
AbSciCon
2017
MESA, ARIZONA

1
00:00:00,220 --> 00:00:12,940
[Music]

2
00:00:16,190 --> 00:00:15,080
so I met salim a graduate student at

3
00:00:18,830 --> 00:00:16,200
University of Washington working with

4
00:00:20,090 --> 00:00:18,840
the vdl and recently we did a project to

5
00:00:21,410 --> 00:00:20,100
see if we could constrain anything about

6
00:00:23,600 --> 00:00:21,420
Proxima Centauri be looking at the

7
00:00:25,280 --> 00:00:23,610
overall emission specifically the five

8
00:00:27,500 --> 00:00:25,290
five seven seven a green line which you

9
00:00:28,760 --> 00:00:27,510
can see here this beautiful image so a

10
00:00:30,109 --> 00:00:28,770
little review about Aurora they are

11
00:00:31,850 --> 00:00:30,119
driven by star planet interaction

12
00:00:33,350 --> 00:00:31,860
typically you have some forcing from the

13
00:00:35,180 --> 00:00:33,360

stellar wind or a transient activity

14
00:00:36,890 --> 00:00:35,190
like what you see here in this cartoon

15
00:00:38,720 --> 00:00:36,900
which compresses the magnetosphere

16
00:00:40,580 --> 00:00:38,730
energizes particles and causes a lot of

17
00:00:41,750 --> 00:00:40,590
interesting physics but what you get in

18
00:00:43,220 --> 00:00:41,760
the end is the precipitation of

19
00:00:45,020 --> 00:00:43,230
particles down into the atmosphere along

20
00:00:47,810 --> 00:00:45,030
the magnetic field and forms these

21
00:00:48,979 --> 00:00:47,820
beautiful bands of color and around in

22
00:00:50,630 --> 00:00:48,989
forms it's a royal oval that we are

23
00:00:53,599 --> 00:00:50,640
where this characteristic a little years

24
00:00:55,430 --> 00:00:53,609
to seeing and so in general I want to

25
00:00:56,930 --> 00:00:55,440
point out that we are looking for Aurora

26
00:00:58,970 --> 00:00:56,940
airglow so we're looking for these

27
00:01:00,799 --> 00:00:58,980
discrete localized and intense emissions

28
00:01:02,330 --> 00:01:00,809
coming from the planet where don't care

29
00:01:04,430 --> 00:01:02,340
about air glow it's a little too faint

30
00:01:06,710 --> 00:01:04,440
we could put our calculations in oh

31
00:01:07,730 --> 00:01:06,720
there's no real chance to see that at

32
00:01:12,160 --> 00:01:07,740
least with present instruments and

33
00:01:15,950 --> 00:01:14,210
so we want a really good star planet

34
00:01:18,020 --> 00:01:15,960
contrast luckily Proxima Centauri is an

35
00:01:19,039 --> 00:01:18,030
indoor so it's beneficial to look in the

36
00:01:20,749 --> 00:01:19,049
optical region if we want to see

37
00:01:24,350 --> 00:01:20,759
something from the planet so the harps

38
00:01:26,660 --> 00:01:24,360

data you can see here yes here check it

39
00:01:28,160 --> 00:01:26,670
in blue if you can actually see that is

40
00:01:30,710 --> 00:01:28,170
right in the middle the optical where

41
00:01:34,280 --> 00:01:30,720
Proxima Centauri actually has whoops so

42
00:01:35,740 --> 00:01:34,290
Proxima Centauri actually has very low

43
00:01:40,039 --> 00:01:35,750
flux and so we're going to look for the

44
00:01:41,330 --> 00:01:40,049
50 577 oxygen line there and it's really

45
00:01:42,380 --> 00:01:41,340
exciting if we could see these lines

46
00:01:43,819 --> 00:01:42,390
because not only would it provide

47
00:01:45,620 --> 00:01:43,829
independent verification of the planet

48
00:01:47,330 --> 00:01:45,630
itself it would also help to constrain

49
00:01:49,340 --> 00:01:47,340
orbital parameters as well as be a

50
00:01:51,260 --> 00:01:49,350
direct verification and identification

51
00:01:52,520 --> 00:01:51,270
of atmospheric species so that would be

52
00:01:54,620 --> 00:01:52,530
very awesome whether it's oxygen or

53
00:01:55,760 --> 00:01:54,630
nitrogen or hydrogen or whatever it'll

54
00:01:57,980 --> 00:01:55,770
be a nice direct observation of the

55
00:01:59,630 --> 00:01:57,990
atmosphere so in general I'm going to

56
00:02:01,249 --> 00:01:59,640
tell you how we estimated the signal

57
00:02:03,380 --> 00:02:01,259
strength how detectable we think those

58
00:02:04,730 --> 00:02:03,390
signals are and then about the search

59
00:02:08,150 --> 00:02:04,740
through the harps the available harps

60
00:02:09,950 --> 00:02:08,160
data the discovery data so for the

61
00:02:11,780 --> 00:02:09,960
signal strength we use two separate

62
00:02:13,490 --> 00:02:11,790
models the one is just a simple kinetic

63
00:02:15,800 --> 00:02:13,500

forcing model and the second is an

64
00:02:18,110 --> 00:02:15,810
empirical image CD fit model by weighing

65
00:02:19,460 --> 00:02:18,120
at all 2014 both of which miss a lot of

66
00:02:20,660 --> 00:02:19,470
magneto spirit physics but they should

67
00:02:22,220 --> 00:02:20,670
be just good enough close to close

68
00:02:24,009 --> 00:02:22,230
enough to a nice order of magnitude

69
00:02:26,179 --> 00:02:24,019
calculation for the aural emission

70
00:02:28,789 --> 00:02:26,189
and so you can think of the

71
00:02:30,649 --> 00:02:28,799
magnetosphere as basically an obstacle

72
00:02:33,319 --> 00:02:30,659
and the fluid flow of the stellar winds

73
00:02:35,149 --> 00:02:33,329
it has some cross-sectional area that is

74
00:02:37,759 --> 00:02:35,159
upon which the stellar wind will impact

75
00:02:39,050 --> 00:02:37,769
and dump energy and so the stellar wind

76
00:02:40,720 --> 00:02:39,060
has some kinetic energy and so therefore

77
00:02:43,339 --> 00:02:40,730
you can calculate simply the power

78
00:02:45,500 --> 00:02:43,349
dumped onto the surface of the

79
00:02:47,059 --> 00:02:45,510
magnetosphere however only a fraction of

80
00:02:49,520 --> 00:02:47,069
that power is then transformed into

81
00:02:51,199 --> 00:02:49,530
electromagnetic auroral emission which

82
00:02:54,860 --> 00:02:51,209
you can see here for Earth it happens to

83
00:02:56,690 --> 00:02:54,870
be by 1% efficiency on average and only

84
00:02:58,399 --> 00:02:56,700
about 2% of that is the five five seven

85
00:02:59,720 --> 00:02:58,409
seven green line and actually that's a

86
00:03:01,729 --> 00:02:59,730
pretty big percentage for a single line

87
00:03:03,920 --> 00:03:01,739
but only got two percent so this is a

88
00:03:06,619 --> 00:03:03,930

very simple kinetic forcing model which

89
00:03:10,099 --> 00:03:06,629
we can use and this gives us a value of

90
00:03:11,659 --> 00:03:10,109
approximately 40 to 50 gigawatts for the

91
00:03:13,520 --> 00:03:11,669
output of just this five five seven

92
00:03:16,220 --> 00:03:13,530
seven green line which is about seventy

93
00:03:18,439 --> 00:03:16,230
to eighty times that of Earth okay so

94
00:03:20,089 --> 00:03:18,449
fairly bright on the second method I

95
00:03:21,949 --> 00:03:20,099
mentioned is wing at all 2014 this

96
00:03:25,670 --> 00:03:21,959
horribly ugly non-linear equation here

97
00:03:28,550 --> 00:03:25,680
they used a 3d global MHD model to fit

98
00:03:29,990 --> 00:03:28,560
the magnetopause surface and across a

99
00:03:32,119 --> 00:03:30,000
wide range of stellar wind parameters

100
00:03:33,399 --> 00:03:32,129
and then fitted or excuse me an invalid

101
00:03:36,920 --> 00:03:33,409
ated against satellite data

102
00:03:38,030 --> 00:03:36,930
magnetospheric satellite data to get an

103
00:03:40,309 --> 00:03:38,040
empirical fit to make sure that is

104
00:03:43,189 --> 00:03:40,319
empirically correct and you can see that

105
00:03:44,509 --> 00:03:43,199
it has the kinetic portion can

106
00:03:46,309 --> 00:03:44,519
contribute by the stellar wind but it

107
00:03:49,129 --> 00:03:46,319
also importantly includes the magnetic a

108
00:03:51,999 --> 00:03:49,139
flower power that you're connecting on

109
00:03:54,020 --> 00:03:52,009
to the magnetosphere both includes the

110
00:03:55,309 --> 00:03:54,030
magnitude and the orientation of the

111
00:03:57,110 --> 00:03:55,319
field which are important because you

112
00:03:58,520 --> 00:03:57,120
must take into account the pointing flux

113
00:03:59,719 --> 00:03:58,530

entering my needle sphere as well as the

114
00:04:01,520 --> 00:03:59,729
orientation of a field which can drive

115
00:04:03,770 --> 00:04:01,530
energetic reconnection events both of

116
00:04:06,349 --> 00:04:03,780
which can affect energization particles

117
00:04:09,050 --> 00:04:06,359
and overall precipitation so we followed

118
00:04:11,089 --> 00:04:09,060
their lead and found a few empirical

119
00:04:12,949 --> 00:04:11,099
measurements of say electron populations

120
00:04:15,319 --> 00:04:12,959
and how they relate to the brightness of

121
00:04:17,089 --> 00:04:15,329
the 577 green line and tried to

122
00:04:19,580 --> 00:04:17,099
determine as close to data as possible

123
00:04:22,670 --> 00:04:19,590
what we would actually see and this is

124
00:04:24,800 --> 00:04:22,680
what we find so for the quiet version

125
00:04:26,959 --> 00:04:24,810
meaning we have no stellar activity and

126
00:04:28,459 --> 00:04:26,969
no geomagnetic activity occurring it

127
00:04:32,029 --> 00:04:28,469
matches pretty well with just a simple

128
00:04:35,510 --> 00:04:32,039
kinetic model including geomagnetic sub

129
00:04:37,150 --> 00:04:35,520
storm activity which we use we use a

130
00:04:38,320 --> 00:04:37,160
proxy basically within

131
00:04:40,030 --> 00:04:38,330
assume very strong reconnection at the

132
00:04:41,680 --> 00:04:40,040
Magneto's claws and reality the

133
00:04:42,790 --> 00:04:41,690
geomagnetic storms have stronger

134
00:04:43,900 --> 00:04:42,800
connections with magneto caused by

135
00:04:45,130 --> 00:04:43,910
driver strong marine current which

136
00:04:46,840 --> 00:04:45,140
effectively weakens the magnetic field

137
00:04:50,280 --> 00:04:46,850
of the planet and can affect their world

138
00:04:53,050 --> 00:04:50,290

activity but you see here we jump up to

139
00:04:56,200 --> 00:04:53,060
140 to 240 gigawatts or so for the Green

140
00:04:57,780 --> 00:04:56,210
Line including the effects of stellar

141
00:04:59,770 --> 00:04:57,790
activity this is a coronal mass ejection

142
00:05:02,230 --> 00:04:59,780
so you know order magnitude greater

143
00:05:03,550 --> 00:05:02,240
density and magnetic flux and a factor

144
00:05:05,260 --> 00:05:03,560
of two or three higher speed and this

145
00:05:07,510 --> 00:05:05,270
ejection of energetic particles out from

146
00:05:09,460 --> 00:05:07,520
the star we jump up to four to eight

147
00:05:11,110 --> 00:05:09,470
terawatts and then if you assume that

148
00:05:12,640 --> 00:05:11,120
this one of these coronal mass ejections

149
00:05:14,320 --> 00:05:12,650
actually drive sub storm activity on the

150
00:05:14,830 --> 00:05:14,330
planet we jump up in the tens of

151
00:05:16,870 --> 00:05:14,840
terawatts

152
00:05:19,120 --> 00:05:16,880
okay so again missing a lot of physics

153
00:05:21,580 --> 00:05:19,130
but decent order of magnitude estimation

154
00:05:22,960 --> 00:05:21,590
and so this ends up being on the order

155
00:05:26,730 --> 00:05:22,970
of tens of thousands of times Earth's

156
00:05:29,110 --> 00:05:26,740
nominal five five seven seven emission

157
00:05:31,450 --> 00:05:29,120
for low to moderate geomagnetic

158
00:05:33,220 --> 00:05:31,460
geomagnetic activity so it looks pretty

159
00:05:35,110 --> 00:05:33,230
good it looks fairly promising I mean

160
00:05:39,010 --> 00:05:35,120
relatively anyway but let's actually

161
00:05:40,330 --> 00:05:39,020
talk about the technical team so this is

162
00:05:42,340 --> 00:05:40,340
the line here on the right this is a

163
00:05:43,810 --> 00:05:42,350

nice high-resolution spectrum we

164
00:05:46,210 --> 00:05:43,820
produced for Proxima Centauri B as

165
00:05:48,880 --> 00:05:46,220
viewed from quadrature you can see the

166
00:05:50,440 --> 00:05:48,890
green line here that we injected it's a

167
00:05:52,420 --> 00:05:50,450
point one terawatt so at the lower end

168
00:05:55,000 --> 00:05:52,430
of our estimations that I just showed

169
00:05:56,409 --> 00:05:55,010
you it has pretty high flux density so

170
00:05:59,230 --> 00:05:56,419
that looks promising however it's an

171
00:06:01,150 --> 00:05:59,240
extremely narrow line and so your active

172
00:06:03,730 --> 00:06:01,160
width is around a third of an angstrom

173
00:06:05,860 --> 00:06:03,740
or so and so you're going to be very

174
00:06:08,920 --> 00:06:05,870
high resolving power to be able to see

175
00:06:12,280 --> 00:06:08,930
any of these very narrow very intense

176
00:06:13,330 --> 00:06:12,290
lines and my understanding is for a lot

177
00:06:16,450 --> 00:06:13,340
of these future missions we discussed

178
00:06:18,640 --> 00:06:16,460
this week we're discussing them in terms

179
00:06:21,640 --> 00:06:18,650
of our value about 100 resolving power

180
00:06:24,190 --> 00:06:21,650
100 which for our full width half max of

181
00:06:25,810 --> 00:06:24,200
this line we calculated means the

182
00:06:27,790 --> 00:06:25,820
spectral element width is about 1,000

183
00:06:28,720 --> 00:06:27,800
times the width of our line so we're not

184
00:06:30,040 --> 00:06:28,730
going to be able to see anything it just

185
00:06:31,510 --> 00:06:30,050
going to be smeared out and lost so we

186
00:06:33,070 --> 00:06:31,520
have to have high resolving power to

187
00:06:35,350 --> 00:06:33,080
view any of these these lines that are

188
00:06:36,340 --> 00:06:35,360

extremely narrow like this obviously so

189
00:06:38,560 --> 00:06:36,350
that means we want to have the best

190
00:06:40,030 --> 00:06:38,570
planet star contrast possible and so

191
00:06:41,940 --> 00:06:40,040
this is a plot of a planet star contrast

192
00:06:44,490 --> 00:06:41,950
in colors and contours

193
00:06:46,200 --> 00:06:44,500
with resolving power on the y-axis and

194
00:06:48,180 --> 00:06:46,210
mom scale and our calculated five five

195
00:06:51,600 --> 00:06:48,190
seven seven green overall power on the

196
00:06:53,460 --> 00:06:51,610
x-axis in log scale also the dashed

197
00:06:55,910 --> 00:06:53,470
lines represent the full width half

198
00:06:58,590 --> 00:06:55,920
maximum selling power in orange and the

199
00:07:01,470 --> 00:06:58,600
equivalent whip resolving power and the

200
00:07:03,630 --> 00:07:01,480
diagonal as it is a function of the

201
00:07:05,250 --> 00:07:03,640
power of emission and so basically you

202
00:07:06,600 --> 00:07:05,260
want to have your observation be inside

203
00:07:08,820 --> 00:07:06,610
this wedge and with the best climate

204
00:07:10,470 --> 00:07:08,830
stark contrast possible harpes for

205
00:07:11,940 --> 00:07:10,480
instance has a resulting power of one

206
00:07:15,750 --> 00:07:11,950
hundred and fifteen thousand so that's

207
00:07:17,070 --> 00:07:15,760
that's our nominal idea that we need to

208
00:07:19,710 --> 00:07:17,080
know somewhere in the order of 10 to the

209
00:07:20,910 --> 00:07:19,720
4 is 10 to the 5 resolving power and if

210
00:07:22,560 --> 00:07:20,920
you look at the powers that we I just

211
00:07:25,920 --> 00:07:22,570
told you on the estimates of our signal

212
00:07:27,720 --> 00:07:25,930
we see that we obtain a star planet

213
00:07:30,000 --> 00:07:27,730

contrast or keeping planet star contrast

214
00:07:31,980 --> 00:07:30,010
of 8 times 10 to the 7 and 7 times 10 to

215
00:07:34,650 --> 00:07:31,990
the minus 5 for direct observation in

216
00:07:37,800 --> 00:07:34,660
the optical around for this emission of

217
00:07:40,440 --> 00:07:37,810
Proxima Centauri so I'm pretty good for

218
00:07:42,690 --> 00:07:40,450
direct observation looking for the

219
00:07:44,010 --> 00:07:42,700
submission but what does this say about

220
00:07:47,910 --> 00:07:44,020
the actual integration time you would

221
00:07:49,200 --> 00:07:47,920
need well so we calculated the

222
00:07:52,140 --> 00:07:49,210
integration time to reach a signal noise

223
00:07:53,670 --> 00:07:52,150
of 6 with an R value of 150 thousand in

224
00:07:55,140 --> 00:07:53,680
all cases so here in x-axis we're

225
00:07:57,330 --> 00:07:55,150
looking at integration time and hours

226
00:08:01,140 --> 00:07:57,340
log scale and we did this for harps have

227
00:08:03,180 --> 00:08:01,150
exlude war and a 30 meter telescope the

228
00:08:04,680 --> 00:08:03,190
green bar is one point our low end point

229
00:08:05,190 --> 00:08:04,690
one terawatts a yellow bar is 10

230
00:08:07,350 --> 00:08:05,200
terawatts

231
00:08:08,670 --> 00:08:07,360
and then highly unlikely which I mostly

232
00:08:12,120 --> 00:08:08,680
ignore the tails and terawatt emission

233
00:08:14,670 --> 00:08:12,130
in red and so you can see for harps we

234
00:08:16,770 --> 00:08:14,680
need somewhere between present-day

235
00:08:20,790 --> 00:08:16,780
hundred thousand to one billion hours of

236
00:08:23,610 --> 00:08:20,800
integration time highly unlikely say

237
00:08:24,960 --> 00:08:23,620
unlikely but for these future

238
00:08:26,340 --> 00:08:24,970

instruments you can see especially on

239
00:08:27,900 --> 00:08:26,350
the top end here for 10 terawatts we

240
00:08:30,000 --> 00:08:27,910
start getting down to the 10 hour one

241
00:08:31,590 --> 00:08:30,010
hour point three hours of integration

242
00:08:34,770 --> 00:08:31,600
time so this becomes highly probable and

243
00:08:36,270 --> 00:08:34,780
I will say that given the activity at

244
00:08:38,040 --> 00:08:36,280
high activity Proxima Centauri and

245
00:08:39,300 --> 00:08:38,050
assuming of course that you have a

246
00:08:41,969 --> 00:08:39,310
magnetic field which we've assumed in

247
00:08:43,950 --> 00:08:41,979
Earth's dipole our sized planet

248
00:08:46,710 --> 00:08:43,960
given exactly if you have a magnetic

249
00:08:48,180 --> 00:08:46,720
field you're likely to drive these logs

250
00:08:50,100 --> 00:08:48,190
team activity is going to likely drive

251
00:08:52,660 --> 00:08:50,110
sub storm activity on the planet there

252
00:08:54,820 --> 00:08:52,670
all these assumptions and

253
00:08:56,140 --> 00:08:54,830
you're going to have some signal that's

254
00:08:57,430 --> 00:08:56,150
between the two bounds that we got at

255
00:08:58,900 --> 00:08:57,440
this point one terawatt in 10 terawatts

256
00:09:00,850 --> 00:08:58,910
so the average flux that we'll see when

257
00:09:02,830 --> 00:09:00,860
we look to cross missing tardy if it has

258
00:09:04,080 --> 00:09:02,840
an atmosphere in a magnetic field it's

259
00:09:06,460 --> 00:09:04,090
going to be somewhere between these

260
00:09:07,750 --> 00:09:06,470
green and yellow lines and you look at

261
00:09:09,250 --> 00:09:07,760
these future missions and you absolutely

262
00:09:11,710 --> 00:09:09,260
see that within a few days these

263
00:09:13,840 --> 00:09:11,720

missions could your admissions and/or

264
00:09:15,990 --> 00:09:13,850
ground-based scope for the 30-meter I

265
00:09:18,850 --> 00:09:16,000
could actually pick out these signals

266
00:09:19,720 --> 00:09:18,860
within a reasonable time and so I should

267
00:09:21,280 --> 00:09:19,730
I should mention I shoulda mentioned

268
00:09:23,080 --> 00:09:21,290
this at the beginning leVoir we

269
00:09:24,610 --> 00:09:23,090
estimated this for a 16 years of war and

270
00:09:26,170 --> 00:09:24,620
this is the certainty of telescope with

271
00:09:30,070 --> 00:09:26,180
a coronagraph of design contrast 10 to

272
00:09:32,050 --> 00:09:30,080
the minus 7 ok so given what I just told

273
00:09:34,240 --> 00:09:32,060
you about harps we did look through the

274
00:09:37,390 --> 00:09:34,250
data and we need you know at least a

275
00:09:40,300 --> 00:09:37,400
hundred thousand hours but we have 70 so

276
00:09:42,400 --> 00:09:40,310
let's see what we can actually find so

277
00:09:44,500 --> 00:09:42,410
to the pipeline that we followed for

278
00:09:47,140 --> 00:09:44,510
time purposes I'm not going to go into

279
00:09:49,270 --> 00:09:47,150
it too much but basically remove the

280
00:09:51,250 --> 00:09:49,280
stellar signal we docile ship into the

281
00:09:52,960 --> 00:09:51,260
proximities rest frame and then want to

282
00:09:56,110 --> 00:09:52,970
stack all of this flux and book for our

283
00:09:57,430 --> 00:09:56,120
5 5 7 7 but it's a radial velocity

284
00:09:58,660 --> 00:09:57,440
measurement so we have to be careful

285
00:10:01,030 --> 00:09:58,670
about looking through the Earth's

286
00:10:04,450 --> 00:10:01,040
atmosphere where we have 5 5 7 7 airglow

287
00:10:05,920 --> 00:10:04,460
and or and the fact that we're looking

288
00:10:07,750 --> 00:10:05,930

to Proxima Centauri which relatively

289
00:10:08,920 --> 00:10:07,760
orbits rapidly and therefore the Rd

290
00:10:11,290 --> 00:10:08,930
signal will be passing through what

291
00:10:14,290 --> 00:10:11,300
we're seeing in overlapping from the

292
00:10:15,850 --> 00:10:14,300
earth so anytime anyone overlaps occurs

293
00:10:17,620 --> 00:10:15,860
either you know from earth signal with

294
00:10:19,690 --> 00:10:17,630
the planet or Proxima Centauri or signal

295
00:10:20,740 --> 00:10:19,700
with the planet we removed that data and

296
00:10:22,750 --> 00:10:20,750
don't consider it to make sure we're not

297
00:10:24,520 --> 00:10:22,760
contaminating and then we use a filter

298
00:10:27,190 --> 00:10:24,530
to get rid of the noise and stack around

299
00:10:31,750 --> 00:10:27,200
the second two bins around the line of

300
00:10:33,550 --> 00:10:31,760
interest so here's a strongest signal we

301
00:10:36,160 --> 00:10:33,560
performing a grid search because we had

302
00:10:37,390 --> 00:10:36,170
to constrain some orbit parameters of

303
00:10:38,860 --> 00:10:37,400
the Rd measurement because the

304
00:10:41,560 --> 00:10:38,870
inclination is absolutely unknown due to

305
00:10:42,820 --> 00:10:41,570
the method used so but our strongest

306
00:10:44,860 --> 00:10:42,830
signal came out with an inclination of

307
00:10:47,410 --> 00:10:44,870
52 degrees this period in the mean

308
00:10:49,420 --> 00:10:47,420
longitude and you can see that here this

309
00:10:51,490 --> 00:10:49,430
is in the rest frame of Proxima Centauri

310
00:10:53,470 --> 00:10:51,500
B this is the blue window you see the

311
00:10:56,350 --> 00:10:53,480
center here centered on our line of

312
00:10:58,660 --> 00:10:56,360
interest and you can see that the earth

313
00:11:00,550 --> 00:10:58,670

lines and then the tiller Cline's from

314
00:11:03,580 --> 00:11:00,560
Earth in green and the lines from the

315
00:11:04,900 --> 00:11:03,590
host star in red and again because we're

316
00:11:05,790 --> 00:11:04,910
now in the rest frame Proxima Centauri B

317
00:11:10,530 --> 00:11:05,800
we see

318
00:11:12,600 --> 00:11:10,540
the nice Doppler shift of Earth and the

319
00:11:14,429 --> 00:11:12,610
star from that point of view so since we

320
00:11:16,919 --> 00:11:14,439
have all of our flux stacked up we can

321
00:11:19,470 --> 00:11:16,929
just are in the flux alone nicely lined

322
00:11:20,429 --> 00:11:19,480
up here for the planet we can just add

323
00:11:22,679 --> 00:11:20,439
all the flux together and look for our

324
00:11:26,340 --> 00:11:22,689
signal we do this and this is what we

325
00:11:28,979 --> 00:11:26,350
see here is the signal it's there's a

326
00:11:29,970 --> 00:11:28,989
bump there yes unfortunately it's in the

327
00:11:31,530 --> 00:11:29,980
middle of bunch of noise and

328
00:11:32,999 --> 00:11:31,540
inconsistent with rest of the noise and

329
00:11:36,479 --> 00:11:33,009
when you've been at the same thing

330
00:11:37,859 --> 00:11:36,489
happens so and in fact it is consistent

331
00:11:40,499 --> 00:11:37,869
with noise what we do is we take we did

332
00:11:43,410 --> 00:11:40,509
then saw this and took a window of 200

333
00:11:45,629 --> 00:11:43,420
angstroms around the other side of the

334
00:11:47,189 --> 00:11:45,639
line of interest and ran this exact this

335
00:11:48,600 --> 00:11:47,199
exact same pipeline the exact same grid

336
00:11:50,160 --> 00:11:48,610
search found the strongest signal for

337
00:11:52,109 --> 00:11:50,170
each wavelength in a 200 angstrom window

338
00:11:54,470 --> 00:11:52,119

and we see this so it's consistent with

339
00:11:57,389 --> 00:11:54,480
correlated stellar noise unfortunately

340
00:11:59,999 --> 00:11:57,399
and we don't expect any emission from

341
00:12:04,559 --> 00:12:00,009
the planet on either side of the 577

342
00:12:05,999 --> 00:12:04,569
line so yeah there's a lot of this going

343
00:12:07,109 --> 00:12:06,009
on so we failed to move all the noise

344
00:12:08,340 --> 00:12:07,119
and that's going to be a limiting

345
00:12:10,019 --> 00:12:08,350
factors or they're seeing these lines at

346
00:12:11,999 --> 00:12:10,029
this point I think at least with the

347
00:12:15,210 --> 00:12:12,009
harps data so the significance is point

348
00:12:18,030 --> 00:12:15,220
7 sigma 20% false alarm probability so

349
00:12:19,470 --> 00:12:18,040
we will actually say that absolutely not

350
00:12:24,600 --> 00:12:19,480
detection because we don't have the

351
00:12:25,739 --> 00:12:24,610
requisite 1 billion hours of data ok but

352
00:12:27,809 --> 00:12:25,749
all is not lost as I mentioned these

353
00:12:29,009 --> 00:12:27,819
future missions have a do enough of a

354
00:12:30,840 --> 00:12:29,019
light bucket that they can collect the

355
00:12:32,160 --> 00:12:30,850
signal and but we need a high resolution

356
00:12:34,439 --> 00:12:32,170
spectrograph to take these signals out

357
00:12:35,879 --> 00:12:34,449
and so that's part of the hope that

358
00:12:37,049 --> 00:12:35,889
we'll see that in the future that these

359
00:12:39,359 --> 00:12:37,059
you know 10 to the 4 to the 5

360
00:12:40,889 --> 00:12:39,369
spectrograph will be included we did

361
00:12:42,749 --> 00:12:40,899
actually elevation we did actually also

362
00:12:44,669 --> 00:12:42,759
ran a search for the strong 3917

363
00:12:46,919 --> 00:12:44,679

nitrogen line and the 6300 oxygen line

364
00:12:48,659 --> 00:12:46,929
but also it's all nothing

365
00:12:51,960 --> 00:12:48,669
so I told you about our signal strength

366
00:12:53,579 --> 00:12:51,970
which is many times that of Earth I told

367
00:12:55,470 --> 00:12:53,589
you about our expected detect ability

368
00:12:57,989 --> 00:12:55,480
and making all these assumptions it

369
00:12:59,340 --> 00:12:57,999
requires really high resolving power and

370
00:13:00,809 --> 00:12:59,350
a large aperture we didn't have that

371
00:13:02,369 --> 00:13:00,819
large aperture unfortunately so we

372
00:13:03,689 --> 00:13:02,379
didn't see anything in the data but we

373
00:13:04,829 --> 00:13:03,699
think the future missions it's it's

374
00:13:06,210 --> 00:13:04,839
likely that we can get some sort of

375
00:13:08,340 --> 00:13:06,220
exciting observation like this and

376
00:13:09,569 --> 00:13:08,350
constrain the atmosphere directly if we

377
00:13:13,919 --> 00:13:09,579
can get all of the technology in place

378
00:13:15,359 --> 00:13:13,929
so thanks to my co-authors and BPL and

379
00:13:20,790 --> 00:13:15,369
thanks to all of you for your attention

380
00:13:25,410 --> 00:13:22,970
[Music]

381
00:13:28,800 --> 00:13:25,420
we have a few minutes for quick

382
00:13:30,300 --> 00:13:28,810
questions hi this is a great effort as I

383
00:13:31,800 --> 00:13:30,310
was wondering if you stack all the lines

384
00:13:33,180 --> 00:13:31,810
together to have in your spectrum is

385
00:13:34,350 --> 00:13:33,190
that a way to sort of decrease the

386
00:13:35,840 --> 00:13:34,360
amount of observing time you need to

387
00:13:38,700 --> 00:13:35,850
detect any emission at all

388
00:13:39,330 --> 00:13:38,710

I'm sorry so if you stack multiple lines

389
00:13:41,670 --> 00:13:39,340
together

390
00:13:44,190 --> 00:13:41,680
I said away sort of to decrease your

391
00:13:45,030 --> 00:13:44,200
observing time you would need I'm not an

392
00:13:47,160 --> 00:13:45,040
observer so that's a really good

393
00:13:48,600 --> 00:13:47,170
question I would refer you to when I co

394
00:13:52,320 --> 00:13:48,610
others and maybe Rodrigo can answer that

395
00:13:53,910 --> 00:13:52,330
now do you mean lines of different

396
00:13:56,130 --> 00:13:53,920
elements or different lines of oxygen

397
00:13:58,020 --> 00:13:56,140
absolutely right but you want to make

398
00:13:59,640 --> 00:13:58,030
sure that you're stacking lines that

399
00:14:01,080 --> 00:13:59,650
exist and so like if you were to stack

400
00:14:03,270 --> 00:14:01,090
the oxygen and the nitrogen line the

401
00:14:04,920 --> 00:14:03,280
nitrogen line doesn't exist you'll get a

402
00:14:07,260 --> 00:14:04,930
lower signal because you're stacking

403
00:14:09,630 --> 00:14:07,270
signal with noise but you've definitely

404
00:14:11,580 --> 00:14:09,640
do a search that way where you you

405
00:14:13,020 --> 00:14:11,590
obviously oxygen has tons of lines of

406
00:14:14,250 --> 00:14:13,030
need for red as well and we could stack

407
00:14:15,660 --> 00:14:14,260
all of those and do some kind of grid

408
00:14:20,180 --> 00:14:15,670
search it would definitely increase your

409
00:14:27,000 --> 00:14:23,040
what is the upper limit correspond to in

410
00:14:28,440 --> 00:14:27,010
terms of terawatts welcome sorry you are

411
00:14:30,210 --> 00:14:28,450
giving the detectability you are

412
00:14:32,160 --> 00:14:30,220
measuring the line strength in terms of

413
00:14:34,260 --> 00:14:32,170

terawatts yes and then you presented an

414
00:14:36,360 --> 00:14:34,270
upper limit in terms of Sigma's what

415
00:14:42,300 --> 00:14:36,370
does that correspond to it in terawatts

416
00:14:44,160 --> 00:14:42,310
oh so I believe so mmm the point seven

417
00:14:46,950 --> 00:14:44,170
think I'm not really sure but we did run

418
00:14:48,060 --> 00:14:46,960
an upper bound of eight segment

419
00:14:49,350 --> 00:14:48,070
detection and I've ended up being

420
00:14:51,270 --> 00:14:49,360
something on the border freed alcantara

421
00:14:53,970 --> 00:14:51,280
watts or so but but the point seven is

422
00:14:55,320 --> 00:14:53,980
no it's something ridiculous that okay

423
00:14:59,490 --> 00:14:55,330
it's in the paper kendra has a spare

424
00:15:00,480 --> 00:14:59,500
let's go let's thank Matt again