Andrew Burkhardt

Session 1 Warm-up Talk: Astronomy & Astrochemistry

1
00:00:00,240 --> 00:00:11,169
[Music]

2
00:00:17,509 --> 00:00:14,720
welcome everyone to 2019 F grad Khan

3
00:00:19,400 --> 00:00:17,519
hope everyone is well caffeinated as we

4
00:00:21,320 --> 00:00:19,410
got a couple of great exciting talks

5
00:00:25,220 --> 00:00:21,330
coming up here I'll be giving the

6
00:00:28,460 --> 00:00:25,230
warm-up talk as Julia said and I'll be

7
00:00:29,599 --> 00:00:28,470
going over kind of the background for

8
00:00:31,339 --> 00:00:29,609
those who aren't used to these warm up

9
00:00:33,530 --> 00:00:31,349
talks they're a background to kind of

10
00:00:35,479 --> 00:00:33,540
prepare you for the slightly more

11
00:00:37,670 --> 00:00:35,489
technical talks that you'll see this

12
00:00:40,400 --> 00:00:37,680
will be themed loosely on the concept of

13
00:00:44,720 --> 00:00:40,410

astronomy in a stroke a mystery so we

14
00:00:46,939 --> 00:00:44,730
may bounce around a little bit and so

15
00:00:48,410 --> 00:00:46,949
yeah we can get started so to start this

16
00:00:51,229 --> 00:00:48,420
is the schedule for what we're going to

17
00:00:52,430 --> 00:00:51,239
be seeing for these next few talks so

18
00:00:54,740 --> 00:00:52,440
I'll be you know we're in the middle of

19
00:00:56,750 --> 00:00:54,750
the warm-up talk right now and then we

20
00:00:58,310 --> 00:00:56,760
have three talks and then we're gonna

21
00:01:01,220 --> 00:00:58,320
have a break for the break everyone's

22
00:01:02,540 --> 00:01:01,230
just gonna go outside right out there

23
00:01:05,090 --> 00:01:02,550
where the tables are or there will be

24
00:01:07,220 --> 00:01:05,100
some refreshments presumably then we'll

25
00:01:09,950 --> 00:01:07,230
have two more talks and then we're gonna

26
00:01:12,260 --> 00:01:09,960
have the lightning talk so anyone who is

27
00:01:13,760 --> 00:01:12,270
currently presenting a poster I think of

28
00:01:14,960 --> 00:01:13,770
your elevator pitch you'll have about a

29
00:01:20,780 --> 00:01:14,970
minute and then we'll cut you off with a

30
00:01:23,150 --> 00:01:20,790
loud annoying noise so prepare to have

31
00:01:24,050 --> 00:01:23,160
your elevator pitch for talking about it

32
00:01:27,020 --> 00:01:24,060
and then after that we're gonna have a

33
00:01:28,670 --> 00:01:27,030
sicom panel and so we're gonna have some

34
00:01:30,920 --> 00:01:28,680
people come up about four speakers up

35
00:01:32,870 --> 00:01:30,930
here so also if you want to have any

36
00:01:34,910 --> 00:01:32,880
major burning questions about science

37
00:01:37,490 --> 00:01:34,920
and science communication think about

38
00:01:41,840 --> 00:01:37,500

those questions now I guess while I'm

39
00:01:43,340 --> 00:01:41,850
talking or during the break beyond that

40
00:01:46,130 --> 00:01:43,350
I don't think there's any other major

41
00:01:49,280 --> 00:01:46,140
announcements so I guess we'll get

42
00:01:51,290 --> 00:01:49,290
started so it's early in the morning and

43
00:01:52,540 --> 00:01:51,300
some of us may be jet-lagged so I wanted

44
00:01:56,150 --> 00:01:52,550
to start off with this quick little

45
00:01:58,550 --> 00:01:56,160
YouTube clip because this is what I do

46
00:02:00,160 --> 00:01:58,560
when I'm bored so to start off we're

47
00:02:02,180 --> 00:02:00,170
we're just gonna go and summarize all of

48
00:02:04,460 --> 00:02:02,190
what I'm gonna be talking about in about

49
00:02:06,440 --> 00:02:04,470
90 seconds by if anyone knows Bill works

50
00:02:11,190 --> 00:02:06,450
he did a nice summary of all this with

51
00:03:36,090 --> 00:03:09,590
[Music]

52
00:03:42,010 --> 00:03:38,020
this continues for the next 20 minutes

53
00:03:44,470 --> 00:03:42,020
you shall watch it sometime so we're

54
00:03:46,390 --> 00:03:44,480
gonna take this little bit slower now to

55
00:03:47,470 --> 00:03:46,400
go through the full story but I figured

56
00:03:49,330 --> 00:03:47,480
you don't appreciate at least something

57
00:03:51,670 --> 00:03:49,340
wake you up in the morning alright so

58
00:03:53,140 --> 00:03:51,680
we're gonna skip over all the Big Bang

59
00:03:54,610 --> 00:03:53,150
cosmology stuff because that's not what

60
00:03:57,220 --> 00:03:54,620
we're here to talk about and we're gonna

61
00:04:00,820 --> 00:03:57,230
start with the concept of blacking out

62
00:04:02,680 --> 00:04:00,830
the screen or star formation so this is

63
00:04:05,500 --> 00:04:02,690

a kind of classic picture that you'll

64
00:04:08,170 --> 00:04:05,510
see of this stellar lifecycle for how

65
00:04:11,470 --> 00:04:08,180
stars form and how the planets around

66
00:04:13,060 --> 00:04:11,480
them will form so often you start we

67
00:04:16,000 --> 00:04:13,070
kind of reset star formation every time

68
00:04:18,850 --> 00:04:16,010
at the death of some star where you have

69
00:04:20,890 --> 00:04:18,860
some sort of supernova there or some

70
00:04:23,770 --> 00:04:20,900
sort of large expansion of the loss of

71
00:04:25,560 --> 00:04:23,780
atmosphere and as the material spreads

72
00:04:29,020 --> 00:04:25,570
out into the interstellar medium it

73
00:04:32,200 --> 00:04:29,030
forms these large clouds that tend to be

74
00:04:34,210 --> 00:04:32,210
rather dense and dark and slowly over

75
00:04:36,640 --> 00:04:34,220
time gravity will collapse and form

76
00:04:38,440 --> 00:04:36,650
protostars and around those protostars

77
00:04:40,480 --> 00:04:38,450
the material will tend to accrete and

78
00:04:42,880 --> 00:04:40,490
they will start to form large disks and

79
00:04:44,740 --> 00:04:42,890
in these disks you'll start to coalesce

80
00:04:46,690 --> 00:04:44,750
little pebbles and in those pebbles will

81
00:04:52,180 --> 00:04:46,700
eventually build up into things such as

82
00:04:54,040 --> 00:04:52,190
planets and comets in meteorites and but

83
00:04:55,690 --> 00:04:54,050
slowly that those pebble start to create

84
00:04:58,480 --> 00:04:55,700
and you form a star and around that star

85
00:05:01,900 --> 00:04:58,490
you form things like planets which is

86
00:05:03,880 --> 00:05:01,910
very exciting and so this this session

87
00:05:07,360 --> 00:05:03,890
is also kind of themed on cuz

88
00:05:08,590 --> 00:05:07,370

astrochemistry as well and so the reason

89
00:05:09,790 --> 00:05:08,600
I pulled this one up in particular is

90
00:05:12,400 --> 00:05:09,800
because chemistry happens throughout

91
00:05:15,370 --> 00:05:12,410
this entire process so you start and you

92
00:05:17,590 --> 00:05:15,380
form your initial elements over here in

93
00:05:19,870 --> 00:05:17,600
the deaths of stars or in the cores of

94
00:05:21,730 --> 00:05:19,880
stars through fusion and so one thing

95
00:05:24,130 --> 00:05:21,740
that astral chemistry seeks to answer is

96
00:05:27,100 --> 00:05:24,140
how do you go from these elemental acids

97
00:05:28,030 --> 00:05:27,110
ashes and you build up all the way you

98
00:05:30,610 --> 00:05:28,040
know you can build up things like

99
00:05:33,130 --> 00:05:30,620
buckyballs and polycyclic aromatic

100
00:05:36,160 --> 00:05:33,140
hydrocarbons which are these large multi

101
00:05:39,550 --> 00:05:36,170
aromatic kind of amorphous species long

102
00:05:41,380 --> 00:05:39,560
linear carbon chain molecules up to more

103
00:05:42,430 --> 00:05:41,390
saturated species things that kind of

104
00:05:44,500 --> 00:05:42,440
resemble a little bit more of what we

105
00:05:45,520 --> 00:05:44,510
see in terrestrial but chemistry is

106
00:05:47,800 --> 00:05:45,530
happening the whole time so how do you

107
00:05:48,930 --> 00:05:47,810
go from these elemental ashes all the

108
00:05:51,300 --> 00:05:48,940
way up to

109
00:05:53,510 --> 00:05:51,310
the ingredients we see kind of in the

110
00:05:56,760 --> 00:05:53,520
primordial solar system or perhaps

111
00:05:59,670 --> 00:05:56,770
afterwards so you start with your

112
00:06:02,340 --> 00:05:59,680
initial ingredients so I mentioned that

113
00:06:04,560 --> 00:06:02,350

a lot of these elements are fused either

114
00:06:08,130 --> 00:06:04,570
through the deaths of stars or through

115
00:06:09,420 --> 00:06:08,140
in these cores of active stars this is

116
00:06:11,850 --> 00:06:09,430
this kind of nice little periodic table

117
00:06:14,160 --> 00:06:11,860
showing all the different sources of how

118
00:06:15,810 --> 00:06:14,170
they're formed but by and large the vast

119
00:06:17,640 --> 00:06:15,820
majority of things hydrogen with a

120
00:06:20,180 --> 00:06:17,650
little bit less is helium and then just

121
00:06:23,120 --> 00:06:20,190
a couple percent is everything else

122
00:06:26,430 --> 00:06:23,130
carbon nitrogen oxygen tend to

123
00:06:29,340 --> 00:06:26,440
demonstrate air and the final products

124
00:06:30,990 --> 00:06:29,350
that we know about a lot of them are

125
00:06:33,060 --> 00:06:31,000
really exciting you know when we go to

126
00:06:35,040 --> 00:06:33,070
look towards things in our solar system

127
00:06:36,990 --> 00:06:35,050
either when we you know throw zetas

128
00:06:39,090 --> 00:06:37,000
missions looking at comets or there were

129
00:06:40,860 --> 00:06:39,100
two meteorite we see things like amino

130
00:06:43,950 --> 00:06:40,870
acids these kind of building blocks of

131
00:06:46,560 --> 00:06:43,960
how we build up more complex things I am

132
00:06:47,910 --> 00:06:46,570
NOT a biologist in training so I'm not a

133
00:06:49,590 --> 00:06:47,920
biologist whatsoever the last time I

134
00:06:51,510 --> 00:06:49,600
took a biology class was sixth grade but

135
00:06:54,930 --> 00:06:51,520
people tell me this is very important

136
00:06:57,750 --> 00:06:54,940
and so I believed them and I try to

137
00:07:00,480 --> 00:06:57,760
build this stuff when I am running my

138
00:07:02,190 --> 00:07:00,490

research which is focused on a chem but

139
00:07:03,960 --> 00:07:02,200
also then you build up this concept of

140
00:07:06,750 --> 00:07:03,970
primordial soup which is if you get

141
00:07:08,250 --> 00:07:06,760
enough complex molecules in one place

142
00:07:09,300 --> 00:07:08,260
and you add a bunch of energy to it and

143
00:07:11,280 --> 00:07:09,310
do a lot of things that sound really

144
00:07:14,370 --> 00:07:11,290
hard eventually life will just kind of

145
00:07:16,650 --> 00:07:14,380
pop out which I obviously stopped and a

146
00:07:18,600 --> 00:07:16,660
lot more depth but the question is how

147
00:07:20,940 --> 00:07:18,610
do you how does this all get here in the

148
00:07:23,550 --> 00:07:20,950
first place and how do we constrain the

149
00:07:27,420 --> 00:07:23,560
chemistry to go from elemental ashes to

150
00:07:30,360 --> 00:07:27,430
amino acids so when after chem there's

151
00:07:32,700 --> 00:07:30,370
kind of three major branches and that we

152
00:07:35,580 --> 00:07:32,710
kind of dictate the studies you know we

153
00:07:37,350 --> 00:07:35,590
talk about these sub regimes last night

154
00:07:40,200 --> 00:07:37,360
so you have the observational components

155
00:07:42,780 --> 00:07:40,210
this can either be going and observing

156
00:07:45,360 --> 00:07:42,790
on a telescope either space-based or on

157
00:07:46,650 --> 00:07:45,370
the ground or it can be actually sending

158
00:07:48,180 --> 00:07:46,660
something out to something in the solar

159
00:07:50,790 --> 00:07:48,190
system and taking measurements that way

160
00:07:52,590 --> 00:07:50,800
you have theory a lot of this in the

161
00:07:55,140 --> 00:07:52,600
interstellar medium will be Astro

162
00:07:57,000 --> 00:07:55,150
chemical modeling but a lot of this is

163
00:07:59,880 --> 00:07:57,010

done for in the atmospheres of planets

164
00:08:02,020 --> 00:07:59,890
and moons as well these are kind of

165
00:08:04,570 --> 00:08:02,030
dominated by AI the Monte Carlo

166
00:08:06,070 --> 00:08:04,580
or kinetic rate equation models to

167
00:08:07,810 --> 00:08:06,080
simulate the chemistry and the physical

168
00:08:10,330 --> 00:08:07,820
conditions and then also you have the

169
00:08:12,300 --> 00:08:10,340
laboratory component which will from the

170
00:08:14,830 --> 00:08:12,310
Astronomy side measure the frequencies

171
00:08:17,410 --> 00:08:14,840
for molecules for us to detect in space

172
00:08:20,080 --> 00:08:17,420
they also try to recreate Astrophysical

173
00:08:21,220 --> 00:08:20,090
conditions however that is rather tough

174
00:08:23,950 --> 00:08:21,230
as a lot of them will definitely tell

175
00:08:26,680 --> 00:08:23,960
you the most powerful high power vacuums

176
00:08:29,050 --> 00:08:26,690
the least dense you can possibly get is

177
00:08:31,570 --> 00:08:29,060
considered extremely dense in space so

178
00:08:33,430 --> 00:08:31,580
we're talking you know 10 to the 8 or 10

179
00:08:35,350 --> 00:08:33,440
to the 6 parts per cubic memory since

180
00:08:37,659 --> 00:08:35,360
they're in a dark cloud compared to

181
00:08:39,940 --> 00:08:37,669
about 10 to the 19 parts per cubic

182
00:08:43,899 --> 00:08:39,950
centimeter is the air were breathing

183
00:08:45,190 --> 00:08:43,909
right now and so our talks are gonna

184
00:08:48,250 --> 00:08:45,200
kind of bounce around between a lot of

185
00:08:49,600 --> 00:08:48,260
these different subjects so for example

186
00:08:52,000 --> 00:08:49,610
on the laboratory side we're gonna have

187
00:08:54,790 --> 00:08:52,010
a talk by Haley here about measuring the

188
00:08:56,800 --> 00:08:54,800

rotational spectra of molecules in order

189
00:08:58,210 --> 00:08:56,810
to complete the inventory of what we

190
00:09:00,550 --> 00:08:58,220
know is in space for us to really

191
00:09:02,500 --> 00:09:00,560
understand the full story of

192
00:09:04,930 --> 00:09:02,510
astrochemistry we need to understand

193
00:09:06,370 --> 00:09:04,940
what all is there and as you get to

194
00:09:07,810 --> 00:09:06,380
larger and larger molecules it gets

195
00:09:10,390 --> 00:09:07,820
harder and harder to detect them so we

196
00:09:12,340 --> 00:09:10,400
need really accurate spectra tuned there

197
00:09:17,230 --> 00:09:12,350
to in order to determine that so have a

198
00:09:19,180 --> 00:09:17,240
nice talk about that and so this is just

199
00:09:21,850 --> 00:09:19,190
a kind of guide ride this is every

200
00:09:23,950 --> 00:09:21,860
single molecule as of about last year I

201
00:09:26,050 --> 00:09:23,960
didn't get an updated table because I

202
00:09:28,030 --> 00:09:26,060
would have taken a while but this is a

203
00:09:29,530 --> 00:09:28,040
little over 200 molecules have been

204
00:09:30,640 --> 00:09:29,540
detected in the interstellar medium and

205
00:09:31,960 --> 00:09:30,650
so we're actually starting to get a

206
00:09:33,790 --> 00:09:31,970
really good idea but you can also see

207
00:09:37,060 --> 00:09:33,800
that this is very much dominated by

208
00:09:38,710 --> 00:09:37,070
these small very small two to three atom

209
00:09:40,510 --> 00:09:38,720
molecules an extra chemistry you

210
00:09:43,660 --> 00:09:40,520
consider complex to be about six atoms

211
00:09:46,180 --> 00:09:43,670
and if you look over here if once you

212
00:09:48,340 --> 00:09:46,190
get up to about twice that 12 the number

213
00:09:50,860 --> 00:09:48,350

gets quite dwindling so it'll be very

214
00:09:52,420 --> 00:09:50,870
exciting as we get more improved spectra

215
00:09:56,230 --> 00:09:52,430
and it's kind of a concerted effort to

216
00:09:57,820 --> 00:09:56,240
try to fill this out a lot more there

217
00:10:00,130 --> 00:09:57,830
was also a good amount of theory talks

218
00:10:02,430 --> 00:10:00,140
here some more or less related to

219
00:10:06,340 --> 00:10:02,440
astrochemistry or just kind of chemistry

220
00:10:09,760 --> 00:10:06,350
in general both seeking to explain the

221
00:10:11,800 --> 00:10:09,770
observations that we see in for example

222
00:10:15,610 --> 00:10:11,810
in the atmospheres of Titan or what we

223
00:10:18,010 --> 00:10:15,620
see in Enceladus well so we have

224
00:10:20,019 --> 00:10:18,020
trying to predict the reactions that we

225
00:10:21,490 --> 00:10:20,029
expect to happen as well so you know

226
00:10:26,710 --> 00:10:21,500
we'll have some nice talks by Ryan and

227
00:10:27,460 --> 00:10:26,720
allene here as well as we'll just focus

228
00:10:33,760 --> 00:10:27,470
on these right now

229
00:10:35,850 --> 00:10:33,770
so here the two of the talks will at

230
00:10:37,960 --> 00:10:35,860
least be tentatively related to tighten

231
00:10:39,910 --> 00:10:37,970
the other one being related to a

232
00:10:42,790 --> 00:10:39,920
different moon of Saturn which is

233
00:10:45,880 --> 00:10:42,800
Enceladus you know here we have Titan is

234
00:10:49,120 --> 00:10:45,890
a particularly interesting source for us

235
00:10:50,800 --> 00:10:49,130
because it's kind of the one of the it's

236
00:10:52,180 --> 00:10:50,810
unique among moons in the solar system

237
00:10:56,019 --> 00:10:52,190
in that it has a very rich nitrogen

238
00:10:58,780 --> 00:10:56,029

atmosphere as well as having a lot of

239
00:11:02,710 --> 00:10:58,790
complex organics we know exists in the

240
00:11:04,120 --> 00:11:02,720
kind of methane rich atmosphere and as

241
00:11:06,760 --> 00:11:04,130
you go down and this is a nice image

242
00:11:08,680 --> 00:11:06,770
from Cassini showing both the optical

243
00:11:10,630 --> 00:11:08,690
and also an infrared image looking at

244
00:11:11,950 --> 00:11:10,640
more of the surface here and it's going

245
00:11:14,079 --> 00:11:11,960
to be particularly interesting going

246
00:11:16,269 --> 00:11:14,089
forward given the Dragonfly mission

247
00:11:17,230 --> 00:11:16,279
which just got selected to be approved

248
00:11:18,850 --> 00:11:17,240
so this will be a really exciting

249
00:11:22,360 --> 00:11:18,860
mission so stay tuned for the exciting

250
00:11:25,000 --> 00:11:22,370
results coming out of that and then

251
00:11:26,829 --> 00:11:25,010
we're also going to have a talk that's

252
00:11:29,710 --> 00:11:26,839
going to be more related to Enceladus

253
00:11:32,710 --> 00:11:29,720
which is another moon of Saturn this one

254
00:11:35,440 --> 00:11:32,720
is known for having this large this ice

255
00:11:38,740 --> 00:11:35,450
crust here the layers not to scale but

256
00:11:43,240 --> 00:11:38,750
these large hydro for hydrothermal vents

257
00:11:46,510 --> 00:11:43,250
that launch material out into the

258
00:11:48,040 --> 00:11:46,520
surrounding area and in here there's

259
00:11:50,320 --> 00:11:48,050
actually been some very exciting work of

260
00:11:52,540 --> 00:11:50,330
finding complex potentially the first

261
00:11:55,630 --> 00:11:52,550
kind of primordial soup potentially

262
00:11:56,920 --> 00:11:55,640
found outside of Earth that may been

263
00:11:59,620 --> 00:11:56,930

found in these vents so that's another

264
00:12:02,350 --> 00:11:59,630
really exciting Avenue that I will be

265
00:12:04,180 --> 00:12:02,360
talking about as well and we're also

266
00:12:05,410 --> 00:12:04,190
gonna have a talk about SETI I didn't

267
00:12:07,480 --> 00:12:05,420
really have a great transition here but

268
00:12:10,750 --> 00:12:07,490
we're gonna be talking it this is also

269
00:12:12,760 --> 00:12:10,760
really exciting these are so the

270
00:12:17,110 --> 00:12:12,770
question is this is the search for

271
00:12:19,120 --> 00:12:17,120
extraterrestrial intelligence and a big

272
00:12:20,500 --> 00:12:19,130
initiative has been pushed for study

273
00:12:23,079 --> 00:12:20,510
with the breakthrough listen project

274
00:12:26,770 --> 00:12:23,089
we're a hundred million dollars is being

275
00:12:28,960 --> 00:12:26,780
put in to try to search for intelligent

276
00:12:30,580 --> 00:12:28,970
signals somewhere

277
00:12:33,520 --> 00:12:30,590
you know in our galaxy or in other

278
00:12:34,690 --> 00:12:33,530
galaxies and so they're recruiting kind

279
00:12:36,190 --> 00:12:34,700
of some of the most powerful radio

280
00:12:37,840 --> 00:12:36,200
telescopes we have available especially

281
00:12:39,550 --> 00:12:37,850
on the low frequency end this is the

282
00:12:40,960 --> 00:12:39,560
Green Bank telescope the largest

283
00:12:43,330 --> 00:12:40,970
steerable object on land the only thing

284
00:12:45,640 --> 00:12:43,340
bigger that you can steer our aircraft a

285
00:12:49,660 --> 00:12:45,650
aircraft carriers and old tankers for

286
00:12:51,790 --> 00:12:49,670
scale that's a building it's really big

287
00:12:52,780 --> 00:12:51,800
you don't realize it's big until you

288
00:12:54,490 --> 00:12:52,790

actually like physically are like

289
00:12:56,380 --> 00:12:54,500
touching it and this was the site of a

290
00:12:57,940 --> 00:12:56,390
PWR two years ago which is kind of cool

291
00:13:00,160 --> 00:12:57,950
but there's a series of other radio

292
00:13:04,330 --> 00:13:00,170
telescopes here this is meerkat this is

293
00:13:08,140 --> 00:13:04,340
the park 64 meter this is on the Lick

294
00:13:11,230 --> 00:13:08,150
Observatory I believe and also some work

295
00:13:13,300 --> 00:13:11,240
with low far as well and so what this is

296
00:13:14,860 --> 00:13:13,310
doing is monitoring me I'm around a

297
00:13:16,630 --> 00:13:14,870
million stars and actually be able to

298
00:13:17,920 --> 00:13:16,640
also monitor about 100 galaxies looking

299
00:13:21,810 --> 00:13:17,930
for these kind of intelligent signals

300
00:13:24,460 --> 00:13:21,820
and trying to determine you know what

301
00:13:26,110 --> 00:13:24,470
what do and a lot of the effort will go

302
00:13:28,630 --> 00:13:26,120
into okay what what kind of signal will

303
00:13:30,220 --> 00:13:28,640
this look like and how do we want to you

304
00:13:31,630 --> 00:13:30,230
know if we want to look everywhere we

305
00:13:32,830 --> 00:13:31,640
need to really figure out what exact

306
00:13:34,300 --> 00:13:32,840
type of signal we're looking for so

307
00:13:37,450 --> 00:13:34,310
that's what we're gonna get a talk from

308
00:13:41,170 --> 00:13:37,460
Sophia about how do we specifically

309
00:13:42,460 --> 00:13:41,180
determine our exact drift rates in terms

310
00:13:44,860 --> 00:13:42,470
of how much frequency shifting we're

311
00:13:48,940 --> 00:13:44,870
going to be getting from any given SETI

312
00:13:51,250 --> 00:13:48,950
signal what would we kind of expect so

313
00:13:53,380 --> 00:13:51,260

yeah that's that's the most my talk here

314
00:13:54,940 --> 00:13:53,390
I would say definitely one great part

315
00:13:56,830 --> 00:13:54,950
about this conference is if you don't

316
00:13:58,090 --> 00:13:56,840
know or didn't catch it please ask this

317
00:13:59,500 --> 00:13:58,100
is the time to ask the questions that

318
00:14:01,210 --> 00:13:59,510
you were too afraid to ask because

319
00:14:03,400 --> 00:14:01,220
everyone here is super friendly and we

320
00:14:05,890 --> 00:14:03,410
all just want to know you know I said I

321
00:14:07,360 --> 00:14:05,900
know nothing about biology and so most

322
00:14:07,720 --> 00:14:07,370
of this I'm gonna try to see if I can

323
00:14:09,160 --> 00:14:07,730
learn more

324
00:14:10,710 --> 00:14:09,170
while I'm here but please don't be

325
00:14:15,130 --> 00:14:10,720
afraid to ask it's a very friendly group

326
00:14:17,040 --> 00:14:15,140
and I guess I'll take any questions yeah