
Kepler
AMES RESEARCH CENTER

1
00:00:12,440 --> 00:00:10,879
good morning

2
00:00:15,259 --> 00:00:12,450
I'm John Junger Canasta public affairs

3
00:00:16,279 --> 00:00:15,269
and welcome to Moffett NASA's Ames

4
00:00:19,070 --> 00:00:16,289
Research Center at Moffett Field

5
00:00:20,720 --> 00:00:19,080
California we're here today to announce

6
00:00:22,759 --> 00:00:20,730
some exciting new discoveries for NASA's

7
00:00:25,609 --> 00:00:22,769
Kepler mission which is managed here at

8
00:00:27,320 --> 00:00:25,619
NASA Ames before we get started I'd like

9
00:00:29,000 --> 00:00:27,330
to just make a quick run to those on the

10
00:00:31,310 --> 00:00:29,010
telephone that there could be a slight

11
00:00:33,290 --> 00:00:31,320
disruption there's a sound that goes off

12
00:00:34,760 --> 00:00:33,300
your compression system if you hear it

13
00:00:36,770 --> 00:00:34,770

don't get alarmed or there's nothing

14
00:00:38,450 --> 00:00:36,780
wrong with your line we'll get started

15
00:00:42,110 --> 00:00:38,460
as soon as it ends it typically lasts

16
00:00:44,030 --> 00:00:42,120
about 60 to 90 seconds to give us

17
00:00:46,430 --> 00:00:44,040
introduction to today's briefing is the

18
00:00:55,380 --> 00:00:46,440
Ames center director Pete worden dr.

19
00:00:58,799 --> 00:00:55,390
worden good morning

20
00:01:00,510 --> 00:00:58,809
I'm very proud to have the Kepler team

21
00:01:02,760 --> 00:01:00,520
here at Ames Research Center where we're

22
00:01:04,439 --> 00:01:02,770
hosting the first Kepler science

23
00:01:06,990 --> 00:01:04,449
conference beginning in just 30 minutes

24
00:01:09,180 --> 00:01:07,000
today we'll hear about another major

25
00:01:13,380 --> 00:01:09,190
milestone on the journey to finding

26
00:01:15,570 --> 00:01:13,390
Earth's twin today's discovery is a

27
00:01:19,320 --> 00:01:15,580
tantalizing indication that with time

28
00:01:22,109 --> 00:01:19,330
kepler may find true earth analogs if

29
00:01:23,999 --> 00:01:22,119
they exist we're getting closer and

30
00:01:26,340 --> 00:01:24,009
closer to discovering the so-called

31
00:01:29,370 --> 00:01:26,350
Goldilocks planet that is both

32
00:01:32,340 --> 00:01:29,380
earth-like and in the habitable zone not

33
00:01:35,190 --> 00:01:32,350
too long ago and in the course of human

34
00:01:36,810 --> 00:01:35,200
history we didn't even know there were

35
00:01:38,910 --> 00:01:36,820
other planets outside our solar system

36
00:01:44,130 --> 00:01:38,920
even in my own lifetime we didn't know

37
00:01:46,290 --> 00:01:44,140
that it wasn't even all that long ago

38
00:01:49,169 --> 00:01:46,300

that we didn't know that the earth was

39
00:01:51,380 --> 00:01:49,179
the center of the universe now we know

40
00:01:53,460 --> 00:01:51,390
that planets are abundant in our galaxy

41
00:01:57,270 --> 00:01:53,470
one could conclude that they're likely

42
00:01:59,160 --> 00:01:57,280
abundant in the universe there are

43
00:02:01,200 --> 00:01:59,170
practically limitless discoveries and

44
00:02:04,100 --> 00:02:01,210
Kepler is making giant leaps in helping

45
00:02:06,859 --> 00:02:04,110
us understand our place in the universe

46
00:02:09,569 --> 00:02:06,869
Kepler just reached another milestone a

47
00:02:10,889 --> 00:02:09,579
thousand days since launch the

48
00:02:13,259 --> 00:02:10,899
discoveries you heard today are very

49
00:02:17,190 --> 00:02:13,269
intriguing and reflect on Kepler's great

50
00:02:18,750 --> 00:02:17,200
potential we've announced 1235 planet

51
00:02:20,449 --> 00:02:18,760
candidates in February and we're

52
00:02:22,530 --> 00:02:20,459
increasing that number today in

53
00:02:24,539 --> 00:02:22,540
confirming and exciting new discovery

54
00:02:26,880 --> 00:02:24,549
all this reflects on a dedicated

55
00:02:29,100 --> 00:02:26,890
professional team and a harbinger of

56
00:02:32,970 --> 00:02:29,110
even bigger discoveries yet to come from

57
00:02:35,490 --> 00:02:32,980
the mission now is a very special kind

58
00:02:38,789 --> 00:02:35,500
of treat I think for me I'd like to

59
00:02:41,250 --> 00:02:38,799
introduce briefly the third director of

60
00:02:46,140 --> 00:02:41,260
NASA Ames Research Center dr. Hans mark

61
00:02:49,319 --> 00:02:46,150
I'm the tenth director dr. mark has been

62
00:02:52,289 --> 00:02:49,329
my mentor he went on to become the

63
00:02:53,940 --> 00:02:52,299

secretary the Air Force the deputy NASA

64
00:02:56,039 --> 00:02:53,950
Administrator the director of Defense

65
00:02:57,060 --> 00:02:56,049
research and engineering and the

66
00:02:59,310 --> 00:02:57,070
Chancellor of the University of Texas

67
00:03:01,979 --> 00:02:59,320
System but he was there when the first

68
00:03:03,869 --> 00:03:01,989
studies were beginning to be done on

69
00:03:05,550 --> 00:03:03,879
finding planets so I'd like to ask dr.

70
00:03:08,160 --> 00:03:05,560
mark just to take a minute or two and

71
00:03:08,790 --> 00:03:08,170
tell you about the past as we're as

72
00:03:14,310 --> 00:03:08,800
thinking

73
00:03:15,300 --> 00:03:14,320
about the exciting future dr. mark thank

74
00:03:20,460 --> 00:03:15,310
you very much

75
00:03:23,630 --> 00:03:20,470
Pete for inviting me here I came from I

76
00:03:28,770 --> 00:03:23,640
came back from the dead to be here you

77
00:03:35,640 --> 00:03:31,920
just a short point we started to

78
00:03:38,850 --> 00:03:35,650
speculate about the existence of planets

79
00:03:43,200 --> 00:03:38,860
around other stars in 1971 in the summer

80
00:03:46,650 --> 00:03:43,210
of 1971 when we conducted a study here

81
00:03:49,310 --> 00:03:46,660
at Ames on how we would go about finding

82
00:03:52,260 --> 00:03:49,320
them finding these planets and of course

83
00:03:53,550 --> 00:03:52,270
one way was to assume there were people

84
00:03:56,340 --> 00:03:53,560
on them and that they were sending

85
00:04:00,060 --> 00:03:56,350
signals out and so this was called the

86
00:04:03,780 --> 00:04:00,070
Cyclops study was the first one I

87
00:04:06,900 --> 00:04:03,790
remember raising $75,000 from NASA

88
00:04:08,820 --> 00:04:06,910

headquarters to execute it and I think

89
00:04:11,520 --> 00:04:08,830
there's one other person in the room who

90
00:04:14,060 --> 00:04:11,530
was there and that's bill Borucki and

91
00:04:15,570 --> 00:04:14,070
were you there Jill you were - okay -

92
00:04:19,400 --> 00:04:15,580
okay

93
00:04:24,030 --> 00:04:19,410
and I just thought I would give you this

94
00:04:26,100 --> 00:04:24,040
short story about how we got this thing

95
00:04:35,430 --> 00:04:26,110
started so thank you very much and a

96
00:04:36,659 --> 00:04:35,440
great pleasure to be here Hans mark it's

97
00:04:38,130 --> 00:04:36,669
now my pleasure introduce our panel

98
00:04:41,850 --> 00:04:38,140
joining us here today

99
00:04:43,470 --> 00:04:41,860
is Natalie Battaglia Keppler deputy

100
00:04:45,380 --> 00:04:43,480
science team lead from San Jose State

101
00:04:47,909 --> 00:04:45,390
University

102
00:04:49,080 --> 00:04:47,919
William Baruch E Kepler principal

103
00:04:53,730 --> 00:04:49,090
investigator from NASA Ames Research

104
00:04:55,530 --> 00:04:53,740
Center and Jill tarter director of the

105
00:04:57,380 --> 00:04:55,540
center for SETI research at the SETI

106
00:04:59,370 --> 00:04:57,390
Institute in Mountain View California

107
00:05:00,810 --> 00:04:59,380
we're gonna start with open your marks

108
00:05:02,130 --> 00:05:00,820
and then take questions here at NASA

109
00:05:06,180 --> 00:05:02,140
Ames followed by our phone bridge

110
00:05:09,510 --> 00:05:06,190
Natalie thanks Jen so before we get to

111
00:05:12,030 --> 00:05:09,520
the discovery that you'll be hearing

112
00:05:14,150 --> 00:05:12,040
about I'd like to share some other news

113
00:05:17,159 --> 00:05:14,160

with you our team has just finished

114
00:05:19,920 --> 00:05:17,169
combing through an additional quarters

115
00:05:21,500 --> 00:05:19,930
worth of data to identify new planet

116
00:05:22,670 --> 00:05:21,510
candidates

117
00:05:25,850 --> 00:05:22,680
and I'd like to share with you the

118
00:05:28,220 --> 00:05:25,860
results of that effort we can start with

119
00:05:31,370 --> 00:05:28,230
the first slide that reminds us of what

120
00:05:34,040 --> 00:05:31,380
the objective of Kepler is we've got a

121
00:05:36,470 --> 00:05:34,050
deliverable a very specific task at hand

122
00:05:38,150 --> 00:05:36,480
which is to determine the fraction of

123
00:05:40,010 --> 00:05:38,160
stars in our galaxy that harbours

124
00:05:42,230 --> 00:05:40,020
potentially habitable earth-sized

125
00:05:45,170 --> 00:05:42,240
planets and we must be mindful of that

126
00:05:49,090 --> 00:05:45,180
and our strategies and our priorities

127
00:05:52,160 --> 00:05:49,100
are devised to accomplish that one goal

128
00:05:54,320 --> 00:05:52,170
since we've launched in 2009 we've

129
00:05:57,530 --> 00:05:54,330
released two catalogs of planet

130
00:06:00,950 --> 00:05:57,540
candidates the first one was in June of

131
00:06:05,120 --> 00:06:00,960
2010 and it was based on four months

132
00:06:08,000 --> 00:06:05,130
worth of data so with this slide I can

133
00:06:10,940 --> 00:06:08,010
communicate to you the results of that

134
00:06:12,770 --> 00:06:10,950
catalog by plotting the size of the

135
00:06:15,740 --> 00:06:12,780
planet candidate versus the orbital

136
00:06:18,350 --> 00:06:15,750
period on the x-axis and some horizontal

137
00:06:20,960 --> 00:06:18,360
lines are added there for guidance to

138
00:06:23,330 --> 00:06:20,970

show you different reference points the

139
00:06:26,650 --> 00:06:23,340
earth Neptune and Jupiter and in this

140
00:06:30,320 --> 00:06:26,660
June catalog we had 312 candidates and

141
00:06:31,850 --> 00:06:30,330
what was most noticeable about it is

142
00:06:34,250 --> 00:06:31,860
that most of those candidates were

143
00:06:37,420 --> 00:06:34,260
smaller than Neptune suggesting that

144
00:06:41,420 --> 00:06:37,430
small planets are going to be common

145
00:06:43,550 --> 00:06:41,430
after June our next catalog release did

146
00:06:48,860 --> 00:06:43,560
not come until February of 2011

147
00:06:51,560 --> 00:06:48,870
and that data analysis was based on 13

148
00:06:54,970 --> 00:06:51,570
months of data so we went from four

149
00:06:57,320 --> 00:06:54,980
months to 13 months and it's no surprise

150
00:06:59,720 --> 00:06:57,330
therefore that the number of candidates

151
00:07:02,540 --> 00:06:59,730
increased significantly so if I can have

152
00:07:05,000 --> 00:07:02,550
the next slide we have the same plot

153
00:07:07,190 --> 00:07:05,010
here but now we've added a group of red

154
00:07:09,860 --> 00:07:07,200
points which indicate the new candidates

155
00:07:11,270 --> 00:07:09,870
in that February 2011 catalog and you

156
00:07:13,100 --> 00:07:11,280
can see it with the counter on the

157
00:07:15,740 --> 00:07:13,110
bottom left-hand corner that the total

158
00:07:20,090 --> 00:07:15,750
number of candidates jumped from 312 up

159
00:07:26,600 --> 00:07:20,100
to 1235 a really gigantic increase in

160
00:07:29,180 --> 00:07:26,610
the number of candidates of those 1235

161
00:07:33,230 --> 00:07:29,190
they're actually associated with 997

162
00:07:34,470 --> 00:07:33,240
stars and what that means is that 17% of

163
00:07:36,600 --> 00:07:34,480

these stars had molt

164
00:07:39,470 --> 00:07:36,610
for planet candidates and that's turned

165
00:07:41,940 --> 00:07:39,480
out to be enormous ly important to us

166
00:07:43,590 --> 00:07:41,950
enormous ly important for accomplishing

167
00:07:46,140 --> 00:07:43,600
our science objectives because these

168
00:07:50,250 --> 00:07:46,150
multis are turning out to be very

169
00:07:53,160 --> 00:07:50,260
powerful systems for confirming the

170
00:07:54,630 --> 00:07:53,170
smallest planets and this data set also

171
00:07:57,420 --> 00:07:54,640
gave us our first habitable zone

172
00:07:59,310 --> 00:07:57,430
candidates and so we were very pleased

173
00:08:03,420 --> 00:07:59,320
about that and and this is where we left

174
00:08:05,940 --> 00:08:03,430
off now I'm going to present new

175
00:08:07,830 --> 00:08:05,950
candidates that have been identified in

176
00:08:09,450 --> 00:08:07,840
this additional quarters worth of data

177
00:08:12,720 --> 00:08:09,460
so what we've done now is we've gone

178
00:08:15,240 --> 00:08:12,730
from 13 months of data to 16 months of

179
00:08:17,760 --> 00:08:15,250
data so we really haven't added that

180
00:08:19,310 --> 00:08:17,770
much data to the pool to the mix and we

181
00:08:22,800 --> 00:08:19,320
weren't quite sure what we would expect

182
00:08:25,050 --> 00:08:22,810
what to expect however if I can have the

183
00:08:28,380 --> 00:08:25,060
next slide the number of planet

184
00:08:29,870 --> 00:08:28,390
candidates has nearly doubled with this

185
00:08:32,310 --> 00:08:29,880
additional three months worth of data

186
00:08:34,770 --> 00:08:32,320
and you can see them here depicted by

187
00:08:39,120 --> 00:08:34,780
the yellow points with the counter in

188
00:08:43,980 --> 00:08:39,130

the bottom left-hand corner this pool of

189
00:08:46,710 --> 00:08:43,990
yellow points represents 1094 new planet

190
00:08:48,240 --> 00:08:46,720
candidates bringing that total up to two

191
00:08:53,250 --> 00:08:48,250
thousand three hundred twenty six and

192
00:08:56,670 --> 00:08:53,260
those are associated with 1792 stars so

193
00:08:59,100 --> 00:08:56,680
we still see this indication of lots of

194
00:09:01,230 --> 00:08:59,110
multiple systems systems where the

195
00:09:03,570 --> 00:09:01,240
planets are flat enough in their orbits

196
00:09:05,780 --> 00:09:03,580
that you get multiple transiting signals

197
00:09:09,990 --> 00:09:05,790
from each of these successive planets

198
00:09:12,000 --> 00:09:10,000
the percentage of multis was 17 percent

199
00:09:13,860 --> 00:09:12,010
in February and now it's gone up a

200
00:09:16,050 --> 00:09:13,870
little

201
00:09:19,020 --> 00:09:16,060
that we did have 170 stars with

202
00:09:21,870 --> 00:09:19,030
multiples and now we've got 367 so the

203
00:09:23,550 --> 00:09:21,880
numbers more than doubled what you can

204
00:09:25,230 --> 00:09:23,560
see nicely in this plot with these

205
00:09:27,810 --> 00:09:25,240
different colors is how the parameter

206
00:09:30,000 --> 00:09:27,820
space is spreading as we collect more

207
00:09:31,980 --> 00:09:30,010
data as you go from blue to red to

208
00:09:34,140 --> 00:09:31,990
yellow you can see quite clearly that

209
00:09:36,900 --> 00:09:34,150
we're pushing down to smaller planets

210
00:09:39,240 --> 00:09:36,910
and longer orbital periods and now we've

211
00:09:41,100 --> 00:09:39,250
got sizeable numbers of candidates that

212
00:09:45,600 --> 00:09:41,110
are not just earth size but actually

213
00:09:48,330 --> 00:09:45,610

below that earth size line in the next

214
00:09:50,700 --> 00:09:48,340
slide you can see the distribution of

215
00:09:54,120 --> 00:09:50,710
which speaks to the gains that we've

216
00:09:56,580 --> 00:09:54,130
seen broken down by size and so from the

217
00:09:59,160 --> 00:09:56,590
left to the right we go from earth size

218
00:10:03,000 --> 00:09:59,170
to super earth size to the Neptune size

219
00:10:05,340 --> 00:10:03,010
Jupiter size and larger Neptune size has

220
00:10:07,320 --> 00:10:05,350
a very large range of definition it's

221
00:10:11,730 --> 00:10:07,330
from twice the size of earth all the way

222
00:10:13,769 --> 00:10:11,740
up to six so it brackets Neptune what

223
00:10:16,320 --> 00:10:13,779
you see in this chart though is that the

224
00:10:19,079 --> 00:10:16,330
increases are predominantly in the

225
00:10:22,590 --> 00:10:19,089
smaller planets the number of earth size

226
00:10:24,990 --> 00:10:22,600
candidates has is now 207 if you

227
00:10:27,420 --> 00:10:25,000
remember in February it was 68 so that

228
00:10:29,300 --> 00:10:27,430
represents over 200 percent increase in

229
00:10:31,650 --> 00:10:29,310
the number of Earth size candidates

230
00:10:32,730 --> 00:10:31,660
similarly for the super earth size we've

231
00:10:34,590 --> 00:10:32,740
got an increase of over a hundred

232
00:10:36,630 --> 00:10:34,600
percent one hundred and thirty six

233
00:10:39,690 --> 00:10:36,640
percent and you don't see that gained

234
00:10:41,460 --> 00:10:39,700
for the larger planets 23 percent and 42

235
00:10:43,620 --> 00:10:41,470
percent for the Jupiter and larger than

236
00:10:45,269 --> 00:10:43,630
Jupiter and this is what this is to be

237
00:10:47,970 --> 00:10:45,279
expected right because as you collect

238
00:10:50,070 --> 00:10:47,980

more data you gain sensitivity to the

239
00:10:51,960 --> 00:10:50,080
smaller signals because you average the

240
00:10:54,150 --> 00:10:51,970
noise down you beat the noise down and

241
00:10:56,790 --> 00:10:54,160
you tease out those very shallow signals

242
00:10:59,280 --> 00:10:56,800
so we expected to see more earth sized

243
00:11:01,200 --> 00:10:59,290
planets however the reality is that

244
00:11:03,480 --> 00:11:01,210
we've also just gotten a lot better at

245
00:11:06,390 --> 00:11:03,490
this we've had a lot of pipeline

246
00:11:08,370 --> 00:11:06,400
improvements that have facilitated the

247
00:11:10,380 --> 00:11:08,380
identification of these smaller planets

248
00:11:12,570 --> 00:11:10,390
and I believe that the growth that we're

249
00:11:16,050 --> 00:11:12,580
seeing here is an indication of these

250
00:11:18,060 --> 00:11:16,060
more powerful pipeline modules and more

251
00:11:20,010 --> 00:11:18,070
powerful statistics for vetting out

252
00:11:22,100 --> 00:11:20,020
which are the true planet candidates and

253
00:11:26,220 --> 00:11:22,110
which are the false positives and that's

254
00:11:28,230 --> 00:11:26,230
contributed to the success in the next

255
00:11:31,350 --> 00:11:28,240
diagram what I'm going to do is switch

256
00:11:34,350 --> 00:11:31,360
the x-axis and instead of plotting the

257
00:11:36,390 --> 00:11:34,360
size against orbital period I'm going to

258
00:11:38,460 --> 00:11:36,400
plot the size against equilibrium

259
00:11:40,380 --> 00:11:38,470
temperature so this is the temperature

260
00:11:43,829 --> 00:11:40,390
you would expect to have on the surface

261
00:11:47,250 --> 00:11:43,839
of a planet being irradiated by a star

262
00:11:49,800 --> 00:11:47,260
at a certain distance no consideration

263
00:11:53,400 --> 00:11:49,810

of atmosphere just a simple equilibrium

264
00:11:55,410 --> 00:11:53,410
temperature and plotted there for

265
00:11:58,650 --> 00:11:55,420
reference in the bottom left-hand corner

266
00:12:01,140 --> 00:11:58,660
is our earth we would have an

267
00:12:02,030 --> 00:12:01,150
equilibrium temperature of about 255

268
00:12:06,030 --> 00:12:02,040
Kelvin

269
00:12:08,130 --> 00:12:06,040
sitting there at one earth radius and as

270
00:12:09,990 --> 00:12:08,140
you go from the blue points to the red

271
00:12:11,820 --> 00:12:10,000
points to the yellow points in that

272
00:12:13,800 --> 00:12:11,830
bottom left-hand corner you can see

273
00:12:17,700 --> 00:12:13,810
quite clearly that we are encroaching

274
00:12:19,980 --> 00:12:17,710
upon this parameter space occupied by

275
00:12:23,010 --> 00:12:19,990
our earth we are getting very close we

276
00:12:26,430 --> 00:12:23,020
are really honing in on the true earth

277
00:12:28,829 --> 00:12:26,440
size habitable planets now the green

278
00:12:30,840 --> 00:12:28,839
shaded region is marking the planet

279
00:12:34,550 --> 00:12:30,850
candidates that span equilibrium

280
00:12:38,010 --> 00:12:34,560
temperatures of 223 degrees Kelvin to

281
00:12:42,690 --> 00:12:38,020
373 that brackets a little bit below the

282
00:12:44,730 --> 00:12:42,700
freezing point of water up to the vapor

283
00:12:47,040 --> 00:12:44,740
point the boiling point of water and

284
00:12:48,900 --> 00:12:47,050
this was our definition of the habitable

285
00:12:51,720 --> 00:12:48,910
zone back in February and by this

286
00:12:55,110 --> 00:12:51,730
definition we had 54 planet candidates

287
00:12:57,360 --> 00:12:55,120
if you remember the thing is that with

288
00:13:00,780 --> 00:12:57,370

the discovery of more and more habitable

289
00:13:03,390 --> 00:13:00,790
planets scientists are becoming more

290
00:13:07,550 --> 00:13:03,400
discerning about what constitutes

291
00:13:09,630 --> 00:13:07,560
habitability and and recognizing that

292
00:13:11,070 --> 00:13:09,640
water's not going to exist on the

293
00:13:13,829 --> 00:13:11,080
surface of a planet if you have no

294
00:13:14,880 --> 00:13:13,839
atmosphere right you have to have an

295
00:13:18,600 --> 00:13:14,890
atmosphere you have to have some

296
00:13:20,820 --> 00:13:18,610
pressure and any atmosphere that you

297
00:13:21,930 --> 00:13:20,830
have is going to work to warm the planet

298
00:13:26,400 --> 00:13:21,940
is going to have a greenhouse effect

299
00:13:27,960 --> 00:13:26,410
right so this changes the the zone of

300
00:13:32,940 --> 00:13:27,970
habitability right it's going to push

301
00:13:35,250 --> 00:13:32,950
out the Goldilocks zone so if we think

302
00:13:38,310 --> 00:13:35,260
about that and recognize that we can

303
00:13:40,200 --> 00:13:38,320
change our criteria our criterion for

304
00:13:43,170 --> 00:13:40,210
habitat habitability by moving the

305
00:13:45,810 --> 00:13:43,180
equilibrium temperature zone and so the

306
00:13:48,720 --> 00:13:45,820
next chart shows you the temperature

307
00:13:51,990 --> 00:13:48,730
range that we're considering it's 185

308
00:13:54,030 --> 00:13:52,000
Kelvin to 303 and if you toggle back and

309
00:13:57,210 --> 00:13:54,040
forth between the previous slide in this

310
00:14:00,810 --> 00:13:57,220
slide you can see how that zone is not

311
00:14:03,300 --> 00:14:00,820
only moving to the left to shorter to

312
00:14:06,300 --> 00:14:03,310
lower equilibrium temperatures it's also

313
00:14:08,579 --> 00:14:06,310

narrowed a bit so our definition of

314
00:14:11,070 --> 00:14:08,589
habitability has become more discerning

315
00:14:12,530 --> 00:14:11,080
and with this new definition we've got

316
00:14:13,960 --> 00:14:12,540
48

317
00:14:16,449 --> 00:14:13,970
planets in

318
00:14:18,699 --> 00:14:16,459
habitable zone and if you were to apply

319
00:14:21,069 --> 00:14:18,709
the same criterion to the February

320
00:14:26,259 --> 00:14:21,079
catalog we would have seen 25 so that's

321
00:14:28,689 --> 00:14:26,269
just a point of reference so what I'd

322
00:14:31,780 --> 00:14:28,699
like to do now is zoom in on this green

323
00:14:33,759 --> 00:14:31,790
region in the next slide to show you the

324
00:14:36,189 --> 00:14:33,769
candidates that are in this Goldilocks

325
00:14:38,379 --> 00:14:36,199
zone you can see it bracketed by the

326
00:14:40,360 --> 00:14:38,389
dashed vertical lines one on the left

327
00:14:41,829 --> 00:14:40,370
and one on the right and in the middle

328
00:14:42,790 --> 00:14:41,839
you have the dashed vertical line

329
00:14:45,550 --> 00:14:42,800
corresponding to the equilibrium

330
00:14:47,369 --> 00:14:45,560
temperature of the earth all right and

331
00:14:51,759 --> 00:14:47,379
the earth is plotted there for reference

332
00:14:54,579 --> 00:14:51,769
so in this plot you can see that well

333
00:14:56,769 --> 00:14:54,589
it's not obvious but we have ten planet

334
00:14:59,590 --> 00:14:56,779
candidates now that are near Earth sized

335
00:15:02,619 --> 00:14:59,600
in the habitable zone and by near Earth

336
00:15:04,800 --> 00:15:02,629
sized I mean two Earth radii and smaller

337
00:15:06,850 --> 00:15:04,810
and you can see that those are

338
00:15:08,949 --> 00:15:06,860

predominantly the yellow points these

339
00:15:11,470 --> 00:15:08,959
are our new newest planet candidates

340
00:15:13,389 --> 00:15:11,480
which makes sense because we're now more

341
00:15:15,819 --> 00:15:13,399
sensitive now that we've collected more

342
00:15:18,129 --> 00:15:15,829
data we're more sensitive to also the

343
00:15:21,490 --> 00:15:18,139
largely longer period candidates and so

344
00:15:23,829 --> 00:15:21,500
we've picked up some of those now I I'd

345
00:15:26,230 --> 00:15:23,839
like to point out one piece of

346
00:15:29,819 --> 00:15:26,240
information if you go to the next slide

347
00:15:33,309 --> 00:15:29,829
I'm gonna superimpose these five arrows

348
00:15:37,629 --> 00:15:33,319
five of these stars that are amongst

349
00:15:39,400 --> 00:15:37,639
these ten have surface gravities in the

350
00:15:41,139 --> 00:15:39,410
Kepler input catalog which is our

351
00:15:42,970 --> 00:15:41,149
catalog of stellar parameters that we

352
00:15:45,369 --> 00:15:42,980
use to characterize these planet

353
00:15:49,030 --> 00:15:45,379
candidates they have surface gravities

354
00:15:50,949 --> 00:15:49,040
that seem a bit too high to us there are

355
00:15:54,249 --> 00:15:50,959
systematic errors in the stellar

356
00:15:56,860 --> 00:15:54,259
parameters in some of them that lead to

357
00:16:00,220 --> 00:15:56,870
higher surface gravity systematically

358
00:16:03,309 --> 00:16:00,230
and we use those surface gravities to

359
00:16:05,079 --> 00:16:03,319
estimate the radius of the star and the

360
00:16:07,929 --> 00:16:05,089
radius of the planet is measured

361
00:16:11,079 --> 00:16:07,939
relative to the star so for these five

362
00:16:13,179 --> 00:16:11,089
candidates it's we have no better

363
00:16:16,240 --> 00:16:13,189

observation to tell us what that surface

364
00:16:18,069 --> 00:16:16,250
gravity should be but yet inspecting the

365
00:16:19,809 --> 00:16:18,079
value that we have in our kepler input

366
00:16:22,509 --> 00:16:19,819
catalog leads me to believe that they're

367
00:16:24,519 --> 00:16:22,519
slightly underestimated and so for five

368
00:16:27,079 --> 00:16:24,529
of those candidates I expect those

369
00:16:29,420 --> 00:16:27,089
systematic errors to push the radius

370
00:16:32,030 --> 00:16:29,430
the equilibrium temperature up to the

371
00:16:34,639 --> 00:16:32,040
the right upper right-hand side of that

372
00:16:37,040 --> 00:16:34,649
diagram I can't yet say how that's going

373
00:16:39,970 --> 00:16:37,050
to affect the parameters exactly but I'm

374
00:16:43,519 --> 00:16:39,980
just introducing that as one caveat

375
00:16:46,429 --> 00:16:43,529
nevertheless of these ten candidates we

376
00:16:49,160 --> 00:16:46,439
do still have five that are very very

377
00:16:50,780 --> 00:16:49,170
high quality robust candidates some of

378
00:16:53,059 --> 00:16:50,790
them are even members of multiple

379
00:16:56,960 --> 00:16:53,069
systems so we believe that we've got

380
00:16:58,730 --> 00:16:56,970
some very very viable candidates here

381
00:17:01,160 --> 00:16:58,740
that are earth sized near-earth sized

382
00:17:03,530 --> 00:17:01,170
and in the habitable zone and and to

383
00:17:05,480 --> 00:17:03,540
illustrate that I'm gonna turn it over

384
00:17:10,329 --> 00:17:05,490
to William burrow key here who's going

385
00:17:12,740 --> 00:17:10,339
to give you an example Thank You Natalie

386
00:17:14,929 --> 00:17:12,750
I'm William burrow key the principal

387
00:17:17,419 --> 00:17:14,939
investigator of the Kepler mission and

388
00:17:20,569 --> 00:17:17,429

today I have the privilege of announcing

389
00:17:23,569 --> 00:17:20,579
the discovery of Kepler's first planet

390
00:17:26,899 --> 00:17:23,579
in the habitable zone of a sun-like star

391
00:17:29,769 --> 00:17:26,909
now Kepler 22b it

392
00:17:32,750 --> 00:17:29,779
it's 2.4 times the size of the earth

393
00:17:34,730 --> 00:17:32,760
it's in an orbital period of 290 days a

394
00:17:38,090 --> 00:17:34,740
little bit shorter than that of the

395
00:17:40,970 --> 00:17:38,100
earth it's a little bit closer to its

396
00:17:44,630 --> 00:17:40,980
star than Earth is to thee to the Sun

397
00:17:46,870 --> 00:17:44,640
about 15% closer but the star is a

398
00:17:49,519 --> 00:17:46,880
little bit dimmer it's a little bit

399
00:17:51,200 --> 00:17:49,529
lower in temperature 220 degrees lower

400
00:17:53,960 --> 00:17:51,210
in temperature it's a little bit smaller

401
00:17:56,750 --> 00:17:53,970
so that means that that planet Kepler

402
00:17:58,850 --> 00:17:56,760
22b has a rather similar temperature to

403
00:18:00,789 --> 00:17:58,860
that of the earth there is serenity of

404
00:18:02,810 --> 00:18:00,799
temperature that Natalie mentioned is

405
00:18:05,510 --> 00:18:02,820
255 degrees Kelvin

406
00:18:07,850 --> 00:18:05,520
this is 262 Kent degrees Kelvin some

407
00:18:10,010 --> 00:18:07,860
seven degrees different so if the

408
00:18:12,860 --> 00:18:10,020
greenhouse warming were similar on this

409
00:18:13,940 --> 00:18:12,870
planet and had a surface it would be its

410
00:18:17,269 --> 00:18:13,950
surface temperature would be something

411
00:18:21,409 --> 00:18:17,279
like 72 Fahrenheit a very pleasant

412
00:18:22,909 --> 00:18:21,419
temperature here on earth the star is

413
00:18:25,010 --> 00:18:22,919

some six hundred light years away so

414
00:18:28,070 --> 00:18:25,020
it's not terribly far away but not

415
00:18:30,710 --> 00:18:28,080
terribly close either you can see the

416
00:18:32,990 --> 00:18:30,720
the images here the orbital periods are

417
00:18:35,330 --> 00:18:33,000
about the same size you can see the star

418
00:18:38,240 --> 00:18:35,340
at the top with a little bit dimmer than

419
00:18:40,280 --> 00:18:38,250
the star at the bottom of the Sun and

420
00:18:43,310 --> 00:18:40,290
you can see how the earth could

421
00:18:46,370 --> 00:18:43,320
Harris to kepler-22b what I'd like to

422
00:18:48,290 --> 00:18:46,380
talk about next is the the data that

423
00:18:50,450 --> 00:18:48,300
made this discovery possible could I

424
00:18:52,970 --> 00:18:50,460
have the next figure what we see at the

425
00:18:54,470 --> 00:18:52,980
top here is the Kepler's light curve and

426
00:18:56,390 --> 00:18:54,480
light curve is simply the brightness of

427
00:18:58,010 --> 00:18:56,400
the star as a function of time so you

428
00:19:02,360 --> 00:18:58,020
see the variation of the brightness of

429
00:19:04,880 --> 00:19:02,370
that over 700 days of observations now

430
00:19:07,070 --> 00:19:04,890
much of the drifts and jumps and think

431
00:19:10,040 --> 00:19:07,080
like that are due to the to the the

432
00:19:13,070 --> 00:19:10,050
measurement errors that we have and we

433
00:19:15,440 --> 00:19:13,080
need to take that out correct the drifts

434
00:19:17,300 --> 00:19:15,450
correct their jumps and what we what our

435
00:19:20,390 --> 00:19:17,310
analysis pipeline does is produce the

436
00:19:22,640 --> 00:19:20,400
curve below it if on the other hand wait

437
00:19:24,590 --> 00:19:22,650
we start and we look at the upper curve

438
00:19:25,940 --> 00:19:24,600

you see there's three triangles the

439
00:19:28,550 --> 00:19:25,950
three triangles are pointing out were

440
00:19:30,890 --> 00:19:28,560
the three transits that are required for

441
00:19:34,460 --> 00:19:30,900
confirmation occurred and if you look

442
00:19:36,320 --> 00:19:34,470
you can't really see the first event the

443
00:19:38,600 --> 00:19:36,330
second event is that tiny little tick

444
00:19:40,700 --> 00:19:38,610
the third event is another tiny little

445
00:19:41,780 --> 00:19:40,710
tick and so it's it's nearly impossible

446
00:19:44,450 --> 00:19:41,790
to see that

447
00:19:46,490 --> 00:19:44,460
bijli somebody tells you but when you

448
00:19:49,250 --> 00:19:46,500
take the data you put it through the

449
00:19:51,200 --> 00:19:49,260
analysis data analysis pipeline what you

450
00:19:52,820 --> 00:19:51,210
end up with that lower panel and it's

451
00:19:55,310 --> 00:19:52,830
very clear the transits are marked

452
00:19:57,880 --> 00:19:55,320
they're very very clear here we've we've

453
00:20:00,050 --> 00:19:57,890
Magda find the the observations the

454
00:20:03,050 --> 00:20:00,060
black areas are areas where the

455
00:20:04,850 --> 00:20:03,060
spacecraft did not take data it turned

456
00:20:07,400 --> 00:20:04,860
towards the earth sent the data back to

457
00:20:09,590 --> 00:20:07,410
us and a large one to the right hand

458
00:20:12,920 --> 00:20:09,600
side is where the spacecraft was in safe

459
00:20:15,140 --> 00:20:12,930
mode again not taking data but what's

460
00:20:17,300 --> 00:20:15,150
special here what's really special is to

461
00:20:19,430 --> 00:20:17,310
notice the first triangle occurs just a

462
00:20:21,530 --> 00:20:19,440
few days after we leave commissioning

463
00:20:22,760 --> 00:20:21,540

and we go into science operations so he

464
00:20:24,680 --> 00:20:22,770
picked up the first of the three

465
00:20:25,460 --> 00:20:24,690
necessary transits the second one is

466
00:20:28,810 --> 00:20:25,470
pretty obvious

467
00:20:31,970 --> 00:20:28,820
the third one occurs just before this

468
00:20:33,920 --> 00:20:31,980
period of about two weeks where the

469
00:20:35,570 --> 00:20:33,930
spacecraft was not taking data again it

470
00:20:40,250 --> 00:20:35,580
was a safe mode that occurred just

471
00:20:42,410 --> 00:20:40,260
before Christmas of 2010 and the we had

472
00:20:44,540 --> 00:20:42,420
this wonderful fortune then to find

473
00:20:46,400 --> 00:20:44,550
these three transits where had there

474
00:20:47,930 --> 00:20:46,410
been any change when they occurred we

475
00:20:50,960 --> 00:20:47,940
would have missed them we would not be

476
00:20:53,690 --> 00:20:50,970
declaring the kepler-22 is our first

477
00:20:55,190 --> 00:20:53,700
plant in habitable zone so it's a

478
00:20:59,240 --> 00:20:55,200
great gift do we consider this sort of

479
00:21:02,090 --> 00:20:59,250
our Christmas planet so let's go on to

480
00:21:04,070 --> 00:21:02,100
the next figure here we've taken those

481
00:21:05,659 --> 00:21:04,080
three transits we've added them together

482
00:21:07,730 --> 00:21:05,669
so you can really clearly see that

483
00:21:10,190 --> 00:21:07,740
transits you see the dip you see how

484
00:21:12,740 --> 00:21:10,200
well is defined the depth of that depth

485
00:21:15,529 --> 00:21:12,750
dip is telling you the size of the

486
00:21:18,080 --> 00:21:15,539
planet the size that planet is 2.4

487
00:21:21,830 --> 00:21:18,090
radius to the earth it's not 2.5 it's

488
00:21:24,620 --> 00:21:21,840

not 2.6 it's 2.4 just just a smidgen

489
00:21:26,360 --> 00:21:24,630
above and below that the period is

490
00:21:28,639 --> 00:21:26,370
something like seven point four hours

491
00:21:31,399 --> 00:21:28,649
and what's especially interesting are

492
00:21:33,830 --> 00:21:31,409
the dots above that the dots above that

493
00:21:37,129 --> 00:21:33,840
are measurements we took not when the

494
00:21:39,259 --> 00:21:37,139
transits occurring but 1/2 an orbital

495
00:21:40,639 --> 00:21:39,269
period later and that's the time where

496
00:21:43,779 --> 00:21:40,649
the planets not going in front of the

497
00:21:46,909 --> 00:21:43,789
star it's going behind the star and so

498
00:21:49,610 --> 00:21:46,919
since the planet has typically gives off

499
00:21:51,230 --> 00:21:49,620
about a billion the light of a star you

500
00:21:53,690 --> 00:21:51,240
shouldn't see any difference and you

501
00:21:55,340 --> 00:21:53,700
don't see any difference if you saw a

502
00:21:57,470 --> 00:21:55,350
decrease it would mean it wasn't a

503
00:21:59,269 --> 00:21:57,480
planet that we were seeing it was a star

504
00:22:01,909 --> 00:21:59,279
because that's light it's light would be

505
00:22:05,240 --> 00:22:01,919
occulted so great confirmation it's a

506
00:22:07,009 --> 00:22:05,250
planet not a little star on the right

507
00:22:09,320 --> 00:22:07,019
hand side is another independent

508
00:22:12,080 --> 00:22:09,330
measurement this is done by the Spitzer

509
00:22:14,720 --> 00:22:12,090
telescope which is also in orbit around

510
00:22:16,370 --> 00:22:14,730
the Sun like the Kepler telescope but

511
00:22:18,500 --> 00:22:16,380
the Spitzer telescope looks in the

512
00:22:20,779 --> 00:22:18,510
infrared portion of the spectrum

513
00:22:23,539 --> 00:22:20,789

Kepler looks in the visible portion and

514
00:22:25,220 --> 00:22:23,549
if it's a planet the depths of both

515
00:22:28,009 --> 00:22:25,230
transits should be essentially the same

516
00:22:30,680 --> 00:22:28,019
with an experimental error and if we

517
00:22:32,509 --> 00:22:30,690
look we see they are the white curve is

518
00:22:35,090 --> 00:22:32,519
the curve from Spitzer the red curve

519
00:22:37,519 --> 00:22:35,100
that from from Kepler and the agreement

520
00:22:39,590 --> 00:22:37,529
is beautiful a compared to the two the

521
00:22:41,899 --> 00:22:39,600
measurement error so another wonderful

522
00:22:44,389 --> 00:22:41,909
confirmation it is a planet it is not

523
00:22:47,149 --> 00:22:44,399
something some other Astrophysical

524
00:22:49,340 --> 00:22:47,159
phenomenon could I have the next figure

525
00:22:51,799 --> 00:22:49,350
please what we're going to talk about

526
00:22:55,279 --> 00:22:51,809
here is what we'd like to be able to get

527
00:22:57,019 --> 00:22:55,289
at is a composition of this planet to

528
00:22:59,810 --> 00:22:57,029
get a clue of the composition you need

529
00:23:01,970 --> 00:22:59,820
the size and you need the density the

530
00:23:04,369 --> 00:23:01,980
density you get from a size and a

531
00:23:06,080 --> 00:23:04,379
measurement of the mass we don't yet

532
00:23:07,220 --> 00:23:06,090
have a measurement of the mass Kepler

533
00:23:10,490 --> 00:23:07,230
measures size

534
00:23:12,680 --> 00:23:10,500
not mass but with our colleagues we can

535
00:23:14,870 --> 00:23:12,690
sometimes get the mass with ground-based

536
00:23:16,990 --> 00:23:14,880
measurements so let's look at what we

537
00:23:20,330 --> 00:23:17,000
have what we can learn from what we have

538
00:23:23,000 --> 00:23:20,340

currently vertical axis is the size the

539
00:23:25,580 --> 00:23:23,010
planet relative the size the earth the

540
00:23:28,129 --> 00:23:25,590
horizontal axis is the at is the mass

541
00:23:30,980 --> 00:23:28,139
that we measure for that planet and

542
00:23:32,990 --> 00:23:30,990
lower left we see Earth and Venus upper

543
00:23:35,419 --> 00:23:33,000
right we see Uranus Neptune two of the

544
00:23:38,779 --> 00:23:35,429
larger planets in our solar system and

545
00:23:41,200 --> 00:23:38,789
then we see some we see a yellow band

546
00:23:43,789 --> 00:23:41,210
which represents the size of Kepler 22b

547
00:23:45,620 --> 00:23:43,799
but we don't know where Kepler 22b

548
00:23:48,139 --> 00:23:45,630
relies on that Bank if you don't have

549
00:23:50,960 --> 00:23:48,149
the mass yet when we look at the other

550
00:23:52,730 --> 00:23:50,970
curves we see the white curve that goes

551
00:23:55,850 --> 00:23:52,740
from the earth up to the right and that

552
00:23:57,529 --> 00:23:55,860
is if you took more rocks more material

553
00:23:59,120 --> 00:23:57,539
that Earth is made out of you kept

554
00:24:00,950 --> 00:23:59,130
adding it to the earth the earth would

555
00:24:04,250 --> 00:24:00,960
grow in size it would grow in mass and

556
00:24:06,049 --> 00:24:04,260
would fall along that curve if instead

557
00:24:07,879 --> 00:24:06,059
we had a planet that was essentially

558
00:24:10,549 --> 00:24:07,889
water and ice that would be the dashed

559
00:24:13,460 --> 00:24:10,559
curve and it's density is less so it's

560
00:24:16,220 --> 00:24:13,470
above the curve of Earth which is mostly

561
00:24:18,080 --> 00:24:16,230
rock and iron and so we would see it

562
00:24:21,110 --> 00:24:18,090
grow and it would cross that yellow

563
00:24:24,769 --> 00:24:21,120

curve the yellow band for kepler-22 as

564
00:24:27,409 --> 00:24:24,779
it got more and more mass toward the

565
00:24:30,169 --> 00:24:27,419
mass of 20 if we talked about planets

566
00:24:31,850 --> 00:24:30,179
that had lots of hydrogen helium when

567
00:24:34,399 --> 00:24:31,860
you add those gases they're very

568
00:24:37,100 --> 00:24:34,409
expensive and so the atmosphere becomes

569
00:24:38,840 --> 00:24:37,110
very large and we see planets like

570
00:24:41,269 --> 00:24:38,850
Uranus and Neptune so 10 percent

571
00:24:44,389 --> 00:24:41,279
hydrogen helium the lower white kirsov

572
00:24:47,269 --> 00:24:44,399
curve 20% a curve somewhat above Uranus

573
00:24:50,360 --> 00:24:47,279
and Neptune it's clear from the yellow

574
00:24:52,610 --> 00:24:50,370
band that's not working for 22 lies it

575
00:24:55,190 --> 00:24:52,620
lies somewhere between Earth composition

576
00:24:57,200 --> 00:24:55,200
so you would expect that they have a lot

577
00:24:59,840 --> 00:24:57,210
of rocky material and it probably has a

578
00:25:02,389 --> 00:24:59,850
lot of water as well this coming summer

579
00:25:04,850 --> 00:25:02,399
we'll have an opportunity to try to

580
00:25:08,029 --> 00:25:04,860
measure that mass because the star will

581
00:25:09,590 --> 00:25:08,039
be high in the sky and the telescope the

582
00:25:11,930 --> 00:25:09,600
ground-based telescopes like air can

583
00:25:14,360 --> 00:25:11,940
possibly harps north will be it will be

584
00:25:16,460 --> 00:25:14,370
able to at least try attempt to get the

585
00:25:18,019 --> 00:25:16,470
mass of this planet and I believe they

586
00:25:20,119 --> 00:25:18,029
will they have a good chance of being

587
00:25:20,930 --> 00:25:20,129
successful and they will know where this

588
00:25:23,840 --> 00:25:20,940

planet lies

589
00:25:25,460 --> 00:25:23,850
on that curve clearly it lies in an area

590
00:25:27,650 --> 00:25:25,470
which hasn't been explored

591
00:25:29,690 --> 00:25:27,660
we have no planets like this in our

592
00:25:32,150 --> 00:25:29,700
solar system things that lie between the

593
00:25:34,430 --> 00:25:32,160
earth and Uranus and Neptune so that

594
00:25:38,600 --> 00:25:34,440
will be a wonderful part of our

595
00:25:41,960 --> 00:25:38,610
discovery so let's go the last figure in

596
00:25:44,570 --> 00:25:41,970
this figure we've we've plotted not only

597
00:25:46,580 --> 00:25:44,580
the earth there in the center at 255

598
00:25:49,820 --> 00:25:46,590
Kelvin but our discovery Kepler 22b

599
00:25:53,210 --> 00:25:49,830
which is fairly close we've also plotted

600
00:25:55,460 --> 00:25:53,220
all the many other planet Kennedy

601
00:25:57,770 --> 00:25:55,470
planets most of these kennedy planets I

602
00:26:00,880 --> 00:25:57,780
think will turn out to be real planets

603
00:26:02,120 --> 00:26:00,890
and what we've seeing are some 48

604
00:26:04,370 --> 00:26:02,130
objects

605
00:26:08,380 --> 00:26:04,380
planetary candidates in the habitable

606
00:26:11,630 --> 00:26:08,390
zone between 185 and 303 degrees Kelvin

607
00:26:14,360 --> 00:26:11,640
it's conceivable that any or many of

608
00:26:17,350 --> 00:26:14,370
these planets and planetary candidates

609
00:26:20,450 --> 00:26:17,360
and their moons could have life and

610
00:26:23,120 --> 00:26:20,460
clearly they're good targets for a SETI

611
00:26:26,630 --> 00:26:23,130
search and Jill tarter is here to tell

612
00:26:29,030 --> 00:26:26,640
us about the SETI search Joe thank you

613
00:26:30,800 --> 00:26:29,040

Bill I'm Jill tarter the director of the

614
00:26:34,010 --> 00:26:30,810
Center for SETI research at the SETI

615
00:26:35,600 --> 00:26:34,020
Institute down the road my team is

616
00:26:38,710 --> 00:26:35,610
interested in using the results of

617
00:26:41,210 --> 00:26:38,720
Kepler to find true earth analogs

618
00:26:43,760 --> 00:26:41,220
according to Carl Sagan and his

619
00:26:46,310 --> 00:26:43,770
colleagues in their 1993 nature paper

620
00:26:48,920 --> 00:26:46,320
titled a search for life on Earth from

621
00:26:51,170 --> 00:26:48,930
the Galileo spacecraft one of the

622
00:26:54,110 --> 00:26:51,180
strongest pieces of evidence for life

623
00:26:56,810 --> 00:26:54,120
indeed intelligent life on Earth was the

624
00:26:59,840 --> 00:26:56,820
presence of narrowband pulsed amplitude

625
00:27:01,970 --> 00:26:59,850
modulated radio transmissions while

626
00:27:04,550 --> 00:27:01,980
there may be some uncertainty about

627
00:27:08,090 --> 00:27:04,560
exactly how to define the habitable zone

628
00:27:10,610 --> 00:27:08,100
an exoplanet that could be detected

629
00:27:13,640 --> 00:27:10,620
through the technic techno signatures of

630
00:27:16,330 --> 00:27:13,650
its inhabitants would surely qualify as

631
00:27:19,430 --> 00:27:16,340
an earth analogue at the SETI Institute

632
00:27:22,280 --> 00:27:19,440
we've been gun using the Allen telescope

633
00:27:26,000 --> 00:27:22,290
array a radio telescope currently

634
00:27:28,790 --> 00:27:26,010
composed of 42 6 metre antennas we've

635
00:27:31,960 --> 00:27:28,800
used it since last January to look for

636
00:27:34,890 --> 00:27:31,970
techno signatures from the Kepler worlds

637
00:27:37,230 --> 00:27:34,900
the Allen telescope array is located in

638
00:27:39,540 --> 00:27:37,240

rural Hat Creek Valley in Northern

639
00:27:42,840 --> 00:27:39,550
California away from the transmitters

640
00:27:44,670 --> 00:27:42,850
that accompany large populations last

641
00:27:46,860 --> 00:27:44,680
April we had to interrupt our

642
00:27:48,930 --> 00:27:46,870
exploration of the kepler world when the

643
00:27:53,070 --> 00:27:48,940
antennas were put into hibernation mode

644
00:27:55,860 --> 00:27:53,080
due to a lack of operating funds but I'm

645
00:27:58,740 --> 00:27:55,870
really pleased to announce that as of

646
00:28:01,830 --> 00:27:58,750
6:18 this morning when the Kepler field

647
00:28:04,140 --> 00:28:01,840
rose over the observatory the ATA was

648
00:28:06,900 --> 00:28:04,150
back on the air continuing the search

649
00:28:08,790 --> 00:28:06,910
for earth analogs this restart of

650
00:28:11,220 --> 00:28:08,800
observing was made possible by the

651
00:28:15,270 --> 00:28:11,230
generosity of the public who responded

652
00:28:17,580 --> 00:28:15,280
to our SETI stars org website and to

653
00:28:20,430 --> 00:28:17,590
funding from the US Air Force as it

654
00:28:22,020 --> 00:28:20,440
assesses the utility of the ATA to

655
00:28:25,530 --> 00:28:22,030
assist in its important space

656
00:28:27,720 --> 00:28:25,540
situational awareness mission because of

657
00:28:30,450 --> 00:28:27,730
the unique capabilities of the ATA it's

658
00:28:33,600 --> 00:28:30,460
our intention to interrogate all nine

659
00:28:36,960 --> 00:28:33,610
billion narrow radio channels that

660
00:28:40,260 --> 00:28:36,970
comprise the naturally quiet terrestrial

661
00:28:42,870 --> 00:28:40,270
microwave window running from one to ten

662
00:28:44,850 --> 00:28:42,880
gigahertz in the spectrum at lower

663
00:28:47,730 --> 00:28:44,860

frequencies there's increasing noise

664
00:28:49,410 --> 00:28:47,740
from galactic synchrotron radiation and

665
00:28:54,240 --> 00:28:49,420
at higher frequencies our own atmosphere

666
00:28:57,030 --> 00:28:54,250
adds additional noise now as a very

667
00:29:00,540 --> 00:28:57,040
small tribute to Professor Bob Roode a

668
00:29:02,790 --> 00:29:00,550
University of Virginia astronomer who

669
00:29:05,130 --> 00:29:02,800
passed away on November 2nd we're

670
00:29:07,410 --> 00:29:05,140
resuming our exploration at the high

671
00:29:09,540 --> 00:29:07,420
frequency end of this quiet window we're

672
00:29:11,340 --> 00:29:09,550
focusing on the 200 million radio

673
00:29:15,420 --> 00:29:11,350
channels that surround the admission

674
00:29:17,730 --> 00:29:15,430
line of the three helium plus ion this

675
00:29:20,580 --> 00:29:17,740
lines at eight point six six gigahertz

676
00:29:22,650 --> 00:29:20,590
and it was suggested by Roode and

677
00:29:25,140 --> 00:29:22,660
professor Tom Vania from Boston

678
00:29:27,480 --> 00:29:25,150
University as an obvious frequency for

679
00:29:31,530 --> 00:29:27,490
interstellar communications it's the

680
00:29:34,620 --> 00:29:31,540
simplest spin flip transition after the

681
00:29:36,750 --> 00:29:34,630
21 centimeter hydrogen line that most

682
00:29:40,050 --> 00:29:36,760
people are familiar with this is an

683
00:29:43,950 --> 00:29:40,060
emission that occurs when the spin of

684
00:29:47,250 --> 00:29:43,960
the electron orbiting the nucleus shifts

685
00:29:48,630 --> 00:29:47,260
from one direction to the other and an

686
00:29:53,789 --> 00:29:48,640
emission

687
00:29:56,700 --> 00:29:53,799
at radio frequencies results rude and

688
00:29:59,009 --> 00:29:56,710

Vania argued that Radio Astronomy errs

689
00:30:01,470 --> 00:29:59,019
on other worlds might be more tolerant

690
00:30:04,200 --> 00:30:01,480
of transmitters operating at this higher

691
00:30:06,210 --> 00:30:04,210
frequency thus keeping their skies quiet

692
00:30:09,090 --> 00:30:06,220
for the study of hydrogen the most

693
00:30:11,370 --> 00:30:09,100
abundant element in the universe this is

694
00:30:14,580 --> 00:30:11,380
the largely unexplored frequency region

695
00:30:16,200 --> 00:30:14,590
for SETI and if it doesn't yield

696
00:30:18,389 --> 00:30:16,210
evidence of extraterrestrial

697
00:30:21,500 --> 00:30:18,399
technologies then we'll go on to study

698
00:30:24,720 --> 00:30:21,510
the rest of the microwave window and

699
00:30:28,200 --> 00:30:24,730
what might a techno signature look like

700
00:30:30,629 --> 00:30:28,210
well perhaps an earth analog might look

701
00:30:32,370 --> 00:30:30,639
like the planet Mars did when we

702
00:30:35,190 --> 00:30:32,380
observed it just before Thanksgiving

703
00:30:37,620 --> 00:30:35,200
both the Mars Reconnaissance Orbiter and

704
00:30:39,990 --> 00:30:37,630
the Mars Express spacecraft happened to

705
00:30:43,879 --> 00:30:40,000
be transiting the planet and their

706
00:30:46,620 --> 00:30:43,889
carrier signals were clearly visible now

707
00:30:50,039 --> 00:30:46,630
extraterrestrial transmitters must be a

708
00:30:52,320 --> 00:30:50,049
lot stronger than these to be visible

709
00:30:55,740 --> 00:30:52,330
over interstellar distances as opposed

710
00:30:59,669 --> 00:30:55,750
to interplanetary distances but we won't

711
00:31:01,590 --> 00:30:59,679
know if they're there unless we look so

712
00:31:04,470 --> 00:31:01,600
as of this morning we're once again

713
00:31:06,539 --> 00:31:04,480

looking at all the Kepler exoplanet

714
00:31:09,990 --> 00:31:06,549
candidates and as of tomorrow morning

715
00:31:12,930 --> 00:31:10,000
our catalog will be twice as big but

716
00:31:15,750 --> 00:31:12,940
just like Jodie Foster and her contact

717
00:31:18,240 --> 00:31:15,760
pushpins we will give a higher priority

718
00:31:21,870 --> 00:31:18,250
to those worlds that our colleagues tell

719
00:31:25,350 --> 00:31:21,880
us are not too warm not too cold but

720
00:31:28,649 --> 00:31:25,360
just right so federal and institutional

721
00:31:31,740 --> 00:31:28,659
funding have brought us to this really

722
00:31:34,379 --> 00:31:31,750
exciting threshold astrobiologists will

723
00:31:36,799 --> 00:31:34,389
examine these exoplanets for signs of

724
00:31:39,210 --> 00:31:36,809
bio signatures but at the SETI Institute

725
00:31:41,759 --> 00:31:39,220
we're going to carry forward the

726
00:31:44,879 --> 00:31:41,769
public's quest for techno signatures and

727
00:31:47,370 --> 00:31:44,889
the ultimate Earth analog as long as the

728
00:31:52,500 --> 00:31:47,380
public continues to support our efforts

729
00:31:53,940 --> 00:31:52,510
on humanity's behalf thank you Jill will

730
00:31:55,830 --> 00:31:53,950
now take questions here at NASA's Ames

731
00:31:57,659 --> 00:31:55,840
Research Center followed by our phone

732
00:31:58,919 --> 00:31:57,669
bridge remember if you have a question

733
00:32:01,470 --> 00:31:58,929
here state your full name and

734
00:32:11,220 --> 00:32:07,770
Oh store that mean oh yeah this it's on

735
00:32:13,280 --> 00:32:11,230
Eric Han with nature magazine I want to

736
00:32:16,010 --> 00:32:13,290
make sure I understand the the

737
00:32:19,890 --> 00:32:16,020
statistics you just gave us not only a

738
00:32:23,070 --> 00:32:19,900

54 sorry 48 in habitable zone but

739
00:32:24,960 --> 00:32:23,080
there's also 207 earth sized candidates

740
00:32:26,250 --> 00:32:24,970
what's the Venn diagram of those was

741
00:32:28,440 --> 00:32:26,260
that the 10 that you're talking about

742
00:32:30,180 --> 00:32:28,450
the 10 that I thought your category for

743
00:32:33,419 --> 00:32:30,190
Earth is even smaller than less than 2

744
00:32:39,750 --> 00:32:33,429
our definition of Earth's size is 1.25

745
00:32:41,659 --> 00:32:39,760
and smaller so you're asking are there

746
00:32:45,720 --> 00:32:41,669
is there an intersection between that

747
00:32:47,909 --> 00:32:45,730
207 and the ones that are 185 to 303 and

748
00:32:51,060 --> 00:32:47,919
I want to say that there's there's one

749
00:32:53,100 --> 00:32:51,070
but it happens to be one of those that

750
00:32:55,890 --> 00:32:53,110
has this anomalously high surface

751
00:32:58,110 --> 00:32:55,900
gravity so I I'm not sure how it's gonna

752
00:32:59,580 --> 00:32:58,120
play out you know as soon as Cygnus gets

753
00:33:02,039 --> 00:32:59,590
back up in the sky will be observing

754
00:33:03,870 --> 00:33:02,049
these candidates to pin down their

755
00:33:06,630 --> 00:33:03,880
stellar properties more accurately and

756
00:33:08,130 --> 00:33:06,640
see what those evaluate those new radii

757
00:33:11,159 --> 00:33:08,140
and if I couldn't follow up with one

758
00:33:16,440 --> 00:33:11,169
more this planet that you've confirmed

759
00:33:20,220 --> 00:33:16,450
you had the three Kepler signals a year

760
00:33:22,110 --> 00:33:20,230
exactly a year ago and presumably you

761
00:33:27,150 --> 00:33:22,120
tried to follow up with ground-based

762
00:33:28,860 --> 00:33:27,160
observations this past summer but you

763
00:33:30,390 --> 00:33:28,870

didn't seem to imply that that worked or

764
00:33:34,970 --> 00:33:30,400
not so what was it that allowed you to

765
00:33:37,650 --> 00:33:34,980
say okay this is a confirmed planet

766
00:33:39,930 --> 00:33:37,660
there's quite a few different tests that

767
00:33:42,659 --> 00:33:39,940
we do and I'll be talking about those a

768
00:33:45,000 --> 00:33:42,669
little bit later but one of the things

769
00:33:48,060 --> 00:33:45,010
that we did was made 16 measurements

770
00:33:50,250 --> 00:33:48,070
with the Keck telescope and that allowed

771
00:33:52,320 --> 00:33:50,260
us to say them mass couldn't be greater

772
00:33:55,650 --> 00:33:52,330
than a certain value something substance

773
00:33:58,950 --> 00:33:55,660
1 Sigma 36 times the mass of the other

774
00:34:02,580 --> 00:33:58,960
earth the measurements were made when

775
00:34:04,440 --> 00:34:02,590
the the planet was going through a node

776
00:34:06,169 --> 00:34:04,450
and it'll be going through a loop this

777
00:34:08,490 --> 00:34:06,179
summer that is to say they the

778
00:34:12,149 --> 00:34:08,500
amplitudes will be that will be very

779
00:34:13,349 --> 00:34:12,159
high of the radial velocity so we're

780
00:34:15,430 --> 00:34:13,359
talking about a radial velocity

781
00:34:19,649 --> 00:34:15,440
measurement that we'll be making in this

782
00:34:23,680 --> 00:34:19,659
summertime the ones that we made earlier

783
00:34:25,300 --> 00:34:23,690
basically told us that the the mass

784
00:34:27,369 --> 00:34:25,310
couldn't be higher than 36 times the

785
00:34:29,169 --> 00:34:27,379
mass of the earth three segments was

786
00:34:32,530 --> 00:34:29,179
something like hundred 26 times the mass

787
00:34:35,200 --> 00:34:32,540
the earth these values are so low that

788
00:34:36,909 --> 00:34:35,210

it can't possibly be a star we're

789
00:34:38,859 --> 00:34:36,919
clearly seeing a signal and the regular

790
00:34:43,540 --> 00:34:38,869
velocity is saying it cannot be a star

791
00:34:47,319 --> 00:34:43,550
it must be a planet observations that we

792
00:34:49,000 --> 00:34:47,329
took and then the Astro seismology too I

793
00:34:50,649 --> 00:34:49,010
mean there are several pieces to the

794
00:34:53,559 --> 00:34:50,659
puzzle that had to all come together to

795
00:34:56,409 --> 00:34:53,569
confirm this and really understand and

796
00:34:58,150 --> 00:34:56,419
know that it is an object a bona fide

797
00:35:03,309 --> 00:34:58,160
planet in the habitable zone it just

798
00:35:06,069 --> 00:35:03,319
takes time high rank lots with Reuters

799
00:35:08,020 --> 00:35:06,079
and Discovery News I guess it's kind of

800
00:35:10,420 --> 00:35:08,030
the same question from the other side of

801
00:35:13,540 --> 00:35:10,430
the coin the if you if you discard the

802
00:35:16,000 --> 00:35:13,550
five stars that you think there's some

803
00:35:19,809 --> 00:35:16,010
okay well okay let's just set aside move

804
00:35:22,990 --> 00:35:19,819
around a moment those five and the

805
00:35:26,440 --> 00:35:23,000
remaining four what's missing what's

806
00:35:28,660 --> 00:35:26,450
missing from the other four candidates

807
00:35:30,700 --> 00:35:28,670
that you could that's that's like a

808
00:35:32,530 --> 00:35:30,710
waiting confirmation is it this issue of

809
00:35:34,089 --> 00:35:32,540
that the telescope happened to be in

810
00:35:36,069 --> 00:35:34,099
safe mode so you weren't able to get

811
00:35:37,990 --> 00:35:36,079
this like you know ding ding ding or

812
00:35:40,480 --> 00:35:38,000
what else yeah that's a good question

813
00:35:43,059 --> 00:35:40,490

the transits are clear they're they're

814
00:35:44,620 --> 00:35:43,069
very high quality candidates what we

815
00:35:46,180 --> 00:35:44,630
want to do now is the series of

816
00:35:48,160 --> 00:35:46,190
follow-up observations that we would

817
00:35:49,660 --> 00:35:48,170
give you know the attention we would

818
00:35:52,359 --> 00:35:49,670
give to these candidates like we did for

819
00:35:54,700 --> 00:35:52,369
K of kepler-22 that was a good example

820
00:35:56,620 --> 00:35:54,710
we want to observe the star and

821
00:35:59,410 --> 00:35:56,630
understand its properties very very well

822
00:36:01,480 --> 00:35:59,420
we want to do some radial velocity work

823
00:36:06,040 --> 00:36:01,490
so that we know that it's not a false

824
00:36:08,109 --> 00:36:06,050
positive we want to just apply all the

825
00:36:10,780 --> 00:36:08,119
different criteria that help us to weed

826
00:36:12,730 --> 00:36:10,790
out any probability that it might be a

827
00:36:16,260 --> 00:36:12,740
false positive before we have confidence

828
00:36:19,059 --> 00:36:16,270
in the planet interpretation so that

829
00:36:21,250 --> 00:36:19,069
that's what's lacking and also I wanted

830
00:36:23,800 --> 00:36:21,260
to know what you mentioned that when you

831
00:36:25,480 --> 00:36:23,810
find them multiple planetary systems

832
00:36:27,520 --> 00:36:25,490
that it's helpful for homing in on

833
00:36:28,960 --> 00:36:27,530
smaller planets how does that work are

834
00:36:29,210 --> 00:36:28,970
you seeing like wobbles in signal that

835
00:36:35,810 --> 00:36:29,220
you

836
00:36:41,089 --> 00:36:35,820
kind of paint a family picture of the 22

837
00:36:42,920 --> 00:36:41,099
couple of 22 the the Maltese have been

838
00:36:46,070 --> 00:36:42,930

important for two reasons one is because

839
00:36:47,900 --> 00:36:46,080
if you've got one candidate orbiting a

840
00:36:49,609 --> 00:36:47,910
star you have a certain probability that

841
00:36:51,859 --> 00:36:49,619
it might be something else some

842
00:36:53,810 --> 00:36:51,869
Astrophysical false positive but if you

843
00:36:56,599 --> 00:36:53,820
have two and that probability is very

844
00:36:58,580 --> 00:36:56,609
low now if you've got two planet

845
00:37:01,910 --> 00:36:58,590
candidates the probability of having two

846
00:37:04,490 --> 00:37:01,920
false positives is ridiculously small so

847
00:37:06,830 --> 00:37:04,500
when you see multiple planets signatures

848
00:37:08,480 --> 00:37:06,840
in your data that increases our

849
00:37:10,460 --> 00:37:08,490
confidence substantially that that

850
00:37:12,710 --> 00:37:10,470
signal is that the planet interpretation

851
00:37:14,240 --> 00:37:12,720
is the right one so that's one thing the

852
00:37:16,160 --> 00:37:14,250
other reason why the multis have become

853
00:37:19,250 --> 00:37:16,170
important is because we are measuring

854
00:37:21,710 --> 00:37:19,260
the timing of the transits and there are

855
00:37:24,470 --> 00:37:21,720
in many cases they are not perfectly

856
00:37:26,930 --> 00:37:24,480
periodic you know they should be if they

857
00:37:28,580 --> 00:37:26,940
obey Kepler's laws right because they

858
00:37:30,920 --> 00:37:28,590
orbit they've got a certain orbital

859
00:37:33,560 --> 00:37:30,930
period and they reoccur at this beating

860
00:37:35,270 --> 00:37:33,570
right but what we observe in many cases

861
00:37:38,240 --> 00:37:35,280
sometimes the transits arrive a little

862
00:37:39,560 --> 00:37:38,250
too soon a little sooner still and then

863
00:37:41,300 --> 00:37:39,570

they start to catch up and then they're

864
00:37:43,520 --> 00:37:41,310
a little bit too late and they're doing

865
00:37:45,290 --> 00:37:43,530
that because neighboring planets are

866
00:37:47,720 --> 00:37:45,300
tugging on one another and they're

867
00:37:49,849 --> 00:37:47,730
exchanging gravitational energy and in

868
00:37:52,190 --> 00:37:49,859
doing so and that exchange is strong

869
00:37:54,079 --> 00:37:52,200
when you have resonances for example you

870
00:37:56,030 --> 00:37:54,089
know if the outer planet orbits once for

871
00:37:58,339 --> 00:37:56,040
every twice that the other planet orbits

872
00:38:00,440 --> 00:37:58,349
and and it's a very powerful technique

873
00:38:02,930 --> 00:38:00,450
for backing out the masses of the

874
00:38:05,240 --> 00:38:02,940
planets so we're finding that that's

875
00:38:06,829 --> 00:38:05,250
much more powerful than we expected it

876
00:38:13,040 --> 00:38:06,839
to be and we're finding it's going to be

877
00:38:14,750 --> 00:38:13,050
very very helpful to us go for chilling

878
00:38:17,329 --> 00:38:14,760
free lens from the Netherlands

879
00:38:20,120 --> 00:38:17,339
two very simple questions I guess the

880
00:38:22,040 --> 00:38:20,130
first one is Kepler 22b in the

881
00:38:24,589 --> 00:38:22,050
constellation of Cygnus or is it in Lyra

882
00:38:27,260 --> 00:38:24,599
and the other one is are there any

883
00:38:31,849 --> 00:38:27,270
indications of this star harboring

884
00:38:32,839 --> 00:38:31,859
multiple planets I don't know the answer

885
00:38:34,430 --> 00:38:32,849
to your first one I don't know whether

886
00:38:36,020 --> 00:38:34,440
this is technically in the Cygnus

887
00:38:39,020 --> 00:38:36,030
constellation or lyre because they

888
00:38:40,580 --> 00:38:39,030

course but against above one another so

889
00:38:44,240 --> 00:38:40,590
I don't know the answer to that but

890
00:38:46,070 --> 00:38:44,250
right hey here's your second question

891
00:38:49,280 --> 00:38:46,080
what was your second question

892
00:38:51,350 --> 00:38:49,290
it's multi-multi we've looked very hard

893
00:38:54,080 --> 00:38:51,360
to see if we can see any transit timing

894
00:38:56,260 --> 00:38:54,090
variations and we don't see them at this

895
00:38:59,060 --> 00:38:56,270
point but we only have three transits

896
00:39:02,030 --> 00:38:59,070
actually the last several months we have

897
00:39:04,930 --> 00:39:02,040
seen a transit number four and we will

898
00:39:07,430 --> 00:39:04,940
see transit number five and this coming

899
00:39:09,440 --> 00:39:07,440
this coming year so we'll have five

900
00:39:11,060 --> 00:39:09,450
transits in the timing variations that

901
00:39:13,310 --> 00:39:11,070
you need to measure we'll get a much

902
00:39:15,350 --> 00:39:13,320
better measurement before but we have no

903
00:39:21,680 --> 00:39:15,360
evidence at this point for another

904
00:39:22,820 --> 00:39:21,690
planet hi Mike wall from space.com so so

905
00:39:24,170 --> 00:39:22,830
you're saying yeah I mean just in the

906
00:39:26,240 --> 00:39:24,180
last three months or I mean in

907
00:39:28,730 --> 00:39:26,250
additional three months after that the

908
00:39:30,560 --> 00:39:28,740
last day last day to release them you

909
00:39:32,450 --> 00:39:30,570
got more than a thousand yeah new

910
00:39:33,680 --> 00:39:32,460
candidates do you anticipate that that

911
00:39:35,690 --> 00:39:33,690
as you get better and better at this

912
00:39:37,610 --> 00:39:35,700
these fines are gonna just keep piling

913
00:39:40,100 --> 00:39:37,620

up or I mean where you gonna plateau

914
00:39:42,410 --> 00:39:40,110
yeah that's a great question I think

915
00:39:44,930 --> 00:39:42,420
that we're going to have at least one

916
00:39:47,210 --> 00:39:44,940
more batch that's going to be a market

917
00:39:48,830 --> 00:39:47,220
increase and I say that because I know

918
00:39:51,320 --> 00:39:48,840
that there are pipeline improvements

919
00:39:54,260 --> 00:39:51,330
coming down the pike here that are going

920
00:39:57,800 --> 00:39:54,270
to help us to identify the small

921
00:39:59,450 --> 00:39:57,810
transits and and so what happens is we

922
00:40:01,760 --> 00:39:59,460
have these things for example called

923
00:40:04,460 --> 00:40:01,770
sudden pixel sensitivity dropouts it's

924
00:40:07,130 --> 00:40:04,470
an instrumental effect that causes the

925
00:40:09,680 --> 00:40:07,140
brightness to appear to to deviate and

926
00:40:11,750 --> 00:40:09,690
we can correct for it

927
00:40:13,640 --> 00:40:11,760
but with our current pipeline we can't

928
00:40:16,280 --> 00:40:13,650
correct for it perfectly or in all cases

929
00:40:17,810 --> 00:40:16,290
and so sometimes what happens is the

930
00:40:20,420 --> 00:40:17,820
pipeline recognizes that little

931
00:40:22,850 --> 00:40:20,430
deviation as a transit and it keys off

932
00:40:24,620 --> 00:40:22,860
on that thinks you have a planet signal

933
00:40:26,630 --> 00:40:24,630
and then it doesn't filter it out

934
00:40:28,820 --> 00:40:26,640
properly because it can't because it

935
00:40:30,410 --> 00:40:28,830
doesn't look like a real transit to go

936
00:40:32,330 --> 00:40:30,420
back and search for real transits that

937
00:40:34,360 --> 00:40:32,340
might be there so we would miss them if

938
00:40:36,260 --> 00:40:34,370

they're there so we've already

939
00:40:38,330 --> 00:40:36,270
implemented we've already designed

940
00:40:40,700 --> 00:40:38,340
software that's going to improve that

941
00:40:42,980 --> 00:40:40,710
significantly and that's going to allow

942
00:40:44,960 --> 00:40:42,990
us to to get rid of these sudden pixel

943
00:40:47,120 --> 00:40:44,970
sensitivity dropouts and find the

944
00:40:49,100 --> 00:40:47,130
smaller planets and I think that that's

945
00:40:51,800 --> 00:40:49,110
one example and I think that that's

946
00:40:53,430 --> 00:40:51,810
going to give us another big haul this

947
00:40:55,140 --> 00:40:53,440
next time but I

948
00:40:59,630 --> 00:40:55,150
I hate to predict but that's what I

949
00:41:05,099 --> 00:41:02,220
Dennis over to me New York Times I just

950
00:41:08,880 --> 00:41:05,109
one small dumb point because I get

951
00:41:11,490 --> 00:41:08,890
confused by all these numbers but there

952
00:41:16,680 --> 00:41:11,500
were ten earth sized planets in

953
00:41:18,120 --> 00:41:16,690
habitable zone would you smaller than

954
00:41:20,880 --> 00:41:18,130
while we're including the super Earths

955
00:41:24,390 --> 00:41:20,890
so you are so 20 to be is one of those

956
00:41:26,280 --> 00:41:24,400
20 to be is slightly larger than two so

957
00:41:28,140 --> 00:41:26,290
that's not one of the ten it's not one

958
00:41:31,800 --> 00:41:28,150
of the ten okay that's close all right

959
00:41:33,540 --> 00:41:31,810
yeah our definition of super Earth is

960
00:41:35,010 --> 00:41:33,550
kind of I mean it's not completely

961
00:41:37,050 --> 00:41:35,020
arbitrary but we have to draw the line

962
00:41:39,150 --> 00:41:37,060
someplace and we are so super earth

963
00:41:42,240 --> 00:41:39,160

ranges from one point two five to two or

964
00:41:45,150 --> 00:41:42,250
three adi but you know we we don't know

965
00:41:46,740 --> 00:41:45,160
anything about the planets between earth

966
00:41:48,569 --> 00:41:46,750
size and neptune size because in our own

967
00:41:51,420 --> 00:41:48,579
solar system we have no examples of such

968
00:41:53,220 --> 00:41:51,430
planets right so between one worth

969
00:41:55,440 --> 00:41:53,230
radius and four earth radius there's

970
00:41:56,730 --> 00:41:55,450
nothing so we don't know what their

971
00:41:58,230 --> 00:41:56,740
compositions they're gonna be we don't

972
00:41:59,970 --> 00:41:58,240
know what fraction are gonna be rocky

973
00:42:02,040 --> 00:41:59,980
what fraction are gonna be water worlds

974
00:42:03,780 --> 00:42:02,050
what fraction or ice worlds we have no

975
00:42:06,000 --> 00:42:03,790
idea until we measure their densities

976
00:42:08,130 --> 00:42:06,010
and get some statistics we just don't

977
00:42:11,040 --> 00:42:08,140
know so we put the line at two we draw

978
00:42:18,390 --> 00:42:11,050
the line the Senate two and kepler-22 is

979
00:42:20,220 --> 00:42:18,400
a little bit larger okay great hi I'm

980
00:42:22,920 --> 00:42:20,230
Dennis Ebbets from Ball Aerospace in

981
00:42:25,500 --> 00:42:22,930
Boulder you're Natalie your number of

982
00:42:28,460 --> 00:42:25,510
seventeen hundred and ninety two stars

983
00:42:30,540 --> 00:42:28,470
that show evidence of planets is a is

984
00:42:33,150 --> 00:42:30,550
extremely interesting you're monitoring

985
00:42:35,069 --> 00:42:33,160
about a hundred and fifty thousand stars

986
00:42:36,900 --> 00:42:35,079
and not suggest that more than one

987
00:42:38,700 --> 00:42:36,910
percent of the stars so that you're

988
00:42:41,280 --> 00:42:38,710

monitoring show evidence of planets and

989
00:42:44,309 --> 00:42:41,290
if I remember right one percent was kind

990
00:42:47,880 --> 00:42:44,319
of the geometrical probability of there

991
00:42:49,559 --> 00:42:47,890
being a transit and that suggests you

992
00:42:52,410 --> 00:42:49,569
know you're exceeding that so it sounds

993
00:42:53,970 --> 00:42:52,420
suspiciously like almost every star

994
00:42:54,510 --> 00:42:53,980
might have some kind of a planetary

995
00:42:57,089 --> 00:42:54,520
system

996
00:42:59,250 --> 00:42:57,099
eight is something is one that one

997
00:43:01,500 --> 00:42:59,260
percent is for a certain orbital period

998
00:43:03,300 --> 00:43:01,510
so if you have very short period objects

999
00:43:04,559 --> 00:43:03,310
and many of ours are short period the

1000
00:43:06,059 --> 00:43:04,569
probability of having an alignment

1001
00:43:06,210 --> 00:43:06,069
having a transit is higher it's more

1002
00:43:08,670 --> 00:43:06,220
like

1003
00:43:10,920 --> 00:43:08,680
10% so you'd multiplied by 10 not 100

1004
00:43:12,300 --> 00:43:10,930
but yeah a point well taken

1005
00:43:14,190 --> 00:43:12,310
that'll be the next thing we do this

1006
00:43:18,570 --> 00:43:14,200
catalog that we are sharing with you

1007
00:43:20,280 --> 00:43:18,580
today and we literally finished like

1008
00:43:22,320 --> 00:43:20,290
Friday morning at 4:00 a.m. or something

1009
00:43:25,740 --> 00:43:22,330
crazy we haven't had the time to look at

1010
00:43:27,839 --> 00:43:25,750
it and and now translate these numbers

1011
00:43:29,099 --> 00:43:27,849
to actual statistics to occurrence rates

1012
00:43:32,580 --> 00:43:29,109
that'll be the next thing that we'll do

1013
00:43:33,990 --> 00:43:32,590

when we get back home okay will now go

1014
00:43:34,890 --> 00:43:34,000
to our phone bridge if you're on the

1015
00:43:36,810 --> 00:43:34,900
phone would like to ask a question

1016
00:43:39,300 --> 00:43:36,820
please remember press star 1 on your

1017
00:43:42,270 --> 00:43:39,310
phone we'll start with David Perlman

1018
00:43:45,500 --> 00:43:42,280
with the San Francisco Chronicle David

1019
00:43:50,940 --> 00:43:45,510
go ahead Thanks thanks very much

1020
00:43:55,170 --> 00:43:50,950
Ferdinand Ali or bill define the

1021
00:43:59,220 --> 00:43:55,180
criteria that turns a candidate into a

1022
00:44:03,330 --> 00:43:59,230
confirmed planet in terms of you know

1023
00:44:06,089 --> 00:44:03,340
readers can understand but basically we

1024
00:44:09,089 --> 00:44:06,099
look at the we look at a series of

1025
00:44:11,070 --> 00:44:09,099
measurements active optics Bekele make a

1026
00:44:13,200 --> 00:44:11,080
series of measurements we do a modeling

1027
00:44:16,380 --> 00:44:13,210
of the size of the star the size of the

1028
00:44:18,630 --> 00:44:16,390
planet how the signal looks like when it

1029
00:44:21,120 --> 00:44:18,640
cross a plant across the star how round

1030
00:44:25,470 --> 00:44:21,130
that is and we put this into a model and

1031
00:44:29,040 --> 00:44:25,480
come up with the likelihood that it's a

1032
00:44:30,420 --> 00:44:29,050
planet we calculate for the the planet

1033
00:44:33,630 --> 00:44:30,430
the probability it's the planet we

1034
00:44:35,010 --> 00:44:33,640
calculate as well the probability that

1035
00:44:37,829 --> 00:44:35,020
it's a false positive

1036
00:44:41,130 --> 00:44:37,839
that's a binary star and so we look at

1037
00:44:43,349 --> 00:44:41,140
the odds what are the odds that it's the

1038
00:44:46,079 --> 00:44:43,359

planet compared to the odds that it's a

1039
00:44:48,030 --> 00:44:46,089
false positive and when that number is

1040
00:44:50,550 --> 00:44:48,040
something in the order for a hundred to

1041
00:44:51,630 --> 00:44:50,560
a thousand then we say we've made all

1042
00:44:53,970 --> 00:44:51,640
the measurements that rule out

1043
00:44:57,390 --> 00:44:53,980
everything we know about the odds are

1044
00:44:59,730 --> 00:44:57,400
greatly in favor of being a planet the

1045
00:45:01,230 --> 00:44:59,740
Kepler science team basically looks at

1046
00:45:03,060 --> 00:45:01,240
this and decides together

1047
00:45:06,599 --> 00:45:03,070
are we willing to defend this as a

1048
00:45:08,760 --> 00:45:06,609
planet if the answer is yes then we have

1049
00:45:11,460 --> 00:45:08,770
the we have marshaled all the evidence

1050
00:45:13,770 --> 00:45:11,470
we submit this as a paper to a

1051
00:45:16,170 --> 00:45:13,780
professional journal and we have outside

1052
00:45:19,020 --> 00:45:16,180
experts look at what we have provided in

1053
00:45:19,800 --> 00:45:19,030
terms of evidence and if they say yes

1054
00:45:22,530 --> 00:45:19,810
the papers

1055
00:45:27,810 --> 00:45:22,540
accept it we say indeed we will declare

1056
00:45:29,850 --> 00:45:27,820
this analysis as a planet we have kind

1057
00:45:31,770 --> 00:45:29,860
of a three pronged approach every three

1058
00:45:34,170 --> 00:45:31,780
different approaches for that lead to

1059
00:45:34,740 --> 00:45:34,180
confirmation one is radial velocity

1060
00:45:38,100 --> 00:45:34,750
right

1061
00:45:40,500 --> 00:45:38,110
Doppler detection traditional the other

1062
00:45:43,350 --> 00:45:40,510
is transit timing variations which I

1063
00:45:45,030 --> 00:45:43,360

described earlier the problem is that

1064
00:45:47,520 --> 00:45:45,040
for the smallest planets those two

1065
00:45:49,800 --> 00:45:47,530
methods don't always work so the third

1066
00:45:52,800 --> 00:45:49,810
approach is to say okay let's make a

1067
00:45:54,600 --> 00:45:52,810
list of every Astrophysical thing that

1068
00:45:56,580 --> 00:45:54,610
this could be other than a planet and

1069
00:45:58,590 --> 00:45:56,590
let's just tick them off one by one

1070
00:46:00,450 --> 00:45:58,600
let's take a series of observations and

1071
00:46:03,000 --> 00:46:00,460
ask ourselves the question is this

1072
00:46:05,580 --> 00:46:03,010
scenario consistent with what I observe

1073
00:46:07,350 --> 00:46:05,590
and you're essentially eliminating all

1074
00:46:09,330 --> 00:46:07,360
the other possibilities that it could be

1075
00:46:12,210 --> 00:46:09,340
and of course you can't eliminate all of

1076
00:46:13,470 --> 00:46:12,220
them but if you can eliminate almost all

1077
00:46:15,480 --> 00:46:13,480
of them to the point where the

1078
00:46:17,550 --> 00:46:15,490
probability of it being an Astrophysical

1079
00:46:19,860 --> 00:46:17,560
false positive is so ridiculously small

1080
00:46:21,480 --> 00:46:19,870
then you say yes we have confidence that

1081
00:46:23,010 --> 00:46:21,490
the planet interpretation is right

1082
00:46:24,990 --> 00:46:23,020
because the probability that it's a

1083
00:46:26,520 --> 00:46:25,000
planet is orders of magnitude higher

1084
00:46:28,830 --> 00:46:26,530
than the probability it's an

1085
00:46:30,630 --> 00:46:28,840
Astrophysical pulse false positive so

1086
00:46:33,750 --> 00:46:30,640
those are the three basic techniques

1087
00:46:38,310 --> 00:46:33,760
that we use to to lead a planet

1088
00:46:39,870 --> 00:46:38,320

candidate to confirmation okay will now

1089
00:46:54,270 --> 00:46:39,880
go to Seth Borenstein with The

1090
00:46:55,650 --> 00:46:54,280
Associated Press B which was the next

1091
00:46:58,470 --> 00:46:55,660
you know just on the edge of the

1092
00:47:01,170 --> 00:46:58,480
habitable zone can you compare this to

1093
00:47:04,230 --> 00:47:01,180
that is this some more can you know more

1094
00:47:08,520 --> 00:47:04,240
habitable more human type habitable than

1095
00:47:10,230 --> 00:47:08,530
that and how I guess and how far how

1096
00:47:14,250 --> 00:47:10,240
many light years are we talking from

1097
00:47:17,460 --> 00:47:14,260
from Earth you know I don't think we

1098
00:47:21,240 --> 00:47:17,470
heard the top of it compared to what in

1099
00:47:24,480 --> 00:47:21,250
September harps announced confirmation

1100
00:47:27,110 --> 00:47:24,490
of HD eight five five one to B it was in

1101
00:47:29,780 --> 00:47:27,120
the constellation vela it was through

1102
00:47:33,630 --> 00:47:29,790
the people over you know harps did that

1103
00:47:39,170 --> 00:47:33,640
as in the habitable zone but barely

1104
00:47:41,910 --> 00:47:39,180
with it was a 3.6 mass earth 85 200

1105
00:47:44,970 --> 00:47:41,920
degrees under 20 degrees Fahrenheit a

1106
00:47:47,100 --> 00:47:44,980
rather hot steamy one so I'm wondering

1107
00:47:49,560 --> 00:47:47,110
how does this compare to that one and

1108
00:47:51,480 --> 00:47:49,570
can you can just sort of paint a picture

1109
00:47:53,790 --> 00:47:51,490
this sounds a lot more comfortable bill

1110
00:47:56,130 --> 00:47:53,800
you you talked about as a pleasant 72

1111
00:47:57,840 --> 00:47:56,140
degrees you know from what we know what

1112
00:48:00,120 --> 00:47:57,850
is a picture you know what would it be

1113
00:48:03,570 --> 00:48:00,130

like on this versus well we know about

1114
00:48:05,430 --> 00:48:03,580
others planets in the habitable zone one

1115
00:48:07,440 --> 00:48:05,440
of the concerns of course is that as you

1116
00:48:09,360 --> 00:48:07,450
warm up I'll plan I think you get the

1117
00:48:10,680 --> 00:48:09,370
temperature higher you get much more of

1118
00:48:12,990 --> 00:48:10,690
apparition of the water the water

1119
00:48:15,150 --> 00:48:13,000
becomes a larger portion of the

1120
00:48:17,010 --> 00:48:15,160
atmosphere at some point the water

1121
00:48:18,360 --> 00:48:17,020
enters the stratosphere and starts and

1122
00:48:20,910 --> 00:48:18,370
you start losing it from a planet

1123
00:48:23,670 --> 00:48:20,920
altogether so the concern is you can't

1124
00:48:25,800 --> 00:48:23,680
really heat a planet up very high before

1125
00:48:27,330 --> 00:48:25,810
you start losing all the water and so I

1126
00:48:30,450 --> 00:48:27,340
don't know what the situation is there

1127
00:48:32,550 --> 00:48:30,460
and another aspect of that is I don't

1128
00:48:36,420 --> 00:48:32,560
believe they got a transit they they got

1129
00:48:38,430 --> 00:48:36,430
a mass but not a size and so you don't

1130
00:48:40,770 --> 00:48:38,440
know whether this is a gas giant or just

1131
00:48:44,250 --> 00:48:40,780
what it is so there's a lot of unknowns

1132
00:48:48,630 --> 00:48:44,260
here I suspect that the planet we have

1133
00:48:52,170 --> 00:48:48,640
found is probably there's a good chance

1134
00:48:54,570 --> 00:48:52,180
that it could be rocky

1135
00:48:57,360 --> 00:48:54,580
I expect that the planet we talked about

1136
00:48:59,490 --> 00:48:57,370
on develop line it could also be rocky

1137
00:49:01,200 --> 00:48:59,500
or at least have a lot of rocky material

1138
00:49:03,570 --> 00:49:01,210

but I don't know that we can tell you

1139
00:49:07,410 --> 00:49:03,580
much more about which one would be more

1140
00:49:09,450 --> 00:49:07,420
habitable but I would certainly like to

1141
00:49:11,270 --> 00:49:09,460
have at a lower temperature rather than

1142
00:49:14,460 --> 00:49:11,280
a higher temperature because the

1143
00:49:18,420 --> 00:49:14,470
evaporation of the other water into the

1144
00:49:21,000 --> 00:49:18,430
atmosphere bill already said this

1145
00:49:22,140 --> 00:49:21,010
earlier but let me just reassign I think

1146
00:49:26,910 --> 00:49:22,150
there's two things that are really

1147
00:49:28,980 --> 00:49:26,920
exciting about Kepler 22b one is that

1148
00:49:31,730 --> 00:49:28,990
it's right in the middle of this

1149
00:49:34,470 --> 00:49:31,740
habitable zone right right next to Earth

1150
00:49:36,450 --> 00:49:34,480
so it's not at either edge and the other

1151
00:49:38,880 --> 00:49:36,460
two are kind of they bracket that

1152
00:49:40,080 --> 00:49:38,890
they're at either edge the second thing

1153
00:49:42,180 --> 00:49:40,090
that's really exciting is that it's

1154
00:49:45,180 --> 00:49:42,190
orbiting a star very very similar to our

1155
00:49:46,570 --> 00:49:45,190
own Sun whereas 8:55 one two and Gliese

1156
00:49:49,330 --> 00:49:46,580
581 are

1157
00:49:52,240 --> 00:49:49,340
are cooler stars you know K and M type

1158
00:49:54,130 --> 00:49:52,250
stars this is a solar analogue it's

1159
00:49:55,510 --> 00:49:54,140
almost a solar twin it's very similar to

1160
00:49:58,660 --> 00:49:55,520
our own Sun and you've got a planet

1161
00:50:00,190 --> 00:49:58,670
twice 2.4 times the the size of the

1162
00:50:02,200 --> 00:50:00,200
earth right smack in the middle of the

1163
00:50:06,310 --> 00:50:02,210

habitable zone so I find it very

1164
00:50:08,770 --> 00:50:06,320
compelling for those two reasons thanks

1165
00:50:11,440 --> 00:50:08,780
will now go to Kelly BD with sky and

1166
00:50:13,210 --> 00:50:11,450
telescope Kelly thanks very much two

1167
00:50:17,620 --> 00:50:13,220
quick ones for Jill I hope they're quick

1168
00:50:22,090 --> 00:50:17,630
um first is how long is the funding 488

1169
00:50:25,630 --> 00:50:22,100
assured and the second question is the

1170
00:50:27,970 --> 00:50:25,640
great Drake Equation has a factor for

1171
00:50:30,040 --> 00:50:27,980
the number of stars that are thought to

1172
00:50:31,360 --> 00:50:30,050
have planets is there some site that

1173
00:50:32,740 --> 00:50:31,370
somewhere between you and the Kepler

1174
00:50:36,510 --> 00:50:32,750
project on what that number will

1175
00:50:39,130 --> 00:50:36,520
ultimately turn out to be well we're

1176
00:50:42,010 --> 00:50:39,140
we're not betting we're just trying to

1177
00:50:44,260 --> 00:50:42,020
look at everything that Kepler has has

1178
00:50:47,650 --> 00:50:44,270
provided as a candidate because remember

1179
00:50:50,680 --> 00:50:47,660
although Kepler may have found larger

1180
00:50:53,140 --> 00:50:50,690
short-period planets that don't

1181
00:50:55,870 --> 00:50:53,150
necessarily look to be particularly

1182
00:50:58,420 --> 00:50:55,880
habitable there may yet be other planets

1183
00:51:01,710 --> 00:50:58,430
in that planetary system to be

1184
00:51:04,480 --> 00:51:01,720
discovered with longer periods so

1185
00:51:06,790 --> 00:51:04,490
planetary systems are a good place to

1186
00:51:09,790 --> 00:51:06,800
look and Kepler is providing us with a

1187
00:51:11,920 --> 00:51:09,800
wonderful set of targets so we're just

1188
00:51:17,820 --> 00:51:11,930

taking everything we can get from from

1189
00:51:23,710 --> 00:51:20,080
actually Kelly I've forgotten your first

1190
00:51:27,940 --> 00:51:23,720
question Oh funding yes how can I forget

1191
00:51:31,240 --> 00:51:27,950
about funding we're good for the short

1192
00:51:33,250 --> 00:51:31,250
term we are in we are negotiations for a

1193
00:51:36,130 --> 00:51:33,260
longer term contract that hasn't come

1194
00:51:38,260 --> 00:51:36,140
through yet but we're very helpful but

1195
00:51:40,660 --> 00:51:38,270
we're going to need to have continued

1196
00:51:43,300 --> 00:51:40,670
public support in addition to finding

1197
00:51:45,370 --> 00:51:43,310
partners to to keep the array

1198
00:51:46,930 --> 00:51:45,380
operational our SETI work has to be

1199
00:51:51,490 --> 00:51:46,940
funded by the public and so that's going

1200
00:51:53,530 --> 00:51:51,500
to be an ongoing obligation thank you

1201
00:52:00,150 --> 00:51:53,540
well now go to Camille Carlisle with sky

1202
00:52:06,210 --> 00:52:03,359
correctly for dr. burr okie did you say

1203
00:52:10,079 --> 00:52:06,220
the planet period is seven point four

1204
00:52:11,819 --> 00:52:10,089
hours no I think you misunderstood the

1205
00:52:13,859 --> 00:52:11,829
plantaris period is two hundred ninety

1206
00:52:16,920 --> 00:52:13,869
days or they could be exact two hundred

1207
00:52:18,210 --> 00:52:16,930
and eighty nine point nine days so

1208
00:52:20,339 --> 00:52:18,220
somewhat similar to that of the earth a

1209
00:52:23,670 --> 00:52:20,349
little bit shorter the duration of the

1210
00:52:26,609 --> 00:52:23,680
transit when the star is being dimmed by

1211
00:52:28,799 --> 00:52:26,619
the planet crossing it is seven point

1212
00:52:33,390 --> 00:52:28,809
four hours I think that's where you got

1213
00:52:34,710 --> 00:52:33,400

the seven point four thank you if you

1214
00:52:37,950 --> 00:52:34,720
have a question on the phone bridge

1215
00:52:39,450 --> 00:52:37,960
press remembers press star power using

1216
00:52:41,190 --> 00:52:39,460
star one on your telephone will not a

1217
00:52:44,339 --> 00:52:41,200
question from another question from Dave

1218
00:52:47,910 --> 00:52:44,349
Perlman the Sampson's Chronicle yo

1219
00:52:52,819 --> 00:52:47,920
thanks again I my phone was dead at the

1220
00:52:56,010 --> 00:52:52,829
right time a long time I'm trying to

1221
00:52:59,670 --> 00:52:56,020
understand whether there was a press

1222
00:53:04,380 --> 00:52:59,680
release from Caltech and it said that it

1223
00:53:06,660 --> 00:53:04,390
found 18 new planets confirmed around

1224
00:53:09,329 --> 00:53:06,670
stars more massive than the Sun is that

1225
00:53:11,539 --> 00:53:09,339
number of those numbers included in

1226
00:53:15,210 --> 00:53:11,549
today's announcements

1227
00:53:16,799 --> 00:53:15,220
no no what you've just said is actually

1228
00:53:18,480 --> 00:53:16,809
news to me I haven't heard that yet

1229
00:53:22,019 --> 00:53:18,490
they're probably talking about it right

1230
00:53:26,339 --> 00:53:22,029
now in the conference but they are

1231
00:53:29,250 --> 00:53:26,349
confirming them and I did I did see a

1232
00:53:31,740 --> 00:53:29,260
preprint that was posted to Astro pH the

1233
00:53:35,039 --> 00:53:31,750
archive and about a week ago with one

1234
00:53:38,460 --> 00:53:35,049
orbiting an M dwarf but this is this is

1235
00:53:44,390 --> 00:53:38,470
news so did that just come out today no

1236
00:53:49,559 --> 00:53:47,789
well you know the the Caltech team is

1237
00:53:51,329 --> 00:53:49,569
not the only other team that's in

1238
00:53:53,299 --> 00:53:51,339

confirming Kepler candidates the

1239
00:53:55,529 --> 00:53:53,309
Europeans have also been very active

1240
00:53:58,200 --> 00:53:55,539
actively working on confirming our

1241
00:54:00,569 --> 00:53:58,210
candidates using the Sofie spectrograph

1242
00:54:03,390 --> 00:54:00,579
for example at the observatory Provence

1243
00:54:04,849 --> 00:54:03,400
and they've already confirmed two that

1244
00:54:08,160 --> 00:54:04,859
are published and they've got another

1245
00:54:10,440 --> 00:54:08,170
batch that are on the preprint servers

1246
00:54:12,839 --> 00:54:10,450
so those will be I'm sure in the

1247
00:54:13,920 --> 00:54:12,849
published literature soon so we're just

1248
00:54:16,230 --> 00:54:13,930
thrilled about this

1249
00:54:17,790 --> 00:54:16,240
need we need all telescopes observing

1250
00:54:19,890 --> 00:54:17,800
these candidates so we can confirm as

1251
00:54:21,750 --> 00:54:19,900
many as possible understand what our

1252
00:54:24,720 --> 00:54:21,760
false positive rate is because that's

1253
00:54:27,210 --> 00:54:24,730
going to increase our the reliability of

1254
00:54:29,099 --> 00:54:27,220
the determination of what we call 8r

1255
00:54:31,260 --> 00:54:29,109
earth right the fraction of stars that

1256
00:54:34,950 --> 00:54:31,270
Harbor these earth-like planets so this

1257
00:54:38,040 --> 00:54:34,960
is this is great well and if I may

1258
00:54:43,440 --> 00:54:38,050
follow I had a question for Jill and

1259
00:54:46,920 --> 00:54:43,450
that relates to the broadcast frequency

1260
00:54:52,410 --> 00:54:46,930
that you are going to zero in on with a

1261
00:54:53,910 --> 00:54:52,420
couple of 22b no that's the those are

1262
00:54:56,660 --> 00:54:53,920
the set of frequencies that we're

1263
00:54:59,190 --> 00:54:56,670

looking at to start our search of the

1264
00:55:00,690 --> 00:54:59,200
terrestrial microwave window so we're

1265
00:55:03,780 --> 00:55:00,700
looking around eight point six six

1266
00:55:06,510 --> 00:55:03,790
gigahertz and that will take us a few

1267
00:55:09,809 --> 00:55:06,520
days actually twice that now since we

1268
00:55:12,809 --> 00:55:09,819
have twice as many candidates to to go

1269
00:55:14,549 --> 00:55:12,819
through and then we'll start back where

1270
00:55:18,510 --> 00:55:14,559
we left off in the spring down at the

1271
00:55:20,339 --> 00:55:18,520
lower frequencies just clarify one thing

1272
00:55:22,349 --> 00:55:20,349
maybe I didn't appreciate your question

1273
00:55:24,420 --> 00:55:22,359
you asked if they're new confirmations

1274
00:55:26,490 --> 00:55:24,430
were included in our count and I'm not

1275
00:55:28,950 --> 00:55:26,500
exactly sure what you mean by that but

1276
00:55:30,839 --> 00:55:28,960
certainly these candidates that they've

1277
00:55:33,750 --> 00:55:30,849
confirmed are probably drawn from our

1278
00:55:35,609 --> 00:55:33,760
February catalog but they would not be

1279
00:55:37,380 --> 00:55:35,619
amongst they would not necessarily be

1280
00:55:38,940 --> 00:55:37,390
amongst the new planet candidates

1281
00:55:42,030 --> 00:55:38,950
because we haven't yet made those

1282
00:55:43,530 --> 00:55:42,040
publicly available thanks I think we

1283
00:55:45,210 --> 00:55:43,540
have time for a couple more questions we

1284
00:55:46,410 --> 00:55:45,220
have to on the phone bridge follow-up

1285
00:55:49,950 --> 00:55:46,420
from Seth Borenstein with The Associated

1286
00:55:52,620 --> 00:55:49,960
Press thanks I just want you know it

1287
00:55:54,569 --> 00:55:52,630
bill or Natalie if you can or even Jill

1288
00:55:56,520 --> 00:55:54,579

if you can just push a little harder out

1289
00:55:59,819 --> 00:55:56,530
what I'm trying to get the sense of is

1290
00:56:01,620 --> 00:55:59,829
it fair to say that this is the most the

1291
00:56:03,809 --> 00:56:01,630
best target right now that we know of

1292
00:56:07,859 --> 00:56:03,819
for the possibility of life elsewhere

1293
00:56:09,329 --> 00:56:07,869
and and why I mean I'm just I have

1294
00:56:11,430 --> 00:56:09,339
editors who just still don't understand

1295
00:56:13,680 --> 00:56:11,440
that this is a story and if you tell me

1296
00:56:15,660 --> 00:56:13,690
how big and leap it is to get something

1297
00:56:18,690 --> 00:56:15,670
so smack in the middle of the habitable

1298
00:56:21,630 --> 00:56:18,700
zone I think it's critically important

1299
00:56:23,069 --> 00:56:21,640
to do that for finally looking at the

1300
00:56:24,720 --> 00:56:23,079
planets in the habitable zone or the

1301
00:56:26,549 --> 00:56:24,730
candidates and have them zone and we're

1302
00:56:27,890 --> 00:56:26,559
confirming them they're not false

1303
00:56:30,450 --> 00:56:27,900
positives they're not going to be

1304
00:56:33,059 --> 00:56:30,460
substantially warmer or colder we have

1305
00:56:36,870 --> 00:56:33,069
now got good candidate good planet

1306
00:56:38,940 --> 00:56:36,880
conformation with Kepler 22b we're

1307
00:56:41,999 --> 00:56:38,950
certain that it is in the habitable zone

1308
00:56:44,789 --> 00:56:42,009
it's not at the edge it's and if it has

1309
00:56:49,079 --> 00:56:44,799
a surface it it ought to have a nice

1310
00:56:51,359 --> 00:56:49,089
temperature one mana one more on the

1311
00:56:52,370 --> 00:56:51,369
telephone from Kelly BD with sky and

1312
00:56:54,599 --> 00:56:52,380
telescope

1313
00:56:57,660 --> 00:56:54,609

thanks very much this is also for bill

1314
00:56:59,670 --> 00:56:57,670
Bru he built the the situation with

1315
00:57:01,140 --> 00:56:59,680
Kepler is such that the stars are a

1316
00:57:03,210 --> 00:57:01,150
little bit noisier than you thought and

1317
00:57:05,670 --> 00:57:03,220
you're actually going to need more time

1318
00:57:07,410 --> 00:57:05,680
to study these in order to get the

1319
00:57:08,789 --> 00:57:07,420
pipeline such that you'll find all the

1320
00:57:10,559 --> 00:57:08,799
candidates you'd like to in the

1321
00:57:12,900 --> 00:57:10,569
habitable zone can you give us an update

1322
00:57:15,239 --> 00:57:12,910
on where you think things stand with

1323
00:57:18,479 --> 00:57:15,249
getting a mission extension I think you

1324
00:57:21,299 --> 00:57:18,489
have a review coming up very shortly yes

1325
00:57:24,960 --> 00:57:21,309
there'll be a senior review coming up

1326
00:57:27,450 --> 00:57:24,970
and I believe in February we're putting

1327
00:57:30,989 --> 00:57:27,460
together a very good proposal pointing

1328
00:57:33,180 --> 00:57:30,999
out that these stars that we have been

1329
00:57:34,440 --> 00:57:33,190
measuring the G stars like the Sun have

1330
00:57:36,749 --> 00:57:34,450
turned out to be quite a bit more

1331
00:57:38,579 --> 00:57:36,759
variable than anyone expected and that

1332
00:57:41,069 --> 00:57:38,589
makes it much more difficult to find

1333
00:57:43,440 --> 00:57:41,079
small planets which are of most interest

1334
00:57:45,539 --> 00:57:43,450
to us particularly small planets in the

1335
00:57:47,999 --> 00:57:45,549
habitable zone and so the only way that

1336
00:57:49,910 --> 00:57:48,009
can be done is to get more transit so

1337
00:57:52,620 --> 00:57:49,920
instead of three transits if we can get

1338
00:57:54,779 --> 00:57:52,630

six or eight transits that would

1339
00:57:56,940 --> 00:57:54,789
dramatically help help us find these

1340
00:57:59,489 --> 00:57:56,950
small planets and so we're asking the

1341
00:58:02,700 --> 00:57:59,499
senior review to entertain our proposal

1342
00:58:04,890 --> 00:58:02,710
and to continue the mission from three

1343
00:58:07,920 --> 00:58:04,900
and a half years is what we have now -

1344
00:58:09,479 --> 00:58:07,930
something of the order of six years or

1345
00:58:12,569 --> 00:58:09,489
something like that to get these

1346
00:58:13,440 --> 00:58:12,579
additional transits we're gonna come

1347
00:58:20,459 --> 00:58:13,450
back here to see if there's any

1348
00:58:22,920 --> 00:58:20,469
follow-up questions in the room I mean I

1349
00:58:25,589 --> 00:58:22,930
realize that there aren't any biologists

1350
00:58:28,200 --> 00:58:25,599
on this panel but um I'm sure in your

1351
00:58:31,229 --> 00:58:28,210
your off hours you must speculate this a

1352
00:58:33,089 --> 00:58:31,239
little bit about aside from having a

1353
00:58:37,499 --> 00:58:33,099
planet the right size and in the right

1354
00:58:40,499 --> 00:58:37,509
place what else would be needed to have

1355
00:58:42,170 --> 00:58:40,509
there be something beyond microbial life

1356
00:58:44,459 --> 00:58:42,180
on it

1357
00:58:46,410 --> 00:58:44,469
question I think Jill is probably the

1358
00:58:48,390 --> 00:58:46,420
best one dance for that there are the

1359
00:58:50,489 --> 00:58:48,400
answers to that question range all over

1360
00:58:53,009 --> 00:58:50,499
the map I mean there are people who have

1361
00:58:55,109 --> 00:58:53,019
this rare earth hypothesis but there are

1362
00:58:58,229 --> 00:58:55,119
so many special things about Earth

1363
00:59:00,569 --> 00:58:58,239

including having a Jupiter at five au

1364
00:59:02,689 --> 00:59:00,579
when you have an earth at 1a you having

1365
00:59:06,959 --> 00:59:02,699
the magnetic field strength that we have

1366
00:59:10,019 --> 00:59:06,969
having etc etc etc but we have an

1367
00:59:11,939 --> 00:59:10,029
example of one in a physics experiment

1368
00:59:13,559 --> 00:59:11,949
when there are multiple outcomes you

1369
00:59:15,239 --> 00:59:13,569
want to run that experiment many times

1370
00:59:17,699 --> 00:59:15,249
and figure out what the branching ratios

1371
00:59:19,349 --> 00:59:17,709
are how many times does it end up in

1372
00:59:21,599 --> 00:59:19,359
this way how many times does it end up

1373
00:59:24,209 --> 00:59:21,609
in that way we haven't been able to do

1374
00:59:26,910 --> 00:59:24,219
those experiments yet we don't know

1375
00:59:32,009 --> 00:59:26,920
whether the earth as it is and life as

1376
00:59:35,039 --> 00:59:32,019
we know it here is a very if the way we

1377
00:59:37,079 --> 00:59:35,049
got here was very unusual that else

1378
00:59:40,049 --> 00:59:37,089
where things go in a different way it

1379
00:59:41,640 --> 00:59:40,059
makes it much easier or are we common I

1380
00:59:45,299 --> 00:59:41,650
mean that seems to be the only

1381
00:59:47,699 --> 00:59:45,309
appropriate way to treat a statistic of

1382
00:59:52,410 --> 00:59:47,709
one is as a median right we're average

1383
00:59:54,299 --> 00:59:52,420
we just don't know that and we can have

1384
00:59:57,900 --> 00:59:54,309
a lot of discussions and certainly

1385
01:00:00,509 --> 00:59:57,910
extremophiles are opening our eyes about

1386
01:00:05,120 --> 01:00:00,519
for microbial life and actually some

1387
01:00:09,599 --> 01:00:05,130
macroscopic life the the conditions that

1388
01:00:13,829 --> 01:00:09,609

can be quite comfortable for different

1389
01:00:16,589 --> 01:00:13,839
forms of life other than human so this

1390
01:00:21,539 --> 01:00:16,599
is a work in progress we just don't know

1391
01:00:24,839 --> 01:00:21,549
we wish in this field number two is the

1392
01:00:29,849 --> 01:00:24,849
all-important number because we count

1393
01:00:32,729 --> 01:00:29,859
one to infinity right as soon as we find

1394
01:00:36,120 --> 01:00:32,739
a different a separate an independent

1395
01:00:37,859 --> 01:00:36,130
example of life somewhere else we're

1396
01:00:39,269 --> 01:00:37,869
gonna know that it's ubiquitous

1397
01:00:43,229 --> 01:00:39,279
throughout the universe so we're all

1398
01:00:44,579 --> 01:00:43,239
looking for number two thanks we'll take

1399
01:00:48,109 --> 01:00:44,589
one more question and then we'll

1400
01:00:56,490 --> 01:00:52,470
um so this new catalogue the candidates

1401
01:00:58,140 --> 01:00:56,500
are now out there as of today it's the

1402
01:01:00,540 --> 01:00:58,150
the catalogs been under review for the

1403
01:01:03,180 --> 01:01:00,550
last week with a science team and so

1404
01:01:06,750 --> 01:01:03,190
once this conference is over we'll go

1405
01:01:08,490 --> 01:01:06,760
back to our computers get it in a form

1406
01:01:10,349 --> 01:01:08,500
that the public can digest and then

1407
01:01:11,550 --> 01:01:10,359
release it so I'm guessing another two

1408
01:01:14,220 --> 01:01:11,560
or three weeks and then it'll be

1409
01:01:15,690 --> 01:01:14,230
publicly available I guess the reason I

1410
01:01:19,310 --> 01:01:15,700
asked I mean so this is I believe the

1411
01:01:25,680 --> 01:01:19,320
27th planet confirmed by the team in

1412
01:01:26,099 --> 01:01:25,690
total by the Kepler team yes 29 that's

1413
01:01:28,470 --> 01:01:26,109

correct

1414
01:01:30,900 --> 01:01:28,480
you're also announcing you know there

1415
01:01:32,760 --> 01:01:30,910
you have over 2,000 candidates right so

1416
01:01:34,260 --> 01:01:32,770
it's two orders of magnitude difference

1417
01:01:36,000 --> 01:01:34,270
between the number of candidates you

1418
01:01:38,280 --> 01:01:36,010
have and the number that you've been

1419
01:01:40,260 --> 01:01:38,290
able to confirm it seems like you're

1420
01:01:44,340 --> 01:01:40,270
drowning and and you desperately need

1421
01:01:46,470 --> 01:01:44,350
help here are you considering turning

1422
01:01:47,849 --> 01:01:46,480
them loose earlier so that you know all

1423
01:01:50,250 --> 01:01:47,859
these other folks that have more

1424
01:01:52,670 --> 01:01:50,260
telescope time can start independently

1425
01:01:55,950 --> 01:01:52,680
confirming yeah well we do already have

1426
01:01:58,440 --> 01:01:55,960
1235 out there so we're still talking

1427
01:02:00,120 --> 01:01:58,450
orders of magnitude but yeah absolutely

1428
01:02:03,060 --> 01:02:00,130
I'll be talking a little bit about that

1429
01:02:05,790 --> 01:02:03,070
in my talk at the conference our plans

1430
01:02:09,599 --> 01:02:05,800
for releasing data so that when they do

1431
01:02:11,760 --> 01:02:09,609
confirm planets they can do an analysis

1432
01:02:13,980 --> 01:02:11,770
that's more robust and get pinned down

1433
01:02:15,780 --> 01:02:13,990
the planet properties more accurately so

1434
01:02:18,060 --> 01:02:15,790
we'll be releasing a lot of data coming

1435
01:02:21,150 --> 01:02:18,070
up here in January we'll have a big data

1436
01:02:23,700 --> 01:02:21,160
release and but you know we don't hold

1437
01:02:25,380 --> 01:02:23,710
up the catalogs by any means we don't

1438
01:02:27,990 --> 01:02:25,390

hold them back as soon as they're ready

1439
01:02:29,640 --> 01:02:28,000
it'll be publicly available so we're

1440
01:02:31,410 --> 01:02:29,650
just we're working literally around the

1441
01:02:33,480 --> 01:02:31,420
clock to get this done as quickly as

1442
01:02:35,670 --> 01:02:33,490
possible it just takes time just takes

1443
01:02:37,200 --> 01:02:35,680
the time that it takes and of course

1444
01:02:39,300 --> 01:02:37,210
you've seen the catalogs earlier

1445
01:02:41,430 --> 01:02:39,310
catalogs come out and the fact that our

1446
01:02:43,710 --> 01:02:41,440
colleagues throughout the world are

1447
01:02:46,050 --> 01:02:43,720
already using that information to do

1448
01:02:48,359 --> 01:02:46,060
confirmations so we have asked for their

1449
01:02:50,340 --> 01:02:48,369
help and they are helping so it's not

1450
01:02:53,660 --> 01:02:50,350
just this group but the whole world

1451
01:02:57,599 --> 01:02:53,670
that's helping us confirm these planets

1452
01:02:59,310 --> 01:02:57,609
there's never been somebody an outside

1453
01:03:00,670 --> 01:02:59,320
astronomer who has come to us who has

1454
01:03:03,160 --> 01:03:00,680
approached us and said I want to

1455
01:03:05,319 --> 01:03:03,170
that we've turned away everybody is

1456
01:03:07,930 --> 01:03:05,329
engaged if they want to be and and we

1457
01:03:10,540 --> 01:03:07,940
will increase that collaboration and

1458
01:03:12,700 --> 01:03:10,550
coordination as we move into the

1459
01:03:15,880 --> 01:03:12,710
hopefully into an extended mission we

1460
01:03:17,650 --> 01:03:15,890
will open up that so that everybody has

1461
01:03:20,079 --> 01:03:17,660
access to all of the information at all

1462
01:03:21,760 --> 01:03:20,089
of the time but yet still try to

1463
01:03:24,370 --> 01:03:21,770

coordinate it because what we don't want

1464
01:03:26,260 --> 01:03:24,380
our wasted resources time on these

1465
01:03:28,000 --> 01:03:26,270
telescopes is extremely difficult to

1466
01:03:29,829 --> 01:03:28,010
come by and is extremely difficult to

1467
01:03:32,349 --> 01:03:29,839
operate those telescopes I mean costly

1468
01:03:36,069 --> 01:03:32,359
you do not want people repeating efforts

1469
01:03:37,510 --> 01:03:36,079
we want to maximize the science yield

1470
01:03:40,000 --> 01:03:37,520
and the way to accomplish that is

1471
01:03:41,559 --> 01:03:40,010
through cooperation another aspect of

1472
01:03:43,420 --> 01:03:41,569
that of course the public is looking at

1473
01:03:46,030 --> 01:03:43,430
the data and as a group called planet

1474
01:03:50,740 --> 01:03:46,040
hunters and they have found planets that

1475
01:03:52,630 --> 01:03:50,750
we have we haven't noticed as readily as

1476
01:03:54,370 --> 01:03:52,640
they have and they brought those to our

1477
01:03:56,319 --> 01:03:54,380
attention so there are a huge number of

1478
01:03:59,650 --> 01:03:56,329
people I think there have been millions

1479
01:04:03,490 --> 01:03:59,660
of downloads of the data for people to

1480
01:04:04,960 --> 01:04:03,500
look at Thank You Natalie William and

1481
01:04:07,030 --> 01:04:04,970
Jill that concludes today's news

1482
01:04:08,650 --> 01:04:07,040
briefing on Kepler for more information