1
00:02:44,150 --> 00:02:41,990
i know it's beautiful this is

2
00:02:46,550 --> 00:02:44,160
spectacular we even thought we'd be

3
00:02:48,550 --> 00:02:46,560
alive at this point well i mean

4
00:02:49,589 --> 00:02:48,560
the fact that these go right up like

5
00:02:51,430 --> 00:02:49,599
that

6
00:02:53,509 --> 00:02:51,440
and then down you know this is

7
00:03:02,229 --> 00:02:53,519
astonishing

8
00:03:08,550 --> 00:03:04,149
i love checking not your two thousand

9
00:05:27,270 --> 00:03:13,430
i know it's beautiful it's spectacular

10
00:05:30,550 --> 00:05:28,710
good afternoon welcome to nasa

11
00:05:32,629 --> 00:05:30,560
headquarters and today space science

12
00:05:34,710 --> 00:05:32,639
update we're very pleased

13
00:05:36,790 --> 00:05:34,720

today to have a panel of astronomers

14
00:05:38,469 --> 00:05:36,800
here to make a significant announcement

15
00:05:41,270 --> 00:05:38,479
on research funded by nasa and the

16
00:05:43,350 --> 00:05:41,280
national science foundation and uh here

17
00:05:45,110 --> 00:05:43,360
to tell us about that

18
00:05:47,189 --> 00:05:45,120
and to introduce our panel to tell us

19
00:05:49,510 --> 00:05:47,199
about that it's dr ann kenney who's the

20
00:05:53,670 --> 00:05:49,520
director of nasa's origin programs here

21
00:05:56,870 --> 00:05:53,680
at nasa headquarters and

22
00:05:58,710 --> 00:05:56,880
uh we have some very exciting science to

23
00:06:02,790 --> 00:05:58,720
talk about today

24
00:06:05,110 --> 00:06:02,800
which has to do with uh planet searches

25
00:06:07,909 --> 00:06:05,120
when you look up in the night sky

26
00:06:10,550 --> 00:06:07,919
now you know with a certainty that there

27
00:06:13,029 --> 00:06:10,560
are planets around some of the stars in

28
00:06:16,070 --> 00:06:13,039
that sky but this has only been the case

29
00:06:18,309 --> 00:06:16,080
since 1994 before then

30
00:06:19,749 --> 00:06:18,319
it was simply not known people thought

31
00:06:22,870 --> 00:06:19,759
that there were probably planets out

32
00:06:25,909 --> 00:06:22,880
there but it wasn't known since 1994

33
00:06:28,710 --> 00:06:25,919
we've discovered about 30 planets i use

34
00:06:30,790 --> 00:06:28,720
a wee very loosely here

35
00:06:32,950 --> 00:06:30,800
since this was not my personal research

36
00:06:34,710 --> 00:06:32,960
but we've discovered about 30 planets of

37
00:06:36,950 --> 00:06:34,720
those 20 of those planets were

38
00:06:39,110 --> 00:06:36,960

discovered by the team that is here to

39
00:06:40,710 --> 00:06:39,120
talk with us today

40
00:06:44,070 --> 00:06:40,720
i would just like to say something about

41
00:06:47,029 --> 00:06:44,080
those planets to put this in perspective

42
00:06:51,350 --> 00:06:47,039
those 30 planets have all been

43
00:06:54,550 --> 00:06:51,360
jupiter mass or larger that means 300

44
00:06:55,430 --> 00:06:54,560
earth mass sized planets

45
00:06:57,350 --> 00:06:55,440
and

46
00:06:59,189 --> 00:06:57,360
the the planets we're going to talk

47
00:07:01,749 --> 00:06:59,199
about today have more to do with

48
00:07:05,670 --> 00:07:01,759
saturn-sized planets which is

49
00:07:07,110 --> 00:07:05,680
100 earth mass so very different order

50
00:07:09,189 --> 00:07:07,120
of magnitude

51
00:07:12,550 --> 00:07:09,199
so as i said

52
00:07:13,990 --> 00:07:12,560
of the of the approximately 30 planets

53
00:07:16,870 --> 00:07:14,000
that we know of 20 of them were

54
00:07:18,790 --> 00:07:16,880
discovered by this team and

55
00:07:20,790 --> 00:07:18,800
this is this is a group that has been

56
00:07:23,510 --> 00:07:20,800
working on this field for approximately

57
00:07:25,909 --> 00:07:23,520
15 years this is very hard work it's

58
00:07:28,309 --> 00:07:25,919
very exacting work

59
00:07:30,629 --> 00:07:28,319
and uh you know i'm really i'm really

60
00:07:33,830 --> 00:07:30,639
pleased to have this group to talk to us

61
00:07:36,710 --> 00:07:33,840
today the the scientists as well as our

62
00:07:39,350 --> 00:07:36,720
uh science experts who will comment on

63
00:07:41,510 --> 00:07:39,360

it so let me let me introduce today's

64
00:07:43,110 --> 00:07:41,520
panel um the

65
00:07:45,990 --> 00:07:43,120
jeff marcy and paul butler are people

66
00:07:48,150 --> 00:07:46,000
that i've known for 15 years myself and

67
00:07:50,150 --> 00:07:48,160
that that makes it a double pleasure

68
00:07:52,550 --> 00:07:50,160
jeff marcy is from university of

69
00:07:55,589 --> 00:07:52,560
california in berkeley

70
00:07:59,110 --> 00:07:55,599
paul butler is from carnegie institution

71
00:08:00,629 --> 00:07:59,120
at washington dc here in town

72
00:08:03,510 --> 00:08:00,639
alan boss

73
00:08:04,550 --> 00:08:03,520
is also from the carnegie institution of

74
00:08:07,589 --> 00:08:04,560
d.c

75
00:08:11,029 --> 00:08:07,599
and heidi hamill from the space science

76
00:08:12,469 --> 00:08:11,039
institute in boulder colorado so jeff

77
00:08:16,070 --> 00:08:12,479
would you like to start out and tell us

78
00:08:21,430 --> 00:08:19,029
using the world's largest telescope the

79
00:08:23,670 --> 00:08:21,440
keck in hawaii

80
00:08:25,670 --> 00:08:23,680
and using some new improvements to our

81
00:08:28,670 --> 00:08:25,680
search technique

82
00:08:32,070 --> 00:08:28,680
we have discovered the first

83
00:08:34,389 --> 00:08:32,080
saturn-sized planets ever found outside

84
00:08:36,870 --> 00:08:34,399
our solar system

85
00:08:38,389 --> 00:08:36,880
in fact we found two saturn's and i'll

86
00:08:39,589 --> 00:08:38,399
be showing you the data for these in

87
00:08:41,750 --> 00:08:39,599
just a moment

88
00:08:43,909 --> 00:08:41,760

one of the saturn's orbits the star

89
00:08:45,829 --> 00:08:43,919
called 79 seti

90
00:08:46,630 --> 00:08:45,839
in the southern hemisphere

91
00:08:51,750 --> 00:08:46,640
and

92
00:08:56,710 --> 00:08:54,790
both of these stars being old sun-like

93
00:08:59,350 --> 00:08:56,720
stars

94
00:09:02,630 --> 00:08:59,360
an artist's rendering is shown in the

95
00:09:05,509 --> 00:09:02,640
animation if i could have it please

96
00:09:08,710 --> 00:09:05,519
this shows a star field and then the

97
00:09:12,470 --> 00:09:08,720
star itself 79 centi and what the

98
00:09:14,710 --> 00:09:12,480
saturn-sized planet may well look like

99
00:09:16,790 --> 00:09:14,720
the artist's rendering shows the size

100
00:09:17,670 --> 00:09:16,800
and orbit of the planet that we actually

101
00:09:21,110 --> 00:09:17,680
measure

102
00:09:23,509 --> 00:09:21,120
and it also shows rings and moons drawn

103
00:09:27,509 --> 00:09:23,519
speculatively to mimic

104
00:09:29,990 --> 00:09:27,519
our own saturn in our solar system

105
00:09:32,230 --> 00:09:30,000
our search technique is is well known to

106
00:09:35,590 --> 00:09:32,240
many people now it involves monitoring

107
00:09:38,870 --> 00:09:35,600
the wobble of these host stars

108
00:09:41,190 --> 00:09:38,880
shown in the next animation

109
00:09:43,910 --> 00:09:41,200
what we detect of course is the wobble

110
00:09:47,190 --> 00:09:43,920
of the star the motion of the star as it

111
00:09:50,389 --> 00:09:47,200
responds to the gravitational pull on

112
00:09:52,310 --> 00:09:50,399
the star exerted by the planet

113
00:09:53,590 --> 00:09:52,320

this wobbling motion of the star tells

114
00:09:55,590 --> 00:09:53,600
us a number of

115
00:09:58,630 --> 00:09:55,600
facts about the planet it tells us the

116
00:10:00,790 --> 00:09:58,640
minimum mass of the planet and it tells

117
00:10:05,110 --> 00:10:00,800
us the orbital size and the orbital

118
00:10:06,069 --> 00:10:05,120
shape within which the planet resides

119
00:10:08,870 --> 00:10:06,079
let me

120
00:10:11,269 --> 00:10:08,880
turn now to the data itself what's uh

121
00:10:14,550 --> 00:10:11,279
really precious to us

122
00:10:17,430 --> 00:10:14,560
the data are shown in the next graphic

123
00:10:19,269 --> 00:10:17,440
the data reveal these saturns and these

124
00:10:20,630 --> 00:10:19,279
that you see here on this graphic are

125
00:10:23,509 --> 00:10:20,640
the data

126
00:10:25,509 --> 00:10:23,519
for the star 79 seti

127
00:10:28,150 --> 00:10:25,519
what you see are the

128
00:10:31,110 --> 00:10:28,160
velocity measurements the dots

129
00:10:33,910 --> 00:10:31,120
versus time on the horizontal axis

130
00:10:35,910 --> 00:10:33,920
taken during the last two years at the

131
00:10:37,829 --> 00:10:35,920
keck telescope you can see that the

132
00:10:41,430 --> 00:10:37,839
velocity of the star

133
00:10:45,350 --> 00:10:41,440
varies back and forth like a buoy

134
00:10:47,509 --> 00:10:45,360
on water waves indicating that 79 seti

135
00:10:50,150 --> 00:10:47,519
indeed wobbles back and forth it has a

136
00:10:52,150 --> 00:10:50,160
saturn mass planet one can use newton's

137
00:10:54,389 --> 00:10:52,160
laws of physics to deduce the mass and

138
00:10:57,670 --> 00:10:54,399

orbit of the planet and that the planet

139
00:11:00,949 --> 00:10:57,680
goes around the star 79 centi uh in

140
00:11:02,949 --> 00:11:00,959
about 75 days

141
00:11:05,750 --> 00:11:02,959
the planet's orbit

142
00:11:07,430 --> 00:11:05,760
around 79 seti is similar in shape and

143
00:11:10,550 --> 00:11:07,440
size to

144
00:11:13,509 --> 00:11:10,560
mercury's orbit around the sun

145
00:11:15,670 --> 00:11:13,519
same distance and even more eccentric

146
00:11:17,269 --> 00:11:15,680
for this this planet a more elongated

147
00:11:19,509 --> 00:11:17,279
orbit

148
00:11:22,230 --> 00:11:19,519
and then finally the last graphic i'd

149
00:11:25,150 --> 00:11:22,240
like to show uh indicates the data we've

150
00:11:26,710 --> 00:11:25,160
acquired for the other star hd

151
00:11:29,269 --> 00:11:26,720
46375

152
00:11:31,910 --> 00:11:29,279
here you're only seeing three days of

153
00:11:34,150 --> 00:11:31,920
data compressed down to three days and

154
00:11:37,590 --> 00:11:34,160
you can see that the planet orbits the

155
00:11:40,310 --> 00:11:37,600
star in only three days one full wobble

156
00:11:43,269 --> 00:11:40,320
in three days and so this planet is very

157
00:11:45,509 --> 00:11:43,279
close to its host star the planet indeed

158
00:11:48,470 --> 00:11:45,519
is about 25 times

159
00:11:50,230 --> 00:11:48,480
closer to its host star than our earth

160
00:11:53,190 --> 00:11:50,240
is to the sun

161
00:11:54,949 --> 00:11:53,200
so it's scorchingly hot on this planet

162
00:11:57,910 --> 00:11:54,959
we estimate the temperature on the

163
00:12:00,150 --> 00:11:57,920

planet to be something like 2000 degrees

164
00:12:02,629 --> 00:12:00,160
fahrenheit due to the proximity of the

165
00:12:05,190 --> 00:12:02,639
planet to the star

166
00:12:06,790 --> 00:12:05,200
and i think now i'd like to turn to paul

167
00:12:10,230 --> 00:12:06,800
butler who can tell us a little more

168
00:12:11,829 --> 00:12:10,240
about the interpretations of these data

169
00:12:13,670 --> 00:12:11,839
thanks jeff

170
00:12:15,350 --> 00:12:13,680
i'm really excited about these

171
00:12:17,430 --> 00:12:15,360
discoveries because they mark two

172
00:12:20,069 --> 00:12:17,440
important mileposts uh in our

173
00:12:21,509 --> 00:12:20,079
exploration of planetary systems uh

174
00:12:22,470 --> 00:12:21,519
because of the way that these planets

175
00:12:24,550 --> 00:12:22,480
are different from the ones that have

176
00:12:26,230 --> 00:12:24,560
been found up until now

177
00:12:27,750 --> 00:12:26,240
but first i'll talk about how these

178
00:12:29,430 --> 00:12:27,760
planets are similar to what have been

179
00:12:31,990 --> 00:12:29,440
found up until now and how they relate

180
00:12:33,670 --> 00:12:32,000
to the planets that have been found

181
00:12:35,509 --> 00:12:33,680
so far all of the planets that have been

182
00:12:38,389 --> 00:12:35,519
found fall in one of two classes they're

183
00:12:40,949 --> 00:12:38,399
either these 51 peg-like orbits four-day

184
00:12:42,710 --> 00:12:40,959
orbits where the planet is roasting hot

185
00:12:44,870 --> 00:12:42,720
or they're more distant orbits but

186
00:12:46,870 --> 00:12:44,880
eccentric not circular orbits like we

187
00:12:49,030 --> 00:12:46,880
find in our own solar system

188
00:12:52,550 --> 00:12:49,040

and these two planets actually fall one

189
00:12:54,870 --> 00:12:52,560
in each class hd 46375 is one of these

190
00:12:58,069 --> 00:12:54,880
51 peg roasting planets

191
00:12:59,509 --> 00:12:58,079
and 79 ceti is eccentric so they've

192
00:13:02,069 --> 00:12:59,519
fallen in the two classes that have been

193
00:13:03,910 --> 00:13:02,079
found up until now

194
00:13:05,829 --> 00:13:03,920
these classes are very different from

195
00:13:08,310 --> 00:13:05,839
solar system planets solar system

196
00:13:11,110 --> 00:13:08,320
planets uh are in beautifully nested

197
00:13:12,949 --> 00:13:11,120
concentric circular orbits and so this

198
00:13:15,030 --> 00:13:12,959
has caused speculation that the planets

199
00:13:17,750 --> 00:13:15,040
that have been found to date are somehow

200
00:13:19,829 --> 00:13:17,760
different than solar system planets

201
00:13:22,150 --> 00:13:19,839
the way we can address this issue is to

202
00:13:24,310 --> 00:13:22,160
look at the mass distribution so if i

203
00:13:26,310 --> 00:13:24,320
can have the mass distribution graphic

204
00:13:28,069 --> 00:13:26,320
what this shows is the number of planets

205
00:13:30,389 --> 00:13:28,079
that have been detected

206
00:13:32,470 --> 00:13:30,399
versus how much mass each planet has so

207
00:13:34,790 --> 00:13:32,480
you see the the scale goes from about 0

208
00:13:36,949 --> 00:13:34,800
to about 15 jupiter mouses

209
00:13:39,030 --> 00:13:36,959
and the thing that initially was quite

210
00:13:40,629 --> 00:13:39,040
startling to us is that we're finding

211
00:13:42,629 --> 00:13:40,639
almost nothing that's this bigger than

212
00:13:44,550 --> 00:13:42,639
about 10 jupiter masses or so such

213
00:13:47,110 --> 00:13:44,560

planets are or such objects would be

214
00:13:49,110 --> 00:13:47,120
very easy to find by virtue of their

215
00:13:51,110 --> 00:13:49,120
huge gravitational field you get

216
00:13:53,269 --> 00:13:51,120
enormous wobbles and yet we're finding

217
00:13:55,350 --> 00:13:53,279
none uh instead what we're finding is

218
00:13:58,069 --> 00:13:55,360
just a trickle of planets uh sort of

219
00:14:00,150 --> 00:13:58,079
between five and ten jupiter masses and

220
00:14:01,829 --> 00:14:00,160
then as we move to smaller mass regimes

221
00:14:03,750 --> 00:14:01,839
one and two jupiter mouses we're finding

222
00:14:04,870 --> 00:14:03,760
just a torrent of discoveries that are

223
00:14:06,870 --> 00:14:04,880
coming through

224
00:14:08,710 --> 00:14:06,880
now the critical thing here is that

225
00:14:10,470 --> 00:14:08,720
these planets that the smallest end the

226
00:14:12,629 --> 00:14:10,480
one and two jupiter mass planets are the

227
00:14:14,949 --> 00:14:12,639
hardest to detect and the ones that we

228
00:14:16,310 --> 00:14:14,959
are most likely to miss in our surveys

229
00:14:18,550 --> 00:14:16,320
so this suggests that there's going to

230
00:14:20,310 --> 00:14:18,560
be many many many more small planets

231
00:14:21,590 --> 00:14:20,320
than there are large planets and of

232
00:14:23,910 --> 00:14:21,600
course the discoveries that we have

233
00:14:25,750 --> 00:14:23,920
today pushed us to even lower masses for

234
00:14:28,310 --> 00:14:25,760
the first time going under 100 earth

235
00:14:33,189 --> 00:14:30,550
now i'd like to talk about uh

236
00:14:35,750 --> 00:14:33,199
why these two discoveries are so special

237
00:14:36,629 --> 00:14:35,760
why they mark two important mild posts

238
00:14:38,710 --> 00:14:36,639

um

239
00:14:40,550 --> 00:14:38,720
first is simply that up until now the

240
00:14:42,230 --> 00:14:40,560
planets as has been stated the planets

241
00:14:45,110 --> 00:14:42,240
have been found are more like jupiter

242
00:14:47,829 --> 00:14:45,120
mass sort of 200 or more earth masses

243
00:14:49,509 --> 00:14:47,839
and uh the one enormous milestone now is

244
00:14:52,150 --> 00:14:49,519
that these things are about 70 to 80

245
00:14:54,710 --> 00:14:52,160
earth masses we've passed 100 earth mass

246
00:14:57,910 --> 00:14:54,720
limit and pushing down even further

247
00:14:59,990 --> 00:14:57,920
um and the second thing is uh this

248
00:15:03,430 --> 00:15:00,000
points out sort of the future so if i

249
00:15:05,350 --> 00:15:03,440
can have the 79 steady graphic again

250
00:15:07,350 --> 00:15:05,360
up until now we've only been able to

251
00:15:09,110 --> 00:15:07,360
find planets that induce really huge

252
00:15:11,350 --> 00:15:09,120
wobbles in their star wobbles that are

253
00:15:14,310 --> 00:15:11,360
about four times bigger than jupiter

254
00:15:16,230 --> 00:15:14,320
induces in the sun and with 79 seti for

255
00:15:18,230 --> 00:15:16,240
the first time we have a wobble here

256
00:15:20,389 --> 00:15:18,240
which is plus or minus about 11 meters a

257
00:15:23,030 --> 00:15:20,399
second which is actually smaller than

258
00:15:24,310 --> 00:15:23,040
the wobble induced on the sun by jupiter

259
00:15:26,310 --> 00:15:24,320
so for the first time we are now

260
00:15:28,550 --> 00:15:26,320
demonstrating that we can detect solar

261
00:15:30,230 --> 00:15:28,560
system like planets uh a real-live

262
00:15:31,829 --> 00:15:30,240
jupiter-like object and a real-life

263
00:15:34,629 --> 00:15:31,839

jupiter-like orbital distance things

264
00:15:36,710 --> 00:15:34,639
that would remind us of ourselves

265
00:15:38,790 --> 00:15:36,720
this is in fact now the biggest

266
00:15:41,030 --> 00:15:38,800
remaining long-term goal of this program

267
00:15:43,670 --> 00:15:41,040
to maintain this kind of precision for

268
00:15:45,749 --> 00:15:43,680
another decade so that we can answer the

269
00:15:47,110 --> 00:15:45,759
the huge looming question what fraction

270
00:15:49,430 --> 00:15:47,120
of these planetary systems are going to

271
00:15:51,350 --> 00:15:49,440
be like our own uh is our own system

272
00:15:52,790 --> 00:15:51,360
rare or is it common completely open

273
00:15:54,389 --> 00:15:52,800
question that we hope to be able to

274
00:15:56,150 --> 00:15:54,399
provide preliminary answers for within

275
00:15:58,310 --> 00:15:56,160
10 years

276
00:15:59,829 --> 00:15:58,320
that's basically my set of comments i'll

277
00:16:01,509 --> 00:15:59,839
turn it over to ann now

278
00:16:03,910 --> 00:16:01,519
thanks paul and jeff i think this

279
00:16:07,189 --> 00:16:03,920
represents an incredible achievement and

280
00:16:09,990 --> 00:16:07,199
very impressive science

281
00:16:12,870 --> 00:16:10,000
so i'd like to turn it now to uh alan

282
00:16:16,150 --> 00:16:12,880
and heidi and ask for uh comments and

283
00:16:17,990 --> 00:16:16,160
context on these results alan okay

284
00:16:19,430 --> 00:16:18,000
i'd like to comment on the

285
00:16:21,189 --> 00:16:19,440
importance of these discoveries within

286
00:16:22,790 --> 00:16:21,199
the context of what's been discovered so

287
00:16:24,310 --> 00:16:22,800
far as well as what will be discovered

288
00:16:27,030 --> 00:16:24,320

in the next few years so if i could have

289
00:16:29,670 --> 00:16:27,040
the discovery space image please

290
00:16:31,350 --> 00:16:29,680
this uh this plot shows you not only the

291
00:16:33,030 --> 00:16:31,360
masses of the objects which have been

292
00:16:35,350 --> 00:16:33,040
discovered so far but also their

293
00:16:37,030 --> 00:16:35,360
separations from their stars

294
00:16:38,629 --> 00:16:37,040
and you can see that there is at the top

295
00:16:41,030 --> 00:16:38,639
of the of the field there are a few

296
00:16:43,110 --> 00:16:41,040
possible brown dwarf companions to some

297
00:16:44,949 --> 00:16:43,120
of these nearby solar type stars but

298
00:16:47,030 --> 00:16:44,959
they're quite rare and surprisingly rare

299
00:16:48,949 --> 00:16:47,040
and there's a rather large gap between

300
00:16:50,710 --> 00:16:48,959
the least massive brown dwarf star and

301
00:16:53,350 --> 00:16:50,720
what we think is the most massive planet

302
00:16:55,189 --> 00:16:53,360
around at around 10 jupiter masses

303
00:16:56,310 --> 00:16:55,199
then below 10 jupiter masses there's

304
00:16:57,910 --> 00:16:56,320
this

305
00:16:59,509 --> 00:16:57,920
grouping of objects that we believe are

306
00:17:01,430 --> 00:16:59,519
gas giant planets very similar to our

307
00:17:03,590 --> 00:17:01,440
own jupiter and there are roughly 30 or

308
00:17:05,270 --> 00:17:03,600
so those objects now

309
00:17:07,429 --> 00:17:05,280
now what you see is first of all at the

310
00:17:11,189 --> 00:17:07,439
very bottom are the two new discoveries

311
00:17:13,029 --> 00:17:11,199
uh highly in in pink hd 46375 and 79

312
00:17:15,669 --> 00:17:13,039
seti those are the two newly discovered

313
00:17:17,590 --> 00:17:15,679

planets and as paul pointed out they map

314
00:17:19,189 --> 00:17:17,600
out a new area of discovery space

315
00:17:20,630 --> 00:17:19,199
they're pushing down the region where we

316
00:17:21,990 --> 00:17:20,640
can find extrasolar planets to

317
00:17:23,350 --> 00:17:22,000
considerably lower masses than what

318
00:17:24,710 --> 00:17:23,360
we've seen before

319
00:17:26,549 --> 00:17:24,720
the first point i want to make about

320
00:17:29,270 --> 00:17:26,559
this though is what you don't see on

321
00:17:30,630 --> 00:17:29,280
this plot which is that you do not see

322
00:17:32,150 --> 00:17:30,640
another gap

323
00:17:33,750 --> 00:17:32,160
you see there's a gap up at the top of

324
00:17:36,230 --> 00:17:33,760
the plot that helps us separate out

325
00:17:38,150 --> 00:17:36,240
brown dwarf stars from gas giant planets

326
00:17:39,669 --> 00:17:38,160
but there's no such gap evidence in the

327
00:17:42,070 --> 00:17:39,679
distribution of what we believe are

328
00:17:44,630 --> 00:17:42,080
planets implying we really are seeing a

329
00:17:46,549 --> 00:17:44,640
continuous distribution in masses of

330
00:17:48,390 --> 00:17:46,559
objects that are gas giant planets and

331
00:17:50,310 --> 00:17:48,400
going into the range perhaps of ice

332
00:17:52,390 --> 00:17:50,320
giant planets eventually and so what

333
00:17:54,150 --> 00:17:52,400
we're seeing is really just the tip of

334
00:17:56,150 --> 00:17:54,160
an iceberg that there is an

335
00:17:58,230 --> 00:17:56,160
incredible number of other plants we'll

336
00:17:59,909 --> 00:17:58,240
be finding as our search techniques

337
00:18:01,909 --> 00:17:59,919
improve if i could have the graphic

338
00:18:04,390 --> 00:18:01,919

backing i want to make the second point

339
00:18:05,270 --> 00:18:04,400
which is actually mentioned by by paul

340
00:18:06,950 --> 00:18:05,280
again

341
00:18:08,950 --> 00:18:06,960
name you'll notice that 79 seti is

342
00:18:10,150 --> 00:18:08,960
sitting out in a region of parameter

343
00:18:12,710 --> 00:18:10,160
space that is

344
00:18:14,950 --> 00:18:12,720
untouched by previous observations all

345
00:18:17,190 --> 00:18:14,960
the previous observations lie above that

346
00:18:18,789 --> 00:18:17,200
top dashed line called old detection

347
00:18:20,150 --> 00:18:18,799
limit which tells you basically that

348
00:18:21,830 --> 00:18:20,160
with a certain amount of precision of

349
00:18:23,830 --> 00:18:21,840
your radial velocity search you can find

350
00:18:26,549 --> 00:18:23,840
everything above that line

351
00:18:28,549 --> 00:18:26,559
79 city for the first time defines a new

352
00:18:30,630 --> 00:18:28,559
line the line says which says new

353
00:18:33,350 --> 00:18:30,640
detection limit pushes it down into a

354
00:18:35,909 --> 00:18:33,360
regime where we can expect to find

355
00:18:38,070 --> 00:18:35,919
around other stars jupiter

356
00:18:40,150 --> 00:18:38,080
analogs that is truly jupiter mass

357
00:18:42,150 --> 00:18:40,160
objects with 12-year period orbits like

358
00:18:43,110 --> 00:18:42,160
jupiter in our solar system and that

359
00:18:45,430 --> 00:18:43,120
sort of

360
00:18:47,909 --> 00:18:45,440
object is really in many ways the holy

361
00:18:50,549 --> 00:18:47,919
grail of what we're after now because

362
00:18:51,510 --> 00:18:50,559
such an object could actually uh

363
00:18:53,510 --> 00:18:51,520

also

364
00:18:54,870 --> 00:18:53,520
be a signpost for finding an earth-like

365
00:18:56,470 --> 00:18:54,880
planet which is which is really what

366
00:18:58,150 --> 00:18:56,480
we're trying to find and holy grail is

367
00:18:59,750 --> 00:18:58,160
sort of a term that gets used and

368
00:19:01,270 --> 00:18:59,760
overused too much i've tried to think of

369
00:19:02,950 --> 00:19:01,280
another analogy i thought perhaps the

370
00:19:05,110 --> 00:19:02,960
golden fleece but of course that has

371
00:19:07,029 --> 00:19:05,120
some rather unfortunate uh connotations

372
00:19:08,390 --> 00:19:07,039
because of senator william proxmeier but

373
00:19:09,830 --> 00:19:08,400
you get the idea we're looking for

374
00:19:12,470 --> 00:19:09,840
something which is very valuable and

375
00:19:14,310 --> 00:19:12,480
very hard to find and the real goal of

376
00:19:16,390 --> 00:19:14,320
much of this long-term program is to try

377
00:19:19,350 --> 00:19:16,400
to find a habitable earth if we can find

378
00:19:20,710 --> 00:19:19,360
a long period jupiter around a nearby

379
00:19:22,310 --> 00:19:20,720
star then that will tell us that might

380
00:19:24,470 --> 00:19:22,320
be a very good candidate for looking for

381
00:19:25,750 --> 00:19:24,480
another earth and my colleague heidi

382
00:19:27,190 --> 00:19:25,760
will be telling us a bit more about what

383
00:19:28,230 --> 00:19:27,200
we can expect to find in the next few

384
00:19:29,909 --> 00:19:28,240
years

385
00:19:31,830 --> 00:19:29,919
that's right i'd like to actually go

386
00:19:34,070 --> 00:19:31,840
back to that graphic again it's a very

387
00:19:35,350 --> 00:19:34,080
complicated graphic but it has so much

388
00:19:38,230 --> 00:19:35,360

information

389
00:19:40,230 --> 00:19:38,240
it really tells us a very a great deal

390
00:19:41,669 --> 00:19:40,240
about what we're talking about today i

391
00:19:43,990 --> 00:19:41,679
also want to highlight something that's

392
00:19:46,549 --> 00:19:44,000
not on this graphic and that is

393
00:19:48,789 --> 00:19:46,559
other planets in our solar system

394
00:19:51,190 --> 00:19:48,799
to really put this in context for you

395
00:19:53,270 --> 00:19:51,200
you see the two uh points there of the

396
00:19:55,669 --> 00:19:53,280
new star the new planets that have been

397
00:19:57,990 --> 00:19:55,679
found and you see jupiter which lies

398
00:20:01,029 --> 00:19:58,000
within the space that we can detect but

399
00:20:04,149 --> 00:20:01,039
saturn is also not in the realm of

400
00:20:05,990 --> 00:20:04,159
detectability by this technique um with

401
00:20:08,310 --> 00:20:06,000
the kinds of work that this team is

402
00:20:10,549 --> 00:20:08,320
doing they're pushing and pushing and

403
00:20:12,470 --> 00:20:10,559
pushing and they probably will be able

404
00:20:15,110 --> 00:20:12,480
to get to well they have gotten to

405
00:20:16,149 --> 00:20:15,120
saturn masses but they haven't gotten

406
00:20:17,590 --> 00:20:16,159
yet to

407
00:20:19,830 --> 00:20:17,600
saturn

408
00:20:22,549 --> 00:20:19,840
orbits and they'll probably be able to

409
00:20:24,390 --> 00:20:22,559
push down the uranus masses too and i

410
00:20:25,590 --> 00:20:24,400
expected a year or maybe even less than

411
00:20:27,830 --> 00:20:25,600
that we'll be hearing from them again

412
00:20:29,909 --> 00:20:27,840
about uranus-sized planets but what

413
00:20:31,830 --> 00:20:29,919

about earth-type planets where would

414
00:20:34,549 --> 00:20:31,840
they fall on that graph that we're

415
00:20:36,950 --> 00:20:34,559
talking about the answer is earth

416
00:20:39,590 --> 00:20:36,960
doesn't fall on that graph it's so far

417
00:20:42,549 --> 00:20:39,600
below it's so small that you wouldn't

418
00:20:43,669 --> 00:20:42,559
even see it on that figure and so we're

419
00:20:45,750 --> 00:20:43,679
really

420
00:20:49,190 --> 00:20:45,760
when we're looking to the future

421
00:20:51,430 --> 00:20:49,200
we're really looking at even

422
00:20:54,310 --> 00:20:51,440
different techniques we're looking at

423
00:20:57,750 --> 00:20:54,320
space-based missions to find terrestrial

424
00:21:01,029 --> 00:20:57,760
planets and that's of course another

425
00:21:02,870 --> 00:21:01,039
holy grail if you will or golden fleece

426
00:21:05,270 --> 00:21:02,880
we're really looking hard to find

427
00:21:07,669 --> 00:21:05,280
terrestrial-type planets it's a key goal

428
00:21:09,590 --> 00:21:07,679
of what nasa is trying to do

429
00:21:11,110 --> 00:21:09,600
and for that we're going to need to go

430
00:21:13,830 --> 00:21:11,120
into outer space and we're going to be

431
00:21:15,350 --> 00:21:13,840
needing slightly newer techniques we're

432
00:21:17,510 --> 00:21:15,360
going to be needing to use techniques

433
00:21:20,789 --> 00:21:17,520
called interferometry for example the

434
00:21:22,470 --> 00:21:20,799
space interferometer mission we'll also

435
00:21:25,029 --> 00:21:22,480
be looking at

436
00:21:26,630 --> 00:21:25,039
the terrestrial planet finder mission

437
00:21:27,510 --> 00:21:26,640
these are going to be

438
00:21:29,029 --> 00:21:27,520

very

439
00:21:32,070 --> 00:21:29,039
important things that we're going to do

440
00:21:34,470 --> 00:21:32,080
in the future the important news today

441
00:21:36,950 --> 00:21:34,480
the reason we're here talking to you

442
00:21:39,909 --> 00:21:36,960
is that the discovery of

443
00:21:41,990 --> 00:21:39,919
saturn-sized objects is an extremely

444
00:21:45,270 --> 00:21:42,000
critical step

445
00:21:47,430 --> 00:21:45,280
towards finding terrestrial type planets

446
00:21:49,830 --> 00:21:47,440
we are now as we've said pushing

447
00:21:52,070 --> 00:21:49,840
boundaries that we have not pushed

448
00:21:55,990 --> 00:21:52,080
before and so that is why we are all

449
00:22:00,549 --> 00:21:57,669
thanks heidi

450
00:22:03,510 --> 00:22:00,559
and before we go back to don i'd just

451
00:22:05,750 --> 00:22:03,520
like to ask jeff and paul

452
00:22:09,590 --> 00:22:05,760
what these discoveries tell us about our

453
00:22:13,350 --> 00:22:11,510
i think one of the remarkable

454
00:22:15,430 --> 00:22:13,360
aspects of these discoveries and our

455
00:22:17,990 --> 00:22:15,440
previous ones is that for the first time

456
00:22:19,669 --> 00:22:18,000
in human history we can compare

457
00:22:21,669 --> 00:22:19,679
the characteristics of our own solar

458
00:22:24,310 --> 00:22:21,679
system with the exquisite nine planets

459
00:22:26,870 --> 00:22:24,320
one of which we cherish the earth

460
00:22:28,549 --> 00:22:26,880
all of which reside in circular orbits

461
00:22:30,230 --> 00:22:28,559
some of them are massive like jupiter

462
00:22:32,230 --> 00:22:30,240
and saturn some of them are rocky like

463
00:22:35,110 --> 00:22:32,240

the earth mars venus

464
00:22:38,149 --> 00:22:35,120
and we have the opportunity now finally

465
00:22:41,430 --> 00:22:38,159
to compare our solar system

466
00:22:43,669 --> 00:22:41,440
to planetary systems as a generic class

467
00:22:46,070 --> 00:22:43,679
in our milky way galaxy

468
00:22:49,190 --> 00:22:46,080
and the early signs are a little bit

469
00:22:49,990 --> 00:22:49,200
frightening actually and it is in brief

470
00:22:52,390 --> 00:22:50,000
that

471
00:22:53,590 --> 00:22:52,400
the planets we are finding as paul

472
00:22:56,789 --> 00:22:53,600
alluded

473
00:23:00,230 --> 00:22:56,799
typically are in elongated eccentric

474
00:23:02,310 --> 00:23:00,240
orbits rather than circular orbits that

475
00:23:05,029 --> 00:23:02,320
characterize the nine planets in our own

476
00:23:08,070 --> 00:23:05,039
solar system and so the early returns in

477
00:23:10,950 --> 00:23:08,080
this poll of planets suggests that our

478
00:23:13,510 --> 00:23:10,960
solar system is somewhat unusual this is

479
00:23:16,230 --> 00:23:13,520
an entirely preliminary thought because

480
00:23:17,430 --> 00:23:16,240
we have not yet discovered true jupiter

481
00:23:20,310 --> 00:23:17,440
analogs

482
00:23:22,630 --> 00:23:20,320
that alan and heidi were referring to

483
00:23:25,510 --> 00:23:22,640
and when we can find jupiter analogs

484
00:23:27,750 --> 00:23:25,520
that orbit as far from their star as our

485
00:23:30,149 --> 00:23:27,760
jupiter orbits the sun then we'll be

486
00:23:33,750 --> 00:23:30,159
able to do a direct comparison but the

487
00:23:36,149 --> 00:23:33,760
early suggestion is that the orbits of

488
00:23:38,230 --> 00:23:36,159

planets around other stars are more

489
00:23:40,710 --> 00:23:38,240
eccentric than those in our own solar

490
00:23:44,310 --> 00:23:40,720
system and this may have something to do

491
00:23:46,549 --> 00:23:44,320
with the fact that biology and life has

492
00:23:49,590 --> 00:23:46,559
flourished here on the earth in our

493
00:23:54,310 --> 00:23:52,070
i'd like to um go back to the mass

494
00:23:55,510 --> 00:23:54,320
distribution diagram for just a moment

495
00:23:57,269 --> 00:23:55,520
uh

496
00:23:58,710 --> 00:23:57,279
one of the extraordinary things about

497
00:23:59,750 --> 00:23:58,720
the distribution of course is that as

498
00:24:01,110 --> 00:23:59,760
you go to lower masses you're seeing

499
00:24:02,630 --> 00:24:01,120
more and more objects although they're

500
00:24:05,510 --> 00:24:02,640
harder to detect

501
00:24:07,750 --> 00:24:05,520
and if we are to maybe somewhat wildly

502
00:24:10,070 --> 00:24:07,760
uh extrapolate that diagram down to

503
00:24:12,070 --> 00:24:10,080
earth masses the early suggestion is

504
00:24:13,590 --> 00:24:12,080
that earth mass planets are probably

505
00:24:15,029 --> 00:24:13,600
extremely common in the galaxy the

506
00:24:16,830 --> 00:24:15,039
galaxy might just be littered with earth

507
00:24:20,149 --> 00:24:16,840
mass planets

508
00:24:21,430 --> 00:24:20,159
um the second point is jeff was

509
00:24:23,909 --> 00:24:21,440
referring to was of course the

510
00:24:25,350 --> 00:24:23,919
habitability of these potential earths

511
00:24:27,110 --> 00:24:25,360
and um

512
00:24:28,710 --> 00:24:27,120
the eccentricity of the orbits of course

513
00:24:30,870 --> 00:24:28,720

of the planets we're finding right now

514
00:24:33,110 --> 00:24:30,880
probably rule out nice stable uh

515
00:24:34,549 --> 00:24:33,120
earth-like orbital positions where you

516
00:24:37,269 --> 00:24:34,559
get liquid water

517
00:24:39,029 --> 00:24:37,279
um we can have the uh the graphic of the

518
00:24:41,750 --> 00:24:39,039
orbital distribution or the uh the

519
00:24:45,990 --> 00:24:44,230
in this diagram here you see where the

520
00:24:48,549 --> 00:24:46,000
sub-saturn that was that we're

521
00:24:50,710 --> 00:24:48,559
announcing today 79 seti how it fits in

522
00:24:51,750 --> 00:24:50,720
relative to the solar system a planet

523
00:24:53,510 --> 00:24:51,760
like this

524
00:24:55,830 --> 00:24:53,520
eve it's about a border hundreds uh

525
00:24:57,909 --> 00:24:55,840
earth masses would make stable orbits in

526
00:24:59,190 --> 00:24:57,919
the inner solar system impossible so if

527
00:25:02,149 --> 00:24:59,200
such a planet were in our own solar

528
00:25:04,070 --> 00:25:02,159
system we wouldn't be here um it

529
00:25:05,750 --> 00:25:04,080
turns out that uh in addition to the

530
00:25:07,830 --> 00:25:05,760
fact that our orbit is circular which

531
00:25:09,750 --> 00:25:07,840
makes for a nice stable uh climate and

532
00:25:11,350 --> 00:25:09,760
allows liquid water to exist year round

533
00:25:13,269 --> 00:25:11,360
and life to flourish

534
00:25:16,149 --> 00:25:13,279
the other planet that's critical to our

535
00:25:18,310 --> 00:25:16,159
life uh is jupiter and the circularity

536
00:25:20,789 --> 00:25:18,320
of jupiter's orbit because jupiter is

537
00:25:22,789 --> 00:25:20,799
the big boy on the block uh more massive

538
00:25:24,310 --> 00:25:22,799

than all the other planets combined

539
00:25:25,990 --> 00:25:24,320
whatever it does it enforces on

540
00:25:27,909 --> 00:25:26,000
everybody else and by virtue of the fact

541
00:25:30,390 --> 00:25:27,919
that jupiter is in a circular orbit it

542
00:25:32,390 --> 00:25:30,400
enforces circularity on the rest of us

543
00:25:34,230 --> 00:25:32,400
jupiter does a second extremely critical

544
00:25:36,149 --> 00:25:34,240
thing which george weather pointed out

545
00:25:37,830 --> 00:25:36,159
it acts as an enormous gravitational

546
00:25:39,190 --> 00:25:37,840
vacuum cleaner sweeping up all of the

547
00:25:41,510 --> 00:25:39,200
comets and asteroids which might

548
00:25:43,830 --> 00:25:41,520
otherwise smash into us and so instead

549
00:25:45,909 --> 00:25:43,840
of having uh one of these huge dinosaur

550
00:25:47,990 --> 00:25:45,919
killing impacts every few weeks we only

551
00:25:50,310 --> 00:25:48,000
have them every uh 10 or 30 million

552
00:25:52,149 --> 00:25:50,320
years so jupiter has these two critical

553
00:25:54,230 --> 00:25:52,159
things to make our existence possible

554
00:25:55,669 --> 00:25:54,240
and that's why it's so important for us

555
00:25:57,269 --> 00:25:55,679
to find solar system analogs

556
00:25:58,630 --> 00:25:57,279
jupiter-like planets orbiting out of the

557
00:26:00,390 --> 00:25:58,640
stars

558
00:26:01,830 --> 00:26:00,400
jeff just mentioned that the early

559
00:26:03,750 --> 00:26:01,840
returns don't look good that most these

560
00:26:06,149 --> 00:26:03,760
things are eccentric it should also be

561
00:26:07,909 --> 00:26:06,159
said that we're finding planets around

562
00:26:09,190 --> 00:26:07,919
about five to ten percent of the stars

563
00:26:10,870 --> 00:26:09,200

right now and what's going on with the

564
00:26:12,390 --> 00:26:10,880
other 90 to 95 percent of the stars

565
00:26:13,990 --> 00:26:12,400
simply isn't known at this point we need

566
00:26:16,149 --> 00:26:14,000
another 10 years of data to make any

567
00:26:17,990 --> 00:26:16,159
speculation whatsoever so the field is

568
00:26:20,070 --> 00:26:18,000
completely open at this point whether

569
00:26:21,990 --> 00:26:20,080
it's every other star that has solar

570
00:26:23,590 --> 00:26:22,000
system like uh objects or every 10th

571
00:26:25,430 --> 00:26:23,600
star or every 100th or every thousand

572
00:26:27,029 --> 00:26:25,440
star completely unknown at this point

573
00:26:28,789 --> 00:26:27,039
and we hope to be able to provide some

574
00:26:29,909 --> 00:26:28,799
empirical limits within the next 10

575
00:26:32,149 --> 00:26:29,919
years

576
00:26:33,750 --> 00:26:32,159
and thanks paul and jeff that's a

577
00:26:36,310 --> 00:26:33,760
beautiful description of our solar

578
00:26:37,510 --> 00:26:36,320
system as a sort of uh family that

579
00:26:39,190 --> 00:26:37,520
protects

580
00:26:42,710 --> 00:26:39,200
where the different members protect each

581
00:26:44,070 --> 00:26:42,720
other for uh developing uh don

582
00:26:46,070 --> 00:26:44,080
all right well thank you very much uh

583
00:26:47,669 --> 00:26:46,080
we'll uh start with questions here at

584
00:26:48,870 --> 00:26:47,679
nasa headquarters and then check our

585
00:26:50,549 --> 00:26:48,880
centers for

586
00:26:52,470 --> 00:26:50,559
go and give your name and affiliate jeff

587
00:26:55,269 --> 00:26:52,480
borenstein night reader newspapers for

588
00:26:57,110 --> 00:26:55,279

dr marcy uh can you tell us exactly what

589
00:26:59,590 --> 00:26:57,120
you did to refine your technique to find

590
00:27:01,110 --> 00:26:59,600
it this way and is there what

591
00:27:04,070 --> 00:27:01,120
on this graphic it talks about new

592
00:27:06,789 --> 00:27:04,080
detection limits is there a discernible

593
00:27:09,669 --> 00:27:06,799
detection limit that you see given the

594
00:27:11,430 --> 00:27:09,679
existing technology is this it or how

595
00:27:16,310 --> 00:27:11,440
far much further can you will you be

596
00:27:21,269 --> 00:27:17,990
what has made these

597
00:27:23,750 --> 00:27:21,279
saturn discoveries possible is indeed

598
00:27:26,230 --> 00:27:23,760
some new breakthroughs technically

599
00:27:28,070 --> 00:27:26,240
in our work at the keck telescope and i

600
00:27:30,789 --> 00:27:28,080
should say that our other collaborator

601
00:27:33,590 --> 00:27:30,799
steve vogt has led the way in this

602
00:27:35,350 --> 00:27:33,600
uh he built a spectrometer which is at

603
00:27:36,710 --> 00:27:35,360
the back end if you will of the keck

604
00:27:38,549 --> 00:27:36,720
telescope five million dollar

605
00:27:40,389 --> 00:27:38,559
spectrometer without which we wouldn't

606
00:27:42,149 --> 00:27:40,399
detect any of these planets

607
00:27:45,269 --> 00:27:42,159
and what we've done in the last two

608
00:27:47,510 --> 00:27:45,279
years paul and i and steve is to learn

609
00:27:49,190 --> 00:27:47,520
some of the nuances the idiosyncrasies

610
00:27:51,669 --> 00:27:49,200
if you will of the behavior of this

611
00:27:54,070 --> 00:27:51,679
spectrometer it's a complicated optical

612
00:27:56,389 --> 00:27:54,080
device nobody could have predicted its

613
00:27:58,470 --> 00:27:56,399

actual performance ahead of time and

614
00:28:00,070 --> 00:27:58,480
we've done a large number of tests

615
00:28:02,789 --> 00:28:00,080
indeed paul and i have spent the

616
00:28:05,110 --> 00:28:02,799
majority of our time carrying out tests

617
00:28:07,350 --> 00:28:05,120
of the performance of the spectrometer

618
00:28:09,590 --> 00:28:07,360
and developing software indeed paul has

619
00:28:13,029 --> 00:28:09,600
led the way in this writing software

620
00:28:15,430 --> 00:28:13,039
that accommodates the idiosyncrasies of

621
00:28:16,950 --> 00:28:15,440
the spectrometer we account for all this

622
00:28:18,950 --> 00:28:16,960
odd behavior

623
00:28:21,190 --> 00:28:18,960
subtracted away from our measurements

624
00:28:23,909 --> 00:28:21,200
leaving us with just the clean data the

625
00:28:27,029 --> 00:28:23,919
clean wobble of the star so that's an

626
00:28:30,630 --> 00:28:27,039
enormous uh boost forward making these

627
00:28:32,389 --> 00:28:30,640
ever smaller planet detections possible

628
00:28:34,710 --> 00:28:32,399
the ultimate limit

629
00:28:37,430 --> 00:28:34,720
is indeed ahead of us

630
00:28:40,310 --> 00:28:37,440
we are measuring the velocities of stars

631
00:28:44,149 --> 00:28:40,320
to plus or minus three meters per second

632
00:28:45,909 --> 00:28:44,159
which is sort of bicycle speed uh it is

633
00:28:48,230 --> 00:28:45,919
remarkable if i may reflect on that for

634
00:28:51,110 --> 00:28:48,240
a moment these stars are enormous

635
00:28:53,750 --> 00:28:51,120
spheres uh a million times bigger than

636
00:28:56,470 --> 00:28:53,760
the earth they are two or three hundred

637
00:28:58,070 --> 00:28:56,480
light years away and these globes of gas

638
00:28:59,909 --> 00:28:58,080

can be measured to plus or minus

639
00:29:01,590 --> 00:28:59,919
bicycling speed

640
00:29:03,269 --> 00:29:01,600
but we are at that point and what we'd

641
00:29:06,230 --> 00:29:03,279
like to do is to measure the speeds of

642
00:29:09,190 --> 00:29:06,240
stars even more accurately to human

643
00:29:10,950 --> 00:29:09,200
walking speed about one meter per second

644
00:29:13,269 --> 00:29:10,960
and i think paul and i feel that that's

645
00:29:16,310 --> 00:29:13,279
a realistic goal given the

646
00:29:18,230 --> 00:29:16,320
the known vagaries of the equipment the

647
00:29:20,710 --> 00:29:18,240
light gathering power of the keck

648
00:29:22,950 --> 00:29:20,720
telescope and we think

649
00:29:24,549 --> 00:29:22,960
with the new improvements that we have

650
00:29:27,350 --> 00:29:24,559
coming down the line we will be able to

651
00:29:30,310 --> 00:29:27,360
detect not just saturn's but neptunes

652
00:29:31,430 --> 00:29:30,320
which are about third the mass of

653
00:29:33,669 --> 00:29:31,440
saturn's

654
00:29:35,990 --> 00:29:33,679
we probably will not be able to go

655
00:29:38,470 --> 00:29:36,000
further uh frankly we'll be out of

656
00:29:40,789 --> 00:29:38,480
business we think in ten years when we

657
00:29:43,110 --> 00:29:40,799
found the saturns as well as

658
00:29:44,710 --> 00:29:43,120
the neptunes and then the jupiters being

659
00:29:47,830 --> 00:29:44,720
cleaned up

660
00:29:51,029 --> 00:29:47,840
we will need indeed to turn to the new

661
00:29:53,269 --> 00:29:51,039
technology that nasa is developing

662
00:29:55,669 --> 00:29:53,279
space-borne telescopes without which we

663
00:29:57,029 --> 00:29:55,679

will never detect earth-like planets

664
00:30:00,630 --> 00:29:57,039
so you might say this is somewhat

665
00:30:02,549 --> 00:30:00,640
unusual and nasa is uh supporting you

666
00:30:05,110 --> 00:30:02,559
know ground-based astronomy but for us

667
00:30:07,190 --> 00:30:05,120
this is a very long-term commitment we

668
00:30:09,990 --> 00:30:07,200
we need the planets

669
00:30:11,830 --> 00:30:10,000
that these guys are finding and i really

670
00:30:13,830 --> 00:30:11,840
would like to emphasize that this is not

671
00:30:15,510 --> 00:30:13,840
uh this is not something they developed

672
00:30:17,269 --> 00:30:15,520
the last 15 minutes these guys have been

673
00:30:20,230 --> 00:30:17,279
at work on this for 15 years when i

674
00:30:23,590 --> 00:30:20,240
first knew jeff 15 years ago i went to

675
00:30:25,669 --> 00:30:23,600
visit uh their setup at lick observatory

676
00:30:29,350 --> 00:30:25,679
and uh you know they were hard on work

677
00:30:31,110 --> 00:30:29,360
on the zeroth generation of of this

678
00:30:33,590 --> 00:30:31,120
technology it's extraordinarily

679
00:30:34,630 --> 00:30:33,600
difficult work that is very precise and

680
00:30:39,430 --> 00:30:34,640
you have to

681
00:30:41,110 --> 00:30:39,440
really be intrepid to succeed at it

682
00:30:46,710 --> 00:30:41,120
leonard

683
00:30:48,789 --> 00:30:46,720
of a little bit on the same wavelength

684
00:30:50,710 --> 00:30:48,799
what about the complementary nature of

685
00:30:52,630 --> 00:30:50,720
the techniques you're using for space

686
00:30:55,110 --> 00:30:52,640
based are you coming up with techniques

687
00:30:57,110 --> 00:30:55,120
that could be applied to space

688
00:30:58,710 --> 00:30:57,120

based instrumentation

689
00:31:00,070 --> 00:30:58,720
i get some sense here there could be a

690
00:31:01,430 --> 00:31:00,080
race between

691
00:31:03,430 --> 00:31:01,440
breakthroughs on the ground with

692
00:31:05,750 --> 00:31:03,440
technology and what nasa is going to be

693
00:31:07,430 --> 00:31:05,760
funding to spend big dollars to put in

694
00:31:10,149 --> 00:31:07,440
space

695
00:31:12,389 --> 00:31:10,159
shall i try it go ahead um

696
00:31:13,590 --> 00:31:12,399
actually i see it a little differently i

697
00:31:15,909 --> 00:31:13,600
see the

698
00:31:18,870 --> 00:31:15,919
ground-based efforts with keck and other

699
00:31:20,710 --> 00:31:18,880
large telescopes as as complementary and

700
00:31:22,789 --> 00:31:20,720
early reconnaissance

701
00:31:24,710 --> 00:31:22,799
for the space-born work that nasa will

702
00:31:26,710 --> 00:31:24,720
be doing and which will you know blow

703
00:31:28,389 --> 00:31:26,720
our minds away i think when it happens

704
00:31:30,630 --> 00:31:28,399
and the reason i say this is that our

705
00:31:33,430 --> 00:31:30,640
technique is just limited we really will

706
00:31:36,230 --> 00:31:33,440
not be able to detect the rocky earth

707
00:31:38,789 --> 00:31:36,240
mass planets the spaceborne techniques

708
00:31:40,070 --> 00:31:38,799
both the space interferometry mission

709
00:31:42,149 --> 00:31:40,080
called sim

710
00:31:43,990 --> 00:31:42,159
being developed here at nasa and also

711
00:31:46,549 --> 00:31:44,000
the terrestrial planet finder mission

712
00:31:49,590 --> 00:31:46,559
also developed here at nasa those two

713
00:31:52,710 --> 00:31:49,600

are targeted specifically to find earth

714
00:31:54,710 --> 00:31:52,720
type planets we can't touch that so in a

715
00:31:57,909 --> 00:31:54,720
way we're operating in parallel the

716
00:32:00,630 --> 00:31:57,919
reconnaissance we do now uh will tell us

717
00:32:03,909 --> 00:32:00,640
which stars have the big bullies the

718
00:32:06,710 --> 00:32:03,919
giant planets they may be signposts for

719
00:32:09,590 --> 00:32:06,720
the earth-like planets that nasa will

720
00:32:11,830 --> 00:32:09,600
come through and detect uh in the coming

721
00:32:13,750 --> 00:32:11,840
decade or two

722
00:32:15,110 --> 00:32:13,760
come on

723
00:32:17,990 --> 00:32:15,120
there's also another element of

724
00:32:20,070 --> 00:32:18,000
competition uh in that nasa has recently

725
00:32:22,230 --> 00:32:20,080
approved another space mission called

726
00:32:24,630 --> 00:32:22,240
fame for the full sky astrometric

727
00:32:26,950 --> 00:32:24,640
mapping explorer which finds planets not

728
00:32:28,549 --> 00:32:26,960
by looking for the doppler shift of the

729
00:32:30,789 --> 00:32:28,559
star but looking for the positional

730
00:32:32,389 --> 00:32:30,799
wobble of the star on the sky

731
00:32:34,549 --> 00:32:32,399
and fame will actually have the ability

732
00:32:36,710 --> 00:32:34,559
to find these long period jupiter-like

733
00:32:39,269 --> 00:32:36,720
planets that that jeff and paul can find

734
00:32:41,110 --> 00:32:39,279
from the ground so unfortunately jeff

735
00:32:42,630 --> 00:32:41,120
and paul have a several year ahead start

736
00:32:44,470 --> 00:32:42,640
fame won't be launched for a few more

737
00:32:46,389 --> 00:32:44,480
years but once it gets up in orbit it

738
00:32:48,549 --> 00:32:46,399

will also be looking for planets in that

739
00:32:51,269 --> 00:32:48,559
same area of parameter space where

740
00:32:52,230 --> 00:32:51,279
jupiter-like objects exist so in this

741
00:32:53,350 --> 00:32:52,240
sense

742
00:32:55,350 --> 00:32:53,360
it's really very good because

743
00:32:56,549 --> 00:32:55,360
competition we all know leads to people

744
00:32:58,549 --> 00:32:56,559
to make sure they're doing the best

745
00:32:59,669 --> 00:32:58,559
possible job but it's also very

746
00:33:00,870 --> 00:32:59,679
important because it will mean that

747
00:33:02,870 --> 00:33:00,880
there will be at least one other

748
00:33:04,950 --> 00:33:02,880
technique to confirm

749
00:33:07,269 --> 00:33:04,960
each other the radial velocity confirms

750
00:33:08,549 --> 00:33:07,279
can confirm instrumentary and vice versa

751
00:33:10,389 --> 00:33:08,559
which is of course

752
00:33:11,509 --> 00:33:10,399
something we really have to

753
00:33:13,269 --> 00:33:11,519
not

754
00:33:14,630 --> 00:33:13,279
forget about in any very difficult

755
00:33:16,710 --> 00:33:14,640
astronomy you really want to make sure

756
00:33:18,710 --> 00:33:16,720
that any dubious measurement can be

757
00:33:20,149 --> 00:33:18,720
confirmed by another measurement and so

758
00:33:22,549 --> 00:33:20,159
you really are finding something which

759
00:33:25,430 --> 00:33:22,559
is reproducible but this is a very

760
00:33:27,909 --> 00:33:25,440
exciting time in a field i mean to only

761
00:33:30,389 --> 00:33:27,919
know 34. with today's announcement i

762
00:33:33,590 --> 00:33:30,399
believe the number is 34. i mean we only

763
00:33:35,909 --> 00:33:33,600

know of 34 planets outside of our solar

764
00:33:38,789 --> 00:33:35,919
system and this is brand new we're going

765
00:33:40,870 --> 00:33:38,799
to learn what animals are in that zoo

766
00:33:44,149 --> 00:33:40,880
and we have no idea today it's going to

767
00:33:44,159 --> 00:33:46,710
bob

768
00:33:50,070 --> 00:33:48,389
sorry i'm sorry one of you mentioned

769
00:33:51,590 --> 00:33:50,080
that neptune when do you mention uranus

770
00:33:52,950 --> 00:33:51,600
which is the

771
00:33:54,230 --> 00:33:52,960
outer limit of what you might do from

772
00:33:55,350 --> 00:33:54,240
groundbreaking i think we've got the

773
00:33:56,789 --> 00:33:55,360
expert

774
00:33:58,870 --> 00:33:56,799
well actually he said they're going to

775
00:34:00,230 --> 00:33:58,880
be looking at at neptune but i think

776
00:34:01,990 --> 00:34:00,240
that uranus is probably going to be

777
00:34:04,950 --> 00:34:02,000
easier for them to find because they're

778
00:34:07,990 --> 00:34:04,960
comparable masses but uranus is closer

779
00:34:09,750 --> 00:34:08,000
in so it has a shorter period and so it

780
00:34:12,230 --> 00:34:09,760
just the closer it is to the star the

781
00:34:15,030 --> 00:34:12,240
easier it is for them to find

782
00:34:19,589 --> 00:34:18,069
does your 34 population include those

783
00:34:21,349 --> 00:34:19,599
so-called free-floating planets that the

784
00:34:22,710 --> 00:34:21,359
royal academy society talked about last

785
00:34:25,510 --> 00:34:22,720
week

786
00:34:27,990 --> 00:34:25,520
i don't think so uh those are brown

787
00:34:30,710 --> 00:34:28,000
dwarfs i believe i believe they aren't

788
00:34:32,149 --> 00:34:30,720

what we would call planets they're we

789
00:34:38,310 --> 00:34:32,159
call them and this isn't meant to be

790
00:34:38,320 --> 00:34:41,270
down front and then

791
00:34:46,149 --> 00:34:44,389
randy shostak reporter with eos news

792
00:34:47,510 --> 00:34:46,159
at what point in your research of these

793
00:34:49,909 --> 00:34:47,520
planets did you

794
00:34:52,869 --> 00:34:49,919
did you say okay we've got uh some other

795
00:34:56,470 --> 00:34:52,879
planets and these are different and what

796
00:35:00,390 --> 00:34:58,230
well um

797
00:35:02,390 --> 00:35:00,400
these discoveries both sort of came on

798
00:35:04,710 --> 00:35:02,400
slowly these were not the sort of eureka

799
00:35:06,870 --> 00:35:04,720
moment discoveries we've had those also

800
00:35:09,270 --> 00:35:06,880
uh in the case of 79 seti we actually

801
00:35:11,430 --> 00:35:09,280
had a 75 day orbit for that a year ago

802
00:35:12,790 --> 00:35:11,440
and we sat on it for an additional year

803
00:35:14,710 --> 00:35:12,800
to make sure that all the data

804
00:35:16,710 --> 00:35:14,720
absolutely fit it exquisitely otherwise

805
00:35:20,550 --> 00:35:16,720
we would never have announced uh in the

806
00:35:22,230 --> 00:35:20,560
other case 46 375 that's got a slightly

807
00:35:24,150 --> 00:35:22,240
larger amplitude the amplitude for that

808
00:35:25,750 --> 00:35:24,160
is about 35 meters a second that's about

809
00:35:28,230 --> 00:35:25,760
three times larger amplitude which means

810
00:35:30,310 --> 00:35:28,240
it's three times easier to detect so

811
00:35:32,230 --> 00:35:30,320
again that that one didn't really push

812
00:35:33,829 --> 00:35:32,240
the system as much it was 79 seti that

813
00:35:35,190 --> 00:35:33,839

we really had to sit on for a long long

814
00:35:36,950 --> 00:35:35,200
time to make sure it was absolutely

815
00:35:39,109 --> 00:35:36,960
right

816
00:35:41,270 --> 00:35:39,119
yeah i'll just follow up to say that uh

817
00:35:43,510 --> 00:35:41,280
to confirm what paul said i was going

818
00:35:45,109 --> 00:35:43,520
back to my emails to remind myself of

819
00:35:48,230 --> 00:35:45,119
the history of the discovery of the

820
00:35:50,790 --> 00:35:48,240
planet around 79 centi and i have an

821
00:35:52,950 --> 00:35:50,800
email from paul that's dated august

822
00:35:54,710 --> 00:35:52,960
of 1999

823
00:35:57,589 --> 00:35:54,720
so i guess that's eight eight or nine

824
00:36:00,870 --> 00:35:57,599
months ago and in the email paul lists

825
00:36:02,630 --> 00:36:00,880
four or five hot candidates that he had

826
00:36:04,230 --> 00:36:02,640
sifted through and discovered in our

827
00:36:07,750 --> 00:36:04,240
existing database

828
00:36:08,790 --> 00:36:07,760
and 79 said he is in there so back in

829
00:36:10,710 --> 00:36:08,800
august

830
00:36:13,109 --> 00:36:10,720
the email from paul said it looks like

831
00:36:15,510 --> 00:36:13,119
it's a 75 day period and the orbital

832
00:36:17,750 --> 00:36:15,520
radius is blah and the mass is blocked

833
00:36:20,310 --> 00:36:17,760
and what we normally do at this stage is

834
00:36:22,630 --> 00:36:20,320
to wait a year typically gather more

835
00:36:24,630 --> 00:36:22,640
data and indeed the data for the past

836
00:36:27,270 --> 00:36:24,640
year has simply confirmed what we had

837
00:36:29,349 --> 00:36:27,280
known back in august of 99

838
00:36:30,710 --> 00:36:29,359

but let me repeat the question he asked

839
00:36:32,390 --> 00:36:30,720
how did you feel when you found these

840
00:36:33,750 --> 00:36:32,400
sub saturns

841
00:36:35,030 --> 00:36:33,760
um i would have been more shocked if

842
00:36:36,630 --> 00:36:35,040
we'd not found them

843
00:36:38,870 --> 00:36:36,640
we built a technique which can find

844
00:36:40,870 --> 00:36:38,880
saturn mass objects within one earth

845
00:36:41,990 --> 00:36:40,880
orbital distance and if we hadn't found

846
00:36:43,030 --> 00:36:42,000
them that would have been infinitely

847
00:36:44,790 --> 00:36:43,040
more shocking because that would have

848
00:36:46,390 --> 00:36:44,800
been there was a gap in the mass and

849
00:36:48,390 --> 00:36:46,400
maybe the objects we had found today

850
00:36:50,630 --> 00:36:48,400
weren't related to solar system planets

851
00:36:52,150 --> 00:36:50,640
but in fact we're seeing no gap as the

852
00:36:53,510 --> 00:36:52,160
technique gets better as our precision

853
00:36:55,109 --> 00:36:53,520
gets better we're finding smaller and

854
00:36:56,630 --> 00:36:55,119
smaller planets and that's exactly what

855
00:36:58,710 --> 00:36:56,640
we expect if these things are in fact

856
00:37:00,150 --> 00:36:58,720
planets as our own planets are

857
00:37:01,030 --> 00:37:00,160
so would have been shocking not to find

858
00:37:04,150 --> 00:37:01,040
them

859
00:37:06,710 --> 00:37:04,160
and i'll add another comment to that

860
00:37:08,630 --> 00:37:06,720
with regard to our emotional reactions

861
00:37:10,710 --> 00:37:08,640
it's very interesting

862
00:37:12,630 --> 00:37:10,720
when paul and i and i i can speak i

863
00:37:14,710 --> 00:37:12,640

think for both of us here when we see a

864
00:37:16,630 --> 00:37:14,720
potential planet coming down our

865
00:37:17,910 --> 00:37:16,640
conveyor belt of data

866
00:37:19,910 --> 00:37:17,920
we are indeed

867
00:37:22,470 --> 00:37:19,920
excited we're happy we're you know we

868
00:37:23,990 --> 00:37:22,480
work very hard for those moments but

869
00:37:28,470 --> 00:37:24,000
frankly the

870
00:37:30,870 --> 00:37:28,480
elation is usually tempered by the

871
00:37:33,109 --> 00:37:30,880
fright that we've made some mistakes

872
00:37:35,510 --> 00:37:33,119
somewhere and indeed that's why we spend

873
00:37:37,910 --> 00:37:35,520
an extra year following up

874
00:37:40,150 --> 00:37:37,920
doing some calculations some theoretical

875
00:37:42,230 --> 00:37:40,160
work we talk with our colleagues

876
00:37:43,990 --> 00:37:42,240
and we try to ascertain whether there's

877
00:37:47,030 --> 00:37:44,000
some way that we could have gone wrong

878
00:37:50,069 --> 00:37:47,040
and paul and i i think it's fair to say

879
00:37:52,150 --> 00:37:50,079
are proudest of the fact that of the 24

880
00:37:54,710 --> 00:37:52,160
planets we've discovered we've never

881
00:37:56,870 --> 00:37:54,720
made a false claim in the past four and

882
00:37:59,670 --> 00:37:56,880
a half years or so and it's a it's a

883
00:38:02,390 --> 00:37:59,680
track record that comes from fear and

884
00:38:05,270 --> 00:38:02,400
concern about making mistakes and

885
00:38:07,670 --> 00:38:05,280
so um you know our excitement always is

886
00:38:09,750 --> 00:38:07,680
tempered by sort of the objectivity of

887
00:38:11,829 --> 00:38:09,760
going back to the blackboard and trying

888
00:38:14,710 --> 00:38:11,839

to figure out what we can do even better

889
00:38:16,310 --> 00:38:14,720
to confirm what we suspect

890
00:38:18,310 --> 00:38:16,320
we'll take out two more questions here

891
00:38:20,630 --> 00:38:18,320
first then go to ames and then come back

892
00:38:21,750 --> 00:38:20,640
to headquarters so kurt go ahead

893
00:38:23,510 --> 00:38:21,760
curtis who played with the washington

894
00:38:25,910 --> 00:38:23,520
post can you explain to us just a little

895
00:38:27,510 --> 00:38:25,920
bit more that uh what precisely

896
00:38:29,510 --> 00:38:27,520
breakthrough it is that you're talking

897
00:38:32,310 --> 00:38:29,520
about in the detection there's no new

898
00:38:33,829 --> 00:38:32,320
detector the resolution is the same the

899
00:38:35,589 --> 00:38:33,839
instrument is the same

900
00:38:37,030 --> 00:38:35,599
so what is the technological

901
00:38:39,670 --> 00:38:37,040
breakthrough specifically that you're

902
00:38:42,310 --> 00:38:39,680
describing we model the spectrometer

903
00:38:44,310 --> 00:38:42,320
better now as the bottom line

904
00:38:45,910 --> 00:38:44,320
these detections are really incredibly

905
00:38:47,430 --> 00:38:45,920
minute uh

906
00:38:49,430 --> 00:38:47,440
literally at the point of olympic

907
00:38:52,390 --> 00:38:49,440
sprinting speed you know uh

908
00:38:54,069 --> 00:38:52,400
and uh it turns out very very teeny

909
00:38:55,670 --> 00:38:54,079
changes in the spectrometer very very

910
00:38:57,829 --> 00:38:55,680
teeny changes in how the light is

911
00:38:59,910 --> 00:38:57,839
focused by the spectrometer can dwarf

912
00:39:01,910 --> 00:38:59,920
our signal and we need to actually build

913
00:39:04,069 --> 00:39:01,920

a physical model of our spectrometer in

914
00:39:05,670 --> 00:39:04,079
the computer and we've made significant

915
00:39:08,710 --> 00:39:05,680
improvements in our modeling within the

916
00:39:14,630 --> 00:39:10,710
okay we'll take one more question here

917
00:39:16,470 --> 00:39:14,640
all right mary oh sorry sorry i just i

918
00:39:18,390 --> 00:39:16,480
you know for us that's the key question

919
00:39:20,710 --> 00:39:18,400
actually that you've asked and i'll just

920
00:39:22,310 --> 00:39:20,720
say somewhat more quantitatively

921
00:39:24,150 --> 00:39:22,320
up till a year ago

922
00:39:26,150 --> 00:39:24,160
the precision with which we could

923
00:39:29,109 --> 00:39:26,160
measure the speeds of stars was plus or

924
00:39:32,069 --> 00:39:29,119
minus eight meters per second

925
00:39:35,030 --> 00:39:32,079
and only in the last 6 to 12 months have

926
00:39:36,710 --> 00:39:35,040
these improvements that paul mentioned

927
00:39:39,109 --> 00:39:36,720
building a computer model of our

928
00:39:41,510 --> 00:39:39,119
spectrometer allowed us to achieve a

929
00:39:43,510 --> 00:39:41,520
precision of plus or minus 3 meters per

930
00:39:44,950 --> 00:39:43,520
second in fact paul and i think that our

931
00:39:47,270 --> 00:39:44,960
precision is even a little better than

932
00:39:49,829 --> 00:39:47,280
three meters a second so we have

933
00:39:53,190 --> 00:39:49,839
demonstrable improvements both in our

934
00:39:56,069 --> 00:39:53,200
results and in the approach that we took

935
00:39:58,470 --> 00:39:56,079
to get to these results

936
00:40:01,910 --> 00:40:00,230
how many other objects do you have on

937
00:40:04,710 --> 00:40:01,920
that hot list of candidates that you

938
00:40:07,589 --> 00:40:04,720

discussed from august of 99 and when

939
00:40:08,829 --> 00:40:07,599
might we learn of those

940
00:40:16,870 --> 00:40:08,839
uh

941
00:40:19,750 --> 00:40:16,880
potential jupiters are are stored on our

942
00:40:21,750 --> 00:40:19,760
hard disk that we haven't yet revealed

943
00:40:25,109 --> 00:40:21,760
it reminds me a little bit of the i love

944
00:40:26,950 --> 00:40:25,119
lucy episode where lucy says to herself

945
00:40:28,309 --> 00:40:26,960
i can have a job and make money and she

946
00:40:30,710 --> 00:40:28,319
goes to be a

947
00:40:32,550 --> 00:40:30,720
quality checker at a candy factory

948
00:40:34,790 --> 00:40:32,560
and the candies come down the conveyor

949
00:40:36,309 --> 00:40:34,800
belt and she sees them coming down and

950
00:40:38,470 --> 00:40:36,319
there's more and more candies and she

951
00:40:40,069 --> 00:40:38,480
can't check their quality and she starts

952
00:40:42,550 --> 00:40:40,079
eating them

953
00:40:45,109 --> 00:40:42,560
to just handle the flow paul and i are

954
00:40:45,990 --> 00:40:45,119
in a very lucky era which i think we're

955
00:40:48,470 --> 00:40:46,000
both

956
00:40:50,390 --> 00:40:48,480
just ecstatic about actually and that is

957
00:40:52,710 --> 00:40:50,400
we can indeed see down the line there

958
00:40:54,390 --> 00:40:52,720
are something like six to ten

959
00:40:56,150 --> 00:40:54,400
planets that we know of that we've

960
00:40:57,990 --> 00:40:56,160
emailed each other about that we talk

961
00:41:00,150 --> 00:40:58,000
about when we're at the telescope that

962
00:41:02,069 --> 00:41:00,160
look promising we are waiting for

963
00:41:04,630 --> 00:41:02,079

another half a year or year or maybe a

964
00:41:05,829 --> 00:41:04,640
year and a half of data to confirm these

965
00:41:07,670 --> 00:41:05,839
planets

966
00:41:09,430 --> 00:41:07,680
some of them are jupiter-sized we have

967
00:41:11,190 --> 00:41:09,440
one i think it's fair to say that's

968
00:41:13,109 --> 00:41:11,200
about a third of a jupiter size very

969
00:41:15,430 --> 00:41:13,119
close to a saturn we decided not to

970
00:41:17,510 --> 00:41:15,440
announce it today but it's a dead ringer

971
00:41:19,510 --> 00:41:17,520
for something about very close to a

972
00:41:21,990 --> 00:41:19,520
saturn size just a little above

973
00:41:24,710 --> 00:41:22,000
so we have a lot of them were the keck

974
00:41:26,470 --> 00:41:24,720
telescope is just this marvelous machine

975
00:41:28,950 --> 00:41:26,480
for finding planets with the

976
00:41:30,710 --> 00:41:28,960
spectrometer and we feel very lucky to

977
00:41:33,030 --> 00:41:30,720
have been in the right place with the

978
00:41:36,550 --> 00:41:33,040
right telescope to to have this conveyor

979
00:41:41,109 --> 00:41:38,150
okay we'll take questions from the aims

980
00:41:43,349 --> 00:41:41,119
research center in california and please

981
00:41:45,349 --> 00:41:43,359
give us your name and affiliation

982
00:41:47,109 --> 00:41:45,359
hi this is glenda chu from san jose

983
00:41:49,270 --> 00:41:47,119
mercury news i have two questions the

984
00:41:50,630 --> 00:41:49,280
first is is there any indication that

985
00:41:54,069 --> 00:41:50,640
either of these planets could harbor

986
00:41:57,190 --> 00:41:55,349
um

987
00:41:59,150 --> 00:41:57,200
it's very unlikely that these planets

988
00:42:01,430 --> 00:41:59,160

would have liquid water uh

989
00:42:03,349 --> 00:42:01,440
hd46375 is in one of these three-day

990
00:42:05,829 --> 00:42:03,359
orbits and so it's going to be heated to

991
00:42:08,309 --> 00:42:05,839
like about 2000 degrees fahrenheit

992
00:42:10,230 --> 00:42:08,319
uh the other planet 79 seti is in a

993
00:42:11,750 --> 00:42:10,240
75-day orbital period the orbital

994
00:42:13,589 --> 00:42:11,760
distance is in fact very similar to

995
00:42:16,069 --> 00:42:13,599
mercury in our own system so it's also

996
00:42:17,670 --> 00:42:16,079
going to be far far too hot

997
00:42:19,750 --> 00:42:17,680
so sadly no liquid water on these

998
00:42:21,589 --> 00:42:19,760
systems

999
00:42:24,710 --> 00:42:21,599
question is can you say something about

1000
00:42:26,710 --> 00:42:24,720
the status of these space-based missions

1001
00:42:28,309 --> 00:42:26,720
that would look for earth-sized planets

1002
00:42:31,910 --> 00:42:28,319
how far along are they in the conveyor

1003
00:42:33,030 --> 00:42:31,920
belt of nasa uh well let me address that

1004
00:42:35,270 --> 00:42:33,040
there's uh

1005
00:42:38,309 --> 00:42:35,280
there's really a uh

1006
00:42:40,309 --> 00:42:38,319
a sort of line of these projects that

1007
00:42:42,710 --> 00:42:40,319
are very interwoven

1008
00:42:45,270 --> 00:42:42,720
um and we we start on the ground

1009
00:42:47,910 --> 00:42:45,280
actually with the keck interferometer to

1010
00:42:50,550 --> 00:42:47,920
try to to really get a grasp on optical

1011
00:42:54,550 --> 00:42:50,560
interferometry from the ground and then

1012
00:42:56,790 --> 00:42:54,560
we do a technology test in space it's

1013
00:42:59,030 --> 00:42:56,800

called space technology three

1014
00:43:01,270 --> 00:42:59,040
and and that is to get a grasp on

1015
00:43:02,870 --> 00:43:01,280
formation flying from space because

1016
00:43:05,190 --> 00:43:02,880
that's what we eventually have to be

1017
00:43:07,510 --> 00:43:05,200
able to do to find the earth-sized

1018
00:43:09,510 --> 00:43:07,520
planets we have to do formation flying

1019
00:43:12,309 --> 00:43:09,520
and then we get a grasp on doing

1020
00:43:14,950 --> 00:43:12,319
informatory in space so that's the space

1021
00:43:17,829 --> 00:43:14,960
interferometry mission and then after

1022
00:43:19,510 --> 00:43:17,839
that and only after that after we have

1023
00:43:22,150 --> 00:43:19,520
proven each

1024
00:43:24,150 --> 00:43:22,160
brick of technology in the wall only

1025
00:43:26,150 --> 00:43:24,160
then do we go on to the terrestrial

1026
00:43:29,510 --> 00:43:26,160
planet finder where these different

1027
00:43:32,150 --> 00:43:29,520
technologies are all utilized so so this

1028
00:43:34,069 --> 00:43:32,160
is a this is a challenge nobody says

1029
00:43:36,150 --> 00:43:34,079
this is easy and i think if it were easy

1030
00:43:38,870 --> 00:43:36,160
and trivial we probably wouldn't be all

1031
00:43:41,910 --> 00:43:38,880
that interested in doing it uh it it's a

1032
00:43:48,630 --> 00:43:41,920
challenge and there is a uh a very

1033
00:43:53,829 --> 00:43:51,190
more questions from ames

1034
00:43:56,950 --> 00:43:53,839
yeah i'm later back from a brazilian

1035
00:43:59,670 --> 00:43:56,960
daily newspaper we started sao paulo and

1036
00:44:02,550 --> 00:43:59,680
my question relates to the orbits of

1037
00:44:04,710 --> 00:44:02,560
these new systems uh you said they are

1038
00:44:07,829 --> 00:44:04,720

most of them are eccentric

1039
00:44:09,910 --> 00:44:07,839
and our own solar system has concentric

1040
00:44:12,550 --> 00:44:09,920
orbits i wonder

1041
00:44:15,750 --> 00:44:12,560
if you have a good explanation for that

1042
00:44:22,790 --> 00:44:15,760
and if it's related to the age of each

1043
00:44:25,349 --> 00:44:24,069
um

1044
00:44:26,550 --> 00:44:25,359
the

1045
00:44:29,030 --> 00:44:26,560
stars

1046
00:44:32,630 --> 00:44:29,040
which we have discovered having these

1047
00:44:35,589 --> 00:44:32,640
planets in eccentric elongated orbits

1048
00:44:37,109 --> 00:44:35,599
have all types of ages some of the stars

1049
00:44:38,550 --> 00:44:37,119
are very young

1050
00:44:40,630 --> 00:44:38,560
in astronomy

1051
00:44:42,390 --> 00:44:40,640
terms that means the stars are only a

1052
00:44:44,550 --> 00:44:42,400
billion years old

1053
00:44:47,829 --> 00:44:44,560
and some of the stars are quite old 10

1054
00:44:50,390 --> 00:44:47,839
billion years old and stars of

1055
00:44:53,910 --> 00:44:50,400
either great youth or great age both

1056
00:44:56,230 --> 00:44:53,920
seem to have these eccentric oval orbits

1057
00:44:57,910 --> 00:44:56,240
we think but it's in the theoretical

1058
00:45:01,430 --> 00:44:57,920
realm that the oval orbits of the

1059
00:45:03,430 --> 00:45:01,440
planets stem from gravitational

1060
00:45:05,670 --> 00:45:03,440
slingshotting of one planet off of

1061
00:45:07,430 --> 00:45:05,680
another uh but we're not really sure

1062
00:45:09,270 --> 00:45:07,440
this is in a realm where we need to

1063
00:45:11,589 --> 00:45:09,280

gather more data and turn to the

1064
00:45:13,270 --> 00:45:11,599
theorists who are generating we could

1065
00:45:15,349 --> 00:45:13,280
try turning to our yeah and i was going

1066
00:45:17,030 --> 00:45:15,359
to say alan boss may have some ideas

1067
00:45:18,390 --> 00:45:17,040
about where the eccentric orbits come

1068
00:45:19,829 --> 00:45:18,400
from yeah that's actually an excellent

1069
00:45:21,829 --> 00:45:19,839
question in fact i think trying to

1070
00:45:23,510 --> 00:45:21,839
understand the eccentric orbits of these

1071
00:45:25,109 --> 00:45:23,520
new extrasolar planets is one of the

1072
00:45:26,470 --> 00:45:25,119
major theoretical problems it's

1073
00:45:28,150 --> 00:45:26,480
outstanding at this point it's really

1074
00:45:29,670 --> 00:45:28,160
very much a surprise because all we of

1075
00:45:31,750 --> 00:45:29,680
course had known before this was our own

1076
00:45:33,270 --> 00:45:31,760
solar system and so theorists had spent

1077
00:45:34,950 --> 00:45:33,280
several decades trying to explain

1078
00:45:36,870 --> 00:45:34,960
circular orbits now suddenly they

1079
00:45:39,030 --> 00:45:36,880
realize they've got to explain eccentric

1080
00:45:41,109 --> 00:45:39,040
orbits as well and one possible

1081
00:45:42,870 --> 00:45:41,119
explanation is what jeff just pointed

1082
00:45:44,710 --> 00:45:42,880
out that perhaps when you make several

1083
00:45:46,390 --> 00:45:44,720
planets they end up so close together

1084
00:45:47,190 --> 00:45:46,400
that they gravitationally perturb each

1085
00:45:48,470 --> 00:45:47,200
other

1086
00:45:49,750 --> 00:45:48,480
even if they start out on circular

1087
00:45:51,990 --> 00:45:49,760
orbits they kick each other into

1088
00:45:53,430 --> 00:45:52,000

eccentric orbits that's one possible way

1089
00:45:55,109 --> 00:45:53,440
of doing it although you have to worry

1090
00:45:56,309 --> 00:45:55,119
about making them so close together in

1091
00:45:58,069 --> 00:45:56,319
the first place which is probably the

1092
00:45:59,109 --> 00:45:58,079
biggest drawback to that particular

1093
00:46:00,390 --> 00:45:59,119
mechanism

1094
00:46:02,230 --> 00:46:00,400
there is another possibility though

1095
00:46:04,390 --> 00:46:02,240
which is that if you make gas giant

1096
00:46:05,990 --> 00:46:04,400
planets through a disk and stability

1097
00:46:07,670 --> 00:46:06,000
which is not the preferred way of making

1098
00:46:09,829 --> 00:46:07,680
it if you make it through a disk which

1099
00:46:12,470 --> 00:46:09,839
is cold enough and massive enough to

1100
00:46:14,390 --> 00:46:12,480
clump together into large balls of gas

1101
00:46:15,829 --> 00:46:14,400
through its own self-gravity

1102
00:46:17,190 --> 00:46:15,839
some recent simulations that i've been

1103
00:46:19,190 --> 00:46:17,200
working on at least imply that when

1104
00:46:19,829 --> 00:46:19,200
those clumps first form they start out

1105
00:46:21,270 --> 00:46:19,839
on

1106
00:46:22,790 --> 00:46:21,280
eccentric orbits so it could be that

1107
00:46:24,950 --> 00:46:22,800
that particular mechanism actually

1108
00:46:26,390 --> 00:46:24,960
produces clumps with eccentric orbits

1109
00:46:28,069 --> 00:46:26,400
but that's really

1110
00:46:29,430 --> 00:46:28,079
pretty much premature to make that claim

1111
00:46:30,870 --> 00:46:29,440
at this point because these are

1112
00:46:32,150 --> 00:46:30,880
calculations that need to be reproduced

1113
00:46:33,910 --> 00:46:32,160

by other workers

1114
00:46:35,829 --> 00:46:33,920
in terms of the conventional making

1115
00:46:37,990 --> 00:46:35,839
jupiter where you build up a solid clump

1116
00:46:39,430 --> 00:46:38,000
and then pull gas onto it those models

1117
00:46:41,190 --> 00:46:39,440
pretty much imply that you start off on

1118
00:46:43,430 --> 00:46:41,200
a circular orbit so we've got a real

1119
00:46:44,390 --> 00:46:43,440
puzzle here well let me address this

1120
00:46:47,030 --> 00:46:44,400
also

1121
00:46:49,510 --> 00:46:47,040
one thing we need to stress is that we

1122
00:46:53,190 --> 00:46:49,520
actually have been finding jupiter-sized

1123
00:46:55,910 --> 00:46:53,200
planets but we haven't yet seen

1124
00:46:57,990 --> 00:46:55,920
a jupiter a true jupiter analog in other

1125
00:47:00,630 --> 00:46:58,000
words one that is at jupiter's distance

1126
00:47:03,750 --> 00:47:00,640
from our sun we have not yet found a

1127
00:47:05,349 --> 00:47:03,760
solar system like our solar system and

1128
00:47:07,109 --> 00:47:05,359
that's because we you guys haven't been

1129
00:47:10,150 --> 00:47:07,119
observing long enough you should be back

1130
00:47:12,390 --> 00:47:10,160
at the telescope for another ten years

1131
00:47:15,510 --> 00:47:12,400
and and then after that then we might be

1132
00:47:17,670 --> 00:47:15,520
able to find solar systems that are like

1133
00:47:21,589 --> 00:47:17,680
our solar system at this point we just

1134
00:47:25,750 --> 00:47:23,030
okay we'll come back here to nasa

1135
00:47:26,790 --> 00:47:25,760
headquarters and take more questions go

1136
00:47:28,630 --> 00:47:26,800
ahead seth

1137
00:47:32,470 --> 00:47:28,640
for dr marcy just to continue on that

1138
00:47:34,069 --> 00:47:32,480

line you mentioned that perhaps our the

1139
00:47:37,030 --> 00:47:34,079
more

1140
00:47:39,670 --> 00:47:37,040
normalized circular concentric orbits of

1141
00:47:42,630 --> 00:47:39,680
our solar system are rare

1142
00:47:45,670 --> 00:47:42,640
is um how i guess i know that's more

1143
00:47:48,390 --> 00:47:45,680
theory how confident are you that you

1144
00:47:49,750 --> 00:47:48,400
that uh you they just aren't that a lot

1145
00:47:50,829 --> 00:47:49,760
of those out there that you're not

1146
00:47:53,349 --> 00:47:50,839
seeing

1147
00:47:55,270 --> 00:47:53,359
versus that they are rare i'm trying to

1148
00:47:57,829 --> 00:47:55,280
understand why you're leaning toward

1149
00:48:00,870 --> 00:47:57,839
that way yeah it's a good question um

1150
00:48:03,589 --> 00:48:00,880
here's the situation paul and i have

1151
00:48:05,270 --> 00:48:03,599
been using the keck telescope uh for the

1152
00:48:07,430 --> 00:48:05,280
past four years

1153
00:48:10,549 --> 00:48:07,440
and i should say by the way that we're

1154
00:48:12,150 --> 00:48:10,559
greatly indebted uh both to nasa and the

1155
00:48:14,390 --> 00:48:12,160
national science foundation for the

1156
00:48:16,309 --> 00:48:14,400
funding to let us do this and also to

1157
00:48:18,549 --> 00:48:16,319
the university of california that also

1158
00:48:21,109 --> 00:48:18,559
operates the keck telescope and i bring

1159
00:48:23,990 --> 00:48:21,119
this up because during the past four

1160
00:48:27,190 --> 00:48:24,000
years we've been gathering data

1161
00:48:30,230 --> 00:48:27,200
which allows us to detect planets in

1162
00:48:33,109 --> 00:48:30,240
orbits that take about four years for

1163
00:48:34,950 --> 00:48:33,119

the planet to go around if a planet took

1164
00:48:36,790 --> 00:48:34,960
more than four years to go around its

1165
00:48:37,589 --> 00:48:36,800
star we haven't been watching long

1166
00:48:39,270 --> 00:48:37,599
enough

1167
00:48:41,349 --> 00:48:39,280
and so with

1168
00:48:44,150 --> 00:48:41,359
nasa and the university of california's

1169
00:48:46,309 --> 00:48:44,160
help as well as nsf we hope to continue

1170
00:48:49,030 --> 00:48:46,319
this project for another five or ten

1171
00:48:51,829 --> 00:48:49,040
years and only then will we be sensitive

1172
00:48:54,150 --> 00:48:51,839
to planets that orbit farther away

1173
00:48:56,549 --> 00:48:54,160
namely the orbits that take longer to go

1174
00:48:58,309 --> 00:48:56,559
around their host star so the bottom

1175
00:49:00,870 --> 00:48:58,319
line is absolutely right as all i think

1176
00:49:02,950 --> 00:49:00,880
all of us now have touched on

1177
00:49:05,190 --> 00:49:02,960
we are very excited about the prospect

1178
00:49:07,589 --> 00:49:05,200
for the future which is to detect

1179
00:49:10,309 --> 00:49:07,599
planets that take as long to go around

1180
00:49:12,470 --> 00:49:10,319
their star a decade or two decades as

1181
00:49:14,630 --> 00:49:12,480
the giant planets in our solar system

1182
00:49:16,549 --> 00:49:14,640
take to go around our sun

1183
00:49:17,430 --> 00:49:16,559
but if scientists have 30 objects

1184
00:49:19,750 --> 00:49:17,440
they're going to start making

1185
00:49:22,790 --> 00:49:19,760
conclusions about 30 objects

1186
00:49:25,109 --> 00:49:22,800
who can resist that temptation

1187
00:49:26,470 --> 00:49:25,119
back over there i'm dan vergano with usa

1188
00:49:27,430 --> 00:49:26,480

today

1189
00:49:29,109 --> 00:49:27,440
i had

1190
00:49:31,829 --> 00:49:29,119
two questions really

1191
00:49:33,589 --> 00:49:31,839
on the wobble charts you showed the data

1192
00:49:35,030 --> 00:49:33,599
points i'm curious about how many data

1193
00:49:36,390 --> 00:49:35,040
points does it take

1194
00:49:40,710 --> 00:49:36,400
to

1195
00:49:46,390 --> 00:49:43,349
um we get early hints literally by the

1196
00:49:48,790 --> 00:49:46,400
fourth or fifth observation

1197
00:49:50,390 --> 00:49:48,800
but we can't really get a good orbit

1198
00:49:52,230 --> 00:49:50,400
until we've got about 15 or 20

1199
00:49:55,430 --> 00:49:52,240
observations

1200
00:49:59,349 --> 00:49:55,440
time baseline that's longer than the

1201
00:50:03,589 --> 00:50:01,030
and the other question is uh can you

1202
00:50:05,270 --> 00:50:03,599
tell me have you ruled out any stars or

1203
00:50:07,190 --> 00:50:05,280
about how many have you rolled out as

1204
00:50:09,430 --> 00:50:07,200
hosts for these hot roasters or et

1205
00:50:10,870 --> 00:50:09,440
cetera yeah the the hot roasters you

1206
00:50:13,349 --> 00:50:10,880
know if you pick a mass limit like a

1207
00:50:14,309 --> 00:50:13,359
saturn mass limit it's easy to rule out

1208
00:50:15,910 --> 00:50:14,319
you know

1209
00:50:18,150 --> 00:50:15,920
my guess is right now probably only

1210
00:50:19,829 --> 00:50:18,160
about one star out of every 200 has got

1211
00:50:23,670 --> 00:50:19,839
one of these hot roaster planets in sort

1212
00:50:26,630 --> 00:50:25,109
the uh

1213
00:50:28,309 --> 00:50:26,640

maybe the more exciting thing to rule

1214
00:50:29,589 --> 00:50:28,319
out is the presence of solar system

1215
00:50:31,750 --> 00:50:29,599
analogs

1216
00:50:33,910 --> 00:50:31,760
and while i wouldn't i wouldn't go so

1217
00:50:35,910 --> 00:50:33,920
far to say we can rule any out we do see

1218
00:50:37,430 --> 00:50:35,920
a lot of stars that are just flat line

1219
00:50:39,109 --> 00:50:37,440
dead stable that show no velocity

1220
00:50:40,950 --> 00:50:39,119
variations above our measurement error

1221
00:50:43,670 --> 00:50:40,960
of three meters a second and we're

1222
00:50:45,910 --> 00:50:43,680
seeing this now over four years five

1223
00:50:48,630 --> 00:50:45,920
years or so so those don't look real

1224
00:50:50,549 --> 00:50:48,640
promising um but let me just ask what

1225
00:50:53,270 --> 00:50:50,559
how many meters a second does the earth

1226
00:50:55,030 --> 00:50:53,280
tug the sun okay earth tugs the sun by

1227
00:50:57,910 --> 00:50:55,040
an imperceptible amount it's about one

1228
00:50:59,510 --> 00:50:57,920
tenth of a meter per second and

1229
00:51:01,109 --> 00:50:59,520
no technology in the world can come

1230
00:51:03,190 --> 00:51:01,119
close to that right now but jupiter

1231
00:51:06,069 --> 00:51:03,200
jupiter tugs the sun by 12 and a half

1232
00:51:07,190 --> 00:51:06,079
meters a second um so with 79 seti for

1233
00:51:09,190 --> 00:51:07,200
the first time we're measuring things

1234
00:51:11,349 --> 00:51:09,200
that have a smaller tug than that so

1235
00:51:13,030 --> 00:51:11,359
jupiter's are now detectable after half

1236
00:51:15,670 --> 00:51:13,040
a jupiter orbital period you expect to

1237
00:51:17,750 --> 00:51:15,680
see the star wobble by border 12 meters

1238
00:51:19,750 --> 00:51:17,760

a second and we have a number of stars

1239
00:51:21,990 --> 00:51:19,760
that after four or five years are just

1240
00:51:22,950 --> 00:51:22,000
dead at the three meter per second level

1241
00:51:24,549 --> 00:51:22,960
and so

1242
00:51:26,069 --> 00:51:24,559
i would say of order a quarter of our

1243
00:51:28,230 --> 00:51:26,079
stars don't look real promising for

1244
00:51:29,990 --> 00:51:28,240
having anything that we can detect uh

1245
00:51:32,150 --> 00:51:30,000
but it'll be fun to do this for another

1246
00:51:33,990 --> 00:51:32,160
10 years and more properly answer your

1247
00:51:39,510 --> 00:51:34,000
question

1248
00:51:44,549 --> 00:51:41,990
stu magnuson with uh space news

1249
00:51:46,630 --> 00:51:44,559
uh i just want to clarify some of you

1250
00:51:49,510 --> 00:51:46,640
kind of answered two questions ago but

1251
00:51:52,470 --> 00:51:49,520
are the wobbles uh for our eccentric

1252
00:51:54,630 --> 00:51:52,480
orbits easier to spot than the circular

1253
00:51:57,109 --> 00:51:54,640
orbits and how many have how many

1254
00:52:01,349 --> 00:51:57,119
circular orbits have you found so far if

1255
00:52:03,589 --> 00:52:02,230
the

1256
00:52:05,190 --> 00:52:03,599
um

1257
00:52:07,030 --> 00:52:05,200
the best way for me to answer the

1258
00:52:09,190 --> 00:52:07,040
question is this it's it's a little bit

1259
00:52:10,950 --> 00:52:09,200
of a complicated question

1260
00:52:13,270 --> 00:52:10,960
i would say the following

1261
00:52:15,510 --> 00:52:13,280
almost all of the planets

1262
00:52:17,910 --> 00:52:15,520
that have these elongated eccentric

1263
00:52:19,829 --> 00:52:17,920

orbits we would have detected them just

1264
00:52:22,230 --> 00:52:19,839
as easily if they had been in circular

1265
00:52:25,030 --> 00:52:22,240
orbits and and the way i'm answering it

1266
00:52:27,430 --> 00:52:25,040
is i think the important way because

1267
00:52:29,270 --> 00:52:27,440
your question is a good one we are we

1268
00:52:30,870 --> 00:52:29,280
one might well worry

1269
00:52:33,589 --> 00:52:30,880
that we have some

1270
00:52:36,230 --> 00:52:33,599
bias toward detecting the elongated

1271
00:52:38,309 --> 00:52:36,240
eccentric orbits over our ability to

1272
00:52:40,790 --> 00:52:38,319
detect circular ones and that's not the

1273
00:52:43,270 --> 00:52:40,800
case the the orbits that we've detected

1274
00:52:44,950 --> 00:52:43,280
that are elongated eccentric these wacky

1275
00:52:47,109 --> 00:52:44,960
orbits

1276
00:52:48,790 --> 00:52:47,119
if the planet had been

1277
00:52:51,030 --> 00:52:48,800
in a circular orbit we would have found

1278
00:52:54,630 --> 00:52:51,040
it just as well

1279
00:52:58,069 --> 00:52:56,470
so um

1280
00:53:00,390 --> 00:52:58,079
here's the statistic

1281
00:53:01,349 --> 00:53:00,400
for what it's worth

1282
00:53:04,069 --> 00:53:01,359
we

1283
00:53:07,910 --> 00:53:04,079
there are 24 planets known around other

1284
00:53:10,549 --> 00:53:07,920
stars that orbit farther than a tenth of

1285
00:53:13,270 --> 00:53:10,559
an earth-sun distance and every single

1286
00:53:17,270 --> 00:53:13,280
one of them 24 out of 24

1287
00:53:19,589 --> 00:53:17,280
orbits in an elongated eccentric orbit

1288
00:53:21,670 --> 00:53:19,599

the planets that we've found and other

1289
00:53:24,309 --> 00:53:21,680
teams the swiss team has contributed

1290
00:53:27,270 --> 00:53:24,319
several those planets that orbit closer

1291
00:53:29,910 --> 00:53:27,280
than one-tenth of an earth-sun distance

1292
00:53:32,230 --> 00:53:29,920
all of them are in circular orbits

1293
00:53:34,309 --> 00:53:32,240
and some people speculate that that may

1294
00:53:36,309 --> 00:53:34,319
be these circular orbits may have

1295
00:53:39,190 --> 00:53:36,319
resulted from

1296
00:53:41,829 --> 00:53:39,200
tides raised on the star and indeed

1297
00:53:45,190 --> 00:53:41,839
tides raised on the planet due to the

1298
00:53:47,030 --> 00:53:45,200
star which tend to circularize the orbit

1299
00:53:47,829 --> 00:53:47,040
even if it were not circular to begin

1300
00:53:52,390 --> 00:53:47,839
with

1301
00:53:55,270 --> 00:53:52,400
so the interesting statistic is the uh

1302
00:53:56,790 --> 00:53:55,280
24 out of 24 planets beyond a tenth of

1303
00:53:59,589 --> 00:53:56,800
an earth sun distance

1304
00:54:00,870 --> 00:53:59,599
that are in these elongated orbits

1305
00:54:01,990 --> 00:54:00,880
there are several of those though that i

1306
00:54:02,870 --> 00:54:02,000
think are

1307
00:54:04,630 --> 00:54:02,880
are

1308
00:54:06,870 --> 00:54:04,640
the planet orbits far enough away from

1309
00:54:09,030 --> 00:54:06,880
its star that the star probably hasn't

1310
00:54:10,150 --> 00:54:09,040
had enough time to circularize its orbit

1311
00:54:11,910 --> 00:54:10,160
so even though they're on circular

1312
00:54:13,750 --> 00:54:11,920
orbits those circular orbits are

1313
00:54:15,510 --> 00:54:13,760

probably primordial but as you go

1314
00:54:16,950 --> 00:54:15,520
farther away as jeff pointed out they're

1315
00:54:18,790 --> 00:54:16,960
essentially all eccentric so there's

1316
00:54:20,790 --> 00:54:18,800
some real puzzles there theoretically to

1317
00:54:22,710 --> 00:54:20,800
explain

1318
00:54:24,390 --> 00:54:22,720
okay we'll try to take them in order

1319
00:54:26,470 --> 00:54:24,400
randy and then paul

1320
00:54:28,309 --> 00:54:26,480
how do you explain the detection gap

1321
00:54:30,230 --> 00:54:28,319
between the brown dwarfs and the planets

1322
00:54:32,230 --> 00:54:30,240
that have been found and why hasn't

1323
00:54:34,069 --> 00:54:32,240
anything been found in the gap

1324
00:54:36,870 --> 00:54:34,079
brown dwarf companions the stars are

1325
00:54:38,549 --> 00:54:36,880
rare um at least within the inner three

1326
00:54:39,990 --> 00:54:38,559
times the earth sun distance which is

1327
00:54:41,270 --> 00:54:40,000
what we're probing now three times

1328
00:54:43,030 --> 00:54:41,280
anything within about three earth sun

1329
00:54:44,470 --> 00:54:43,040
distances of its star

1330
00:54:46,230 --> 00:54:44,480
we don't find any brown dwarfs we have

1331
00:54:47,829 --> 00:54:46,240
one thousand stars under survey we had

1332
00:54:49,510 --> 00:54:47,839
three telescopes we're doing a full sky

1333
00:54:51,990 --> 00:54:49,520
survey we're going to extend that to

1334
00:54:53,510 --> 00:54:52,000
2000 stars out out of 500 stars that

1335
00:54:55,030 --> 00:54:53,520
we've carefully examined now over three

1336
00:54:56,870 --> 00:54:55,040
or four years there aren't any we don't

1337
00:54:58,789 --> 00:54:56,880
see a single object so they're rare

1338
00:55:00,309 --> 00:54:58,799

brown dwarfs wild brown dwarfs are very

1339
00:55:02,549 --> 00:55:00,319
common there's probably two brown dwarfs

1340
00:55:04,230 --> 00:55:02,559
in our galaxy for every star uh for

1341
00:55:06,069 --> 00:55:04,240
whatever reason the brown dwarfs do not

1342
00:55:08,069 --> 00:55:06,079
form around stars at least within the

1343
00:55:09,510 --> 00:55:08,079
inner part of the solar system and

1344
00:55:11,109 --> 00:55:09,520
that's up to somebody like alan to

1345
00:55:12,789 --> 00:55:11,119
explain that

1346
00:55:15,109 --> 00:55:12,799
it's just empirical i can comment on

1347
00:55:16,950 --> 00:55:15,119
that also uh we have to remember that

1348
00:55:18,870 --> 00:55:16,960
discovery space diagram we showed is

1349
00:55:21,270 --> 00:55:18,880
actually for companions to solar type

1350
00:55:23,589 --> 00:55:21,280
stars stars like our sun if you did a

1351
00:55:25,829 --> 00:55:23,599
similar plot for companions to brown

1352
00:55:27,430 --> 00:55:25,839
dwarf stars you would find they all have

1353
00:55:29,190 --> 00:55:27,440
a brown dwarf companion at least half of

1354
00:55:31,990 --> 00:55:29,200
them do the point is that if you look at

1355
00:55:33,750 --> 00:55:32,000
binary stars binary stars tend to have

1356
00:55:35,510 --> 00:55:33,760
roughly equal mass companions or at

1357
00:55:37,589 --> 00:55:35,520
least a companion that's perhaps no more

1358
00:55:39,589 --> 00:55:37,599
than a third or a fifth of its mass you

1359
00:55:41,030 --> 00:55:39,599
start getting down to 101 mass ratio

1360
00:55:43,510 --> 00:55:41,040
which is where you would be for a brown

1361
00:55:45,910 --> 00:55:43,520
dwarf companion to a

1362
00:55:47,109 --> 00:55:45,920
sun-like star those things just are very

1363
00:55:49,829 --> 00:55:47,119

rare we know from looking at other

1364
00:55:51,990 --> 00:55:49,839
binary stars so when you form two stars

1365
00:55:54,549 --> 00:55:52,000
they tend to be roughly equal mass

1366
00:55:56,150 --> 00:55:54,559
and so that's why the solar type stars

1367
00:55:58,950 --> 00:55:56,160
essentially have zero brown dwarf

1368
00:56:00,549 --> 00:55:58,960
companions and that but that gives us a

1369
00:56:01,510 --> 00:56:00,559
great handle for making the argument

1370
00:56:02,549 --> 00:56:01,520
that we've really found something

1371
00:56:04,789 --> 00:56:02,559
completely different here that we're

1372
00:56:06,150 --> 00:56:04,799
finding planets not brown dwarf stars if

1373
00:56:08,150 --> 00:56:06,160
it turned out that brown dwarfs could

1374
00:56:09,270 --> 00:56:08,160
co-exist with planets we'd be in a real

1375
00:56:10,950 --> 00:56:09,280
mess right now we wouldn't be able to

1376
00:56:12,870 --> 00:56:10,960
tell the two from each other but luckily

1377
00:56:14,390 --> 00:56:12,880
nature has been kind and it's given us a

1378
00:56:16,789 --> 00:56:14,400
fairly clear signature as to what we're

1379
00:56:20,309 --> 00:56:16,799
seeing so we're really at the birth of a

1380
00:56:22,470 --> 00:56:20,319
field here as we understand the the

1381
00:56:25,190 --> 00:56:22,480
relation between different planets in a

1382
00:56:27,589 --> 00:56:25,200
planetary system and this is just the

1383
00:56:30,150 --> 00:56:27,599
very very beginning of of a field that's

1384
00:56:33,030 --> 00:56:30,160
brand new to us we we simply haven't had

1385
00:56:36,630 --> 00:56:33,040
the ability the power to see these very

1386
00:56:38,630 --> 00:56:36,640
small and dim objects in the universe

1387
00:56:40,150 --> 00:56:38,640
okay that front row we'll we'll try to

1388
00:56:41,829 --> 00:56:40,160

uh press on and get all the questions in

1389
00:56:44,789 --> 00:56:41,839
that we can but we'll have a heart out

1390
00:56:46,870 --> 00:56:44,799
here in about in eight minutes uh marcia

1391
00:56:50,309 --> 00:56:46,880
freeman with 21st century science and

1392
00:56:51,910 --> 00:56:50,319
technology magazine uh you had some

1393
00:56:54,069 --> 00:56:51,920
other announcement last november which

1394
00:56:57,349 --> 00:56:54,079
was very important relates to something

1395
00:56:59,910 --> 00:56:57,359
that dr boss said which was a transit of

1396
00:57:02,870 --> 00:56:59,920
a planet across the face of a star which

1397
00:57:05,910 --> 00:57:02,880
was a second confirming technique of a

1398
00:57:07,670 --> 00:57:05,920
planet an extrasolar planet and i'm

1399
00:57:10,630 --> 00:57:07,680
wondering if you could

1400
00:57:12,390 --> 00:57:10,640
mention what you learn additionally

1401
00:57:15,750 --> 00:57:12,400
about a planet

1402
00:57:17,829 --> 00:57:15,760
from a second confirming technique

1403
00:57:19,670 --> 00:57:17,839
let me just make one comment

1404
00:57:21,270 --> 00:57:19,680
the first and most important thing that

1405
00:57:24,069 --> 00:57:21,280
you learned from that was this is what

1406
00:57:26,390 --> 00:57:24,079
people thought they were

1407
00:57:28,789 --> 00:57:26,400
it was it was not a

1408
00:57:30,630 --> 00:57:28,799
variation in a star it was not some

1409
00:57:32,470 --> 00:57:30,640
completely other thing that we don't

1410
00:57:34,870 --> 00:57:32,480
understand

1411
00:57:37,589 --> 00:57:34,880
yeah i guess i would start by adding as

1412
00:57:39,589 --> 00:57:37,599
alan boss mentioned it's glorious in

1413
00:57:42,950 --> 00:57:39,599

science and it's the hallmark of science

1414
00:57:45,910 --> 00:57:42,960
as a human activity to have an entirely

1415
00:57:47,990 --> 00:57:45,920
independent technique by competitors

1416
00:57:50,309 --> 00:57:48,000
perhaps even

1417
00:57:52,150 --> 00:57:50,319
establish the reality of some physical

1418
00:57:54,789 --> 00:57:52,160
phenomenon which had already been

1419
00:57:57,750 --> 00:57:54,799
suspected by one technique so that's the

1420
00:58:00,069 --> 00:57:57,760
ground base that we like to operate from

1421
00:58:01,990 --> 00:58:00,079
various groups attacking a problem from

1422
00:58:02,870 --> 00:58:02,000
different directions getting the same

1423
00:58:04,870 --> 00:58:02,880
answer

1424
00:58:06,309 --> 00:58:04,880
the one thing we've learned that i think

1425
00:58:09,430 --> 00:58:06,319
is the most exciting about the

1426
00:58:13,349 --> 00:58:09,440
transiting planet is its

1427
00:58:15,910 --> 00:58:13,359
size its diameter we had known the mass

1428
00:58:17,750 --> 00:58:15,920
roughly from our wobble measurements

1429
00:58:20,230 --> 00:58:17,760
and we had known its orbit but we didn't

1430
00:58:22,710 --> 00:58:20,240
know its actual physical dimension

1431
00:58:24,549 --> 00:58:22,720
we now know that these planets are as

1432
00:58:26,789 --> 00:58:24,559
large as our own jupiter

1433
00:58:29,829 --> 00:58:26,799
approximately and that tells us that

1434
00:58:31,349 --> 00:58:29,839
they are made of gas rather than solid

1435
00:58:33,430 --> 00:58:31,359
of course an object that's solid would

1436
00:58:35,270 --> 00:58:33,440
be more compressed and smaller

1437
00:58:37,670 --> 00:58:35,280
and the transiting planet by virtue of

1438
00:58:40,069 --> 00:58:37,680

the fact that the star dims as the

1439
00:58:42,470 --> 00:58:40,079
planet crosses in front allows us to

1440
00:58:44,870 --> 00:58:42,480
measure the size of the planet and hence

1441
00:58:47,109 --> 00:58:44,880
determine that it's large and hence

1442
00:58:48,789 --> 00:58:47,119
gaseous

1443
00:58:53,510 --> 00:58:48,799
leonard

1444
00:58:56,309 --> 00:58:53,520
um maybe jump into the future a bit

1445
00:58:59,750 --> 00:58:56,319
several decades listening to dan golden

1446
00:59:01,270 --> 00:58:59,760
he's challenged you kind of folks to uh

1447
00:59:03,190 --> 00:59:01,280
to image uh

1448
00:59:04,710 --> 00:59:03,200
continents or oceans maybe a couple

1449
00:59:07,190 --> 00:59:04,720
weeks ago you might have said bald spots

1450
00:59:09,589 --> 00:59:07,200
on aliens i don't know what but it's

1451
00:59:12,789 --> 00:59:09,599
certainly a challenge what do you think

1452
00:59:14,710 --> 00:59:12,799
uh the prospect is in your own mind the

1453
00:59:17,109 --> 00:59:14,720
march of technology and again these

1454
00:59:18,549 --> 00:59:17,119
space-based capabilities of doing that

1455
00:59:21,270 --> 00:59:18,559
heidi do you want to give that a yeah

1456
00:59:24,470 --> 00:59:21,280
well ann already gave a really nice

1457
00:59:26,069 --> 00:59:24,480
summary of what nasa's plans are and how

1458
00:59:28,470 --> 00:59:26,079
they plan to proceed

1459
00:59:30,870 --> 00:59:28,480
and i think that most of us

1460
00:59:32,789 --> 00:59:30,880
recognize that that's a great plan we

1461
00:59:35,510 --> 00:59:32,799
also recognize that it's a tough thing

1462
00:59:37,270 --> 00:59:35,520
to do i think that we all understand

1463
00:59:40,150 --> 00:59:37,280

that the interferometry method is the

1464
00:59:42,870 --> 00:59:40,160
way we have to go this is where you take

1465
00:59:44,789 --> 00:59:42,880
multiple telescopes and you can separate

1466
00:59:46,390 --> 00:59:44,799
them by great distances and yet you can

1467
00:59:48,230 --> 00:59:46,400
combine the signal

1468
00:59:50,950 --> 00:59:48,240
to give you a telescope that has the

1469
00:59:52,950 --> 00:59:50,960
effective area of this the difference

1470
00:59:54,549 --> 00:59:52,960
between the two that that's really what

1471
00:59:57,670 --> 00:59:54,559
we're going to need

1472
00:59:59,829 --> 00:59:57,680
to really be able to you know see the

1473
01:00:02,470 --> 00:59:59,839
continents on another planet i think

1474
01:00:04,549 --> 01:00:02,480
another thing that most of us believe is

1475
01:00:07,510 --> 01:00:04,559
feasible in the next

1476
01:00:09,030 --> 01:00:07,520
well why don't we say in our lifetimes

1477
01:00:12,630 --> 01:00:09,040
is that that's a that's probably the

1478
01:00:15,030 --> 01:00:12,640
right time skill here um is to use these

1479
01:00:18,549 --> 01:00:15,040
very large telescopes or arrays of

1480
01:00:21,030 --> 01:00:18,559
telescopes to measure the the chemical

1481
01:00:23,270 --> 01:00:21,040
signatures of what is on these planets

1482
01:00:25,510 --> 01:00:23,280
to to use spectroscopy

1483
01:00:29,349 --> 01:00:25,520
to really detect whether or not there's

1484
01:00:31,270 --> 01:00:29,359
ozone or methane or some other kind of

1485
01:00:33,910 --> 01:00:31,280
signature that is there

1486
01:00:36,150 --> 01:00:33,920
i think most of us think that's probably

1487
01:00:39,109 --> 01:00:36,160
more likely than taking

1488
01:00:40,630 --> 01:00:39,119

pictures of these planets

1489
01:00:42,390 --> 01:00:40,640
and it's going to give us more

1490
01:00:45,750 --> 01:00:42,400
quantitative information

1491
01:00:47,510 --> 01:00:45,760
about planets around other stars

1492
01:00:49,670 --> 01:00:47,520
but after we get a spectrum of a planet

1493
01:00:51,030 --> 01:00:49,680
and find out that it has ozone it's

1494
01:00:53,030 --> 01:00:51,040
going to be i think inevitable that

1495
01:00:54,789 --> 01:00:53,040
we're going to want to eventually take

1496
01:00:57,670 --> 01:00:54,799
the big leap and build a terrestrial

1497
01:00:59,589 --> 01:00:57,680
planet imager this may be 30 40 years in

1498
01:01:00,710 --> 01:00:59,599
the future but it's something that's

1499
01:01:02,390 --> 01:01:00,720
going to be an imperative for our

1500
01:01:03,349 --> 01:01:02,400
civilization it'll be a lot easier to do

1501
01:01:05,190 --> 01:01:03,359
that than it will be to build a

1502
01:01:06,870 --> 01:01:05,200
spacecraft to go there which we'll talk

1503
01:01:07,829 --> 01:01:06,880
about even farther in the future so it's

1504
01:01:10,069 --> 01:01:07,839
one of these

1505
01:01:11,270 --> 01:01:10,079
another giant steps we'll be taking and

1506
01:01:12,710 --> 01:01:11,280
if we know that there are earths out

1507
01:01:14,390 --> 01:01:12,720
there nearby we're going to want to take

1508
01:01:15,589 --> 01:01:14,400
a picture of them and we'll figure out a

1509
01:01:16,630 --> 01:01:15,599
way to do it

1510
01:01:18,950 --> 01:01:16,640
and just to give you a little

1511
01:01:20,789 --> 01:01:18,960
perspective looking backwards 15 years

1512
01:01:23,030 --> 01:01:20,799
when these guys were starting on this 15

1513
01:01:24,390 --> 01:01:23,040

years ago people laughed at them for

1514
01:01:26,150 --> 01:01:24,400
doing this

1515
01:01:27,910 --> 01:01:26,160
jeff and i have a friend in astronomy

1516
01:01:30,309 --> 01:01:27,920
who's got a really great test for how to

1517
01:01:31,829 --> 01:01:30,319
tell whether a project is worth doing

1518
01:01:33,430 --> 01:01:31,839
and that is you you go out to dinner

1519
01:01:35,510 --> 01:01:33,440
with them and you describe the science

1520
01:01:37,670 --> 01:01:35,520
and if they all burst out laughing then

1521
01:01:40,630 --> 01:01:37,680
that's a great thing to do so you know

1522
01:01:42,069 --> 01:01:40,640
sometimes it takes very new ideas and

1523
01:01:44,470 --> 01:01:42,079
these guys are working on something that

1524
01:01:47,349 --> 01:01:44,480
15 years ago was a joke

1525
01:01:49,349 --> 01:01:47,359
no maybe not quite a joke but but most

1526
01:01:52,630 --> 01:01:49,359
astronomers were not on the wagon that

1527
01:01:54,870 --> 01:01:52,640
this is a very cool stuff and you know

1528
01:01:56,789 --> 01:01:54,880
when we sit now and look into the future

1529
01:01:59,270 --> 01:01:56,799
15 or 20 years you've really got to push

1530
01:02:01,589 --> 01:01:59,280
your ideas

1531
01:02:04,150 --> 01:02:01,599
we have time for about maybe one or two

1532
01:02:05,670 --> 01:02:04,160
more go ahead

1533
01:02:07,589 --> 01:02:05,680
i just wanted to clarify you i think

1534
01:02:09,829 --> 01:02:07,599
jeff had said that about one-fourth of

1535
01:02:12,870 --> 01:02:09,839
the stars that you look at are not good

1536
01:02:14,390 --> 01:02:12,880
candidates for planets and out of wha

1537
01:02:19,190 --> 01:02:14,400
what kind of a population is that that

1538
01:02:22,710 --> 01:02:20,950

uh let's see i'm not quite sure what

1539
01:02:25,190 --> 01:02:22,720
you're referring to

1540
01:02:27,190 --> 01:02:25,200
with regard to one quarter of the

1541
01:02:28,710 --> 01:02:27,200
stars or planets not being that was

1542
01:02:30,470 --> 01:02:28,720
paul's statement uh

1543
01:02:32,309 --> 01:02:30,480
but you know where the one quarter came

1544
01:02:33,349 --> 01:02:32,319
from just about one quarter of our stars

1545
01:02:35,190 --> 01:02:33,359
are flat they're not showing any

1546
01:02:36,549 --> 01:02:35,200
variation ah i see

1547
01:02:38,309 --> 01:02:36,559
how many stars have you looked at is

1548
01:02:41,349 --> 01:02:38,319
what he wants to know okay

1549
01:02:43,349 --> 01:02:41,359
200 500 we have right now about 1 100

1550
01:02:44,870 --> 01:02:43,359
stars in our sample about 500 stars

1551
01:02:46,390 --> 01:02:44,880
we've looked at over a long enough

1552
01:02:47,430 --> 01:02:46,400
period of time that we can say at least

1553
01:02:49,990 --> 01:02:47,440
over three or four years we're not

1554
01:02:52,470 --> 01:02:50,000
seeing variations our goal is to ramp up

1555
01:02:55,270 --> 01:02:52,480
the survey to about 2 000 stars which

1556
01:02:57,349 --> 01:02:55,280
will allow us to do every star within

1557
01:02:58,710 --> 01:02:57,359
about 150 light years and we hope to

1558
01:03:00,390 --> 01:02:58,720
ramp up within the next two or three

1559
01:03:03,349 --> 01:03:00,400
years and get every nearby star under

1560
01:03:05,270 --> 01:03:03,359
survey

1561
01:03:07,029 --> 01:03:05,280
okay unfortunately we have run out of

1562
01:03:09,029 --> 01:03:07,039
time we're losing the satellite and

1563
01:03:10,230 --> 01:03:09,039

we're going to have to

1564
01:03:11,910 --> 01:03:10,240
close down

1565
01:03:14,549 --> 01:03:11,920
you'll be available for

1566
01:03:16,549 --> 01:03:14,559
uh questions here in nasa headquarters

1567
01:03:17,750 --> 01:03:16,559
uh thank you very much for joining us

1568
01:03:18,870 --> 01:03:17,760
today

1569
01:03:20,470 --> 01:03:18,880
we

1570
01:03:22,870 --> 01:03:20,480
have a slate coming up here showing you

1571
01:03:25,109 --> 01:03:22,880
the website where you can get the images

1572
01:03:26,870 --> 01:03:25,119
uh and the other information from today

1573
01:03:29,430 --> 01:03:26,880
also information about the missions that

1574
01:03:32,710 --> 01:03:29,440
were discussed you can find at

1575
01:03:35,109 --> 01:03:32,720
the nasa website space science.nasa.gov