
AbSciCon
2017
MESA, ARIZONA

1
00:00:12,250 --> 00:00:06,150
you

2
00:00:16,510 --> 00:00:14,160
[Music]

3
00:00:18,310 --> 00:00:16,520
first off let me to mention really

4
00:00:22,179 --> 00:00:18,320
really quickly that this is actually my

5
00:00:24,339 --> 00:00:22,189
first foray into the exo astrobiology

6
00:00:26,609 --> 00:00:24,349
exoplanet habitability world and I

7
00:00:28,930 --> 00:00:26,619
really enjoyed apps icon conference so

8
00:00:30,519 --> 00:00:28,940
thanks to Apps icon for existing and

9
00:00:33,220 --> 00:00:30,529
thanks to all the people who put this on

10
00:00:36,520 --> 00:00:33,230
so I think by now we know we've heard

11
00:00:37,660 --> 00:00:36,530
enough that M dwarfs and exoplanets go

12
00:00:40,630 --> 00:00:37,670
together like peanut butter and jelly

13
00:00:42,670 --> 00:00:40,640

they really are a really nice place to

14
00:00:45,880 --> 00:00:42,680
study exoplanet science especially

15
00:00:47,889 --> 00:00:45,890
habitable zone exoplanets and we've

16
00:00:49,389 --> 00:00:47,899
heard a lot about M dwarfs so far but I

17
00:00:53,290 --> 00:00:49,399
haven't seen anyone actually put up any

18
00:00:54,490 --> 00:00:53,300
of their actual physical properties so I

19
00:00:55,540 --> 00:00:54,500
want to run through some numbers really

20
00:00:56,860 --> 00:00:55,550
quick because I think these are

21
00:00:59,139 --> 00:00:56,870
important I think some people might not

22
00:01:01,959 --> 00:00:59,149
actually know this stuff so we actually

23
00:01:03,160 --> 00:01:01,969
have M doors have masses from about half

24
00:01:04,660 --> 00:01:03,170
a solar mass all the way down to the

25
00:01:07,900 --> 00:01:04,670
hydrogen burning limit at point O eight

26
00:01:11,710 --> 00:01:07,910
solar masses they have temperatures from

27
00:01:14,560 --> 00:01:11,720
2400 to 3800 Kelvin there are more than

28
00:01:15,880 --> 00:01:14,570
anything else out there a star wise so

29
00:01:17,859 --> 00:01:15,890
none of us have actually gone outside

30
00:01:19,660 --> 00:01:17,869
and looked up and seen an AM dork before

31
00:01:21,070 --> 00:01:19,670
they're all too faint and divisible to

32
00:01:22,750 --> 00:01:21,080
actually see but there are more M doors

33
00:01:24,219 --> 00:01:22,760
than anything else

34
00:01:26,320 --> 00:01:24,229
thanks to Kepler we know that

35
00:01:28,359 --> 00:01:26,330
statistically speaking they all have

36
00:01:30,370 --> 00:01:28,369
exoplanets and a lot of these exoplanets

37
00:01:31,929 --> 00:01:30,380
that are a significant portion of them

38
00:01:33,730 --> 00:01:31,939

have earth dish sized planets in their

39
00:01:35,649 --> 00:01:33,740
habitable zone but it really is the

40
00:01:37,179 --> 00:01:35,659
physical characteristics that make the

41
00:01:39,640 --> 00:01:37,189
biggest difference in why we are so

42
00:01:43,359 --> 00:01:39,650
focused on them right so a lower mass

43
00:01:45,280 --> 00:01:43,369
means that an earth-sized planet naboo

44
00:01:46,929 --> 00:01:45,290
ozone will will induce a larger radio

45
00:01:49,140 --> 00:01:46,939
velocity signal and so that's great that

46
00:01:51,310 --> 00:01:49,150
larger signal is better for observers

47
00:01:53,140 --> 00:01:51,320
the lower temperature means lower the

48
00:01:55,210 --> 00:01:53,150
velocity and so a transiting exoplanet

49
00:01:57,550 --> 00:01:55,220
will have a deeper transit depth that's

50
00:01:58,990 --> 00:01:57,560
also great for us and the lower

51
00:02:01,149 --> 00:01:59,000
temperature also means a closer

52
00:02:02,710 --> 00:02:01,159
habitable zone so all the habitable

53
00:02:04,950 --> 00:02:02,720
zones of M dwarfs are within the orbit

54
00:02:07,749 --> 00:02:04,960
of mercury which is about point for au

55
00:02:09,219 --> 00:02:07,759
so they're very very compact systems and

56
00:02:11,830 --> 00:02:09,229
these shorter periods are great for

57
00:02:13,360 --> 00:02:11,840
detection and follow-up so if you're

58
00:02:14,800 --> 00:02:13,370
waiting for something to transit more

59
00:02:16,240 --> 00:02:14,810
than once you can wait days and weeks

60
00:02:18,280 --> 00:02:16,250
for planets in the habitable zones

61
00:02:21,550 --> 00:02:18,290
around M Dwarfs but a solar type star

62
00:02:23,470 --> 00:02:21,560
you've got to wait a year or so okay so

63
00:02:25,260 --> 00:02:23,480

this has not gone all these

64
00:02:27,180 --> 00:02:25,270
observational

65
00:02:28,800 --> 00:02:27,190
Vantage's have not gone unnoticed by

66
00:02:30,450 --> 00:02:28,810
astronomers and I won't belabor this

67
00:02:32,040 --> 00:02:30,460
because we've seen all this but we've

68
00:02:34,170 --> 00:02:32,050
made some really spectacular discoveries

69
00:02:37,110 --> 00:02:34,180
around M dwarfs recently and equally

70
00:02:40,590 --> 00:02:37,120
spectacular exoplanet artwork which is

71
00:02:41,910 --> 00:02:40,600
great for all of our talks but some of

72
00:02:45,090 --> 00:02:41,920
this I just want to point out that these

73
00:02:47,430 --> 00:02:45,100
spectral types range from M 3 4 GJ 11:32

74
00:02:48,720 --> 00:02:47,440
and 5 and a half for products an m8 for

75
00:02:52,730 --> 00:02:48,730
Travis one so we're really running the

76
00:02:55,350 --> 00:02:52,740
whole range of m-dwarf spectral types

77
00:02:57,240 --> 00:02:55,360
okay so but the real question we want to

78
00:03:00,930 --> 00:02:57,250
ask yourself is reason we're all here is

79
00:03:03,240 --> 00:03:00,940
our our habitable zone planets orbitting

80
00:03:04,820 --> 00:03:03,250
M Bors truly habitable and we've heard a

81
00:03:07,350 --> 00:03:04,830
lot from a lot of different speakers

82
00:03:09,330 --> 00:03:07,360
about how this is an extremely complex

83
00:03:11,370 --> 00:03:09,340
issue we have the tidal locking scenario

84
00:03:14,670 --> 00:03:11,380
and all the issues that that entails the

85
00:03:16,260 --> 00:03:14,680
prolonged main-sequence evolution the

86
00:03:18,210 --> 00:03:16,270
more frequent flaring which we just kind

87
00:03:21,810 --> 00:03:18,220
of talked about we had a really nice

88
00:03:23,310 --> 00:03:21,820

discussion about and increased high

89
00:03:26,790 --> 00:03:23,320
energy radiation and that's what I'm

90
00:03:28,320 --> 00:03:26,800
really focused on today okay and so one

91
00:03:30,600 --> 00:03:28,330
of the reasons that this increased

92
00:03:31,980 --> 00:03:30,610
high-energy radiation is so important

93
00:03:33,090 --> 00:03:31,990
around M courses because the habitable

94
00:03:36,540 --> 00:03:33,100
zones are so close so they're much

95
00:03:37,770 --> 00:03:36,550
closer and this really great figure put

96
00:03:39,480 --> 00:03:37,780
together by of junior school next shows

97
00:03:41,040 --> 00:03:39,490
across absorption cross-sections for a

98
00:03:46,350 --> 00:03:41,050
bunch of different molecules that we may

99
00:03:48,990 --> 00:03:46,360
be interested in and and sorry and the

100
00:03:52,860 --> 00:03:49,000
wavelength for those cross sections and

101
00:03:54,720 --> 00:03:52,870
so the best place to observe em doors to

102
00:03:57,180 --> 00:03:54,730
find out what this high-energy radiation

103
00:03:58,890 --> 00:03:57,190
would look like is in the e UV but

104
00:04:00,810 --> 00:03:58,900
unfortunately we don't have something

105
00:04:03,810 --> 00:04:00,820
that observes there at the moment what

106
00:04:07,680 --> 00:04:03,820
we do have however is Galax so Galax is

107
00:04:09,660 --> 00:04:07,690
a Galaxy Evolution Explorer what I like

108
00:04:14,070 --> 00:04:09,670
to think of also as a serendipitous

109
00:04:17,430 --> 00:04:14,080
m-dwarf Evolution Explorer so Galax had

110
00:04:21,720 --> 00:04:17,440
to UV bands the f UV and the new UV

111
00:04:23,220 --> 00:04:21,730
which are seeing here and so the idea

112
00:04:25,710 --> 00:04:23,230
behind what we're doing is we want to

113
00:04:29,159 --> 00:04:25,720

look at a whole range of spectral types

114
00:04:31,530 --> 00:04:29,169
and ages of M dwarfs and constrain

115
00:04:34,560 --> 00:04:31,540
what's going on in these this wavelength

116
00:04:36,630 --> 00:04:34,570
region and to help inform the the low

117
00:04:37,980 --> 00:04:36,640
mass models so that we can get an a

118
00:04:40,650 --> 00:04:37,990
better idea of also what

119
00:04:42,450 --> 00:04:40,660
happening over here that makes sense all

120
00:04:44,880 --> 00:04:42,460
right and so this is why the hazmat

121
00:04:46,980 --> 00:04:44,890
program was initiated hazmat stands for

122
00:04:49,770 --> 00:04:46,990
habitable zones and m-dwarf activity

123
00:04:51,300 --> 00:04:49,780
across time and so this is a really nice

124
00:04:52,650 --> 00:04:51,310
paper by shkolnik environment so this is

125
00:04:55,140 --> 00:04:52,660
one of the first results of the hazmat

126
00:04:58,680 --> 00:04:55,150
program what we're showing here is the

127
00:05:03,540 --> 00:04:58,690
flux density ratio for fuv in blue and

128
00:05:06,810 --> 00:05:03,550
near UV in white for M doors at

129
00:05:11,220 --> 00:05:06,820
different ages and so the evolution of

130
00:05:13,110 --> 00:05:11,230
the UV flux in the n UV nephew baby band

131
00:05:14,910 --> 00:05:13,120
looks something like pretty flat for the

132
00:05:16,920 --> 00:05:14,920
first few hundred million years and then

133
00:05:18,660 --> 00:05:16,930
a decrease as you get to say Heidi's age

134
00:05:20,550 --> 00:05:18,670
and then a further decrease as you get

135
00:05:23,940 --> 00:05:20,560
to field age which we're calling around

136
00:05:27,000 --> 00:05:23,950
five Giga years but this initial survey

137
00:05:29,730 --> 00:05:27,010
was done mostly with early type M and as

138
00:05:31,020 --> 00:05:29,740

we've seen in a lot of talks some of our

139
00:05:33,120 --> 00:05:31,030
most spectacular discoveries around

140
00:05:36,090 --> 00:05:33,130
later types so box 10 is an M 5.5

141
00:05:37,680 --> 00:05:36,100
Trappist m8 and so we're asking the

142
00:05:40,290 --> 00:05:37,690
question now what about late M's does

143
00:05:43,680 --> 00:05:40,300
this evolution look the same for late M

144
00:05:45,510 --> 00:05:43,690
doors and so the way we're going about

145
00:05:46,980 --> 00:05:45,520
doing this is we have we have a really

146
00:05:49,170 --> 00:05:46,990
large database of high-resolution

147
00:05:51,180 --> 00:05:49,180
optical spectra from quite a few

148
00:05:53,520 --> 00:05:51,190
different books normally quite a few

149
00:05:55,320 --> 00:05:53,530
different observatories and so we're

150
00:05:56,880 --> 00:05:55,330
looking at all the spectra finding new

151
00:05:59,670 --> 00:05:56,890
moving group members so moving groups

152
00:06:01,380 --> 00:05:59,680
are young coeval groups of stars in the

153
00:06:04,680 --> 00:06:01,390
solar neighborhood that provide an ice

154
00:06:05,850 --> 00:06:04,690
age data point for this kind of study so

155
00:06:07,380 --> 00:06:05,860
we're finding new moving group members

156
00:06:08,760 --> 00:06:07,390
and there are other groups that are also

157
00:06:11,190 --> 00:06:08,770
we're not the only ones interested in

158
00:06:12,180 --> 00:06:11,200
this for many many other reasons so

159
00:06:16,050 --> 00:06:12,190
there are other groups that are looking

160
00:06:18,540 --> 00:06:16,060
for late type M dwarfs of moving groups

161
00:06:20,160 --> 00:06:18,550
and some really nice surveys have been

162
00:06:21,240 --> 00:06:20,170
published recently like the Tyrael Hydra

163
00:06:23,040 --> 00:06:21,250

Association there was a really nice

164
00:06:25,230 --> 00:06:23,050
paper but Jonathan Gagne earlier this

165
00:06:27,210 --> 00:06:25,240
year the beta Pictoris moving group with

166
00:06:28,590 --> 00:06:27,220
an age of 24 million years this is the

167
00:06:29,340 --> 00:06:28,600
paper that's submitted at the moment it

168
00:06:31,650 --> 00:06:29,350
should be out soon

169
00:06:33,300 --> 00:06:31,660
stay tuned for that the Tuck

170
00:06:34,440 --> 00:06:33,310
association with an age of around 45

171
00:06:36,870 --> 00:06:34,450
million years there's a really nice

172
00:06:38,670 --> 00:06:36,880
survey by Adam Krauss in 2014 we're

173
00:06:40,470 --> 00:06:38,680
using the high D sample from Goldman in

174
00:06:42,840 --> 00:06:40,480
2013 so there's a really deep Heidi

175
00:06:44,430 --> 00:06:42,850
survey for low mass numbers and then for

176
00:06:46,520 --> 00:06:44,440
our older members we're using the eight

177
00:06:48,480 --> 00:06:46,530
parts example from David Kirkpatrick

178
00:06:50,010 --> 00:06:48,490
because most things in the solar

179
00:06:51,839 --> 00:06:50,020
neighborhood like really

180
00:06:53,730 --> 00:06:51,849
immediate solar neighborhood our field

181
00:06:56,279 --> 00:06:53,740
age that we can apply an older age to

182
00:06:57,869 --> 00:06:56,289
those and so this is the sample we're

183
00:06:59,249 --> 00:06:57,879
working with right now compared to the

184
00:07:03,210 --> 00:06:59,259
sample from the school neck in farming

185
00:07:04,830 --> 00:07:03,220
2014 paper and you can see for most for

186
00:07:07,020 --> 00:07:04,840
several of these groups especially kW

187
00:07:09,059 --> 00:07:07,030
Hydra beta pick in the old sample we're

188
00:07:10,830 --> 00:07:09,069

not only adding more members but we're

189
00:07:12,930 --> 00:07:10,840
also adding more later type members as

190
00:07:13,920 --> 00:07:12,940
well these are all the ones I should

191
00:07:16,170 --> 00:07:13,930
mention this these are all the ones that

192
00:07:17,779 --> 00:07:16,180
actually have a Gallic detection right

193
00:07:19,770 --> 00:07:17,789
so there are some that were observed by

194
00:07:21,059 --> 00:07:19,780
actually observed by Galax but we're not

195
00:07:25,200 --> 00:07:21,069
detected and those aren't included on

196
00:07:26,760 --> 00:07:25,210
these okay for the next few figures I'm

197
00:07:29,149 --> 00:07:26,770
actually going to break it up into two

198
00:07:31,770 --> 00:07:29,159
spectral type bins early em and later em

199
00:07:33,510 --> 00:07:31,780
and later M is going to stop at m6

200
00:07:35,430 --> 00:07:33,520
because some of these groups like tuck

201
00:07:37,230 --> 00:07:35,440
horn the hidys this basically as far out

202
00:07:39,210 --> 00:07:37,240
in spectral type range we want to get so

203
00:07:41,100 --> 00:07:39,220
we did m3 to m7 we'd be including some

204
00:07:43,350 --> 00:07:41,110
from some groups and not others so we're

205
00:07:45,450 --> 00:07:43,360
stopping at m6 just for this the

206
00:07:47,159 --> 00:07:45,460
purposes of this talk and we could break

207
00:07:49,230 --> 00:07:47,169
them up into eat individual spectral

208
00:07:51,360 --> 00:07:49,240
types but early in light kind of gets

209
00:07:53,010 --> 00:07:51,370
the point across so we have early M

210
00:07:55,770 --> 00:07:53,020
types on the left side so again this is

211
00:07:57,930 --> 00:07:55,780
the flux density ratio versus age and

212
00:08:00,020 --> 00:07:57,940
then we have lay thames over here so

213
00:08:02,040 --> 00:08:00,030

early M's you can see a similar

214
00:08:03,420 --> 00:08:02,050
unsurprisingly if we find a very similar

215
00:08:05,580 --> 00:08:03,430
trend of oracle in the environment found

216
00:08:07,230 --> 00:08:05,590
which is that it's a relatively flat for

217
00:08:09,839 --> 00:08:07,240
early ages and then you get a drop at

218
00:08:13,170 --> 00:08:09,849
heidi's age and then all the way down to

219
00:08:15,180 --> 00:08:13,180
the field age drops even further these

220
00:08:17,219 --> 00:08:15,190
red points are the medians of all these

221
00:08:19,110 --> 00:08:17,229
distributions so some of them have

222
00:08:21,029 --> 00:08:19,120
really large distributions but there are

223
00:08:23,969 --> 00:08:21,039
a lot of points underneath these medians

224
00:08:26,700 --> 00:08:23,979
so in general they're representatives of

225
00:08:27,779 --> 00:08:26,710
these groups for late type M's though

226
00:08:32,670 --> 00:08:27,789
you'll see something a little bit

227
00:08:35,069 --> 00:08:32,680
different so it looks like the the near

228
00:08:37,500 --> 00:08:35,079
UV evolution so the near UV flux is

229
00:08:40,050 --> 00:08:37,510
pretty much consistent all the way up to

230
00:08:42,600 --> 00:08:40,060
heidi's age and then drops down a little

231
00:08:45,600 --> 00:08:42,610
bit to field age and this distribution

232
00:08:47,160 --> 00:08:45,610
this spread is much larger than what we

233
00:08:49,190 --> 00:08:47,170
have over here but there are a lot of

234
00:08:51,060 --> 00:08:49,200
data points again under this spot so the

235
00:08:55,230 --> 00:08:51,070
error bars which we'll see on the next

236
00:08:57,510 --> 00:08:55,240
slide are are more representative of

237
00:08:59,010 --> 00:08:57,520
what the spread really is okay so the

238
00:09:02,180 --> 00:08:59,020

here those two distributions compared to

239
00:09:03,830 --> 00:09:02,190
each other again nothing too dramatic

240
00:09:07,870 --> 00:09:03,840
here but when you know a couple things

241
00:09:10,400 --> 00:09:07,880
to point out is that the relative change

242
00:09:13,010 --> 00:09:10,410
from from tuck or edge which is around

243
00:09:15,500 --> 00:09:13,020
45 million years to Heidi's age which is

244
00:09:17,780 --> 00:09:15,510
600 million years there's pretty much no

245
00:09:19,670 --> 00:09:17,790
change for the late MS but for the early

246
00:09:21,110 --> 00:09:19,680
ends we see a decrease and select

247
00:09:25,220 --> 00:09:21,120
density ratio of around two and a half

248
00:09:27,470 --> 00:09:25,230
times right and if you go from tuck or

249
00:09:31,280 --> 00:09:27,480
age to field age we only see a decrease

250
00:09:32,960 --> 00:09:31,290
of about three times what we would see

251
00:09:36,860 --> 00:09:32,970
at younger ages for the field age and

252
00:09:38,780 --> 00:09:36,870
for the early type M s we see a decrease

253
00:09:41,480 --> 00:09:38,790
by about eleven tile factory of eleven

254
00:09:46,460 --> 00:09:41,490
right and so this is what this is

255
00:09:49,070 --> 00:09:46,470
telling us is that the the UV flux is

256
00:09:50,390 --> 00:09:49,080
remaining at a higher level for later

257
00:09:51,860 --> 00:09:50,400
type M's for a longer period of time

258
00:09:56,390 --> 00:09:51,870
which is kind of what we expected but

259
00:10:00,740 --> 00:09:56,400
it's nice to see it in the data for okay

260
00:10:02,090 --> 00:10:00,750
for late type for late type or sorry for

261
00:10:03,470 --> 00:10:02,100
the f UV it gets a little more

262
00:10:06,260 --> 00:10:03,480
complicated so what we're actually

263
00:10:07,700 --> 00:10:06,270

seeing unfortunately is the Hyades all

264
00:10:08,990 --> 00:10:07,710
the heidi's members we searched the best

265
00:10:13,490 --> 00:10:09,000
majority of them were actually not

266
00:10:14,720 --> 00:10:13,500
detected and so only ten de Sarre

267
00:10:16,760 --> 00:10:14,730
fifteen to twenty percent of them were

268
00:10:18,650 --> 00:10:16,770
detected in the early spectral type

269
00:10:20,600 --> 00:10:18,660
range and only five to ten percent were

270
00:10:22,520 --> 00:10:20,610
detected light spectral types but we can

271
00:10:25,400 --> 00:10:22,530
say something a little bit about this

272
00:10:26,660 --> 00:10:25,410
distribution so again pretty flat I

273
00:10:29,390 --> 00:10:26,670
think I know what this is happening but

274
00:10:30,740 --> 00:10:29,400
that's a different process and they

275
00:10:32,270 --> 00:10:30,750
decreased quite a bit over here so

276
00:10:35,270 --> 00:10:32,280
unfortunately we don't have a lot of

277
00:10:39,770 --> 00:10:35,280
constraints here your guess as to what's

278
00:10:41,630 --> 00:10:39,780
going on come on buddy it's probably

279
00:10:43,670 --> 00:10:41,640
much better much much better than my

280
00:10:47,060 --> 00:10:43,680
guess as to what's going on but

281
00:10:50,150 --> 00:10:47,070
seriously we can say that the difference

282
00:10:52,340 --> 00:10:50,160
in the medians here is only for a factor

283
00:10:54,440 --> 00:10:52,350
of four but for the early type stars is

284
00:10:55,970 --> 00:10:54,450
a factor of 35 so it's even more

285
00:10:57,829 --> 00:10:55,980
dramatic for the fuv what's going on

286
00:10:59,720 --> 00:10:57,839
with these plate type stars and really

287
00:11:03,320 --> 00:10:59,730
really quickly I just want to get into

288
00:11:04,430 --> 00:11:03,330

the new UV - new UV flux ratio so we've

289
00:11:05,690 --> 00:11:04,440
heard about this in some of the earlier

290
00:11:08,120 --> 00:11:05,700
talks this week and I actually just

291
00:11:09,950 --> 00:11:08,130
stole a quote right out of Harmon 2015

292
00:11:12,380 --> 00:11:09,960
so whether Oh - and carbon monoxide can

293
00:11:14,300 --> 00:11:12,390
accumulate - appreciable concentrations

294
00:11:15,180 --> 00:11:14,310
depends on the ratio of F UV - new UV

295
00:11:17,070 --> 00:11:15,190
radiation coming from

296
00:11:18,360 --> 00:11:17,080
oink's parrots are so this ratio is

297
00:11:19,740 --> 00:11:18,370
really important for figuring out the

298
00:11:21,930 --> 00:11:19,750
chemistry and the atmospheres that are

299
00:11:24,360 --> 00:11:21,940
that are occurring on any orbiting

300
00:11:26,070 --> 00:11:24,370
planet and so what we're seeing is it's

301
00:11:28,170 --> 00:11:26,080
not only a function of spectral type

302
00:11:31,290 --> 00:11:28,180
right so this is the old spectral type

303
00:11:32,730 --> 00:11:31,300
here but it's also a function of age but

304
00:11:34,440 --> 00:11:32,740
the age is kind of interesting because

305
00:11:36,240 --> 00:11:34,450
the differences in ages are only showing

306
00:11:38,160 --> 00:11:36,250
up for the early spectral types and not

307
00:11:40,770 --> 00:11:38,170
the late spectral text right so if you

308
00:11:42,810 --> 00:11:40,780
want to figure out the fu V 2 nu V ratio

309
00:11:44,850 --> 00:11:42,820
you need to know the age and spectral

310
00:11:48,150 --> 00:11:44,860
type kind of well okay so I'll just

311
00:11:58,170 --> 00:11:48,160
leave up the summary and wait questions

312
00:12:00,450 --> 00:11:58,180
thank you thanks for the quote before

313
00:12:00,780 --> 00:12:00,460

you say anything absolutely it was my

314
00:12:03,030 --> 00:12:00,790
pleasure

315
00:12:04,950 --> 00:12:03,040
Sonny Harmon Penn State I was curious if

316
00:12:06,060 --> 00:12:04,960
you have any idea so it looked like you

317
00:12:09,660 --> 00:12:06,070
didn't quite get out the lyman-alpha

318
00:12:11,460 --> 00:12:09,670
right if you have some idea of how the

319
00:12:14,130 --> 00:12:11,470
lyman-alpha is going to dominate fuv

320
00:12:15,480 --> 00:12:14,140
over those age right so you're

321
00:12:17,700 --> 00:12:15,490
absolutely right lyman-alpha will

322
00:12:19,200 --> 00:12:17,710
dominate the FPV range but i think i

323
00:12:22,950 --> 00:12:19,210
think what we're learning in a Virginia

324
00:12:25,860 --> 00:12:22,960
can correct me if I'm wrong the that fuv

325
00:12:27,750 --> 00:12:25,870
will still scale relatively right so

326
00:12:28,980 --> 00:12:27,760
your f UV 2 n UV ratio will still be

327
00:12:31,230 --> 00:12:28,990
similar whether or not you include

328
00:12:32,490 --> 00:12:31,240
lyman-alpha or not right because there

329
00:12:38,220 --> 00:12:32,500
are other lines in there there will also

330
00:12:38,700 --> 00:12:38,230
be brighter less bright Thanks no

331
00:12:40,260 --> 00:12:38,710
problem

332
00:12:42,570 --> 00:12:40,270
all right we actually also have a

333
00:12:46,230 --> 00:12:42,580
question from Ravi Kapoor he was

334
00:12:47,820 --> 00:12:46,240
watching online hi Ravi Robert why do

335
00:12:49,770 --> 00:12:47,830
you lead type main sequence and UV

336
00:12:53,400 --> 00:12:49,780
fluxes why don't they drop as much with

337
00:12:55,260 --> 00:12:53,410
age the main thing for late type why do

338
00:12:57,480 --> 00:12:55,270

they not drop much all right I said main

339
00:12:59,400 --> 00:12:57,490
secrets why don't wait type M s & UV

340
00:13:00,810 --> 00:12:59,410
fluxes why don't they drop the page yeah

341
00:13:02,100 --> 00:13:00,820
so that gets into the physical reason

342
00:13:05,040 --> 00:13:02,110
why this is happening which I didn't

343
00:13:07,800 --> 00:13:05,050
mention at all and my guess is is that

344
00:13:11,400 --> 00:13:07,810
it's all related to rotation right so a

345
00:13:14,850 --> 00:13:11,410
so near so late type stars don't spin

346
00:13:16,500 --> 00:13:14,860
down nearly as fast what's happening is

347
00:13:18,480 --> 00:13:16,510
you're basically on the edge of where

348
00:13:22,020 --> 00:13:18,490
you become fully convective between m3

349
00:13:23,820 --> 00:13:22,030
and m4 and so M later M don't spin down

350
00:13:25,300 --> 00:13:23,830
so they're still rapidly rotating and

351
00:13:26,410 --> 00:13:25,310
rotation related to activity

352
00:13:27,670 --> 00:13:26,420
and that's why they're just staying

353
00:13:33,390 --> 00:13:27,680
active for much longer periods of time