
ssd.jpl.nasa.gov/horizons.cgi
“Target Body” = 285263

1
00:00:12,390 --> 00:00:09,830
and qe2 is about 1.7 miles in size and

2
00:00:15,910 --> 00:00:12,400
we know it's a safe distance away it's

3
00:00:17,750 --> 00:00:15,920
about 3.6 million miles from the planet

4
00:00:19,830 --> 00:00:17,760
and we have an image that you're looking

5
00:00:21,750 --> 00:00:19,840
at right now it was taken yesterday from

6
00:00:24,710 --> 00:00:21,760
the south african astronomical

7
00:00:26,950 --> 00:00:24,720
observatory so indeed

8
00:00:29,589 --> 00:00:26,960
telescopes around the world are

9
00:00:31,830 --> 00:00:29,599
beginning to see it we are right now in

10
00:00:34,790 --> 00:00:31,840
mission control to bring you a preview

11
00:00:36,950 --> 00:00:34,800
show of qe2 and give you some tips on

12
00:00:38,950 --> 00:00:36,960
how to see it for yourself and also

13
00:00:41,350 --> 00:00:38,960

answer some of your questions posted on

14
00:00:43,990 --> 00:00:41,360
social media and this is all before

15
00:00:50,389 --> 00:00:44,000
closest approach which occurs tomorrow

16
00:00:54,869 --> 00:00:50,399
may 31st at 1 59 pm pacific 4 59 eastern

17
00:00:57,430 --> 00:00:54,879
time and 20 59 utc

18
00:01:00,310 --> 00:00:57,440
hello everyone i'm gay hill we'll be

19
00:01:02,709 --> 00:01:00,320
talking to folks at the south african

20
00:01:04,310 --> 00:01:02,719
observatory in just a moment but let's

21
00:01:07,350 --> 00:01:04,320
give you a little background on the

22
00:01:09,750 --> 00:01:07,360
asteroid protecting the planet is a nasa

23
00:01:12,149 --> 00:01:09,760
priority and though this asteroid is not

24
00:01:14,550 --> 00:01:12,159
a threat it is an excellent learning

25
00:01:17,590 --> 00:01:14,560
opportunity nasa will be getting its

26
00:01:20,230 --> 00:01:17,600
best look at this asteroid ever using

27
00:01:22,230 --> 00:01:20,240
advanced and detailed radar let me

28
00:01:24,630 --> 00:01:22,240
introduce you right now to paul chodes

29
00:01:27,030 --> 00:01:24,640
he's a scientist with nasa's near earth

30
00:01:30,230 --> 00:01:27,040
object program office based right here

31
00:01:31,510 --> 00:01:30,240
at jpl the neo program has already

32
00:01:34,710 --> 00:01:31,520
identified

33
00:01:37,510 --> 00:01:34,720
95 percent of the asteroids that have

34
00:01:39,350 --> 00:01:37,520
orbits very close to earth and are over

35
00:01:41,749 --> 00:01:39,360
one kilometer

36
00:01:45,429 --> 00:01:41,759
in diameter which is about a half a mile

37
00:01:47,510 --> 00:01:45,439
in diameter 1998 kiwi do happens to be

38
00:01:49,270 --> 00:01:47,520

one of these that we're talking about

39
00:01:51,030 --> 00:01:49,280
and paul why don't you just kind of

40
00:01:52,870 --> 00:01:51,040
brief us tell us a little bit about this

41
00:01:55,109 --> 00:01:52,880
particular asteroid well this is one of

42
00:01:57,270 --> 00:01:55,119
the big ones so it's one of the 95

43
00:01:59,190 --> 00:01:57,280
percent that we've characterized it was

44
00:02:02,630 --> 00:01:59,200
discovered about 15 years ago and it's

45
00:02:04,789 --> 00:02:02,640
one of the initial successes of our

46
00:02:06,149 --> 00:02:04,799
efforts to find the big asteroids that

47
00:02:08,309 --> 00:02:06,159
could hit the earth and cause global

48
00:02:10,309 --> 00:02:08,319
catastrophe so it's certainly one to

49
00:02:11,830 --> 00:02:10,319
keep an eye on we know it's passing at a

50
00:02:16,550 --> 00:02:11,840
comfortable distance

51
00:02:18,710 --> 00:02:16,560
and the name why why 1998 qe2 there's a

52
00:02:20,630 --> 00:02:18,720
formula to this right yes it's not named

53
00:02:22,550 --> 00:02:20,640
after the ocean liner it's not named

54
00:02:25,030 --> 00:02:22,560
after queen elizabeth ii it's it's a

55
00:02:27,110 --> 00:02:25,040
standard asteroid name 1998 is the year

56
00:02:31,030 --> 00:02:27,120
it was discovered and q indicates the

57
00:02:33,430 --> 00:02:31,040
month and e2 um it was the previous one

58
00:02:35,670 --> 00:02:33,440
was d2 and the next one would be f2 it's

59
00:02:38,070 --> 00:02:35,680
just a standard designation all right so

60
00:02:41,990 --> 00:02:38,080
you gave us an image yesterday to show

61
00:02:43,670 --> 00:02:42,000
us the orbit of qe2 and we can go to it

62
00:02:45,910 --> 00:02:43,680
right now and take a look at it it's

63
00:02:47,990 --> 00:02:45,920

pretty large yes this is an eccentric

64
00:02:50,390 --> 00:02:48,000
orbit you can see that it right now it's

65
00:02:52,309 --> 00:02:50,400
right beside the earth very close but at

66
00:02:54,630 --> 00:02:52,319
its farthest point from the sun it goes

67
00:02:56,550 --> 00:02:54,640
out to the outer asteroid belt in fact

68
00:02:58,630 --> 00:02:56,560
pretty close to the orbit of jupiter so

69
00:03:01,110 --> 00:02:58,640
it's an eccentric orbit in a way it's a

70
00:03:04,070 --> 00:03:01,120
visitor from deep space and you also

71
00:03:06,070 --> 00:03:04,080
gave us a a graphic to show us the

72
00:03:08,390 --> 00:03:06,080
closest approach to kind of give us an

73
00:03:10,149 --> 00:03:08,400
understanding of how far away it really

74
00:03:11,910 --> 00:03:10,159
is just to put it in perspective that's

75
00:03:14,390 --> 00:03:11,920
right and we have that image right here

76
00:03:16,070 --> 00:03:14,400
it is uh yes you can see on the left is

77
00:03:18,070 --> 00:03:16,080
the earth and the ring around the earth

78
00:03:20,550 --> 00:03:18,080
is the moon's orbit for scale you can

79
00:03:23,190 --> 00:03:20,560
see that the asteroid passes by i put

80
00:03:25,190 --> 00:03:23,200
the dates on this diagram it's about 15

81
00:03:26,550 --> 00:03:25,200
times farther than the moon is from the

82
00:03:28,789 --> 00:03:26,560
earth so it's a very comfortable

83
00:03:29,670 --> 00:03:28,799
distance but for an asteroid this size

84
00:03:34,550 --> 00:03:29,680
that's

85
00:03:36,390 --> 00:03:34,560
would keep an eye on if it for any

86
00:03:38,470 --> 00:03:36,400
reason gets closer

87
00:03:39,589 --> 00:03:38,480
to us than the distance we have right

88
00:03:41,190 --> 00:03:39,599

here

89
00:03:43,270 --> 00:03:41,200
exactly we want to keep an eye on all of

90
00:03:44,630 --> 00:03:43,280
the these asteroids especially the large

91
00:03:46,390 --> 00:03:44,640
ones and

92
00:03:48,550 --> 00:03:46,400
we don't know of any

93
00:03:49,830 --> 00:03:48,560
uh asteroids that have a significant

94
00:03:51,670 --> 00:03:49,840
chance of hitting the earth right now

95
00:03:53,670 --> 00:03:51,680
but we calculate the orbits for all of

96
00:03:55,670 --> 00:03:53,680
them and project them into the future so

97
00:03:57,830 --> 00:03:55,680
we're familiar with this particular

98
00:03:59,589 --> 00:03:57,840
asteroid do we know what it's made of

99
00:04:01,589 --> 00:03:59,599
what are some of the characteristics

100
00:04:03,990 --> 00:04:01,599
things like that yes this uh this

101
00:04:05,589 --> 00:04:04,000
asteroid is what we call a c type and we

102
00:04:07,990 --> 00:04:05,599
think that is associated with

103
00:04:10,149 --> 00:04:08,000
carbonaceous chondrite meteorites so we

104
00:04:12,470 --> 00:04:10,159
have an example of a carbonaceous

105
00:04:14,229 --> 00:04:12,480
chondrite meteorite it's very dark this

106
00:04:16,870 --> 00:04:14,239
the outer crust of course is black as

107
00:04:18,789 --> 00:04:16,880
many meteorites are but even the inside

108
00:04:21,909 --> 00:04:18,799
is very dark indeed it's a very

109
00:04:24,469 --> 00:04:21,919
primitive type of meteorite formed in

110
00:04:26,710 --> 00:04:24,479
the outer solar system it has amino

111
00:04:28,950 --> 00:04:26,720
acids in it organic compounds and a lot

112
00:04:31,990 --> 00:04:28,960
of carbon which makes it dark so it is a

113
00:04:34,550 --> 00:04:32,000

very dark object all right so we have

114
00:04:36,469 --> 00:04:34,560
been briefed a little bit on qe2 and

115
00:04:38,550 --> 00:04:36,479
let's go ahead and speak to some folks

116
00:04:41,909 --> 00:04:38,560
who have actually seen it

117
00:04:44,710 --> 00:04:41,919
qe2 was discovered 15 years ago in a

118
00:04:47,350 --> 00:04:44,720
survey using optical telescopes and the

119
00:04:49,670 --> 00:04:47,360
south african astronomical observatory

120
00:04:51,590 --> 00:04:49,680
in sutherland is a

121
00:04:54,310 --> 00:04:51,600
optical telescope it's used for

122
00:04:57,189 --> 00:04:54,320
education and also research and on the

123
00:04:59,990 --> 00:04:57,199
line right now is nick loring she is one

124
00:05:01,590 --> 00:05:00,000
of the astronomers at that facility nick

125
00:05:03,270 --> 00:05:01,600
what do you see what did you see last

126
00:05:08,070 --> 00:05:03,280
night

127
00:05:09,990 --> 00:05:08,080
saw the asteroid

128
00:05:12,150 --> 00:05:10,000
so what we could see was we could see a

129
00:05:14,550 --> 00:05:12,160
few background styles which were just

130
00:05:15,510 --> 00:05:14,560
like white specks of light which weren't

131
00:05:17,909 --> 00:05:15,520
moving

132
00:05:19,830 --> 00:05:17,919
and then we actually saw this white star

133
00:05:23,189 --> 00:05:19,840
that looked like a star moving across

134
00:05:24,550 --> 00:05:23,199
the field just very very slowly and um

135
00:05:26,230 --> 00:05:24,560
we we knew immediately that was the

136
00:05:27,749 --> 00:05:26,240
asteroid because it was moving against

137
00:05:30,150 --> 00:05:27,759
the the background of the stationary

138
00:05:31,990 --> 00:05:30,160

stars so so it just looked like a white

139
00:05:33,590 --> 00:05:32,000
dot it actually looked like a star it's

140
00:05:34,870 --> 00:05:33,600
just so we could tell it wasn't a star

141
00:05:37,270 --> 00:05:34,880
because it was moving relative to the

142
00:05:39,430 --> 00:05:37,280
background stars was this difficult to

143
00:05:44,310 --> 00:05:39,440
find

144
00:05:46,710 --> 00:05:44,320
because um the asteroids orbit has been

145
00:05:50,390 --> 00:05:46,720
it's been mapped very well and it's um

146
00:05:52,550 --> 00:05:50,400
we actually use jpl's web page to

147
00:05:54,469 --> 00:05:52,560
find the coordinates at a specific time

148
00:05:56,469 --> 00:05:54,479
point at the telescope at the at the

149
00:05:59,270 --> 00:05:56,479
coordinates and there it was right right

150
00:06:01,830 --> 00:05:59,280
in the middle well that's uh paul the uh

151
00:06:03,670 --> 00:06:01,840
nick mentioned that she used jpl's

152
00:06:05,590 --> 00:06:03,680
website to help her with the coordinates

153
00:06:06,469 --> 00:06:05,600
could you talk a little bit about that

154
00:06:08,150 --> 00:06:06,479
well

155
00:06:10,230 --> 00:06:08,160
asteroids are

156
00:06:12,230 --> 00:06:10,240
observed by astronomers around the world

157
00:06:13,510 --> 00:06:12,240
and all of the data is collected into a

158
00:06:15,350 --> 00:06:13,520
large set of

159
00:06:17,029 --> 00:06:15,360
observations which we then use to

160
00:06:18,950 --> 00:06:17,039
calculate an orbit and run it into the

161
00:06:21,110 --> 00:06:18,960
future and so we can

162
00:06:23,749 --> 00:06:21,120
predict where she should look to find

163
00:06:25,590 --> 00:06:23,759

this asteroid and uh we know pretty well

164
00:06:27,189 --> 00:06:25,600
pretty accurately where it is so the if

165
00:06:28,950 --> 00:06:27,199
the predictions you get from our website

166
00:06:31,029 --> 00:06:28,960
on the orbital elements and where to

167
00:06:33,189 --> 00:06:31,039
look are quite accurate we're glad to

168
00:06:35,110 --> 00:06:33,199
hear that was helpful nick and now how

169
00:06:38,550 --> 00:06:35,120
are people reacting to this are they

170
00:06:40,070 --> 00:06:38,560
very enthused and excited

171
00:06:41,670 --> 00:06:40,080
absolutely yeah people are really

172
00:06:43,909 --> 00:06:41,680
excited because i think it's just nice

173
00:06:45,350 --> 00:06:43,919
when you can actually see something um

174
00:06:47,270 --> 00:06:45,360
for your with your own eyes you know

175
00:06:49,029 --> 00:06:47,280
when when when we talk about our stories

176
00:06:51,029 --> 00:06:49,039
we think of things far away in space

177
00:06:52,550 --> 00:06:51,039
that we can't see and now all of a

178
00:06:55,350 --> 00:06:52,560
sudden they can actually watch the

179
00:06:58,309 --> 00:06:55,360
asteroid moving for themselves so we've

180
00:07:01,430 --> 00:06:58,319
had um quite a lot of um interest on our

181
00:07:03,430 --> 00:07:01,440
facebook and twitter sites and the press

182
00:07:04,629 --> 00:07:03,440
and media and family and friends you

183
00:07:06,710 --> 00:07:04,639
know we share we're sharing the

184
00:07:09,589 --> 00:07:06,720
information on facebook and we're

185
00:07:10,710 --> 00:07:09,599
getting so many sort of uh comments and

186
00:07:13,110 --> 00:07:10,720
people are really we are really

187
00:07:15,430 --> 00:07:13,120
enthusiastic so nick we have to explain

188
00:07:17,830 --> 00:07:15,440

to the audience we really were planning

189
00:07:19,430 --> 00:07:17,840
to have a view of this live but

190
00:07:21,189 --> 00:07:19,440
apparently weather is not good over

191
00:07:22,309 --> 00:07:21,199
there i understand

192
00:07:23,990 --> 00:07:22,319
yeah

193
00:07:25,749 --> 00:07:24,000
unfortunately the weather is not playing

194
00:07:27,589 --> 00:07:25,759
along tonight we had a lovely clear

195
00:07:28,710 --> 00:07:27,599
night yesterday we got some really good

196
00:07:30,629 --> 00:07:28,720
footage

197
00:07:33,589 --> 00:07:30,639
and tonight unfortunately we've been in

198
00:07:35,350 --> 00:07:33,599
and out of cloud and just prior to um

199
00:07:37,029 --> 00:07:35,360
the start of the program it's really

200
00:07:39,430 --> 00:07:37,039
clouded up for us so we've just been

201
00:07:42,830 --> 00:07:39,440
unlucky unfortunately but that's how it

202
00:07:44,550 --> 00:07:42,840
goes it's it's part of the territory i

203
00:07:45,909 --> 00:07:44,560
understand

204
00:07:48,230 --> 00:07:45,919
part of the package of being an

205
00:07:49,749 --> 00:07:48,240
astronomer is sitting up in the mountain

206
00:07:51,589 --> 00:07:49,759
in the freezing cold

207
00:07:53,430 --> 00:07:51,599
you know under cloud

208
00:07:55,830 --> 00:07:53,440
all right well thank you so much that

209
00:07:58,469 --> 00:07:55,840
was nick loring she is with the south

210
00:08:01,110 --> 00:07:58,479
african astronomical observatory in

211
00:08:04,070 --> 00:08:01,120
sutherland south africa thank you very

212
00:08:06,469 --> 00:08:04,080
very much for helping us out today

213
00:08:09,749 --> 00:08:06,479

well for astronomers using

214
00:08:12,309 --> 00:08:09,759
optical telescopes 1998 qe2 is faint

215
00:08:16,150 --> 00:08:12,319
it's far away it's not very exciting but

216
00:08:18,629 --> 00:08:16,160
for radar astronomers qe2 is outstanding

217
00:08:22,629 --> 00:08:18,639
with radar they have image resolution of

218
00:08:24,790 --> 00:08:22,639
about 12 feet on an object 3.6 million

219
00:08:26,550 --> 00:08:24,800
miles away and by the time they're

220
00:08:29,510 --> 00:08:26,560
through with this observation they'll

221
00:08:36,149 --> 00:08:29,520
have a better idea of qe2's orbit its

222
00:08:41,750 --> 00:08:39,350
1998 qe2 is going to make a relatively

223
00:08:44,389 --> 00:08:41,760
close approach to earth on may 31st the

224
00:08:46,310 --> 00:08:44,399
orbit for this object is very well known

225
00:08:48,710 --> 00:08:46,320
it'll be to the south rising in the

226
00:08:50,949 --> 00:08:48,720
southeast setting in the southwest

227
00:08:52,949 --> 00:08:50,959
in late may especially early june it'll

228
00:08:55,350 --> 00:08:52,959
reach a visual magnitude of about 10 and

229
00:08:57,590 --> 00:08:55,360
a half to 11 and that means that amateur

230
00:08:58,949 --> 00:08:57,600
astronomers who have four or six-inch

231
00:09:00,949 --> 00:08:58,959
telescopes

232
00:09:03,509 --> 00:09:00,959
could potentially see it

233
00:09:06,389 --> 00:09:03,519
it is going to come within 15 lunar

234
00:09:08,470 --> 00:09:06,399
distances about 15 times the distance

235
00:09:11,190 --> 00:09:08,480
between the earth and the moon although

236
00:09:13,509 --> 00:09:11,200
it is labeled as a potentially hazardous

237
00:09:15,750 --> 00:09:13,519
asteroid what that really means is that

238
00:09:17,269 --> 00:09:15,760

its orbit can approach within a certain

239
00:09:18,550 --> 00:09:17,279
distance of the earth's orbit for the

240
00:09:19,910 --> 00:09:18,560
foreseeable future there's nothing to

241
00:09:22,310 --> 00:09:19,920
worry about i mean it's far more

242
00:09:24,150 --> 00:09:22,320
dangerous to walk across the street the

243
00:09:26,470 --> 00:09:24,160
asteroid is believed to be about 1.7

244
00:09:28,550 --> 00:09:26,480
miles in diameter that is about 9 qe2

245
00:09:32,310 --> 00:09:28,560
cruise ships end to end

246
00:09:34,870 --> 00:09:32,320
rotates with 5.3 hours and we know it's

247
00:09:36,949 --> 00:09:34,880
likely rounded even the most powerful

248
00:09:38,949 --> 00:09:36,959
optical telescopes and i'm talking even

249
00:09:41,110 --> 00:09:38,959
in a hubble telescope they can only see

250
00:09:43,670 --> 00:09:41,120
this asteroid as a point of light it is

251
00:09:46,070 --> 00:09:43,680
just too far and too small radar is a

252
00:09:49,829 --> 00:09:46,080
very powerful instrument that we use to

253
00:09:51,910 --> 00:09:49,839
study near-earth asteroids

254
00:09:53,990 --> 00:09:51,920
was millions of kilometers away

255
00:09:56,470 --> 00:09:54,000
and we were able to resolve surface

256
00:09:57,670 --> 00:09:56,480
rocks we could see boulders

257
00:09:58,949 --> 00:09:57,680
there are currently only two radar

258
00:10:01,110 --> 00:09:58,959
facilities in the world that have

259
00:10:03,030 --> 00:10:01,120
sufficient sensitivity for doing regular

260
00:10:05,430 --> 00:10:03,040
observations of near-earth objects

261
00:10:07,110 --> 00:10:05,440
arecibo and goldstone it provides an

262
00:10:09,030 --> 00:10:07,120
extraordinary opportunity to get very

263
00:10:11,269 --> 00:10:09,040

detailed radar images you are

264
00:10:13,509 --> 00:10:11,279
transmitting microwaves it's propagating

265
00:10:16,069 --> 00:10:13,519
at a speed of light toward the asteroid

266
00:10:18,150 --> 00:10:16,079
it is bouncing back

267
00:10:20,230 --> 00:10:18,160
and this radar echo is containing

268
00:10:22,230 --> 00:10:20,240
surface features of the asteroid it's

269
00:10:24,710 --> 00:10:22,240
telling us about its rotation

270
00:10:27,269 --> 00:10:24,720
and it's very precisely pinpointing its

271
00:10:29,509 --> 00:10:27,279
distance from the radar

272
00:10:31,030 --> 00:10:29,519
this is a great opportunity because

273
00:10:33,829 --> 00:10:31,040
instead of sending a spacecraft to an

274
00:10:35,590 --> 00:10:33,839
asteroid you are on earth an asteroid is

275
00:10:37,350 --> 00:10:35,600
coming to you we think we're going to

276
00:10:38,870 --> 00:10:37,360
see images that will rival the caliber

277
00:10:39,990 --> 00:10:38,880
of what we can get from a spacecraft fly

278
00:10:41,750 --> 00:10:40,000
by mission

279
00:10:44,550 --> 00:10:41,760
they really should be that detailed and

280
00:10:46,150 --> 00:10:44,560
opportunities like that

281
00:10:47,750 --> 00:10:46,160
they sometimes happen a few times a year

282
00:10:50,710 --> 00:10:47,760
but this is the best one that we know of

283
00:10:57,910 --> 00:10:53,509
and last night goldstone's 70 meter

284
00:11:00,389 --> 00:10:57,920
antenna also known as dss 14 was moved

285
00:11:03,990 --> 00:11:00,399
into position and pointed at asteroid

286
00:11:06,389 --> 00:11:04,000
1998 qe2 and as we heard it's one of two

287
00:11:08,949 --> 00:11:06,399
telescopes in the world that are large

288
00:11:11,509 --> 00:11:08,959

enough and with transmitters powerful

289
00:11:14,710 --> 00:11:11,519
enough to observe asteroids so last

290
00:11:17,350 --> 00:11:14,720
night dss 14 sent out a radar signal

291
00:11:19,590 --> 00:11:17,360
from the antenna the energy bounced off

292
00:11:21,829 --> 00:11:19,600
the asteroid and was received by the

293
00:11:24,470 --> 00:11:21,839
same antenna and then processed into

294
00:11:26,949 --> 00:11:24,480
images images like these they don't look

295
00:11:29,430 --> 00:11:26,959
like pictures on your regular digital

296
00:11:31,670 --> 00:11:29,440
camera there are more like ultrasound

297
00:11:33,509 --> 00:11:31,680
images the principles are quite similar

298
00:11:35,829 --> 00:11:33,519
they don't look like regular pictures

299
00:11:38,150 --> 00:11:35,839
but you can still see things and

300
00:11:40,389 --> 00:11:38,160
recognize things right now radar

301
00:11:42,710 --> 00:11:40,399
scientist marina brosovich is part of

302
00:11:44,710 --> 00:11:42,720
that observation team and she is at

303
00:11:46,870 --> 00:11:44,720
goldstone right now she was observing

304
00:11:49,590 --> 00:11:46,880
last night to give us the results hi

305
00:11:52,069 --> 00:11:49,600
marina hi how are you so how did it go

306
00:11:55,190 --> 00:11:52,079
last night well it was quite a bit of

307
00:11:57,509 --> 00:11:55,200
surprise so it turns out the 1998 qe2 is

308
00:11:59,910 --> 00:11:57,519
a binary asteroid

309
00:12:01,829 --> 00:11:59,920
this is something that we did not expect

310
00:12:03,110 --> 00:12:01,839
especially i was looking at this earlier

311
00:12:05,509 --> 00:12:03,120
footage and we have to make some

312
00:12:06,790 --> 00:12:05,519
revisions to that period of rotation

313
00:12:08,949 --> 00:12:06,800

so initially we thought that it's

314
00:12:10,790 --> 00:12:08,959
rotating with a period of 5.3 hours

315
00:12:12,790 --> 00:12:10,800
because that was what was reported to us

316
00:12:14,629 --> 00:12:12,800
by the uh from by the optical observers

317
00:12:17,509 --> 00:12:14,639
and based on the light curves

318
00:12:18,710 --> 00:12:17,519
but in for such a type of rotation we

319
00:12:20,949 --> 00:12:18,720
really don't expect to see any

320
00:12:22,310 --> 00:12:20,959
satellites uh we're talking this one

321
00:12:24,470 --> 00:12:22,320
turned out to be

322
00:12:26,629 --> 00:12:24,480
rotating probably much more rapidly

323
00:12:28,470 --> 00:12:26,639
uh probably less than four hours

324
00:12:31,030 --> 00:12:28,480
and the first thing we see there's this

325
00:12:33,750 --> 00:12:31,040
uh object and it has a satellite well we

326
00:12:36,710 --> 00:12:33,760
have the still pictures that we can show

327
00:12:40,069 --> 00:12:36,720
folks um and you can see the different

328
00:12:42,230 --> 00:12:40,079
frames and a very light small object in

329
00:12:44,949 --> 00:12:42,240
front of it

330
00:12:47,590 --> 00:12:44,959
yes so what you can see here this larger

331
00:12:49,910 --> 00:12:47,600
uh the the larger object on the screen

332
00:12:51,829 --> 00:12:49,920
that is the primary that is the primary

333
00:12:54,069 --> 00:12:51,839
and then this little bright speck of

334
00:12:55,829 --> 00:12:54,079
light over here in the back that is the

335
00:12:58,389 --> 00:12:55,839
satellite and the satellite is in its

336
00:13:00,550 --> 00:12:58,399
orbit around around its primary uh like

337
00:13:02,550 --> 00:13:00,560
the moon would go around the earth

338
00:13:04,069 --> 00:13:02,560

so what you are seeing over here these

339
00:13:05,509 --> 00:13:04,079
are radar images they are different than

340
00:13:06,870 --> 00:13:05,519
optical images

341
00:13:09,590 --> 00:13:06,880
and

342
00:13:11,910 --> 00:13:09,600
each frame is a snippet about 10 minutes

343
00:13:14,230 --> 00:13:11,920
of data and you can clearly see that

344
00:13:16,629 --> 00:13:14,240
both the primary the these kind of

345
00:13:18,829 --> 00:13:16,639
features on the primary this kind of

346
00:13:22,150 --> 00:13:18,839
radar dark spot is

347
00:13:24,389 --> 00:13:22,160
rotating it's it's rotating as the this

348
00:13:26,870 --> 00:13:24,399
time sequence is progressing and at the

349
00:13:30,069 --> 00:13:26,880
same time what you're seeing is that the

350
00:13:32,470 --> 00:13:30,079
um the satellite is moving

351
00:13:35,190 --> 00:13:32,480
more toward the back so it's moving away

352
00:13:38,310 --> 00:13:35,200
from from the asteroid now where this is

353
00:13:40,389 --> 00:13:38,320
really evident is when you put it into a

354
00:13:45,030 --> 00:13:40,399
movie form and we can show folks that

355
00:13:48,150 --> 00:13:46,629
there you see it yeah you can clearly

356
00:13:50,710 --> 00:13:48,160
see you can see the evidence of the

357
00:13:52,710 --> 00:13:50,720
rotation of the primary because uh this

358
00:13:55,189 --> 00:13:52,720
is i have to say that this these um

359
00:13:57,430 --> 00:13:55,199
resolution of these images is 75 meters

360
00:13:59,350 --> 00:13:57,440
per pixel so we still haven't reached

361
00:14:00,829 --> 00:13:59,360
our highest possible resolution because

362
00:14:04,310 --> 00:14:00,839
the object is still a little bit far

363
00:14:06,069 --> 00:14:04,320

away but even at a 75 meter resolution

364
00:14:08,629 --> 00:14:06,079
what we can see is there's cert there

365
00:14:10,870 --> 00:14:08,639
are clearly some radar dark features

366
00:14:12,629 --> 00:14:10,880
some concavities maybe

367
00:14:14,389 --> 00:14:12,639
maybe those are impact craters or

368
00:14:16,629 --> 00:14:14,399
something but we can't know this for

369
00:14:18,550 --> 00:14:16,639
sure and we definitely can see that

370
00:14:21,189 --> 00:14:18,560
there is a satellite we estimate the

371
00:14:23,910 --> 00:14:21,199
size of the primary was was right on so

372
00:14:26,389 --> 00:14:23,920
this was it's about 2.7 kilometer in

373
00:14:28,629 --> 00:14:26,399
diameter and the satellite is about 600

374
00:14:31,189 --> 00:14:28,639
meters in diameter so this satellite

375
00:14:31,990 --> 00:14:31,199
appears to be small on the radar image

376
00:14:33,750 --> 00:14:32,000
but

377
00:14:35,829 --> 00:14:33,760
it's not this is kind of this different

378
00:14:38,949 --> 00:14:35,839
dimension on horizontal axis it's a

379
00:14:39,829 --> 00:14:38,959
measure of how fast it rotates so this

380
00:14:41,990 --> 00:14:39,839
wide

381
00:14:44,310 --> 00:14:42,000
echo it just means that the primary is

382
00:14:45,430 --> 00:14:44,320
rotating really fast so period less than

383
00:14:47,670 --> 00:14:45,440
four hours

384
00:14:49,590 --> 00:14:47,680
and the little in the back the narrow

385
00:14:52,150 --> 00:14:49,600
echo just means that this asteroid is

386
00:14:55,829 --> 00:14:52,160
rotating really slowly probably periods

387
00:14:58,470 --> 00:14:55,839
of less than one day but many many hours

388
00:15:01,509 --> 00:14:58,480

well you sent us a video

389
00:15:03,829 --> 00:15:01,519
earlier today to give us an example you

390
00:15:05,990 --> 00:15:03,839
think that there are

391
00:15:09,189 --> 00:15:06,000
great similarities between

392
00:15:10,949 --> 00:15:09,199
qe2 and another asteroid that you have

393
00:15:13,670 --> 00:15:10,959
and we can roll that too

394
00:15:15,030 --> 00:15:13,680
yes well so far we know that about 16

395
00:15:16,949 --> 00:15:15,040
of asteroids in the near-earth

396
00:15:19,829 --> 00:15:16,959
population that have diameters greater

397
00:15:22,470 --> 00:15:19,839
than 200 meters we know they're binaries

398
00:15:24,310 --> 00:15:22,480
and this is uh one well-studied binary

399
00:15:26,870 --> 00:15:24,320
that's based on our construction of

400
00:15:28,310 --> 00:15:26,880
radar data and when you reconstruct what

401
00:15:30,389 --> 00:15:28,320
greater data really means you end up

402
00:15:34,230 --> 00:15:30,399
with this three-dimensional shape model

403
00:15:35,670 --> 00:15:34,240
and this is asteroid 1999 kw-4

404
00:15:38,389 --> 00:15:35,680
and it's one of the best studies

405
00:15:40,550 --> 00:15:38,399
binaries you see its primary rotating

406
00:15:42,150 --> 00:15:40,560
really rapidly and then you see the

407
00:15:43,829 --> 00:15:42,160
satellite

408
00:15:45,829 --> 00:15:43,839
that is that is in the orbit around

409
00:15:47,749 --> 00:15:45,839
around this primary

410
00:15:50,230 --> 00:15:47,759
the reason why these the binary

411
00:15:52,389 --> 00:15:50,240
asteroids are so important is because we

412
00:15:53,590 --> 00:15:52,399
can estimate the mass of the of the

413
00:15:55,509 --> 00:15:53,600

asteroids

414
00:15:57,269 --> 00:15:55,519
and if you know the size then you can

415
00:15:59,670 --> 00:15:57,279
estimate the density and you can

416
00:16:01,590 --> 00:15:59,680
estimate the internal structure

417
00:16:02,629 --> 00:16:01,600
and from here you can

418
00:16:04,310 --> 00:16:02,639
infer

419
00:16:06,629 --> 00:16:04,320
things about the collisional history of

420
00:16:09,509 --> 00:16:06,639
the asteroid and in general about the

421
00:16:11,749 --> 00:16:09,519
processes that shaped the

422
00:16:14,069 --> 00:16:11,759
terrestrial planets and the main belt

423
00:16:16,790 --> 00:16:14,079
asteroids so you're able to get more

424
00:16:19,189 --> 00:16:16,800
information this is information that be

425
00:16:21,509 --> 00:16:19,199
could be used for missions i i

426
00:16:23,590 --> 00:16:21,519
understand that we used radar

427
00:16:26,069 --> 00:16:23,600
information to help us with missions

428
00:16:28,230 --> 00:16:26,079
like the hartley 2 mission in fact

429
00:16:30,710 --> 00:16:28,240
yes that is correct we we frequently we

430
00:16:33,350 --> 00:16:30,720
several on several occasions we radar

431
00:16:35,910 --> 00:16:33,360
provided a really key kind of data that

432
00:16:37,590 --> 00:16:35,920
helped make the mission kind of up they

433
00:16:39,670 --> 00:16:37,600
optimize their

434
00:16:41,749 --> 00:16:39,680
navigation sequence

435
00:16:43,590 --> 00:16:41,759
and they they just plan the it's

436
00:16:45,990 --> 00:16:43,600
possible to plan much safer and more

437
00:16:48,550 --> 00:16:46,000
efficient mission if you

438
00:16:51,590 --> 00:16:48,560

know how the object looks like prior of

439
00:16:53,910 --> 00:16:51,600
getting there and people are always

440
00:16:56,310 --> 00:16:53,920
concerned about the orbit of these

441
00:16:58,870 --> 00:16:56,320
asteroids that they could be on a

442
00:17:01,030 --> 00:16:58,880
collision course with the earth and

443
00:17:02,790 --> 00:17:01,040
there are times where we think oh it

444
00:17:04,230 --> 00:17:02,800
looks like it but then as we get more

445
00:17:06,230 --> 00:17:04,240
and more information like the

446
00:17:08,470 --> 00:17:06,240
information we're getting today we can

447
00:17:10,470 --> 00:17:08,480
refine those orbits and we will be able

448
00:17:12,069 --> 00:17:10,480
to refine it again after this

449
00:17:13,750 --> 00:17:12,079
observation correct

450
00:17:16,470 --> 00:17:13,760
yeah that is correct so one of the one

451
00:17:18,309 --> 00:17:16,480
of the really kind of powers of radar is

452
00:17:20,710 --> 00:17:18,319
that it can it can locate where the

453
00:17:22,150 --> 00:17:20,720
asteroid is very precisely it provides

454
00:17:24,949 --> 00:17:22,160
this very tight

455
00:17:26,630 --> 00:17:24,959
uh tight point in its orbit and refines

456
00:17:29,029 --> 00:17:26,640
it and based on that you can kind of

457
00:17:31,590 --> 00:17:29,039
extend you can extend the orbit of that

458
00:17:36,470 --> 00:17:33,590
centuries in advance and you can know

459
00:17:38,870 --> 00:17:36,480
exactly you can better assess the risk

460
00:17:40,870 --> 00:17:38,880
and the risk of potentially the asteroid

461
00:17:42,549 --> 00:17:40,880
hitting the earth well before you go

462
00:17:45,750 --> 00:17:42,559
away marina we have a couple of

463
00:17:47,590 --> 00:17:45,760

questions from the social media audience

464
00:17:49,909 --> 00:17:47,600
these are questions that were posted on

465
00:17:51,990 --> 00:17:49,919
our twitter page for asteroid watch and

466
00:17:54,230 --> 00:17:52,000
here's one that's for you

467
00:17:57,510 --> 00:17:54,240
what is the frequency of the radar that

468
00:18:00,390 --> 00:17:57,520
you use and how big is your transmitter

469
00:18:02,150 --> 00:18:00,400
transceiver and where is it located

470
00:18:04,310 --> 00:18:02,160
okay so we have we're working with the

471
00:18:06,390 --> 00:18:04,320
two radars they're only currently we are

472
00:18:08,470 --> 00:18:06,400
working with the radar at our sibo we

473
00:18:10,789 --> 00:18:08,480
are working radar at gallstone so

474
00:18:13,270 --> 00:18:10,799
goldstone this is a 70 meter antenna

475
00:18:16,549 --> 00:18:13,280
it's transmitting at

476
00:18:17,590 --> 00:18:16,559
60 megahertz we have 500 kilowatts of

477
00:18:20,310 --> 00:18:17,600
power

478
00:18:21,750 --> 00:18:20,320
and then at our sibo we have 300 meter

479
00:18:24,230 --> 00:18:21,760
diameter dish

480
00:18:25,990 --> 00:18:24,240
and that one is a one megawatt power

481
00:18:29,750 --> 00:18:26,000
transmitter and it's transmitting in

482
00:18:31,909 --> 00:18:29,760
2380 megahertz our sibo is about 20

483
00:18:33,830 --> 00:18:31,919
times more sensitive than goldstone but

484
00:18:35,990 --> 00:18:33,840
goldstone can cover much more in the sky

485
00:18:37,909 --> 00:18:36,000
because we have fully steerable antenna

486
00:18:39,590 --> 00:18:37,919
so in effect these two systems are

487
00:18:41,270 --> 00:18:39,600
really complementary

488
00:18:44,230 --> 00:18:41,280

all right here's another question from

489
00:18:45,110 --> 00:18:44,240
asteroid watch is the radar a ground

490
00:18:48,310 --> 00:18:45,120
brace

491
00:18:51,909 --> 00:18:48,320
a ground base or space radar to track

492
00:18:56,470 --> 00:18:54,390
well well space radars are used all

493
00:18:58,390 --> 00:18:56,480
being constantly in the missions but

494
00:19:00,230 --> 00:18:58,400
kind of just to get the science data but

495
00:19:02,870 --> 00:19:00,240
it's really not necessary

496
00:19:05,669 --> 00:19:02,880
uh to have a kind of space radar

497
00:19:07,590 --> 00:19:05,679
uh we we already are doing quite a bit

498
00:19:11,029 --> 00:19:07,600
of work with these two

499
00:19:13,430 --> 00:19:11,039
radars that we have on earth all right

500
00:19:15,830 --> 00:19:13,440
so those are two questions from asteroid

501
00:19:17,270 --> 00:19:15,840
watch and if you also have questions

502
00:19:19,669 --> 00:19:17,280
yourself that you would want to send

503
00:19:23,909 --> 00:19:19,679
them in to us go ahead to our twitter

504
00:19:26,310 --> 00:19:23,919
page at asteroid watch twitter.com slash

505
00:19:27,990 --> 00:19:26,320
asteroid watch thanks marina we look

506
00:19:31,270 --> 00:19:28,000
forward to seeing more results on this

507
00:19:33,590 --> 00:19:31,280
data 1998 qe2 should be a great radar

508
00:19:35,830 --> 00:19:33,600
target from today all the way through

509
00:19:39,510 --> 00:19:35,840
june 9. thanks marina thank you very

510
00:19:42,310 --> 00:19:39,520
much and as we mentioned seeing 1998 qe2

511
00:19:44,549 --> 00:19:42,320
can be a challenge it is small it is

512
00:19:46,549 --> 00:19:44,559
faint and it moves slowly you won't be

513
00:19:49,669 --> 00:19:46,559

able to see the asteroid with the naked

514
00:19:52,710 --> 00:19:49,679
eye or even binoculars because it's 15

515
00:19:54,789 --> 00:19:52,720
times as far away as the moon but if you

516
00:19:57,590 --> 00:19:54,799
have the right telescope and nowhere to

517
00:19:59,270 --> 00:19:57,600
look backyard astronomers will be able

518
00:20:01,909 --> 00:19:59,280
to see it and that's why we pulled in

519
00:20:03,750 --> 00:20:01,919
steve whistler steve is a jpl system

520
00:20:06,789 --> 00:20:03,760
engineer that's worked on missions like

521
00:20:08,710 --> 00:20:06,799
deep impact and epoxy and he's also a

522
00:20:12,230 --> 00:20:08,720
trained astronomer who works with the

523
00:20:14,310 --> 00:20:12,240
amateur community now steve you spotted

524
00:20:16,230 --> 00:20:14,320
qe2 yourself yesterday on your own

525
00:20:17,510 --> 00:20:16,240
telescope that's right i set it up last

526
00:20:19,669 --> 00:20:17,520
night and

527
00:20:23,590 --> 00:20:19,679
fortunately i had clear weather and i

528
00:20:26,710 --> 00:20:23,600
got about 40 minutes worth of imaging

529
00:20:28,310 --> 00:20:26,720
out of it and uh yeah so it's definitely

530
00:20:30,870 --> 00:20:28,320
possible to see with a small amateur

531
00:20:32,310 --> 00:20:30,880
telescope even from a

532
00:20:33,510 --> 00:20:32,320
near jpl here where there's a lot of

533
00:20:35,190 --> 00:20:33,520
light pollution

534
00:20:36,470 --> 00:20:35,200
we have the picture that you sent us we

535
00:20:39,590 --> 00:20:36,480
could put it up

536
00:20:41,190 --> 00:20:39,600
this this the small little smudge there

537
00:20:43,909 --> 00:20:41,200
is the asteroid

538
00:20:44,950 --> 00:20:43,919

there's a reference star that i

539
00:20:47,430 --> 00:20:44,960
put in there

540
00:20:49,190 --> 00:20:47,440
but it was it was fairly easy to set up

541
00:20:50,950 --> 00:20:49,200
and see you need to

542
00:20:53,029 --> 00:20:50,960
know where to look and the best way to

543
00:20:55,590 --> 00:20:53,039
find out is to download the coordinates

544
00:20:57,669 --> 00:20:55,600
from jpl's horizon website i entered

545
00:20:59,830 --> 00:20:57,679
them into my computer and told the

546
00:21:02,390 --> 00:20:59,840
telescope to point there so let's back

547
00:21:04,549 --> 00:21:02,400
up a little bit so how bright was it

548
00:21:05,909 --> 00:21:04,559
this is 11th magnitude so it's about 100

549
00:21:07,190 --> 00:21:05,919
times fainter than can be seen with the

550
00:21:08,549 --> 00:21:07,200
naked eye

551
00:21:11,029 --> 00:21:08,559
this is what you wouldn't be able to see

552
00:21:12,950 --> 00:21:11,039
in binoculars either and again it moves

553
00:21:14,549 --> 00:21:12,960
so slowly it would be very hard to see

554
00:21:17,350 --> 00:21:14,559
visually just looking through the

555
00:21:19,029 --> 00:21:17,360
telescope the the image there was 30

556
00:21:22,870 --> 00:21:19,039
seconds and so there was just a very

557
00:21:24,149 --> 00:21:22,880
smooth smudge in 30 seconds so

558
00:21:26,470 --> 00:21:24,159
photographically it's much more

559
00:21:28,789 --> 00:21:26,480
interesting well folks will want to ask

560
00:21:31,190 --> 00:21:28,799
what size telescope did you use i used a

561
00:21:33,270 --> 00:21:31,200
10 10-inch telescope we have pictures of

562
00:21:34,070 --> 00:21:33,280
of ones here too as well that we can cut

563
00:21:41,510 --> 00:21:34,080

to

564
00:21:42,789 --> 00:21:41,520
inches

565
00:21:44,390 --> 00:21:42,799
that is not a computer controlled

566
00:21:46,710 --> 00:21:44,400
telescope and would be relatively hard

567
00:21:48,549 --> 00:21:46,720
to find it in that in this case this one

568
00:21:50,470 --> 00:21:48,559
would be tough uh yes yeah you really

569
00:21:51,909 --> 00:21:50,480
need a good star chart to understand

570
00:21:53,750 --> 00:21:51,919
what the background star field is going

571
00:21:55,669 --> 00:21:53,760
to look like and understand where the

572
00:21:59,270 --> 00:21:55,679
asteroid will be relative to those stars

573
00:22:01,350 --> 00:21:59,280
and then it's it's not too hard to do so

574
00:22:03,669 --> 00:22:01,360
to help folks along we could provide

575
00:22:05,270 --> 00:22:03,679
them a little bit of a star chart we

576
00:22:07,190 --> 00:22:05,280
created one for them we can take a look

577
00:22:09,430 --> 00:22:07,200
and you can help them with this sure now

578
00:22:11,590 --> 00:22:09,440
this will show the path of the asteroid

579
00:22:13,909 --> 00:22:11,600
through the night sky it's basically

580
00:22:16,390 --> 00:22:13,919
it's got a southern declination so it's

581
00:22:18,149 --> 00:22:16,400
it is visible from los angeles tomorrow

582
00:22:19,909 --> 00:22:18,159
night it'll get as high as 37 degrees

583
00:22:21,669 --> 00:22:19,919
above the horizon the further south you

584
00:22:23,510 --> 00:22:21,679
go the better further north it's going

585
00:22:25,830 --> 00:22:23,520
to be a little bit worse

586
00:22:27,350 --> 00:22:25,840
you would need a detailed star chart

587
00:22:28,950 --> 00:22:27,360
with the surrounding

588
00:22:30,470 --> 00:22:28,960

stars that you would be able to see from

589
00:22:31,909 --> 00:22:30,480
your telescope in order to really pick

590
00:22:33,750 --> 00:22:31,919
it out and understand where it is

591
00:22:34,870 --> 00:22:33,760
relative to the stars because it is

592
00:22:36,230 --> 00:22:34,880
going to look like a star even in the

593
00:22:39,110 --> 00:22:36,240
hubble space telescope it would look

594
00:22:41,510 --> 00:22:39,120
like a star how many days would we have

595
00:22:44,549 --> 00:22:41,520
this viewing opportunity uh that i am

596
00:22:45,830 --> 00:22:44,559
not sure of certainly a few more days um

597
00:22:48,870 --> 00:22:45,840
it would be

598
00:22:50,630 --> 00:22:48,880
visible so definitely look for it

599
00:22:52,470 --> 00:22:50,640
in the southern skies but again if you

600
00:22:54,230 --> 00:22:52,480
go to horizon's website or there's

601
00:22:55,590 --> 00:22:54,240
another another a number of other

602
00:22:57,190 --> 00:22:55,600
websites where you can download

603
00:22:59,990 --> 00:22:57,200
information that will tell you its

604
00:23:01,909 --> 00:23:00,000
position and magnitude for every day

605
00:23:04,230 --> 00:23:01,919
so a lot of people aren't aware of this

606
00:23:07,510 --> 00:23:04,240
that there are telescopes that you can

607
00:23:09,990 --> 00:23:07,520
just take this orbital information

608
00:23:11,110 --> 00:23:10,000
downloaded it into your telescope and

609
00:23:13,350 --> 00:23:11,120
computer

610
00:23:15,110 --> 00:23:13,360
and it looks for it for you that's right

611
00:23:17,909 --> 00:23:15,120
so where would you get information like

612
00:23:20,549 --> 00:23:17,919
that there's a number of sites that have

613
00:23:22,549 --> 00:23:20,559

the orbital elements again jpl's horizon

614
00:23:24,149 --> 00:23:22,559
website is what i used and there we have

615
00:23:29,750 --> 00:23:24,159
it on the screen for you is

616
00:23:29,760 --> 00:23:33,350
horizons.cgi

617
00:23:38,310 --> 00:23:35,590
and the target body that they type in is

618
00:23:43,350 --> 00:23:38,320
this number that is the jpl id for the

619
00:23:48,789 --> 00:23:46,149
so folks who probably are going to be

620
00:23:51,750 --> 00:23:48,799
pretty sophisticated have sophisticated

621
00:23:53,830 --> 00:23:51,760
computers and telescopes will be able to

622
00:23:55,669 --> 00:23:53,840
get amateur telescopes sold today have

623
00:23:57,830 --> 00:23:55,679
computer control of some sort all right

624
00:23:59,590 --> 00:23:57,840
but if you have one that you would have

625
00:24:02,630 --> 00:23:59,600
to focus yourself it's going to be a

626
00:24:04,710 --> 00:24:02,640
little tough yes okay so we have a

627
00:24:07,750 --> 00:24:04,720
couple of social media questions for you

628
00:24:10,870 --> 00:24:07,760
steve the first one is am i going to be

629
00:24:12,710 --> 00:24:10,880
able to see it in south florida oh yes

630
00:24:14,149 --> 00:24:12,720
actually probably better than probably

631
00:24:16,230 --> 00:24:14,159
better than here

632
00:24:19,269 --> 00:24:16,240
assuming it's not cloudy yeah all right

633
00:24:20,950 --> 00:24:19,279
so that so pretty much um

634
00:24:22,630 --> 00:24:20,960
all over the united states we should be

635
00:24:25,350 --> 00:24:22,640
able to see it yeah you know i really

636
00:24:27,110 --> 00:24:25,360
couldn't say for like san francisco and

637
00:24:29,110 --> 00:24:27,120
above again it's going to be really low

638
00:24:30,549 --> 00:24:29,120

on the rise in the further north you go

639
00:24:33,190 --> 00:24:30,559
but certainly from the southern united

640
00:24:37,269 --> 00:24:33,200
states it'll be easily visible all right

641
00:24:40,310 --> 00:24:37,279
um some other questions um

642
00:24:43,110 --> 00:24:40,320
this would be probably more towards

643
00:24:44,870 --> 00:24:43,120
folks who are worried about asteroids

644
00:24:47,830 --> 00:24:44,880
and i don't think that that would be

645
00:24:50,149 --> 00:24:47,840
good for you um just rules of thumb

646
00:24:52,310 --> 00:24:50,159
advice for people who want to do this

647
00:24:53,269 --> 00:24:52,320
especially first-timers

648
00:24:54,950 --> 00:24:53,279
should they

649
00:24:56,950 --> 00:24:54,960
go to

650
00:24:58,149 --> 00:24:56,960
you know various planetariums or

651
00:24:59,830 --> 00:24:58,159
something like that would that be

652
00:25:02,310 --> 00:24:59,840
helpful it's really helpful to join an

653
00:25:03,909 --> 00:25:02,320
astronomy club to to learn because

654
00:25:05,750 --> 00:25:03,919
talking to people and seeing how they do

655
00:25:09,269 --> 00:25:05,760
it is one of the best ways to learn uh

656
00:25:10,470 --> 00:25:09,279
this this hobby and websites too

657
00:25:12,789 --> 00:25:10,480
lots of great information on the

658
00:25:15,190 --> 00:25:12,799
websites

659
00:25:16,630 --> 00:25:15,200
as well all right yahoo groups those

660
00:25:19,510 --> 00:25:16,640
sorts of things

661
00:25:21,909 --> 00:25:19,520
i i should plug our own um normal

662
00:25:24,470 --> 00:25:21,919
feature we have a feature on our own

663
00:25:26,310 --> 00:25:24,480

video website here at jpl the what's up

664
00:25:28,230 --> 00:25:26,320
series that's correct every single month

665
00:25:30,390 --> 00:25:28,240
we will tell you what to look for in the

666
00:25:32,390 --> 00:25:30,400
night sky so that's another one to keep

667
00:25:35,350 --> 00:25:32,400
in mind well steve thank you thanks for

668
00:25:36,470 --> 00:25:35,360
the tips and the advice and many of you

669
00:25:38,390 --> 00:25:36,480
who have

670
00:25:41,110 --> 00:25:38,400
probably the more sophisticated

671
00:25:42,549 --> 00:25:41,120
telescopes will be able to see qe2

672
00:25:45,269 --> 00:25:42,559
so

673
00:25:47,510 --> 00:25:45,279
you will be able to see 1998 qe2 in your

674
00:25:49,990 --> 00:25:47,520
own backyard but some of you won't but

675
00:25:52,070 --> 00:25:50,000
don't despair we have one more way for

676
00:25:55,110 --> 00:25:52,080
you to track this asteroid it's a

677
00:25:57,430 --> 00:25:55,120
visualization tool developed here at jpl

678
00:25:59,590 --> 00:25:57,440
it is called eyes on the solar system

679
00:26:01,510 --> 00:25:59,600
visualization producer doug ellison is

680
00:26:05,430 --> 00:26:01,520
here in mission control right now to

681
00:26:07,269 --> 00:26:05,440
give folks tips on how to use it duck

682
00:26:09,029 --> 00:26:07,279
thanks gay well good morning everybody

683
00:26:10,870 --> 00:26:09,039
and some of you i'm sure have already

684
00:26:12,630 --> 00:26:10,880
used our tool called eyes on the solar

685
00:26:14,630 --> 00:26:12,640
system for those of you that haven't you

686
00:26:16,950 --> 00:26:14,640
need any java enabled web browser on a

687
00:26:20,870 --> 00:26:16,960
mac or a pc and you just need to go to

688
00:26:21,990 --> 00:26:20,880

this website here it's at eyes.nasa.gov

689
00:26:23,669 --> 00:26:22,000
now the next few minutes i'm going to

690
00:26:25,029 --> 00:26:23,679
give a brief tour of a few interesting

691
00:26:26,870 --> 00:26:25,039
things in eyes on the solar system you

692
00:26:28,230 --> 00:26:26,880
can look at over the next year or so and

693
00:26:31,190 --> 00:26:28,240
show you how you can ride on board with

694
00:26:32,310 --> 00:26:31,200
1998 qe2 as well over the next few days

695
00:26:34,230 --> 00:26:32,320
let's go and have a look at eyes on the

696
00:26:36,470 --> 00:26:34,240
solar system as you can see right here

697
00:26:38,710 --> 00:26:36,480
what we have is essentially a live view

698
00:26:40,870 --> 00:26:38,720
of where qe2 is right now using the very

699
00:26:42,789 --> 00:26:40,880
same trajectory data that steve was just

700
00:26:45,590 --> 00:26:42,799
talking about and you can see that it's

701
00:26:46,950 --> 00:26:45,600
about 3.6 million miles from the earth

702
00:26:49,269 --> 00:26:46,960
and we can take a look at the asteroid

703
00:26:50,950 --> 00:26:49,279
of course the news that qe2 has a small

704
00:26:52,870 --> 00:26:50,960
moon was a surprise to all of us and so

705
00:26:54,870 --> 00:26:52,880
we'll be adding that in the next few

706
00:26:57,669 --> 00:26:54,880
weeks to give qe2 the most accurate

707
00:26:58,789 --> 00:26:57,679
representation we can but let's leave

708
00:27:00,390 --> 00:26:58,799
this little module for now i'm going to

709
00:27:01,510 --> 00:27:00,400
look at some other things in and around

710
00:27:03,590 --> 00:27:01,520
our solar system that might be

711
00:27:05,190 --> 00:27:03,600
interesting things that people may not

712
00:27:07,269 --> 00:27:05,200
have figured out for themselves in eyes

713
00:27:09,190 --> 00:27:07,279

on the solar system before i'm going to

714
00:27:11,269 --> 00:27:09,200
go and click on the visual controls tab

715
00:27:13,029 --> 00:27:11,279
in the bottom right hand corner here and

716
00:27:14,630 --> 00:27:13,039
way up at the top under the different

717
00:27:16,149 --> 00:27:14,640
sections that kind of the layers of

718
00:27:17,669 --> 00:27:16,159
objects we have in eyes on the solar

719
00:27:19,590 --> 00:27:17,679
system there's a section called small

720
00:27:21,430 --> 00:27:19,600
bodies that's where we keep things like

721
00:27:23,350 --> 00:27:21,440
asteroids and comets now i'm going to

722
00:27:24,630 --> 00:27:23,360
turn on the comets layer and you can see

723
00:27:26,549 --> 00:27:24,640
eyes on the television gets actually

724
00:27:27,990 --> 00:27:26,559
quite busy you can see our old friend

725
00:27:30,310 --> 00:27:28,000
hartley too that we explored with the

726
00:27:32,630 --> 00:27:30,320
epoxy spacecraft comet ellen in over

727
00:27:34,149 --> 00:27:32,640
here halley's comment of course but two

728
00:27:36,070 --> 00:27:34,159
comments in particular can be very very

729
00:27:37,990 --> 00:27:36,080
exciting over the next year or so i'm

730
00:27:39,909 --> 00:27:38,000
going to go and look at comet ison you

731
00:27:41,909 --> 00:27:39,919
can see it's orbit here

732
00:27:43,590 --> 00:27:41,919
if we start fast forwarding through time

733
00:27:45,510 --> 00:27:43,600
we're looking at may this control down

734
00:27:47,350 --> 00:27:45,520
here we can actually skip forwards and

735
00:27:48,710 --> 00:27:47,360
now we're seeing common eyes on screen

736
00:27:50,070 --> 00:27:48,720
towards the inner solar system you can

737
00:27:51,830 --> 00:27:50,080
see right there

738
00:27:53,510 --> 00:27:51,840

in october of this year it actually gets

739
00:27:55,669 --> 00:27:53,520
pretty close to the planet mars let's go

740
00:27:57,110 --> 00:27:55,679
and see just how close that is we can

741
00:27:58,789 --> 00:27:57,120
double click on an object and ride on

742
00:28:00,310 --> 00:27:58,799
board with it i'm going to zoom out just

743
00:28:02,710 --> 00:28:00,320
a little bit so we can have a look at

744
00:28:04,630 --> 00:28:02,720
the coma around the comet and i can

745
00:28:06,630 --> 00:28:04,640
right click on any object in eyes on the

746
00:28:08,789 --> 00:28:06,640
solar system measure the distance from

747
00:28:10,230 --> 00:28:08,799
something click on something else and

748
00:28:12,230 --> 00:28:10,240
i've got a virtual tape measure through

749
00:28:13,750 --> 00:28:12,240
space that tells me how far apart these

750
00:28:15,830 --> 00:28:13,760
two objects are at this point you can

751
00:28:18,389 --> 00:28:15,840
see that mars and comet ice on in

752
00:28:20,230 --> 00:28:18,399
october of 2013 are about 10 million

753
00:28:21,590 --> 00:28:20,240
miles apart and they get within about 8

754
00:28:22,710 --> 00:28:21,600
million miles

755
00:28:24,149 --> 00:28:22,720
i'm going to back out to the whole of

756
00:28:25,909 --> 00:28:24,159
the solar system again with the home

757
00:28:27,190 --> 00:28:25,919
button and i'm going to keep fast

758
00:28:29,110 --> 00:28:27,200
forwarding and eventually you'll see

759
00:28:31,269 --> 00:28:29,120
comet ison get incredibly close to the

760
00:28:32,950 --> 00:28:31,279
sun it's an incredibly close flyby

761
00:28:35,430 --> 00:28:32,960
something known as a sun grazing comet

762
00:28:37,190 --> 00:28:35,440
it gets so close now if it survives that

763
00:28:39,029 --> 00:28:37,200

incredibly close approach to the sun

764
00:28:41,350 --> 00:28:39,039
it's going to be a spectacular comet for

765
00:28:42,950 --> 00:28:41,360
people to see from the earth at the end

766
00:28:44,789 --> 00:28:42,960
of this year and the beginning of next

767
00:28:46,389 --> 00:28:44,799
year now let's go look at a different

768
00:28:48,070 --> 00:28:46,399
asteroid

769
00:28:49,510 --> 00:28:48,080
a different comet what i'm going to look

770
00:28:51,350 --> 00:28:49,520
at now is the one discovered by the

771
00:28:55,750 --> 00:28:51,360
siding springs observatory it's right

772
00:28:58,070 --> 00:28:55,760
down here called 2013 a1 here it is

773
00:28:59,669 --> 00:28:58,080
i'm going to go right on board the comet

774
00:29:01,590 --> 00:28:59,679
and you can see right now it's way way

775
00:29:03,190 --> 00:29:01,600
out below the solar system and i'm going

776
00:29:05,750 --> 00:29:03,200
to actually lock the camera from the

777
00:29:07,430 --> 00:29:05,760
shoulder of this comet onto the planet

778
00:29:09,909 --> 00:29:07,440
mars let's lock the camera by right

779
00:29:11,110 --> 00:29:09,919
clicking the mouse and hitting lock on

780
00:29:13,590 --> 00:29:11,120
and i'm going to fast forward you can

781
00:29:20,389 --> 00:29:13,600
see we're now getting through november

782
00:29:23,909 --> 00:29:22,149
you can see the maven spacecraft gets to

783
00:29:26,470 --> 00:29:23,919
mars not long before this comet flies

784
00:29:27,909 --> 00:29:26,480
past

785
00:29:29,510 --> 00:29:27,919
and towards the end of next year there

786
00:29:30,630 --> 00:29:29,520
you saw it very very quick flyby i was

787
00:29:32,630 --> 00:29:30,640
fast-forwarding a little bit too quick

788
00:29:36,870 --> 00:29:32,640

let's rewind time and look at that flyby

789
00:29:41,430 --> 00:29:38,549
as we get closer you can see mars's

790
00:29:43,350 --> 00:29:41,440
moons phobos and dmos there they are

791
00:29:44,870 --> 00:29:43,360
and from this comet it gets incredibly

792
00:29:47,430 --> 00:29:44,880
close to the planet mars let's just see

793
00:29:49,510 --> 00:29:47,440
how close that is

794
00:29:51,909 --> 00:29:49,520
let's go and look at mars

795
00:29:53,510 --> 00:29:51,919
let's go and zoom well out of the planet

796
00:29:55,430 --> 00:29:53,520
and we can measure that distance as well

797
00:29:57,430 --> 00:29:55,440
we can right click on mars measure the

798
00:29:58,710 --> 00:29:57,440
distance from and left click on the

799
00:30:01,669 --> 00:29:58,720
comet and you can see at this point it's

800
00:30:03,269 --> 00:30:01,679
only 72 000 miles an incredibly close

801
00:30:04,950 --> 00:30:03,279
flyby it's gonna be a spectacular thing

802
00:30:06,789 --> 00:30:04,960
to see from the surface of mars

803
00:30:09,430 --> 00:30:06,799
hopefully with our spacecraft in orbit

804
00:30:10,470 --> 00:30:09,440
around mars and from the surface

805
00:30:12,149 --> 00:30:10,480
and of course comets aren't just

806
00:30:13,830 --> 00:30:12,159
something we look at from a long long

807
00:30:15,590 --> 00:30:13,840
way away occasionally we send spacecraft

808
00:30:17,350 --> 00:30:15,600
to don't go and take a slightly closer

809
00:30:19,909 --> 00:30:17,360
look at them and if we go back to the

810
00:30:22,070 --> 00:30:19,919
present day you'll see that this comet

811
00:30:24,230 --> 00:30:22,080
here chirami of garasimenko has a

812
00:30:25,510 --> 00:30:24,240
spacecraft very close to rosetta and

813
00:30:26,870 --> 00:30:25,520

right now they're only a few million

814
00:30:29,909 --> 00:30:26,880
miles apart in fact you can see that

815
00:30:31,830 --> 00:30:29,919
distance 16.6 million miles if i start

816
00:30:34,470 --> 00:30:31,840
fast forwarding time to about 12 months

817
00:30:36,149 --> 00:30:34,480
from now the rosetta mission which is a

818
00:30:38,630 --> 00:30:36,159
collaboration between the european space

819
00:30:39,669 --> 00:30:38,640
agency and nasa as well if we go all the

820
00:30:40,630 --> 00:30:39,679
way through the beginning of next year

821
00:30:42,789 --> 00:30:40,640
you're going to see that the rosetta

822
00:30:44,310 --> 00:30:42,799
spacecraft gets incredibly close to this

823
00:30:45,830 --> 00:30:44,320
uh this comet as well in fact it's going

824
00:30:47,510 --> 00:30:45,840
to go into orbit around the comet and

825
00:30:49,590 --> 00:30:47,520
eventually put a lander onto the surface

826
00:30:50,870 --> 00:30:49,600
of that comet as well

827
00:30:52,549 --> 00:30:50,880
and so now we're going to do is just go

828
00:30:54,149 --> 00:30:52,559
back to our little qe2 module so you can

829
00:30:56,070 --> 00:30:54,159
all at home right on board the asteroid

830
00:30:58,070 --> 00:30:56,080
see exactly where it is up in the top

831
00:31:00,310 --> 00:30:58,080
corner is the tours and features module

832
00:31:01,669 --> 00:31:00,320
i'm going to hit 1998 qe2 and we take

833
00:31:03,830 --> 00:31:01,679
you to this little mini module just

834
00:31:05,830 --> 00:31:03,840
about qe2 and by hitting the right along

835
00:31:07,509 --> 00:31:05,840
button there i am on board the asteroid

836
00:31:09,029 --> 00:31:07,519
you can see the earth and the moon right

837
00:31:11,190 --> 00:31:09,039
behind it for the kind of bruce willis

838
00:31:12,549 --> 00:31:11,200

view bring up the controls and hit this

839
00:31:13,830 --> 00:31:12,559
kind of ride along button here and

840
00:31:15,669 --> 00:31:13,840
suddenly you're riding on board the

841
00:31:17,750 --> 00:31:15,679
asteroid as it does its flyby of the

842
00:31:19,110 --> 00:31:17,760
earth over the next few days so that's

843
00:31:21,990 --> 00:31:19,120
eyes on the solar system once again you

844
00:31:23,110 --> 00:31:22,000
can go to it by going to eyes.nasa.gov

845
00:31:24,070 --> 00:31:23,120
and with that i'm going to throw it back

846
00:31:26,549 --> 00:31:24,080
together

847
00:31:27,830 --> 00:31:26,559
thanks doug so you get to see it even

848
00:31:30,230 --> 00:31:27,840
though you don't see it in your own

849
00:31:32,870 --> 00:31:30,240
backyard you can see it on the web

850
00:31:35,830 --> 00:31:32,880
page is back with us he's with the neo

851
00:31:38,470 --> 00:31:35,840
program office let's kind of help people

852
00:31:41,110 --> 00:31:38,480
understand why asteroids are so

853
00:31:43,909 --> 00:31:41,120
important there's a variety of reasons

854
00:31:45,350 --> 00:31:43,919
it's not just the catastrophic fear

855
00:31:47,990 --> 00:31:45,360
factor

856
00:31:49,509 --> 00:31:48,000
these are the some of the most primitive

857
00:31:51,830 --> 00:31:49,519
objects in the solar system so they give

858
00:31:53,750 --> 00:31:51,840
us information if we can study them uh

859
00:31:56,470 --> 00:31:53,760
about how the solar system was formed

860
00:31:57,990 --> 00:31:56,480
what were the ingredients uh that that

861
00:32:00,470 --> 00:31:58,000
were in the nebula which formed the

862
00:32:01,669 --> 00:32:00,480
solar system the some of the most

863
00:32:03,990 --> 00:32:01,679

primitive

864
00:32:06,310 --> 00:32:04,000
objects that we can use to study the

865
00:32:07,350 --> 00:32:06,320
early nebula of the solar system

866
00:32:11,110 --> 00:32:07,360
so

867
00:32:13,590 --> 00:32:11,120
uh

868
00:32:15,830 --> 00:32:13,600
are these things something that we would

869
00:32:17,590 --> 00:32:15,840
be interested in in the future

870
00:32:19,430 --> 00:32:17,600
it's also

871
00:32:21,350 --> 00:32:19,440
uh surprising that there are hydrated

872
00:32:23,830 --> 00:32:21,360
minerals in some of these objects which

873
00:32:25,830 --> 00:32:23,840
were formed in the uh outer

874
00:32:28,710 --> 00:32:25,840
area uh outer asteroid belt so they

875
00:32:30,549 --> 00:32:28,720
didn't receive a lot of heating and so

876
00:32:34,070 --> 00:32:30,559
it's possible that we could actually

877
00:32:36,230 --> 00:32:34,080
mine these objects if we go out and with

878
00:32:38,389 --> 00:32:36,240
some sort of in the distant future

879
00:32:40,870 --> 00:32:38,399
possibly or not so distant future we

880
00:32:43,110 --> 00:32:40,880
could go out and extract things like

881
00:32:45,590 --> 00:32:43,120
water and oxygen from these and use them

882
00:32:47,430 --> 00:32:45,600
as resources in space possibly there are

883
00:32:49,350 --> 00:32:47,440
also many minerals that

884
00:32:51,669 --> 00:32:49,360
are present in these objects

885
00:32:54,070 --> 00:32:51,679
and so in it's possible that these

886
00:32:55,750 --> 00:32:54,080
things could be a source of

887
00:32:57,190 --> 00:32:55,760
you know resources and minerals that we

888
00:32:59,509 --> 00:32:57,200

could use on the earth

889
00:33:01,830 --> 00:32:59,519
but it seems the common person seems to

890
00:33:04,310 --> 00:33:01,840
be most interested about asteroids

891
00:33:07,509 --> 00:33:04,320
because of concerns of the safety of the

892
00:33:09,509 --> 00:33:07,519
planet and your office has the job of

893
00:33:12,950 --> 00:33:09,519
tracking these asteroids and we we have

894
00:33:14,789 --> 00:33:12,960
a graphic of what we have seen in terms

895
00:33:16,950 --> 00:33:14,799
of numbers

896
00:33:19,590 --> 00:33:16,960
since may 8th but you tell me that the

897
00:33:21,029 --> 00:33:19,600
numbers have already increased

898
00:33:23,269 --> 00:33:21,039
yes i think the number of near-earth

899
00:33:25,990 --> 00:33:23,279
asteroids listed on the top there is up

900
00:33:27,669 --> 00:33:26,000
by at least 50 since may the 8th in in

901
00:33:29,190 --> 00:33:27,679
less than a month in less than a month

902
00:33:33,590 --> 00:33:29,200
objects

903
00:33:35,750 --> 00:33:33,600
rate of something like 80 per month

904
00:33:37,190 --> 00:33:35,760
and asteroids in general are discovered

905
00:33:39,430 --> 00:33:37,200
at something like

906
00:33:41,350 --> 00:33:39,440
3 000 per month and so

907
00:33:43,669 --> 00:33:41,360
the the numbers are just exploding we

908
00:33:46,310 --> 00:33:43,679
have 600 000 asteroids in our database

909
00:33:48,310 --> 00:33:46,320
right now for the uh for the entire uh

910
00:33:50,950 --> 00:33:48,320
list of asteroids but you seem to have a

911
00:33:54,549 --> 00:33:50,960
real handle on the larger ones the ones

912
00:33:55,590 --> 00:33:54,559
that are over one kilometer say

913
00:33:57,590 --> 00:33:55,600

yes

914
00:33:59,830 --> 00:33:57,600
those were the first priority of the

915
00:34:01,990 --> 00:33:59,840
earth object program office

916
00:34:03,750 --> 00:34:02,000
we wanted to know their orbits very

917
00:34:05,669 --> 00:34:03,760
accurately and the uncertainties and we

918
00:34:07,110 --> 00:34:05,679
wanted to project them into the future

919
00:34:09,109 --> 00:34:07,120
we wanted to know whether they could hit

920
00:34:10,950 --> 00:34:09,119
the earth especially so

921
00:34:12,950 --> 00:34:10,960
we take the observations from the minor

922
00:34:15,030 --> 00:34:12,960
planet center located in cambridge

923
00:34:17,190 --> 00:34:15,040
massachusetts they collect worldwide

924
00:34:19,349 --> 00:34:17,200
observations we use those then to

925
00:34:21,430 --> 00:34:19,359
compute high precision orbits for these

926
00:34:23,030 --> 00:34:21,440
asteroids and that's a complicated

927
00:34:25,270 --> 00:34:23,040
mathematical process but it's very

928
00:34:27,190 --> 00:34:25,280
important and then project those into

929
00:34:29,430 --> 00:34:27,200
the future and look at all possible

930
00:34:32,550 --> 00:34:29,440
possibilities we take into account the

931
00:34:34,550 --> 00:34:32,560
gravity of the solar system we go 100

932
00:34:37,270 --> 00:34:34,560
years into the future

933
00:34:39,430 --> 00:34:37,280
so it's it's long on a human time scale

934
00:34:41,270 --> 00:34:39,440
but on a solar system time scale that's

935
00:34:43,589 --> 00:34:41,280
just a blink of the eye and that

936
00:34:44,550 --> 00:34:43,599
information is constantly changing

937
00:34:46,790 --> 00:34:44,560
because

938
00:34:48,470 --> 00:34:46,800

as we get more and more information say

939
00:34:51,990 --> 00:34:48,480
the things we're getting from radar

940
00:34:54,790 --> 00:34:52,000
today all that changes the computation

941
00:34:56,950 --> 00:34:54,800
of the orbit yes so we will use the

942
00:34:59,109 --> 00:34:56,960
radar measurements that were made last

943
00:35:00,790 --> 00:34:59,119
night and will be made tomorrow we'll

944
00:35:02,630 --> 00:35:00,800
use those to improve the orbit even

945
00:35:04,870 --> 00:35:02,640
better in this case we know this

946
00:35:06,390 --> 00:35:04,880
asteroid can't hit the earth but

947
00:35:08,550 --> 00:35:06,400
using the radar measurements we'll be

948
00:35:10,390 --> 00:35:08,560
able to predict it accurately hundreds

949
00:35:12,550 --> 00:35:10,400
of years into the future and i would

950
00:35:15,430 --> 00:35:12,560
think that that information would be key

951
00:35:17,510 --> 00:35:15,440
if you are going to have a mission to an

952
00:35:19,990 --> 00:35:17,520
asteroid you have to know exactly where

953
00:35:21,990 --> 00:35:20,000
it is at any given time yes the more

954
00:35:24,150 --> 00:35:22,000
observations we get the better radar

955
00:35:26,790 --> 00:35:24,160
really helps to pin down the orbit of an

956
00:35:28,950 --> 00:35:26,800
asteroid as well as setting up as

957
00:35:30,550 --> 00:35:28,960
indicating the size of it so

958
00:35:31,990 --> 00:35:30,560
we saw it this morning those amazing

959
00:35:34,870 --> 00:35:32,000
images that's the first time i've seen

960
00:35:36,950 --> 00:35:34,880
them um where which marina showed were

961
00:35:38,710 --> 00:35:36,960
very impressive now we know

962
00:35:41,750 --> 00:35:38,720
that the size our estimates of the size

963
00:35:43,430 --> 00:35:41,760

was pretty accurate binary and a binary

964
00:35:45,990 --> 00:35:43,440
marina must have been really excited to

965
00:35:48,150 --> 00:35:46,000
see that the binaries are not so common

966
00:35:50,550 --> 00:35:48,160
uh so i was very exciting i'm happy to

967
00:35:52,390 --> 00:35:50,560
see that uh and we can get a good idea

968
00:35:55,190 --> 00:35:52,400
now of the mass

969
00:35:57,430 --> 00:35:55,200
of that asteroid if we track and know a

970
00:36:00,390 --> 00:35:57,440
little bit about the orbit of the of the

971
00:36:01,829 --> 00:36:00,400
secondary the satellite because the

972
00:36:04,230 --> 00:36:01,839
orbital period of the satellite is

973
00:36:07,670 --> 00:36:04,240
related to the mass of the asteroid all

974
00:36:10,550 --> 00:36:07,680
right so the next mission to an asteroid

975
00:36:13,190 --> 00:36:10,560
is one to an asteroid called bennu and

976
00:36:16,150 --> 00:36:13,200
we have a picture of bennu

977
00:36:18,390 --> 00:36:16,160
yes now bennu is about half a kilometer

978
00:36:20,390 --> 00:36:18,400
500 meters in diameter actually it's

979
00:36:23,430 --> 00:36:20,400
probably very similar in size to the

980
00:36:25,829 --> 00:36:23,440
satellite of kiwi too come to think of

981
00:36:28,069 --> 00:36:25,839
it that the mission that will go to

982
00:36:29,750 --> 00:36:28,079
bennu is called osiris-rex it's a very

983
00:36:33,109 --> 00:36:29,760
exciting mission to be launched in the

984
00:36:34,950 --> 00:36:33,119
year 2016. we have visuals of that okay

985
00:36:37,349 --> 00:36:34,960
let's see the visual

986
00:36:39,510 --> 00:36:37,359
there it is here we are this they asked

987
00:36:41,829 --> 00:36:39,520
oh here we are arriving at the asteroid

988
00:36:44,230 --> 00:36:41,839

and around the year 2018 after uh

989
00:36:46,230 --> 00:36:44,240
approximately a year of studying the

990
00:36:48,790 --> 00:36:46,240
asteroid at a distance the spacecraft

991
00:36:51,109 --> 00:36:48,800
will deploy an arm and pick up samples

992
00:36:52,069 --> 00:36:51,119
from the surface of the asteroid a

993
00:36:53,589 --> 00:36:52,079
certain

994
00:36:56,550 --> 00:36:53,599
number of grams will put it into a

995
00:36:58,150 --> 00:36:56,560
return capsule and then osiris-rex will

996
00:36:59,829 --> 00:36:58,160
come back to the earth and deploy that

997
00:37:01,270 --> 00:36:59,839
capsule and it will land in the year

998
00:37:03,829 --> 00:37:01,280
2023

999
00:37:06,150 --> 00:37:03,839
in utah and we'll actually have actual

1000
00:37:08,710 --> 00:37:06,160
samples from that asteroid that is an

1001
00:37:10,710 --> 00:37:08,720
incredibly ambitious endeavor very

1002
00:37:13,270 --> 00:37:10,720
exciting but there is another one that

1003
00:37:14,630 --> 00:37:13,280
is even more ambitious

1004
00:37:17,589 --> 00:37:14,640
yes

1005
00:37:21,349 --> 00:37:17,599
nasa has proposed an asteroid initiative

1006
00:37:24,150 --> 00:37:21,359
with a very exciting goal of going out

1007
00:37:25,190 --> 00:37:24,160
to find a nearer earth asteroid one

1008
00:37:27,030 --> 00:37:25,200
that's in an

1009
00:37:28,230 --> 00:37:27,040
orbit that's pretty close to the earth

1010
00:37:30,230 --> 00:37:28,240
and we would

1011
00:37:31,589 --> 00:37:30,240
send a spacecraft out there a high-tech

1012
00:37:35,349 --> 00:37:31,599
spacecraft

1013
00:37:36,950 --> 00:37:35,359

powered by solar arrays deploy a bag

1014
00:37:39,910 --> 00:37:36,960
around this asteroid it has to be the

1015
00:37:42,710 --> 00:37:39,920
right size here about 20 to 30 feet in

1016
00:37:45,589 --> 00:37:42,720
diameter we'll deploy a bag inflate it

1017
00:37:47,589 --> 00:37:45,599
and then move the spacecraft

1018
00:37:49,270 --> 00:37:47,599
match its orbital speed of the rotation

1019
00:37:50,470 --> 00:37:49,280
speed move the spacecraft around the

1020
00:37:53,430 --> 00:37:50,480
asteroid

1021
00:37:55,910 --> 00:37:53,440
put it in the bag and then cinch the bag

1022
00:37:58,310 --> 00:37:55,920
thus capturing the asteroid

1023
00:37:59,990 --> 00:37:58,320
then we will actually have an entire

1024
00:38:01,589 --> 00:38:00,000
asteroid which we will have studied in

1025
00:38:03,750 --> 00:38:01,599
detail

1026
00:38:05,750 --> 00:38:03,760
at some distance and we'll be able to

1027
00:38:08,390 --> 00:38:05,760
study how the whole thing is constructed

1028
00:38:09,910 --> 00:38:08,400
what its bulk properties are

1029
00:38:11,910 --> 00:38:09,920
and this would be very useful

1030
00:38:13,829 --> 00:38:11,920
information if we ever ever had to

1031
00:38:14,950 --> 00:38:13,839
deflect an asteroid we need to know

1032
00:38:16,550 --> 00:38:14,960
things like

1033
00:38:17,750 --> 00:38:16,560
the the bulk properties and the density

1034
00:38:19,270 --> 00:38:17,760
that sort of thing

1035
00:38:21,349 --> 00:38:19,280
here we see the asteroid being pulled

1036
00:38:24,310 --> 00:38:21,359
into the space close to the spacecraft

1037
00:38:27,270 --> 00:38:24,320
the advanced ion engines firing we push

1038
00:38:28,390 --> 00:38:27,280

the space the the asteroid back towards

1039
00:38:30,150 --> 00:38:28,400
the earth

1040
00:38:32,470 --> 00:38:30,160
actually towards the moon and put it

1041
00:38:33,990 --> 00:38:32,480
into orbit around the moon which is a

1042
00:38:36,310 --> 00:38:34,000
stable place

1043
00:38:38,550 --> 00:38:36,320
then the orion spacecraft

1044
00:38:39,910 --> 00:38:38,560
would launch with us with astronauts

1045
00:38:41,750 --> 00:38:39,920
from florida

1046
00:38:43,510 --> 00:38:41,760
and it could go up and visit the

1047
00:38:44,950 --> 00:38:43,520
captured asteroid which is in orbit

1048
00:38:47,270 --> 00:38:44,960
around the moon

1049
00:38:50,390 --> 00:38:47,280
they could use tools to actually take

1050
00:38:52,630 --> 00:38:50,400
samples from the asteroid and take very

1051
00:38:55,829 --> 00:38:52,640
the most interesting samples that uh

1052
00:38:57,990 --> 00:38:55,839
from interesting areas on this asteroid

1053
00:38:59,670 --> 00:38:58,000
we put the samples then and return those

1054
00:39:00,950 --> 00:38:59,680
to the earth and we could study them up

1055
00:39:03,670 --> 00:39:00,960
close

1056
00:39:06,150 --> 00:39:03,680
it's a very exciting mission

1057
00:39:09,030 --> 00:39:06,160
you personally have a

1058
00:39:11,910 --> 00:39:09,040
role a sort of a predecessor role to

1059
00:39:14,310 --> 00:39:11,920
this mission in that it's going to be

1060
00:39:16,870 --> 00:39:14,320
your job to find us that asteroid well

1061
00:39:19,349 --> 00:39:16,880
the the near earth object program office

1062
00:39:20,470 --> 00:39:19,359
is charged with finding and selecting a

1063
00:39:23,510 --> 00:39:20,480

good target

1064
00:39:25,030 --> 00:39:23,520
and we need to find one that matches

1065
00:39:27,349 --> 00:39:25,040
certain constraints it has to be about

1066
00:39:30,390 --> 00:39:27,359
the right size 20 to 30 feet and

1067
00:39:32,710 --> 00:39:30,400
especially it has to be in an orbit that

1068
00:39:34,069 --> 00:39:32,720
passes the earth fairly slowly so that

1069
00:39:36,470 --> 00:39:34,079
the moon would have a chance of

1070
00:39:38,790 --> 00:39:36,480
capturing it so we are looking for very

1071
00:39:41,349 --> 00:39:38,800
specific orbit types as well

1072
00:39:44,310 --> 00:39:41,359
and we have about a dozen candidates

1073
00:39:45,750 --> 00:39:44,320
already and we we think we will find

1074
00:39:47,510 --> 00:39:45,760
more good candidates in the next few

1075
00:39:49,349 --> 00:39:47,520
years so we'll be looking

1076
00:39:51,030 --> 00:39:49,359
at all the discoveries and searching for

1077
00:39:53,270 --> 00:39:51,040
these asteroids will be a high priority

1078
00:39:54,150 --> 00:39:53,280
in the next few years but it's it's the

1079
00:39:55,670 --> 00:39:54,160
same

1080
00:39:57,750 --> 00:39:55,680
survey that we'll be searching for

1081
00:39:59,670 --> 00:39:57,760
asteroids that could hit the earth so

1082
00:40:01,589 --> 00:39:59,680
it's the same basic technique but we'll

1083
00:40:03,510 --> 00:40:01,599
be watching for those ones which are in

1084
00:40:05,349 --> 00:40:03,520
orbits that could come close to the

1085
00:40:07,349 --> 00:40:05,359
earth very slowly and could be captured

1086
00:40:08,470 --> 00:40:07,359
and you're just discovering new ones

1087
00:40:09,270 --> 00:40:08,480
every day

1088
00:40:13,510 --> 00:40:09,280

so

1089
00:40:14,950 --> 00:40:13,520
every day yes uh we'll but we'll be

1090
00:40:16,470 --> 00:40:14,960
looking for just the right one i think

1091
00:40:19,349 --> 00:40:16,480
right we'll find one in the next few

1092
00:40:22,390 --> 00:40:19,359
years and timed just right to be where

1093
00:40:24,069 --> 00:40:22,400
you want it just then we also need it to

1094
00:40:25,750 --> 00:40:24,079
naturally come by the earth at about the

1095
00:40:27,990 --> 00:40:25,760
right time as well that's right all

1096
00:40:30,470 --> 00:40:28,000
right we'll find one as promised we are

1097
00:40:32,390 --> 00:40:30,480
doing some of the um social media

1098
00:40:34,870 --> 00:40:32,400
questions that you've sent in we have

1099
00:40:37,829 --> 00:40:34,880
one from ted wade

1100
00:40:41,190 --> 00:40:37,839
if hubble is retired or replaced can it

1101
00:40:42,950 --> 00:40:41,200
be assigned to neo search duties that's

1102
00:40:44,230 --> 00:40:42,960
an interesting question well a good

1103
00:40:46,230 --> 00:40:44,240
question

1104
00:40:48,710 --> 00:40:46,240
hubble is not well suited to search for

1105
00:40:51,349 --> 00:40:48,720
asteroids it's actually has a very

1106
00:40:54,069 --> 00:40:51,359
narrow field of view and can take very

1107
00:40:56,470 --> 00:40:54,079
detailed close-ups of particular objects

1108
00:40:58,069 --> 00:40:56,480
but what we need is to search large

1109
00:40:59,190 --> 00:40:58,079
regions of the sky

1110
00:41:00,550 --> 00:40:59,200
to find

1111
00:41:02,790 --> 00:41:00,560
an object in which we don't know where

1112
00:41:04,710 --> 00:41:02,800
it is so we we need to have a large

1113
00:41:06,710 --> 00:41:04,720

field of view so hubble is not the

1114
00:41:09,030 --> 00:41:06,720
appropriate

1115
00:41:11,349 --> 00:41:09,040
instrument to find asteroids well we

1116
00:41:13,190 --> 00:41:11,359
have marina standing by as well both of

1117
00:41:16,390 --> 00:41:13,200
you could help us with this

1118
00:41:18,470 --> 00:41:16,400
what do we know about 1998 qe2

1119
00:41:21,750 --> 00:41:18,480
composition and what might we learn

1120
00:41:23,750 --> 00:41:21,760
about it during the this flyby so both

1121
00:41:24,950 --> 00:41:23,760
of you can probably help us with that

1122
00:41:26,790 --> 00:41:24,960
you know a little bit about the

1123
00:41:28,550 --> 00:41:26,800
composition you said

1124
00:41:30,950 --> 00:41:28,560
we think we know basically what it looks

1125
00:41:33,910 --> 00:41:30,960
like yes um and that it's very dark it's

1126
00:41:35,349 --> 00:41:33,920
carbonaceous and it uh very primitive

1127
00:41:38,309 --> 00:41:35,359
elements coming from the outer solar

1128
00:41:40,790 --> 00:41:38,319
system but uh i was fascinated to see

1129
00:41:43,910 --> 00:41:40,800
the craters on marina's images very

1130
00:41:45,750 --> 00:41:43,920
interesting um we uh and we were as i

1131
00:41:47,990 --> 00:41:45,760
say it'd be great to learn about the

1132
00:41:49,829 --> 00:41:48,000
density of this object

1133
00:41:52,630 --> 00:41:49,839
from the orbital period of its satellite

1134
00:41:55,030 --> 00:41:52,640
then we will know approximately

1135
00:41:57,349 --> 00:41:55,040
give us better idea of the composition

1136
00:41:59,589 --> 00:41:57,359
i'll give this question also to marina

1137
00:42:02,870 --> 00:41:59,599
the question is

1138
00:42:04,630 --> 00:42:02,880

what do we know about qe2's composition

1139
00:42:07,589 --> 00:42:04,640
and what might we learn during this

1140
00:42:10,230 --> 00:42:07,599
flyby and you and i talked a little bit

1141
00:42:12,710 --> 00:42:10,240
earlier on you said since it's dark it

1142
00:42:13,510 --> 00:42:12,720
may be larger than you thought it would

1143
00:42:15,190 --> 00:42:13,520
was

1144
00:42:18,150 --> 00:42:15,200
do you still believe that's the case

1145
00:42:21,750 --> 00:42:18,160
that it's larger than you thought

1146
00:42:26,950 --> 00:42:24,230
i don't hear a thing apparently

1147
00:42:28,950 --> 00:42:26,960
apparently i hear you hear me um but

1148
00:42:30,790 --> 00:42:28,960
there was a question at one point and i

1149
00:42:33,190 --> 00:42:30,800
can hear gail barry okay

1150
00:42:35,030 --> 00:42:33,200
i think she can i can hear it yes okay

1151
00:42:37,270 --> 00:42:35,040
marina can hear me do you think that

1152
00:42:39,589 --> 00:42:37,280
this asteroid is larger than you first

1153
00:42:43,190 --> 00:42:39,599
anticipated it to be

1154
00:42:45,589 --> 00:42:43,200
uh 1998 qe2 it's it's about uh right

1155
00:42:47,510 --> 00:42:45,599
size so whatever this was this was

1156
00:42:50,069 --> 00:42:47,520
initially estimated by spitzer science

1157
00:42:52,150 --> 00:42:50,079
telescope uh based on special science

1158
00:42:54,230 --> 00:42:52,160
telescope data they estimated it it has

1159
00:42:57,510 --> 00:42:54,240
reflectivity about six percent

1160
00:42:59,270 --> 00:42:57,520
and 2.7 kilometer diameter so from what

1161
00:43:03,190 --> 00:42:59,280
we can see from the visible extent of

1162
00:43:05,030 --> 00:43:03,200
the radar images it is it is about right

1163
00:43:07,910 --> 00:43:05,040

now this is

1164
00:43:09,990 --> 00:43:07,920
one radar observation but you mentioned

1165
00:43:12,710 --> 00:43:10,000
that you're going to be doing several

1166
00:43:14,710 --> 00:43:12,720
others in in the coming year is that

1167
00:43:16,790 --> 00:43:14,720
yeah yeah it is correct what do we do

1168
00:43:18,870 --> 00:43:16,800
this is uh basically we we always

1169
00:43:20,390 --> 00:43:18,880
observe uh with well last year was

1170
00:43:23,670 --> 00:43:20,400
really busy let me tell you about last

1171
00:43:26,390 --> 00:43:23,680
year last year we observed 66 asteroids

1172
00:43:29,270 --> 00:43:26,400
only at our sibo and we observed 28

1173
00:43:31,589 --> 00:43:29,280
asteroids at goldstone we we spent like

1174
00:43:33,589 --> 00:43:31,599
400 hours observing asteroids only at

1175
00:43:35,990 --> 00:43:33,599
goldstone so it's we are you know we

1176
00:43:38,390 --> 00:43:36,000
have a very busy asteroid season ahead

1177
00:43:39,750 --> 00:43:38,400
uh we are probably expecting again

1178
00:43:41,990 --> 00:43:39,760
probably 50

1179
00:43:44,150 --> 00:43:42,000
objects to be observed not everything is

1180
00:43:45,510 --> 00:43:44,160
going to be glorious images as you have

1181
00:43:47,990 --> 00:43:45,520
seen some of them will be just a

1182
00:43:49,910 --> 00:43:48,000
detection but just as important because

1183
00:43:52,230 --> 00:43:49,920
we can get their orbits right

1184
00:43:53,670 --> 00:43:52,240
and maybe some initial physical

1185
00:43:54,390 --> 00:43:53,680
characterization

1186
00:43:56,230 --> 00:43:54,400
but

1187
00:43:57,910 --> 00:43:56,240
i think that the next good target next

1188
00:44:01,270 --> 00:43:57,920

good radar target is coming this summer

1189
00:44:03,270 --> 00:44:01,280
it's coming in august it's asteroid 2005

1190
00:44:06,309 --> 00:44:03,280
wk4

1191
00:44:09,109 --> 00:44:06,319
and it's about 300 meters as we think

1192
00:44:12,230 --> 00:44:09,119
it's about 300 meters in diameter so it

1193
00:44:14,309 --> 00:44:12,240
is a smaller than the satellite of 1998

1194
00:44:15,349 --> 00:44:14,319
qe2 which is about 600 meters in

1195
00:44:17,190 --> 00:44:15,359
diameter

1196
00:44:19,510 --> 00:44:17,200
and this one is going to come relatively

1197
00:44:21,510 --> 00:44:19,520
close about eight lunar distances and so

1198
00:44:22,550 --> 00:44:21,520
we expect to really have a very nice

1199
00:44:24,870 --> 00:44:22,560
images

1200
00:44:27,589 --> 00:44:24,880
and then the next year we are going to

1201
00:44:30,390 --> 00:44:27,599
have a chance to observe a comet

1202
00:44:35,190 --> 00:44:30,400
so this is going to become a linear it's

1203
00:44:36,950 --> 00:44:35,200
209 p comet linear in may of 2013

1204
00:44:38,950 --> 00:44:36,960
usually we don't have opportunities to

1205
00:44:41,030 --> 00:44:38,960
observe comet with with radar because

1206
00:44:43,910 --> 00:44:41,040
they just don't come close enough this

1207
00:44:45,190 --> 00:44:43,920
one is going to be at about 20 22 lunar

1208
00:44:47,349 --> 00:44:45,200
distances

1209
00:44:49,670 --> 00:44:47,359
and we'll we'll you know we'll be able

1210
00:44:51,670 --> 00:44:49,680
to get a peek at this type of object

1211
00:44:53,589 --> 00:44:51,680
but what is interesting it is going to

1212
00:44:55,750 --> 00:44:53,599
be a real treat for the optical

1213
00:44:58,470 --> 00:44:55,760

observers because there are some

1214
00:45:00,710 --> 00:44:58,480
indications that there is going to be a

1215
00:45:02,790 --> 00:45:00,720
really amazing meteor shower

1216
00:45:05,510 --> 00:45:02,800
caused by this comet so this comet is

1217
00:45:08,069 --> 00:45:05,520
periodic comet and earth is going to

1218
00:45:11,589 --> 00:45:08,079
pass through the trails of that this

1219
00:45:12,390 --> 00:45:11,599
comet deposited in 1800s

1220
00:45:14,150 --> 00:45:12,400
and

1221
00:45:15,990 --> 00:45:14,160
in may of next year

1222
00:45:17,349 --> 00:45:16,000
there is supposed to be a really nice

1223
00:45:19,829 --> 00:45:17,359
meteor shower

1224
00:45:22,230 --> 00:45:19,839
and we will also get to observe the

1225
00:45:24,630 --> 00:45:22,240
objects that produce this meteor shower

1226
00:45:27,349 --> 00:45:24,640
all right i have another asteroid watch

1227
00:45:30,230 --> 00:45:27,359
question either from marina or paul

1228
00:45:32,870 --> 00:45:30,240
i know how you find them but how do you

1229
00:45:35,589 --> 00:45:32,880
work out its trajectory based on a

1230
00:45:37,670 --> 00:45:35,599
single lens scope

1231
00:45:40,309 --> 00:45:37,680
well it's not just a single observation

1232
00:45:42,710 --> 00:45:40,319
we actually collect all the observations

1233
00:45:44,950 --> 00:45:42,720
and there could be hundreds of them

1234
00:45:46,710 --> 00:45:44,960
for a well-observed object and we fold

1235
00:45:49,750 --> 00:45:46,720
them all into the math

1236
00:45:51,990 --> 00:45:49,760
of the known gravity fields of the sun

1237
00:45:53,750 --> 00:45:52,000
and all of the planets and we figure out

1238
00:45:55,910 --> 00:45:53,760

which is the orbit that will fit all of

1239
00:45:57,510 --> 00:45:55,920
those best so and there's some

1240
00:45:59,109 --> 00:45:57,520
uncertainty of course there always will

1241
00:46:02,309 --> 00:45:59,119
be some because the observations are not

1242
00:46:04,230 --> 00:46:02,319
perfect but we get a very good idea the

1243
00:46:06,630 --> 00:46:04,240
more observations the better we'll get a

1244
00:46:09,589 --> 00:46:06,640
very good idea of the orbit and at a

1245
00:46:11,670 --> 00:46:09,599
particular time and then we will project

1246
00:46:13,510 --> 00:46:11,680
that into the future as well all right

1247
00:46:15,670 --> 00:46:13,520
so we're going to wrap up some of these

1248
00:46:18,309 --> 00:46:15,680
questions for now

1249
00:46:19,670 --> 00:46:18,319
and we'd like to thank marina for

1250
00:46:23,030 --> 00:46:19,680
helping us out with some of these

1251
00:46:25,430 --> 00:46:23,040
asteroid questions thank you so much

1252
00:46:27,829 --> 00:46:25,440
and some of these questions were very

1253
00:46:30,309 --> 00:46:27,839
good and very sharp they they are

1254
00:46:32,790 --> 00:46:30,319
already aware of how we track asteroids

1255
00:46:35,270 --> 00:46:32,800
they are more interested on how exactly

1256
00:46:36,069 --> 00:46:35,280
do we figure out the orbits

1257
00:46:38,069 --> 00:46:36,079
so

1258
00:46:41,030 --> 00:46:38,079
we're going to move on ahead now

1259
00:46:43,510 --> 00:46:41,040
asteroids are a very high priority at

1260
00:46:47,109 --> 00:46:43,520
nasa for a number of different reasons

1261
00:46:49,510 --> 00:46:47,119
to protect the planet as paul told us to

1262
00:46:52,630 --> 00:46:49,520
understand how the solar system formed

1263
00:46:55,910 --> 00:46:52,640

because it holds the elements that were

1264
00:46:57,510 --> 00:46:55,920
the very very beginning of our formation

1265
00:47:00,069 --> 00:46:57,520
and to explore

1266
00:47:02,790 --> 00:47:00,079
it as a possible resource that one day

1267
00:47:05,270 --> 00:47:02,800
we could possibly mine these asteroids

1268
00:47:07,670 --> 00:47:05,280
to tell us more it is my pleasure to

1269
00:47:10,309 --> 00:47:07,680
introduce the administrator of nasa

1270
00:47:12,630 --> 00:47:10,319
charles bolden he joins us now from nasa

1271
00:47:14,710 --> 00:47:12,640
headquarters in washington d.c

1272
00:47:18,950 --> 00:47:14,720
administrator bolden thanks so much for

1273
00:47:22,230 --> 00:47:20,630
very much for letting me come to you i

1274
00:47:24,150 --> 00:47:22,240
don't know whether uh whether i'm coming

1275
00:47:25,670 --> 00:47:24,160
through or not but i've had an

1276
00:47:27,910 --> 00:47:25,680
opportunity to listen to some of the

1277
00:47:30,150 --> 00:47:27,920
questions and and the comments that have

1278
00:47:31,750 --> 00:47:30,160
been going on and i find it quite

1279
00:47:33,829 --> 00:47:31,760
enlightening you know

1280
00:47:36,710 --> 00:47:33,839
as we get more and more excited about

1281
00:47:39,910 --> 00:47:36,720
every opportunity to to see an asteroid

1282
00:47:43,030 --> 00:47:39,920
or a comet or learn more about it

1283
00:47:45,349 --> 00:47:43,040
we find that nasa's present strategy for

1284
00:47:46,470 --> 00:47:45,359
dealing with asteroids is falling more

1285
00:47:48,790 --> 00:47:46,480
into line

1286
00:47:50,710 --> 00:47:48,800
i would remind everyone that in our 2014

1287
00:47:53,190 --> 00:47:50,720
budget request the president actually

1288
00:47:54,870 --> 00:47:53,200

added an additional 20 million dollars

1289
00:47:57,109 --> 00:47:54,880
bringing us up to a grand total of 40

1290
00:47:59,270 --> 00:47:57,119
million dollars for what i consider to

1291
00:48:01,510 --> 00:47:59,280
be the most critical effort right now

1292
00:48:03,109 --> 00:48:01,520
which is uh identification and

1293
00:48:05,829 --> 00:48:03,119
characterization

1294
00:48:07,270 --> 00:48:05,839
of near-earth asteroids particularly

1295
00:48:10,069 --> 00:48:07,280
earth-threatening

1296
00:48:12,150 --> 00:48:10,079
asteroids those that that we know very

1297
00:48:13,430 --> 00:48:12,160
little about and and know not enough

1298
00:48:16,710 --> 00:48:13,440
about the number

1299
00:48:19,190 --> 00:48:16,720
size characteristics of them

1300
00:48:21,270 --> 00:48:19,200
we mentioned in our 2014 budget also

1301
00:48:22,950 --> 00:48:21,280
that we were we would put aside 105

1302
00:48:25,510 --> 00:48:22,960
million dollars

1303
00:48:28,230 --> 00:48:25,520
to begin or to continue our effort to do

1304
00:48:30,790 --> 00:48:28,240
three things uh one identification and

1305
00:48:32,950 --> 00:48:30,800
characterization second which is sort of

1306
00:48:34,950 --> 00:48:32,960
new would be actually

1307
00:48:37,030 --> 00:48:34,960
rendezvousing with and trying to

1308
00:48:39,750 --> 00:48:37,040
redirect an asteroid

1309
00:48:41,990 --> 00:48:39,760
sort of in response to our question that

1310
00:48:43,750 --> 00:48:42,000
we always get about can we protect the

1311
00:48:44,710 --> 00:48:43,760
planet the answer to that is no right

1312
00:48:46,309 --> 00:48:44,720
now

1313
00:48:48,549 --> 00:48:46,319

but if we're able to demonstrate that

1314
00:48:51,430 --> 00:48:48,559
humans are able to redirect an asteroid

1315
00:48:53,270 --> 00:48:51,440
or deflect it in some slight way we may

1316
00:48:55,430 --> 00:48:53,280
be getting close to the day that we say

1317
00:48:58,630 --> 00:48:55,440
yes we can protect the planet and then

1318
00:49:01,190 --> 00:48:58,640
the third segment of that strategy is to

1319
00:49:03,510 --> 00:49:01,200
utilize sls and mpcv or our heavy lift

1320
00:49:05,510 --> 00:49:03,520
rocket and multi-purpose crew vehicle in

1321
00:49:07,589 --> 00:49:05,520
development right now uh to take an

1322
00:49:10,950 --> 00:49:07,599
asteroid an astronaut crew

1323
00:49:12,870 --> 00:49:10,960
uh into cis lunar space in a in a stable

1324
00:49:14,790 --> 00:49:12,880
orbit where we would have relocated the

1325
00:49:16,710 --> 00:49:14,800
asteroid to actually do some human

1326
00:49:17,510 --> 00:49:16,720
interaction with an asteroid all of this

1327
00:49:20,470 --> 00:49:17,520
in

1328
00:49:23,109 --> 00:49:20,480
challenge to put humans with an asteroid

1329
00:49:24,150 --> 00:49:23,119
by 2025. i don't need to tell this

1330
00:49:27,829 --> 00:49:24,160
audience

1331
00:49:31,910 --> 00:49:27,839
nasa has a long long long history

1332
00:49:33,510 --> 00:49:31,920
of investigation and study of asteroids

1333
00:49:35,910 --> 00:49:33,520
we work with our international partners

1334
00:49:37,510 --> 00:49:35,920
for example the the japanese uh very

1335
00:49:39,670 --> 00:49:37,520
successful with their hayabusa mission

1336
00:49:41,990 --> 00:49:39,680
and bringing back uh a sample we have

1337
00:49:44,309 --> 00:49:42,000
osiris osiris-rex that we're all excited

1338
00:49:45,910 --> 00:49:44,319

about that's going to launch uh in the

1339
00:49:48,230 --> 00:49:45,920
next few years and then bring us back a

1340
00:49:51,109 --> 00:49:48,240
sample in the 2020s

1341
00:49:53,589 --> 00:49:51,119
and we also are currently watching uh

1342
00:49:56,150 --> 00:49:53,599
dawn the the dawn spacecraft

1343
00:49:58,630 --> 00:49:56,160
wind its way away from vesta where it

1344
00:50:00,630 --> 00:49:58,640
made amazing discoveries onto cirrus

1345
00:50:03,270 --> 00:50:00,640
that i am told as an asteroid but some

1346
00:50:06,710 --> 00:50:03,280
people may even classify as a minor as a

1347
00:50:08,390 --> 00:50:06,720
as a minor planet or a dwarf planet so

1348
00:50:09,670 --> 00:50:08,400
there's a lot of excitement ahead and i

1349
00:50:10,390 --> 00:50:09,680
just want to thank you all for letting

1350
00:50:11,990 --> 00:50:10,400
me

1351
00:50:13,829 --> 00:50:12,000
join this team today to talk a little

1352
00:50:15,270 --> 00:50:13,839
bit about what nasa's doing so i think

1353
00:50:17,190 --> 00:50:15,280
you're probably going to move on to

1354
00:50:19,349 --> 00:50:17,200
questions or something and i'll

1355
00:50:22,150 --> 00:50:19,359
stand by yes i have one for you right

1356
00:50:24,870 --> 00:50:22,160
now how does the asteroid initiative fit

1357
00:50:27,750 --> 00:50:24,880
into this overall agency plan to go to

1358
00:50:30,230 --> 00:50:27,760
mars and beyond

1359
00:50:32,710 --> 00:50:30,240
the asteroid strategy if you will

1360
00:50:35,109 --> 00:50:32,720
consist of three segments as i as i just

1361
00:50:37,190 --> 00:50:35,119
mentioned and very briefly for the sake

1362
00:50:39,109 --> 00:50:37,200
of redundancy let me let me mention what

1363
00:50:41,270 --> 00:50:39,119

they are again the first part of the

1364
00:50:43,750 --> 00:50:41,280
strategy the critical part for us

1365
00:50:46,549 --> 00:50:43,760
is identification and characterization

1366
00:50:48,630 --> 00:50:46,559
of of as many asteroids in our solar

1367
00:50:50,230 --> 00:50:48,640
system as we can the ones we're

1368
00:50:52,710 --> 00:50:50,240
primarily interested in and the ones

1369
00:50:54,630 --> 00:50:52,720
that the folk at jpl and other other

1370
00:50:56,230 --> 00:50:54,640
nasa centers are working on is

1371
00:50:58,069 --> 00:50:56,240
identifying those that are earth

1372
00:51:01,190 --> 00:50:58,079
threatening the the near-earth objects

1373
00:51:04,230 --> 00:51:01,200
that are that at some point may may have

1374
00:51:05,990 --> 00:51:04,240
a potential to impact earth or

1375
00:51:08,069 --> 00:51:06,000
impact some of the satellites that are

1376
00:51:09,910 --> 00:51:08,079
orbiting earth so that's that's the

1377
00:51:12,230 --> 00:51:09,920
first segment the president has proposed

1378
00:51:14,309 --> 00:51:12,240
40 million dollars for that in the 2014

1379
00:51:16,230 --> 00:51:14,319
budget the second segment that we're

1380
00:51:18,630 --> 00:51:16,240
proposing which is new

1381
00:51:20,790 --> 00:51:18,640
is to actually utilize continue our

1382
00:51:22,710 --> 00:51:20,800
development of solar electric propulsion

1383
00:51:25,030 --> 00:51:22,720
new propulsion techniques

1384
00:51:27,829 --> 00:51:25,040
to rendezvous with and actually try to

1385
00:51:30,710 --> 00:51:27,839
redirect a small asteroid

1386
00:51:33,349 --> 00:51:30,720
or a small piece of an asteroid to the

1387
00:51:35,670 --> 00:51:33,359
lunar vicinity what we call cislunar or

1388
00:51:37,670 --> 00:51:35,680

some people call it translunar space so

1389
00:51:39,030 --> 00:51:37,680
it would be in a counter-rotating orbit

1390
00:51:41,030 --> 00:51:39,040
of the moon

1391
00:51:43,270 --> 00:51:41,040
putting it close enough that that within

1392
00:51:45,270 --> 00:51:43,280
a reasonable amount of time we could

1393
00:51:47,510 --> 00:51:45,280
launch an astronaut crew that would go

1394
00:51:50,470 --> 00:51:47,520
rendezvous in lunar orbit with this

1395
00:51:52,150 --> 00:51:50,480
asteroid and do the third segment uh

1396
00:51:54,630 --> 00:51:52,160
which would be to actually have human

1397
00:51:57,270 --> 00:51:54,640
interaction with an asteroid it is still

1398
00:51:58,870 --> 00:51:57,280
to be decided whether that's robotic uh

1399
00:52:00,950 --> 00:51:58,880
human interaction where the crew never

1400
00:52:03,589 --> 00:52:00,960
has to leave the vehicle or whether we

1401
00:52:05,910 --> 00:52:03,599
venture out on an eva and do some some

1402
00:52:07,430 --> 00:52:05,920
direct intervention or interaction with

1403
00:52:10,069 --> 00:52:07,440
it uh like

1404
00:52:12,470 --> 00:52:10,079
physically taking samples by hand so

1405
00:52:14,309 --> 00:52:12,480
that we can bring them back to earth

1406
00:52:16,710 --> 00:52:14,319
one thing i will tell or some

1407
00:52:18,630 --> 00:52:16,720
clarification that i will tell people

1408
00:52:21,190 --> 00:52:18,640
this is not a science

1409
00:52:23,430 --> 00:52:21,200
strategy this is not a human exploration

1410
00:52:25,510 --> 00:52:23,440
strategy it's not a technology

1411
00:52:27,030 --> 00:52:25,520
development strategy it is for perhaps

1412
00:52:29,030 --> 00:52:27,040
the first time

1413
00:52:31,109 --> 00:52:29,040

a synergized strategy that pulls

1414
00:52:32,549 --> 00:52:31,119
together everything that nasa does and

1415
00:52:34,150 --> 00:52:32,559
does so well

1416
00:52:35,750 --> 00:52:34,160
and it even involves our aeronautics

1417
00:52:38,069 --> 00:52:35,760
mission directorate because that's the

1418
00:52:40,549 --> 00:52:38,079
home of of of our knowledge of

1419
00:52:42,390 --> 00:52:40,559
fundamental hypersonics research

1420
00:52:44,470 --> 00:52:42,400
and every time you leave and return to

1421
00:52:45,750 --> 00:52:44,480
the planet or go to another planet

1422
00:52:47,430 --> 00:52:45,760
nowadays

1423
00:52:49,270 --> 00:52:47,440
we're utilizing what the aeronautics

1424
00:52:51,589 --> 00:52:49,280
folk teach us about hypersonics research

1425
00:52:53,670 --> 00:52:51,599
so it's exciting for us i hope it's

1426
00:52:55,030 --> 00:52:53,680
exciting for all of our employees

1427
00:52:57,349 --> 00:52:55,040
because they're going to be doing a

1428
00:52:59,349 --> 00:52:57,359
taste of everything and and

1429
00:53:00,950 --> 00:52:59,359
as always happens there nobody's going

1430
00:53:02,950 --> 00:53:00,960
to be perfectly happy but everybody

1431
00:53:05,349 --> 00:53:02,960
hopefully will get a piece of this pie

1432
00:53:07,990 --> 00:53:05,359
well speaking of synergy you you

1433
00:53:09,829 --> 00:53:08,000
mentioned that a lot of different pieces

1434
00:53:12,870 --> 00:53:09,839
will be fitting together

1435
00:53:15,670 --> 00:53:12,880
different nasa centers but other us

1436
00:53:18,710 --> 00:53:15,680
agencies perhaps perhaps international

1437
00:53:20,870 --> 00:53:18,720
partnerships what are we talking about

1438
00:53:22,790 --> 00:53:20,880

gay it is our hope and and we have

1439
00:53:25,030 --> 00:53:22,800
already begun the effort of working

1440
00:53:26,230 --> 00:53:25,040
collaboratively with other agencies of

1441
00:53:28,549 --> 00:53:26,240
the government

1442
00:53:29,430 --> 00:53:28,559
whether it's the department of energy

1443
00:53:31,270 --> 00:53:29,440
uh

1444
00:53:32,950 --> 00:53:31,280
on and on and on

1445
00:53:34,630 --> 00:53:32,960
and we have also engaged our

1446
00:53:36,950 --> 00:53:34,640
international partners

1447
00:53:39,190 --> 00:53:36,960
one of the first sets of calls that i

1448
00:53:41,109 --> 00:53:39,200
made on the morning

1449
00:53:43,750 --> 00:53:41,119
that we were rolling our budget out was

1450
00:53:45,349 --> 00:53:43,760
to the heads of of of our partner

1451
00:53:47,670 --> 00:53:45,359
agencies on the international space

1452
00:53:50,470 --> 00:53:47,680
station and there are there are five big

1453
00:53:52,710 --> 00:53:50,480
agencies that that predominantly run the

1454
00:53:55,270 --> 00:53:52,720
international space agency uh the

1455
00:53:57,510 --> 00:53:55,280
russian space agency jaxa from japan

1456
00:53:59,750 --> 00:53:57,520
canadian space agency the european space

1457
00:54:02,470 --> 00:53:59,760
agency which is huge uh jean-jacques

1458
00:54:04,069 --> 00:54:02,480
dordan is the as the the um the head of

1459
00:54:06,630 --> 00:54:04,079
the european space agency which

1460
00:54:08,549 --> 00:54:06,640
encompasses uh more than 20 different

1461
00:54:11,190 --> 00:54:08,559
nations in europe and then the united

1462
00:54:13,510 --> 00:54:11,200
states through nasa but all of them were

1463
00:54:15,109 --> 00:54:13,520

briefed on this concept all of them were

1464
00:54:17,510 --> 00:54:15,119
very receptive

1465
00:54:19,750 --> 00:54:17,520
and everybody's waiting to see

1466
00:54:21,589 --> 00:54:19,760
how we're going to formulate the the

1467
00:54:23,349 --> 00:54:21,599
actual details of the mission so mission

1468
00:54:26,150 --> 00:54:23,359
formulation will begin

1469
00:54:28,309 --> 00:54:26,160
uh later this this summer

1470
00:54:30,790 --> 00:54:28,319
and hopefully we will be able to come

1471
00:54:32,870 --> 00:54:30,800
out and and brief the american public on

1472
00:54:35,829 --> 00:54:32,880
a little bit more meaty concept sometime

1473
00:54:38,069 --> 00:54:35,839
next fall or winter all right well we

1474
00:54:40,870 --> 00:54:38,079
promised our audience that we would also

1475
00:54:42,470 --> 00:54:40,880
give you a social media question so here

1476
00:54:43,190 --> 00:54:42,480
is one and it could be a tough one for

1477
00:54:46,069 --> 00:54:43,200
you

1478
00:54:48,950 --> 00:54:46,079
it's they usually are yeah they are

1479
00:54:52,470 --> 00:54:48,960
if an asteroid was to collide with earth

1480
00:54:54,950 --> 00:54:52,480
is there anything we could do about it

1481
00:54:58,309 --> 00:54:54,960
gay unfortunately for the for the

1482
00:55:00,390 --> 00:54:58,319
questioner um the answer is no right now

1483
00:55:02,470 --> 00:55:00,400
the and let's let's not say that we we

1484
00:55:05,270 --> 00:55:02,480
work with fema today with the federal

1485
00:55:06,870 --> 00:55:05,280
emergency management agency we work with

1486
00:55:08,390 --> 00:55:06,880
department of state we work with the

1487
00:55:11,109 --> 00:55:08,400
department of defense

1488
00:55:12,950 --> 00:55:11,119

when we get indications and it is nasa

1489
00:55:14,950 --> 00:55:12,960
usually that gets the first indications

1490
00:55:15,910 --> 00:55:14,960
that a near-earth object is inbound

1491
00:55:18,309 --> 00:55:15,920
whether it's

1492
00:55:20,470 --> 00:55:18,319
junk falling from space as we have had

1493
00:55:22,789 --> 00:55:20,480
happen several times over the past

1494
00:55:24,710 --> 00:55:22,799
12 to 14 months or whether it is really

1495
00:55:26,549 --> 00:55:24,720
an asteroid

1496
00:55:28,230 --> 00:55:26,559
as was the case

1497
00:55:31,190 --> 00:55:28,240
a few months ago

1498
00:55:33,109 --> 00:55:31,200
we we notify our partner agencies if

1499
00:55:34,549 --> 00:55:33,119
it's one that looks like its trajectory

1500
00:55:36,069 --> 00:55:34,559
is going to bring it and potentially

1501
00:55:38,870 --> 00:55:36,079
impact earth

1502
00:55:41,190 --> 00:55:38,880
we work as diligently as we can with

1503
00:55:42,230 --> 00:55:41,200
other agencies to get an as accurate a

1504
00:55:45,109 --> 00:55:42,240
prediction

1505
00:55:47,829 --> 00:55:45,119
of the entry point and potential impact

1506
00:55:49,670 --> 00:55:47,839
point as we can so that the so that fema

1507
00:55:52,230 --> 00:55:49,680
can then begin to work if it's going to

1508
00:55:54,470 --> 00:55:52,240
impact uh the continental the united

1509
00:55:56,710 --> 00:55:54,480
states or so the state department can

1510
00:55:59,190 --> 00:55:56,720
begin to act if we think that it's going

1511
00:56:01,109 --> 00:55:59,200
to impact one of our one another nation

1512
00:56:03,349 --> 00:56:01,119
of the world because these are not

1513
00:56:05,510 --> 00:56:03,359

national threats these are these are

1514
00:56:07,270 --> 00:56:05,520
global threats and so

1515
00:56:09,750 --> 00:56:07,280
we have already had to do this many

1516
00:56:11,510 --> 00:56:09,760
times in the past

1517
00:56:12,950 --> 00:56:11,520
and and it seems to have worked

1518
00:56:14,630 --> 00:56:12,960
relatively well

1519
00:56:17,430 --> 00:56:14,640
we were surprised i think as everybody

1520
00:56:19,510 --> 00:56:17,440
knows by the by the small asteroid that

1521
00:56:20,870 --> 00:56:19,520
that surprised us over russia about two

1522
00:56:22,230 --> 00:56:20,880
or three months ago

1523
00:56:23,910 --> 00:56:22,240
um but

1524
00:56:25,750 --> 00:56:23,920
that's what we're trying to avoid with

1525
00:56:27,829 --> 00:56:25,760
increased effort on identification and

1526
00:56:29,750 --> 00:56:27,839
characterization is it so that we're not

1527
00:56:32,950 --> 00:56:29,760
surprised by something that can can

1528
00:56:35,589 --> 00:56:32,960
impact earth uh but the the mitigation

1529
00:56:37,990 --> 00:56:35,599
the actual ability to protect earth uh

1530
00:56:39,990 --> 00:56:38,000
is not within our technological grasp

1531
00:56:42,470 --> 00:56:40,000
right now and that's that's why this the

1532
00:56:45,190 --> 00:56:42,480
asteroid strategy and the second segment

1533
00:56:47,510 --> 00:56:45,200
of of actually a an effort to redirect

1534
00:56:50,069 --> 00:56:47,520
an asteroid is so so important to the

1535
00:56:52,549 --> 00:56:50,079
world not just to the us and we heard it

1536
00:56:55,270 --> 00:56:52,559
from you it's not a an easy thing to

1537
00:56:56,789 --> 00:56:55,280
answer but there are steps being made in

1538
00:56:59,589 --> 00:56:56,799

that direction and that's the most

1539
00:57:01,589 --> 00:56:59,599
important thing yes very much so all

1540
00:57:03,190 --> 00:57:01,599
right well thank you so much for the

1541
00:57:04,950 --> 00:57:03,200
update administrator bold and we

1542
00:57:07,430 --> 00:57:04,960
appreciate you carving out a little bit

1543
00:57:09,349 --> 00:57:07,440
of your day just for us and to be a part

1544
00:57:10,789 --> 00:57:09,359
of our program thanks so much okay

1545
00:57:12,789 --> 00:57:10,799
thanks so very much for letting me be a

1546
00:57:15,430 --> 00:57:12,799
part of the program and and thanks to

1547
00:57:18,230 --> 00:57:15,440
all of the folk around the nasa family

1548
00:57:21,270 --> 00:57:18,240
uh who who work at this so diligently

1549
00:57:23,270 --> 00:57:21,280
every day um my visit to jpl for example

1550
00:57:25,430 --> 00:57:23,280
last week was v really really really

1551
00:57:27,270 --> 00:57:25,440
enlightening and informative to me

1552
00:57:29,510 --> 00:57:27,280
and it's always good to meet with a

1553
00:57:31,190 --> 00:57:29,520
bunch of people that that are passionate

1554
00:57:32,630 --> 00:57:31,200
about things like saving the earth the

1555
00:57:34,470 --> 00:57:32,640
way that you all are out there thank you

1556
00:57:36,549 --> 00:57:34,480
very much oh it's a pleasure having you

1557
00:57:38,390 --> 00:57:36,559
a part of the show thank you

1558
00:57:40,710 --> 00:57:38,400
so we have a few more

1559
00:57:43,109 --> 00:57:40,720
social media questions that i can have

1560
00:57:45,109 --> 00:57:43,119
you feel paul if you're okay and some of

1561
00:57:46,230 --> 00:57:45,119
them are kind of tough

1562
00:57:48,549 --> 00:57:46,240
um

1563
00:57:51,589 --> 00:57:48,559

how far can we watch an incoming

1564
00:57:55,109 --> 00:57:51,599
asteroid and get an early warning

1565
00:57:57,030 --> 00:57:55,119
well that would depend on how big it is

1566
00:57:58,710 --> 00:57:57,040
and it would also depend on its sort of

1567
00:58:01,349 --> 00:57:58,720
orbit this was an eccentric orbit for

1568
00:58:02,870 --> 00:58:01,359
qe2 we had a chance to see it 15 years

1569
00:58:05,030 --> 00:58:02,880
ago and we discovered it then when it

1570
00:58:07,510 --> 00:58:05,040
was relatively near the earth

1571
00:58:09,829 --> 00:58:07,520
we would

1572
00:58:11,750 --> 00:58:09,839
be able to see many of these many orbits

1573
00:58:14,630 --> 00:58:11,760
before they would hit the earth if if it

1574
00:58:17,510 --> 00:58:14,640
was on a collision course so the idea is

1575
00:58:18,870 --> 00:58:17,520
to discover them as early as possible

1576
00:58:21,270 --> 00:58:18,880
the earlier we find them the more

1577
00:58:23,589 --> 00:58:21,280
warning time we have more information

1578
00:58:26,230 --> 00:58:23,599
well that wraps things up for us here at

1579
00:58:29,270 --> 00:58:26,240
jpl we'd like to thank the folks at the

1580
00:58:31,430 --> 00:58:29,280
south africa astronomical observatory in

1581
00:58:34,069 --> 00:58:31,440
sutherland the radar scientists and the

1582
00:58:36,150 --> 00:58:34,079
team at goldstone of course paul chodas

1583
00:58:39,510 --> 00:58:36,160
steve whistler and doug ellison here at

1584
00:58:41,910 --> 00:58:39,520
jpl in mission control and we and of

1585
00:58:43,990 --> 00:58:41,920
course administrator bolden and we look

1586
00:58:46,150 --> 00:58:44,000
forward to all the exciting results

1587
00:58:48,309 --> 00:58:46,160
ahead now if you're interested in more

1588
00:58:51,829 --> 00:58:48,319

information about asteroids here are two

1589
00:58:54,150 --> 00:58:51,839
websites to check out nasa.gov

1590
00:58:56,870 --> 00:58:54,160
asteroids or you can follow us on

1591
00:58:59,190 --> 00:58:56,880
twitter at twitter.com