
AbSciCon
2017
MESA, ARIZONA

1
00:00:00,220 --> 00:00:12,320
[Music]

2
00:00:17,630 --> 00:00:14,750
all right thanks very much I've had a

3
00:00:18,770 --> 00:00:17,640
pretty good set up so far and right

4
00:00:22,820 --> 00:00:18,780
upfront I'll tell you this is a bit of a

5
00:00:25,130 --> 00:00:22,830
sales pitch and hopefully I'm going to

6
00:00:27,589 --> 00:00:25,140
set up Deborah Fisher for the live wire

7
00:00:29,810 --> 00:00:27,599
talk with with a little bit of

8
00:00:35,420 --> 00:00:29,820
background and at least a little bit of

9
00:00:37,220 --> 00:00:35,430
a push and in a previous era question

10
00:00:39,200 --> 00:00:37,230
you know she mentioned you know the

11
00:00:41,569 --> 00:00:39,210
search for are we alone and I think it's

12
00:00:43,790 --> 00:00:41,579
even broader than that natural biology

13
00:00:47,119 --> 00:00:43,800

is asking you know where did we come

14
00:00:48,650 --> 00:00:47,129
from where are we going and are we alone

15
00:00:52,220 --> 00:00:48,660
and I think these are the driving

16
00:00:54,919 --> 00:00:52,230
questions not only for astrobiology but

17
00:00:57,799 --> 00:00:54,929
for cosmology as well and so whatever

18
00:01:00,619 --> 00:00:57,809
future Large Telescope that we build to

19
00:01:03,739 --> 00:01:00,629
try and look for you know signs of

20
00:01:05,780 --> 00:01:03,749
habitability or habitable exoplanets we

21
00:01:07,100 --> 00:01:05,790
also want to address general cosmology

22
00:01:08,840 --> 00:01:07,110
as well because we're part of a much

23
00:01:10,160 --> 00:01:08,850
bigger community and these large

24
00:01:13,160 --> 00:01:10,170
investments are going to be something

25
00:01:17,810 --> 00:01:13,170
that we have to share across the

26
00:01:20,170 --> 00:01:17,820
spectrum of politics this is an image

27
00:01:22,550 --> 00:01:20,180
from the deep space climate Observatory

28
00:01:24,980 --> 00:01:22,560
spacecraft of the earth and the moon and

29
00:01:27,680 --> 00:01:24,990
imagine the moment when we have not an

30
00:01:29,570 --> 00:01:27,690
image but at least a mental image of

31
00:01:33,140 --> 00:01:29,580
another system that's like our home

32
00:01:35,230 --> 00:01:33,150
planet the problem is and our 2.0 as we

33
00:01:39,980 --> 00:01:35,240
all know is going to be incredibly faint

34
00:01:41,960 --> 00:01:39,990
how faint you may ask fainter than the

35
00:01:44,720 --> 00:01:41,970
faintest galaxies in the Hubble Deep

36
00:01:48,680 --> 00:01:44,730
Field and so this is the grand challenge

37
00:01:51,500 --> 00:01:48,690
that we have ahead of us you've heard a

38
00:01:55,370 --> 00:01:51,510

number of talks that are addressing you

39
00:01:58,580 --> 00:01:55,380
know either networks addressing

40
00:02:00,680 --> 00:01:58,590
planetary atmospheres about you know

41
00:02:03,830 --> 00:02:00,690
planets that are sub Neptune's planets

42
00:02:07,340 --> 00:02:03,840
that are rocky Earth's we are not just

43
00:02:10,699 --> 00:02:07,350
looking to be lucky to find that one

44
00:02:14,479 --> 00:02:10,709
rocky planet around a very near stellar

45
00:02:15,860 --> 00:02:14,489
system M star we really need to assume

46
00:02:17,509 --> 00:02:15,870
that we're not going to be lucky and we

47
00:02:21,350 --> 00:02:17,519
want a large number of planets to look

48
00:02:23,380 --> 00:02:21,360
at not only because we want to try and

49
00:02:25,520 --> 00:02:23,390
find a planet that might be habitable

50
00:02:27,440 --> 00:02:25,530
but also because we want to

51
00:02:29,390 --> 00:02:27,450
try and understand the context and the

52
00:02:31,040 --> 00:02:29,400
range because if we're not lucky we

53
00:02:33,140 --> 00:02:31,050
still want to do great science we don't

54
00:02:35,750 --> 00:02:33,150
understand what the prospects are and so

55
00:02:37,910 --> 00:02:35,760
this is a chart that shows the diameter

56
00:02:40,610 --> 00:02:37,920
of the telescope that we might build and

57
00:02:42,530 --> 00:02:40,620
the EXO earth candidate yield so this is

58
00:02:44,930 --> 00:02:42,540
just a subset of the planets that we

59
00:02:48,890 --> 00:02:44,940
might see and you and you can see here

60
00:02:51,140 --> 00:02:48,900
you know that if we want to get two or

61
00:02:52,729 --> 00:02:51,150
three you know we can build you know a

62
00:02:55,309 --> 00:02:52,739
small telescope if we want to get

63
00:02:57,320 --> 00:02:55,319

hundreds of planets to interrogate we're

64
00:03:01,699 --> 00:02:57,330
going to have to be up in the 15 to 20

65
00:03:04,729 --> 00:03:01,709
meter telescope size so really if you

66
00:03:06,170 --> 00:03:04,739
just get to the cut to the chase you

67
00:03:09,050 --> 00:03:06,180
need a telescope that's bigger than

68
00:03:13,130 --> 00:03:09,060
about fifteen or sixteen meters now

69
00:03:16,580 --> 00:03:13,140
that's a big telescope but it makes a

70
00:03:19,130 --> 00:03:16,590
big difference and I don't want to ping

71
00:03:20,990 --> 00:03:19,140
on anybody's small telescope keeping in

72
00:03:23,930 --> 00:03:21,000
mind that I'm a Hubble hugger and Hubble

73
00:03:26,930 --> 00:03:23,940
is 2.4 meters so but size does matter

74
00:03:30,020 --> 00:03:26,940
here's a four meter telescope this is

75
00:03:32,300 --> 00:03:30,030
the exoplanet yield looking across the

76
00:03:35,360 --> 00:03:32,310
spectrum of planets from rocky

77
00:03:37,550 --> 00:03:35,370
earth-like planets to Neptunes to

78
00:03:39,440 --> 00:03:37,560
Jupiter's and this is the kind of

79
00:03:41,539 --> 00:03:39,450
histogram you can get with a four meter

80
00:03:44,030 --> 00:03:41,549
telescope in a reasonable lifetime of

81
00:03:45,620 --> 00:03:44,040
the telescope and it's pretty puny we're

82
00:03:47,780 --> 00:03:45,630
not going to build a scientific

83
00:03:49,670 --> 00:03:47,790
enterprise around this if you go to 16

84
00:03:54,440 --> 00:03:49,680
meters now you're talking about you know

85
00:03:56,270 --> 00:03:54,450
lots of rocky planets lots of Neptune's

86
00:03:58,280 --> 00:03:56,280
and even a reasonable number of

87
00:04:00,890 --> 00:03:58,290
Jupiter's and this is showing the

88
00:04:03,979 --> 00:04:00,900

breakdown between hot warm and cold so

89
00:04:07,670 --> 00:04:03,989
that even have more distribution this is

90
00:04:11,060 --> 00:04:07,680
Drake demyans you know great spectrum of

91
00:04:12,710 --> 00:04:11,070
a happens to be a hot Jupiter and the

92
00:04:14,509 --> 00:04:12,720
question is is this characteristic of

93
00:04:16,190 --> 00:04:14,519
all half Jupiter's and the answer is no

94
00:04:18,080 --> 00:04:16,200
you know when you go and look at a

95
00:04:19,400 --> 00:04:18,090
number of them which is remarkable that

96
00:04:21,469 --> 00:04:19,410
we can do that at all

97
00:04:23,360 --> 00:04:21,479
but we start seeing that every one of

98
00:04:27,920 --> 00:04:23,370
these is different and this was a

99
00:04:31,670 --> 00:04:27,930
significant investment 498 HST orbits so

100
00:04:34,250 --> 00:04:31,680
there's also a time factor so this is a

101
00:04:37,909 --> 00:04:34,260
great cartoon that we show showing a

102
00:04:39,200 --> 00:04:37,919
spectrum of you know a rocky planet with

103
00:04:40,460 --> 00:04:39,210
an atmosphere and

104
00:04:43,040 --> 00:04:40,470
wouldn't it be great if we could measure

105
00:04:45,890 --> 00:04:43,050
the scattering in the atmosphere oxygen

106
00:04:47,570 --> 00:04:45,900
and ozone lines you know some indication

107
00:04:50,570 --> 00:04:47,580
you know from sessions on either side of

108
00:04:53,089 --> 00:04:50,580
us of you know colors that indicate you

109
00:04:56,749 --> 00:04:53,099
know signs of life water vapor carbon

110
00:04:59,240 --> 00:04:56,759
dioxide methane this cartoon though is a

111
00:05:01,400 --> 00:04:59,250
relatively high resolution spectrum and

112
00:05:04,460 --> 00:05:01,410
you know you look at this and this has a

113
00:05:06,529 --> 00:05:04,470

resolution of a resolution of somewhere

114
00:05:08,330 --> 00:05:06,539
around a few hundred to be able to get

115
00:05:11,779 --> 00:05:08,340
something of this great detail and we'd

116
00:05:14,480 --> 00:05:11,789
love to get this this is then when you

117
00:05:16,790 --> 00:05:14,490
jump to the simulations of what you get

118
00:05:20,659 --> 00:05:16,800
from a four meter telescope and it's not

119
00:05:23,930 --> 00:05:20,669
that great cartoon and the the other

120
00:05:25,610 --> 00:05:23,940
factor that was mentioned earlier is for

121
00:05:27,560 --> 00:05:25,620
a corona graphic telescope you're also

122
00:05:34,159 --> 00:05:27,570
limited by the interworking angle you

123
00:05:36,529 --> 00:05:34,169
get a cut off just below 1 micron clip

124
00:05:39,860 --> 00:05:36,539
this is what you can get with a 16 meter

125
00:05:41,659 --> 00:05:39,870
so it's quantitatively much different

126
00:05:43,070 --> 00:05:41,669
and you get to go to longer wavelengths

127
00:05:45,140 --> 00:05:43,080
cut off by the thermal limit of the

128
00:05:48,439 --> 00:05:45,150
telescope rather than by the diffraction

129
00:05:50,659 --> 00:05:48,449
limit and so the other factor is that

130
00:05:53,870 --> 00:05:50,669
big telescopes are much faster you get

131
00:05:55,790 --> 00:05:53,880
the spectra higher resolution you can

132
00:05:58,240 --> 00:05:55,800
separate the planet from the host star

133
00:06:01,070 --> 00:05:58,250
and you can get it in much less time

134
00:06:02,810 --> 00:06:01,080
this is just a quick picture that shows

135
00:06:05,990 --> 00:06:02,820
you the longest observable wavelength

136
00:06:07,850 --> 00:06:06,000
for a star at 10 parsecs and it's that

137
00:06:10,430 --> 00:06:07,860
inner working angle that's a function of

138
00:06:11,930 --> 00:06:10,440

lambda over D and it changes as you go

139
00:06:13,520 --> 00:06:11,940
in wavelength simply because of that

140
00:06:15,529 --> 00:06:13,530
lambda dependence the wavelength

141
00:06:17,510 --> 00:06:15,539
dependence and so if you're trying to

142
00:06:20,510 --> 00:06:17,520
separate a star from an earth at 1 au

143
00:06:22,279 --> 00:06:20,520
you get cut off just below 1 micron for

144
00:06:24,379 --> 00:06:22,289
M stars it's even worse of course

145
00:06:26,749 --> 00:06:24,389
because the habitable zone is so much

146
00:06:29,779 --> 00:06:26,759
closer if you go to a 16 metre telescope

147
00:06:32,089 --> 00:06:29,789
as you go to longer wavelengths you get

148
00:06:33,950 --> 00:06:32,099
to water feature just below a micron and

149
00:06:38,779 --> 00:06:33,960
you can keep going all the way up to the

150
00:06:41,480 --> 00:06:38,789
thermal limit of the telescope so the

151
00:06:43,810 --> 00:06:41,490
big question on the table is if we see a

152
00:06:47,360 --> 00:06:43,820
spectrum like this and we see some

153
00:06:49,219 --> 00:06:47,370
statistically significant dip one

154
00:06:51,850 --> 00:06:49,229
resolution element around the water line

155
00:06:54,040 --> 00:06:51,860
you know what does that allow us

156
00:06:59,320 --> 00:06:54,050
to say what will be perhaps the greatest

157
00:07:00,820 --> 00:06:59,330
scientific discovery ever made and I

158
00:07:02,740 --> 00:07:00,830
think we want to have data that looks

159
00:07:04,480 --> 00:07:02,750
something like this where we can

160
00:07:08,680 --> 00:07:04,490
definitively say where we have several

161
00:07:10,420 --> 00:07:08,690
resolution elements the other factor is

162
00:07:13,690 --> 00:07:10,430
it'll take about ten days of observation

163
00:07:15,970 --> 00:07:13,700

to make a spectrum like that to take one

164
00:07:18,640 --> 00:07:15,980
and about an hour with a 16 meter so we

165
00:07:21,480 --> 00:07:18,650
can cover a lot more exoplanets to make

166
00:07:24,400 --> 00:07:21,490
that discovery our resolution goes from

167
00:07:27,820 --> 00:07:24,410
resolving power about 70 to 500

168
00:07:31,480 --> 00:07:27,830
signalize ratio of 15 to 50 longest

169
00:07:33,250 --> 00:07:31,490
observable wavelengths I talked about so

170
00:07:34,900 --> 00:07:33,260
with a four meter telescope and those

171
00:07:37,180 --> 00:07:34,910
kind of observation times you can only

172
00:07:40,000 --> 00:07:37,190
examine about 12 exoplanets at that low

173
00:07:41,350 --> 00:07:40,010
resolution versus hundreds with a 16

174
00:07:43,360 --> 00:07:41,360
meter and of course we know where all

175
00:07:46,030 --> 00:07:43,370
the stars are so it allows you to go

176
00:07:49,030 --> 00:07:46,040
from you know 10 parsecs out to 30

177
00:07:51,970 --> 00:07:49,040
parsecs and you get to do all the rest

178
00:07:54,220 --> 00:07:51,980
of the cosmology and galactic astronomy

179
00:07:56,020 --> 00:07:54,230
another important point is that the

180
00:07:58,180 --> 00:07:56,030
larger your telescope and the shorter

181
00:08:00,280 --> 00:07:58,190
the observation time you can also do

182
00:08:02,620 --> 00:08:00,290
what we've done with epoxy and Galileo

183
00:08:05,200 --> 00:08:02,630
is actually build maps of these

184
00:08:08,170 --> 00:08:05,210
exoplanets through multicolor photometry

185
00:08:10,780 --> 00:08:08,180
and that's because you can observe multi

186
00:08:13,330 --> 00:08:10,790
colors and have exposure times as at 10

187
00:08:15,280 --> 00:08:13,340
parsecs with a 16 meter you can get a

188
00:08:17,260 --> 00:08:15,290

number of observations per day and watch

189
00:08:19,810 --> 00:08:17,270
the rotation of the planet just from the

190
00:08:21,820 --> 00:08:19,820
color changes with a 12 meter you can

191
00:08:24,250 --> 00:08:21,830
get to about an hour 8 meter here in a

192
00:08:25,990 --> 00:08:24,260
few hours and a 4 meter at least with a

193
00:08:27,220 --> 00:08:26,000
plan of the rotates in 24 hours you're

194
00:08:29,170 --> 00:08:27,230
spread out throughout the whole day and

195
00:08:31,000 --> 00:08:29,180
you can't do it and that's important

196
00:08:32,590 --> 00:08:31,010
because if you see color changes that

197
00:08:34,090 --> 00:08:32,600
indicate continents and oceans that

198
00:08:36,310 --> 00:08:34,100
almost certainly in first plate

199
00:08:39,460 --> 00:08:36,320
tectonics which figures into our you

200
00:08:40,540 --> 00:08:39,470
know origins of life of course I

201
00:08:43,540 --> 00:08:40,550
mentioned that it can do a lot of other

202
00:08:45,400 --> 00:08:43,550
astronomy for instance a two point four

203
00:08:47,620 --> 00:08:45,410
meter Hubble here's a surface image of

204
00:08:50,680 --> 00:08:47,630
Pluto not so great of course we have New

205
00:08:53,530 --> 00:08:50,690
Horizons but with a 12-meter you can

206
00:08:56,350 --> 00:08:53,540
start to get resolutions on Pluto at 210

207
00:08:58,630 --> 00:08:56,360
kilometers here's geysers on Europa

208
00:09:00,550 --> 00:08:58,640
something we hope plumes that we would

209
00:09:02,980 --> 00:09:00,560
be able to do with a 12 meter you can

210
00:09:04,560 --> 00:09:02,990
certainly resolve those and the other

211
00:09:05,580 --> 00:09:04,570
factor

212
00:09:07,620 --> 00:09:05,590
that we heard is we really want

213
00:09:10,620 --> 00:09:07,630

ultraviolet and optical and that's

214
00:09:14,100 --> 00:09:10,630
something that is is plausible so here's

215
00:09:16,140 --> 00:09:14,110
and at last concept you know this is

216
00:09:18,210 --> 00:09:16,150
something that is really the next step

217
00:09:20,400 --> 00:09:18,220
beyond James Webb Space Telescope and

218
00:09:23,760 --> 00:09:20,410
when we start talking about well 12

219
00:09:26,250 --> 00:09:23,770
meters this verses 15 1 a 15 or 16 be

220
00:09:27,870 --> 00:09:26,260
much more expensive or even or 20 and it

221
00:09:29,880 --> 00:09:27,880
turns out that the price of the optics

222
00:09:32,670 --> 00:09:29,890
is only about 15 percent of the overall

223
00:09:34,740 --> 00:09:32,680
observatory and so if we build a 12

224
00:09:37,620 --> 00:09:34,750
meter and we get a great spectrum of an

225
00:09:38,820 --> 00:09:37,630
exoplanet and we see some feature we

226
00:09:40,170 --> 00:09:38,830
don't want to be in the position of

227
00:09:41,730 --> 00:09:40,180
saying wow that looks really interesting

228
00:09:43,350 --> 00:09:41,740
now we have to build the bigger

229
00:09:49,050 --> 00:09:43,360
telescope to find out if it's really

230
00:09:50,610 --> 00:09:49,060
important this is actually me we know

231
00:09:53,430 --> 00:09:50,620
how to build telescopes we know how to

232
00:09:56,010 --> 00:09:53,440
work on telescopes human spaceflight is

233
00:09:58,710 --> 00:09:56,020
building architectures already for the

234
00:10:00,930 --> 00:09:58,720
2020s that involve robotics that involve

235
00:10:02,880 --> 00:10:00,940
people so this is a notional idea of how

236
00:10:04,380 --> 00:10:02,890
you might be able to assemble using the

237
00:10:06,180 --> 00:10:04,390
Orion spacecraft in the Space Launch

238
00:10:09,000 --> 00:10:06,190

System which is also important for

239
00:10:11,400 --> 00:10:09,010
Europa to build in this case a 20 plus

240
00:10:13,290 --> 00:10:11,410
meter telescope and these are astronauts

241
00:10:18,270 --> 00:10:13,300
with large segments mapping them

242
00:10:19,650 --> 00:10:18,280
together like Legos so if we really want

243
00:10:21,570 --> 00:10:19,660
to find out this answer if we want to

244
00:10:23,280 --> 00:10:21,580
get the high resolution spectra if we

245
00:10:24,600 --> 00:10:23,290
want to look at networks if we want to

246
00:10:27,120 --> 00:10:24,610
look complexity if we're going to look

247
00:10:28,950 --> 00:10:27,130
at multiple spectral lines and and lots

248
00:10:30,840 --> 00:10:28,960
of different planetary systems to be

249
00:10:33,450 --> 00:10:30,850
able to make sense of where the earth

250
00:10:36,390 --> 00:10:33,460
sits where Venus Mars sits and where our

251
00:10:39,540 --> 00:10:36,400
potential earth 2.0 mean might be we

252
00:10:41,610 --> 00:10:39,550
need to be bold and today actually is

253
00:10:44,880 --> 00:10:41,620
Hubble's birthday Hubble's anniversary

254
00:10:46,350 --> 00:10:44,890
on orbit so I'd want to quick show of

255
00:10:48,450 --> 00:10:46,360
hands although this audience isn't quite

256
00:10:49,860 --> 00:10:48,460
like the biology centric ones but how

257
00:10:53,790 --> 00:10:49,870
many people in the audience are younger

258
00:10:57,870 --> 00:10:53,800
than 27 you have never known a world

259
00:11:00,420 --> 00:10:57,880
without a hubble space telescope sadly

260
00:11:02,760 --> 00:11:00,430
that won't last forever and what is

261
00:11:04,920 --> 00:11:02,770
going to be our next ultraviolet visible

262
00:11:06,360 --> 00:11:04,930
telescope we don't know the answer to

263
00:11:08,670 --> 00:11:06,370

that we're going to have to create that

264
00:11:11,910 --> 00:11:08,680
future the Hubble wasn't created by a

265
00:11:14,400 --> 00:11:11,920
decadal survey it was endorsed by it the

266
00:11:16,890 --> 00:11:14,410
James Webb Space Telescope a truly

267
00:11:18,480 --> 00:11:16,900
audacious telescope October 2018 will

268
00:11:21,150 --> 00:11:18,490
launch wasn't created by the decade

269
00:11:23,160 --> 00:11:21,160
survey was endorsed by it so you know I

270
00:11:25,079 --> 00:11:23,170
think as astrobiologists we need to

271
00:11:27,690 --> 00:11:25,089
create the future that we want to see

272
00:11:30,090 --> 00:11:27,700
and we need to be bold and ambitious to

273
00:11:32,639 --> 00:11:30,100
do that so I'm excited because I think

274
00:11:35,220 --> 00:11:32,649
we all can imagine the moment when we do

275
00:11:37,440 --> 00:11:35,230
find that earth 2.0 or we do learn about

276
00:11:47,389 --> 00:11:37,450
a lot of different habitable planets but

277
00:11:57,930 --> 00:11:55,430
time for a few questions do you envisage

278
00:11:59,910 --> 00:11:57,940
something like the 16 meter telescope

279
00:12:03,750 --> 00:11:59,920
that you were talking about that it

280
00:12:05,730 --> 00:12:03,760
would be mostly a follow-up of known

281
00:12:08,250 --> 00:12:05,740
planets or discovery of new planets

282
00:12:11,400 --> 00:12:08,260
because the former requires a critical

283
00:12:15,000 --> 00:12:11,410
mass of targets that are appropriate and

284
00:12:17,400 --> 00:12:15,010
the latter will require more time to get

285
00:12:20,639 --> 00:12:17,410
the same amount of spectra as follow-up

286
00:12:22,050 --> 00:12:20,649
I think the good news about a the larger

287
00:12:24,420 --> 00:12:22,060
your aperture the faster your

288
00:12:26,400 --> 00:12:24,430

observations and so you can you can do

289
00:12:27,630 --> 00:12:26,410
both you know will certainly have from

290
00:12:30,870 --> 00:12:27,640
the transiting exoplanet survey

291
00:12:33,449 --> 00:12:30,880
satellite lots of transiting exoplanets

292
00:12:35,850 --> 00:12:33,459
we have mostly around M stars but the

293
00:12:38,190 --> 00:12:35,860
other good news is if with a large

294
00:12:40,889 --> 00:12:38,200
telescope say a 20 metre telescope you

295
00:12:43,079 --> 00:12:40,899
can very quickly at low resolution do

296
00:12:45,480 --> 00:12:43,089
direct imaging to identify the planets

297
00:12:46,949 --> 00:12:45,490
we know all the spectral types so we'll

298
00:12:48,660 --> 00:12:46,959
be able to identify planets in the

299
00:12:50,940 --> 00:12:48,670
habitable zone with relatively fast

300
00:12:53,069 --> 00:12:50,950
observations and then you can triage

301
00:12:55,470 --> 00:12:53,079
those to decide which ones do you want

302
00:12:57,240 --> 00:12:55,480
to followup on and so it's very general

303
00:12:59,190 --> 00:12:57,250
purpose the challenge will be arm

304
00:13:02,040 --> 00:12:59,200
wrestling with the cosmologists you know

305
00:13:03,630 --> 00:13:02,050
looking at you know distant galaxies and

306
00:13:06,150 --> 00:13:03,640
the folks who are doing galaxy surveys

307
00:13:07,980 --> 00:13:06,160
looking at individual stars in the

308
00:13:11,329 --> 00:13:07,990
entire local group doing what we've done

309
00:13:13,800 --> 00:13:11,339
within dromeda and Julia gulia & Elkins

310
00:13:18,389 --> 00:13:13,810
University of Washington work so thank

311
00:13:25,439 --> 00:13:22,410
we have two more myths I think what I

312
00:13:28,129 --> 00:13:25,449
just wanted to ask you something really

313
00:13:31,800 --> 00:13:28,139

it's not exactly a science question but

314
00:13:34,499 --> 00:13:31,810
so let's say people are not excited

315
00:13:39,629 --> 00:13:34,509
enough or finding life on little planets

316
00:13:43,710 --> 00:13:39,639
cosmologists okay and if it what can we

317
00:13:45,600 --> 00:13:43,720
I know what can we do so if you have

318
00:13:47,400 --> 00:13:45,610
some kind of a presentation like this or

319
00:13:50,100 --> 00:13:47,410
if you want to talk with them so what

320
00:13:51,689 --> 00:13:50,110
can we do because it needs to be some

321
00:13:54,150 --> 00:13:51,699
kind of a general astrophysics mission

322
00:13:56,430 --> 00:13:54,160
more than an exoplanet mission so

323
00:13:58,680 --> 00:13:56,440
contrary to everyone's believed it jwc

324
00:14:01,079 --> 00:13:58,690
is an asteroid with a commission it's

325
00:14:03,180 --> 00:14:01,089
not exactly enough to change website

326
00:14:05,850 --> 00:14:03,190
telescope is a good example where when

327
00:14:08,370 --> 00:14:05,860
it was started you know the total

328
00:14:11,970 --> 00:14:08,380
universe of known exoplanets was exactly

329
00:14:13,740 --> 00:14:11,980
zero yet if we were to design a

330
00:14:15,509 --> 00:14:13,750
telescope that was optimized for

331
00:14:18,030 --> 00:14:15,519
exoplanets we build James Webb Space

332
00:14:21,210 --> 00:14:18,040
Telescope so we were lucky but we were

333
00:14:22,769 --> 00:14:21,220
lucky deliberately in that we built a

334
00:14:24,059 --> 00:14:22,779
general-purpose Observatory that was

335
00:14:26,790 --> 00:14:24,069
very good at a lot of different

336
00:14:29,400 --> 00:14:26,800
astronomy and you know if you were to

337
00:14:32,069 --> 00:14:29,410
build a 16 meter you know UV visible

338
00:14:34,500 --> 00:14:32,079

telescope like a very large Hubble it

339
00:14:36,509 --> 00:14:34,510
will be tremendous across all areas of

340
00:14:39,150 --> 00:14:36,519
science and so even if you're a

341
00:14:40,410 --> 00:14:39,160
cosmologists who's really interested in

342
00:14:42,720 --> 00:14:40,420
the search for life in the universe but

343
00:14:44,850 --> 00:14:42,730
also you know you have your grant to do

344
00:14:47,250 --> 00:14:44,860
you know the most distant galaxies

345
00:14:48,840 --> 00:14:47,260
earliest galaxies you can appreciate the

346
00:14:50,720 --> 00:14:48,850
astrobiology question but you know that

347
00:14:53,610 --> 00:14:50,730
this telescope will also be really great

348
00:14:56,850 --> 00:14:53,620
for your work and almost anything that

349
00:14:59,280 --> 00:14:56,860
you know Hubble is doing a larger Hubble

350
00:15:01,410 --> 00:14:59,290
would do and then it's up to peer review

351
00:15:04,170 --> 00:15:01,420
and competition to decide how to

352
00:15:06,150 --> 00:15:04,180
actually use the telescope but I think

353
00:15:07,980 --> 00:15:06,160
everyone is interested in you know the

354
00:15:12,720 --> 00:15:07,990
question of are we alone that's a kind

355
00:15:14,400 --> 00:15:12,730
of a universal question Thanks one

356
00:15:18,420 --> 00:15:14,410
really quick question very quick

357
00:15:19,889 --> 00:15:18,430
question how much of your vision you're

358
00:15:21,389 --> 00:15:19,899
speaking here about the telescope but

359
00:15:23,819 --> 00:15:21,399
how look to the vision is also about

360
00:15:26,150 --> 00:15:23,829
those Legos being put together up in

361
00:15:28,710 --> 00:15:26,160
space by human beings

362
00:15:31,380 --> 00:15:28,720
so I'm a scientist but I'm also an

363
00:15:33,180 --> 00:15:31,390

engineer and an astronaut and so I like

364
00:15:35,430 --> 00:15:33,190
to jump to the okay how are we going to

365
00:15:37,020 --> 00:15:35,440
do it pretty quickly but I think you'll

366
00:15:39,480 --> 00:15:37,030
hear next that you can get pretty big

367
00:15:41,430 --> 00:15:39,490
without having to invoke astronauts

368
00:15:42,840 --> 00:15:41,440
assembling things but on the other side

369
00:15:45,180 --> 00:15:42,850
I'm looking at a human spaceflight

370
00:15:46,740 --> 00:15:45,190
enterprise that quite frankly for at

371
00:15:47,880 --> 00:15:46,750
least the last eight years has been

372
00:15:49,920 --> 00:15:47,890
going sideways

373
00:15:51,120 --> 00:15:49,930
we have great capabilities but we don't

374
00:15:53,700 --> 00:15:51,130
know where we're going or what we're

375
00:15:56,460 --> 00:15:53,710
going to use them for and so I see this

376
00:15:58,260 --> 00:15:56,470
as sort of bearing the vision of you

377
00:16:00,960 --> 00:15:58,270
know what should humans be doing in

378
00:16:03,510 --> 00:16:00,970
space and what should we be doing a

379
00:16:05,970 --> 00:16:03,520
scientist that you know it's kind of an

380
00:16:08,220 --> 00:16:05,980
opportunity for us that we'll have all

381
00:16:10,200 --> 00:16:08,230
this capability to put people in space

382
00:16:12,840 --> 00:16:10,210
to put robotics in space to put large

383
00:16:15,480 --> 00:16:12,850
things in space well let's use that

384
00:16:16,860 --> 00:16:15,490
wisely and what better use than building

385
00:16:21,360 --> 00:16:16,870
a big telescope to find out if we're

386
00:16:25,020 --> 00:16:23,490
following on that so one of the big

387
00:16:26,730 --> 00:16:25,030
differences between Hubble and James

388
00:16:28,740 --> 00:16:26,740

Webb is serviceability and that James

389
00:16:29,880 --> 00:16:28,750
Webb has done do you think that

390
00:16:31,530 --> 00:16:29,890
serviceability is going to be an

391
00:16:34,680 --> 00:16:31,540
important part of the future Space

392
00:16:36,510 --> 00:16:34,690
Telescope's I think that the question of

393
00:16:38,340 --> 00:16:36,520
serviceability beyond whether you

394
00:16:40,260 --> 00:16:38,350
assemble it or not which is completely

395
00:16:44,040 --> 00:16:40,270
separable question is really important

396
00:16:46,610 --> 00:16:44,050
the reason why you saw in Daniels talk

397
00:16:49,590 --> 00:16:46,620
he's amazing Wide Field Camera 3

398
00:16:51,540 --> 00:16:49,600
spectrum dispersed you know spectra is

399
00:16:53,970 --> 00:16:51,550
because we could put in Wide Field

400
00:16:56,010 --> 00:16:53,980
Camera 3 you know 25 years after the

401
00:16:58,050 --> 00:16:56,020
telescope or 23 years after the

402
00:17:00,240 --> 00:16:58,060
telescope was put up and so

403
00:17:02,070 --> 00:17:00,250
serviceability and once you have a basic

404
00:17:04,260 --> 00:17:02,080
optics that are good the serviceability

405
00:17:07,500 --> 00:17:04,270
Act allows you to put new instruments in

406
00:17:09,000 --> 00:17:07,510
that keep the observatory vital the

407
00:17:11,970 --> 00:17:09,010
James Webb Space Telescope should

408
00:17:13,650 --> 00:17:11,980
hopefully last about 11 years which 11

409
00:17:16,559 --> 00:17:13,660
or 12 years which is its propellant

410
00:17:18,600 --> 00:17:16,569
margin and then we're done you know

411
00:17:20,370 --> 00:17:18,610
today we're celebrating hubble's 27th

412
00:17:22,230 --> 00:17:20,380
anniversary that's part of the power of

413
00:17:24,569 --> 00:17:22,240

Hubble so I think the serviceability is

414
00:17:26,970 --> 00:17:24,579
a critical role and and Congress

415
00:17:29,190 --> 00:17:26,980
actually coded that in the authorization

416
00:17:31,200 --> 00:17:29,200
NASA Authorization Act of 2010 that

417
00:17:33,600 --> 00:17:31,210
requires all future observatories to

418
00:17:37,480 --> 00:17:33,610
evaluate when practical I think they use

419
00:17:41,980 --> 00:17:37,490
the word practicable serviceability so

420
00:17:42,340 --> 00:17:41,990
as always by law we have to do it let's

421
00:17:43,410 --> 00:17:42,350
think