

1
00:00:07,710 --> 00:00:11,980
hello everybody and welcome to this

2
00:00:09,849 --> 00:00:13,599
week's Hubble hang out my name is Tony

3
00:00:11,980 --> 00:00:15,548
Darnell I work in space telescope

4
00:00:13,599 --> 00:00:16,778
science institute and I think we have a

5
00:00:15,548 --> 00:00:17,980
really great hangout plan for you

6
00:00:16,778 --> 00:00:19,899
although I say that every week because

7
00:00:17,980 --> 00:00:20,890
we always have great hangouts planned I

8
00:00:19,899 --> 00:00:22,989
think you're going to enjoy this one

9
00:00:20,890 --> 00:00:26,170
though astronomers using the Hubble

10
00:00:22,989 --> 00:00:28,928
Space Telescope have pointed it at wasp

11
00:00:26,170 --> 00:00:31,359
43 be an exoplanet that will be talking

12
00:00:28,928 --> 00:00:33,039
about later on and made a thermal map of

13
00:00:31,359 --> 00:00:35,230
it will also talk about what that is um

14
00:00:33,039 --> 00:00:36,759
so before I get started with this i want

15
00:00:35,229 --> 00:00:38,500
to mention real quickly that if you're

16
00:00:36,759 --> 00:00:40,238
going to be in New York I want to remind

17
00:00:38,500 --> 00:00:43,450
you that they have the Hubble at 25

18
00:00:40,238 --> 00:00:45,099
exhibit going on there and and I also

19
00:00:43,450 --> 00:00:47,469
want to note that they have a next

20
00:00:45,100 --> 00:00:49,239
Wednesday of at they're going to be

21
00:00:47,469 --> 00:00:51,550
having a public event where they'll have

22
00:00:49,238 --> 00:00:54,070
astronauts who's worked on the Hubble

23
00:00:51,549 --> 00:00:56,169
Space Telescope giving different giving

24
00:00:54,070 --> 00:00:58,448
giving some remarks so if you're in New

25
00:00:56,170 --> 00:00:59,620
York I would highly encourage you go and

26
00:00:58,448 --> 00:01:02,649
check that out it sounds like a lot of

27
00:00:59,619 --> 00:01:06,069
fun so with that I'll go ahead and get

28
00:01:02,649 --> 00:01:07,540
started the thermal map of wasp 43b

29

00:01:06,069 --> 00:01:09,579
we're gonna that's the topic of today

30
00:01:07,540 --> 00:01:11,680
and when to joining me to help with the

31
00:01:09,579 --> 00:01:13,929
discussion is dr. carol christian as she

32
00:01:11,680 --> 00:01:15,730
is always with me every week she's the

33
00:01:13,930 --> 00:01:20,770
outreach scientist for the Hubble Space

34
00:01:15,730 --> 00:01:24,010
Telescope hi Carol also hello also with

35
00:01:20,769 --> 00:01:25,780
me is scott lewis who is the driver of

36
00:01:24,010 --> 00:01:29,020
the internet forest he monitors all the

37
00:01:25,780 --> 00:01:31,180
social media streams and making post

38
00:01:29,019 --> 00:01:32,619
images and comments and keeps things

39
00:01:31,180 --> 00:01:35,170
going while while we're online having

40
00:01:32,620 --> 00:01:36,969
the discussion hi Scott welcome Thank

41
00:01:35,170 --> 00:01:39,519
You Kenny how's it going oh really good

42
00:01:36,969 --> 00:01:41,920
so how why don't you do this we tell

43
00:01:39,519 --> 00:01:44,949

people how they can interact with us so

44

00:01:41,920 --> 00:01:46,570

a multitude of ways that you can

45

00:01:44,950 --> 00:01:48,370

interact with us since we're streaming

46

00:01:46,569 --> 00:01:50,529

live on youtube you can make comments

47

00:01:48,370 --> 00:01:52,719

directly onto YouTube but we also have

48

00:01:50,530 --> 00:01:54,489

the Q&A app enabled so on the bottom

49

00:01:52,719 --> 00:01:56,829

left-hand side of the window you should

50

00:01:54,489 --> 00:01:59,199

see hello yellow prompt they'll actually

51

00:01:56,829 --> 00:02:01,299

open up a window allow you to ask us

52

00:01:59,200 --> 00:02:04,600

questions directly we can select them as

53

00:02:01,299 --> 00:02:06,459

available on YouTube and a Google+ and

54

00:02:04,599 --> 00:02:08,769

we're also over on twitter using the

55

00:02:06,459 --> 00:02:10,689

hashtag hubble hang out and i will be

56

00:02:08,770 --> 00:02:13,640

tweeting throughout this entire time so

57

00:02:10,689 --> 00:02:16,310

i would love to tweet back at you

58
00:02:13,639 --> 00:02:18,439
and also the event page where i will be

59
00:02:16,310 --> 00:02:20,330
posting some images as well so many ways

60
00:02:18,439 --> 00:02:21,680
for you to be in in touch with us I may

61
00:02:20,330 --> 00:02:23,690
love getting your questions and comments

62
00:02:21,680 --> 00:02:24,860
and answering them on air okay as with

63
00:02:23,689 --> 00:02:26,300
all things when you're talking Scott I

64
00:02:24,860 --> 00:02:28,640
phased out there did you say the hubble

65
00:02:26,300 --> 00:02:32,060
hubble hang out hashtag part deux no I I

66
00:02:28,639 --> 00:02:34,159
don't love her yeah okay okay cuz i was

67
00:02:32,060 --> 00:02:36,709
reading what you were dr. d alright so

68
00:02:34,159 --> 00:02:38,689
today we have with us dr. Kevin

69
00:02:36,709 --> 00:02:40,550
Stephenson he's a NASA Sagan fellow at

70
00:02:38,689 --> 00:02:43,099
the University of Chicago and we also

71
00:02:40,550 --> 00:02:44,989
have Laura cried Berg I she's a grad

72
00:02:43,099 --> 00:02:47,479
student so at the University of Chicago

73
00:02:44,989 --> 00:02:50,920
here to tell us about their research

74
00:02:47,479 --> 00:02:53,539
where they looked at a an exoplanet and

75
00:02:50,919 --> 00:02:55,939
one Kevin I'll start with you why don't

76
00:02:53,539 --> 00:02:57,349
you give us a brief overview of the work

77
00:02:55,939 --> 00:02:58,489
you've done a brief summary of the work

78
00:02:57,349 --> 00:03:00,439
you've done and then I'm going to go

79
00:02:58,489 --> 00:03:03,340
into exoplanets in general just a little

80
00:03:00,439 --> 00:03:05,889
bit a lot of the work that I've done

81
00:03:03,340 --> 00:03:08,569
focuses on extrasolar planets

82
00:03:05,889 --> 00:03:10,488
particularly the characterization so

83
00:03:08,569 --> 00:03:12,530
what what I try to do is try to

84
00:03:10,489 --> 00:03:14,599
understand what the atmospheres of these

85
00:03:12,530 --> 00:03:17,000
exoplanets are made out of we know

86

00:03:14,599 --> 00:03:20,840
typically they're fairly large of gas

87
00:03:17,000 --> 00:03:22,489
balls and they can have high in helium

88
00:03:20,840 --> 00:03:24,289
but we're more than any other aspects of

89
00:03:22,489 --> 00:03:26,299
water carbon monoxide carbon dioxide

90
00:03:24,289 --> 00:03:29,419
methane that sort of thing and to

91
00:03:26,299 --> 00:03:31,340
understand really the the circulation

92
00:03:29,419 --> 00:03:32,899
the temperature everything about these

93
00:03:31,340 --> 00:03:35,239
plants that can tell us a little bit

94
00:03:32,900 --> 00:03:36,980
more about our own solar system in the

95
00:03:35,239 --> 00:03:40,730
galaxy as a whole so I truly try to

96
00:03:36,979 --> 00:03:42,679
understand exoplanets and where they

97
00:03:40,729 --> 00:03:44,030
come from based off of our measurements

98
00:03:42,680 --> 00:03:47,239
with for example Hubble Space Telescope

99
00:03:44,030 --> 00:03:49,729
oh great so let's talk about that a

100
00:03:47,239 --> 00:03:51,170

little bit so what what are you finding

101

00:03:49,729 --> 00:03:52,518
out about the characteristics of

102

00:03:51,169 --> 00:03:54,619
exoplanets I mean this is a brand new

103

00:03:52,519 --> 00:03:57,590
field of study relatively speaking

104

00:03:54,620 --> 00:03:58,789
exoplanets are just everywhere now it

105

00:03:57,590 --> 00:04:00,799
seems so what are you finding out about

106

00:03:58,789 --> 00:04:03,409
them well there's certainly a tons of

107

00:04:00,799 --> 00:04:05,209
surprises everywhere we look out we've

108

00:04:03,409 --> 00:04:08,959
we've made measurements over the last

109

00:04:05,209 --> 00:04:11,719
ten years and and it seems that every

110

00:04:08,959 --> 00:04:13,189
time we make a prediction something

111

00:04:11,719 --> 00:04:14,780
comes up and we and we see something

112

00:04:13,189 --> 00:04:16,339
completely differently it's not that the

113

00:04:14,780 --> 00:04:19,129
predictions are accurate is just that

114

00:04:16,339 --> 00:04:21,589
the universe is so much more diverse

115
00:04:19,129 --> 00:04:24,409
than we expect so sometimes we might

116
00:04:21,589 --> 00:04:26,810
hope to detect methane and and we don't

117
00:04:24,410 --> 00:04:27,050
and sometimes we might expect us we hope

118
00:04:26,810 --> 00:04:30,740
to

119
00:04:27,050 --> 00:04:32,180
we don't like to see it can we do for

120
00:04:30,740 --> 00:04:34,639
example with with the observations that

121
00:04:32,180 --> 00:04:39,408
we're doing here we would expect maybe

122
00:04:34,639 --> 00:04:40,550
the that the planet might be a similar

123
00:04:39,408 --> 00:04:42,769
in temperature on the day in the night

124
00:04:40,550 --> 00:04:44,449
side and this blitz in fact surprising

125
00:04:42,769 --> 00:04:46,519
when we saw that the days height was so

126
00:04:44,449 --> 00:04:47,960
much hotter than the night side so it

127
00:04:46,519 --> 00:04:50,149
just goes to tell you that there really

128
00:04:47,959 --> 00:04:51,500
is a diversity of X appliance out there

129
00:04:50,149 --> 00:04:53,478
and we're just scratching the surface

130
00:04:51,500 --> 00:04:55,399
yeah that to add to that i would say

131
00:04:53,478 --> 00:04:57,250
that when Kevin talked about this

132
00:04:55,399 --> 00:04:59,810
diversity it's really we've uncovered

133
00:04:57,250 --> 00:05:01,399
planets that are completely unlike

134
00:04:59,810 --> 00:05:03,288
anything that we have in our own solar

135
00:05:01,399 --> 00:05:04,218
system is sort of the planet that we've

136
00:05:03,288 --> 00:05:09,079
studied that we're going to be talking

137
00:05:04,218 --> 00:05:11,959
about today incredibly hot it's orbital

138
00:05:09,079 --> 00:05:13,878
period is less than 24 hours and to give

139
00:05:11,959 --> 00:05:15,560
you a sense of scale mercury which is

140
00:05:13,879 --> 00:05:17,689
the closest planet to the Sun takes

141
00:05:15,560 --> 00:05:20,389
about 90 days to complete a full orbit

142
00:05:17,689 --> 00:05:23,240
and the planet that we looked at was

143

00:05:20,389 --> 00:05:25,610
from three takes I think 19 and a half

144
00:05:23,240 --> 00:05:26,960
hours is that right go straight okay

145
00:05:25,610 --> 00:05:28,370
great well I want to get to that I want

146
00:05:26,959 --> 00:05:30,138
to want to cover that more detail just a

147
00:05:28,370 --> 00:05:32,120
little bit more but Laura since I've got

148
00:05:30,139 --> 00:05:33,769
you here let's so you're a grad student

149
00:05:32,120 --> 00:05:35,509
you're working i do work with Kevin

150
00:05:33,769 --> 00:05:38,240
presumably I one of the things I love

151
00:05:35,509 --> 00:05:40,340
about people up and coming in astronomy

152
00:05:38,240 --> 00:05:41,930
is learning about how they got into it

153
00:05:40,339 --> 00:05:43,818
are you specializing in exoplanet

154
00:05:41,930 --> 00:05:46,879
research too or are you looking tired

155
00:05:43,819 --> 00:05:48,379
yeah the main focus is my PhD is trying

156
00:05:46,879 --> 00:05:50,478
to characterize the atmosphere to be

157
00:05:48,379 --> 00:05:52,009

splendid great so you're also interested

158

00:05:50,478 --> 00:05:55,038

in atmospheres just like Kevin no

159

00:05:52,009 --> 00:05:57,110

coincidence i think so okay with us so

160

00:05:55,038 --> 00:05:58,339

atmospheres around exoplanets i want to

161

00:05:57,110 --> 00:06:00,949

talk about how you detect that in a

162

00:05:58,339 --> 00:06:05,508

minute but first is there any sense of

163

00:06:00,949 --> 00:06:07,069

how the ratio of nominee of all the

164

00:06:05,509 --> 00:06:09,379

exoplanets out there how many have

165

00:06:07,069 --> 00:06:10,729

atmospheres do you have any sense of

166

00:06:09,379 --> 00:06:13,069

that yet is that coming out of the

167

00:06:10,728 --> 00:06:14,839

observations that's a great question

168

00:06:13,069 --> 00:06:18,229

it's something that we're we're trying

169

00:06:14,839 --> 00:06:19,878

to understand right now actually we're

170

00:06:18,228 --> 00:06:23,930

trying to figure out where the boundary

171

00:06:19,879 --> 00:06:26,689

is between planets that are um big balls

172
00:06:23,930 --> 00:06:29,300
of gas basically like saturn and jupiter

173
00:06:26,689 --> 00:06:30,860
and some shrink them they get more rocky

174
00:06:29,300 --> 00:06:34,129
closer to the earth and we want to know

175
00:06:30,860 --> 00:06:37,158
um how big planets have to be in order

176
00:06:34,129 --> 00:06:38,718
to have a big puffy atmosphere made of

177
00:06:37,158 --> 00:06:40,728
hydrogen helium and whether they can

178
00:06:38,718 --> 00:06:43,308
hold on to that

179
00:06:40,728 --> 00:06:46,490
and whether some of the rocky or planets

180
00:06:43,309 --> 00:06:48,529
have atmospheres themselves and i would

181
00:06:46,490 --> 00:06:50,930
say Kevin what's planets have

182
00:06:48,528 --> 00:06:53,360
atmospheres right absolutely even

183
00:06:50,930 --> 00:06:55,610
something like Mars that who has it has

184
00:06:53,360 --> 00:06:57,499
a very tenuous atmosphere it it still

185
00:06:55,610 --> 00:07:01,129
has an atmosphere but it's not certainly

186
00:06:57,499 --> 00:07:03,979
anything that's thick enough to to breed

187
00:07:01,129 --> 00:07:06,889
on if it had oxygen for example but

188
00:07:03,978 --> 00:07:09,949
there are very small planet that we

189
00:07:06,889 --> 00:07:12,019
expect to be very close to their stars

190
00:07:09,949 --> 00:07:14,240
that may not have atmosphere simply

191
00:07:12,019 --> 00:07:16,370
because they're too hot okay so you're

192
00:07:14,240 --> 00:07:17,960
finding so when you say most you

193
00:07:16,370 --> 00:07:22,788
wouldn't be talking about 90%

194
00:07:17,959 --> 00:07:26,658
ninety-nine percent well it II was 950

195
00:07:22,788 --> 00:07:28,308
950 that's a lot I mean not only are

196
00:07:26,658 --> 00:07:30,408
there a lot of exoplanets but that most

197
00:07:28,309 --> 00:07:32,960
of them have atmospheres to me is very

198
00:07:30,408 --> 00:07:34,459
exciting now I that's obviously there's

199
00:07:32,959 --> 00:07:35,658
a wide range of atmospheres and we'll

200

00:07:34,459 --> 00:07:38,209
talk about some of those here in just a

201
00:07:35,658 --> 00:07:40,129
minute but it but at least for life

202
00:07:38,209 --> 00:07:41,628
elsewhere having an atmosphere is

203
00:07:40,129 --> 00:07:45,528
probably a good thing so it's good to

204
00:07:41,629 --> 00:07:47,569
know the most planets have won the so

205
00:07:45,528 --> 00:07:48,918
how do you find out what's the way when

206
00:07:47,569 --> 00:07:50,209
you look at these exoplanets mean the

207
00:07:48,918 --> 00:07:52,818
fact you're looking at them at all is

208
00:07:50,209 --> 00:07:54,050
amazing but how do you find the

209
00:07:52,819 --> 00:07:57,259
atmosphere how do you measure that it

210
00:07:54,050 --> 00:08:00,918
has one there's two different ways that

211
00:07:57,259 --> 00:08:03,139
we can measure an atmosphere and it's a

212
00:08:00,918 --> 00:08:05,628
trick that we use for transiting planets

213
00:08:03,139 --> 00:08:09,468
what happens is if the alignment of the

214
00:08:05,629 --> 00:08:12,139

planet as it orbits its star is is head

215

00:08:09,468 --> 00:08:14,360

it's just the right inclination we can

216

00:08:12,139 --> 00:08:16,278

actually see the planet as across this

217

00:08:14,360 --> 00:08:19,009

in front of the star this is called the

218

00:08:16,278 --> 00:08:20,180

transit and also when the planet goes in

219

00:08:19,009 --> 00:08:23,028

behind the star we call that in the

220

00:08:20,180 --> 00:08:26,300

clips and and there's there's different

221

00:08:23,028 --> 00:08:28,848

ways of combining this information to

222

00:08:26,300 --> 00:08:31,069

understand the atmosphere so for example

223

00:08:28,848 --> 00:08:34,278

if the planet is really hot we can

224

00:08:31,069 --> 00:08:38,509

actually measure its emission the planet

225

00:08:34,278 --> 00:08:41,059

is as a lot of heat being bombarded from

226

00:08:38,509 --> 00:08:43,218

its star on to its on to its atmosphere

227

00:08:41,059 --> 00:08:45,739

and then it rear ad eights that and we

228

00:08:43,219 --> 00:08:47,629

can see that as the planet goes in

229
00:08:45,740 --> 00:08:51,438
behind the star basically the difference

230
00:08:47,629 --> 00:08:53,179
of the planet and the star and minus you

231
00:08:51,438 --> 00:08:54,379
know the star itself on the planet

232
00:08:53,179 --> 00:08:56,719
disappears that

233
00:08:54,379 --> 00:08:59,269
can really tell us about the the heat

234
00:08:56,720 --> 00:09:01,820
coming off of the atmosphere itself in

235
00:08:59,269 --> 00:09:04,759
the transit it's a little bit different

236
00:09:01,820 --> 00:09:08,120
we actually measure the light coming off

237
00:09:04,759 --> 00:09:10,399
the star it grazes the atmosphere of the

238
00:09:08,120 --> 00:09:12,259
planet and tells us information about

239
00:09:10,399 --> 00:09:13,610
above the atmosphere that way so there's

240
00:09:12,259 --> 00:09:16,009
two different techniques that we can

241
00:09:13,610 --> 00:09:18,139
apply for transiting planets just to

242
00:09:16,009 --> 00:09:19,730
learn about the atmosphere so yeah we've

243
00:09:18,139 --> 00:09:20,990
talked about in our other exoplanet

244
00:09:19,730 --> 00:09:22,159
hangouts in the past those two men

245
00:09:20,990 --> 00:09:23,870
there's two methods of finding an

246
00:09:22,159 --> 00:09:25,610
exoplanet a tall one is there as the

247
00:09:23,870 --> 00:09:27,019
transit method that Kevin just mentioned

248
00:09:25,610 --> 00:09:29,120
the other one is a another method called

249
00:09:27,019 --> 00:09:32,809
radial velocity which is a third as well

250
00:09:29,120 --> 00:09:34,759
but they use the spectra spectroscope a

251
00:09:32,809 --> 00:09:37,279
spectrograph and look at the rich the

252
00:09:34,759 --> 00:09:39,590
wobble of the star as it goes across or

253
00:09:37,279 --> 00:09:41,029
goes around the of the planet orbits

254
00:09:39,590 --> 00:09:42,560
around the star and that's called radial

255
00:09:41,029 --> 00:09:43,939
velocity and you can learn about that

256
00:09:42,559 --> 00:09:45,259
any of our other hangouts I don't really

257

00:09:43,940 --> 00:09:47,540
want to go into it too much here but

258
00:09:45,259 --> 00:09:48,799
those are the two main ways so you but

259
00:09:47,539 --> 00:09:51,439
so you can get an idea of the

260
00:09:48,799 --> 00:09:53,899
temperature of the of the atmosphere

261
00:09:51,440 --> 00:09:55,820
Kevin but is there anything else you can

262
00:09:53,899 --> 00:09:58,549
learn about how do you find out the

263
00:09:55,820 --> 00:10:00,770
other things about that atmosphere well

264
00:09:58,549 --> 00:10:02,689
there's there's certain odd what what

265
00:10:00,769 --> 00:10:05,029
you want to do is probe the atmosphere

266
00:10:02,690 --> 00:10:06,920
at different wavelengths so when you

267
00:10:05,029 --> 00:10:09,889
look at the atmosphere at a specific

268
00:10:06,919 --> 00:10:13,099
wavelength it basically you'll be

269
00:10:09,889 --> 00:10:15,289
probing a particular altitude or depth

270
00:10:13,100 --> 00:10:16,670
of that planet within the atmosphere and

271
00:10:15,289 --> 00:10:19,429

then if you go to a second wavelength

272

00:10:16,669 --> 00:10:22,189

you probe a different altitude or depth

273

00:10:19,429 --> 00:10:24,620

of that atmosphere so by looking at a

274

00:10:22,190 --> 00:10:28,070

broad set of wavelengths that you can go

275

00:10:24,620 --> 00:10:29,870

from optical to near-infrared you can

276

00:10:28,070 --> 00:10:31,580

actually probe different layers of the

277

00:10:29,870 --> 00:10:33,049

atmosphere and measure its temperature

278

00:10:31,580 --> 00:10:35,930

at those different layers and you can

279

00:10:33,049 --> 00:10:37,909

really put it all together to form a

280

00:10:35,929 --> 00:10:40,459

better understanding of map if you will

281

00:10:37,909 --> 00:10:42,799

of the planets a thermal structure and

282

00:10:40,460 --> 00:10:44,540

its composition right yeah that's a good

283

00:10:42,799 --> 00:10:46,129

point it's important you can you can

284

00:10:44,539 --> 00:10:50,269

learn what the atmosphere is made out of

285

00:10:46,129 --> 00:10:51,740

what gases are in it and by just looking

286
00:10:50,269 --> 00:10:53,090
at it in different wavelengths different

287
00:10:51,740 --> 00:10:55,669
filters and measuring the heat that

288
00:10:53,090 --> 00:10:58,639
comes out because what happens is when

289
00:10:55,669 --> 00:11:00,289
this is for transiting planets when the

290
00:10:58,639 --> 00:11:02,029
light from the star is passing through

291
00:11:00,289 --> 00:11:04,480
the planet's atmosphere some of it gets

292
00:11:02,029 --> 00:11:06,679
absorbed by molecules that are there and

293
00:11:04,480 --> 00:11:08,089
that's something we can measure in a lab

294
00:11:06,679 --> 00:11:10,458
is how different mall

295
00:11:08,089 --> 00:11:15,230
it's sort of light and so by comparing

296
00:11:10,458 --> 00:11:17,808
what we see to do our data from labs we

297
00:11:15,230 --> 00:11:19,278
can back out of that what molecules are

298
00:11:17,808 --> 00:11:21,049
in the atmosphere doing the absorption

299
00:11:19,278 --> 00:11:23,028
and so we've used this technique to

300
00:11:21,049 --> 00:11:25,219
discover water in the atmosphere is a

301
00:11:23,028 --> 00:11:26,240
bunch of planet so far so let me make

302
00:11:25,220 --> 00:11:27,860
sure I'm getting this right there's two

303
00:11:26,240 --> 00:11:29,360
there's two kinds of measurements or one

304
00:11:27,860 --> 00:11:31,490
of them uses a transit to measure the

305
00:11:29,360 --> 00:11:33,110
heat in different wavelengths coming off

306
00:11:31,490 --> 00:11:34,519
of the atmosphere to get an idea of what

307
00:11:33,110 --> 00:11:36,528
the characteristics are based on

308
00:11:34,519 --> 00:11:38,568
wavelength and then there's the light

309
00:11:36,528 --> 00:11:41,088
passing through the atmosphere through a

310
00:11:38,568 --> 00:11:42,438
spectrograph onto a and we're spinning

311
00:11:41,089 --> 00:11:44,600
up and seeing the spectrum and the

312
00:11:42,438 --> 00:11:46,549
absorption lines that you see in that

313
00:11:44,600 --> 00:11:48,139
spectrum touch I you subtle elements

314

00:11:46,549 --> 00:11:49,519
that might be in that atmosphere so for

315
00:11:48,139 --> 00:11:51,709
example if it has water vapor there

316
00:11:49,519 --> 00:11:54,799
would be an absorption line at the water

317
00:11:51,708 --> 00:11:57,469
vapor line great okay so good okay so

318
00:11:54,799 --> 00:12:01,698
let's let's move on to a planet at the

319
00:11:57,470 --> 00:12:03,019
wasp uh-uh what is it 43b I keep for

320
00:12:01,698 --> 00:12:06,378
some reason it's just not sticking in my

321
00:12:03,019 --> 00:12:07,730
head and so you started on this a little

322
00:12:06,379 --> 00:12:09,350
bit Laura so I'll let you go ahead and

323
00:12:07,730 --> 00:12:12,438
finish tell us a little bit about this

324
00:12:09,350 --> 00:12:16,670
planet how far away is it wait I want to

325
00:12:12,438 --> 00:12:19,068
know why it's called wasp oh oh okay

326
00:12:16,669 --> 00:12:21,799
Carol I should do it discovered by a

327
00:12:19,068 --> 00:12:24,078
ground-based planet search using the

328
00:12:21,799 --> 00:12:26,178

transit technique to look for periodic

329

00:12:24,078 --> 00:12:28,188

dips in brightness of a star caused by

330

00:12:26,178 --> 00:12:30,350

the planet transiting the front and I

331

00:12:28,188 --> 00:12:32,778

think the acronym stands for wide angle

332

00:12:30,350 --> 00:12:37,730

search for planets or something it's a

333

00:12:32,778 --> 00:12:40,778

British um planet search program and 43

334

00:12:37,730 --> 00:12:43,009

is the 43rd one no they get to name it

335

00:12:40,778 --> 00:12:45,470

basically it's like Kepler gets name

336

00:12:43,009 --> 00:12:46,970

there as waspers anemia yeah which I

337

00:12:45,470 --> 00:12:49,370

suppose is only fairy computer they

338

00:12:46,970 --> 00:12:50,778

thank you well it's only fair but they

339

00:12:49,370 --> 00:12:53,178

need to come up with better names I mean

340

00:12:50,778 --> 00:12:56,499

I'll you know okay it we've got watch

341

00:12:53,178 --> 00:12:59,120

there's another survey called hat um

342

00:12:56,499 --> 00:13:00,558

we've got the Kepler yeah I don't know I

343
00:12:59,120 --> 00:13:02,269
keep telling my mom I'm gonna name a

344
00:13:00,558 --> 00:13:05,509
planet after her she doesn't really know

345
00:13:02,269 --> 00:13:07,818
that I'm not searching I can't name them

346
00:13:05,509 --> 00:13:12,009
after her buttock behave yeah you don't

347
00:13:07,818 --> 00:13:12,009
get that privilege I guess none of us do

348
00:13:16,559 --> 00:13:18,619
you

349
00:13:24,328 --> 00:13:26,388
you

350
00:13:26,490 --> 00:13:34,320
okay can you hear me sorry we just got a

351
00:13:30,899 --> 00:13:37,528
freeze yeah we all know we had its prom

352
00:13:34,320 --> 00:13:40,050
last last week are we back yeah I think

353
00:13:37,528 --> 00:13:44,490
so i think we're back we're back okay

354
00:13:40,049 --> 00:13:46,949
okay so what i was saying with them lat

355
00:13:44,490 --> 00:13:50,639
43 p is about 300 light-years away from

356
00:13:46,950 --> 00:13:53,220
us which sounds like it's pretty far but

357
00:13:50,639 --> 00:13:55,708
in the fall of the universe that's

358
00:13:53,220 --> 00:13:58,320
actually incredibly close the Milky Way

359
00:13:55,708 --> 00:14:01,289
is a hundred thousand light-years across

360
00:13:58,320 --> 00:14:04,320
Kevin's that right 7,000 lawyers I'm

361
00:14:01,289 --> 00:14:06,659
different cake and it's where it is it's

362
00:14:04,320 --> 00:14:08,339
just 300 light-years distant from us and

363
00:14:06,659 --> 00:14:09,809
that makes it easier to study because

364
00:14:08,339 --> 00:14:13,260
it's orbiting a star that's relatively

365
00:14:09,809 --> 00:14:15,539
bright it is twice the mass of Jupiter

366
00:14:13,259 --> 00:14:17,939
so Jupiter is the most massive planet

367
00:14:15,539 --> 00:14:20,419
and our own solar system and this planet

368
00:14:17,940 --> 00:14:22,950
is two times more massive than that and

369
00:14:20,419 --> 00:14:24,649
the other thing about it that makes it

370
00:14:22,950 --> 00:14:27,690
really different from what we know of

371

00:14:24,649 --> 00:14:29,940
how many from our solar system is just

372
00:14:27,690 --> 00:14:33,149
how close it orbits to its host star so

373
00:14:29,940 --> 00:14:35,850
it takes less than 20 hours to complete

374
00:14:33,149 --> 00:14:38,639
a full orbital revolution around the

375
00:14:35,850 --> 00:14:41,100
star and that means that it's really

376
00:14:38,639 --> 00:14:44,370
roasting hot because it's so close to

377
00:14:41,100 --> 00:14:46,740
this really bright star so yeah but

378
00:14:44,370 --> 00:14:48,720
that's it in a nutshell and in this is

379
00:14:46,740 --> 00:14:51,690
it's representative of a class of

380
00:14:48,720 --> 00:14:53,459
planets called hot Jupiters um which are

381
00:14:51,690 --> 00:14:55,310
so named because they're extremely hot

382
00:14:53,458 --> 00:14:58,289
orbiting very close to their host stars

383
00:14:55,309 --> 00:15:01,289
and these were among the first planets

384
00:14:58,289 --> 00:15:04,259
to be discovered there they transit

385
00:15:01,289 --> 00:15:06,539

frequently and they they make a big tub

386

00:15:04,259 --> 00:15:08,309

on their host star and so it's easy to

387

00:15:06,539 --> 00:15:10,230

detect them both with radial velocities

388

00:15:08,309 --> 00:15:13,588

and transit and so although they're

389

00:15:10,230 --> 00:15:16,170

relatively rare in terms of what kinds

390

00:15:13,589 --> 00:15:18,600

of planets orbit are most common in the

391

00:15:16,169 --> 00:15:21,149

galaxy they're among that you use to

392

00:15:18,600 --> 00:15:22,980

study yeah that's an interesting point I

393

00:15:21,149 --> 00:15:24,958

what there it turns out i think neptune

394

00:15:22,980 --> 00:15:26,570

size planets right are the most common

395

00:15:24,958 --> 00:15:30,479

is that what i was that what I heard

396

00:15:26,570 --> 00:15:32,010

although smaller yeah those are much

397

00:15:30,480 --> 00:15:33,509

more common so we have a two

398

00:15:32,009 --> 00:15:37,019

jupiter-mass planet you but you've also

399

00:15:33,509 --> 00:15:38,578

said that it had its orbit is really

400
00:15:37,019 --> 00:15:40,019
fast you said it just goes around in

401
00:15:38,578 --> 00:15:44,578
about 19 hours or I

402
00:15:40,019 --> 00:15:46,919
that thing is really spinning so uh what

403
00:15:44,578 --> 00:15:49,618
what does that does that mean is it's uh

404
00:15:46,919 --> 00:15:52,498
is tidally locked around the stars is

405
00:15:49,619 --> 00:15:54,629
one side always facing it yes yeah so

406
00:15:52,499 --> 00:15:59,519
just like the moon has one side always

407
00:15:54,629 --> 00:16:02,249
face of the earth okay so here at Scott

408
00:15:59,519 --> 00:16:03,959
showing us the actual map that you guys

409
00:16:02,249 --> 00:16:05,329
made why don't you Kevin you want to

410
00:16:03,958 --> 00:16:08,099
tell us about what we're looking at here

411
00:16:05,328 --> 00:16:10,558
certainly so this is a artist rendition

412
00:16:08,100 --> 00:16:13,249
of of the type of measurement that we

413
00:16:10,558 --> 00:16:17,458
made and it's actually showing the heat

414
00:16:13,249 --> 00:16:19,499
of the planet as it goes around the star

415
00:16:17,458 --> 00:16:23,698
so we have the star in the center of

416
00:16:19,499 --> 00:16:25,528
wasps 43 and we're showing the planet at

417
00:16:23,698 --> 00:16:29,219
different phases so what we did is we

418
00:16:25,528 --> 00:16:31,769
actually observed the planet for three

419
00:16:29,220 --> 00:16:34,798
complete rotation so it went around its

420
00:16:31,769 --> 00:16:37,558
star three times and because it's

421
00:16:34,798 --> 00:16:39,619
tidally locked the bright side of the

422
00:16:37,558 --> 00:16:41,519
planet that day side of the planet is

423
00:16:39,619 --> 00:16:44,790
consistently the dayside of the planet

424
00:16:41,519 --> 00:16:47,789
and is bombarded by all of this heat

425
00:16:44,789 --> 00:16:49,740
from its star so the dayside is very

426
00:16:47,789 --> 00:16:53,938
very hot and that's shown in white on

427
00:16:49,740 --> 00:16:55,318
the graphic and as the dayside you see

428

00:16:53,938 --> 00:16:57,269
at zero degrees which that it's a

429
00:16:55,318 --> 00:16:59,938
full-on day side that we can see as the

430
00:16:57,269 --> 00:17:02,339
planet orbits around it star we begin to

431
00:16:59,938 --> 00:17:04,918
see uh like you know phases of the moon

432
00:17:02,339 --> 00:17:07,459
we begin to see that the Nightside come

433
00:17:04,919 --> 00:17:09,870
into view and we can see that it is very

434
00:17:07,459 --> 00:17:11,308
cold on the night side less than a

435
00:17:09,869 --> 00:17:14,250
thousand degrees Fahrenheit and that's

436
00:17:11,308 --> 00:17:17,480
depicted in black there and so when at

437
00:17:14,250 --> 00:17:20,220
180 degrees full on night side we don't

438
00:17:17,480 --> 00:17:22,798
get a lot of signal from the planet

439
00:17:20,220 --> 00:17:25,588
itself and then as it comes back through

440
00:17:22,798 --> 00:17:29,009
90 degrees in and zero again or 270 and

441
00:17:25,588 --> 00:17:31,190
0 then the dayside comes back in and we

442
00:17:29,009 --> 00:17:35,158

see it's essentially a sinusoidal

443

00:17:31,190 --> 00:17:36,630

increase in emission from the planet and

444

00:17:35,159 --> 00:17:39,750

then a decrease and an increase in

445

00:17:36,630 --> 00:17:42,360

decrease okay I want to get to a couple

446

00:17:39,750 --> 00:17:45,480

of relevant comments on our questions on

447

00:17:42,359 --> 00:17:48,719

the Q&A app Eric charland is asking how

448

00:17:45,480 --> 00:17:52,500

precise are those measurements of gas in

449

00:17:48,720 --> 00:17:54,579

exoplanet atmospheres how precise update

450

00:17:52,500 --> 00:17:58,809

in other words how well do you know

451

00:17:54,579 --> 00:18:00,549

these temperatures Laura do you want to

452

00:17:58,809 --> 00:18:02,619

talk about how well we constrained the

453

00:18:00,549 --> 00:18:04,000

water on this planet I can talk about

454

00:18:02,619 --> 00:18:05,679

that so it so like I was saying earlier

455

00:18:04,000 --> 00:18:07,269

one of the things that you can learn

456

00:18:05,680 --> 00:18:12,220

about the atmosphere is what it's made

457
00:18:07,269 --> 00:18:15,039
out of and so for West 43d we made the

458
00:18:12,220 --> 00:18:16,870
most precise estimate of the water

459
00:18:15,039 --> 00:18:20,309
abundance so how much water is in the

460
00:18:16,869 --> 00:18:22,839
atmosphere for any exoplanet so far and

461
00:18:20,309 --> 00:18:25,419
we we measured it to within about a

462
00:18:22,839 --> 00:18:27,490
factor of 10 or so when we when we talk

463
00:18:25,420 --> 00:18:30,580
about water abundances we often compare

464
00:18:27,490 --> 00:18:33,220
them to the expected amount of water you

465
00:18:30,579 --> 00:18:35,799
would get in a gas with what's known as

466
00:18:33,220 --> 00:18:38,589
solar composition so if you took the

467
00:18:35,799 --> 00:18:40,240
material that made up the Sun there is

468
00:18:38,589 --> 00:18:41,709
some oxygen atoms in there and you've

469
00:18:40,240 --> 00:18:45,730
pulled it down to the temperature of the

470
00:18:41,710 --> 00:18:48,519
planet it would form water and so what

471
00:18:45,730 --> 00:18:50,529
we measured for wasco decreasing he said

472
00:18:48,519 --> 00:18:52,690
its water abundance is about between a

473
00:18:50,529 --> 00:18:54,730
half and three and a half times the

474
00:18:52,690 --> 00:19:00,700
expectation for this solar composition

475
00:18:54,730 --> 00:19:05,650
gas and so a factor of 10 is really

476
00:19:00,700 --> 00:19:07,390
stunning to think that 300 way yeah so

477
00:19:05,650 --> 00:19:10,150
not only not only is it the sites but

478
00:19:07,390 --> 00:19:12,400
it's also something we can't measure for

479
00:19:10,150 --> 00:19:14,380
the solar system planets at all so

480
00:19:12,400 --> 00:19:16,870
Jupiter and Saturn are so cold that

481
00:19:14,380 --> 00:19:18,340
their water has frozen out in deeper

482
00:19:16,869 --> 00:19:21,429
parts of their atmospheres and it's out

483
00:19:18,339 --> 00:19:24,069
of reach for us to study and so these

484
00:19:21,430 --> 00:19:26,200
hot Jupiters have such high atmosphere

485

00:19:24,069 --> 00:19:29,559
temperatures that water is all in the

486
00:19:26,200 --> 00:19:33,400
gas phase and we can use them to try to

487
00:19:29,559 --> 00:19:35,409
learn about how much water um went into

488
00:19:33,400 --> 00:19:36,759
forming them and waters had to be really

489
00:19:35,410 --> 00:19:38,380
important building block for planet

490
00:19:36,759 --> 00:19:40,119
finish and that's why we always been

491
00:19:38,380 --> 00:19:41,620
interested in this what about the

492
00:19:40,119 --> 00:19:43,000
temperatures themselves the temperature

493
00:19:41,619 --> 00:19:46,719
measurements themselves how accurate are

494
00:19:43,000 --> 00:19:49,890
they yeah the temperature estimate has

495
00:19:46,720 --> 00:19:51,730
to make certain assumptions uh the

496
00:19:49,890 --> 00:19:53,500
difficulty with the measurement that

497
00:19:51,730 --> 00:19:56,920
we're making is we're really looking at

498
00:19:53,500 --> 00:19:59,319
the planet's entire face when we're

499
00:19:56,920 --> 00:20:02,009

making a measurement so the dayside for

500

00:19:59,319 --> 00:20:04,928

example we can't just we can't a

501

00:20:02,009 --> 00:20:05,859

pinpoint or make a temperature

502

00:20:04,929 --> 00:20:08,080

measurement at

503

00:20:05,859 --> 00:20:09,369

cific spots on the planet's surface we

504

00:20:08,079 --> 00:20:12,548

kind of have to take everything as a

505

00:20:09,369 --> 00:20:15,428

whole so uh the measurements are very

506

00:20:12,548 --> 00:20:18,160

precise when you average over the face

507

00:20:15,429 --> 00:20:20,679

of the planet itself that we can see but

508

00:20:18,160 --> 00:20:23,650

the it's it's difficult to actually say

509

00:20:20,679 --> 00:20:26,019

well this exact spot on within the

510

00:20:23,650 --> 00:20:27,720

planet has this particular temperature

511

00:20:26,019 --> 00:20:30,548

because of course there's going to be

512

00:20:27,720 --> 00:20:31,808

more local variations in the temperature

513

00:20:30,548 --> 00:20:33,460

just like what we have here on earth

514
00:20:31,808 --> 00:20:37,269
that's not going to be the same

515
00:20:33,460 --> 00:20:38,919
temperature everywhere in North America

516
00:20:37,269 --> 00:20:40,869
it's going to vary but if you take an

517
00:20:38,919 --> 00:20:43,809
average measurement over the entire

518
00:20:40,869 --> 00:20:45,250
continent you can we can say with fairly

519
00:20:43,808 --> 00:20:48,279
good precision what that average

520
00:20:45,250 --> 00:20:50,259
temperature is yeah then about a couple

521
00:20:48,279 --> 00:20:52,359
hundred degrees or so a couple hundred

522
00:20:50,259 --> 00:20:54,548
degrees okay well Scott's got an

523
00:20:52,359 --> 00:20:56,289
animation up who wants to talk about

524
00:20:54,548 --> 00:20:58,690
that how about you got go ahead Laura oh

525
00:20:56,289 --> 00:21:02,289
this is gonna be I like Kevin talk about

526
00:20:58,690 --> 00:21:06,130
okay Kevin is alright that's fine so

527
00:21:02,289 --> 00:21:08,230
what this graphic is showing is the in

528
00:21:06,130 --> 00:21:10,929
the all star in the top left hand corner

529
00:21:08,230 --> 00:21:12,370
it is the emission spectrum the amount

530
00:21:10,929 --> 00:21:15,809
of light that we're measuring as a

531
00:21:12,369 --> 00:21:18,849
function of wavelength as the planet

532
00:21:15,808 --> 00:21:21,849
makes one complete rotation so the

533
00:21:18,849 --> 00:21:23,980
time-lapse video shows what we call the

534
00:21:21,849 --> 00:21:27,189
spectrum and there's a water absorption

535
00:21:23,980 --> 00:21:31,440
feature some so between 1.3 and 1.6

536
00:21:27,190 --> 00:21:33,669
microns roughly there is in white on the

537
00:21:31,440 --> 00:21:37,000
graphic there there's a large water

538
00:21:33,669 --> 00:21:39,340
absorption feature and we see that water

539
00:21:37,000 --> 00:21:42,548
because the amount of light that we

540
00:21:39,339 --> 00:21:44,558
measure dips there so as certain as

541
00:21:42,548 --> 00:21:46,690
certain phases there's that there's a

542

00:21:44,558 --> 00:21:48,819
dip around that region and we can say

543
00:21:46,690 --> 00:21:51,548
well that is because we measure water

544
00:21:48,819 --> 00:21:53,950
inside the atmosphere and the reason why

545
00:21:51,548 --> 00:21:56,230
this entire red line is going up and

546
00:21:53,950 --> 00:21:58,990
down is as I mentioned before the

547
00:21:56,230 --> 00:22:00,759
planets day side comes in and out of

548
00:21:58,990 --> 00:22:02,650
view so as the day side comes into view

549
00:22:00,759 --> 00:22:04,569
you can see that on the bottom with

550
00:22:02,650 --> 00:22:06,910
these brightness temperature maps the

551
00:22:04,569 --> 00:22:08,409
brightness increases and then as the

552
00:22:06,910 --> 00:22:10,330
night side comes into view the

553
00:22:08,410 --> 00:22:13,509
brightness decreases and that's also

554
00:22:10,329 --> 00:22:15,909
reflected with thermal profile so we

555
00:22:13,509 --> 00:22:18,429
have a measurement of what the

556
00:22:15,910 --> 00:22:19,720

temperature of this planet and it is over

557

00:22:18,429 --> 00:22:22,000
this face

558

00:22:19,720 --> 00:22:24,970
on the day side and it notice it's quite

559

00:22:22,000 --> 00:22:27,009
warm it's in the 1500 to 2000 Kelvin

560

00:22:24,970 --> 00:22:28,870
range which is you know up to 3,000

561

00:22:27,009 --> 00:22:30,308
Fahrenheit and as the new night tide

562

00:22:28,869 --> 00:22:31,899
comes in to view the temperature

563

00:22:30,308 --> 00:22:36,029
essentially drops like a rock to

564

00:22:31,900 --> 00:22:38,230
something below a thousand Fahrenheit

565

00:22:36,029 --> 00:22:40,058
that would make sense and again on the

566

00:22:38,230 --> 00:22:42,970
bottom these temperature map is just

567

00:22:40,058 --> 00:22:45,519
three different examples of what the

568

00:22:42,970 --> 00:22:46,929
temperature is at different altitudes so

569

00:22:45,519 --> 00:22:49,269
wavelengths different wavelengths

570

00:22:46,929 --> 00:22:50,590
different depths inside the atmosphere

571
00:22:49,269 --> 00:22:53,379
so you can see some are brighter and

572
00:22:50,589 --> 00:22:57,399
some are cooler so I have a question so

573
00:22:53,380 --> 00:22:59,679
you have very hot atmosphere on one side

574
00:22:57,400 --> 00:23:02,620
and cooler on the other one would expect

575
00:22:59,679 --> 00:23:05,620
there would be like really amazing winds

576
00:23:02,619 --> 00:23:08,379
on this planet but apparently they're

577
00:23:05,619 --> 00:23:10,449
insufficient to actually circulate the

578
00:23:08,380 --> 00:23:12,190
atmosphere enough to equalize its

579
00:23:10,450 --> 00:23:16,210
temperature because it's so close to its

580
00:23:12,190 --> 00:23:19,298
parent star is that the idea so there

581
00:23:16,210 --> 00:23:23,019
are very strong supersonic winds on this

582
00:23:19,298 --> 00:23:25,418
planet and the question is is it's a

583
00:23:23,019 --> 00:23:27,609
question of time scales how long does it

584
00:23:25,419 --> 00:23:29,830
take to push the wind from the day side

585
00:23:27,609 --> 00:23:31,899
to the night side right versus how long

586
00:23:29,829 --> 00:23:34,779
does it take for that heat to rear a d8

587
00:23:31,900 --> 00:23:37,059
out and as it happens with this planet

588
00:23:34,779 --> 00:23:39,970
it doesn't take a long two for the hate

589
00:23:37,058 --> 00:23:42,308
to basically re-radiate so the wind

590
00:23:39,970 --> 00:23:44,589
although fast just doesn't have enough

591
00:23:42,308 --> 00:23:49,359
time to push that heat from the day side

592
00:23:44,589 --> 00:23:51,759
to the night side so what you obviously

593
00:23:49,359 --> 00:23:53,469
we used the Hubble to make these these

594
00:23:51,759 --> 00:23:55,179
measurements and we're looking at the

595
00:23:53,470 --> 00:23:58,509
wavelength go up and down in the near-ir

596
00:23:55,179 --> 00:24:01,690
around the 1.3 to 1.6 wavelength range

597
00:23:58,509 --> 00:24:05,109
what what instruments were used to make

598
00:24:01,690 --> 00:24:08,140
these observations on Hubble with Hubble

599

00:24:05,109 --> 00:24:10,689
we used a wide field camera 3 that is by

600
00:24:08,140 --> 00:24:13,809
the old standby yeah the old stem I did

601
00:24:10,690 --> 00:24:15,548
the old dependable right it's right came

602
00:24:13,808 --> 00:24:19,298
in to commissioning around two thousand

603
00:24:15,548 --> 00:24:21,609
nine I believe and it's just been a

604
00:24:19,298 --> 00:24:23,918
fantastic work horse for exoplanet

605
00:24:21,609 --> 00:24:27,609
characterization it is it's amazingly

606
00:24:23,919 --> 00:24:30,309
precise instrument has great stability

607
00:24:27,609 --> 00:24:32,798
and it allows us to make high precision

608
00:24:30,308 --> 00:24:33,759
measurements of exoplanets particularly

609
00:24:32,798 --> 00:24:36,700
if you're in

610
00:24:33,759 --> 00:24:40,839
in water because it has that sensitivity

611
00:24:36,700 --> 00:24:42,160
from 1.1 to 1.7 microns for example in

612
00:24:40,839 --> 00:24:45,879
the case that the measurements that we

613
00:24:42,160 --> 00:24:47,500

used here so it's it's been a really

614

00:24:45,880 --> 00:24:49,240

great instrument to use and we're going

615

00:24:47,500 --> 00:24:52,089

to be testing it further actually with

616

00:24:49,240 --> 00:24:53,799

with other other wavelengths and other

617

00:24:52,089 --> 00:24:55,449

planets of course well that's what I was

618

00:24:53,799 --> 00:24:56,950

going to ask you next so there are other

619

00:24:55,450 --> 00:24:58,569

planets in your future then that you're

620

00:24:56,950 --> 00:25:02,170

going to be trying to do these maps with

621

00:24:58,569 --> 00:25:05,619

right oh yeah haha do you have Hubble

622

00:25:02,170 --> 00:25:08,529

time coming up this year or is it down

623

00:25:05,619 --> 00:25:10,329

the road a bit wait we have servations

624

00:25:08,529 --> 00:25:14,619

that are still going into your cycle

625

00:25:10,329 --> 00:25:17,559

okay and we're asking for more time so

626

00:25:14,619 --> 00:25:19,329

uh is this a difficult thing to do with

627

00:25:17,559 --> 00:25:23,009

uh with Hubble is this a hard

628
00:25:19,329 --> 00:25:25,899
measurement to make and by heart i mean

629
00:25:23,009 --> 00:25:27,759
exacting and difficult to process the

630
00:25:25,900 --> 00:25:29,170
data and understand what you're looking

631
00:25:27,759 --> 00:25:30,940
at what does i mean to do these

632
00:25:29,170 --> 00:25:33,070
observations like Kevin Kevin got into

633
00:25:30,940 --> 00:25:35,769
this a little bit about how fantastic 43

634
00:25:33,069 --> 00:25:37,779
is but his instruments were never

635
00:25:35,769 --> 00:25:40,000
designed to do the kind of stuff that we

636
00:25:37,779 --> 00:25:43,240
do we're measuring the brightness of the

637
00:25:40,000 --> 00:25:45,670
star at precision on the order of you

638
00:25:43,240 --> 00:25:48,009
know less than 100 parts per million

639
00:25:45,670 --> 00:25:50,529
we're measuring very very very very tiny

640
00:25:48,009 --> 00:25:54,759
changes in the brightness of the star

641
00:25:50,529 --> 00:25:56,829
and the instrument is it has time

642
00:25:54,759 --> 00:25:59,680
varying sensitivity and so that

643
00:25:56,829 --> 00:26:01,689
basically their instrument systematics

644
00:25:59,680 --> 00:26:02,830
that are two orders of fine into larger

645
00:26:01,690 --> 00:26:06,670
than the signal that we're trying to

646
00:26:02,829 --> 00:26:09,339
detect and so there's a lot of data

647
00:26:06,670 --> 00:26:11,980
processing that goes into seeing what we

648
00:26:09,339 --> 00:26:14,139
see yeah that's what we built Kepler for

649
00:26:11,980 --> 00:26:16,569
was to make that kind of that kind of

650
00:26:14,140 --> 00:26:18,009
precision measurement so I can see so I

651
00:26:16,569 --> 00:26:19,329
see what you mean about it not being

652
00:26:18,009 --> 00:26:21,009
designed for that but you're still able

653
00:26:19,329 --> 00:26:23,109
to extract this information that's right

654
00:26:21,009 --> 00:26:26,079
yeah and it comes out looking fantastic

655
00:26:23,109 --> 00:26:27,639
this is the first um the first instant

656

00:26:26,079 --> 00:26:30,399
for we've had spectroscopy didn't mean

657
00:26:27,640 --> 00:26:32,890
matches up with models for what the

658
00:26:30,400 --> 00:26:34,930
atmosphere should look like so we were

659
00:26:32,890 --> 00:26:37,480
really believing this data would work

660
00:26:34,930 --> 00:26:39,310
and we're observing in a new mode if it

661
00:26:37,480 --> 00:26:41,380
was developed specifically to observe

662
00:26:39,309 --> 00:26:43,269
bright target like what we're doing a

663
00:26:41,380 --> 00:26:46,090
new mode can you try what do you mean by

664
00:26:43,269 --> 00:26:47,589
that yeah so it's um this is a really

665
00:26:46,089 --> 00:26:50,168
cool thing so I

666
00:26:47,589 --> 00:26:52,889
the detector will saturate pretty

667
00:26:50,169 --> 00:26:57,460
quickly for very brightest targets and

668
00:26:52,890 --> 00:26:59,259
it takes some time to read it out and so

669
00:26:57,460 --> 00:27:01,150
every time you take a short exposure and

670
00:26:59,259 --> 00:27:04,240

you waste a bunch of time reading it out

671

00:27:01,150 --> 00:27:05,679

you are losing time on target like on

672

00:27:04,240 --> 00:27:09,849

sky when you're actually detecting

673

00:27:05,679 --> 00:27:11,830

photons and to help get around this that

674

00:27:09,849 --> 00:27:14,199

book that space telescope designed a

675

00:27:11,829 --> 00:27:17,439

technique that allows the telescope to

676

00:27:14,200 --> 00:27:19,419

sort of move the target star on the

677

00:27:17,440 --> 00:27:22,120

detector over the course of an exposure

678

00:27:19,419 --> 00:27:26,470

and that smears out the light if you

679

00:27:22,119 --> 00:27:28,658

don't get um saturation is quickly and

680

00:27:26,470 --> 00:27:30,788

so that allows us to take longer

681

00:27:28,659 --> 00:27:32,350

exposures and use the telescope more

682

00:27:30,788 --> 00:27:35,038

efficiently for these really bright

683

00:27:32,349 --> 00:27:38,099

targets and that totally broke open the

684

00:27:35,038 --> 00:27:40,269

door to doing observations like this oh

685
00:27:38,099 --> 00:27:41,798
that's wonderful we should hang out on

686
00:27:40,269 --> 00:27:45,038
that technique Caroline we're more about

687
00:27:41,798 --> 00:27:47,259
that the idea is if you have to take a

688
00:27:45,038 --> 00:27:48,908
very fast exposure and then read it out

689
00:27:47,259 --> 00:27:53,109
you're spending all your time reading

690
00:27:48,909 --> 00:27:54,610
the debate there is a few in Creek to

691
00:27:53,109 --> 00:27:57,069
increase the exposure time then the

692
00:27:54,609 --> 00:27:59,619
readout time is less percent of the

693
00:27:57,069 --> 00:28:02,859
entire so exactly what we effectively

694
00:27:59,619 --> 00:28:06,489
did is increase the amount of exposure

695
00:28:02,859 --> 00:28:11,139
time we can get by a factor of more than

696
00:28:06,490 --> 00:28:13,028
five Wow like ten percent efficient 27

697
00:28:11,140 --> 00:28:15,460
year eighty percent efficient wow that's

698
00:28:13,028 --> 00:28:17,648
great that is amazing so what about

699
00:28:15,460 --> 00:28:18,880
soaking ground-based telescopes do this

700
00:28:17,648 --> 00:28:21,849
or is this something we got to have be

701
00:28:18,880 --> 00:28:24,760
in space for this is something we have

702
00:28:21,849 --> 00:28:26,829
to absolutely be in space for so the the

703
00:28:24,759 --> 00:28:28,898
measurement that we made remember the

704
00:28:26,829 --> 00:28:31,599
the planet orbits in nineteen and a half

705
00:28:28,898 --> 00:28:34,808
hours so it it's essentially impossible

706
00:28:31,599 --> 00:28:36,129
to stay on a target for that long it's

707
00:28:34,808 --> 00:28:37,778
pine from the ground because obviously

708
00:28:36,130 --> 00:28:40,929
you have to deal with things like the

709
00:28:37,778 --> 00:28:43,179
Sun coming up so first of all you need a

710
00:28:40,929 --> 00:28:45,880
space telescope for that because of the

711
00:28:43,179 --> 00:28:48,490
duration of the measurement and also

712
00:28:45,880 --> 00:28:51,760
because of the precision for we are

713

00:28:48,490 --> 00:28:53,620
measuring water in this case and it can

714
00:28:51,759 --> 00:28:55,720
be very difficult to do that when you're

715
00:28:53,619 --> 00:28:57,788
on the ground because you have a pesky

716
00:28:55,720 --> 00:29:00,399
thing known as you know atmosphere

717
00:28:57,788 --> 00:29:01,400
that's in the way and absorbing water

718
00:29:00,398 --> 00:29:05,119
you can

719
00:29:01,400 --> 00:29:06,560
HP keeping us alive well it's great for

720
00:29:05,119 --> 00:29:09,169
that but it's really annoying for

721
00:29:06,559 --> 00:29:10,940
astronomers it is yeah you know okay

722
00:29:09,170 --> 00:29:12,500
well that's great so Adam synergy has a

723
00:29:10,940 --> 00:29:16,009
question on the QA app that I've been

724
00:29:12,500 --> 00:29:17,809
reading and I'm died I don't understand

725
00:29:16,009 --> 00:29:20,089
one of the terms of using but well read

726
00:29:17,809 --> 00:29:22,099
it to you because so he's asking as I

727
00:29:20,089 --> 00:29:24,409

understand it both the hot spot on the

728

00:29:22,099 --> 00:29:26,689

day side and the cold spot on the night

729

00:29:24,410 --> 00:29:29,570

side of wasp 43b were observed to be

730

00:29:26,690 --> 00:29:32,059

offset relative to the substellar and

731

00:29:29,569 --> 00:29:33,409

anti subcellar points where they might

732

00:29:32,059 --> 00:29:35,720

expect it to be what are the likely

733

00:29:33,410 --> 00:29:39,880

reasons for this I don't know the

734

00:29:35,720 --> 00:29:42,620

subcellar point is that's neck question

735

00:29:39,880 --> 00:29:45,170

that is it that is a that is a well post

736

00:29:42,619 --> 00:29:50,089

question actually madam Adams always got

737

00:29:45,170 --> 00:29:53,269

good question ok so the substellar point

738

00:29:50,089 --> 00:29:55,789

is the point that is closest to the star

739

00:29:53,269 --> 00:29:58,190

on point on the planet that's closest to

740

00:29:55,789 --> 00:30:00,769

the star so you not at that point to be

741

00:29:58,190 --> 00:30:02,690

the hottest the anti stellar point is

742
00:30:00,769 --> 00:30:04,579
the opposite is the point on the planet

743
00:30:02,690 --> 00:30:05,990
that is furthest from the star this is

744
00:30:04,579 --> 00:30:08,899
going to be the night side so you'd

745
00:30:05,990 --> 00:30:10,880
expect that to be the coolest I think we

746
00:30:08,900 --> 00:30:14,360
do have a graphic that shows the white

747
00:30:10,880 --> 00:30:15,950
light curve white light phase curve if

748
00:30:14,359 --> 00:30:21,109
we can bring that up and that really

749
00:30:15,950 --> 00:30:22,880
shows okay perfect so this is this is a

750
00:30:21,109 --> 00:30:25,699
graphic here and it's showing as a

751
00:30:22,880 --> 00:30:26,890
function of orbital phase so as the

752
00:30:25,700 --> 00:30:29,539
planet makes one complete rotation

753
00:30:26,890 --> 00:30:31,580
there's an increase in brightness as the

754
00:30:29,539 --> 00:30:34,009
day side comes into view and right

755
00:30:31,579 --> 00:30:36,500
around point five we see this drop that

756
00:30:34,009 --> 00:30:38,269
right there the second Eric cliffs where

757
00:30:36,500 --> 00:30:40,730
the planet goes behind the star and then

758
00:30:38,269 --> 00:30:42,500
again then as the day side goes out of

759
00:30:40,730 --> 00:30:45,140
view the temperature drops what you'll

760
00:30:42,500 --> 00:30:46,819
notice is the key in if there were no

761
00:30:45,140 --> 00:30:50,020
wins what you would expect is the

762
00:30:46,819 --> 00:30:52,549
brightness to peak somewhere around the

763
00:30:50,019 --> 00:30:53,900
secondary clips about point five and

764
00:30:52,549 --> 00:30:56,389
then you would have expect to have a

765
00:30:53,900 --> 00:30:58,759
minimum around zero if the orbital phase

766
00:30:56,390 --> 00:31:00,650
of zero and that's not happening in this

767
00:30:58,759 --> 00:31:03,440
case so you can see the minimum probably

768
00:31:00,650 --> 00:31:06,170
curves closer to a phase 0 point 1 and

769
00:31:03,440 --> 00:31:09,470
the maximum occurs closer to a phase of

770

00:31:06,170 --> 00:31:12,140
point for so the maximum we can explain

771
00:31:09,470 --> 00:31:14,870
that by winds so what happens is that

772
00:31:12,140 --> 00:31:18,220
the the circulation pattern

773
00:31:14,869 --> 00:31:20,869
on the planet pushes that hot day side

774
00:31:18,220 --> 00:31:22,970
downstream a little bit and and then by

775
00:31:20,869 --> 00:31:24,679
the time it really exerts its authority

776
00:31:22,970 --> 00:31:26,990
the planet has already rotated a little

777
00:31:24,680 --> 00:31:30,890
bit and it's peaking around a phase of 0

778
00:31:26,990 --> 00:31:33,259
point for 2.43 roughly the night side

779
00:31:30,890 --> 00:31:35,210
that is an excellent question and we can

780
00:31:33,259 --> 00:31:37,519
explain that none of the models that we

781
00:31:35,210 --> 00:31:40,250
have right now adequately explain why

782
00:31:37,519 --> 00:31:43,400
the night side has been shifted to later

783
00:31:40,250 --> 00:31:44,829
on past transit so that is an open

784
00:31:43,400 --> 00:31:47,240

question that we're still looking into

785

00:31:44,829 --> 00:31:49,428

nice and well done Adam thank you for

786

00:31:47,240 --> 00:31:52,069

that question Craig Landon is asking

787

00:31:49,429 --> 00:31:54,320

also on the Q&A app given that there are

788

00:31:52,069 --> 00:31:56,779

as many types of exoplanets as there are

789

00:31:54,319 --> 00:31:59,000

types of stellar classification is there

790

00:31:56,779 --> 00:32:02,000

any exoplanet classification based on

791

00:31:59,000 --> 00:32:05,150

composition atmosphere size anything

792

00:32:02,000 --> 00:32:08,210

except these names based on solar system

793

00:32:05,150 --> 00:32:10,160

types yeah is there any is there any

794

00:32:08,210 --> 00:32:12,590

classification based on what the planet

795

00:32:10,160 --> 00:32:15,590

itself is like it's where there are a

796

00:32:12,589 --> 00:32:18,279

couple of ideas that we that the

797

00:32:15,589 --> 00:32:22,369

scientists have put forth based on a

798

00:32:18,279 --> 00:32:25,339

composition and temperature that that we

799

00:32:22,369 --> 00:32:27,949
believe might classify a plan one

800

00:32:25,339 --> 00:32:30,589
example for example is a thermal

801

00:32:27,950 --> 00:32:34,130
inversion so all of the temperatures

802

00:32:30,589 --> 00:32:37,299
that we've shown decrease with

803

00:32:34,130 --> 00:32:39,500
increasing altitude and it is fairly

804

00:32:37,299 --> 00:32:43,279
basically as you go higher up against

805

00:32:39,500 --> 00:32:45,920
colder oh and some measurements have

806

00:32:43,279 --> 00:32:48,558
suggested that planets might get hotter

807

00:32:45,920 --> 00:32:50,058
as you increase your altitude and there

808

00:32:48,558 --> 00:32:51,859
is actually a debate going on about

809

00:32:50,058 --> 00:32:54,950
whether or not that's true but but

810

00:32:51,859 --> 00:32:56,779
people have have predicted that there

811

00:32:54,950 --> 00:32:58,910
are two different types of planets two

812

00:32:56,779 --> 00:33:01,940
classes based on whether you have an in

813
00:32:58,910 --> 00:33:04,550
temperature inversion or do not another

814
00:33:01,940 --> 00:33:06,620
way of classifying the planet is how

815
00:33:04,549 --> 00:33:09,289
much carbon there is versus how much

816
00:33:06,619 --> 00:33:12,349
oxygen so there there's an interesting

817
00:33:09,289 --> 00:33:14,509
debate also about call it a carbon to

818
00:33:12,349 --> 00:33:16,730
oxygen ratio if there is a lot of carbon

819
00:33:14,509 --> 00:33:18,700
on a planet you might have interesting

820
00:33:16,730 --> 00:33:21,019
chemistry going on in its atmosphere

821
00:33:18,700 --> 00:33:22,549
versus if you have more oxygen in the

822
00:33:21,019 --> 00:33:24,710
planet you'll have different chemistry

823
00:33:22,549 --> 00:33:28,250
going on so that's just two ideas of

824
00:33:24,710 --> 00:33:30,289
what people have a that they can

825
00:33:28,250 --> 00:33:32,059
hopefully used to classify planets but

826
00:33:30,289 --> 00:33:35,299
certainly this is an ongoing debate and

827

00:33:32,059 --> 00:33:38,329
it will be for some time until we have a

828
00:33:35,299 --> 00:33:41,659
lot more measurement of these plants

829
00:33:38,329 --> 00:33:43,399
with the characterize not just a dozen

830
00:33:41,660 --> 00:33:45,170
or two but maybe a hundred then we'll

831
00:33:43,400 --> 00:33:47,269
really be able to pull out statistical

832
00:33:45,170 --> 00:33:49,250
information about these planets so i

833
00:33:47,269 --> 00:33:51,019
have i have a question then you're

834
00:33:49,250 --> 00:33:53,000
talking about using inversion as a

835
00:33:51,019 --> 00:33:54,740
classification but as we know the earth

836
00:33:53,000 --> 00:33:58,279
has of inversion layers too but they're

837
00:33:54,740 --> 00:34:00,289
not persistent so seems like maybe some

838
00:33:58,279 --> 00:34:03,349
other planets might not have persistent

839
00:34:00,289 --> 00:34:07,099
inversion layers no no that's not true

840
00:34:03,349 --> 00:34:10,339
here oh ok sorry excuse me I should go

841
00:34:07,099 --> 00:34:16,489

back to reading a book we're taking

842

00:34:10,340 --> 00:34:20,300

we're taking baby steps here means that

843

00:34:16,489 --> 00:34:22,099

we've measured we measured as thermal

844

00:34:20,300 --> 00:34:23,330

inversion in an exoplanet atmosphere and

845

00:34:22,099 --> 00:34:27,559

then they came back later and said oh

846

00:34:23,329 --> 00:34:28,878

now we don't see it muchly on something

847

00:34:27,559 --> 00:34:31,039

being wrong with the interpreter for the

848

00:34:28,878 --> 00:34:34,039

data analysis rather than the planet

849

00:34:31,039 --> 00:34:36,610

actually changing babies apology you

850

00:34:34,039 --> 00:34:40,668

know I'm gonna jump in the fray Tony oh

851

00:34:36,610 --> 00:34:42,889

I love it thank you okay so Michael

852

00:34:40,668 --> 00:34:45,079

jobin is back giving us some comments hi

853

00:34:42,889 --> 00:34:47,780

Mike it's good to see you again he's

854

00:34:45,079 --> 00:34:50,210

commenting that it's amazing that you

855

00:34:47,780 --> 00:34:52,190

know it is tidally locked that's true I

856
00:34:50,210 --> 00:34:53,960
mean it is what are the the

857
00:34:52,190 --> 00:34:56,570
characteristics of a tightly lying to me

858
00:34:53,960 --> 00:34:58,070
it would let's say it weren't tightly

859
00:34:56,570 --> 00:34:59,780
locked what would would you be able to

860
00:34:58,070 --> 00:35:02,030
tell from the thermal maps that you're

861
00:34:59,780 --> 00:35:03,950
making that it's not or is that a is

862
00:35:02,030 --> 00:35:06,500
that is that something that's relatively

863
00:35:03,949 --> 00:35:09,349
easy to find out yes so that there are

864
00:35:06,500 --> 00:35:11,329
planets for example that have large

865
00:35:09,349 --> 00:35:13,219
eccentricities so it's that means that

866
00:35:11,329 --> 00:35:17,869
its orbit isn't circular around its star

867
00:35:13,219 --> 00:35:21,169
if it has this highly eccentric orbit

868
00:35:17,869 --> 00:35:23,539
what happens is the dayside isn't a

869
00:35:21,170 --> 00:35:25,220
permanent day side and the heat

870
00:35:23,539 --> 00:35:29,840
signature that we're seeing the increase

871
00:35:25,219 --> 00:35:32,899
and decrease in flux is not uh it is not

872
00:35:29,840 --> 00:35:35,530
timed synchronized with the orbit of the

873
00:35:32,900 --> 00:35:38,200
planet and and so you get an interesting

874
00:35:35,530 --> 00:35:42,109
ratio where perhaps the planet rotates

875
00:35:38,199 --> 00:35:44,239
three times for every twice

876
00:35:42,108 --> 00:35:46,548
goes around its star and it's an

877
00:35:44,239 --> 00:35:48,650
interesting play on the dynamics and

878
00:35:46,548 --> 00:35:51,489
circulation of those plans and in this

879
00:35:48,650 --> 00:35:54,650
case we do know that the eccentricity is

880
00:35:51,489 --> 00:35:57,079
very much near zero and ended it so it

881
00:35:54,650 --> 00:35:59,298
is tightly locked nice good job thanks

882
00:35:57,079 --> 00:36:02,089
Michael he's also commenting he may be

883
00:35:59,298 --> 00:36:06,498
commented that i like atmospheres i use

884

00:36:02,088 --> 00:36:08,268
one every day yes i do too so and 1 more

885
00:36:06,498 --> 00:36:09,768
comment here from Cecil Morgan let me

886
00:36:08,268 --> 00:36:11,808
get this right those look really good

887
00:36:09,768 --> 00:36:15,709
question there yeah plus 3 on this one

888
00:36:11,809 --> 00:36:17,028
uh getting voted up wasp wasp 3043 be

889
00:36:15,710 --> 00:36:19,730
was described as being gravitationally

890
00:36:17,028 --> 00:36:22,130
locked to its star like the moon is to

891
00:36:19,730 --> 00:36:23,748
earth would be more accurate to say

892
00:36:22,130 --> 00:36:25,338
there is a permanent density and

893
00:36:23,748 --> 00:36:27,649
temperature gradient towards the star

894
00:36:25,338 --> 00:36:32,150
that is not necessarily the same as this

895
00:36:27,650 --> 00:36:34,278
planet spin rate uh yeah the planet

896
00:36:32,150 --> 00:36:37,099
doesn't actually have a surface right

897
00:36:34,278 --> 00:36:38,539
it's a gas on face yes so that is a more

898
00:36:37,099 --> 00:36:41,838

accurate way to describe what we're

899

00:36:38,539 --> 00:36:44,539

talking about good nice nicely done so

900

00:36:41,838 --> 00:36:47,028

how long did it take to get this map

901

00:36:44,539 --> 00:36:49,549

built out of in terms of observation

902

00:36:47,028 --> 00:36:54,469

orbits or whatever how long was it a was

903

00:36:49,548 --> 00:36:56,449

it a long process or was it well it

904

00:36:54,469 --> 00:36:58,939

depends on depends on who you're asking

905

00:36:56,449 --> 00:37:00,469

like in the fume of things it wasn't

906

00:36:58,940 --> 00:37:04,068

that much time and told Kevin how many

907

00:37:00,469 --> 00:37:06,889

orbits of use 5161 orbits one or the

908

00:37:04,068 --> 00:37:12,230

Senate orbit is 96 minutes long wow

909

00:37:06,889 --> 00:37:17,058

that's a lot the time so it's and it was

910

00:37:12,230 --> 00:37:18,498

and um it was a really intensive

911

00:37:17,059 --> 00:37:20,660

observational program this is I think

912

00:37:18,498 --> 00:37:25,179

the most Hubble time that has ever been

913
00:37:20,659 --> 00:37:27,288
devoted to a single exoplanet every ah

914
00:37:25,179 --> 00:37:29,239
but at the same time you know when I

915
00:37:27,289 --> 00:37:30,380
told my friends Oh Hubble's looking at

916
00:37:29,239 --> 00:37:34,249
our planet right now and then the next

917
00:37:30,380 --> 00:37:36,619
day practically done that that made it

918
00:37:34,248 --> 00:37:39,048
seem really quick I'm doing my movement

919
00:37:36,619 --> 00:37:42,289
in the sunshine without going on alright

920
00:37:39,048 --> 00:37:43,818
but our telescope allocation tango

921
00:37:42,289 --> 00:37:45,499
specific yeah that's a lot of that was a

922
00:37:43,818 --> 00:37:47,179
lot yeah so guy Eric charlyn on the Q&A

923
00:37:45,498 --> 00:37:51,018
app is asking do you guys are you guys

924
00:37:47,179 --> 00:37:55,460
on Twitter can you be followed I have a

925
00:37:51,018 --> 00:38:00,229
Twitter yeah Stolte one thing on it

926
00:37:55,460 --> 00:38:01,699
haha see we can change that yeah I too

927
00:38:00,230 --> 00:38:05,059
have a Twitter account but I don't tweet

928
00:38:01,699 --> 00:38:07,399
on it I just follow yeah my friend was

929
00:38:05,059 --> 00:38:10,159
like I fries would I can put it on my

930
00:38:07,400 --> 00:38:12,650
little name tag well you don't tweet on

931
00:38:10,159 --> 00:38:13,759
it there's no boy guys aren't you guys

932
00:38:12,650 --> 00:38:16,910
are tweeting let us know what you're

933
00:38:13,760 --> 00:38:19,910
doing i was thinking i'd be really fun

934
00:38:16,909 --> 00:38:21,589
to tweet in observing run some time to

935
00:38:19,909 --> 00:38:23,480
go through the whole process of like

936
00:38:21,590 --> 00:38:26,960
flying down to Chile or whatever it is

937
00:38:23,480 --> 00:38:28,550
and like all of the UM touch-and-go I

938
00:38:26,960 --> 00:38:30,260
started the night when we're trying to

939
00:38:28,550 --> 00:38:32,240
get our target alignment everything

940
00:38:30,260 --> 00:38:34,550
people make it go cool I could be done

941

00:38:32,239 --> 00:38:36,919
with hitter account that's really great

942
00:38:34,550 --> 00:38:38,269
so let's talk about the future a little

943
00:38:36,920 --> 00:38:40,909
bit you're gonna you're going to apply

944
00:38:38,269 --> 00:38:43,369
this technique that measuring these

945
00:38:40,909 --> 00:38:46,629
thermal maps to other stars how are you

946
00:38:43,369 --> 00:38:49,309
going to pick which stars to look at

947
00:38:46,630 --> 00:38:52,390
this is actually it's an interesting

948
00:38:49,309 --> 00:38:55,400
question this method that we used is

949
00:38:52,389 --> 00:38:57,589
really restricted to planets with very

950
00:38:55,400 --> 00:39:00,980
very short orbital periods basically

951
00:38:57,590 --> 00:39:02,690
less than a day and so we have really

952
00:39:00,980 --> 00:39:05,360
just a small handful four or five

953
00:39:02,690 --> 00:39:06,619
planets hot Jupiter planets with oral

954
00:39:05,360 --> 00:39:10,070
periods less than a day that we can

955
00:39:06,619 --> 00:39:14,079

apply this technique to outside of that

956

00:39:10,070 --> 00:39:17,480

it becomes much more challenging for

957

00:39:14,079 --> 00:39:20,449

more technical reasons for the telescope

958

00:39:17,480 --> 00:39:22,280

itself than the observations what

959

00:39:20,449 --> 00:39:24,429

happens with the telescope for example

960

00:39:22,280 --> 00:39:28,280

is they have to go through

961

00:39:24,429 --> 00:39:29,960

recalibrations every 14 or so orbits

962

00:39:28,280 --> 00:39:32,900

which requires you to actually stop

963

00:39:29,960 --> 00:39:33,920

making measurements additionally what

964

00:39:32,900 --> 00:39:38,530

happens with the Hubble Space Telescope

965

00:39:33,920 --> 00:39:41,030

is that it orbits the earth and every

966

00:39:38,530 --> 00:39:43,460

yet most you're going to get about seven

967

00:39:41,030 --> 00:39:44,960

HST orbits of the earth before it

968

00:39:43,460 --> 00:39:48,079

crosses what's known as the South

969

00:39:44,960 --> 00:39:51,050

Atlantic anomaly and that is essentially

970
00:39:48,079 --> 00:39:52,460
a region hyannis region in South

971
00:39:51,050 --> 00:39:55,760
Atlantic where you have to shut down all

972
00:39:52,460 --> 00:39:57,590
the instruments so it it becomes really

973
00:39:55,760 --> 00:40:00,680
difficult to make this type of

974
00:39:57,590 --> 00:40:02,660
measurement over a span of two or three

975
00:40:00,679 --> 00:40:05,480
days because you have all of these

976
00:40:02,659 --> 00:40:07,009
different physical effects that you have

977
00:40:05,480 --> 00:40:08,440
to deal with that interrupt your

978
00:40:07,010 --> 00:40:10,599
measurements

979
00:40:08,440 --> 00:40:13,150
okay so should add though that this is

980
00:40:10,599 --> 00:40:15,818
going to change big time when the James

981
00:40:13,150 --> 00:40:17,920
Webb Space Telescope is launched in what

982
00:40:15,818 --> 00:40:21,400
way because that will be so a whole

983
00:40:17,920 --> 00:40:24,010
bunch of ways um first thing is that it

984
00:40:21,400 --> 00:40:25,960
won't be orbiting the earth it'll be in

985
00:40:24,010 --> 00:40:28,450
a heliocentric orbit so we're bidding

986
00:40:25,960 --> 00:40:30,699
the Sun and that will allow continuous

987
00:40:28,449 --> 00:40:32,919
observation of any time that you want

988
00:40:30,699 --> 00:40:35,379
for a much longer time than before you

989
00:40:32,920 --> 00:40:37,690
get into these obstacles like Kevin was

990
00:40:35,380 --> 00:40:39,309
talking about and it's a much bigger

991
00:40:37,690 --> 00:40:41,800
telescope and so we'll be able to

992
00:40:39,309 --> 00:40:44,409
observe fainter targets than and so that

993
00:40:41,800 --> 00:40:46,539
that really increases the sample size

994
00:40:44,409 --> 00:40:48,098
the slightest bit we can look at but are

995
00:40:46,539 --> 00:40:51,338
you still restricted to those planets

996
00:40:48,099 --> 00:40:55,030
that are less than a day um okay would

997
00:40:51,338 --> 00:40:57,190
we observe for longer than a day longer

998

00:40:55,030 --> 00:41:00,970
periods planets we can observe smaller

999
00:40:57,190 --> 00:41:02,500
planets think your target stars and will

1000
00:41:00,969 --> 00:41:04,598
also get wavelengths coverage that is

1001
00:41:02,500 --> 00:41:05,889
much greater than what Hubble offers and

1002
00:41:04,599 --> 00:41:08,769
so that will allow us to look at

1003
00:41:05,889 --> 00:41:10,389
different molecules and a cooler

1004
00:41:08,769 --> 00:41:14,108
temperature planets and all kinds of

1005
00:41:10,389 --> 00:41:16,299
stuff for remove that yeah so that sets

1006
00:41:14,108 --> 00:41:19,358
everybody's waiting for her jdub we

1007
00:41:16,300 --> 00:41:20,740
asked you a nice nice nice time to have

1008
00:41:19,358 --> 00:41:24,338
that up there and have hubble up at the

1009
00:41:20,739 --> 00:41:26,769
same time Patrick Calhoun on the Q&A app

1010
00:41:24,338 --> 00:41:28,929
is going how long till we send a probe

1011
00:41:26,769 --> 00:41:33,969
to an exoplanet I can answer that one

1012
00:41:28,929 --> 00:41:35,169

long time yeah long time although I

1013

00:41:33,969 --> 00:41:38,108

think Scott you're building one in your

1014

00:41:35,170 --> 00:41:40,358

basement right I live in an apartment

1015

00:41:38,108 --> 00:41:42,250

building in the city of Los Angeles so

1016

00:41:40,358 --> 00:41:47,619

yeah that would make it would be your

1017

00:41:42,250 --> 00:41:49,960

neighbor Patrick to Nessus on Twitter as

1018

00:41:47,619 --> 00:41:52,150

well an a I think it's something we have

1019

00:41:49,960 --> 00:41:56,289

to consider the fact that we have to

1020

00:41:52,150 --> 00:41:59,800

propel something to another star system

1021

00:41:56,289 --> 00:42:01,630

and somehow deal with telemetry on that

1022

00:41:59,800 --> 00:42:03,550

we would have to have something

1023

00:42:01,630 --> 00:42:06,849

extremely sophisticated and it would

1024

00:42:03,550 --> 00:42:08,500

take thousands of years to be able to to

1025

00:42:06,849 --> 00:42:09,818

get anywhere near being able to do

1026

00:42:08,500 --> 00:42:12,789

something like rice and we're looking at

1027
00:42:09,818 --> 00:42:14,500
260 light years away and even if we went

1028
00:42:12,789 --> 00:42:16,449
at the speed of light it would take 260

1029
00:42:14,500 --> 00:42:18,789
years to get there and then we have all

1030
00:42:16,449 --> 00:42:21,699
kind of other issues so it'll be a while

1031
00:42:18,789 --> 00:42:22,159
yeah unless somebody can discover a way

1032
00:42:21,699 --> 00:42:25,669
around

1033
00:42:22,159 --> 00:42:27,649
all those david s physics laws and some

1034
00:42:25,670 --> 00:42:30,740
chatter about sending a probe to Alpha

1035
00:42:27,650 --> 00:42:33,170
Centauri where an earth-sized planet was

1036
00:42:30,739 --> 00:42:37,368
recently discovered to be to be orbiting

1037
00:42:33,170 --> 00:42:39,470
one of the scars and I think the idea

1038
00:42:37,369 --> 00:42:42,289
was that it would cost like a trillion

1039
00:42:39,469 --> 00:42:46,250
dollars and youth technology that hasn't

1040
00:42:42,289 --> 00:42:50,599
been developed yet and the closest star

1041
00:42:46,250 --> 00:42:54,318
system to us right and as we powered by

1042
00:42:50,599 --> 00:42:55,609
space unicorns that's a good power

1043
00:42:54,318 --> 00:42:58,548
source by the way those RS really

1044
00:42:55,608 --> 00:43:01,038
powerful uh let me yes I just want it

1045
00:42:58,548 --> 00:43:02,929
okay sorry you guys just to back up

1046
00:43:01,039 --> 00:43:05,210
something that Kevin said this is

1047
00:43:02,929 --> 00:43:09,519
actually so you can bring up a space

1048
00:43:05,210 --> 00:43:15,318
uniform go to get the exoplanet app and

1049
00:43:09,519 --> 00:43:17,599
on the on this side which you can so I'm

1050
00:43:15,318 --> 00:43:18,980
advertising go get the exoplanet app I

1051
00:43:17,599 --> 00:43:21,289
don't expect you to be able to see this

1052
00:43:18,980 --> 00:43:24,230
but I'm saying it looks pretty good okay

1053
00:43:21,289 --> 00:43:25,700
it serves that the mass and the orbital

1054
00:43:24,230 --> 00:43:28,429
period and notice there's hardly any

1055

00:43:25,699 --> 00:43:31,278
less than a day over here so those are

1056
00:43:28,429 --> 00:43:33,139
the ones that Kevin and Laura looking at

1057
00:43:31,278 --> 00:43:36,409
they're down there it's just a handful

1058
00:43:33,139 --> 00:43:39,639
um and some of them are small so they're

1059
00:43:36,409 --> 00:43:42,139
gonna be really faint anyway that's nice

1060
00:43:39,639 --> 00:43:44,058
good job that's awesome Carol thanks so

1061
00:43:42,139 --> 00:43:45,409
yes download the exoplanet app that's uh

1062
00:43:44,059 --> 00:43:48,230
that's and you can do your own

1063
00:43:45,409 --> 00:43:51,019
correlations diagrams and look at the

1064
00:43:48,230 --> 00:43:53,778
orbital systems and all that stuff so

1065
00:43:51,019 --> 00:43:56,509
Laura I I have a reality on iOS or

1066
00:43:53,778 --> 00:43:58,460
Android or how what his name was on an

1067
00:43:56,510 --> 00:44:00,770
iphone but I think and there he has a

1068
00:43:58,460 --> 00:44:02,809
website too so it's a he has a website

1069
00:44:00,769 --> 00:44:04,068

that has all the data on it too is we

1070

00:44:02,809 --> 00:44:06,950

can tell people to do that but we need

1071

00:44:04,068 --> 00:44:11,568

to tell me where to go oh okay I'll find

1072

00:44:06,949 --> 00:44:14,449

it okay cool girl hell yeah all right

1073

00:44:11,568 --> 00:44:15,889

you too uh so Laura while I've got we

1074

00:44:14,449 --> 00:44:17,538

have a few minutes I'd like to ask you I

1075

00:44:15,889 --> 00:44:21,230

know you're a grad student you're

1076

00:44:17,539 --> 00:44:23,059

studying to get your PhD now can you do

1077

00:44:21,230 --> 00:44:25,278

it what advice what first I'd like to

1078

00:44:23,059 --> 00:44:27,048

know two things what made you decide to

1079

00:44:25,278 --> 00:44:29,088

get into astronomy in this particular

1080

00:44:27,048 --> 00:44:30,679

career path and when do you have any

1081

00:44:29,088 --> 00:44:31,639

advice for other you know my girls in

1082

00:44:30,679 --> 00:44:33,980

high school thinking about doing

1083

00:44:31,639 --> 00:44:35,900

something similar oh it's story a little

1084
00:44:33,980 --> 00:44:37,940
bit yeah so I

1085
00:44:35,900 --> 00:44:39,559
fortunate to have a lot of support for

1086
00:44:37,940 --> 00:44:43,429
my interest in science when I was in

1087
00:44:39,559 --> 00:44:45,140
high school and and I when I got to

1088
00:44:43,429 --> 00:44:46,608
college I realized that all of the

1089
00:44:45,139 --> 00:44:49,730
classes that I wanted to take for

1090
00:44:46,608 --> 00:44:52,639
astronomy classes and so I just went for

1091
00:44:49,730 --> 00:44:55,608
it haha and i think the stuff that's so

1092
00:44:52,639 --> 00:44:59,239
cool i decided to keep doing it um but

1093
00:44:55,608 --> 00:45:02,269
yeah for four young women and in school

1094
00:44:59,239 --> 00:45:06,229
who are thinking about science like go

1095
00:45:02,269 --> 00:45:08,690
for it it's so fun I mean it's like I'm

1096
00:45:06,230 --> 00:45:10,699
having a blast did you ever have

1097
00:45:08,690 --> 00:45:13,909
telescopes growing up or anything like

1098
00:45:10,699 --> 00:45:17,058
that or just all your courses no this is

1099
00:45:13,909 --> 00:45:20,028
cool I'm good well alright well thanks

1100
00:45:17,059 --> 00:45:24,500
yeah I wish you luck and I when do you

1101
00:45:20,028 --> 00:45:26,539
defend your thesis probably in spring of

1102
00:45:24,500 --> 00:45:28,699
2016 so I have about a year and a half

1103
00:45:26,539 --> 00:45:32,450
yeah that's always an open question I

1104
00:45:28,699 --> 00:45:33,798
know but I didn't okay uh Scott am I

1105
00:45:32,449 --> 00:45:36,139
missing anything I think I got them all

1106
00:45:33,798 --> 00:45:39,588
mine I think we got them all as well

1107
00:45:36,139 --> 00:45:42,558
okay you're on it today I'll good and

1108
00:45:39,588 --> 00:45:45,440
Carol did just share with me so do a

1109
00:45:42,559 --> 00:45:46,880
quick screen share as well for that she

1110
00:45:45,440 --> 00:45:50,990
was talking about is available for

1111
00:45:46,880 --> 00:45:53,858
iphone I exoplanet app com to take a

1112

00:45:50,989 --> 00:45:57,679
look at it where we're going through so

1113
00:45:53,858 --> 00:46:00,558
does seem to be won on the the for the

1114
00:45:57,679 --> 00:46:02,778
Android I do know that the gentleman in

1115
00:46:00,559 --> 00:46:06,380
Europe who does the exoplanet app he

1116
00:46:02,778 --> 00:46:09,710
mean the exoplanet database that that

1117
00:46:06,380 --> 00:46:11,990
the iphone ipad app is the one that he

1118
00:46:09,710 --> 00:46:15,889
populates i haven't tried the Android

1119
00:46:11,989 --> 00:46:17,689
one but also in the app in the app he

1120
00:46:15,889 --> 00:46:20,420
also has a reference to his webpage but

1121
00:46:17,690 --> 00:46:22,608
he's a he's like a graduate student okay

1122
00:46:20,420 --> 00:46:24,950
so no complaining about why it isn't on

1123
00:46:22,608 --> 00:46:28,759
multi platforms he like laura is

1124
00:46:24,949 --> 00:46:30,318
supposed to be doing his thesis in fact

1125
00:46:28,760 --> 00:46:32,329
i think he actually got his degree and

1126
00:46:30,318 --> 00:46:34,730

he's now gainfully employed somewhere

1127

00:46:32,329 --> 00:46:36,829

but he did this as a part of you know

1128

00:46:34,730 --> 00:46:39,849

when he was researching exoplanets oh

1129

00:46:36,829 --> 00:46:42,019

don't don't hit him too hard about it

1130

00:46:39,849 --> 00:46:46,099

that's just curious i wanted on my

1131

00:46:42,019 --> 00:46:47,000

tablet look yeah i'm gonna look and see

1132

00:46:46,099 --> 00:46:48,109

if i can get it on Android as well

1133

00:46:47,000 --> 00:46:50,179

thanks for sharing that Carol that's

1134

00:46:48,108 --> 00:46:53,119

really cool okay well I guess

1135

00:46:50,179 --> 00:46:54,980

that's it for this week guys I hope

1136

00:46:53,119 --> 00:46:57,279

you'll tune in next Thursday where we

1137

00:46:54,980 --> 00:46:59,719

will have the Hubble hang out on the

1138

00:46:57,280 --> 00:47:02,750

nuts and bolts of Hubble I mean have you

1139

00:46:59,719 --> 00:47:04,039

ever wondered how to drive the Hubble

1140

00:47:02,750 --> 00:47:05,630

Space Telescope how do you work it how

1141
00:47:04,039 --> 00:47:06,860
do they point it what are they you know

1142
00:47:05,630 --> 00:47:08,780
what what are the minute you know what

1143
00:47:06,860 --> 00:47:10,220
are the mechanics of actually operating

1144
00:47:08,780 --> 00:47:12,050
the Hubble Space Telescope we're going

1145
00:47:10,219 --> 00:47:14,179
to have engineers from Goddard with us

1146
00:47:12,050 --> 00:47:15,519
next week to talk more about that also

1147
00:47:14,179 --> 00:47:19,250
don't forget about the intrepid museum

1148
00:47:15,519 --> 00:47:20,929
exhibit going on right now and the top

1149
00:47:19,250 --> 00:47:22,099
going on next wednesday so if you're in

1150
00:47:20,929 --> 00:47:25,339
New York we hope you can stop by and

1151
00:47:22,099 --> 00:47:26,599
check that out Carol Scott anything we

1152
00:47:25,340 --> 00:47:28,910
should add you want you wanna add

1153
00:47:26,599 --> 00:47:30,710
anything no it's gonna be awesome I

1154
00:47:28,909 --> 00:47:32,509
can't wait to to meet up with the

1155
00:47:30,710 --> 00:47:34,940
engineers at Goddard I know I've always

1156
00:47:32,510 --> 00:47:36,950
wanted to learn how to do that Laura and

1157
00:47:34,940 --> 00:47:38,929
Kevin you guys were awesome thank you

1158
00:47:36,949 --> 00:47:40,789
this really interesting work thanks for

1159
00:47:38,929 --> 00:47:43,789
all the great information and sharing

1160
00:47:40,789 --> 00:47:45,710
what you've been doing with us and I

1161
00:47:43,789 --> 00:47:46,820
guess we'll we'll close it this look

1162
00:47:45,710 --> 00:47:50,240
that will close it for this week space

1163
00:47:46,820 --> 00:47:53,360
fans thank you thank you for watching

1164
00:47:50,239 --> 00:47:58,269
and as always keep looking at going up

1165
00:47:53,360 --> 00:47:58,269
thank you everyone right I