
AB
GRAD
CON23

1
00:00:00,000 --> 00:00:04,220
hello

2
00:00:04,230 --> 00:00:12,470
[Music]

3
00:00:16,730 --> 00:00:14,450
um my name is Missy Houston

4
00:00:19,189 --> 00:00:16,740
um I'm sort of a fifth year grad student

5
00:00:21,470 --> 00:00:19,199
at Penn State in astronomy as you may

6
00:00:24,050 --> 00:00:21,480
have guessed from my background

7
00:00:25,910 --> 00:00:24,060
um but I just successfully defended my

8
00:00:32,810 --> 00:00:25,920
thesis last week so I've gone ahead and

9
00:00:36,709 --> 00:00:34,729
I don't get my diploma and start my

10
00:00:39,350 --> 00:00:36,719
postdoc until August but I'm still going

11
00:00:41,150 --> 00:00:39,360
to call myself Dr Houston now

12
00:00:43,369 --> 00:00:41,160
um so I'm going to be talking about

13
00:00:44,750 --> 00:00:43,379

something that was not in my thesis so I

14
00:00:46,190 --> 00:00:44,760
hadn't thought about too much for a

15
00:00:47,090 --> 00:00:46,200
couple months but I'm getting back to it

16
00:00:48,650 --> 00:00:47,100
now

17
00:00:50,150 --> 00:00:48,660
um this is some work I'm doing as part

18
00:00:52,970 --> 00:00:50,160
of the Penn State extraterrestrial

19
00:00:54,889 --> 00:00:52,980
Intelligence Center and this work is

20
00:00:57,830 --> 00:00:54,899
actually being led by a Dr Sophia shake

21
00:01:01,250 --> 00:00:57,840
at the study Institute

22
00:01:02,750 --> 00:01:01,260
so um this project came out of a group a

23
00:01:05,270 --> 00:01:02,760
collaboration called characterizing

24
00:01:07,850 --> 00:01:05,280
atmospheric techno signatures or cats

25
00:01:10,670 --> 00:01:07,860
which I'm very glad we found a good

26
00:01:12,770 --> 00:01:10,680
abbreviation for and um so what this

27
00:01:14,990 --> 00:01:12,780
group is doing is just kind of creating

28
00:01:17,030 --> 00:01:15,000
a library of possible techno signatures

29
00:01:20,510 --> 00:01:17,040
and especially focusing on atmospheric

30
00:01:22,070 --> 00:01:20,520
techno signatures as jwst launches and

31
00:01:24,410 --> 00:01:22,080
we're making a lot of advances in our

32
00:01:26,630 --> 00:01:24,420
ability to characterize exoplanet

33
00:01:27,890 --> 00:01:26,640
atmospheres

34
00:01:29,390 --> 00:01:27,900
um but this project we're talking about

35
00:01:31,370 --> 00:01:29,400
today actually goes a bit more broad

36
00:01:32,929 --> 00:01:31,380
than that and we're thinking of all the

37
00:01:33,950 --> 00:01:32,939
Techno signatures that we produce here

38
00:01:35,450 --> 00:01:33,960

on Earth

39
00:01:37,370 --> 00:01:35,460
so the project we're calling Earth

40
00:01:40,310 --> 00:01:37,380
detecting Earth is establishing

41
00:01:42,469 --> 00:01:40,320
benchmarks for detectability based on

42
00:01:45,230 --> 00:01:42,479
how strong our techno signatures we

43
00:01:46,670 --> 00:01:45,240
produce here on Earth are and how far

44
00:01:48,830 --> 00:01:46,680
away

45
00:01:51,530 --> 00:01:48,840
um we you would be able to use our

46
00:01:53,950 --> 00:01:51,540
telescopes to successfully detect our

47
00:01:57,230 --> 00:01:53,960
techno signatures

48
00:01:58,310 --> 00:01:57,240
so this is a very preliminary version of

49
00:01:59,990 --> 00:01:58,320
our plot here we're going to have more

50
00:02:03,109 --> 00:02:00,000
techno signatures than this and we still

51
00:02:05,569 --> 00:02:03,119
have to finish up a few calculations to

52
00:02:06,830 --> 00:02:05,579
get all our distances right but

53
00:02:08,330 --> 00:02:06,840
um we're basically just trying to

54
00:02:10,249 --> 00:02:08,340
calculate the detectable distance for

55
00:02:12,350 --> 00:02:10,259
our telescopes to observe our techno

56
00:02:14,330 --> 00:02:12,360
signatures for all of the Techno

57
00:02:17,210 --> 00:02:14,340
signatures that we could think of that

58
00:02:20,030 --> 00:02:18,470
so

59
00:02:22,369 --> 00:02:20,040
um this is related to a similar concept

60
00:02:24,530 --> 00:02:22,379
called the ignoscale which was proposed

61
00:02:27,589 --> 00:02:24,540
by socasinovaro at all a couple years

62
00:02:29,869 --> 00:02:27,599
ago this term is defined as the relative

63
00:02:31,850 --> 00:02:29,879

size or intensity of a techno signature

64
00:02:34,750 --> 00:02:31,860
in units of the same type no signature

65
00:02:37,670 --> 00:02:34,760
as produced by Earth's technology

66
00:02:40,070 --> 00:02:37,680
so kind of the first step in our project

67
00:02:42,710 --> 00:02:40,080
is to quantify the strength of Earth's

68
00:02:44,750 --> 00:02:42,720
current day techno signatures and this

69
00:02:48,290 --> 00:02:44,760
is kind of defining the power level that

70
00:02:50,210 --> 00:02:48,300
is an ignoscale value of one

71
00:02:52,070 --> 00:02:50,220
and then we're going to determine what

72
00:02:54,410 --> 00:02:52,080
distance we can use our technology to

73
00:02:56,150 --> 00:02:54,420
detect those technical signatures and to

74
00:02:57,550 --> 00:02:56,160
keep things kind of uniform among all

75
00:03:01,070 --> 00:02:57,560
detective signatures we're looking at

76
00:03:02,330 --> 00:03:01,080
we're adopting a signal noise ratio of

77
00:03:04,009 --> 00:03:02,340
five

78
00:03:05,809 --> 00:03:04,019
um but we're also going to talk a bit

79
00:03:07,729 --> 00:03:05,819
about scaling relations you can use if

80
00:03:10,130 --> 00:03:07,739
you want to get higher signal to noise

81
00:03:12,410 --> 00:03:10,140
or something like that

82
00:03:15,229 --> 00:03:12,420
so I'm just kind of going to go through

83
00:03:16,430 --> 00:03:15,239
a few of our calculations here

84
00:03:20,390 --> 00:03:16,440
um

85
00:03:21,649 --> 00:03:20,400
weight over so uh the first kind of

86
00:03:24,050 --> 00:03:21,659
technical signature I want to talk about

87
00:03:25,729 --> 00:03:24,060
is intermittent celestially targeted

88
00:03:27,649 --> 00:03:25,739

radio Transmissions

89
00:03:30,770 --> 00:03:27,659
so the types of signals that would

90
00:03:32,449 --> 00:03:30,780
produce this are Medi signals so

91
00:03:34,790 --> 00:03:32,459
intentional messages that we have sent

92
00:03:36,290 --> 00:03:34,800
out ostensibly to communicate with

93
00:03:39,290 --> 00:03:36,300
extraterrestrial life but we don't

94
00:03:41,089 --> 00:03:39,300
really do a lot of that so

95
00:03:44,390 --> 00:03:41,099
um the more common types of signals we

96
00:03:48,289 --> 00:03:44,400
send out are powerful radio signals

97
00:03:50,449 --> 00:03:48,299
targeted at planets and asteroids in the

98
00:03:53,149 --> 00:03:50,459
solar system in order to characterize

99
00:03:55,610 --> 00:03:53,159
them with radar

100
00:03:58,009 --> 00:03:55,620
so for our calculation we are assuming

101
00:04:00,530 --> 00:03:58,019
that our radar transmitter is Arecibo

102
00:04:03,649 --> 00:04:00,540
Rip but

103
00:04:05,449 --> 00:04:03,659
um our Observer for radio observations

104
00:04:09,110 --> 00:04:05,459
we are using the currently under

105
00:04:11,330 --> 00:04:09,120
construction square kilometer array if

106
00:04:12,470 --> 00:04:11,340
we assume assume an observation time of

107
00:04:14,270 --> 00:04:12,480
one hour

108
00:04:16,670 --> 00:04:14,280
then we get our Earth detecting Earth

109
00:04:18,409 --> 00:04:16,680
detectable distance of 12 000 light

110
00:04:19,670 --> 00:04:18,419
years for our most powerful radio

111
00:04:22,610 --> 00:04:19,680
signals

112
00:04:24,050 --> 00:04:22,620
so this is the highest number that we're

113
00:04:25,790 --> 00:04:24,060

going to see in terms of our distances

114
00:04:28,070 --> 00:04:25,800
here but I wanted to start with it to

115
00:04:30,050 --> 00:04:28,080
really emphasize that

116
00:04:31,610 --> 00:04:30,060
um I see techno signatures as a really

117
00:04:33,650 --> 00:04:31,620
important part of the search for

118
00:04:36,230 --> 00:04:33,660
biosignatures because when you think

119
00:04:38,749 --> 00:04:36,240
about all of the signs of life that we

120
00:04:40,370 --> 00:04:38,759
produce here on Earth our radio signals

121
00:04:41,930 --> 00:04:40,380
are by far the most detectable thing

122
00:04:45,170 --> 00:04:41,940
that we produce

123
00:04:47,030 --> 00:04:45,180
so I really hope that the fields of

124
00:04:49,189 --> 00:04:47,040
biosignatures intactive signatures can

125
00:04:50,510 --> 00:04:49,199
work closely together because I think we

126
00:04:52,730 --> 00:04:50,520
want to take as many approaches as

127
00:04:55,749 --> 00:04:52,740
possible to find any types of life we

128
00:04:58,370 --> 00:04:55,759
can in the universe

129
00:05:00,710 --> 00:04:58,380
so the next category of techno signature

130
00:05:02,870 --> 00:05:00,720
is just another type of radio signal

131
00:05:05,450 --> 00:05:02,880
intermittent celestially untargeted

132
00:05:07,969 --> 00:05:05,460
leakage so these are

133
00:05:10,129 --> 00:05:07,979
signals that we intentionally send into

134
00:05:12,590 --> 00:05:10,139
the sky but not necessarily with the aim

135
00:05:16,129 --> 00:05:12,600
of going to space so things like

136
00:05:18,110 --> 00:05:16,139
Military and Commercial aircraft radar

137
00:05:20,570 --> 00:05:18,120
we're just kind of assuming the standard

138
00:05:22,310 --> 00:05:20,580

aircraft radar systems for a transmitter

139
00:05:24,469 --> 00:05:22,320
and again observing with the square

140
00:05:26,330 --> 00:05:24,479
kilometer array

141
00:05:29,450 --> 00:05:26,340
and our Earth attacking earth distance

142
00:05:30,830 --> 00:05:29,460
is a bit over 200 light years

143
00:05:32,450 --> 00:05:30,840
um so this is a still a pretty big

144
00:05:34,610 --> 00:05:32,460
distance this includes quite a number of

145
00:05:36,890 --> 00:05:34,620
stars

146
00:05:40,189 --> 00:05:36,900
um if we're considering you know the

147
00:05:41,810 --> 00:05:40,199
Stars within this distance range

148
00:05:43,969 --> 00:05:41,820
uh the next Technic signature I want to

149
00:05:46,310 --> 00:05:43,979
talk about is persistent omnidirectional

150
00:05:48,770 --> 00:05:46,320
radio leakage so there was some early

151
00:05:50,450 --> 00:05:48,780
work done on this topic actually in 1989

152
00:05:52,850 --> 00:05:50,460
where

153
00:05:53,930 --> 00:05:52,860
um Sullivan at all simulated

154
00:05:56,689 --> 00:05:53,940
um

155
00:05:58,310 --> 00:05:56,699
the output of Earth's television Tower

156
00:06:01,430 --> 00:05:58,320
Transmissions as you might be able to

157
00:06:04,070 --> 00:06:01,440
observe them from space and concluded

158
00:06:06,950 --> 00:06:04,080
that it's possible that other life out

159
00:06:09,110 --> 00:06:06,960
in the universe knows that we're here

160
00:06:12,050 --> 00:06:09,120
um our TV signals aren't quite as

161
00:06:14,689 --> 00:06:12,060
powerful now as they were in the peak

162
00:06:16,730 --> 00:06:14,699
a time but um we've got all kinds of

163
00:06:19,189 --> 00:06:16,740

mobile cell phone towers all over the

164
00:06:20,870 --> 00:06:19,199
world now so there's a really great

165
00:06:23,150 --> 00:06:20,880
paper that just came out a few weeks ago

166
00:06:25,249 --> 00:06:23,160
by Mira Sade at all

167
00:06:27,469 --> 00:06:25,259
um that kind of does a similar

168
00:06:29,629 --> 00:06:27,479
calculation to the Sullivan paper but

169
00:06:32,150 --> 00:06:29,639
using mobile phone towers instead of

170
00:06:38,150 --> 00:06:35,270
so we adopted their value of a

171
00:06:40,129 --> 00:06:38,160
transmitter strength of four gigawatts

172
00:06:43,370 --> 00:06:40,139
and again using the square kilometer

173
00:06:45,409 --> 00:06:43,380
array as our radio detector and we got a

174
00:06:46,490 --> 00:06:45,419
detectable distance of just under a

175
00:06:48,650 --> 00:06:46,500
light year

176
00:06:51,770 --> 00:06:48,660
so this is a little bit too short of a

177
00:06:53,749 --> 00:06:51,780
distance to reach any nearby stars

178
00:06:55,670 --> 00:06:53,759
um but it's getting pretty close and as

179
00:06:57,650 --> 00:06:55,680
radio technology improves this kind of

180
00:07:00,170 --> 00:06:57,660
uh thing is going to become more

181
00:07:04,550 --> 00:07:02,090
the next techno signature I want to talk

182
00:07:07,189 --> 00:07:04,560
about is intermittent targeted laser

183
00:07:10,490 --> 00:07:07,199
leakage so these are laser signals that

184
00:07:13,189 --> 00:07:10,500
we happen to be sending out into space

185
00:07:13,909 --> 00:07:13,199
um so for the non astronomers in the

186
00:07:14,870 --> 00:07:13,919
room

187
00:07:16,969 --> 00:07:14,880
um

188
00:07:20,029 --> 00:07:16,979

the example that I want to use here is

189
00:07:22,670 --> 00:07:20,039
Adaptive Optics lasers Adaptive Optics

190
00:07:25,129 --> 00:07:22,680
is an astronomy technique where you take

191
00:07:27,409 --> 00:07:25,139
ground-based telescopes and distort

192
00:07:29,510 --> 00:07:27,419
their mirrors and in order to account

193
00:07:32,270 --> 00:07:29,520
for the effects of the atmosphere on the

194
00:07:34,670 --> 00:07:32,280
light that we observed from space

195
00:07:36,529 --> 00:07:34,680
um and uh there are kind of a lot of

196
00:07:38,390 --> 00:07:36,539
factors that goes into that but one

197
00:07:40,730 --> 00:07:38,400
thing is that sometimes we need to

198
00:07:43,730 --> 00:07:40,740
create an artificial guide star to

199
00:07:46,129 --> 00:07:43,740
calibrate these and so what we do is

200
00:07:48,290 --> 00:07:46,139
send really powerful lasers shooting

201
00:07:49,670 --> 00:07:48,300
into the atmosphere so that's some

202
00:07:51,890 --> 00:07:49,680
amount of that laser power hits the

203
00:07:54,110 --> 00:07:51,900
atmosphere and bounces back for us to

204
00:07:56,390 --> 00:07:54,120
observe while a lot of that laser power

205
00:07:58,430 --> 00:07:56,400
just happens to go out into space

206
00:08:02,629 --> 00:07:58,440
wherever it's headed

207
00:08:04,730 --> 00:08:02,639
so um for our calculation for laser

208
00:08:07,370 --> 00:08:04,740
leakage we use the Keck 10 meter

209
00:08:08,330 --> 00:08:07,380
telescope and it's of Adaptive Optics

210
00:08:10,309 --> 00:08:08,340
system

211
00:08:12,529 --> 00:08:10,319
and we get a detectable distance of

212
00:08:15,469 --> 00:08:12,539
about 10 light years so this distance

213
00:08:17,689 --> 00:08:15,479

does include a few nearby stars but it's

214
00:08:19,610 --> 00:08:17,699
important to note that we're not

215
00:08:21,770 --> 00:08:19,620
actually directing these lasers at any

216
00:08:23,330 --> 00:08:21,780
nearby stars because you only need to

217
00:08:25,730 --> 00:08:23,340
use Adaptive Optics

218
00:08:28,309 --> 00:08:25,740
um the laser artificial guide star if

219
00:08:31,070 --> 00:08:28,319
you don't have a real well-known bright

220
00:08:33,949 --> 00:08:31,080
star you can look at so we're never

221
00:08:37,570 --> 00:08:33,959
really doing that right at nearby Stars

222
00:08:42,250 --> 00:08:39,769
so the next category of techno

223
00:08:44,389 --> 00:08:42,260
signatures I want to get into are

224
00:08:46,910 --> 00:08:44,399
exoplanetary techno signatures that you

225
00:08:49,870 --> 00:08:46,920
might detect for example in our in the

226
00:08:52,370 --> 00:08:49,880
atmosphere of a planet

227
00:08:54,530 --> 00:08:52,380
so we've got an example here of one

228
00:08:57,050 --> 00:08:54,540
possible atmospheric pollutant which is

229
00:08:59,090 --> 00:08:57,060
nitrogen dioxide and this is based on

230
00:09:01,009 --> 00:08:59,100
work done by kaparapu at all a couple

231
00:09:03,829 --> 00:09:01,019
years ago

232
00:09:06,410 --> 00:09:03,839
so this simulation was performed using

233
00:09:09,949 --> 00:09:06,420
the planetary Spectrum generator and

234
00:09:11,570 --> 00:09:09,959
assuming that our Observer is a luvex

235
00:09:13,790 --> 00:09:11,580
which I guess is now called habitable

236
00:09:16,730 --> 00:09:13,800
worlds Observatory

237
00:09:19,310 --> 00:09:16,740
um which is a space mission that's under

238
00:09:21,769 --> 00:09:19,320

development but is the combination of

239
00:09:24,050 --> 00:09:21,779
luvar and habex Mission Concepts that

240
00:09:27,829 --> 00:09:24,060
was for a few months called lubrics but

241
00:09:30,170 --> 00:09:27,839
now this is already out of date so

242
00:09:32,389 --> 00:09:30,180
um our detectable distance here is a

243
00:09:34,910 --> 00:09:32,399
little over three light years so this

244
00:09:35,449 --> 00:09:34,920
includes some nearby stars

245
00:09:37,610 --> 00:09:35,459
um

246
00:09:40,070 --> 00:09:37,620
but it's important to know that NO2 can

247
00:09:41,630 --> 00:09:40,080
also be created through natural means so

248
00:09:43,850 --> 00:09:41,640
there's a lot of complicated chemistry

249
00:09:45,410 --> 00:09:43,860
at play here to determine whether it's

250
00:09:47,870 --> 00:09:45,420
actually artificial

251
00:09:48,530 --> 00:09:47,880
but a really important thing about these

252
00:09:50,269 --> 00:09:48,540
um

253
00:09:53,329 --> 00:09:50,279
cultural app atmospheric pollution

254
00:09:55,190 --> 00:09:53,339
signatures is that you can use the same

255
00:09:57,470 --> 00:09:55,200
observations to search for techno

256
00:09:59,509 --> 00:09:57,480
signatures and biosignatures when you're

257
00:10:00,530 --> 00:09:59,519
looking at the Spectra so I think it's a

258
00:10:04,610 --> 00:10:00,540
really great way that these two

259
00:10:09,050 --> 00:10:06,050
um and then the last techno signature

260
00:10:12,050 --> 00:10:09,060
I'm going to talk about is City Lights

261
00:10:14,449 --> 00:10:12,060
so I'm showing a picture here of Earth

262
00:10:15,290 --> 00:10:14,459
as each part of the world appears at

263
00:10:17,150 --> 00:10:15,300

night

264
00:10:19,670 --> 00:10:17,160
with City Lights

265
00:10:22,070 --> 00:10:19,680
um so for this calculation we're using

266
00:10:24,230 --> 00:10:22,080
some work done by Thomas Beatty where he

267
00:10:27,410 --> 00:10:24,240
assumes that our lights are primarily

268
00:10:29,570 --> 00:10:27,420
from high pressure sodium lamps

269
00:10:31,730 --> 00:10:29,580
in this simulation our Observer is

270
00:10:33,769 --> 00:10:31,740
luvore a so a slightly earlier version

271
00:10:36,350 --> 00:10:33,779
of the lyrics I talked about last time

272
00:10:39,530 --> 00:10:36,360
luvore was an earlier Mission concept

273
00:10:41,030 --> 00:10:39,540
concept for that so this exact design is

274
00:10:43,030 --> 00:10:41,040
not going to be launched in space but

275
00:10:46,329 --> 00:10:43,040
we're going to have something similar

276
00:10:49,850 --> 00:10:46,339
and our distance for this one is only

277
00:10:52,310 --> 00:10:49,860
0.075 light years so this means

278
00:10:54,470 --> 00:10:52,320
um that we could only use something like

279
00:10:56,090 --> 00:10:54,480
luvor to detect our city lights if we're

280
00:10:59,150 --> 00:10:56,100
in the Oort cloud which is just kind of

281
00:11:00,650 --> 00:10:59,160
the outer regions of the solar system

282
00:11:02,329 --> 00:11:00,660
um so if you want to detect this kind of

283
00:11:05,329 --> 00:11:02,339
thing you're going to have to

284
00:11:08,389 --> 00:11:05,339
uh have a planet that has a lot more

285
00:11:12,710 --> 00:11:10,730
and so I'll just kind of leave up my

286
00:11:15,350 --> 00:11:12,720
summary slide here as the list of the

287
00:11:16,910 --> 00:11:15,360
Techno signatures that we're looking at

288
00:11:19,069 --> 00:11:16,920

um the first few on the list here are

289
00:11:21,050 --> 00:11:19,079
the ones that we quickly went over I've

290
00:11:22,550 --> 00:11:21,060
got a few more highlighted in yellow and

291
00:11:23,750 --> 00:11:22,560
for those our calculations are still

292
00:11:26,990 --> 00:11:23,760
underway

293
00:11:28,130 --> 00:11:27,000
and then we've crossed a few out

294
00:11:30,829 --> 00:11:28,140
um that turned out to be techno

295
00:11:33,829 --> 00:11:30,839
signatures we've crossed off of um

296
00:11:36,050 --> 00:11:33,839
consideration for various reasons mostly

297
00:11:37,610 --> 00:11:36,060
because it's just not feasible to

298
00:11:38,750 --> 00:11:37,620
observe them from space at all we'd be

299
00:11:40,730 --> 00:11:38,760
talking about still in Earth's

300
00:11:42,170 --> 00:11:40,740
atmosphere for our distance

301
00:11:43,130 --> 00:11:42,180
or because

302
00:11:44,870 --> 00:11:43,140
um

303
00:11:47,030 --> 00:11:44,880
another possible techno signature is

304
00:11:49,509 --> 00:11:47,040
observing the contents of Earth's

305
00:11:52,130 --> 00:11:49,519
atmosphere over time and how it changes

306
00:11:53,930 --> 00:11:52,140
but we decided for this project that

307
00:11:56,509 --> 00:11:53,940
we're not going to get into things that

308
00:11:59,569 --> 00:11:56,519
are based on changes over time because

309
00:12:01,009 --> 00:11:59,579
uh this is already a really big paper as

310
00:12:02,930 --> 00:12:01,019
is

311
00:12:12,110 --> 00:12:02,940
um so yeah I can take questions I also

312
00:12:16,130 --> 00:12:14,690
all right thank you Macy our new doctor

313
00:12:17,509 --> 00:12:16,140

Houston

314
00:12:19,009 --> 00:12:17,519
um unfortunately we only have time for

315
00:12:22,490 --> 00:12:19,019
one question so I want to see some real

316
00:12:26,449 --> 00:12:24,769
hi um thank you so much for your talk I

317
00:12:28,009 --> 00:12:26,459
definitely agree with you that take my

318
00:12:30,410 --> 00:12:28,019
signature and by signature scientists

319
00:12:32,449 --> 00:12:30,420
need to work more closely together

320
00:12:34,610 --> 00:12:32,459
um I was wondering I know the paper is

321
00:12:36,350 --> 00:12:34,620
already super cool as it is but as a

322
00:12:38,630 --> 00:12:36,360
sort of follow-up

323
00:12:40,610 --> 00:12:38,640
um would it be possible to estimate what

324
00:12:42,769 --> 00:12:40,620
sort of techno signal like how those

325
00:12:44,389 --> 00:12:42,779
techno signatures would evolve

326
00:12:45,889 --> 00:12:44,399
um in the future and if there's one

327
00:12:49,370 --> 00:12:45,899
that's going to shoot up and at what

328
00:12:52,430 --> 00:12:49,380
point in our future uh would we be

329
00:12:54,670 --> 00:12:52,440
detectable to most terrestrial planets

330
00:12:57,110 --> 00:12:54,680
in our galaxy

331
00:12:58,430 --> 00:12:57,120
yeah we'll talk a little bit about that

332
00:12:59,990 --> 00:12:58,440
in the discussion but we're not going to

333
00:13:01,970 --> 00:13:00,000
get too quantitative

334
00:13:05,090 --> 00:13:01,980
um but that is something that comes up

335
00:13:07,129 --> 00:13:05,100
as in you know uh one of the main things

336
00:13:09,889 --> 00:13:07,139
you hear people talk about this in is is

337
00:13:11,629 --> 00:13:09,899
like radio leakage because like

338
00:13:13,430 --> 00:13:11,639

if our cell phone towers were more

339
00:13:15,530 --> 00:13:13,440
directed you know down at the Earth they

340
00:13:17,449 --> 00:13:15,540
could be more efficient and maybe more

341
00:13:19,430 --> 00:13:17,459
advanced technology has less leakage

342
00:13:21,650 --> 00:13:19,440
into space just because

343
00:13:23,030 --> 00:13:21,660
it's a waste of energy

344
00:13:24,829 --> 00:13:23,040
um so yeah these are things we think

345
00:13:26,509 --> 00:13:24,839
about I don't have any definitive

346
00:13:33,080 --> 00:13:26,519
answers right now

347
00:13:37,630 --> 00:13:35,030
[Music]

348
00:13:46,430 --> 00:13:37,640
[Applause]