

1
00:00:05,599 --> 00:00:10,378
hello everybody and welcome to this

2
00:00:07,919 --> 00:00:12,239
week's Hubbell hangout this is a special

3
00:00:10,378 --> 00:00:14,458
edition Hubble hangout because it is st.

4
00:00:12,239 --> 00:00:17,160
Patrick's Day so on welcome you all here

5
00:00:14,458 --> 00:00:19,469
for this really cool hangout where

6
00:00:17,160 --> 00:00:21,750
astronomers using the Hubble Space

7
00:00:19,469 --> 00:00:23,309
Telescope have developed a new data

8
00:00:21,750 --> 00:00:26,129
processing technique which has allowed

9
00:00:23,309 --> 00:00:28,108
them to for the first time measure the

10
00:00:26,129 --> 00:00:31,588
composition of an atmosphere of an

11
00:00:28,109 --> 00:00:33,090
exoplanet that is of the class of a

12
00:00:31,588 --> 00:00:34,829
super earth and we'll talk about what

13
00:00:33,090 --> 00:00:36,690
all of this means as we get going in the

14
00:00:34,829 --> 00:00:38,070
Hangout but it's very exciting stuff

15
00:00:36,689 --> 00:00:39,479
because they've been they I want we're

16
00:00:38,070 --> 00:00:42,929
gonna learn about the new method they've

17
00:00:39,479 --> 00:00:45,000
used to to make these measurements as

18
00:00:42,929 --> 00:00:46,948
well as what is it my mean for the for

19
00:00:45,000 --> 00:00:48,869
exoplanet research in the future so

20
00:00:46,948 --> 00:00:51,988
we'll get started by first introducing

21
00:00:48,869 --> 00:00:54,570
my my friends my co-host dr. Carol

22
00:00:51,988 --> 00:00:56,518
Christian she is the HST the Hubble

23
00:00:54,570 --> 00:00:58,018
Space Telescope outreach scientist hello

24
00:00:56,518 --> 00:01:01,500
again Carol it's good to see you again

25
00:00:58,018 --> 00:01:03,420
hey Tony how are you I'm doing really

26
00:01:01,500 --> 00:01:08,280
good because it's st. Patrick's Day are

27
00:01:03,420 --> 00:01:10,680
you excited yes I don't have any green

28
00:01:08,280 --> 00:01:15,359
beer yet unfortunately for our drinking

29

00:01:10,680 --> 00:01:19,320
game but yes we're gonna happen anyway

30
00:01:15,359 --> 00:01:25,019
so you can drink coffee I'll come up

31
00:01:19,319 --> 00:01:26,519
with it don't worry as always yeah so

32
00:01:25,019 --> 00:01:27,989
that means in that voice is Scott Lewis

33
00:01:26,519 --> 00:01:30,000
from you guys know here's our Internet

34
00:01:27,989 --> 00:01:31,289
driver extraordinaire and so welcome

35
00:01:30,000 --> 00:01:33,659
back Scott it's good to see you again as

36
00:01:31,290 --> 00:01:34,950
well thank you this hangout seems kind

37
00:01:33,659 --> 00:01:37,229
of exciting to me guys I can't wait to

38
00:01:34,950 --> 00:01:39,090
learn more about what this what this

39
00:01:37,230 --> 00:01:42,000
exoplanet measurements are are like and

40
00:01:39,090 --> 00:01:44,310
what they what they might mean but

41
00:01:42,000 --> 00:01:45,840
before we get going and I introduce our

42
00:01:44,310 --> 00:01:48,960
guests from the University of College at

43
00:01:45,840 --> 00:01:50,549

London we want to have you prepared to

44

00:01:48,959 --> 00:01:53,849

ask us questions we want you to interact

45

00:01:50,549 --> 00:01:59,030

with us and join us in the st. Patrick's

46

00:01:53,849 --> 00:02:03,959

Day drinking game where we have and

47

00:01:59,030 --> 00:02:05,099

coffee okay all right so we but we do

48

00:02:03,959 --> 00:02:06,209

want you to know seriously we want your

49

00:02:05,099 --> 00:02:07,769

questions and comments during the

50

00:02:06,209 --> 00:02:08,968

Hangout and Scott why don't you tell

51

00:02:07,769 --> 00:02:11,489

everybody how they can do that

52

00:02:08,968 --> 00:02:12,989

absolutely so the more anything everyone

53

00:02:11,489 --> 00:02:14,340

loading in here since we're live on

54

00:02:12,989 --> 00:02:17,219

YouTube using glue

55

00:02:14,340 --> 00:02:19,489

YouTube live effect you can go ahead and

56

00:02:17,219 --> 00:02:22,259

use the live chat so I'm seeking our

57

00:02:19,489 --> 00:02:23,819

frequent flyer and regular commenter

58
00:02:22,259 --> 00:02:26,219
Michael Jovians and they're great

59
00:02:23,818 --> 00:02:29,068
Michael yeah it's grinning that we're

60
00:02:26,219 --> 00:02:30,419
alive so yes hi everyone so if you have

61
00:02:29,068 --> 00:02:33,988
any questions or comments regarding

62
00:02:30,419 --> 00:02:35,369
today's show or or the research that's

63
00:02:33,989 --> 00:02:37,560
been put out there please feel free to

64
00:02:35,370 --> 00:02:40,080
ask us questions make your comments in

65
00:02:37,560 --> 00:02:42,060
there have a friendly discussion I do

66
00:02:40,080 --> 00:02:45,750
have the banhammer ready if I need to

67
00:02:42,060 --> 00:02:47,580
and I will use it but more more likely

68
00:02:45,750 --> 00:02:50,068
you guys have been really who's been

69
00:02:47,580 --> 00:02:52,049
really awesome the other way too that we

70
00:02:50,068 --> 00:02:54,389
are going to be continuing this

71
00:02:52,049 --> 00:02:56,580
conversation both live and afterwards is

72
00:02:54,389 --> 00:02:59,488
using the hashtag Hubbell hangout on

73
00:02:56,580 --> 00:03:01,230
Twitter so I'll be live tweeting as

74
00:02:59,489 --> 00:03:03,090
we're going along complete with any

75
00:03:01,229 --> 00:03:04,619
graphics and links to press releases and

76
00:03:03,090 --> 00:03:07,739
things like that we're going on so I

77
00:03:04,620 --> 00:03:10,230
will be monitoring the the Twitter feed

78
00:03:07,739 --> 00:03:11,789
we also have events up on Google+ and

79
00:03:10,229 --> 00:03:14,459
Facebook so I'll be monitoring those as

80
00:03:11,789 --> 00:03:16,919
well so if you have any any questions or

81
00:03:14,459 --> 00:03:18,750
any insightful comments please feel free

82
00:03:16,919 --> 00:03:21,659
to send them our way and we'll make sure

83
00:03:18,750 --> 00:03:24,479
that I bring them up and we'll try to

84
00:03:21,659 --> 00:03:29,099
get them answered on air did you say

85
00:03:24,479 --> 00:03:31,018
hash tag part 2 I did Hubbell hangout in

86

00:03:29,099 --> 00:03:37,199
a drinking game I think it's going to be

87
00:03:31,019 --> 00:03:40,349
either hydrogen or helium okay yeah well

88
00:03:37,199 --> 00:03:42,358
exoplanets a little too easy i do i do

89
00:03:40,349 --> 00:03:48,568
love everyone a little bit

90
00:03:42,359 --> 00:03:51,889
I want hydrogen cyanide hi this is gonna

91
00:03:48,568 --> 00:03:51,888
be okay

92
00:03:57,229 --> 00:04:06,919
yeah or it's your boss dang stop talking

93
00:04:00,449 --> 00:04:08,669
about drinking on air okay so as I

94
00:04:06,919 --> 00:04:12,328
really that's right what do you do with

95
00:04:08,669 --> 00:04:13,409
all my drinking games on my boy so this

96
00:04:12,329 --> 00:04:15,989
cuz we're go ahead and get started so

97
00:04:13,409 --> 00:04:19,228
for the first time astronomers have been

98
00:04:15,989 --> 00:04:22,259
able to measure directly the composition

99
00:04:19,228 --> 00:04:25,168
of a super-earth exoplanet and of the

100
00:04:22,259 --> 00:04:27,029

star system known as 55 Cancri and this

101

00:04:25,168 --> 00:04:28,019
is a star system that is about 40

102

00:04:27,029 --> 00:04:30,059
life. you 40 light

103

00:04:28,019 --> 00:04:32,279
years from Earth in the constellation of

104

00:04:30,060 --> 00:04:35,250
cancer and so joining me to talk about

105

00:04:32,279 --> 00:04:36,598
this are some group from the University

106

00:04:35,250 --> 00:04:39,120
of College at London all three of these

107

00:04:36,598 --> 00:04:40,918
guys so we have Angelo CRS he's a PhD

108

00:04:39,120 --> 00:04:44,399
student we also have Ingo Waldman a

109

00:04:40,918 --> 00:04:45,508
postdoc as well as Marko Rotato a grad

110

00:04:44,399 --> 00:04:47,459
student all of these guys are

111

00:04:45,509 --> 00:04:48,930
responsible in some way or another for

112

00:04:47,459 --> 00:04:50,549
the development of this technique which

113

00:04:48,930 --> 00:04:55,500
we will get into but welcome guys this

114

00:04:50,550 --> 00:04:57,360
is your first Hubble hangout yes yes I

115
00:04:55,500 --> 00:04:59,908
guys all right goods well thank you for

116
00:04:57,360 --> 00:05:01,949
joining us so let's start with let's

117
00:04:59,908 --> 00:05:05,430
start with you Angelo's tell us a little

118
00:05:01,949 --> 00:05:06,990
bit about what you found and a little

119
00:05:05,430 --> 00:05:11,689
bit about this super-earth give us some

120
00:05:06,990 --> 00:05:14,750
background on this a new birth is

121
00:05:11,689 --> 00:05:19,319
light-years away from the earth and

122
00:05:14,750 --> 00:05:23,459
orbiting its host star in a very close

123
00:05:19,319 --> 00:05:26,580
so the orbit is only 18 hours this means

124
00:05:23,459 --> 00:05:29,698
that the temperature is o the orbit of

125
00:05:26,579 --> 00:05:32,609
this planet is 18 hours in hours yes

126
00:05:29,699 --> 00:05:34,460
here is wow that's pretty so it's

127
00:05:32,610 --> 00:05:36,840
smoking it's going around pretty good

128
00:05:34,459 --> 00:05:39,468
that makes you even older than you

129
00:05:36,839 --> 00:05:43,408
thought you were Tony that's right so

130
00:05:39,468 --> 00:05:45,990
years I am years old thank you

131
00:05:43,408 --> 00:06:05,158
I'm glad you know I'm here to help

132
00:05:45,990 --> 00:06:07,620
hydrogen cyanide the more you know so it

133
00:06:05,158 --> 00:06:15,269
is the temperature on its surface is

134
00:06:07,620 --> 00:06:21,180
expecting to be about two thousand two

135
00:06:15,269 --> 00:06:23,848
thousand Kelvin 18-hour year this place

136
00:06:21,180 --> 00:06:26,699
not sound like a vacation spot no

137
00:06:23,848 --> 00:06:36,569
doesn't sound really Pleasant no all

138
00:06:26,699 --> 00:06:39,770
right well I you realize Carol I'm gonna

139
00:06:36,569 --> 00:06:39,769
be bouncing off the walls

140
00:06:39,829 --> 00:06:47,689
I would give away our punchlines so with

141
00:06:44,990 --> 00:06:52,160
our drinking game but the I wanted so is

142
00:06:47,689 --> 00:06:54,620
this exoplanet it's 55 Cancri E and the

143

00:06:52,160 --> 00:06:56,120
e is what is that what does that mean by

144
00:06:54,620 --> 00:06:58,370
the way it's a little II which

145
00:06:56,120 --> 00:07:02,689
apparently matters so what does that

146
00:06:58,370 --> 00:07:05,660
mean there are five planets in this

147
00:07:02,689 --> 00:07:07,310
system the way they make them in order

148
00:07:05,660 --> 00:07:13,100
of distance from the Sun or the distance

149
00:07:07,310 --> 00:07:13,879
the order of things so the order he said

150
00:07:13,100 --> 00:07:19,100
e

151
00:07:13,879 --> 00:07:28,310
B C F and D as you go from the inner to

152
00:07:19,100 --> 00:07:30,920
the outer what was a I thought that was

153
00:07:28,310 --> 00:07:34,269
just you know it's just when you're in

154
00:07:30,920 --> 00:07:34,270
Canada and like oh it's over there a

155
00:07:34,600 --> 00:07:38,720
right well so the e is there is an

156
00:07:37,160 --> 00:07:41,090
indicator for the the fact that this was

157
00:07:38,720 --> 00:07:47,990

the fourth I guess right planning for

158

00:07:41,089 --> 00:07:49,369

that was in that system for okay all

159

00:07:47,990 --> 00:07:51,560

right and Ingo can you tell me a little

160

00:07:49,370 --> 00:07:53,180

bit about the the the program the

161

00:07:51,560 --> 00:07:55,100

observations that were used with Hubble

162

00:07:53,180 --> 00:07:56,240

to sort of gather this data you were

163

00:07:55,100 --> 00:07:58,640

telling me somebody was telling me but

164

00:07:56,240 --> 00:08:01,340

I'll ask you anyway what the the the the

165

00:07:58,639 --> 00:08:03,919

the data came from a request from a much

166

00:08:01,339 --> 00:08:05,959

larger group right yeah yeah yeah so it

167

00:08:03,920 --> 00:08:08,030

was a u.s. group and the request is that

168

00:08:05,959 --> 00:08:11,810

you know it's a Treasury proposal and so

169

00:08:08,029 --> 00:08:14,149

all the data is immediately public you

170

00:08:11,810 --> 00:08:16,100

know we we build this pipeline and we

171

00:08:14,149 --> 00:08:17,629

just ran it on the on the archive from

172
00:08:16,100 --> 00:08:25,550
the a blog you know you just pulled the

173
00:08:17,629 --> 00:08:29,509
entire thing down you just put it on the

174
00:08:25,550 --> 00:08:30,770
cluster compute it's fine and and yeah

175
00:08:29,509 --> 00:08:32,120
you know and then we can we get the

176
00:08:30,769 --> 00:08:34,879
spectrum out and we're like oh wow

177
00:08:32,120 --> 00:08:38,570
that's that's interesting so you know

178
00:08:34,879 --> 00:08:40,970
let's go ahead and entities and so Marco

179
00:08:38,570 --> 00:08:42,710
this was done with the with the

180
00:08:40,970 --> 00:08:46,879
instrument on board huh book called the

181
00:08:42,710 --> 00:08:48,560
Wide Field Camera 3 right yeah camera

182
00:08:46,879 --> 00:08:50,210
what's it what what sort of observations

183
00:08:48,559 --> 00:08:53,689
does it make does it give you so

184
00:08:50,210 --> 00:08:57,379
basically you you obtain spectra of of

185
00:08:53,690 --> 00:09:00,019
the system as the planet transiting in

186
00:08:57,379 --> 00:09:03,909
front of the star and the technique

187
00:09:00,019 --> 00:09:07,399
angles actually developed was able to

188
00:09:03,909 --> 00:09:09,259
correct for the systematics that are

189
00:09:07,399 --> 00:09:13,429
involved with these kind of measurements

190
00:09:09,259 --> 00:09:16,310
at a very accurate level so that we were

191
00:09:13,429 --> 00:09:18,948
able basically to obtain a spectrum that

192
00:09:16,309 --> 00:09:21,198
showed some modulation which indicated

193
00:09:18,948 --> 00:09:23,568
that this display had actually an

194
00:09:21,198 --> 00:09:24,948
atmosphere okay I want to get to that

195
00:09:23,568 --> 00:09:26,479
processing technique in just a minute

196
00:09:24,948 --> 00:09:27,828
but I wanted I just want to finish

197
00:09:26,480 --> 00:09:29,750
laying the groundwork for the system

198
00:09:27,828 --> 00:09:32,809
itself and where it is so this thing is

199
00:09:29,750 --> 00:09:33,980
about 40 light years away not gonna be

200

00:09:32,809 --> 00:09:36,138
something we're gonna be heading to I

201
00:09:33,980 --> 00:09:37,480
think the next welding also from the

202
00:09:36,139 --> 00:09:39,620
sound of it we wouldn't really want to

203
00:09:37,480 --> 00:09:41,209
but what is this that I want to talk a

204
00:09:39,620 --> 00:09:43,639
little bit about what a super-earth is

205
00:09:41,208 --> 00:09:51,169
is it like a place where Superman comes

206
00:09:43,639 --> 00:09:53,028
from what is a super it's we don't

207
00:09:51,169 --> 00:09:55,610
actually have in our own solar system so

208
00:09:53,028 --> 00:09:59,299
it's it's kind of weird right before

209
00:09:55,610 --> 00:10:04,129
that meet somewhere between for ages and

210
00:09:59,299 --> 00:10:05,809
Neptune and up to sort of 10 but I'm

211
00:10:04,129 --> 00:10:07,549
important it's a rocky planet right

212
00:10:05,809 --> 00:10:09,049
that's between the radius not

213
00:10:07,549 --> 00:10:11,419
necessarily so

214
00:10:09,049 --> 00:10:13,309

it's assumed to be mainly terrestrial

215

00:10:11,419 --> 00:10:17,179

but we don't really know so some of them

216

00:10:13,309 --> 00:10:20,750

could be mini mini Neptune's 55 concrete

217

00:10:17,179 --> 00:10:24,258

is probably very rocky insides well sort

218

00:10:20,750 --> 00:10:25,730

of molten lava sort of thing yeah but we

219

00:10:24,259 --> 00:10:27,620

don't have that you know solar system so

220

00:10:25,730 --> 00:10:29,420

it's quite an interesting planet or if

221

00:10:27,620 --> 00:10:32,000

it's about the biggest rocky planet here

222

00:10:29,419 --> 00:10:35,778

right and more would be embarrassing if

223

00:10:32,000 --> 00:10:38,539

I didn't know that but yeah yeah pretty

224

00:10:35,778 --> 00:10:42,799

embarrassing yeah thank you for pointing

225

00:10:38,539 --> 00:10:44,360

that out but yeah the so so for for

226

00:10:42,799 --> 00:10:46,609

these things to be between the size of

227

00:10:44,360 --> 00:10:48,379

the earth and say Neptune as you say is

228

00:10:46,610 --> 00:10:50,050

there an upper limit to how big these

229
00:10:48,379 --> 00:10:52,429
rocky planets can get I mean are there

230
00:10:50,049 --> 00:10:54,500
these would be awfully heavy

231
00:10:52,429 --> 00:10:55,909
correct so at some point they might just

232
00:10:54,500 --> 00:10:57,230
what they is there a point where they

233
00:10:55,909 --> 00:11:00,078
just crush themselves or is there an

234
00:10:57,230 --> 00:11:03,139
upper limit to how big super Earths can

235
00:11:00,078 --> 00:11:04,789
be if they're rocky I guess that's an

236
00:11:03,139 --> 00:11:05,659
that's a more involved question than I

237
00:11:04,789 --> 00:11:07,339
thought because you're saying they're

238
00:11:05,659 --> 00:11:10,969
not necessarily to rest

239
00:11:07,340 --> 00:11:13,430
so yeah so you know it's it's it's just

240
00:11:10,970 --> 00:11:17,240
a definition of size at the moment but

241
00:11:13,429 --> 00:11:19,519
yeah if they arrest real if they're big

242
00:11:17,240 --> 00:11:21,110
enough as a cool right you'd assume that

243

00:11:19,519 --> 00:11:22,549
they create loads of hydrogen in their

244

00:11:21,110 --> 00:11:27,080
formation and that they actually end up

245

00:11:22,549 --> 00:11:29,479
like Jupiter okay maybe they have a big

246

00:11:27,080 --> 00:11:32,420
pool okay with that this sort of leads

247

00:11:29,480 --> 00:11:33,830
into a comment that that Michael joban

248

00:11:32,419 --> 00:11:35,029
has left on YouTube and I will go ahead

249

00:11:33,830 --> 00:11:36,560
and get to that now you know when he was

250

00:11:35,029 --> 00:11:39,439
commenting on the fact that this has got

251

00:11:36,559 --> 00:11:42,109
an 18 hour orbit and he goes man I bet

252

00:11:39,440 --> 00:11:43,820
in his egg shaped or something so that's

253

00:11:42,110 --> 00:11:45,649
a but the point I think he's making and

254

00:11:43,820 --> 00:11:47,360
I'd like to follow up on that is isn't

255

00:11:45,649 --> 00:11:49,519
that isn't there gonna do some crazy

256

00:11:47,360 --> 00:11:50,930
things I mean the earth is not it's not

257

00:11:49,519 --> 00:11:53,419
a perfect sphere something called an

258
00:11:50,929 --> 00:11:55,069
oblate spheroid which because it's

259
00:11:53,419 --> 00:11:59,149
spinning and rotating it sort of flat in

260
00:11:55,070 --> 00:12:01,100
the middle so is that affecting this

261
00:11:59,149 --> 00:12:06,769
thing's shape at all i'm scottie right

262
00:12:01,100 --> 00:12:09,440
or do we know yeah it must be affected

263
00:12:06,769 --> 00:12:12,740
by tidal forces yeah since it is close

264
00:12:09,440 --> 00:12:15,050
so close and you know surfaces like lava

265
00:12:12,740 --> 00:12:19,730
by itself anyway so it's that's really

266
00:12:15,049 --> 00:12:23,209
Rock no it's a thousand degrees up of

267
00:12:19,730 --> 00:12:24,379
like melting point of iron okay well

268
00:12:23,210 --> 00:12:25,790
let's get to how you know that then

269
00:12:24,379 --> 00:12:27,919
let's go to your processing technique

270
00:12:25,789 --> 00:12:39,110
and since and since Marko you were the

271
00:12:27,919 --> 00:12:39,860

one on HST explain why the width Wide

272

00:12:39,110 --> 00:12:43,399

Field Camera 3

273

00:12:39,860 --> 00:12:45,470

spectrograph is the one you need because

274

00:12:43,399 --> 00:12:48,079

we've talked about on this on hangouts

275

00:12:45,470 --> 00:12:50,529

we've talked about the cosmic origins

276

00:12:48,080 --> 00:12:54,350

spectrograph which sounds cosmic and

277

00:12:50,529 --> 00:12:57,110

this spectrograph so why is white field

278

00:12:54,350 --> 00:13:03,170

camera 3 specifically interesting for

279

00:12:57,110 --> 00:13:08,899

this so it's the infrared part of wt3

280

00:13:03,169 --> 00:13:11,779

camera we see between 1.1 and 1.7 C's 5

281

00:13:08,899 --> 00:13:14,959

micron and it's more interesting because

282

00:13:11,779 --> 00:13:18,139

we can see signature micro signatures at

283

00:13:14,960 --> 00:13:21,200

these wavelengths so this the signal

284

00:13:18,139 --> 00:13:25,490

from the planet is not dominated by you

285

00:13:21,200 --> 00:13:29,480

sputtering or present of clouds so we

286
00:13:25,490 --> 00:13:32,450
can see molecules easier okay okay

287
00:13:29,480 --> 00:13:34,629
thanks possible to see molecules from

288
00:13:32,450 --> 00:13:37,278
the other wavelets

289
00:13:34,629 --> 00:13:39,769
well very small water features for

290
00:13:37,278 --> 00:13:42,110
example could be seen with space but

291
00:13:39,769 --> 00:13:44,899
really we've come free is the instrument

292
00:13:42,110 --> 00:13:46,550
to use if you want to detect molecular

293
00:13:44,899 --> 00:13:49,698
features with Hubble

294
00:13:46,549 --> 00:13:52,490
and right now you would like to go even

295
00:13:49,698 --> 00:13:55,698
further read to where the biggest

296
00:13:52,490 --> 00:13:57,259
molecular features are with countries

297
00:13:55,698 --> 00:14:02,719
actually the best instrument right now

298
00:13:57,259 --> 00:14:04,039
that we have and that leads into I think

299
00:14:02,720 --> 00:14:06,589
what I like to where I like to go with

300
00:14:04,039 --> 00:14:08,208
this is that it is I think this is the

301
00:14:06,589 --> 00:14:11,420
kind of observation that might be more

302
00:14:08,208 --> 00:14:13,099
routine with something like the James

303
00:14:11,419 --> 00:14:15,559
Webb Space Telescope which is going to

304
00:14:13,100 --> 00:14:18,050
be entirely an infrared telescope and in

305
00:14:15,559 --> 00:14:20,539
one of its goals in science is to do the

306
00:14:18,049 --> 00:14:22,729
kind of measurement that you guys have

307
00:14:20,539 --> 00:14:24,588
made here and this is the what's what's

308
00:14:22,730 --> 00:14:28,670
exciting about what you've done is that

309
00:14:24,589 --> 00:14:31,519
this is the first detection of gases in

310
00:14:28,669 --> 00:14:33,799
an atmosphere of a super-earth plan it's

311
00:14:31,519 --> 00:14:36,198
the first time this has been done and

312
00:14:33,799 --> 00:14:37,669
using Hubble and as you would we just

313
00:14:36,198 --> 00:14:39,319
talked about the Wide Field Camera 3

314

00:14:37,669 --> 00:14:43,698
which is it primarily an infrared

315
00:14:39,320 --> 00:14:45,890
telescope or infrared camera the you

316
00:14:43,698 --> 00:14:47,659
were able to get this detection of what

317
00:14:45,889 --> 00:14:50,269
was in this atmosphere and I want to

318
00:14:47,659 --> 00:14:53,000
talk about how you did it so what was

319
00:14:50,269 --> 00:14:54,889
your new you had to invent the

320
00:14:53,000 --> 00:14:56,839
processing technique to get this done so

321
00:14:54,889 --> 00:14:58,189
what did you do and I guess I'll send

322
00:14:56,839 --> 00:15:07,459
that to a Marco since you're the main

323
00:14:58,190 --> 00:15:09,709
you would do one that's a well so the

324
00:15:07,458 --> 00:15:13,219
main problem with this kind of

325
00:15:09,708 --> 00:15:15,859
observation is that we can only do these

326
00:15:13,220 --> 00:15:18,949
measurements in very very bright targets

327
00:15:15,860 --> 00:15:22,519
very bright stars close by very close to

328
00:15:18,948 --> 00:15:24,049

us on the other hand we have W camera

329

00:15:22,519 --> 00:15:27,889
and especially doing for a detector

330

00:15:24,049 --> 00:15:29,929
which is very sensitive this means that

331

00:15:27,889 --> 00:15:34,909
we can it's very difficult to observe

332

00:15:29,929 --> 00:15:38,870
these targets and because they will such

333

00:15:34,909 --> 00:15:40,730
your ccd cameras new detectors like the

334

00:15:38,870 --> 00:15:43,129
bright the light from the star is so

335

00:15:40,730 --> 00:15:46,940
bright compared to the flat light from

336

00:15:43,129 --> 00:15:50,230
the planet I was made for a fainter that

337

00:15:46,940 --> 00:15:55,820
I get so for cosmological research

338

00:15:50,230 --> 00:16:00,409
mainly right so and a new technique was

339

00:15:55,820 --> 00:16:02,780
introduced in 2012 so during the

340

00:16:00,409 --> 00:16:06,909
observation instead of having Kabul

341

00:16:02,779 --> 00:16:10,309
staring at the target Hubble is moving

342

00:16:06,909 --> 00:16:13,149
moving in a way that the star is no

343
00:16:10,309 --> 00:16:15,919
longer at the spectrum actually it's not

344
00:16:13,149 --> 00:16:20,449
standing at actually one position on the

345
00:16:15,919 --> 00:16:24,379
detector but it's moving along one the

346
00:16:20,450 --> 00:16:26,540
one axis vector so this makes the

347
00:16:24,379 --> 00:16:29,120
process of the data a bit more difficult

348
00:16:26,539 --> 00:16:33,829
because there are other systematics

349
00:16:29,120 --> 00:16:34,820
going into these and so let me just make

350
00:16:33,830 --> 00:16:38,690
sure I understood what you just said

351
00:16:34,820 --> 00:16:41,690
you're you take a you go you open the

352
00:16:38,690 --> 00:16:43,850
exposure and you move back and forth

353
00:16:41,690 --> 00:16:46,370
just a little bit in one direction and

354
00:16:43,850 --> 00:16:48,200
you smear it out across the detector am

355
00:16:46,370 --> 00:16:57,399
i imagining this right we have a figure

356
00:16:48,200 --> 00:17:03,830
for this okay so with this knob right

357
00:16:57,399 --> 00:17:04,818
lobby talking about Scott yeah but it's

358
00:17:03,830 --> 00:17:06,529
essentially it's you know it's

359
00:17:04,818 --> 00:17:08,209
essentially smearing like it's slowing

360
00:17:06,529 --> 00:17:09,849
across the star because it hasn't a

361
00:17:08,209 --> 00:17:12,769
shutter that's the main problem right

362
00:17:09,849 --> 00:17:14,719
and so this the field of view by the way

363
00:17:12,769 --> 00:17:17,150
the Hubble has got a tiny field of view

364
00:17:14,720 --> 00:17:19,430
and the way I've always described it

365
00:17:17,150 --> 00:17:21,740
it's just like a grain of sand held out

366
00:17:19,430 --> 00:17:23,449
at arm's length up at the sky that's how

367
00:17:21,740 --> 00:17:25,279
much of the sky had images at one time

368
00:17:23,449 --> 00:17:26,930
so it's very small okay he's got it up

369
00:17:25,279 --> 00:17:28,309
so why don't you show us what we're

370
00:17:26,930 --> 00:17:31,789
looking or tell us what we're looking at

371

00:17:28,309 --> 00:17:36,190
he had here certainly the depth of

372
00:17:31,789 --> 00:17:39,759
actually looking across the white arrow

373
00:17:36,190 --> 00:17:43,160
on the as the spearing of the

374
00:17:39,759 --> 00:17:45,349
perspective on this paper so then this

375
00:17:43,160 --> 00:17:47,620
is the spectrum of 55 Cancri right this

376
00:17:45,349 --> 00:17:49,629
is the star and the star

377
00:17:47,619 --> 00:17:51,909
yes okay so you can take that if you

378
00:17:49,630 --> 00:17:53,800
smeared it in one direction of course

379
00:17:51,910 --> 00:17:56,590
you as a person white are yeah exactly

380
00:17:53,799 --> 00:17:57,730
and in this case because the target is

381
00:17:56,589 --> 00:18:02,859
very bright

382
00:17:57,730 --> 00:18:06,940
you have to scan very fast so this is

383
00:18:02,859 --> 00:18:10,359
eight seconds exposure but that's like

384
00:18:06,940 --> 00:18:11,860
300 pixels something scan okay what does

385
00:18:10,359 --> 00:18:15,939

this get you what what's the advantage

386

00:18:11,859 --> 00:18:18,329

here my excuse me what is this why why

387

00:18:15,940 --> 00:18:22,029

do you do this what's the what is

388

00:18:18,329 --> 00:18:25,359

otherwise the the because it it'll just

389

00:18:22,029 --> 00:18:26,769

saturate the detector measurement yeah

390

00:18:25,359 --> 00:18:29,859

and so you need it because it has no

391

00:18:26,769 --> 00:18:31,660

shutter that's the problem as soon as

392

00:18:29,859 --> 00:18:33,839

you look at the star you're gonna

393

00:18:31,660 --> 00:18:36,429

saturate with comfrey we've come free so

394

00:18:33,839 --> 00:18:39,308

sensitive right it's beautiful cosmology

395

00:18:36,429 --> 00:18:42,130

and not for like looking at the next by

396

00:18:39,308 --> 00:18:43,779

star which we kind of have to do for

397

00:18:42,130 --> 00:18:45,880

exoplanets because the the signal we're

398

00:18:43,779 --> 00:18:48,428

looking for the planet is she knows one

399

00:18:45,880 --> 00:18:52,840

photon in 10,000 so we need loads of

400
00:18:48,429 --> 00:18:55,600
photons we need a bright star so so as

401
00:18:52,839 --> 00:18:57,279
soon as we look at at the star it just

402
00:18:55,599 --> 00:18:59,649
saturates immediately and the only thing

403
00:18:57,279 --> 00:19:03,910
we can do without a shutter is just move

404
00:18:59,650 --> 00:19:06,160
Hubble along just sort of smear it the

405
00:19:03,910 --> 00:19:08,380
signal across the detector okay I can

406
00:19:06,160 --> 00:19:12,100
see how this gets you a non saturated

407
00:19:08,380 --> 00:19:13,780
spectrum of the star without you know

408
00:19:12,099 --> 00:19:17,019
going reaching the limits of each pixel

409
00:19:13,779 --> 00:19:21,069
and and blowing them out but the where's

410
00:19:17,019 --> 00:19:23,859
the planet in this how do you extract so

411
00:19:21,069 --> 00:19:25,899
these observations as Mike said before

412
00:19:23,859 --> 00:19:28,990
during the transit of the planet so

413
00:19:25,900 --> 00:19:30,910
we're looking that's important we're

414
00:19:28,990 --> 00:19:34,420
looking at the star but in between the

415
00:19:30,910 --> 00:19:36,250
star in us there is a pallet so like if

416
00:19:34,420 --> 00:19:39,100
you think an experiment in a physics lab

417
00:19:36,250 --> 00:19:41,619
where you have a lung and a cold and

418
00:19:39,099 --> 00:19:43,689
cold air and light is going through and

419
00:19:41,619 --> 00:19:45,279
then you gauge the spectrum so it's

420
00:19:43,690 --> 00:19:47,920
something like this we have a stellar

421
00:19:45,279 --> 00:19:50,230
light going through the atmosphere of

422
00:19:47,920 --> 00:19:53,320
the planet so it's filtered through the

423
00:19:50,230 --> 00:19:55,390
atmosphere and it's carrying a signal

424
00:19:53,319 --> 00:19:59,189
about a thing you said the signal is one

425
00:19:55,390 --> 00:20:01,140
photon per 10,000 so so

426
00:19:59,190 --> 00:20:04,470
embedded in this star spectrum the

427
00:20:01,140 --> 00:20:07,590
smeared out snorum is isn't is the

428

00:20:04,470 --> 00:20:09,480
spectrum of the light that is gone from

429
00:20:07,589 --> 00:20:12,829
the star through the planet's atmosphere

430
00:20:09,480 --> 00:20:15,299
because it's transiting and into the

431
00:20:12,829 --> 00:20:18,019
detector and so somewhere in there and

432
00:20:15,299 --> 00:20:21,059
you're saying out of for every 10,000

433
00:20:18,019 --> 00:20:23,279
photons one of them is from the planet

434
00:20:21,059 --> 00:20:24,389
you're a there's a there's a embedded

435
00:20:23,279 --> 00:20:26,750
spectrum in there that you have to

436
00:20:24,390 --> 00:20:32,430
somehow extract am I getting that right

437
00:20:26,750 --> 00:20:35,460
yes you've served is this planet as it

438
00:20:32,430 --> 00:20:37,410
runs it so you have a spectrum of the

439
00:20:35,460 --> 00:20:39,360
star alone without the planet in the

440
00:20:37,410 --> 00:20:40,860
spectrum of the star with the planet

441
00:20:39,359 --> 00:20:43,769
with the spectrum of the planet

442
00:20:40,859 --> 00:20:48,539

implanted and there are techniques

443

00:20:43,769 --> 00:20:51,299

basically to recover this the signal the

444

00:20:48,539 --> 00:20:54,210

spectral signature of the planet is that

445

00:20:51,299 --> 00:20:57,419

the bottom part there yeah well that's

446

00:20:54,210 --> 00:20:59,220

the extraction which yes this is this is

447

00:20:57,420 --> 00:21:03,539

how we deal with some systematics that

448

00:20:59,220 --> 00:21:05,880

are caused by the scanning process but

449

00:21:03,539 --> 00:21:09,029

the main thing is that we we extract the

450

00:21:05,880 --> 00:21:11,910

stellar flux per wavelength and then we

451

00:21:09,029 --> 00:21:14,700

started the light curve so if you have a

452

00:21:11,910 --> 00:21:17,220

normal photo mitri of a transiting

453

00:21:14,700 --> 00:21:20,539

planet like all the like Kepler for

454

00:21:17,220 --> 00:21:24,329

example or other last year that detect

455

00:21:20,539 --> 00:21:26,369

exoplanets you have you can see the the

456

00:21:24,329 --> 00:21:28,740

flux going down during the transit if

457
00:21:26,369 --> 00:21:31,229
you do that in different wavelengths and

458
00:21:28,740 --> 00:21:33,509
you measure the depth in either the

459
00:21:31,230 --> 00:21:36,360
different wavelengths then you can you

460
00:21:33,509 --> 00:21:38,609
can see if the depth is changing and

461
00:21:36,359 --> 00:21:40,819
that's lead us to the next figure where

462
00:21:38,609 --> 00:21:42,869
is the spectrum and the final result so

463
00:21:40,819 --> 00:21:44,189
okay let's take a look at that but

464
00:21:42,869 --> 00:21:46,849
before we change this guy what are these

465
00:21:44,190 --> 00:21:50,070
little vertical dots these old circles

466
00:21:46,849 --> 00:21:52,619
so this is where that different

467
00:21:50,069 --> 00:21:54,269
wavelengths are so so that the different

468
00:21:52,619 --> 00:21:59,489
photons of the different wavelengths so

469
00:21:54,269 --> 00:22:01,109
as Hubble is scanning then the spectrum

470
00:21:59,490 --> 00:22:03,859
is not uniform at the detector and

471
00:22:01,109 --> 00:22:06,329
that's why it took us something more

472
00:22:03,859 --> 00:22:06,899
it's a bit more difficult to extract the

473
00:22:06,329 --> 00:22:08,970
spectrum

474
00:22:06,900 --> 00:22:12,750
oh so that's what that's a mapping of

475
00:22:08,970 --> 00:22:15,990
the way it is in the pixel the isn't

476
00:22:12,750 --> 00:22:18,660
popping of the spatial scan spectrum may

477
00:22:15,990 --> 00:22:21,809
not another simple spectrum that usually

478
00:22:18,660 --> 00:22:23,970
Slyke and one-dimensional oh wow that's

479
00:22:21,809 --> 00:22:25,200
very cool okay I can see the differences

480
00:22:23,970 --> 00:22:26,970
in it okay I just wanted to know what

481
00:22:25,200 --> 00:22:28,950
those were okay so Scott if you could go

482
00:22:26,970 --> 00:22:35,900
to the next one and we can see hopefully

483
00:22:28,950 --> 00:22:35,900
what what they found so so what is this

484
00:22:41,329 --> 00:22:49,889
recognize it right you can click on my

485

00:22:48,599 --> 00:22:52,019
thumbnail and we'll make it fullscreen

486
00:22:49,890 --> 00:22:55,890
for you that's right what I click on

487
00:22:52,019 --> 00:23:01,859
Scott's on male and yes the confusion

488
00:22:55,890 --> 00:23:08,250
you see I'm just making up data sets as

489
00:23:01,859 --> 00:23:14,399
we're going along like her from Kepler

490
00:23:08,250 --> 00:23:17,099
upper though so you see in the actual

491
00:23:14,400 --> 00:23:23,940
spectrum and it's the spectral signature

492
00:23:17,099 --> 00:23:25,829
of probably hydrogen helium which is

493
00:23:23,940 --> 00:23:29,640
basically being obtained with this

494
00:23:25,829 --> 00:23:31,379
technique okay so there's a lot here

495
00:23:29,640 --> 00:23:33,000
there's this is the top one is an

496
00:23:31,380 --> 00:23:35,850
atmospheric absorption thing this is

497
00:23:33,000 --> 00:23:36,990
where the the the chemical or whatever

498
00:23:35,849 --> 00:23:38,639
the atoms are that you're looking at

499
00:23:36,990 --> 00:23:41,759

would be absorbed and along the bottom

500

00:23:38,640 --> 00:23:46,490

this is the wavelength is that right yep

501

00:23:41,759 --> 00:23:50,220

so the x-axis is wavelength cons okay

502

00:23:46,490 --> 00:23:56,029

the top is the actual spectrum from w3

503

00:23:50,220 --> 00:23:58,829

so it is between 1.1 and 1.67 micron and

504

00:23:56,029 --> 00:24:01,019

the data are the transit depth which as

505

00:23:58,829 --> 00:24:04,049

we said before the transit depth at

506

00:24:01,019 --> 00:24:06,000

different wavelengths basically shows

507

00:24:04,049 --> 00:24:08,609

how big is the planet at different

508

00:24:06,000 --> 00:24:11,220

wavelengths the planet appears smaller

509

00:24:08,609 --> 00:24:13,979

or bigger at different wavelengths

510

00:24:11,220 --> 00:24:16,559

because there are some gases that absorb

511

00:24:13,980 --> 00:24:19,049

light at different weight so this is

512

00:24:16,559 --> 00:24:22,200

basically what this figure is telling us

513

00:24:19,049 --> 00:24:24,659

it's not flat so if you suppose like a

514
00:24:22,200 --> 00:24:26,430
rocky surface without an atmosphere you

515
00:24:24,660 --> 00:24:32,509
would see a flat line

516
00:24:26,430 --> 00:24:35,580
bah-ha modulation with several Sigma

517
00:24:32,509 --> 00:24:38,519
significance we can say that there is a

518
00:24:35,579 --> 00:24:40,470
gas that is causing these differences

519
00:24:38,519 --> 00:24:42,029
basically so at different wavelengths

520
00:24:40,470 --> 00:24:43,410
the planet is smaller or larger

521
00:24:42,029 --> 00:24:45,619
depending on what wavelength you're

522
00:24:43,410 --> 00:24:48,170
looking at and this is at just one point

523
00:24:45,619 --> 00:24:51,839
across the star isn't it

524
00:24:48,170 --> 00:24:53,640
well we fully the entire I know you

525
00:24:51,839 --> 00:24:57,179
followed it across the entire transit

526
00:24:53,640 --> 00:24:59,009
but this is that one spot right well

527
00:24:57,180 --> 00:25:04,380
yeah that's kind of the you know that's

528
00:24:59,009 --> 00:25:07,170
the oval approached eclipse step off the

529
00:25:04,380 --> 00:25:08,760
entire transit I see okay so you had to

530
00:25:07,170 --> 00:25:10,230
extract two signals what I would

531
00:25:08,759 --> 00:25:12,799
emphasize this because this is amazing

532
00:25:10,230 --> 00:25:15,509
you had to extract it one at signal one

533
00:25:12,799 --> 00:25:18,149
ten-thousandth as bright as what was

534
00:25:15,509 --> 00:25:19,829
coming from that star and you did it you

535
00:25:18,150 --> 00:25:21,360
have these these vertical lines on this

536
00:25:19,829 --> 00:25:23,669
top graph are your error bars

537
00:25:21,359 --> 00:25:26,429
some of them presumably it means how

538
00:25:23,670 --> 00:25:29,850
confident you are of this measurement

539
00:25:26,430 --> 00:25:32,789
correct yeah okay and so here so you

540
00:25:29,849 --> 00:25:34,949
saying that if it was a uniform rocky

541
00:25:32,789 --> 00:25:37,379
planet that it would be flat but this is

542

00:25:34,950 --> 00:25:44,130
the flat this isn't black no this is far

543
00:25:37,380 --> 00:25:46,710
from flat and yeah well the surface is

544
00:25:44,130 --> 00:25:48,600
not uniform right so it means that there

545
00:25:46,710 --> 00:25:52,700
is something above this above the

546
00:25:48,599 --> 00:25:52,699
surface and this is probably cussing

547
00:25:53,509 --> 00:25:56,490
okay

548
00:25:54,779 --> 00:26:00,059
the exciting thing right people we

549
00:25:56,490 --> 00:26:04,680
looked into two suburbs before GJ 1214

550
00:26:00,059 --> 00:26:12,690
and HT 97 another one six five eight I

551
00:26:04,680 --> 00:26:15,390
had property so we just saw a perfectly

552
00:26:12,690 --> 00:26:17,509
flat line and looking at it over and

553
00:26:15,390 --> 00:26:22,410
over and we looked with ground-based

554
00:26:17,509 --> 00:26:24,839
observatories and it's possible then

555
00:26:22,410 --> 00:26:26,880
that a telltale sign of an atmosphere is

556
00:26:24,839 --> 00:26:29,549

the the flatness of that particular

557

00:26:26,880 --> 00:26:31,020

looking graph in other exoplanets if you

558

00:26:29,549 --> 00:26:32,940

see that you can say well probably

559

00:26:31,019 --> 00:26:35,339

doesn't have an atmosphere well it does

560

00:26:32,940 --> 00:26:37,200

it like it's assumed that these planets

561

00:26:35,339 --> 00:26:39,679

have an atmosphere but have a cloud tech

562

00:26:37,200 --> 00:26:42,680

that hides any animal or

563

00:26:39,680 --> 00:26:46,640

would be the other sites uniform it's

564

00:26:42,680 --> 00:26:49,610

either rock or uniform okay cool great

565

00:26:46,640 --> 00:26:51,020

well so my understanding is that so

566

00:26:49,609 --> 00:26:54,019

you've shown the data points and then

567

00:26:51,019 --> 00:26:57,920

and then you do then you say well what

568

00:26:54,019 --> 00:27:01,430

can this be and then you make a hydrogen

569

00:26:57,920 --> 00:27:04,700

and helium model and that's the dashed

570

00:27:01,430 --> 00:27:06,620

orange line and you say oh okay that

571
00:27:04,700 --> 00:27:08,840
doesn't work either it's not flat and

572
00:27:06,619 --> 00:27:10,789
it's not just hydrogen and helium and

573
00:27:08,839 --> 00:27:12,619
then you try to figure out in addition

574
00:27:10,789 --> 00:27:16,399
to hydrogen and helium what else is

575
00:27:12,619 --> 00:27:18,409
there is that the idea well with a

576
00:27:16,400 --> 00:27:20,150
priest step off you see and it's not

577
00:27:18,410 --> 00:27:22,810
flat and you panic because you think

578
00:27:20,150 --> 00:27:22,810
something's broken

579
00:27:23,589 --> 00:27:29,539
you didn't calibrate it properly or like

580
00:27:27,200 --> 00:27:34,880
a panic so they had to invent a clever

581
00:27:29,539 --> 00:27:42,109
technique to and I like panic driven

582
00:27:34,880 --> 00:27:43,820
software so that is so the bottom the

583
00:27:42,109 --> 00:27:45,589
bottom graph then is yours as Carol said

584
00:27:43,819 --> 00:27:49,429
that's your model of if it was just

585
00:27:45,589 --> 00:27:51,529
hydrogen and helium and then actually I

586
00:27:49,430 --> 00:27:54,230
guess I don't understand some of this so

587
00:27:51,529 --> 00:27:56,329
the the Spitzer data will help me

588
00:27:54,230 --> 00:28:00,019
understand this bottom graph okay so we

589
00:27:56,329 --> 00:28:02,779
have the same models we see above the

590
00:28:00,019 --> 00:28:05,269
orange line that shows the hydrogen

591
00:28:02,779 --> 00:28:08,089
helium home the atmosphere and the model

592
00:28:05,269 --> 00:28:10,730
with which includes the hydrogen cyanide

593
00:28:08,089 --> 00:28:14,740
at along in a longer wavelength range

594
00:28:10,730 --> 00:28:17,029
right so if we could have served is this

595
00:28:14,740 --> 00:28:20,089
spectrum and in a longer wavelength

596
00:28:17,029 --> 00:28:24,019
range these would be the two models that

597
00:28:20,089 --> 00:28:26,359
we're looking at and saying that we

598
00:28:24,019 --> 00:28:28,910
cannot really distinguish between the h2

599

00:28:26,359 --> 00:28:30,919
and helium model and the HCM detection

600
00:28:28,910 --> 00:28:33,529
so where we weren't actually claiming

601
00:28:30,920 --> 00:28:41,900
the full HCN detection but there is just

602
00:28:33,529 --> 00:28:44,839
an indication that hydrogen cyanide also

603
00:28:41,900 --> 00:28:46,220
qualifies so if you hear that I don't

604
00:28:44,839 --> 00:28:50,949
have to grind more coffee beans real

605
00:28:46,220 --> 00:28:52,569
quick hold on I'll be back so

606
00:28:50,950 --> 00:28:54,519
really want to distinguish between the

607
00:28:52,569 --> 00:28:57,339
zoo models we need to go to longer

608
00:28:54,519 --> 00:29:00,190
wavelengths and and that's where James

609
00:28:57,339 --> 00:29:02,339
Webb will be able to do so that Spitzer

610
00:29:00,190 --> 00:29:05,139
point you see there that's the only

611
00:29:02,339 --> 00:29:06,788
symmetric point with a super large error

612
00:29:05,138 --> 00:29:09,148
bar that we have that doesn't really

613
00:29:06,788 --> 00:29:09,148

help

614

00:29:11,909 --> 00:29:18,399

just for people to look at this and

615

00:29:15,909 --> 00:29:21,369

understand if you look at the lower you

616

00:29:18,398 --> 00:29:23,678

lower one you see a rectangle and the

617

00:29:21,368 --> 00:29:26,288

rectangle is where the Wide Field Camera

618

00:29:23,679 --> 00:29:29,619

3 data is if I understand this correctly

619

00:29:26,288 --> 00:29:31,839

and that is expanded above so you can

620

00:29:29,618 --> 00:29:34,538

see it spread out more but the whole

621

00:29:31,839 --> 00:29:37,209

model covers the whole wavelength region

622

00:29:34,538 --> 00:29:38,858

and this is the demonstration that okay

623

00:29:37,210 --> 00:29:40,569

Spitzer didn't give us enough data

624

00:29:38,858 --> 00:29:47,739

points boy we would like to have some

625

00:29:40,569 --> 00:29:50,499

James Webb okay now one of the

626

00:29:47,739 --> 00:29:53,319

trademarks of hydrogen cyanide being in

627

00:29:50,499 --> 00:30:02,409

an atmosphere is that hydrogen cyanide

628
00:29:53,319 --> 00:30:05,888
is an indicator of a very high carbon to

629
00:30:02,409 --> 00:30:08,649
oxygen okay so that means there is a lot

630
00:30:05,888 --> 00:30:11,908
of carbon in this in this atmosphere as

631
00:30:08,648 --> 00:30:14,199
well what is that what is that

632
00:30:11,909 --> 00:30:17,470
indicative of anything as but as far as

633
00:30:14,200 --> 00:30:19,090
the habitability of the planet or

634
00:30:17,470 --> 00:30:22,269
Maynard's or anything oh my god it's too

635
00:30:19,089 --> 00:30:23,918
hard yes well I know the reason whether

636
00:30:22,269 --> 00:30:26,700
all the tardigrades on their turn to

637
00:30:23,919 --> 00:30:31,330
charcoal yeah like we'd seen for them

638
00:30:26,700 --> 00:30:33,869
see I like hot hot planets oh well you

639
00:30:31,329 --> 00:30:36,668
could go back to Florida

640
00:30:33,868 --> 00:30:38,499
alright so know this that this this is

641
00:30:36,669 --> 00:30:39,909
an indicator of having a very high ratio

642
00:30:38,499 --> 00:30:41,169
of carbon to oxygen and I just want to

643
00:30:39,909 --> 00:30:43,720
talk a little bit about what that might

644
00:30:41,169 --> 00:30:46,869
mean as far as the other aspects of the

645
00:30:43,720 --> 00:30:48,629
nature of this planet right I mean there

646
00:30:46,868 --> 00:30:51,128
were the previous studies that evening

647
00:30:48,628 --> 00:30:54,278
the carbon to oxygen ratio is so high

648
00:30:51,128 --> 00:30:58,118
that the entire inside of 55 countries

649
00:30:54,278 --> 00:31:00,278
made out of diamonds so I don't know

650
00:30:58,118 --> 00:31:02,439
whether that's no confirmed or not I

651
00:31:00,278 --> 00:31:04,119
mean it's been debates it's massively in

652
00:31:02,440 --> 00:31:06,009
the fields but

653
00:31:04,119 --> 00:31:07,899
not the first measurement that shows

654
00:31:06,009 --> 00:31:09,879
that they may potentially be quite a lot

655
00:31:07,900 --> 00:31:12,100
of carbon in there so highly reduced

656

00:31:09,880 --> 00:31:14,350
atmosphere

657
00:31:12,099 --> 00:31:16,329
so you see Scott it isn't out now it is

658
00:31:14,349 --> 00:31:23,439
a pretty fun place to go lots of time

659
00:31:16,329 --> 00:31:25,509
yeah that's all me Justin I'm Scottish I

660
00:31:23,440 --> 00:31:27,370
will just like I go outside here now you

661
00:31:25,509 --> 00:31:31,890
person the flames going there we're just

662
00:31:27,369 --> 00:31:35,349
yeah yeah that was the sunburn would be

663
00:31:31,890 --> 00:31:37,060
quite supreme alright well so now that

664
00:31:35,349 --> 00:31:39,849
you've got this technique down and

665
00:31:37,059 --> 00:31:41,230
you've been looking at super-earth and

666
00:31:39,849 --> 00:31:42,579
you've got a pretty good idea of its

667
00:31:41,230 --> 00:31:44,200
atmosphere the fact that it even has one

668
00:31:42,579 --> 00:31:47,349
and hopefully we've shown a lot of

669
00:31:44,200 --> 00:31:48,910
people what that's like to to you know

670
00:31:47,349 --> 00:31:50,409

be able to determine whether some of

671

00:31:48,910 --> 00:31:53,290

these exoplanets have a name

672

00:31:50,410 --> 00:31:55,230

have a plot atmosphere and I are you

673

00:31:53,289 --> 00:31:57,519

gonna be turning this technique to other

674

00:31:55,230 --> 00:31:59,079

other systems are you doing are you

675

00:31:57,519 --> 00:32:03,329

spreading this out a little bit more is

676

00:31:59,079 --> 00:32:09,279

it more work to be done on them by Carol

677

00:32:03,329 --> 00:32:12,429

yeah well there we expect also in the

678

00:32:09,279 --> 00:32:12,879

future for more closed super-earth to be

679

00:32:12,430 --> 00:32:16,750

found

680

00:32:12,880 --> 00:32:20,710

so there are missions that are dedicated

681

00:32:16,750 --> 00:32:24,519

to finding small planets around closeby

682

00:32:20,710 --> 00:32:26,470

stars but since I start these things

683

00:32:24,519 --> 00:32:28,240

Lisa starts with going to be close by

684

00:32:26,470 --> 00:32:31,480

we're going to have the same problem

685
00:32:28,240 --> 00:32:36,910
with Hubble we need to use the same the

686
00:32:31,480 --> 00:32:42,039
same technique and so use the Hubble to

687
00:32:36,910 --> 00:32:43,810
scan for these targets so we will meet

688
00:32:42,039 --> 00:32:45,909
we'll have to use the same technique

689
00:32:43,809 --> 00:32:48,279
there's no alternative route that's

690
00:32:45,910 --> 00:32:51,480
right the problem so far is that we

691
00:32:48,279 --> 00:32:51,480
don't have enough super Earths

692
00:32:52,289 --> 00:32:59,549
can be served with three or you know any

693
00:32:56,730 --> 00:33:02,799
telescope so what we really want is to

694
00:32:59,549 --> 00:33:06,279
have new super Hertz and then you'll be

695
00:33:02,799 --> 00:33:13,180
able to there are a few others that you

696
00:33:06,279 --> 00:33:14,920
observed yet so we will serve these yes

697
00:33:13,180 --> 00:33:16,750
that's a good point I guess it's not

698
00:33:14,920 --> 00:33:17,830
enough to just have Hubble observations

699
00:33:16,750 --> 00:33:20,558
of these

700
00:33:17,829 --> 00:33:23,439
you've got to have the specifics smeared

701
00:33:20,558 --> 00:33:25,569
observations why your technique and

702
00:33:23,440 --> 00:33:27,940
extract the signal from the planet out

703
00:33:25,569 --> 00:33:30,339
so you really got to redo this unique

704
00:33:27,940 --> 00:33:33,750
atomic so I mean there's you know the

705
00:33:30,339 --> 00:33:36,339
NASA has the test mission approved and

706
00:33:33,750 --> 00:33:38,829
right passes transiting exoplanet survey

707
00:33:36,339 --> 00:33:42,129
satellite that's gonna be launched next

708
00:33:38,829 --> 00:33:45,308
year right yes and tests will just

709
00:33:42,130 --> 00:33:48,700
provide a hopefully hopefully fantastic

710
00:33:45,308 --> 00:33:52,048
amount of closeby suburbs at least you

711
00:33:48,700 --> 00:33:52,048
know that's what the propagandists is

712
00:33:52,528 --> 00:33:57,429
but will that will that signal be it

713

00:33:55,778 --> 00:33:58,839
won't be the smeared type you'll you

714
00:33:57,429 --> 00:34:00,580
won't need it tests will be able to do

715
00:33:58,839 --> 00:34:03,099
this in a way that doesn't saturate

716
00:34:00,579 --> 00:34:05,558
things right finds them this is just a

717
00:34:03,099 --> 00:34:07,898
photometry mission right so it's

718
00:34:05,558 --> 00:34:09,789
similar to Kepler but it looks like the

719
00:34:07,898 --> 00:34:14,069
close by stars Kepler looks at the very

720
00:34:09,789 --> 00:34:16,480
far away condemned to faint was actually

721
00:34:14,070 --> 00:34:19,109
so we have loads of super-earths in the

722
00:34:16,480 --> 00:34:22,990
Kepler view but they're just two things

723
00:34:19,108 --> 00:34:24,969
well say some Queen we're sorry to get a

724
00:34:22,989 --> 00:34:26,769
few questions in from the YouTube chest

725
00:34:24,969 --> 00:34:28,928
let me get those out just to be clear

726
00:34:26,769 --> 00:34:38,858
they want more super-earths and they

727
00:34:28,929 --> 00:34:42,039

want in jwc time you know i want to use

728

00:34:38,858 --> 00:34:44,619

a telescope that's the area of a tennis

729

00:34:42,039 --> 00:34:49,809

court four stories tall and I want more

730

00:34:44,619 --> 00:34:53,099

planets that send them their way I'll

731

00:34:49,809 --> 00:34:53,099

write Santa for you this year

732

00:34:53,820 --> 00:34:57,550

you know what Carol I think we've ever

733

00:34:55,719 --> 00:35:06,669

had anybody on this hangout that said

734

00:34:57,550 --> 00:35:10,030

they'd wanted less I don't need any more

735

00:35:06,670 --> 00:35:11,800

thank you there's somebody there's a

736

00:35:10,030 --> 00:35:14,650

question here about whether you recorded

737

00:35:11,800 --> 00:35:18,339

several how many transits did you record

738

00:35:14,650 --> 00:35:21,250

of 55 Cancri was it just one to two

739

00:35:18,338 --> 00:35:24,429

transits okay good and Ken Brandt is

740

00:35:21,250 --> 00:35:26,650

asking is the planet tidally locked I

741

00:35:24,429 --> 00:35:28,059

wonder what it the Nightside temp is

742
00:35:26,650 --> 00:35:30,430
like is it tightly locked first of all

743
00:35:28,059 --> 00:35:31,369
it is at least that's what we assume it

744
00:35:30,429 --> 00:35:34,338
is

745
00:35:31,369 --> 00:35:37,220
backside temperature is about 1500

746
00:35:34,338 --> 00:35:42,318
Kelvin that's about 700 800 Kelvin

747
00:35:37,219 --> 00:35:44,298
colder 700-800 okay so that's quite a

748
00:35:42,318 --> 00:35:46,068
difference so we have a couple of artist

749
00:35:44,298 --> 00:35:47,599
impressions and maybe maybe Scott could

750
00:35:46,068 --> 00:35:50,119
put one of those up we'll take a look at

751
00:35:47,599 --> 00:35:53,380
that briefly of what and putting all

752
00:35:50,119 --> 00:35:55,190
this information together you know as

753
00:35:53,380 --> 00:35:56,630
astronomers do they'd like to make these

754
00:35:55,190 --> 00:35:59,088
artist impressions of what they think it

755
00:35:56,630 --> 00:36:01,760
might look like and so here we're

756
00:35:59,088 --> 00:36:05,088
looking at a planet very close to a star

757
00:36:01,760 --> 00:36:08,200
boy the the the Sun is gonna be very

758
00:36:05,088 --> 00:36:11,239
high in the sky big in the sky that's

759
00:36:08,199 --> 00:36:12,348
and you're saying and it's red you were

760
00:36:11,239 --> 00:36:15,618
saying earlier that it was primarily

761
00:36:12,349 --> 00:36:17,990
lava right yeah because of the tidal

762
00:36:15,619 --> 00:36:19,700
forces and the eatin and all the and

763
00:36:17,989 --> 00:36:23,209
it's amazing that it even has is I just

764
00:36:19,699 --> 00:36:24,679
why do you think the the solar wind from

765
00:36:23,210 --> 00:36:32,679
the star doesn't blow the atmosphere

766
00:36:24,679 --> 00:36:34,848
away absolutely no idea at this stage

767
00:36:32,679 --> 00:36:38,179
okay cuz that yeah would seem to be a

768
00:36:34,849 --> 00:36:39,349
pretty big factor in and whether it had

769
00:36:38,179 --> 00:36:42,529
an atmosphere or not that's pretty good

770

00:36:39,349 --> 00:36:43,900
what people do this it would have like a

771
00:36:42,530 --> 00:36:46,790
hydrogen atmosphere it's it's

772
00:36:43,900 --> 00:36:49,338
necessarily expected so there may either

773
00:36:46,789 --> 00:36:53,088
be a process where you can hang on to

774
00:36:49,338 --> 00:36:56,259
its original hydrogen core or some

775
00:36:53,088 --> 00:37:00,558
replenishing from a surface chemistry

776
00:36:56,260 --> 00:37:05,240
the outgassing hydrogen constantly yeah

777
00:37:00,559 --> 00:37:07,250
so yeah so this would be and this was a

778
00:37:05,239 --> 00:37:09,909
web what remind me it was one point how

779
00:37:07,250 --> 00:37:14,349
big was larger than the earth one point

780
00:37:09,909 --> 00:37:14,348
in terms of masses a times

781
00:37:16,449 --> 00:37:20,929
radly ninth larger than the earth so

782
00:37:19,068 --> 00:37:22,308
that's pretty it's pretty big okay so

783
00:37:20,929 --> 00:37:24,739
and so that answers your question

784
00:37:22,309 --> 00:37:26,210

strikes I strike wonder how long that

785

00:37:24,739 --> 00:37:28,189

atmosphere will deal with the solar wind

786

00:37:26,210 --> 00:37:30,139

situation so that's a good question so

787

00:37:28,190 --> 00:37:33,108

that that's something I guess everybody

788

00:37:30,139 --> 00:37:35,298

would like to find out the idea that

789

00:37:33,108 --> 00:37:38,328

apparently the atmosphere may just be

790

00:37:35,298 --> 00:37:40,548

chance you know permanence that's that

791

00:37:38,329 --> 00:37:43,030

it may lose and regain its atmosphere no

792

00:37:40,548 --> 00:37:45,219

guessing so

793

00:37:43,030 --> 00:37:47,019

his observations looked at it and they

794

00:37:45,219 --> 00:37:49,299

didn't find an atmosphere we found a

795

00:37:47,019 --> 00:37:51,159

pretty clear signal in two different

796

00:37:49,300 --> 00:37:52,900

transits so there may be you know there

797

00:37:51,159 --> 00:37:55,329

may be some you may not be a permanent

798

00:37:52,900 --> 00:37:56,860

atmosphere together I see you're saying

799
00:37:55,329 --> 00:38:00,460
that because of the tidal forces on the

800
00:37:56,860 --> 00:38:02,680
planet the the the stuff is underneath

801
00:38:00,460 --> 00:38:05,650
that lava whatever it could be just

802
00:38:02,679 --> 00:38:08,500
gases pouring out of thee okay that's

803
00:38:05,650 --> 00:38:12,400
their point that you saw in the previous

804
00:38:08,500 --> 00:38:14,650
drop was an average of several transits

805
00:38:12,400 --> 00:38:16,510
that were observed with Spitzer and a

806
00:38:14,650 --> 00:38:21,099
previous study from a few months ago

807
00:38:16,510 --> 00:38:23,320
actually showed that apparently it's our

808
00:38:21,099 --> 00:38:25,329
data point is varying a lot indicating

809
00:38:23,320 --> 00:38:29,380
that maybe these a series is probably

810
00:38:25,329 --> 00:38:31,690
changing in size that's how you would

811
00:38:29,380 --> 00:38:33,460
know you though if those if those data

812
00:38:31,690 --> 00:38:34,809
points were moving around pretty rapidly

813
00:38:33,460 --> 00:38:38,139
it wouldn't be a very stable atmosphere

814
00:38:34,809 --> 00:38:40,809
be something gushing out of it and sort

815
00:38:38,139 --> 00:38:44,650
of you know certain would Spitzer so you

816
00:38:40,809 --> 00:38:48,029
know so the thing is you know once we

817
00:38:44,650 --> 00:38:48,030
have James Webb talk we hope it's

818
00:38:55,679 --> 00:39:00,639
waiting for you hurry up all right the

819
00:38:58,869 --> 00:39:02,380
the nebulous princess is asking the

820
00:39:00,639 --> 00:39:05,500
question can the presence of an

821
00:39:02,380 --> 00:39:07,119
atmosphere that close to its star be

822
00:39:05,500 --> 00:39:10,570
used to infer anything about whether

823
00:39:07,119 --> 00:39:11,739
this has a magnetic field I mean do we

824
00:39:10,570 --> 00:39:15,269
know anything can no can we learn

825
00:39:11,739 --> 00:39:15,269
anything about a magnetic field here

826
00:39:15,630 --> 00:39:19,090
just because it has an atmosphere

827

00:39:17,349 --> 00:39:29,710
doesn't mean you've got a magnetic field

828
00:39:19,090 --> 00:39:32,170
by the way look like we don't know you

829
00:39:29,710 --> 00:39:34,720
know that active geologically it might

830
00:39:32,170 --> 00:39:39,130
have some kind of if it's outgassing it

831
00:39:34,719 --> 00:39:41,679
might have whether it's a global dynamo

832
00:39:39,130 --> 00:39:44,800
it's not clear we know that the density

833
00:39:41,679 --> 00:39:46,569
of the pine is quite low but we don't

834
00:39:44,800 --> 00:39:48,430
know more about this and all of the core

835
00:39:46,570 --> 00:39:51,030
sorry say that again the density is low

836
00:39:48,429 --> 00:39:54,190
you said densities right low so the

837
00:39:51,030 --> 00:39:56,400
planet is quite large operate for a

838
00:39:54,190 --> 00:39:58,740
earth white planner for a rocky planet

839
00:39:56,400 --> 00:40:03,660
for a planet that is eight times heavier

840
00:39:58,739 --> 00:40:05,758
than the earth yeah quite large how do

841
00:40:03,659 --> 00:40:07,469

you so where do you get that house how

842

00:40:05,759 --> 00:40:09,469

do you get the density from that I'm

843

00:40:07,469 --> 00:40:13,078

very curious about that so you know

844

00:40:09,469 --> 00:40:15,389

entity comes from you combined combined

845

00:40:13,079 --> 00:40:18,650

measurement of transits and radial

846

00:40:15,389 --> 00:40:22,018

velocity so from visual velocity is the

847

00:40:18,650 --> 00:40:22,980

pulling star goes around ok sure because

848

00:40:22,018 --> 00:40:24,508

that would tell you about its mass

849

00:40:22,980 --> 00:40:26,519

that's right that's a good point ok good

850

00:40:24,509 --> 00:40:29,009

so you also measure the wobble of the

851

00:40:26,518 --> 00:40:31,439

star with with with c3 as well okay

852

00:40:29,009 --> 00:40:33,748

basically measurements are from other

853

00:40:31,440 --> 00:40:34,730

ways through Maps so abscissas

854

00:40:33,748 --> 00:40:39,838

high-precision

855

00:40:34,730 --> 00:40:42,719

spectrograph Oh Monsieur I mean very

856
00:40:39,838 --> 00:40:44,998
high-resolution spectroscopy to observe

857
00:40:42,719 --> 00:40:54,929
the shift of the lines of the stars due

858
00:40:44,998 --> 00:40:57,689
to such a small planet right so the

859
00:40:54,929 --> 00:40:59,909
difference between radio velocity and

860
00:40:57,690 --> 00:41:01,409
the transit method they each have their

861
00:40:59,909 --> 00:41:03,028
own strengths of weaknesses I each tell

862
00:41:01,409 --> 00:41:05,818
you something different about the planet

863
00:41:03,028 --> 00:41:07,768
in the case of a transit you can learn a

864
00:41:05,818 --> 00:41:09,449
lot about its size because of how much

865
00:41:07,768 --> 00:41:11,879
it blocks the star's light and from the

866
00:41:09,449 --> 00:41:14,219
radio velocity how massive it is because

867
00:41:11,880 --> 00:41:16,079
of how much it tugs on the star except

868
00:41:14,219 --> 00:41:17,189
you have to compensate for all the other

869
00:41:16,079 --> 00:41:20,579
planets that are out there which I'm

870
00:41:17,190 --> 00:41:22,108
sure you guys do as well right so you

871
00:41:20,579 --> 00:41:24,059
can kind of get a sense of how massive

872
00:41:22,108 --> 00:41:26,159
this planet is minus all the other

873
00:41:24,059 --> 00:41:28,710
planets pulling on the star yeah right

874
00:41:26,159 --> 00:41:30,899
in the radial velocity the measurements

875
00:41:28,710 --> 00:41:33,329
they takings are gone but they are not

876
00:41:30,900 --> 00:41:37,318
transiting so for us they are not

877
00:41:33,329 --> 00:41:38,910
affecting anything so this just read

878
00:41:37,318 --> 00:41:45,239
let's just summarize a little bit here

879
00:41:38,909 --> 00:41:47,818
voting group on this but I want to know

880
00:41:45,239 --> 00:41:49,858
about this planetary system because what

881
00:41:47,818 --> 00:41:52,199
Angela just said was important that I

882
00:41:49,858 --> 00:41:53,759
had read about it but this is it has a

883
00:41:52,199 --> 00:41:56,788
bunch of planets but this is you only

884

00:41:53,759 --> 00:41:57,568
transmit one yes good that raised your

885
00:41:56,789 --> 00:42:01,710
question here

886
00:41:57,568 --> 00:42:04,829
anyway go ahead say was these guys have

887
00:42:01,710 --> 00:42:07,079
looked at a star smeared it out over a

888
00:42:04,829 --> 00:42:09,490
over a camera that has numerous

889
00:42:07,079 --> 00:42:12,700
spectrograph picked out a cig

890
00:42:09,489 --> 00:42:15,819
10,000 times dimmer than the star it was

891
00:42:12,699 --> 00:42:17,588
orbiting figured out what it was the

892
00:42:15,820 --> 00:42:19,780
atmosphere that first of all they had an

893
00:42:17,588 --> 00:42:21,429
atmosphere and that it went what it was

894
00:42:19,780 --> 00:42:29,890
on and hydrogen cyanide among other

895
00:42:21,429 --> 00:42:32,169
things and that they also were able to

896
00:42:29,889 --> 00:42:33,699
look at a radial velocity met images

897
00:42:32,170 --> 00:42:35,680
from other instruments to get a sense of

898
00:42:33,699 --> 00:42:38,739

the mass of this planet and having to

899

00:42:35,679 --> 00:42:40,750

deal with all the other planets in that

900

00:42:38,739 --> 00:42:43,000

system I mean this is the kind of work

901

00:42:40,750 --> 00:42:45,338

that blows my mind because of all the

902

00:42:43,000 --> 00:42:47,710

things you've got it account for not

903

00:42:45,338 --> 00:42:49,329

even to mention all the idiosyncrasies

904

00:42:47,710 --> 00:42:51,099

involved in the data itself you got to

905

00:42:49,329 --> 00:42:53,049

calibrate all the instrument effects out

906

00:42:51,099 --> 00:42:54,670

I mean this is amazing stuff as far as

907

00:42:53,050 --> 00:42:58,330

the signal and what we're able to learn

908

00:42:54,670 --> 00:43:00,849

from just literally a few photons just I

909

00:42:58,329 --> 00:43:02,710

just always in office so the system

910

00:43:00,849 --> 00:43:03,880

itself Carol wants to learn a little bit

911

00:43:02,710 --> 00:43:05,320

more of the system itself we've already

912

00:43:03,880 --> 00:43:07,900

talked about there's five other four

913
00:43:05,320 --> 00:43:09,338
other planets I think so but they're not

914
00:43:07,900 --> 00:43:13,660
transiting what are they doing are they

915
00:43:09,338 --> 00:43:17,460
doing some kind of you know just not

916
00:43:13,659 --> 00:43:20,348
looking like perfectly edge-on that's

917
00:43:17,460 --> 00:43:22,269
you know one yes the other ones are just

918
00:43:20,349 --> 00:43:24,609
a bit you know not transiting in our

919
00:43:22,269 --> 00:43:29,739
line of sight but they're they're doing

920
00:43:24,608 --> 00:43:34,329
fine yeah they gave us a phone call

921
00:43:29,739 --> 00:43:39,639
they're like no no worries with you

922
00:43:34,329 --> 00:43:41,230
right now it's it's it's you not me it's

923
00:43:39,639 --> 00:43:43,539
because we're not transiting you know

924
00:43:41,230 --> 00:43:47,159
like as much that's fine we'll just sit

925
00:43:43,539 --> 00:43:47,159
over here in the dark that's all right

926
00:43:47,579 --> 00:43:55,750
but it's important at least they've been

927
00:43:50,349 --> 00:43:57,430
found okay so presumably that was solely

928
00:43:55,750 --> 00:43:58,539
from the radio velocity method right I

929
00:43:57,429 --> 00:44:00,669
mean there's no other way to really tell

930
00:43:58,539 --> 00:44:02,199
so that's that's all you have you should

931
00:44:00,670 --> 00:44:04,300
point out that there's a real bias to

932
00:44:02,199 --> 00:44:05,949
the transit method and that bias is that

933
00:44:04,300 --> 00:44:07,450
we're we're only talking about planets

934
00:44:05,949 --> 00:44:10,149
Kepler that's all it looked at were

935
00:44:07,449 --> 00:44:12,789
these dips and brightness but that and

936
00:44:10,150 --> 00:44:14,139
it came up with an estimate of or came

937
00:44:12,789 --> 00:44:17,259
up with a lot you know 5,000 plus

938
00:44:14,139 --> 00:44:19,480
candidate planets around stars that it

939
00:44:17,260 --> 00:44:21,640
160,000 or so stars it was looking at

940
00:44:19,480 --> 00:44:23,230
but that doesn't mean that's all there

941

00:44:21,639 --> 00:44:24,639
was it's just how many were

942
00:44:23,230 --> 00:44:27,490
happened to be passing in between the

943
00:44:24,639 --> 00:44:29,379
star and the Kepler telescope and the

944
00:44:27,489 --> 00:44:31,089
same is true here there are so many

945
00:44:29,380 --> 00:44:33,039
planets and they've come up that and so

946
00:44:31,090 --> 00:44:36,039
they've extrapolated and I'm not sure

947
00:44:33,039 --> 00:44:38,858
what the what the method they used to do

948
00:44:36,039 --> 00:44:41,170
that was but if you look at the transits

949
00:44:38,858 --> 00:44:42,909
we can see and then you extrapolate that

950
00:44:41,170 --> 00:44:45,490
in some intelligent way they have come

951
00:44:42,909 --> 00:44:48,969
up with the figure of 1.6 planets for

952
00:44:45,489 --> 00:44:51,219
every star on average in our galaxy and

953
00:44:48,969 --> 00:44:52,539
so those are apparently include a lot of

954
00:44:51,219 --> 00:44:55,299
the ones that we can't see or that

955
00:44:52,539 --> 00:44:57,608

aren't transiting as well so the the

956

00:44:55,300 --> 00:44:59,380

radial velocity method though that is

957

00:44:57,608 --> 00:45:01,119

not that it's not suffer from that same

958

00:44:59,380 --> 00:45:04,260

bias will see it no matter where they

959

00:45:01,119 --> 00:45:04,260

are whether they're line-of-sight

960

00:45:06,900 --> 00:45:15,519

well if they rotate okay so we're

961

00:45:09,070 --> 00:45:18,220

looking from the top of the plane of the

962

00:45:15,519 --> 00:45:19,869

wobble no matter what well yeah it was

963

00:45:18,219 --> 00:45:22,419

but then we wouldn't be seeing it then

964

00:45:19,869 --> 00:45:25,090

we'd be seeing astrometry so Gaia would

965

00:45:22,420 --> 00:45:29,680

pick up on the you know ninety degree

966

00:45:25,090 --> 00:45:31,300

angle to the to the plane once some guy

967

00:45:29,679 --> 00:45:33,819

is probably gonna find another ten

968

00:45:31,300 --> 00:45:35,650

thousand planets or so because let's

969

00:45:33,820 --> 00:45:37,809

talk about Gaia Gaia is tell us a little

970
00:45:35,650 --> 00:45:42,070
bit about that guy is amazing I love

971
00:45:37,809 --> 00:45:47,049
Gaia God big thumbs up from Scott on

972
00:45:42,070 --> 00:45:48,789
Gaia Gaia okay guy is her is his friend

973
00:45:47,050 --> 00:45:49,690
okay but tell us a little bit Keith

974
00:45:48,789 --> 00:45:51,849
could give us a little background on

975
00:45:49,690 --> 00:45:55,780
what guy is gonna do them well it's

976
00:45:51,849 --> 00:45:57,759
astronomy from a tree mission that's

977
00:45:55,780 --> 00:46:00,340
currently flying mapping all the closeby

978
00:45:57,760 --> 00:46:03,280
stars and and figuring out the parallax

979
00:46:00,340 --> 00:46:06,190
distances to till the stars really high

980
00:46:03,280 --> 00:46:08,470
precision but as a sight product that

981
00:46:06,190 --> 00:46:11,019
the Gaia pipeline actually has a little

982
00:46:08,469 --> 00:46:14,259
extra planet module attached to it which

983
00:46:11,019 --> 00:46:17,469
just looks for tiny little bubbles of

984
00:46:14,260 --> 00:46:19,300
the star and and then essentially the

985
00:46:17,469 --> 00:46:21,069
same thing that radial velocity just

986
00:46:19,300 --> 00:46:23,769
looked at from a from a completely

987
00:46:21,070 --> 00:46:26,140
different angle depending they start

988
00:46:23,769 --> 00:46:28,420
going away in towards us you know left

989
00:46:26,139 --> 00:46:31,409
and right and taking spectra actually

990
00:46:28,420 --> 00:46:34,210
take images and you can see the star

991
00:46:31,409 --> 00:46:36,279
moving right and so for those of you

992
00:46:34,210 --> 00:46:36,940
don't know astrometry is this is the

993
00:46:36,280 --> 00:46:38,530
study

994
00:46:36,940 --> 00:46:40,539
you know measuring exactly where

995
00:46:38,530 --> 00:46:42,760
something has in its distance about from

996
00:46:40,539 --> 00:46:44,949
us so that's what astrometry doesn't guy

997
00:46:42,760 --> 00:46:48,640
is gonna be well-suited to help us find

998

00:46:44,949 --> 00:46:50,169
that out for a lot of stars so that's

999
00:46:48,639 --> 00:46:52,389
gotta that's an important mission that's

1000
00:46:50,170 --> 00:46:55,869
uh that's what is that that's happening

1001
00:46:52,389 --> 00:46:57,699
soon right well it's flying now yeah

1002
00:46:55,869 --> 00:47:02,068
it's already you know we talked about

1003
00:46:57,699 --> 00:47:09,189
before but yeah it's launched what 2013

1004
00:47:02,068 --> 00:47:14,279
data release you need to wait many many

1005
00:47:09,190 --> 00:47:14,280
years before you can actually complete

1006
00:47:17,730 --> 00:47:24,099
the orbit that's right you need to be

1007
00:47:22,480 --> 00:47:27,460
the time series to really get the knack

1008
00:47:24,099 --> 00:47:29,410
your measurement of the motions of these

1009
00:47:27,460 --> 00:47:30,490
things which blows me away in another

1010
00:47:29,409 --> 00:47:31,299
way too but that just the fact that

1011
00:47:30,489 --> 00:47:33,759
we're doing that at all is just

1012
00:47:31,300 --> 00:47:36,460

astonishing but the so getting back to

1013

00:47:33,760 --> 00:47:41,319

your super earth measurements here with

1014

00:47:36,460 --> 00:47:43,780

55 Cancri E V the since you were able to

1015

00:47:41,318 --> 00:47:45,759

detect the atmosphere or in some of its

1016

00:47:43,780 --> 00:47:48,430

components using this new technique I

1017

00:47:45,760 --> 00:47:51,310

can imagine that you could also use it

1018

00:47:48,429 --> 00:47:53,098

couldn't you for things like hot

1019

00:47:51,309 --> 00:47:55,420

Jupiters or other planets that are

1020

00:47:53,099 --> 00:47:57,430

passing or orbiting around other stars

1021

00:47:55,420 --> 00:47:59,200

for I have you have you mean we can

1022

00:47:57,429 --> 00:48:00,429

learn more about their compositions as

1023

00:47:59,199 --> 00:48:02,858

well that's using this technique

1024

00:48:00,429 --> 00:48:05,379

couldn't we and it might be easier

1025

00:48:02,858 --> 00:48:11,338

because maybe the photon signal might be

1026

00:48:05,380 --> 00:48:13,660

higher most of the observations of

1027
00:48:11,338 --> 00:48:15,699
atmospheres but exoplanetary atmospheres

1028
00:48:13,659 --> 00:48:18,159
had been done using contributors because

1029
00:48:15,699 --> 00:48:20,919
the signal is much much stronger and

1030
00:48:18,159 --> 00:48:22,389
it's much easier to observe signal

1031
00:48:20,920 --> 00:48:24,700
because the signal is stronger

1032
00:48:22,389 --> 00:48:28,719
it's very extended atmospheres made of

1033
00:48:24,699 --> 00:48:31,000
hydrogen while turning to super fertile

1034
00:48:28,719 --> 00:48:33,368
atmospheres the atoms are smaller and

1035
00:48:31,000 --> 00:48:36,579
are often assumed to be dominated by

1036
00:48:33,369 --> 00:48:39,400
heavier gases and heavier gases will

1037
00:48:36,579 --> 00:48:42,160
have smaller molecular features which

1038
00:48:39,400 --> 00:48:48,809
will be even more difficult to detect so

1039
00:48:42,159 --> 00:48:50,170
this technique of scanning basically

1040
00:48:48,809 --> 00:48:52,829
looping out

1041
00:48:50,170 --> 00:48:55,690
of course the star is very useful for

1042
00:48:52,829 --> 00:48:57,869
smaller planets with more names

1043
00:48:55,690 --> 00:49:01,510
atmospheres of course it's also used

1044
00:48:57,869 --> 00:49:03,969
right and the relations are loved most

1045
00:49:01,510 --> 00:49:06,370
of the observations contributors right

1046
00:49:03,969 --> 00:49:08,559
now are coming in a scanning mode

1047
00:49:06,369 --> 00:49:10,779
because even for hot Jupiters the

1048
00:49:08,559 --> 00:49:13,900
brighter is a star the star the better

1049
00:49:10,780 --> 00:49:16,450
CL we have so we're taking advantage of

1050
00:49:13,900 --> 00:49:19,000
these cunning even 402 meters we prefer

1051
00:49:16,449 --> 00:49:20,469
to close by stops generally right and

1052
00:49:19,000 --> 00:49:22,030
because then you're saying because of

1053
00:49:20,469 --> 00:49:24,129
the sensitivity of whoops III you were

1054
00:49:22,030 --> 00:49:26,110
able you needed to do this this scanning

1055

00:49:24,130 --> 00:49:31,960
technique but to other instruments also

1056
00:49:26,110 --> 00:49:32,620
use it very specific to FC three way

1057
00:49:31,960 --> 00:49:35,559
you've come up with

1058
00:49:32,619 --> 00:49:38,199
yeah and they started up with complete

1059
00:49:35,559 --> 00:49:40,210
and and realized you know we can't

1060
00:49:38,199 --> 00:49:43,449
actually Dominican expand it related

1061
00:49:40,210 --> 00:49:51,820
just for the painter targets and that's

1062
00:49:43,449 --> 00:49:55,960
the ISO introduced on those two as well

1063
00:49:51,820 --> 00:49:57,730
2012 and you know they they try to play

1064
00:49:55,960 --> 00:49:59,110
a bit with that and they took a few

1065
00:49:57,730 --> 00:50:01,539
years to figure out how to keep the

1066
00:49:59,110 --> 00:50:03,309
telescope stable right because it has

1067
00:50:01,539 --> 00:50:06,329
the reaction wheels basically turning

1068
00:50:03,309 --> 00:50:11,019
and it's completely out of the box

1069
00:50:06,329 --> 00:50:12,610

measurements you guys need to be careful

1070

00:50:11,019 --> 00:50:19,659

with how well don't be breaking it with

1071

00:50:12,610 --> 00:50:21,099

your weird three all right well that's

1072

00:50:19,659 --> 00:50:22,210

great I want to thank this has been very

1073

00:50:21,099 --> 00:50:24,099

interesting you want to thank you guys

1074

00:50:22,210 --> 00:50:25,420

let me check in with Scott have you have

1075

00:50:24,099 --> 00:50:26,710

you given me all the comments and

1076

00:50:25,420 --> 00:50:28,349

questions that you've seen so far is

1077

00:50:26,710 --> 00:50:30,519

there anything on Twitter

1078

00:50:28,349 --> 00:50:32,889

the only other things we've actually

1079

00:50:30,519 --> 00:50:33,519

answered while on air so everything else

1080

00:50:32,889 --> 00:50:35,409

has been great

1081

00:50:33,519 --> 00:50:39,039

alright alright Carol D everything you

1082

00:50:35,409 --> 00:50:42,009

like to add and no I I think this is

1083

00:50:39,039 --> 00:50:44,289

like astonishing this to invent great

1084
00:50:42,010 --> 00:50:46,870
software technique and analyze the data

1085
00:50:44,289 --> 00:50:50,110
this way and I think that the drifting

1086
00:50:46,869 --> 00:50:52,659
of the telescope it's tricky but wow the

1087
00:50:50,110 --> 00:50:55,900
payoff is big so that's the thing about

1088
00:50:52,659 --> 00:50:58,449
Hubble now is that you know as soon as

1089
00:50:55,900 --> 00:51:00,670
an instrument is put on everybody has a

1090
00:50:58,449 --> 00:51:03,219
collection of things they want to do and

1091
00:51:00,670 --> 00:51:04,400
the great thing about the fact that

1092
00:51:03,219 --> 00:51:06,558
Hubble has been

1093
00:51:04,400 --> 00:51:09,559
for a while is now we can really think

1094
00:51:06,559 --> 00:51:13,579
about these new unique innovative ways

1095
00:51:09,559 --> 00:51:15,440
of using the telescope and you know

1096
00:51:13,579 --> 00:51:19,359
nobody would have been excuse me

1097
00:51:15,440 --> 00:51:19,358
envisioned anything like this ten years

1098
00:51:20,259 --> 00:51:25,429
all right so what's next for you guys

1099
00:51:23,449 --> 00:51:26,719
anything what are you gonna do now in

1100
00:51:25,429 --> 00:51:29,449
the chief Oh are you going to Disney

1101
00:51:26,719 --> 00:51:45,439
World or some countries yeah they're

1102
00:51:29,449 --> 00:51:46,608
going to the pub okay so okay well I

1103
00:51:45,440 --> 00:51:47,900
guess that's it what I want to thank you

1104
00:51:46,608 --> 00:51:49,400
all I thank you guys very much for

1105
00:51:47,900 --> 00:51:51,289
taking the time out to share your

1106
00:51:49,400 --> 00:51:52,970
research with us this is amazing stuff

1107
00:51:51,289 --> 00:51:54,499
I'm really impressed with the way in

1108
00:51:52,969 --> 00:51:56,689
which not only you guys are using the

1109
00:51:54,498 --> 00:51:59,449
Hubble and whips III but this processing

1110
00:51:56,690 --> 00:52:02,900
technique as well I'm hoping that we get

1111
00:51:59,449 --> 00:52:08,210
say there's a phone part that's you the

1112

00:52:02,900 --> 00:52:09,920
Sun Wow okay well been the only one and

1113
00:52:08,210 --> 00:52:11,749
all of our years has never had my phone

1114
00:52:09,920 --> 00:52:14,289
ring while on here because I'm a

1115
00:52:11,748 --> 00:52:14,288
professional

1116
00:52:20,108 --> 00:52:24,608
no actually my phone goes off like crazy

1117
00:52:28,420 --> 00:52:35,409
they know how pretty I am they see me on

1118
00:52:30,798 --> 00:52:38,630
air and like oh Scott and I'm lying so

1119
00:52:35,409 --> 00:52:40,159
alright alright guys well thank you guys

1120
00:52:38,630 --> 00:52:43,249
I want to like I said oh and thank you

1121
00:52:40,159 --> 00:52:44,868
guys for taking hope that you will let

1122
00:52:43,248 --> 00:52:46,818
us know if the next big the next big

1123
00:52:44,869 --> 00:52:49,309
thing that you guys do with Hubble we're

1124
00:52:46,818 --> 00:52:51,170
looking for I'm wanting the app I'm

1125
00:52:49,309 --> 00:52:53,180
waiting for the app to come out that

1126
00:52:51,170 --> 00:52:57,278

shows you know how I want to be this

1127

00:52:53,179 --> 00:52:57,278

data processing on my own smartphone

1128

00:53:00,880 --> 00:53:10,640

it's like Astro tinder you're like smear

1129

00:53:03,798 --> 00:53:14,298

left for that and you remember you gotta

1130

00:53:10,639 --> 00:53:16,250

here and money in San Francisco you need

1131

00:53:14,298 --> 00:53:22,489

my trademark Astro tinder real quick

1132

00:53:16,250 --> 00:53:35,090

be right back your left smear right and

1133

00:53:22,489 --> 00:53:36,469

you got it there's your Tigers that just

1134

00:53:35,090 --> 00:53:41,090

won't put that out there no pictures of

1135

00:53:36,469 --> 00:53:43,429

the Tigers Angeles Angeles TRS Ingo

1136

00:53:41,090 --> 00:53:44,750

Waldman and Marco Roach a doe from all

1137

00:53:43,429 --> 00:53:46,159

from the University College at London

1138

00:53:44,750 --> 00:53:48,980

thank you for taking time out to talk to

1139

00:53:46,159 --> 00:53:51,980

us and good luck on on future stuff you

1140

00:53:48,980 --> 00:53:53,329

guys you're gonna I could tell you're

1141
00:53:51,980 --> 00:53:57,230
gonna make a big difference so thank you

1142
00:53:53,329 --> 00:53:59,599
for taking time out thank you all right

1143
00:53:57,230 --> 00:54:00,800
well on behalf of carol christian and

1144
00:53:59,599 --> 00:54:03,710
scott lewis i want to thank you guys for

1145
00:54:00,800 --> 00:54:06,500
watching we'll be back next week what

1146
00:54:03,710 --> 00:54:08,990
you gonna do Carol do we know who might

1147
00:54:06,500 --> 00:54:23,210
be something about massive stars massive

1148
00:54:08,989 --> 00:54:25,819
scars like a big deal no I've had like a

1149
00:54:23,210 --> 00:54:35,570
pot of coffee this show so I'm sure I'll

1150
00:54:25,820 --> 00:54:37,010
have a lot of ideas alright folks I want

1151
00:54:35,570 --> 00:54:38,390
to thank you all for watching now join

1152
00:54:37,010 --> 00:54:40,550
us next week we'll be back talking about

1153
00:54:38,389 --> 00:54:43,699
presumably massive stars but it might be

1154
00:54:40,550 --> 00:54:45,440
a surprise well let me know if you're

1155
00:54:43,699 --> 00:54:46,759
not subscribing to the Hubble site

1156
00:54:45,440 --> 00:54:48,530
channel you need to do that because

1157
00:54:46,760 --> 00:54:50,990
that's where you'll find out future

1158
00:54:48,530 --> 00:54:55,070
events also follow us on Facebook at

1159
00:54:50,989 --> 00:54:58,429
Hubble as Hubble Space Telescope we're

1160
00:54:55,070 --> 00:55:00,890
on twitter at hubble telescope so make

1161
00:54:58,429 --> 00:55:02,000
sure you follow us and and well that's

1162
00:55:00,889 --> 00:55:03,469
how you can learn about the next hang

1163
00:55:02,000 --> 00:55:04,909
house well thank you all for watching

1164
00:55:03,469 --> 00:55:07,219
one thank you guys for your questions

1165
00:55:04,909 --> 00:55:09,379
and comments they were awesome as they

1166
00:55:07,219 --> 00:55:12,109
always are we'll see you next week and

1167
00:55:09,380 --> 00:55:14,890
as always until then keep keep looking

1168
00:55:12,110 --> 00:55:14,890
it okay