
HUBBLE
hangouts
The Thermal Map of Exoplanet Wasp 43b
Thursday November 6, 2014 3pm EST 8pm UT

1
00:00:11,970 --> 00:00:09,839
hello everybody and welcome to this

2
00:00:13,589 --> 00:00:11,980
week's Hubble hang out my name is Tony

3
00:00:15,539 --> 00:00:13,599
Darnell I work in space telescope

4
00:00:16,769 --> 00:00:15,549
science institute and I think we have a

5
00:00:17,970 --> 00:00:16,779
really great hangout plan for you

6
00:00:19,890 --> 00:00:17,980
although I say that every week because

7
00:00:20,880 --> 00:00:19,900
we always have great hangouts planned I

8
00:00:22,980 --> 00:00:20,890
think you're going to enjoy this one

9
00:00:26,160 --> 00:00:22,990
though astronomers using the Hubble

10
00:00:28,919 --> 00:00:26,170
Space Telescope have pointed it at wasp

11
00:00:31,349 --> 00:00:28,929
43 be an exoplanet that will be talking

12
00:00:33,030 --> 00:00:31,359
about later on and made a thermal map of

13
00:00:35,220 --> 00:00:33,040

it will also talk about what that is um

14
00:00:36,750 --> 00:00:35,230
so before I get started with this i want

15
00:00:38,490 --> 00:00:36,760
to mention real quickly that if you're

16
00:00:40,229 --> 00:00:38,500
going to be in New York I want to remind

17
00:00:43,440 --> 00:00:40,239
you that they have the Hubble at 25

18
00:00:45,090 --> 00:00:43,450
exhibit going on there and and I also

19
00:00:47,459 --> 00:00:45,100
want to note that they have a next

20
00:00:49,229 --> 00:00:47,469
Wednesday of at they're going to be

21
00:00:51,540 --> 00:00:49,239
having a public event where they'll have

22
00:00:54,060 --> 00:00:51,550
astronauts who's worked on the Hubble

23
00:00:56,160 --> 00:00:54,070
Space Telescope giving different giving

24
00:00:58,439 --> 00:00:56,170
giving some remarks so if you're in New

25
00:00:59,610 --> 00:00:58,449
York I would highly encourage you go and

26
00:01:02,639 --> 00:00:59,620
check that out it sounds like a lot of

27
00:01:06,060 --> 00:01:02,649
fun so with that I'll go ahead and get

28
00:01:07,530 --> 00:01:06,070
started the thermal map of wasp 43b

29
00:01:09,570 --> 00:01:07,540
we're gonna that's the topic of today

30
00:01:11,670 --> 00:01:09,580
and when to joining me to help with the

31
00:01:13,920 --> 00:01:11,680
discussion is dr. carol christian as she

32
00:01:15,720 --> 00:01:13,930
is always with me every week she's the

33
00:01:20,760 --> 00:01:15,730
outreach scientist for the Hubble Space

34
00:01:24,000 --> 00:01:20,770
Telescope hi Carol also hello also with

35
00:01:25,770 --> 00:01:24,010
me is scott lewis who is the driver of

36
00:01:29,010 --> 00:01:25,780
the internet forest he monitors all the

37
00:01:31,170 --> 00:01:29,020
social media streams and making post

38
00:01:32,610 --> 00:01:31,180

images and comments and keeps things

39
00:01:35,160 --> 00:01:32,620
going while while we're online having

40
00:01:36,960 --> 00:01:35,170
the discussion hi Scott welcome Thank

41
00:01:39,510 --> 00:01:36,970
You Kenny how's it going oh really good

42
00:01:41,910 --> 00:01:39,520
so how why don't you do this we tell

43
00:01:44,940 --> 00:01:41,920
people how they can interact with us so

44
00:01:46,560 --> 00:01:44,950
a multitude of ways that you can

45
00:01:48,360 --> 00:01:46,570
interact with us since we're streaming

46
00:01:50,520 --> 00:01:48,370
live on youtube you can make comments

47
00:01:52,710 --> 00:01:50,530
directly onto YouTube but we also have

48
00:01:54,480 --> 00:01:52,720
the Q&A app enabled so on the bottom

49
00:01:56,820 --> 00:01:54,490
left-hand side of the window you should

50
00:01:59,190 --> 00:01:56,830
see hello yellow prompt they'll actually

51
00:02:01,290 --> 00:01:59,200
open up a window allow you to ask us

52
00:02:04,590 --> 00:02:01,300
questions directly we can select them as

53
00:02:06,450 --> 00:02:04,600
available on YouTube and a Google+ and

54
00:02:08,760 --> 00:02:06,460
we're also over on twitter using the

55
00:02:10,680 --> 00:02:08,770
hashtag hubble hang out and i will be

56
00:02:13,630 --> 00:02:10,690
tweeting throughout this entire time so

57
00:02:16,300 --> 00:02:13,640
i would love to tweet back at you

58
00:02:18,430 --> 00:02:16,310
and also the event page where i will be

59
00:02:20,320 --> 00:02:18,440
posting some images as well so many ways

60
00:02:21,670 --> 00:02:20,330
for you to be in in touch with us I may

61
00:02:23,680 --> 00:02:21,680
love getting your questions and comments

62
00:02:24,850 --> 00:02:23,690
and answering them on air okay as with

63
00:02:26,290 --> 00:02:24,860

all things when you're talking Scott I

64
00:02:28,630 --> 00:02:26,300
phased out there did you say the hubble

65
00:02:32,050 --> 00:02:28,640
hubble hang out hashtag part deux no I I

66
00:02:34,150 --> 00:02:32,060
don't love her yeah okay okay cuz i was

67
00:02:36,699 --> 00:02:34,160
reading what you were dr. d alright so

68
00:02:38,680 --> 00:02:36,709
today we have with us dr. Kevin

69
00:02:40,540 --> 00:02:38,690
Stephenson he's a NASA Sagan fellow at

70
00:02:43,090 --> 00:02:40,550
the University of Chicago and we also

71
00:02:44,979 --> 00:02:43,100
have Laura cried Berg I she's a grad

72
00:02:47,470 --> 00:02:44,989
student so at the University of Chicago

73
00:02:50,910 --> 00:02:47,480
here to tell us about their research

74
00:02:53,530 --> 00:02:50,920
where they looked at a an exoplanet and

75
00:02:55,930 --> 00:02:53,540
one Kevin I'll start with you why don't

76
00:02:57,340 --> 00:02:55,940
you give us a brief overview of the work

77
00:02:58,479 --> 00:02:57,350
you've done a brief summary of the work

78
00:03:00,430 --> 00:02:58,489
you've done and then I'm going to go

79
00:03:03,330 --> 00:03:00,440
into exoplanets in general just a little

80
00:03:05,880 --> 00:03:03,340
bit a lot of the work that I've done

81
00:03:08,560 --> 00:03:05,890
focuses on extrasolar planets

82
00:03:10,479 --> 00:03:08,570
particularly the characterization so

83
00:03:12,520 --> 00:03:10,489
what what I try to do is try to

84
00:03:14,590 --> 00:03:12,530
understand what the atmospheres of these

85
00:03:16,990 --> 00:03:14,600
exoplanets are made out of we know

86
00:03:20,830 --> 00:03:17,000
typically they're fairly large of gas

87
00:03:22,479 --> 00:03:20,840
balls and they can have high in helium

88
00:03:24,280 --> 00:03:22,489

but we're more than any other aspects of

89
00:03:26,289 --> 00:03:24,290
water carbon monoxide carbon dioxide

90
00:03:29,410 --> 00:03:26,299
methane that sort of thing and to

91
00:03:31,330 --> 00:03:29,420
understand really the the circulation

92
00:03:32,890 --> 00:03:31,340
the temperature everything about these

93
00:03:35,229 --> 00:03:32,900
plants that can tell us a little bit

94
00:03:36,970 --> 00:03:35,239
more about our own solar system in the

95
00:03:40,720 --> 00:03:36,980
galaxy as a whole so I truly try to

96
00:03:42,670 --> 00:03:40,730
understand exoplanets and where they

97
00:03:44,020 --> 00:03:42,680
come from based off of our measurements

98
00:03:47,229 --> 00:03:44,030
with for example Hubble Space Telescope

99
00:03:49,720 --> 00:03:47,239
oh great so let's talk about that a

100
00:03:51,160 --> 00:03:49,730
little bit so what what are you finding

101
00:03:52,509 --> 00:03:51,170
out about the characteristics of

102
00:03:54,610 --> 00:03:52,519
exoplanets I mean this is a brand new

103
00:03:57,580 --> 00:03:54,620
field of study relatively speaking

104
00:03:58,780 --> 00:03:57,590
exoplanets are just everywhere now it

105
00:04:00,789 --> 00:03:58,790
seems so what are you finding out about

106
00:04:03,400 --> 00:04:00,799
them well there's certainly a tons of

107
00:04:05,199 --> 00:04:03,410
surprises everywhere we look out we've

108
00:04:08,949 --> 00:04:05,209
we've made measurements over the last

109
00:04:11,710 --> 00:04:08,959
ten years and and it seems that every

110
00:04:13,180 --> 00:04:11,720
time we make a prediction something

111
00:04:14,770 --> 00:04:13,190
comes up and we and we see something

112
00:04:16,330 --> 00:04:14,780
completely differently it's not that the

113
00:04:19,120 --> 00:04:16,340

predictions are accurate is just that

114
00:04:21,580 --> 00:04:19,130
the universe is so much more diverse

115
00:04:24,400 --> 00:04:21,590
than we expect so sometimes we might

116
00:04:26,800 --> 00:04:24,410
hope to detect methane and and we don't

117
00:04:27,040 --> 00:04:26,810
and sometimes we might expect us we hope

118
00:04:32,170 --> 00:04:27,050
to

119
00:04:34,629 --> 00:04:32,180
example with with the observations that

120
00:04:39,399 --> 00:04:34,639
we're doing here we would expect maybe

121
00:04:40,540 --> 00:04:39,409
the that the planet might be a similar

122
00:04:42,760 --> 00:04:40,550
in temperature on the day in the night

123
00:04:44,439 --> 00:04:42,770
side and this blitz in fact surprising

124
00:04:46,510 --> 00:04:44,449
when we saw that the days height was so

125
00:04:47,950 --> 00:04:46,520
much hotter than the night side so it

126
00:04:50,140 --> 00:04:47,960
just goes to tell you that there really

127
00:04:51,490 --> 00:04:50,150
is a diversity of X appliance out there

128
00:04:53,469 --> 00:04:51,500
and we're just scratching the surface

129
00:04:55,390 --> 00:04:53,479
yeah that to add to that i would say

130
00:04:57,240 --> 00:04:55,400
that when Kevin talked about this

131
00:04:59,800 --> 00:04:57,250
diversity it's really we've uncovered

132
00:05:01,390 --> 00:04:59,810
planets that are completely unlike

133
00:05:03,279 --> 00:05:01,400
anything that we have in our own solar

134
00:05:04,209 --> 00:05:03,289
system is sort of the planet that we've

135
00:05:09,070 --> 00:05:04,219
studied that we're going to be talking

136
00:05:11,950 --> 00:05:09,080
about today incredibly hot it's orbital

137
00:05:13,869 --> 00:05:11,960
period is less than 24 hours and to give

138
00:05:15,550 --> 00:05:13,879

you a sense of scale mercury which is

139
00:05:17,680 --> 00:05:15,560
the closest planet to the Sun takes

140
00:05:20,379 --> 00:05:17,690
about 90 days to complete a full orbit

141
00:05:23,230 --> 00:05:20,389
and the planet that we looked at was

142
00:05:25,600 --> 00:05:23,240
from three takes I think 19 and a half

143
00:05:26,950 --> 00:05:25,610
hours is that right go straight okay

144
00:05:28,360 --> 00:05:26,960
great well I want to get to that I want

145
00:05:30,129 --> 00:05:28,370
to want to cover that more detail just a

146
00:05:32,110 --> 00:05:30,139
little bit more but Laura since I've got

147
00:05:33,760 --> 00:05:32,120
you here let's so you're a grad student

148
00:05:35,499 --> 00:05:33,770
you're working i do work with Kevin

149
00:05:38,230 --> 00:05:35,509
presumably I one of the things I love

150
00:05:40,330 --> 00:05:38,240
about people up and coming in astronomy

151
00:05:41,920 --> 00:05:40,340
is learning about how they got into it

152
00:05:43,809 --> 00:05:41,930
are you specializing in exoplanet

153
00:05:46,870 --> 00:05:43,819
research too or are you looking tired

154
00:05:48,370 --> 00:05:46,880
yeah the main focus is my PhD is trying

155
00:05:50,469 --> 00:05:48,380
to characterize the atmosphere to be

156
00:05:51,999 --> 00:05:50,479
splendid great so you're also interested

157
00:05:55,029 --> 00:05:52,009
in atmospheres just like Kevin no

158
00:05:57,100 --> 00:05:55,039
coincidence i think so okay with us so

159
00:05:58,330 --> 00:05:57,110
atmospheres around exoplanets i want to

160
00:06:00,939 --> 00:05:58,340
talk about how you detect that in a

161
00:06:05,499 --> 00:06:00,949
minute but first is there any sense of

162
00:06:07,059 --> 00:06:05,509
how the ratio of nominee of all the

163
00:06:09,369 --> 00:06:07,069

exoplanets out there how many have

164
00:06:10,719 --> 00:06:09,379
atmospheres do you have any sense of

165
00:06:13,059 --> 00:06:10,729
that yet is that coming out of the

166
00:06:14,830 --> 00:06:13,069
observations that's a great question

167
00:06:18,219 --> 00:06:14,840
it's something that we're we're trying

168
00:06:19,869 --> 00:06:18,229
to understand right now actually we're

169
00:06:23,920 --> 00:06:19,879
trying to figure out where the boundary

170
00:06:26,680 --> 00:06:23,930
is between planets that are um big balls

171
00:06:29,290 --> 00:06:26,690
of gas basically like saturn and jupiter

172
00:06:30,850 --> 00:06:29,300
and some shrink them they get more rocky

173
00:06:34,119 --> 00:06:30,860
closer to the earth and we want to know

174
00:06:37,149 --> 00:06:34,129
um how big planets have to be in order

175
00:06:38,709 --> 00:06:37,159
to have a big puffy atmosphere made of

176
00:06:40,719 --> 00:06:38,719
hydrogen helium and whether they can

177
00:06:43,299 --> 00:06:40,729
hold on to that

178
00:06:46,480 --> 00:06:43,309
and whether some of the rocky or planets

179
00:06:48,519 --> 00:06:46,490
have atmospheres themselves and i would

180
00:06:50,920 --> 00:06:48,529
say Kevin what's planets have

181
00:06:53,350 --> 00:06:50,930
atmospheres right absolutely even

182
00:06:55,600 --> 00:06:53,360
something like Mars that who has it has

183
00:06:57,489 --> 00:06:55,610
a very tenuous atmosphere it it still

184
00:07:01,119 --> 00:06:57,499
has an atmosphere but it's not certainly

185
00:07:03,969 --> 00:07:01,129
anything that's thick enough to to breed

186
00:07:06,879 --> 00:07:03,979
on if it had oxygen for example but

187
00:07:09,939 --> 00:07:06,889
there are very small planet that we

188
00:07:12,010 --> 00:07:09,949

expect to be very close to their stars

189
00:07:14,230 --> 00:07:12,020
that may not have atmosphere simply

190
00:07:16,360 --> 00:07:14,240
because they're too hot okay so you're

191
00:07:17,950 --> 00:07:16,370
finding so when you say most you

192
00:07:22,779 --> 00:07:17,960
wouldn't be talking about 90%

193
00:07:26,649 --> 00:07:22,789
ninety-nine percent well it II was 950

194
00:07:28,299 --> 00:07:26,659
950 that's a lot I mean not only are

195
00:07:30,399 --> 00:07:28,309
there a lot of exoplanets but that most

196
00:07:32,950 --> 00:07:30,409
of them have atmospheres to me is very

197
00:07:34,450 --> 00:07:32,960
exciting now I that's obviously there's

198
00:07:35,649 --> 00:07:34,460
a wide range of atmospheres and we'll

199
00:07:38,200 --> 00:07:35,659
talk about some of those here in just a

200
00:07:40,119 --> 00:07:38,210
minute but it but at least for life

201
00:07:41,619 --> 00:07:40,129
elsewhere having an atmosphere is

202
00:07:45,519 --> 00:07:41,629
probably a good thing so it's good to

203
00:07:47,559 --> 00:07:45,529
know the most planets have won the so

204
00:07:48,909 --> 00:07:47,569
how do you find out what's the way when

205
00:07:50,199 --> 00:07:48,919
you look at these exoplanets mean the

206
00:07:52,809 --> 00:07:50,209
fact you're looking at them at all is

207
00:07:54,040 --> 00:07:52,819
amazing but how do you find the

208
00:07:57,249 --> 00:07:54,050
atmosphere how do you measure that it

209
00:08:00,909 --> 00:07:57,259
has one there's two different ways that

210
00:08:03,129 --> 00:08:00,919
we can measure an atmosphere and it's a

211
00:08:05,619 --> 00:08:03,139
trick that we use for transiting planets

212
00:08:09,459 --> 00:08:05,629
what happens is if the alignment of the

213
00:08:12,129 --> 00:08:09,469

planet as it orbits its star is is head

214
00:08:14,350 --> 00:08:12,139
it's just the right inclination we can

215
00:08:16,269 --> 00:08:14,360
actually see the planet as across this

216
00:08:18,999 --> 00:08:16,279
in front of the star this is called the

217
00:08:20,170 --> 00:08:19,009
transit and also when the planet goes in

218
00:08:23,019 --> 00:08:20,180
behind the star we call that in the

219
00:08:26,290 --> 00:08:23,029
clips and and there's there's different

220
00:08:28,839 --> 00:08:26,300
ways of combining this information to

221
00:08:31,059 --> 00:08:28,849
understand the atmosphere so for example

222
00:08:34,269 --> 00:08:31,069
if the planet is really hot we can

223
00:08:38,500 --> 00:08:34,279
actually measure its emission the planet

224
00:08:41,050 --> 00:08:38,510
is as a lot of heat being bombarded from

225
00:08:43,209 --> 00:08:41,060
its star on to its on to its atmosphere

226
00:08:45,730 --> 00:08:43,219
and then it rear ad eights that and we

227
00:08:47,620 --> 00:08:45,740
can see that as the planet goes in

228
00:08:51,429 --> 00:08:47,630
behind the star basically the difference

229
00:08:53,170 --> 00:08:51,439
of the planet and the star and minus you

230
00:08:54,370 --> 00:08:53,180
know the star itself on the planet

231
00:08:56,710 --> 00:08:54,380
disappears that

232
00:08:59,260 --> 00:08:56,720
can really tell us about the the heat

233
00:09:01,810 --> 00:08:59,270
coming off of the atmosphere itself in

234
00:09:04,750 --> 00:09:01,820
the transit it's a little bit different

235
00:09:08,110 --> 00:09:04,760
we actually measure the light coming off

236
00:09:10,390 --> 00:09:08,120
the star it grazes the atmosphere of the

237
00:09:12,250 --> 00:09:10,400
planet and tells us information about

238
00:09:13,600 --> 00:09:12,260

above the atmosphere that way so there's

239
00:09:16,000 --> 00:09:13,610
two different techniques that we can

240
00:09:18,130 --> 00:09:16,010
apply for transiting planets just to

241
00:09:19,720 --> 00:09:18,140
learn about the atmosphere so yeah we've

242
00:09:20,980 --> 00:09:19,730
talked about in our other exoplanet

243
00:09:22,150 --> 00:09:20,990
hangouts in the past those two men

244
00:09:23,860 --> 00:09:22,160
there's two methods of finding an

245
00:09:25,600 --> 00:09:23,870
exoplanet a tall one is there as the

246
00:09:27,010 --> 00:09:25,610
transit method that Kevin just mentioned

247
00:09:29,110 --> 00:09:27,020
the other one is a another method called

248
00:09:32,800 --> 00:09:29,120
radial velocity which is a third as well

249
00:09:34,750 --> 00:09:32,810
but they use the spectra spectroscope a

250
00:09:37,270 --> 00:09:34,760
spectrograph and look at the rich the

251
00:09:39,580 --> 00:09:37,280
wobble of the star as it goes across or

252
00:09:41,020 --> 00:09:39,590
goes around the of the planet orbits

253
00:09:42,550 --> 00:09:41,030
around the star and that's called radial

254
00:09:43,930 --> 00:09:42,560
velocity and you can learn about that

255
00:09:45,250 --> 00:09:43,940
any of our other hangouts I don't really

256
00:09:47,530 --> 00:09:45,260
want to go into it too much here but

257
00:09:48,790 --> 00:09:47,540
those are the two main ways so you but

258
00:09:51,430 --> 00:09:48,800
so you can get an idea of the

259
00:09:53,890 --> 00:09:51,440
temperature of the of the atmosphere

260
00:09:55,810 --> 00:09:53,900
Kevin but is there anything else you can

261
00:09:58,540 --> 00:09:55,820
learn about how do you find out the

262
00:10:00,760 --> 00:09:58,550
other things about that atmosphere well

263
00:10:02,680 --> 00:10:00,770

there's there's certain odd what what

264
00:10:05,020 --> 00:10:02,690
you want to do is probe the atmosphere

265
00:10:06,910 --> 00:10:05,030
at different wavelengths so when you

266
00:10:09,880 --> 00:10:06,920
look at the atmosphere at a specific

267
00:10:13,090 --> 00:10:09,890
wavelength it basically you'll be

268
00:10:15,280 --> 00:10:13,100
probing a particular altitude or depth

269
00:10:16,660 --> 00:10:15,290
of that planet within the atmosphere and

270
00:10:19,420 --> 00:10:16,670
then if you go to a second wavelength

271
00:10:22,180 --> 00:10:19,430
you probe a different altitude or depth

272
00:10:24,610 --> 00:10:22,190
of that atmosphere so by looking at a

273
00:10:28,060 --> 00:10:24,620
broad set of wavelengths that you can go

274
00:10:29,860 --> 00:10:28,070
from optical to near-infrared you can

275
00:10:31,570 --> 00:10:29,870
actually probe different layers of the

276
00:10:33,040 --> 00:10:31,580
atmosphere and measure its temperature

277
00:10:35,920 --> 00:10:33,050
at those different layers and you can

278
00:10:37,900 --> 00:10:35,930
really put it all together to form a

279
00:10:40,450 --> 00:10:37,910
better understanding of map if you will

280
00:10:42,790 --> 00:10:40,460
of the planets a thermal structure and

281
00:10:44,530 --> 00:10:42,800
its composition right yeah that's a good

282
00:10:46,120 --> 00:10:44,540
point it's important you can you can

283
00:10:50,260 --> 00:10:46,130
learn what the atmosphere is made out of

284
00:10:51,730 --> 00:10:50,270
what gases are in it and by just looking

285
00:10:53,080 --> 00:10:51,740
at it in different wavelengths different

286
00:10:55,660 --> 00:10:53,090
filters and measuring the heat that

287
00:10:58,630 --> 00:10:55,670
comes out because what happens is when

288
00:11:00,280 --> 00:10:58,640

this is for transiting planets when the

289
00:11:02,020 --> 00:11:00,290
light from the star is passing through

290
00:11:04,470 --> 00:11:02,030
the planet's atmosphere some of it gets

291
00:11:06,670 --> 00:11:04,480
absorbed by molecules that are there and

292
00:11:08,079 --> 00:11:06,680
that's something we can measure in a lab

293
00:11:10,449 --> 00:11:08,089
is how different mall

294
00:11:15,220 --> 00:11:10,459
it's sort of light and so by comparing

295
00:11:17,799 --> 00:11:15,230
what we see to do our data from labs we

296
00:11:19,269 --> 00:11:17,809
can back out of that what molecules are

297
00:11:21,040 --> 00:11:19,279
in the atmosphere doing the absorption

298
00:11:23,019 --> 00:11:21,050
and so we've used this technique to

299
00:11:25,210 --> 00:11:23,029
discover water in the atmosphere is a

300
00:11:26,230 --> 00:11:25,220
bunch of planet so far so let me make

301
00:11:27,850 --> 00:11:26,240
sure I'm getting this right there's two

302
00:11:29,350 --> 00:11:27,860
there's two kinds of measurements or one

303
00:11:31,480 --> 00:11:29,360
of them uses a transit to measure the

304
00:11:33,100 --> 00:11:31,490
heat in different wavelengths coming off

305
00:11:34,509 --> 00:11:33,110
of the atmosphere to get an idea of what

306
00:11:36,519 --> 00:11:34,519
the characteristics are based on

307
00:11:38,559 --> 00:11:36,529
wavelength and then there's the light

308
00:11:41,079 --> 00:11:38,569
passing through the atmosphere through a

309
00:11:42,429 --> 00:11:41,089
spectrograph onto a and we're spinning

310
00:11:44,590 --> 00:11:42,439
up and seeing the spectrum and the

311
00:11:46,540 --> 00:11:44,600
absorption lines that you see in that

312
00:11:48,129 --> 00:11:46,550
spectrum touch I you subtle elements

313
00:11:49,509 --> 00:11:48,139

that might be in that atmosphere so for

314
00:11:51,699 --> 00:11:49,519
example if it has water vapor there

315
00:11:54,790 --> 00:11:51,709
would be an absorption line at the water

316
00:11:57,460 --> 00:11:54,800
vapor line great okay so good okay so

317
00:12:01,689 --> 00:11:57,470
let's let's move on to a plant at the

318
00:12:03,009 --> 00:12:01,699
wasp uh-uh what is it 43b I keep for

319
00:12:06,369 --> 00:12:03,019
some reason it's just not sticking in my

320
00:12:07,720 --> 00:12:06,379
head and so you started on this a little

321
00:12:09,340 --> 00:12:07,730
bit Laura so I'll let you go ahead and

322
00:12:12,429 --> 00:12:09,350
finish tell us a little bit about this

323
00:12:16,660 --> 00:12:12,439
planet how far away is it wait I want to

324
00:12:19,059 --> 00:12:16,670
know why it's called wasp oh oh okay

325
00:12:21,790 --> 00:12:19,069
Carol I should do it discovered by a

326
00:12:24,069 --> 00:12:21,800
ground-based planet search using the

327
00:12:26,169 --> 00:12:24,079
transit technique to look for periodic

328
00:12:28,179 --> 00:12:26,179
dips in brightness of a star caused by

329
00:12:30,340 --> 00:12:28,189
the planet transiting the front and I

330
00:12:32,769 --> 00:12:30,350
think the acronym stands for wide angle

331
00:12:37,720 --> 00:12:32,779
search for planets or something it's a

332
00:12:40,769 --> 00:12:37,730
British um planet search program and 43

333
00:12:42,999 --> 00:12:40,779
is the 43rd one no they get to name it

334
00:12:45,460 --> 00:12:43,009
basically it's like Kepler gets name

335
00:12:46,960 --> 00:12:45,470
there as waspers anemia yeah which I

336
00:12:49,360 --> 00:12:46,970
suppose is only fairy computer they

337
00:12:50,769 --> 00:12:49,370
thank you well it's only fair but they

338
00:12:53,169 --> 00:12:50,779

need to come up with better names I mean

339
00:12:56,489 --> 00:12:53,179
I'll you know okay it we've got watch

340
00:12:59,110 --> 00:12:56,499
there's another survey called hat um

341
00:13:00,549 --> 00:12:59,120
we've got the Kepler yeah I don't know I

342
00:13:02,259 --> 00:13:00,559
keep telling my mom I'm gonna name a

343
00:13:05,499 --> 00:13:02,269
planet after her she doesn't really know

344
00:13:07,809 --> 00:13:05,509
that I'm not searching I can't name them

345
00:13:16,550 --> 00:13:07,819
after her buttock behave yeah you don't

346
00:13:34,310 --> 00:13:24,319
you

347
00:13:37,519 --> 00:13:34,320
freeze yeah we all know we had its prom

348
00:13:40,040 --> 00:13:37,529
last last week are we back yeah I think

349
00:13:44,480 --> 00:13:40,050
so i think we're back we're back okay

350
00:13:46,940 --> 00:13:44,490
okay so what i was saying with them lat

351
00:13:50,630 --> 00:13:46,950
43 p is about 300 light-years away from

352
00:13:53,210 --> 00:13:50,640
us which sounds like it's pretty far but

353
00:13:55,699 --> 00:13:53,220
in the fail of the universe that's

354
00:13:58,310 --> 00:13:55,709
actually incredibly close the Milky Way

355
00:14:01,280 --> 00:13:58,320
is a hundred thousand light-years across

356
00:14:04,310 --> 00:14:01,290
Kevin's that right 7,000 lawyers I'm

357
00:14:06,650 --> 00:14:04,320
different cake and it's where it is it's

358
00:14:08,329 --> 00:14:06,660
just 300 light-years distant from us and

359
00:14:09,800 --> 00:14:08,339
that makes it easier to study because

360
00:14:13,250 --> 00:14:09,810
it's orbiting a star that's relatively

361
00:14:15,530 --> 00:14:13,260
bright it is twice the mass of Jupiter

362
00:14:17,930 --> 00:14:15,540
so Jupiter is the most massive planet

363
00:14:20,410 --> 00:14:17,940

and our own solar system and this planet

364
00:14:22,940 --> 00:14:20,420
is two times more massive than that and

365
00:14:24,639 --> 00:14:22,950
the other thing about it that makes it

366
00:14:27,680 --> 00:14:24,649
really different from what we know of

367
00:14:29,930 --> 00:14:27,690
how many from our solar system is just

368
00:14:33,139 --> 00:14:29,940
how close it orbits to its host star so

369
00:14:35,840 --> 00:14:33,149
it takes less than 20 hours to complete

370
00:14:38,630 --> 00:14:35,850
a full orbital revolution around the

371
00:14:41,090 --> 00:14:38,640
star and that means that it's really

372
00:14:44,360 --> 00:14:41,100
roasting hot because it's so close to

373
00:14:46,730 --> 00:14:44,370
this really bright star so yeah but

374
00:14:48,710 --> 00:14:46,740
that's it in a nutshell and in this is

375
00:14:51,680 --> 00:14:48,720
it's representative of a class of

376
00:14:53,449 --> 00:14:51,690
planets called hot Jupiters um which are

377
00:14:55,300 --> 00:14:53,459
so named because they're extremely hot

378
00:14:58,280 --> 00:14:55,310
orbiting very close to their host stars

379
00:15:01,280 --> 00:14:58,290
and these were among the first planets

380
00:15:04,250 --> 00:15:01,290
to be discovered there they transit

381
00:15:06,530 --> 00:15:04,260
frequently and they they make a big tub

382
00:15:08,300 --> 00:15:06,540
on their host star and so it's easy to

383
00:15:10,220 --> 00:15:08,310
detect them both with radial velocities

384
00:15:13,579 --> 00:15:10,230
and transit and so although they're

385
00:15:16,160 --> 00:15:13,589
relatively rare in terms of what kinds

386
00:15:18,590 --> 00:15:16,170
of planets orbit are most common in the

387
00:15:21,139 --> 00:15:18,600
galaxy they're among that you use to

388
00:15:22,970 --> 00:15:21,149

study yeah that's an interesting point I

389
00:15:24,949 --> 00:15:22,980
what there it turns out i think neptune

390
00:15:26,560 --> 00:15:24,959
size planets right are the most common

391
00:15:30,470 --> 00:15:26,570
is that what i was that what I heard

392
00:15:32,000 --> 00:15:30,480
although smaller yeah those are much

393
00:15:33,500 --> 00:15:32,010
more common so we have a two

394
00:15:37,010 --> 00:15:33,510
jupiter-mass planet you but you've also

395
00:15:38,569 --> 00:15:37,020
said that it had its orbit is really

396
00:15:40,009 --> 00:15:38,579
fast you said it just goes around in

397
00:15:44,569 --> 00:15:40,019
about 19 hours or I

398
00:15:46,910 --> 00:15:44,579
that thing is really spinning so uh what

399
00:15:49,609 --> 00:15:46,920
what does that does that mean is it's uh

400
00:15:52,489 --> 00:15:49,619
is tidally locked around the stars is

401
00:15:54,619 --> 00:15:52,499
one side always facing it yes yeah so

402
00:15:59,509 --> 00:15:54,629
just like the moon has one side always

403
00:16:02,239 --> 00:15:59,519
face of the earth okay so here at Scott

404
00:16:03,949 --> 00:16:02,249
showing us the actual map that you guys

405
00:16:05,319 --> 00:16:03,959
made why don't you Kevin you want to

406
00:16:08,090 --> 00:16:05,329
tell us about what we're looking at here

407
00:16:10,549 --> 00:16:08,100
certainly so this is a artist rendition

408
00:16:13,239 --> 00:16:10,559
of of the type of measurement that we

409
00:16:17,449 --> 00:16:13,249
made and it's actually showing the heat

410
00:16:19,489 --> 00:16:17,459
of the planet as it goes around the star

411
00:16:23,689 --> 00:16:19,499
so we have the star in the center of

412
00:16:25,519 --> 00:16:23,699
wasps 43 and we're showing the planet at

413
00:16:29,210 --> 00:16:25,529

different phases so what we did is we

414
00:16:31,759 --> 00:16:29,220
actually observed the planet for three

415
00:16:34,789 --> 00:16:31,769
complete rotation so it went around its

416
00:16:37,549 --> 00:16:34,799
star three times and because it's

417
00:16:39,609 --> 00:16:37,559
tidally locked the bright side of the

418
00:16:41,509 --> 00:16:39,619
planet that day side of the planet is

419
00:16:44,780 --> 00:16:41,519
consistently the dayside of the planet

420
00:16:47,780 --> 00:16:44,790
and is bombarded by all of this heat

421
00:16:49,730 --> 00:16:47,790
from its star so the dayside is very

422
00:16:53,929 --> 00:16:49,740
very hot and that's shown in white on

423
00:16:55,309 --> 00:16:53,939
the graphic and as the dayside you see

424
00:16:57,259 --> 00:16:55,319
at zero degrees which that it's a

425
00:16:59,929 --> 00:16:57,269
full-on day side that we can see as the

426
00:17:02,329 --> 00:16:59,939
planet orbits around it star we begin to

427
00:17:04,909 --> 00:17:02,339
see uh like you know phases of the moon

428
00:17:07,449 --> 00:17:04,919
we begin to see that the Nightside come

429
00:17:09,860 --> 00:17:07,459
into view and we can see that it is very

430
00:17:11,299 --> 00:17:09,870
cold on the night side less than a

431
00:17:14,240 --> 00:17:11,309
thousand degrees Fahrenheit and that's

432
00:17:17,470 --> 00:17:14,250
depicted in black there and so when at

433
00:17:20,210 --> 00:17:17,480
180 degrees full on night side we don't

434
00:17:22,789 --> 00:17:20,220
get a lot of signal from the planet

435
00:17:25,579 --> 00:17:22,799
itself and then as it comes back through

436
00:17:29,000 --> 00:17:25,589
90 degrees in and zero again or 270 and

437
00:17:31,180 --> 00:17:29,010
0 then the dayside comes back in and we

438
00:17:35,149 --> 00:17:31,190

see it's essentially a sinusoidal

439
00:17:36,620 --> 00:17:35,159
increase in emission from the planet and

440
00:17:39,740 --> 00:17:36,630
then a decrease and an increase in

441
00:17:42,350 --> 00:17:39,750
decrease okay I want to get to a couple

442
00:17:45,470 --> 00:17:42,360
of relevant comments on our questions on

443
00:17:48,710 --> 00:17:45,480
the Q&A app Eric charland is asking how

444
00:17:52,490 --> 00:17:48,720
precise are those measurements of gas in

445
00:17:54,570 --> 00:17:52,500
exoplanet atmospheres how precise update

446
00:17:58,800 --> 00:17:54,580
in other words how well do you know

447
00:18:00,540 --> 00:17:58,810
these temperatures Laura do you want to

448
00:18:02,610 --> 00:18:00,550
talk about how well we constrained the

449
00:18:03,990 --> 00:18:02,620
water on this planet I can talk about

450
00:18:05,670 --> 00:18:04,000
that so it so like I was saying earlier

451
00:18:07,260 --> 00:18:05,680
one of the things that you can learn

452
00:18:12,210 --> 00:18:07,270
about the atmosphere is what it's made

453
00:18:15,030 --> 00:18:12,220
out of and so for West 43d we made the

454
00:18:16,860 --> 00:18:15,040
most precise estimate of the water

455
00:18:20,300 --> 00:18:16,870
abundance so how much water is in the

456
00:18:22,830 --> 00:18:20,310
atmosphere for any exoplanet so far and

457
00:18:25,410 --> 00:18:22,840
we we measured it to within about a

458
00:18:27,480 --> 00:18:25,420
factor of 10 or so when we when we talk

459
00:18:30,570 --> 00:18:27,490
about water abundances we often compare

460
00:18:33,210 --> 00:18:30,580
them to the expected amount of water you

461
00:18:35,790 --> 00:18:33,220
would get in a gas with what's known as

462
00:18:38,580 --> 00:18:35,800
solar composition so if you took the

463
00:18:40,230 --> 00:18:38,590

material that made up the Sun there is

464
00:18:41,700 --> 00:18:40,240
some oxygen atoms in there and you've

465
00:18:45,720 --> 00:18:41,710
pulled it down to the temperature of the

466
00:18:48,510 --> 00:18:45,730
planet it would form water and so what

467
00:18:50,520 --> 00:18:48,520
we measured for wasco decreasing he said

468
00:18:52,680 --> 00:18:50,530
its water abundance is about between a

469
00:18:54,720 --> 00:18:52,690
half and three and a half times the

470
00:19:00,690 --> 00:18:54,730
expectation for this solar composition

471
00:19:05,640 --> 00:19:00,700
gas and so a factor of 10 is really

472
00:19:07,380 --> 00:19:05,650
stunning to think that 300 way yeah so

473
00:19:10,140 --> 00:19:07,390
not only not only is it the sites but

474
00:19:12,390 --> 00:19:10,150
it's also something we can't measure for

475
00:19:14,370 --> 00:19:12,400
the solar system planets at all so

476
00:19:16,860 --> 00:19:14,380
Jupiter and Saturn are so cold that

477
00:19:18,330 --> 00:19:16,870
their water has frozen out in deeper

478
00:19:21,420 --> 00:19:18,340
parts of their atmospheres and it's out

479
00:19:24,060 --> 00:19:21,430
of reach for us to study and so these

480
00:19:26,190 --> 00:19:24,070
hot Jupiters have such high atmosphere

481
00:19:29,550 --> 00:19:26,200
temperatures that water is all in the

482
00:19:33,390 --> 00:19:29,560
gas phase and we can use them to try to

483
00:19:35,400 --> 00:19:33,400
learn about how much water um went into

484
00:19:36,750 --> 00:19:35,410
forming them and waters had to be really

485
00:19:38,370 --> 00:19:36,760
important building block for planet

486
00:19:40,110 --> 00:19:38,380
finish and that's why we always been

487
00:19:41,610 --> 00:19:40,120
interested in this what about the

488
00:19:42,990 --> 00:19:41,620

temperatures themselves the temperature

489
00:19:46,710 --> 00:19:43,000
measurements themselves how accurate are

490
00:19:49,880 --> 00:19:46,720
they yeah the temperature estimate has

491
00:19:51,720 --> 00:19:49,890
to make certain assumptions uh the

492
00:19:53,490 --> 00:19:51,730
difficulty with the measurement that

493
00:19:56,910 --> 00:19:53,500
we're making is we're really looking at

494
00:19:59,310 --> 00:19:56,920
the planet's entire face when we're

495
00:20:02,000 --> 00:19:59,320
making a measurement so the dayside for

496
00:20:04,919 --> 00:20:02,010
example we can't just we can't a

497
00:20:05,850 --> 00:20:04,929
pinpoint or make a temperature

498
00:20:08,070 --> 00:20:05,860
measurement at

499
00:20:09,360 --> 00:20:08,080
cific spots on the planet's surface we

500
00:20:12,539 --> 00:20:09,370
kind of have to take everything as a

501
00:20:15,419 --> 00:20:12,549
whole so uh the measurements are very

502
00:20:18,150 --> 00:20:15,429
precise when you average over the face

503
00:20:20,669 --> 00:20:18,160
of the planet itself that we can see but

504
00:20:23,640 --> 00:20:20,679
the it's it's difficult to actually say

505
00:20:26,010 --> 00:20:23,650
well this exact spot on within the

506
00:20:27,710 --> 00:20:26,020
planet has this particular temperature

507
00:20:30,539 --> 00:20:27,720
because of course there's going to be

508
00:20:31,799 --> 00:20:30,549
more local variations in the temperature

509
00:20:33,450 --> 00:20:31,809
just like what we have here on earth

510
00:20:37,260 --> 00:20:33,460
that's not going to be the same

511
00:20:38,909 --> 00:20:37,270
temperature everywhere in North America

512
00:20:40,860 --> 00:20:38,919
it's going to vary but if you take an

513
00:20:43,799 --> 00:20:40,870

average measurement over the entire

514
00:20:45,240 --> 00:20:43,809
continent you can we can say with fairly

515
00:20:48,270 --> 00:20:45,250
good precision what that average

516
00:20:50,250 --> 00:20:48,280
temperature is yeah then about a couple

517
00:20:52,350 --> 00:20:50,260
hundred degrees or so a couple hundred

518
00:20:54,539 --> 00:20:52,360
degrees okay well Scott's got an

519
00:20:56,280 --> 00:20:54,549
animation up who wants to talk about

520
00:20:58,680 --> 00:20:56,290
that how about you got go ahead Laura oh

521
00:21:02,280 --> 00:20:58,690
this is gonna be I like Kevin talk about

522
00:21:06,120 --> 00:21:02,290
okay Kevin is alright that's fine so

523
00:21:08,220 --> 00:21:06,130
what this graphic is showing is the in

524
00:21:10,919 --> 00:21:08,230
the all star in the top left hand corner

525
00:21:12,360 --> 00:21:10,929
it is the emission spectrum the amount

526
00:21:15,799 --> 00:21:12,370
of light that we're measuring as a

527
00:21:18,840 --> 00:21:15,809
function of wavelength as the planet

528
00:21:21,840 --> 00:21:18,850
makes one complete rotation so the

529
00:21:23,970 --> 00:21:21,850
time-lapse video shows what we call the

530
00:21:27,180 --> 00:21:23,980
spectrum and there's a water absorption

531
00:21:31,430 --> 00:21:27,190
feature some so between 1.3 and 1.6

532
00:21:33,659 --> 00:21:31,440
microns roughly there is in white on the

533
00:21:36,990 --> 00:21:33,669
graphic there there's a large water

534
00:21:39,330 --> 00:21:37,000
absorption future and we see that water

535
00:21:42,539 --> 00:21:39,340
because the amount of light that we

536
00:21:44,549 --> 00:21:42,549
measure dips there so as certain as

537
00:21:46,680 --> 00:21:44,559
certain phases there's that there's a

538
00:21:48,810 --> 00:21:46,690

dip around that region and we can say

539
00:21:51,539 --> 00:21:48,820
well that is because we measure water

540
00:21:53,940 --> 00:21:51,549
inside the atmosphere and the reason why

541
00:21:56,220 --> 00:21:53,950
this entire red line is going up and

542
00:21:58,980 --> 00:21:56,230
down is as I mentioned before the

543
00:22:00,750 --> 00:21:58,990
planets day side comes in and out of

544
00:22:02,640 --> 00:22:00,760
view so as the day side comes into view

545
00:22:04,560 --> 00:22:02,650
you can see that on the bottom with

546
00:22:06,900 --> 00:22:04,570
these brightness temperature maps the

547
00:22:08,400 --> 00:22:06,910
brightness increases and then as the

548
00:22:10,320 --> 00:22:08,410
night side comes into view the

549
00:22:13,500 --> 00:22:10,330
brightness decreases and that's also

550
00:22:15,900 --> 00:22:13,510
reflected with thermal profile so we

551
00:22:18,419 --> 00:22:15,910
have a measurement of what the

552
00:22:19,710 --> 00:22:18,429
temperature of this plan and it is over

553
00:22:21,990 --> 00:22:19,720
this face

554
00:22:24,960 --> 00:22:22,000
on the day side and it notice it's quite

555
00:22:27,000 --> 00:22:24,970
warm it's in the 1500 to 2000 Kelvin

556
00:22:28,860 --> 00:22:27,010
range which is you know up to 3,000

557
00:22:30,299 --> 00:22:28,870
Fahrenheit and as the new night tide

558
00:22:31,890 --> 00:22:30,309
comes in to view the temperature

559
00:22:36,020 --> 00:22:31,900
essentially drops like a rock to

560
00:22:38,220 --> 00:22:36,030
something below a thousand Fahrenheit

561
00:22:40,049 --> 00:22:38,230
that would make sense and again on the

562
00:22:42,960 --> 00:22:40,059
bottom these temperature map is just

563
00:22:45,510 --> 00:22:42,970

three different examples of what the

564
00:22:46,919 --> 00:22:45,520
temperature is at different altitudes so

565
00:22:49,260 --> 00:22:46,929
wavelengths different wavelengths

566
00:22:50,580 --> 00:22:49,270
different depths inside the atmosphere

567
00:22:53,370 --> 00:22:50,590
so you can see some are brighter and

568
00:22:57,390 --> 00:22:53,380
some are cooler so I have a question so

569
00:22:59,669 --> 00:22:57,400
you have very hot atmosphere on one side

570
00:23:02,610 --> 00:22:59,679
and cooler on the other one would expect

571
00:23:05,610 --> 00:23:02,620
there would be like really amazing winds

572
00:23:08,370 --> 00:23:05,620
on this planet but apparently they're

573
00:23:10,440 --> 00:23:08,380
insufficient to actually circulate the

574
00:23:12,180 --> 00:23:10,450
atmosphere enough to equalize its

575
00:23:16,200 --> 00:23:12,190
temperature because it's so close to its

576
00:23:19,289 --> 00:23:16,210
parent star is that the idea so there

577
00:23:23,010 --> 00:23:19,299
are very strong supersonic winds on this

578
00:23:25,409 --> 00:23:23,020
planet and the question is is is it's a

579
00:23:27,600 --> 00:23:25,419
question of time scales how long does it

580
00:23:29,820 --> 00:23:27,610
take to push the wind from the day side

581
00:23:31,890 --> 00:23:29,830
to the night side right versus how long

582
00:23:34,770 --> 00:23:31,900
does it take for that heat to rear a d8

583
00:23:37,049 --> 00:23:34,780
out and as it happens with this planet

584
00:23:39,960 --> 00:23:37,059
it doesn't take a long two for the hate

585
00:23:42,299 --> 00:23:39,970
to basically re-radiate so the wind

586
00:23:44,580 --> 00:23:42,309
although fast just doesn't have enough

587
00:23:49,350 --> 00:23:44,590
time to push that heat from the day side

588
00:23:51,750 --> 00:23:49,360

to the night side so what you obviously

589
00:23:53,460 --> 00:23:51,760
we used the Hubble to make these these

590
00:23:55,169 --> 00:23:53,470
measurements and we're looking at the

591
00:23:58,500 --> 00:23:55,179
wavelength go up and down in the near-ir

592
00:24:01,680 --> 00:23:58,510
around the 1.3 to 1.6 wavelength range

593
00:24:05,100 --> 00:24:01,690
what what instruments were used to make

594
00:24:08,130 --> 00:24:05,110
these observations on Hubble with Hubble

595
00:24:10,680 --> 00:24:08,140
we used a wide field camera 3 that is by

596
00:24:13,799 --> 00:24:10,690
the old standby yeah the old stem I did

597
00:24:15,539 --> 00:24:13,809
the old dependable right it's right came

598
00:24:19,289 --> 00:24:15,549
in to commissioning around two thousand

599
00:24:21,600 --> 00:24:19,299
nine I believe and it's just been a

600
00:24:23,909 --> 00:24:21,610
fantastic work horse for exoplanet

601
00:24:27,600 --> 00:24:23,919
characterization it is it's amazingly

602
00:24:30,299 --> 00:24:27,610
precise instrument has great stability

603
00:24:32,789 --> 00:24:30,309
and it allows us to make high precision

604
00:24:33,750 --> 00:24:32,799
measurements of exoplanets particularly

605
00:24:36,690 --> 00:24:33,760
if you're in

606
00:24:40,830 --> 00:24:36,700
in water because it has that sensitivity

607
00:24:42,150 --> 00:24:40,840
from 1.1 to 1.7 microns for example in

608
00:24:45,870 --> 00:24:42,160
the case that the measurements that we

609
00:24:47,490 --> 00:24:45,880
used here so it's it's been a really

610
00:24:49,230 --> 00:24:47,500
great instrument to use and we're going

611
00:24:52,080 --> 00:24:49,240
to be testing it further actually with

612
00:24:53,790 --> 00:24:52,090
with other other wavelengths and other

613
00:24:55,440 --> 00:24:53,800

planets of course well that's what I was

614
00:24:56,940 --> 00:24:55,450
going to ask you next so there are other

615
00:24:58,560 --> 00:24:56,950
planets in your future then that you're

616
00:25:02,160 --> 00:24:58,570
going to be trying to do these maps with

617
00:25:05,610 --> 00:25:02,170
right oh yeah haha do you have Hubble

618
00:25:08,520 --> 00:25:05,620
time coming up this year or is it down

619
00:25:10,320 --> 00:25:08,530
the road a bit wait we have servations

620
00:25:14,610 --> 00:25:10,330
that are still going into your cycle

621
00:25:17,550 --> 00:25:14,620
okay and we're asking for more time so

622
00:25:19,320 --> 00:25:17,560
uh is this a difficult thing to do with

623
00:25:23,000 --> 00:25:19,330
uh with Hubble is this a hard

624
00:25:25,890 --> 00:25:23,010
measurement to make and by heart i mean

625
00:25:27,750 --> 00:25:25,900
exacting and difficult to process the

626
00:25:29,160 --> 00:25:27,760
data and understand what you're looking

627
00:25:30,930 --> 00:25:29,170
at what does i mean to do these

628
00:25:33,060 --> 00:25:30,940
observations like Kevin Kevin got into

629
00:25:35,760 --> 00:25:33,070
this a little bit about how fantastic 43

630
00:25:37,770 --> 00:25:35,770
is but his instruments were never

631
00:25:39,990 --> 00:25:37,780
designed to do the kind of stuff that we

632
00:25:43,230 --> 00:25:40,000
do we're measuring the brightness of the

633
00:25:45,660 --> 00:25:43,240
star at precision on the order of you

634
00:25:48,000 --> 00:25:45,670
know less than 100 parts per million

635
00:25:50,520 --> 00:25:48,010
we're measuring very very very very tiny

636
00:25:54,750 --> 00:25:50,530
changes in the brightness of the star

637
00:25:56,820 --> 00:25:54,760
and the instrument is it has time

638
00:25:59,670 --> 00:25:56,830

varying sensitivity and so that

639
00:26:01,680 --> 00:25:59,680
basically their instrument systematics

640
00:26:02,820 --> 00:26:01,690
that are two orders of fine into larger

641
00:26:06,660 --> 00:26:02,830
than the signal that we're trying to

642
00:26:09,330 --> 00:26:06,670
detect and so there's a lot of data

643
00:26:11,970 --> 00:26:09,340
processing that goes into seeing what we

644
00:26:14,130 --> 00:26:11,980
see yeah that's what we built Kepler for

645
00:26:16,560 --> 00:26:14,140
was to make that kind of that kind of

646
00:26:18,000 --> 00:26:16,570
precision measurement so I can see so I

647
00:26:19,320 --> 00:26:18,010
see what you mean about it not being

648
00:26:21,000 --> 00:26:19,330
designed for that but you're still able

649
00:26:23,100 --> 00:26:21,010
to extract this information that's right

650
00:26:26,070 --> 00:26:23,110
yeah and it comes out looking fantastic

651
00:26:27,630 --> 00:26:26,080
this is the first um the first instant

652
00:26:30,390 --> 00:26:27,640
for we've had spectroscopy didn't mean

653
00:26:32,880 --> 00:26:30,400
matches up with models for what the

654
00:26:34,920 --> 00:26:32,890
atmosphere should look like so we were

655
00:26:37,470 --> 00:26:34,930
really believing this data would work

656
00:26:39,300 --> 00:26:37,480
and we're observing in a new mode if it

657
00:26:41,370 --> 00:26:39,310
was developed specifically to observe

658
00:26:43,260 --> 00:26:41,380
bright target like what we're doing a

659
00:26:46,080 --> 00:26:43,270
new mode can you try what do you mean by

660
00:26:47,580 --> 00:26:46,090
that yeah so it's um this is a really

661
00:26:50,159 --> 00:26:47,590
cool thing so I

662
00:26:52,880 --> 00:26:50,169
the detector will saturate pretty

663
00:26:57,450 --> 00:26:52,890

quickly for very brightest targets and

664
00:26:59,250 --> 00:26:57,460
it takes some time to read it out and so

665
00:27:01,140 --> 00:26:59,260
every time you take a short exposure and

666
00:27:04,230 --> 00:27:01,150
you waste a bunch of time reading it out

667
00:27:05,669 --> 00:27:04,240
you are losing time on target like on

668
00:27:09,840 --> 00:27:05,679
sky when you're actually detecting

669
00:27:11,820 --> 00:27:09,850
photons and to help get around this that

670
00:27:14,190 --> 00:27:11,830
book that space telescope designed a

671
00:27:17,430 --> 00:27:14,200
technique that allows the telescope to

672
00:27:19,409 --> 00:27:17,440
sort of move the target star on the

673
00:27:22,110 --> 00:27:19,419
detector over the course of an exposure

674
00:27:26,460 --> 00:27:22,120
and that smears out the light if you

675
00:27:28,649 --> 00:27:26,470
don't get um saturation is quickly and

676
00:27:30,779 --> 00:27:28,659
so that allows us to take longer

677
00:27:32,340 --> 00:27:30,789
exposures and use the telescope more

678
00:27:35,029 --> 00:27:32,350
efficiently for these really bright

679
00:27:38,090 --> 00:27:35,039
targets and that totally broke open the

680
00:27:40,260 --> 00:27:38,100
door to doing observations like this oh

681
00:27:41,789 --> 00:27:40,270
that's wonderful we should hang out on

682
00:27:45,029 --> 00:27:41,799
that technique Caroline we're more about

683
00:27:47,250 --> 00:27:45,039
that the idea is if you have to take a

684
00:27:48,899 --> 00:27:47,260
very fast exposure and then read it out

685
00:27:53,100 --> 00:27:48,909
you're spending all your time reading

686
00:27:54,600 --> 00:27:53,110
the debate there is a few in Creek to

687
00:27:57,060 --> 00:27:54,610
increase the exposure time then the

688
00:27:59,610 --> 00:27:57,070

readout time is less percent of the

689
00:28:02,850 --> 00:27:59,620
entire so exactly what we effectively

690
00:28:06,480 --> 00:28:02,860
did is increase the amount of exposure

691
00:28:11,130 --> 00:28:06,490
time we can get by a factor of more than

692
00:28:13,019 --> 00:28:11,140
five Wow like ten percent efficient 27

693
00:28:15,450 --> 00:28:13,029
year eighty percent efficient wow that's

694
00:28:17,639 --> 00:28:15,460
great that is amazing so what about

695
00:28:18,870 --> 00:28:17,649
soaking ground-based telescopes do this

696
00:28:21,840 --> 00:28:18,880
or is this something we got to have be

697
00:28:24,750 --> 00:28:21,850
in space for this is something we have

698
00:28:26,820 --> 00:28:24,760
to absolutely be in space for so the the

699
00:28:28,889 --> 00:28:26,830
measurement that we made remember the

700
00:28:31,590 --> 00:28:28,899
the planet orbits in nineteen and a half

701
00:28:34,799 --> 00:28:31,600
hours so it it's essentially impossible

702
00:28:36,120 --> 00:28:34,809
to stay on a target for that long it's

703
00:28:37,769 --> 00:28:36,130
pine from the ground because obviously

704
00:28:40,919 --> 00:28:37,779
you have to deal with things like the

705
00:28:43,169 --> 00:28:40,929
Sun coming up so first of all you need a

706
00:28:45,870 --> 00:28:43,179
space telescope for that because of the

707
00:28:48,480 --> 00:28:45,880
duration of the measurement and also

708
00:28:51,750 --> 00:28:48,490
because of the precision for we are

709
00:28:53,610 --> 00:28:51,760
measuring water in this case and it can

710
00:28:55,710 --> 00:28:53,620
be very difficult to do that when you're

711
00:28:57,779 --> 00:28:55,720
on the ground because you have a pesky

712
00:29:00,389 --> 00:28:57,789
thing known as you know atmosphere

713
00:29:01,390 --> 00:29:00,399

that's in the way and absorbing water

714
00:29:05,110 --> 00:29:01,400
you can

715
00:29:06,550 --> 00:29:05,120
HP keeping us alive well it's great for

716
00:29:09,160 --> 00:29:06,560
that but it's really annoying for

717
00:29:10,930 --> 00:29:09,170
astronomers it is yeah you know okay

718
00:29:12,490 --> 00:29:10,940
well that's great so Adam synergy has a

719
00:29:16,000 --> 00:29:12,500
question on the QA app that I've been

720
00:29:17,800 --> 00:29:16,010
reading and I'm died I don't understand

721
00:29:20,080 --> 00:29:17,810
one of the terms of using but well read

722
00:29:22,090 --> 00:29:20,090
it to you because so he's asking as I

723
00:29:24,400 --> 00:29:22,100
understand it both the hot spot on the

724
00:29:26,680 --> 00:29:24,410
day side and the cold spot on the night

725
00:29:29,560 --> 00:29:26,690
side of wasp 43b were observed to be

726
00:29:32,050 --> 00:29:29,570
offset relative to the substellar and

727
00:29:33,400 --> 00:29:32,060
anti subcellar points where they might

728
00:29:35,710 --> 00:29:33,410
expect it to be what are the likely

729
00:29:39,870 --> 00:29:35,720
reasons for this I don't know the

730
00:29:42,610 --> 00:29:39,880
subcellar point is that's neck question

731
00:29:45,160 --> 00:29:42,620
that is it that is a that is a well post

732
00:29:50,080 --> 00:29:45,170
question actually madam Adams always got

733
00:29:53,260 --> 00:29:50,090
good question ok so the substellar point

734
00:29:55,780 --> 00:29:53,270
is the point that is closest to the star

735
00:29:58,180 --> 00:29:55,790
on point on the plant that's closest to

736
00:30:00,760 --> 00:29:58,190
the star so you not at that point to be

737
00:30:02,680 --> 00:30:00,770
the hottest the anti stellar point is

738
00:30:04,570 --> 00:30:02,690

the opposite is the point on the planet

739
00:30:05,980 --> 00:30:04,580
that is furthest from the star this is

740
00:30:08,890 --> 00:30:05,990
going to be the night side so you'd

741
00:30:10,870 --> 00:30:08,900
expect that to be the coolest I think we

742
00:30:14,350 --> 00:30:10,880
do have a graphic that shows the white

743
00:30:15,940 --> 00:30:14,360
light curve white light phase curve if

744
00:30:21,100 --> 00:30:15,950
we can bring that up and that really

745
00:30:22,870 --> 00:30:21,110
shows okay perfect so this is this is a

746
00:30:25,690 --> 00:30:22,880
graphic here and it's showing as a

747
00:30:26,880 --> 00:30:25,700
function of orbital phase so as the

748
00:30:29,530 --> 00:30:26,890
planet makes one complete rotation

749
00:30:31,570 --> 00:30:29,540
there's an increase in brightness as the

750
00:30:34,000 --> 00:30:31,580
day side comes into view and right

751
00:30:36,490 --> 00:30:34,010
around point five we see this drop that

752
00:30:38,260 --> 00:30:36,500
right there the second Eric cliffs where

753
00:30:40,720 --> 00:30:38,270
the planet goes behind the star and then

754
00:30:42,490 --> 00:30:40,730
again then as the day side goes out of

755
00:30:45,130 --> 00:30:42,500
view the temperature drops what you'll

756
00:30:46,810 --> 00:30:45,140
notice is the key in if there were no

757
00:30:50,010 --> 00:30:46,820
wins what you would expect is the

758
00:30:52,540 --> 00:30:50,020
brightness to peak somewhere around the

759
00:30:53,890 --> 00:30:52,550
secondary clips about point five and

760
00:30:56,380 --> 00:30:53,900
then you would have expect to have a

761
00:30:58,750 --> 00:30:56,390
minimum around zero if the orbital phase

762
00:31:00,640 --> 00:30:58,760
of zero and that's not happening in this

763
00:31:03,430 --> 00:31:00,650

case so you can see the minimum probably

764
00:31:06,160 --> 00:31:03,440
curves closer to a phase 0 point 1 and

765
00:31:09,460 --> 00:31:06,170
the maximum occurs closer to a phase of

766
00:31:12,130 --> 00:31:09,470
point for so the maximum we can explain

767
00:31:14,860 --> 00:31:12,140
that by winds so what happens is that

768
00:31:18,210 --> 00:31:14,870
the the circulation pattern

769
00:31:20,860 --> 00:31:18,220
on the planet pushes that hot day side

770
00:31:22,960 --> 00:31:20,870
downstream a little bit and and then by

771
00:31:24,670 --> 00:31:22,970
the time it really eights its authority

772
00:31:26,980 --> 00:31:24,680
the planet has already rotated a little

773
00:31:30,880 --> 00:31:26,990
bit and it's peaking around a phase of 0

774
00:31:33,250 --> 00:31:30,890
point for 2.43 roughly the night side

775
00:31:35,200 --> 00:31:33,260
that is an excellent question and we can

776
00:31:37,510 --> 00:31:35,210
explain that none of the models that we

777
00:31:40,240 --> 00:31:37,520
have right now adequately explain why

778
00:31:43,390 --> 00:31:40,250
the night side has been shifted to later

779
00:31:44,820 --> 00:31:43,400
on past transit so that is an open

780
00:31:47,230 --> 00:31:44,830
question that we're still looking into

781
00:31:49,419 --> 00:31:47,240
nice and well done Adam thank you for

782
00:31:52,060 --> 00:31:49,429
that question Craig Landon is asking

783
00:31:54,310 --> 00:31:52,070
also on the Q&A app given that there are

784
00:31:56,770 --> 00:31:54,320
as many types of exoplanets as there are

785
00:31:58,990 --> 00:31:56,780
types of stellar classification is there

786
00:32:01,990 --> 00:31:59,000
any exoplanet classification based on

787
00:32:05,140 --> 00:32:02,000
composition atmosphere size anything

788
00:32:08,200 --> 00:32:05,150

except these names based on solar system

789
00:32:10,150 --> 00:32:08,210
types yeah is there any is there any

790
00:32:12,580 --> 00:32:10,160
classification based on what the planet

791
00:32:15,580 --> 00:32:12,590
itself is like it's where there are a

792
00:32:18,270 --> 00:32:15,590
couple of ideas that we that the

793
00:32:22,360 --> 00:32:18,280
scientists have put forth based on a

794
00:32:25,330 --> 00:32:22,370
composition and temperature that that we

795
00:32:27,940 --> 00:32:25,340
believe might classify a plan one

796
00:32:30,580 --> 00:32:27,950
example for example is a thermal

797
00:32:34,120 --> 00:32:30,590
inversion so all of the temperatures

798
00:32:37,290 --> 00:32:34,130
that we've shown decrease with

799
00:32:39,490 --> 00:32:37,300
increasing altitude and it is fairly

800
00:32:43,270 --> 00:32:39,500
basically as you go higher up against

801
00:32:45,910 --> 00:32:43,280
colder oh and some measurements have

802
00:32:48,549 --> 00:32:45,920
suggested that planets might get hotter

803
00:32:50,049 --> 00:32:48,559
as you increase your altitude and there

804
00:32:51,850 --> 00:32:50,059
is actually a debate going on about

805
00:32:54,940 --> 00:32:51,860
whether or not that's true but but

806
00:32:56,770 --> 00:32:54,950
people have have predicted that there

807
00:32:58,900 --> 00:32:56,780
are two different types of planets two

808
00:33:01,930 --> 00:32:58,910
classes based on whether you have an in

809
00:33:04,540 --> 00:33:01,940
temperature inversion or do not another

810
00:33:06,610 --> 00:33:04,550
way of classifying the planet is how

811
00:33:09,280 --> 00:33:06,620
much carbon there is versus how much

812
00:33:12,340 --> 00:33:09,290
oxygen so there there's an interesting

813
00:33:14,500 --> 00:33:12,350

debate also about call it a carbon to

814
00:33:16,720 --> 00:33:14,510
oxygen ratio if there is a lot of carbon

815
00:33:18,690 --> 00:33:16,730
on a planet you might have interesting

816
00:33:21,010 --> 00:33:18,700
chemistry going on in its atmosphere

817
00:33:22,540 --> 00:33:21,020
versus if you have more oxygen in the

818
00:33:24,700 --> 00:33:22,550
planet you'll have different chemistry

819
00:33:28,240 --> 00:33:24,710
going on so that's just two ideas of

820
00:33:30,280 --> 00:33:28,250
what people have a that they can

821
00:33:32,050 --> 00:33:30,290
hopefully used to classify planets but

822
00:33:35,290 --> 00:33:32,060
certainly this is an ongoing debate and

823
00:33:38,320 --> 00:33:35,300
it will be for some time until we have a

824
00:33:41,650 --> 00:33:38,330
lot more measurement of these plants

825
00:33:43,390 --> 00:33:41,660
with the characterize not just a dozen

826
00:33:45,160 --> 00:33:43,400
or two but maybe a hundred then we'll

827
00:33:47,260 --> 00:33:45,170
really be able to pull out statistical

828
00:33:49,240 --> 00:33:47,270
information about these planets so i

829
00:33:51,010 --> 00:33:49,250
have i have a question then you're

830
00:33:52,990 --> 00:33:51,020
talking about using inversion as a

831
00:33:54,730 --> 00:33:53,000
classification but as we know the earth

832
00:33:58,270 --> 00:33:54,740
has of inversion layers too but they're

833
00:34:00,280 --> 00:33:58,280
not persistent so seems like maybe some

834
00:34:03,340 --> 00:34:00,290
other planets might not have persistent

835
00:34:07,090 --> 00:34:03,350
inversion layers no no that's not true

836
00:34:10,330 --> 00:34:07,100
here oh ok sorry excuse me I should go

837
00:34:16,480 --> 00:34:10,340
back to reading a book we're taking

838
00:34:20,290 --> 00:34:16,490

we're taking baby steps here means that

839
00:34:22,090 --> 00:34:20,300
we've measured we measured as thermal

840
00:34:23,320 --> 00:34:22,100
inversion in an exoplanet atmosphere and

841
00:34:27,550 --> 00:34:23,330
then they came back later and said oh

842
00:34:28,869 --> 00:34:27,560
now we don't see it muchly on something

843
00:34:31,030 --> 00:34:28,879
being wrong with the interpreter for the

844
00:34:34,030 --> 00:34:31,040
data analysis rather than the planet

845
00:34:36,600 --> 00:34:34,040
actually changing babies apology you

846
00:34:40,659 --> 00:34:36,610
know I'm gonna jump in the fray Tony oh

847
00:34:42,879 --> 00:34:40,669
I love it thank you okay so Michael

848
00:34:45,070 --> 00:34:42,889
jobin is back giving us some comments hi

849
00:34:47,770 --> 00:34:45,080
Mike it's good to see you again he's

850
00:34:50,200 --> 00:34:47,780
commenting that it's amazing that you

851
00:34:52,180 --> 00:34:50,210
know it is tidally locked that's true I

852
00:34:53,950 --> 00:34:52,190
mean it is what are the the

853
00:34:56,560 --> 00:34:53,960
characteristics of a tightly lying to me

854
00:34:58,060 --> 00:34:56,570
it would let's say it weren't tightly

855
00:34:59,770 --> 00:34:58,070
locked what would would you be able to

856
00:35:02,020 --> 00:34:59,780
tell from the thermal maps that you're

857
00:35:03,940 --> 00:35:02,030
making that it's not or is that a is

858
00:35:06,490 --> 00:35:03,950
that is that something that's relatively

859
00:35:09,340 --> 00:35:06,500
easy to find out yes so that there are

860
00:35:11,320 --> 00:35:09,350
planets for example that have large

861
00:35:13,210 --> 00:35:11,330
eccentricities so it's that means that

862
00:35:17,860 --> 00:35:13,220
its orbit isn't circular around its star

863
00:35:21,160 --> 00:35:17,870

if it has this highly eccentric orbit

864
00:35:23,530 --> 00:35:21,170
what happens is the dayside isn't a

865
00:35:25,210 --> 00:35:23,540
permanent day side and the heat

866
00:35:29,830 --> 00:35:25,220
signature that we're seeing the increase

867
00:35:32,890 --> 00:35:29,840
and decrease in flux is not uh it is not

868
00:35:35,520 --> 00:35:32,900
timed synchronized with the orbit of the

869
00:35:38,190 --> 00:35:35,530
planet and and so you get an interesting

870
00:35:42,099 --> 00:35:38,200
ratio where perhaps the planet rotates

871
00:35:44,229 --> 00:35:42,109
three times for every twice

872
00:35:46,539 --> 00:35:44,239
goes around its star and it's an

873
00:35:48,640 --> 00:35:46,549
interesting play on the dynamics and

874
00:35:51,479 --> 00:35:48,650
circulation of those plans and in this

875
00:35:54,640 --> 00:35:51,489
case we do know that the eccentricity is

876
00:35:57,069 --> 00:35:54,650
very much near zero and ended it so it

877
00:35:59,289 --> 00:35:57,079
is tightly locked nice good job thanks

878
00:36:02,079 --> 00:35:59,299
Michael he's also commenting he may be

879
00:36:06,489 --> 00:36:02,089
commented that i like atmospheres i use

880
00:36:08,259 --> 00:36:06,499
one every day yes i do too so and 1 more

881
00:36:09,759 --> 00:36:08,269
comment here from Cecil Morgan let me

882
00:36:11,799 --> 00:36:09,769
get this right those look really good

883
00:36:15,700 --> 00:36:11,809
question there yeah plus 3 on this one

884
00:36:17,019 --> 00:36:15,710
uh getting voted up wasp wasp 3043 be

885
00:36:19,720 --> 00:36:17,029
was described as being gravitationally

886
00:36:22,120 --> 00:36:19,730
locked to its star like the moon is to

887
00:36:23,739 --> 00:36:22,130
earth would be more accurate to say

888
00:36:25,329 --> 00:36:23,749

there is a permanent density and

889
00:36:27,640 --> 00:36:25,339
temperature gradient towards the star

890
00:36:32,140 --> 00:36:27,650
that is not necessarily the same as this

891
00:36:34,269 --> 00:36:32,150
planet spin rate uh yeah the planet

892
00:36:37,089 --> 00:36:34,279
doesn't actually have a surface right

893
00:36:38,529 --> 00:36:37,099
it's a gas on face yes so that is a more

894
00:36:41,829 --> 00:36:38,539
accurate way to describe what we're

895
00:36:44,529 --> 00:36:41,839
talking about good nice nicely done so

896
00:36:47,019 --> 00:36:44,539
how long did it take to get this map

897
00:36:49,539 --> 00:36:47,029
built out of in terms of observation

898
00:36:54,460 --> 00:36:49,549
orbits or whatever how long was it a was

899
00:36:56,440 --> 00:36:54,470
it a long process or was it well it

900
00:36:58,930 --> 00:36:56,450
depends on depends on who you're asking

901
00:37:00,460 --> 00:36:58,940
like in the fume of things it wasn't

902
00:37:04,059 --> 00:37:00,470
that much time and told Kevin how many

903
00:37:06,880 --> 00:37:04,069
orbits of use 5161 orbits one or the

904
00:37:12,220 --> 00:37:06,890
Senate orbit is 96 minutes long wow

905
00:37:17,049 --> 00:37:12,230
that's a lot the time so it's and it was

906
00:37:18,489 --> 00:37:17,059
and um it was a really intensive

907
00:37:20,650 --> 00:37:18,499
observational program this is I think

908
00:37:25,170 --> 00:37:20,660
the most Hubble time that has ever been

909
00:37:27,279 --> 00:37:25,180
devoted to a single exoplanet every ah

910
00:37:29,229 --> 00:37:27,289
but at the same time you know when I

911
00:37:30,370 --> 00:37:29,239
told my friends Oh Hubble's looking at

912
00:37:34,239 --> 00:37:30,380
our planet right now and then the next

913
00:37:36,609 --> 00:37:34,249

day practically done that that made it

914
00:37:39,039 --> 00:37:36,619
seem really quick I'm doing my movement

915
00:37:42,279 --> 00:37:39,049
in the sunshine without going on alright

916
00:37:43,809 --> 00:37:42,289
but our telescope allocation tango

917
00:37:45,489 --> 00:37:43,819
specific yeah that's a lot of that was a

918
00:37:47,170 --> 00:37:45,499
lot yeah so guy Eric charlyn on the Q&A

919
00:37:51,009 --> 00:37:47,180
app is asking do you guys are you guys

920
00:37:55,450 --> 00:37:51,019
on Twitter can you be followed I have a

921
00:38:00,220 --> 00:37:55,460
Twitter yeah Stolte one thing on it

922
00:38:01,690 --> 00:38:00,230
haha see we can change that yeah I too

923
00:38:05,050 --> 00:38:01,700
have a Twitter account but I don't tweet

924
00:38:07,390 --> 00:38:05,060
on it I just follow yeah my friend was

925
00:38:10,150 --> 00:38:07,400
like l fries would I can put it on my

926
00:38:12,640 --> 00:38:10,160
little name tag well you don't tweet on

927
00:38:13,750 --> 00:38:12,650
it there's no boy guys aren't you guys

928
00:38:16,900 --> 00:38:13,760
are tweeting let us know what you're

929
00:38:19,900 --> 00:38:16,910
doing i was thinking i'd be really fun

930
00:38:21,580 --> 00:38:19,910
to tweet in observing run some time to

931
00:38:23,470 --> 00:38:21,590
go through the whole process of like

932
00:38:26,950 --> 00:38:23,480
flying down to Chile or whatever it is

933
00:38:28,540 --> 00:38:26,960
and like all of the UM touch-and-go I

934
00:38:30,250 --> 00:38:28,550
started the night when we're trying to

935
00:38:32,230 --> 00:38:30,260
get our target alignment everything

936
00:38:34,540 --> 00:38:32,240
people make it go cool I could be done

937
00:38:36,910 --> 00:38:34,550
with hitter account that's really great

938
00:38:38,260 --> 00:38:36,920

so let's talk about the future a little

939
00:38:40,900 --> 00:38:38,270
bit you're gonna you're going to apply

940
00:38:43,360 --> 00:38:40,910
this technique that measuring these

941
00:38:46,620 --> 00:38:43,370
thermal maps to other stars how are you

942
00:38:49,300 --> 00:38:46,630
going to pick which stars to look at

943
00:38:52,380 --> 00:38:49,310
this is actually it's an interesting

944
00:38:55,390 --> 00:38:52,390
question this method that we used is

945
00:38:57,580 --> 00:38:55,400
really restricted to planets with very

946
00:39:00,970 --> 00:38:57,590
very short orbital periods basically

947
00:39:02,680 --> 00:39:00,980
less than a day and so we have really

948
00:39:05,350 --> 00:39:02,690
just a small handful four or five

949
00:39:06,610 --> 00:39:05,360
planets hot Jupiter planets with oral

950
00:39:10,060 --> 00:39:06,620
periods less than a day that we can

951
00:39:14,070 --> 00:39:10,070
apply this technique to outside of that

952
00:39:17,470 --> 00:39:14,080
it becomes much more challenging for

953
00:39:20,440 --> 00:39:17,480
more technical reasons for the telescope

954
00:39:22,270 --> 00:39:20,450
itself than the observations what

955
00:39:24,420 --> 00:39:22,280
happens with the telescope for example

956
00:39:28,270 --> 00:39:24,430
is they have to go through

957
00:39:29,950 --> 00:39:28,280
recalibrations every 14 or so orbits

958
00:39:32,890 --> 00:39:29,960
which requires you to actually stop

959
00:39:33,910 --> 00:39:32,900
making measurements additionally what

960
00:39:38,520 --> 00:39:33,920
happens with the Hubble Space Telescope

961
00:39:41,020 --> 00:39:38,530
is that it orbits the earth and every

962
00:39:43,450 --> 00:39:41,030
yet most you're going to get about seven

963
00:39:44,950 --> 00:39:43,460

HST orbits of the earth before it

964
00:39:48,070 --> 00:39:44,960
crosses what's known as the South

965
00:39:51,040 --> 00:39:48,080
Atlantic anomaly and that is essentially

966
00:39:52,450 --> 00:39:51,050
a region hyannis region in South

967
00:39:55,750 --> 00:39:52,460
Atlantic where you have to shut down all

968
00:39:57,580 --> 00:39:55,760
the instruments so it it becomes really

969
00:40:00,670 --> 00:39:57,590
difficult to make this type of

970
00:40:02,650 --> 00:40:00,680
measurement over a span of two or three

971
00:40:05,470 --> 00:40:02,660
days because you have all of these

972
00:40:07,000 --> 00:40:05,480
different physical effects that you have

973
00:40:08,430 --> 00:40:07,010
to deal with that interrupt your

974
00:40:10,589 --> 00:40:08,440
measurements

975
00:40:13,140 --> 00:40:10,599
okay so should add though that this is

976
00:40:15,809 --> 00:40:13,150
going to change big time when the James

977
00:40:17,910 --> 00:40:15,819
Webb Space Telescope is launched in what

978
00:40:21,390 --> 00:40:17,920
way because that will be so a whole

979
00:40:24,000 --> 00:40:21,400
bunch of ways um first thing is that it

980
00:40:25,950 --> 00:40:24,010
won't be orbiting the earth it'll be in

981
00:40:28,440 --> 00:40:25,960
a heliocentric orbit so we're bidding

982
00:40:30,690 --> 00:40:28,450
the Sun and that will allow continuous

983
00:40:32,910 --> 00:40:30,700
observation of any time that you want

984
00:40:35,370 --> 00:40:32,920
for a much longer time fan before you

985
00:40:37,680 --> 00:40:35,380
get into these obstacles like kevin was

986
00:40:39,300 --> 00:40:37,690
talking about and it's a much bigger

987
00:40:41,790 --> 00:40:39,310
telescope and so we'll be able to

988
00:40:44,400 --> 00:40:41,800

observe fainter targets cars and so that

989
00:40:46,530 --> 00:40:44,410
that really increases the sample size

990
00:40:48,089 --> 00:40:46,540
the slightest bit we can look at but are

991
00:40:51,329 --> 00:40:48,099
you still restricted to those planets

992
00:40:55,020 --> 00:40:51,339
that are less than a day um okay would

993
00:40:57,180 --> 00:40:55,030
we observe for longer than a day longer

994
00:41:00,960 --> 00:40:57,190
periods planets we can observe smaller

995
00:41:02,490 --> 00:41:00,970
planets think your target stars and will

996
00:41:04,589 --> 00:41:02,500
also get wavelengths coverage that is

997
00:41:05,880 --> 00:41:04,599
much greater than what Hubble offers and

998
00:41:08,760 --> 00:41:05,890
so that will allow us to look at

999
00:41:10,380 --> 00:41:08,770
different molecules and a cooler

1000
00:41:14,099 --> 00:41:10,390
temperature planets and all kinds of

1001
00:41:16,290 --> 00:41:14,109
stuff for remove that yeah so that sets

1002
00:41:19,349 --> 00:41:16,300
everybody's waiting for her jdub we

1003
00:41:20,730 --> 00:41:19,359
asked you a nice nice nice time to have

1004
00:41:24,329 --> 00:41:20,740
that up there and have hubble up at the

1005
00:41:26,760 --> 00:41:24,339
same time Patrick Calhoun on the Q&A app

1006
00:41:28,920 --> 00:41:26,770
is going how long till we send a probe

1007
00:41:33,960 --> 00:41:28,930
to an exoplanet I can answer that one

1008
00:41:35,160 --> 00:41:33,970
long time yeah long time although I

1009
00:41:38,099 --> 00:41:35,170
think Scott you're building one in your

1010
00:41:40,349 --> 00:41:38,109
basement right I live in an apartment

1011
00:41:42,240 --> 00:41:40,359
building in the city of Los Angeles so

1012
00:41:47,609 --> 00:41:42,250
yeah that would make it would be your

1013
00:41:49,950 --> 00:41:47,619

neighbor Patrick to Nessus on Twitter as

1014
00:41:52,140 --> 00:41:49,960
well an a I think it's something we have

1015
00:41:56,280 --> 00:41:52,150
to consider the fact that we have to

1016
00:41:59,790 --> 00:41:56,290
propel something to another star system

1017
00:42:01,620 --> 00:41:59,800
and somehow deal with telemetry on that

1018
00:42:03,540 --> 00:42:01,630
we would have to have something

1019
00:42:06,839 --> 00:42:03,550
extremely sophisticated and it would

1020
00:42:08,490 --> 00:42:06,849
take thousands of years to be able to to

1021
00:42:09,809 --> 00:42:08,500
get anywhere near being able to do

1022
00:42:12,780 --> 00:42:09,819
something like rice and we're looking at

1023
00:42:14,490 --> 00:42:12,790
260 light years away and even if we went

1024
00:42:16,440 --> 00:42:14,500
at the speed of light it would take 260

1025
00:42:18,780 --> 00:42:16,450
years to get there and then we have all

1026
00:42:21,690 --> 00:42:18,790
kind of other issues so it'll be a while

1027
00:42:22,150 --> 00:42:21,700
yeah unless somebody can discover a way

1028
00:42:25,660 --> 00:42:22,160
around

1029
00:42:27,640 --> 00:42:25,670
all those david s physics laws and some

1030
00:42:30,730 --> 00:42:27,650
chatter about sending a probe to Alpha

1031
00:42:33,160 --> 00:42:30,740
Centauri where an earth-sized planet was

1032
00:42:37,359 --> 00:42:33,170
recently discovered to be to be orbiting

1033
00:42:39,460 --> 00:42:37,369
one of the scars and I think the idea

1034
00:42:42,279 --> 00:42:39,470
was that it would cost like a trillion

1035
00:42:46,240 --> 00:42:42,289
dollars and youth technology that hasn't

1036
00:42:50,589 --> 00:42:46,250
been developed yet and the closest star

1037
00:42:54,309 --> 00:42:50,599
system to us right and as we powered by

1038
00:42:55,599 --> 00:42:54,319

space unicorns that's a good power

1039
00:42:58,539 --> 00:42:55,609
source by the way those RS really

1040
00:43:01,029 --> 00:42:58,549
powerful uh let me yes I just want it

1041
00:43:02,920 --> 00:43:01,039
okay sorry you guys just to back up

1042
00:43:05,200 --> 00:43:02,930
something that Kevin said this is

1043
00:43:09,510 --> 00:43:05,210
actually so you can bring up a space

1044
00:43:15,309 --> 00:43:09,520
uniform go to get the exoplanet app and

1045
00:43:17,589 --> 00:43:15,319
on the on this side which you can so I'm

1046
00:43:18,970 --> 00:43:17,599
advertising go get the exoplanet app I

1047
00:43:21,279 --> 00:43:18,980
don't expect you to be able to see this

1048
00:43:24,220 --> 00:43:21,289
but I'm saying it looks pretty good okay

1049
00:43:25,690 --> 00:43:24,230
it serves that the mass and the orbital

1050
00:43:28,420 --> 00:43:25,700
period and notice there's hardly any

1051
00:43:31,269 --> 00:43:28,430
less than a day over here so those are

1052
00:43:33,130 --> 00:43:31,279
the ones that Kevin and Laura looking at

1053
00:43:36,400 --> 00:43:33,140
they're down there it's just a handful

1054
00:43:39,630 --> 00:43:36,410
um and some of them are small so they're

1055
00:43:42,130 --> 00:43:39,640
gonna be really faint anyway that's nice

1056
00:43:44,049 --> 00:43:42,140
good job that's awesome Carol thanks so

1057
00:43:45,400 --> 00:43:44,059
yes download the exoplanet app that's uh

1058
00:43:48,220 --> 00:43:45,410
that's and you can do your own

1059
00:43:51,010 --> 00:43:48,230
correlations diagrams and look at the

1060
00:43:53,769 --> 00:43:51,020
orbital systems and all that stuff so

1061
00:43:56,500 --> 00:43:53,779
Laura I I have a reality on iOS or

1062
00:43:58,450 --> 00:43:56,510
Android or how what his name was on an

1063
00:44:00,760 --> 00:43:58,460

iphone but I think and there he has a

1064
00:44:02,799 --> 00:44:00,770
website too so it's a he has a website

1065
00:44:04,059 --> 00:44:02,809
that has all the data on it too is we

1066
00:44:06,940 --> 00:44:04,069
can tell people to do that but we need

1067
00:44:11,559 --> 00:44:06,950
to tell me where to go oh okay I'll find

1068
00:44:14,440 --> 00:44:11,569
it okay cool girl hell yeah all right

1069
00:44:15,880 --> 00:44:14,450
you too uh so Laura while I've got we

1070
00:44:17,529 --> 00:44:15,890
have a few minutes I'd like to ask you I

1071
00:44:21,220 --> 00:44:17,539
know you're a grad student you're

1072
00:44:23,049 --> 00:44:21,230
studying to get your PhD now can you do

1073
00:44:25,269 --> 00:44:23,059
it what advice what first I'd like to

1074
00:44:27,039 --> 00:44:25,279
know two things what made you decide to

1075
00:44:29,079 --> 00:44:27,049
get into astronomy in this particular

1076
00:44:30,670 --> 00:44:29,089
career path and when do you have any

1077
00:44:31,630 --> 00:44:30,680
advice for other you know my girls in

1078
00:44:33,970 --> 00:44:31,640
high school thinking about doing

1079
00:44:35,890 --> 00:44:33,980
something similar oh it's story a little

1080
00:44:37,930 --> 00:44:35,900
bit yeah so I

1081
00:44:39,549 --> 00:44:37,940
fortunate to have a lot of support for

1082
00:44:43,420 --> 00:44:39,559
my interest in science when I was in

1083
00:44:45,130 --> 00:44:43,430
high school and and I when I got to

1084
00:44:46,599 --> 00:44:45,140
college I realized that all of the

1085
00:44:49,720 --> 00:44:46,609
classes that I wanted to take for

1086
00:44:52,630 --> 00:44:49,730
astronomy classes and so I just went for

1087
00:44:55,599 --> 00:44:52,640
it haha and i think the stuff that's so

1088
00:44:59,230 --> 00:44:55,609

cool i decided to keep doing it um but

1089
00:45:02,260 --> 00:44:59,240
yeah for four young women and in school

1090
00:45:06,220 --> 00:45:02,270
who are thinking about science like go

1091
00:45:08,680 --> 00:45:06,230
for it it's so fun I mean it's like I'm

1092
00:45:10,690 --> 00:45:08,690
having a blast did you ever have

1093
00:45:13,900 --> 00:45:10,700
telescopes growing up or anything like

1094
00:45:17,049 --> 00:45:13,910
that or just all your courses no this is

1095
00:45:20,019 --> 00:45:17,059
cool I'm good well alright well thanks

1096
00:45:24,490 --> 00:45:20,029
yeah I wish you luck and I when do you

1097
00:45:26,529 --> 00:45:24,500
defend your thesis probably in spring of

1098
00:45:28,690 --> 00:45:26,539
2016 so I have about a year and a half

1099
00:45:32,440 --> 00:45:28,700
yeah that's always an open question I

1100
00:45:33,789 --> 00:45:32,450
know but I didn't okay uh Scott am I

1101
00:45:36,130 --> 00:45:33,799
missing anything I think I got them all

1102
00:45:39,579 --> 00:45:36,140
mine I think we got them all as well

1103
00:45:42,549 --> 00:45:39,589
okay you're on it today I'll good and

1104
00:45:45,430 --> 00:45:42,559
Carol did just share with me so do a

1105
00:45:46,870 --> 00:45:45,440
quick screen share as well for that she

1106
00:45:50,980 --> 00:45:46,880
was talking about is available for

1107
00:45:53,849 --> 00:45:50,990
iphone I exoplanet app com to take a

1108
00:45:57,670 --> 00:45:53,859
look at it where we're going through so

1109
00:46:00,549 --> 00:45:57,680
does seem to be won on the the for the

1110
00:46:02,769 --> 00:46:00,559
Android I do know that the gentleman in

1111
00:46:06,370 --> 00:46:02,779
Europe who does the exoplanet app he

1112
00:46:09,700 --> 00:46:06,380
mean the exoplanet database that that

1113
00:46:11,980 --> 00:46:09,710

the iphone ipad app is the one that he

1114
00:46:15,880 --> 00:46:11,990
populates i haven't tried the Android

1115
00:46:17,680 --> 00:46:15,890
one but also in the app in the app he

1116
00:46:20,410 --> 00:46:17,690
also has a reference to his webpage but

1117
00:46:22,599 --> 00:46:20,420
he's a he's like a graduate student okay

1118
00:46:24,940 --> 00:46:22,609
so no complaining about why it isn't on

1119
00:46:28,750 --> 00:46:24,950
multi platforms he like laura is

1120
00:46:30,309 --> 00:46:28,760
supposed to be doing his thesis in fact

1121
00:46:32,319 --> 00:46:30,319
i think he actually got his degree and

1122
00:46:34,720 --> 00:46:32,329
he's now gainfully employed somewhere

1123
00:46:36,819 --> 00:46:34,730
but he did this as a part of you know

1124
00:46:39,839 --> 00:46:36,829
when he was researching exoplanets oh

1125
00:46:42,010 --> 00:46:39,849
don't don't hit him too hard about it

1126
00:46:46,089 --> 00:46:42,020
that's just curious i wanted on my

1127
00:46:46,990 --> 00:46:46,099
tablet look yeah i'm gonna look and see

1128
00:46:48,099 --> 00:46:47,000
if i can get it on Android as well

1129
00:46:50,170 --> 00:46:48,109
thanks for sharing that Carol that's

1130
00:46:53,110 --> 00:46:50,180
really cool okay well I guess

1131
00:46:54,970 --> 00:46:53,120
that's it for this week guys I hope

1132
00:46:57,270 --> 00:46:54,980
you'll tune in next Thursday where we

1133
00:46:59,710 --> 00:46:57,280
will have the Hubble hang out on the

1134
00:47:02,740 --> 00:46:59,720
nuts and bolts of Hubble I mean have you

1135
00:47:04,030 --> 00:47:02,750
ever wondered how to drive the Hubble

1136
00:47:05,620 --> 00:47:04,040
Space Telescope how do you work it how

1137
00:47:06,850 --> 00:47:05,630
do they point it what are they you know

1138
00:47:08,770 --> 00:47:06,860

what what are the minute you know what

1139
00:47:10,210 --> 00:47:08,780
are the mechanics of actually operating

1140
00:47:12,040 --> 00:47:10,220
the Hubble Space Telescope we're going

1141
00:47:14,170 --> 00:47:12,050
to have engineers from Goddard with us

1142
00:47:15,510 --> 00:47:14,180
next week to talk more about that also

1143
00:47:19,240 --> 00:47:15,520
don't forget about the intrepid museum

1144
00:47:20,920 --> 00:47:19,250
exhibit going on right now and the top

1145
00:47:22,090 --> 00:47:20,930
going on next wednesday so if you're in

1146
00:47:25,330 --> 00:47:22,100
New York we hope you can stop by and

1147
00:47:26,590 --> 00:47:25,340
check that out Carol Scott anything we

1148
00:47:28,900 --> 00:47:26,600
should add you want you wanna add

1149
00:47:30,700 --> 00:47:28,910
anything no it's gonna be awesome I

1150
00:47:32,500 --> 00:47:30,710
can't wait to to meet up with the

1151
00:47:34,930 --> 00:47:32,510
engineers at Goddard I know I've always

1152
00:47:36,940 --> 00:47:34,940
wanted to learn how to do that Laura and

1153
00:47:38,920 --> 00:47:36,950
Kevin you guys were awesome thank you

1154
00:47:40,780 --> 00:47:38,930
this really interesting work thanks for

1155
00:47:43,780 --> 00:47:40,790
all the great information and sharing

1156
00:47:45,700 --> 00:47:43,790
what you've been doing with us and I

1157
00:47:46,810 --> 00:47:45,710
guess we'll we'll close it this look

1158
00:47:50,230 --> 00:47:46,820
that will close it for this week space

1159
00:47:53,350 --> 00:47:50,240
fans thank you thank you for watching