2017 Astrobiology Graduate Conference

Charlottesville, VA

1
00:00:00,790 --> 00:00:07,210
[Music]

2
00:00:11,690 --> 00:00:08,930
I'm SIA

3
00:00:13,640 --> 00:00:11,700
Kazak as' and I'm graduate student at

4
00:00:15,440 --> 00:00:13,650
Cornell University and part of the new

5
00:00:18,650 --> 00:00:15,450
Carl Sagan Institute it's very exciting

6
00:00:21,849 --> 00:00:18,660
we're going to talk about it more and oh

7
00:00:24,580 --> 00:00:21,859
I don't get a timer like everyone else

8
00:00:26,870 --> 00:00:24,590
okay cool

9
00:00:29,779 --> 00:00:26,880
so I'm going to be talking to you guys

10
00:00:32,060 --> 00:00:29,789
about UV environments of earth-like

11
00:00:34,520 --> 00:00:32,070
planets orbiting white dwarf

12
00:00:35,930 --> 00:00:34,530
so the warm-up talked was really good

13
00:00:37,400 --> 00:00:35,940

thank you for that I'm going to still

14
00:00:40,360 --> 00:00:37,410
review some of it in case you weren't

15
00:00:43,819 --> 00:00:40,370
listening or you know it's just fun

16
00:00:46,130 --> 00:00:43,829
alright so the main my main motivation

17
00:00:50,180 --> 00:00:46,140
and the main motivation of our group is

18
00:00:52,490 --> 00:00:50,190
to look for life in the universe and we

19
00:00:56,299 --> 00:00:52,500
have no idea what kinds of forms that

20
00:00:58,430 --> 00:00:56,309
life can take but we know that we're

21
00:01:01,040 --> 00:00:58,440
life so we're going to start with that

22
00:01:03,200 --> 00:01:01,050
and then maybe branch out from there so

23
00:01:05,690 --> 00:01:03,210
that means I care about habitable zones

24
00:01:07,310 --> 00:01:05,700
I care about where liquid water could be

25
00:01:10,039 --> 00:01:07,320
on the surface of a planet and I care

26
00:01:11,210 --> 00:01:10,049
about possible bio signatures and one of

27
00:01:13,460 --> 00:01:11,220
the big goals of the Carl Sagan

28
00:01:16,100 --> 00:01:13,470
Institute is to sort of build up this

29
00:01:18,410 --> 00:01:16,110
kind of spectral library for future

30
00:01:21,350 --> 00:01:18,420
reference so in the future when we can

31
00:01:23,660 --> 00:01:21,360
actually spectrally characterize

32
00:01:25,999 --> 00:01:23,670
exoplanet atmospheres maybe we'll know

33
00:01:29,840 --> 00:01:26,009
what a desert world would look like or a

34
00:01:36,020 --> 00:01:29,850
water world or an earth-like planet

35
00:01:38,450 --> 00:01:36,030
orbiting a white door what okay so is

36
00:01:41,149 --> 00:01:38,460
there a laser on this yes okay so this

37
00:01:42,170 --> 00:01:41,159
was covered briefly in the warm-up talk

38
00:01:45,050 --> 00:01:42,180

thank you for that

39
00:01:47,569 --> 00:01:45,060
so most of a star's life time is when

40
00:01:49,760 --> 00:01:47,579
it's on the main sequence simply put

41
00:01:52,819 --> 00:01:49,770
that's just when in the core of the star

42
00:01:54,980 --> 00:01:52,829
it's fusing hydrogen so we're right here

43
00:01:57,139 --> 00:01:54,990
most of the star's life time is the main

44
00:02:00,740 --> 00:01:57,149
sequence so the main sequence is what's

45
00:02:02,719 --> 00:02:00,750
mainly been studied and it's great my

46
00:02:05,359 --> 00:02:02,729
whole thesis is everything but the main

47
00:02:08,749 --> 00:02:05,369
sequence so I'm going to be looking at

48
00:02:09,830 --> 00:02:08,759
white dwarf tiny but Pierce it's very

49
00:02:12,930 --> 00:02:09,840
exciting

50
00:02:15,150 --> 00:02:12,940
so why do we care about planets around

51
00:02:16,800 --> 00:02:15,160
white dwarfs you might be thinking I've

52
00:02:18,300 --> 00:02:16,810
never heard of a plan around white door

53
00:02:21,600 --> 00:02:18,310
that's because none have been found yet

54
00:02:23,550 --> 00:02:21,610
but there's a lot of evidence for it

55
00:02:26,460 --> 00:02:23,560
which is why it's very exciting

56
00:02:29,880 --> 00:02:26,470
and so there is a disc picture in this

57
00:02:33,660 --> 00:02:29,890
talk too so the majority of white dwarfs

58
00:02:36,660 --> 00:02:33,670
show evidence of recent accretion of

59
00:02:38,430 --> 00:02:36,670
rocky bodies in their atmospheres which

60
00:02:40,620 --> 00:02:38,440
there have even been some papers that

61
00:02:42,090 --> 00:02:40,630
are able to reconstruct exactly what

62
00:02:44,700 --> 00:02:42,100
would have had to fall on the white

63
00:02:48,030 --> 00:02:44,710

dwarf to create that pollution so it

64
00:02:49,980 --> 00:02:48,040
looks like most white dwarfs have rocky

65
00:02:51,860 --> 00:02:49,990
bodies accreta on them so maybe not all

66
00:02:55,350 --> 00:02:51,870
of the planets fall in on them

67
00:02:56,970 --> 00:02:55,360
also it would be very or people believe

68
00:02:58,949 --> 00:02:56,980
it would be very easy to detect in a

69
00:03:01,710 --> 00:02:58,959
transit so like mentioned before a white

70
00:03:03,060 --> 00:03:01,720
door is about the size of Earth so we're

71
00:03:04,860 --> 00:03:03,070
using the transit method so we're

72
00:03:06,480 --> 00:03:04,870
looking at the white dwarf waiting for

73
00:03:08,040 --> 00:03:06,490
something to dim its brightness if Earth

74
00:03:09,930 --> 00:03:08,050
passes in front of it it's going to look

75
00:03:12,210 --> 00:03:09,940
like all of the light and that's a

76
00:03:14,430 --> 00:03:12,220
really strong signal so there's actually

77
00:03:16,920 --> 00:03:14,440
a bunch of studies going on looking for

78
00:03:20,400 --> 00:03:16,930
these white dwarf planets particular k2

79
00:03:24,120 --> 00:03:20,410
is really excited about it so what I

80
00:03:26,759 --> 00:03:24,130
care about though because I'm me is if

81
00:03:29,400 --> 00:03:26,769
these white dwarfs do have planets under

82
00:03:32,220 --> 00:03:29,410
the best conditions are they suitable

83
00:03:35,160 --> 00:03:32,230
host for life or will the UV just

84
00:03:40,110 --> 00:03:35,170
radiate them and if there is life there

85
00:03:41,940 --> 00:03:40,120
would we be able to detect it so the

86
00:03:44,430 --> 00:03:41,950
atmospheric composition of these planets

87
00:03:48,420 --> 00:03:44,440
and taking into account how they would

88
00:03:50,100 --> 00:03:48,430

interact with the UV profile of the

89
00:03:54,509 --> 00:03:50,110
white dwarf will help us answer these

90
00:03:56,970 --> 00:03:54,519
questions so as I'm sure a bunch of you

91
00:03:59,910 --> 00:03:56,980
know atmospheres of planets are affected

92
00:04:01,710 --> 00:03:59,920
by so many things so I'm going to pay

93
00:04:02,850 --> 00:04:01,720
attention to two of them this is what

94
00:04:05,430 --> 00:04:02,860
I'm going to pay attention to I'm going

95
00:04:07,890 --> 00:04:05,440
to look at the photochemistry which if

96
00:04:11,699 --> 00:04:07,900
you're a physicist like me and you that

97
00:04:13,140 --> 00:04:11,709
word scares you it's just UV photons

98
00:04:14,070 --> 00:04:13,150
they're really high-energy they're just

99
00:04:15,449 --> 00:04:14,080
going and they're breaking apart

100
00:04:18,000 --> 00:04:15,459
molecules and they're changing the

101
00:04:19,770 --> 00:04:18,010
chemistry of the atmosphere and then I

102
00:04:22,420 --> 00:04:19,780
care about three different types of UV

103
00:04:27,129 --> 00:04:22,430
which are pictured here so UVC

104
00:04:30,040 --> 00:04:27,139
Sandra's u-v-a is not so UVA is actually

105
00:04:33,159 --> 00:04:30,050
pretty useful it helped power complex

106
00:04:36,640 --> 00:04:33,169
processes UVB if you've ever had sunburn

107
00:04:39,520 --> 00:04:36,650
or a tan its EVPs fault it's partially

108
00:04:42,189 --> 00:04:39,530
shielded by ozone and then UVC is a lot

109
00:04:45,370 --> 00:04:42,199
worse than sunburn it destroys your DNA

110
00:04:47,170 --> 00:04:45,380
so that's what I care about the most

111
00:04:53,290 --> 00:04:47,180
here and it's almost completely shielded

112
00:04:55,240 --> 00:04:53,300
by Earth's ozone layer so for the sake

113
00:04:58,390 --> 00:04:55,250

of this short talk I'm going to mainly

114
00:05:00,070 --> 00:04:58,400
talk about this potential bio signature

115
00:05:01,150 --> 00:05:00,080
even though there are multiples and

116
00:05:04,180 --> 00:05:01,160
hopefully we'll hear more about them

117
00:05:06,040 --> 00:05:04,190
later originally people thought if we're

118
00:05:08,140 --> 00:05:06,050
looking for indications of life in the

119
00:05:10,510 --> 00:05:08,150
spectrum of an exoplanet atmosphere

120
00:05:12,670 --> 00:05:10,520
maybe we just have to look for oxygen

121
00:05:15,310 --> 00:05:12,680
you're like oxygen that's life but we

122
00:05:19,420 --> 00:05:15,320
later on realize that oxygen can be

123
00:05:22,629 --> 00:05:19,430
created by non-biological sources so we

124
00:05:25,080 --> 00:05:22,639
want to know if it's biological or just

125
00:05:29,529 --> 00:05:25,090
something else we care about the biology

126
00:05:31,659 --> 00:05:29,539
so we want to see basically oxygen with

127
00:05:33,279 --> 00:05:31,669
something that's destroying the oxygen

128
00:05:38,529 --> 00:05:33,289
so we know the oxygen is being

129
00:05:40,149 --> 00:05:38,539
continuously created by life so methane

130
00:05:42,820 --> 00:05:40,159
is the example I'm going to use here it

131
00:05:45,219 --> 00:05:42,830
is a reducing species it's created by

132
00:05:49,110 --> 00:05:45,229
termites natural gas all of these things

133
00:05:52,810 --> 00:05:49,120
that life does and the main chemical

134
00:05:55,120 --> 00:05:52,820
processes reactions of methane destroy

135
00:05:57,700 --> 00:05:55,130
oxygen say we see strong oxygen signal

136
00:06:00,850 --> 00:05:57,710
and on also methane we have a pretty

137
00:06:04,540 --> 00:06:00,860
good idea that the oxygen is being

138
00:06:05,680 --> 00:06:04,550

continuously produced some people argue

139
00:06:10,029 --> 00:06:05,690
with this you could come talk to me

140
00:06:12,310 --> 00:06:10,039
about it afterwards ok so really briefly

141
00:06:14,020 --> 00:06:12,320
just so that everyone knows what I'm

142
00:06:16,570 --> 00:06:14,030
going to be caring about in this talk I

143
00:06:17,830 --> 00:06:16,580
care a lot about the ozone layer because

144
00:06:19,899 --> 00:06:17,840
like I said before that's going to

145
00:06:22,870 --> 00:06:19,909
shield the UV and protect surface life

146
00:06:25,330 --> 00:06:22,880
so the ozone is created by shorter

147
00:06:27,670 --> 00:06:25,340
wavelengths in the UV so we care about

148
00:06:31,779 --> 00:06:27,680
that because of UV shielding and also

149
00:06:35,080 --> 00:06:31,789
important is that ozone fatalis also

150
00:06:35,950 --> 00:06:35,090
creates hydroxyl Oh H and we care about

151
00:06:37,870 --> 00:06:35,960
that because

152
00:06:40,059 --> 00:06:37,880
called the detergent of the atmosphere

153
00:06:41,800 --> 00:06:40,069
which basically means it reacts with a

154
00:06:44,050 --> 00:06:41,810
bunch of other species that we care

155
00:06:47,260 --> 00:06:44,060
about and it depletes them so it does

156
00:06:48,580 --> 00:06:47,270
fundamentally change the atmosphere like

157
00:06:50,710 --> 00:06:48,590
I mentioned before I'm going to talk

158
00:06:52,180 --> 00:06:50,720
mainly about methane if you want to hear

159
00:06:53,800 --> 00:06:52,190
about all the other species that I care

160
00:06:56,920 --> 00:06:53,810
about you could come talk to me after or

161
00:06:57,640 --> 00:06:56,930
you can read my paper get lots of reads

162
00:07:01,480 --> 00:06:57,650
on 80s

163
00:07:05,770 --> 00:07:01,490

great so yes lots of methane being

164
00:07:07,330 --> 00:07:05,780
destroyed by hydroxyl okay so like I

165
00:07:09,939 --> 00:07:07,340
mentioned before most people have looked

166
00:07:12,520 --> 00:07:09,949
at the main sequence and I'm looking at

167
00:07:15,460 --> 00:07:12,530
Wyatt door so how what do I need to take

168
00:07:16,960 --> 00:07:15,470
into account about a white door the

169
00:07:18,730 --> 00:07:16,970
spectra are different so there was

170
00:07:21,909 --> 00:07:18,740
something like this in the warm-up slide

171
00:07:22,900 --> 00:07:21,919
if you'll notice here so there I have

172
00:07:24,939 --> 00:07:22,910
the three temperatures I have six

173
00:07:26,800 --> 00:07:24,949
thousand five thousand four thousand the

174
00:07:28,930 --> 00:07:26,810
red lines are from main sequence stars

175
00:07:32,740 --> 00:07:28,940
and the blue ones are from white dwarfs

176
00:07:34,390 --> 00:07:32,750
and you'll notice that these sort of

177
00:07:35,140 --> 00:07:34,400
just the white dwarfs are looks like a

178
00:07:38,050 --> 00:07:35,150
blackbody

179
00:07:39,520 --> 00:07:38,060
that's because white dwarfs are highly

180
00:07:41,350 --> 00:07:39,530
differentiated because there's no

181
00:07:44,110 --> 00:07:41,360
confusion going on so the heavy elements

182
00:07:46,420 --> 00:07:44,120
sink to the center so if you're looking

183
00:07:48,760 --> 00:07:46,430
at it you're basically just seeing only

184
00:07:50,320 --> 00:07:48,770
hydrogen lines and five thousand Kelvin

185
00:07:52,719 --> 00:07:50,330
and under hydrogen is neutral so you

186
00:07:56,709 --> 00:07:52,729
don't even have those lines what I

187
00:07:58,180 --> 00:07:56,719
really care about is the UV so like I

188
00:08:00,909 --> 00:07:58,190

mentioned before there's the three types

189
00:08:03,459 --> 00:08:00,919
of UV which I have color-coded here in

190
00:08:05,230 --> 00:08:03,469
fun traffic light colors for you

191
00:08:07,629 --> 00:08:05,240
and you'll notice here the blue lines

192
00:08:10,659 --> 00:08:07,639
are the white door the red main sequence

193
00:08:12,219 --> 00:08:10,669
for the same temperature so you can see

194
00:08:15,670 --> 00:08:12,229
that there are definitely differences

195
00:08:17,469 --> 00:08:15,680
here and also all of these are scaled to

196
00:08:20,430 --> 00:08:17,479
the solar constant so they're all scaled

197
00:08:24,399 --> 00:08:20,440
to the one au equivalent to yield

198
00:08:25,990 --> 00:08:24,409
roughly similar surface temperatures so

199
00:08:28,180 --> 00:08:26,000
one of the main differences you see here

200
00:08:29,980 --> 00:08:28,190
is that there's a little extra UV for

201
00:08:31,899 --> 00:08:29,990
the main sequence there the studio

202
00:08:35,050 --> 00:08:31,909
chromosphere ik activity so just what's

203
00:08:36,850 --> 00:08:35,060
going on the atmosphere of the star so

204
00:08:39,130 --> 00:08:36,860
just looking at all these from the first

205
00:08:41,260 --> 00:08:39,140
time I looked at it 4,000 Kelvin cases

206
00:08:42,790 --> 00:08:41,270
most different so I was seeing the

207
00:08:46,100 --> 00:08:42,800
photochemistry would be most different

208
00:08:48,639 --> 00:08:46,110
there let's see

209
00:08:51,380 --> 00:08:48,649
okay so the models that I ran I

210
00:08:53,030 --> 00:08:51,390
basically put in planets that were the

211
00:08:56,600 --> 00:08:53,040
same as Earth with the same outgassing

212
00:08:58,759 --> 00:08:56,610
rates of life and I ran the three

213
00:09:00,670 --> 00:08:58,769

temperature cases for white dwarfs and

214
00:09:03,620 --> 00:09:00,680
the main sequence stars

215
00:09:06,620 --> 00:09:03,630
so why did I pick those temperatures

216
00:09:08,840 --> 00:09:06,630
there was actually a reason as sunny

217
00:09:10,639 --> 00:09:08,850
mentioned during the warm-up talk the

218
00:09:13,370 --> 00:09:10,649
white dwarf is cooling over time so it

219
00:09:15,470 --> 00:09:13,380
starts off very very hot and cools over

220
00:09:17,900 --> 00:09:15,480
time and the habitable zone is

221
00:09:20,180 --> 00:09:17,910
continuously changing so we want to look

222
00:09:21,620 --> 00:09:20,190
at a time when the habitable zone stays

223
00:09:25,430 --> 00:09:21,630
in the same place for long enough that

224
00:09:28,009 --> 00:09:25,440
life can grow in a ball so if you look

225
00:09:30,380 --> 00:09:28,019
between 6000 and 4000 Kelvin that's

226
00:09:32,120 --> 00:09:30,390
about 10 billion years right there and

227
00:09:34,579 --> 00:09:32,130
considering that we are much less than

228
00:09:37,370 --> 00:09:34,589
10 billion years here on earth I'd say

229
00:09:39,259 --> 00:09:37,380
that's enough time so that is why pick

230
00:09:41,569 --> 00:09:39,269
those I didn't pick anything less than

231
00:09:43,310 --> 00:09:41,579
4000 because white dwarfs that cool

232
00:09:46,850 --> 00:09:43,320
don't really exist yet because the

233
00:09:50,509 --> 00:09:46,860
universe isn't old enough so I try to be

234
00:09:54,650 --> 00:09:50,519
a little realistic speaking of realistic

235
00:09:57,590 --> 00:09:54,660
here's the 1d climate code we use it's a

236
00:10:00,380 --> 00:09:57,600
cup coupled climate photochemistry qey

237
00:10:02,720 --> 00:10:00,390
basically we it calculates the

238
00:10:04,639 --> 00:10:02,730

temperature pressure profile looking at

239
00:10:06,740 --> 00:10:04,649
the major greenhouse gases and it goes

240
00:10:08,960 --> 00:10:06,750
into the photochemistry code and it uses

241
00:10:10,759 --> 00:10:08,970
the temperature profile to update the

242
00:10:12,019 --> 00:10:10,769
chemistry you update the chemistry then

243
00:10:13,400 --> 00:10:12,029
you update the temperature then you

244
00:10:16,280 --> 00:10:13,410
update the chemistry and you just sort

245
00:10:18,710 --> 00:10:16,290
of go back and forth until it's reached

246
00:10:20,449 --> 00:10:18,720
equilibrium and you have the star as an

247
00:10:24,500 --> 00:10:20,459
input so you get the atmosphere to reach

248
00:10:26,569 --> 00:10:24,510
equilibrium for that specific star for

249
00:10:29,420 --> 00:10:26,579
the results I know that different people

250
00:10:31,610 --> 00:10:29,430
learn differently so I have a graph and

251
00:10:35,630 --> 00:10:31,620
then on the next slide I also have it in

252
00:10:38,329 --> 00:10:35,640
words if you hate graphs so here really

253
00:10:41,210 --> 00:10:38,339
quick just hitting on the highlights we

254
00:10:43,639 --> 00:10:41,220
have each row is a different temperature

255
00:10:45,860 --> 00:10:43,649
at just at first glance you can see the

256
00:10:49,120 --> 00:10:45,870
4000 Kelvin case is the most different

257
00:10:53,569 --> 00:10:49,130
as we all predict it together

258
00:10:56,120 --> 00:10:53,579
so there's actually an excess of ozone a

259
00:10:58,750 --> 00:10:56,130
little bit in each case which actually

260
00:11:01,810 --> 00:10:58,760
caused more hydroxyl to be created

261
00:11:04,930 --> 00:11:01,820
and that caused more depletion of

262
00:11:07,259 --> 00:11:04,940
methane so there was more ozone because

263
00:11:10,000 --> 00:11:07,269

there's more UV at specific wavelengths

264
00:11:12,490 --> 00:11:10,010
which caused more hydroxyl which caused

265
00:11:14,079 --> 00:11:12,500
less methane and then I put in water

266
00:11:15,970 --> 00:11:14,089
because we all care about water and

267
00:11:18,490 --> 00:11:15,980
you'll see there is the difference

268
00:11:20,769 --> 00:11:18,500
mainly in the 4000 Kelvin case because

269
00:11:23,139 --> 00:11:20,779
at the wavelengths that water is

270
00:11:26,590 --> 00:11:23,149
breaking a broken apart by photolysis

271
00:11:29,050 --> 00:11:26,600
there was a lot more of UV flux at that

272
00:11:33,610 --> 00:11:29,060
wavelength for the white dwarf then the

273
00:11:35,730 --> 00:11:33,620
main sequence star so in words basically

274
00:11:38,410 --> 00:11:35,740
a lot of the white dwarf planets

275
00:11:40,629 --> 00:11:38,420
compared to the main sequence star at

276
00:11:43,180 --> 00:11:40,639
the wavelengths where ozone is created

277
00:11:46,870 --> 00:11:43,190
there was more ozone which created more

278
00:11:48,460 --> 00:11:46,880
hydroxyl in the hydroxyl depleted the

279
00:11:50,829 --> 00:11:48,470
methane and also I didn't talk about

280
00:11:52,930 --> 00:11:50,839
these but I put them in for fun more

281
00:11:55,660 --> 00:11:52,940
because of the increased hydroxyl there

282
00:11:58,180 --> 00:11:55,670
was more co2 which is very green house

283
00:12:00,670 --> 00:11:58,190
of gas and then more methyl chloride and

284
00:12:07,180 --> 00:12:00,680
nitrous oxide which are other biological

285
00:12:09,340 --> 00:12:07,190
species and real quick here's an idea of

286
00:12:13,480 --> 00:12:09,350
what the UV to the ground looks like for

287
00:12:15,970 --> 00:12:13,490
reference we are roughly like this 6,000

288
00:12:17,379 --> 00:12:15,980

Kelvin main sequence star right here you

289
00:12:20,050 --> 00:12:17,389
might notice that ozone is most

290
00:12:21,430 --> 00:12:20,060
efficient shielding at around 260

291
00:12:25,300 --> 00:12:21,440
nanometers which is why there let's

292
00:12:29,410 --> 00:12:25,310
shape so you could see that the stars

293
00:12:31,990 --> 00:12:29,420
with less UV flux the cooler ones are

294
00:12:33,819 --> 00:12:32,000
actually they have more UV at the

295
00:12:37,090 --> 00:12:33,829
surface harmful UV and that's because

296
00:12:39,009 --> 00:12:37,100
there's less ozone so this is morally

297
00:12:40,480 --> 00:12:39,019
just a general comment for stars but if

298
00:12:43,960 --> 00:12:40,490
you're going to compare white dwarf

299
00:12:46,059 --> 00:12:43,970
planets to main-sequence planets the UV

300
00:12:47,740 --> 00:12:46,069
to the ground is comparable so we don't

301
00:12:51,550 --> 00:12:47,750
have to worry about surface life being

302
00:12:53,170 --> 00:12:51,560
irradiated so in summary we have to

303
00:12:55,569 --> 00:12:53,180
relay with white dwarfs think about the

304
00:12:58,180 --> 00:12:55,579
changing habitable zone as the white

305
00:13:00,250 --> 00:12:58,190
dwarf cools the lack of chromis Pyrrhic

306
00:13:03,550 --> 00:13:00,260
activity causes changes in the

307
00:13:05,139 --> 00:13:03,560
photochemistry the UVC shielding is

308
00:13:08,949 --> 00:13:05,149
comparable so we don't have to worry

309
00:13:11,019 --> 00:13:08,959
about DNA damage and also with the

310
00:13:11,710 --> 00:13:11,029
hydroxyl there could be depletion of

311
00:13:13,449 --> 00:13:11,720
potential

312
00:13:14,920 --> 00:13:13,459
I owe signatures for the white dwarfs so

313
00:13:18,460 --> 00:13:14,930

you know if there is life there it might

314
00:13:21,699 --> 00:13:18,470
be more difficult to find it so a paper

315
00:13:24,309 --> 00:13:21,709
I'm writing right now is creating

316
00:13:26,619 --> 00:13:24,319
planetary spectra for these models so I

317
00:13:37,389 --> 00:13:26,629
will be doing an analysis of the bio

318
00:13:39,850 --> 00:13:37,399
signature deductions oh thank you hi

319
00:13:41,800 --> 00:13:39,860
that was really neat talk thank you have

320
00:13:43,990 --> 00:13:41,810
a quick question regarding the white

321
00:13:47,379 --> 00:13:44,000
dwarfs and proposing that you would have

322
00:13:48,850 --> 00:13:47,389
a habitable planet how do you what's the

323
00:13:52,059 --> 00:13:48,860
scenario you can envision in terms of

324
00:13:53,410 --> 00:13:52,069
having the raw material hydrated

325
00:13:54,790 --> 00:13:53,420
material that would avaible would be

326
00:13:55,300 --> 00:13:54,800
able to survive the transition to white

327
00:13:57,639 --> 00:13:55,310
dwarf

328
00:14:00,340 --> 00:13:57,649
through the red giant expansion phase

329
00:14:01,780 --> 00:14:00,350
that's a very good question my adviser

330
00:14:05,499 --> 00:14:01,790
says officially I'm not supposed to

331
00:14:07,929 --> 00:14:05,509
comment on this but because we just care

332
00:14:11,769 --> 00:14:07,939
about the modelling but as I mentioned

333
00:14:13,600 --> 00:14:11,779
earlier that there are a lot of disks

334
00:14:15,340 --> 00:14:13,610
that sort of resemble protoplanetary

335
00:14:16,809 --> 00:14:15,350
discs found their own white dwarfs so

336
00:14:18,910 --> 00:14:16,819
there could be some sort of second wave

337
00:14:22,869 --> 00:14:18,920
planet formation within late water

338
00:14:25,449 --> 00:14:22,879

delivery thank you that was an

339
00:14:28,360 --> 00:14:25,459
absolutely fantastic talk oh thank you

340
00:14:30,280 --> 00:14:28,370
so my question is and maybe this is

341
00:14:32,230 --> 00:14:30,290
embedded somewhere in the modeling but

342
00:14:33,639 --> 00:14:32,240
so you mentioned that obviously the

343
00:14:35,350 --> 00:14:33,649
epital zone is highly dependent on the

344
00:14:37,240 --> 00:14:35,360
rate of cooling you also mentioned that

345
00:14:39,069 --> 00:14:37,250
do do these photochemical effects you're

346
00:14:40,809 --> 00:14:39,079
getting a lot of carbon dioxide which as

347
00:14:43,660 --> 00:14:40,819
you mentioned is a greenhouse gas yeah

348
00:14:45,009 --> 00:14:43,670
therefore would that nuts potentially be

349
00:14:46,780 --> 00:14:45,019
conducive to having a habitable

350
00:14:47,889 --> 00:14:46,790
temperature range on our planet for a

351
00:14:49,900 --> 00:14:47,899
longer period of time just because you

352
00:14:53,860 --> 00:14:49,910
have all that co2 to keep it warm even

353
00:14:57,960 --> 00:14:53,870
as the dwarf cools yeah oh that's very

354
00:15:02,559 --> 00:14:57,970
interesting yes it possibly could that

355
00:15:05,369 --> 00:15:02,569
was yes thank you totally possible okay

356
00:15:08,259 --> 00:15:05,379
um be my co-author we'll do it together

357
00:15:09,759 --> 00:15:08,269
yes I might have missed this but um how

358
00:15:11,710 --> 00:15:09,769
did you decide what your atmospheric

359
00:15:12,910 --> 00:15:11,720
composition was and is it just like

360
00:15:15,670 --> 00:15:12,920
starting with like the moderate Earth

361
00:15:18,490 --> 00:15:15,680
atmospheric composition or yes I'm

362
00:15:20,439 --> 00:15:18,500
actually also writing a paper on earth

363
00:15:22,629 --> 00:15:20,449

throughout time around white doors I'm

364
00:15:25,420 --> 00:15:22,639
just really into white dwarfs yes we

365
00:15:27,760 --> 00:15:25,430
were using modern earth for this

366
00:15:30,280 --> 00:15:27,770
as sort of the best case scenario and

367
00:15:32,850 --> 00:15:30,290
seeing if we could even detect life and

368
00:15:35,100 --> 00:15:32,860
have life exists starting off from Earth

369
00:15:37,329 --> 00:15:35,110
okay

370
00:15:40,000 --> 00:15:37,339
just very stupid question

371
00:15:42,100 --> 00:15:40,010
and what's carrot what's going to happen

372
00:15:44,230 --> 00:15:42,110
there - white white doors at the end of

373
00:15:46,810 --> 00:15:44,240
their lives can they become a planet

374
00:15:49,240 --> 00:15:46,820
themselves so Wyatt Doris when they cool

375
00:15:51,880 --> 00:15:49,250
down completely they become black Dorf

376
00:15:54,100 --> 00:15:51,890
but those don't exist yet because the

377
00:15:56,670 --> 00:15:54,110
universe isn't old enough so it just

378
00:16:00,660 --> 00:15:56,680
sort of cools down completely and then

379
00:16:03,990 --> 00:16:00,670
just there being really dense and very

380
00:16:06,490 --> 00:16:04,000
cold and it's very sad

381
00:16:10,840 --> 00:16:06,500
but don't worry they don't exist don't

382
00:16:13,960 --> 00:16:12,000
since you're messing with the

383
00:16:15,970 --> 00:16:13,970
atmospheric chemistry do you know what's

384
00:16:18,100 --> 00:16:15,980
going to happen to cloud formation and

385
00:16:22,480 --> 00:16:18,110
aerosol formation because that really

386
00:16:24,460 --> 00:16:22,490
affects the temperature and oh yeah so

387
00:16:27,550 --> 00:16:24,470
I'll put in a plug for my officemate

388
00:16:29,769 --> 00:16:27,560

Jack Madden's poster which is eventually

389
00:16:32,680 --> 00:16:29,779
this week where he will talk about those

390
00:16:35,199 --> 00:16:32,690
sorts of effects so yes these were clear

391
00:16:36,970 --> 00:16:35,209
sky models that I use our code does use

392
00:16:39,699 --> 00:16:36,980
clouds but this was just sort of to see

393
00:16:42,699 --> 00:16:39,709
even with everything going perfectly

394
00:16:45,730 --> 00:16:42,709
could we still detect life but yes

395
00:16:49,150 --> 00:16:45,740
clouds have a big effect so Jack we'll

396
00:16:52,240 --> 00:16:49,160
explain that later hi I might have

397
00:16:53,829 --> 00:16:52,250
missed this but how different is the

398
00:16:57,120 --> 00:16:53,839
radiation environment around white doors

399
00:17:00,310 --> 00:16:57,130
than like M dwarfs which also high UV

400
00:17:02,380 --> 00:17:00,320
yeah so the white dwarfs don't have

401
00:17:05,020 --> 00:17:02,390
flares like the M dwarfs the main

402
00:17:07,809 --> 00:17:05,030
difference between the UV as I showed

403
00:17:10,439 --> 00:17:07,819
before is that the white dwarfs don't

404
00:17:12,790 --> 00:17:10,449
have chromosphere ik activity which

405
00:17:14,500 --> 00:17:12,800
white dwarfs literally looks like black

406
00:17:16,210 --> 00:17:14,510
bodies whereas if you have a

407
00:17:17,770 --> 00:17:16,220
main-sequence star with chromosphere ik

408
00:17:20,049 --> 00:17:17,780
activity there's a black body but

409
00:17:22,870 --> 00:17:20,059
there's also a bit at the end tacked on

410
00:17:29,320 --> 00:17:22,880
from the chromosphere ik activity so

411
00:17:35,950 --> 00:17:33,850
one last quick question nabis for fast

412
00:17:37,659 --> 00:17:35,960
have you thought about maybe doing some

413
00:17:39,779 --> 00:17:37,669

sort of bench work looking at

414
00:17:42,159 --> 00:17:39,789
polymerization under different UV

415
00:17:45,190 --> 00:17:42,169
radiation environments for example if

416
00:17:48,820 --> 00:17:45,200
you have a more lean starting chemistry

417
00:17:51,220 --> 00:17:48,830
for a white dwarf scenario I haven't but

418
00:17:53,139 --> 00:17:51,230
that's a good idea I'm open to lots of

419
00:17:55,840 --> 00:17:53,149
different things I have like 30 years of

420
00:17:58,330 --> 00:17:55,850
grad school yeah left I figure so I'm

421
00:18:01,390 --> 00:17:58,340
gonna do it all and on that high note