1
00:00:14,789 --> 00:00:12,549
welcome to nasa ames research center at

2
00:00:16,390 --> 00:00:14,799
moffett field calvin california

3
00:00:19,269 --> 00:00:16,400
we're here today to announce new

4
00:00:22,390 --> 00:00:19,279
discoveries from nasa's kepler mission

5
00:00:24,230 --> 00:00:22,400
which is managed right here at nasa ames

6
00:00:27,029 --> 00:00:24,240
getting us started with a few opening

7
00:00:34,310 --> 00:00:27,039
remarks is center director dr pete

8
00:00:37,750 --> 00:00:35,990
thank you michelle

9
00:00:39,670 --> 00:00:37,760
just as an open introduction this is

10
00:00:42,229 --> 00:00:39,680
really cool

11
00:00:44,549 --> 00:00:42,239
the i'd like to welcome all of you to

12
00:00:46,630 --> 00:00:44,559
nasa ames research center here in

13
00:00:47,990 --> 00:00:46,640

silicon valley and just like the

14
00:00:50,069 --> 00:00:48,000
companies

15
00:00:52,869 --> 00:00:50,079
that surround us

16
00:00:55,910 --> 00:00:52,879
and the universities

17
00:00:58,150 --> 00:00:55,920
this region has always been known for

18
00:00:59,349 --> 00:00:58,160
innovative different in groundbreaking

19
00:01:00,950 --> 00:00:59,359
[Music]

20
00:01:02,869 --> 00:01:00,960
approaches

21
00:01:06,070 --> 00:01:02,879
nothing represents that better than

22
00:01:07,750 --> 00:01:06,080
kepler now i'm an astronomer

23
00:01:10,070 --> 00:01:07,760
or used to be

24
00:01:11,990 --> 00:01:10,080
before i became a bureaucrat

25
00:01:13,750 --> 00:01:12,000
but uh

26
00:01:15,190 --> 00:01:13,760
sometime in the last century i was in

27
00:01:17,429 --> 00:01:15,200
graduate school

28
00:01:18,789 --> 00:01:17,439
and the thing that inspired me

29
00:01:21,590 --> 00:01:18,799
was uh

30
00:01:23,350 --> 00:01:21,600
the idea that we might someday find

31
00:01:26,550 --> 00:01:23,360
planets around other stars and at that

32
00:01:31,590 --> 00:01:27,590
and i

33
00:01:33,590 --> 00:01:31,600
was hoping that sometime maybe before i

34
00:01:34,870 --> 00:01:33,600
went on to my final reward that we would

35
00:01:37,030 --> 00:01:34,880
find

36
00:01:40,149 --> 00:01:37,040
planets but it was kind of a iffy

37
00:01:45,270 --> 00:01:43,910
decade or two later i i heard uh

38
00:01:46,630 --> 00:01:45,280

one of the guys you're gonna hear today

39
00:01:48,469 --> 00:01:46,640
william beruki

40
00:01:51,030 --> 00:01:48,479
talk about a concept

41
00:01:52,710 --> 00:01:51,040
and i and some of my colleagues said ah

42
00:01:55,670 --> 00:01:52,720
that'll never work

43
00:01:57,990 --> 00:01:55,680
uh nasa said the same thing but they

44
00:01:58,260 --> 00:01:58,000
thought it just might work

45
00:01:59,590 --> 00:01:58,270
so

46
00:02:01,670 --> 00:01:59,600
[Music]

47
00:02:03,510 --> 00:02:01,680
uh bill was given a little bit of money

48
00:02:05,510 --> 00:02:03,520
and

49
00:02:06,389 --> 00:02:05,520
it actually got turned down i think four

50
00:02:08,949 --> 00:02:06,399
times

51
00:02:10,070 --> 00:02:08,959
until it finally got selected

52
00:02:11,830 --> 00:02:10,080
uh

53
00:02:14,150 --> 00:02:11,840
and kepler

54
00:02:15,750 --> 00:02:14,160
as we know it today has been an

55
00:02:17,030 --> 00:02:15,760
unbelievably

56
00:02:18,869 --> 00:02:17,040
phenomenal

57
00:02:21,270 --> 00:02:18,879
uh

58
00:02:24,309 --> 00:02:21,280
scientific instrument it has confirmed

59
00:02:28,229 --> 00:02:24,319
more than 115 planets and it has

60
00:02:29,030 --> 00:02:28,239
uh over 2 700 planet candidates

61
00:02:34,309 --> 00:02:29,040
uh

62
00:02:38,790 --> 00:02:34,319
resulted in it being extended an

63
00:02:40,710 --> 00:02:38,800

additional four years through 2016

64
00:02:42,150 --> 00:02:40,720
and this has also brought us here to

65
00:02:44,390 --> 00:02:42,160
discuss

66
00:02:45,509 --> 00:02:44,400
some of the key results we have today

67
00:02:48,710 --> 00:02:45,519
now

68
00:02:49,830 --> 00:02:48,720
probably in closing this brief

69
00:02:51,350 --> 00:02:49,840
introduction

70
00:02:53,750 --> 00:02:51,360
that kepler

71
00:02:57,030 --> 00:02:53,760
represents the spirit

72
00:02:58,949 --> 00:02:57,040
and ingenuity of this center

73
00:03:01,830 --> 00:02:58,959
silicon valley

74
00:03:04,949 --> 00:03:01,840
california nasa and most importantly the

75
00:03:07,830 --> 00:03:04,959
united states i know of no better

76
00:03:10,070 --> 00:03:07,840
way to kind of say that we

77
00:03:12,309 --> 00:03:10,080
all of us still have the right stuff

78
00:03:13,509 --> 00:03:12,319
so i want to congratulate the team

79
00:03:14,869 --> 00:03:13,519
looking forward to hearing what they

80
00:03:16,309 --> 00:03:14,879
have to say

81
00:03:17,430 --> 00:03:16,319
and i want to turn it back to michelle

82
00:03:25,270 --> 00:03:17,440
so

83
00:03:30,070 --> 00:03:27,990
all right thank you dr warden

84
00:03:31,589 --> 00:03:30,080
it's now my distinct pleasure

85
00:03:33,509 --> 00:03:31,599
to introduce

86
00:03:36,149 --> 00:03:33,519
our panel today

87
00:03:38,630 --> 00:03:36,159
so joining us live via via video

88
00:03:40,070 --> 00:03:38,640

teleconference from nasa headquarters is

89
00:03:42,070 --> 00:03:40,080
paul hertz

90
00:03:43,350 --> 00:03:42,080
astrophysics director at nasa

91
00:03:45,750 --> 00:03:43,360
headquarters

92
00:03:48,470 --> 00:03:45,760
and joining us live here at nasa ames we

93
00:03:50,070 --> 00:03:48,480
have roger hunter kepler project manager

94
00:03:51,910 --> 00:03:50,080
here at nasa ames

95
00:03:54,149 --> 00:03:51,920
we have william beruki

96
00:03:55,830 --> 00:03:54,159
kepler's principal science investigator

97
00:03:57,910 --> 00:03:55,840
also at nasa ames

98
00:04:00,229 --> 00:03:57,920
and we have thomas barkley kepler

99
00:04:03,429 --> 00:04:00,239
scientist at the bay area environmental

100
00:04:05,670 --> 00:04:03,439
research institute in sonoma california

101
00:04:07,910 --> 00:04:05,680
and we also have lisa keltenager

102
00:04:10,149 --> 00:04:07,920
research group leader at the max planck

103
00:04:12,309 --> 00:04:10,159
institute of astronomy and research

104
00:04:14,229 --> 00:04:12,319
associate at harvard smithsonian center

105
00:04:16,870 --> 00:04:14,239
for astrophysics at cambridge

106
00:04:18,310 --> 00:04:16,880
massachusetts

107
00:04:19,590 --> 00:04:18,320
we're going to start with opening

108
00:04:21,749 --> 00:04:19,600
remarks

109
00:04:23,590 --> 00:04:21,759
and then take questions here at ames and

110
00:04:25,350 --> 00:04:23,600
then we're going to join have questions

111
00:04:26,870 --> 00:04:25,360
from our panelists

112
00:04:29,830 --> 00:04:26,880
from our participants on the

113
00:04:32,150 --> 00:04:29,840

teleconference

114
00:04:35,030 --> 00:04:32,160
and then we're also going to take

115
00:04:36,870 --> 00:04:35,040
questions from those on social media so

116
00:04:38,870 --> 00:04:36,880
if you are interested in asking a

117
00:04:41,749 --> 00:04:38,880
question please

118
00:04:43,590 --> 00:04:41,759
tweet or post your question with hashtag

119
00:04:45,749 --> 00:04:43,600
ask nasa

120
00:04:47,510 --> 00:04:45,759
and those joining on the phone bridge if

121
00:04:50,070 --> 00:04:47,520
you'd like to ask a question

122
00:04:56,790 --> 00:04:50,080
push star pound

123
00:05:00,469 --> 00:04:58,710
thanks very much michelle

124
00:05:01,670 --> 00:05:00,479
um

125
00:05:03,270 --> 00:05:01,680
so

126
00:05:05,670 --> 00:05:03,280
i'm paul hertz i'm the director of

127
00:05:10,550 --> 00:05:05,680
astrophysics at what nasa headquarters

128
00:05:15,670 --> 00:05:13,430
so nasa astrophysics mission is to

129
00:05:17,590 --> 00:05:15,680
unravel the mysteries of the universe to

130
00:05:20,629 --> 00:05:17,600
help understand how the universe began

131
00:05:22,550 --> 00:05:20,639
evolved and to search and disc uh to

132
00:05:25,510 --> 00:05:22,560
search for and study planets around

133
00:05:27,590 --> 00:05:25,520
other stars and like dr warden i

134
00:05:29,430 --> 00:05:27,600
remember when none had been discovered i

135
00:05:31,590 --> 00:05:29,440
used to be an astronomer before i became

136
00:05:33,749 --> 00:05:31,600
a bureaucrat and now it's one of our

137
00:05:36,629 --> 00:05:33,759
prime missions

138
00:05:38,310 --> 00:05:36,639

the kepler space telescope is one of 12

139
00:05:40,790 --> 00:05:38,320
satellites that we have operating right

140
00:05:43,270 --> 00:05:40,800
now and it's the only one that's capable

141
00:05:47,510 --> 00:05:43,280
of discovering and studying earth-sized

142
00:05:51,029 --> 00:05:48,950
it's not going to be the last such

143
00:05:53,909 --> 00:05:51,039
satellite nasa has recently announced

144
00:05:56,309 --> 00:05:53,919
the selection of a follow-on mission

145
00:05:58,390 --> 00:05:56,319
called the transiting exoplanet survey

146
00:06:01,270 --> 00:05:58,400
satellite or tess which will launch

147
00:06:04,629 --> 00:06:01,280
around 2017 and we'll discover planets

148
00:06:06,230 --> 00:06:04,639
around the star's nearest to our own sun

149
00:06:09,430 --> 00:06:06,240
but today's announcement is about a

150
00:06:12,950 --> 00:06:09,440
kepler discovery uh one which takes us

151
00:06:14,790 --> 00:06:12,960
on the path towards understanding uh how

152
00:06:17,029 --> 00:06:14,800
many star how many planets there are

153
00:06:19,590 --> 00:06:17,039
around other uh stars and whether they

154
00:06:21,510 --> 00:06:19,600
are small enough to be rocky and whether

155
00:06:24,230 --> 00:06:21,520
any of them might be habitable and have

156
00:06:26,469 --> 00:06:24,240
liquid water on them this is a gradual

157
00:06:28,390 --> 00:06:26,479
path that kepler has been taking us down

158
00:06:31,189 --> 00:06:28,400
and today's exciting announcement takes

159
00:06:34,070 --> 00:06:31,199
us even closer to that goal of finding

160
00:06:35,590 --> 00:06:34,080
habitable planets around other stars so

161
00:06:37,189 --> 00:06:35,600
with that i'm going to pass it back over

162
00:06:40,390 --> 00:06:37,199
to roger hunter the kepler project

163
00:06:41,670 --> 00:06:40,400

manager there at ames research center

164
00:06:43,590 --> 00:06:41,680
thank you paul we're counting on you

165
00:06:44,870 --> 00:06:43,600
bureaucrats to give us astronomers more

166
00:06:45,749 --> 00:06:44,880
money

167
00:06:47,749 --> 00:06:45,759
and so

168
00:06:49,110 --> 00:06:47,759
we have some really juicy information to

169
00:06:51,510 --> 00:06:49,120
talk about today

170
00:06:54,070 --> 00:06:51,520
and it's my job to set the stage with a

171
00:06:56,070 --> 00:06:54,080
preamble and if you go to my first chart

172
00:06:58,710 --> 00:06:56,080
i want to talk just a little bit about

173
00:07:01,189 --> 00:06:58,720
the scientific objectives of kepler

174
00:07:03,350 --> 00:07:01,199
we've always wanted to know how rare or

175
00:07:04,710 --> 00:07:03,360
how common are planets like the earth in

176
00:07:07,029 --> 00:07:04,720
the galaxy

177
00:07:09,749 --> 00:07:07,039
we want to know what percentage of stars

178
00:07:12,469 --> 00:07:09,759
in the galaxy harbor potential habitable

179
00:07:14,710 --> 00:07:12,479
planets if you go to my next chart

180
00:07:16,710 --> 00:07:14,720
i want to talk about the results

181
00:07:19,110 --> 00:07:16,720
that we've experienced so far three

182
00:07:21,510 --> 00:07:19,120
months ago the kepler mission showed

183
00:07:22,870 --> 00:07:21,520
this chart to the public

184
00:07:25,029 --> 00:07:22,880
and as you can see

185
00:07:28,189 --> 00:07:25,039
we have already identified within just

186
00:07:30,870 --> 00:07:28,199
the first 22 months of this mission

187
00:07:33,189 --> 00:07:30,880
2740 planet candidates

188
00:07:34,790 --> 00:07:33,199

one thing to take away from this chart

189
00:07:37,589 --> 00:07:34,800
also is this

190
00:07:40,790 --> 00:07:37,599
there are a lot of plentiful small

191
00:07:44,309 --> 00:07:40,800
planets out there and that is key

192
00:07:46,629 --> 00:07:44,319
we have 16 quarters of observations in

193
00:07:47,990 --> 00:07:46,639
the bank and this is just from the first

194
00:07:50,550 --> 00:07:48,000
22 months

195
00:07:52,550 --> 00:07:50,560
let's go to my next chart

196
00:07:53,990 --> 00:07:52,560
let's do a quick refresher on how this

197
00:07:55,990 --> 00:07:54,000
system works

198
00:07:57,990 --> 00:07:56,000
kepler detects planets by transit

199
00:08:00,550 --> 00:07:58,000
photometry if you're standing on the

200
00:08:02,869 --> 00:08:00,560
edge of our solar system and looking in

201
00:08:04,629 --> 00:08:02,879
you'd see the earth do this once a year

202
00:08:06,469 --> 00:08:04,639
and we're using the same concept as

203
00:08:08,869 --> 00:08:06,479
we're looking at stars thousands of

204
00:08:10,950 --> 00:08:08,879
light years from us and when that planet

205
00:08:12,950 --> 00:08:10,960
crosses the face of that star we can

206
00:08:15,430 --> 00:08:12,960
measure the change in brightness so

207
00:08:17,110 --> 00:08:15,440
precisely that we can give you three

208
00:08:19,909 --> 00:08:17,120
vital pieces of information about that

209
00:08:21,990 --> 00:08:19,919
planet how big is it what is its orbital

210
00:08:22,869 --> 00:08:22,000
period and what is the distance from its

211
00:08:24,469 --> 00:08:22,879
star

212
00:08:27,670 --> 00:08:24,479
those are key in determining whether a

213
00:08:29,430 --> 00:08:27,680

planet is in the habitable zone or not

214
00:08:30,950 --> 00:08:29,440
now until today

215
00:08:32,949 --> 00:08:30,960
until today

216
00:08:34,790 --> 00:08:32,959
kepler had announced only two other

217
00:08:36,230 --> 00:08:34,800
planets in a habitable zone

218
00:08:38,070 --> 00:08:36,240
kepler-22b

219
00:08:40,709 --> 00:08:38,080
and kepler-47c

220
00:08:43,670 --> 00:08:40,719
and both of them were relatively large

221
00:08:45,990 --> 00:08:43,680
22b was 2.4 times the size of earth and

222
00:08:47,750 --> 00:08:46,000
49c was even bigger almost five times

223
00:08:49,990 --> 00:08:47,760
the size of earth but what we're going

224
00:08:51,670 --> 00:08:50,000
to talk to you about today are two

225
00:08:54,310 --> 00:08:51,680
planetary systems

226
00:08:56,070 --> 00:08:54,320
one harbors two habitable zone planets

227
00:08:57,990 --> 00:08:56,080
and that it harbors another one that is

228
00:09:00,389 --> 00:08:58,000
right on the cusp of the habitable zone

229
00:09:01,350 --> 00:09:00,399
and these are smaller planets

230
00:09:02,870 --> 00:09:01,360
i'm going to turn this over to bill

231
00:09:04,310 --> 00:09:02,880
baruchy to announce the first

232
00:09:05,750 --> 00:09:04,320
discoveries

233
00:09:07,430 --> 00:09:05,760
thank you roger

234
00:09:10,870 --> 00:09:07,440
kepler is certainly making excellent

235
00:09:13,030 --> 00:09:10,880
progress towards the goals that roger

236
00:09:14,230 --> 00:09:13,040
enunciated so clearly

237
00:09:16,070 --> 00:09:14,240
and so today

238
00:09:17,990 --> 00:09:16,080

could i have next figure please

239
00:09:19,269 --> 00:09:18,000
today i'd like to announce these two

240
00:09:21,110 --> 00:09:19,279
planets

241
00:09:23,590 --> 00:09:21,120
some of larger than the earth and the

242
00:09:26,310 --> 00:09:23,600
habitable zone of a single star

243
00:09:27,829 --> 00:09:26,320
the planet in the center there

244
00:09:30,150 --> 00:09:27,839
uh is a little bit bigger than the earth

245
00:09:31,910 --> 00:09:30,160
1.4 times the size of the earth the

246
00:09:34,070 --> 00:09:31,920
other one's 1.6 times the size of the

247
00:09:36,070 --> 00:09:34,080
earth we think there's a good chance

248
00:09:39,590 --> 00:09:36,080
that the center one there might be in

249
00:09:42,790 --> 00:09:39,600
fact a uh rocky planet and in fact these

250
00:09:45,590 --> 00:09:42,800
two planets are the our best candidates

251
00:09:47,670 --> 00:09:45,600
for planets uh that might be habitable

252
00:09:49,430 --> 00:09:47,680
not just in the habitable zone

253
00:09:51,110 --> 00:09:49,440
they're part of a planetary system of

254
00:09:53,509 --> 00:09:51,120
five planets that we've discovered so

255
00:09:55,110 --> 00:09:53,519
far but these are the two most important

256
00:09:56,389 --> 00:09:55,120
that are most important and the ones

257
00:09:59,670 --> 00:09:56,399
that we'll discuss

258
00:10:01,190 --> 00:09:59,680
at length could i have the next figure

259
00:10:03,430 --> 00:10:01,200
when we talk about the habitable zone we

260
00:10:06,150 --> 00:10:03,440
really need to understand what we're

261
00:10:07,750 --> 00:10:06,160
trying to portray here and that is we

262
00:10:09,990 --> 00:10:07,760
could imagine taking a planet and

263
00:10:11,990 --> 00:10:10,000

putting it close to a star if it's so

264
00:10:14,870 --> 00:10:12,000
close in that red region for example

265
00:10:16,150 --> 00:10:14,880
that the it's too hot the oceans boil

266
00:10:18,550 --> 00:10:16,160
on the other hand we move the plant too

267
00:10:21,350 --> 00:10:18,560
far away in that blue region it's too

268
00:10:23,110 --> 00:10:21,360
cold the oceans would be frozen solid in

269
00:10:24,230 --> 00:10:23,120
the other case do we think that's

270
00:10:26,470 --> 00:10:24,240
conducive

271
00:10:28,230 --> 00:10:26,480
to the evolution of life

272
00:10:30,710 --> 00:10:28,240
in the middle between the fire and the

273
00:10:32,389 --> 00:10:30,720
ice is this green zone the habitable

274
00:10:34,630 --> 00:10:32,399
zone where a planet

275
00:10:36,790 --> 00:10:34,640
at that distance around its star could

276
00:10:39,030 --> 00:10:36,800
have liquid water on its surface

277
00:10:41,430 --> 00:10:39,040
that habitable zone shown in green

278
00:10:43,350 --> 00:10:41,440
is a function of of the star how big is

279
00:10:45,110 --> 00:10:43,360
the star how hot is the star and you can

280
00:10:46,949 --> 00:10:45,120
see for the hottest stars it's quite far

281
00:10:49,350 --> 00:10:46,959
out it gets smaller towards sunlike

282
00:10:50,389 --> 00:10:49,360
stars and even smaller toward cooler

283
00:10:53,430 --> 00:10:50,399
stars

284
00:10:55,110 --> 00:10:53,440
the star for kepler 62 is actually a

285
00:10:56,069 --> 00:10:55,120
little bit cooler and smaller than the

286
00:10:59,590 --> 00:10:56,079
sun

287
00:11:03,829 --> 00:11:01,269
roger talked about uh

288
00:11:06,069 --> 00:11:03,839

two large planets and they're shown here

289
00:11:08,630 --> 00:11:06,079
the vertical axis is the size of the

290
00:11:10,470 --> 00:11:08,640
planet relative to the size of the earth

291
00:11:12,710 --> 00:11:10,480
the horizontal axis is its orbital

292
00:11:15,509 --> 00:11:12,720
period earth is the lower right hand

293
00:11:17,509 --> 00:11:15,519
corner and that's there for reference

294
00:11:19,110 --> 00:11:17,519
roger mentioned the two upper ones we're

295
00:11:23,590 --> 00:11:19,120
interested in the two lower ones that's

296
00:11:27,350 --> 00:11:23,600
kepler 62e orbital period 122 days

297
00:11:30,069 --> 00:11:27,360
kepler 62 f orbital period of about 267

298
00:11:31,910 --> 00:11:30,079
days getting close to the orbital period

299
00:11:35,110 --> 00:11:31,920
of of the earth

300
00:11:38,870 --> 00:11:36,710
this is an animation we can see us are

301
00:11:40,550 --> 00:11:38,880
flying through past the two outer

302
00:11:42,710 --> 00:11:40,560
planets and then we come to the inner

303
00:11:45,269 --> 00:11:42,720
planets there are three inner planets

304
00:11:48,310 --> 00:11:45,279
one of which is the size of mars we look

305
00:11:50,389 --> 00:11:48,320
at the the star itself that star is

306
00:11:53,030 --> 00:11:50,399
two-thirds the size of the sun

307
00:11:54,069 --> 00:11:53,040
it's about uh one-fifth is luminous as

308
00:11:59,269 --> 00:11:54,079
the sun

309
00:12:01,110 --> 00:11:59,279
billion years old so it and its planets

310
00:12:02,230 --> 00:12:01,120
are older than our sun older than our

311
00:12:04,790 --> 00:12:02,240
planets

312
00:12:06,710 --> 00:12:04,800
it's about 1200 light years away so it's

313
00:12:08,069 --> 00:12:06,720

not all that close

314
00:12:09,910 --> 00:12:08,079
here we can see the plant is the

315
00:12:12,150 --> 00:12:09,920
habitable zone and we're moving towards

316
00:12:14,389 --> 00:12:12,160
this planet that we believe is warm it

317
00:12:16,870 --> 00:12:14,399
may be a water planet and so it'll be

318
00:12:18,389 --> 00:12:16,880
hot warm and have lots of water and in

319
00:12:20,389 --> 00:12:18,399
fact if you look at the back side it

320
00:12:22,949 --> 00:12:20,399
might very well have lightning

321
00:12:27,190 --> 00:12:22,959
the next planet that's showing up is 62f

322
00:12:29,910 --> 00:12:27,200
the one that we think may very well be a

323
00:12:32,710 --> 00:12:29,920
rocky planet it's much cooler it's got

324
00:12:35,269 --> 00:12:32,720
polar caps now we're surmising this uh

325
00:12:37,670 --> 00:12:35,279
polar caps we think that it may have

326
00:12:41,509 --> 00:12:37,680
significant land masses and certainly a

327
00:12:45,030 --> 00:12:43,670
the three inner planets

328
00:12:46,870 --> 00:12:45,040
and the two outer planets are part of

329
00:12:48,629 --> 00:12:46,880
this five planet system

330
00:12:50,870 --> 00:12:48,639
but we don't know that we found all the

331
00:12:53,269 --> 00:12:50,880
planets it may very well be that as we

332
00:12:54,470 --> 00:12:53,279
continue to look we'll find planets that

333
00:12:56,069 --> 00:12:54,480
are much further out i don't know

334
00:12:57,750 --> 00:12:56,079
whether it'll be jupiter's or whatever

335
00:12:59,670 --> 00:12:57,760
but we're continuing to look for these

336
00:13:03,030 --> 00:12:59,680
other planets as well

337
00:13:08,870 --> 00:13:06,069
here's our comparison of the kepler 62

338
00:13:10,470 --> 00:13:08,880

planetary system and our solar system

339
00:13:11,509 --> 00:13:10,480
there's some similarities there's some

340
00:13:13,829 --> 00:13:11,519
differences

341
00:13:16,150 --> 00:13:13,839
certainly the habitable habitable zone

342
00:13:17,670 --> 00:13:16,160
is quite a bit smaller than that of the

343
00:13:19,030 --> 00:13:17,680
solar system

344
00:13:21,350 --> 00:13:19,040
so that's a difference but there's

345
00:13:24,150 --> 00:13:21,360
similarities if we look at

346
00:13:25,829 --> 00:13:24,160
the three inner planets for kepler-62

347
00:13:28,389 --> 00:13:25,839
they're all so close to their star

348
00:13:30,150 --> 00:13:28,399
they're very very hot

349
00:13:32,150 --> 00:13:30,160
you could some of them have might have

350
00:13:34,389 --> 00:13:32,160
liquid zinc on the surface hot enough to

351
00:13:36,310 --> 00:13:34,399
have liquid cadmium on others so they're

352
00:13:38,310 --> 00:13:36,320
very hot and that's very much like

353
00:13:40,790 --> 00:13:38,320
mercury and venus

354
00:13:42,470 --> 00:13:40,800
if we look there's two planets

355
00:13:44,629 --> 00:13:42,480
in the habitable zone of the solar

356
00:13:48,550 --> 00:13:44,639
system earth and mars

357
00:13:50,389 --> 00:13:48,560
and two in the system 62 e and f

358
00:13:53,030 --> 00:13:50,399
62e is

359
00:13:55,670 --> 00:13:53,040
somewhat bigger we think might be a

360
00:13:58,310 --> 00:13:55,680
a water world but we don't really know

361
00:14:00,310 --> 00:13:58,320
we have not been able to measure the

362
00:14:02,230 --> 00:14:00,320
masses of these objects that's something

363
00:14:04,710 --> 00:14:02,240

we would hope to do someday in the

364
00:14:07,110 --> 00:14:04,720
future but right now we are telling you

365
00:14:09,509 --> 00:14:07,120
what we know and what we think is a

366
00:14:10,629 --> 00:14:09,519
reasonable understanding of what these

367
00:14:12,710 --> 00:14:10,639
planets

368
00:14:16,629 --> 00:14:12,720
are like

369
00:14:21,110 --> 00:14:18,710
when i talk about the fact that we think

370
00:14:24,310 --> 00:14:21,120
the uh these two planets might be rocky

371
00:14:26,230 --> 00:14:24,320
or rocky and a water world what

372
00:14:28,550 --> 00:14:26,240
what evidence do we have for that what

373
00:14:30,550 --> 00:14:28,560
can we surmise and so again we have a

374
00:14:31,990 --> 00:14:30,560
graph here the size relative to the

375
00:14:34,230 --> 00:14:32,000
earth on the vertical axis the

376
00:14:35,750 --> 00:14:34,240
horizontal axis is the orbital period

377
00:14:37,030 --> 00:14:35,760
and again the earth's there for

378
00:14:38,550 --> 00:14:37,040
reference

379
00:14:40,230 --> 00:14:38,560
but these aren't planets just in the

380
00:14:41,750 --> 00:14:40,240
habitable zone if you look to the left

381
00:14:43,509 --> 00:14:41,760
there are three planets

382
00:14:46,790 --> 00:14:43,519
choro7b

383
00:14:49,110 --> 00:14:46,800
kepler 36b and kepler-10b

384
00:14:50,870 --> 00:14:49,120
these are planets that are that are

385
00:14:53,590 --> 00:14:50,880
small in fact the same size as

386
00:14:56,150 --> 00:14:53,600
kepler-62f but they're very close to

387
00:14:58,470 --> 00:14:56,160
their star they move very rapidly and

388
00:15:00,870 --> 00:14:58,480

that means with a radio velocity

389
00:15:03,430 --> 00:15:00,880
we can have people like our colleagues

390
00:15:05,590 --> 00:15:03,440
like jeff marcy go to the keck telescope

391
00:15:07,509 --> 00:15:05,600
and measure their masses and we get

392
00:15:09,430 --> 00:15:07,519
densities we know

393
00:15:11,990 --> 00:15:09,440
these are rocky we have measured their

394
00:15:14,790 --> 00:15:12,000
densities and they are the

395
00:15:17,110 --> 00:15:14,800
same size as kepler-62f so we surmise

396
00:15:18,069 --> 00:15:17,120
62f is also

397
00:15:20,470 --> 00:15:18,079
rocky

398
00:15:22,710 --> 00:15:20,480
that would be consistent with theory and

399
00:15:25,030 --> 00:15:22,720
we note that we have never found a gas

400
00:15:27,910 --> 00:15:25,040
planet anywhere near that small so we

401
00:15:29,269 --> 00:15:27,920
think 62f has got a good chance of being

402
00:15:32,310 --> 00:15:29,279
a rocky planet

403
00:15:34,550 --> 00:15:32,320
62e is a little bit bigger

404
00:15:37,350 --> 00:15:34,560
it might be rocky it might be a water

405
00:15:39,590 --> 00:15:37,360
world we don't know and in fact it might

406
00:15:41,430 --> 00:15:39,600
if it represents a water world it's

407
00:15:43,269 --> 00:15:41,440
a planet like we've never we don't have

408
00:15:44,870 --> 00:15:43,279
in our own solar system so sort of a

409
00:15:46,550 --> 00:15:44,880
mystery planet

410
00:15:47,910 --> 00:15:46,560
but the summary of this is we have found

411
00:15:49,670 --> 00:15:47,920
two planets

412
00:15:51,990 --> 00:15:49,680
that in the habitable zone of another

413
00:15:54,629 --> 00:15:52,000

star and they are the best candidates

414
00:15:56,389 --> 00:15:54,639
found to date for habitable planets now

415
00:15:58,389 --> 00:15:56,399
at this point i'd like to

416
00:16:00,310 --> 00:15:58,399
introduce tom barkley who will tell you

417
00:16:02,069 --> 00:16:00,320
about another planetary system that

418
00:16:04,790 --> 00:16:02,079
kepler has discovered

419
00:16:06,790 --> 00:16:04,800
thanks bill so i think we're seeing very

420
00:16:09,189 --> 00:16:06,800
nicely as kepler goes along we're

421
00:16:11,269 --> 00:16:09,199
finding these small planets on longer

422
00:16:13,430 --> 00:16:11,279
and longer orbital periods pushing

423
00:16:15,189 --> 00:16:13,440
towards finding these small planets in

424
00:16:17,590 --> 00:16:15,199
the habitable zone

425
00:16:18,629 --> 00:16:17,600
moving on to the next slide

426
00:16:19,910 --> 00:16:18,639
so

427
00:16:20,870 --> 00:16:19,920
bill's

428
00:16:23,110 --> 00:16:20,880
star

429
00:16:24,550 --> 00:16:23,120
is about one-fifth as luminous to the

430
00:16:27,030 --> 00:16:24,560
sun we probably wouldn't consider it a

431
00:16:28,949 --> 00:16:27,040
sun-like star

432
00:16:31,670 --> 00:16:28,959
the purpose of the kepler mission is to

433
00:16:33,030 --> 00:16:31,680
find small planets orbiting sun-like

434
00:16:35,269 --> 00:16:33,040
stars

435
00:16:37,430 --> 00:16:35,279
that's very different to bill's system

436
00:16:40,230 --> 00:16:37,440
today i'm announcing a super-sized

437
00:16:41,670 --> 00:16:40,240
planet that's a planet about 1.7 times

438
00:16:44,230 --> 00:16:41,680

the size of earth

439
00:16:46,629 --> 00:16:44,240
orbiting within or close by to the

440
00:16:48,470 --> 00:16:46,639
habitable zone of a star very much like

441
00:16:51,030 --> 00:16:48,480
our sun

442
00:16:54,069 --> 00:16:51,040
next slide please i want to take you

443
00:16:55,910 --> 00:16:54,079
back now to january of this year

444
00:16:57,189 --> 00:16:55,920
we announced the new kepler planet

445
00:16:58,790 --> 00:16:57,199
catalog

446
00:17:00,710 --> 00:16:58,800
these are our new planet candidates

447
00:17:02,829 --> 00:17:00,720
they're not confirmed but they look like

448
00:17:05,350 --> 00:17:02,839
planets from what we understood at the

449
00:17:07,909 --> 00:17:05,360
time this

450
00:17:10,069 --> 00:17:07,919
plot here shows the size of the planet

451
00:17:13,350 --> 00:17:10,079
and the vertical axis and our best guess

452
00:17:16,069 --> 00:17:13,360
at a temperature on the horizontal the

453
00:17:17,750 --> 00:17:16,079
green region is the habitable zone what

454
00:17:18,789 --> 00:17:17,760
we defined as a project as a habitable

455
00:17:20,630 --> 00:17:18,799
zone

456
00:17:23,829 --> 00:17:20,640
the four yellow dots

457
00:17:26,470 --> 00:17:23,839
show four new potentially rocky super

458
00:17:27,909 --> 00:17:26,480
earth-sized candidates and we were

459
00:17:30,310 --> 00:17:27,919
really excited to buy one of these

460
00:17:32,310 --> 00:17:30,320
candidates we catalogued it as koi

461
00:17:35,350 --> 00:17:32,320
172.02

462
00:17:38,870 --> 00:17:35,360
we're excited because it was orbiting a

463
00:17:40,789 --> 00:17:38,880

sun-like star near to the habitable zone

464
00:17:43,029 --> 00:17:40,799
today we can announce we've confirmed

465
00:17:49,270 --> 00:17:43,039
that this is a bonafide planet this is a

466
00:17:53,750 --> 00:17:51,430
here we show a schematic of the

467
00:17:55,590 --> 00:17:53,760
habitable zone if you compare it to what

468
00:17:57,990 --> 00:17:55,600
bill showed earlier the habitable zones

469
00:17:59,590 --> 00:17:58,000
much further out that's the green region

470
00:18:03,270 --> 00:17:59,600
and these showing the solar system

471
00:18:06,710 --> 00:18:03,280
compared to our system um to scale

472
00:18:08,870 --> 00:18:06,720
it's very similar size to the habitable

473
00:18:10,710 --> 00:18:08,880
zone of our own star

474
00:18:12,470 --> 00:18:10,720
we see our planets here

475
00:18:15,190 --> 00:18:12,480
there are two planets in the capital 69

476
00:18:17,430 --> 00:18:15,200
system 69b orbits very close to its

477
00:18:20,150 --> 00:18:17,440
start it goes around every 13 days and

478
00:18:22,549 --> 00:18:20,160
is about 2.4 times as big as earth it's

479
00:18:24,230 --> 00:18:22,559
very unlikely to have a rocky surface

480
00:18:27,750 --> 00:18:24,240
and it's going to be a hot world what

481
00:18:30,150 --> 00:18:27,760
we're very excited about is kepler

482
00:18:32,310 --> 00:18:30,160
here we see it orbiting close to the

483
00:18:35,190 --> 00:18:32,320
inner edge of the habitable zone so as

484
00:18:37,190 --> 00:18:35,200
bill eloquently said the habitable zone

485
00:18:39,270 --> 00:18:37,200
is a region between fire and ice well

486
00:18:41,590 --> 00:18:39,280
this is orbiting closer to the fire than

487
00:18:43,430 --> 00:18:41,600
the ice

488
00:18:45,590 --> 00:18:43,440

um we

489
00:18:48,870 --> 00:18:45,600
consider this perhaps to be more of a

490
00:18:50,230 --> 00:18:48,880
super venus than a super earth perhaps

491
00:18:52,310 --> 00:18:50,240
we're not entirely clear of where the

492
00:18:54,789 --> 00:18:52,320
habitable zone is it's an ongoing

493
00:18:56,710 --> 00:18:54,799
research area

494
00:18:58,470 --> 00:18:56,720
come on to the next so i want to show

495
00:19:00,230 --> 00:18:58,480
you here the progression we're making as

496
00:19:01,990 --> 00:19:00,240
a project

497
00:19:05,430 --> 00:19:02,000
16 months ago we announced the discovery

498
00:19:08,150 --> 00:19:05,440
of kepler's 22b that was 2.4 times as

499
00:19:11,190 --> 00:19:08,160
big as earth we now consider this a sub

500
00:19:13,830 --> 00:19:11,200
neptune size a mini neptune sized planet

501
00:19:15,990 --> 00:19:13,840
because it's unlikely to be like the

502
00:19:18,230 --> 00:19:16,000
terrestrial planets our own solar system

503
00:19:20,310 --> 00:19:18,240
venus earth and mars

504
00:19:22,789 --> 00:19:20,320
today we're announcing the discovery of

505
00:19:25,669 --> 00:19:22,799
three super-earth-sized planets these

506
00:19:27,909 --> 00:19:25,679
are planets that may be rocky may have

507
00:19:30,710 --> 00:19:27,919
liquid water at the surfaces

508
00:19:32,390 --> 00:19:30,720
below about 1.5 earth radius

509
00:19:35,830 --> 00:19:32,400
we probably we're more likely to have a

510
00:19:39,190 --> 00:19:35,840
rocky surface this is kepler 62 f

511
00:19:40,070 --> 00:19:39,200
as we move larger in size we're getting

512
00:19:41,190 --> 00:19:40,080
more

513
00:19:44,789 --> 00:19:41,200

mass in the

514
00:19:47,029 --> 00:19:44,799
the planet we're able to hold more uh

515
00:19:49,590 --> 00:19:47,039
lighter elements lighter molecules and

516
00:19:51,669 --> 00:19:49,600
so you're likely to possibly have liquid

517
00:19:53,830 --> 00:19:51,679
water at the surface perhaps we're not

518
00:19:54,710 --> 00:19:53,840
too clear and the reason we're not clear

519
00:19:56,310 --> 00:19:54,720
about

520
00:19:57,909 --> 00:19:56,320
what makes up these planets is we don't

521
00:20:00,230 --> 00:19:57,919
have anything like this in our own solar

522
00:20:02,630 --> 00:20:00,240
system we don't know the mass so we have

523
00:20:07,430 --> 00:20:02,640
to go to models and theory to try and

524
00:20:13,669 --> 00:20:10,950
so we see here our progression towards

525
00:20:15,909 --> 00:20:13,679
this earth-sized planet

526
00:20:18,549 --> 00:20:15,919
however we're not quite there yet you

527
00:20:20,310 --> 00:20:18,559
see none of these are quite earth-sized

528
00:20:22,310 --> 00:20:20,320
but we're pushing towards it with our

529
00:20:23,750 --> 00:20:22,320
announcement today of three super

530
00:20:24,710 --> 00:20:23,760
earth-sized planets in the habitable

531
00:20:27,110 --> 00:20:24,720
zone

532
00:20:28,470 --> 00:20:27,120
thank you i'll pass on to lisa caldenega

533
00:20:31,590 --> 00:20:28,480
now

534
00:20:35,510 --> 00:20:31,600
so as phil and tom told you it's like we

535
00:20:38,070 --> 00:20:35,520
having for the first time planets

536
00:20:40,230 --> 00:20:38,080
that are below two earth radii

537
00:20:43,350 --> 00:20:40,240
what we usually use is a cutter for a

538
00:20:45,510 --> 00:20:43,360

solid planet and then 1.5 we use as a

539
00:20:48,549 --> 00:20:45,520
cutoff from the models for a rocky

540
00:20:50,230 --> 00:20:48,559
planet so somewhere between 1.5 and 2

541
00:20:52,950 --> 00:20:50,240
what you're getting is more and more

542
00:20:55,510 --> 00:20:52,960
water in these models so

543
00:20:58,149 --> 00:20:55,520
as i agree with phil this fascinating

544
00:21:00,549 --> 00:20:58,159
idea is that maybe we've actually found

545
00:21:02,630 --> 00:21:00,559
the first ocean planets the first

546
00:21:05,590 --> 00:21:02,640
waterworlds out there and what it just

547
00:21:07,750 --> 00:21:05,600
shows you is the diversity that we're

548
00:21:10,390 --> 00:21:07,760
discovering out there and let me say

549
00:21:13,110 --> 00:21:10,400
that we only have the radius so what we

550
00:21:15,110 --> 00:21:13,120
infer from the models is very exciting

551
00:21:16,549 --> 00:21:15,120
but always has to be taken a little bit

552
00:21:18,470 --> 00:21:16,559
with a grain of salt

553
00:21:21,029 --> 00:21:18,480
could i have the next slime please

554
00:21:23,590 --> 00:21:21,039
so this is what we already showed you

555
00:21:26,870 --> 00:21:23,600
and here what i want to also point out

556
00:21:29,270 --> 00:21:26,880
you see on the left 69c then you have

557
00:21:31,430 --> 00:21:29,280
the smaller one 62 e

558
00:21:33,430 --> 00:21:31,440
and then 62 f

559
00:21:35,430 --> 00:21:33,440
and it's also the same progressions that

560
00:21:37,510 --> 00:21:35,440
the earth is here as a reference it's

561
00:21:38,950 --> 00:21:37,520
the same progression for the flux that

562
00:21:40,789 --> 00:21:38,960
they're getting for the heat that

563
00:21:43,190 --> 00:21:40,799

they're getting from their own star

564
00:21:45,830 --> 00:21:43,200
compared to our own sun next slide

565
00:21:47,669 --> 00:21:45,840
please and so what we usually do is we

566
00:21:49,350 --> 00:21:47,679
actually show you this in term of a

567
00:21:51,750 --> 00:21:49,360
habitable zone

568
00:21:53,430 --> 00:21:51,760
and you see the shaded blue region and

569
00:21:56,310 --> 00:21:53,440
you see the systems that we just

570
00:21:59,270 --> 00:21:56,320
announced so the lower system so the sun

571
00:22:02,789 --> 00:21:59,280
is a bit cooler 62's big cooler than our

572
00:22:04,630 --> 00:22:02,799
own sun 69 is roughly well warmer not

573
00:22:05,350 --> 00:22:04,640
like our sun but a bit cooler than our

574
00:22:08,789 --> 00:22:05,360
sun

575
00:22:11,190 --> 00:22:08,799
but you see that for 62 both of the

576
00:22:12,950 --> 00:22:11,200
planets lie in what we call the

577
00:22:14,789 --> 00:22:12,960
habitable sound

578
00:22:16,789 --> 00:22:14,799
and one lies smack in the middle of

579
00:22:18,950 --> 00:22:16,799
where all our atmospheric models

580
00:22:21,270 --> 00:22:18,960
actually say if this is a rock if it's

581
00:22:23,590 --> 00:22:21,280
like earth geological actives that can

582
00:22:27,029 --> 00:22:23,600
actually bump co2 in the atmosphere take

583
00:22:28,950 --> 00:22:27,039
it back out then it has or it can have a

584
00:22:30,710 --> 00:22:28,960
temperature on the surface that we do

585
00:22:31,990 --> 00:22:30,720
again we don't know that but it is a

586
00:22:33,830 --> 00:22:32,000
possibility

587
00:22:37,669 --> 00:22:33,840
and also 62

588
00:22:40,710 --> 00:22:37,679

f as uh 62e sorry the closer in one that

589
00:22:42,710 --> 00:22:40,720
bill talked about so this one is also in

590
00:22:45,029 --> 00:22:42,720
the habitable sound so we have two

591
00:22:47,029 --> 00:22:45,039
shaded regions here that you see one is

592
00:22:48,710 --> 00:22:47,039
the narrow habitable zone based on our

593
00:22:50,070 --> 00:22:48,720
atmospheric models where we put

594
00:22:52,230 --> 00:22:50,080
everything in that we know from the

595
00:22:54,310 --> 00:22:52,240
earth and we know that we have a couple

596
00:22:56,230 --> 00:22:54,320
of things missing this is why we call it

597
00:22:59,029 --> 00:22:56,240
the narrow habitable cell in the bright

598
00:23:01,350 --> 00:22:59,039
blue region because for example cloud

599
00:23:03,430 --> 00:23:01,360
feedback is something that we don't have

600
00:23:05,990 --> 00:23:03,440
in there we don't know how to do that

601
00:23:07,909 --> 00:23:06,000
yet for extrasolar planet atmospheres

602
00:23:10,070 --> 00:23:07,919
because it's very complicated problem

603
00:23:11,750 --> 00:23:10,080
but if you actually heat up a planet you

604
00:23:13,430 --> 00:23:11,760
have more water in its atmosphere so you

605
00:23:16,149 --> 00:23:13,440
should have more clouds and that

606
00:23:17,830 --> 00:23:16,159
basically puts 62e also in the

607
00:23:20,470 --> 00:23:17,840
temperature range of liquid water on the

608
00:23:22,149 --> 00:23:20,480
surface and as well said it might be

609
00:23:24,470 --> 00:23:22,159
that we actually looking at one of the

610
00:23:26,070 --> 00:23:24,480
first water worlds out there

611
00:23:28,630 --> 00:23:26,080
and so what you see in this graphic is

612
00:23:31,430 --> 00:23:28,640
our own solar system on the top then you

613
00:23:33,110 --> 00:23:31,440

see for reference kepler-22b as we say

614
00:23:35,510 --> 00:23:33,120
it's actually a mini neptune because

615
00:23:38,470 --> 00:23:35,520
it's too big and then for reference you

616
00:23:40,630 --> 00:23:38,480
see uh 69 where both of the planets are

617
00:23:44,470 --> 00:23:40,640
not within the habitable zone but the

618
00:23:46,710 --> 00:23:44,480
arrow bars for 60 69c are actually big

619
00:23:48,470 --> 00:23:46,720
enough that if we get really really

620
00:23:50,870 --> 00:23:48,480
lucky and the star is actually cooler

621
00:23:52,950 --> 00:23:50,880
than we think then it could be on this

622
00:23:55,029 --> 00:23:52,960
border to the habitable zone so right

623
00:23:56,789 --> 00:23:55,039
now it looks like a super venus but if

624
00:23:59,269 --> 00:23:56,799
all the error bars pan out in the right

625
00:24:01,510 --> 00:23:59,279
direction it might just be at the venus

626
00:24:03,190 --> 00:24:01,520
border and maybe a little bit inside but

627
00:24:05,909 --> 00:24:03,200
the other two planet that you see in the

628
00:24:08,310 --> 00:24:05,919
lower part in the 62 system is what has

629
00:24:10,549 --> 00:24:08,320
got us so excited and

630
00:24:12,470 --> 00:24:10,559
me very excited to work on this project

631
00:24:13,909 --> 00:24:12,480
so next slide please

632
00:24:16,070 --> 00:24:13,919
what we of course want to show you here

633
00:24:17,430 --> 00:24:16,080
is what is special or

634
00:24:19,590 --> 00:24:17,440
why are we so excited about these

635
00:24:21,830 --> 00:24:19,600
planets here use these three gray

636
00:24:24,149 --> 00:24:21,840
circles and those show you the uh

637
00:24:26,310 --> 00:24:24,159
confirmed radio velocity planets so you

638
00:24:28,470 --> 00:24:26,320

probably heard a lot about uh the first

639
00:24:30,149 --> 00:24:28,480
habitable planets and so on and so forth

640
00:24:31,510 --> 00:24:30,159
and so we show them for reference and

641
00:24:34,070 --> 00:24:31,520
you see that they all fall in the

642
00:24:35,269 --> 00:24:34,080
habitable sound and for those we know

643
00:24:37,190 --> 00:24:35,279
the mass

644
00:24:39,750 --> 00:24:37,200
and it's also very exciting because they

645
00:24:41,990 --> 00:24:39,760
could be rocks or they could be many

646
00:24:43,909 --> 00:24:42,000
neptunes but they have a potential that

647
00:24:47,750 --> 00:24:43,919
they could be rocks but for this new

648
00:24:50,070 --> 00:24:47,760
system 62 e and f the radius tells us

649
00:24:50,789 --> 00:24:50,080
that they're actually solid what makes

650
00:24:53,190 --> 00:24:50,799
it

651
00:24:54,710 --> 00:24:53,200
for me very fascinating candidates and

652
00:24:55,590 --> 00:24:54,720
the best candidates in the habitable

653
00:24:57,590 --> 00:24:55,600
zone

654
00:24:59,909 --> 00:24:57,600
could i have the next slide please

655
00:25:01,830 --> 00:24:59,919
so here we just shade everything out

656
00:25:04,630 --> 00:25:01,840
that you know for reference and we just

657
00:25:07,269 --> 00:25:04,640
show you the beautiful new discoveries

658
00:25:08,950 --> 00:25:07,279
and what you really want is you really

659
00:25:11,430 --> 00:25:08,960
want to collect the light from these

660
00:25:13,590 --> 00:25:11,440
planets to figure out to take the data

661
00:25:14,390 --> 00:25:13,600
not just in fear whether or not there's

662
00:25:17,430 --> 00:25:14,400
water

663
00:25:19,510 --> 00:25:17,440

and even signs of life on these planets

664
00:25:21,190 --> 00:25:19,520
and as paul said we just got a mission

665
00:25:23,590 --> 00:25:21,200
approved called tess

666
00:25:26,630 --> 00:25:23,600
that will look for such planets around

667
00:25:28,549 --> 00:25:26,640
the closest stars to us because as bill

668
00:25:30,950 --> 00:25:28,559
said this is a thousand two hundred

669
00:25:34,070 --> 00:25:30,960
light years away so we'd have to build a

670
00:25:36,149 --> 00:25:34,080
huge telescope much bigger than jwst to

671
00:25:38,470 --> 00:25:36,159
actually read the data and the

672
00:25:40,870 --> 00:25:38,480
fingerprint of that planet to figure out

673
00:25:44,310 --> 00:25:40,880
if they're really water worlds or not

674
00:25:45,110 --> 00:25:44,320
and if i can have the next slide

675
00:25:47,190 --> 00:25:45,120
what

676
00:25:48,950 --> 00:25:47,200
sorry next slide

677
00:25:50,230 --> 00:25:48,960
here what i just want to give you a

678
00:25:52,470 --> 00:25:50,240
flavor off

679
00:25:54,630 --> 00:25:52,480
is all the candidates we have already

680
00:25:56,950 --> 00:25:54,640
with the kepler mission so you see the

681
00:25:59,430 --> 00:25:56,960
confirmed ones at this really pretty uh

682
00:26:01,430 --> 00:25:59,440
images but you see all the other ones

683
00:26:03,510 --> 00:26:01,440
that we're very excited of that we're

684
00:26:06,310 --> 00:26:03,520
still confirming the blue the green ones

685
00:26:08,149 --> 00:26:06,320
sorry i actually uh smaller than so you

686
00:26:09,909 --> 00:26:08,159
see the small dots here these are the

687
00:26:11,590 --> 00:26:09,919
ones that we're really excited about in

688
00:26:14,630 --> 00:26:11,600

the habitable zone it just shows you

689
00:26:16,950 --> 00:26:14,640
what variety and what is coming up there

690
00:26:19,669 --> 00:26:16,960
only candidates not confirmed yet but

691
00:26:22,070 --> 00:26:19,679
this is coming up so we are on the verge

692
00:26:24,310 --> 00:26:22,080
of the discovery of so many

693
00:26:25,510 --> 00:26:24,320
very exciting planets that in turn will

694
00:26:27,830 --> 00:26:25,520
tell us

695
00:26:28,710 --> 00:26:27,840
so much more about how rocky planets

696
00:26:31,510 --> 00:26:28,720
work

697
00:26:33,669 --> 00:26:31,520
how they can be diverse and we will then

698
00:26:35,669 --> 00:26:33,679
learn something as well for our own

699
00:26:38,149 --> 00:26:35,679
earth that's why we're also doing that

700
00:26:40,710 --> 00:26:38,159
we want to if we can have a look in the

701
00:26:42,549 --> 00:26:40,720
future of our own earth and learn from

702
00:26:45,110 --> 00:26:42,559
all these planets out there how rocky

703
00:26:47,510 --> 00:26:45,120
worlds work in the first place

704
00:26:50,149 --> 00:26:47,520
and so if i can go to the last slide

705
00:26:52,070 --> 00:26:50,159
here i would like to just speculate and

706
00:26:53,190 --> 00:26:52,080
that's what we're doing we have the

707
00:26:55,909 --> 00:26:53,200
radius

708
00:26:56,789 --> 00:26:55,919
of these two planets in the 62 system

709
00:27:00,630 --> 00:26:56,799
and

710
00:27:02,710 --> 00:27:00,640
it already we have two planets in our

711
00:27:05,269 --> 00:27:02,720
solar system that are in this habitable

712
00:27:07,750 --> 00:27:05,279
zone but mars is too small it doesn't

713
00:27:09,990 --> 00:27:07,760

have enough gravity to keep holding on

714
00:27:11,990 --> 00:27:10,000
to an atmosphere that could heat it that

715
00:27:14,390 --> 00:27:12,000
has enough greenhouse gas

716
00:27:16,390 --> 00:27:14,400
but f that would also have to build up a

717
00:27:18,710 --> 00:27:16,400
lot of greenhouse gas to keep warm

718
00:27:21,510 --> 00:27:18,720
because it's further out than we are

719
00:27:23,510 --> 00:27:21,520
from the in it's not further out but in

720
00:27:25,750 --> 00:27:23,520
terms of flux how much radiation it gets

721
00:27:27,269 --> 00:27:25,760
from its star it's further out than we

722
00:27:29,750 --> 00:27:27,279
are so it would have to build up a lot

723
00:27:31,830 --> 00:27:29,760
of co2 to be habitable

724
00:27:33,750 --> 00:27:31,840
and e basically gets a little bit more

725
00:27:36,149 --> 00:27:33,760
flux than we do so you want it to be

726
00:27:39,029 --> 00:27:36,159
cloudy just to reflect a bit more flux

727
00:27:41,190 --> 00:27:39,039
out into space and keep nice and warm

728
00:27:43,110 --> 00:27:41,200
but this is an artist's impression of

729
00:27:45,269 --> 00:27:43,120
potentially you know just one

730
00:27:47,750 --> 00:27:45,279
interpretation of these planets

731
00:27:50,389 --> 00:27:47,760
and think about it these planets get as

732
00:27:52,789 --> 00:27:50,399
close to each other as venus does at its

733
00:27:54,870 --> 00:27:52,799
closest approximation to us

734
00:27:57,190 --> 00:27:54,880
and they're bigger so that would be

735
00:27:59,750 --> 00:27:57,200
amazing beautiful jewel up there in the

736
00:28:00,630 --> 00:27:59,760
sky if you could be on a planet looking

737
00:28:02,549 --> 00:28:00,640
up

738
00:28:04,470 --> 00:28:02,559

and so i just want to leave you with

739
00:28:06,789 --> 00:28:04,480
this artist impression again

740
00:28:08,549 --> 00:28:06,799
saying that we have not

741
00:28:10,950 --> 00:28:08,559
had a look at the atmosphere we can't

742
00:28:14,070 --> 00:28:10,960
right now we need closer by planets to

743
00:28:16,389 --> 00:28:14,080
do that but from the radius

744
00:28:18,310 --> 00:28:16,399
we know or we infer

745
00:28:20,310 --> 00:28:18,320
that it's actually solid planets we

746
00:28:21,990 --> 00:28:20,320
don't have a better explanation very

747
00:28:22,950 --> 00:28:22,000
hard to make these gas when they're

748
00:28:25,269 --> 00:28:22,960
small

749
00:28:27,830 --> 00:28:25,279
and so for the first time

750
00:28:30,389 --> 00:28:27,840
we found a system where potentially

751
00:28:32,549 --> 00:28:30,399
you could have even one more habitable

752
00:28:35,029 --> 00:28:32,559
planet and that's of course potentially

753
00:28:36,310 --> 00:28:35,039
then in our own world thank you very

754
00:28:39,110 --> 00:28:36,320
much

755
00:28:41,430 --> 00:28:39,120
fantastic thank you all

756
00:28:43,669 --> 00:28:41,440
we'll now move to questions here at nasa

757
00:28:45,269 --> 00:28:43,679
ames followed by those participating on

758
00:28:48,149 --> 00:28:45,279
the phone bridge

759
00:28:49,990 --> 00:28:48,159
those on the phone please press star one

760
00:28:51,510 --> 00:28:50,000
to get if you'd like to ask a question

761
00:28:53,510 --> 00:28:51,520
and get into the cube

762
00:28:55,269 --> 00:28:53,520
and then again we'll also take questions

763
00:28:57,350 --> 00:28:55,279

uh via social media

764
00:28:58,230 --> 00:28:57,360
so you can tweet or post your question

765
00:29:00,630 --> 00:28:58,240
with

766
00:29:03,110 --> 00:29:00,640
ask nasa

767
00:29:05,029 --> 00:29:03,120
so for those in the auditorium please

768
00:29:07,110 --> 00:29:05,039
raise your hand and a mic runner will

769
00:29:16,950 --> 00:29:07,120
come to you if you could please stand

770
00:29:16,960 --> 00:29:23,430
hold on

771
00:29:26,389 --> 00:29:24,830
oh my

772
00:29:28,389 --> 00:29:26,399
gosh

773
00:29:30,389 --> 00:29:28,399
uh hi my name is adam becker i'm a

774
00:29:32,149 --> 00:29:30,399
reporter with new scientist

775
00:29:34,789 --> 00:29:32,159
uh i have a

776
00:29:36,950 --> 00:29:34,799
few questions uh

777
00:29:38,830 --> 00:29:36,960
so first of all uh i i don't think i

778
00:29:42,230 --> 00:29:38,840
caught how far away is

779
00:29:43,750 --> 00:29:42,240
kepler-69 it's about 2 000 light years 2

780
00:29:44,549 --> 00:29:43,760
000 light years

781
00:29:46,070 --> 00:29:44,559
okay

782
00:29:47,269 --> 00:29:46,080
and uh is there

783
00:29:49,350 --> 00:29:47,279
is there any reason to think that

784
00:29:50,789 --> 00:29:49,360
there's something special about sun-like

785
00:29:52,950 --> 00:29:50,799
stars

786
00:29:54,950 --> 00:29:52,960
is there i mean and i guess this is this

787
00:29:58,149 --> 00:29:54,960
is really for all of you i mean

788
00:30:01,190 --> 00:29:58,159

is there a a world in the habitable zone

789
00:30:03,430 --> 00:30:01,200
of a dimmer star like kepler 62 could

790
00:30:05,430 --> 00:30:03,440
still have liquid water on it

791
00:30:07,909 --> 00:30:05,440
so is there is there something special

792
00:30:09,669 --> 00:30:07,919
about earth-like planets around sun-like

793
00:30:10,549 --> 00:30:09,679
stars as opposed to earth-like planets

794
00:30:12,149 --> 00:30:10,559
around

795
00:30:14,710 --> 00:30:12,159
dimmer stars

796
00:30:17,990 --> 00:30:14,720
can i maybe take that so what we're

797
00:30:19,190 --> 00:30:18,000
basing our information or our models on

798
00:30:22,389 --> 00:30:19,200
is the earth

799
00:30:24,310 --> 00:30:22,399
and then if you change the sunlight well

800
00:30:26,789 --> 00:30:24,320
it might get a little bit rather but our

801
00:30:29,110 --> 00:30:26,799
atmospheric models account for that so

802
00:30:31,510 --> 00:30:29,120
if the star gets smaller there is no

803
00:30:33,190 --> 00:30:31,520
reason to believe that you couldn't have

804
00:30:35,669 --> 00:30:33,200
water that you couldn't have signatures

805
00:30:37,750 --> 00:30:35,679
for life or like conditions for life on

806
00:30:39,830 --> 00:30:37,760
the other hand what you do have to say

807
00:30:41,830 --> 00:30:39,840
if you super conservative

808
00:30:44,470 --> 00:30:41,840
is that the one case for life that we

809
00:30:47,029 --> 00:30:44,480
have is the earth so a lot of people or

810
00:30:49,909 --> 00:30:47,039
some people would like to have the exact

811
00:30:50,870 --> 00:30:49,919
earth's analog around the exact sun

812
00:30:53,269 --> 00:30:50,880
analog

813
00:30:55,590 --> 00:30:53,279

but i would personally say

814
00:30:58,070 --> 00:30:55,600
chances that it has the same amount of

815
00:31:01,029 --> 00:30:58,080
water or continents so everybody some

816
00:31:02,789 --> 00:31:01,039
people want to have exactly the same mix

817
00:31:04,710 --> 00:31:02,799
we don't think that's necessary because

818
00:31:06,549 --> 00:31:04,720
think of the earth just generally it

819
00:31:08,870 --> 00:31:06,559
changed through its lifetime it was

820
00:31:11,110 --> 00:31:08,880
habitable for all of the time and just

821
00:31:13,669 --> 00:31:11,120
because your star is colder as long as

822
00:31:15,990 --> 00:31:13,679
you close in like with a bonfire smaller

823
00:31:17,750 --> 00:31:16,000
fire you want to stand closer to be warm

824
00:31:19,029 --> 00:31:17,760
hotter fire you want to be further away

825
00:31:21,110 --> 00:31:19,039
to be warm

826
00:31:23,269 --> 00:31:21,120
i see no reason why

827
00:31:26,070 --> 00:31:23,279
there would be anything special about a

828
00:31:28,230 --> 00:31:26,080
sun analog star all the stars of sun

829
00:31:30,389 --> 00:31:28,240
like but again if you want to be the

830
00:31:32,149 --> 00:31:30,399
person that says i don't believe life

831
00:31:35,269 --> 00:31:32,159
could have gone any other way needs

832
00:31:37,590 --> 00:31:35,279
exactly the sun exactly the earth

833
00:31:39,909 --> 00:31:37,600
you have so far some argument because we

834
00:31:41,830 --> 00:31:39,919
haven't found signatures of life on

835
00:31:44,310 --> 00:31:41,840
other planets we don't think you're

836
00:31:46,870 --> 00:31:44,320
right but we cannot prove you wrong

837
00:31:48,630 --> 00:31:46,880
tom did you have anything to add to that

838
00:31:51,110 --> 00:31:48,640

well very simply what i was going to say

839
00:31:53,190 --> 00:31:51,120
is the one planet we know of with life

840
00:31:55,110 --> 00:31:53,200
orbits a sun-like star

841
00:31:58,149 --> 00:31:55,120
and that seemed natural to be the first

842
00:32:00,789 --> 00:31:58,159
place to study in detail would be these

843
00:32:02,789 --> 00:32:00,799
sun-like stars the other thing i could

844
00:32:05,110 --> 00:32:02,799
mention is that when you think about

845
00:32:07,190 --> 00:32:05,120
being on 62 f

846
00:32:09,190 --> 00:32:07,200
and looking out at that star it would

847
00:32:10,549 --> 00:32:09,200
look about the same as our star except

848
00:32:13,190 --> 00:32:10,559
it'd be bigger

849
00:32:15,430 --> 00:32:13,200
but the luminosity or the light that you

850
00:32:17,190 --> 00:32:15,440
were experiencing the illumination level

851
00:32:20,149 --> 00:32:17,200
would be like if you were walking around

852
00:32:23,350 --> 00:32:20,159
on earth uh on a cloudy day it drops by

853
00:32:25,350 --> 00:32:23,360
a factor of five like on a cloudy day so

854
00:32:26,710 --> 00:32:25,360
it's it's not too obvious that you could

855
00:32:28,230 --> 00:32:26,720
tell the difference if you were on that

856
00:32:29,909 --> 00:32:28,240
planet

857
00:32:31,669 --> 00:32:29,919
adam you had another question

858
00:32:33,029 --> 00:32:31,679
i have several other questions if i can

859
00:32:35,430 --> 00:32:33,039
ask

860
00:32:37,029 --> 00:32:35,440
all right let's see how it goes okay

861
00:32:38,710 --> 00:32:37,039
um

862
00:32:41,110 --> 00:32:38,720
so

863
00:32:43,669 --> 00:32:41,120

uh is there is there a simple way to

864
00:32:45,669 --> 00:32:43,679
explain why

865
00:32:47,830 --> 00:32:45,679
we think that these worlds that are you

866
00:32:49,909 --> 00:32:47,840
know slightly larger than earth could be

867
00:32:53,190 --> 00:32:49,919
water worlds as opposed to worlds with a

868
00:32:55,190 --> 00:32:53,200
mix of water and land on them like earth

869
00:32:57,909 --> 00:32:55,200
i don't know can i sorry

870
00:32:59,590 --> 00:32:57,919
it falls into my jurisdiction sorry uh

871
00:33:01,350 --> 00:32:59,600
the idea is just uh if you take

872
00:33:02,310 --> 00:33:01,360
planetary if you take a planet like

873
00:33:05,269 --> 00:33:02,320
yours

874
00:33:07,990 --> 00:33:05,279
keep the water mass fraction the same

875
00:33:10,070 --> 00:33:08,000
just make the mass bigger the volume you

876
00:33:12,149 --> 00:33:10,080
know mass and volume so basically what

877
00:33:13,990 --> 00:33:12,159
you get is you get enough water that you

878
00:33:15,990 --> 00:33:14,000
can cover the whole surface

879
00:33:18,070 --> 00:33:16,000
just because you make it

880
00:33:19,750 --> 00:33:18,080
four times as massive as the earth right

881
00:33:21,190 --> 00:33:19,760
according to the radius but the radius

882
00:33:23,269 --> 00:33:21,200
doesn't go to four times so the surface

883
00:33:25,590 --> 00:33:23,279
doesn't go to four times so you actually

884
00:33:28,310 --> 00:33:25,600
end up with more water on

885
00:33:30,149 --> 00:33:28,320
on the on the top and generally we don't

886
00:33:30,950 --> 00:33:30,159
really know how much water plants should

887
00:33:33,590 --> 00:33:30,960
have

888
00:33:35,669 --> 00:33:33,600

and earth even so we see a lot of ocean

889
00:33:38,870 --> 00:33:35,679
is extremely dry

890
00:33:40,470 --> 00:33:38,880
so you know there's just the chance that

891
00:33:42,950 --> 00:33:40,480
the bigger the planet gets the easier it

892
00:33:45,029 --> 00:33:42,960
is it holds on to lighter elements like

893
00:33:46,789 --> 00:33:45,039
water and so the more water you could

894
00:33:48,789 --> 00:33:46,799
have does this

895
00:33:51,990 --> 00:33:48,799
uh earth is extremely dry compared to

896
00:33:54,549 --> 00:33:52,000
what add to in terms of mass percent if

897
00:33:56,710 --> 00:33:54,559
you just check how much percentage in in

898
00:33:58,470 --> 00:33:56,720
mass of the earth you have it's a very

899
00:34:01,750 --> 00:33:58,480
small number of water compared to

900
00:34:01,760 --> 00:34:06,310
okay thank you um

901
00:34:13,270 --> 00:34:09,909
yeah uh along the same lines uh is there

902
00:34:14,470 --> 00:34:13,280
is there any reason to think um

903
00:34:17,030 --> 00:34:14,480
is there any reason to think that these

904
00:34:18,829 --> 00:34:17,040
planets on the interior of the habitable

905
00:34:21,349 --> 00:34:18,839
zone like

906
00:34:23,270 --> 00:34:21,359
kepler-69c would have an atmosphere like

907
00:34:24,710 --> 00:34:23,280
venus as opposed to earth is there is

908
00:34:27,990 --> 00:34:24,720
there any reason to be that pessimistic

909
00:34:29,750 --> 00:34:28,000
or should we be optimistic

910
00:34:32,310 --> 00:34:29,760
bill or tom

911
00:34:33,589 --> 00:34:32,320
well certainly if you have a planet that

912
00:34:35,349 --> 00:34:33,599
hot

913
00:34:37,669 --> 00:34:35,359

that big

914
00:34:40,069 --> 00:34:37,679
and as massive as you might expect you

915
00:34:42,389 --> 00:34:40,079
would certainly expect a lot of co2 to

916
00:34:44,790 --> 00:34:42,399
be come from from the rocks into into

917
00:34:47,190 --> 00:34:44,800
the atmosphere and so you might have an

918
00:34:49,109 --> 00:34:47,200
atmosphere that thick that big and

919
00:34:50,710 --> 00:34:49,119
making the planet even hotter than it

920
00:34:52,470 --> 00:34:50,720
would be if it didn't have that

921
00:34:54,310 --> 00:34:52,480
atmosphere atmospheres usually make the

922
00:34:57,750 --> 00:34:54,320
planet hotter certainly never make it

923
00:35:01,430 --> 00:35:00,069
wait i thought uh sorry follow-up

924
00:35:02,790 --> 00:35:01,440
question i thought that sometimes an

925
00:35:06,550 --> 00:35:02,800
atmosphere can make you colder if

926
00:35:07,750 --> 00:35:06,560
there's enough clouds wasn't that what

927
00:35:09,349 --> 00:35:07,760
yeah maybe

928
00:35:11,270 --> 00:35:09,359
what do you have is

929
00:35:13,589 --> 00:35:11,280
colder compared to us right we have a

930
00:35:15,910 --> 00:35:13,599
certain amount of clouds and if you

931
00:35:18,150 --> 00:35:15,920
don't make more for e then it would

932
00:35:19,589 --> 00:35:18,160
become pretty hot and muggy but if you

933
00:35:20,870 --> 00:35:19,599
make a little more clouds because you

934
00:35:23,030 --> 00:35:20,880
have much more water vapor in the

935
00:35:24,470 --> 00:35:23,040
atmosphere you should be fine

936
00:35:27,190 --> 00:35:24,480
and generally what

937
00:35:28,950 --> 00:35:27,200
as bill was saying

938
00:35:33,670 --> 00:35:28,960

we have

939
00:35:35,430 --> 00:35:33,680
venus is like the earth in the beginning

940
00:35:38,150 --> 00:35:35,440
but you move it well if you move the

941
00:35:40,550 --> 00:35:38,160
earth in towards venus is position

942
00:35:42,630 --> 00:35:40,560
then because it's so hot as bill said

943
00:35:44,630 --> 00:35:42,640
you will start to evaporate all of your

944
00:35:46,550 --> 00:35:44,640
water and then you can't get rid of the

945
00:35:48,630 --> 00:35:46,560
co2 anymore will build up so it gets

946
00:35:51,109 --> 00:35:48,640
hotter and hotter and hotter and you end

947
00:35:52,470 --> 00:35:51,119
up with venus and as bill just stated if

948
00:35:54,310 --> 00:35:52,480
the gravity

949
00:35:56,470 --> 00:35:54,320
or the mass of this thing is even bigger

950
00:35:58,069 --> 00:35:56,480
right it might hold on to more of that

951
00:35:59,430 --> 00:35:58,079
and get more of the co2 so it can be

952
00:36:00,870 --> 00:35:59,440
even worse

953
00:36:02,550 --> 00:36:00,880
this is based on modeling what we

954
00:36:04,390 --> 00:36:02,560
usually do for this outer line of the

955
00:36:06,150 --> 00:36:04,400
habitable zone that i showed you we just

956
00:36:08,470 --> 00:36:06,160
have a look in our solar system and we

957
00:36:10,550 --> 00:36:08,480
say okay venus is inhabitable so if you

958
00:36:12,630 --> 00:36:10,560
get so much radiation from your stars

959
00:36:14,470 --> 00:36:12,640
venus it's probably too much

960
00:36:16,790 --> 00:36:14,480
and then on the outside we take mars and

961
00:36:18,150 --> 00:36:16,800
say okay if moss were bigger it would be

962
00:36:19,990 --> 00:36:18,160
better because you could hold on to

963
00:36:21,829 --> 00:36:20,000

greenhouse gases but that's roughly from

964
00:36:23,510 --> 00:36:21,839
the data where we take the real limits

965
00:36:24,470 --> 00:36:23,520
of the habitable sound

966
00:36:26,550 --> 00:36:24,480
does this

967
00:36:27,990 --> 00:36:26,560
yeah that answers the question

968
00:36:29,670 --> 00:36:28,000
if i have time to ask one more okay

969
00:36:31,510 --> 00:36:29,680
we'll give you one more thank you yeah

970
00:36:33,589 --> 00:36:31,520
uh so there are these two definitions of

971
00:36:34,950 --> 00:36:33,599
the habitable zone can one of you speak

972
00:36:38,710 --> 00:36:34,960
a little bit more about

973
00:36:43,190 --> 00:36:40,950
i'll give that one a try

974
00:36:45,270 --> 00:36:43,200
basically we have two ways of estimating

975
00:36:47,910 --> 00:36:45,280
what the habitable zone is one is to

976
00:36:49,910 --> 00:36:47,920
look at our own solar system as elisa's

977
00:36:52,230 --> 00:36:49,920
pointed out if you got out as far as

978
00:36:54,550 --> 00:36:52,240
venus uh we believe it will be just too

979
00:36:56,870 --> 00:36:54,560
hot to hold that water to get the out

980
00:36:58,310 --> 00:36:56,880
beyond mars again too cold so the ocean

981
00:37:00,710 --> 00:36:58,320
might be frozen and we call that the

982
00:37:03,270 --> 00:37:00,720
empirical habitable zone

983
00:37:05,750 --> 00:37:03,280
but people like lisa and several other

984
00:37:07,510 --> 00:37:05,760
groups are trying to build models of how

985
00:37:08,950 --> 00:37:07,520
the atmosphere affects it how thick the

986
00:37:11,270 --> 00:37:08,960
atmosphere is what the composition would

987
00:37:13,349 --> 00:37:11,280
be and what cloud cover would do and so

988
00:37:15,109 --> 00:37:13,359

they calculate an inner zone that's a

989
00:37:16,870 --> 00:37:15,119
little bit tighter than the other one

990
00:37:18,870 --> 00:37:16,880
that they say this is the best place

991
00:37:20,310 --> 00:37:18,880
where you'd expect to have water on a

992
00:37:22,150 --> 00:37:20,320
surface so we have two ways of

993
00:37:23,750 --> 00:37:22,160
estimating it and she's described both

994
00:37:25,750 --> 00:37:23,760
of those for you

995
00:37:27,589 --> 00:37:25,760
and so baby basically just as a small

996
00:37:29,589 --> 00:37:27,599
comment and build it this exactly

997
00:37:31,670 --> 00:37:29,599
perfect we don't know

998
00:37:33,109 --> 00:37:31,680
how in this models to include what

999
00:37:35,750 --> 00:37:33,119
cloud's going to do

1000
00:37:37,030 --> 00:37:35,760
and so therefore it's too narrow because

1001
00:37:39,349 --> 00:37:37,040
when it gets hot you should get more

1002
00:37:41,829 --> 00:37:39,359
clouds on the inside they actually are

1003
00:37:44,150 --> 00:37:41,839
water clouds so they cool you on the

1004
00:37:46,310 --> 00:37:44,160
outside there's co2 clouds so they warm

1005
00:37:48,230 --> 00:37:46,320
you different kind of things but it's

1006
00:37:49,990 --> 00:37:48,240
very hard to model these things so we

1007
00:37:51,349 --> 00:37:50,000
know that the narrow habitable zone as

1008
00:37:53,510 --> 00:37:51,359
bill said

1009
00:37:56,069 --> 00:37:53,520
misses this crucial factor so it's too

1010
00:37:58,150 --> 00:37:56,079
small but we know that within this one

1011
00:37:59,349 --> 00:37:58,160
even our existing models we can make it

1012
00:38:01,030 --> 00:37:59,359
work

1013
00:38:02,310 --> 00:38:01,040

great thank you

1014
00:38:05,030 --> 00:38:02,320
all right let's take our attention to

1015
00:38:06,230 --> 00:38:05,040
the phones and and ask a question out

1016
00:38:07,270 --> 00:38:06,240
there and then we'll come back to the

1017
00:38:10,069 --> 00:38:07,280
room here

1018
00:38:11,349 --> 00:38:10,079
i'll turn it over to the operator to

1019
00:38:13,270 --> 00:38:11,359
turn it over to the media to ask

1020
00:38:14,870 --> 00:38:13,280
questions on the phone bridge

1021
00:38:17,030 --> 00:38:14,880
thank you

1022
00:38:20,390 --> 00:38:17,040
we have a question from seth bornstein

1023
00:38:22,470 --> 00:38:20,400
associated press your line is open

1024
00:38:25,430 --> 00:38:22,480
yes thank you for doing this um i guess

1025
00:38:27,829 --> 00:38:25,440
this would be for lisa or bill

1026
00:38:30,710 --> 00:38:27,839
um in terms of the difference between

1027
00:38:32,710 --> 00:38:30,720
enf the sort of the rockiness versus the

1028
00:38:35,829 --> 00:38:32,720
water worldness

1029
00:38:39,349 --> 00:38:35,839
one does in general the thought that uh

1030
00:38:41,510 --> 00:38:39,359
more watery is more more conducive to

1031
00:38:43,910 --> 00:38:41,520
the uh beginning and evolution of life

1032
00:38:44,710 --> 00:38:43,920
or what or is it more rocky i mean and

1033
00:38:47,190 --> 00:38:44,720
just

1034
00:38:49,589 --> 00:38:47,200
a sense i know we have no idea what any

1035
00:38:51,349 --> 00:38:49,599
kind of life could develop on here but a

1036
00:38:52,550 --> 00:38:51,359
sense of what kind of life we you know

1037
00:38:54,150 --> 00:38:52,560
since this is

1038
00:38:57,829 --> 00:38:54,160

you know potentially very hot you know

1039
00:38:59,270 --> 00:38:57,839
habitable what kind of life could uh

1040
00:39:01,030 --> 00:38:59,280
are we talking about when we're talking

1041
00:39:03,349 --> 00:39:01,040
about the potential for life and and

1042
00:39:05,510 --> 00:39:03,359
what differences would the two planets

1043
00:39:07,910 --> 00:39:05,520
make between each other

1044
00:39:10,550 --> 00:39:07,920
miss the rookie

1045
00:39:12,550 --> 00:39:10,560
okay i'll try to answer that uh

1046
00:39:14,710 --> 00:39:12,560
if we look at our own ocean it is just

1047
00:39:17,109 --> 00:39:14,720
absolutely full of life we think in fact

1048
00:39:19,270 --> 00:39:17,119
life might have begun there in the ocean

1049
00:39:20,790 --> 00:39:19,280
vents and places like that where

1050
00:39:22,550 --> 00:39:20,800
chemicals like hydrogen

1051
00:39:24,310 --> 00:39:22,560
hydrogen sulfide come out things that

1052
00:39:26,870 --> 00:39:24,320
are poisonous to us

1053
00:39:28,230 --> 00:39:26,880
so and the variety of life is absolutely

1054
00:39:30,630 --> 00:39:28,240
unbelievable if you look at our own

1055
00:39:33,670 --> 00:39:30,640
oceans so speculating as to what those

1056
00:39:35,109 --> 00:39:33,680
oceans would be like is is a puzzle but

1057
00:39:36,710 --> 00:39:35,119
one of the things that's important is to

1058
00:39:39,430 --> 00:39:36,720
get uh

1059
00:39:41,589 --> 00:39:39,440
rocky material minerals uh elements into

1060
00:39:43,510 --> 00:39:41,599
that water and one of some of the work

1061
00:39:45,670 --> 00:39:43,520
that lisa and her group has have done

1062
00:39:48,630 --> 00:39:45,680
and we'll be talking about uh i believe

1063
00:39:50,069 --> 00:39:48,640

in another press release is that

1064
00:39:52,310 --> 00:39:50,079
there is a way of getting the rocky

1065
00:39:54,550 --> 00:39:52,320
material from the core into the ocean so

1066
00:39:57,109 --> 00:39:54,560
there is the chemicals that are required

1067
00:39:58,069 --> 00:39:57,119
to build life

1068
00:40:01,430 --> 00:39:58,079
clearly

1069
00:40:03,670 --> 00:40:01,440
life where that builds radio telescopes

1070
00:40:05,910 --> 00:40:03,680
and communicates with us or has tel uh

1071
00:40:08,150 --> 00:40:05,920
optical telescopes is probably much less

1072
00:40:10,550 --> 00:40:08,160
likely on a water world

1073
00:40:13,430 --> 00:40:10,560
unless there is some land uh whereas

1074
00:40:15,589 --> 00:40:13,440
with the rocky world uh

1075
00:40:18,230 --> 00:40:15,599
it might very well be quite similar to

1076
00:40:20,550 --> 00:40:18,240
the earth in in in almost every way

1077
00:40:23,030 --> 00:40:20,560
other than gravity would be higher it

1078
00:40:25,670 --> 00:40:23,040
would be more uh you know

1079
00:40:26,710 --> 00:40:25,680
we might not have gotten off of uh uh uh

1080
00:40:32,550 --> 00:40:26,720
uh

1081
00:40:34,950 --> 00:40:32,560
some arms simply because that gravity is

1082
00:40:37,030 --> 00:40:34,960
higher but we could walk on that uh it

1083
00:40:38,390 --> 00:40:37,040
would just be a little bit uh more

1084
00:40:40,069 --> 00:40:38,400
difficult so

1085
00:40:43,349 --> 00:40:40,079
it seems to me those both of those

1086
00:40:45,589 --> 00:40:43,359
planets have a real chance of

1087
00:40:48,870 --> 00:40:45,599
habitability but we really don't know

1088
00:40:51,270 --> 00:40:48,880

what life requires to get started so we

1089
00:40:53,829 --> 00:40:51,280
don't know whether they have any life

1090
00:40:55,190 --> 00:40:53,839
so i completely agree with bell one of

1091
00:40:56,950 --> 00:40:55,200
the other things that would also be

1092
00:40:59,349 --> 00:40:56,960
interesting in terms of uh somebody

1093
00:41:02,069 --> 00:40:59,359
asked me what about if you fly there

1094
00:41:03,589 --> 00:41:02,079
uh as we said the outer one as in the

1095
00:41:05,430 --> 00:41:03,599
car and the models of the habitable zone

1096
00:41:07,910 --> 00:41:05,440
will have to build up a lot of co2

1097
00:41:09,670 --> 00:41:07,920
greenhouse gases to stay warm so if you

1098
00:41:11,270 --> 00:41:09,680
land on the other one don't take off

1099
00:41:12,950 --> 00:41:11,280
your spacesuit

1100
00:41:15,109 --> 00:41:12,960
because it's not very good for us to

1101
00:41:17,750 --> 00:41:15,119
breathe more than one bar or like a lot

1102
00:41:19,910 --> 00:41:17,760
of co2 we'll have to get some masks to

1103
00:41:21,430 --> 00:41:19,920
do that while the other one potentially

1104
00:41:23,990 --> 00:41:21,440
is going to be very hot and muggy but

1105
00:41:25,910 --> 00:41:24,000
doesn't need that kind of co2 again we

1106
00:41:27,750 --> 00:41:25,920
don't know how these worlds could at all

1107
00:41:29,750 --> 00:41:27,760
develop but if you want to write a

1108
00:41:32,710 --> 00:41:29,760
science fiction story and you land on

1109
00:41:35,670 --> 00:41:32,720
both at least we're sure that on f you

1110
00:41:37,750 --> 00:41:35,680
don't want to take your mask thingy off

1111
00:41:39,990 --> 00:41:37,760
the other thing that lisa's mentioned

1112
00:41:41,030 --> 00:41:40,000
along this line i think was rather

1113
00:41:42,630 --> 00:41:41,040

interesting

1114
00:41:44,630 --> 00:41:42,640
if you've got a planet with a massive

1115
00:41:47,109 --> 00:41:44,640
atmosphere

1116
00:41:49,670 --> 00:41:47,119
an ocean planet we know that at least in

1117
00:41:51,750 --> 00:41:49,680
our ocean we have flying fish

1118
00:41:52,470 --> 00:41:51,760
and they fly to get away from

1119
00:41:55,349 --> 00:41:52,480
uh

1120
00:42:01,270 --> 00:41:55,359
predators so we might find in fact they

1121
00:42:09,990 --> 00:42:02,230
all right let's move to the next

1122
00:42:13,510 --> 00:42:11,510
our next question comes from david

1123
00:42:14,710 --> 00:42:13,520
perlman san francisco chronicle your

1124
00:42:17,109 --> 00:42:14,720
line is open

1125
00:42:21,190 --> 00:42:17,119
oh hi thank you uh

1126
00:42:24,790 --> 00:42:21,200
my question really is is for dr barkley

1127
00:42:27,109 --> 00:42:24,800
and 67 and 69 c

1128
00:42:30,150 --> 00:42:27,119
first of all has republic has that been

1129
00:42:31,030 --> 00:42:30,160
published anywhere yet and second of all

1130
00:42:32,630 --> 00:42:31,040
could you

1131
00:42:35,670 --> 00:42:32,640
go a little more

1132
00:42:37,109 --> 00:42:35,680
repeat a little bit more about why

1133
00:42:39,510 --> 00:42:37,119
69c

1134
00:42:42,230 --> 00:42:39,520
might be a good candidate for

1135
00:42:44,470 --> 00:42:42,240
habitability

1136
00:42:46,309 --> 00:42:44,480
yes so the um paper was published in the

1137
00:42:47,270 --> 00:42:46,319
astrophysical journal today i believe at

1138
00:42:49,190 --> 00:42:47,280

11 00

1139
00:42:50,790 --> 00:42:49,200
a.m this morning pacific time

1140
00:42:52,710 --> 00:42:50,800
um

1141
00:42:55,109 --> 00:42:52,720
plus 69

1142
00:42:56,630 --> 00:42:55,119
c is certainly on the inner edge of what

1143
00:42:59,190 --> 00:42:56,640
we've considered to be the habitable

1144
00:43:00,790 --> 00:42:59,200
zone by the product project

1145
00:43:06,630 --> 00:43:00,800
the

1146
00:43:08,710 --> 00:43:06,640
exciting things is this is no longer an

1147
00:43:11,589 --> 00:43:08,720
academic theoretical exercise because we

1148
00:43:14,230 --> 00:43:11,599
are finding planets that really

1149
00:43:15,109 --> 00:43:14,240
fit into these models can really test

1150
00:43:20,069 --> 00:43:15,119
new

1151
00:43:23,109 --> 00:43:20,079
on i think it's very exciting

1152
00:43:25,670 --> 00:43:23,119
there is probably this planet is closer

1153
00:43:27,990 --> 00:43:25,680
to a venus than an earth but we're not

1154
00:43:30,630 --> 00:43:28,000
sure it has an orbital period between

1155
00:43:32,550 --> 00:43:30,640
venus and earth it's longer than venus

1156
00:43:34,309 --> 00:43:32,560
and it's around a cooler star

1157
00:43:35,510 --> 00:43:34,319
slightly but still very similar to the

1158
00:43:38,790 --> 00:43:35,520
sun

1159
00:43:40,069 --> 00:43:38,800
so the answer is we're not sure yet

1160
00:43:41,589 --> 00:43:40,079
one of the most exciting things from

1161
00:43:43,349 --> 00:43:41,599
these discoveries i think is the fact

1162
00:43:45,829 --> 00:43:43,359
that we are finding these small planets

1163
00:43:47,670 --> 00:43:45,839

on these longer orbital periods so we're

1164
00:43:50,470 --> 00:43:47,680
pushing towards the habitable zone

1165
00:43:52,630 --> 00:43:50,480
suggesting that there are many

1166
00:43:54,790 --> 00:43:52,640
small bodies within the habitable zones

1167
00:43:57,109 --> 00:43:54,800
of their host stars

1168
00:43:59,030 --> 00:43:57,119
i think follow up with one can can i

1169
00:44:00,630 --> 00:43:59,040
just make one comment to that it's as

1170
00:44:02,630 --> 00:44:00,640
tom pointed out and i think that's a

1171
00:44:04,790 --> 00:44:02,640
very good point it's like what we know

1172
00:44:07,349 --> 00:44:04,800
we know from our solo system and from

1173
00:44:09,670 --> 00:44:07,359
our atmospheric modeling

1174
00:44:11,829 --> 00:44:09,680
if you could also say maybe venus is a

1175
00:44:13,829 --> 00:44:11,839
fluke maybe other planets

1176
00:44:15,670 --> 00:44:13,839
could somehow have survived more

1177
00:44:17,510 --> 00:44:15,680
radiation than venus and that's what tom

1178
00:44:20,069 --> 00:44:17,520
is pointing out so maybe

1179
00:44:22,550 --> 00:44:20,079
and especially with future telescopes

1180
00:44:24,390 --> 00:44:22,560
when we find such planets close around

1181
00:44:26,950 --> 00:44:24,400
close stars so tess is going to give us

1182
00:44:28,470 --> 00:44:26,960
targets and then jwst hopefully can have

1183
00:44:31,270 --> 00:44:28,480
a look at that we can test that we can

1184
00:44:33,349 --> 00:44:31,280
see if there is an option that if you

1185
00:44:35,430 --> 00:44:33,359
get more flux than venus you can still

1186
00:44:38,390 --> 00:44:35,440
be a habitable world right now we don't

1187
00:44:40,150 --> 00:44:38,400
know of one but you know we can't 100

1188
00:44:41,190 --> 00:44:40,160

exclude it either dave you had a

1189
00:44:44,470 --> 00:44:41,200
follow-up

1190
00:44:48,069 --> 00:44:44,480
yes i did just a quick one uh which

1191
00:44:51,349 --> 00:44:48,079
candidate for habitable zones

1192
00:44:53,910 --> 00:44:51,359
are you people agreeing on and is there

1193
00:44:56,550 --> 00:44:53,920
a big difference in your in your

1194
00:44:58,550 --> 00:44:56,560
attitude towards habitable zones

1195
00:45:01,030 --> 00:44:58,560
there isn't one standard

1196
00:45:02,870 --> 00:45:01,040
how do you determine that which

1197
00:45:05,190 --> 00:45:02,880
kind of habitable zone you're talking

1198
00:45:07,349 --> 00:45:05,200
about bill or tom

1199
00:45:10,870 --> 00:45:07,359
yeah so so basically as bill was

1200
00:45:12,550 --> 00:45:10,880
explaining before um we do agree so this

1201
00:45:14,630 --> 00:45:12,560
is one of the exciting things in science

1202
00:45:17,030 --> 00:45:14,640
now we're working on the models but we

1203
00:45:19,349 --> 00:45:17,040
do agree because the basics we actually

1204
00:45:21,109 --> 00:45:19,359
talk to each other and we figure out how

1205
00:45:23,430 --> 00:45:21,119
our different models work and we make

1206
00:45:25,750 --> 00:45:23,440
independent analysis and we agree on the

1207
00:45:27,030 --> 00:45:25,760
limits of the habitable zone that we use

1208
00:45:29,030 --> 00:45:27,040
and so

1209
00:45:31,829 --> 00:45:29,040
bill explained it very eloquently how we

1210
00:45:33,589 --> 00:45:31,839
do this so in the narrow habitable film

1211
00:45:35,190 --> 00:45:33,599
that we have in our paper

1212
00:45:37,670 --> 00:45:35,200
and that we also show in the science

1213
00:45:39,190 --> 00:45:37,680

paper and bell science paper is where we

1214
00:45:41,109 --> 00:45:39,200
take the earth

1215
00:45:43,109 --> 00:45:41,119
and as i said we don't have a feedback

1216
00:45:45,430 --> 00:45:43,119
for cloud but other than that we know

1217
00:45:47,430 --> 00:45:45,440
how the earth would evolve if you put it

1218
00:45:49,109 --> 00:45:47,440
closer to the sun and further away from

1219
00:45:51,430 --> 00:45:49,119
the sun getting really hot getting

1220
00:45:53,030 --> 00:45:51,440
really cold and the other zone because

1221
00:45:55,510 --> 00:45:53,040
we know that we're missing cloud

1222
00:45:58,309 --> 00:45:55,520
feedback in this model that we use for

1223
00:46:00,309 --> 00:45:58,319
the neurohabitable zone is empirically

1224
00:46:03,030 --> 00:46:00,319
looking at mars and venus in our own

1225
00:46:05,910 --> 00:46:03,040
system and determining it there so

1226
00:46:07,990 --> 00:46:05,920
there is no conflict at all about uh

1227
00:46:09,990 --> 00:46:08,000
where the habitable zone is you know we

1228
00:46:11,349 --> 00:46:10,000
might uh say okay now we found something

1229
00:46:13,430 --> 00:46:11,359
new and so you can stretch it out a

1230
00:46:16,390 --> 00:46:13,440
little bit but the empirical habitable

1231
00:46:17,990 --> 00:46:16,400
zone from the data in our solar system

1232
00:46:19,670 --> 00:46:18,000
basically tells us that venus is not

1233
00:46:22,069 --> 00:46:19,680
habitable and so

1234
00:46:24,150 --> 00:46:22,079
that's what we take for data-based

1235
00:46:26,710 --> 00:46:24,160
habitable zone so what tom was saying

1236
00:46:28,790 --> 00:46:26,720
it's just that there's an error bar in

1237
00:46:30,790 --> 00:46:28,800
where the planet actually is

1238
00:46:33,190 --> 00:46:30,800

or or how hot the star really is so

1239
00:46:33,990 --> 00:46:33,200
there's an air barn how much of the flux

1240
00:46:39,430 --> 00:46:34,000
the

1241
00:46:40,950 --> 00:46:39,440
its star that planet 69 c gets and if

1242
00:46:43,190 --> 00:46:40,960
you have a look at one of the first of

1243
00:46:46,470 --> 00:46:43,200
my slides or one of them you see this

1244
00:46:48,790 --> 00:46:46,480
habitable sound and for kaplan 96 c you

1245
00:46:52,630 --> 00:46:48,800
see this arrow bar

1246
00:46:54,950 --> 00:46:52,640
69 sorry 69c not 96 sorry 69th you see

1247
00:46:57,589 --> 00:46:54,960
this arrow bar and you know part of the

1248
00:46:59,670 --> 00:46:57,599
aero bar gets into the habitable sound

1249
00:47:02,390 --> 00:46:59,680
so with with new measurements we figure

1250
00:47:04,150 --> 00:47:02,400
out the star is actually cooler it gets

1251
00:47:06,150 --> 00:47:04,160
radiates less then

1252
00:47:07,589 --> 00:47:06,160
we shift it into the habitable sun right

1253
00:47:09,190 --> 00:47:07,599
and tom or bill did you have a quick

1254
00:47:11,190 --> 00:47:09,200
follow-up to that

1255
00:47:12,790 --> 00:47:11,200
okay well i think that uh you know

1256
00:47:13,990 --> 00:47:12,800
lisa's pointed out

1257
00:47:16,550 --> 00:47:14,000
that the

1258
00:47:18,390 --> 00:47:16,560
wider zone is based on our own solar

1259
00:47:21,270 --> 00:47:18,400
system and that these systems are

1260
00:47:22,710 --> 00:47:21,280
different and that they might very well

1261
00:47:24,230 --> 00:47:22,720
have an empirical

1262
00:47:26,950 --> 00:47:24,240
we may very well find the empirical

1263
00:47:28,790 --> 00:47:26,960

habitat is wider than we have found and

1264
00:47:31,190 --> 00:47:28,800
so we do need to look at that data and

1265
00:47:32,950 --> 00:47:31,200
so i think that atom's quite right this

1266
00:47:35,270 --> 00:47:32,960
is something that we consider in the

1267
00:47:36,470 --> 00:47:35,280
habitable zone or so close that it's

1268
00:47:38,230 --> 00:47:36,480
we consider it a habitable zone

1269
00:47:40,390 --> 00:47:38,240
basically we're coming up on the top of

1270
00:47:41,750 --> 00:47:40,400
the hour already so uh we have a few

1271
00:47:43,670 --> 00:47:41,760
more questions or we have a number of

1272
00:47:45,670 --> 00:47:43,680
questions from social media so let's try

1273
00:47:46,790 --> 00:47:45,680
to get through um a few more and if we

1274
00:47:48,150 --> 00:47:46,800
could answer questions a little more

1275
00:47:49,589 --> 00:47:48,160
briefly that way we can get to more

1276
00:47:52,390 --> 00:47:49,599
questions so let's go back here in the

1277
00:47:54,230 --> 00:47:52,400
room we had a question in the front yeah

1278
00:47:55,349 --> 00:47:54,240
hi um my name is mike steger i'm with

1279
00:47:57,349 --> 00:47:55,359
21st

1280
00:47:59,670 --> 00:47:57,359
century science and technology

1281
00:48:01,349 --> 00:47:59,680
i just want to first just applaud what

1282
00:48:03,430 --> 00:48:01,359
you've done to keep people inspired

1283
00:48:05,910 --> 00:48:03,440
regarding space exploration especially

1284
00:48:07,270 --> 00:48:05,920
under these austere budgetary conditions

1285
00:48:09,270 --> 00:48:07,280
i'm glad you guys could all make it here

1286
00:48:10,549 --> 00:48:09,280
today um

1287
00:48:12,309 --> 00:48:10,559
uh

1288
00:48:14,950 --> 00:48:12,319

what two questions one more a bit more

1289
00:48:16,470 --> 00:48:14,960
uh future oriented we mentioned tess i'd

1290
00:48:18,069 --> 00:48:16,480
like to know a little bit more about

1291
00:48:19,430 --> 00:48:18,079
where we can go and especially if we

1292
00:48:21,349 --> 00:48:19,440
were able to expand the budget what do

1293
00:48:23,510 --> 00:48:21,359
we see as possible not so much

1294
00:48:25,190 --> 00:48:23,520
restricted but what's actually available

1295
00:48:27,750 --> 00:48:25,200
technologically to really look at these

1296
00:48:29,589 --> 00:48:27,760
questions and then second

1297
00:48:30,390 --> 00:48:29,599
because we the the

1298
00:48:32,230 --> 00:48:30,400
um

1299
00:48:33,910 --> 00:48:32,240
we've found over the last few decades

1300
00:48:36,230 --> 00:48:33,920
you know life is far more formidable

1301
00:48:38,150 --> 00:48:36,240
than we had maybe previously considered

1302
00:48:40,630 --> 00:48:38,160
under what concern considerations do we

1303
00:48:44,150 --> 00:48:40,640
have in looking at the organization

1304
00:48:45,670 --> 00:48:44,160
of the uh the star system

1305
00:48:48,069 --> 00:48:45,680
in terms of you know planetary

1306
00:48:50,710 --> 00:48:48,079
arrangements how that might affect the

1307
00:48:52,390 --> 00:48:50,720
characteristics and in that context what

1308
00:48:53,430 --> 00:48:52,400
we've what was recently announced a few

1309
00:48:55,190 --> 00:48:53,440
months ago

1310
00:48:57,109 --> 00:48:55,200
the asteroid belts

1311
00:49:00,230 --> 00:48:57,119
how these are found to be consistent in

1312
00:49:01,190 --> 00:49:00,240
some of the uh the project's research

1313
00:49:02,870 --> 00:49:01,200

so

1314
00:49:04,230 --> 00:49:02,880
there's just two questions if those

1315
00:49:05,430 --> 00:49:04,240
could be addressed let me answer the

1316
00:49:07,030 --> 00:49:05,440
first question

1317
00:49:10,470 --> 00:49:07,040
basically you're saying what could we do

1318
00:49:15,670 --> 00:49:13,109
and it it's almost limitless the

1319
00:49:18,790 --> 00:49:15,680
objective of what we're trying to do is

1320
00:49:21,030 --> 00:49:18,800
to explore the galaxy looking for life

1321
00:49:23,510 --> 00:49:21,040
kepler is this one first step

1322
00:49:25,910 --> 00:49:23,520
tess is another step but the next big

1323
00:49:27,589 --> 00:49:25,920
step is likely to be something like

1324
00:49:28,870 --> 00:49:27,599
about what people were talking about

1325
00:49:31,109 --> 00:49:28,880
years previous

1326
00:49:32,790 --> 00:49:31,119
the terrestrial planet finder

1327
00:49:35,109 --> 00:49:32,800
what we're trying to do there is to look

1328
00:49:38,230 --> 00:49:35,119
at the atmospheres of these planets

1329
00:49:39,829 --> 00:49:38,240
and find out are they co2 is there water

1330
00:49:41,829 --> 00:49:39,839
with those two things you can have life

1331
00:49:43,990 --> 00:49:41,839
those are plants what plants need if you

1332
00:49:45,510 --> 00:49:44,000
have oxygen maybe they're higher animals

1333
00:49:46,630 --> 00:49:45,520
as well

1334
00:49:49,109 --> 00:49:46,640
if they're

1335
00:49:51,510 --> 00:49:49,119
freons i mean you've got it made

1336
00:49:53,750 --> 00:49:51,520
obviously intelligent life is there so

1337
00:49:55,910 --> 00:49:53,760
we want to look at the composition of

1338
00:49:59,349 --> 00:49:55,920

these atmospheres and that's going to

1339
00:50:01,190 --> 00:49:59,359
take a much more expensive extensive

1340
00:50:02,950 --> 00:50:01,200
mission but we've talked about it we've

1341
00:50:04,790 --> 00:50:02,960
planned it

1342
00:50:06,710 --> 00:50:04,800
once we got the once we get the funds in

1343
00:50:08,950 --> 00:50:06,720
the future i think we'll see rapid

1344
00:50:11,349 --> 00:50:08,960
progress in that direction because we

1345
00:50:13,349 --> 00:50:11,359
have several different methods of

1346
00:50:15,430 --> 00:50:13,359
approaching that in fact the national

1347
00:50:17,190 --> 00:50:15,440
academy of sciences have said that when

1348
00:50:19,829 --> 00:50:17,200
we get the numbers for kepler

1349
00:50:21,190 --> 00:50:19,839
we know how frequent earth's inhabitable

1350
00:50:22,790 --> 00:50:21,200
zone are

1351
00:50:24,790 --> 00:50:22,800
if they're very frequent just look at

1352
00:50:26,549 --> 00:50:24,800
the nearest stars if there were any

1353
00:50:28,549 --> 00:50:26,559
freak infrequent then you have to look

1354
00:50:30,309 --> 00:50:28,559
much further out into the galaxy so you

1355
00:50:31,750 --> 00:50:30,319
build a much bigger more powerful

1356
00:50:33,589 --> 00:50:31,760
instrument but a much much more

1357
00:50:34,870 --> 00:50:33,599
expensive one so we're looking forward

1358
00:50:37,589 --> 00:50:34,880
to getting these

1359
00:50:39,270 --> 00:50:37,599
frequencies of planets

1360
00:50:41,829 --> 00:50:39,280
as a function of size and habitable zone

1361
00:50:42,950 --> 00:50:41,839
and so on but i think that's what we're

1362
00:50:44,870 --> 00:50:42,960
going to see in the future is the

1363
00:50:47,270 --> 00:50:44,880

movement toward a better understanding

1364
00:50:49,990 --> 00:50:47,280
of these planets and whether they might

1365
00:50:52,069 --> 00:50:50,000
have life but even if you found that

1366
00:50:54,870 --> 00:50:52,079
if you found an atmosphere like that

1367
00:50:56,790 --> 00:50:54,880
with water and co2 and oxygen you that's

1368
00:50:59,190 --> 00:50:56,800
not a proof there's life you'll have to

1369
00:51:01,750 --> 00:50:59,200
have missions beyond that that will help

1370
00:51:02,950 --> 00:51:01,760
us understand uh is there actually life

1371
00:51:05,750 --> 00:51:02,960
there

1372
00:51:08,069 --> 00:51:05,760
so we've got ways of using your money

1373
00:51:09,910 --> 00:51:08,079
through our children and grandchildren

1374
00:51:11,750 --> 00:51:09,920
lots of plants

1375
00:51:13,109 --> 00:51:11,760
and many i can touch on the other thing

1376
00:51:16,950 --> 00:51:13,119
you talked about

1377
00:51:18,630 --> 00:51:16,960
being very versatile one of the things

1378
00:51:21,190 --> 00:51:18,640
that i also want to point out is this

1379
00:51:23,589 --> 00:51:21,200
habitable sound is defined as where we

1380
00:51:26,710 --> 00:51:23,599
can have liquid water on the surface of

1381
00:51:28,470 --> 00:51:26,720
a planet or a moon if you want

1382
00:51:30,950 --> 00:51:28,480
if you freeze

1383
00:51:32,630 --> 00:51:30,960
the surface of the planet over it's not

1384
00:51:34,950 --> 00:51:32,640
to say that you couldn't have an ocean

1385
00:51:36,710 --> 00:51:34,960
below where you could have life but if

1386
00:51:39,190 --> 00:51:36,720
you can't go there this is our whole

1387
00:51:40,950 --> 00:51:39,200
discussion of going to europa

1388
00:51:43,030 --> 00:51:40,960

basically going drilling through the ice

1389
00:51:44,470 --> 00:51:43,040
and having a look if you take your rope

1390
00:51:47,030 --> 00:51:44,480
or something bigger than your roper

1391
00:51:49,510 --> 00:51:47,040
right with a huge ice layer put it 10

1392
00:51:51,829 --> 00:51:49,520
light years away it's not easier to

1393
00:51:54,069 --> 00:51:51,839
detect if there's life right and so this

1394
00:51:56,150 --> 00:51:54,079
habitable zone in a way

1395
00:51:58,870 --> 00:51:56,160
we define it for liquid water so that

1396
00:52:00,630 --> 00:51:58,880
whatever life produces has an easy

1397
00:52:03,030 --> 00:52:00,640
chance to get in the atmosphere and so

1398
00:52:05,510 --> 00:52:03,040
we don't have to fly there we can build

1399
00:52:07,990 --> 00:52:05,520
bigger telescopes as bill just said to

1400
00:52:10,790 --> 00:52:08,000
pick up the signatures of life from the

1401
00:52:12,390 --> 00:52:10,800
atmosphere because i think we're not

1402
00:52:14,309 --> 00:52:12,400
talking even if you give us loads of

1403
00:52:16,710 --> 00:52:14,319
money actually flying to a thousand two

1404
00:52:19,589 --> 00:52:16,720
hundred light-year things or planets

1405
00:52:21,670 --> 00:52:19,599
very far away will require some really

1406
00:52:23,430 --> 00:52:21,680
really good engineers and so if anybody

1407
00:52:26,630 --> 00:52:23,440
has a smart idea how we can travel

1408
00:52:29,030 --> 00:52:26,640
faster than light please let us know

1409
00:52:31,510 --> 00:52:29,040
great okay let's go back to the phones

1410
00:52:33,990 --> 00:52:31,520
operator

1411
00:52:35,670 --> 00:52:34,000
we have a question from david templeton

1412
00:52:37,430 --> 00:52:35,680
pittsburgh post gazette your line is

1413
00:52:40,230 --> 00:52:37,440

open

1414
00:52:43,589 --> 00:52:40,240
yes if if you were uh if kepler were

1415
00:52:44,390 --> 00:52:43,599
looking at the uh our solar system

1416
00:52:49,030 --> 00:52:44,400
would

1417
00:52:51,510 --> 00:52:49,040
and mars be

1418
00:52:53,589 --> 00:52:51,520
kind of on the edge or beyond the narrow

1419
00:52:54,950 --> 00:52:53,599
zone or what what would what would it

1420
00:52:57,430 --> 00:52:54,960
conclude

1421
00:52:58,710 --> 00:52:57,440
about our solar system

1422
00:53:00,549 --> 00:52:58,720
well the first thing of course is

1423
00:53:02,630 --> 00:53:00,559
because kepler's

1424
00:53:05,190 --> 00:53:02,640
has been analyzed data for only the

1425
00:53:07,109 --> 00:53:05,200
first uh about two years we would not

1426
00:53:09,270 --> 00:53:07,119
have seen three transits of any planet

1427
00:53:11,030 --> 00:53:09,280
in the habitable zone and certainly

1428
00:53:13,349 --> 00:53:11,040
that's goes for earth and certainly that

1429
00:53:15,349 --> 00:53:13,359
goes for mars so we wouldn't have seen

1430
00:53:17,190 --> 00:53:15,359
anything yet we have to look longer we

1431
00:53:19,349 --> 00:53:17,200
have to look at the data that we have

1432
00:53:22,069 --> 00:53:19,359
stored but if we

1433
00:53:23,670 --> 00:53:22,079
uh postulate that we've looked longer we

1434
00:53:27,190 --> 00:53:23,680
would expect to find

1435
00:53:29,910 --> 00:53:27,200
those planets certainly a 62f in the

1436
00:53:31,430 --> 00:53:29,920
narrow habitable zone i don't know about

1437
00:53:34,710 --> 00:53:31,440
62e

1438
00:53:37,030 --> 00:53:34,720

lisa so basically uh what you have and a

1439
00:53:39,190 --> 00:53:37,040
good point about in our own solar system

1440
00:53:41,589 --> 00:53:39,200
both earth and mars fall in this narrow

1441
00:53:43,510 --> 00:53:41,599
habitable zone but mars is just too

1442
00:53:45,510 --> 00:53:43,520
small it doesn't hold on to an

1443
00:53:48,230 --> 00:53:45,520
atmosphere like the earth does so it

1444
00:53:50,790 --> 00:53:48,240
cannot build up greenhouse gases that

1445
00:53:52,630 --> 00:53:50,800
could keep it warm at that radiation

1446
00:53:55,670 --> 00:53:52,640
because it gets less radiation less

1447
00:53:58,309 --> 00:53:55,680
energy from its star than our own planet

1448
00:54:00,309 --> 00:53:58,319
so the habitable sound is defined for an

1449
00:54:02,230 --> 00:54:00,319
earth or something bigger than an earth

1450
00:54:04,150 --> 00:54:02,240
and you keep moving it closer to the

1451
00:54:07,270 --> 00:54:04,160
star further out from the star and

1452
00:54:09,750 --> 00:54:07,280
figure out where it actually stops

1453
00:54:11,349 --> 00:54:09,760
so it gets frozen on the outside and

1454
00:54:14,069 --> 00:54:11,359
loses all its water on the inside that's

1455
00:54:16,630 --> 00:54:14,079
how we define it and so for enf bringing

1456
00:54:18,470 --> 00:54:16,640
it back to the kepler 62 system this

1457
00:54:20,870 --> 00:54:18,480
really narrow definition of the narrow

1458
00:54:23,349 --> 00:54:20,880
habitable zone where we don't have any

1459
00:54:26,309 --> 00:54:23,359
cloud feedback again i said clouds warm

1460
00:54:29,670 --> 00:54:26,319
or cool depending which ones they are

1461
00:54:30,790 --> 00:54:29,680
f is in it it needs to build up lots of

1462
00:54:32,790 --> 00:54:30,800
co2

1463
00:54:35,349 --> 00:54:32,800

to actually stay warm like if you put

1464
00:54:36,870 --> 00:54:35,359
the earth at the mars position and e is

1465
00:54:38,549 --> 00:54:36,880
just in this

1466
00:54:41,030 --> 00:54:38,559
wider habitable zone because it will

1467
00:54:44,630 --> 00:54:41,040
actually need to have more clouds to be

1468
00:54:44,640 --> 00:54:47,190
thank you

1469
00:54:51,510 --> 00:54:48,710
our next question comes from eileen

1470
00:54:53,589 --> 00:54:51,520
klotz raiders your light is now open

1471
00:54:56,069 --> 00:54:53,599
hi um thanks very much i just had a

1472
00:54:58,230 --> 00:54:56,079
quick question about the um listing of

1473
00:55:01,109 --> 00:54:58,240
the list the growing list of exoplanets

1474
00:55:03,190 --> 00:55:01,119
um on exoplanets

1475
00:55:05,750 --> 00:55:03,200
dot org i didn't see

1476
00:55:08,789 --> 00:55:05,760
any of these new candidates on there and

1477
00:55:10,470 --> 00:55:08,799
the total on that site had 697. is that

1478
00:55:13,910 --> 00:55:10,480
accurate and

1479
00:55:16,309 --> 00:55:13,920
is it reasonable just to add these three

1480
00:55:17,589 --> 00:55:16,319
or these let's say five for the total

1481
00:55:20,710 --> 00:55:17,599
number including the ones in the

1482
00:55:22,630 --> 00:55:20,720
habitable zone to that list

1483
00:55:25,750 --> 00:55:22,640
so we're announcing seven

1484
00:55:28,230 --> 00:55:25,760
new planets today five round kepler 62

1485
00:55:30,230 --> 00:55:28,240
and two around kepler 69 and these are

1486
00:55:32,630 --> 00:55:30,240
confirmed planets so they will be i

1487
00:55:34,630 --> 00:55:32,640
presume added to the list uh as soon as

1488
00:55:36,870 --> 00:55:34,640

possible these results have only come

1489
00:55:40,230 --> 00:55:36,880
out at 11am today so that i think they

1490
00:55:40,240 --> 00:55:42,789
thanks

1491
00:55:46,950 --> 00:55:45,030
nancy atkinson universe today your line

1492
00:55:48,870 --> 00:55:46,960
is open

1493
00:55:50,950 --> 00:55:48,880
can you talk a bit more about how

1494
00:55:52,950 --> 00:55:50,960
important these planets atmospheres are

1495
00:55:54,549 --> 00:55:52,960
to make them habitable and

1496
00:55:56,630 --> 00:55:54,559
and then uh you did talk a little bit

1497
00:55:58,470 --> 00:55:56,640
about the terrestrial planet finder and

1498
00:56:00,870 --> 00:55:58,480
that kind of mission but what kind of

1499
00:56:03,430 --> 00:56:00,880
mission or telescope do we need to find

1500
00:56:06,950 --> 00:56:03,440
out more about the atmospheres of this

1501
00:56:13,349 --> 00:56:08,069
the

1502
00:56:16,950 --> 00:56:13,359
is a great step forward in technology it

1503
00:56:20,309 --> 00:56:18,630
that's the edge at the edge of what we

1504
00:56:22,789 --> 00:56:20,319
might be able to do

1505
00:56:24,870 --> 00:56:22,799
you need a big telescope you need to

1506
00:56:25,750 --> 00:56:24,880
have a telescope that blocks out the

1507
00:56:27,750 --> 00:56:25,760
light

1508
00:56:30,150 --> 00:56:27,760
of the star because it's over a billion

1509
00:56:32,309 --> 00:56:30,160
times brighter than that of a planet

1510
00:56:33,990 --> 00:56:32,319
that's extremely difficult to do to the

1511
00:56:35,750 --> 00:56:34,000
point where you blocked it out so

1512
00:56:38,470 --> 00:56:35,760
thoroughly that you can actually see the

1513
00:56:40,870 --> 00:56:38,480

planet but once you can do that

1514
00:56:43,510 --> 00:56:40,880
then you can actually do spectra and get

1515
00:56:45,270 --> 00:56:43,520
the composition of the atmosphere

1516
00:56:46,950 --> 00:56:45,280
when people were

1517
00:56:49,190 --> 00:56:46,960
developing the concepts and the

1518
00:56:51,109 --> 00:56:49,200
engineering ideas for the transfer

1519
00:56:53,670 --> 00:56:51,119
planet finder they felt they might be

1520
00:56:56,390 --> 00:56:53,680
able to go out something like

1521
00:56:58,150 --> 00:56:56,400
30 light years maybe 100 light years

1522
00:57:02,549 --> 00:56:58,160
not as far as the planets we're talk

1523
00:57:07,589 --> 00:57:05,030
i think what will help them

1524
00:57:10,710 --> 00:57:07,599
and help the

1525
00:57:12,549 --> 00:57:10,720
jwst to look at some planets is tess

1526
00:57:14,309 --> 00:57:12,559
tess will go and look through the entire

1527
00:57:16,789 --> 00:57:14,319
sky and find

1528
00:57:18,789 --> 00:57:16,799
those stars with planets that are closer

1529
00:57:21,670 --> 00:57:18,799
and nearby

1530
00:57:24,390 --> 00:57:21,680
in many ways kepler was a a

1531
00:57:26,390 --> 00:57:24,400
a scout it scouted deep into the into

1532
00:57:27,910 --> 00:57:26,400
the galaxy to find out what the

1533
00:57:30,230 --> 00:57:27,920
frequencies were

1534
00:57:32,549 --> 00:57:30,240
to show there were a lot of planets to

1535
00:57:34,950 --> 00:57:32,559
find it's accomplished that and now

1536
00:57:36,950 --> 00:57:34,960
these new missions will come online and

1537
00:57:40,390 --> 00:57:36,960
give us more information about these

1538
00:57:42,150 --> 00:57:40,400

planets but the big step is that step

1539
00:57:44,470 --> 00:57:42,160
when we first start measuring the

1540
00:57:48,069 --> 00:57:44,480
composition of the atmospheres and that

1541
00:57:50,470 --> 00:57:48,079
will be a very technologically difficult

1542
00:57:52,470 --> 00:57:50,480
task

1543
00:57:55,510 --> 00:57:52,480
okay uh irene just a follow-up to your

1544
00:57:56,950 --> 00:57:55,520
question about the number of confirmed

1545
00:57:59,109 --> 00:57:56,960
planets you can go out to the nasa

1546
00:58:04,069 --> 00:57:59,119
exoplanet archive and that's exoplanet

1547
00:58:08,390 --> 00:58:06,150
and you'll also be able to access all of

1548
00:58:09,270 --> 00:58:08,400
the kepler missions data

1549
00:58:10,630 --> 00:58:09,280
that

1550
00:58:12,470 --> 00:58:10,640
has the light curves and everything and

1551
00:58:14,309 --> 00:58:12,480
you'll have the confirmed plan account

1552
00:58:15,190 --> 00:58:14,319
there so these planets will be added to

1553
00:58:17,829 --> 00:58:15,200
that

1554
00:58:20,710 --> 00:58:17,839
so let's go to social media then now

1555
00:58:22,870 --> 00:58:20,720
that we've wrapped up our calls on

1556
00:58:24,710 --> 00:58:22,880
uh the oh pardon me uh we do have one

1557
00:58:27,589 --> 00:58:24,720
more uh call

1558
00:58:30,789 --> 00:58:27,599
a question from the phone cesar bama or

1559
00:58:33,109 --> 00:58:30,799
global newspaper your line is open

1560
00:58:37,030 --> 00:58:33,119
yes uh thank you i would like to know

1561
00:58:38,870 --> 00:58:37,040
what would it take to to to to to to

1562
00:58:40,549 --> 00:58:38,880
verify this uh

1563
00:58:41,470 --> 00:58:40,559

two new planets in

1564
00:58:49,109 --> 00:58:41,480
in

1565
00:58:51,589 --> 00:58:49,119
planets or are they too far away that

1566
00:58:53,270 --> 00:58:51,599
that our technology our current uh

1567
00:58:55,349 --> 00:58:53,280
capabilities can

1568
00:58:56,630 --> 00:58:55,359
take

1569
00:58:59,270 --> 00:58:56,640
can uh

1570
00:59:01,670 --> 00:58:59,280
confirm us that

1571
00:59:03,910 --> 00:59:01,680
let me answer that one basically we want

1572
00:59:06,390 --> 00:59:03,920
to know the mass of the planet as well

1573
00:59:09,750 --> 00:59:06,400
as its size that gives you the density

1574
00:59:13,430 --> 00:59:09,760
if the density is like the earth 5.7 or

1575
00:59:15,190 --> 00:59:13,440
it's like 10b which is over 8 8.8 then

1576
00:59:17,349 --> 00:59:15,200
we're pretty sure it's rocky

1577
00:59:19,349 --> 00:59:17,359
the difficulty is that when a planet's

1578
00:59:21,510 --> 00:59:19,359
in the habitable sound it's so far from

1579
00:59:23,109 --> 00:59:21,520
a start it's moving very slowly these

1580
00:59:24,630 --> 00:59:23,119
planets are small and they're fairly

1581
00:59:27,270 --> 00:59:24,640
light compared to the giants that we've

1582
00:59:29,510 --> 00:59:27,280
been looking at consequently the radial

1583
00:59:31,430 --> 00:59:29,520
velocity method the doppler method where

1584
00:59:33,430 --> 00:59:31,440
you're looking at the wobble of the star

1585
00:59:35,510 --> 00:59:33,440
doesn't have the precision required it

1586
00:59:37,030 --> 00:59:35,520
can't make that measurement

1587
00:59:39,030 --> 00:59:37,040
we have a second way of getting at

1588
00:59:41,190 --> 00:59:39,040

masses and that is if there's two

1589
00:59:43,030 --> 00:59:41,200
planets in orbit they tend to affect one

1590
00:59:44,710 --> 00:59:43,040
another they tend to slow the outer

1591
00:59:47,430 --> 00:59:44,720
planet down for a while and it speed

1592
00:59:49,589 --> 00:59:47,440
speeds up so the habitable the

1593
00:59:51,349 --> 00:59:49,599
orbital period changes in a rather

1594
00:59:52,470 --> 00:59:51,359
regular way it gets a little bit longer

1595
00:59:54,390 --> 00:59:52,480
gets a little bit shorter gets a little

1596
00:59:56,230 --> 00:59:54,400
bit longer and by the amount that it

1597
00:59:57,670 --> 00:59:56,240
gets longer and shorter

1598
00:59:59,589 --> 00:59:57,680
and the distance from the that other

1599
01:00:01,990 --> 00:59:59,599
planet you can get at the mass of these

1600
01:00:04,230 --> 01:00:02,000
plants and we have found and determined

1601
01:00:07,510 --> 01:00:04,240
masses that way but we have not found

1602
01:00:09,109 --> 01:00:07,520
any planets in 62 or 69

1603
01:00:10,789 --> 01:00:09,119
that are close enough to affect the

1604
01:00:11,670 --> 01:00:10,799
planets we're talking about that may

1605
01:00:13,589 --> 01:00:11,680
happen

1606
01:00:16,069 --> 01:00:13,599
you know in the years coming but right

1607
01:00:18,230 --> 01:00:16,079
now we don't we don't see the variation

1608
01:00:20,789 --> 01:00:18,240
that's needed to get these masses so

1609
01:00:22,390 --> 01:00:20,799
right now we have no method

1610
01:00:24,309 --> 01:00:22,400
of getting

1611
01:00:26,710 --> 01:00:24,319
measurements of the mass we can only use

1612
01:00:29,190 --> 01:00:26,720
our theory and to surmise it from what

1613
01:00:32,950 --> 01:00:29,200

we've learned about other planets which

1614
01:00:34,069 --> 01:00:32,960
perhaps are closer to their stars

1615
01:00:36,390 --> 01:00:34,079
let's take our first question from

1616
01:00:38,870 --> 01:00:36,400
social media

1617
01:00:41,430 --> 01:00:38,880
where were you able to detect solar-like

1618
01:00:46,069 --> 01:00:41,440
oscillations in kepler-62 the star to

1619
01:00:50,470 --> 01:00:47,349
the stars

1620
01:00:51,990 --> 01:00:50,480
most stars have some variability they

1621
01:00:56,470 --> 01:00:52,000
they have

1622
01:00:58,150 --> 01:00:56,480
storms like the sun and that produces uh

1623
01:01:01,030 --> 01:00:58,160
acoustic waves that pass through them

1624
01:01:03,030 --> 01:01:01,040
that oscillation that vibration can tell

1625
01:01:04,549 --> 01:01:03,040
you about the interior of a star it can

1626
01:01:07,990 --> 01:01:04,559
tell you about the size of the star with

1627
01:01:10,630 --> 01:01:08,000
very high accuracy give you some idea of

1628
01:01:12,549 --> 01:01:10,640
the chemicals there

1629
01:01:15,190 --> 01:01:12,559
but to do that you need an enormous

1630
01:01:17,990 --> 01:01:15,200
amount of light over a fairly long

1631
01:01:19,990 --> 01:01:18,000
period of time our telescope is big

1632
01:01:22,950 --> 01:01:20,000
enough to do that for many

1633
01:01:26,069 --> 01:01:22,960
other stars but not for kepler

1634
01:01:26,950 --> 01:01:26,079
62. for kepler 62 it's just simply too

1635
01:01:28,870 --> 01:01:26,960
dim

1636
01:01:29,990 --> 01:01:28,880
now kepler 69

1637
01:01:32,150 --> 01:01:30,000
that's bright enough isn't it

1638
01:01:33,990 --> 01:01:32,160

unfortunately this yeah

1639
01:01:35,910 --> 01:01:34,000
for sun-like stars we can detect these

1640
01:01:38,230 --> 01:01:35,920
solar-like oscillations from which and

1641
01:01:41,109 --> 01:01:38,240
use that to derive very accurate stellar

1642
01:01:42,870 --> 01:01:41,119
properties unfortunately kept 69 was

1643
01:01:44,470 --> 01:01:42,880
also too faint to be able to detect

1644
01:01:45,670 --> 01:01:44,480
these oscillations

1645
01:01:46,950 --> 01:01:45,680
so we

1646
01:01:48,549 --> 01:01:46,960
had to

1647
01:01:50,870 --> 01:01:48,559
measure the stellar properties of

1648
01:01:54,230 --> 01:01:50,880
stellar mass and radius via spectra

1649
01:01:55,430 --> 01:01:54,240
which is very good but less accurate

1650
01:01:57,670 --> 01:01:55,440
okay let's take another question from

1651
01:02:01,029 --> 01:01:57,680
social media how will the habitable zone

1652
01:02:03,349 --> 01:02:01,039
change throughout a star's life cycle

1653
01:02:04,950 --> 01:02:03,359
so that's a very good question because

1654
01:02:07,029 --> 01:02:04,960
that's what we're trying to learn for

1655
01:02:09,510 --> 01:02:07,039
the future but generally if you just

1656
01:02:10,630 --> 01:02:09,520
think about it initially the star is

1657
01:02:12,710 --> 01:02:10,640
colder

1658
01:02:15,670 --> 01:02:12,720
and so the sun was for example 30

1659
01:02:17,349 --> 01:02:15,680
percent less luminous we got 30 less

1660
01:02:19,270 --> 01:02:17,359
energy when it was really young when it

1661
01:02:22,069 --> 01:02:19,280
just started out and now it's just

1662
01:02:24,870 --> 01:02:22,079
brightening with time and so basically

1663
01:02:27,190 --> 01:02:24,880

um it gets hotter and hotter with time

1664
01:02:29,829 --> 01:02:27,200
but this habitable sound is actually

1665
01:02:32,789 --> 01:02:29,839
defined for a planet that can deal with

1666
01:02:35,750 --> 01:02:32,799
that meaning that if it gets hotter it

1667
01:02:37,829 --> 01:02:35,760
washes out the greenhouse gases like co2

1668
01:02:40,470 --> 01:02:37,839
very efficiently from its atmosphere

1669
01:02:43,190 --> 01:02:40,480
well if it gets colder it freezes the

1670
01:02:45,109 --> 01:02:43,200
surface over and so it builds up co2 in

1671
01:02:46,710 --> 01:02:45,119
the atmosphere until it's warm again and

1672
01:02:49,109 --> 01:02:46,720
that's basically similar to what

1673
01:02:50,390 --> 01:02:49,119
happened if you want to think about it

1674
01:02:52,710 --> 01:02:50,400
during the earth's lifetime in the

1675
01:02:55,109 --> 01:02:52,720
beginning was colder we had more co2

1676
01:02:56,390 --> 01:02:55,119
more greenhouse gases to keep us warm

1677
01:02:58,549 --> 01:02:56,400
but

1678
01:02:59,670 --> 01:02:58,559
if you now go really far in the future

1679
01:03:02,150 --> 01:02:59,680
let's say

1680
01:03:05,190 --> 01:03:02,160
a second lifetime of us so we're about

1681
01:03:07,109 --> 01:03:05,200
4.5 billion years old then at one point

1682
01:03:09,190 --> 01:03:07,119
the planet actually stops being able to

1683
01:03:11,190 --> 01:03:09,200
cope with that because you get so much

1684
01:03:14,470 --> 01:03:11,200
radiation that you start to evaporate

1685
01:03:16,309 --> 01:03:14,480
the oceans but that's a really long time

1686
01:03:18,630 --> 01:03:16,319
from now so the habitable selling

1687
01:03:20,630 --> 01:03:18,640
concept and the lines that we showed you

1688
01:03:22,150 --> 01:03:20,640

are good for a couple of billion years

1689
01:03:24,150 --> 01:03:22,160
and still for a couple of billion years

1690
01:03:25,990 --> 01:03:24,160
to come

1691
01:03:27,029 --> 01:03:26,000
let's take one last question from social

1692
01:03:28,950 --> 01:03:27,039
media

1693
01:03:31,430 --> 01:03:28,960
how does the discovery of the earth like

1694
01:03:33,829 --> 01:03:31,440
planets like kepler-69s

1695
01:03:36,069 --> 01:03:33,839
and kepler-62s help us understand our

1696
01:03:37,910 --> 01:03:36,079
own world

1697
01:03:39,510 --> 01:03:37,920
tom you want to take this i'd like to

1698
01:03:41,910 --> 01:03:39,520
make it clear that we wouldn't describe

1699
01:03:44,069 --> 01:03:41,920
these as earth-like planets these

1700
01:03:45,990 --> 01:03:44,079
planets are larger than the earth we

1701
01:03:48,630 --> 01:03:46,000
call them super earths

1702
01:03:52,630 --> 01:03:48,640
we're still progressing towards finding

1703
01:03:54,309 --> 01:03:52,640
the first truly earth-like planets

1704
01:03:56,069 --> 01:03:54,319
that's that's where we'll probably be in

1705
01:03:58,470 --> 01:03:56,079
a few years

1706
01:04:00,230 --> 01:03:58,480
when we find these if they exist and we

1707
01:04:01,910 --> 01:04:00,240
simply don't know whether other

1708
01:04:04,870 --> 01:04:01,920
earth-like planets are out there yet we

1709
01:04:06,710 --> 01:04:04,880
haven't found any

1710
01:04:08,950 --> 01:04:06,720
lisa

1711
01:04:10,870 --> 01:04:08,960
let me i i agree with tom but let me

1712
01:04:13,430 --> 01:04:10,880
take a little more positive view from a

1713
01:04:14,630 --> 01:04:13,440

planetary modeler because if you have a

1714
01:04:20,230 --> 01:04:14,640
rock

1715
01:04:22,870 --> 01:04:20,240
then we think we can learn a lot

1716
01:04:24,549 --> 01:04:22,880
from once we get the atmosphere and look

1717
01:04:26,470 --> 01:04:24,559
at the spectral fingerprint because it

1718
01:04:29,589 --> 01:04:26,480
will just tell us how an earth a bit

1719
01:04:32,309 --> 01:04:29,599
bigger a bit smaller actually works and

1720
01:04:34,470 --> 01:04:32,319
so yes i would like to find the exact

1721
01:04:36,309 --> 01:04:34,480
earth analog i keep calling these

1722
01:04:38,630 --> 01:04:36,319
planets earth-like because yes they are

1723
01:04:40,230 --> 01:04:38,640
bigger they are super and somebody once

1724
01:04:42,230 --> 01:04:40,240
asked me is it like better to live there

1725
01:04:45,029 --> 01:04:42,240
i don't think so but you know we called

1726
01:04:47,510 --> 01:04:45,039
them super so now we stuck with it um

1727
01:04:49,829 --> 01:04:47,520
but the super earth and mini earth if

1728
01:04:51,829 --> 01:04:49,839
you want is just a bit smaller actually

1729
01:04:53,109 --> 01:04:51,839
should function and again we don't know

1730
01:04:55,430 --> 01:04:53,119
that but they should function from

1731
01:04:57,349 --> 01:04:55,440
everything we now similar to the earth

1732
01:04:59,670 --> 01:04:57,359
down to a size where they're not

1733
01:05:02,230 --> 01:04:59,680
geologically active anymore they cool

1734
01:05:04,710 --> 01:05:02,240
out faster and thus cannot recycle

1735
01:05:07,510 --> 01:05:04,720
greenhouse gases like mars did but i

1736
01:05:09,349 --> 01:05:07,520
think these discoveries i actually

1737
01:05:10,630 --> 01:05:09,359
informing us and we're learning about

1738
01:05:12,549 --> 01:05:10,640

our own world

1739
01:05:13,670 --> 01:05:12,559
uh with every step with every model that

1740
01:05:15,029 --> 01:05:13,680
we do

1741
01:05:17,029 --> 01:05:15,039
great the other thing is telling us the

1742
01:05:18,549 --> 01:05:17,039
course disease discovery show that other

1743
01:05:20,789 --> 01:05:18,559
planetary systems

1744
01:05:23,190 --> 01:05:20,799
can be very different from our own and

1745
01:05:25,190 --> 01:05:23,200
yet might well be habitable so that

1746
01:05:27,270 --> 01:05:25,200
that's new knowledge for people to try

1747
01:05:29,510 --> 01:05:27,280
to understand when we're thinking about

1748
01:05:31,029 --> 01:05:29,520
how did our solar system form

1749
01:05:34,069 --> 01:05:31,039
other solar systems have plants and

1750
01:05:35,750 --> 01:05:34,079
handle zones how did ours form

1751
01:05:37,829 --> 01:05:35,760
great thank you very much thanks

1752
01:05:39,750 --> 01:05:37,839
panelists that concludes today's news

1753
01:05:43,230 --> 01:05:39,760
briefing to learn more about nasa's

1754
01:05:46,309 --> 01:05:43,240
kepler mission visit us on the web at

1755
01:05:48,390 --> 01:05:46,319
www.nasa.gov forward slash kepler

1756
01:05:50,710 --> 01:05:48,400
and you can also join us on social media

1757
01:05:53,349 --> 01:05:50,720
and you can go to twitter twitter.com

1758
01:05:56,190 --> 01:05:53,359
forward slash nasa kepler and join us in

1759
01:05:59,109 --> 01:05:56,200
on facebook as well at

1760
01:06:00,870 --> 01:05:59,119
www.facebook.com forward slash nasa's

1761
01:06:02,710 --> 01:06:00,880
kepler mission

1762
01:06:06,610 --> 01:06:02,720
thank you all for joining and clear