
INFLUENCE OF UV ACTIVITY ON THE SPECTRAL FINGERPRINTS OF EARTH-LIKE PLANETS AROUND M DWARFS
Sarah Rugheimer
AbGradCon
July 31st, 2014
Collaborators:
Lisa Kaltenegger (MPIA, Germany)
Antigona Segura (ICN-UNA Mexico)
Jeffrey Linsky (JILA, UC-Boulder)
Subu Mohanty (Imperial College, UK)

1
00:00:10,009 --> 00:00:08,150
oh yeah we started the session with not

2
00:00:12,169 --> 00:00:10,019
an isotope talk we're ending the session

3
00:00:15,020 --> 00:00:12,179
with not an iso to attack and you

4
00:00:16,550 --> 00:00:15,030
already saw me today so you can kind of

5
00:00:18,950 --> 00:00:16,560
just fall asleep but I'm talking about

6
00:00:21,140 --> 00:00:18,960
something entirely different and what

7
00:00:24,380 --> 00:00:21,150
I'm interested in is how we could detect

8
00:00:26,450 --> 00:00:24,390
bio signatures around other stars around

9
00:00:28,040 --> 00:00:26,460
planets around other stars and in

10
00:00:31,160 --> 00:00:28,050
particular I'm going to talk about the

11
00:00:33,709 --> 00:00:31,170
smallest stars today and for the non

12
00:00:36,530 --> 00:00:33,719
astronomers in the room these are a

13
00:00:40,100 --> 00:00:36,540

graph like a pictorial representation of

14
00:00:42,440 --> 00:00:40,110
all the stars within 10 parsecs a parsec

15
00:00:44,720 --> 00:00:42,450
is roughly you know three point three

16
00:00:46,340 --> 00:00:44,730
light years so it's 33 lightyears this

17
00:00:49,400 --> 00:00:46,350
is our solar neighborhood these are the

18
00:00:52,010 --> 00:00:49,410
closest closest stars and you can see

19
00:00:54,110 --> 00:00:52,020
that most of them are red small things

20
00:00:57,020 --> 00:00:54,120
and that's this M star class here these

21
00:01:00,529 --> 00:00:57,030
are the small stars in fact 75% of stars

22
00:01:02,930 --> 00:01:00,539
are these very small stars for our son

23
00:01:05,020 --> 00:01:02,940
for example as a g-type star one of

24
00:01:07,070 --> 00:01:05,030
these yellow guys so much bigger and

25
00:01:09,320 --> 00:01:07,080
small stars have a couple unique

26
00:01:11,750 --> 00:01:09,330
advantages which you probably know but

27
00:01:13,730 --> 00:01:11,760
just to reiterate the transit signal is

28
00:01:15,740 --> 00:01:13,740
much as fractionally much higher this is

29
00:01:19,429 --> 00:01:15,750
a two percent signal versus a you know

30
00:01:21,830 --> 00:01:19,439
point zero or 0.5% transit signal so

31
00:01:24,859 --> 00:01:21,840
when we're going to follow up these

32
00:01:26,510 --> 00:01:24,869
planets over the coming decades the the

33
00:01:29,630 --> 00:01:26,520
small star is much easier just because

34
00:01:32,630 --> 00:01:29,640
the planet the ratio and sizes is much

35
00:01:34,880 --> 00:01:32,640
more beneficial as well the habitable

36
00:01:36,620 --> 00:01:34,890
zone is much closer for the small stars

37
00:01:38,270 --> 00:01:36,630
meaning they transit more frequently

38
00:01:39,859 --> 00:01:38,280

though this could be a problem if you're

39
00:01:42,560 --> 00:01:39,869
trying to separate the starlight it is

40
00:01:46,639 --> 00:01:42,570
very beneficial for transits so for many

41
00:01:48,859 --> 00:01:46,649
reasons the smallest star which is also

42
00:01:51,020 --> 00:01:48,869
happens to be the most abundant is a

43
00:01:52,999 --> 00:01:51,030
very beneficial for us to follow up on

44
00:01:57,649 --> 00:01:53,009
and I just wanted to quickly show this

45
00:01:59,240 --> 00:01:57,659
plot this shows the GJ 1214b and all

46
00:02:00,770 --> 00:01:59,250
this data has been collected and these

47
00:02:03,620 --> 00:02:00,780
are different models and we're really

48
00:02:06,709 --> 00:02:03,630
trying to pin down what what is actually

49
00:02:09,260 --> 00:02:06,719
this composition of this star and it has

50
00:02:11,660 --> 00:02:09,270
required huge like years of effort and

51
00:02:13,400 --> 00:02:11,670
we're still you know not able to

52
00:02:13,790 --> 00:02:13,410
distinguish things too well we know it's

53
00:02:16,880 --> 00:02:13,800
flat

54
00:02:18,020 --> 00:02:16,890
but but what basically the point is

55
00:02:19,820 --> 00:02:18,030
distinguishing even the most basic

56
00:02:23,120 --> 00:02:19,830
possible atmospheres is only going to be

57
00:02:26,600 --> 00:02:23,130
possible for these clothes star systems

58
00:02:28,700 --> 00:02:26,610
and most of them are M stars so M stars

59
00:02:31,400 --> 00:02:28,710
are also they have a huge range and

60
00:02:34,400 --> 00:02:31,410
temperatures and radii and masses so

61
00:02:35,660 --> 00:02:34,410
they're a big special class and so I in

62
00:02:37,640 --> 00:02:35,670
this talk today I'm going to talk about

63
00:02:39,920 --> 00:02:37,650

how that spectral class affects the

64
00:02:41,780 --> 00:02:39,930
atmosphere and also when we're looking

65
00:02:43,880 --> 00:02:41,790
at atmospheres you have a couple

66
00:02:45,680 --> 00:02:43,890
different main things going on you have

67
00:02:47,120 --> 00:02:45,690
the photochemistry which is what I'm

68
00:02:49,130 --> 00:02:47,130
going to be focusing on how does the

69
00:02:51,170 --> 00:02:49,140
starlight affect the atmosphere you have

70
00:02:52,490 --> 00:02:51,180
the outgassing of life that's going to

71
00:02:55,850 --> 00:02:52,500
put things into the atmosphere

72
00:02:57,770 --> 00:02:55,860
outgassing from volcanoes all that sort

73
00:02:59,240 --> 00:02:57,780
of stuff and then you've atmospheric

74
00:03:02,480 --> 00:02:59,250
escape and then you have biological and

75
00:03:06,680 --> 00:03:02,490
geological processing so previously I

76
00:03:08,750 --> 00:03:06,690
worked mainly in the FG k stellar range

77
00:03:11,720 --> 00:03:08,760
which is the stars that are bet hotter

78
00:03:13,760 --> 00:03:11,730
than M stars and now I'm adding in these

79
00:03:15,530 --> 00:03:13,770
M star models and if you're not an

80
00:03:17,450 --> 00:03:15,540
astronomer don't worry about it but what

81
00:03:19,850 --> 00:03:17,460
I want you to take away is the M stars

82
00:03:21,530 --> 00:03:19,860
are much their peak is much more red so

83
00:03:23,479 --> 00:03:21,540
most of their wavelength is happening

84
00:03:26,900 --> 00:03:23,489
much more in the red region so if you're

85
00:03:29,120 --> 00:03:26,910
doing a prebiotic worker you know

86
00:03:30,470 --> 00:03:29,130
various biological work if you want to

87
00:03:32,540 --> 00:03:30,480
model something around M sorry you need

88
00:03:33,740 --> 00:03:32,550

to have an entirely different sort of

89
00:03:35,979 --> 00:03:33,750
light source that you're going to be

90
00:03:39,680 --> 00:03:35,989
using to simulate that environment and

91
00:03:43,070 --> 00:03:39,690
when we're talking about atmospheres the

92
00:03:44,660 --> 00:03:43,080
UV part the ultraviolet part is really

93
00:03:46,940 --> 00:03:44,670
important it dominates the

94
00:03:49,030 --> 00:03:46,950
photochemistry which dominates what is

95
00:03:51,620 --> 00:03:49,040
going to end up in the atmosphere and

96
00:03:53,449 --> 00:03:51,630
for M stars you can see there's this

97
00:03:56,479 --> 00:03:53,459
huge range between the models that's

98
00:03:58,790 --> 00:03:56,489
that red line is just a stellar model

99
00:04:02,710 --> 00:03:58,800
and they don't really they don't pretend

100
00:04:05,420 --> 00:04:02,720
to model the UV but this is a basically

101
00:04:07,880 --> 00:04:05,430
no chromospheric emission so there's no

102
00:04:10,970 --> 00:04:07,890
activity from this and then the black

103
00:04:13,970 --> 00:04:10,980
line is basically a dealio which is a

104
00:04:18,199 --> 00:04:13,980
very flaring star very young active star

105
00:04:20,690 --> 00:04:18,209
and then the green line is GJ 436 which

106
00:04:23,360 --> 00:04:20,700
is a star that's a little less active

107
00:04:25,969 --> 00:04:23,370
but you can see that there's just orders

108
00:04:27,740 --> 00:04:25,979
a magnitude of difference here in the

109
00:04:29,090 --> 00:04:27,750
fluxes so

110
00:04:30,830 --> 00:04:29,100
I'm talking today I'm going to talk

111
00:04:32,570 --> 00:04:30,840
about active models and inactive models

112
00:04:35,090 --> 00:04:32,580
that active models are these most active

113
00:04:36,920 --> 00:04:35,100

cases then I'll be talking about some of

114
00:04:38,600 --> 00:04:36,930
the observed stars and the inactive

115
00:04:41,210 --> 00:04:38,610
models are really these limiting cases

116
00:04:46,100 --> 00:04:41,220
whether they actually correspond to a

117
00:04:49,400 --> 00:04:46,110
physical stars is not yet known for for

118
00:04:51,320 --> 00:04:49,410
the non astronomers in the in the bunch

119
00:04:52,910 --> 00:04:51,330
this might not make a whole lot of sense

120
00:04:55,130 --> 00:04:52,920
but basically what I'm trying to do is

121
00:04:58,310 --> 00:04:55,140
scale because we don't have UV

122
00:05:00,200 --> 00:04:58,320
observations for a lot of M stars we

123
00:05:04,280 --> 00:05:00,210
only have them for you know a handful

124
00:05:07,220 --> 00:05:04,290
six or so so I took basically this this

125
00:05:09,500 --> 00:05:07,230
assumption that H alpha which is the

126
00:05:12,950 --> 00:05:09,510
transition from the N equals 3 to the N

127
00:05:15,860 --> 00:05:12,960
equals 2 state here to I assume that

128
00:05:18,290 --> 00:05:15,870
that corresponds with UV levels for

129
00:05:20,900 --> 00:05:18,300
active mstars and then we use well

130
00:05:22,880 --> 00:05:20,910
observed UV em starts to scale

131
00:05:24,590 --> 00:05:22,890
accordingly because H alpha is really

132
00:05:26,300 --> 00:05:24,600
well measured for thousands and

133
00:05:28,460 --> 00:05:26,310
thousands of M stars so that's basically

134
00:05:31,400 --> 00:05:28,470
the idea and then we're going to compare

135
00:05:33,230 --> 00:05:31,410
these with UV observations so the other

136
00:05:35,450 --> 00:05:33,240
thing that you might just if you is like

137
00:05:39,080 --> 00:05:35,460
a kind of a takeaway knowledge thing

138
00:05:41,780 --> 00:05:39,090

from this talk early M stars are active

139
00:05:43,880 --> 00:05:41,790
for around a couple billion years and

140
00:05:46,400 --> 00:05:43,890
then they become inactive but the later

141
00:05:48,590 --> 00:05:46,410
m star so that's the cooler mstars the

142
00:05:51,530 --> 00:05:48,600
even smaller ones they remain active for

143
00:05:53,330 --> 00:05:51,540
you know six seven eight billion years

144
00:05:55,700 --> 00:05:53,340
so that's something to consider when

145
00:05:58,640 --> 00:05:55,710
we're looking out for biosignatures

146
00:06:00,800 --> 00:05:58,650
around these start planets around these

147
00:06:03,260 --> 00:06:00,810
stars because the activity strongly will

148
00:06:05,380 --> 00:06:03,270
influence the type of photochemistry

149
00:06:08,090 --> 00:06:05,390
that will happen in the atmosphere and

150
00:06:11,210 --> 00:06:08,100
so this is basically the scaling we used

151
00:06:12,800 --> 00:06:11,220
which is from Andrew West paper where he

152
00:06:15,050 --> 00:06:12,810
measured the mean age alpha with

153
00:06:19,370 --> 00:06:15,060
spectral type and then we scale our

154
00:06:21,020 --> 00:06:19,380
models according to that and then these

155
00:06:23,409 --> 00:06:21,030
we you might have heard of the muscle

156
00:06:26,060 --> 00:06:23,419
stars either the six well-known observed

157
00:06:27,969 --> 00:06:26,070
muscle stars in a UV so we have good

158
00:06:30,530 --> 00:06:27,979
observations of these but these are

159
00:06:32,330 --> 00:06:30,540
these stars were typically classified as

160
00:06:34,880 --> 00:06:32,340
quiet stars so we wanted to get kind of

161
00:06:38,760 --> 00:06:34,890
a the most active case the least active

162
00:06:45,270 --> 00:06:42,270
um here is a figure this is a lot of

163
00:06:47,249 --> 00:06:45,280

lines so what I want you to take away is

164
00:06:49,890 --> 00:06:47,259
that there are these lines that you

165
00:06:51,779 --> 00:06:49,900
can't see the here which I need to make

166
00:06:54,089 --> 00:06:51,789
bigger but these are the chemicals that

167
00:06:57,270 --> 00:06:54,099
are going into the spectra here and so

168
00:07:00,839 --> 00:06:57,280
basically this dotted black line is the

169
00:07:02,520 --> 00:07:00,849
IR spectrum from from this planet this

170
00:07:04,770 --> 00:07:02,530
is an active case and this is an

171
00:07:06,180 --> 00:07:04,780
inactive case and and then these are the

172
00:07:09,450 --> 00:07:06,190
individual components so you can see

173
00:07:11,700 --> 00:07:09,460
what's dominating the spectrum you know

174
00:07:13,529 --> 00:07:11,710
which molecule is contributing most to

175
00:07:15,330 --> 00:07:13,539
the spectrum at that point so this is a

176
00:07:17,850 --> 00:07:15,340
way just to kind of break up the

177
00:07:19,680 --> 00:07:17,860
spectrum into okay here you can see co2

178
00:07:21,990 --> 00:07:19,690
is dominating most of it here you can

179
00:07:25,950 --> 00:07:22,000
see water is dominating here you can see

180
00:07:27,540 --> 00:07:25,960
methane is dominating and and so and and

181
00:07:29,909 --> 00:07:27,550
the biggest difference between this

182
00:07:31,830 --> 00:07:29,919
active and inactive case in our models

183
00:07:35,570 --> 00:07:31,840
is that methane becomes much more

184
00:07:38,279 --> 00:07:35,580
abundant and n2o which is produced by

185
00:07:40,080 --> 00:07:38,289
microbial life becomes much more

186
00:07:42,119 --> 00:07:40,090
abundant and that starts to dominate the

187
00:07:45,029 --> 00:07:42,129
spectrum so we might be able to see

188
00:07:47,219 --> 00:07:45,039

these especially in 20 or even CH 3 CL

189
00:07:51,570 --> 00:07:47,229
around some of these more in active

190
00:07:53,999 --> 00:07:51,580
cases and this is the spectrum of what

191
00:07:56,249 --> 00:07:54,009
we would observe maybe from earth again

192
00:07:58,080 --> 00:07:56,259
if you're not an astronomer don't worry

193
00:08:00,330 --> 00:07:58,090
about the details but just see that

194
00:08:04,100 --> 00:08:00,340
there are differences between you know

195
00:08:06,450 --> 00:08:04,110
the different star types and these I

196
00:08:09,269 --> 00:08:06,460
labeled the features you know so you

197
00:08:13,110 --> 00:08:09,279
have the co2 you have ozone methane

198
00:08:14,760 --> 00:08:13,120
water this is for the active case here's

199
00:08:17,120 --> 00:08:14,770
the difference for the inactive you see

200
00:08:20,700 --> 00:08:17,130
that the n 20 really starts to pop out

201
00:08:23,600 --> 00:08:20,710
here a totally different spectrum in

202
00:08:26,519 --> 00:08:23,610
these regions here you have that end 20

203
00:08:30,600 --> 00:08:26,529
and for the muscle stars we also start

204
00:08:32,459 --> 00:08:30,610
seeing n 20 in the 17 micron band region

205
00:08:34,199 --> 00:08:32,469
so that's also interesting so even with

206
00:08:36,839 --> 00:08:34,209
you know stars that we have while

207
00:08:38,699 --> 00:08:36,849
characterized UV we might be able to see

208
00:08:40,560 --> 00:08:38,709
that n 20 feature and furthermore

209
00:08:44,280 --> 00:08:40,570
there's been some recent work that shows

210
00:08:47,819 --> 00:08:44,290
that some mstars may even be approaching

211
00:08:49,740 --> 00:08:47,829
this limiting case limit from the GALEX

212
00:08:51,430 --> 00:08:49,750
data we're seeing some stars that have

213
00:08:54,010 --> 00:08:51,440

very very like

214
00:08:56,290 --> 00:08:54,020
most black body level fluxes in the UV

215
00:08:58,450 --> 00:08:56,300
so that might be interesting for the

216
00:08:59,500 --> 00:08:58,460
astronomers in the room and then in the

217
00:09:00,670 --> 00:08:59,510
visible the visible is a little more

218
00:09:02,500 --> 00:09:00,680
boring than the IR there's a lot more

219
00:09:04,210 --> 00:09:02,510
cool features I think in the IR but

220
00:09:06,450 --> 00:09:04,220
there is an oxygen feature in the

221
00:09:09,850 --> 00:09:06,460
visible so that's always important and

222
00:09:11,140 --> 00:09:09,860
here again don't really consider the

223
00:09:13,270 --> 00:09:11,150
differences but just see that there's

224
00:09:16,090 --> 00:09:13,280
there are quite substantial differences

225
00:09:18,520 --> 00:09:16,100
as you go through from m02 m9 spectral

226
00:09:20,980 --> 00:09:18,530
class and the different and they change

227
00:09:24,100 --> 00:09:20,990
based on whether you have active or

228
00:09:25,690 --> 00:09:24,110
inactive and the observed models but I

229
00:09:27,070 --> 00:09:25,700
want to really focus on the oxygen

230
00:09:28,990 --> 00:09:27,080
feature because that's the most

231
00:09:31,240 --> 00:09:29,000
interesting feature in the visible and

232
00:09:32,710 --> 00:09:31,250
here you can see the oxygen in all of

233
00:09:35,560 --> 00:09:32,720
our models we ran it at modern earth

234
00:09:39,280 --> 00:09:35,570
fluxes it was twenty one percent so the

235
00:09:42,790 --> 00:09:39,290
the you know the relative absorption was

236
00:09:44,470 --> 00:09:42,800
the same for any of the stars but but

237
00:09:47,410 --> 00:09:44,480
what we're going to observe if we do a

238
00:09:49,090 --> 00:09:47,420

direct detection mission is will be

239
00:09:50,680 --> 00:09:49,100
influenced by the reflected light so we

240
00:09:54,400 --> 00:09:50,690
have the light coming in from the star

241
00:09:57,100 --> 00:09:54,410
it's reflected from the planet and then

242
00:09:59,740 --> 00:09:57,110
so the features will be dependent on

243
00:10:02,320 --> 00:09:59,750
what the spectrum of the star is if that

244
00:10:05,470 --> 00:10:02,330
makes sense and because the spectrum of

245
00:10:07,810 --> 00:10:05,480
the star is Soloflex in the oxygen

246
00:10:10,900 --> 00:10:07,820
region for those cooler stars as you get

247
00:10:12,280 --> 00:10:10,910
cooler you actually have like almost

248
00:10:13,840 --> 00:10:12,290
even though you have twenty one percent

249
00:10:17,590 --> 00:10:13,850
oxygen you can't see any feature there

250
00:10:19,060 --> 00:10:17,600
for the for the latest mstars it just is

251
00:10:20,800 --> 00:10:19,070
like on you know and that doesn't matter

252
00:10:23,770 --> 00:10:20,810
whether whether it's an inactive or

253
00:10:25,480 --> 00:10:23,780
active M star because the UV is not that

254
00:10:28,060 --> 00:10:25,490
part of the spectrum this is just the

255
00:10:30,130 --> 00:10:28,070
the regular part of the stellar spectrum

256
00:10:32,640 --> 00:10:30,140
so it might mean that it could be very

257
00:10:37,480 --> 00:10:32,650
difficult for us to detect the oxygen

258
00:10:41,290 --> 00:10:37,490
feature in the visible so basically in a

259
00:10:43,510 --> 00:10:41,300
nutshell UV drives the photochemistry we

260
00:10:46,030 --> 00:10:43,520
made these lists of models the o2

261
00:10:49,240 --> 00:10:46,040
becomes very difficult to detect for the

262
00:10:50,950 --> 00:10:49,250
latest mstars and if you have low V

263
00:10:55,810 --> 00:10:50,960

you're reducing species will increase

264
00:10:57,820 --> 00:10:55,820
your species like methane and 20 methyl

265
00:11:00,130 --> 00:10:57,830
chloride will build up maybe possibly to

266
00:11:02,890 --> 00:11:00,140
observable levels but as some really

267
00:11:04,050 --> 00:11:02,900
great research has shown including Sony

268
00:11:06,420 --> 00:11:04,060
earlier and

269
00:11:07,830 --> 00:11:06,430
Fang and Shawn donegal Goldman have been

270
00:11:10,320 --> 00:11:07,840
working on there is definitely a

271
00:11:12,480 --> 00:11:10,330
potential for false positives more so

272
00:11:14,790 --> 00:11:12,490
around these stars then around the FG k

273
00:11:17,100 --> 00:11:14,800
stars so we need to be really careful to

274
00:11:18,750 --> 00:11:17,110
get the full planetary context and I

275
00:11:20,640 --> 00:11:18,760
would argue part of that context is

276
00:11:21,930 --> 00:11:20,650
knowing what the UV of the star is we're

277
00:11:25,200 --> 00:11:21,940
never going to be able to interpret the

278
00:11:26,970 --> 00:11:25,210
spectrum unless we know how much the UV

279
00:11:29,310 --> 00:11:26,980
fluxes and currently we don't have a

280
00:11:30,540 --> 00:11:29,320
mission design you know past Hubble

281
00:11:40,880 --> 00:11:30,550
that's going to be able to measure the

282
00:11:51,540 --> 00:11:47,700
thank you Sarah yeah great talk thank

283
00:11:54,210 --> 00:11:51,550
you so am I understand that that change

284
00:11:56,430 --> 00:11:54,220
in activity is not a gray thing so it's

285
00:12:00,360 --> 00:11:56,440
really different different wavelengths

286
00:12:01,980 --> 00:12:00,370
so what does it mean for trends and

287
00:12:03,930 --> 00:12:01,990
observations at different points of time

288
00:12:05,460 --> 00:12:03,940

that you want to put together to get a

289
00:12:07,620 --> 00:12:05,470
transmission or emission spectra of

290
00:12:10,980 --> 00:12:07,630
these guys does it even is it impossible

291
00:12:13,530 --> 00:12:10,990
yeah well that's a good question so I

292
00:12:15,750 --> 00:12:13,540
mean it's mainly in the UV most transit

293
00:12:18,510 --> 00:12:15,760
missions I feel like aren't doing

294
00:12:20,400 --> 00:12:18,520
observations at those wavelengths but

295
00:12:21,780 --> 00:12:20,410
you also shot the infrared spectrum I'd

296
00:12:24,570 --> 00:12:21,790
the difference between active and

297
00:12:26,970 --> 00:12:24,580
inactive and then that me phantoms up

298
00:12:29,940 --> 00:12:26,980
and active inactive models in the

299
00:12:31,680 --> 00:12:29,950
infrared are the same so it's really

300
00:12:34,050 --> 00:12:31,690
basically you have the difference up to

301
00:12:36,330 --> 00:12:34,060
about three thousand angstroms and and

302
00:12:38,010 --> 00:12:36,340
then the it doesn't really matter so I

303
00:12:39,720 --> 00:12:38,020
would say if you're if you're and

304
00:12:41,670 --> 00:12:39,730
especially flaring and stuff like that

305
00:12:43,830 --> 00:12:41,680
could be a and and the difference in

306
00:12:45,450 --> 00:12:43,840
magnitude is quite substantial so I

307
00:12:46,890 --> 00:12:45,460
would say a couple things so it really

308
00:12:49,080 --> 00:12:46,900
depends on what the age of the star is

309
00:12:51,360 --> 00:12:49,090
if it's a really young star and you're

310
00:12:54,810 --> 00:12:51,370
doing your transit observations in the

311
00:12:56,220 --> 00:12:54,820
UV that he could be a big problem but I

312
00:12:58,740 --> 00:12:56,230
think most of the time people are

313
00:13:01,170 --> 00:12:58,750

probably going to be looking you know

314
00:13:03,180 --> 00:13:01,180
especially in the I are you know more

315
00:13:04,920 --> 00:13:03,190
that five to 20 micron region then it's

316
00:13:06,740 --> 00:13:04,930
not going to matter or if you're looking

317
00:13:08,150 --> 00:13:06,750
at an older star that's quieted down

318
00:13:09,680 --> 00:13:08,160
it's not going to matter but that's a

319
00:13:13,130 --> 00:13:09,690
very good point in that you know just

320
00:13:15,080 --> 00:13:13,140
the month-to-month UV flux level could

321
00:13:18,740 --> 00:13:15,090
change photo so the time skates a month

322
00:13:20,030 --> 00:13:18,750
but bunt flaring you know I should I

323
00:13:21,710 --> 00:13:20,040
should know this more I think I think

324
00:13:24,140 --> 00:13:21,720
they do observe them pretty you know

325
00:13:27,200 --> 00:13:24,150
like some quite substantial changes like

326
00:13:28,760 --> 00:13:27,210
an ad Leo the flare you know months it

327
00:13:31,370 --> 00:13:28,770
one month's the next was quite different

328
00:13:34,810 --> 00:13:31,380
in activity levels and won't recommend

329
00:13:37,220 --> 00:13:34,820
so um but we should mention that these

330
00:13:39,830 --> 00:13:37,230
planets are most probably tightly locked

331
00:13:42,740 --> 00:13:39,840
and that also might have an impact on

332
00:13:44,360 --> 00:13:42,750
know how their yes females been some

333
00:13:45,980 --> 00:13:44,370
research done with 3d modeling that

334
00:13:48,590 --> 00:13:45,990
probably the tidal locking you'll still

335
00:13:49,790 --> 00:13:48,600
have enough you know circulation of the

336
00:13:52,610 --> 00:13:49,800
atmosphere that you won't have problems

337
00:13:54,440 --> 00:13:52,620
like the atmosphere collapsing also you

338
00:13:56,360 --> 00:13:54,450

have like spin orbit residences which

339
00:13:58,580 --> 00:13:56,370
mean that quite a few of these planets

340
00:14:00,050 --> 00:13:58,590
might not be tidally locked but

341
00:14:02,330 --> 00:14:00,060
certainly yeah you need you really need

342
00:14:04,100 --> 00:14:02,340
to I think dig into 3d models to see the

343
00:14:12,200 --> 00:14:04,110
atmospheric dynamics for a tidally

344
00:14:16,480 --> 00:14:12,210
locked planet any more questions all

345
00:14:19,250 --> 00:14:16,490
right today Sarah can do this all day