Ask An Astrobiologist

Episode 44: September 30th, 2021

# Prof. Abel Méndez

NASA Astrobiology Program

1
00:00:10,860 --> 00:00:08,950
[Music]

2
00:00:34,709 --> 00:00:10,870
so

3
00:00:40,470 --> 00:00:38,069
greetings friends fellow earthlings and

4
00:00:43,110 --> 00:00:40,480
maybe hopeful explorers of potentially

5
00:00:45,029 --> 00:00:43,120
habitable worlds out there

6
00:00:47,750 --> 00:00:45,039
welcome to ask an astrobiologist the

7
00:00:49,830 --> 00:00:47,760
show that seeks to celebrate the science

8
00:00:51,910 --> 00:00:49,840
and the scientists involved in our quest

9
00:00:54,470 --> 00:00:51,920
to understand the nature of life

10
00:00:57,029 --> 00:00:54,480
i'm your host dr graham lau also known

11
00:00:59,029 --> 00:00:57,039
online now as space beard and we're

12
00:01:01,910 --> 00:00:59,039
brought to you by the nasa astrobiology

13
00:01:04,869 --> 00:01:01,920

program and saginet.org

14
00:01:07,910 --> 00:01:04,879
you know when i was a kid we didn't know

15
00:01:09,830 --> 00:01:07,920
of any exoplanets for sure we had ideas

16
00:01:11,510 --> 00:01:09,840
that there were worlds out there

17
00:01:13,510 --> 00:01:11,520
but it wasn't until the early 90s that

18
00:01:15,990 --> 00:01:13,520
we first started detecting worlds around

19
00:01:18,310 --> 00:01:16,000
other stars and now we know of thousands

20
00:01:19,830 --> 00:01:18,320
of exoplanets out there and now we can

21
00:01:21,910 --> 00:01:19,840
also start asking questions about

22
00:01:24,789 --> 00:01:21,920
whether some of those worlds are

23
00:01:26,550 --> 00:01:24,799
habitable or could be inhabited by life

24
00:01:28,870 --> 00:01:26,560
as we know it and so we have a very

25
00:01:30,550 --> 00:01:28,880
special guest for today's episode to

26
00:01:33,030 --> 00:01:30,560
explore some of those kinds of questions

27
00:01:35,749 --> 00:01:33,040
with us and to share his work in this

28
00:01:38,149 --> 00:01:35,759
realm of habitable worlds out there

29
00:01:40,069 --> 00:01:38,159
now before i introduce our wonderful

30
00:01:42,310 --> 00:01:40,079
guest we have a little housekeeping to

31
00:01:44,630 --> 00:01:42,320
do as always we like to point out those

32
00:01:47,030 --> 00:01:44,640
of you out there who are sharing about

33
00:01:49,350 --> 00:01:47,040
our show sharing about our wonderful

34
00:01:51,030 --> 00:01:49,360
astrobiologist guests uh getting

35
00:01:52,550 --> 00:01:51,040
involved in the conversation with them

36
00:01:53,429 --> 00:01:52,560
about their research and the things they

37
00:01:55,590 --> 00:01:53,439
do

38
00:01:57,510 --> 00:01:55,600

and this month we have to give a shout

39
00:02:00,069 --> 00:01:57,520
out to the reigning

40
00:02:03,270 --> 00:02:00,079
ambassador for the show denise at

41
00:02:05,109 --> 00:02:03,280
astrobio dnz on twitter

42
00:02:07,350 --> 00:02:05,119
denise is a master's student in

43
00:02:09,029 --> 00:02:07,360
molecular biology and evolution at the

44
00:02:11,029 --> 00:02:09,039
university of kiel

45
00:02:11,910 --> 00:02:11,039
she's shared many times about our show

46
00:02:13,910 --> 00:02:11,920
and has gotten involved in the

47
00:02:15,350 --> 00:02:13,920
conversation so denise thank you very

48
00:02:17,430 --> 00:02:15,360
much for being involved and ask an

49
00:02:19,830 --> 00:02:17,440
astrobiologist

50
00:02:22,949 --> 00:02:19,840
now that said i get to introduce our

51
00:02:25,430 --> 00:02:22,959
guest professor abel mendes professor

52
00:02:27,190 --> 00:02:25,440
mendes is a planetary astrobiologist and

53
00:02:28,869 --> 00:02:27,200
the director of the planetary

54
00:02:31,990 --> 00:02:28,879
habitability laboratory at the

55
00:02:33,990 --> 00:02:32,000
university of puerto rico at arecibo

56
00:02:35,110 --> 00:02:34,000
his research focuses on the habitability

57
00:02:37,190 --> 00:02:35,120
of earth

58
00:02:39,750 --> 00:02:37,200
the worlds of our solar system and some

59
00:02:42,710 --> 00:02:39,760
of those worlds out there around

60
00:02:46,710 --> 00:02:45,190
he's been a nasa mirs fellow in physics

61
00:02:49,670 --> 00:02:46,720
and astrophysics and has research

62
00:02:52,550 --> 00:02:49,680
experience at fermilab nasa goddard nasa

63
00:02:54,790 --> 00:02:52,560

ames and with the arecibo observatory uh

64
00:02:56,470 --> 00:02:54,800
so professor abdel mendez uh thank you

65
00:02:58,790 --> 00:02:56,480
for joining us and welcome to ask an

66
00:03:00,550 --> 00:02:58,800
astrobiologist

67
00:03:02,710 --> 00:03:00,560
hello thank you for having me my

68
00:03:04,390 --> 00:03:02,720
pleasure to be here with all you

69
00:03:05,830 --> 00:03:04,400
it's so great to have you join us i

70
00:03:08,550 --> 00:03:05,840
think a lot of our audience might know

71
00:03:10,790 --> 00:03:08,560
you the best from twitter uh at prof

72
00:03:13,910 --> 00:03:10,800
abba mendez where you share a lot of

73
00:03:16,070 --> 00:03:13,920
news about astrobiology and planetary

74
00:03:17,830 --> 00:03:16,080
science i think a lot of folks follow

75
00:03:20,229 --> 00:03:17,840
you just to get that good hit of

76
00:03:22,229 --> 00:03:20,239
astrobiology news every day but maybe

77
00:03:23,509 --> 00:03:22,239
they don't know as much about your

78
00:03:24,949 --> 00:03:23,519
research so

79
00:03:26,789 --> 00:03:24,959
i'd like to start off with you just

80
00:03:28,949 --> 00:03:26,799
talking a little bit about what what

81
00:03:31,589 --> 00:03:28,959
really got you into your career field

82
00:03:35,110 --> 00:03:31,599
what inspired you as a child to pursue a

83
00:03:37,910 --> 00:03:35,120
career in planetary astrobiology

84
00:03:39,830 --> 00:03:37,920
well i always love astronomy and the

85
00:03:43,030 --> 00:03:39,840
idea of extraterrestrial life in the

86
00:03:45,350 --> 00:03:43,040
universe i grew up watching star trek

87
00:03:46,390 --> 00:03:45,360
and the cosmos television series by carl

88
00:03:48,869 --> 00:03:46,400

sagan

89
00:03:51,509 --> 00:03:48,879
i had a telescope and a computer since i

90
00:03:53,589 --> 00:03:51,519
was 10 years old i had a wonderful view

91
00:03:55,910 --> 00:03:53,599
of the night sky from my home back in

92
00:03:58,470 --> 00:03:55,920
then in rural puerto rico

93
00:04:01,110 --> 00:03:58,480
there were so many streets there were

94
00:04:04,229 --> 00:04:01,120
not that many streetlies back then so i

95
00:04:05,350 --> 00:04:04,239
was able to appreciate our galaxy the

96
00:04:07,270 --> 00:04:05,360
milky way

97
00:04:08,949 --> 00:04:07,280
i contemplated the stars i'm planning

98
00:04:11,670 --> 00:04:08,959
almost every night i took notes and

99
00:04:13,110 --> 00:04:11,680
wrote code in basic computer language to

100
00:04:15,350 --> 00:04:13,120
predict the position of planets back

101
00:04:17,909 --> 00:04:15,360
then as soon as i learned about the

102
00:04:20,150 --> 00:04:17,919
receivable observatory asked my parents

103
00:04:23,430 --> 00:04:20,160
to visit observatory we went even below

104
00:04:25,990 --> 00:04:23,440
the edition in egypt on my first visit

105
00:04:28,310 --> 00:04:26,000
i had a blast that day i met many

106
00:04:30,230 --> 00:04:28,320
scientists there and they were eager to

107
00:04:33,590 --> 00:04:30,240
talk to me about their research at

108
00:04:35,990 --> 00:04:33,600
observatory and i was just 12 years old

109
00:04:37,909 --> 00:04:36,000
the observatory reinforced my interest

110
00:04:40,230 --> 00:04:37,919
in astronomy and i was very curious

111
00:04:41,030 --> 00:04:40,240
about the reciprocal message i would

112
00:04:42,469 --> 00:04:41,040
first

113
00:04:44,629 --> 00:04:42,479

attempt to send a message to other

114
00:04:45,990 --> 00:04:44,639
civilizations if there's anybody

115
00:04:48,469 --> 00:04:46,000
listening out there

116
00:04:50,390 --> 00:04:48,479
so i decided to study physics

117
00:04:52,550 --> 00:04:50,400
against the recommendations of many of

118
00:04:54,550 --> 00:04:52,560
my friends they say that i should do

119
00:04:57,749 --> 00:04:54,560
engineering instead because that's where

120
00:04:59,270 --> 00:04:57,759
the money is i decided for my passion

121
00:05:01,189 --> 00:04:59,280
and never looked back

122
00:05:04,230 --> 00:05:01,199
i did a bachelor master in theoretical

123
00:05:06,390 --> 00:05:04,240
physics at the university of puerto rico

124
00:05:08,310 --> 00:05:06,400
my university didn't have an astronomy

125
00:05:10,550 --> 00:05:08,320
program so i took as many courses in

126
00:05:12,070 --> 00:05:10,560
astronomy mathematics and computer

127
00:05:14,310 --> 00:05:12,080
science as possible

128
00:05:17,029 --> 00:05:14,320
during graduate school i selected a

129
00:05:18,629 --> 00:05:17,039
thesis project in biophysics because it

130
00:05:20,469 --> 00:05:18,639
was very interesting i had a lot of

131
00:05:22,830 --> 00:05:20,479
computational work

132
00:05:25,909 --> 00:05:22,840
that was my first big connection with

133
00:05:27,990 --> 00:05:25,919
biology i also participated but then of

134
00:05:30,710 --> 00:05:28,000
many physics and planetary research

135
00:05:32,150 --> 00:05:30,720
programs for students at nasa angler and

136
00:05:34,469 --> 00:05:32,160
the science

137
00:05:36,950 --> 00:05:34,479
i started teaching position at the

138
00:05:40,629 --> 00:05:36,960

university of puerto rico in arecibo in

139
00:05:42,150 --> 00:05:40,639
1996 my campus is about 30 minutes from

140
00:05:44,390 --> 00:05:42,160
the observatory

141
00:05:46,870 --> 00:05:44,400
it was back then that i had the freedom

142
00:05:49,430 --> 00:05:46,880
to conduct my own research topic and i

143
00:05:51,110 --> 00:05:49,440
decided to take back my passion for the

144
00:05:52,870 --> 00:05:51,120
idea of strata racial life in the

145
00:05:54,390 --> 00:05:52,880
universe

146
00:05:55,909 --> 00:05:54,400
that year was announced the discovery of

147
00:05:58,790 --> 00:05:55,919
the martial meteorite with potential

148
00:06:00,710 --> 00:05:58,800
faucets so that was the thing that

149
00:06:03,029 --> 00:06:00,720
probably motivated me more

150
00:06:04,830 --> 00:06:03,039
i went to one to the early astrobiology

151
00:06:08,710 --> 00:06:04,840
school to train myself more in

152
00:06:11,029 --> 00:06:08,720
astrobiology field in 2000 nasa had his

153
00:06:13,830 --> 00:06:11,039
first astrobiology science conference at

154
00:06:15,590 --> 00:06:13,840
cyclone and i was there

155
00:06:17,430 --> 00:06:15,600
there were not that many hispanic

156
00:06:20,550 --> 00:06:17,440
persons but then i was on the only

157
00:06:22,870 --> 00:06:20,560
person from puerto rico there i was

158
00:06:25,350 --> 00:06:22,880
particularly interested in the concept

159
00:06:27,430 --> 00:06:25,360
of habitability how we can measure how

160
00:06:28,710 --> 00:06:27,440
good or bad an environment

161
00:06:31,909 --> 00:06:28,720
is for life

162
00:06:36,550 --> 00:06:31,919
i had two very influential books early

163
00:06:41,350 --> 00:06:38,469

an introduction

164
00:06:42,790 --> 00:06:41,360
to environmental uh biophysics by

165
00:06:45,590 --> 00:06:42,800
campbell and norma

166
00:06:46,390 --> 00:06:45,600
1998

167
00:06:56,469 --> 00:06:46,400
i

168
00:06:59,350 --> 00:06:56,479
and you can very you can very well call

169
00:07:02,309 --> 00:06:59,360
this book habitability physical factors

170
00:07:04,550 --> 00:07:02,319
i also like the natural selection of the

171
00:07:07,270 --> 00:07:04,560
chemical elements by willian and frausto

172
00:07:09,749 --> 00:07:07,280
da silva 1996

173
00:07:11,430 --> 00:07:09,759
you can call this book habitability now

174
00:07:13,589 --> 00:07:11,440
chemical factors

175
00:07:15,990 --> 00:07:13,599
and for astronomy

176
00:07:19,110 --> 00:07:16,000
i love physics and chemistry of the

177
00:07:21,589 --> 00:07:19,120
solar system by lewis 1997

178
00:07:24,629 --> 00:07:21,599
so these three books are probably the

179
00:07:27,350 --> 00:07:24,639
most influential ones early on

180
00:07:28,629 --> 00:07:27,360
through all my career my computers got

181
00:07:34,469 --> 00:07:28,639
smaller

182
00:07:37,670 --> 00:07:36,550
i love that concept computers get

183
00:07:39,749 --> 00:07:37,680
smaller to tell us because it gets

184
00:07:41,909 --> 00:07:39,759
bigger um which is really important i i

185
00:07:44,390 --> 00:07:41,919
do want to talk at length about arecibo

186
00:07:48,070 --> 00:07:44,400
with you um in a bit but but first um so

187
00:07:49,990 --> 00:07:48,080
you are a professor uh at upr arecibo um

188
00:07:51,749 --> 00:07:50,000

i wonder if you could tell our audience

189
00:07:53,990 --> 00:07:51,759
about the things you teach and maybe

190
00:07:55,909 --> 00:07:54,000
even your vision for the future of

191
00:07:57,990 --> 00:07:55,919
students studying with you from puerto

192
00:08:01,589 --> 00:07:58,000
rico

193
00:08:04,950 --> 00:08:01,599
yes i started in 2010 our planetary

194
00:08:07,589 --> 00:08:04,960
habitability laboratory this is a a

195
00:08:09,670 --> 00:08:07,599
research and educational laboratory

196
00:08:11,270 --> 00:08:09,680
especially to do theoretical work about

197
00:08:13,430 --> 00:08:11,280
understanding habitability from the

198
00:08:15,990 --> 00:08:13,440
solar system and exoplanet

199
00:08:18,230 --> 00:08:16,000
and i'm part of this uh project we train

200
00:08:20,070 --> 00:08:18,240
students in research and we have also a

201
00:08:23,189 --> 00:08:20,080
astrobiology course

202
00:08:26,869 --> 00:08:23,199
for for our students so right now we

203
00:08:27,990 --> 00:08:26,879
have about 30 students three private and

204
00:08:29,990 --> 00:08:28,000
uh

205
00:08:31,510 --> 00:08:30,000
the rest are undergraduates involved in

206
00:08:34,149 --> 00:08:31,520
different projects

207
00:08:40,149 --> 00:08:34,159
uh regarding uh

208
00:08:43,990 --> 00:08:42,469
that's fantastic and so can you tell us

209
00:08:45,910 --> 00:08:44,000
uh about the planetary habitability

210
00:08:48,630 --> 00:08:45,920
laboratory um what are some of the

211
00:08:51,030 --> 00:08:48,640
primary missions and objectives um

212
00:08:54,070 --> 00:08:51,040
through phl uh uh you know what are you

213
00:08:57,269 --> 00:08:54,080

trying to develop uh through the dhl yes

214
00:08:58,949 --> 00:08:57,279
we want to we started this project uh

215
00:09:00,870 --> 00:08:58,959
because there are

216
00:09:02,630 --> 00:09:00,880
back then in the early days of

217
00:09:05,190 --> 00:09:02,640
astrobiology we noticed that there were

218
00:09:06,790 --> 00:09:05,200
many misconceptions even until today

219
00:09:09,750 --> 00:09:06,800
about habitability

220
00:09:11,590 --> 00:09:09,760
for example that we can define

221
00:09:13,990 --> 00:09:11,600
that we cannot define habitability

222
00:09:16,550 --> 00:09:14,000
because it's very extra constant that we

223
00:09:19,350 --> 00:09:16,560
cannot quantify it because it's too

224
00:09:21,829 --> 00:09:19,360
complicated or that we cannot assess

225
00:09:23,190 --> 00:09:21,839
that ability of faraway words because we

226
00:09:24,470 --> 00:09:23,200
don't know all the details of the

227
00:09:25,350 --> 00:09:24,480
environment

228
00:09:28,949 --> 00:09:25,360
so

229
00:09:31,670 --> 00:09:28,959
i started asking myself how to define a

230
00:09:34,310 --> 00:09:31,680
measure habitability so that's the main

231
00:09:36,710 --> 00:09:34,320
a problem around 20 years ago in the

232
00:09:39,590 --> 00:09:36,720
early days of astrobiology field i

233
00:09:42,710 --> 00:09:39,600
started by looking for a definition

234
00:09:45,190 --> 00:09:42,720
including beyond the astrobiology field

235
00:09:47,190 --> 00:09:45,200
and i found i found that most dictionary

236
00:09:49,350 --> 00:09:47,200
definitions were associated to human

237
00:09:51,590 --> 00:09:49,360
habitation habitability disassociated

238
00:09:54,389 --> 00:09:51,600

with human habitation

239
00:09:56,949 --> 00:09:54,399
this this topic seemed important enough

240
00:09:59,910 --> 00:09:56,959
disabling the whole chapter in biology

241
00:10:02,470 --> 00:09:59,920
but to my surprise the words

242
00:10:06,069 --> 00:10:02,480
habitable and habitability were not

243
00:10:08,550 --> 00:10:06,079
generally present in biology textbooks

244
00:10:11,110 --> 00:10:08,560
therefore i thought that like everybody

245
00:10:14,150 --> 00:10:11,120
else that the topic of habitability was

246
00:10:16,310 --> 00:10:14,160
a new problem or question in biology

247
00:10:18,790 --> 00:10:16,320
brought by the astrobiology that the

248
00:10:19,990 --> 00:10:18,800
biological concept of habitability was

249
00:10:22,310 --> 00:10:20,000
exclusively

250
00:10:23,829 --> 00:10:22,320
an astrobiology topic

251
00:10:25,910 --> 00:10:23,839
but

252
00:10:28,470 --> 00:10:25,920
the first astrobiology paper to

253
00:10:30,870 --> 00:10:28,480
directory address how to quantify

254
00:10:34,310 --> 00:10:30,880
habitability was published by chuck and

255
00:10:36,470 --> 00:10:34,320
holland in astrobiology in 2007

256
00:10:38,230 --> 00:10:36,480
they suggest using the available

257
00:10:40,630 --> 00:10:38,240
powerful life

258
00:10:43,509 --> 00:10:40,640
or energy per time as the best proceed

259
00:10:46,069 --> 00:10:43,519
to quantify habitability

260
00:10:48,790 --> 00:10:46,079
a paper around that time by tory holler

261
00:10:51,509 --> 00:10:48,800
for nasa ames also concur with using

262
00:10:53,350 --> 00:10:51,519
energy to quantify habitability i was

263
00:10:55,509 --> 00:10:53,360

fascinated with this idea but not

264
00:10:56,949 --> 00:10:55,519
totally convinced it was the final

265
00:11:00,389 --> 00:10:56,959
solution

266
00:11:03,509 --> 00:11:00,399
then in around 2009 i found something

267
00:11:05,829 --> 00:11:03,519
that changed everything for me i found a

268
00:11:08,310 --> 00:11:05,839
1993 paper

269
00:11:10,310 --> 00:11:08,320
by rice and others not related to

270
00:11:13,509 --> 00:11:10,320
astrobiology at all

271
00:11:16,069 --> 00:11:13,519
but using the word habitability to refer

272
00:11:17,990 --> 00:11:16,079
to the quality of a semi-arid land for

273
00:11:20,310 --> 00:11:18,000
some type of birds

274
00:11:22,150 --> 00:11:20,320
the paper also pointed that their model

275
00:11:26,230 --> 00:11:22,160
was consistent with the habitat

276
00:11:29,190 --> 00:11:26,240
suitability indus used in ecology

277
00:11:31,430 --> 00:11:29,200
i searched for that phrase habitat

278
00:11:32,949 --> 00:11:31,440
suitability and went to the source and i

279
00:11:34,990 --> 00:11:32,959
was overblown

280
00:11:38,069 --> 00:11:35,000
i finally realized that what

281
00:11:40,710 --> 00:11:38,079
astrobiologists called habitability as a

282
00:11:42,069 --> 00:11:40,720
new problem was actually a whole problem

283
00:11:45,750 --> 00:11:42,079
provencali

284
00:11:49,030 --> 00:11:45,760
called habitat suitability in biology

285
00:11:50,710 --> 00:11:49,040
in the late 1970s ecologists were using

286
00:11:53,750 --> 00:11:50,720
different measures

287
00:11:55,910 --> 00:11:53,760
of habitability

288
00:11:57,590 --> 00:11:55,920

uh of the avita quality not all

289
00:11:59,430 --> 00:11:57,600
consistent between them

290
00:12:02,949 --> 00:11:59,440
same problem with astrobiologists are

291
00:12:05,430 --> 00:12:02,959
having today then in 1980

292
00:12:07,590 --> 00:12:05,440
the u.s fish and wildlife service

293
00:12:10,389 --> 00:12:07,600
decided to fix this and create a

294
00:12:13,030 --> 00:12:10,399
standard this description

295
00:12:14,949 --> 00:12:13,040
of habitability or a white paper

296
00:12:17,590 --> 00:12:14,959
which they call the habitat suitability

297
00:12:19,190 --> 00:12:17,600
in this mode i then realized that the

298
00:12:21,030 --> 00:12:19,200
problem of defining quantified

299
00:12:22,870 --> 00:12:21,040
habitability was already solved by a

300
00:12:27,430 --> 00:12:22,880
biologist

301
00:12:31,590 --> 00:12:29,350
habitability model for astrobiology

302
00:12:34,310 --> 00:12:31,600
describing how the astrobiology field

303
00:12:37,110 --> 00:12:34,320
can incorporate the ecology ecological

304
00:12:38,550 --> 00:12:37,120
definition of habitability

305
00:12:43,269 --> 00:12:38,560
so

306
00:12:45,430 --> 00:12:43,279
concepts of habitability habitability is

307
00:12:46,629 --> 00:12:45,440
defined as the suitability environment

308
00:12:48,790 --> 00:12:46,639
for life

309
00:12:50,550 --> 00:12:48,800
it is proportional to carrying capacity

310
00:12:53,110 --> 00:12:50,560
this is a key word in biology which is

311
00:12:55,590 --> 00:12:53,120
the maximum stable biomass that an

312
00:12:59,509 --> 00:12:55,600
environment can sustain this is how they

313
00:13:01,750 --> 00:12:59,519

quantify habitability in bio biology

314
00:13:04,389 --> 00:13:01,760
habitability is used to determine how a

315
00:13:05,990 --> 00:13:04,399
set of environmental factors impact life

316
00:13:08,150 --> 00:13:06,000
their presence or abundance the key

317
00:13:10,310 --> 00:13:08,160
thing here about this streaming is that

318
00:13:12,949 --> 00:13:10,320
the set of environmental factors are not

319
00:13:15,350 --> 00:13:12,959
necessarily the only important ones but

320
00:13:17,990 --> 00:13:15,360
the ones you want to understand how

321
00:13:19,990 --> 00:13:18,000
significant or not they are for life and

322
00:13:22,550 --> 00:13:20,000
everybody thinking about what all the

323
00:13:24,150 --> 00:13:22,560
factors that we need to combine no no

324
00:13:26,389 --> 00:13:24,160
you you

325
00:13:27,430 --> 00:13:26,399
do habitability by parts you want to

326
00:13:30,710 --> 00:13:27,440
understand

327
00:13:32,790 --> 00:13:30,720
a set of factors at a time

328
00:13:35,110 --> 00:13:32,800
and i love the classical elements

329
00:13:38,069 --> 00:13:35,120
analogy for the requirements of life

330
00:13:40,550 --> 00:13:38,079
life needs the classical energy elements

331
00:13:43,189 --> 00:13:40,560
air water earth and fire and more

332
00:13:44,150 --> 00:13:43,199
correctly a gas liquid solid and some

333
00:13:45,910 --> 00:13:44,160
energy

334
00:13:48,389 --> 00:13:45,920
one of the reason is that the elements

335
00:13:50,470 --> 00:13:48,399
necessary for dna and other biogenic

336
00:13:52,949 --> 00:13:50,480
elements are not available in a single

337
00:13:55,350 --> 00:13:52,959
state of matter so you need them for

338
00:13:57,509 --> 00:13:55,360

them to be mixed with a source of energy

339
00:14:04,069 --> 00:13:57,519
so follow the classical elements you're

340
00:14:07,910 --> 00:14:05,750
yeah very interesting i i like that you

341
00:14:10,629 --> 00:14:07,920
know you tie this back this idea of of

342
00:14:11,990 --> 00:14:10,639
habitat suitability indices um and this

343
00:14:13,350 --> 00:14:12,000
issue that you know some you know for

344
00:14:16,470 --> 00:14:13,360
instance planetary scientists and

345
00:14:18,230 --> 00:14:16,480
astrophysicists weren't reading old

346
00:14:20,150 --> 00:14:18,240
ecology papers or aware of what's going

347
00:14:21,990 --> 00:14:20,160
on in ecology it's one reason i love

348
00:14:24,230 --> 00:14:22,000
astrobiology so much is that we're kind

349
00:14:25,910 --> 00:14:24,240
of we're kind of breaking that structure

350
00:14:27,990 --> 00:14:25,920
of putting every science into its

351
00:14:29,590 --> 00:14:28,000
sub-sub-discipline where people don't

352
00:14:31,990 --> 00:14:29,600
talk to each other and it kind of fixes

353
00:14:33,350 --> 00:14:32,000
that by forcing us to think about what

354
00:14:35,430 --> 00:14:33,360
other people in different disciplines

355
00:14:37,430 --> 00:14:35,440
are doing um before we move on i do want

356
00:14:39,189 --> 00:14:37,440
to mention one of the polls that we had

357
00:14:40,150 --> 00:14:39,199
through the nasa astrobiology twitter

358
00:14:43,189 --> 00:14:40,160
account

359
00:14:45,189 --> 00:14:43,199
at nasa astrobio we asked all of the

360
00:14:47,910 --> 00:14:45,199
followers of the nasa astrobiology

361
00:14:50,150 --> 00:14:47,920
account just about how many of these

362
00:14:50,949 --> 00:14:50,160
exoplanets have we actually detected so

363
00:14:53,110 --> 00:14:50,959

far

364
00:14:55,389 --> 00:14:53,120
uh we had four potential answers either

365
00:14:58,710 --> 00:14:55,399
251

366
00:14:59,710 --> 00:14:58,720
3728 4500

367
00:15:01,430 --> 00:14:59,720
or 10

368
00:15:04,310 --> 00:15:01,440
502

369
00:15:06,230 --> 00:15:04,320
and the majority got the answer right at

370
00:15:07,910 --> 00:15:06,240
45 21.

371
00:15:09,910 --> 00:15:07,920
personally i didn't have that number

372
00:15:11,670 --> 00:15:09,920
memorized i just have a rough idea of

373
00:15:13,590 --> 00:15:11,680
where it is right now because i feel

374
00:15:15,670 --> 00:15:13,600
like every time i memorize a number for

375
00:15:17,670 --> 00:15:15,680
how many confirmed exoplanets we have

376
00:15:19,430 --> 00:15:17,680
that never changes you know days or

377
00:15:20,710 --> 00:15:19,440
weeks or months later and it's just

378
00:15:23,350 --> 00:15:20,720
there's no point in you know continually

379
00:15:26,230 --> 00:15:23,360
memorizing but um but we had a whole lot

380
00:15:29,269 --> 00:15:26,240
of votes uh 56.8 percent of those who

381
00:15:31,189 --> 00:15:29,279
voted 183 votes got it right um that's a

382
00:15:34,069 --> 00:15:31,199
lot of worlds out there and based on

383
00:15:35,910 --> 00:15:34,079
that soul number alone in a very close

384
00:15:38,150 --> 00:15:35,920
place to us we found exoplanets very

385
00:15:39,829 --> 00:15:38,160
close to our own solar system and then a

386
00:15:41,829 --> 00:15:39,839
bunch more kind of close to the center

387
00:15:44,550 --> 00:15:41,839
of the galaxy but we really haven't

388
00:15:46,870 --> 00:15:44,560

found any yet uh confirmed anywhere

389
00:15:49,030 --> 00:15:46,880
outside of that in the galaxy but just

390
00:15:52,310 --> 00:15:49,040
based on the math that means there's a

391
00:15:54,870 --> 00:15:52,320
lot of worlds out there um you know it

392
00:15:56,790 --> 00:15:54,880
could be 400 billion 800 billion maybe a

393
00:15:58,470 --> 00:15:56,800
trillion worlds out there we really

394
00:16:00,710 --> 00:15:58,480
don't know but we have a good estimate

395
00:16:03,110 --> 00:16:00,720
now that maybe there's at least 1.6

396
00:16:04,550 --> 00:16:03,120
worlds per star if not more

397
00:16:06,550 --> 00:16:04,560
um and so how many of those are

398
00:16:08,550 --> 00:16:06,560
habitable is a big question

399
00:16:10,790 --> 00:16:08,560
and so when i when i was first mentioned

400
00:16:12,870 --> 00:16:10,800
i was going to have you on the show uh a

401
00:16:14,230 --> 00:16:12,880
young graduate student reached out to me

402
00:16:15,910 --> 00:16:14,240
and said that they've actually been

403
00:16:18,069 --> 00:16:15,920
using your your habitability uh

404
00:16:20,230 --> 00:16:18,079
exoplanet uh habitability catalog for

405
00:16:22,150 --> 00:16:20,240
some time now and i wonder if you could

406
00:16:23,749 --> 00:16:22,160
tell our audience then about you know

407
00:16:25,350 --> 00:16:23,759
how you've developed the catalog and how

408
00:16:27,509 --> 00:16:25,360
these factors you mentioned earlier kind

409
00:16:28,629 --> 00:16:27,519
of build into this idea of of how we're

410
00:16:30,710 --> 00:16:28,639
now taking

411
00:16:32,629 --> 00:16:30,720
our idea of what could mean habitability

412
00:16:35,590 --> 00:16:32,639
and how we're actually now classifying

413
00:16:36,870 --> 00:16:35,600

potentially habitable worlds out there

414
00:16:39,590 --> 00:16:36,880
well

415
00:16:41,749 --> 00:16:39,600
we have the habit of exoplanet catalog

416
00:16:43,430 --> 00:16:41,759
it's an online database of potentially

417
00:16:45,990 --> 00:16:43,440
habitable words discoveries for

418
00:16:48,710 --> 00:16:46,000
scientists educators and general public

419
00:16:50,870 --> 00:16:48,720
it just started by accident

420
00:16:52,150 --> 00:16:50,880
i just wanted to keep track of the new

421
00:16:53,990 --> 00:16:52,160
discoveries

422
00:16:55,829 --> 00:16:54,000
and decide that why not put that

423
00:16:58,069 --> 00:16:55,839
everything online

424
00:17:01,670 --> 00:16:58,079
and using a little bit of art because i

425
00:17:02,710 --> 00:17:01,680
used to draw so now i have a another uh

426
00:17:04,870 --> 00:17:02,720
reason

427
00:17:07,510 --> 00:17:04,880
another excuse to

428
00:17:10,549 --> 00:17:07,520
to draw some nice images of a

429
00:17:13,350 --> 00:17:10,559
representation of exoplanets just for

430
00:17:16,549 --> 00:17:13,360
for visualization purposes only

431
00:17:19,829 --> 00:17:16,559
so we started with that catalog in 2011

432
00:17:20,949 --> 00:17:19,839
so this uh december

433
00:17:23,270 --> 00:17:20,959
uh

434
00:17:24,309 --> 00:17:23,280
fifth we celebrate ten years with the

435
00:17:26,549 --> 00:17:24,319
catalogue

436
00:17:28,710 --> 00:17:26,559
the color identify classifies and

437
00:17:31,110 --> 00:17:28,720
compare exoplanets of interest for the

438
00:17:33,830 --> 00:17:31,120

search for life in the universe latest

439
00:17:35,590 --> 00:17:33,840
update lists up to 60 potentially

440
00:17:39,909 --> 00:17:35,600
habitable words

441
00:17:41,750 --> 00:17:39,919
but only out of those 24 of those uh are

442
00:17:43,430 --> 00:17:41,760
what we call the conservative samples

443
00:17:45,190 --> 00:17:43,440
are more likely to have habitable

444
00:17:48,630 --> 00:17:45,200
conditions based on their signs and

445
00:17:51,190 --> 00:17:48,640
installation so i have to stress out

446
00:17:54,470 --> 00:17:51,200
that even that we have these nice images

447
00:17:56,710 --> 00:17:54,480
and views in our catalog page they are

448
00:17:59,110 --> 00:17:56,720
just active representation

449
00:18:00,870 --> 00:17:59,120
the only correct thing of those images

450
00:18:02,549 --> 00:18:00,880
is about their size and their

451
00:18:04,310 --> 00:18:02,559
uncertainties

452
00:18:07,830 --> 00:18:04,320
and that we know that they have the

453
00:18:09,990 --> 00:18:07,840
right orbit to be considered potentially

454
00:18:11,029 --> 00:18:10,000
habitable which we call the habitable

455
00:18:13,350 --> 00:18:11,039
zone

456
00:18:15,990 --> 00:18:13,360
or the stellar more properly the sterile

457
00:18:18,630 --> 00:18:16,000
habitable zone so they are more likely

458
00:18:21,190 --> 00:18:18,640
to have uh good temperatures given if

459
00:18:23,830 --> 00:18:21,200
they have an atmosphere just to have a

460
00:18:26,390 --> 00:18:23,840
liquid water at the surface

461
00:18:29,110 --> 00:18:26,400
so from all these objects

462
00:18:31,830 --> 00:18:29,120
they could be right there could be wrong

463
00:18:32,950 --> 00:18:31,840

they could be oceans were there they

464
00:18:35,029 --> 00:18:32,960
could be

465
00:18:37,909 --> 00:18:35,039
uh dry lands

466
00:18:40,150 --> 00:18:37,919
worse without atmosphere without water

467
00:18:42,950 --> 00:18:40,160
or even um

468
00:18:44,870 --> 00:18:42,960
even planets that are too big

469
00:18:47,270 --> 00:18:44,880
based on our the certainty that are

470
00:18:49,990 --> 00:18:47,280
probably more like mini net we don't

471
00:18:52,950 --> 00:18:50,000
know we have this sample there and what

472
00:18:53,830 --> 00:18:52,960
we need to do is explore each of each

473
00:18:56,230 --> 00:18:53,840
one

474
00:18:58,549 --> 00:18:56,240
as good as possible

475
00:19:01,190 --> 00:18:58,559
probably the most interesting planet are

476
00:19:03,590 --> 00:19:01,200
those around trap is one

477
00:19:05,750 --> 00:19:03,600
because it has three or even four

478
00:19:07,110 --> 00:19:05,760
planets in the habitable zone and close

479
00:19:09,110 --> 00:19:07,120
enough to prepare for further

480
00:19:11,350 --> 00:19:09,120
characterization for with future

481
00:19:13,190 --> 00:19:11,360
telescopes so that's one big problem

482
00:19:15,990 --> 00:19:13,200
that many of those planets are too far

483
00:19:18,310 --> 00:19:16,000
and we won't know anything about or more

484
00:19:19,510 --> 00:19:18,320
in the future but a few of those are

485
00:19:21,590 --> 00:19:19,520
close enough

486
00:19:24,310 --> 00:19:21,600
that that we will go the next step

487
00:19:26,390 --> 00:19:24,320
learning about their atmosphere

488
00:19:27,909 --> 00:19:26,400

eventually something about the surface

489
00:19:30,630 --> 00:19:27,919
properties

490
00:19:34,870 --> 00:19:30,640
and uh in between probably if they are

491
00:19:37,669 --> 00:19:36,310
yeah and that so

492
00:19:39,350 --> 00:19:37,679
myself and some others have argued

493
00:19:41,590 --> 00:19:39,360
before that the word habitable zone

494
00:19:43,830 --> 00:19:41,600
itself is potentially presumptive and

495
00:19:45,029 --> 00:19:43,840
misleading um because we don't know as

496
00:19:47,350 --> 00:19:45,039
you mentioned what those worlds are

497
00:19:49,750 --> 00:19:47,360
actually like inside of that zone just

498
00:19:51,510 --> 00:19:49,760
based on its orbital position alone and

499
00:19:52,870 --> 00:19:51,520
so i'm wondering if i can ask you this

500
00:19:54,870 --> 00:19:52,880
question um

501
00:19:58,070 --> 00:19:54,880
what happens if we find out that there

502
00:20:00,070 --> 00:19:58,080
is life in europa's ocean and enceladus

503
00:20:01,909 --> 00:20:00,080
ocean and maybe we discover signs of

504
00:20:03,909 --> 00:20:01,919
life from a titanian ocean at the

505
00:20:06,390 --> 00:20:03,919
surface with dragonfly what if we

506
00:20:09,430 --> 00:20:06,400
discover that life is potentially more

507
00:20:10,630 --> 00:20:09,440
common on icy ocean worlds does that

508
00:20:13,350 --> 00:20:10,640
mean we've been looking in the wrong

509
00:20:15,190 --> 00:20:13,360
place or are we still very justified in

510
00:20:17,110 --> 00:20:15,200
looking in this realm of the goldilocks

511
00:20:18,390 --> 00:20:17,120
zone for liquid water because of what we

512
00:20:19,350 --> 00:20:18,400
currently know

513
00:20:21,909 --> 00:20:19,360

okay

514
00:20:24,310 --> 00:20:21,919
oh i know that the concept of the

515
00:20:26,950 --> 00:20:24,320
habitable sum is confusing

516
00:20:29,190 --> 00:20:26,960
but we should state that there are two

517
00:20:33,270 --> 00:20:29,200
concepts here if you're using the word

518
00:20:36,310 --> 00:20:33,280
the habitable song as a a general uh uh

519
00:20:38,950 --> 00:20:36,320
statement or word transpiration or as a

520
00:20:41,430 --> 00:20:38,960
proper name and here when we call the

521
00:20:43,190 --> 00:20:41,440
the habitable song using astronomy it's

522
00:20:45,110 --> 00:20:43,200
used as a proper name you can

523
00:20:46,710 --> 00:20:45,120
collaborate with the stellar potentially

524
00:20:49,350 --> 00:20:46,720
habitable zone

525
00:20:52,149 --> 00:20:49,360
and it says particular song and and

526
00:20:54,950 --> 00:20:52,159
relating that to what ecologists do

527
00:20:57,510 --> 00:20:54,960
regarding habitability this totally

528
00:21:00,310 --> 00:20:57,520
makes sense because when you evaluate

529
00:21:02,950 --> 00:21:00,320
habitability you evaluate a certain

530
00:21:04,870 --> 00:21:02,960
environment under certain conditions on

531
00:21:07,110 --> 00:21:04,880
the certain variables

532
00:21:10,549 --> 00:21:07,120
so this particular stellar habitable

533
00:21:13,990 --> 00:21:10,559
zone are for earth-like planets surface

534
00:21:16,870 --> 00:21:14,000
or liquid water and then surface life

535
00:21:18,870 --> 00:21:16,880
but the fact is there is a library of

536
00:21:21,110 --> 00:21:18,880
habitable zones

537
00:21:23,830 --> 00:21:21,120
you can consider planetary habitable

538
00:21:25,990 --> 00:21:23,840

zones you can consider sterile habitable

539
00:21:28,310 --> 00:21:26,000
zones around stars like this one

540
00:21:30,630 --> 00:21:28,320
and the classical habitable zone or even

541
00:21:32,549 --> 00:21:30,640
galactic habitable zones

542
00:21:34,870 --> 00:21:32,559
and if you are considering planetary

543
00:21:36,549 --> 00:21:34,880
habitable zones you can

544
00:21:38,870 --> 00:21:36,559
decide and this is something that we

545
00:21:40,630 --> 00:21:38,880
learned from ecologies once you want to

546
00:21:43,270 --> 00:21:40,640
evaluate the habitability of the system

547
00:21:44,549 --> 00:21:43,280
you have to decide the space that you

548
00:21:46,149 --> 00:21:44,559
are considering

549
00:21:47,669 --> 00:21:46,159
and the time frame that you're

550
00:21:50,310 --> 00:21:47,679
considering

551
00:21:52,789 --> 00:21:50,320
and the space here could be just surface

552
00:21:54,870 --> 00:21:52,799
or it could be surface or could be that

553
00:21:58,470 --> 00:21:54,880
surface including oceans

554
00:21:59,990 --> 00:21:58,480
and then uh you will create a library

555
00:22:02,630 --> 00:22:00,000
so eventually we will create something

556
00:22:04,630 --> 00:22:02,640
like the book the habitable zones and

557
00:22:07,350 --> 00:22:04,640
then a library of different

558
00:22:09,990 --> 00:22:07,360
considerations and including those in

559
00:22:12,310 --> 00:22:10,000
the surface and the oceans and like in

560
00:22:15,029 --> 00:22:12,320
the solar system as you mentioned and

561
00:22:17,590 --> 00:22:15,039
like europa and insalados and and even

562
00:22:18,950 --> 00:22:17,600
the titan surface and the on the life as

563
00:22:21,029 --> 00:22:18,960

we don't know it

564
00:22:23,750 --> 00:22:21,039
so though those are different habitable

565
00:22:25,590 --> 00:22:23,760
zones it will be amazing yeah the only

566
00:22:27,430 --> 00:22:25,600
thing that that kind of that brings up a

567
00:22:29,430 --> 00:22:27,440
really good point too

568
00:22:31,110 --> 00:22:29,440
but that brings a good point uh you've

569
00:22:32,390 --> 00:22:31,120
recently announced this new planet hab

570
00:22:34,230 --> 00:22:32,400
collaboration

571
00:22:35,430 --> 00:22:34,240
where yourself and a rather large group

572
00:22:36,870 --> 00:22:35,440
of researchers are going to work

573
00:22:38,789 --> 00:22:36,880
together to kind of

574
00:22:41,029 --> 00:22:38,799
help us define and develop these metrics

575
00:22:42,870 --> 00:22:41,039
of what makes something habitable um i

576
00:22:45,350 --> 00:22:42,880
wonder if you can speak to the current

577
00:22:46,870 --> 00:22:45,360
work uh for the planethab collaboration

578
00:22:49,190 --> 00:22:46,880
and how you envision the future moving

579
00:22:53,270 --> 00:22:49,200
forward with that team

580
00:22:56,070 --> 00:22:53,280
i think this is a re-emerging field

581
00:22:57,669 --> 00:22:56,080
so right now ecologists have been doing

582
00:22:59,350 --> 00:22:57,679
them from forever

583
00:23:01,510 --> 00:22:59,360
since the 70s

584
00:23:03,830 --> 00:23:01,520
now we are starting to apply this model

585
00:23:06,549 --> 00:23:03,840
to astrobiology so it is applica

586
00:23:09,270 --> 00:23:06,559
different application and extension of

587
00:23:11,270 --> 00:23:09,280
these ideas so that's why we have a

588
00:23:12,950 --> 00:23:11,280

large collaboration of over 30

589
00:23:15,830 --> 00:23:12,960
scientists from different disciplines

590
00:23:17,669 --> 00:23:15,840
from astronomy to biology and ecology

591
00:23:20,070 --> 00:23:17,679
very important

592
00:23:23,270 --> 00:23:20,080
that we're trying to get together all

593
00:23:24,390 --> 00:23:23,280
these ideas and creating a different

594
00:23:27,510 --> 00:23:24,400
models

595
00:23:31,110 --> 00:23:27,520
so the idea now is that

596
00:23:34,789 --> 00:23:31,120
now that we have this uh uh uh

597
00:23:37,190 --> 00:23:34,799
white paper guiding on how it works

598
00:23:39,029 --> 00:23:37,200
then we will address specific

599
00:23:39,990 --> 00:23:39,039
environments we are working with people

600
00:23:41,909 --> 00:23:40,000
uh

601
00:23:44,950 --> 00:23:41,919
re-evaluating the habitability of the

602
00:23:48,230 --> 00:23:44,960
surface of mars and not to say that mars

603
00:23:51,510 --> 00:23:48,240
is habitable but we can say how bad it

604
00:23:53,990 --> 00:23:51,520
is also so you think that this model is

605
00:23:55,750 --> 00:23:54,000
just to the idea to tell just how is

606
00:23:57,430 --> 00:23:55,760
this available or not that's an

607
00:23:59,190 --> 00:23:57,440
oversimplification

608
00:24:01,510 --> 00:23:59,200
once you're comparing environment you

609
00:24:04,390 --> 00:24:01,520
want you really want to know which one

610
00:24:08,230 --> 00:24:04,400
are worse or good or bad in the case of

611
00:24:10,070 --> 00:24:08,240
mars we can have a scale how bad it is

612
00:24:12,630 --> 00:24:10,080
and then move forward

613
00:24:14,710 --> 00:24:12,640

deeper to the surface to other better

614
00:24:16,549 --> 00:24:14,720
environments so that's the idea and

615
00:24:20,230 --> 00:24:16,559
other people working with the oceans in

616
00:24:25,190 --> 00:24:20,240
europa and then each each uh environment

617
00:24:28,230 --> 00:24:26,789
yeah so i'm really glad you have this

618
00:24:30,230 --> 00:24:28,240
collaboration now so i'm looking forward

619
00:24:31,750 --> 00:24:30,240
to the work coming out of that i know i

620
00:24:34,230 --> 00:24:31,760
read that you have a session at apps

621
00:24:36,470 --> 00:24:34,240
icon 2022 that i'm sure our audience

622
00:24:38,549 --> 00:24:36,480
will look forward to participating in or

623
00:24:40,230 --> 00:24:38,559
coming to watch if they're registered

624
00:24:41,430 --> 00:24:40,240
i want to switch the conversation just a

625
00:24:43,669 --> 00:24:41,440
little bit in the time that you and i

626
00:24:44,789 --> 00:24:43,679
have left for i open it up to audience

627
00:24:46,310 --> 00:24:44,799
questions

628
00:24:48,310 --> 00:24:46,320
our audience right now can ask their

629
00:24:50,310 --> 00:24:48,320
questions on the facebook chat or on the

630
00:24:52,070 --> 00:24:50,320
youtube chat and we will do our best to

631
00:24:55,190 --> 00:24:52,080
get those questions over so that we can

632
00:24:57,750 --> 00:24:55,200
ask them of professor mendez um we did

633
00:24:59,110 --> 00:24:57,760
have one other nasa astro bio poll on

634
00:25:01,029 --> 00:24:59,120
the twitter

635
00:25:03,350 --> 00:25:01,039
at nasa astrobio

636
00:25:05,590 --> 00:25:03,360
we asked everyone when was the very

637
00:25:07,990 --> 00:25:05,600
first exoplanets detected when were the

638
00:25:10,789 --> 00:25:08,000

first exoplanets detected uh using

639
00:25:12,549 --> 00:25:10,799
arecibo by the way uh and we had a few

640
00:25:16,310 --> 00:25:12,559
answers in there the two that had the

641
00:25:18,950 --> 00:25:16,320
most were 1992 and 1995.

642
00:25:21,110 --> 00:25:18,960
so we had some people argue it was 95

643
00:25:23,750 --> 00:25:21,120
and yes that was when we found 51 pega

644
00:25:25,669 --> 00:25:23,760
cb the first exoplanet around a main

645
00:25:27,430 --> 00:25:25,679
sequence star but actually the very

646
00:25:28,950 --> 00:25:27,440
first detections that we know of came in

647
00:25:31,110 --> 00:25:28,960
1992

648
00:25:33,430 --> 00:25:31,120
uh finding exoplanets around pulsars was

649
00:25:36,230 --> 00:25:33,440
the very first time we found exoplanets

650
00:25:38,870 --> 00:25:36,240
out there and now we have over 4 500 and

651
00:25:41,510 --> 00:25:38,880
aracebo was part of that history of

652
00:25:43,510 --> 00:25:41,520
these detections of exoplanets out there

653
00:25:45,269 --> 00:25:43,520
arecibo had its construction completed

654
00:25:47,430 --> 00:25:45,279
in 1963.

655
00:25:49,269 --> 00:25:47,440
many of us who are nerds for things like

656
00:25:52,549 --> 00:25:49,279
this we know that era sibo is featured

657
00:25:54,390 --> 00:25:52,559
in films like the amazing contact

658
00:25:56,630 --> 00:25:54,400
as well as in golden eye and several

659
00:25:59,029 --> 00:25:56,640
other movies uh we've seen pictures of

660
00:26:00,870 --> 00:25:59,039
arecibo you know from the time we were

661
00:26:02,789 --> 00:26:00,880
children thinking about this telescope

662
00:26:05,110 --> 00:26:02,799
and how important it was and i think

663
00:26:07,909 --> 00:26:05,120

many of you hopefully are also aware

664
00:26:09,830 --> 00:26:07,919
that we lost the main telescope at the

665
00:26:11,190 --> 00:26:09,840
arizona observatory

666
00:26:12,710 --> 00:26:11,200
last year

667
00:26:14,549 --> 00:26:12,720
the main

668
00:26:15,590 --> 00:26:14,559
telescope collapsed and took out the

669
00:26:17,190 --> 00:26:15,600
dish

670
00:26:19,350 --> 00:26:17,200
and this was kind of you know in some

671
00:26:21,669 --> 00:26:19,360
ways a long time coming too there was a

672
00:26:23,269 --> 00:26:21,679
major hurricane in puerto rico in 2017

673
00:26:25,430 --> 00:26:23,279
hurricane maria

674
00:26:27,909 --> 00:26:25,440
it caused a large number of fatalities a

675
00:26:29,430 --> 00:26:27,919
very large amount of damage to property

676
00:26:33,029 --> 00:26:29,440
it was a devastating hurricane for the

677
00:26:34,789 --> 00:26:33,039
island and it also damaged arecibo and

678
00:26:36,789 --> 00:26:34,799
with that with a lack of funding to

679
00:26:39,110 --> 00:26:36,799
support upgrading the telescope

680
00:26:40,149 --> 00:26:39,120
maintaining it uh we led to this

681
00:26:42,549 --> 00:26:40,159
collapse

682
00:26:45,269 --> 00:26:42,559
uh and so professor mendez you've used

683
00:26:48,630 --> 00:26:45,279
aracebo for observations um you know

684
00:26:50,470 --> 00:26:48,640
you're a professor um nearby um to the

685
00:26:52,149 --> 00:26:50,480
observatory i'm wondering if you could

686
00:26:55,430 --> 00:26:52,159
tell us you know about what this really

687
00:26:56,549 --> 00:26:55,440
meant to young people in puerto rico and

688
00:27:00,549 --> 00:26:56,559

you know really what led to this

689
00:27:06,070 --> 00:27:03,110
that was very hard for everybody here in

690
00:27:09,110 --> 00:27:06,080
puerto rico arecibo is iconic not only

691
00:27:11,029 --> 00:27:09,120
in the world but also uh for puerto rico

692
00:27:13,029 --> 00:27:11,039
we are very proud

693
00:27:16,710 --> 00:27:13,039
of our observatory

694
00:27:18,230 --> 00:27:16,720
but uh we are trying to move forward

695
00:27:20,310 --> 00:27:18,240
and i

696
00:27:22,789 --> 00:27:20,320
as i said i stood the possibility of

697
00:27:25,190 --> 00:27:22,799
life as elsewhere in the theoretical

698
00:27:26,870 --> 00:27:25,200
framework but we also use the arecibo

699
00:27:28,389 --> 00:27:26,880
observatory to study start with

700
00:27:31,350 --> 00:27:28,399
potentially known

701
00:27:33,510 --> 00:27:31,360
uh the non-potentially habitable planets

702
00:27:35,590 --> 00:27:33,520
we want to understand the impact of

703
00:27:36,630 --> 00:27:35,600
radiation environmental stars on their

704
00:27:38,630 --> 00:27:36,640
planet

705
00:27:40,710 --> 00:27:38,640
because some stars are very stable like

706
00:27:42,470 --> 00:27:40,720
our sun but others are like red door

707
00:27:44,310 --> 00:27:42,480
stars are very active constantly

708
00:27:46,710 --> 00:27:44,320
emitting extra doses of radiation which

709
00:27:49,350 --> 00:27:46,720
could degrade the atmosphere of planets

710
00:27:51,190 --> 00:27:49,360
even made them not suitable for light

711
00:27:53,029 --> 00:27:51,200
i have been monitoring from the receiver

712
00:27:53,990 --> 00:27:53,039
observatory some of these after start

713
00:27:56,230 --> 00:27:54,000

for the

714
00:28:00,070 --> 00:27:56,240
last five four years

715
00:28:03,029 --> 00:28:00,080
so i used observatory before maria and i

716
00:28:06,710 --> 00:28:03,039
noticed the after the hurricane

717
00:28:09,990 --> 00:28:06,720
how uh the shaking of the structure made

718
00:28:12,870 --> 00:28:10,000
the observations a little bit sense less

719
00:28:13,750 --> 00:28:12,880
bit sensitive it was totally usable

720
00:28:18,789 --> 00:28:13,760
yet

721
00:28:23,110 --> 00:28:20,389
then uh

722
00:28:26,470 --> 00:28:23,120
a little bit of history about this in

723
00:28:28,310 --> 00:28:26,480
august 10 uh 2020 the auxiliary cable

724
00:28:31,510 --> 00:28:28,320
supported the receiver platform platform

725
00:28:33,029 --> 00:28:31,520
broke causing a 100 feet a long gash on

726
00:28:35,669 --> 00:28:33,039
the reflector dish

727
00:28:36,630 --> 00:28:35,679
i used observatory just one week before

728
00:28:38,470 --> 00:28:36,640
that

729
00:28:39,590 --> 00:28:38,480
and i was planning to involve more

730
00:28:43,510 --> 00:28:39,600
students

731
00:28:45,669 --> 00:28:43,520
the observatory

732
00:28:48,630 --> 00:28:45,679
and i was planning to trade more and

733
00:28:50,149 --> 00:28:48,640
that semester and that starting august

734
00:28:53,510 --> 00:28:50,159
we had the issue

735
00:28:56,789 --> 00:28:53,520
then on november 6 a second uh

736
00:28:59,190 --> 00:28:56,799
2020 receive call cable broke

737
00:29:01,590 --> 00:28:59,200
this time involving one of the four long

738
00:29:02,950 --> 00:29:01,600

main support cables causing additional

739
00:29:05,110 --> 00:29:02,960
damage

740
00:29:06,630 --> 00:29:05,120
and finally in the early morning of

741
00:29:08,710 --> 00:29:06,640
december first

742
00:29:10,470 --> 00:29:08,720
uh 2020 the main platform with all the

743
00:29:13,590 --> 00:29:10,480
telescope receiver collapse destroying

744
00:29:16,310 --> 00:29:13,600
the telescope today the observatory

745
00:29:19,350 --> 00:29:16,320
keeps working using other less known

746
00:29:21,830 --> 00:29:19,360
instruments so we only lost the big

747
00:29:24,070 --> 00:29:21,840
famous telescope but the receiver

748
00:29:26,950 --> 00:29:24,080
observatory is still working there the

749
00:29:29,029 --> 00:29:26,960
buildings the people everybody's there

750
00:29:31,750 --> 00:29:29,039
they are working toward replacing or

751
00:29:35,909 --> 00:29:31,760
upgrading his famous telescope sometime

752
00:29:40,789 --> 00:29:38,870
that's fantastic and no i i had never

753
00:29:42,230 --> 00:29:40,799
honestly visited arecibo unfortunately

754
00:29:43,430 --> 00:29:42,240
i've never been there but i've heard

755
00:29:44,549 --> 00:29:43,440
from a lot of friends and you mentioned

756
00:29:46,789 --> 00:29:44,559
when you kind of first started in

757
00:29:48,149 --> 00:29:46,799
astrobiology there weren't anyone there

758
00:29:49,590 --> 00:29:48,159
wasn't anyone else from puerto rico and

759
00:29:52,789 --> 00:29:49,600
now we have several puerto rican

760
00:29:54,549 --> 00:29:52,799
scientists in astrobiology and planetary

761
00:29:56,549 --> 00:29:54,559
science and you know you have to wonder

762
00:29:59,190 --> 00:29:56,559
was was the arecibo observatory part of

763
00:30:01,029 --> 00:29:59,200

what inspired them i've heard from many

764
00:30:03,750 --> 00:30:01,039
uh folks from puerto rico that that

765
00:30:05,510 --> 00:30:03,760
having arecibo was not only iconic but

766
00:30:06,870 --> 00:30:05,520
really inspired them to feel like part

767
00:30:08,950 --> 00:30:06,880
of what we're doing right now in

768
00:30:11,029 --> 00:30:08,960
exploring the cosmos and and better

769
00:30:12,789 --> 00:30:11,039
understanding the future i'll also say

770
00:30:15,909 --> 00:30:12,799
that one thing that i learned and i'm

771
00:30:17,350 --> 00:30:15,919
sure many others did was the phrase

772
00:30:18,840 --> 00:30:17,360
might pronounce this wrong is it is it

773
00:30:22,549 --> 00:30:18,850
wepa

774
00:30:24,549 --> 00:30:22,559
[Laughter]

775
00:30:26,310 --> 00:30:24,559
so i saw this phrase over and over again

776
00:30:28,230 --> 00:30:26,320
on twitter i had to look it up to find

777
00:30:30,070 --> 00:30:28,240
out what this phrase was that was being

778
00:30:31,909 --> 00:30:30,080
used over and over again

779
00:30:33,669 --> 00:30:31,919
and i saw like a lot of camaraderie and

780
00:30:36,549 --> 00:30:33,679
support from the community from from

781
00:30:38,710 --> 00:30:36,559
puerto rico for arecibo and for the

782
00:30:39,669 --> 00:30:38,720
potential future to support a potential

783
00:30:41,669 --> 00:30:39,679
future

784
00:30:43,110 --> 00:30:41,679
for the telescope for the observatory

785
00:30:45,430 --> 00:30:43,120
i'm very glad you mentioned that the

786
00:30:47,830 --> 00:30:45,440
observatory is still functioning and

787
00:30:50,710 --> 00:30:47,840
there is a plan a potential plan for a

788
00:30:52,389 --> 00:30:50,720

future of a larger telescope at the

789
00:30:54,230 --> 00:30:52,399
observatory i'm wondering if you could

790
00:30:56,310 --> 00:30:54,240
tell us a bit about what that looks like

791
00:30:58,470 --> 00:30:56,320
right now um we're getting close to one

792
00:30:59,830 --> 00:30:58,480
year after the collapse

793
00:31:01,110 --> 00:30:59,840
how do you envision the future of

794
00:31:01,990 --> 00:31:01,120
arecibo

795
00:31:03,830 --> 00:31:02,000
yes

796
00:31:06,149 --> 00:31:03,840
scientists there and all scientists

797
00:31:08,630 --> 00:31:06,159
around the world the

798
00:31:11,110 --> 00:31:08,640
community of arecibo users are working

799
00:31:13,430 --> 00:31:11,120
toward the future observatory

800
00:31:15,509 --> 00:31:13,440
they are planning things in the short

801
00:31:18,389 --> 00:31:15,519
term and the long term

802
00:31:20,870 --> 00:31:18,399
for the short term probably next year so

803
00:31:22,549 --> 00:31:20,880
other instruments smaller intro

804
00:31:23,750 --> 00:31:22,559
instrument located

805
00:31:26,950 --> 00:31:23,760
throughout the

806
00:31:27,750 --> 00:31:26,960
arecibo observatory campus

807
00:31:29,990 --> 00:31:27,760
but

808
00:31:31,110 --> 00:31:30,000
eventually there are two possible

809
00:31:33,669 --> 00:31:31,120
options

810
00:31:37,669 --> 00:31:33,679
the observatory could be fixed

811
00:31:39,190 --> 00:31:37,679
uh the main dish seventy percent of the

812
00:31:42,149 --> 00:31:39,200
seventy-five percent of the main dish is

813
00:31:45,350 --> 00:31:42,159

still working so that's easy to repair

814
00:31:48,549 --> 00:31:45,360
so what collapse was the main receivers

815
00:31:51,269 --> 00:31:48,559
that was hanging by three towers

816
00:31:54,630 --> 00:31:51,279
and that was the most expensive part

817
00:31:57,350 --> 00:31:54,640
but there are other ways to fix that if

818
00:31:58,549 --> 00:31:57,360
you put the receivers instead of hanging

819
00:32:00,470 --> 00:31:58,559
at the top

820
00:32:04,630 --> 00:32:00,480
at the bottom

821
00:32:07,750 --> 00:32:04,640
and then hanging a secondary reflector

822
00:32:10,070 --> 00:32:07,760
like like a cassegrain telescope

823
00:32:12,630 --> 00:32:10,080
so that's one alternative to fix the

824
00:32:15,830 --> 00:32:12,640
telescope but that if that happens it

825
00:32:17,990 --> 00:32:15,840
will take five or ten years

826
00:32:20,630 --> 00:32:18,000
but there are other options

827
00:32:23,509 --> 00:32:20,640
built a totally new telescope in the

828
00:32:24,789 --> 00:32:23,519
next generation a receivable telescope

829
00:32:27,350 --> 00:32:24,799
ringgit

830
00:32:29,669 --> 00:32:27,360
and this is one idea that

831
00:32:30,789 --> 00:32:29,679
we are proposing with the receivo

832
00:32:32,230 --> 00:32:30,799
community

833
00:32:34,950 --> 00:32:32,240
of scientists

834
00:32:37,350 --> 00:32:34,960
is that uh building a face array

835
00:32:39,350 --> 00:32:37,360
telescope so it will

836
00:32:41,669 --> 00:32:39,360
totally look different it will be

837
00:32:45,269 --> 00:32:41,679
instead of one single dish will be

838
00:32:47,110 --> 00:32:45,279

thousands or some smaller dishes

839
00:32:50,149 --> 00:32:47,120
working together

840
00:32:53,190 --> 00:32:50,159
and uh in a face array mode

841
00:32:56,549 --> 00:32:53,200
and that means that you can do

842
00:32:59,830 --> 00:32:56,559
you will have a more sensitive telescope

843
00:33:02,710 --> 00:32:59,840
and it will i will be able to without

844
00:33:05,190 --> 00:33:02,720
moving that much to observe different

845
00:33:08,230 --> 00:33:05,200
video in the sky even so it will be put

846
00:33:10,630 --> 00:33:08,240
in a platform that is movable so you

847
00:33:12,389 --> 00:33:10,640
will have a longer

848
00:33:15,029 --> 00:33:12,399
region of the sky that you will be

849
00:33:18,070 --> 00:33:15,039
observing and you will be observing

850
00:33:20,070 --> 00:33:18,080
places never seen before by any big

851
00:33:23,110 --> 00:33:20,080
radio telescope because

852
00:33:26,310 --> 00:33:23,120
this radio telescope like the one in

853
00:33:27,669 --> 00:33:26,320
china fast have limited capability of

854
00:33:28,789 --> 00:33:27,679
the sky

855
00:33:32,630 --> 00:33:28,799
that uh

856
00:33:33,750 --> 00:33:32,640
uh that you you can do so but that

857
00:33:36,149 --> 00:33:33,760
uh

858
00:33:38,630 --> 00:33:36,159
next generation telescope probably is

859
00:33:40,310 --> 00:33:38,640
something for 10 or or

860
00:33:43,350 --> 00:33:40,320
15 year frames

861
00:33:45,909 --> 00:33:43,360
so the community is working to uh

862
00:33:46,630 --> 00:33:45,919
writing proposals in between

863
00:33:55,990 --> 00:33:46,640

and

864
00:33:57,029 --> 00:33:56,000
see what that looks like i know there's

865
00:33:58,470 --> 00:33:57,039
a lot of people out there who are

866
00:34:00,149 --> 00:33:58,480
curious to see how they can be involved

867
00:34:01,830 --> 00:34:00,159
in supporting the telescope and the

868
00:34:03,830 --> 00:34:01,840
future of the observatory

869
00:34:05,110 --> 00:34:03,840
um i i do i realize we're kind of

870
00:34:07,190 --> 00:34:05,120
running over on time from you know you

871
00:34:08,790 --> 00:34:07,200
and i discussing things and i do want to

872
00:34:11,030 --> 00:34:08,800
open it up to the audience questions

873
00:34:13,270 --> 00:34:11,040
here as soon as i can um i have one more

874
00:34:14,629 --> 00:34:13,280
question though of my own first um you

875
00:34:16,710 --> 00:34:14,639
know so you know with looking at

876
00:34:18,629 --> 00:34:16,720
potentially habitable exoplanets out

877
00:34:20,470 --> 00:34:18,639
there we have some really incredible

878
00:34:22,710 --> 00:34:20,480
telescopes coming up soon the james webb

879
00:34:25,829 --> 00:34:22,720
space telescope the nancy grace roman

880
00:34:27,510 --> 00:34:25,839
telescope uh we'll hear soon from the

881
00:34:28,310 --> 00:34:27,520
planetary decadal about what might

882
00:34:30,149 --> 00:34:28,320
happen

883
00:34:31,589 --> 00:34:30,159
soon with maybe levoir or habex or one

884
00:34:33,589 --> 00:34:31,599
of these other options for a next

885
00:34:35,030 --> 00:34:33,599
generation large telescope there's

886
00:34:36,869 --> 00:34:35,040
definitely a lot of things coming coming

887
00:34:40,470 --> 00:34:36,879
in the near future and in the next few

888
00:34:42,790 --> 00:34:40,480

decades for us to observe exoplanets to

889
00:34:44,950 --> 00:34:42,800
look at their atmospheres maybe one day

890
00:34:46,230 --> 00:34:44,960
in the not too too distant future maybe

891
00:34:48,310 --> 00:34:46,240
even understanding a bit of their

892
00:34:49,510 --> 00:34:48,320
surface processes what their surfaces

893
00:34:51,669 --> 00:34:49,520
look like

894
00:34:54,149 --> 00:34:51,679
i'm wondering so say say you weren't

895
00:34:56,069 --> 00:34:54,159
limited by funding you could build any

896
00:34:57,670 --> 00:34:56,079
telescope you wanted to to look at

897
00:34:59,589 --> 00:34:57,680
anything you wanted to

898
00:35:02,310 --> 00:34:59,599
what telescope would you build and what

899
00:35:03,990 --> 00:35:02,320
would you look at

900
00:35:06,230 --> 00:35:04,000
that's fascinating

901
00:35:07,349 --> 00:35:06,240
the last decade we have been collecting

902
00:35:09,270 --> 00:35:07,359
plants

903
00:35:11,750 --> 00:35:09,280
or places to look

904
00:35:14,870 --> 00:35:11,760
now we have the places to look and

905
00:35:18,550 --> 00:35:14,880
in this decade we will try to get some

906
00:35:19,910 --> 00:35:18,560
idea of their atmosphere if any

907
00:35:23,430 --> 00:35:19,920
then eventually

908
00:35:24,550 --> 00:35:23,440
properties about the surface and and and

909
00:35:28,470 --> 00:35:24,560
and life

910
00:35:34,390 --> 00:35:31,589
big net thing to do will be an array of

911
00:35:37,109 --> 00:35:34,400
telescopes in a space

912
00:35:38,950 --> 00:35:37,119
and this array will not only you can

913
00:35:41,670 --> 00:35:38,960

build star by building our rail

914
00:35:44,870 --> 00:35:41,680
telescope of on earth but then it will

915
00:35:47,910 --> 00:35:44,880
be to have many telescopes in orbit

916
00:35:51,430 --> 00:35:47,920
including ones in the orbit opposite

917
00:35:54,710 --> 00:35:51,440
to to earth orbiting our sun so you will

918
00:35:56,630 --> 00:35:54,720
have a constant instantaneous baseline

919
00:35:57,430 --> 00:35:56,640
for interferometry

920
00:36:00,310 --> 00:35:57,440
and

921
00:36:02,950 --> 00:36:00,320
also uh an increase your not only your

922
00:36:05,510 --> 00:36:02,960
sensitivity if you have mini telescope

923
00:36:08,470 --> 00:36:05,520
but also because of the distance

924
00:36:10,310 --> 00:36:08,480
the spatial resolution of telescope so i

925
00:36:13,030 --> 00:36:10,320
think that will be the

926
00:36:17,190 --> 00:36:13,040
thing so not just one telescope many

927
00:36:20,870 --> 00:36:19,349
awesome i look forward to it the mendez

928
00:36:22,230 --> 00:36:20,880
telescope um

929
00:36:24,150 --> 00:36:22,240
when it's in space i look forward to

930
00:36:25,430 --> 00:36:24,160
seeing that happen um we can go to the

931
00:36:26,950 --> 00:36:25,440
audience q a now though we do have a

932
00:36:28,950 --> 00:36:26,960
bunch of questions that the audience has

933
00:36:31,190 --> 00:36:28,960
been asking through twitter and through

934
00:36:32,870 --> 00:36:31,200
facebook and through youtube uh and so

935
00:36:36,230 --> 00:36:32,880
i'll start off with a question from raul

936
00:36:37,190 --> 00:36:36,240
magana um user at raoul magana 2 on

937
00:36:40,310 --> 00:36:37,200
twitter

938
00:36:42,550 --> 00:36:40,320

rahul wonders if the successes of life

939
00:36:45,030 --> 00:36:42,560
as we know it here on earth

940
00:36:46,710 --> 00:36:45,040
implies that we will likely find life as

941
00:36:47,589 --> 00:36:46,720
we know it elsewhere

942
00:36:48,950 --> 00:36:47,599
um

943
00:36:50,870 --> 00:36:48,960
i guess you know since we have living

944
00:36:52,630 --> 00:36:50,880
things here right now does that mean we

945
00:36:55,030 --> 00:36:52,640
should expect that aliens look just like

946
00:36:58,069 --> 00:36:55,040
us basically well

947
00:37:00,150 --> 00:36:58,079
okay uh when i started in this field

948
00:37:02,230 --> 00:37:00,160
i was a draw to this field because

949
00:37:03,589 --> 00:37:02,240
looking live elsewhere so that was an

950
00:37:06,710 --> 00:37:03,599
important thing

951
00:37:08,950 --> 00:37:06,720
life as words is is is is

952
00:37:11,589 --> 00:37:08,960
the thing to go for it

953
00:37:13,109 --> 00:37:11,599
and that's probably the easiest solution

954
00:37:15,829 --> 00:37:13,119
because uh

955
00:37:18,230 --> 00:37:15,839
we have stars here the sun you see stars

956
00:37:20,550 --> 00:37:18,240
everywhere you have we have planets here

957
00:37:23,510 --> 00:37:20,560
you see now planets

958
00:37:26,069 --> 00:37:23,520
everywhere so why not live here life

959
00:37:29,030 --> 00:37:26,079
everywhere so that's the simple solution

960
00:37:31,910 --> 00:37:29,040
but once you study astrobiology and i

961
00:37:34,390 --> 00:37:31,920
mean all the details of this you go into

962
00:37:35,510 --> 00:37:34,400
the physics chemistry and biology of

963
00:37:36,470 --> 00:37:35,520

life

964
00:37:38,870 --> 00:37:36,480
you

965
00:37:40,390 --> 00:37:38,880
start to get doubts

966
00:37:43,430 --> 00:37:40,400
because

967
00:37:45,430 --> 00:37:43,440
you see how difficult is for all the

968
00:37:47,829 --> 00:37:45,440
conditions to come right not only of

969
00:37:50,390 --> 00:37:47,839
life also but on the planet life might

970
00:37:52,790 --> 00:37:50,400
be easy to start but the planet to keep

971
00:37:54,790 --> 00:37:52,800
that life for long enough or something

972
00:37:57,270 --> 00:37:54,800
uh uh

973
00:38:00,470 --> 00:37:57,280
more complex to happen so there are many

974
00:38:01,829 --> 00:38:00,480
factors that could go wrong so now i am

975
00:38:03,430 --> 00:38:01,839
surprised

976
00:38:04,630 --> 00:38:03,440
that uh

977
00:38:07,190 --> 00:38:04,640
we are here

978
00:38:10,230 --> 00:38:07,200
more than everything and now i don't

979
00:38:12,390 --> 00:38:10,240
think and i'm just not interested in

980
00:38:13,829 --> 00:38:12,400
looking on life elsewhere

981
00:38:16,870 --> 00:38:13,839
i also

982
00:38:19,990 --> 00:38:16,880
uh the idea of not finding life is

983
00:38:23,670 --> 00:38:20,000
important and it will be for example

984
00:38:25,190 --> 00:38:23,680
amazing that if you look up in

985
00:38:27,109 --> 00:38:25,200
habitable environments because all

986
00:38:29,510 --> 00:38:27,119
habitable environments having liquid

987
00:38:31,109 --> 00:38:29,520
water on earth have life is that true

988
00:38:33,430 --> 00:38:31,119

elsewhere

989
00:38:34,390 --> 00:38:33,440
we actually haven't looked a habitable

990
00:38:36,630 --> 00:38:34,400
place

991
00:38:38,550 --> 00:38:36,640
and for example if we look at running

992
00:38:40,630 --> 00:38:38,560
water on mars

993
00:38:42,950 --> 00:38:40,640
we see on the deep surface we find a

994
00:38:44,710 --> 00:38:42,960
running water and by all the standards

995
00:38:48,550 --> 00:38:44,720
if we put terrestrial light there it

996
00:38:49,990 --> 00:38:48,560
will survive and then we don't see any

997
00:38:53,349 --> 00:38:50,000
life at all

998
00:38:56,790 --> 00:38:53,359
that will be more amazing what went

999
00:38:58,069 --> 00:38:56,800
wrong are we so special so the big

1000
00:39:01,430 --> 00:38:58,079
answer

1001
00:39:04,710 --> 00:39:01,440
is right there on mars and is

1002
00:39:06,069 --> 00:39:04,720
not finding life is bigger answer than

1003
00:39:06,950 --> 00:39:06,079
finding life

1004
00:39:10,390 --> 00:39:06,960
so

1005
00:39:13,349 --> 00:39:10,400
it is important to look for life uh of

1006
00:39:15,109 --> 00:39:13,359
any way possible it's also good to

1007
00:39:17,030 --> 00:39:15,119
consider other

1008
00:39:19,510 --> 00:39:17,040
life as we don't know it

1009
00:39:21,109 --> 00:39:19,520
but the problem is that life as we know

1010
00:39:24,230 --> 00:39:21,119
it use

1011
00:39:25,109 --> 00:39:24,240
most of the most abundant elements on

1012
00:39:32,390 --> 00:39:25,119
life

1013
00:39:35,109 --> 00:39:32,400

will have to compete anyway

1014
00:39:37,589 --> 00:39:35,119
from one life that we know it works that

1015
00:39:40,829 --> 00:39:37,599
use those elements so it will be an

1016
00:39:43,109 --> 00:39:40,839
advantage so probably that's why in

1017
00:39:44,550 --> 00:39:43,119
titan uh conditions which are very

1018
00:39:47,109 --> 00:39:44,560
different

1019
00:39:50,069 --> 00:39:47,119
one of saturn the conditions are very

1020
00:39:52,630 --> 00:39:50,079
different for our life so maybe there is

1021
00:39:54,630 --> 00:39:52,640
a different process but i can tell you

1022
00:39:56,710 --> 00:39:54,640
because it has a

1023
00:39:58,230 --> 00:39:56,720
very low energy available because of the

1024
00:40:00,710 --> 00:39:58,240
low temperatures

1025
00:40:03,910 --> 00:40:00,720
then evolution there everything will go

1026
00:40:07,109 --> 00:40:03,920
slower and will be probably

1027
00:40:09,510 --> 00:40:07,119
is any life it will be less

1028
00:40:14,710 --> 00:40:09,520
concentrated less dense as compared to

1029
00:40:17,349 --> 00:40:15,750
yeah and there's still so much to

1030
00:40:18,710 --> 00:40:17,359
explore

1031
00:40:20,870 --> 00:40:18,720
and with our explorations we have

1032
00:40:22,069 --> 00:40:20,880
another question from atmo hoodles on

1033
00:40:24,470 --> 00:40:22,079
youtube

1034
00:40:25,990 --> 00:40:24,480
she has two questions one is whether or

1035
00:40:28,150 --> 00:40:26,000
not there are any teams planning on

1036
00:40:29,990 --> 00:40:28,160
using jwst to check out any of these

1037
00:40:31,190 --> 00:40:30,000
planets further and and i can answer

1038
00:40:33,349 --> 00:40:31,200

that yes there's a bunch of

1039
00:40:35,670 --> 00:40:33,359
observational astronomers and planetary

1040
00:40:38,550 --> 00:40:35,680
scientists who are have been very

1041
00:40:40,069 --> 00:40:38,560
excited for quite some time for jwst for

1042
00:40:42,309 --> 00:40:40,079
the purpose that it will give us very

1043
00:40:44,470 --> 00:40:42,319
good resolution uh and looking at some

1044
00:40:45,990 --> 00:40:44,480
of these atmospheres of exoplanets uh

1045
00:40:48,309 --> 00:40:46,000
we've had a lot of folks on the show

1046
00:40:50,790 --> 00:40:48,319
previously who have done observational

1047
00:40:53,910 --> 00:40:50,800
astrophysics or know those who do it uh

1048
00:40:55,829 --> 00:40:53,920
who plan to use jwst just for that

1049
00:40:57,829 --> 00:40:55,839
but professor mendes for you

1050
00:41:01,190 --> 00:40:57,839
muhoodles wants to know

1051
00:41:02,630 --> 00:41:01,200
how new data from jwst might impact the

1052
00:41:05,910 --> 00:41:02,640
catalog

1053
00:41:08,710 --> 00:41:05,920
oh okay that's great so right now we

1054
00:41:11,990 --> 00:41:08,720
have objects of interest and uh all

1055
00:41:13,670 --> 00:41:12,000
those 24 uh

1056
00:41:16,309 --> 00:41:13,680
better objects

1057
00:41:17,750 --> 00:41:16,319
we don't have any idea of their

1058
00:41:22,230 --> 00:41:17,760
atmosphere

1059
00:41:25,829 --> 00:41:22,240
or surface properties so if any of the

1060
00:41:28,870 --> 00:41:25,839
observations of james webb uh tells us

1061
00:41:31,109 --> 00:41:28,880
something about atmosphere definitely we

1062
00:41:32,870 --> 00:41:31,119
will highlight those objects

1063
00:41:33,990 --> 00:41:32,880

but probably at the beginning will be

1064
00:41:36,069 --> 00:41:34,000
only

1065
00:41:38,150 --> 00:41:36,079
things about the characterization of the

1066
00:41:40,470 --> 00:41:38,160
atmosphere so

1067
00:41:42,950 --> 00:41:40,480
what ingredients are what molecules are

1068
00:41:44,309 --> 00:41:42,960
there not necessarily life that was

1069
00:41:47,430 --> 00:41:44,319
important point

1070
00:41:50,309 --> 00:41:47,440
but then uh eventually we might be

1071
00:41:52,150 --> 00:41:50,319
detecting some biosignature strong

1072
00:41:55,030 --> 00:41:52,160
compounds in the atmosphere that tells

1073
00:41:57,829 --> 00:41:55,040
that probably a biological process is

1074
00:42:00,230 --> 00:41:57,839
going on so that will be highlight those

1075
00:42:02,870 --> 00:42:00,240
planets are we we'll put that in the web

1076
00:42:03,829 --> 00:42:02,880
page flashing or something like

1077
00:42:06,309 --> 00:42:03,839
that

1078
00:42:09,910 --> 00:42:06,319
because for for instance now we are

1079
00:42:11,510 --> 00:42:09,920
moving from just objects to something

1080
00:42:17,670 --> 00:42:11,520
more real

1081
00:42:22,309 --> 00:42:20,230
awesome um and i mentioned when we first

1082
00:42:23,910 --> 00:42:22,319
started the show that you are very well

1083
00:42:25,270 --> 00:42:23,920
known on twitter for all the cool news

1084
00:42:28,470 --> 00:42:25,280
you share not just about things like

1085
00:42:29,910 --> 00:42:28,480
jwst and and the catalog but also

1086
00:42:31,589 --> 00:42:29,920
just for all the science and

1087
00:42:34,069 --> 00:42:31,599
astrobiology you share

1088
00:42:36,950 --> 00:42:34,079

uh so my friend joey pastorski who is at

1089
00:42:39,349 --> 00:42:36,960
joeypasterski on twitter uh he also with

1090
00:42:41,990 --> 00:42:39,359
me co-leads the the early career council

1091
00:42:43,750 --> 00:42:42,000
of the network for life detection um

1092
00:42:45,109 --> 00:42:43,760
joey wants to wants to know since you do

1093
00:42:46,950 --> 00:42:45,119
such a great job of communicating and

1094
00:42:49,910 --> 00:42:46,960
sharing lots of science

1095
00:42:51,750 --> 00:42:49,920
on social media uh how do you balance

1096
00:42:53,990 --> 00:42:51,760
having such an active social media

1097
00:42:56,309 --> 00:42:54,000
presence with your research and teaching

1098
00:42:57,750 --> 00:42:56,319
responsibilities um and he rephrased it

1099
00:43:01,190 --> 00:42:57,760
and basically said how do you not get

1100
00:43:05,589 --> 00:43:03,430
that's a great question and i have the

1101
00:43:08,390 --> 00:43:05,599
secret for that

1102
00:43:10,390 --> 00:43:08,400
okay okay let's say that twitter for me

1103
00:43:12,390 --> 00:43:10,400
is part of the job and that's my only

1104
00:43:13,670 --> 00:43:12,400
social media i don't use facebook or

1105
00:43:16,790 --> 00:43:13,680
anything else

1106
00:43:19,589 --> 00:43:16,800
and what i like is to read most of my

1107
00:43:23,430 --> 00:43:19,599
information because i didn't have

1108
00:43:26,150 --> 00:43:23,440
a specific course about biophysics or

1109
00:43:29,030 --> 00:43:26,160
astronomy and planetary science i have

1110
00:43:30,550 --> 00:43:29,040
to get that from myself and install it

1111
00:43:33,109 --> 00:43:30,560
with box

1112
00:43:36,790 --> 00:43:33,119
and i lit read a lot

1113
00:43:39,190 --> 00:43:36,800

and uh so twitter for me is what you are

1114
00:43:40,550 --> 00:43:39,200
actually seeing my post is what i'm

1115
00:43:43,750 --> 00:43:40,560
reading

1116
00:43:48,550 --> 00:43:43,760
so what i have a a a

1117
00:43:52,630 --> 00:43:49,670
a program

1118
00:43:54,790 --> 00:43:52,640
that get keywords from the internet and

1119
00:43:56,470 --> 00:43:54,800
from twitter from everywhere else so

1120
00:43:59,270 --> 00:43:56,480
topics i like

1121
00:44:01,510 --> 00:43:59,280
and when i like a topic or i reading a

1122
00:44:03,190 --> 00:44:01,520
topic i just share it

1123
00:44:05,109 --> 00:44:03,200
i just share for everybody else

1124
00:44:07,829 --> 00:44:05,119
especially my students so they're

1125
00:44:10,870 --> 00:44:07,839
they're there for reverence so it has it

1126
00:44:12,950 --> 00:44:10,880
has it is important for us to have that

1127
00:44:14,069 --> 00:44:12,960
reference sometimes i remember

1128
00:44:25,190 --> 00:44:14,079
i

1129
00:44:27,430 --> 00:44:25,200
just to keep track

1130
00:44:30,870 --> 00:44:27,440
of the signs i like

1131
00:44:33,109 --> 00:44:30,880
and uh and uh what i am reading and also

1132
00:44:34,790 --> 00:44:33,119
to share with my students and to the

1133
00:44:36,550 --> 00:44:34,800
general public

1134
00:44:38,390 --> 00:44:36,560
that's awesome yeah i i appreciate

1135
00:44:39,990 --> 00:44:38,400
following you on twitter um i get a lot

1136
00:44:41,190 --> 00:44:40,000
of things to read i find articles to

1137
00:44:43,589 --> 00:44:41,200
read because of you so i really

1138
00:44:46,470 --> 00:44:43,599

appreciate your work there um we have a

1139
00:44:48,630 --> 00:44:46,480
question from andrew planet on facebook

1140
00:44:50,390 --> 00:44:48,640
um and andrew basically wants to know um

1141
00:44:53,349 --> 00:44:50,400
you know we found some exoplanets early

1142
00:44:54,950 --> 00:44:53,359
on um with more indirect methods have we

1143
00:44:57,990 --> 00:44:54,960
gone back with our more evolving

1144
00:44:59,589 --> 00:44:58,000
technology to look at these worlds um

1145
00:45:01,910 --> 00:44:59,599
maybe for instance you could speak to

1146
00:45:03,910 --> 00:45:01,920
are we going back now to try to image

1147
00:45:05,589 --> 00:45:03,920
some of these exoplanets that we found

1148
00:45:07,750 --> 00:45:05,599
around other stars using using things

1149
00:45:09,510 --> 00:45:07,760
like transit and the radial methods and

1150
00:45:11,910 --> 00:45:09,520
stuff like that

1151
00:45:13,750 --> 00:45:11,920
well uh imaging a

1152
00:45:16,630 --> 00:45:13,760
one of this planet will be something

1153
00:45:18,470 --> 00:45:16,640
very hard it will be something for the

1154
00:45:20,630 --> 00:45:18,480
future maybe

1155
00:45:22,870 --> 00:45:20,640
one more decade or two decades

1156
00:45:25,670 --> 00:45:22,880
uh constructing a telescope that will

1157
00:45:27,589 --> 00:45:25,680
have some culture of the star because

1158
00:45:30,230 --> 00:45:27,599
the stars are very bright

1159
00:45:33,030 --> 00:45:30,240
and then this uh potentially habitable

1160
00:45:35,990 --> 00:45:33,040
planet has already talked too close

1161
00:45:37,910 --> 00:45:36,000
and they are outshined by by the start

1162
00:45:40,630 --> 00:45:37,920
so you need to have a different

1163
00:45:43,430 --> 00:45:40,640

instrument right now to do that

1164
00:45:45,589 --> 00:45:43,440
so we are in this decade at least using

1165
00:45:47,990 --> 00:45:45,599
transit characterizing the atmosphere of

1166
00:45:50,069 --> 00:45:48,000
this planet then there are a series of

1167
00:45:52,390 --> 00:45:50,079
instruments or concept instruments that

1168
00:45:55,190 --> 00:45:52,400
are planned for the future which have a

1169
00:45:57,990 --> 00:45:55,200
culture so you can see actually the

1170
00:46:00,550 --> 00:45:58,000
individual light of the of the of the

1171
00:46:03,670 --> 00:46:00,560
planet once you do that

1172
00:46:06,390 --> 00:46:03,680
you can do a spectroscopy and see again

1173
00:46:09,349 --> 00:46:06,400
the atmosphere of the planet but you can

1174
00:46:11,349 --> 00:46:09,359
also learn about properties of the

1175
00:46:13,270 --> 00:46:11,359
surface also because as the planet

1176
00:46:16,069 --> 00:46:13,280
rotates

1177
00:46:18,630 --> 00:46:16,079
if it has oceans and you have land

1178
00:46:20,870 --> 00:46:18,640
oceans are much darker than land and you

1179
00:46:22,870 --> 00:46:20,880
will see you still see the planet as a

1180
00:46:24,550 --> 00:46:22,880
dot of light but you will see

1181
00:46:26,630 --> 00:46:24,560
brightening because of the land

1182
00:46:28,630 --> 00:46:26,640
reflection darkening

1183
00:46:29,910 --> 00:46:28,640
the ocean and it will be its large

1184
00:46:31,270 --> 00:46:29,920
transition

1185
00:46:34,710 --> 00:46:31,280
and

1186
00:46:37,750 --> 00:46:34,720
then you can tell through time hey this

1187
00:46:39,349 --> 00:46:37,760
planet have land and oceans

1188
00:46:42,390 --> 00:46:39,359

and that's that will be something

1189
00:46:44,550 --> 00:46:42,400
amazing it is the planet is covered

1190
00:46:46,390 --> 00:46:44,560
by clouds everywhere you you won't be

1191
00:46:48,710 --> 00:46:46,400
able to tell anything this is a desert

1192
00:46:51,670 --> 00:46:48,720
planet or is it an ocean planet you

1193
00:46:53,349 --> 00:46:51,680
won't tell it but the ones that we would

1194
00:46:55,510 --> 00:46:53,359
love to see

1195
00:46:57,990 --> 00:46:55,520
then we have this possibility also to

1196
00:47:01,589 --> 00:46:58,000
learn something about their surface long

1197
00:47:05,030 --> 00:47:01,599
before we can have a a actual close-in

1198
00:47:07,990 --> 00:47:06,870
awesome yeah it makes me think right now

1199
00:47:09,750 --> 00:47:08,000
there could be someone watching this

1200
00:47:11,349 --> 00:47:09,760
show right now perhaps a young person

1201
00:47:13,510 --> 00:47:11,359
who's interested in astrobiology and

1202
00:47:15,030 --> 00:47:13,520
planetary science who might help us make

1203
00:47:17,109 --> 00:47:15,040
those very first detections of seeing

1204
00:47:19,109 --> 00:47:17,119
the ocean versus the land and helping us

1205
00:47:20,790 --> 00:47:19,119
study more about these worlds and and

1206
00:47:23,270 --> 00:47:20,800
that takes me to the next question from

1207
00:47:25,030 --> 00:47:23,280
abelen bradford on youtube

1208
00:47:27,589 --> 00:47:25,040
abeblin has said that she uses

1209
00:47:28,630 --> 00:47:27,599
winogradski columns in teaching to

1210
00:47:29,910 --> 00:47:28,640
introduce

1211
00:47:31,430 --> 00:47:29,920
students to the concept of the

1212
00:47:33,589 --> 00:47:31,440
microbiome

1213
00:47:35,670 --> 00:47:33,599

um and she wants to know are there any

1214
00:47:37,750 --> 00:47:35,680
tools that you might recommend that can

1215
00:47:39,349 --> 00:47:37,760
help the students to understand your

1216
00:47:40,710 --> 00:47:39,359
work

1217
00:47:44,630 --> 00:47:40,720
oh

1218
00:47:47,430 --> 00:47:44,640
i think i used before a lot

1219
00:47:49,750 --> 00:47:47,440
the analogy that i talked about about

1220
00:47:53,030 --> 00:47:49,760
the classical elements

1221
00:47:56,150 --> 00:47:53,040
because for example when i say people

1222
00:48:00,230 --> 00:47:56,160
students relate that easy because of the

1223
00:48:01,190 --> 00:48:00,240
tv with air water earth and fire

1224
00:48:03,190 --> 00:48:01,200
and

1225
00:48:06,950 --> 00:48:03,200
they know those concepts

1226
00:48:09,349 --> 00:48:06,960
and uh i was amazed that

1227
00:48:10,870 --> 00:48:09,359
once the students learned that and we

1228
00:48:14,230 --> 00:48:10,880
showed them examples let's say for

1229
00:48:17,190 --> 00:48:14,240
example a rainforest wire rainforest is

1230
00:48:19,270 --> 00:48:17,200
that habitable because it has these four

1231
00:48:21,510 --> 00:48:19,280
elements on abundance

1232
00:48:23,030 --> 00:48:21,520
but what about a desert so there's a

1233
00:48:24,309 --> 00:48:23,040
limiting factor of

1234
00:48:27,430 --> 00:48:24,319
liquid water

1235
00:48:29,109 --> 00:48:27,440
and what about the the ocean the ocean

1236
00:48:31,109 --> 00:48:29,119
it looks like a desert of light and

1237
00:48:34,230 --> 00:48:31,119
there's a plenty of water there

1238
00:48:37,349 --> 00:48:34,240

and you see that there's limited of

1239
00:48:39,030 --> 00:48:37,359
oxygen there gases are less dissolved

1240
00:48:42,309 --> 00:48:39,040
that are that depth

1241
00:48:44,069 --> 00:48:42,319
and there's also less energy so once

1242
00:48:47,589 --> 00:48:44,079
they got that

1243
00:48:50,150 --> 00:48:47,599
when i just uh presented okay let's uh

1244
00:48:52,870 --> 00:48:50,160
estimate and talk about habitability of

1245
00:48:54,470 --> 00:48:52,880
the oceans in europa

1246
00:48:56,870 --> 00:48:54,480
and say okay

1247
00:49:00,150 --> 00:48:56,880
what will happen and then look okay let

1248
00:49:02,630 --> 00:49:00,160
me see about gas okay no atmosphere okay

1249
00:49:05,270 --> 00:49:02,640
we have something wrong here and then

1250
00:49:07,030 --> 00:49:05,280
about the energy well chemical energy

1251
00:49:10,230 --> 00:49:07,040
sunlight there is a

1252
00:49:13,430 --> 00:49:10,240
that's below a deep layer of ice

1253
00:49:15,109 --> 00:49:13,440
and then realize that that's worse than

1254
00:49:17,510 --> 00:49:15,119
any ocean

1255
00:49:20,069 --> 00:49:17,520
here on earth and in those conditions

1256
00:49:21,750 --> 00:49:20,079
you only have microbial life

1257
00:49:24,630 --> 00:49:21,760
and then this is worse

1258
00:49:26,230 --> 00:49:24,640
and we have life here

1259
00:49:28,470 --> 00:49:26,240
so

1260
00:49:29,349 --> 00:49:28,480
i asked them do you think that

1261
00:49:33,510 --> 00:49:29,359
you will

1262
00:49:35,829 --> 00:49:33,520
fishes will be able to live they say no

1263
00:49:38,790 --> 00:49:35,839

no they realize that and i have seen

1264
00:49:41,349 --> 00:49:38,800
scientists postulating about maybe their

1265
00:49:44,549 --> 00:49:41,359
fishes or something well with that

1266
00:49:46,790 --> 00:49:44,559
simple analogy you can go that far and i

1267
00:49:50,230 --> 00:49:46,800
use that analogy because also in the

1268
00:49:52,150 --> 00:49:50,240
concept of habitability uh in a more

1269
00:49:54,549 --> 00:49:52,160
quantitative way

1270
00:49:57,270 --> 00:49:54,559
you use that information just to put

1271
00:49:59,349 --> 00:49:57,280
numbers to your problem

1272
00:50:03,670 --> 00:49:59,359
so i think that's a as a powerful

1273
00:50:06,950 --> 00:50:03,680
analogy for for for starting us as uh

1274
00:50:08,950 --> 00:50:06,960
habitability assessments for kids

1275
00:50:10,630 --> 00:50:08,960
awesome yeah the technology is so

1276
00:50:12,069 --> 00:50:10,640
important for making things relative to

1277
00:50:13,109 --> 00:50:12,079
our own understanding especially for

1278
00:50:15,109 --> 00:50:13,119
children

1279
00:50:17,270 --> 00:50:15,119
i might add for for abel and for any

1280
00:50:18,470 --> 00:50:17,280
educators who are watching uh if you go

1281
00:50:21,109 --> 00:50:18,480
to

1282
00:50:23,109 --> 00:50:21,119
astrobiology.nasa.gov

1283
00:50:24,150 --> 00:50:23,119
the website of the nasa astrobiology

1284
00:50:26,309 --> 00:50:24,160
program

1285
00:50:29,109 --> 00:50:26,319
there's a page called education where we

1286
00:50:30,950 --> 00:50:29,119
have a whole bunch of resources on

1287
00:50:33,670 --> 00:50:30,960
education including lots of really cool

1288
00:50:35,190 --> 00:50:33,680

analogies uh learning materials links to

1289
00:50:37,109 --> 00:50:35,200
other programs and how to teach

1290
00:50:40,230 --> 00:50:37,119
astrobiology including things like

1291
00:50:42,069 --> 00:50:40,240
planetary astrobiology and exoplanets

1292
00:50:44,790 --> 00:50:42,079
our next question for you uh professor

1293
00:50:47,510 --> 00:50:44,800
mendez comes from carson who goes by at

1294
00:50:49,430 --> 00:50:47,520
the fermi paradox on twitter

1295
00:50:51,750 --> 00:50:49,440
carson wants to know what do you think

1296
00:50:55,589 --> 00:50:51,760
is the most interesting problem

1297
00:50:58,630 --> 00:50:56,390
well

1298
00:51:01,670 --> 00:50:58,640
i think that the most interesting

1299
00:51:03,589 --> 00:51:01,680
problem is to find out if all habitable

1300
00:51:06,309 --> 00:51:03,599
places

1301
00:51:09,190 --> 00:51:06,319
are supposed to have life i think that's

1302
00:51:12,549 --> 00:51:09,200
the big question it's not

1303
00:51:15,910 --> 00:51:12,559
the interest of finding life alone

1304
00:51:18,710 --> 00:51:15,920
so so saying that a mission is uh

1305
00:51:20,230 --> 00:51:18,720
looking for finding life if it doesn't

1306
00:51:21,910 --> 00:51:20,240
find life then

1307
00:51:24,309 --> 00:51:21,920
all we can the mission was not

1308
00:51:28,950 --> 00:51:24,319
successful no no no that's not a good

1309
00:51:32,870 --> 00:51:28,960
approach is just missions should look

1310
00:51:34,950 --> 00:51:32,880
to determine if all habitable places can

1311
00:51:37,510 --> 00:51:34,960
sustain life or not

1312
00:51:40,230 --> 00:51:37,520
i think that's a more important question

1313
00:51:42,309 --> 00:51:40,240

so far we know that not all environments

1314
00:51:44,390 --> 00:51:42,319
can support life we see the moon we see

1315
00:51:46,150 --> 00:51:44,400
the mars we see that

1316
00:51:47,430 --> 00:51:46,160
now that question is answered not all

1317
00:51:49,430 --> 00:51:47,440
environments

1318
00:51:52,470 --> 00:51:49,440
support life it's not that easy

1319
00:51:55,910 --> 00:51:52,480
but then that those that we know that

1320
00:51:58,390 --> 00:51:55,920
are habitable by our standards

1321
00:52:00,630 --> 00:51:58,400
are they able to support life elsewhere

1322
00:52:04,390 --> 00:52:00,640
that's i think that's the big question

1323
00:52:05,829 --> 00:52:04,400
um uh and i say before if we find that

1324
00:52:07,430 --> 00:52:05,839
some or

1325
00:52:08,950 --> 00:52:07,440
all those

1326
00:52:11,430 --> 00:52:08,960
don't

1327
00:52:14,069 --> 00:52:11,440
is telling that life is uh in the

1328
00:52:17,109 --> 00:52:14,079
universe is not that common as we

1329
00:52:19,510 --> 00:52:17,119
believe maybe it's hard for the original

1330
00:52:21,510 --> 00:52:19,520
life and then for for or maintaining

1331
00:52:22,309 --> 00:52:21,520
life so there are those two problems

1332
00:52:26,950 --> 00:52:22,319
there

1333
00:52:29,910 --> 00:52:28,950
yeah absolutely and so we have a couple

1334
00:52:31,829 --> 00:52:29,920
of questions coming in i know we're

1335
00:52:33,349 --> 00:52:31,839
starting to run down time a little bit i

1336
00:52:34,710 --> 00:52:33,359
have just a few more

1337
00:52:36,230 --> 00:52:34,720
two questions came in that are very

1338
00:52:39,270 --> 00:52:36,240

relatively relevant to our discussion of

1339
00:52:40,870 --> 00:52:39,280
the arecibo telescope um the first one

1340
00:52:42,069 --> 00:52:40,880
i'm not sure at what level you'd like to

1341
00:52:43,990 --> 00:52:42,079
speak to this

1342
00:52:46,390 --> 00:52:44,000
tom caruso who's watching on facebook

1343
00:52:47,829 --> 00:52:46,400
has asked if you can discuss

1344
00:52:50,470 --> 00:52:47,839
some of the radio observations from

1345
00:52:52,150 --> 00:52:50,480
arecibo uh specifically tom wants to

1346
00:52:53,990 --> 00:52:52,160
know about the discovery of water in

1347
00:52:55,670 --> 00:52:54,000
craters on mercury

1348
00:52:57,589 --> 00:52:55,680
but as i mentioned earlier arecibo has

1349
00:52:58,870 --> 00:52:57,599
actually had a lot of discoveries i

1350
00:53:00,549 --> 00:52:58,880
wonder if you could just speak to the

1351
00:53:02,309 --> 00:53:00,559
use of radio observatories for looking

1352
00:53:04,069 --> 00:53:02,319
at things like water and craters and

1353
00:53:06,630 --> 00:53:04,079
even more

1354
00:53:09,030 --> 00:53:06,640
and the observatory as you said has been

1355
00:53:11,270 --> 00:53:09,040
used for many different things

1356
00:53:13,670 --> 00:53:11,280
one thing that i want to point out is

1357
00:53:16,790 --> 00:53:13,680
that the difference of their original

1358
00:53:18,870 --> 00:53:16,800
observatory was that it was also able to

1359
00:53:21,270 --> 00:53:18,880
receive signals like every radio

1360
00:53:24,630 --> 00:53:21,280
telescope as a receiver but also

1361
00:53:27,750 --> 00:53:24,640
transmit signals and once you transmit

1362
00:53:30,230 --> 00:53:27,760
signals you can use a radar mode and

1363
00:53:31,910 --> 00:53:30,240

transmit the signal and bounce back

1364
00:53:34,309 --> 00:53:31,920
and now when that

1365
00:53:35,829 --> 00:53:34,319
in that mode you can learn a lot more

1366
00:53:38,470 --> 00:53:35,839
about the universe

1367
00:53:39,430 --> 00:53:38,480
as long as what you are looking is close

1368
00:53:42,710 --> 00:53:39,440
enough

1369
00:53:43,750 --> 00:53:42,720
for that transmission to go back

1370
00:53:46,950 --> 00:53:43,760
and

1371
00:53:48,950 --> 00:53:46,960
so in the radar mode when you say that

1372
00:53:51,589 --> 00:53:48,960
radio light

1373
00:53:53,750 --> 00:53:51,599
to the surface and then interact with

1374
00:53:56,470 --> 00:53:53,760
the surface it comes back with different

1375
00:53:58,710 --> 00:53:56,480
information it's like you turn a white

1376
00:54:01,589 --> 00:53:58,720
light to a surface and this is dark

1377
00:54:03,030 --> 00:54:01,599
surface okay that server is dark or

1378
00:54:05,349 --> 00:54:03,040
different colors

1379
00:54:07,589 --> 00:54:05,359
and if you analyze in terms of a

1380
00:54:08,870 --> 00:54:07,599
spectroscopy what different elements

1381
00:54:11,589 --> 00:54:08,880
absorb

1382
00:54:13,990 --> 00:54:11,599
different type of light then when you

1383
00:54:15,030 --> 00:54:14,000
return light your radial light in this

1384
00:54:17,190 --> 00:54:15,040
case

1385
00:54:19,589 --> 00:54:17,200
can tell you uh different properties of

1386
00:54:23,829 --> 00:54:19,599
the surface so that's why the receiver

1387
00:54:26,309 --> 00:54:23,839
has been used to also see not only moon

1388
00:54:29,430 --> 00:54:26,319

but also in mercury

1389
00:54:30,870 --> 00:54:29,440
and uh at least looking for uh that uh

1390
00:54:32,470 --> 00:54:30,880
water

1391
00:54:34,630 --> 00:54:32,480
i got yeah one of them i mentioned

1392
00:54:36,549 --> 00:54:34,640
erasibo had like the first maps of the

1393
00:54:38,470 --> 00:54:36,559
surface of venus um there's lots of

1394
00:54:40,390 --> 00:54:38,480
things we've done in radar mode a lot of

1395
00:54:42,470 --> 00:54:40,400
folks they think of the magellan radar

1396
00:54:45,030 --> 00:54:42,480
maps of venus but uh we actually had

1397
00:54:47,270 --> 00:54:45,040
arecibo radar maps of venus as well

1398
00:54:50,150 --> 00:54:47,280
um so you know we've done a lot in the

1399
00:54:51,750 --> 00:54:50,160
past with the uh arecibo observatory

1400
00:54:54,309 --> 00:54:51,760
our next question from facebook comes

1401
00:54:56,390 --> 00:54:54,319
from martin hazzowski um martin actually

1402
00:54:58,710 --> 00:54:56,400
wants to know if uh if you can speak to

1403
00:55:00,950 --> 00:54:58,720
the value or if there is some value

1404
00:55:02,870 --> 00:55:00,960
to pairing the resolution of a next

1405
00:55:04,630 --> 00:55:02,880
generation arecibo

1406
00:55:06,630 --> 00:55:04,640
with something like a proposed lunar

1407
00:55:08,230 --> 00:55:06,640
based radio telescope

1408
00:55:10,630 --> 00:55:08,240
and not even offer you know any other

1409
00:55:14,549 --> 00:55:10,640
telescopes is there a way for us to pair

1410
00:55:19,990 --> 00:55:17,750
definitely okay we need to construct

1411
00:55:21,190 --> 00:55:20,000
more big radio telescope around the

1412
00:55:23,990 --> 00:55:21,200
world

1413
00:55:26,230 --> 00:55:24,000

right now we have a

1414
00:55:29,190 --> 00:55:26,240
fast in china

1415
00:55:30,470 --> 00:55:29,200
it's looking is it has a limited field

1416
00:55:32,309 --> 00:55:30,480
of view

1417
00:55:34,710 --> 00:55:32,319
and then uh

1418
00:55:37,030 --> 00:55:34,720
imagine that we are looking at something

1419
00:55:40,390 --> 00:55:37,040
inspiring happening in one location in

1420
00:55:42,789 --> 00:55:40,400
the sky and earth move and then you miss

1421
00:55:44,549 --> 00:55:42,799
part of that uh observation because you

1422
00:55:46,549 --> 00:55:44,559
don't have any telescope on the other

1423
00:55:48,630 --> 00:55:46,559
side as sensitive

1424
00:55:51,430 --> 00:55:48,640
as the one or close to sensitive as the

1425
00:55:53,510 --> 00:55:51,440
one in china so there are many research

1426
00:55:56,789 --> 00:55:53,520
projects and scientists trying to do

1427
00:55:59,990 --> 00:55:56,799
research in the radio spectrum and we

1428
00:56:01,109 --> 00:56:00,000
need more instruments everywhere every

1429
00:56:02,630 --> 00:56:01,119
everywhere

1430
00:56:05,430 --> 00:56:02,640
and definitely

1431
00:56:08,950 --> 00:56:05,440
an instrument on the moon

1432
00:56:11,990 --> 00:56:08,960
will be something amazing because on

1433
00:56:14,829 --> 00:56:12,000
earth and i can attest to this

1434
00:56:17,829 --> 00:56:14,839
you have the problem of a radio

1435
00:56:20,069 --> 00:56:17,839
interference and it kills you

1436
00:56:22,309 --> 00:56:20,079
many observations for example

1437
00:56:24,390 --> 00:56:22,319
we were doing observations in one

1438
00:56:27,109 --> 00:56:24,400

particular frequency

1439
00:56:28,230 --> 00:56:27,119
and we have the problem of the airplanes

1440
00:56:35,349 --> 00:56:28,240
radar

1441
00:56:37,589 --> 00:56:35,359
far away

1442
00:56:40,230 --> 00:56:37,599
in the airport here in puerto rico far

1443
00:56:42,630 --> 00:56:40,240
away from the observatory but

1444
00:56:44,630 --> 00:56:42,640
the receiver was so sensitive

1445
00:56:47,430 --> 00:56:44,640
that he was picking that

1446
00:56:50,309 --> 00:56:47,440
and it was random it was something not

1447
00:56:53,349 --> 00:56:50,319
expected because of the so many

1448
00:56:55,270 --> 00:56:53,359
airplanes they turn off on off this uh

1449
00:56:58,710 --> 00:56:55,280
radar for for landing

1450
00:57:01,190 --> 00:56:58,720
and uh so we have the that issue not

1451
00:57:03,510 --> 00:57:01,200
having that on the moon because it's in

1452
00:57:05,270 --> 00:57:03,520
the far side blocked by

1453
00:57:07,589 --> 00:57:05,280
or blocking

1454
00:57:09,510 --> 00:57:07,599
by all terrestrial communication

1455
00:57:12,390 --> 00:57:09,520
that will be a

1456
00:57:14,230 --> 00:57:12,400
silent noise and anything

1457
00:57:15,589 --> 00:57:14,240
will be something astronomical and that

1458
00:57:16,710 --> 00:57:15,599
will be great

1459
00:57:19,349 --> 00:57:16,720
but still

1460
00:57:21,589 --> 00:57:19,359
it will look at one particular direction

1461
00:57:23,510 --> 00:57:21,599
and you have many telescopes everywhere

1462
00:57:25,430 --> 00:57:23,520
it will be good not only in the moon

1463
00:57:27,270 --> 00:57:25,440

even in a space different radio

1464
00:57:28,630 --> 00:57:27,280
telescope not that big probably because

1465
00:57:31,030 --> 00:57:28,640
in the moon you

1466
00:57:32,710 --> 00:57:31,040
could build something big

1467
00:57:34,710 --> 00:57:32,720
taking advantage of the crater the

1468
00:57:37,349 --> 00:57:34,720
problem is that it will be much more

1469
00:57:41,109 --> 00:57:37,359
expensive than anything on earth

1470
00:57:43,750 --> 00:57:41,119
and uh for if you are trying first do

1471
00:57:46,150 --> 00:57:43,760
many around earth big ones because are

1472
00:57:47,910 --> 00:57:46,160
less expensive than the moon

1473
00:57:49,270 --> 00:57:47,920
then in space

1474
00:57:51,109 --> 00:57:49,280
smaller ones

1475
00:57:54,950 --> 00:57:51,119
and then you will have all the bases

1476
00:57:58,950 --> 00:57:57,190
and and then one day you'll have a

1477
00:58:01,109 --> 00:57:58,960
telescope the size of the entire solar

1478
00:58:02,549 --> 00:58:01,119
system with a giant interferometer right

1479
00:58:04,630 --> 00:58:02,559
that's what that's what some of us nerd

1480
00:58:06,150 --> 00:58:04,640
out about is the potential for you know

1481
00:58:09,670 --> 00:58:06,160
a couple of centuries maybe from now of

1482
00:58:11,829 --> 00:58:09,680
having solar system sized observatory um

1483
00:58:13,589 --> 00:58:11,839
professor abel mendez it's been so great

1484
00:58:15,670 --> 00:58:13,599
having you on the show i really

1485
00:58:17,910 --> 00:58:15,680
appreciate you joining us and sharing

1486
00:58:21,270 --> 00:58:17,920
about your history your research about

1487
00:58:22,710 --> 00:58:21,280
arecibo uh its past and future um are

1488
00:58:24,950 --> 00:58:22,720

there any any messages you'd like to

1489
00:58:27,349 --> 00:58:24,960
share with our audience young old and

1490
00:58:28,870 --> 00:58:27,359
anyone else out there before we complete

1491
00:58:32,230 --> 00:58:28,880
this show

1492
00:58:34,390 --> 00:58:32,240
oh yes uh i just want to highlight that

1493
00:58:36,470 --> 00:58:34,400
there is a big cinematography project

1494
00:58:38,150 --> 00:58:36,480
coming up soon about the receivable

1495
00:58:41,190 --> 00:58:38,160
observatory

1496
00:58:43,270 --> 00:58:41,200
and uh i hope that you see you will see

1497
00:58:45,109 --> 00:58:43,280
you will learn more about the history

1498
00:58:47,910 --> 00:58:45,119
what we have done

1499
00:58:50,870 --> 00:58:47,920
and what's the future of the observatory

1500
00:58:52,390 --> 00:58:50,880
oh thank you very much know

1501
00:58:54,390 --> 00:58:52,400
oh yeah it's been so great having you

1502
00:58:56,630 --> 00:58:54,400
with us uh and when that does come out

1503
00:58:59,030 --> 00:58:56,640
we will share it through our audience at

1504
00:59:01,430 --> 00:58:59,040
saginet and with the nasa astrobiology

1505
00:59:02,950 --> 00:59:01,440
audience as well uh for those watching

1506
00:59:04,950 --> 00:59:02,960
if you'd like to do the cool thing and

1507
00:59:07,430 --> 00:59:04,960
jump on twitter and follow professor

1508
00:59:11,109 --> 00:59:07,440
mendez you can do that uh his twitter

1509
00:59:12,549 --> 00:59:11,119
handle is at prof abell mendes or if you

1510
00:59:14,150 --> 00:59:12,559
just type his name into the search he

1511
00:59:15,750 --> 00:59:14,160
comes up right away

1512
00:59:17,990 --> 00:59:15,760
you can also learn more about the

1513
00:59:22,870 --> 00:59:18,000

planetary habitability laboratory by

1514
00:59:26,230 --> 00:59:24,309
and if any of you are interested in

1515
00:59:28,390 --> 00:59:26,240
following along finding out more about

1516
00:59:29,829 --> 00:59:28,400
our show as well as about all the

1517
00:59:32,710 --> 00:59:29,839
incredible things coming through the

1518
00:59:34,549 --> 00:59:32,720
nasa astrobiology program you can tune

1519
00:59:36,630 --> 00:59:34,559
in and join sign up right now for the

1520
00:59:38,069 --> 00:59:36,640
mailing list our producer and director

1521
00:59:39,829 --> 00:59:38,079
mike tuijan is sharing that with you

1522
00:59:42,150 --> 00:59:39,839
right now how to sign up and follow

1523
00:59:43,589 --> 00:59:42,160
along with nasa astrobiology

1524
00:59:46,549 --> 00:59:43,599
thank you to everyone in the audience

1525
00:59:49,770 --> 00:59:46,559
for joining us and until next time keep

1526
01:00:21,430 --> 00:59:49,780
exploring and stay curious