science go study these

593
00:26:37,790 --> 00:26:33,720
questions about the or propulsion work

594
00:26:39,200 --> 00:26:37,800
or not and it's just seemed to be enough

595
00:26:40,880 --> 00:26:39,210
money in the budget make it happen right

596
00:26:44,000 --> 00:26:40,890
now there's an instrument called but the

597
00:26:45,140 --> 00:26:44,010
poles is out to do group of payload

598
00:26:49,430 --> 00:26:45,150
instruments to go and address the

599
00:26:51,620 --> 00:26:49,440
science goals that we are really unravel

600
00:26:53,960 --> 00:26:51,630
all these questions about Europa that we

601
00:26:55,310 --> 00:26:53,970
have now and vault really rolling on

602
00:26:58,490 --> 00:26:55,320
this NASA mission out so we're all

603
00:27:02,600 --> 00:26:58,500
really excited oh that's great so are

604
00:27:04,130 --> 00:27:02,610
you guys planning on looking at yo Keem

605
00:27:05,510 --> 00:27:04,140
Alaska's to you are you planning on

606
00:27:08,750 --> 00:27:05,520
looking at Europa any more in the future

607
00:27:11,660 --> 00:27:08,760
oh maybe you should give that to

608
00:27:14,690 --> 00:27:11,670
Lawrence like the reason sorry I was the

609
00:27:16,910 --> 00:27:14,700
p.i on the first two campaigns that to

610
00:27:20,500 --> 00:27:16,920
up to it now Lauren's took over it now

611
00:27:23,210 --> 00:27:20,510
Lawrence's is the p.i on the next huge

612
00:27:25,250 --> 00:27:23,220
campaign that we're looking at all so he

613
00:27:29,540 --> 00:27:25,260

can told you you know that okay so

614
00:27:32,990 --> 00:27:29,550
Lawrence yes so we and we already had

615
00:27:35,560 --> 00:27:33,000
like em follow-up observations after the

616
00:27:39,410 --> 00:27:35,570
initial detection early this year and

617
00:27:41,480 --> 00:27:39,420
but they could not confirm the initial

618
00:27:44,750 --> 00:27:41,490
detection basically I mean it's it's

619
00:27:46,790 --> 00:27:44,760
it's it's never really said that like

620
00:27:49,010 --> 00:27:46,800
Kurt said before that there's no plumes

621
00:27:49,970 --> 00:27:49,020
it's just we don't see you don't haven't

622
00:27:52,180 --> 00:27:49,980
seen them

623
00:27:54,140 --> 00:27:52,190
these follow-up observations so to

624
00:27:58,190 --> 00:27:54,150
follow observation didn't bring

625
00:28:00,560 --> 00:27:58,200
confirmation and but on the other way

626
00:28:04,610 --> 00:28:00,570
they they also do not exclude it all

627
00:28:06,740 --> 00:28:04,620
that there's plumes and um so we're

628
00:28:09,200 --> 00:28:06,750
still looking for confirmation of these

629
00:28:12,409 --> 00:28:09,210
booms and in a possible way and I think

630
00:28:14,240 --> 00:28:12,419
other people are too and so we will also

631
00:28:16,700 --> 00:28:14,250
have observations with the same

632
00:28:18,680 --> 00:28:16,710
technique basically we just detected two

633
00:28:21,409 --> 00:28:18,690
blooms in the next Hubble cycle so

634
00:28:25,070 --> 00:28:21,419
starting this fall and then going on and

635
00:28:27,740 --> 00:28:25,080
until early next next year and we'll try

636
00:28:29,680 --> 00:28:27,750
a couple of times again and the same

637
00:28:33,230 --> 00:28:29,690
technique to see the plums again oh

638
00:28:35,000 --> 00:28:33,240

great so the so we've got more

639
00:28:36,590 --> 00:28:35,010
observations coming up there are other

640
00:28:39,830 --> 00:28:36,600
people are confirming once you've got

641
00:28:45,500 --> 00:28:39,840
let's talk a little bit about whether or

642
00:28:48,770 --> 00:28:45,510
not the this does this do you gives us

643
00:28:50,450 --> 00:28:48,780
more motivation to not only back and

644
00:28:51,890 --> 00:28:50,460
look for for water there but what are

645
00:28:54,950 --> 00:28:51,900
the implications do you think Lauren's

646
00:28:56,930 --> 00:28:54,960
analysis you three for the chance of

647
00:28:59,360 --> 00:28:56,940
life in the solar system now I know this

648
00:29:00,470 --> 00:28:59,370
is a that's a speculative thing but but

649
00:29:02,060 --> 00:29:00,480
you know what are your you have an

650
00:29:04,970 --> 00:29:02,070
opinion on what this might mean for that

651
00:29:09,830 --> 00:29:04,980
i mean i would i would say it doesn't

652
00:29:11,960 --> 00:29:09,840
have any implications for for life on

653
00:29:13,430 --> 00:29:11,970
Europa just the existence of blooms

654
00:29:16,700 --> 00:29:13,440
doesn't have any implications because

655
00:29:20,090 --> 00:29:16,710
they're not I mean it's just they

656
00:29:22,490 --> 00:29:20,100
potentially give us a way and to probe

657
00:29:25,010 --> 00:29:22,500
the subsurface an environment of

658
00:29:27,710 --> 00:29:25,020
Europa's subsurface ocean subsurface

659
00:29:29,659 --> 00:29:27,720
lakes because if they are and connected

660
00:29:31,640 --> 00:29:29,669
to a subsurface lake you could think of

661
00:29:34,690 --> 00:29:31,650
a spacecraft flying through the plume

662
00:29:37,610 --> 00:29:34,700
measuring particles or just orbiting and

663
00:29:39,380 --> 00:29:37,620

euro per and observing to come from

664
00:29:42,049 --> 00:29:39,390
nearby and getting an idea of the

665
00:29:44,810 --> 00:29:42,059
composition and off the clothes and

666
00:29:47,570 --> 00:29:44,820
thereby after the subsurface and since

667
00:29:49,970 --> 00:29:47,580
like this the subsurface liquid

668
00:29:53,120 --> 00:29:49,980
environment and might be habitable so

669
00:29:56,390 --> 00:29:53,130
might Harbor life cannot exclude this

670
00:29:58,039 --> 00:29:56,400
and the plumes might allow us to check

671
00:30:01,100 --> 00:29:58,049
this and much easier than we thought

672
00:30:02,840 --> 00:30:01,110
before Scott had a comment up but I

673
00:30:03,860 --> 00:30:02,850
don't know if it got shown but it's from

674
00:30:06,530 --> 00:30:03,870
YouTube thank you for doing that

675
00:30:08,600 --> 00:30:06,540
god it's auto raag 134 from youtube goes

676
00:30:12,620 --> 00:30:08,610
if there is liquid water there is life

677
00:30:15,200 --> 00:30:12,630
well period okay it should be our

678
00:30:16,850 --> 00:30:15,210
highest priority mission and then he

679
00:30:18,020 --> 00:30:16,860
also goes on the state to a I think it

680
00:30:20,630 --> 00:30:18,030
got cut off in there because it why

681
00:30:22,220 --> 00:30:20,640
don't we fly a crap through a plume and

682
00:30:25,670 --> 00:30:22,230
look for life so you kind of touched on

683
00:30:27,410 --> 00:30:25,680
line already but is there any plans for

684
00:30:29,630 --> 00:30:27,420
that and what would what would they be

685
00:30:32,450 --> 00:30:29,640
looking for if they are if we're flying

686
00:30:33,950 --> 00:30:32,460
a spacecraft through a plume what sort

687
00:30:35,720 --> 00:30:33,960
of instruments but we have to have on

688
00:30:40,630 --> 00:30:35,730

there to be looking for these signs of

689
00:30:42,710 --> 00:30:40,640
life I'll answer that we have a

690
00:30:45,350 --> 00:30:42,720
instruments called the mass

691
00:30:48,350 --> 00:30:45,360
spectrometers that can take an atom or

692
00:30:50,480 --> 00:30:48,360
molecule into a chamber and measure it

693
00:30:53,000 --> 00:30:50,490
Friday different ways to understand by

694
00:30:54,650 --> 00:30:53,010
to mass mostly which constituent looking

695
00:30:57,230 --> 00:30:54,660
at if you look at a periodic table of

696
00:30:59,630 --> 00:30:57,240
elements just know by the mass this

697
00:31:02,750 --> 00:30:59,640
community what species you're looking at

698
00:31:04,610 --> 00:31:02,760
then measured abundances that way and so

699
00:31:06,980 --> 00:31:04,620
water vapor is going to be the main

700
00:31:09,950 --> 00:31:06,990
thing coming out at at assess we fly

701
00:31:12,740 --> 00:31:09,960
through these poon but uh as we found on

702
00:31:14,890 --> 00:31:12,750
Enceladus 108 here in Southwest Research

703
00:31:17,360 --> 00:31:14,900
pneus to Lisa's experiment actually

704
00:31:20,540 --> 00:31:17,370
there are other species of interest like

705
00:31:23,150 --> 00:31:20,550
ammonia carbon monoxide and other types

706
00:31:25,130 --> 00:31:23,160
of hydrocarbons to already known to be a

707
00:31:27,440 --> 00:31:25,140
solid plan so that's the kind of thing

708
00:31:29,419 --> 00:31:27,450
that we look at coming out of Europa as

709
00:31:30,680 --> 00:31:29,429
well but the composition might be a

710
00:31:32,660 --> 00:31:30,690
little different just based on the

711
00:31:35,299 --> 00:31:32,670
chemistry of Europa's ocean compared to

712
00:31:38,210 --> 00:31:35,309
that of the solidus justice last year

713
00:31:40,960 --> 00:31:38,220

and solidus was known to have a really

714
00:31:44,840 --> 00:31:40,970
extended subjects oceans well that's a

715
00:31:47,750 --> 00:31:44,850
good so Tom Snyder Q&A app is asking

716
00:31:52,600 --> 00:31:47,760
does the water vapor remain in the Rose

717
00:32:00,730 --> 00:31:56,930
Lorenz in the am yeah so that's that's

718
00:32:03,770 --> 00:32:00,740
to do with it gravitation at Europa and

719
00:32:06,010 --> 00:32:03,780
also like the altitude we we kind of

720
00:32:08,930 --> 00:32:06,020
estimate for the plumes and and

721
00:32:10,790 --> 00:32:08,940
particles need a speed of about two

722
00:32:14,180 --> 00:32:10,800
kilometers per second to leave the

723
00:32:17,000 --> 00:32:14,190
gravity field of Europa and then from

724
00:32:17,360 --> 00:32:17,010
what we see we think that particles as a

725
00:32:19,250 --> 00:32:17,370
low

726
00:32:22,010 --> 00:32:19,260
or speed so they cannot leave the

727
00:32:23,270 --> 00:32:22,020
gravity field of Europa or most of them

728
00:32:26,960 --> 00:32:23,280
like probably more than ninety percent

729
00:32:28,730 --> 00:32:26,970
will fall back to the surface and as the

730
00:32:34,490 --> 00:32:28,740
surface temperatures are allowed about

731
00:32:36,700 --> 00:32:34,500
like 100 m 130 kelvin so clearly below

732
00:32:39,980 --> 00:32:36,710
freezing these these water molecules

733
00:32:44,270 --> 00:32:39,990
will freeze immediately and stick to the

734
00:32:46,850 --> 00:32:44,280
surface so and yeah okay alright so i

735
00:32:50,630 --> 00:32:46,860
can imagine depending on the the tidal

736
00:32:52,700 --> 00:32:50,640
forces that Europa is under one could

737
00:32:55,870 --> 00:32:52,710
imagine that i don't know i imagine that

738
00:32:58,820 --> 00:32:55,880

the source of energy for that keeps this

739
00:33:01,070 --> 00:32:58,830
if the keeps the water liquid would be

740
00:33:05,770 --> 00:33:01,080
from this this tidal heat correct or am

741
00:33:08,450 --> 00:33:05,780
I am I completely not understanding the

742
00:33:11,270 --> 00:33:08,460
characteristics of Europa wouldn't it

743
00:33:14,990 --> 00:33:11,280
need this sort of this tidal friction to

744
00:33:18,410 --> 00:33:15,000
keep the water liquid yes that's correct

745
00:33:21,290 --> 00:33:18,420
okay so if that's true then it's

746
00:33:22,730 --> 00:33:21,300
possible that it could be pockets of

747
00:33:25,640 --> 00:33:22,740
water here and there and not necessarily

748
00:33:27,470 --> 00:33:25,650
uniform all the way around the plan or

749
00:33:30,440 --> 00:33:27,480
around the moon so we might have just

750
00:33:32,810 --> 00:33:30,450
small areas where water might be but

751
00:33:37,310 --> 00:33:32,820
other areas where you know it's still

752
00:33:39,919 --> 00:33:37,320
ice all the way down correct only for

753
00:33:42,650 --> 00:33:39,929
the part that connects to space I think

754
00:33:44,330 --> 00:33:42,660
consensus is is that the the global I

755
00:33:46,130 --> 00:33:44,340
mean the subsurface ocean would be a

756
00:33:48,710 --> 00:33:46,140
global one just based on the dynamics of

757
00:33:51,200 --> 00:33:48,720
the data that was sent back from Galileo

758
00:33:52,760 --> 00:33:51,210
now from would you agree to that yeah

759
00:33:54,500 --> 00:33:52,770
yeah exactly i think that needs to be

760
00:33:57,440 --> 00:33:54,510
separated there's very strong evidence

761
00:34:00,980 --> 00:33:57,450
that there is this global subsurface

762
00:34:03,890 --> 00:34:00,990
ocean okay we've already and that comes

763
00:34:06,049 --> 00:34:03,900

from the geology of the surface that can

764
00:34:08,180 --> 00:34:06,059
only be reasonably explained like if

765
00:34:11,899 --> 00:34:08,190
there is an ocean because if there's an

766
00:34:15,110 --> 00:34:11,909
ocean the tides are much stronger and so

767
00:34:17,750 --> 00:34:15,120
that allows to give to make the cracks

768
00:34:19,940 --> 00:34:17,760
on the surface and at the same time the

769
00:34:22,340 --> 00:34:19,950
magnetometer has measured magnetic field

770
00:34:26,000 --> 00:34:22,350
anomalies which only really can be

771
00:34:29,419 --> 00:34:26,010
explained with the global ocean I say

772
00:34:30,700 --> 00:34:29,429
okay so the I I want to point out real

773
00:34:33,609 --> 00:34:30,710
quick that Judy Schmidt is common

774
00:34:35,889 --> 00:34:33,619
on the Q&A app in celle des is much

775
00:34:37,930 --> 00:34:35,899
smaller than Europa and there is a great

776
00:34:40,119 --> 00:34:37,940
a pod astronomy picture of the day

777
00:34:42,040 --> 00:34:40,129
coming up to show this tomorrow so thank

778
00:34:44,320 --> 00:34:42,050
you Judy oh I will think so keep on look

779
00:34:45,579 --> 00:34:44,330
at that's it that's the Astronomy

780
00:34:46,629 --> 00:34:45,589
Picture of the Day it's a great thing if

781
00:34:47,740 --> 00:34:46,639
you haven't subscribed to it and checked

782
00:34:51,070 --> 00:34:47,750
it out every day it's a wonderful thing

783
00:34:54,760 --> 00:34:51,080
to do to look at I I have a question

784
00:34:59,130 --> 00:34:54,770
haha so my question is when you look at

785
00:35:01,660 --> 00:34:59,140
the images that we have from Galileo of

786
00:35:04,570 --> 00:35:01,670
Enceladus and you see some of these very

787
00:35:06,670 --> 00:35:04,580
dark deep what appeared to be you would

788
00:35:10,540 --> 00:35:06,680

might interpret as deep or very long

789
00:35:14,530 --> 00:35:10,550
cracks do we actually have imagery of

790
00:35:17,380 --> 00:35:14,540
the place where you saw the plume do you

791
00:35:21,359 --> 00:35:17,390
know if that's a big crack or what is

792
00:35:25,770 --> 00:35:21,369
actually there since it was so far south

793
00:35:28,630 --> 00:35:25,780
and we do have like to a certain extent

794
00:35:31,780 --> 00:35:28,640
image material of Europa surface and

795
00:35:33,910 --> 00:35:31,790
it's it's covering pretty like the

796
00:35:37,510 --> 00:35:33,920
majority of the surface but at a

797
00:35:39,190 --> 00:35:37,520
different resolutions and so far in

798
00:35:42,430 --> 00:35:39,200
these images from Galileo we have not

799
00:35:45,280 --> 00:35:42,440
put not like correlate a certain and

800
00:35:48,339 --> 00:35:45,290
surface fracture to the plumeria because

801
00:35:49,870 --> 00:35:48,349
one reason is that the the limited

802
00:35:53,020 --> 00:35:49,880
resolution of the Hubble images do not

803
00:35:54,820 --> 00:35:53,030
allow to exactly and locate the club so

804
00:35:57,510 --> 00:35:54,830
we cannot say that like a year at this

805
00:36:00,760 --> 00:35:57,520
longitude and latitude of a surface and

806
00:36:03,130 --> 00:36:00,770
the other thing is that the resolution

807
00:36:05,440 --> 00:36:03,140
of the Galileo images gets worse towards

808
00:36:07,210 --> 00:36:05,450
the poles like the pole yeah we don't

809
00:36:09,130 --> 00:36:07,220
have good resolution in some areas at

810
00:36:14,140 --> 00:36:09,140
the South Pole and that makes it even

811
00:36:17,310 --> 00:36:14,150
more difficult and okay I suspected that

812
00:36:19,660 --> 00:36:17,320
was the case but you know this is a

813
00:36:22,329 --> 00:36:19,670

contrast to acknowledge from solidus

814
00:36:24,310 --> 00:36:22,339
we're with the Cassini mission at Saturn

815
00:36:25,660 --> 00:36:24,320
system they have flown by the South Pole

816
00:36:27,130 --> 00:36:25,670
of Enceladus and taken really

817
00:36:30,070 --> 00:36:27,140
spectacular images of these tiger

818
00:36:32,770 --> 00:36:30,080
stripes someone now it is features to

819
00:36:35,160 --> 00:36:32,780
what we see on Europa perhaps and there

820
00:36:40,960 --> 00:36:35,170
you can really pinpoint where these Jets

821
00:36:43,880 --> 00:36:40,970
favorite filter now ok so I gotta have a

822
00:36:45,799 --> 00:36:43,890
common hear from Joe Beneke from YouTube

823
00:36:47,210 --> 00:36:45,809
who is saying who's asking why is there

824
00:36:50,120 --> 00:36:47,220
so much more talk surrounding Europa

825
00:36:53,029 --> 00:36:50,130
than Enceladus the answer to that is

826
00:36:54,829 --> 00:36:53,039
this this particular hangout is on some

827
00:36:57,769 --> 00:36:54,839
findings of water vapor flumes found

828
00:36:59,870 --> 00:36:57,779
over Europa and that's how we're talking

829
00:37:02,150 --> 00:36:59,880
about it here in this particular one

830
00:37:04,609 --> 00:37:02,160
although we have compared Europa with

831
00:37:07,789 --> 00:37:04,619
the plumes in on Enceladus as well so

832
00:37:10,190 --> 00:37:07,799
that's why we're talking about it i can

833
00:37:13,039 --> 00:37:10,200
add something there only okay if you

834
00:37:15,470 --> 00:37:13,049
think of Enceladus its radius is about

835
00:37:17,420 --> 00:37:15,480
250 kilometers the plumes are seeing are

836
00:37:19,930 --> 00:37:17,430
about 200 kilometers and scale Europe is

837
00:37:22,220 --> 00:37:19,940
just a much much bigger world and as

838
00:37:24,470 --> 00:37:22,230

probably as much water under its

839
00:37:26,569 --> 00:37:24,480
subsurface ice shell as we have here on

840
00:37:29,269 --> 00:37:26,579
earth and so a lot of scientists a lot

841
00:37:31,279 --> 00:37:29,279
of astrobiologists speculate that Europe

842
00:37:33,650 --> 00:37:31,289
is just a more likely place for life to

843
00:37:36,109 --> 00:37:33,660
evolve and has more energy resources for

844
00:37:38,240 --> 00:37:36,119
it to you sort of feed through the

845
00:37:40,279 --> 00:37:38,250
habitable environment and that's not to

846
00:37:43,009 --> 00:37:40,289
say that solidus is an amazing itself I

847
00:37:47,059 --> 00:37:43,019
mean it's a skies are shooting on

848
00:37:49,160 --> 00:37:47,069
several a satellite radii away I think

849
00:37:51,890 --> 00:37:49,170
the bullets really distinct bones but I

850
00:37:53,870 --> 00:37:51,900
think Romeo Third Earth easier to

851
00:37:58,700 --> 00:37:53,880
explore future missions to some extent

852
00:38:00,259 --> 00:37:58,710
and that's what we focus on right so

853
00:38:03,470 --> 00:38:00,269
thank you that was good that was great

854
00:38:05,660 --> 00:38:03,480
so uh I would try and pronounce this

855
00:38:08,059 --> 00:38:05,670
name but I would mess it up so i won't i

856
00:38:10,880 --> 00:38:08,069
won't do that but the this is from

857
00:38:12,529 --> 00:38:10,890
youtube he goes hi all i'm 25 and i

858
00:38:16,009 --> 00:38:12,539
wonder if there's a chance for me to

859
00:38:17,390 --> 00:38:16,019
witness landing probe on Europa i don't

860
00:38:19,509 --> 00:38:17,400
think there's you didn't mention

861
00:38:22,370 --> 00:38:19,519
anything about landing on Europa did you

862
00:38:27,259 --> 00:38:22,380
as far as the future future missions

863
00:38:30,230 --> 00:38:27,269

there was a study recently we're both a

864
00:38:33,289 --> 00:38:30,240
lander an orbiter and a flyby mission

865
00:38:35,120 --> 00:38:33,299
more like a la hora senior they orbit

866
00:38:37,220 --> 00:38:35,130
around Jupiter Saturn but just fly by

867
00:38:39,019 --> 00:38:37,230
the salads and these were all studied

868
00:38:41,930 --> 00:38:39,029
and the lander was determined to be the

869
00:38:44,569 --> 00:38:41,940
hardest one once the three to achieve in

870
00:38:46,009 --> 00:38:44,579
the next decade or so so a lot of what

871
00:38:49,099 --> 00:38:46,019
we want to do with our our next mission

872
00:38:51,579 --> 00:38:49,109
to Europa is to scout out landing sites

873
00:38:55,370 --> 00:38:51,589
for that Lander that would do great song

874
00:38:57,349 --> 00:38:55,380
he's safe to finance a blank spot all

875
00:38:59,150 --> 00:38:57,359
right anybody who ever saw the movie too

876
00:39:05,380 --> 00:38:59,160
he 10 knows that we were warned to stay

877
00:39:11,930 --> 00:39:05,390
away from there so just so you know okay

878
00:39:13,549 --> 00:39:11,940
here I come on up it's maybe all the one

879
00:39:15,559 --> 00:39:13,559
of the reason why there is more talk

880
00:39:20,390 --> 00:39:15,569
about Europa because there's a science

881
00:39:24,670 --> 00:39:20,400
fiction literature on what you know and

882
00:39:27,200 --> 00:39:24,680
then there is your mother report how and

883
00:39:29,539 --> 00:39:27,210
when you get people's imaginations doing

884
00:39:31,009 --> 00:39:29,549
it you tend to be able to get more at

885
00:39:33,799 --> 00:39:31,019
least public's way and people will talk

886
00:39:37,759 --> 00:39:33,809
that's right yes so thank you arthur c

887
00:39:39,380 --> 00:39:37,769
clarke adam synergy from the QA app is

888
00:39:41,120 --> 00:39:39,390

asking am i right to think that the

889
00:39:43,099 --> 00:39:41,130
amount of water in these plumes will

890
00:39:45,019 --> 00:39:43,109
change over time according to the

891
00:39:46,700 --> 00:39:45,029
varying strengths of tidal interactions

892
00:39:47,839 --> 00:39:46,710
with jupiter we touch down that a little

893
00:39:51,170 --> 00:39:47,849
bit but you guys want to comment on that

894
00:39:55,880 --> 00:39:51,180
one more time let's let's go to rents

895
00:39:58,099 --> 00:39:55,890
okay and yes that is that is likely i

896
00:40:00,499 --> 00:39:58,109
mean that's what we think and because we

897
00:40:04,609 --> 00:40:00,509
have not seen the plumes in in all

898
00:40:06,829 --> 00:40:04,619
observations and but we do not know

899
00:40:08,539 --> 00:40:06,839
exactly i mean we just we've seen them

900
00:40:12,079 --> 00:40:08,549
once we have not seen them four times

901
00:40:15,079 --> 00:40:12,089
now and we see a similar phenomenon and

902
00:40:17,420 --> 00:40:15,089
Enceladus and that is variable so it is

903
00:40:20,599 --> 00:40:17,430
very likely that these films are very

904
00:40:23,930 --> 00:40:20,609
over time and another reason is that

905
00:40:25,940 --> 00:40:23,940
they are and a lot of mass is checked it

906
00:40:28,430 --> 00:40:25,950
here and if they were going on for like

907
00:40:29,989 --> 00:40:28,440
decades and hundreds of years and you

908
00:40:32,150 --> 00:40:29,999
would probably see something on the

909
00:40:33,979 --> 00:40:32,160
surface you would see a bright feature

910
00:40:37,309 --> 00:40:33,989
on the surface and we don't we don't see

911
00:40:40,519 --> 00:40:37,319
that so and it's very likely that their

912
00:40:44,359 --> 00:40:40,529
time variable and maybe even going on

913
00:40:46,579 --> 00:40:44,369

and off okay the parts let's also talk

914
00:40:48,890 --> 00:40:46,589
about some things we have and for the

915
00:40:50,630 --> 00:40:48,900
next set puzzle observations and you

916
00:40:52,789 --> 00:40:50,640
know we thought well what if the plumes

917
00:40:54,799 --> 00:40:52,799
on Europa more like balloons on eyewear

918
00:40:56,809 --> 00:40:54,809
the book tunes on earth the volcanoes on

919
00:40:58,519 --> 00:40:56,819
Earth where they turn on and then

920
00:41:00,620 --> 00:40:58,529
they're dormant for a couple years maybe

921
00:41:03,019 --> 00:41:00,630
they just come go with us for a de clé

922
00:41:05,029 --> 00:41:03,029
then then we saw it and solidus got

923
00:41:07,190 --> 00:41:05,039
excited about original so the next set

924
00:41:08,930 --> 00:41:07,200
of observations we had five before one

925
00:41:10,640 --> 00:41:08,940
of which showed something we have about

926
00:41:11,240 --> 00:41:10,650
twenty eight twenty three different

927
00:41:14,600 --> 00:41:11,250
visits

928
00:41:17,030 --> 00:41:14,610
58 different orbits spread across next

929
00:41:19,850 --> 00:41:17,040
even though and we're really going to

930
00:41:21,140 --> 00:41:19,860
try to more robustly search for this

931
00:41:23,030 --> 00:41:21,150
type of variability and get to the

932
00:41:25,730 --> 00:41:23,040
bottom of running through beautiful or

933
00:41:27,020 --> 00:41:25,740
whether it's much Braddock that'll be

934
00:41:30,530 --> 00:41:27,030
great that'll be great information to

935
00:41:33,800 --> 00:41:30,540
have so Jim Jim tier is asking also on

936
00:41:35,720 --> 00:41:33,810
the Q&A app it might be possible that if

937
00:41:38,210 --> 00:41:35,730
there are microorganisms they get shot

938
00:41:40,100 --> 00:41:38,220

into Europa's atmosphere via the plumes

939
00:41:41,540 --> 00:41:40,110
and he's nasty I guess it's a comment

940
00:41:44,600 --> 00:41:41,550
one of the question but like that sort

941
00:41:46,880 --> 00:41:44,610
of alludes to this idea of a little bit

942
00:41:49,040 --> 00:41:46,890
i think on panspermia right i mean one

943
00:41:51,200 --> 00:41:49,050
of the things that these microorganisms

944
00:41:53,270 --> 00:41:51,210
are simple cell life or whatever you

945
00:41:55,100 --> 00:41:53,280
want to call it it might be one way in

946
00:41:57,260 --> 00:41:55,110
which things travel from one planet to

947
00:42:01,430 --> 00:41:57,270
another do you any of you have a comment

948
00:42:04,100 --> 00:42:01,440
on that I think that's pretty far out to

949
00:42:06,160 --> 00:42:04,110
think of that actor oh yeah I want some

950
00:42:10,850 --> 00:42:06,170
europen tardigrades that'd be awesome

951
00:42:13,220 --> 00:42:10,860
don't think that's the case but hey

952
00:42:15,590 --> 00:42:13,230
although you're saying that its water

953
00:42:19,250 --> 00:42:15,600
there water plumes what is the

954
00:42:21,740 --> 00:42:19,260
temperature of this water so they'll

955
00:42:24,770 --> 00:42:21,750
have to like if there is that there they

956
00:42:26,450 --> 00:42:24,780
would have to be extreme of files and I

957
00:42:30,050 --> 00:42:26,460
mean we know that we have extreme the

958
00:42:33,410 --> 00:42:30,060
files that can exist in space like like

959
00:42:35,570 --> 00:42:33,420
tardigrade but like I'm Scott Lewis like

960
00:42:38,390 --> 00:42:35,580
a Scott yell I am pretty extreme to the

961
00:42:43,190 --> 00:42:38,400
max all the time 120 degrees in

962
00:42:45,320 --> 00:42:43,200
September in LA but um yeah I think with

963
00:42:47,600 --> 00:42:45,330

that it would have to be an extreme

964
00:42:48,950 --> 00:42:47,610
about be at least from what we know of

965
00:42:51,710 --> 00:42:48,960
life to exist because we can only

966
00:42:53,540 --> 00:42:51,720
observe life in the place that we see it

967
00:42:55,820 --> 00:42:53,550
which is only here on this planet so far

968
00:42:57,050 --> 00:42:55,830
and it would have to compare to that and

969
00:42:58,940 --> 00:42:57,060
I think that's the biggest thing with

970
00:43:01,340 --> 00:42:58,950
all the astrobiologist I've spoken with

971
00:43:03,560 --> 00:43:01,350
is they're looking base up the only data

972
00:43:07,520 --> 00:43:03,570
set they have which is on this tiny

973
00:43:10,760 --> 00:43:07,530
little planet around a mediocre star in

974
00:43:13,220 --> 00:43:10,770
our galaxy and so what Carol just ask is

975
00:43:14,690 --> 00:43:13,230
related to Ronald inches or comment here

976
00:43:15,890 --> 00:43:14,700
who's going who's asking what kind of

977
00:43:20,300 --> 00:43:15,900
temperatures are involved in these

978
00:43:22,430 --> 00:43:20,310
plumes and atmospheric pressure so what

979
00:43:23,810 --> 00:43:22,440
do you have a sense of that I mean it

980
00:43:25,870 --> 00:43:23,820
would be are you able to find that out

981
00:43:28,130 --> 00:43:25,880
from these up

982
00:43:30,020 --> 00:43:28,140
things like a bastard pressure and

983
00:43:31,550 --> 00:43:30,030
temperature yeah Lawrence you work those

984
00:43:34,010 --> 00:43:31,560
numbers just based on the height that

985
00:43:35,930 --> 00:43:34,020
this water was ejected we knew what its

986
00:43:38,930 --> 00:43:35,940
velocity was and we confer temperature

987
00:43:42,740 --> 00:43:38,940
of what the water was at the event there

988
00:43:44,390 --> 00:43:42,750

knew it was more like 260 Kelvin maybe

989
00:43:47,900 --> 00:43:44,400
10 degrees your freakin comfort

990
00:43:50,930 --> 00:43:47,910
principle to make water and evaporate

991
00:43:53,120 --> 00:43:50,940
you need I mean that in order to be at

992
00:43:56,359 --> 00:43:53,130
least it's a triple point and so you

993
00:43:59,980 --> 00:43:56,369
need temperatures of 270 Kelvin or more

994
00:44:03,020 --> 00:43:59,990
and to get water into the vapor phase

995
00:44:06,260 --> 00:44:03,030
but we can yeah mostly only speculate

996
00:44:08,359 --> 00:44:06,270
what's going on and exactly and what

997
00:44:10,309 --> 00:44:08,369
temperatures so it's it's better

998
00:44:13,339 --> 00:44:10,319
definitely not going to be really hot

999
00:44:15,730 --> 00:44:13,349
there like a thousand degrees or

1000
00:44:19,510 --> 00:44:15,740
something and would we just above the

1001
00:44:22,099 --> 00:44:19,520
treble point probably and just enough

1002
00:44:24,920 --> 00:44:22,109
temperature to to get it into the wiper

1003
00:44:26,359 --> 00:44:24,930
face awesome good question in brothers

1004
00:44:28,609 --> 00:44:26,369
they don't know their watch what do you

1005
00:44:30,800 --> 00:44:28,619
mean by the triple point right that's at

1006
00:44:34,160 --> 00:44:30,810
the point that combination of

1007
00:44:36,770 --> 00:44:34,170
temperature and pressure where water can

1008
00:44:41,210 --> 00:44:36,780
exist in all three states that it can be

1009
00:44:43,940 --> 00:44:41,220
liquid solid or in the gas phase and by

1010
00:44:46,010 --> 00:44:43,950
like infinite infinitely small changes

1011
00:44:49,730 --> 00:44:46,020
of the temperature or pressure you can

1012
00:44:51,970 --> 00:44:49,740
change between the three states and yeah

1013
00:44:55,609 --> 00:44:51,980

that's basically it's a triple point

1014
00:44:58,970 --> 00:44:55,619
okay so where is big oh sorry go ahead

1015
00:45:01,700 --> 00:44:58,980
no go bow it with respect to life life

1016
00:45:03,380 --> 00:45:01,710
is altered earth-like found at places

1017
00:45:04,910 --> 00:45:03,390
where people originally didn't think

1018
00:45:07,670 --> 00:45:04,920
they would find life I mean there's like

1019
00:45:09,920 --> 00:45:07,680
like bacteria live in the deep sea like

1020
00:45:11,180 --> 00:45:09,930
completely separated from from the Sun

1021
00:45:15,280 --> 00:45:11,190
and death and life so called a

1022
00:45:17,870 --> 00:45:15,290
speculation that there is life like

1023
00:45:19,760 --> 00:45:17,880
bacterial microbes like India and what

1024
00:45:22,520 --> 00:45:19,770
what's called Lake Vostok which is the

1025
00:45:25,280 --> 00:45:22,530
sea like under the Antarctica just like

1026
00:45:27,710 --> 00:45:25,290
like three kilometres below the sea ice

1027
00:45:31,430 --> 00:45:27,720
shield off antarctica I said 250

1028
00:45:33,410 --> 00:45:31,440
kilometres long see that sort of similar

1029
00:45:35,230 --> 00:45:33,420
what we expected Europa and these are

1030
00:45:37,790 --> 00:45:35,240
plated like Lake Vostok it's not

1031
00:45:38,510 --> 00:45:37,800
improvement but there are so many places

1032
00:45:40,010 --> 00:45:38,520
at earth

1033
00:45:41,750 --> 00:45:40,020
people I garage we didn't think that

1034
00:45:44,300 --> 00:45:41,760
it's a possibility for life but they

1035
00:45:47,090 --> 00:45:44,310
find it on life on these very extreme

1036
00:45:48,410 --> 00:45:47,100
conditions also on earth yeah now sort

1037
00:45:49,640 --> 00:45:48,420
of her lewd to what Scott was talking

1038
00:45:51,560 --> 00:45:49,650

about with extreme of files you know

1039
00:45:54,370 --> 00:45:51,570
they for we find these weasel these life

1040
00:45:58,220 --> 00:45:54,380
forms and very inhospitable places so

1041
00:46:01,400 --> 00:45:58,230
who knows Andrew planet offer from the

1042
00:46:03,740 --> 00:46:01,410
QA app is making a comment and a

1043
00:46:05,960 --> 00:46:03,750
question does the throwaway society we

1044
00:46:08,360 --> 00:46:05,970
live in produce throwaway spacecraft

1045
00:46:11,060 --> 00:46:08,370
could we make them last much longer by

1046
00:46:12,950 --> 00:46:11,070
refueling or replenishing late into

1047
00:46:15,950 --> 00:46:12,960
their missions with whatever they run

1048
00:46:20,060 --> 00:46:15,960
out of I know that sounds like kind of a

1049
00:46:24,530 --> 00:46:20,070
Carol question made a big announcement

1050
00:46:25,970 --> 00:46:24,540
yesterday yeah so i guess i would say if

1051
00:46:27,980 --> 00:46:25,980
i if i had to comment on that i would

1052
00:46:30,380 --> 00:46:27,990
say you know that it depends on on the

1053
00:46:32,540 --> 00:46:30,390
mission practicalities and and sometimes

1054
00:46:35,000 --> 00:46:32,550
throw away spacecraft are the best way

1055
00:46:37,370 --> 00:46:35,010
to go they really are wow yeah i mean

1056
00:46:39,560 --> 00:46:37,380
let's look for example we were talking

1057
00:46:41,180 --> 00:46:39,570
about lander so we have the Mars rovers

1058
00:46:43,370 --> 00:46:41,190
they were designed for a certain period

1059
00:46:45,080 --> 00:46:43,380
of performance and they actually lasted

1060
00:46:48,440 --> 00:46:45,090
much longer and in that case you use

1061
00:46:50,210 --> 00:46:48,450
solar panels you know how much light is

1062
00:46:52,670 --> 00:46:50,220
going to come from the Sun throughout

1063
00:46:55,760 --> 00:46:52,680

the seasons in Mars and you try to

1064
00:46:59,000 --> 00:46:55,770
generate enough energy for the rover to

1065
00:47:02,470 --> 00:46:59,010
be operable orbiting satellites tend to

1066
00:47:06,290 --> 00:47:02,480
last longer and you know as we know

1067
00:47:08,650 --> 00:47:06,300
Voyager like way out there and it's so

1068
00:47:12,470 --> 00:47:08,660
feebly sending us little signal so

1069
00:47:15,590 --> 00:47:12,480
sometimes a small probe can be very

1070
00:47:19,100 --> 00:47:15,600
effective another strategy is to do

1071
00:47:20,960 --> 00:47:19,110
multiple targets so go from one place to

1072
00:47:23,330 --> 00:47:20,970
another so there have been satellites

1073
00:47:25,010 --> 00:47:23,340
that have done that on from here to here

1074
00:47:26,690 --> 00:47:25,020
to here and then make sometimes there's

1075
00:47:29,390 --> 00:47:26,700
an extended mission that if you

1076
00:47:32,720 --> 00:47:29,400
accomplish these two goals then you can

1077
00:47:35,330 --> 00:47:32,730
do the next one Raleigh God as had two

1078
00:47:37,040 --> 00:47:35,340
places to go to it had best in series so

1079
00:47:38,390 --> 00:47:37,050
that they were able to use their ion

1080
00:47:41,780 --> 00:47:38,400
propulsion to go to two different

1081
00:47:43,580 --> 00:47:41,790
objects and I think with that what

1082
00:47:46,580 --> 00:47:43,590
you're talking is completely on point

1083
00:47:49,010 --> 00:47:46,590
Landers if you're trying to get your

1084
00:47:50,450 --> 00:47:49,020
Lander to another surface that means

1085
00:47:51,340 --> 00:47:50,460
you're going to have to send all the

1086
00:47:55,060 --> 00:47:51,350
fuel to

1087
00:47:56,350 --> 00:47:55,070
to achieve escape velocity somehow to be

1088
00:47:58,570 --> 00:47:56,360

able to do that to get to another place

1089
00:48:00,700 --> 00:47:58,580
and that's just not practical right and

1090
00:48:03,160 --> 00:48:00,710
with with things like SpaceX which i

1091
00:48:05,130 --> 00:48:03,170
think is at least going in some

1092
00:48:09,040 --> 00:48:05,140
direction where they're trying to find

1093
00:48:10,720 --> 00:48:09,050
reusable rockets that you know the

1094
00:48:13,360 --> 00:48:10,730
primary and secondary stages can be

1095
00:48:14,970 --> 00:48:13,370
reused but what we're sending out there

1096
00:48:17,230 --> 00:48:14,980
I don't think it's really practical

1097
00:48:19,390 --> 00:48:17,240
economics as far just thinking about the

1098
00:48:22,420 --> 00:48:19,400
resources to do that would be far away

1099
00:48:24,430 --> 00:48:22,430
then the cash market is not to be

1100
00:48:26,260 --> 00:48:24,440
underestimated but he focuses although

1101
00:48:29,170 --> 00:48:26,270
hang out Hubble is the best example of

1102
00:48:31,600 --> 00:48:29,180
let's go up replenish it exactly that is

1103
00:48:33,550 --> 00:48:31,610
right but it's also just above our heads

1104
00:48:35,560 --> 00:48:33,560
if we had something out on Europa for

1105
00:48:37,840 --> 00:48:35,570
example sending something out to refuel

1106
00:48:40,300 --> 00:48:37,850
it I'd like Scott said you know they

1107
00:48:42,340 --> 00:48:40,310
take all the fuel that we would I would

1108
00:48:43,840 --> 00:48:42,350
send a new one yeah if we're gonna send

1109
00:48:46,150 --> 00:48:43,850
something out there about the same as

1110
00:48:47,800 --> 00:48:46,160
you send a new one yeah everything

1111
00:48:52,180 --> 00:48:47,810
problems tend to be much smaller than

1112
00:48:54,160 --> 00:48:52,190
the Hubble mirror so um yeah so there is

1113
00:48:56,050 --> 00:48:54,170

cost benefit in that how far out you

1114
00:48:58,420 --> 00:48:56,060
have to go in a few a service it you

1115
00:49:00,700 --> 00:48:58,430
might in a couple years say oh forget

1116
00:49:02,500 --> 00:49:00,710
that you know I need new technology

1117
00:49:05,410 --> 00:49:02,510
because the new tip there are going to

1118
00:49:07,660 --> 00:49:05,420
be new technologies we are not using you

1119
00:49:09,430 --> 00:49:07,670
know old technologies for these

1120
00:49:11,410 --> 00:49:09,440
satellites and so you want to

1121
00:49:13,510 --> 00:49:11,420
investigate in the best possible way and

1122
00:49:15,370 --> 00:49:13,520
that's cost-effective now what would be

1123
00:49:18,730 --> 00:49:15,380
nice is if we could figure out how we

1124
00:49:22,660 --> 00:49:18,740
can fuel in syd you so somehow harm

1125
00:49:25,510 --> 00:49:22,670
harvest materials out there that would

1126
00:49:27,580 --> 00:49:25,520
provide whatever energy or something but

1127
00:49:32,440 --> 00:49:27,590
we're not there yet yeah done another

1128
00:49:33,940 --> 00:49:32,450
utilize the Stargate and no you're

1129
00:49:36,810 --> 00:49:33,950
supposed to be throwing that out there

1130
00:49:39,400 --> 00:49:36,820
yet late yeah no there's no Stargate

1131
00:49:40,630 --> 00:49:39,410
nevermind anyway it was a good comment I

1132
00:49:42,520 --> 00:49:40,640
don't know and roofie if you should

1133
00:49:45,160 --> 00:49:42,530
think about those a throwaway spacecraft

1134
00:49:49,450 --> 00:49:45,170
that it's just a sing I mean single use

1135
00:49:52,750 --> 00:49:49,460
some if it it's not like you know that

1136
00:49:55,720 --> 00:49:52,760
we're trying to conserve plastic bottles

1137
00:49:57,970 --> 00:49:55,730
or something these really do need to it

1138
00:50:00,130 --> 00:49:57,980

would take a lot more resources to make

1139
00:50:02,110 --> 00:50:00,140
it refuel able and reusable probably i

1140
00:50:04,480 --> 00:50:02,120
would think anyway so that's my thought

1141
00:50:05,200 --> 00:50:04,490
on that Carol I have one thing I like to

1142
00:50:06,610 --> 00:50:05,210
that

1143
00:50:09,250 --> 00:50:06,620
this was a good one for you too but

1144
00:50:11,620 --> 00:50:09,260
Michael jobin and as asking does the

1145
00:50:14,950 --> 00:50:11,630
Hubble Space Telescope wobble from

1146
00:50:18,910 --> 00:50:14,960
Earth's varying gravity as it orbits or

1147
00:50:20,770 --> 00:50:18,920
say the moon tugging on it and and is

1148
00:50:23,380 --> 00:50:20,780
that why the Pluto pics are not so good

1149
00:50:29,140 --> 00:50:23,390
I'm not so sure no I don't like that

1150
00:50:31,330 --> 00:50:29,150
laughter awesome fantastic I know go

1151
00:50:34,000 --> 00:50:31,340
around the from the position of the

1152
00:50:36,340 --> 00:50:34,010
earth Hubble Space lost tape has taken

1153
00:50:38,950 --> 00:50:36,350
exquisite pictures and well it's just

1154
00:50:42,180 --> 00:50:38,960
the size of the of the mirror it has

1155
00:50:44,500 --> 00:50:42,190
nothing to do it wobbling her around I'm

1156
00:50:46,780 --> 00:50:44,510
sure they're a slight variation OTT so

1157
00:50:50,200 --> 00:50:46,790
much to the moon but the earth but the

1158
00:50:54,280 --> 00:50:50,210
way that we use the telescope is that we

1159
00:50:56,650 --> 00:50:54,290
use guidance both there's they're all

1160
00:50:59,920 --> 00:50:56,660
kinds of guidance system on the Hubble

1161
00:51:02,350 --> 00:50:59,930
to keep it on point on the target now

1162
00:51:05,460 --> 00:51:02,360
things like solar system objects are a

1163
00:51:09,340 --> 00:51:05,470

little more challenging because we

1164
00:51:12,100 --> 00:51:09,350
though the telescope is built to look at

1165
00:51:14,260 --> 00:51:12,110
distant stars distant objects and so the

1166
00:51:16,600 --> 00:51:14,270
whole system responds to that but we

1167
00:51:18,730 --> 00:51:16,610
still can make adjustments so that we

1168
00:51:23,620 --> 00:51:18,740
can track along and look at the solar

1169
00:51:26,260 --> 00:51:23,630
system objects but I object to the Pluto

1170
00:51:29,110 --> 00:51:26,270
images are not good enough they're

1171
00:51:31,630 --> 00:51:29,120
spectacular for the size of that mirror

1172
00:51:33,280 --> 00:51:31,640
and that is the limiting peter in space

1173
00:51:35,200 --> 00:51:33,290
that you'll get something different

1174
00:51:37,390 --> 00:51:35,210
that's just a matter of optical

1175
00:51:38,860 --> 00:51:37,400
resolution that's right so it's have

1176
00:51:40,570 --> 00:51:38,870
drawn this year's hubble still has some

1177
00:51:42,880 --> 00:51:40,580
of the best reaction with big fly wheels

1178
00:51:48,160 --> 00:51:42,890
for doing for the accurate pointing oh

1179
00:51:54,750 --> 00:51:48,170
it was rising yeah right so uh so that

1180
00:51:56,950 --> 00:51:54,760
would be our opinion on that Andrew so

1181
00:51:59,710 --> 00:51:56,960
Craig Landon's going don't forget

1182
00:52:03,090 --> 00:51:59,720
cassini-huygens we can accomplish

1183
00:52:05,860 --> 00:52:03,100
whatever we need without sci-fi good

1184
00:52:08,710 --> 00:52:05,870
although although sci-fi is nice to kind

1185
00:52:11,200 --> 00:52:08,720
of moat you know open our minds get us

1186
00:52:13,600 --> 00:52:11,210
motivated but I don't want to point out

1187
00:52:17,200 --> 00:52:13,610
that we just can't randomly send you

1188
00:52:17,920 --> 00:52:17,210

know or satellites out there I will also

1189
00:52:20,260 --> 00:52:17,930
point out that

1190
00:52:23,950 --> 00:52:20,270
Space Telescope help look for landing

1191
00:52:26,290 --> 00:52:23,960
sites on Mars so we need ground-based

1192
00:52:28,180 --> 00:52:26,300
and space-based telescopes to

1193
00:52:30,370 --> 00:52:28,190
investigate these phenomenon like the

1194
00:52:32,680 --> 00:52:30,380
water flows and really thoroughly

1195
00:52:34,720 --> 00:52:32,690
understand the phenomenon before we just

1196
00:52:36,370 --> 00:52:34,730
start sending stuff out there and hoping

1197
00:52:38,500 --> 00:52:36,380
we go through a plume now that would be

1198
00:52:41,349 --> 00:52:38,510
a throwaway mission I mean we've got to

1199
00:52:44,079 --> 00:52:41,359
know what we're going to do and so these

1200
00:52:45,940 --> 00:52:44,089
telescopes and orbiting the Earth and

1201
00:52:48,430 --> 00:52:45,950
especially Hubble and some ground-based

1202
00:52:50,109 --> 00:52:48,440
telescopes are used because we're very

1203
00:52:52,390 --> 00:52:50,119
judicious about how we do the

1204
00:52:54,490 --> 00:52:52,400
investigations before we just start

1205
00:52:58,599 --> 00:52:54,500
slinging stuff out there and hoping we

1206
00:53:00,790 --> 00:52:58,609
need discover something yeah so um auto

1207
00:53:03,400 --> 00:53:00,800
raag one two three four again on youtube

1208
00:53:04,690 --> 00:53:03,410
is commenting that actually it's kind of

1209
00:53:08,079 --> 00:53:04,700
an interesting comment what we may think

1210
00:53:11,740 --> 00:53:08,089
of as extreme for life may not may be

1211
00:53:14,230 --> 00:53:11,750
the most common form as an interesting

1212
00:53:17,170 --> 00:53:14,240
thought because what for all we know if

1213
00:53:19,059 --> 00:53:17,180

life is common in the universe and we

1214
00:53:21,309 --> 00:53:19,069
don't know the answer to that yet then

1215
00:53:22,750 --> 00:53:21,319
it may be that the most common form of

1216
00:53:24,490 --> 00:53:22,760
it is in the form of what Scott was

1217
00:53:28,450 --> 00:53:24,500
calling extremophiles these these these

1218
00:53:32,650 --> 00:53:28,460
very simple life forms that are they can

1219
00:53:34,660 --> 00:53:32,660
exist in the outer reaches of space so

1220
00:53:37,240 --> 00:53:34,670
that's a good point that's a good

1221
00:53:39,520 --> 00:53:37,250
comment anything else got that I'm am I

1222
00:53:42,010 --> 00:53:39,530
missing anything am i you you saw

1223
00:53:43,569 --> 00:53:42,020
everything that I want to talk about is

1224
00:53:46,720 --> 00:53:43,579
anybody tweeting I haven't had a chance

1225
00:53:48,579 --> 00:53:46,730
to look at my bubble hash tag in this

1226
00:53:50,859 --> 00:53:48,589
war look at almost tweets and there's a

1227
00:53:53,680 --> 00:53:50,869
lot of retweets so that's good oh good

1228
00:53:55,510 --> 00:53:53,690
yep Oh awesome yeah Scott's owning a

1229
00:53:59,319 --> 00:53:55,520
Hubble hang out hashtag thank you for

1230
00:54:02,319 --> 00:53:59,329
taking on Twitter it's cool so I

1231
00:54:04,599 --> 00:54:02,329
actually had a question about the Jovian

1232
00:54:07,150 --> 00:54:04,609
system since not all of us know

1233
00:54:09,339 --> 00:54:07,160
everything about this 60 moons or

1234
00:54:13,750 --> 00:54:09,349
whatever are there any other of the

1235
00:54:16,930 --> 00:54:13,760
moons around jupiter that might have a

1236
00:54:19,720 --> 00:54:16,940
similar situation we talked about and

1237
00:54:21,819 --> 00:54:19,730
sell it is around Saturn but are there

1238
00:54:30,390 --> 00:54:21,829

any other moons that might be

1239
00:54:32,880 --> 00:54:30,400
interesting in this regard kirkham beta

1240
00:54:35,910 --> 00:54:32,890
okay what's the answer we think that

1241
00:54:39,150 --> 00:54:35,920
ganymede uh also has a subsurface ocean

1242
00:54:41,010 --> 00:54:39,160
just much further down and well you know

1243
00:54:43,740 --> 00:54:41,020
less likely that it would communicate to

1244
00:54:45,599 --> 00:54:43,750
the surface and have offense but maybe

1245
00:54:47,339 --> 00:54:45,609
not all the question was some sort of

1246
00:54:50,010 --> 00:54:47,349
subsurface lake or that sort of thing to

1247
00:54:52,319 --> 00:54:50,020
so something that we're look talking

1248
00:54:54,120 --> 00:54:52,329
about on Jews project the mission is

1249
00:54:56,089 --> 00:54:54,130
going to orbit around again I'll be

1250
00:54:59,849 --> 00:54:56,099
looking for that hard they're

1251
00:55:04,170 --> 00:54:59,859
interesting okay I mean and mr. tail oh

1252
00:55:06,450 --> 00:55:04,180
all moons have seen atmospheres aeo has

1253
00:55:08,609 --> 00:55:06,460
the walkin ISM you wrote for any way in

1254
00:55:10,200 --> 00:55:08,619
addition to the blooms it has an oxygen

1255
00:55:12,480 --> 00:55:10,210
atmosphere that's also being discovered

1256
00:55:16,140 --> 00:55:12,490
with hubble hubble space telescope in

1257
00:55:18,390 --> 00:55:16,150
the 90s and that name it has also an

1258
00:55:20,579 --> 00:55:18,400
oxygen atmosphere thin oxygen atmosphere

1259
00:55:23,640 --> 00:55:20,589
also discovered with her book and their

1260
00:55:26,220 --> 00:55:23,650
color salon x1 has a CO 2 atmosphere and

1261
00:55:27,990 --> 00:55:26,230
like a yacht and oxygen atmosphere and

1262
00:55:31,019 --> 00:55:28,000
they are also speculation that all the

1263
00:55:32,789 --> 00:55:31,029

other two like can evade and Callisto

1264
00:55:34,380 --> 00:55:32,799
but that's also spake only speculation

1265
00:55:37,260 --> 00:55:34,390
that they may be also have flumes

1266
00:55:40,859 --> 00:55:37,270
because my god subject to these to these

1267
00:55:42,720 --> 00:55:40,869
tidal forces but it's only speculation

1268
00:55:44,730 --> 00:55:42,730
that theory in the paper stays no

1269
00:55:47,309 --> 00:55:44,740
observational evidence for perfumes

1270
00:55:49,859 --> 00:55:47,319
economy but because the titles are

1271
00:55:54,269 --> 00:55:49,869
strong so it's an idea that could that

1272
00:55:56,010 --> 00:55:54,279
they could be there Wow interesting very

1273
00:55:57,450 --> 00:55:56,020
much so I know folks on the Pluto

1274
00:56:00,180 --> 00:55:57,460
mission new horizons are excited by the

1275
00:56:01,950 --> 00:56:00,190
potential for seeing not water vapor

1276
00:56:04,559 --> 00:56:01,960
pros but other types of plumes like we

1277
00:56:07,589 --> 00:56:04,569
saw with Voyager on Triton Neptune's

1278
00:56:09,990 --> 00:56:07,599
moon Triton different gases coming out

1279
00:56:14,760 --> 00:56:10,000
of the surface there other processes but

1280
00:56:16,470 --> 00:56:14,770
uh so exhibition is fiction enter the

1281
00:56:19,380 --> 00:56:16,480
inner solar system moons aren't so

1282
00:56:21,539 --> 00:56:19,390
interesting all the movies Jupiter out

1283
00:56:25,859 --> 00:56:21,549
words are pretty interesting it turns

1284
00:56:30,750 --> 00:56:25,869
out solar systems pretty gassy lot of

1285
00:56:32,039 --> 00:56:30,760
gassing going on here I do all right ok

1286
00:56:34,950 --> 00:56:32,049
folks well I guess that's it for this

1287
00:56:38,130 --> 00:56:34,960
week I thank you guys for for for

1288
00:56:39,779 --> 00:56:38,140

watching I want to thank you dr. want to

1289
00:56:41,370 --> 00:56:39,789
thank dr. you walking sore from

1290
00:56:43,630 --> 00:56:41,380
University of Cologne dr. Kerr

1291
00:56:44,650 --> 00:56:43,640
Rutherford dr. Lorenz Roth for

1292
00:56:46,540 --> 00:56:44,660
telling us about these great

1293
00:56:47,590 --> 00:56:46,550
observations and we look forward to

1294
00:56:50,560 --> 00:56:47,600
hearing more from you in the future

1295
00:56:51,940 --> 00:56:50,570
thank you guys very much for hanging out

1296
00:56:55,630 --> 00:56:51,950
with us and telling us about all this

1297
00:56:58,330 --> 00:56:55,640
yeah yeah they're saying thanks so much

1298
00:56:59,560 --> 00:56:58,340
yeah hey Carolyn's got thank you this

1299
00:57:01,380 --> 00:56:59,570
has been awesome thank you very much for

1300
00:57:07,060 --> 00:57:01,390
your help for when I was temporarily

1301
00:57:08,800 --> 00:57:07,070
engaged otherwise and and don't forget

1302
00:57:11,800 --> 00:57:08,810
this the tonight folks we got a special

1303
00:57:14,920 --> 00:57:11,810
Hubble public lecture on neutrinos and

1304
00:57:18,300 --> 00:57:14,930
also next week Carol Scott and I will be

1305
00:57:23,410 --> 00:57:18,310
talking about 3d printing in outer space

1306
00:57:25,030 --> 00:57:23,420
yes and and in other areas too but will

1307
00:57:27,250 --> 00:57:25,040
be so that will be next week and we look

1308
00:57:29,560 --> 00:57:27,260
forward to seeing you then thank you all