
AbSciCon
2017
MESA, ARIZONA

1
00:00:00,220 --> 00:00:12,289
[Music]

2
00:00:15,949 --> 00:00:13,640
I'm gonna make a little bit more nesting

3
00:00:18,019 --> 00:00:15,959
than that and talk about travel on which

4
00:00:20,960 --> 00:00:18,029
we found out about right after we

5
00:00:22,909 --> 00:00:20,970
submitted abstracts so this goes right

6
00:00:25,159 --> 00:00:22,919
in with Robbie and spoiler alert I agree

7
00:00:27,319 --> 00:00:25,169
totally with what Robbie just said one

8
00:00:28,880 --> 00:00:27,329
he is the only planet I find that can be

9
00:00:41,389 --> 00:00:28,890
really earth-like so that's great to

10
00:00:42,860 --> 00:00:41,399
agree so fortunately I can just skip all

11
00:00:44,660 --> 00:00:42,870
the habitable zone stuff Jacob and

12
00:00:48,740 --> 00:00:44,670
Robbie gave excellent introductions to

13
00:00:54,979 --> 00:00:48,750

this it's not going to work go go

14
00:00:56,090 --> 00:00:54,989
forward okay oops too far No all right

15
00:00:57,319 --> 00:00:56,100
and I'm going to jump right into what

16
00:00:59,330 --> 00:00:57,329
I'm going to be talking about which is

17
00:01:01,190 --> 00:00:59,340
different climatic states you can have

18
00:01:04,219 --> 00:01:01,200
for these variety of different amador of

19
00:01:06,230 --> 00:01:04,229
terrestrial planets kind of giving a

20
00:01:08,410 --> 00:01:06,240
little teaser to a bunch of the work on

21
00:01:13,130 --> 00:01:08,420
proxy NV that'll be presented on Friday

22
00:01:14,510 --> 00:01:13,140
this plot shows a different variety of

23
00:01:16,669 --> 00:01:14,520
evolutionary States that could happen

24
00:01:18,949 --> 00:01:16,679
around an M dwarf because of its super

25
00:01:20,840 --> 00:01:18,959
luminous pre main sequence phase you can

26
00:01:23,090 --> 00:01:20,850
strip off a lot of water and end up with

27
00:01:24,499 --> 00:01:23,100
different combinations of of how much

28
00:01:27,260 --> 00:01:24,509
water and how much oxygen you have to

29
00:01:28,669 --> 00:01:27,270
the point where Rodrigo lugar and Barnes

30
00:01:30,319 --> 00:01:28,679
and some other papers showed that you

31
00:01:32,840 --> 00:01:30,329
could have you know hundreds even

32
00:01:34,429 --> 00:01:32,850
thousands of bars of oxygen abiotic we

33
00:01:36,440 --> 00:01:34,439
produced oxygen on an M dwarf

34
00:01:40,160 --> 00:01:36,450
terrestrial planet even in the habitable

35
00:01:43,489 --> 00:01:40,170
zones such as procs 10 B so that is kind

36
00:01:46,370 --> 00:01:43,499
of a downer but there's other potential

37
00:01:48,109 --> 00:01:46,380
States we could have as well and the

38
00:01:49,789 --> 00:01:48,119

work by Barnsdall that synergy right now

39
00:01:51,349 --> 00:01:49,799
showed a bunch of different evolutionary

40
00:01:53,719 --> 00:01:51,359
states and in the second paper by

41
00:01:55,309 --> 00:01:53,729
Meadows well we went through a bunch of

42
00:01:57,349 --> 00:01:55,319
these different planetary states that

43
00:01:59,719 --> 00:01:57,359
could exist around a habitable zone

44
00:02:02,419 --> 00:01:59,729
planet of M dwarf and just to go through

45
00:02:03,769 --> 00:02:02,429
some of these really quickly we believe

46
00:02:06,649 --> 00:02:03,779
we can find ways that you can have X of

47
00:02:08,330 --> 00:02:06,659
Earth maybe a little bit extra co2 to

48
00:02:10,040 --> 00:02:08,340
keep it warm enough you could have an

49
00:02:12,320 --> 00:02:10,050
early Earth type planet you could have a

50
00:02:16,370 --> 00:02:12,330
one of these abiotic oxygen planets that

51
00:02:17,809 --> 00:02:16,380
we found from the evolutionary work you

52
00:02:19,670 --> 00:02:17,819
could also have kind of these more

53
00:02:21,230 --> 00:02:19,680
evolved atmospheres just like the oxygen

54
00:02:24,140 --> 00:02:21,240
one if you did strip off the oxygen

55
00:02:25,400 --> 00:02:24,150
you could also out gas co2 as well just

56
00:02:26,960 --> 00:02:25,410
like with Venus

57
00:02:30,200 --> 00:02:26,970
and so you could end up with some kind

58
00:02:32,930 --> 00:02:30,210
of ExoMars like peter GAO did some work

59
00:02:34,760 --> 00:02:32,940
in 2015 showing that if you have a very

60
00:02:37,850 --> 00:02:34,770
very desiccated planet with less than 1

61
00:02:39,380 --> 00:02:37,860
ppm hydrogen you could have a planet

62
00:02:42,890 --> 00:02:39,390
that's in photochemical equilibrium

63
00:02:45,080 --> 00:02:42,900

between co2 co2 and some ozone and in

64
00:02:47,150 --> 00:02:45,090
this planet the recombination rate for

65
00:02:48,860 --> 00:02:47,160
co2 would just be so low that you could

66
00:02:50,720 --> 00:02:48,870
have again another ibotta coxa gen

67
00:02:52,460 --> 00:02:50,730
signature there's a couple others I

68
00:02:54,680 --> 00:02:52,470
think sandy Harmon had touched on in an

69
00:02:56,630 --> 00:02:54,690
earlier talk then you could also have

70
00:02:58,700 --> 00:02:56,640
perhaps a planet that out gas co2 but

71
00:02:59,990 --> 00:02:58,710
also still had oxygen and then you could

72
00:03:01,760 --> 00:03:00,000
even just have extra Venus where the

73
00:03:04,670 --> 00:03:01,770
oxygen got stripped off but it out gas

74
00:03:06,890 --> 00:03:04,680
co2 later and these just for Proximus NB

75
00:03:08,600 --> 00:03:06,900
and Viki will talk Vicky Meadows will

76
00:03:10,370 --> 00:03:08,610
talk a lot more about these on Friday

77
00:03:11,930 --> 00:03:10,380
but you can even get a planet in the

78
00:03:16,010 --> 00:03:11,940
middle of the habitable zone with Venus

79
00:03:18,530 --> 00:03:16,020
like temperatures so going forward to

80
00:03:20,600 --> 00:03:18,540
what I'll be doing with Trappist one is

81
00:03:23,090 --> 00:03:20,610
here's just a kind of a little diagram

82
00:03:26,690 --> 00:03:23,100
of the models i'm using i'm a new 1d

83
00:03:29,420 --> 00:03:26,700
rated convective model we call dis VPL

84
00:03:32,390 --> 00:03:29,430
climate and it does fantastic radiative

85
00:03:33,830 --> 00:03:32,400
transfer line-by-line multi-stream multi

86
00:03:36,050 --> 00:03:33,840
scattering everything convection and

87
00:03:40,190 --> 00:03:36,060
condensation we couple this with our

88
00:03:42,140 --> 00:03:40,200

photochemical model at MOS and it does

89
00:03:44,630 --> 00:03:42,150
all those stuff together and what we do

90
00:03:47,180 --> 00:03:44,640
is we iterate the temperature profiles

91
00:03:48,830 --> 00:03:47,190
with the condensed bowls and the

92
00:03:50,420 --> 00:03:48,840
photochemical species so the climate

93
00:03:52,490 --> 00:03:50,430
model we start with provides a

94
00:03:53,840 --> 00:03:52,500
temperature structure the mixing ratios

95
00:03:56,240 --> 00:03:53,850
we've assumed to begin with based on

96
00:03:58,910 --> 00:03:56,250
those earlier climatic States and then

97
00:04:00,710 --> 00:03:58,920
also the condensable profiles and that

98
00:04:02,420 --> 00:04:00,720
feeds into the photochemical model and

99
00:04:04,090 --> 00:04:02,430
then the photochemical model is iterated

100
00:04:06,350 --> 00:04:04,100
to equilibrium and then it can feed back

101
00:04:08,570 --> 00:04:06,360
the various constituents and how they've

102
00:04:10,280 --> 00:04:08,580
changed and so these are iterated

103
00:04:12,770 --> 00:04:10,290
separately and coupled until equilibrium

104
00:04:15,050 --> 00:04:12,780
until they're both in equilibrium and

105
00:04:17,240 --> 00:04:15,060
then at any given point and we have our

106
00:04:20,810 --> 00:04:17,250
you know converged state and at any

107
00:04:22,550 --> 00:04:20,820
given point we also can produce line by

108
00:04:24,770 --> 00:04:22,560
line transmission and direct imaging

109
00:04:26,150 --> 00:04:24,780
spectra which in this session we want to

110
00:04:29,050 --> 00:04:26,160
connect modeling with observations so

111
00:04:31,370 --> 00:04:29,060
that's SP is observable as the spectra

112
00:04:32,960 --> 00:04:31,380
we go forward there we go

113
00:04:34,820 --> 00:04:32,970

so talking just a little bit about how

114
00:04:37,280 --> 00:04:34,830
the model iterates and it's condensable

115
00:04:39,110 --> 00:04:37,290
here's just a snippet of runs these are

116
00:04:41,180 --> 00:04:39,120
nestled even the converse one

117
00:04:44,030 --> 00:04:41,190
but how we have a temperature profile on

118
00:04:45,980 --> 00:04:44,040
left of an EXO Venus such as Travis 1c

119
00:04:48,590 --> 00:04:45,990
potentially and then the condensable

120
00:04:50,930 --> 00:04:48,600
mixing ratios of the actual condensate

121
00:04:52,310 --> 00:04:50,940
on the right and you can see how as the

122
00:04:54,710 --> 00:04:52,320
model goes through several model runs

123
00:04:56,629 --> 00:04:54,720
and it goes you know the temperature

124
00:04:58,520 --> 00:04:56,639
profile varies until the dotted line was

125
00:05:00,230 --> 00:04:58,530
the last one the same thing here we see

126
00:05:01,700 --> 00:05:00,240
how the mixing ratio has changed

127
00:05:03,770 --> 00:05:01,710
throughout the climate run so we're

128
00:05:06,530 --> 00:05:03,780
calculating the condensed flows at every

129
00:05:08,330 --> 00:05:06,540
time step and then we can prescribe the

130
00:05:10,490 --> 00:05:08,340
aerosols based on how much condensate

131
00:05:14,050 --> 00:05:10,500
mass is left and then the radiative

132
00:05:17,270 --> 00:05:14,060
transfer routine can use those aerosols

133
00:05:19,219 --> 00:05:17,280
so going on to the results which is what

134
00:05:20,629 --> 00:05:19,229
I really want to talk about before I go

135
00:05:22,969 --> 00:05:20,639
to those slides I'm going to show a few

136
00:05:24,260 --> 00:05:22,979
transmission spectra while the baseline

137
00:05:25,760 --> 00:05:24,270
values are different because these

138
00:05:28,550 --> 00:05:25,770

planets I'm showing are different sizes

139
00:05:31,340 --> 00:05:28,560
around the same star they all have the

140
00:05:34,190 --> 00:05:31,350
same scaling of 200 ppm from from the

141
00:05:36,140 --> 00:05:34,200
y-axis and then I also show which is the

142
00:05:38,090 --> 00:05:36,150
exciting part I think for the public is

143
00:05:39,500 --> 00:05:38,100
what these planets would look like to

144
00:05:43,850 --> 00:05:39,510
the naked eye to the human eye

145
00:05:45,650 --> 00:05:43,860
observed from afar oh sorry

146
00:05:46,820 --> 00:05:45,660
those will actually be the transients

147
00:05:50,240 --> 00:05:46,830
vector I want to go through the climates

148
00:05:53,120 --> 00:05:50,250
first and so instead of doing all six of

149
00:05:55,430 --> 00:05:53,130
those from that we talked about with

150
00:05:55,760 --> 00:05:55,440
proxy and B with seven plans to choose

151
00:05:57,500 --> 00:05:55,770
from

152
00:05:59,840 --> 00:05:57,510
and all these different climates the

153
00:06:01,279 --> 00:05:59,850
model takes a long time only doing a few

154
00:06:03,590 --> 00:06:01,289
of the examples that are converged EXO

155
00:06:06,529 --> 00:06:03,600
Earth with extra co2 like we talked

156
00:06:09,020 --> 00:06:06,539
about and it's important to note too

157
00:06:10,909 --> 00:06:09,030
here you get a 200 fold increase in

158
00:06:14,300 --> 00:06:10,919
methane which I don't think is mentioned

159
00:06:16,430 --> 00:06:14,310
yet these M Dwarfs the photochemistry is

160
00:06:18,260 --> 00:06:16,440
very important and you end up with a lot

161
00:06:20,570 --> 00:06:18,270
more methane so that will be an

162
00:06:22,190 --> 00:06:20,580
observable feature we all see the EXO

163
00:06:23,659 --> 00:06:22,200

Venus with the sulfuric acid

164
00:06:26,420 --> 00:06:23,669
condensation and then the a about ik

165
00:06:28,129 --> 00:06:26,430
ocean planets or ocean lost planets that

166
00:06:31,850 --> 00:06:28,139
are completely desiccated at the EM so

167
00:06:34,700 --> 00:06:31,860
no water and you get interesting

168
00:06:36,320 --> 00:06:34,710
temperatures there we go again we have

169
00:06:38,830 --> 00:06:36,330
the one he like I agreed with with Ravi

170
00:06:40,879 --> 00:06:38,840
said about Eric Wolf's work I also had

171
00:06:43,790 --> 00:06:40,889
struggle trying to make these warm

172
00:06:45,770 --> 00:06:43,800
enough they would freeze over I didn't

173
00:06:47,960 --> 00:06:45,780
try the maximum greenhouse type thing

174
00:06:49,820 --> 00:06:47,970
yet with those but even once I got up to

175
00:06:51,420 --> 00:06:49,830
a large fraction of you know less than 1

176
00:06:53,070 --> 00:06:51,430
bar of co2 they were still 4

177
00:06:55,980 --> 00:06:53,080
one over and then these went in to run

178
00:06:58,140 --> 00:06:55,990
away X 11 s these are hard they're still

179
00:07:00,270 --> 00:06:58,150
running but you get very hot you can

180
00:07:02,400 --> 00:07:00,280
very hot temperatures this is even a

181
00:07:03,810 --> 00:07:02,410
clear sky Venus and some preliminary

182
00:07:05,520 --> 00:07:03,820
work we've done has shown that so Furyk

183
00:07:07,410 --> 00:07:05,530
acid may not even form as much around

184
00:07:08,790 --> 00:07:07,420
these stars so you may end up with a

185
00:07:11,070 --> 00:07:08,800
clear sky Venus that doesn't even have

186
00:07:13,710 --> 00:07:11,080
sulfuric acid clouds but for this case

187
00:07:15,240 --> 00:07:13,720
with 4 ppm this one does then of course

188
00:07:18,030 --> 00:07:15,250

a about a coxton planet without water

189
00:07:20,100 --> 00:07:18,040
actually is much cooler so you can get

190
00:07:24,710 --> 00:07:20,110
you know so-called habitable temperature

191
00:07:31,140 --> 00:07:26,910
already gave the caveat about this again

192
00:07:34,260 --> 00:07:31,150
you get eye color and the plot here so

193
00:07:36,150 --> 00:07:34,270
this beautiful pale orange dot would be

194
00:07:38,340 --> 00:07:36,160
an extrovert so it's not even not a pale

195
00:07:40,980 --> 00:07:38,350
blue playdoh blue dot like our earth and

196
00:07:43,080 --> 00:07:40,990
it's not a pale lavender dot like we

197
00:07:44,940 --> 00:07:43,090
found for Proxima and B which would kind

198
00:07:46,680 --> 00:07:44,950
of be like this color it's still just

199
00:07:48,960 --> 00:07:46,690
reflecting the color of the star which

200
00:07:50,520 --> 00:07:48,970
is roughly this color the important

201
00:07:54,180 --> 00:07:50,530
thing here is you get these pretty

202
00:07:55,950 --> 00:07:54,190
decent ozone features right here you get

203
00:07:57,450 --> 00:07:55,960
whopping co2 feature which is going to

204
00:07:59,910 --> 00:07:57,460
be a feature pretty much any outcast

205
00:08:01,710 --> 00:07:59,920
planet co2 gives us that nice band there

206
00:08:03,120 --> 00:08:01,720
and a bunch of methane and co2 and water

207
00:08:06,300 --> 00:08:03,130
features are interspersed through here

208
00:08:08,250 --> 00:08:06,310
and from the 0.1 percent methane that

209
00:08:09,630 --> 00:08:08,260
you get it's actually you get

210
00:08:11,940 --> 00:08:09,640
substantial methane features and if you

211
00:08:14,370 --> 00:08:11,950
look at the differences here you get

212
00:08:17,310 --> 00:08:14,380
easily 50 ppm features across the board

213
00:08:19,130 --> 00:08:17,320

here and almost 100 ppm for co2 so this

214
00:08:21,840 --> 00:08:19,140
is I would say definitely observable

215
00:08:25,920 --> 00:08:21,850
JWST and you even have other scientists

216
00:08:27,630 --> 00:08:25,930
I know there's a lot of you know cynical

217
00:08:28,950 --> 00:08:27,640
work about like oh it might just be 50

218
00:08:30,480 --> 00:08:28,960
ppm people like Drake Deming have

219
00:08:32,040 --> 00:08:30,490
suggested that you might get down to the

220
00:08:34,710 --> 00:08:32,050
note the photon noise floor of one to

221
00:08:36,600 --> 00:08:34,720
two ppm for JDBC which would be

222
00:08:39,270 --> 00:08:36,610
fantastic and then you would see all of

223
00:08:43,820 --> 00:08:39,280
this but even at 50 ppm if we want to be

224
00:08:46,950 --> 00:08:43,830
you know pessimistic you get co2 out

225
00:08:49,230 --> 00:08:46,960
moving on to the other ones EXO Venus

226
00:08:52,620 --> 00:08:49,240
this is like one sees this is very Venus

227
00:08:53,730 --> 00:08:52,630
like you can notice that like many of

228
00:08:56,610 --> 00:08:53,740
the transmission spectra that have been

229
00:08:58,320 --> 00:08:56,620
taken by HST for cloudy planets you get

230
00:08:59,820 --> 00:08:58,330
a flat and featureless spectrum in the

231
00:09:01,320 --> 00:08:59,830
visible and nothing important to see

232
00:09:03,300 --> 00:09:01,330
there other than the fact that you can

233
00:09:04,199 --> 00:09:03,310
see the transit height is so much higher

234
00:09:06,299 --> 00:09:04,209
in terms of the

235
00:09:07,739 --> 00:09:06,309
planetary structure you're only probing

236
00:09:09,449 --> 00:09:07,749
the very upper reaches of this

237
00:09:12,210 --> 00:09:09,459
atmosphere and we're not going to really

238
00:09:13,499 --> 00:09:12,220

know this part of that's not the

239
00:09:16,439 --> 00:09:13,509
observable right this is the modeler

240
00:09:20,369 --> 00:09:16,449
side and this is the observers like you

241
00:09:22,470 --> 00:09:20,379
still get over 50 ppm of signal for co2

242
00:09:26,819 --> 00:09:22,480
and these fantastic co2 bands and that's

243
00:09:29,759 --> 00:09:26,829
really all there is there except this

244
00:09:31,889 --> 00:09:29,769
v-shape that the job our knees pointed

245
00:09:33,210 --> 00:09:31,899
out to me about sulfuric acid which you

246
00:09:34,259 --> 00:09:33,220
say oh okay I don't know if there's

247
00:09:36,210 --> 00:09:34,269
really a v-shape right there that's

248
00:09:38,489 --> 00:09:36,220
what's really flat but when you zoom in

249
00:09:40,619 --> 00:09:38,499
on the data then you can see that there

250
00:09:43,590 --> 00:09:40,629
is an actual like 2 to 4 ppm v-shape

251
00:09:46,650 --> 00:09:43,600
centered at 2.7 microns and then in the

252
00:09:48,929 --> 00:09:46,660
near IR so if we get down to 1 to 2 ppm

253
00:09:50,910 --> 00:09:48,939
noise floor and jwc even this would be

254
00:09:54,090 --> 00:09:50,920
an observable feature for a Venus like

255
00:09:56,129 --> 00:09:54,100
planet which would be fantastic and then

256
00:09:58,470 --> 00:09:56,139
my last atmosphere I simulated here

257
00:10:00,059 --> 00:09:58,480
would be at the abiotic oxygen planet

258
00:10:01,739 --> 00:10:00,069
and I think we've had a lot of talks in

259
00:10:03,449 --> 00:10:01,749
the session about co2 earth-like planets

260
00:10:06,600 --> 00:10:03,459
and so I get to talk about one that's

261
00:10:08,129 --> 00:10:06,610
really very different this you see this

262
00:10:09,419 --> 00:10:08,139
beautiful color this I mean this is not

263
00:10:12,030 --> 00:10:09,429

just a pale blue dot this is like a

264
00:10:13,650 --> 00:10:12,040
brilliant blue dot significant ozone

265
00:10:17,160 --> 00:10:13,660
bands because this desiccated planet

266
00:10:20,669 --> 00:10:17,170
can't destroy those own you get even a

267
00:10:23,669 --> 00:10:20,679
hundred ppm features out of co2 ozone

268
00:10:26,309 --> 00:10:23,679
and even you get observable collisional

269
00:10:27,989 --> 00:10:26,319
induced absorption features of oxygen so

270
00:10:30,119 --> 00:10:27,999
these could be differentiated from each

271
00:10:32,789 --> 00:10:30,129
other by some of the various features

272
00:10:35,039 --> 00:10:32,799
having that strong ozone lack of water

273
00:10:40,949 --> 00:10:35,049
or lack of methane in a desiccated

274
00:10:42,720 --> 00:10:40,959
planet so in conclusion I've shown that

275
00:10:45,239 --> 00:10:42,730
these climates are really dependent on

276
00:10:46,769 --> 00:10:45,249
the evolution of the star the M dwarfs

277
00:10:49,530 --> 00:10:46,779
are very super luminous to remain

278
00:10:50,939 --> 00:10:49,540
sequence phase this can desiccate the

279
00:10:52,769 --> 00:10:50,949
planet it can strip off the atmosphere

280
00:10:54,900 --> 00:10:52,779
or it could leave the the atmosphere

281
00:10:56,639 --> 00:10:54,910
with with some amount of water depending

282
00:10:58,799 --> 00:10:56,649
on how much hydrogen the planet started

283
00:11:01,289 --> 00:10:58,809
with and how much water you can actually

284
00:11:03,629 --> 00:11:01,299
retain or the planet could out gas and

285
00:11:06,119 --> 00:11:03,639
so the composition of the planet then

286
00:11:07,980 --> 00:11:06,129
drives the climate and this ends up

287
00:11:09,629 --> 00:11:07,990
giving us what the state is for a given

288
00:11:11,789 --> 00:11:09,639

planets insulation it's not just its

289
00:11:13,379 --> 00:11:11,799
position in the habitable zone any given

290
00:11:15,889 --> 00:11:13,389
position may have a variety of different

291
00:11:19,199 --> 00:11:15,899
states depending on the

292
00:11:20,790 --> 00:11:19,209
and furthermore Trappist one will be a

293
00:11:22,769 --> 00:11:20,800
great example to provide us an

294
00:11:24,540 --> 00:11:22,779
opportunity to examine this evolutionary

295
00:11:25,620 --> 00:11:24,550
sequence with seven planets and I kind

296
00:11:27,269 --> 00:11:25,630
of skipped over that colors gets the

297
00:11:29,009 --> 00:11:27,279
abalone part but with these three

298
00:11:31,050 --> 00:11:29,019
planets in the habitable zone with two

299
00:11:33,090 --> 00:11:31,060
outside and the Venus area and then a

300
00:11:35,100 --> 00:11:33,100
couple that are really cold we can

301
00:11:36,960 --> 00:11:35,110
really with trap you know if we can

302
00:11:38,310 --> 00:11:36,970
observe the Trappist planets with jwc

303
00:11:40,290 --> 00:11:38,320
this could give us a whole number of

304
00:11:43,410 --> 00:11:40,300
examples of how this evolutionary

305
00:11:54,509 --> 00:11:43,420
sequence might occur just from looking

306
00:11:56,180 --> 00:11:54,519
at the one stellar target thank you good

307
00:11:59,310 --> 00:11:56,190
great talk

308
00:12:01,290 --> 00:11:59,320
so two questions one can you go back to

309
00:12:04,350 --> 00:12:01,300
your slide to where you showed the Venus

310
00:12:07,230 --> 00:12:04,360
spectrum I think it went a bit fast for

311
00:12:09,810 --> 00:12:07,240
me to see the transit death how much is

312
00:12:11,370 --> 00:12:09,820
how much you sell residue this total

313
00:12:14,400 --> 00:12:11,380

thing is 200 ppm right here so the

314
00:12:19,350 --> 00:12:14,410
differential is between you know 70 75

315
00:12:21,030 --> 00:12:19,360
and call it 70 10 so 65 ppm ish is over

316
00:12:23,040 --> 00:12:21,040
50 still for those and this you're only

317
00:12:25,769 --> 00:12:23,050
probing 90 kilometers which is the top

318
00:12:28,740 --> 00:12:25,779
of the cloud deck basically okay and

319
00:12:31,319 --> 00:12:28,750
that's 100 pascals there that's this is

320
00:12:36,680 --> 00:12:31,329
for the Venus analog that yeah okay yeah

321
00:12:42,750 --> 00:12:40,949
great talk um in terms of the actual you

322
00:12:44,220 --> 00:12:42,760
know noise floor or what you can

323
00:12:46,170 --> 00:12:44,230
actually observe with wavelengths that

324
00:12:48,660 --> 00:12:46,180
encourage you to actually go online and

325
00:12:50,579 --> 00:12:48,670
run some of these Sims them on you know

326
00:12:52,470 --> 00:12:50,589
connects or another JDBC calculation

327
00:12:54,870 --> 00:12:52,480
you'll find that the Miri instrument

328
00:12:57,449 --> 00:12:54,880
which is beyond five microns has broad

329
00:12:59,189 --> 00:12:57,459
bands but the not just the noise floor

330
00:13:00,689 --> 00:12:59,199
but the overall sensitivity and

331
00:13:03,660 --> 00:13:00,699
throughput of the instrument is much

332
00:13:08,160 --> 00:13:03,670
poorer than an infrared one so your co2

333
00:13:12,120 --> 00:13:08,170
then at 4.5 or 4.3 letters may be much

334
00:13:14,519 --> 00:13:12,130
better for co2 constraints or anything

335
00:13:15,780 --> 00:13:14,529
else so I would really focus on short

336
00:13:17,069 --> 00:13:15,790
words of 5 microns which there's a

337
00:13:20,610 --> 00:13:17,079
number of great bands and all of your

338
00:13:22,500 --> 00:13:20,620

models and Miri yes it appears from

339
00:13:24,489 --> 00:13:22,510
these plots as if it's the best but if

340
00:13:26,049 --> 00:13:24,499
you focus on short words and I

341
00:13:28,449 --> 00:13:26,059
you run some accusations you should be

342
00:13:30,369 --> 00:13:28,459
so my question to us on that is in the

343
00:13:32,289 --> 00:13:30,379
earth like one that could really hit

344
00:13:36,729 --> 00:13:32,299
home too far could really help because

345
00:13:38,739 --> 00:13:36,739
these are strong bands right here too we

346
00:13:40,479 --> 00:13:38,749
could have the methane so those could be

347
00:13:43,419 --> 00:13:40,489
really great yeah good to know thank you

348
00:13:45,119 --> 00:13:43,429
I might add to that that Jacob Lustig

349
00:13:47,799 --> 00:13:45,129
Jager is going to be talking about

350
00:13:50,529 --> 00:13:47,809
spectral mapping and whatnot and so that

351
00:13:52,749 --> 00:13:50,539
might be great to to consider other ways

352
00:13:54,459 --> 00:13:52,759
of observing a live inspector I just

353
00:13:56,649 --> 00:13:54,469
have a quick crawl up toward avi you are

354
00:14:02,049 --> 00:13:56,659
seeing with the broadness of the

355
00:14:05,169 --> 00:14:02,059
features help in the mihrab and to do if

356
00:14:06,669 --> 00:14:05,179
the the transit depth is below 50 ppm

357
00:14:08,259 --> 00:14:06,679
with the broadness of the features will

358
00:14:10,839 --> 00:14:08,269
have helped so far exactly because this

359
00:14:13,869 --> 00:14:10,849
is the co2 Bank it's so large that it

360
00:14:16,409 --> 00:14:13,879
you get a strong signal over a large

361
00:14:25,659 --> 00:14:16,419
wavelength range so even at Corey fans

362
00:14:30,519 --> 00:14:25,669
so actually yeah so like okay if you had

363
00:14:32,649 --> 00:14:30,529

a box here okay so I'm going to talk on

364
00:14:34,689 --> 00:14:32,659
Friday about actually using phase

365
00:14:36,429 --> 00:14:34,699
dependent thermal emission to go after

366
00:14:38,169 --> 00:14:36,439
things like co2 because it is so broad

367
00:14:39,429 --> 00:14:38,179
and we can use a merry bands for that so

368
00:14:42,549 --> 00:14:39,439
that's a different way of getting at

369
00:14:45,389 --> 00:14:42,559
this it's time for one quick questions

370
00:14:48,729 --> 00:14:45,399
in this is quick thanks for a great talk

371
00:14:50,259 --> 00:14:48,739
so given the uncertainty on the bulk

372
00:14:52,689 --> 00:14:50,269
densities of the planets from the

373
00:14:55,509 --> 00:14:52,699
transit time variations how sensitive

374
00:14:57,639 --> 00:14:55,519
the convergence of your models to those

375
00:15:00,029 --> 00:14:57,649
bulk densities and did you try a range

376
00:15:02,469 --> 00:15:00,039
within the uncertainties of of those

377
00:15:03,849 --> 00:15:02,479
I've not tried a range for each plan and

378
00:15:06,249 --> 00:15:03,859
I just essentially took the nominal

379
00:15:08,349 --> 00:15:06,259
value and there are they yeah he said

380
00:15:11,609 --> 00:15:08,359
the air bars are huge on the mass that

381
00:15:14,439 --> 00:15:11,619
definitely changes the scale heights and

382
00:15:16,449 --> 00:15:14,449
so that would that would certainly

383
00:15:18,759 --> 00:15:16,459
affect some of these results what I

384
00:15:20,199 --> 00:15:18,769
found is that using you know flying

385
00:15:23,529 --> 00:15:20,209
these same atmospheres to each planet

386
00:15:25,719 --> 00:15:23,539
the ones that can converge the the

387
00:15:27,219 --> 00:15:25,729
climate states are relatively robust

388
00:15:31,299 --> 00:15:27,229

amongst the different masses of the

389
00:15:33,309 --> 00:15:31,309
planets so you know doing like D and E

390
00:15:34,689 --> 00:15:33,319
and getting you know consistent

391
00:15:36,519 --> 00:15:34,699
temperatures given the fact that their

392
00:15:37,689 --> 00:15:36,529
insulation is lower for for a for

393
00:15:40,479 --> 00:15:37,699
example

394
00:15:43,460 --> 00:15:40,489
climate still show similar things okay