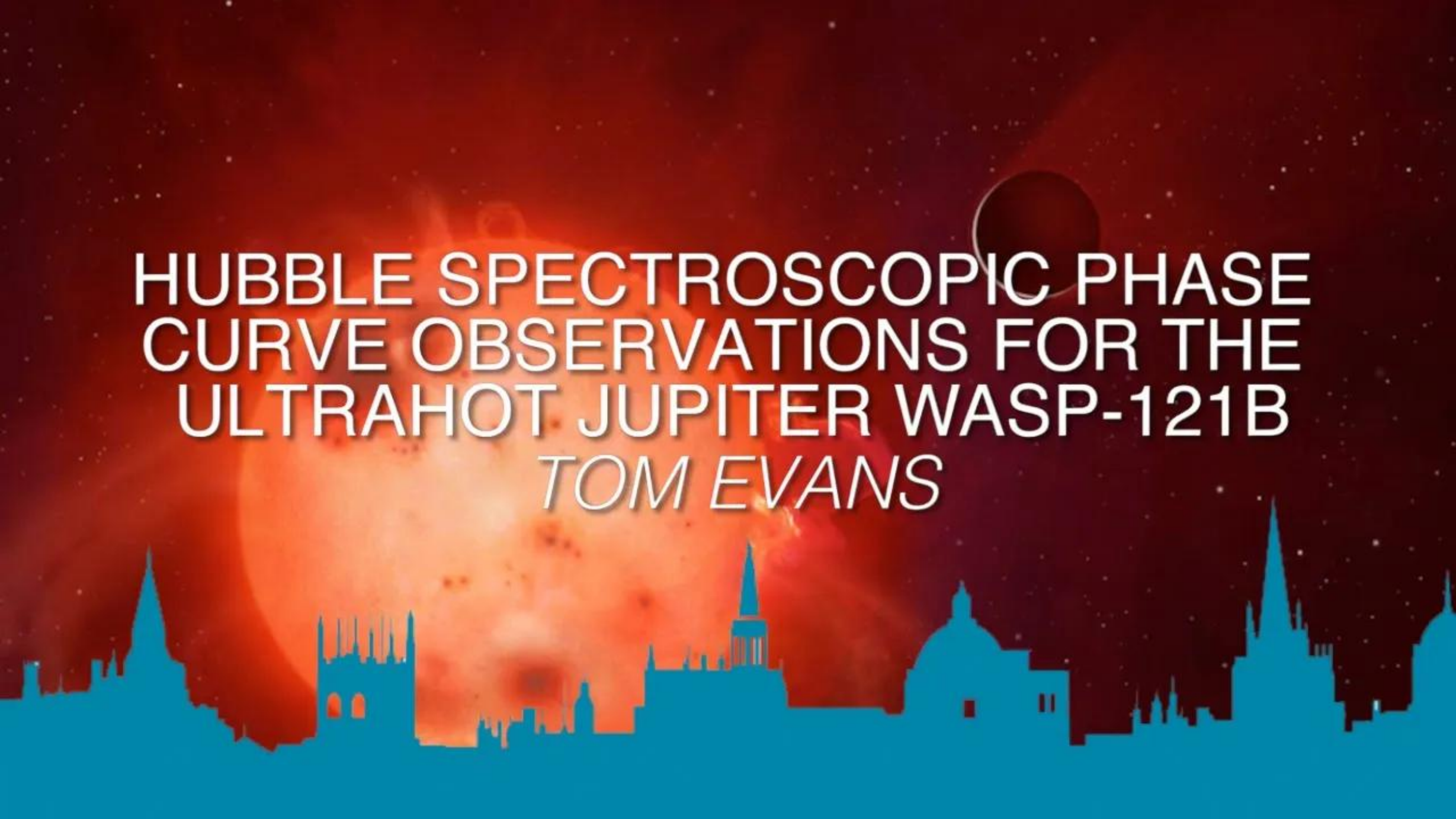
HUBBLE SPECTROSCOPIC PHASE CURVE OBSERVATIONS FOR THE ULTRAHOT JUPITER WASP-121B
TOM EVANS

1
00:00:08,590 --> 00:00:07,170
[Music]

2
00:00:13,390 --> 00:00:08,600
okay thank you

3
00:00:16,089 --> 00:00:13,400
um all right so today I am going to be

4
00:00:19,269 --> 00:00:16,099
giving an update on a Hubbell program

5
00:00:23,710 --> 00:00:19,279
that I'm leading with Tiffany Kataria at

6
00:00:28,359 --> 00:00:23,720
JPL to measure the face curve for the

7
00:00:31,330 --> 00:00:28,369
ultra jupiter was 1:21 being so to put

8
00:00:34,450 --> 00:00:31,340
plus 121 in the context of the overall

9
00:00:38,319 --> 00:00:34,460
exoplanet population here is a mass

10
00:00:40,869 --> 00:00:38,329
radius diagram showing the currently

11
00:00:44,619 --> 00:00:40,879
known transiting exoplanets with

12
00:00:47,229 --> 00:00:44,629
measured masses and so what's 121 is way

13
00:00:49,450 --> 00:00:47,239

off here it's one of the most inflated

14
00:00:51,400 --> 00:00:49,460
and highest temperature exoplanets that

15
00:00:53,500 --> 00:00:51,410
we currently know of and these

16
00:00:54,610 --> 00:00:53,510
properties make it exceptionally

17
00:00:57,670 --> 00:00:54,620
favorable for atoms fair

18
00:00:59,560 --> 00:00:57,680
characterization both with thermal

19
00:01:04,210 --> 00:00:59,570
emission measurements and transmission

20
00:01:06,550 --> 00:01:04,220
spectroscopy so this is the hubble phase

21
00:01:09,999 --> 00:01:06,560
curve that we have measured for lost 121

22
00:01:14,050 --> 00:01:10,009
B and so I'm going to be talking about

23
00:01:16,690 --> 00:01:14,060
that as we go along but before I do so I

24
00:01:20,169 --> 00:01:16,700
want to give some background on what's

25
00:01:22,089 --> 00:01:20,179
121 why is a particularly compelling

26
00:01:25,150 --> 00:01:22,099
target on what we know about it already

27
00:01:28,870 --> 00:01:25,160
so perhaps the the main claim to fame

28
00:01:32,499 --> 00:01:28,880
for what 121 B is it was the first

29
00:01:34,570 --> 00:01:32,509
exoplanet for which we made a robust

30
00:01:37,779 --> 00:01:34,580
detection of a thermal inversion on the

31
00:01:40,120 --> 00:01:37,789
dayside hemisphere and we did that by

32
00:01:43,870 --> 00:01:40,130
measuring a secondary Eclipse with

33
00:01:45,999 --> 00:01:43,880
Hubble y fo camera three and measuring

34
00:01:50,669 --> 00:01:46,009
the dayside emission spectrum which is

35
00:01:54,490 --> 00:01:50,679
shown up here from 1.1 to 1.6 micron and

36
00:01:57,910 --> 00:01:54,500
the thing that we saw was that this 1.4

37
00:01:59,859 --> 00:01:57,920
micron water band is seen in a mission

38
00:02:01,869 --> 00:01:59,869

rather than absorption and that tells

39
00:02:05,139 --> 00:02:01,879
you that the temperature is increasing

40
00:02:06,400 --> 00:02:05,149
with altitude in the atmosphere which is

41
00:02:08,529 --> 00:02:06,410
what we see there and this is something

42
00:02:11,199 --> 00:02:08,539
that have been predicted for these

43
00:02:12,610 --> 00:02:11,209
highly irradiated exoplanets that are

44
00:02:15,820 --> 00:02:12,620
tidally locked going back to at least

45
00:02:18,050 --> 00:02:15,830
the early 2000s if you have an

46
00:02:20,270 --> 00:02:18,060
atmospheric opacity and the optical

47
00:02:24,949 --> 00:02:20,280
that is comparable to or greater than

48
00:02:26,839 --> 00:02:24,959
that in the infrared so we've also

49
00:02:29,870 --> 00:02:26,849
measured a very detailed transmission

50
00:02:32,050 --> 00:02:29,880
spectrum for 1:21 this is all data taken

51
00:02:35,440 --> 00:02:32,060
with Hubble wife your camera and sniffs

52
00:02:37,940 --> 00:02:35,450
we see the water band at 1.4 micron

53
00:02:39,890 --> 00:02:37,950
something at 1.2 micron that we still

54
00:02:43,400 --> 00:02:39,900
don't really know what it is and

55
00:02:45,350 --> 00:02:43,410
throughout the optical a bunch of stuff

56
00:02:48,860 --> 00:02:45,360
going on that can be well explained by

57
00:02:50,630 --> 00:02:48,870
vanadium oxide absorption bands and then

58
00:02:54,590 --> 00:02:50,640
when you get to even shorter wavelengths

59
00:02:55,759 --> 00:02:54,600
the opacity shoots up into the UV and

60
00:02:57,770 --> 00:02:55,769
that's something that we hadn't seen

61
00:03:01,640 --> 00:02:57,780
before in an exoplanet transmission

62
00:03:04,460 --> 00:03:01,650
spectrum in the paper we speculated that

63
00:03:06,259 --> 00:03:04,470

it might be something like a forest of

64
00:03:09,380 --> 00:03:06,269
heavy metal lines that have strong

65
00:03:11,570 --> 00:03:09,390
features at those wavelengths or even

66
00:03:15,500 --> 00:03:11,580
something a little more exotic like SH

67
00:03:17,180 --> 00:03:15,510
which is a predicted photochemical

68
00:03:21,920 --> 00:03:17,190
product that you might get in these

69
00:03:23,990 --> 00:03:21,930
highly irradiated atmospheres and so

70
00:03:26,120 --> 00:03:24,000
even more recently we've extended the

71
00:03:28,160 --> 00:03:26,130
transmission spectrum of lost 121 to

72
00:03:30,229 --> 00:03:28,170
even shorter wavelengths so this is a

73
00:03:34,190 --> 00:03:30,239
paper that came out just a week or so

74
00:03:36,410 --> 00:03:34,200
ago led by Davidson so the data I just

75
00:03:38,240 --> 00:03:36,420
showed on the previous slide is here and

76
00:03:40,670 --> 00:03:38,250
you see that rise towards the UV and

77
00:03:43,910 --> 00:03:40,680
when we go even further into the UV that

78
00:03:46,759 --> 00:03:43,920
opacity just shoots up it keeps going on

79
00:03:49,160 --> 00:03:46,769
and so this is data that was taken with

80
00:03:50,870 --> 00:03:49,170
a nichelle spectrograph on Hubble so

81
00:03:54,259 --> 00:03:50,880
we're actually able to go too much

82
00:03:57,410 --> 00:03:54,269
higher spectral resolution and when I

83
00:03:59,210 --> 00:03:57,420
replug that transmission spectrum at the

84
00:04:02,330 --> 00:03:59,220
full resolving power we have access to

85
00:04:05,180 --> 00:04:02,340
you start to see the absorption lines

86
00:04:07,759 --> 00:04:05,190
due to individual metal ions like iron

87
00:04:09,410 --> 00:04:07,769
and magnesium pop up and these are

88
00:04:12,220 --> 00:04:09,420

actually the cause of these lines are

89
00:04:15,020 --> 00:04:12,230
extending beyond the Roche lobe of

90
00:04:17,390 --> 00:04:15,030
what's 121 so we're detecting this

91
00:04:22,310 --> 00:04:17,400
exosphere filled with heavy metal ions

92
00:04:25,340 --> 00:04:22,320
which is pretty extreme okay so going

93
00:04:28,100 --> 00:04:25,350
back to the phase curve itself this is

94
00:04:29,899 --> 00:04:28,110
the final sanitized all cleaned up phase

95
00:04:32,130 --> 00:04:29,909
curve that looks beautiful but I just

96
00:04:36,150 --> 00:04:32,140
wanted to briefly Heil

97
00:04:37,860 --> 00:04:36,160
um what the raw data looks like and what

98
00:04:39,960 --> 00:04:37,870
we have to go through to get to that

99
00:04:41,430 --> 00:04:39,970
final product on just so this is

100
00:04:43,110 --> 00:04:41,440
something people keep in mind when

101
00:04:45,570 --> 00:04:43,120
they're looking at the final products of

102
00:04:47,130 --> 00:04:45,580
these observational studies so here are

103
00:04:50,870 --> 00:04:47,140
the two raw phase curves that we

104
00:04:53,610 --> 00:04:50,880
measured and these blue lines are the

105
00:04:55,620 --> 00:04:53,620
final phase curve signal that we recover

106
00:04:57,240 --> 00:04:55,630
and as you can see there's all sorts of

107
00:04:59,460 --> 00:04:57,250
stuff going on like you've got these

108
00:05:01,740 --> 00:04:59,470
long term instrumental drifts that we

109
00:05:04,050 --> 00:05:01,750
need to simultaneously account for when

110
00:05:06,120 --> 00:05:04,060
we're modeling the planet signal because

111
00:05:08,540 --> 00:05:06,130
the observations were such long duration

112
00:05:11,160 --> 00:05:08,550
we had to make multiple guides scarf

113
00:05:12,960 --> 00:05:11,170

reset which has the potential to

114
00:05:16,320 --> 00:05:12,970
introduce discontinuities between

115
00:05:18,930 --> 00:05:16,330
different chunks of data so it's a very

116
00:05:20,790 --> 00:05:18,940
challenging data analysis and every

117
00:05:22,730 --> 00:05:20,800
choice that we make has the potential to

118
00:05:24,930 --> 00:05:22,740
introduce some biases to the final

119
00:05:28,020 --> 00:05:24,940
observables that we recover so just

120
00:05:30,540 --> 00:05:28,030
something to keep in mind but assuming

121
00:05:32,730 --> 00:05:30,550
we did do a good job in robustly

122
00:05:35,850 --> 00:05:32,740
modeling those systematics along with

123
00:05:38,340 --> 00:05:35,860
the planet signal there are a few main

124
00:05:41,250 --> 00:05:38,350
observables that we try to extract from

125
00:05:43,590 --> 00:05:41,260
from these phase curve observations so

126
00:05:47,610 --> 00:05:43,600
the first is where the peak of the phase

127
00:05:51,000 --> 00:05:47,620
curve occurs relative to the eclipses

128
00:05:52,500 --> 00:05:51,010
mid time the hotspot offset we also want

129
00:05:54,810 --> 00:05:52,510
to measure the secondary eclipses depth

130
00:05:56,820 --> 00:05:54,820
because that allows us to infer the

131
00:06:00,180 --> 00:05:56,830
emission from the planets dayside

132
00:06:02,370 --> 00:06:00,190
Hemisphere and also the amplitude of the

133
00:06:05,160 --> 00:06:02,380
phase curve if we take the difference of

134
00:06:06,990 --> 00:06:05,170
that and the eclipses depth we are able

135
00:06:10,920 --> 00:06:07,000
to deduce the emission from the planets

136
00:06:13,830 --> 00:06:10,930
Nightside Hemisphere so these are the

137
00:06:17,570 --> 00:06:13,840
numbers that we get for what's 121 B in

138
00:06:21,150 --> 00:06:17,580

particular we measure a an eastward

139
00:06:25,200 --> 00:06:21,160
hotspot offset of about 6 degrees plus

140
00:06:28,850 --> 00:06:25,210
or minus roughly 2 degrees and we also

141
00:06:31,410 --> 00:06:28,860
seem to measure the Nightside emission

142
00:06:37,110 --> 00:06:31,420
at about a 100 ppm at the

143
00:06:40,680 --> 00:06:37,120
three-and-a-half Sigma level now to put

144
00:06:44,040 --> 00:06:40,690
that in the context of other exoplanets

145
00:06:45,960 --> 00:06:44,050
for which we've have published Hubble

146
00:06:47,700 --> 00:06:45,970
phase curve observations

147
00:06:50,820 --> 00:06:47,710
and they've only been three of those

148
00:06:54,240 --> 00:06:50,830
aside from what 121 and I've arranged

149
00:06:57,450 --> 00:06:54,250
them here in order of increasing day

150
00:07:01,260 --> 00:06:57,460
side temperature and one robust trend

151
00:07:05,040 --> 00:07:01,270
that seems to be there is that as you go

152
00:07:08,070 --> 00:07:05,050
to higher temperatures the eastward

153
00:07:09,750 --> 00:07:08,080
hotspot offset decreases and this is

154
00:07:12,600 --> 00:07:09,760
also a trend that we've seen in the more

155
00:07:14,400 --> 00:07:12,610
numerous pizza-face curves and it kind

156
00:07:18,750 --> 00:07:14,410
of makes census Emily was pointing out

157
00:07:20,970 --> 00:07:18,760
hotter stuff radiates faster and so it's

158
00:07:24,360 --> 00:07:20,980
going to have re-radiated a lot of its

159
00:07:26,100 --> 00:07:24,370
energy before it has a chance to infect

160
00:07:28,530 --> 00:07:26,110
too far from the substellar point

161
00:07:30,540 --> 00:07:28,540
therefore you get a lower hotspot offset

162
00:07:32,550 --> 00:07:30,550
and also in all of these phase curves

163
00:07:40,230 --> 00:07:32,560

we're measuring very large day/night

164
00:07:41,580 --> 00:07:40,240
contrasts of above 90% okay and one

165
00:07:44,670 --> 00:07:41,590
other thing I just briefly want to

166
00:07:46,590 --> 00:07:44,680
mention is that because what's 121

167
00:07:49,110 --> 00:07:46,600
orbits so close to its host star it's

168
00:07:52,340 --> 00:07:49,120
subjected to really strong tired tidal

169
00:07:54,900 --> 00:07:52,350
forces and it's also very inflated so

170
00:07:56,760 --> 00:07:54,910
there's a very good chance that it will

171
00:07:59,670 --> 00:07:56,770
be distorted into an ellipsoidal shape

172
00:08:02,909 --> 00:07:59,680
and so if you imagine this kind of egg

173
00:08:04,670 --> 00:08:02,919
like object orbiting around the host

174
00:08:06,870 --> 00:08:04,680
star you're going to see different

175
00:08:09,810 --> 00:08:06,880
cross-sectional areas during the course

176
00:08:12,540 --> 00:08:09,820
of the orbit and that's going to be

177
00:08:15,800 --> 00:08:12,550
maximized at the points of quadrature in

178
00:08:18,270 --> 00:08:15,810
the planet's orbit and so that will

179
00:08:19,500 --> 00:08:18,280
provide an additional modulation of the

180
00:08:21,900 --> 00:08:19,510
brightness that we receive from the

181
00:08:24,200 --> 00:08:21,910
planet and we think that there's some

182
00:08:28,409 --> 00:08:24,210
marginal evidence for that happening in

183
00:08:30,510 --> 00:08:28,419
what's 1:21 s atmosphere and so the blue

184
00:08:33,089 --> 00:08:30,520
line I've plotted here is the same as

185
00:08:36,180 --> 00:08:33,099
the red line but with our inferred

186
00:08:39,089 --> 00:08:36,190
ellipsoidal variation signal removed and

187
00:08:41,400 --> 00:08:39,099
that corresponds to a variation in the

188
00:08:44,880 --> 00:08:41,410

planet's cross-sectional area of about

189
00:08:49,860 --> 00:08:44,890
10% over the course of its orbit at the

190
00:08:53,070 --> 00:08:49,870
roughly 2 sigma level okay so by

191
00:08:54,810 --> 00:08:53,080
measuring the brightness variations of

192
00:08:57,840 --> 00:08:54,820
the planet over the course of its orbit

193
00:08:59,519 --> 00:08:57,850
we are also able to

194
00:09:02,009 --> 00:08:59,529
learn something about how the

195
00:09:03,689 --> 00:09:02,019
temperature of the planet varies with

196
00:09:05,850 --> 00:09:03,699
longitude and if we make additional

197
00:09:08,879 --> 00:09:05,860
assumptions how it varies with latitude

198
00:09:11,910 --> 00:09:08,889
as well and so this is the temperature

199
00:09:14,670 --> 00:09:11,920
map that we have produced based on the

200
00:09:17,670 --> 00:09:14,680
phase curve data using the analytic

201
00:09:20,519 --> 00:09:17,680
model of Zhang and showmen which is

202
00:09:23,189 --> 00:09:20,529
inspired by GCM results and maybe the

203
00:09:25,699 --> 00:09:23,199
big point to make is just how dramatic

204
00:09:29,189 --> 00:09:25,709
the day/night temperature difference is

205
00:09:33,749 --> 00:09:29,199
ranging from 3000 Kelvin plus on the day

206
00:09:37,650 --> 00:09:33,759
side to more like 1600 Kelvin on the

207
00:09:39,449 --> 00:09:37,660
night side and this seems to be broadly

208
00:09:42,210 --> 00:09:39,459
in agreement with predictions made by

209
00:09:45,090 --> 00:09:42,220
more sophisticated 3d GCN's such as this

210
00:09:48,139 --> 00:09:45,100
one that parmentier Adel published for

211
00:09:51,240 --> 00:09:48,149
was 121 last year which also predicts

212
00:09:54,240 --> 00:09:51,250
3000 if Kelvin day side temperatures and

213
00:10:00,110 --> 00:09:54,250

night side temperatures significantly

214
00:10:02,790 --> 00:10:00,120
below 2000 Kelvin and so the thing that

215
00:10:05,840 --> 00:10:02,800
one interesting speculation that we can

216
00:10:08,220 --> 00:10:05,850
make having measured the night side

217
00:10:11,189 --> 00:10:08,230
temperature of what's 121 using the

218
00:10:13,439 --> 00:10:11,199
phase curve is about the efficiency of

219
00:10:16,590 --> 00:10:13,449
day night cold trapping within the

220
00:10:19,550 --> 00:10:16,600
atmosphere so this is a plot of pressure

221
00:10:21,929 --> 00:10:19,560
versus temperature with dashed lines

222
00:10:23,639 --> 00:10:21,939
indicating the condensation curves for

223
00:10:26,429 --> 00:10:23,649
various compounds that we expect in the

224
00:10:29,939 --> 00:10:26,439
atmosphere and then that green region is

225
00:10:32,699 --> 00:10:29,949
the day side sorry the night side

226
00:10:34,170 --> 00:10:32,709
temperature that we've inferred and you

227
00:10:37,499 --> 00:10:34,180
can see that throughout most of the

228
00:10:39,240 --> 00:10:37,509
atmospheric column that such a

229
00:10:42,329 --> 00:10:39,250
temperature would be cool enough for

230
00:10:45,360 --> 00:10:42,339
species like these magnesium based

231
00:10:48,569 --> 00:10:45,370
silicates and iron to condense on the

232
00:10:50,460 --> 00:10:48,579
night side but as I mentioned earlier

233
00:10:52,920 --> 00:10:50,470
we've seen in the UV transmission

234
00:10:55,249 --> 00:10:52,930
spectrum that magnesium and iron appear

235
00:10:58,050 --> 00:10:55,259
to be up in the exosphere so presumably

236
00:10:59,970 --> 00:10:58,060
they're not being cold trapped on the

237
00:11:01,800 --> 00:10:59,980
night side hemisphere and being forever

238
00:11:04,530 --> 00:11:01,810

locked down in the deep layers of the

239
00:11:08,040 --> 00:11:04,540
atmosphere the same argument applies for

240
00:11:11,430 --> 00:11:08,050
titanium and vanadium compounds although

241
00:11:13,590 --> 00:11:11,440
the evidence for those tion vo is

242
00:11:18,270 --> 00:11:13,600
robust I'd say in the current data that

243
00:11:20,460 --> 00:11:18,280
we had and philosopher between okay so a

244
00:11:22,350 --> 00:11:20,470
really great thing that we get from

245
00:11:24,210 --> 00:11:22,360
these two phase curve observations is

246
00:11:26,130 --> 00:11:24,220
four additional measurements of the

247
00:11:28,130 --> 00:11:26,140
secondary Eclipse to add to our on

248
00:11:31,440 --> 00:11:28,140
single Eclipse that we had originally

249
00:11:33,570 --> 00:11:31,450
and you can so I guess this is the data

250
00:11:35,550 --> 00:11:33,580
set that we've started with and now this

251
00:11:38,000 --> 00:11:35,560
is the secondary Eclipse measurement

252
00:11:41,100 --> 00:11:38,010
that we had for wasp 121 and you can

253
00:11:43,860 --> 00:11:41,110
imagine just how well we're able to

254
00:11:47,160 --> 00:11:43,870
refine our measurement of the dayside

255
00:11:51,540 --> 00:11:47,170
emission spectrum using this new data

256
00:11:54,000 --> 00:11:51,550
set so here is the emission spectrum as

257
00:11:57,480 --> 00:11:54,010
of earlier this year this is the

258
00:11:59,870 --> 00:11:57,490
original g1 for one data showing this

259
00:12:02,900 --> 00:11:59,880
water band and this thing that we

260
00:12:05,520 --> 00:12:02,910
speculated might year vo emission band

261
00:12:08,430 --> 00:12:05,530
and then going down to shorter

262
00:12:11,880 --> 00:12:08,440
wavelengths the g1 o2 data show evidence

263
00:12:15,120 --> 00:12:11,890

for h- emission and we've also added the

264
00:12:19,140 --> 00:12:15,130
test data point there recently and so

265
00:12:22,440 --> 00:12:19,150
the new emission spectrum looks like

266
00:12:25,760 --> 00:12:22,450
this it looks lovely the the water band

267
00:12:30,120 --> 00:12:25,770
is very robustly unconfirmed however the

268
00:12:32,130 --> 00:12:30,130
vanadium oxide feature disappears so we

269
00:12:33,870 --> 00:12:32,140
think that that was probably either a

270
00:12:36,540 --> 00:12:33,880
statistical fluctuation in the data or

271
00:12:41,670 --> 00:12:36,550
some systematic that we didn't handle on

272
00:12:44,670 --> 00:12:41,680
in the analysis and we're able to take

273
00:12:47,400 --> 00:12:44,680
that new emission spectrum and perform

274
00:12:50,220 --> 00:12:47,410
atmospheric retrieval analyses to

275
00:12:52,680 --> 00:12:50,230
recover on the vertical properties of

276
00:12:55,350 --> 00:12:52,690
the dayside hemisphere such as the

277
00:12:58,620 --> 00:12:55,360
temperature profile and the chemistry

278
00:13:00,180 --> 00:12:58,630
which i i won't go into in too much

279
00:13:01,980 --> 00:13:00,190
detail the chemistry's got lots of

280
00:13:05,220 --> 00:13:01,990
interesting stuff going on like thermal

281
00:13:07,410 --> 00:13:05,230
dissociation of molecules and the

282
00:13:13,410 --> 00:13:07,420
release of electrons generates ions and

283
00:13:16,950 --> 00:13:13,420
stuff like that okay so the the next

284
00:13:19,680 --> 00:13:16,960
steps are in this project are to go from

285
00:13:22,020 --> 00:13:19,690
the single emission spectrum that we

286
00:13:23,940 --> 00:13:22,030
have at second for the dayside

287
00:13:25,049 --> 00:13:23,950
hemisphere as well as the broadband

288
00:13:28,919 --> 00:13:25,059

phase curve

289
00:13:32,639 --> 00:13:28,929
spectroscopic channels and repeat that

290
00:13:35,579 --> 00:13:32,649
analysis for each of those and that will

291
00:13:37,379 --> 00:13:35,589
allow us to measure the emission of the

292
00:13:40,229 --> 00:13:37,389
planet at different points in the

293
00:13:44,549 --> 00:13:40,239
planets orbital phase and this is the

294
00:13:48,119 --> 00:13:44,559
output from the Parmentier 3d GCM for

295
00:13:50,399 --> 00:13:48,129
what 121 B and we hope that we'll be

296
00:13:52,979 --> 00:13:50,409
able to see something like this in the

297
00:13:55,769 --> 00:13:52,989
data where we've got the water emission

298
00:13:58,949 --> 00:13:55,779
band on the dayside hemisphere that then

299
00:14:00,779 --> 00:13:58,959
transitions to an absorption band on the

300
00:14:06,089 --> 00:14:00,789
Nightside hemisphere where you no longer

301
00:14:10,169 --> 00:14:06,099
have a thermal inversion and so we hope

302
00:14:11,389 --> 00:14:10,179
and we expect that this data set will

303
00:14:14,789 --> 00:14:11,399
become one of if not the most

304
00:14:17,669 --> 00:14:14,799
constraining data set for 3d models of

305
00:14:19,199 --> 00:14:17,679
hot jupiter atmospheres to date so

306
00:14:21,329 --> 00:14:19,209
that's something to look out for in the

307
00:14:33,780 --> 00:14:21,339
coming months and we're working on that

308
00:14:38,590 --> 00:14:35,200
Wow

309
00:14:40,780 --> 00:14:38,600
another hunts reason already I'm going

310
00:14:51,340 --> 00:14:40,790
to give them make to somebody who hasn't

311
00:14:53,860 --> 00:14:51,350
talked yet University Dexter I was just

312
00:14:55,840 --> 00:14:53,870
wondering if similarly today Eclipse you

313
00:14:57,790 --> 00:14:55,850

could look at the transmission spectrum

314
00:14:59,680 --> 00:14:57,800
you've got and compare that to the bump

315
00:15:01,210 --> 00:14:59,690
at 1.1 microns we see and does that

316
00:15:03,610 --> 00:15:01,220
disappear as well is that still there

317
00:15:05,080 --> 00:15:03,620
yeah I'm working on that for some reason

318
00:15:07,150 --> 00:15:05,090
I didn't show it for a reason the

319
00:15:10,090 --> 00:15:07,160
transmission spectrum is a little more

320
00:15:13,480 --> 00:15:10,100
challenging um it doesn't appear to be

321
00:15:17,980 --> 00:15:13,490
as repeatable as the secondary Eclipse

322
00:15:20,320 --> 00:15:17,990
observations so the water band is

323
00:15:25,150 --> 00:15:20,330
certainly present in one of the transits

324
00:15:27,220 --> 00:15:25,160
the other transit it's less pronounced I

325
00:15:29,260 --> 00:15:27,230
don't know you could be go out on a limb

326
00:15:31,620 --> 00:15:29,270
and speculate about the possibility of

327
00:15:33,700 --> 00:15:31,630
weather at the planetary limb on

328
00:15:35,610 --> 00:15:33,710
affecting the transmission spectrum

329
00:15:38,890 --> 00:15:35,620
because these two phase curves were

330
00:15:40,690 --> 00:15:38,900
observed about a year apart so there is

331
00:15:42,430 --> 00:15:40,700
certainly ample opportunity for

332
00:15:43,870 --> 00:15:42,440
different weather systems to develop but

333
00:15:45,720 --> 00:15:43,880
I don't know I'm always a bit reluctant

334
00:15:48,280 --> 00:15:45,730
to claim weather because I think

335
00:15:54,490 --> 00:15:48,290
systematics is usually the more likely

336
00:15:56,800 --> 00:15:54,500
answer but we'll see hello Loren Supino

337
00:15:59,080 --> 00:15:56,810
University of Amsterdam you showed this

338
00:16:01,750 --> 00:15:59,090

new UV data taken with echelle

339
00:16:03,970 --> 00:16:01,760
spectrograph onboard of HST and there

340
00:16:06,810 --> 00:16:03,980
are some very evident atomic lines in

341
00:16:09,130 --> 00:16:06,820
there and I think they're mostly ionized

342
00:16:11,470 --> 00:16:09,140
is that what you expect because it

343
00:16:14,890 --> 00:16:11,480
reminds me of what was found in another

344
00:16:16,510 --> 00:16:14,900
ultra hot Jupiter which is Delta 9 and I

345
00:16:18,250 --> 00:16:16,520
think it was not entirely clear there

346
00:16:21,040 --> 00:16:18,260
that this is what you expect

347
00:16:24,400 --> 00:16:21,050
so can you expand on that yeah so I

348
00:16:27,880 --> 00:16:24,410
don't know for sure but I believe that

349
00:16:30,520 --> 00:16:27,890
the neutral iron and magnesium lines

350
00:16:32,350 --> 00:16:30,530
were not evident in the data so whatever

351
00:16:36,490 --> 00:16:32,360
magnesium and iron is up there is

352
00:16:38,350 --> 00:16:36,500
ionized perhaps you're on that those

353
00:16:40,540 --> 00:16:38,360
metals are subject to more intense UV

354
00:16:42,250 --> 00:16:40,550
radiation up there and they're more

355
00:16:44,560 --> 00:16:42,260
likely to be ionized because they're

356
00:16:46,660 --> 00:16:44,570
further I guess from the planet on

357
00:16:49,450 --> 00:16:46,670
they're less protected by I don't know

358
00:16:51,280 --> 00:16:49,460
magnetic fields or something but I don't

359
00:16:53,320 --> 00:16:51,290
know too much about that the lead author

360
00:16:55,930 --> 00:16:53,330
of the paper David Singh is here at the

361
00:17:04,810 --> 00:16:55,940
conference you might want to follow that

362
00:17:08,319 --> 00:17:04,820
up it's gonna insert directly at

363
00:17:11,230 --> 00:17:08,329

everything at hu I would say that the

364
00:17:12,910 --> 00:17:11,240
unclear thing is a priori where the

365
00:17:13,300 --> 00:17:12,920
metal lines are are they open the

366
00:17:16,960 --> 00:17:13,310
exosphere

367
00:17:18,790 --> 00:17:16,970
are they down lower and then if they're

368
00:17:21,640 --> 00:17:18,800
up really high you probably have very

369
00:17:23,410 --> 00:17:21,650
high temperatures and so certainly 1:21

370
00:17:26,319 --> 00:17:23,420
way up in the atmosphere even be able to

371
00:17:29,830 --> 00:17:26,329
Roche lobe it's you know probably 10,000

372
00:17:31,840 --> 00:17:29,840
or more Kelvin and if it's much lower

373
00:17:35,470 --> 00:17:31,850
maybe like Cal 9 you're looking much

374
00:17:37,960 --> 00:17:35,480
deeper down and so you have more

375
00:17:41,050 --> 00:17:37,970
neutrals so I didn't see any neutrals

376
00:17:51,250 --> 00:17:41,060
maybe if we dig further we can see them

377
00:17:53,560 --> 00:17:51,260
later but I haven't seen yet so oh god

378
00:17:55,540 --> 00:17:53,570
we have a lot of you okay the three more

379
00:17:58,890 --> 00:17:55,550
that are here which has Christian Josh

380
00:18:03,310 --> 00:17:58,900
on Damien and then we're good orange

381
00:18:05,140 --> 00:18:03,320
Thank You Daniel incidence the

382
00:18:07,240 --> 00:18:05,150
transmission spectra you're seeing they

383
00:18:09,370 --> 00:18:07,250
are from the terminator regions right so

384
00:18:12,250 --> 00:18:09,380
that means you can't can't conclude that

385
00:18:15,190 --> 00:18:12,260
here that you have these iron lines also

386
00:18:17,890 --> 00:18:15,200
on the on the on the night side because

387
00:18:20,770 --> 00:18:17,900
at somebody did this and Fortran yeah

388
00:18:22,390 --> 00:18:20,780

anyway to answer to an today with remark

389
00:18:24,130 --> 00:18:22,400
if she do the calculations who basically

390
00:18:25,810 --> 00:18:24,140
see that you have ionized I will an

391
00:18:27,340 --> 00:18:25,820
ionized ionized magnesium over there

392
00:18:28,920 --> 00:18:27,350
three thousand came in this is coming

393
00:18:33,010 --> 00:18:28,930
out of Kofi Jones

394
00:18:35,380 --> 00:18:33,020
GCMs so therefore seeing this is singly

395
00:18:38,170 --> 00:18:35,390
ionized matter it's not such a big

396
00:18:43,590 --> 00:18:38,180
surprise because it's basically falls

397
00:18:50,800 --> 00:18:47,710
hey just loitering here Johns Hopkins so

398
00:18:53,470 --> 00:18:50,810
in terms of the metal ions in that my

399
00:18:55,240 --> 00:18:53,480
Phoenix Marsh and that singly ionized

400
00:18:57,700 --> 00:18:55,250
iron is actually the most important

401
00:18:58,720 --> 00:18:57,710
opacity source in terms of absorbing the

402
00:19:01,289 --> 00:18:58,730
irradiation of

403
00:19:03,340 --> 00:19:01,299
Delabar so we totally expect those in

404
00:19:06,549 --> 00:19:03,350
plants like whilst we one my question

405
00:19:07,659 --> 00:19:06,559
though is so I'd on your brightness

406
00:19:09,940 --> 00:19:07,669
temperature map there's brightness

407
00:19:11,500 --> 00:19:09,950
temperatures of like 3500 Kelvin which

408
00:19:12,880 --> 00:19:11,510
is kind of surprising to me because I

409
00:19:15,370 --> 00:19:12,890
would expect all the water to have been

410
00:19:17,169 --> 00:19:15,380
dissociated by then so but you still see

411
00:19:20,470 --> 00:19:17,179
the water in the emission right you

412
00:19:24,430 --> 00:19:20,480
could comment on that movie yeah so I

413
00:19:26,530 --> 00:19:24,440

guess my read on this is that if the

414
00:19:28,000 --> 00:19:26,540
entire day side hemisphere that we're

415
00:19:30,760 --> 00:19:28,010
proving in secondary acquits is

416
00:19:34,120 --> 00:19:30,770
essentially defined by the edge of that

417
00:19:39,370 --> 00:19:34,130
white region there so yes there is this

418
00:19:41,890 --> 00:19:39,380
big red log that's 3,000 Kelvin plus

419
00:19:46,150 --> 00:19:41,900
where you would expect most of the water

420
00:19:47,799 --> 00:19:46,160
to be dissociated but I assume it is

421
00:19:50,200 --> 00:19:47,809
around the edges of the dayside

422
00:19:52,539 --> 00:19:50,210
hemisphere that there is still water

423
00:19:54,669 --> 00:19:52,549
existing that is enough to generate the

424
00:19:57,789 --> 00:19:54,679
emission feature that we see I should

425
00:20:00,250 --> 00:19:57,799
highlight is very muted compared to what

426
00:20:02,230 --> 00:20:00,260
you would expect if there was water

427
00:20:04,270 --> 00:20:02,240
present across the entire day side

428
00:20:06,159 --> 00:20:04,280
hemisphere so that thermal dissociation

429
00:20:09,700 --> 00:20:06,169
is included in the model that I showed

430
00:20:12,340 --> 00:20:09,710
prodded and it is a muted water feature

431
00:20:14,260 --> 00:20:12,350
and I just comment on and that

432
00:20:16,630 --> 00:20:14,270
digitation doesn't mean that you don't

433
00:20:19,600 --> 00:20:16,640
see the water because if you go deep

434
00:20:21,669 --> 00:20:19,610
enough if you're dissipated then what is

435
00:20:24,100 --> 00:20:21,679
not absorbing and that is it's there at

436
00:20:26,740 --> 00:20:24,110
high pressure so so you're gonna see the

437
00:20:30,400 --> 00:20:26,750
water just going to be squeezed in terms

438
00:20:32,440 --> 00:20:30,410

of strings and then yet for the last

439
00:20:35,230 --> 00:20:32,450
thing we really have to wrap up and run

440
00:20:38,590 --> 00:20:35,240
for lunch okay Daniel from MIT you had

441
00:20:41,740 --> 00:20:38,600
commented on a trend with the hotspot

442
00:20:43,600 --> 00:20:41,750
offset with temperature but that same

443
00:20:47,230 --> 00:20:43,610
plot I think also showed the day/night

444
00:20:48,490 --> 00:20:47,240
temperature differences and I'm not sure

445
00:20:49,930 --> 00:20:48,500
if i remember that correctly but if

446
00:20:51,880 --> 00:20:49,940
there was any trend in that it actually

447
00:20:54,220 --> 00:20:51,890
seemed to go the opposite way do you

448
00:20:56,400 --> 00:20:54,230
have a comment on that slide or was it

449
00:20:58,930 --> 00:20:56,410
this one

450
00:21:00,880 --> 00:20:58,940
you're missing the arrow boss oh yeah

451
00:21:03,400 --> 00:21:00,890
yeah so I don't know often when people

452
00:21:06,669 --> 00:21:03,410
report the day to night contrast they

453
00:21:08,289 --> 00:21:06,679
either report it in a um temperature

454
00:21:11,320 --> 00:21:08,299
contrast or day to night contrast so I

455
00:21:12,340 --> 00:21:11,330
just um I haven't included Aero bars in

456
00:21:13,930 --> 00:21:12,350
that column because

457
00:21:16,510 --> 00:21:13,940
I sort of got it from a fairly

458
00:21:18,100 --> 00:21:16,520
heterogeneous set of papers at the time

459
00:21:20,140 --> 00:21:18,110
the point was that they all seemed to

460
00:21:23,140 --> 00:21:20,150
suggest of 90 percent plus I wouldn't

461
00:21:26,230 --> 00:21:23,150
read too much inside um although like

462
00:21:28,390 --> 00:21:26,240
what's 43 I believe is a puzzling one

463
00:21:30,250 --> 00:21:28,400

because it's significantly cooler and

464
00:21:32,799 --> 00:21:30,260
you wouldn't expect such a high day

465
00:21:34,060 --> 00:21:32,809
night contrast it's my understanding and

466
00:21:36,070 --> 00:21:34,070
this is something that model is in

467
00:21:38,980 --> 00:21:36,080
theorists currently trying to work out