

HUBBLE
25



HUBBLE

hangouts

March 17, 2016 3pm EDT

A Super-Earth: First Detection
of its Atmosphere

1
00:00:10,369 --> 00:00:07,910
hello everybody and welcome to this

2
00:00:12,229 --> 00:00:10,379
week's Hubbell hangout this is a special

3
00:00:14,449 --> 00:00:12,239
edition Hubble hangout because it is st.

4
00:00:17,150 --> 00:00:14,459
Patrick's Day so on welcome you all here

5
00:00:19,460 --> 00:00:17,160
for this really cool hangout where

6
00:00:21,740 --> 00:00:19,470
astronomers using the Hubble Space

7
00:00:23,300 --> 00:00:21,750
Telescope have developed a new data

8
00:00:26,120 --> 00:00:23,310
processing technique which has allowed

9
00:00:28,099 --> 00:00:26,130
them to for the first time measure the

10
00:00:31,579 --> 00:00:28,109
composition of an atmosphere of an

11
00:00:33,080 --> 00:00:31,589
exoplanet that is of the class of a

12
00:00:34,819 --> 00:00:33,090
super earth and we'll talk about what

13
00:00:36,680 --> 00:00:34,829

all of this means as we get going in the

14

00:00:38,060 --> 00:00:36,690

Hangout but it's very exciting stuff

15

00:00:39,470 --> 00:00:38,070

because they've been they I want we're

16

00:00:42,920 --> 00:00:39,480

gonna learn about the new method they've

17

00:00:44,990 --> 00:00:42,930

used to to make these measurements as

18

00:00:46,939 --> 00:00:45,000

well as what is it my mean for the for

19

00:00:48,860 --> 00:00:46,949

exoplanet research in the future so

20

00:00:51,979 --> 00:00:48,870

we'll get started by first introducing

21

00:00:54,560 --> 00:00:51,989

my my friends my co-host dr. Carol

22

00:00:56,509 --> 00:00:54,570

Christian she is the HST the Hubble

23

00:00:58,009 --> 00:00:56,519

Space Telescope outreach scientist hello

24

00:01:01,490 --> 00:00:58,019

again Carol it's good to see you again

25

00:01:03,410 --> 00:01:01,500

hey Tony how are you I'm doing really

26

00:01:08,270 --> 00:01:03,420

good because it's st. Patrick's Day are

27

00:01:10,670 --> 00:01:08,280

you excited yes I don't have any green

28

00:01:15,350 --> 00:01:10,680

beer yet unfortunately for our drinking

29

00:01:19,310 --> 00:01:15,360

game but yes we're gonna happen anyway

30

00:01:25,010 --> 00:01:19,320

so you can drink coffee I'll come up

31

00:01:26,510 --> 00:01:25,020

with it don't worry as always yeah so

32

00:01:27,980 --> 00:01:26,520

that means in that voice is Scott Lewis

33

00:01:29,990 --> 00:01:27,990

from you guys know here's our Internet

34

00:01:31,280 --> 00:01:30,000

driver extraordinaire and so welcome

35

00:01:33,650 --> 00:01:31,290

back Scott it's good to see you again as

36

00:01:34,940 --> 00:01:33,660

well thank you this hangout seems kind

37

00:01:37,220 --> 00:01:34,950

of exciting to me guys I can't wait to

38

00:01:39,080 --> 00:01:37,230

learn more about what this what this

39

00:01:41,990 --> 00:01:39,090

exoplanet measurements are are like and

40

00:01:44,300 --> 00:01:42,000

what they what they might mean but

41

00:01:45,830 --> 00:01:44,310

before we get going and I introduce our

42

00:01:48,950 --> 00:01:45,840

guests from the University of College at

43

00:01:50,540 --> 00:01:48,960

London we want to have you prepared to

44

00:01:53,840 --> 00:01:50,550

ask us questions we want you to interact

45

00:01:59,020 --> 00:01:53,850

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

46

00:02:03,950 --> 00:01:59,030

Day drinking game where we have and

47

00:02:05,090 --> 00:02:03,960

coffee okay all right so we but we do

48

00:02:06,200 --> 00:02:05,100

want you to know seriously we want your

49

00:02:07,760 --> 00:02:06,210

questions and comments during the

50

00:02:08,959 --> 00:02:07,770

Hangout and Scott why don't you tell

51
00:02:11,479 --> 00:02:08,969
everybody how they can do that

52
00:02:12,979 --> 00:02:11,489
absolutely so the more anything everyone

53
00:02:14,330 --> 00:02:12,989
loading in here since we're live on

54
00:02:17,210 --> 00:02:14,340
YouTube using glue

55
00:02:19,479 --> 00:02:17,220
YouTube live effect you can go ahead and

56
00:02:22,250 --> 00:02:19,489
use the live chat so I'm seeking our

57
00:02:23,809 --> 00:02:22,260
frequent flyer and regular commenter

58
00:02:26,210 --> 00:02:23,819
Michael Jovians and they're great

59
00:02:29,059 --> 00:02:26,220
Michael yeah it's grinning that we're

60
00:02:30,410 --> 00:02:29,069
alive so yes hi everyone so if you have

61
00:02:33,979 --> 00:02:30,420
any questions or comments regarding

62
00:02:35,360 --> 00:02:33,989
today's show or or the research that's

63
00:02:37,550 --> 00:02:35,370

been put out there please feel free to

64

00:02:40,070 --> 00:02:37,560

ask us questions make your comments in

65

00:02:42,050 --> 00:02:40,080

there have a friendly discussion I do

66

00:02:45,740 --> 00:02:42,060

have the banhammer ready if I need to

67

00:02:47,570 --> 00:02:45,750

and I will use it but more more likely

68

00:02:50,059 --> 00:02:47,580

you guys have been really who's been

69

00:02:52,039 --> 00:02:50,069

really awesome the other way too that we

70

00:02:54,380 --> 00:02:52,049

are going to be continuing this

71

00:02:56,570 --> 00:02:54,390

conversation both live and afterwards is

72

00:02:59,479 --> 00:02:56,580

using the hashtag Hubbell hangout on

73

00:03:01,220 --> 00:02:59,489

Twitter so I'll be live tweeting as

74

00:03:03,080 --> 00:03:01,230

we're going along complete with any

75

00:03:04,610 --> 00:03:03,090

graphics and links to press releases and

76

00:03:07,729 --> 00:03:04,620

things like that we're going on so I

77

00:03:10,220 --> 00:03:07,739

will be monitoring the the Twitter feed

78

00:03:11,780 --> 00:03:10,230

we also have events up on Google+ and

79

00:03:14,449 --> 00:03:11,790

Facebook so I'll be monitoring those as

80

00:03:16,910 --> 00:03:14,459

well so if you have any any questions or

81

00:03:18,740 --> 00:03:16,920

any insightful comments please feel free

82

00:03:21,650 --> 00:03:18,750

to send them our way and we'll make sure

83

00:03:24,470 --> 00:03:21,660

that I bring them up and we'll try to

84

00:03:29,090 --> 00:03:24,480

get them answered on air did you say

85

00:03:31,009 --> 00:03:29,100

hash tag part 2 I did Hubbell hangout in

86

00:03:37,190 --> 00:03:31,019

a drinking game I think it's going to be

87

00:03:40,340 --> 00:03:37,200

either hydrogen or helium okay yeah well

88

00:03:42,349 --> 00:03:40,350

exoplanets a little too easy i do i do

89

00:03:48,559 --> 00:03:42,359

love everyone a little bit

90

00:03:57,220 --> 00:03:48,569

I want hydrogen cyanide hi this is gonna

91

00:04:06,910 --> 00:04:00,440

yeah or it's your boss dang stop talking

92

00:04:08,660 --> 00:04:06,920

about drinking on air okay so as I

93

00:04:12,319 --> 00:04:08,670

really that's right what do you do with

94

00:04:13,400 --> 00:04:12,329

all my drinking games on my boy so this

95

00:04:15,979 --> 00:04:13,410

cuz we're go ahead and get started so

96

00:04:19,219 --> 00:04:15,989

for the first time astronomers have been

97

00:04:22,250 --> 00:04:19,229

able to measure directly the composition

98

00:04:25,159 --> 00:04:22,260

of a super-earth exoplanet and of the

99

00:04:27,020 --> 00:04:25,169

star system known as 55 Cancri and this

100

00:04:28,010 --> 00:04:27,030

is a star system that is about 40

101
00:04:30,050 --> 00:04:28,020
life.you 40 light

102
00:04:32,270 --> 00:04:30,060
years from Earth in the constellation of

103
00:04:35,240 --> 00:04:32,280
cancer and so joining me to talk about

104
00:04:36,589 --> 00:04:35,250
this are some group from the University

105
00:04:39,110 --> 00:04:36,599
of College at London all three of these

106
00:04:40,909 --> 00:04:39,120
guys so we have Angelo CRS he's a PhD

107
00:04:44,390 --> 00:04:40,919
student we also have Ingo Waldman a

108
00:04:45,499 --> 00:04:44,400
postdoc as well as Marko Rotato a grad

109
00:04:47,450 --> 00:04:45,509
student all of these guys are

110
00:04:48,920 --> 00:04:47,460
responsible in some way or another for

111
00:04:50,540 --> 00:04:48,930
the development of this technique which

112
00:04:55,490 --> 00:04:50,550
we will get into but welcome guys this

113
00:04:57,350 --> 00:04:55,500

is your first Hubble hangout yes yes I

114

00:04:59,899 --> 00:04:57,360

guys all right goods well thank you for

115

00:05:01,939 --> 00:04:59,909

joining us so let's start with let's

116

00:05:05,420 --> 00:05:01,949

start with you Angelo's tell us a little

117

00:05:06,980 --> 00:05:05,430

bit about what you found and a little

118

00:05:11,680 --> 00:05:06,990

bit about this super-earth give us some

119

00:05:14,740 --> 00:05:11,690

background on this a new birth is

120

00:05:19,309 --> 00:05:14,750

light-years away from the earth and

121

00:05:23,450 --> 00:05:19,319

orbiting its host star in a very close

122

00:05:26,570 --> 00:05:23,460

so the orbit is only 18 hours this means

123

00:05:29,689 --> 00:05:26,580

that the temperature is o the orbit of

124

00:05:32,600 --> 00:05:29,699

this planet is 18 hours in hours yes

125

00:05:34,450 --> 00:05:32,610

here is wow that's pretty so it's

126

00:05:36,830 --> 00:05:34,460

smoking it's going around pretty good

127

00:05:39,459 --> 00:05:36,840

that makes you even older than you

128

00:05:43,399 --> 00:05:39,469

thought you were Tony that's right so

129

00:05:45,980 --> 00:05:43,409

years I am years old thank you

130

00:06:05,149 --> 00:05:45,990

I'm glad you know I'm here to help

131

00:06:07,610 --> 00:06:05,159

hydrogen cyanide the more you know so it

132

00:06:15,260 --> 00:06:07,620

is the temperature on its surface is

133

00:06:21,170 --> 00:06:15,270

expecting to be about two thousand two

134

00:06:23,839 --> 00:06:21,180

thousand Kelvin 18-hour year this place

135

00:06:26,689 --> 00:06:23,849

not sound like a vacation spot no

136

00:06:36,560 --> 00:06:26,699

doesn't sound really Pleasant no all

137

00:06:39,820 --> 00:06:36,570

right well I you realize Carol I'm gonna

138

00:06:47,680 --> 00:06:44,980

I would give away our punchlines so with

139

00:06:52,150 --> 00:06:47,690

our drinking game but the I wanted so is

140

00:06:54,610 --> 00:06:52,160

this exoplanet it's 55 Cancri E and the

141

00:06:56,110 --> 00:06:54,620

e is what is that what does that mean by

142

00:06:58,360 --> 00:06:56,120

the way it's a little II which

143

00:07:02,680 --> 00:06:58,370

apparently matters so what does that

144

00:07:05,650 --> 00:07:02,690

mean there are five planets in this

145

00:07:07,300 --> 00:07:05,660

system the way they make them in order

146

00:07:13,090 --> 00:07:07,310

of distance from the Sun or the distance

147

00:07:13,870 --> 00:07:13,100

the order of things so the order he said

148

00:09:21,189 --> 00:07:13,880

e

149

00:09:23,559 --> 00:09:21,199

that this display had actually an

150

00:09:24,939 --> 00:09:23,569

atmosphere okay I want to get to that

151
00:09:26,470 --> 00:09:24,949
processing technique in just a minute

152
00:09:27,819 --> 00:09:26,480
but I wanted I just want to finish

153
00:09:29,740 --> 00:09:27,829
laying the groundwork for the system

154
00:09:32,800 --> 00:09:29,750
itself and where it is so this thing is

155
00:09:33,970 --> 00:09:32,810
about 40 light years away not gonna be

156
00:09:36,129 --> 00:09:33,980
something we're gonna be heading to I

157
00:09:37,470 --> 00:09:36,139
think the next welding also from the

158
00:09:39,610 --> 00:09:37,480
sound of it we wouldn't really want to

159
00:09:41,199 --> 00:09:39,620
but what is this that I want to talk a

160
00:09:43,629 --> 00:09:41,209
little bit about what a super-earth is

161
00:09:51,160 --> 00:09:43,639
is it like a place where Superman comes

162
00:09:53,019 --> 00:09:51,170
from what is a super it's we don't

163
00:09:55,600 --> 00:09:53,029

actually have in our own solar system so

164

00:09:59,290 --> 00:09:55,610

it's it's kind of weird right before

165

00:10:04,120 --> 00:09:59,300

that meet somewhere between for ages and

166

00:10:05,800 --> 00:10:04,130

Neptune and up to sort of 10 but I'm

167

00:10:07,540 --> 00:10:05,810

important it's a rocky planet right

168

00:10:09,040 --> 00:10:07,550

that's between the radius not

169

00:10:11,410 --> 00:10:09,050

necessarily so

170

00:10:13,300 --> 00:10:11,420

it's assumed to be mainly terrestrial

171

00:10:17,170 --> 00:10:13,310

but we don't really know so some of them

172

00:10:20,740 --> 00:10:17,180

could be mini mini Neptune's 55 concrete

173

00:10:24,249 --> 00:10:20,750

is probably very rocky insides well sort

174

00:10:25,720 --> 00:10:24,259

of molten lava sort of thing yeah but we

175

00:10:27,610 --> 00:10:25,730

don't have that you know solar system so

176

00:10:29,410 --> 00:10:27,620

it's quite an interesting planet or if

177

00:10:31,990 --> 00:10:29,420

it's about the biggest rocky planet here

178

00:10:35,769 --> 00:10:32,000

right and more would be embarrassing if

179

00:10:38,530 --> 00:10:35,779

I didn't know that but yeah yeah pretty

180

00:10:42,790 --> 00:10:38,540

embarrassing yeah thank you for pointing

181

00:10:44,350 --> 00:10:42,800

that out but yeah the so so for for

182

00:10:46,600 --> 00:10:44,360

these things to be between the size of

183

00:10:48,370 --> 00:10:46,610

the earth and say Neptune as you say is

184

00:10:50,040 --> 00:10:48,380

there an upper limit to how big these

185

00:10:52,420 --> 00:10:50,050

rocky planets can get I mean are there

186

00:10:54,490 --> 00:10:52,430

these would be awfully heavy

187

00:10:55,900 --> 00:10:54,500

correct so at some point they might just

188

00:10:57,220 --> 00:10:55,910

what they is there a point where they

189

00:11:00,069 --> 00:10:57,230

just crush themselves or is there an

190

00:11:03,129 --> 00:11:00,079

upper limit to how big super Earths can

191

00:11:04,780 --> 00:11:03,139

be if they're rocky I guess that's an

192

00:11:05,650 --> 00:11:04,790

that's a more involved question than I

193

00:11:07,330 --> 00:11:05,660

thought because you're saying they're

194

00:11:10,960 --> 00:11:07,340

not necessarily to rest

195

00:11:13,420 --> 00:11:10,970

so yeah so you know it's it's it's just

196

00:11:17,230 --> 00:11:13,430

a definition of size at the moment but

197

00:11:19,510 --> 00:11:17,240

yeah if they arrest real if they're big

198

00:11:21,100 --> 00:11:19,520

enough as a cool right you'd assume that

199

00:11:22,540 --> 00:11:21,110

they create loads of hydrogen in their

200

00:11:27,070 --> 00:11:22,550

formation and that they actually end up

201
00:11:29,470 --> 00:11:27,080
like Jupiter okay maybe they have a big

202
00:11:32,410 --> 00:11:29,480
pool okay with that this sort of leads

203
00:11:33,820 --> 00:11:32,420
into a comment that that Michael joban

204
00:11:35,020 --> 00:11:33,830
has left on YouTube and I will go ahead

205
00:11:36,550 --> 00:11:35,030
and get to that now you know when he was

206
00:11:39,430 --> 00:11:36,560
commenting on the fact that this has got

207
00:11:42,100 --> 00:11:39,440
an 18 hour orbit and he goes man I bet

208
00:11:43,810 --> 00:11:42,110
in his egg shaped or something so that's

209
00:11:45,640 --> 00:11:43,820
a but the point I think he's making and

210
00:11:47,350 --> 00:11:45,650
I'd like to follow up on that is isn't

211
00:11:49,510 --> 00:11:47,360
that isn't there gonna do some crazy

212
00:11:50,920 --> 00:11:49,520
things I mean the earth is not it's not

213
00:11:53,410 --> 00:11:50,930

a perfect sphere something called an

214

00:11:55,060 --> 00:11:53,420

oblate spheroid which because it's

215

00:11:59,140 --> 00:11:55,070

spinning and rotating it sort of flat in

216

00:12:01,090 --> 00:11:59,150

the middle so is that affecting this

217

00:12:06,760 --> 00:12:01,100

thing's shape at all i'm scottie right

218

00:12:09,430 --> 00:12:06,770

or do we know yeah it must be affected

219

00:12:12,730 --> 00:12:09,440

by tidal forces yeah since it is close

220

00:12:15,040 --> 00:12:12,740

so close and you know surfaces like lava

221

00:12:19,720 --> 00:12:15,050

by itself anyway so it's that's really

222

00:12:23,200 --> 00:12:19,730

Rock no it's a thousand degrees up of

223

00:12:24,370 --> 00:12:23,210

like melting point of iron okay well

224

00:12:25,780 --> 00:12:24,380

let's get to how you know that then

225

00:12:27,910 --> 00:12:25,790

let's go to your processing technique

226

00:12:39,100 --> 00:12:27,920

and since and since Marko you were the

227

00:12:39,850 --> 00:12:39,110

one on HST explain why the width Wide

228

00:12:43,390 --> 00:12:39,860

Field Camera 3

229

00:12:45,460 --> 00:12:43,400

spectrograph is the one you need because

230

00:12:48,070 --> 00:12:45,470

we've talked about on this on hangouts

231

00:12:50,520 --> 00:12:48,080

we've talked about the cosmic origins

232

00:12:54,340 --> 00:12:50,530

spectrograph which sounds cosmic and

233

00:12:57,100 --> 00:12:54,350

this spectrograph so why is white field

234

00:13:03,160 --> 00:12:57,110

camera 3 specifically interesting for

235

00:13:08,890 --> 00:13:03,170

this so it's the infrared part of wt3

236

00:13:11,770 --> 00:13:08,900

camera we see between 1.1 and 1.7 C's 5

237

00:13:14,950 --> 00:13:11,780

micron and it's more interesting because

238

00:13:18,130 --> 00:13:14,960

we can see signature micro signatures at

239

00:13:21,190 --> 00:13:18,140

these wavelengths so this the signal

240

00:13:25,480 --> 00:13:21,200

from the planet is not dominated by you

241

00:13:29,470 --> 00:13:25,490

sputtering or present of clouds so we

242

00:13:32,440 --> 00:13:29,480

can see molecules easier okay okay

243

00:13:34,620 --> 00:13:32,450

thanks possible to see molecules from

244

00:13:37,269 --> 00:13:34,630

the other wavelets

245

00:13:39,759 --> 00:13:37,279

well very small water features for

246

00:13:42,100 --> 00:13:39,769

example could be seen with space but

247

00:13:44,889 --> 00:13:42,110

really we've come free is the instrument

248

00:13:46,540 --> 00:13:44,899

to use if you want to detect molecular

249

00:13:49,689 --> 00:13:46,550

features with Hubble

250

00:13:52,480 --> 00:13:49,699

and right now you would like to go even

251
00:13:55,689 --> 00:13:52,490
further read to where the biggest

252
00:13:57,250 --> 00:13:55,699
molecular features are with countries

253
00:14:02,710 --> 00:13:57,260
actually the best instrument right now

254
00:14:04,030 --> 00:14:02,720
that we have and that leads into I think

255
00:14:06,579 --> 00:14:04,040
what I like to where I like to go with

256
00:14:08,199 --> 00:14:06,589
this is that it is I think this is the

257
00:14:11,410 --> 00:14:08,209
kind of observation that might be more

258
00:14:13,090 --> 00:14:11,420
routine with something like the James

259
00:14:15,550 --> 00:14:13,100
Webb Space Telescope which is going to

260
00:14:18,040 --> 00:14:15,560
be entirely an infrared telescope and in

261
00:14:20,530 --> 00:14:18,050
one of its goals in science is to do the

262
00:14:22,720 --> 00:14:20,540
kind of measurement that you guys have

263
00:14:24,579 --> 00:14:22,730

made here and this is the what's what's

264

00:14:28,660 --> 00:14:24,589

exciting about what you've done is that

265

00:14:31,509 --> 00:14:28,670

this is the first detection of gases in

266

00:14:33,790 --> 00:14:31,519

an atmosphere of a super-earth plan it's

267

00:14:36,189 --> 00:14:33,800

the first time this has been done and

268

00:14:37,660 --> 00:14:36,199

using Hubble and as you would we just

269

00:14:39,310 --> 00:14:37,670

talked about the Wide Field Camera 3

270

00:14:43,689 --> 00:14:39,320

which is it primarily an infrared

271

00:14:45,880 --> 00:14:43,699

telescope or infrared camera the you

272

00:14:47,650 --> 00:14:45,890

were able to get this detection of what

273

00:14:50,259 --> 00:14:47,660

was in this atmosphere and I want to

274

00:14:52,990 --> 00:14:50,269

talk about how you did it so what was

275

00:14:54,880 --> 00:14:53,000

your new you had to invent the

276
00:14:56,829 --> 00:14:54,890
processing technique to get this done so

277
00:14:58,180 --> 00:14:56,839
what did you do and I guess I'll send

278
00:15:07,449 --> 00:14:58,190
that to a Marco since you're the main

279
00:15:09,699 --> 00:15:07,459
you would do one that's a well so the

280
00:15:13,210 --> 00:15:09,709
main problem with this kind of

281
00:15:15,850 --> 00:15:13,220
observation is that we can only do these

282
00:15:18,939 --> 00:15:15,860
measurements in very very bright targets

283
00:15:22,509 --> 00:15:18,949
very bright stars close by very close to

284
00:15:24,040 --> 00:15:22,519
us on the other hand we have W camera

285
00:15:27,879 --> 00:15:24,050
and especially doing for a detector

286
00:15:29,920 --> 00:15:27,889
which is very sensitive this means that

287
00:15:34,900 --> 00:15:29,930
we can it's very difficult to observe

288
00:15:38,860 --> 00:15:34,910

these targets and because they will such

289

00:15:40,720 --> 00:15:38,870

your ccd cameras new detectors like the

290

00:15:43,120 --> 00:15:40,730

bright the light from the star is so

291

00:15:46,930 --> 00:15:43,130

bright compared to the flat light from

292

00:15:50,220 --> 00:15:46,940

the planet I was made for a fainter that

293

00:15:55,810 --> 00:15:50,230

I get so for cosmological research

294

00:16:00,400 --> 00:15:55,820

mainly right so and a new technique was

295

00:16:02,770 --> 00:16:00,410

introduced in 2012 so during the

296

00:16:06,900 --> 00:16:02,780

observation instead of having Kabul

297

00:16:10,300 --> 00:16:06,910

staring at the target Hubble is moving

298

00:16:13,140 --> 00:16:10,310

moving in a way that the star is no

299

00:16:15,910 --> 00:16:13,150

longer at the spectrum actually it's not

300

00:16:20,440 --> 00:16:15,920

standing at actually one position on the

301
00:16:24,370 --> 00:16:20,450
detector but it's moving along one the

302
00:16:26,530 --> 00:16:24,380
one axis vector so this makes the

303
00:16:29,110 --> 00:16:26,540
process of the data a bit more difficult

304
00:16:33,820 --> 00:16:29,120
because there are other systematics

305
00:16:34,810 --> 00:16:33,830
going into these and so let me just make

306
00:16:38,680 --> 00:16:34,820
sure I understood what you just said

307
00:16:41,680 --> 00:16:38,690
you're you take a you go you open the

308
00:16:43,840 --> 00:16:41,690
exposure and you move back and forth

309
00:16:46,360 --> 00:16:43,850
just a little bit in one direction and

310
00:16:48,190 --> 00:16:46,370
you smear it out across the detector am

311
00:16:57,390 --> 00:16:48,200
i imagining this right we have a figure

312
00:17:03,820 --> 00:16:57,400
for this okay so with this knob right

313
00:17:04,809 --> 00:17:03,830

lobby talking about Scott yeah but it's

314

00:17:06,520 --> 00:17:04,819

essentially it's you know it's

315

00:17:08,199 --> 00:17:06,530

essentially smearing like it's slowing

316

00:17:09,840 --> 00:17:08,209

across the star because it hasn't a

317

00:17:12,760 --> 00:17:09,850

shutter that's the main problem right

318

00:17:14,710 --> 00:17:12,770

and so this the field of view by the way

319

00:17:17,140 --> 00:17:14,720

the Hubble has got a tiny field of view

320

00:17:19,420 --> 00:17:17,150

and the way I've always described it

321

00:17:21,730 --> 00:17:19,430

it's just like a grain of sand held out

322

00:17:23,439 --> 00:17:21,740

at arm's length up at the sky that's how

323

00:17:25,270 --> 00:17:23,449

much of the sky had images at one time

324

00:17:26,920 --> 00:17:25,280

so it's very small okay he's got it up

325

00:17:28,300 --> 00:17:26,930

so why don't you show us what we're

326

00:17:31,780 --> 00:17:28,310

looking or tell us what we're looking at

327

00:17:36,180 --> 00:17:31,790

he had here certainly the depth of

328

00:17:39,750 --> 00:17:36,190

actually looking across the white arrow

329

00:17:43,150 --> 00:17:39,760

on the as the spearing of the

330

00:17:45,340 --> 00:17:43,160

perspective on this paper so then this

331

00:17:47,610 --> 00:17:45,350

is the spectrum of 55 Cancri right this

332

00:17:49,620 --> 00:17:47,620

is the star and the star

333

00:17:51,900 --> 00:17:49,630

yes okay so you can take that if you

334

00:17:53,790 --> 00:17:51,910

smearred it in one direction of course

335

00:17:56,580 --> 00:17:53,800

you as a person white are yeah exactly

336

00:17:57,720 --> 00:17:56,590

and in this case because the target is

337

00:18:02,850 --> 00:17:57,730

very bright

338

00:18:06,930 --> 00:18:02,860

you have to scan very fast so this is

339

00:18:10,350 --> 00:18:06,940

eight seconds exposure but that's like

340

00:18:11,850 --> 00:18:10,360

300 pixels something scan okay what does

341

00:18:15,930 --> 00:18:11,860

this get you what what's the advantage

342

00:18:18,320 --> 00:18:15,940

here my excuse me what is this why why

343

00:18:22,020 --> 00:18:18,330

do you do this what's the what is

344

00:18:25,350 --> 00:18:22,030

otherwise the the because it it'll just

345

00:18:26,760 --> 00:18:25,360

saturate the detector measurement yeah

346

00:18:29,850 --> 00:18:26,770

and so you need it because it has no

347

00:18:31,650 --> 00:18:29,860

shutter that's the problem as soon as

348

00:18:33,830 --> 00:18:31,660

you look at the star you're gonna

349

00:18:36,419 --> 00:18:33,840

saturate with comfrey we've come free so

350

00:18:39,299 --> 00:18:36,429

sensitive right it's beautiful cosmology

351

00:18:42,120 --> 00:18:39,309

and not for like looking at the next by

352

00:18:43,770 --> 00:18:42,130

star which we kind of have to do for

353

00:18:45,870 --> 00:18:43,780

exoplanets because the the signal we're

354

00:18:48,419 --> 00:18:45,880

looking for the planet is she knows one

355

00:18:52,830 --> 00:18:48,429

photon in 10,000 so we need loads of

356

00:18:55,590 --> 00:18:52,840

photons we need a bright star so so as

357

00:18:57,270 --> 00:18:55,600

soon as we look at at the star it just

358

00:18:59,640 --> 00:18:57,280

saturates immediately and the only thing

359

00:19:03,900 --> 00:18:59,650

we can do without a shutter is just move

360

00:19:06,150 --> 00:19:03,910

Hubble along just sort of smear it the

361

00:19:08,370 --> 00:19:06,160

signal across the detector okay I can

362

00:19:12,090 --> 00:19:08,380

see how this gets you a non saturated

363

00:19:13,770 --> 00:19:12,100

spectrum of the star without you know

364

00:19:17,010 --> 00:19:13,780

going reaching the limits of each pixel

365

00:19:21,060 --> 00:19:17,020

and and blowing them out but the where's

366

00:19:23,850 --> 00:19:21,070

the planet in this how do you extract so

367

00:19:25,890 --> 00:19:23,860

these observations as Mike said before

368

00:19:28,980 --> 00:19:25,900

during the transit of the planet so

369

00:19:30,900 --> 00:19:28,990

we're looking that's important we're

370

00:19:34,410 --> 00:19:30,910

looking at the star but in between the

371

00:19:36,240 --> 00:19:34,420

star in us there is a pallet so like if

372

00:19:39,090 --> 00:19:36,250

you think an experiment in a physics lab

373

00:19:41,610 --> 00:19:39,100

where you have a lung and a cold and

374

00:19:43,680 --> 00:19:41,620

cold air and light is going through and

375

00:19:45,270 --> 00:19:43,690

then you gauge the spectrum so it's

376

00:19:47,910 --> 00:19:45,280

something like this we have a stellar

377

00:19:50,220 --> 00:19:47,920

light going through the atmosphere of

378

00:19:53,310 --> 00:19:50,230

the planet so it's filtered through the

379

00:19:55,380 --> 00:19:53,320

atmosphere and it's carrying a signal

380

00:19:59,180 --> 00:19:55,390

about a thing you said the signal is one

381

00:20:01,130 --> 00:19:59,190

photon per 10,000 so so

382

00:20:04,460 --> 00:20:01,140

embedded in this star spectrum the

383

00:20:07,580 --> 00:20:04,470

smear out snorum is isn't is the

384

00:20:09,470 --> 00:20:07,590

spectrum of the light that is gone from

385

00:20:12,820 --> 00:20:09,480

the star through the planet's atmosphere

386

00:20:15,290 --> 00:20:12,830

because it's transiting and into the

387

00:20:18,010 --> 00:20:15,300

detector and so somewhere in there and

388

00:20:21,050 --> 00:20:18,020

you're saying out of for every 10,000

389

00:20:23,270 --> 00:20:21,060

photons one of them is from the planet

390

00:20:24,380 --> 00:20:23,280

you're a there's a there's a embedded

391

00:20:26,740 --> 00:20:24,390

spectrum in there that you have to

392

00:20:32,420 --> 00:20:26,750

somehow extract am I getting that right

393

00:20:35,450 --> 00:20:32,430

yes you've served is this planet as it

394

00:20:37,400 --> 00:20:35,460

runs it so you have a spectrum of the

395

00:20:39,350 --> 00:20:37,410

star alone without the planet in the

396

00:20:40,850 --> 00:20:39,360

spectrum of the star with the planet

397

00:20:43,760 --> 00:20:40,860

with the spectrum of the planet

398

00:20:48,530 --> 00:20:43,770

implanted and there are techniques

399

00:20:51,290 --> 00:20:48,540

basically to recover this the signal the

400

00:20:54,200 --> 00:20:51,300

spectral signature of the planet is that

401
00:20:57,410 --> 00:20:54,210
the bottom part there yeah well that's

402
00:20:59,210 --> 00:20:57,420
the extraction which yes this is this is

403
00:21:03,530 --> 00:20:59,220
how we deal with some systematics that

404
00:21:05,870 --> 00:21:03,540
are caused by the scanning process but

405
00:21:09,020 --> 00:21:05,880
the main thing is that we we extract the

406
00:21:11,900 --> 00:21:09,030
stellar flux per wavelength and then we

407
00:21:14,690 --> 00:21:11,910
started the light curve so if you have a

408
00:21:17,210 --> 00:21:14,700
normal photo mitri of a transiting

409
00:21:20,530 --> 00:21:17,220
planet like all the like Kepler for

410
00:21:24,320 --> 00:21:20,540
example or other last year that detect

411
00:21:26,360 --> 00:21:24,330
exoplanets you have you can see the the

412
00:21:28,730 --> 00:21:26,370
flux going down during the transit if

413
00:21:31,220 --> 00:21:28,740

you do that in different wavelengths and

414

00:21:33,500 --> 00:21:31,230

you measure the depth in either the

415

00:21:36,350 --> 00:21:33,510

different wavelengths then you can you

416

00:21:38,600 --> 00:21:36,360

can see if the depth is changing and

417

00:21:40,810 --> 00:21:38,610

that's lead us to the next figure where

418

00:21:42,860 --> 00:21:40,820

is the spectrum and the final result so

419

00:21:44,180 --> 00:21:42,870

okay let's take a look at that but

420

00:21:46,840 --> 00:21:44,190

before we change this guy what are these

421

00:21:50,060 --> 00:21:46,850

little vertical dots these old circles

422

00:21:52,610 --> 00:21:50,070

so this is where that different

423

00:21:54,260 --> 00:21:52,620

wavelengths are so so that the different

424

00:21:59,480 --> 00:21:54,270

photons of the different wavelengths so

425

00:22:01,100 --> 00:21:59,490

as Hubble is scanning then the spectrum

426

00:22:03,850 --> 00:22:01,110

is not uniform at the detector and

427

00:22:06,320 --> 00:22:03,860

that's why it took us something more

428

00:22:06,890 --> 00:22:06,330

it's a bit more difficult to extract the

429

00:22:08,960 --> 00:22:06,900

spectrum

430

00:22:12,740 --> 00:22:08,970

oh so that's what that's a mapping of

431

00:22:15,980 --> 00:22:12,750

the way it is in the pixel the isn't

432

00:22:18,650 --> 00:22:15,990

popping of the spatial scan spectrum may

433

00:22:21,800 --> 00:22:18,660

not another simple spectrum that usually

434

00:22:23,960 --> 00:22:21,810

Slyke and one-dimensional oh wow that's

435

00:22:25,190 --> 00:22:23,970

very cool okay I can see the differences

436

00:22:26,960 --> 00:22:25,200

in it okay I just wanted to know what

437

00:22:28,940 --> 00:22:26,970

those were okay so Scott if you could go

438

00:22:41,320 --> 00:22:28,950

to the next one and we can see hopefully

439

00:22:49,880 --> 00:22:48,590

recognize it right you can click on my

440

00:22:52,010 --> 00:22:49,890

thumbnail and we'll make it fullscreen

441

00:22:55,880 --> 00:22:52,020

for you that's right what I click on

442

00:23:01,850 --> 00:22:55,890

Scott's on male and yes the confusion

443

00:23:08,240 --> 00:23:01,860

you see I'm just making up data sets as

444

00:23:14,390 --> 00:23:08,250

we're going along like her from Kepler

445

00:23:17,090 --> 00:23:14,400

upper though so you see in the actual

446

00:23:23,930 --> 00:23:17,100

spectrum and it's the spectral signature

447

00:23:25,820 --> 00:23:23,940

of probably hydrogen helium which is

448

00:23:29,630 --> 00:23:25,830

basically being obtained with this

449

00:23:31,370 --> 00:23:29,640

technique okay so there's a lot here

450

00:23:32,990 --> 00:23:31,380

there's this is the top one is an

451

00:23:35,840 --> 00:23:33,000

atmospheric absorption thing this is

452

00:23:36,980 --> 00:23:35,850

where the the the chemical or whatever

453

00:23:38,630 --> 00:23:36,990

the atoms are that you're looking at

454

00:23:41,750 --> 00:23:38,640

would be absorbed and along the bottom

455

00:23:46,480 --> 00:23:41,760

this is the wavelength is that right yep

456

00:23:50,210 --> 00:23:46,490

so the x-axis is wavelength cons okay

457

00:23:56,020 --> 00:23:50,220

the top is the actual spectrum from w3

458

00:23:58,820 --> 00:23:56,030

so it is between 1.1 and 1.67 micron and

459

00:24:01,010 --> 00:23:58,830

the data are the transit depth which as

460

00:24:04,040 --> 00:24:01,020

we said before the transit depth at

461

00:24:05,990 --> 00:24:04,050

different wavelengths basically shows

462

00:24:08,600 --> 00:24:06,000

how big is the planet at different

463

00:24:11,210 --> 00:24:08,610

wavelengths the planet appears smaller

464

00:24:13,970 --> 00:24:11,220

or bigger at different wavelengths

465

00:24:16,550 --> 00:24:13,980

because there are some gases that absorb

466

00:24:19,040 --> 00:24:16,560

light at different weight so this is

467

00:24:22,190 --> 00:24:19,050

basically what this figure is telling us

468

00:24:24,650 --> 00:24:22,200

it's not flat so if you suppose like a

469

00:24:26,420 --> 00:24:24,660

rocky surface without an atmosphere you

470

00:24:32,500 --> 00:24:26,430

would see a flat line

471

00:24:35,570 --> 00:24:32,510

bah-ha modulation with several Sigma

472

00:24:38,510 --> 00:24:35,580

significance we can say that there is a

473

00:24:40,460 --> 00:24:38,520

gas that is causing these differences

474

00:24:42,020 --> 00:24:40,470

basically so at different wavelengths

475

00:24:43,400 --> 00:24:42,030

the planet is smaller or larger

476
00:24:45,610 --> 00:24:43,410
depending on what wavelength you're

477
00:24:48,160 --> 00:24:45,620
looking at and this is at just one point

478
00:24:51,830 --> 00:24:48,170
across the star isn't it

479
00:24:53,630 --> 00:24:51,840
well we fully the entire I know you

480
00:24:57,170 --> 00:24:53,640
followed it across the entire transit

481
00:24:59,000 --> 00:24:57,180
but this is that one spot right well

482
00:25:04,370 --> 00:24:59,010
yeah that's kind of the you know that's

483
00:25:07,160 --> 00:25:04,380
the oval approached eclipse step off the

484
00:25:08,750 --> 00:25:07,170
entire transit I see okay so you had to

485
00:25:10,220 --> 00:25:08,760
extract two signals what I would

486
00:25:12,790 --> 00:25:10,230
emphasize this because this is amazing

487
00:25:15,500 --> 00:25:12,800
you had to extract it one at signal one

488
00:25:18,140 --> 00:25:15,510

ten-thousandth as bright as what was

489

00:25:19,820 --> 00:25:18,150

coming from that star and you did it you

490

00:25:21,350 --> 00:25:19,830

have these these vertical lines on this

491

00:25:23,660 --> 00:25:21,360

top graph are your error bars

492

00:25:26,420 --> 00:25:23,670

some of them presumably it means how

493

00:25:29,840 --> 00:25:26,430

confident you are of this measurement

494

00:25:32,780 --> 00:25:29,850

correct yeah okay and so here so you

495

00:25:34,940 --> 00:25:32,790

saying that if it was a uniform rocky

496

00:25:37,370 --> 00:25:34,950

planet that it would be flat but this is

497

00:25:44,120 --> 00:25:37,380

the flat this isn't black no this is far

498

00:25:46,700 --> 00:25:44,130

from flat and yeah well the surface is

499

00:25:48,590 --> 00:25:46,710

not uniform right so it means that there

500

00:25:53,500 --> 00:25:48,600

is something above this above the

501

00:25:56,480 --> 00:25:54,770

okay

502

00:26:00,050 --> 00:25:56,490

the exciting thing right people we

503

00:26:04,670 --> 00:26:00,060

looked into two suburbs before GJ 1214

504

00:26:12,680 --> 00:26:04,680

and HT 97 another one six five eight I

505

00:26:15,380 --> 00:26:12,690

had property so we just saw a perfectly

506

00:26:17,500 --> 00:26:15,390

flat line and looking at it over and

507

00:26:22,400 --> 00:26:17,510

over and we looked with ground-based

508

00:26:24,830 --> 00:26:22,410

observatories and it's possible then

509

00:26:26,870 --> 00:26:24,840

that a telltale sign of an atmosphere is

510

00:26:29,540 --> 00:26:26,880

the the flatness of that particular

511

00:26:31,010 --> 00:26:29,550

looking graph in other exoplanets if you

512

00:26:32,930 --> 00:26:31,020

see that you can say well probably

513

00:26:35,330 --> 00:26:32,940

doesn't have an atmosphere well it does

514

00:26:37,190 --> 00:26:35,340

it like it's assumed that these planets

515

00:26:39,670 --> 00:26:37,200

have an atmosphere but have a cloud tech

516

00:26:42,670 --> 00:26:39,680

that hides any animal or

517

00:26:46,630 --> 00:26:42,680

would be the other sites uniform it's

518

00:26:49,600 --> 00:26:46,640

either rock or uniform okay cool great

519

00:26:51,010 --> 00:26:49,610

well so my understanding is that so

520

00:26:54,010 --> 00:26:51,020

you've shown the data points and then

521

00:26:57,910 --> 00:26:54,020

and then you do then you say well what

522

00:27:01,420 --> 00:26:57,920

can this be and then you make a hydrogen

523

00:27:04,690 --> 00:27:01,430

and helium model and that's the dashed

524

00:27:06,610 --> 00:27:04,700

orange line and you say oh okay that

525

00:27:08,830 --> 00:27:06,620

doesn't work either it's not flat and

526
00:27:10,780 --> 00:27:08,840
it's not just hydrogen and helium and

527
00:27:12,610 --> 00:27:10,790
then you try to figure out in addition

528
00:27:16,390 --> 00:27:12,620
to hydrogen and helium what else is

529
00:27:18,400 --> 00:27:16,400
there is that the idea well with a

530
00:27:20,140 --> 00:27:18,410
priest step off you see and it's not

531
00:27:23,580 --> 00:27:20,150
flat and you panic because you think

532
00:27:29,530 --> 00:27:27,190
you didn't calibrate it properly or like

533
00:27:34,870 --> 00:27:29,540
a panic so they had to invent a clever

534
00:27:42,100 --> 00:27:34,880
technique to and I like panic driven

535
00:27:43,810 --> 00:27:42,110
software so that is so the bottom the

536
00:27:45,580 --> 00:27:43,820
bottom graph then is yours as Carol said

537
00:27:49,420 --> 00:27:45,590
that's your model of if it was just

538
00:27:51,520 --> 00:27:49,430

hydrogen and helium and then actually I

539

00:27:54,220 --> 00:27:51,530

guess I don't understand some of this so

540

00:27:56,320 --> 00:27:54,230

the the Spitzer data will help me

541

00:28:00,010 --> 00:27:56,330

understand this bottom graph okay so we

542

00:28:02,770 --> 00:28:00,020

have the same models we see above the

543

00:28:05,260 --> 00:28:02,780

orange line that shows the hydrogen

544

00:28:08,080 --> 00:28:05,270

helium home the atmosphere and the model

545

00:28:10,720 --> 00:28:08,090

with which includes the hydrogen cyanide

546

00:28:14,730 --> 00:28:10,730

at along in a longer wavelength range

547

00:28:17,020 --> 00:28:14,740

right so if we could have served is this

548

00:28:20,080 --> 00:28:17,030

spectrum and in a longer wavelength

549

00:28:24,010 --> 00:28:20,090

range these would be the two models that

550

00:28:26,350 --> 00:28:24,020

we're looking at and saying that we

551
00:28:28,900 --> 00:28:26,360
cannot really distinguish between the h2

552
00:28:30,910 --> 00:28:28,910
and helium model and the HCM detection

553
00:28:33,520 --> 00:28:30,920
so where we weren't actually claiming

554
00:28:41,890 --> 00:28:33,530
the full HCN detection but there is just

555
00:28:44,830 --> 00:28:41,900
an indication that hydrogen cyanide also

556
00:28:46,210 --> 00:28:44,840
qualifies so if you hear that I don't

557
00:28:50,940 --> 00:28:46,220
have to grind more coffee beans real

558
00:28:52,560 --> 00:28:50,950
quick hold on I'll be back so

559
00:28:54,509 --> 00:28:52,570
really want to distinguish between the

560
00:28:57,330 --> 00:28:54,519
zoo models we need to go to longer

561
00:29:00,180 --> 00:28:57,340
wavelengths and and that's where James

562
00:29:02,330 --> 00:29:00,190
Webb will be able to do so that Spitzer

563
00:29:05,129 --> 00:29:02,340

point you see there that's the only

564

00:29:06,779 --> 00:29:05,139

symmetric point with a super large error

565

00:29:11,899 --> 00:29:06,789

bar that we have that doesn't really

566

00:29:18,389 --> 00:29:15,899

just for people to look at this and

567

00:29:21,359 --> 00:29:18,399

understand if you look at the lower you

568

00:29:23,669 --> 00:29:21,369

lower one you see a rectangle and the

569

00:29:26,279 --> 00:29:23,679

rectangle is where the Wide Field Camera

570

00:29:29,609 --> 00:29:26,289

3 data is if I understand this correctly

571

00:29:31,830 --> 00:29:29,619

and that is expanded above so you can

572

00:29:34,529 --> 00:29:31,840

see it spread out more but the whole

573

00:29:37,200 --> 00:29:34,539

model covers the whole wavelength region

574

00:29:38,849 --> 00:29:37,210

and this is the demonstration that okay

575

00:29:40,560 --> 00:29:38,859

Spitzer didn't give us enough data

576
00:29:47,729 --> 00:29:40,570
points boy we would like to have some

577
00:29:50,489 --> 00:29:47,739
James Webb okay now one of the

578
00:29:53,310 --> 00:29:50,499
trademarks of hydrogen cyanide being in

579
00:30:02,399 --> 00:29:53,320
an atmosphere is that hydrogen cyanide

580
00:30:05,879 --> 00:30:02,409
is an indicator of a very high carbon to

581
00:30:08,639 --> 00:30:05,889
oxygen okay so that means there is a lot

582
00:30:11,899 --> 00:30:08,649
of carbon in this in this atmosphere as

583
00:30:14,190 --> 00:30:11,909
well what is that what is that

584
00:30:17,460 --> 00:30:14,200
indicative of anything as but as far as

585
00:30:19,080 --> 00:30:17,470
the habitability of the planet or

586
00:30:22,259 --> 00:30:19,090
Maynard's or anything oh my god it's too

587
00:30:23,909 --> 00:30:22,269
hard yes well I know the reason whether

588
00:30:26,690 --> 00:30:23,919

all the tardigrades on their turn to

589

00:30:31,320 --> 00:30:26,700

charcoal yeah like we'd seen for them

590

00:30:33,859 --> 00:30:31,330

see I like hot hot planets oh well you

591

00:30:36,659 --> 00:30:33,869

could go back to Florida

592

00:30:38,489 --> 00:30:36,669

alright so know this that this this is

593

00:30:39,899 --> 00:30:38,499

an indicator of having a very high ratio

594

00:30:41,159 --> 00:30:39,909

of carbon to oxygen and I just want to

595

00:30:43,710 --> 00:30:41,169

talk a little bit about what that might

596

00:30:46,859 --> 00:30:43,720

mean as far as the other aspects of the

597

00:30:48,619 --> 00:30:46,869

nature of this planet right I mean there

598

00:30:51,119 --> 00:30:48,629

were the previous studies that evening

599

00:30:54,269 --> 00:30:51,129

the carbon to oxygen ratio is so high

600

00:30:58,109 --> 00:30:54,279

that the entire inside of 55 countries

601
00:31:00,269 --> 00:30:58,119
made out of diamonds so I don't know

602
00:31:02,430 --> 00:31:00,279
whether that's no confirmed or not I

603
00:31:04,110 --> 00:31:02,440
mean it's been debates it's massively in

604
00:31:06,000 --> 00:31:04,120
the fields but

605
00:31:07,890 --> 00:31:06,010
not the first measurement that shows

606
00:31:09,870 --> 00:31:07,900
that they may potentially be quite a lot

607
00:31:12,090 --> 00:31:09,880
of carbon in there so highly reduced

608
00:31:14,340 --> 00:31:12,100
atmosphere

609
00:31:16,320 --> 00:31:14,350
so you see Scott it isn't out now it is

610
00:31:23,430 --> 00:31:16,330
a pretty fun place to go lots of time

611
00:31:25,500 --> 00:31:23,440
yeah that's all me Justin I'm Scottish I

612
00:31:27,360 --> 00:31:25,510
will just like I go outside here now you

613
00:31:31,880 --> 00:31:27,370

person the flames going there we're just

614

00:31:35,340 --> 00:31:31,890

yeah yeah that was the sunburn would be

615

00:31:37,050 --> 00:31:35,350

quite supreme alright well so now that

616

00:31:39,840 --> 00:31:37,060

you've got this technique down and

617

00:31:41,220 --> 00:31:39,850

you've been looking at super-earth and

618

00:31:42,570 --> 00:31:41,230

you've got a pretty good idea of its

619

00:31:44,190 --> 00:31:42,580

atmosphere the fact that it even has one

620

00:31:47,340 --> 00:31:44,200

and hopefully we've shown a lot of

621

00:31:48,900 --> 00:31:47,350

people what that's like to to you know

622

00:31:50,400 --> 00:31:48,910

be able to determine whether some of

623

00:31:53,280 --> 00:31:50,410

these exits are super-earths have a name

624

00:31:55,220 --> 00:31:53,290

have a plot atmosphere and I are you

625

00:31:57,510 --> 00:31:55,230

gonna be turning this technique to other

626

00:31:59,070 --> 00:31:57,520

other systems are you doing are you

627

00:32:03,320 --> 00:31:59,080

spreading this out a little bit more is

628

00:32:09,270 --> 00:32:03,330

it more work to be done on them by Carol

629

00:32:12,420 --> 00:32:09,280

yeah well there we expect also in the

630

00:32:12,870 --> 00:32:12,430

future for more closed super-earth to be

631

00:32:16,740 --> 00:32:12,880

found

632

00:32:20,700 --> 00:32:16,750

so there are missions that are dedicated

633

00:32:24,510 --> 00:32:20,710

to finding small planets around closeby

634

00:32:26,460 --> 00:32:24,520

stars but since I start these things

635

00:32:28,230 --> 00:32:26,470

Lisa starts with going to be close by

636

00:32:31,470 --> 00:32:28,240

we're going to have the same problem

637

00:32:36,900 --> 00:32:31,480

with Hubble we need to use the same the

638

00:32:42,030 --> 00:32:36,910

same technique and so use the Hubble to

639

00:32:43,800 --> 00:32:42,040

scan for these targets so we will meet

640

00:32:45,900 --> 00:32:43,810

we'll have to use the same technique

641

00:32:48,270 --> 00:32:45,910

there's no alternative route that's

642

00:32:52,280 --> 00:32:48,280

right the problem so far is that we

643

00:32:59,540 --> 00:32:56,720

can be served with three or you know any

644

00:33:02,790 --> 00:32:59,550

telescope so what we really want is to

645

00:33:06,270 --> 00:33:02,800

have new super Hertz and then you'll be

646

00:33:13,170 --> 00:33:06,280

able to there are a few others that you

647

00:33:14,910 --> 00:33:13,180

observed yet so we will serve these yes

648

00:33:16,740 --> 00:33:14,920

that's a good point I guess it's not

649

00:33:17,820 --> 00:33:16,750

enough to just have Hubble observations

650

00:33:20,549 --> 00:33:17,830

of these

651
00:33:23,430 --> 00:33:20,559
you've got to have the specifics smeared

652
00:33:25,560 --> 00:33:23,440
observations why your technique and

653
00:33:27,930 --> 00:33:25,570
extract the signal from the planet out

654
00:33:30,330 --> 00:33:27,940
so you really got to redo this unique

655
00:33:33,740 --> 00:33:30,340
atomic so I mean there's you know the

656
00:33:36,330 --> 00:33:33,750
NASA has the test mission approved and

657
00:33:38,820 --> 00:33:36,340
right passes transiting exoplanet survey

658
00:33:42,120 --> 00:33:38,830
satellite that's gonna be launched next

659
00:33:45,299 --> 00:33:42,130
year right yes and tests will just

660
00:33:48,690 --> 00:33:45,309
provide a hopefully hopefully fantastic

661
00:33:52,519 --> 00:33:48,700
amount of closeby suburbs at least you

662
00:33:57,419 --> 00:33:55,769
but will that will that signal be it

663
00:33:58,830 --> 00:33:57,429

won't be the smeared type you'll you

664

00:34:00,570 --> 00:33:58,840

won't need it tests will be able to do

665

00:34:03,090 --> 00:34:00,580

this in a way that doesn't saturate

666

00:34:05,549 --> 00:34:03,100

things right finds them this is just a

667

00:34:07,889 --> 00:34:05,559

photomeatery mission right so it's

668

00:34:09,780 --> 00:34:07,899

similar to Kepler but it looks like the

669

00:34:14,060 --> 00:34:09,790

close by stars Kepler looks at the very

670

00:34:16,470 --> 00:34:14,070

far away condemned to faint was actually

671

00:34:19,099 --> 00:34:16,480

so we have loads of super-earths in the

672

00:34:22,980 --> 00:34:19,109

Kepler view but they're just two things

673

00:34:24,960 --> 00:34:22,990

well say some Queen we're sorry to get a

674

00:34:26,760 --> 00:34:24,970

few questions in from the YouTube chest

675

00:34:28,919 --> 00:34:26,770

let me get those out just to be clear

676
00:34:38,849 --> 00:34:28,929
they want more super-earths and they

677
00:34:42,030 --> 00:34:38,859
want in jwc time you know i want to use

678
00:34:44,609 --> 00:34:42,040
a telescope that's the area of a tennis

679
00:34:49,800 --> 00:34:44,619
court four stories tall and I want more

680
00:34:53,810 --> 00:34:49,810
planets that send them their way I'll

681
00:34:57,540 --> 00:34:55,710
you know what Carol I think we've ever

682
00:35:06,660 --> 00:34:57,550
had anybody on this hangout that said

683
00:35:10,020 --> 00:35:06,670
they'd wanted less I don't need any more

684
00:35:11,790 --> 00:35:10,030
thank you there's somebody there's a

685
00:35:14,640 --> 00:35:11,800
question here about whether you recorded

686
00:35:18,329 --> 00:35:14,650
several how many transits did you record

687
00:35:21,240 --> 00:35:18,339
of 55 Cancri was it just one to two

688
00:35:24,420 --> 00:35:21,250

transits okay good and Ken Brandt is

689

00:35:26,640 --> 00:35:24,430

asking is the planet tidally locked I

690

00:35:28,050 --> 00:35:26,650

wonder what it the Nightside temp is

691

00:35:30,420 --> 00:35:28,060

like is it tightly locked first of all

692

00:35:31,359 --> 00:35:30,430

it is at least that's what we assume it

693

00:35:37,210 --> 00:35:31,369

is

694

00:35:42,309 --> 00:35:37,220

Kelvin that's about 700 800 Kelvin

695

00:35:44,289 --> 00:35:42,319

colder 700-800 okay so that's quite a

696

00:35:46,059 --> 00:35:44,299

difference so we have a couple of artist

697

00:35:47,589 --> 00:35:46,069

impressions and maybe maybe Scott could

698

00:35:50,109 --> 00:35:47,599

put one of those up we'll take a look at

699

00:35:53,370 --> 00:35:50,119

that briefly of what and putting all

700

00:35:55,180 --> 00:35:53,380

this information together you know as

701
00:35:56,620 --> 00:35:55,190
astronomers do they'd like to make these

702
00:35:59,079 --> 00:35:56,630
artist impressions of what they think it

703
00:36:01,750 --> 00:35:59,089
might look like and so here we're

704
00:36:05,079 --> 00:36:01,760
looking at a planet very close to a star

705
00:36:08,190 --> 00:36:05,089
boy the the the Sun is gonna be very

706
00:36:11,230 --> 00:36:08,200
high in the sky big in the sky that's

707
00:36:12,339 --> 00:36:11,240
and you're saying and it's red you were

708
00:36:15,609 --> 00:36:12,349
saying earlier that it was primarily

709
00:36:17,980 --> 00:36:15,619
lava right yeah because of the tidal

710
00:36:19,690 --> 00:36:17,990
forces and the eatin and all the and

711
00:36:23,200 --> 00:36:19,700
it's amazing that it even has is I just

712
00:36:24,670 --> 00:36:23,210
why do you think the the solar wind from

713
00:36:32,670 --> 00:36:24,680

the star doesn't blow the atmosphere

714

00:36:34,839 --> 00:36:32,680

away absolutely no idea at this stage

715

00:36:38,170 --> 00:36:34,849

okay cuz that yeah would seem to be a

716

00:36:39,339 --> 00:36:38,180

pretty big factor in and whether it had

717

00:36:42,520 --> 00:36:39,349

an atmosphere or not that's pretty good

718

00:36:43,890 --> 00:36:42,530

what people do this it would have like a

719

00:36:46,780 --> 00:36:43,900

hydrogen atmosphere it's it's

720

00:36:49,329 --> 00:36:46,790

necessarily expected so there may either

721

00:36:53,079 --> 00:36:49,339

be a process where you can hang on to

722

00:36:56,250 --> 00:36:53,089

its original hydrogen core or some

723

00:37:00,549 --> 00:36:56,260

replenishing from a surface chemistry

724

00:37:05,230 --> 00:37:00,559

the outgassing hydrogen constantly yeah

725

00:37:07,240 --> 00:37:05,240

so yeah so this would be and this was a

726

00:37:09,900 --> 00:37:07,250

web what remind me it was one point how

727

00:37:16,440 --> 00:37:09,910

big was larger than the earth one point

728

00:37:20,920 --> 00:37:19,059

radly ninth larger than the earth so

729

00:37:22,299 --> 00:37:20,930

that's pretty it's pretty big okay so

730

00:37:24,730 --> 00:37:22,309

and so that answers your question

731

00:37:26,200 --> 00:37:24,740

strikes I strike wonder how long that

732

00:37:28,180 --> 00:37:26,210

atmosphere will deal with the solar wind

733

00:37:30,130 --> 00:37:28,190

situation so that's a good question so

734

00:37:33,099 --> 00:37:30,140

that that's something I guess everybody

735

00:37:35,289 --> 00:37:33,109

would like to find out the idea that

736

00:37:38,319 --> 00:37:35,299

apparently the atmosphere may just be

737

00:37:40,539 --> 00:37:38,329

chance you know permanence that's that

738

00:37:43,020 --> 00:37:40,549

it may lose and regain its atmosphere no

739

00:37:45,210 --> 00:37:43,030

guessing so

740

00:37:47,010 --> 00:37:45,220

his observations looked at it and they

741

00:37:49,290 --> 00:37:47,020

didn't find an atmosphere we found a

742

00:37:51,150 --> 00:37:49,300

pretty clear signal in two different

743

00:37:52,890 --> 00:37:51,160

transits so there may be you know there

744

00:37:55,320 --> 00:37:52,900

may be some you may not be a permanent

745

00:37:56,850 --> 00:37:55,330

atmosphere together I see you're saying

746

00:38:00,450 --> 00:37:56,860

that because of the tidal forces on the

747

00:38:02,670 --> 00:38:00,460

planet the the the stuff is underneath

748

00:38:05,640 --> 00:38:02,680

that lava whatever it could be just

749

00:38:08,490 --> 00:38:05,650

gases pouring out of thee okay that's

750

00:38:12,390 --> 00:38:08,500

their point that you saw in the previous

751
00:38:14,640 --> 00:38:12,400
drop was an average of several transits

752
00:38:16,500 --> 00:38:14,650
that were observed with Spitzer and a

753
00:38:21,090 --> 00:38:16,510
previous study from a few months ago

754
00:38:23,310 --> 00:38:21,100
actually showed that apparently it's our

755
00:38:25,320 --> 00:38:23,320
data point is varying a lot indicating

756
00:38:29,370 --> 00:38:25,330
that maybe these a series is probably

757
00:38:31,680 --> 00:38:29,380
changing in size that's how you would

758
00:38:33,450 --> 00:38:31,690
know you though if those if those data

759
00:38:34,800 --> 00:38:33,460
points were moving around pretty rapidly

760
00:38:38,130 --> 00:38:34,810
it wouldn't be a very stable atmosphere

761
00:38:40,800 --> 00:38:38,140
be something gushing out of it and sort

762
00:38:44,640 --> 00:38:40,810
of you know certain would Spitzer so you

763
00:38:55,670 --> 00:38:44,650

know so the thing is you know once we

764

00:39:00,630 --> 00:38:58,860

waiting for you hurry up all right the

765

00:39:02,370 --> 00:39:00,640

the nebulous princess is asking the

766

00:39:05,490 --> 00:39:02,380

question can the presence of an

767

00:39:07,110 --> 00:39:05,500

atmosphere that close to its star be

768

00:39:10,560 --> 00:39:07,120

used to infer anything about whether

769

00:39:11,730 --> 00:39:10,570

this has a magnetic field I mean do we

770

00:39:15,620 --> 00:39:11,740

know anything can no can we learn

771

00:39:19,080 --> 00:39:17,340

just because it has an atmosphere

772

00:39:29,700 --> 00:39:19,090

doesn't mean you've got a magnetic field

773

00:39:32,160 --> 00:39:29,710

by the way look like we don't know you

774

00:39:34,710 --> 00:39:32,170

know that active geologically it might

775

00:39:39,120 --> 00:39:34,720

have some kind of if it's outgassing it

776

00:39:41,670 --> 00:39:39,130

might have whether it's a global dynamo

777

00:39:44,790 --> 00:39:41,680

it's not clear we know that the density

778

00:39:46,560 --> 00:39:44,800

of the pine is quite low but we don't

779

00:39:48,420 --> 00:39:46,570

know more about this and all of the core

780

00:39:51,020 --> 00:39:48,430

sorry say that again the density is low

781

00:39:54,180 --> 00:39:51,030

you said densities right low so the

782

00:39:56,390 --> 00:39:54,190

planet is quite large operate for a

783

00:39:58,730 --> 00:39:56,400

earth white planner for a rocky planet

784

00:40:03,650 --> 00:39:58,740

for a planet that is eight times heavier

785

00:40:05,749 --> 00:40:03,660

than the earth yeah quite large how do

786

00:40:07,460 --> 00:40:05,759

you so where do you get that house how

787

00:40:09,460 --> 00:40:07,470

do you get the density from that I'm

788

00:40:13,069 --> 00:40:09,470

very curious about that so you know

789

00:40:15,380 --> 00:40:13,079

entity comes from you combined combined

790

00:40:18,640 --> 00:40:15,390

measurement of transits and radial

791

00:40:22,009 --> 00:40:18,650

velocity so from visual velocity is the

792

00:40:22,970 --> 00:40:22,019

pulling star goes around ok sure because

793

00:40:24,499 --> 00:40:22,980

that would tell you about its mass

794

00:40:26,509 --> 00:40:24,509

that's right that's a good point ok good

795

00:40:28,999 --> 00:40:26,519

so you also measure the wobble of the

796

00:40:31,430 --> 00:40:29,009

star with with with c3 as well okay

797

00:40:33,739 --> 00:40:31,440

basically measurements are from other

798

00:40:34,720 --> 00:40:33,749

ways through Maps so abscissas

799

00:40:39,829 --> 00:40:34,730

high-precision

800

00:40:42,710 --> 00:40:39,839

spectrograph Oh Monsieur I mean very

801
00:40:44,989 --> 00:40:42,720
high-resolution spectroscopy to observe

802
00:40:54,920 --> 00:40:44,999
the shift of the lines of the stars due

803
00:40:57,680 --> 00:40:54,930
to such a small planet right so the

804
00:40:59,900 --> 00:40:57,690
difference between radio velocity and

805
00:41:01,400 --> 00:40:59,910
the transit method they each have their

806
00:41:03,019 --> 00:41:01,410
own strengths of weaknesses I each tell

807
00:41:05,809 --> 00:41:03,029
you something different about the planet

808
00:41:07,759 --> 00:41:05,819
in the case of a transit you can learn a

809
00:41:09,440 --> 00:41:07,769
lot about its size because of how much

810
00:41:11,870 --> 00:41:09,450
it blocks the star's light and from the

811
00:41:14,210 --> 00:41:11,880
radio velocity how massive it is because

812
00:41:16,069 --> 00:41:14,220
of how much it tugs on the star except

813
00:41:17,180 --> 00:41:16,079

you have to compensate for all the other

814

00:41:20,569 --> 00:41:17,190

planets that are out there which I'm

815

00:41:22,099 --> 00:41:20,579

sure you guys do as well right so you

816

00:41:24,049 --> 00:41:22,109

can kind of get a sense of how massive

817

00:41:26,150 --> 00:41:24,059

this planet is minus all the other

818

00:41:28,700 --> 00:41:26,160

planets pulling on the star yeah right

819

00:41:30,890 --> 00:41:28,710

in the radial velocity the measurements

820

00:41:33,319 --> 00:41:30,900

they takings are gone but they are not

821

00:41:37,309 --> 00:41:33,329

transiting so for us they are not

822

00:41:38,900 --> 00:41:37,319

affecting anything so this just read

823

00:41:45,229 --> 00:41:38,910

let's just summarize a little bit here

824

00:41:47,809 --> 00:41:45,239

voting group on this but I want to know

825

00:41:49,849 --> 00:41:47,819

about this planetary system because what

826
00:41:52,190 --> 00:41:49,859
Angela just said was important that I

827
00:41:53,749 --> 00:41:52,200
had read about it but this is it has a

828
00:41:56,779 --> 00:41:53,759
bunch of planets but this is you only

829
00:41:57,559 --> 00:41:56,789
transmit one yes good that raised your

830
00:42:01,700 --> 00:41:57,569
question here

831
00:42:04,819 --> 00:42:01,710
anyway go ahead say was these guys have

832
00:42:07,069 --> 00:42:04,829
looked at a star smeared it out over a

833
00:42:09,480 --> 00:42:07,079
over a camera that has numerous

834
00:42:12,690 --> 00:42:09,490
spectrograph picked out a cig

835
00:42:15,810 --> 00:42:12,700
10,000 times dimmer than the star it was

836
00:42:17,579 --> 00:42:15,820
orbiting figured out what it was the

837
00:42:19,770 --> 00:42:17,589
atmosphere that first of all they had an

838
00:42:21,420 --> 00:42:19,780

atmosphere and that it went what it was

839

00:42:29,880 --> 00:42:21,430

on and hydrogen cyanide among other

840

00:42:32,160 --> 00:42:29,890

things and that they also were able to

841

00:42:33,690 --> 00:42:32,170

look at a radial velocity met images

842

00:42:35,670 --> 00:42:33,700

from other instruments to get a sense of

843

00:42:38,730 --> 00:42:35,680

the mass of this planet and having to

844

00:42:40,740 --> 00:42:38,740

deal with all the other planets in that

845

00:42:42,990 --> 00:42:40,750

system I mean this is the kind of work

846

00:42:45,329 --> 00:42:43,000

that blows my mind because of all the

847

00:42:47,700 --> 00:42:45,339

things you've got it account for not

848

00:42:49,320 --> 00:42:47,710

even to mention all the idiosyncrasies

849

00:42:51,089 --> 00:42:49,330

involved in the data itself you got to

850

00:42:53,040 --> 00:42:51,099

calibrate all the instrument effects out

851

00:42:54,660 --> 00:42:53,050

I mean this is amazing stuff as far as

852

00:42:58,320 --> 00:42:54,670

the signal and what we're able to learn

853

00:43:00,839 --> 00:42:58,330

from just literally a few photons just I

854

00:43:02,700 --> 00:43:00,849

just always in office so the system

855

00:43:03,870 --> 00:43:02,710

itself Carol wants to learn a little bit

856

00:43:05,310 --> 00:43:03,880

more of the system itself we've already

857

00:43:07,890 --> 00:43:05,320

talked about there's five other four

858

00:43:09,329 --> 00:43:07,900

other planets I think so but they're not

859

00:43:13,650 --> 00:43:09,339

transiting what are they doing are they

860

00:43:17,450 --> 00:43:13,660

doing some kind of you know just not

861

00:43:20,339 --> 00:43:17,460

looking like perfectly edge-on that's

862

00:43:22,260 --> 00:43:20,349

you know one yes the other ones are just

863

00:43:24,599 --> 00:43:22,270

a bit you know not transiting in our

864

00:43:29,730 --> 00:43:24,609

line of sight but they're they're doing

865

00:43:34,320 --> 00:43:29,740

fine yeah they gave us a phone call

866

00:43:39,630 --> 00:43:34,330

they're like no no worries with you

867

00:43:41,220 --> 00:43:39,640

right now it's it's it's you not me it's

868

00:43:43,530 --> 00:43:41,230

because we're not transiting you know

869

00:43:47,570 --> 00:43:43,540

like as much that's fine we'll just sit

870

00:43:55,740 --> 00:43:50,339

but it's important at least they've been

871

00:43:57,420 --> 00:43:55,750

found okay so presumably that was solely

872

00:43:58,530 --> 00:43:57,430

from the radio velocity method right I

873

00:44:00,660 --> 00:43:58,540

mean there's no other way to really tell

874

00:44:02,190 --> 00:44:00,670

so that's that's all you have you should

875

00:44:04,290 --> 00:44:02,200

point out that there's a real bias to

876

00:44:05,940 --> 00:44:04,300

the transit method and that bias is that

877

00:44:07,440 --> 00:44:05,950

we're we're only talking about planets

878

00:44:10,140 --> 00:44:07,450

Kepler that's all it looked at were

879

00:44:12,780 --> 00:44:10,150

these dips and brightness but that and

880

00:44:14,130 --> 00:44:12,790

it came up with an estimate of or came

881

00:44:17,250 --> 00:44:14,140

up with a lot you know 5,000 plus

882

00:44:19,470 --> 00:44:17,260

candidate planets around stars that it

883

00:44:21,630 --> 00:44:19,480

160,000 or so stars it was looking at

884

00:44:23,220 --> 00:44:21,640

but that doesn't mean that's all there

885

00:44:24,630 --> 00:44:23,230

was it's just how many were

886

00:44:27,480 --> 00:44:24,640

happened to be passing in between the

887

00:44:29,370 --> 00:44:27,490

star and the Kepler telescope and the

888

00:44:31,080 --> 00:44:29,380

same is true here there are so many

889

00:44:33,030 --> 00:44:31,090

planets and they've come up that and so

890

00:44:36,030 --> 00:44:33,040

they've extrapolated and I'm not sure

891

00:44:38,849 --> 00:44:36,040

what the what the method they used to do

892

00:44:41,160 --> 00:44:38,859

that was but if you look at the transits

893

00:44:42,900 --> 00:44:41,170

we can see and then you extrapolate that

894

00:44:45,480 --> 00:44:42,910

in some intelligent way they have come

895

00:44:48,960 --> 00:44:45,490

up with the figure of 1.6 planets for

896

00:44:51,210 --> 00:44:48,970

every star on average in our galaxy and

897

00:44:52,530 --> 00:44:51,220

so those are apparently include a lot of

898

00:44:55,290 --> 00:44:52,540

the ones that we can't see or that

899

00:44:57,599 --> 00:44:55,300

aren't transiting as well so the the

900

00:44:59,370 --> 00:44:57,609

radial velocity method though that is

901
00:45:01,109 --> 00:44:59,380
not that it's not suffer from that same

902
00:45:06,890 --> 00:45:01,119
bias will see it no matter where they

903
00:45:15,510 --> 00:45:09,060
well if they rotate okay so we're

904
00:45:18,210 --> 00:45:15,520
looking from the top of the plane of the

905
00:45:19,859 --> 00:45:18,220
wobble no matter what well yeah it was

906
00:45:22,410 --> 00:45:19,869
but then we wouldn't be seeing it then

907
00:45:25,080 --> 00:45:22,420
we'd be seeing astrometry so Gaia would

908
00:45:29,670 --> 00:45:25,090
pick up on the you know ninety degree

909
00:45:31,290 --> 00:45:29,680
angle to the to the plane once some guy

910
00:45:33,810 --> 00:45:31,300
is probably gonna find another ten

911
00:45:35,640 --> 00:45:33,820
thousand planets or so because let's

912
00:45:37,800 --> 00:45:35,650
talk about Gaia Gaia is tell us a little

913
00:45:42,060 --> 00:45:37,810

bit about that guy is amazing I love

914

00:45:47,040 --> 00:45:42,070

Gaia God big thumbs up from Scott on

915

00:45:48,780 --> 00:45:47,050

Gaia Gaia okay guy is her is his friend

916

00:45:49,680 --> 00:45:48,790

okay but tell us a little bit Keith

917

00:45:51,840 --> 00:45:49,690

could give us a little background on

918

00:45:55,770 --> 00:45:51,850

what guy is gonna do them well it's

919

00:45:57,750 --> 00:45:55,780

astronomy from a tree mission that's

920

00:46:00,330 --> 00:45:57,760

currently flying mapping all the closeby

921

00:46:03,270 --> 00:46:00,340

stars and and figuring out the parallax

922

00:46:06,180 --> 00:46:03,280

distances to till the stars really high

923

00:46:08,460 --> 00:46:06,190

precision but as a sight product that

924

00:46:11,010 --> 00:46:08,470

the Gaia pipeline actually has a little

925

00:46:14,250 --> 00:46:11,020

extra planet module attached to it which

926
00:46:17,460 --> 00:46:14,260
just looks for tiny little bubbles of

927
00:46:19,290 --> 00:46:17,470
the star and and then essentially the

928
00:46:21,060 --> 00:46:19,300
same thing that radial velocity just

929
00:46:23,760 --> 00:46:21,070
looked at from a from a completely

930
00:46:26,130 --> 00:46:23,770
different angle depending they start

931
00:46:28,410 --> 00:46:26,140
going away in towards us you know left

932
00:46:31,400 --> 00:46:28,420
and right and taking spectra actually

933
00:46:34,200 --> 00:46:31,410
take images and you can see the star

934
00:46:36,270 --> 00:46:34,210
moving right and so for those of you

935
00:46:36,930 --> 00:46:36,280
don't know astrometry is this is the

936
00:46:38,520 --> 00:46:36,940
study

937
00:46:40,530 --> 00:46:38,530
you know measuring exactly where

938
00:46:42,750 --> 00:46:40,540

something has in its distance about from

939

00:46:44,940 --> 00:46:42,760

us so that's what astrometry doesn't guy

940

00:46:48,630 --> 00:46:44,950

is gonna be well-suited to help us find

941

00:46:50,160 --> 00:46:48,640

that out for a lot of stars so that's

942

00:46:52,380 --> 00:46:50,170

gotta that's an important mission that's

943

00:46:55,859 --> 00:46:52,390

uh that's what is that that's happening

944

00:46:57,690 --> 00:46:55,869

soon right well it's flying now yeah

945

00:47:02,059 --> 00:46:57,700

it's already you know we talked about

946

00:47:09,180 --> 00:47:02,069

before but yeah it's launched what 2013

947

00:47:17,720 --> 00:47:09,190

data release you need to wait many many

948

00:47:24,089 --> 00:47:22,470

the orbit that's right you need to be

949

00:47:27,450 --> 00:47:24,099

the time series to really get the knack

950

00:47:29,400 --> 00:47:27,460

your measurement of the motions of these

951
00:47:30,480 --> 00:47:29,410
things which blows me away in another

952
00:47:31,290 --> 00:47:30,490
way too but that just the fact that

953
00:47:33,750 --> 00:47:31,300
we're doing that at all is just

954
00:47:36,450 --> 00:47:33,760
astonishing but the so getting back to

955
00:47:41,309 --> 00:47:36,460
your super earth measurements here with

956
00:47:43,770 --> 00:47:41,319
55 Cancri E V the since you were able to

957
00:47:45,750 --> 00:47:43,780
detect the atmosphere or in some of its

958
00:47:48,420 --> 00:47:45,760
components using this new technique I

959
00:47:51,300 --> 00:47:48,430
can imagine that you could also use it

960
00:47:53,089 --> 00:47:51,310
couldn't you for things like hot

961
00:47:55,410 --> 00:47:53,099
Jupiters or other planets that are

962
00:47:57,420 --> 00:47:55,420
passing or orbiting around other stars

963
00:47:59,190 --> 00:47:57,430

for I have you have you mean we can

964

00:48:00,420 --> 00:47:59,200

learn more about their compositions as

965

00:48:02,849 --> 00:48:00,430

well that's using this technique

966

00:48:05,370 --> 00:48:02,859

couldn't we and it might be easier

967

00:48:11,329 --> 00:48:05,380

because maybe the photon signal might be

968

00:48:13,650 --> 00:48:11,339

higher most of the observations of

969

00:48:15,690 --> 00:48:13,660

atmospheres but exoplanetary atmospheres

970

00:48:18,150 --> 00:48:15,700

had been done using contributors because

971

00:48:20,910 --> 00:48:18,160

the signal is much much stronger and

972

00:48:22,380 --> 00:48:20,920

it's much easier to observe signal

973

00:48:24,690 --> 00:48:22,390

because the signal is stronger

974

00:48:28,710 --> 00:48:24,700

it's very extended atmospheres made of

975

00:48:30,990 --> 00:48:28,720

hydrogen while turning to super fertile

976
00:48:33,359 --> 00:48:31,000
atmospheres the atoms are smaller and

977
00:48:36,569 --> 00:48:33,369
are often assumed to be dominated by

978
00:48:39,390 --> 00:48:36,579
heavier gases and heavier gases will

979
00:48:42,150 --> 00:48:39,400
have smaller molecular features which

980
00:48:48,800 --> 00:48:42,160
will be even more difficult to detect so

981
00:48:50,160 --> 00:48:48,810
this technique of scanning basically

982
00:48:52,820 --> 00:48:50,170
looping out

983
00:48:55,680 --> 00:48:52,830
of course the star is very useful for

984
00:48:57,860 --> 00:48:55,690
smaller planets with more names

985
00:49:01,500 --> 00:48:57,870
atmospheres of course it's also used

986
00:49:03,960 --> 00:49:01,510
right and the relations are loved most

987
00:49:06,360 --> 00:49:03,970
of the observations contributors right

988
00:49:08,550 --> 00:49:06,370

now are coming in a scanning mode

989

00:49:10,770 --> 00:49:08,560

because even for hot Jupiters the

990

00:49:13,890 --> 00:49:10,780

brighter is a star the star the better

991

00:49:16,440 --> 00:49:13,900

CL we have so we're taking advantage of

992

00:49:18,990 --> 00:49:16,450

these cunning even 402 meters we prefer

993

00:49:20,460 --> 00:49:19,000

to close by stops generally right and

994

00:49:22,020 --> 00:49:20,470

because then you're saying because of

995

00:49:24,120 --> 00:49:22,030

the sensitivity of whoops III you were

996

00:49:26,100 --> 00:49:24,130

able you needed to do this this scanning

997

00:49:31,950 --> 00:49:26,110

technique but to other instruments also

998

00:49:32,610 --> 00:49:31,960

use it very specific to FC three way

999

00:49:35,550 --> 00:49:32,620

you've come up with

1000

00:49:38,190 --> 00:49:35,560

yeah and they started up with complete

1001
00:49:40,200 --> 00:49:38,200
and and realized you know we can't

1002
00:49:43,440 --> 00:49:40,210
actually Dominican expand it related

1003
00:49:51,810 --> 00:49:43,450
just for the painter targets and that's

1004
00:49:55,950 --> 00:49:51,820
the ISO introduced on those two as well

1005
00:49:57,720 --> 00:49:55,960
2012 and you know they they try to play

1006
00:49:59,100 --> 00:49:57,730
a bit with that and they took a few

1007
00:50:01,530 --> 00:49:59,110
years to figure out how to keep the

1008
00:50:03,300 --> 00:50:01,540
telescope stable right because it has

1009
00:50:06,320 --> 00:50:03,310
the reaction wheels basically turning

1010
00:50:11,010 --> 00:50:06,330
and it's completely out of the box

1011
00:50:12,600 --> 00:50:11,020
measurements you guys need to be careful

1012
00:50:19,650 --> 00:50:12,610
with how well don't be breaking it with

1013
00:50:21,090 --> 00:50:19,660

your weird three all right well that's

1014

00:50:22,200 --> 00:50:21,100

great I want to thank this has been very

1015

00:50:24,090 --> 00:50:22,210

interesting you want to thank you guys

1016

00:50:25,410 --> 00:50:24,100

let me check in with Scott have you have

1017

00:50:26,700 --> 00:50:25,420

you given me all the comments and

1018

00:50:28,340 --> 00:50:26,710

questions that you've seen so far is

1019

00:50:30,510 --> 00:50:28,350

there anything on Twitter

1020

00:50:32,880 --> 00:50:30,520

the only other things we've actually

1021

00:50:33,510 --> 00:50:32,890

answered while on air so everything else

1022

00:50:35,400 --> 00:50:33,520

has been great

1023

00:50:39,030 --> 00:50:35,410

alright alright Carol D everything you

1024

00:50:42,000 --> 00:50:39,040

like to add and no I I think this is

1025

00:50:44,280 --> 00:50:42,010

like astonishing this to invent great

1026
00:50:46,860 --> 00:50:44,290
software technique and analyze the data

1027
00:50:50,100 --> 00:50:46,870
this way and I think that the drifting

1028
00:50:52,650 --> 00:50:50,110
of the telescope it's tricky but wow the

1029
00:50:55,890 --> 00:50:52,660
payoff is big so that's the thing about

1030
00:50:58,440 --> 00:50:55,900
Hubble now is that you know as soon as

1031
00:51:00,660 --> 00:50:58,450
an instrument is put on everybody has a

1032
00:51:03,210 --> 00:51:00,670
collection of things they want to do and

1033
00:51:04,390 --> 00:51:03,220
the great thing about the fact that

1034
00:51:06,549 --> 00:51:04,400
Hubble has been

1035
00:51:09,549 --> 00:51:06,559
for a while is now we can really think

1036
00:51:13,569 --> 00:51:09,559
about these new unique innovative ways

1037
00:51:15,430 --> 00:51:13,579
of using the telescope and you know

1038
00:51:20,249 --> 00:51:15,440

nobody would have been excuse me

1039

00:51:25,420 --> 00:51:23,440

all right so what's next for you guys

1040

00:51:26,710 --> 00:51:25,430

anything what are you gonna do now in

1041

00:51:29,440 --> 00:51:26,720

the chief Oh are you going to Disney

1042

00:51:45,430 --> 00:51:29,450

World or some countries yeah they're

1043

00:51:46,599 --> 00:51:45,440

going to the pub okay so okay well I

1044

00:51:47,890 --> 00:51:46,609

guess that's it what I want to thank you

1045

00:51:49,390 --> 00:51:47,900

all I thank you guys very much for

1046

00:51:51,279 --> 00:51:49,400

taking the time out to share your

1047

00:51:52,960 --> 00:51:51,289

research with us this is amazing stuff

1048

00:51:54,489 --> 00:51:52,970

I'm really impressed with the way in

1049

00:51:56,680 --> 00:51:54,499

which not only you guys are using the

1050

00:51:59,440 --> 00:51:56,690

Hubble and whips III but this processing

1051
00:52:02,890 --> 00:51:59,450
technique as well I'm hoping that we get

1052
00:52:08,200 --> 00:52:02,900
say there's a phone part that's you the

1053
00:52:09,910 --> 00:52:08,210
Sun Wow okay well been the only one and

1054
00:52:11,739 --> 00:52:09,920
all of our years has never had my phone

1055
00:52:20,099 --> 00:52:11,749
ring while on here because I'm a

1056
00:52:20,109 --> 00:52:28,410
no actually my phone goes off like crazy

1057
00:52:35,400 --> 00:52:30,789
they know how pretty I am they see me on

1058
00:52:38,620 --> 00:52:35,410
air and like oh Scott and I'm lying so

1059
00:52:40,150 --> 00:52:38,630
alright alright guys well thank you guys

1060
00:52:43,239 --> 00:52:40,160
I want to like I said oh and thank you

1061
00:52:44,859 --> 00:52:43,249
guys for taking hope that you will let

1062
00:52:46,809 --> 00:52:44,869
us know if the next big the next big

1063
00:52:49,299 --> 00:52:46,819

thing that you guys do with Hubble we're

1064

00:52:51,160 --> 00:52:49,309

looking for I'm wanting the app I'm

1065

00:52:53,170 --> 00:52:51,170

waiting for the app to come out that

1066

00:53:00,870 --> 00:52:53,180

shows you know how I want to be this

1067

00:53:10,630 --> 00:53:03,789

it's like Astro tinder you're like smear

1068

00:53:14,289 --> 00:53:10,640

left for that and you remember you gotta

1069

00:53:16,240 --> 00:53:14,299

here and money in San Francisco you need

1070

00:53:22,480 --> 00:53:16,250

my trademark Astro tinder real quick

1071

00:53:35,080 --> 00:53:22,490

be right back your left smear right and

1072

00:53:36,460 --> 00:53:35,090

you got it there's your Tigers that just

1073

00:53:41,080 --> 00:53:36,470

won't put that out there no pictures of

1074

00:53:43,420 --> 00:53:41,090

the Tigers Angeles Angeles TRS Ingo

1075

00:53:44,740 --> 00:53:43,430

Waldman and Marco Roach a doe from all

1076
00:53:46,150 --> 00:53:44,750
from the University College at London

1077
00:53:48,970 --> 00:53:46,160
thank you for taking time out to talk to

1078
00:53:51,970 --> 00:53:48,980
us and good luck on on future stuff you

1079
00:53:53,320 --> 00:53:51,980
guys you're gonna I could tell you're

1080
00:53:57,220 --> 00:53:53,330
gonna make a big difference so thank you

1081
00:53:59,590 --> 00:53:57,230
for taking time out thank you all right

1082
00:54:00,790 --> 00:53:59,600
well on behalf of carol christian and

1083
00:54:03,700 --> 00:54:00,800
scott lewis i want to thank you guys for

1084
00:54:06,490 --> 00:54:03,710
watching we'll be back next week what

1085
00:54:08,980 --> 00:54:06,500
you gonna do Carol do we know who might

1086
00:54:23,200 --> 00:54:08,990
be something about massive stars massive

1087
00:54:25,810 --> 00:54:23,210
scars like a big deal no I've had like a

1088
00:54:35,560 --> 00:54:25,820

pot of coffee this show so I'm sure I'll

1089

00:54:37,000 --> 00:54:35,570

have a lot of ideas alright folks I want

1090

00:54:38,380 --> 00:54:37,010

to thank you all for watching now join

1091

00:54:40,540 --> 00:54:38,390

us next week we'll be back talking about

1092

00:54:43,690 --> 00:54:40,550

presumably massive stars but it might be

1093

00:54:45,430 --> 00:54:43,700

a surprise well let me know if you're

1094

00:54:46,750 --> 00:54:45,440

not subscribing to the Hubble site

1095

00:54:48,520 --> 00:54:46,760

channel you need to do that because

1096

00:54:50,980 --> 00:54:48,530

that's where you'll find out future

1097

00:54:55,060 --> 00:54:50,990

events also follow us on Facebook at

1098

00:54:58,420 --> 00:54:55,070

Hubble as Hubble Space Telescope we're

1099

00:55:00,880 --> 00:54:58,430

on twitter at hubble telescope so make

1100

00:55:01,990 --> 00:55:00,890

sure you follow us and and well that's

1101

00:55:03,460 --> 00:55:02,000

how you can learn about the next hang

1102

00:55:04,900 --> 00:55:03,470

house well thank you all for watching

1103

00:55:07,210 --> 00:55:04,910

one thank you guys for your questions

1104

00:55:09,370 --> 00:55:07,220

and comments they were awesome as they

1105

00:55:12,100 --> 00:55:09,380

always are we'll see you next week and