Panelists

Attendees (14)

- Hosts (1)
  - Estelle Dodson
- Presenters (4)
  - Andy Burnett
  - Nancy Kiang
  - Shawn Domagal-Gold...
  - Tyler Robinson
- Participants (9)
  - Alexander Pavlov
  - David Des Marais
  - Glenn Ciolek
  - John Rummel
  - Mike Gaunce
  - Niki Parenteau
  - Patricio Rojo
  - Pauli
  - Steve Vance

Open Chat (Everyone)

Nancy Kiang: Shall we discuss this at the end of the presentation? I.e. what kind of habitability are going to miss given priorities of detection methods?

Tyler Robinson: Yeah, we should.

--------- (11/07/2013 11:17) ---------

Tyler Robinson: As Shawn mentioned, Seager et al. (2013):

Tyler Robinson: http://arxiv.org/abs/1309.6014

David Des Marais: Such differences in operational definitions of habitability are part of the reason that our solar system and exoplanets are necessarily addressed in separate white papers...

--------- (11/07/2013 11:19) ---------

Nancy Kiang: Also false positives occur if the"biosignature" is in the wrong context, e.g. oxygen on a dry cold planet.

David Des Marais is typing...

Teleconference Instructions (Parti...

Teleconference Line: 866-692-3158
Passcode: 9109668#
Please use *6 to MUTE your phone's mic when not speaking.
More info: https://astrobiologyfuture.org

Share 7 - Shawn Domagal-Goldman

Full Screen

Google Drive is now full screen. Exit Full Screen Allow

Things to work on in the coming 10 years

- A quantitative "habitability factor" for observation prioritization.
- Given the "habitability factor" of a particular planet, derive potential biosignatures given habitability constraints.
- A comprehensive catalog of biosignatures and false positives and false negatives.
- Starlight suppression technologies to permit direct imaging of potentially habitable exoplanets, or (less ideally) improved transit spectroscopy.
- Understanding the information content of planetary spectra, including methods to retrieve or infer surface properties relevant to habitability, particularly surface liquid water.
- Comparative climatology: Are super-Earths habitable? Inhabited?

Slide 19 Exit

1
00:00:15,680 --> 00:00:11,810
okay hello everyone so next in our

2
00:00:18,200 --> 00:00:15,690
series of webinars are just a couple of

3
00:00:21,410 --> 00:00:18,210
points for anyone who hasn't attended

4
00:00:24,109 --> 00:00:21,420
any of in previous ones the slides for

5
00:00:27,470 --> 00:00:24,119
this event are now directly linked from

6
00:00:30,529 --> 00:00:27,480
the events entry on the astrobiology

7
00:00:32,959 --> 00:00:30,539
website so if you are watching this

8
00:00:35,840 --> 00:00:32,969
little later date or your only dialed in

9
00:00:40,459 --> 00:00:35,850
to the telecom you can pull down the

10
00:00:44,180 --> 00:00:40,469
slides and what work along with us the

11
00:00:46,850 --> 00:00:44,190
video for this will be up probably in

12
00:00:49,760 --> 00:00:46,860
about a week's time as we're going

13
00:00:52,069 --> 00:00:49,770

through the webinar by all means pop

14
00:00:54,700 --> 00:00:52,079
your questions or thoughts into the text

15
00:00:57,020 --> 00:00:54,710
chat will note them at the bottom

16
00:00:58,970 --> 00:00:57,030
everything is being recorded just so you

17
00:01:02,660 --> 00:00:58,980
know so we've got audio and torture

18
00:01:04,850 --> 00:01:02,670
typing with attribution and then at the

19
00:01:07,039 --> 00:01:04,860
end after the presentations will open up

20
00:01:11,810 --> 00:01:07,049
the phone lines and have the

21
00:01:14,000 --> 00:01:11,820
conversation ulema okay sure thank you

22
00:01:15,950 --> 00:01:14,010
Andy and thanks Estelle for making all

23
00:01:18,200 --> 00:01:15,960
this possible and I'd also like to thank

24
00:01:19,940 --> 00:01:18,210
time up and doctors ty Robinson and NT

25
00:01:22,160 --> 00:01:19,950
king who are hanging on the line there

26
00:01:23,600 --> 00:01:22,170
in case or any questions and I'm sure

27
00:01:25,820 --> 00:01:23,610
there will be that I can't answer or if

28
00:01:28,640 --> 00:01:25,830
they want to mention something that I

29
00:01:30,950 --> 00:01:28,650
forgot to mention today's topic is how

30
00:01:32,870 --> 00:01:30,960
can we identify habitable planets and

31
00:01:35,450 --> 00:01:32,880
search for life beyond our solar system

32
00:01:37,310 --> 00:01:35,460
this follows on yesterday's presentation

33
00:01:38,630 --> 00:01:37,320
pretty directly yesterday I don't

34
00:01:40,719 --> 00:01:38,640
remember the exact wording but it was

35
00:01:43,880 --> 00:01:40,729
something like how can we identify

36
00:01:45,620 --> 00:01:43,890
habitable environments inside the solar

37
00:01:48,289 --> 00:01:45,630
system and so this is sort of

38
00:01:50,840 --> 00:01:48,299

integrating that over a sphere a globe

39
00:01:53,030 --> 00:01:50,850
and looking at the debt sphere from far

40
00:01:55,160 --> 00:01:53,040
far away in other words for planets

41
00:01:57,590 --> 00:01:55,170
around other stars as opposed to planets

42
00:01:59,600 --> 00:01:57,600
in our own solar system I am also means

43
00:02:02,060 --> 00:01:59,610
remote detection of both habitability in

44
00:02:04,069 --> 00:02:02,070
life we're going to follow the same sort

45
00:02:06,170 --> 00:02:04,079
of nucleus of people with a third

46
00:02:08,660 --> 00:02:06,180
actually the fourth telecom after the

47
00:02:10,279 --> 00:02:08,670
new year that parrots the second part of

48
00:02:12,949 --> 00:02:10,289
this which is the search for life inside

49
00:02:13,710 --> 00:02:12,959
the solar system so we we did a search

50
00:02:16,800 --> 00:02:13,720
for habitable and

51
00:02:17,880 --> 00:02:16,810
inside the solar system yesterday today

52
00:02:19,530 --> 00:02:17,890
we're doing the search for habitable

53
00:02:21,480 --> 00:02:19,540
planets and the search for life beyond

54
00:02:22,710 --> 00:02:21,490
the solar system and in a few months

55
00:02:24,420 --> 00:02:22,720
because we're still working on the

56
00:02:26,790 --> 00:02:24,430
document will do a search for life

57
00:02:28,260 --> 00:02:26,800
inside the solar system white paper and

58
00:02:30,750 --> 00:02:28,270
the reason that we've smushed the two

59
00:02:32,190 --> 00:02:30,760
together in for exoplanets of a search

60
00:02:34,440 --> 00:02:32,200
for life and habitable environments

61
00:02:36,150 --> 00:02:34,450
together outside the solar system is

62
00:02:37,770 --> 00:02:36,160
that the techniques are really similar

63
00:02:39,390 --> 00:02:37,780

and a lot of the driving questions are

64
00:02:41,430 --> 00:02:39,400
very interrelated this we're going to

65
00:02:44,370 --> 00:02:41,440
see today one other just housekeeping

66
00:02:45,900 --> 00:02:44,380
note the format I'm presenting with

67
00:02:48,780 --> 00:02:45,910
today and the foreman of our document is

68
00:02:50,490 --> 00:02:48,790
a new template that Michael new gave me

69
00:02:52,199 --> 00:02:50,500
last Friday that we're trying to

70
00:02:55,199 --> 00:02:52,209
implement so we're sort of the lab rats

71
00:02:56,940 --> 00:02:55,209
for that or lab microbes as most of our

72
00:02:59,070 --> 00:02:56,950
community tend to work with smaller

73
00:03:01,410 --> 00:02:59,080
organisms as opposed to the macro

74
00:03:03,270 --> 00:03:01,420
organisms but if you want to take a look

75
00:03:05,010 --> 00:03:03,280
at this and implement it yourselves feel

76
00:03:07,620 --> 00:03:05,020
free to do so I found it pretty useful

77
00:03:09,150 --> 00:03:07,630
it follows on the templates that a

78
00:03:12,360 --> 00:03:09,160
couple of groups have been using the

79
00:03:14,520 --> 00:03:12,370
last two weeks that both the authors and

80
00:03:16,260 --> 00:03:14,530
the community have seemed to enjoy so

81
00:03:19,170 --> 00:03:16,270
hopefully this goes well and if it

82
00:03:21,780 --> 00:03:19,180
doesn't let us know so with that said on

83
00:03:24,060 --> 00:03:21,790
to our presentation this is fortunate

84
00:03:26,070 --> 00:03:24,070
and unfortunate timing in many ways I

85
00:03:27,870 --> 00:03:26,080
think it's unfortunate because we have

86
00:03:30,330 --> 00:03:27,880
lots of people either in California

87
00:03:32,430 --> 00:03:30,340
physically at NASA Ames or remotely

88
00:03:34,410 --> 00:03:32,440

tuning in to the meeting that's going on

89
00:03:36,900 --> 00:03:34,420
there right now which is the second

90
00:03:38,130 --> 00:03:36,910
Kepler science conference and on Monday

91
00:03:40,440 --> 00:03:38,140
at that conference there is an

92
00:03:43,170 --> 00:03:40,450
associated press release and press

93
00:03:45,120 --> 00:03:43,180
telecon about this announcement about an

94
00:03:47,449 --> 00:03:45,130
estimation of how many potentially

95
00:03:50,070 --> 00:03:47,459
habitable worlds there are in our galaxy

96
00:03:52,350 --> 00:03:50,080
and the answer is in the tens of

97
00:03:54,060 --> 00:03:52,360
billions now there are people in

98
00:03:56,070 --> 00:03:54,070
exoplanet community and I would actually

99
00:03:57,690 --> 00:03:56,080
say that most of the astrobiologists

100
00:03:59,220 --> 00:03:57,700
that populate the exoplanet community

101
00:04:02,400 --> 00:03:59,230
have some issues with the press

102
00:04:04,110 --> 00:04:02,410
conference of a paper with the exact

103
00:04:06,449 --> 00:04:04,120
percentage of stars that might have

104
00:04:09,570 --> 00:04:06,459
these potentially habitable worlds the

105
00:04:13,140 --> 00:04:09,580
big picture a number is still the same

106
00:04:14,670 --> 00:04:13,150
whether the qualitative conclusion still

107
00:04:16,680 --> 00:04:14,680
the same there's lots of potentially

108
00:04:18,570 --> 00:04:16,690
habitable worlds out there they say 40

109
00:04:20,039 --> 00:04:18,580
billion even people that might be a

110
00:04:22,260 --> 00:04:20,049
little bit more skeptical might put the

111
00:04:24,300 --> 00:04:22,270
number at 10 billion but at some point

112
00:04:26,159 --> 00:04:24,310
you don't need many more habitable

113
00:04:27,450 --> 00:04:26,169

planets it will affect telescope design

114
00:04:30,240 --> 00:04:27,460
and stuff like that but

115
00:04:32,129 --> 00:04:30,250
the big news here is really a sound

116
00:04:34,830 --> 00:04:32,139
there's a lot of habitable planets out

117
00:04:36,210 --> 00:04:34,840
there that we want to explore and so

118
00:04:38,400 --> 00:04:36,220
that leads us to the questions we'd like

119
00:04:39,990 --> 00:04:38,410
to answer over the next 10 years are

120
00:04:42,960 --> 00:04:40,000
they have bubble and if they are

121
00:04:44,460 --> 00:04:42,970
habitable do they have life and a lot of

122
00:04:46,680 --> 00:04:44,470
this text that you're going to see here

123
00:04:48,960 --> 00:04:46,690
is just copied and pasted from our

124
00:04:50,760 --> 00:04:48,970
document so if you see yourself reacting

125
00:04:53,249 --> 00:04:50,770
to this in a way that makes you think we

126
00:04:54,779 --> 00:04:53,259
forgot something or makes you think we

127
00:04:57,210 --> 00:04:54,789
said something that's incorrect please

128
00:04:58,439 --> 00:04:57,220
speak up and let us know because we need

129
00:05:01,020 --> 00:04:58,449
to get that into the document that's

130
00:05:02,400 --> 00:05:01,030
what this telecon is all about so the

131
00:05:05,370 --> 00:05:02,410
introduction I'm just going to

132
00:05:07,230 --> 00:05:05,380
paraphrase a bit exoplanetary sign so

133
00:05:09,330 --> 00:05:07,240
it's science about stars planets around

134
00:05:10,710 --> 00:05:09,340
other stars it's rapidly growing in part

135
00:05:13,620 --> 00:05:10,720
because our data set is rapidly growing

136
00:05:15,689 --> 00:05:13,630
and it's evolving in the near future we

137
00:05:17,400 --> 00:05:15,699
may be asked to prioritize these

138
00:05:19,320 --> 00:05:17,410

habitable planets that we're finding for

139
00:05:21,899 --> 00:05:19,330
targeted follow-up observations which is

140
00:05:23,790 --> 00:05:21,909
a lot we'll talk about today and those

141
00:05:26,010 --> 00:05:23,800
data will provide limited glimpses into

142
00:05:27,779 --> 00:05:26,020
the atmospheric and surface environments

143
00:05:29,520 --> 00:05:27,789
of those exoplanets and allow us to

144
00:05:32,189 --> 00:05:29,530
constrain the likelihood of surface

145
00:05:33,779 --> 00:05:32,199
liquid water in or life liquid water

146
00:05:35,550 --> 00:05:33,789
being the main thing that we used to

147
00:05:37,980 --> 00:05:35,560
discriminate potentially habitable

148
00:05:39,450 --> 00:05:37,990
versus not potentially habitable worlds

149
00:05:41,399 --> 00:05:39,460
and like being the thing that

150
00:05:43,920 --> 00:05:41,409
astrobiology is ultimately out there in

151
00:05:45,300 --> 00:05:43,930
the long run well with the accelerating

152
00:05:46,950 --> 00:05:45,310
rate of discovery of exoplanets you want

153
00:05:49,020 --> 00:05:46,960
to be able to target for observations

154
00:05:51,209 --> 00:05:49,030
those planets most likely to harbor

155
00:05:52,980 --> 00:05:51,219
liquid water and hence potentially so

156
00:05:54,420 --> 00:05:52,990
this is the first thing other than the

157
00:05:56,399 --> 00:05:54,430
title that you'll see in the template

158
00:05:58,020 --> 00:05:56,409
that we applied and this is just a

159
00:05:59,909 --> 00:05:58,030
summary of sort of where we're at this

160
00:06:02,430 --> 00:05:59,919
is also from that cupola me dancing I'm

161
00:06:05,070 --> 00:06:02,440
gonna leave that music and this is

162
00:06:06,719 --> 00:06:05,080
called a coupler or read three and

163
00:06:08,189 --> 00:06:06,729

rockets ring Roman numeral three if you

164
00:06:10,230 --> 00:06:08,199
want to look for this and yourself or

165
00:06:12,779 --> 00:06:10,240
use it in a talk this is a slide

166
00:06:14,640 --> 00:06:12,789
summarizing all of the coupler objects

167
00:06:15,659 --> 00:06:14,650
of interest and if you hear k live from

168
00:06:18,659 --> 00:06:15,669
that team that's what that represents

169
00:06:20,100 --> 00:06:18,669
this is all the planets or planet

170
00:06:22,050 --> 00:06:20,110
candidates that the Kepler mission has

171
00:06:23,909 --> 00:06:22,060
found and there are literally thousands

172
00:06:26,339 --> 00:06:23,919
of them many of them are terrestrial

173
00:06:27,689 --> 00:06:26,349
size many of them are in the habitable

174
00:06:29,550 --> 00:06:27,699
zone and many of them are both

175
00:06:31,560 --> 00:06:29,560
terrestrial sized and in the habitable

176
00:06:33,510 --> 00:06:31,570
zone and the question is how do we

177
00:06:35,070 --> 00:06:33,520
prioritize amongst all of these for

178
00:06:36,719 --> 00:06:35,080
future observations when we want to look

179
00:06:38,070 --> 00:06:36,729
for life and one of those big

180
00:06:39,839 --> 00:06:38,080
prioritization is going to be

181
00:06:40,650 --> 00:06:39,849
detectability which we're not going to

182
00:06:41,760 --> 00:06:40,660
talk a lot about

183
00:06:43,710 --> 00:06:41,770
we're going to talk more about the

184
00:06:45,420 --> 00:06:43,720
astrobiology signs of the other

185
00:06:47,010 --> 00:06:45,430
criterion for prioritization which is

186
00:06:49,050 --> 00:06:47,020
how likely is that planet the hard to

187
00:06:52,650 --> 00:06:49,060
life or at least to have the potential

188
00:06:54,540 --> 00:06:52,660

to harbor life so this is the next part

189
00:06:56,610 --> 00:06:54,550
of the template which is background just

190
00:06:58,320 --> 00:06:56,620
a couple paragraphs saying you know what

191
00:07:01,110 --> 00:06:58,330
is this all about and why is it related

192
00:07:02,670 --> 00:07:01,120
to astrobiology a habitable XO and I

193
00:07:04,380 --> 00:07:02,680
just took the topic sentences from those

194
00:07:06,900 --> 00:07:04,390
paragraphs so what this is all about is

195
00:07:08,790 --> 00:07:06,910
that a habitable planet is typically or

196
00:07:11,010 --> 00:07:08,800
traditionally defined as a world able to

197
00:07:12,330 --> 00:07:11,020
maintain liquid water on its surface and

198
00:07:14,160 --> 00:07:12,340
if you hear the words habitable zone

199
00:07:16,140 --> 00:07:14,170
that's generally what we're talking

200
00:07:17,880 --> 00:07:16,150
about if you hear earth-like potentially

201
00:07:20,850 --> 00:07:17,890
earth-like that's generally what people

202
00:07:22,590 --> 00:07:20,860
are referring to information provided by

203
00:07:24,320 --> 00:07:22,600
current exoplanet detection techniques

204
00:07:26,340 --> 00:07:24,330
and available or near future

205
00:07:28,080 --> 00:07:26,350
instrumentation instrumentation can

206
00:07:31,260 --> 00:07:28,090
begin to address the likelihood that a

207
00:07:32,820 --> 00:07:31,270
certain exoplanet acceptable so then the

208
00:07:34,980 --> 00:07:32,830
next thing you'll see in the template

209
00:07:36,630 --> 00:07:34,990
and in our document is a splitting up

210
00:07:38,850 --> 00:07:36,640
into subtopics you don't have to do this

211
00:07:40,650 --> 00:07:38,860
we found it useful because we're altima

212
00:07:42,450 --> 00:07:40,660
tlie addressing two questions the first

213
00:07:44,700 --> 00:07:42,460

about habitability and the second about

214
00:07:46,440 --> 00:07:44,710
license so for us you'll see some top

215
00:07:49,260 --> 00:07:46,450
agay characterizing potentially

216
00:07:51,180 --> 00:07:49,270
habitable exoplanets and then you'll see

217
00:07:53,580 --> 00:07:51,190
a subtopic beyond the search for life on

218
00:07:55,380 --> 00:07:53,590
those potentially habitable exoplanets

219
00:07:59,310 --> 00:07:55,390
and these are just a few of the bullets

220
00:08:01,890 --> 00:07:59,320
from our subtopic a explanation tourism

221
00:08:03,360 --> 00:08:01,900
pros form on the main document planet

222
00:08:05,790 --> 00:08:03,370
origins we want to know more about how

223
00:08:08,240 --> 00:08:05,800
they form which was a white paper we saw

224
00:08:10,040 --> 00:08:08,250
a couple weeks ago maybe a week ago

225
00:08:12,690 --> 00:08:10,050
composition of the interstellar medium

226
00:08:15,480 --> 00:08:12,700
accretion process is an orbital orbital

227
00:08:17,520 --> 00:08:15,490
evolutions this is how all about how the

228
00:08:19,890 --> 00:08:17,530
bolt planet forms what is it made of

229
00:08:22,250 --> 00:08:19,900
where is it located with regards to its

230
00:08:25,250 --> 00:08:22,260
star and does it have the elements and

231
00:08:27,630 --> 00:08:25,260
ideally the molecules that lightnings

232
00:08:29,940 --> 00:08:27,640
the next bullet here is a planet and

233
00:08:31,680 --> 00:08:29,950
system configuration what's the star

234
00:08:33,839 --> 00:08:31,690
type what is the stellar planetary

235
00:08:35,880 --> 00:08:33,849
system environment what is the planet's

236
00:08:37,650 --> 00:08:35,890
mass and the planet size what are its

237
00:08:39,659 --> 00:08:37,660
orbital parameters and what are what is

238
00:08:41,760 --> 00:08:39,669

its composition this is once you form

239
00:08:44,280 --> 00:08:41,770
that planet actually looking at how big

240
00:08:46,290 --> 00:08:44,290
is it if it's too big it might collapse

241
00:08:48,510 --> 00:08:46,300
a gas envelope around it and be more

242
00:08:49,860 --> 00:08:48,520
like Jupiter and you might prophesize

243
00:08:51,780 --> 00:08:49,870
about floaters or something like that

244
00:08:54,090 --> 00:08:51,790
living there I think that's way less

245
00:08:55,620 --> 00:08:54,100
likely and be if it is

246
00:08:57,540 --> 00:08:55,630
those types of organisms do exist

247
00:08:59,639 --> 00:08:57,550
they're going to be at I think a lot

248
00:09:01,319 --> 00:08:59,649
harder to detect spectroscopically from

249
00:09:02,840 --> 00:09:01,329
firelight which is something we'll get

250
00:09:05,610 --> 00:09:02,850
to later on in this presentation

251
00:09:07,199 --> 00:09:05,620
conversely if a planet is too small like

252
00:09:09,629 --> 00:09:07,209
the moon I think is a great example of

253
00:09:10,980 --> 00:09:09,639
this the moon is a rocky planet smack

254
00:09:13,379 --> 00:09:10,990
dab in the middle of the habitable zone

255
00:09:15,540 --> 00:09:13,389
right if it's just as much energy from

256
00:09:18,150 --> 00:09:15,550
its parent star the Sun that we get from

257
00:09:20,220 --> 00:09:18,160
our parents start his son but it's far

258
00:09:22,019 --> 00:09:20,230
too small to hold an atmosphere so it's

259
00:09:24,689 --> 00:09:22,029
not habitable that's why it's not

260
00:09:25,829 --> 00:09:24,699
habitable if the moon were the size of

261
00:09:27,900 --> 00:09:25,839
the earth and you looked in a true

262
00:09:29,519 --> 00:09:27,910
binary planet system the moon could

263
00:09:31,410 --> 00:09:29,529

potentially be habitable right but it's

264
00:09:33,809 --> 00:09:31,420
not so size size matters when it comes

265
00:09:35,610 --> 00:09:33,819
to exoplanets the stellar properties

266
00:09:37,620 --> 00:09:35,620
also matter it matters because that

267
00:09:40,019 --> 00:09:37,630
defines how far out you have to be from

268
00:09:42,360 --> 00:09:40,029
That star to get at the right amount of

269
00:09:43,920 --> 00:09:42,370
energy to maintain liquid water it also

270
00:09:46,019 --> 00:09:43,930
matters because the distribution of

271
00:09:48,090 --> 00:09:46,029
energy from short wavelength DV photons

272
00:09:50,009 --> 00:09:48,100
of longer wavelengths visible and

273
00:09:51,689 --> 00:09:50,019
infrared photons really affects the

274
00:09:53,370 --> 00:09:51,699
chemistry of the atmosphere and that in

275
00:09:54,590 --> 00:09:53,380
turn can affect both the habitability of

276
00:09:56,430 --> 00:09:54,600
the planet because it's those

277
00:09:57,930 --> 00:09:56,440
atmospheric chemicals that are causing

278
00:10:00,240 --> 00:09:57,940
the greenhouse effect that maintain

279
00:10:02,249 --> 00:10:00,250
habitability and it can affect the bio

280
00:10:03,689 --> 00:10:02,259
signatures because the biosignatures for

281
00:10:05,970 --> 00:10:03,699
the most part are ultimately going to be

282
00:10:07,980 --> 00:10:05,980
gaseous although nancy has some great

283
00:10:09,230 --> 00:10:07,990
ideas on non gaseous power signatures

284
00:10:12,240 --> 00:10:09,240
that will hopefully talk about later

285
00:10:13,559 --> 00:10:12,250
finally planet evolution the ability to

286
00:10:15,449 --> 00:10:13,569
maintain liquid surface water a

287
00:10:17,309 --> 00:10:15,459
habitability factor if your tongue I've

288
00:10:20,610 --> 00:10:17,319

talked about the surface water quite a

289
00:10:22,050 --> 00:10:20,620
bit and I should say let me pause here

290
00:10:23,329 --> 00:10:22,060
for a second we use the word habitable

291
00:10:25,920 --> 00:10:23,339
zone and that can be controversial

292
00:10:28,290 --> 00:10:25,930
within the planetary sciences community

293
00:10:30,389 --> 00:10:28,300
because those folks know of planets like

294
00:10:31,860 --> 00:10:30,399
Europa that are clearly habitable even

295
00:10:33,569 --> 00:10:31,870
though it's well outside the habitable

296
00:10:35,550 --> 00:10:33,579
zone same thing with piping and sell it

297
00:10:38,730 --> 00:10:35,560
is and pretty much any proposed outer

298
00:10:40,590 --> 00:10:38,740
solar system both abode for life it also

299
00:10:42,780 --> 00:10:40,600
has been controversial within the

300
00:10:44,340 --> 00:10:42,790
exoplanet community because they want us

301
00:10:45,780 --> 00:10:44,350
to think outside the box when it comes

302
00:10:47,370 --> 00:10:45,790
to looking for life they you know

303
00:10:49,350 --> 00:10:47,380
there's been proposals of dry planets

304
00:10:51,509 --> 00:10:49,360
that might have an expanded habitable

305
00:10:53,490 --> 00:10:51,519
zone or hydrogen dominated atmospheres

306
00:10:55,470 --> 00:10:53,500
that might maintain liquid water oceans

307
00:10:57,480 --> 00:10:55,480
far far away from the star and outside

308
00:11:00,749 --> 00:10:57,490
the classical or canonical or past

309
00:11:01,620 --> 00:11:00,759
accountable zone and I think that you

310
00:11:02,910 --> 00:11:01,630
know there might be room for a

311
00:11:05,009 --> 00:11:02,920
discussion about a better term than

312
00:11:06,960 --> 00:11:05,019
habitable zone because we're really

313
00:11:09,449 --> 00:11:06,970

referring to there is a specific

314
00:11:11,249 --> 00:11:09,459
type of habitability that allows us to

315
00:11:13,230 --> 00:11:11,259
probe that planet from life from far

316
00:11:16,559 --> 00:11:13,240
away and what that really means is a

317
00:11:19,530 --> 00:11:16,569
planet that has or can maintain a large

318
00:11:21,090 --> 00:11:19,540
enough biosphere to produce a very large

319
00:11:24,059 --> 00:11:21,100
atmospheric or at least spectroscopic

320
00:11:25,710 --> 00:11:24,069
signature that can be seen through all

321
00:11:27,059 --> 00:11:25,720
the noise provided by the star because

322
00:11:29,009 --> 00:11:27,069
the stars much brighter than the planet

323
00:11:30,990 --> 00:11:29,019
to the planet the planet the biosphere

324
00:11:32,879 --> 00:11:31,000
better be producing a whopping big

325
00:11:34,379 --> 00:11:32,889
signature if we're going to be able to

326
00:11:36,360 --> 00:11:34,389
see it from far away against the

327
00:11:37,829 --> 00:11:36,370
background of the star and all of the

328
00:11:40,769 --> 00:11:37,839
things that the planet is doing that arc

329
00:11:41,910 --> 00:11:40,779
biology so that's why we have focused on

330
00:11:43,619 --> 00:11:41,920
liquid water it's not because we're

331
00:11:45,389 --> 00:11:43,629
excluding other kinds of life it's

332
00:11:47,369 --> 00:11:45,399
because we know how to detect that and

333
00:11:48,900 --> 00:11:47,379
it's going to be frankly a lot easier to

334
00:11:51,449 --> 00:11:48,910
detect even if we had some theoretical

335
00:11:53,999 --> 00:11:51,459
way to detect non-water based life or

336
00:11:55,710 --> 00:11:54,009
non certain on surface biospheres the

337
00:11:58,050 --> 00:11:55,720
habitability factor is basically a

338
00:12:00,269 --> 00:11:58,060

quantitative means of assessing the

339
00:12:01,860 --> 00:12:00,279
likelihood that a planet has liquid

340
00:12:03,769 --> 00:12:01,870
water and if we want to go beyond liquid

341
00:12:06,059 --> 00:12:03,779
water which I think we should get to

342
00:12:07,829 --> 00:12:06,069
also those factors as well so

343
00:12:09,869 --> 00:12:07,839
habitability fact you could imagine it

344
00:12:11,460 --> 00:12:09,879
as integrating over all the parameter

345
00:12:13,530 --> 00:12:11,470
space of a particular planet and

346
00:12:15,299 --> 00:12:13,540
assessing the likelihood at that planet

347
00:12:17,999 --> 00:12:15,309
has life or at least has the conditions

348
00:12:20,639 --> 00:12:18,009
amenable to life okay so here are some

349
00:12:22,230 --> 00:12:20,649
sub questions on subtopic aids so this

350
00:12:23,819 --> 00:12:22,240
would be the next thing in each sub

351
00:12:25,499 --> 00:12:23,829
topic you'll have an explanation and

352
00:12:28,710 --> 00:12:25,509
then you'll have the sub questions for

353
00:12:30,420 --> 00:12:28,720
that sub topic so one is how can we

354
00:12:32,160 --> 00:12:30,430
improve characterization method so as

355
00:12:34,139 --> 00:12:32,170
not to miss detection of surface liquid

356
00:12:35,790 --> 00:12:34,149
water so this is you know we don't want

357
00:12:37,619 --> 00:12:35,800
to have a false negative we don't want

358
00:12:40,139 --> 00:12:37,629
to look at a planet say it doesn't have

359
00:12:41,819 --> 00:12:40,149
water and when in fact it does because

360
00:12:44,610 --> 00:12:41,829
that might be one of our butter planets

361
00:12:46,019 --> 00:12:44,620
to do follow-up observations of can we

362
00:12:47,549 --> 00:12:46,029
define habitability factor which is

363
00:12:49,379 --> 00:12:47,559

something i just discussed that

364
00:12:51,269 --> 00:12:49,389
encompasses planetary characteristics

365
00:12:52,740 --> 00:12:51,279
and planet star and planet planetary

366
00:12:55,350 --> 00:12:52,750
system interactions to inform the

367
00:12:57,540 --> 00:12:55,360
relatively likelihood I need to rephrase

368
00:12:59,999 --> 00:12:57,550
that that the planet is habitable so

369
00:13:01,559 --> 00:13:00,009
this is all about the you know again

370
00:13:03,480 --> 00:13:01,569
that sort of quantitative assessment

371
00:13:05,970 --> 00:13:03,490
incorporating as much as we possibly can

372
00:13:08,280 --> 00:13:05,980
into whether or not a planet can

373
00:13:10,769 --> 00:13:08,290
potentially Harbor a global detectable

374
00:13:12,509 --> 00:13:10,779
biosphere lastly what are the potential

375
00:13:13,319 --> 00:13:12,519
extensions to the habitable zone are

376
00:13:15,030 --> 00:13:13,329
they associated with different

377
00:13:16,889 --> 00:13:15,040
habitability signatures and different

378
00:13:18,389 --> 00:13:16,899
biosignatures so this is where we start

379
00:13:19,750 --> 00:13:18,399
to blend the two together you know

380
00:13:21,640 --> 00:13:19,760
people are talking about it

381
00:13:24,130 --> 00:13:21,650
own planet that's really dry and it

382
00:13:26,260 --> 00:13:24,140
suppresses some of the positive feedback

383
00:13:28,510 --> 00:13:26,270
loops involving water that can cause

384
00:13:32,140 --> 00:13:28,520
apply the free is over or to steam away

385
00:13:33,520 --> 00:13:32,150
if if that planet is habitable maybe it

386
00:13:36,330 --> 00:13:33,530
has a different type of bio signature

387
00:13:38,530 --> 00:13:36,340
than a wet planet like modern art has

388
00:13:40,060 --> 00:13:38,540

likewise if a planet has a hydrogen

389
00:13:41,350 --> 00:13:40,070
dominated biosphere doesn't have

390
00:13:43,210 --> 00:13:41,360
different bio signatures there's

391
00:13:45,190 --> 00:13:43,220
actually I think a really nice paper by

392
00:13:46,930 --> 00:13:45,200
Sara Seager about this a couple weeks

393
00:13:48,880 --> 00:13:46,940
ago I think it was a nap shape but I'm

394
00:13:52,000 --> 00:13:48,890
forgetting exactly where it appeared you

395
00:13:52,960 --> 00:13:52,010
can look it up google it but these are

396
00:13:54,340 --> 00:13:52,970
the types of questions you want to

397
00:13:56,230 --> 00:13:54,350
answer not just as a planet habitable

398
00:13:58,630 --> 00:13:56,240
but what is that what did the

399
00:14:00,280 --> 00:13:58,640
constraints on habitability mean for the

400
00:14:02,800 --> 00:14:00,290
bio signatures and that's where subtopic

401
00:14:04,830 --> 00:14:02,810
80 and so topic d start to me so

402
00:14:06,820 --> 00:14:04,840
subtopic b is about that search for life

403
00:14:08,260 --> 00:14:06,830
detecting the presence of life on an

404
00:14:10,870 --> 00:14:08,270
extra sort and snare back at the

405
00:14:12,670 --> 00:14:10,880
explanation part of the subtopic

406
00:14:14,140 --> 00:14:12,680
detecting the presence of life on an

407
00:14:16,480 --> 00:14:14,150
extrasolar planet requires understanding

408
00:14:18,580 --> 00:14:16,490
life scorable impact on its environment

409
00:14:20,290 --> 00:14:18,590
for a variety of different energy

410
00:14:21,970 --> 00:14:20,300
metabolisms and planetary environments

411
00:14:24,490 --> 00:14:21,980
and i'm going to define metabolisms at

412
00:14:26,350 --> 00:14:24,500
the end here we mean something specific

413
00:14:28,480 --> 00:14:26,360

which isn't always a biologist mean sort

414
00:14:30,820 --> 00:14:28,490
of the net chemical reaction that life

415
00:14:34,210 --> 00:14:30,830
does or the net chemical reactions life

416
00:14:36,670 --> 00:14:34,220
do not all the network of reactions that

417
00:14:38,380 --> 00:14:36,680
occur inside a cell that causes

418
00:14:40,660 --> 00:14:38,390
confusion sometimes so like for example

419
00:14:42,490 --> 00:14:40,670
metabolisms we mean methanogenesis or

420
00:14:44,950 --> 00:14:42,500
oxygenic photosynthesis or nitrogen

421
00:14:47,440 --> 00:14:44,960
fixation we want to know the process of

422
00:14:49,000 --> 00:14:47,450
the biota or the ecosystem is imparting

423
00:14:51,220 --> 00:14:49,010
on to the atmosphere and onto the

424
00:14:53,080 --> 00:14:51,230
external environment what's going on

425
00:14:54,190 --> 00:14:53,090
inside the cell I shouldn't say we don't

426
00:14:57,040 --> 00:14:54,200
care about because we care a great deal

427
00:14:58,750 --> 00:14:57,050
about it but for the most part in our

428
00:15:00,850 --> 00:14:58,760
models and in our considerations it's a

429
00:15:02,650 --> 00:15:00,860
black box and so long as the biologists

430
00:15:04,810 --> 00:15:02,660
are understanding and characterizing

431
00:15:07,210 --> 00:15:04,820
that black that black box accurately and

432
00:15:09,520 --> 00:15:07,220
as completely as possible then then

433
00:15:11,980 --> 00:15:09,530
we're quite happy with it although you

434
00:15:13,270 --> 00:15:11,990
know other people might might have

435
00:15:15,430 --> 00:15:13,280
different opinions on that but that's

436
00:15:17,050 --> 00:15:15,440
sort of my take the search for life

437
00:15:19,410 --> 00:15:17,060
whether in tissue or remote requires

438
00:15:22,720 --> 00:15:19,420

prioritization in other words were

439
00:15:24,670 --> 00:15:22,730
literally in a world in a galaxy with 10

440
00:15:26,470 --> 00:15:24,680
billion extrasolar planets that might be

441
00:15:30,580 --> 00:15:26,480
habitable which ones do you look at

442
00:15:32,830 --> 00:15:30,590
first so the sub questions for subtopic

443
00:15:33,610 --> 00:15:32,840
be metabolism environment connections

444
00:15:36,190 --> 00:15:33,620
how to improve

445
00:15:37,780 --> 00:15:36,200
understanding and prioritize targets so

446
00:15:40,000 --> 00:15:37,790
that's what I was just referring to

447
00:15:42,670 --> 00:15:40,010
detectability what's the most easily

448
00:15:44,590 --> 00:15:42,680
observable biosignatures if ozone and

449
00:15:45,910 --> 00:15:44,600
oxygen and methane which are sort of the

450
00:15:47,890 --> 00:15:45,920
traditional ones if there are the most

451
00:15:50,170 --> 00:15:47,900
easily observable ones or the most

452
00:15:51,490 --> 00:15:50,180
characterized ones then those are two

453
00:15:55,150 --> 00:15:51,500
two or three the ones and we're going to

454
00:15:56,980 --> 00:15:55,160
look at first and we also have to keep

455
00:15:58,840 --> 00:15:56,990
in mind technology right we there are

456
00:16:00,550 --> 00:15:58,850
some great proposals for biosignatures

457
00:16:03,670 --> 00:16:00,560
out there and ones that have been used

458
00:16:05,530 --> 00:16:03,680
to I think pretty good success here on

459
00:16:06,700 --> 00:16:05,540
earth and either are being used or will

460
00:16:08,680 --> 00:16:06,710
be used on the near term and Mars

461
00:16:10,540 --> 00:16:08,690
isotopic fractionation is a great

462
00:16:13,720 --> 00:16:10,550
example and maybe one day they'll be

463
00:16:15,790 --> 00:16:13,730

used in other solar system targets but a

464
00:16:18,610 --> 00:16:15,800
lot of those signatures aren't going to

465
00:16:21,040 --> 00:16:18,620
be in a capable of being applied to

466
00:16:22,300 --> 00:16:21,050
these remote observations especially

467
00:16:23,890 --> 00:16:22,310
when you get into like ionized

468
00:16:25,390 --> 00:16:23,900
diffraction you're just not going to be

469
00:16:27,310 --> 00:16:25,400
able to apply that to an extrasolar

470
00:16:28,720 --> 00:16:27,320
planet until they get enough money and

471
00:16:30,250 --> 00:16:28,730
fuel the Senate probe there and that I

472
00:16:32,590 --> 00:16:30,260
definitely don't plan on being alive

473
00:16:33,790 --> 00:16:32,600
that long and I definitely don't plan on

474
00:16:36,550 --> 00:16:33,800
being alive long enough for the probe to

475
00:16:37,810 --> 00:16:36,560
reach the planet so robots combination

476
00:16:39,280 --> 00:16:37,820
of wavelength ranges and spectral

477
00:16:40,990 --> 00:16:39,290
features to target because keep in mind

478
00:16:42,550 --> 00:16:41,000
pretty much until we said that probe all

479
00:16:43,930 --> 00:16:42,560
we're getting is a spectrum different

480
00:16:45,579 --> 00:16:43,940
colors of light and we're analyzing

481
00:16:47,470 --> 00:16:45,589
those different colors to find out what

482
00:16:49,720 --> 00:16:47,480
chemicals are in the atmosphere what's

483
00:16:52,030 --> 00:16:49,730
on surface and what those two things

484
00:16:54,130 --> 00:16:52,040
mean for the the presence of life on the

485
00:16:55,840 --> 00:16:54,140
planet and then lastly a topic near and

486
00:16:57,970 --> 00:16:55,850
dear to my own heart false positives and

487
00:16:59,710 --> 00:16:57,980
false negatives we neither we need to

488
00:17:02,260 --> 00:16:59,720

look at all the possibilities for a

489
00:17:04,000 --> 00:17:02,270
living planet to make us think that is

490
00:17:06,520 --> 00:17:04,010
dead because it doesn't have the bio

491
00:17:08,140 --> 00:17:06,530
signatures that we're looking for and we

492
00:17:09,819 --> 00:17:08,150
also want to avoid the case where a dead

493
00:17:12,429 --> 00:17:09,829
planet has geological or other

494
00:17:14,500 --> 00:17:12,439
non-biological processes that generate

495
00:17:17,140 --> 00:17:14,510
either the gases that we're looking for

496
00:17:19,270 --> 00:17:17,150
so you could imagine a planet that

497
00:17:22,090 --> 00:17:19,280
generates oxygen or ozone or methane

498
00:17:24,579 --> 00:17:22,100
that imparts that signature on to the

499
00:17:26,980 --> 00:17:24,589
atmosphere and also the possibility that

500
00:17:28,630 --> 00:17:26,990
that planet can generate other gases

501
00:17:30,549 --> 00:17:28,640
that happen to have a similar absorption

502
00:17:31,930 --> 00:17:30,559
feature especially when our first

503
00:17:34,240 --> 00:17:31,940
observations aren't going to have an

504
00:17:35,799 --> 00:17:34,250
extremely high resolution spectral

505
00:17:38,049 --> 00:17:35,809
resolution so in other words if you've

506
00:17:39,130 --> 00:17:38,059
got two gases oxygen and I can't think

507
00:17:40,299 --> 00:17:39,140
of another example off the top of my

508
00:17:42,370 --> 00:17:40,309
head and they absorb it the same

509
00:17:43,810 --> 00:17:42,380
wavelength of light the measurement

510
00:17:45,220 --> 00:17:43,820
you're making is absorption at that

511
00:17:47,350 --> 00:17:45,230
wavelength of light and if you've got

512
00:17:49,930 --> 00:17:47,360
that other guests that non biosignature

513
00:17:51,430 --> 00:17:49,940

the atmosphere it could for all for all

514
00:17:53,799 --> 00:17:51,440
the purposes that we're using it for

515
00:17:56,530 --> 00:17:53,809
look like the bio signature and so we

516
00:17:57,940 --> 00:17:56,540
want to at least be capable of

517
00:17:59,950 --> 00:17:57,950
understanding those so we have ways to

518
00:18:02,530 --> 00:17:59,960
discriminate between the false positives

519
00:18:03,760 --> 00:18:02,540
in the true positives okay so things to

520
00:18:04,870 --> 00:18:03,770
work on under coming ten years I've

521
00:18:06,669 --> 00:18:04,880
probably talked about a lot of this

522
00:18:08,799 --> 00:18:06,679
already we want this quantitative

523
00:18:10,450 --> 00:18:08,809
habitability factor given that

524
00:18:12,280 --> 00:18:10,460
habitability factor we want the bio

525
00:18:13,539 --> 00:18:12,290
signatures for that specific planet

526
00:18:15,400 --> 00:18:13,549
given the constraints from the

527
00:18:17,200 --> 00:18:15,410
habitability assessment we want a

528
00:18:18,850 --> 00:18:17,210
comprehensive catalog of bio signatures

529
00:18:21,100 --> 00:18:18,860
as well as false positives and negatives

530
00:18:23,590 --> 00:18:21,110
for those bio signatures and for those

531
00:18:25,360 --> 00:18:23,600
biospheres we started suppression

532
00:18:27,310 --> 00:18:25,370
technology so we haven't talked a lot

533
00:18:29,380 --> 00:18:27,320
about technology and in general we're

534
00:18:31,120 --> 00:18:29,390
avoiding that in the roadmap we put this

535
00:18:33,370 --> 00:18:31,130
one bullet point in here because it's so

536
00:18:35,260 --> 00:18:33,380
critical we need better starlight

537
00:18:37,630 --> 00:18:35,270
suppression technology so we can

538
00:18:39,460 --> 00:18:37,640

directly image these planets that's

539
00:18:41,620 --> 00:18:39,470
going to be the best way to get the data

540
00:18:43,960 --> 00:18:41,630
that we want to assess habitability and

541
00:18:45,880 --> 00:18:43,970
to assess the presence of life otherwise

542
00:18:48,220 --> 00:18:45,890
there's almost no way to do it we can do

543
00:18:49,390 --> 00:18:48,230
it with transit spectroscopy that's only

544
00:18:52,270 --> 00:18:49,400
going to probe the upper part of the

545
00:18:54,039 --> 00:18:52,280
atmosphere and so almost this is one of

546
00:18:56,500 --> 00:18:54,049
those fields where you sort of have this

547
00:18:59,110 --> 00:18:56,510
one call pole technol technology wise

548
00:19:00,789 --> 00:18:59,120
that is going to hold all of our other

549
00:19:02,470 --> 00:19:00,799
research up for quite some time in my

550
00:19:04,600 --> 00:19:02,480
opinion everything else is going to be

551
00:19:06,549 --> 00:19:04,610
theoretical until we get the the

552
00:19:08,049 --> 00:19:06,559
starlight suppression down to about

553
00:19:10,299 --> 00:19:08,059
usually the numbers like ten to the

554
00:19:12,430 --> 00:19:10,309
tenth so the basically we have to

555
00:19:14,740 --> 00:19:12,440
suppress the starlight by a factor of

556
00:19:16,090 --> 00:19:14,750
ten to the tenth more than we suppress

557
00:19:18,130 --> 00:19:16,100
the light coming from the plan the plan

558
00:19:19,480 --> 00:19:18,140
white and that'll let us image the

559
00:19:21,130 --> 00:19:19,490
planet and then do all the wonderful

560
00:19:24,549 --> 00:19:21,140
things we're talking about in this

561
00:19:26,470 --> 00:19:24,559
presentation understanding the

562
00:19:28,720 --> 00:19:26,480
information content of planetary spectra

563
00:19:30,549 --> 00:19:28,730

including methods to retrieve on first

564
00:19:32,650 --> 00:19:30,559
surface properties relevant habitability

565
00:19:34,690 --> 00:19:32,660
particularly surface liquid water so

566
00:19:36,700 --> 00:19:34,700
we'd like to have some way to not just

567
00:19:38,230 --> 00:19:36,710
have a spectrum come in and say oh that

568
00:19:40,180 --> 00:19:38,240
looks like it has oxygen and that looks

569
00:19:42,400 --> 00:19:40,190
like it has carbon dioxide we'd like to

570
00:19:44,890 --> 00:19:42,410
have some rigorous and robust

571
00:19:46,480 --> 00:19:44,900
methodology that will do that as the

572
00:19:48,370 --> 00:19:46,490
data come in because otherwise we're at

573
00:19:51,490 --> 00:19:48,380
the imposing our own hypotheses on that

574
00:19:54,000 --> 00:19:51,500
planet on to our analyses and lastly

575
00:19:55,750 --> 00:19:54,010
compared to climb ecology our super is

576
00:19:57,700 --> 00:19:55,760
inhabiting a beautiful are they

577
00:19:59,669 --> 00:19:57,710
inhabited these are the types of things

578
00:20:01,240 --> 00:19:59,679
we can get at if we've got good models

579
00:20:06,100 --> 00:20:01,250
that can

580
00:20:09,400 --> 00:20:06,110
also Mars and Venus and guest ideally

581
00:20:11,230 --> 00:20:09,410
the gas giants Titan and the entire

582
00:20:13,360 --> 00:20:11,240
history of those planets because if we

583
00:20:15,730 --> 00:20:13,370
have a model that can do these things we

584
00:20:17,080 --> 00:20:15,740
have more confidence that it can do sort

585
00:20:19,270 --> 00:20:17,090
of in between planets right if you've

586
00:20:21,280 --> 00:20:19,280
got a model that can do earth they can

587
00:20:22,810 --> 00:20:21,290
also do a gas giant well you have a

588
00:20:24,670 --> 00:20:22,820

little bit more confidence that could it

589
00:20:26,530 --> 00:20:24,680
can do the in between cases of super

590
00:20:29,170 --> 00:20:26,540
earth planets then you would if the

591
00:20:30,160 --> 00:20:29,180
model was just validated against her the

592
00:20:31,630 --> 00:20:30,170
other thing we need in terms of

593
00:20:33,670 --> 00:20:31,640
comparative climate ology is not just

594
00:20:36,340 --> 00:20:33,680
comparing one models results on

595
00:20:38,350 --> 00:20:36,350
different planets but also comparing

596
00:20:39,880 --> 00:20:38,360
different models on the same plan right

597
00:20:42,460 --> 00:20:39,890
this is something that earth scientists

598
00:20:44,260 --> 00:20:42,470
have done very successfully in the IPCC

599
00:20:47,260 --> 00:20:44,270
the Intergovernmental Panel on Climate

600
00:20:48,550 --> 00:20:47,270
Change for well over a decade now and I

601
00:20:51,160 --> 00:20:48,560
think we need to take their lead and

602
00:20:54,130 --> 00:20:51,170
start comparing our different models for

603
00:20:56,380 --> 00:20:54,140
terrestrial planets inside and being on

604
00:20:57,790 --> 00:20:56,390
our solar system so we better understand

605
00:20:59,740 --> 00:20:57,800
the uncertainties and all these

606
00:21:01,930 --> 00:20:59,750
different models their uncertainty is as

607
00:21:04,690 --> 00:21:01,940
a suite of models and so that we can

608
00:21:07,570 --> 00:21:04,700
start understanding which parts of which

609
00:21:08,890 --> 00:21:07,580
models seem to perform the best and then

610
00:21:10,690 --> 00:21:08,900
once you start doing that you can start

611
00:21:12,190 --> 00:21:10,700
you know swap and come out a little bit

612
00:21:14,950 --> 00:21:12,200
and there's danger there because

613
00:21:16,480 --> 00:21:14,960

sometimes that means you're all using

614
00:21:18,430 --> 00:21:16,490
each other's code to the point where all

615
00:21:20,080 --> 00:21:18,440
the models become homogeneous which is a

616
00:21:21,100 --> 00:21:20,090
problem sometimes in the rent sciences

617
00:21:23,380 --> 00:21:21,110
community and that's something we need

618
00:21:25,120 --> 00:21:23,390
to be cognizant on but the brighter side

619
00:21:29,050 --> 00:21:25,130
of that is the best code in the long run

620
00:21:30,490 --> 00:21:29,060
will went out and so will happen if we

621
00:21:32,590 --> 00:21:30,500
keep innovating and coming up with new

622
00:21:34,690 --> 00:21:32,600
ideas especially for the weak points

623
00:21:38,200 --> 00:21:34,700
like clouds or whatnot that will improve

624
00:21:40,270 --> 00:21:38,210
our community in the long run okay so

625
00:21:42,310 --> 00:21:40,280
connections to other questions this is

626
00:21:44,410 --> 00:21:42,320
again the next and I should say if you

627
00:21:46,960 --> 00:21:44,420
see something big up in the topic part

628
00:21:49,120 --> 00:21:46,970
of these slides that's another step in

629
00:21:50,830 --> 00:21:49,130
the template another top headline in the

630
00:21:53,590 --> 00:21:50,840
template so connections to other

631
00:21:55,270 --> 00:21:53,600
questions these are the ones we just

632
00:21:57,550 --> 00:21:55,280
pulled off of the document how we

633
00:21:58,840 --> 00:21:57,560
remotely find and identify an inhabited

634
00:22:01,270 --> 00:21:58,850
planet so that there's obvious

635
00:22:02,830 --> 00:22:01,280
connections there how can a world

636
00:22:04,030 --> 00:22:02,840
generate and support life and how can we

637
00:22:05,950 --> 00:22:04,040
use remote characterization to

638
00:22:07,120 --> 00:22:05,960

understand such worlds again that's a

639
00:22:09,160 --> 00:22:07,130
lot of the techniques we've been

640
00:22:10,870 --> 00:22:09,170
discussing today how do habitable

641
00:22:12,370 --> 00:22:10,880
planetary systems form that's sort of

642
00:22:14,500 --> 00:22:12,380
how did we how did the planets get there

643
00:22:15,039 --> 00:22:14,510
and it also helps to some degree because

644
00:22:17,529 --> 00:22:15,049
it's similar

645
00:22:19,989 --> 00:22:17,539
tools to analyzing the planet planet

646
00:22:22,119 --> 00:22:19,999
interaction parts of habitability it

647
00:22:24,669 --> 00:22:22,129
also can impact the history the

648
00:22:26,619 --> 00:22:24,679
habitable history of that planet so the

649
00:22:28,359 --> 00:22:26,629
roy barnes and brian jackson have done

650
00:22:30,700 --> 00:22:28,369
some interesting work about planets that

651
00:22:32,350 --> 00:22:30,710
may be in habitable zone now but what

652
00:22:34,029 --> 00:22:32,360
actually Stephen Cain and some other

653
00:22:36,070 --> 00:22:34,039
people out in California have done this

654
00:22:38,649 --> 00:22:36,080
where you have systems that may be

655
00:22:39,700 --> 00:22:38,659
habitable now but have had parts of

656
00:22:42,129 --> 00:22:39,710
their histories where they had gone

657
00:22:43,779 --> 00:22:42,139
through uninhabitable phase space and

658
00:22:45,310 --> 00:22:43,789
you'd like to identify those ahead of

659
00:22:47,379 --> 00:22:45,320
time as you can and it's the same tools

660
00:22:50,200 --> 00:22:47,389
as how the habitable planetary systems

661
00:22:52,060 --> 00:22:50,210
form people use at least subsets at both

662
00:22:53,590 --> 00:22:52,070
tools are the same what is the

663
00:22:55,359 --> 00:22:53,600

applicability of our geophysical

664
00:22:57,220 --> 00:22:55,369
knowledge of birth of rocky exoplanets I

665
00:22:59,649 --> 00:22:57,230
personally this isn't an area of

666
00:23:01,570 --> 00:22:59,659
research that I pursue but I have always

667
00:23:03,039 --> 00:23:01,580
maintained that this is one of our

668
00:23:05,739 --> 00:23:03,049
biggest unknowns when it comes to

669
00:23:08,470 --> 00:23:05,749
exoplanet research how important is it

670
00:23:09,970 --> 00:23:08,480
to have any kind of tectonics you know

671
00:23:11,560 --> 00:23:09,980
whether it's plate tectonics like we

672
00:23:13,779 --> 00:23:11,570
have on earth or some sort of lid or

673
00:23:16,359 --> 00:23:13,789
overturn tectonics like we have on Venus

674
00:23:18,840 --> 00:23:16,369
or pipe vulcanism like we have an IL it

675
00:23:21,940 --> 00:23:18,850
first of all how important is tektronix

676
00:23:24,909 --> 00:23:21,950
? what controls whether or not a planet

677
00:23:27,729 --> 00:23:24,919
has tectonics what do the different

678
00:23:29,739 --> 00:23:27,739
types of tectonic regimes imply for

679
00:23:31,989 --> 00:23:29,749
habitability and what controls that what

680
00:23:34,749 --> 00:23:31,999
controls whether your plate over turn or

681
00:23:36,700 --> 00:23:34,759
pipe vulcanism right people have started

682
00:23:38,529 --> 00:23:36,710
to look at this just over the last

683
00:23:40,479 --> 00:23:38,539
decade but I think that that research is

684
00:23:42,940 --> 00:23:40,489
still pretty new and I think there's a

685
00:23:44,499 --> 00:23:42,950
lot of room to improve on that and it's

686
00:23:45,999 --> 00:23:44,509
not because people haven't done good

687
00:23:48,430 --> 00:23:46,009
work it done excellent work but we're

688
00:23:49,749 --> 00:23:48,440

just getting started as a community how

689
00:23:51,940 --> 00:23:49,759
can we enhance the utility of bio

690
00:23:53,200 --> 00:23:51,950
signatures that's obvious right we if

691
00:23:54,519 --> 00:23:53,210
we're going to look for life we want to

692
00:23:57,580 --> 00:23:54,529
make sure that these bio signatures are

693
00:23:58,930 --> 00:23:57,590
robust how did the evolution of the

694
00:24:01,389 --> 00:23:58,940
atmosphere and its interactions with the

695
00:24:04,139 --> 00:24:01,399
solid earth and biosphere inform our

696
00:24:06,220 --> 00:24:04,149
exploration of habitable worlds and this

697
00:24:07,960 --> 00:24:06,230
is similar to the thing I said a couple

698
00:24:09,970 --> 00:24:07,970
points above right like you want to know

699
00:24:11,409 --> 00:24:09,980
how the mantle the redox state of the

700
00:24:13,570 --> 00:24:11,419
mantle the chemical composition of the

701
00:24:15,909 --> 00:24:13,580
mantle affects the atmosphere you'd also

702
00:24:18,999 --> 00:24:15,919
like to know the opposite how does this

703
00:24:21,310 --> 00:24:19,009
the carbonate silicate feedback cycle

704
00:24:23,440 --> 00:24:21,320
work and a very generic sense are there

705
00:24:25,840 --> 00:24:23,450
other carbonate silicate like feedback

706
00:24:28,480 --> 00:24:25,850
cycles then that's the the mechanism by

707
00:24:28,960 --> 00:24:28,490
which the lithosphere the rocky part of

708
00:24:31,240 --> 00:24:28,970
the restore

709
00:24:34,510 --> 00:24:31,250
acted as a thermostat over long time

710
00:24:36,100 --> 00:24:34,520
periods of Earth's surface habitable are

711
00:24:38,169 --> 00:24:36,110
there other versions of that that apply

712
00:24:39,640 --> 00:24:38,179
to exoplanets with different rock

713
00:24:41,440 --> 00:24:39,650

composition or different atmospheric

714
00:24:42,640 --> 00:24:41,450
composition these are the types of

715
00:24:47,260 --> 00:24:42,650
things I'd like to hear a lot more

716
00:24:49,870 --> 00:24:47,270
people doing research on John explained

717
00:24:51,430 --> 00:24:49,880
to him in there I just want to jump in

718
00:24:53,560 --> 00:24:51,440
to note these are the these questions

719
00:24:55,810 --> 00:24:53,570
that are all explored and more detail in

720
00:24:58,750 --> 00:24:55,820
the other white paper ducks so these are

721
00:25:01,840 --> 00:24:58,760
guys that has sort of documents right

722
00:25:03,730 --> 00:25:01,850
I'm trying to I guess just describe the

723
00:25:04,870 --> 00:25:03,740
relationship between this end and then

724
00:25:06,640 --> 00:25:04,880
highlighting there is where I think

725
00:25:10,750 --> 00:25:06,650
there's there's a particular relevancy

726
00:25:13,000 --> 00:25:10,760
and especially when it's not obvious how

727
00:25:14,620 --> 00:25:13,010
can we understand her past present and

728
00:25:18,820 --> 00:25:14,630
future as proxies for habitable worlds

729
00:25:20,320 --> 00:25:18,830
this is an area of work where I think

730
00:25:22,090 --> 00:25:20,330
it's particularly related to the false

731
00:25:24,340 --> 00:25:22,100
positives and false negatives if you

732
00:25:26,470 --> 00:25:24,350
want to look at a weird biosphere in my

733
00:25:28,330 --> 00:25:26,480
mind the best place to go is early Earth

734
00:25:29,740 --> 00:25:28,340
when the basket was weird and yet we

735
00:25:32,470 --> 00:25:29,750
know it existed and we know it worked

736
00:25:34,600 --> 00:25:32,480
because there's lots of rock data that

737
00:25:36,220 --> 00:25:34,610
are telling us all those things and

738
00:25:38,620 --> 00:25:36,230

what's more because the rock data are

739
00:25:40,419 --> 00:25:38,630
there we can do the scientific method we

740
00:25:42,190 --> 00:25:40,429
can propose hypotheses for how those

741
00:25:44,770 --> 00:25:42,200
vows that biosphere work at that time

742
00:25:48,399 --> 00:25:44,780
and test them with further examinations

743
00:25:49,480 --> 00:25:48,409
of the rock record and all of those

744
00:25:51,220 --> 00:25:49,490
lessons are going to be applied to

745
00:25:53,080 --> 00:25:51,230
exoplanets because you have a different

746
00:25:54,760 --> 00:25:53,090
biosphere you know work you want to

747
00:25:56,760 --> 00:25:54,770
examine it in great detail it's um I

748
00:25:59,560 --> 00:25:56,770
always say the early Earth is the best

749
00:26:02,049 --> 00:25:59,570
and most complete record of an alien

750
00:26:03,549 --> 00:26:02,059
biosphere that we have and how can we

751
00:26:06,789 --> 00:26:03,559
identify habitable environments in the

752
00:26:08,830 --> 00:26:06,799
solar system the lessons we learn by

753
00:26:10,360 --> 00:26:08,840
searching for habitable environments and

754
00:26:12,789 --> 00:26:10,370
searching for life whether it's on early

755
00:26:13,930 --> 00:26:12,799
Earth or other planets are always going

756
00:26:16,930 --> 00:26:13,940
to be applicable to our search elsewhere

757
00:26:20,350 --> 00:26:16,940
I think the case of false positives and

758
00:26:22,510 --> 00:26:20,360
false negatives has tremendous analogs

759
00:26:24,159 --> 00:26:22,520
and parallel stories in our search for

760
00:26:27,310 --> 00:26:24,169
the earliest life on Earth and in our

761
00:26:29,649 --> 00:26:27,320
search for life on other planets and we

762
00:26:32,409 --> 00:26:29,659
could go on a long detail about that but

763
00:26:34,600 --> 00:26:32,419

I should be quiet soon so Nancy and Ty

764
00:26:36,100 --> 00:26:34,610
and if one else can talk okay then

765
00:26:37,779 --> 00:26:36,110
there's a glossary and I promise the

766
00:26:40,120 --> 00:26:37,789
definition of metabolism there it is I

767
00:26:42,220 --> 00:26:40,130
also define the habitable zone because I

768
00:26:45,490 --> 00:26:42,230
want to be explicit about what we mean

769
00:26:46,330 --> 00:26:45,500
in this sort of subsection of the

770
00:26:48,669 --> 00:26:46,340
community when we talk about

771
00:26:50,140 --> 00:26:48,679
habitability and that's not to mean that

772
00:26:52,360 --> 00:26:50,150
we're right and everyone else is wrong

773
00:26:53,980 --> 00:26:52,370
and so this is just how the term is

774
00:26:55,480 --> 00:26:53,990
historical used and I think if people

775
00:26:57,310 --> 00:26:55,490
won't have a discussion about a new term

776
00:26:59,650 --> 00:26:57,320
that explains the same phenomenon I

777
00:27:01,180 --> 00:26:59,660
think that that can be helping but for

778
00:27:02,289 --> 00:27:01,190
context this is the way it's been used

779
00:27:04,590 --> 00:27:02,299
in the past and if you see it in

780
00:27:07,480 --> 00:27:04,600
literature this is how it has business

781
00:27:09,460 --> 00:27:07,490
and metabolism again when we say

782
00:27:11,020 --> 00:27:09,470
metabolism we're looking at what goes

783
00:27:13,750 --> 00:27:11,030
into an organism and what comes out of

784
00:27:15,549 --> 00:27:13,760
an organism on a chemical basis we're

785
00:27:19,299 --> 00:27:15,559
not worried about all the reactions are

786
00:27:21,190 --> 00:27:19,309
crying inside the organism oh and i had

787
00:27:22,539 --> 00:27:21,200
evolution i meant to define evolution

788
00:27:25,090 --> 00:27:22,549

this is something else that often can

789
00:27:27,400 --> 00:27:25,100
cause some Crossfield confusion we don't

790
00:27:29,159 --> 00:27:27,410
always mean Darwinian or Lamarckian or

791
00:27:32,590 --> 00:27:29,169
any other kind of biological evolution

792
00:27:35,560 --> 00:27:32,600
on how organisms evolve over time within

793
00:27:38,110 --> 00:27:35,570
a biosphere we're talking about change

794
00:27:40,120 --> 00:27:38,120
over time just built the property delta

795
00:27:42,549 --> 00:27:40,130
T okay so evolution of a planet you can

796
00:27:44,560 --> 00:27:42,559
have an evolution of a biosphere you can

797
00:27:46,090 --> 00:27:44,570
have evolution of organisms when we use

798
00:27:48,190 --> 00:27:46,100
evolution we don't mean the specific

799
00:27:49,810 --> 00:27:48,200
process that Darwin wrote about so many

800
00:27:51,789 --> 00:27:49,820
years ago we don't have any references

801
00:27:53,620 --> 00:27:51,799
yet so this is blank but I wanted to

802
00:27:55,690 --> 00:27:53,630
include it so people got a feel for what

803
00:27:58,419 --> 00:27:55,700
the new template look like and then I

804
00:28:00,130 --> 00:27:58,429
think this is this is the last slide

805
00:28:02,770 --> 00:28:00,140
that's part of the template the authors

806
00:28:04,360 --> 00:28:02,780
um I've been talking and running over

807
00:28:06,220 --> 00:28:04,370
Nancy and time so I apologize for that

808
00:28:09,460 --> 00:28:06,230
but Nancy and I've done a lot of great

809
00:28:10,870 --> 00:28:09,470
work on this time particular really dr.

810
00:28:13,180 --> 00:28:10,880
document into shape over the past

811
00:28:15,190 --> 00:28:13,190
weekend Brittany Schmidt and Steve Vance

812
00:28:18,280 --> 00:28:15,200
and Robin Wordsworth and Dave dem array

813
00:28:20,470 --> 00:28:18,290

and Roger Brockman and Vicky meadows are

814
00:28:22,900 --> 00:28:20,480
all part of the larger group that's done

815
00:28:25,270 --> 00:28:22,910
this series of four webinars of which

816
00:28:27,340 --> 00:28:25,280
this is the third on habitability and

817
00:28:29,530 --> 00:28:27,350
the search for life inside and beyond

818
00:28:31,060 --> 00:28:29,540
the solar system I should say that that

819
00:28:33,490 --> 00:28:31,070
Brittany and Steve really did great work

820
00:28:35,590 --> 00:28:33,500
on the very front end of that getting us

821
00:28:37,659 --> 00:28:35,600
organized and splitting a monster

822
00:28:38,919 --> 00:28:37,669
document that we had up into the three

823
00:28:40,690 --> 00:28:38,929
or four documents that we're now

824
00:28:43,510 --> 00:28:40,700
presenting so this really is a team

825
00:28:45,280 --> 00:28:43,520
effort it's been almost all my word so

826
00:28:47,710 --> 00:28:45,290
far but not even close to all my work

827
00:28:50,470 --> 00:28:47,720
it's probably almost the opposite so

828
00:28:52,030 --> 00:28:50,480
with that I will leave you to our last

829
00:28:53,740 --> 00:28:52,040
line which is just encouragement to

830
00:28:55,720 --> 00:28:53,750
check out the document I don't intend

831
00:28:57,010 --> 00:28:55,730
you to read this or to even

832
00:28:59,350 --> 00:28:57,020
be able to make up the individual

833
00:29:00,820 --> 00:28:59,360
characters on your screen this is just

834
00:29:02,230 --> 00:29:00,830
to show you that there still is a lot

835
00:29:04,570 --> 00:29:02,240
more material we have not discussed

836
00:29:05,920 --> 00:29:04,580
today that's in the document and so I

837
00:29:07,870 --> 00:29:05,930
encourage you to go and take a look at

838
00:29:10,120 --> 00:29:07,880

that document and see if we've missed

839
00:29:11,920 --> 00:29:10,130
anything or gotten anything wrong so we

840
00:29:14,490 --> 00:29:11,930
look forward to your feedback guess

841
00:29:18,550 --> 00:29:14,500
starting now if anyone has any questions

842
00:29:20,470 --> 00:29:18,560
well could I suggest that firstly do you

843
00:29:22,390 --> 00:29:20,480
want to address any of the questions

844
00:29:25,360 --> 00:29:22,400
that have been coming up in the chat box

845
00:29:27,280 --> 00:29:25,370
because I can say men seem to be taken

846
00:29:31,480 --> 00:29:27,290
away other things that they worth

847
00:29:33,970 --> 00:29:31,490
expanding a pony right now I would say

848
00:29:36,070 --> 00:29:33,980
let's leave that time an see why don't

849
00:29:37,690 --> 00:29:36,080
you guys start the I have not been able

850
00:29:39,160 --> 00:29:37,700
to see the questions I'm going to stop

851
00:29:43,180 --> 00:29:39,170
sharing my screen shot and i'm going to

852
00:29:45,970 --> 00:29:43,190
send the chat transcript to you Nancy

853
00:29:49,420 --> 00:29:45,980
and ties it's easier greed and email but

854
00:29:51,580 --> 00:29:49,430
that go on in parallel but Nancy Todd

855
00:29:54,840 --> 00:29:51,590
you to want to take over and because i

856
00:30:01,990 --> 00:29:58,120
sergeant note down what questions are in

857
00:30:05,770 --> 00:30:02,000
the chat so Glenn and geo look at a

858
00:30:08,200 --> 00:30:05,780
mismatching wanted a couple of us wanted

859
00:30:10,090 --> 00:30:08,210
to discuss what potentially habitable

860
00:30:12,550 --> 00:30:10,100
environments are we going to miss

861
00:30:16,500 --> 00:30:12,560
because of prioritization for detection

862
00:30:19,090 --> 00:30:16,510
methods that's one question there's a

863
00:30:21,760 --> 00:30:19,100

daisy marie made a suggestion that one

864
00:30:24,100 --> 00:30:21,770
habit habitability factor may be too

865
00:30:26,200 --> 00:30:24,110
restrictive so maybe we might want to

866
00:30:31,930 --> 00:30:26,210
come up with a habitability profile

867
00:30:35,320 --> 00:30:31,940
instead and and i think john rummel was

868
00:30:38,410 --> 00:30:35,330
noting on intelligent life being also

869
00:30:39,910 --> 00:30:38,420
offering off the bio signatures so those

870
00:30:44,500 --> 00:30:39,920
are three prominent questions that came

871
00:30:46,330 --> 00:30:44,510
up in the chat okay um unless there's

872
00:30:51,070 --> 00:30:46,340
anything else you want to say on that

873
00:30:53,920 --> 00:30:51,080
let me encourage our participants the

874
00:30:55,990 --> 00:30:53,930
telephone lines are open if you want

875
00:30:58,660 --> 00:30:56,000
what we've done in the past is you can

876
00:31:00,520 --> 00:30:58,670
click the little hand icon as you see it

877
00:31:03,580 --> 00:31:00,530
we're going to clears next to my name on

878
00:31:05,200 --> 00:31:03,590
you know you want to speak or if you

879
00:31:07,029 --> 00:31:05,210
feel a warm

880
00:31:13,750 --> 00:31:07,039
yes you can just want to stop talking

881
00:31:14,919 --> 00:31:13,760
now good like a hand well let me respond

882
00:31:18,389 --> 00:31:14,929
to one of the things i just heard which

883
00:31:23,590 --> 00:31:18,399
is this idea of a sort of a habitability

884
00:31:25,029 --> 00:31:23,600
was the term profile okay so i think

885
00:31:27,760 --> 00:31:25,039
that's a great idea and the only thing I

886
00:31:29,019 --> 00:31:27,770
I want to be explicit about is I didn't

887
00:31:31,210 --> 00:31:29,029
mean to say you know we should get

888
00:31:34,600 --> 00:31:31,220

together as a community and come up with

889
00:31:36,760 --> 00:31:34,610
one algorithm or one equation to define

890
00:31:38,320 --> 00:31:36,770
the habitability factor I probably

891
00:31:41,799 --> 00:31:38,330
should have said habitability factor is

892
00:31:43,149 --> 00:31:41,809
plural and and by making a single er

893
00:31:44,470 --> 00:31:43,159
I've actually ignored something that

894
00:31:46,389 --> 00:31:44,480
able Mendez has been doing with

895
00:31:49,060 --> 00:31:46,399
coworkers which is he's been coming up

896
00:31:51,240 --> 00:31:49,070
with quite a few different i would say

897
00:31:53,649 --> 00:31:51,250
qualitative for semi quantitative

898
00:31:56,169 --> 00:31:53,659
assessments of potential habitability of

899
00:31:57,820 --> 00:31:56,179
exoplanets and i think that's a great

900
00:31:59,710 --> 00:31:57,830
start I think we need multiple

901
00:32:02,190 --> 00:31:59,720
approaches you know and the more

902
00:32:04,750 --> 00:32:02,200
approaches we have the more our

903
00:32:06,970 --> 00:32:04,760
collective capability is going to be so

904
00:32:09,669 --> 00:32:06,980
you might have one have ability factor

905
00:32:12,580 --> 00:32:09,679
that's really tuned towards how similar

906
00:32:13,899 --> 00:32:12,590
the planet is to Earth in terms of its

907
00:32:15,519 --> 00:32:13,909
potential to have a modern earth

908
00:32:19,060 --> 00:32:15,529
biosphere like you might have another

909
00:32:20,799 --> 00:32:19,070
that is a little bit more aggressive and

910
00:32:22,269 --> 00:32:20,809
a little bit more optimistic if you want

911
00:32:24,399 --> 00:32:22,279
to use up the mystic pessimistic turns

912
00:32:26,019 --> 00:32:24,409
in terms of the hydrogen dominated

913
00:32:28,210 --> 00:32:26,029

biospheres or dry valocer's and things

914
00:32:30,100 --> 00:32:28,220
like that so there might be different

915
00:32:32,620 --> 00:32:30,110
approaches and you might end up having

916
00:32:34,810 --> 00:32:32,630
some catalog of what makes the planet

917
00:32:36,639 --> 00:32:34,820
habitable around it comfortable as Dave

918
00:32:38,380 --> 00:32:36,649
suggested so I think multiple approaches

919
00:32:39,220 --> 00:32:38,390
are good because the different

920
00:32:40,330 --> 00:32:39,230
approaches are going to use for

921
00:32:42,370 --> 00:32:40,340
different things some of them are going

922
00:32:44,110 --> 00:32:42,380
to be is for prioritization some of them

923
00:32:45,909 --> 00:32:44,120
are going to be used for real science

924
00:32:48,190 --> 00:32:45,919
you know where we're trying to classify

925
00:32:51,279 --> 00:32:48,200
these things to a taxonomy of exoplanets

926
00:32:52,769 --> 00:32:51,289
something else able to started to do so

927
00:32:55,389 --> 00:32:52,779
I think different approaches are good

928
00:32:59,980 --> 00:32:55,399
and almost subject of what they said

929
00:33:02,409 --> 00:32:59,990
Dave Thomas yeah well you know now that

930
00:33:04,240 --> 00:33:02,419
you guys have found all these it's huge

931
00:33:06,399 --> 00:33:04,250
potential for habitable planets or

932
00:33:07,990 --> 00:33:06,409
potentially habitable planets you're in

933
00:33:09,730 --> 00:33:08,000
the same situation that the Mars program

934
00:33:12,130 --> 00:33:09,740
was when we found water all over the

935
00:33:13,539 --> 00:33:12,140
place or evidence of it you know and

936
00:33:15,519 --> 00:33:13,549
that is you've got an embarrassment of

937
00:33:16,400 --> 00:33:15,529
riches and as you rightly pointed out

938
00:33:18,790 --> 00:33:16,410

you're going to have to

939
00:33:21,530 --> 00:33:18,800
how to prioritize amongst those riches

940
00:33:25,130 --> 00:33:21,540
the historical precedent for this is

941
00:33:27,140 --> 00:33:25,140
site selection for landing the Curiosity

942
00:33:29,090 --> 00:33:27,150
rover you know and the incredible

943
00:33:32,330 --> 00:33:29,100
exercise that would that we went through

944
00:33:33,890 --> 00:33:32,340
in doing that and I guess where I'm

945
00:33:35,540 --> 00:33:33,900
coming from here is that there were four

946
00:33:37,460 --> 00:33:35,550
sites in the end that y'all just looked

947
00:33:39,890 --> 00:33:37,470
wonderful you know they had evidence of

948
00:33:42,170 --> 00:33:39,900
holding water evidence that it was you

949
00:33:44,630 --> 00:33:42,180
could get hot that were involved and on

950
00:33:46,910 --> 00:33:44,640
and on and on and if you would come up

951
00:33:50,270 --> 00:33:46,920
and you address this saying that you're

952
00:33:51,740 --> 00:33:50,280
having really fact but he just came up

953
00:33:54,260 --> 00:33:51,750
with a single number that would have a

954
00:33:57,140 --> 00:33:54,270
you know rated those they would have all

955
00:33:59,600 --> 00:33:57,150
been the same but by considering all but

956
00:34:01,760 --> 00:33:59,610
at criteria that we consider important

957
00:34:03,440 --> 00:34:01,770
for a site the thing that really made

958
00:34:06,140 --> 00:34:03,450
Gale Crater jump out in front of the

959
00:34:09,320 --> 00:34:06,150
others was this accessibility of a long

960
00:34:12,020 --> 00:34:09,330
record of deposits during a key period

961
00:34:14,030 --> 00:34:12,030
in early Mars history where environment

962
00:34:16,669 --> 00:34:14,040
climate change was really big deal and

963
00:34:18,800 --> 00:34:16,679

that tent pole got so tall compared to

964
00:34:21,490 --> 00:34:18,810
the others that Gale prevailed and so

965
00:34:25,550 --> 00:34:21,500
I'm just saying that in your exoplanet

966
00:34:28,400 --> 00:34:25,560
profiles are you know factors whatever

967
00:34:29,750 --> 00:34:28,410
that you allow that visibility into what

968
00:34:32,060 --> 00:34:29,760
could turn out to be an unanticipated

969
00:34:34,430 --> 00:34:32,070
tall tent pole that would pretty much

970
00:34:35,840 --> 00:34:34,440
Trump a lot of the other things that

971
00:34:39,140 --> 00:34:35,850
otherwise would have given you also

972
00:34:40,850 --> 00:34:39,150
positive factors so just making sure you

973
00:34:42,950 --> 00:34:40,860
have enough resolution but also that

974
00:34:44,360 --> 00:34:42,960
people think about the different apples

975
00:34:46,909 --> 00:34:44,370
oranges and peaches that go into

976
00:34:49,010 --> 00:34:46,919
assessing habitability preparing

977
00:34:51,080 --> 00:34:49,020
yourself for that that star player that

978
00:34:53,390 --> 00:34:51,090
suddenly comes out of the pack well

979
00:34:55,190 --> 00:34:53,400
that's that's what if I to expand on

980
00:34:56,750 --> 00:34:55,200
your analogy a little bit data one of

981
00:34:58,580 --> 00:34:56,760
the other things it seems to be taken

982
00:35:00,260 --> 00:34:58,590
into account and i have was my part of

983
00:35:02,030 --> 00:35:00,270
this like you were but is the other

984
00:35:03,740 --> 00:35:02,040
types of science one can do it a site

985
00:35:05,450 --> 00:35:03,750
and I I think the same thing would apply

986
00:35:08,720 --> 00:35:05,460
to an exoplanet if you've got an

987
00:35:11,330 --> 00:35:08,730
exoplanet that has interesting non paske

988
00:35:13,700 --> 00:35:11,340

biological science to be done in that

989
00:35:15,650 --> 00:35:13,710
system you might prioritize that over an

990
00:35:18,320 --> 00:35:15,660
equally interesting astrobiological

991
00:35:20,600 --> 00:35:18,330
target that is maybe less interesting

992
00:35:25,160 --> 00:35:20,610
for non astrobiological the XO planetary

993
00:35:26,450 --> 00:35:25,170
science purposes and you know just to go

994
00:35:29,090 --> 00:35:26,460
a little bit back on your analogy I

995
00:35:30,190 --> 00:35:29,100
think maybe not the 19 the last you know

996
00:35:33,970 --> 00:35:30,200
decade or two but may

997
00:35:35,200 --> 00:35:33,980
like the 1950s or 1960s pre Viking might

998
00:35:36,310 --> 00:35:35,210
be a better analogy just because we

999
00:35:40,089 --> 00:35:36,320
don't have the embarrassment of riches

1000
00:35:42,880 --> 00:35:40,099
of data that the Mars community has for

1001
00:35:44,800 --> 00:35:42,890
site selection right we we have very

1002
00:35:46,750 --> 00:35:44,810
limited data on these exoplanets which

1003
00:35:49,540 --> 00:35:46,760
is one of the reasons the prioritization

1004
00:35:51,550 --> 00:35:49,550
is so difficult is you know we generally

1005
00:35:53,140 --> 00:35:51,560
know how big they are hopefully we know

1006
00:35:55,030 --> 00:35:53,150
the mass and the radius usually we only

1007
00:35:56,319 --> 00:35:55,040
know one of the other we know how far

1008
00:35:58,450 --> 00:35:56,329
away it is we know where to point the

1009
00:36:01,390 --> 00:35:58,460
telescope we know how far it is from its

1010
00:36:03,099 --> 00:36:01,400
start how much energy it gets and if we

1011
00:36:04,720 --> 00:36:03,109
again if we have mass and radius and

1012
00:36:06,609 --> 00:36:04,730
we're lucky in that way we can make some

1013
00:36:08,260 --> 00:36:06,619

guesses about composition and density

1014
00:36:11,349 --> 00:36:08,270
and things bulk composition and density

1015
00:36:15,790 --> 00:36:11,359
on but chances are we're not going to

1016
00:36:17,410 --> 00:36:15,800
have a lot of information and nearly not

1017
00:36:20,859 --> 00:36:17,420
nearly as much as as the Mars community

1018
00:36:23,020 --> 00:36:20,869
has when it comes to sex selection but

1019
00:36:24,370 --> 00:36:23,030
the biggest daily as the Mars program

1020
00:36:26,109 --> 00:36:24,380
was when we were figuring out what

1021
00:36:28,540 --> 00:36:26,119
instruments to put on the first mapping

1022
00:36:30,160 --> 00:36:28,550
orbiters and that was to say what are

1023
00:36:32,560 --> 00:36:30,170
the list of measurements that need to be

1024
00:36:35,859 --> 00:36:32,570
done to allow you the input to your

1025
00:36:37,540 --> 00:36:35,869
habitability factor or whatever and it

1026
00:36:39,640 --> 00:36:37,550
but it but the key thing is it's a short

1027
00:36:41,260 --> 00:36:39,650
list of observations and so the value of

1028
00:36:42,700 --> 00:36:41,270
thinking about a factors that you're

1029
00:36:44,680 --> 00:36:42,710
narrowing a list of all the darn things

1030
00:36:46,089 --> 00:36:44,690
you might want to observe to a smaller

1031
00:36:47,650 --> 00:36:46,099
more tractable list that you could

1032
00:36:49,930 --> 00:36:47,660
actually apply to us large number of

1033
00:36:52,030 --> 00:36:49,940
targets and so maybe you're sort of in

1034
00:36:53,829 --> 00:36:52,040
that period where the Mars program was

1035
00:36:56,079 --> 00:36:53,839
where you're arguing about types of

1036
00:37:02,890 --> 00:36:56,089
orbiters to send in order to get to that

1037
00:37:06,819 --> 00:37:02,900
next level of information so I just put

1038
00:37:11,140 --> 00:37:06,829

up a link and the link is to the PBS

1039
00:37:13,720 --> 00:37:11,150
Newshour on Tuesday and basically it's

1040
00:37:16,750 --> 00:37:13,730
geoff marcy talking about the kepler

1041
00:37:19,420 --> 00:37:16,760
results and at the end he makes a very

1042
00:37:22,630 --> 00:37:19,430
good point with respect to how said he

1043
00:37:25,150 --> 00:37:22,640
fits into all of us I don't know in the

1044
00:37:28,150 --> 00:37:25,160
current road map where said he shows up

1045
00:37:30,400 --> 00:37:28,160
if at all but I do think that there

1046
00:37:32,980 --> 00:37:30,410
ought to be a place where it can be

1047
00:37:35,290 --> 00:37:32,990
hooked in because it is a technique that

1048
00:37:38,319 --> 00:37:35,300
could of course transform our

1049
00:37:41,470 --> 00:37:38,329
understanding or at least our evidence

1050
00:37:43,220 --> 00:37:41,480
for life elsewhere and potential for

1051
00:37:46,550 --> 00:37:43,230
intelligent life is really

1052
00:37:49,370 --> 00:37:46,560
real estate question is anybody out

1053
00:37:51,530 --> 00:37:49,380
there do we already own it all but I

1054
00:37:55,820 --> 00:37:51,540
think that it ought to be kept in at

1055
00:38:03,130 --> 00:37:55,830
some point and I invite you to watch the

1056
00:38:11,740 --> 00:38:05,870
that I was done with that John speaking

1057
00:38:15,170 --> 00:38:11,750
yes how to death or related question our

1058
00:38:17,150 --> 00:38:15,180
artificial kinds of biogenic gas is

1059
00:38:18,650 --> 00:38:17,160
detectable on our earth as bio

1060
00:38:23,000 --> 00:38:18,660
signatures like industrial pollution

1061
00:38:25,099 --> 00:38:23,010
should we look for those too yeah I do

1062
00:38:27,590 --> 00:38:25,109
think that it's a lot easier to envision

1063
00:38:30,020 --> 00:38:27,600

detecting things that don't have to want

1064
00:38:33,290 --> 00:38:30,030
to be detected or haven't developed

1065
00:38:35,240 --> 00:38:33,300
their own NSA problems but I do also

1066
00:38:38,540 --> 00:38:35,250
think that it's an approach that is

1067
00:38:41,660 --> 00:38:38,550
legitimate you're and one that ought to

1068
00:38:48,050 --> 00:38:41,670
be pursued at some you know low level of

1069
00:38:50,450 --> 00:38:48,060
effort so the approach that I at least

1070
00:38:53,840 --> 00:38:50,460
right now have is when we find a planet

1071
00:38:56,000 --> 00:38:53,850
that has life on it in my mind that's

1072
00:38:58,849 --> 00:38:56,010
the point to really focus on study type

1073
00:39:00,200 --> 00:38:58,859
efforts on that object now there's one

1074
00:39:01,490 --> 00:39:00,210
exception of that a lot of the couple of

1075
00:39:03,200 --> 00:39:01,500
planets and this might have been part of

1076
00:39:04,910 --> 00:39:03,210
what Geoff Marcy was referring to a lot

1077
00:39:08,300 --> 00:39:04,920
of the Kepler objects are too far away

1078
00:39:11,180 --> 00:39:08,310
to do any detailed follow-up observation

1079
00:39:13,580 --> 00:39:11,190
with direct imaging and characterization

1080
00:39:15,650 --> 00:39:13,590
so even if we got a flagship level

1081
00:39:17,180 --> 00:39:15,660
telescope that can block out the light

1082
00:39:19,940 --> 00:39:17,190
of a contestar so that we can see the

1083
00:39:21,950 --> 00:39:19,950
planet even if we got that for many of

1084
00:39:23,720 --> 00:39:21,960
the kepler planet specifically we would

1085
00:39:25,520 --> 00:39:23,730
not be able to see the planet we are

1086
00:39:27,109 --> 00:39:25,530
because they're too far away or I'm

1087
00:39:28,730 --> 00:39:27,119
going to be able to see and directly

1088
00:39:30,740 --> 00:39:28,740

image the planets that our culture to us

1089
00:39:32,180 --> 00:39:30,750
for those planets that are in the

1090
00:39:34,130 --> 00:39:32,190
habitable zone and are of the right size

1091
00:39:35,900 --> 00:39:34,140
to be habitable the next step

1092
00:39:38,030 --> 00:39:35,910
scientifically to probe those planets

1093
00:39:39,410 --> 00:39:38,040
for life is setting is to listen for

1094
00:39:40,820 --> 00:39:39,420
radio transmissions or something like

1095
00:39:42,710 --> 00:39:40,830
that that's the only thing you can do

1096
00:39:46,280 --> 00:39:42,720
next although then maybe some if you can

1097
00:39:47,810 --> 00:39:46,290
get some spectroscopic some transit

1098
00:39:50,510 --> 00:39:47,820
spectroscopy you might be able to get

1099
00:39:52,340 --> 00:39:50,520
something out of that but absent a new

1100
00:39:54,320 --> 00:39:52,350
mission or a new technique that i

1101
00:39:56,180 --> 00:39:54,330
haven't seen mentioned by people that's

1102
00:39:56,980 --> 00:39:56,190
sort of the next step okay so that's one

1103
00:39:59,260 --> 00:39:56,990
place study

1104
00:40:02,109 --> 00:39:59,270
and the other is something similar to

1105
00:40:03,910 --> 00:40:02,119
what will discuss which is sort of

1106
00:40:05,770 --> 00:40:03,920
piggybacking if you're looking at a

1107
00:40:07,810 --> 00:40:05,780
planet as Nancy suggested and you're

1108
00:40:12,540 --> 00:40:07,820
looking for oxygen and methane and ozone

1109
00:40:15,040 --> 00:40:12,550
and a and clearly industrial non-natural

1110
00:40:17,230 --> 00:40:15,050
non-biological non geological gasp pops

1111
00:40:19,120 --> 00:40:17,240
up in your spectrum with a very clear

1112
00:40:20,260 --> 00:40:19,130
distinguishable feature now that's

1113
00:40:21,940 --> 00:40:20,270

something that's interesting and

1114
00:40:25,060 --> 00:40:21,950
interesting with with regards to

1115
00:40:28,690 --> 00:40:25,070
intelligence I think there's also the

1116
00:40:30,330 --> 00:40:28,700
possibility that if these if a Eddie

1117
00:40:32,710 --> 00:40:30,340
exists at the National terrestrial

1118
00:40:35,710 --> 00:40:32,720
society existed and they lived in the

1119
00:40:38,290 --> 00:40:35,720
right system may also might choose to

1120
00:40:41,170 --> 00:40:38,300
alter the climate of planets in that

1121
00:40:42,190 --> 00:40:41,180
system to suit themselves and that and

1122
00:40:44,140 --> 00:40:42,200
the owners i mentioned that is that's

1123
00:40:46,000 --> 00:40:44,150
going to be a bigger signature on the

1124
00:40:48,790 --> 00:40:46,010
atmosphere because they're so

1125
00:40:51,280 --> 00:40:48,800
dramatically altering the climate then a

1126
00:40:53,560 --> 00:40:51,290
pollution signature would be pollution

1127
00:40:55,390 --> 00:40:53,570
signature because if it's pollution you

1128
00:40:56,320 --> 00:40:55,400
generally don't want to keep doing it

1129
00:40:58,000 --> 00:40:56,330
forever and so it's going to be

1130
00:41:00,070 --> 00:40:58,010
short-lived so we have to get the right

1131
00:41:02,440 --> 00:41:00,080
timing on an astronomical timescale to

1132
00:41:04,990 --> 00:41:02,450
see it and generally they don't affect

1133
00:41:06,730 --> 00:41:05,000
the climate radiation budget too much

1134
00:41:08,020 --> 00:41:06,740
and so they don't have large features

1135
00:41:10,359 --> 00:41:08,030
and unless we have a super high

1136
00:41:11,560 --> 00:41:10,369
resolution telescope in terms of

1137
00:41:13,330 --> 00:41:11,570
wavelength the wavenumber we're not

1138
00:41:15,430 --> 00:41:13,340

going to go to detect them if you're

1139
00:41:16,720 --> 00:41:15,440
going to see and extraterrestrial

1140
00:41:19,090 --> 00:41:16,730
intelligence chances are they're going

1141
00:41:20,170 --> 00:41:19,100
to be having some huge effect on the

1142
00:41:23,109 --> 00:41:20,180
radiative transfer budget of the

1143
00:41:24,730 --> 00:41:23,119
atmosphere the most likely case is that

1144
00:41:25,810 --> 00:41:24,740
they're altering the climate of another

1145
00:41:27,520 --> 00:41:25,820
planet now I don't think that that's

1146
00:41:29,590 --> 00:41:27,530
particularly likely that we're going to

1147
00:41:31,090 --> 00:41:29,600
see that but I think I'm afraid it's not

1148
00:41:32,800 --> 00:41:31,100
most likely that's the most detectable

1149
00:41:34,450 --> 00:41:32,810
case that's a better way to phrase it I

1150
00:41:36,160 --> 00:41:34,460
don't think it's very likely but at

1151
00:41:40,120 --> 00:41:36,170
least if that was happening it would be

1152
00:41:42,760 --> 00:41:40,130
more easily detectable but you get up

1153
00:41:44,650 --> 00:41:42,770
for free well yet right so I don't just

1154
00:41:47,620 --> 00:41:44,660
agree with their your general concepts

1155
00:41:50,980 --> 00:41:47,630
but I do think that it's important that

1156
00:41:53,590 --> 00:41:50,990
we adopt the principle that the highest

1157
00:41:56,440 --> 00:41:53,600
priority science isn't the only thing

1158
00:41:58,210 --> 00:41:56,450
that gets funded otherwise we would stop

1159
00:41:59,920 --> 00:41:58,220
looking until we had that sunlight

1160
00:42:02,740 --> 00:41:59,930
suppression technology that you had

1161
00:42:04,540 --> 00:42:02,750
called for earlier you know there are

1162
00:42:07,030 --> 00:42:04,550
many different ways to go about this

1163
00:42:09,950 --> 00:42:07,040

when people were first starting to look

1164
00:42:13,460 --> 00:42:09,960
for exoplanets it was considered that

1165
00:42:15,589 --> 00:42:13,470
if you didn't have specific kinds of

1166
00:42:20,210 --> 00:42:15,599
telescope never be able to do with this

1167
00:42:21,920 --> 00:42:20,220
but in fact the way that planets were

1168
00:42:24,470 --> 00:42:21,930
getting detected from the Earth's

1169
00:42:26,180 --> 00:42:24,480
surface was completely different than

1170
00:42:28,970 --> 00:42:26,190
what everybody said you had to have in

1171
00:42:33,140 --> 00:42:28,980
the way of a mission and so I think it's

1172
00:42:36,650 --> 00:42:33,150
important to consider the effort as a

1173
00:42:38,390 --> 00:42:36,660
legitimate one not worry about sinking a

1174
00:42:40,450 --> 00:42:38,400
whole lot of money into it we're already

1175
00:42:43,099 --> 00:42:40,460
going to build a square kilometer array

1176
00:42:45,640 --> 00:42:43,109
whether we like it or not I mean it

1177
00:42:48,650 --> 00:42:45,650
doesn't really address these issues

1178
00:42:51,560 --> 00:42:48,660
specifically and just you know keep it

1179
00:42:54,320 --> 00:42:51,570
in as something that has the continuity

1180
00:42:57,280 --> 00:42:54,330
so that you don't leave it on the

1181
00:43:01,400 --> 00:42:57,290
cutting room floor in a way that is

1182
00:43:05,390 --> 00:43:01,410
essentially intellectually not justified

1183
00:43:08,240 --> 00:43:05,400
so I'm monetarily you know we paid a

1184
00:43:10,160 --> 00:43:08,250
bunch for SETI over the years but by

1185
00:43:12,470 --> 00:43:10,170
comparison to anything we've done in the

1186
00:43:15,010 --> 00:43:12,480
International Space Station or any other

1187
00:43:17,690 --> 00:43:15,020
space mission it's been a chump change

1188
00:43:20,060 --> 00:43:17,700

and just to emphasize that point

1189
00:43:22,579 --> 00:43:20,070
everything that I discussed it at Nancy

1190
00:43:24,410 --> 00:43:22,589
mentioned at this point is more or less

1191
00:43:27,410 --> 00:43:24,420
theoretical I don't think we've done as

1192
00:43:29,780 --> 00:43:27,420
nearly a thorough of a job looking at

1193
00:43:32,630 --> 00:43:29,790
the potential industrial civilization

1194
00:43:35,150 --> 00:43:32,640
bio signatures or techno signatures as

1195
00:43:37,040 --> 00:43:35,160
we have four more generic biosignatures

1196
00:43:38,839 --> 00:43:37,050
and the reason is we're prioritizing the

1197
00:43:40,370 --> 00:43:38,849
bio signatures but you're right we don't

1198
00:43:42,440 --> 00:43:40,380
want to prioritize them to the exclusion

1199
00:43:44,420 --> 00:43:42,450
of these other things that we might one

1200
00:43:46,880 --> 00:43:44,430
day see especially when the big cost

1201
00:43:48,200 --> 00:43:46,890
which is the mission is is the same

1202
00:43:49,579 --> 00:43:48,210
because you can run the same mission to

1203
00:43:52,970 --> 00:43:49,589
get to the same mission will give you

1204
00:43:54,710 --> 00:43:52,980
both datasets so you're I completely

1205
00:43:58,550 --> 00:43:54,720
agree we don't want to prioritize one

1206
00:44:03,290 --> 00:43:58,560
thing to the exclusion of the other it's

1207
00:44:07,490 --> 00:44:03,300
pretty nice to have all the link so

1208
00:44:09,770 --> 00:44:07,500
other other topics other directions that

1209
00:44:11,870 --> 00:44:09,780
we would be awful should be thinking

1210
00:44:18,800 --> 00:44:11,880
about what else might we suggest to help

1211
00:44:28,740 --> 00:44:21,540
so daisy marie likes the idea of the

1212
00:44:30,240 --> 00:44:28,750
glossary a lot and we're trying to

1213
00:44:33,329 --> 00:44:30,250

highlight two things in the glossary one

1214
00:44:36,150 --> 00:44:33,339
is terms that might not be common in

1215
00:44:38,370 --> 00:44:36,160
other fields and the other is war and

1216
00:44:41,339 --> 00:44:38,380
potentially worse words that are common

1217
00:44:43,380 --> 00:44:41,349
in use differently in other fields does

1218
00:44:49,800 --> 00:44:43,390
anybody want to suggest editor terms

1219
00:44:52,260 --> 00:44:49,810
besides the ones John put up or email us

1220
00:44:55,079 --> 00:44:52,270
if you figure essence or comment on the

1221
00:44:57,420 --> 00:44:55,089
document okay and they've also had a

1222
00:44:59,970 --> 00:44:57,430
suggestion to include the techno

1223
00:45:01,680 --> 00:44:59,980
signatures in the document which Nancy

1224
00:45:05,460 --> 00:45:01,690
said she that we weren't and I agree we

1225
00:45:07,859 --> 00:45:05,470
should the document will be switched

1226
00:45:10,050 --> 00:45:07,869
over the comment mode as soon as this

1227
00:45:12,599 --> 00:45:10,060
webinar is finished and just in case

1228
00:45:14,550 --> 00:45:12,609
anyone hasn't done this before all you

1229
00:45:16,829 --> 00:45:14,560
do is you home line two piece of text

1230
00:45:18,870 --> 00:45:16,839
right click and choose comment and you

1231
00:45:20,820 --> 00:45:18,880
can stick the equivalent of a post-it

1232
00:45:25,109 --> 00:45:20,830
note on me on the edge of the document

1233
00:45:27,839 --> 00:45:25,119
for that any other questions any other

1234
00:45:31,890 --> 00:45:27,849
points that people want to raise around

1235
00:45:35,099 --> 00:45:31,900
this topic yeah I'll challenge this

1236
00:45:37,280 --> 00:45:35,109
deviant's I you know they've made it

1237
00:45:42,000 --> 00:45:37,290
worry about the embarrassment of riches

1238
00:45:45,000 --> 00:45:42,010

there were certain words I and then

1239
00:45:46,170 --> 00:45:45,010
Shawn you know you responded saying well

1240
00:45:48,570 --> 00:45:46,180
maybe maybe the embarrassment of riches

1241
00:45:51,150 --> 00:45:48,580
a little more meager than that parallel

1242
00:45:54,000 --> 00:45:51,160
Hydra is where we were with regard to

1243
00:45:56,760 --> 00:45:54,010
observation of the outer solar system in

1244
00:45:58,680 --> 00:45:56,770
early 70s when infrared spectroscopy was

1245
00:46:00,750 --> 00:45:58,690
just coming online and then you know we

1246
00:46:02,339 --> 00:46:00,760
had we knew there are a lot of objects

1247
00:46:04,530 --> 00:46:02,349
out there and we were just beginning to

1248
00:46:06,570 --> 00:46:04,540
see transit and to be able to look at

1249
00:46:08,310 --> 00:46:06,580
insphere compositions I'm excited that

1250
00:46:09,750 --> 00:46:08,320
you know the left the intervening four

1251
00:46:11,550 --> 00:46:09,760
years have allowed us to get

1252
00:46:13,680 --> 00:46:11,560
increasingly more detailed information

1253
00:46:15,510 --> 00:46:13,690
and even a spatially resolved from these

1254
00:46:19,050 --> 00:46:15,520
features so it's very analogous to every

1255
00:46:20,609 --> 00:46:19,060
planet discovery I'm happy that there's

1256
00:46:22,829 --> 00:46:20,619
a possibility of those fields will kind

1257
00:46:28,750 --> 00:46:22,839
of move together and ask some of the

1258
00:46:35,380 --> 00:46:31,960
that's totally great I think that's a

1259
00:46:38,260 --> 00:46:35,390
great analogy and um one thing that we

1260
00:46:40,630 --> 00:46:38,270
didn't talk about is I think there's

1261
00:46:41,680 --> 00:46:40,640
some room and I've seen Dave Spiegel

1262
00:46:43,090 --> 00:46:41,690
mentioned this in a facebook

1263
00:46:45,820 --> 00:46:43,100

conversation outside of conversations

1264
00:46:48,250 --> 00:46:45,830
with Brittany Schmidt about this in car

1265
00:46:50,680 --> 00:46:48,260
rides around DC is the possibility to

1266
00:46:52,000 --> 00:46:50,690
look to look at solar system objects and

1267
00:46:55,720 --> 00:46:52,010
then particularly the outer solar system

1268
00:46:57,340 --> 00:46:55,730
objects as analogs for exoplanets one

1269
00:46:59,620 --> 00:46:57,350
question that I don't think we've

1270
00:47:01,870 --> 00:46:59,630
adequately addressed is I mentioned this

1271
00:47:06,460 --> 00:47:01,880
in yesterday's yesterday's webinar is

1272
00:47:09,640 --> 00:47:06,470
whether or not a giant icy world could

1273
00:47:12,490 --> 00:47:09,650
have a remotely detectable gaseous by

1274
00:47:13,840 --> 00:47:12,500
signature so imagine if I want to click

1275
00:47:16,000 --> 00:47:13,850
in corn the term super you wrote though

1276
00:47:18,070 --> 00:47:16,010
a planet like your oppa what the size of

1277
00:47:19,660 --> 00:47:18,080
worth it has enough grab mass and

1278
00:47:21,910 --> 00:47:19,670
gravity to hold on to and retain an

1279
00:47:23,470 --> 00:47:21,920
atmosphere is there enough communication

1280
00:47:25,060 --> 00:47:23,480
between the subsurface and the

1281
00:47:26,650 --> 00:47:25,070
atmosphere of that planet for the

1282
00:47:29,440 --> 00:47:26,660
atmosphere to accumulate a bio signature

1283
00:47:31,990 --> 00:47:29,450
from the subsurface we often assume

1284
00:47:33,490 --> 00:47:32,000
Europa is not if it has life that life

1285
00:47:36,460 --> 00:47:33,500
wouldn't be detectable across

1286
00:47:39,010 --> 00:47:36,470
interstellar space I totally agree with

1287
00:47:41,500 --> 00:47:39,020
that assessment if there was a true

1288
00:47:42,550 --> 00:47:41,510

Europa analog in another system we

1289
00:47:44,200 --> 00:47:42,560
really would have no shot at

1290
00:47:46,810 --> 00:47:44,210
characterizing any life that existed in

1291
00:47:48,610 --> 00:47:46,820
the subsurface but I don't think we've

1292
00:47:50,380 --> 00:47:48,620
answered whether that's because the

1293
00:47:52,390 --> 00:47:50,390
planet is too small or whether there's

1294
00:47:55,810 --> 00:47:52,400
too little communication between sub

1295
00:47:58,150 --> 00:47:55,820
surface and the surface if it's really

1296
00:48:00,280 --> 00:47:58,160
the latter that's holding us up then

1297
00:48:02,170 --> 00:48:00,290
there's there's no shot at detecting

1298
00:48:03,550 --> 00:48:02,180
there's no communication you're not

1299
00:48:04,840 --> 00:48:03,560
going to see the past year if there's

1300
00:48:06,220 --> 00:48:04,850
communication and the problem with your

1301
00:48:07,450 --> 00:48:06,230
face it's not holding on to the

1302
00:48:09,340 --> 00:48:07,460
atmosphere that would retain that

1303
00:48:11,470 --> 00:48:09,350
communication well then we've got a shot

1304
00:48:13,030 --> 00:48:11,480
if we find a stupid Europa elsewhere and

1305
00:48:14,800 --> 00:48:13,040
it doesn't necessarily have to be

1306
00:48:16,810 --> 00:48:14,810
managed it has to have enough tidal

1307
00:48:19,510 --> 00:48:16,820
energy to maintain a liquid water so I

1308
00:48:20,950 --> 00:48:19,520
just want to throw that out there not

1309
00:48:23,080 --> 00:48:20,960
that that was seized point but it's

1310
00:48:25,750 --> 00:48:23,090
related to this whole outer source

1311
00:48:27,160 --> 00:48:25,760
system as an analog for after soul event

1312
00:48:29,020 --> 00:48:27,170
and I point it's close to my heart I

1313
00:48:32,410 --> 00:48:29,030

worry that your superhero but maybe more

1314
00:48:34,210 --> 00:48:32,420
akin to a super Ganymede super gonorrhea

1315
00:48:36,640 --> 00:48:34,220
and spurs may be a sweet spot though

1316
00:48:38,470 --> 00:48:36,650
where that kind of detection as possible

1317
00:48:42,070 --> 00:48:38,480
I'm wondering how that factors into

1318
00:48:42,579 --> 00:48:42,080
whether you can see signatures of what's

1319
00:48:44,319 --> 00:48:42,589
happening

1320
00:48:48,400 --> 00:48:44,329
in the deeper interior what are the

1321
00:48:50,769 --> 00:48:48,410
neurological aspects to tell you um if I

1322
00:48:53,499 --> 00:48:50,779
tectonics is occurring I said a metal

1323
00:48:55,180 --> 00:48:53,509
core I doubt those sort of things are

1324
00:48:58,150 --> 00:48:55,190
directly communicated to the atmosphere

1325
00:48:59,589 --> 00:48:58,160
but I don't know Venus and Earth are

1326
00:49:01,390 --> 00:48:59,599
definitely two different planets that

1327
00:49:06,099 --> 00:49:01,400
have atmospheric signatures and what's

1328
00:49:07,209 --> 00:49:06,109
what their interior doing you would

1329
00:49:13,870 --> 00:49:07,219
definitely know better than I would

1330
00:49:33,420 --> 00:49:13,880
excuse fair enough so make sure that's

1331
00:49:37,329 --> 00:49:33,430
in there i guess like fast typing yeah

1332
00:49:40,630 --> 00:49:37,339
TV news so Glenn has another point in

1333
00:49:42,309 --> 00:49:40,640
here in addition to advances and

1334
00:49:44,680 --> 00:49:42,319
observation and detection capabilities

1335
00:49:46,950 --> 00:49:44,690
we need advances to deal with a large

1336
00:49:48,729 --> 00:49:46,960
datasets statistical analyses

1337
00:49:52,089 --> 00:49:48,739
computational models data mining

1338
00:49:53,289 --> 00:49:52,099

analysis technology etc yep that's

1339
00:49:55,479 --> 00:49:53,299
that's one of the think the big

1340
00:49:58,509 --> 00:49:55,489
priorities is you know data retrieval

1341
00:50:00,489 --> 00:49:58,519
and data assessment and that's something

1342
00:50:02,140 --> 00:50:00,499
that we're we're really just getting

1343
00:50:04,059 --> 00:50:02,150
started on and if you if you're

1344
00:50:08,339 --> 00:50:04,069
interested in that there is some

1345
00:50:10,749 --> 00:50:08,349
preliminary work on gas giants spectral

1346
00:50:13,239 --> 00:50:10,759
analysis but so we've got some spectra

1347
00:50:14,890 --> 00:50:13,249
already of exoplanets but no one really

1348
00:50:17,019 --> 00:50:14,900
thinks they're the planets that we've

1349
00:50:20,200 --> 00:50:17,029
got spectra for habitable the closest

1350
00:50:22,479 --> 00:50:20,210
thing is probably Gliese at 1214b which

1351
00:50:24,219 --> 00:50:22,489
is a planet that has a few times the

1352
00:50:27,219 --> 00:50:24,229
mass of the Earth I remember exactly how

1353
00:50:28,989 --> 00:50:27,229
many times in SEOs GJ 1214b is but

1354
00:50:30,789 --> 00:50:28,999
that's why they closed the most

1355
00:50:31,930 --> 00:50:30,799
habitable exoplanet Leah the spectrum of

1356
00:50:34,120 --> 00:50:31,940
and I don't think anyone thinks it's

1357
00:50:36,160 --> 00:50:34,130
habitable at anyway we have spectra

1358
00:50:37,660 --> 00:50:36,170
people started to analyze those spectra

1359
00:50:39,910 --> 00:50:37,670
and you've started to do it with

1360
00:50:44,759 --> 00:50:39,920
somewhat automated tools that try to get

1361
00:50:47,049 --> 00:50:44,769
at the most statistically likely

1362
00:50:49,180 --> 00:50:47,059
atmosphere that would explain the data

1363
00:50:50,979 --> 00:50:49,190

set that have so the people are just

1364
00:50:52,569 --> 00:50:50,989
started to do that work we need to

1365
00:50:55,120 --> 00:50:52,579
improve the self consistency of those

1366
00:50:55,820 --> 00:50:55,130
techniques we need to ramp them up in

1367
00:50:57,770 --> 00:50:55,830
terms of their

1368
00:50:59,840 --> 00:50:57,780
spectral resolution for when we get

1369
00:51:02,000 --> 00:50:59,850
higher resolution spectra of stuff like

1370
00:51:03,950 --> 00:51:02,010
that so we're doing it but as a

1371
00:51:09,380 --> 00:51:03,960
community but we're just getting started

1372
00:51:12,620 --> 00:51:09,390
and then alex is just raising a question

1373
00:51:14,510 --> 00:51:12,630
about distinguishing between pric and

1374
00:51:19,970 --> 00:51:14,520
unsee with substantial amounts of

1375
00:51:21,890 --> 00:51:19,980
organic mastering it can we do that Alex

1376
00:51:26,480 --> 00:51:21,900
do you want to elaborate are you on the

1377
00:51:28,670 --> 00:51:26,490
phone should be the lines open it's

1378
00:51:31,640 --> 00:51:28,680
basically towards you I mean you brought

1379
00:51:34,160 --> 00:51:31,650
it up about the exchange between imagine

1380
00:51:36,530 --> 00:51:34,170
you have super super super European says

1381
00:51:39,350 --> 00:51:36,540
right you know and there is some

1382
00:51:42,080 --> 00:51:39,360
exchange between subsurface bias here

1383
00:51:43,790 --> 00:51:42,090
with the atmosphere but you know I mean

1384
00:51:45,590 --> 00:51:43,800
to the very least you would have to have

1385
00:51:47,810 --> 00:51:45,600
some exchange between waters with the

1386
00:51:50,270 --> 00:51:47,820
surface is right you know you have to

1387
00:51:54,500 --> 00:51:50,280
have a migration there is there is such

1388
00:51:56,840 --> 00:51:54,510

transfer material in Europa but I just

1389
00:51:58,340 --> 00:51:56,850
don't know how sensitive i think is all

1390
00:52:00,800 --> 00:51:58,350
be the changing is there something

1391
00:52:03,140 --> 00:52:00,810
actually in the form reflected white

1392
00:52:04,760 --> 00:52:03,150
which you can say if you have if you

1393
00:52:06,590 --> 00:52:04,770
have substantial month organics nice

1394
00:52:09,380 --> 00:52:06,600
weather you can distinguish one versus

1395
00:52:11,810 --> 00:52:09,390
the other I just have no clue what that

1396
00:52:13,790 --> 00:52:11,820
is i'm just educating this might get

1397
00:52:15,560 --> 00:52:13,800
this might be a case where you wouldn't

1398
00:52:18,710 --> 00:52:15,570
need that atmosphere like is the the

1399
00:52:21,020 --> 00:52:18,720
signature is embedded in the surface the

1400
00:52:25,700 --> 00:52:21,030
john r mo just said organic so consider

1401
00:52:28,760 --> 00:52:25,710
are all detectable John you want

1402
00:52:31,880 --> 00:52:28,770
elaborate oh no I mean if you take a

1403
00:52:34,100 --> 00:52:31,890
look at the spectrum if you look at what

1404
00:52:36,410 --> 00:52:34,110
we get reflected off of your open al l

1405
00:52:39,140 --> 00:52:36,420
mean we have Tom accord and his

1406
00:52:41,990 --> 00:52:39,150
instrument you know showing high salt

1407
00:52:45,410 --> 00:52:42,000
concentrations in different places pure

1408
00:52:48,140 --> 00:52:45,420
ice is white and now we are of course of

1409
00:52:50,840 --> 00:52:48,150
God you know God headed to series where

1410
00:52:53,390 --> 00:52:50,850
there's some really intriguing recent

1411
00:52:56,840 --> 00:52:53,400
observations that suggested it's going

1412
00:53:05,600 --> 00:52:56,850
to be much more very dated than we might

1413
00:53:08,730 --> 00:53:05,610

have hoped god I'm so with this I think

1414
00:53:10,440 --> 00:53:08,740
I can make the plans as well

1415
00:53:14,700 --> 00:53:10,450
and if you I think Alex and John you

1416
00:53:19,050 --> 00:53:14,710
guys shouldn't do this I think knowledge

1417
00:53:21,480 --> 00:53:19,060
is Alex were you making point again Alex

1418
00:53:24,120 --> 00:53:21,490
Alex can you speak a little louder to

1419
00:53:25,560 --> 00:53:24,130
Mike isn't picking you up very well I'm

1420
00:53:27,600 --> 00:53:25,570
just saying so is this a legitimate

1421
00:53:32,250 --> 00:53:27,610
strategy for example anis as well in

1422
00:53:34,470 --> 00:53:32,260
some kind of future when if you know if

1423
00:53:36,480 --> 00:53:34,480
you have if you will be able to study

1424
00:53:40,410 --> 00:53:36,490
albedo of that exit planet you know will

1425
00:53:43,560 --> 00:53:40,420
you be able to see to see those features

1426
00:53:45,920 --> 00:53:43,570
I mean that I'm just curious um it's

1427
00:53:49,740 --> 00:53:45,930
such a it's such a small signal that is

1428
00:53:51,930 --> 00:53:49,750
not a viable strategy at all to see if

1429
00:53:57,510 --> 00:53:51,940
you have any kind of organics in that in

1430
00:53:59,310 --> 00:53:57,520
that frozen planet point there would be

1431
00:54:02,580 --> 00:53:59,320
little atmosphere to have to go through

1432
00:54:04,470 --> 00:54:02,590
right somebody right right so you have

1433
00:54:06,900 --> 00:54:04,480
an icy bowl you know your plan serious

1434
00:54:09,300 --> 00:54:06,910
frozen out you know it's not tapping the

1435
00:54:10,980 --> 00:54:09,310
bowl on the surface you know but you

1436
00:54:12,510 --> 00:54:10,990
have if there's something in the

1437
00:54:13,680 --> 00:54:12,520
subsurface presumably there is always

1438
00:54:16,470 --> 00:54:13,690

migration because there's all the

1439
00:54:19,140 --> 00:54:16,480
sublimation of ice I was a transfer of

1440
00:54:20,400 --> 00:54:19,150
ice from Equatorial to polar regions so

1441
00:54:21,990 --> 00:54:20,410
you will have to bring some of the

1442
00:54:24,810 --> 00:54:22,000
material up to the surface soon or later

1443
00:54:26,220 --> 00:54:24,820
so is it possible to distinguish valve

1444
00:54:30,020 --> 00:54:26,230
either those features if you have

1445
00:54:34,620 --> 00:54:30,030
organics in them in that frozen world

1446
00:54:41,910 --> 00:54:34,630
that's all I think is a good idea to

1447
00:54:43,859 --> 00:54:41,920
explore hi gfs on it seems like the

1448
00:54:45,660 --> 00:54:43,869
defense pointed out the atmosphere being

1449
00:54:47,580 --> 00:54:45,670
tenuous means that yeah you should have

1450
00:54:52,500 --> 00:54:47,590
access to spectral features from the

1451
00:54:54,810 --> 00:54:52,510
surface but it's at this point it's an

1452
00:54:57,390 --> 00:54:54,820
interesting analogy to make to Europa

1453
00:54:58,950 --> 00:54:57,400
and studying the cycling between an

1454
00:55:01,230 --> 00:54:58,960
ocean and what you might get up to the

1455
00:55:03,960 --> 00:55:01,240
surface out might change chemically is

1456
00:55:05,910 --> 00:55:03,970
it transits to the surface and then what

1457
00:55:08,400 --> 00:55:05,920
the radiation environment at the surface

1458
00:55:09,599 --> 00:55:08,410
does to those chemicals and whether or

1459
00:55:12,330 --> 00:55:09,609
not you could interpret those these are

1460
00:55:15,150 --> 00:55:12,340
all really interesting questions well I

1461
00:55:17,010 --> 00:55:15,160
think those where here's we're being

1462
00:55:19,800 --> 00:55:17,020
able to detect a magnetic field remotely

1463
00:55:21,270 --> 00:55:19,810

five factors into habitability I think

1464
00:55:23,690 --> 00:55:21,280
this came up in previous

1465
00:55:26,160 --> 00:55:23,700
discussion whether we should consider

1466
00:55:28,710 --> 00:55:26,170
detecting a magnetic field as something

1467
00:55:30,660 --> 00:55:28,720
that's relevant availability both from

1468
00:55:32,490 --> 00:55:30,670
the standpoint of the earth analogy and

1469
00:55:35,310 --> 00:55:32,500
also from the standpoint of the Jupiter

1470
00:55:37,260 --> 00:55:35,320
system analogy the Jupiter system being

1471
00:55:40,380 --> 00:55:37,270
one in which the magnetic field is a

1472
00:55:42,150 --> 00:55:40,390
driver for radiation at the surface and

1473
00:55:47,430 --> 00:55:42,160
ability would be a really relevant thing

1474
00:55:50,520 --> 00:55:47,440
for astrobiology the ski film yeah that

1475
00:55:52,080 --> 00:55:50,530
was yeah that was me and more broadly I

1476
00:55:53,820 --> 00:55:52,090
think we have to go beyond the water and

1477
00:55:55,020 --> 00:55:53,830
think about things other than the

1478
00:55:56,880 --> 00:55:55,030
presence of work with water and

1479
00:55:59,250 --> 00:55:56,890
specifically beyond the presence of

1480
00:56:01,110 --> 00:55:59,260
surface liquid water as compared to as a

1481
00:56:02,550 --> 00:56:01,120
concern of habitability we want to know

1482
00:56:04,500 --> 00:56:02,560
more than just that the cases the

1483
00:56:06,410 --> 00:56:04,510
weather isn't the water and we also need

1484
00:56:10,280 --> 00:56:06,420
to consider other other possibilities

1485
00:56:12,390 --> 00:56:10,290
things that could have impact like um

1486
00:56:14,220 --> 00:56:12,400
Alex I think the answer your question is

1487
00:56:16,820 --> 00:56:14,230
that we got from panels theoretically

1488
00:56:19,640 --> 00:56:16,830

yes we could look at this sort of thing

1489
00:56:23,340 --> 00:56:19,650
practically I think you and John should

1490
00:56:25,230 --> 00:56:23,350
look at that and find out what the

1491
00:56:26,400 --> 00:56:25,240
answer is see how big a spectral

1492
00:56:29,070 --> 00:56:26,410
signature we could get from a surface

1493
00:56:31,200 --> 00:56:29,080
how deep that feature is and how broad

1494
00:56:37,770 --> 00:56:31,210
it is and how that matches up to

1495
00:56:39,900 --> 00:56:37,780
proposed instrumentation I'm not

1496
00:56:42,540 --> 00:56:39,910
inspector guy just now how how quickly

1497
00:56:44,880 --> 00:56:42,550
our guidance can be degraded in the Indy

1498
00:56:48,300 --> 00:56:44,890
Isis or in the soil is pending on the

1499
00:56:50,700 --> 00:56:48,310
flocks of radiation and that's possible

1500
00:56:52,170 --> 00:56:50,710
fast and you know but you guys when you

1501
00:56:54,840 --> 00:56:52,180
should feature data than answer your tie

1502
00:56:57,240 --> 00:56:54,850
and they can make prospectus for you we

1503
00:56:59,670 --> 00:56:57,250
will seek out the appropriate expert to

1504
00:57:01,080 --> 00:56:59,680
engage them in this question yeah well

1505
00:57:02,430 --> 00:57:01,090
have as you pointed out John will have

1506
00:57:06,960 --> 00:57:02,440
some good data from serious to base

1507
00:57:11,160 --> 00:57:06,970
things on okay lowest in two or three

1508
00:57:14,160 --> 00:57:11,170
minutes of the webinar other any amounts

1509
00:57:16,860 --> 00:57:14,170
with people into the chip in the

1510
00:57:19,530 --> 00:57:16,870
document is now open for commenting if

1511
00:57:21,580 --> 00:57:19,540
you've got it open at the moment close

1512
00:57:24,790 --> 00:57:21,590
it and reopen it Emile your

1513
00:57:27,700 --> 00:57:24,800

be able to to make your comments but any

1514
00:57:32,290 --> 00:57:27,710
other last thoughts before before move

1515
00:57:33,880 --> 00:57:32,300
on Steve appears to have found the

1516
00:57:36,730 --> 00:57:33,890
applause button I didn't know there was

1517
00:57:39,160 --> 00:57:36,740
one of elephants kidding oh yeah there's

1518
00:57:42,460 --> 00:57:39,170
a quite a few little commentary buttons

1519
00:57:44,560 --> 00:57:42,470
smiley face oh cool well we can all the

1520
00:57:48,220 --> 00:57:44,570
muse ourselves now but now I'm comment

1521
00:57:54,280 --> 00:57:48,230
button I'm sure to be there in the next

1522
00:57:56,050 --> 00:57:54,290
relation okay no other comments thank

1523
00:57:59,530 --> 00:57:56,060
you very much to our presenters please

1524
00:58:03,250 --> 00:57:59,540
go and add your thoughts to the document

1525
00:58:05,830 --> 00:58:03,260
and if there any discussion items that

1526
00:58:08,590 --> 00:58:05,840
people on Toronto if we if the document

1527
00:58:10,840 --> 00:58:08,600
is too constraining in the sense of your

1528
00:58:13,780 --> 00:58:10,850
comments you really want to discuss more

1529
00:58:15,760 --> 00:58:13,790
so I just send a note to support at no

1530
00:58:18,130 --> 00:58:15,770
innovation calm and we can open up a

1531
00:58:19,750 --> 00:58:18,140
discussion thread for you we haven't

1532
00:58:21,550 --> 00:58:19,760
they did to do it so far it seems to be

1533
00:58:25,540 --> 00:58:21,560
but commenting directly and the document

1534
00:58:27,430 --> 00:58:25,550
works well but if you need greater space

1535
00:58:31,170 --> 00:58:27,440
for developing thoughts then of course

1536
00:58:34,030 --> 00:58:31,180
we can set up way hmm wonder that and

1537
00:58:38,680 --> 00:58:34,040
will just allow join to finish typing

1538
00:58:41,200 --> 00:58:38,690

and then we Laura draw to a close all

1539
00:58:42,880 --> 00:58:41,210
right looks like that's that okay thank

1540
00:58:46,750 --> 00:58:42,890
you very much everyone she really every