
Jason Kessler
Program Executive, NASA's Asteroid Grand Challenge

1
00:00:05,910 --> 00:00:03,909
hi thank you for joining us on nasa

2
00:00:07,990 --> 00:00:05,920
television for nasa's asteroid update

3
00:00:09,509 --> 00:00:08,000
i'm public affairs officer trent parado

4
00:00:11,669 --> 00:00:09,519
we have a lot of exciting news to cover

5
00:00:13,270 --> 00:00:11,679
today on nasa's asteroid work now you

6
00:00:15,509 --> 00:00:13,280
may know that nasa tracks near-earth

7
00:00:17,109 --> 00:00:15,519
objects like asteroids and this includes

8
00:00:19,189 --> 00:00:17,119
potentially hazardous ones you may have

9
00:00:20,390 --> 00:00:19,199
heard of the asteroid grand challenge

10
00:00:22,870 --> 00:00:20,400
which is where the public can actually

11
00:00:24,310 --> 00:00:22,880
help accelerate nasa's work hunting for

12
00:00:25,910 --> 00:00:24,320
potentially dangerous asteroids and

13
00:00:27,189 --> 00:00:25,920

coming up with ideas

14
00:00:29,109 --> 00:00:27,199
on what to do with them you'll hear much

15
00:00:30,790 --> 00:00:29,119
more about nasa's detection efforts in

16
00:00:32,389 --> 00:00:30,800
the asteroid grand challenge which just

17
00:00:34,630 --> 00:00:32,399
celebrated its one year anniversary

18
00:00:36,709 --> 00:00:34,640
yesterday uh coming up in the program

19
00:00:38,950 --> 00:00:36,719
you'll also hear much more about nasa's

20
00:00:40,630 --> 00:00:38,960
asteroid redirect mission uh now this is

21
00:00:43,270 --> 00:00:40,640
an effort to send a robotic spacecraft

22
00:00:45,110 --> 00:00:43,280
to an asteroid capture the entirety of

23
00:00:46,950 --> 00:00:45,120
it or maybe a portion of it move that

24
00:00:48,790 --> 00:00:46,960
asteroid mass to a stable orbit around

25
00:00:51,189 --> 00:00:48,800
the moon where astronauts will visit it

26
00:00:52,950 --> 00:00:51,199
in the 2020s and return to earth with

27
00:00:54,389 --> 00:00:52,960
samples of that asteroid in doing the

28
00:00:56,470 --> 00:00:54,399
mission we'll test a number of the key

29
00:00:58,630 --> 00:00:56,480
technologies and capabilities we need

30
00:01:00,549 --> 00:00:58,640
for future human missions to mars it's

31
00:01:02,709 --> 00:01:00,559
very exciting time here as nasa's on the

32
00:01:04,310 --> 00:01:02,719
path to send humans to mars and asteroid

33
00:01:06,630 --> 00:01:04,320
plays a big part of that a lot of

34
00:01:08,070 --> 00:01:06,640
exciting astronaut asteroid news to come

35
00:01:09,429 --> 00:01:08,080
we have a distinguished panel of guests

36
00:01:11,750 --> 00:01:09,439
here in washington and joining us

37
00:01:13,429 --> 00:01:11,760
virtually to tell us more about that i'd

38
00:01:15,190 --> 00:01:13,439

like to introduce each of them they'll

39
00:01:16,630 --> 00:01:15,200
give brief remarks we'll circle back for

40
00:01:18,469 --> 00:01:16,640
question and answer with the press if

41
00:01:19,749 --> 00:01:18,479
you're joining us online you can ask

42
00:01:22,710 --> 00:01:19,759
questions of the panelists using the

43
00:01:24,230 --> 00:01:22,720
hashtag on twitter ask nasa we'd also

44
00:01:26,870 --> 00:01:24,240
encourage you to join the conversation

45
00:01:28,630 --> 00:01:26,880
online on twitter using the hashtag nasa

46
00:01:30,710 --> 00:01:28,640
asteroid and of course you can find out

47
00:01:32,469 --> 00:01:30,720
more information about everything you

48
00:01:35,830 --> 00:01:32,479
hear here today on the web at

49
00:01:38,950 --> 00:01:37,749
asteroid initiative i'll begin by

50
00:01:41,190 --> 00:01:38,960
introducing our panelists here in

51
00:01:43,190 --> 00:01:41,200
washington to my left

52
00:01:45,670 --> 00:01:43,200
i'm joined by michelle gates who is the

53
00:01:47,510 --> 00:01:45,680
program director for nasa's asteroid

54
00:01:49,109 --> 00:01:47,520
redirect mission

55
00:01:51,109 --> 00:01:49,119
with michelle here in washington is

56
00:01:53,510 --> 00:01:51,119
lindley johnson he is the program

57
00:01:55,190 --> 00:01:53,520
executive nasa's near-earth object

58
00:01:56,550 --> 00:01:55,200
program

59
00:01:58,230 --> 00:01:56,560
headed out to the west coast to our

60
00:02:00,709 --> 00:01:58,240
colleagues at jpl the jet propulsion

61
00:02:03,190 --> 00:02:00,719
laboratory in pasadena california we are

62
00:02:05,270 --> 00:02:03,200
joined by paul chotis he's a program

63
00:02:07,270 --> 00:02:05,280

scientist at nasa's near earth object

64
00:02:09,430 --> 00:02:07,280
program

65
00:02:11,830 --> 00:02:09,440
farther west we go to hawaii we're

66
00:02:14,869 --> 00:02:11,840
joined there by david tholen david is an

67
00:02:16,150 --> 00:02:14,879
astronomer at the university of hawaii

68
00:02:18,470 --> 00:02:16,160
his colleague at the university of

69
00:02:20,710 --> 00:02:18,480
hawaii uh research assistant marco

70
00:02:22,390 --> 00:02:20,720
miceli is joining us by phone he's

71
00:02:24,550 --> 00:02:22,400
currently in for scotty italy where he's

72
00:02:28,229 --> 00:02:24,560
working at the european space agency

73
00:02:30,869 --> 00:02:28,239
near earth object coordination center

74
00:02:32,470 --> 00:02:30,879
next we go to arizona where we are going

75
00:02:34,710 --> 00:02:32,480
to northern arizona university where

76
00:02:36,949 --> 00:02:34,720
we're joined by david trilling

77
00:02:38,630 --> 00:02:36,959
who is an associate professor

78
00:02:40,869 --> 00:02:38,640
and michael mohmert who is a

79
00:02:42,790 --> 00:02:40,879
post-doctoral researcher

80
00:02:44,550 --> 00:02:42,800
we head back to california at nasa's

81
00:02:45,750 --> 00:02:44,560
ames research center at moffett field in

82
00:02:47,350 --> 00:02:45,760
california

83
00:02:50,150 --> 00:02:47,360
and we're joined by there by jason

84
00:02:52,710 --> 00:02:50,160
kessler jason is a program executive for

85
00:02:54,070 --> 00:02:52,720
nasa's asteroid grand challenge he's at

86
00:02:55,830 --> 00:02:54,080
ames he works here at headquarters he's

87
00:02:58,550 --> 00:02:55,840
at aims right now at the solar system

88
00:03:00,869 --> 00:02:58,560

exploration research virtual institute

89
00:03:03,750 --> 00:03:00,879
or survey you'll hear more about the

90
00:03:05,110 --> 00:03:03,760
two-day workshop that jason and servi

91
00:03:07,030 --> 00:03:05,120
are working on right now the asteroid

92
00:03:08,949 --> 00:03:07,040
grand challenge which i said before is

93
00:03:11,270 --> 00:03:08,959
the public's opportunity to engage with

94
00:03:13,350 --> 00:03:11,280
us in the hunt for asteroids so with

95
00:03:14,949 --> 00:03:13,360
that we'll begin here in washington with

96
00:03:16,630 --> 00:03:14,959
remarks and we'll start with michelle

97
00:03:18,869 --> 00:03:16,640
gates michelle

98
00:03:20,710 --> 00:03:18,879
hi good afternoon it's great to be able

99
00:03:22,229 --> 00:03:20,720
to share with you just a little status

100
00:03:23,990 --> 00:03:22,239
of where we are with the asteroid

101
00:03:26,229 --> 00:03:24,000
redirect mission

102
00:03:28,869 --> 00:03:26,239
as you may know the mission consists of

103
00:03:30,949 --> 00:03:28,879
three very important elements the first

104
00:03:33,750 --> 00:03:30,959
being the identification

105
00:03:35,910 --> 00:03:33,760
of candidate target asteroids which our

106
00:03:37,430 --> 00:03:35,920
colleagues here will talk more about in

107
00:03:38,949 --> 00:03:37,440
this segment

108
00:03:41,430 --> 00:03:38,959
excuse me you can see

109
00:03:42,869 --> 00:03:41,440
on the slide the ground and space assets

110
00:03:44,710 --> 00:03:42,879
that we use

111
00:03:46,390 --> 00:03:44,720
for observation tracking and

112
00:03:49,670 --> 00:03:46,400
characterization

113
00:03:52,070 --> 00:03:49,680

of these small bodies second is the

114
00:03:55,030 --> 00:03:52,080
redirect element in which we'll launch a

115
00:03:58,390 --> 00:03:55,040
robotic spacecraft to redirect a small

116
00:04:00,949 --> 00:03:58,400
asteroid to a stable location in lunar

117
00:04:03,190 --> 00:04:00,959
orbit the third element is the

118
00:04:04,149 --> 00:04:03,200
exploration element where our crews will

119
00:04:07,270 --> 00:04:04,159
launch

120
00:04:08,070 --> 00:04:07,280
on the sls and orion spacecraft

121
00:04:10,390 --> 00:04:08,080
to

122
00:04:12,550 --> 00:04:10,400
explore and take samples of the asteroid

123
00:04:16,390 --> 00:04:12,560
and return them home with them

124
00:04:22,310 --> 00:04:19,270
so this is our latest uh really quick

125
00:04:25,189 --> 00:04:22,320
animation with some updates showing the

126
00:04:27,189 --> 00:04:25,199
high powered long life solar electric

127
00:04:30,469 --> 00:04:27,199
powered spacecraft

128
00:04:32,790 --> 00:04:30,479
uh executing one of two

129
00:04:36,390 --> 00:04:32,800
of the capture options

130
00:04:38,629 --> 00:04:36,400
and the astronauts launching on orion

131
00:04:41,510 --> 00:04:38,639
traveling through lunar gravity assist

132
00:04:43,350 --> 00:04:41,520
egressing from orion

133
00:04:45,990 --> 00:04:43,360
trip translating hand over hand

134
00:04:48,070 --> 00:04:46,000
translation in that particular concept

135
00:04:50,070 --> 00:04:48,080
removing samples practicing all the

136
00:04:53,590 --> 00:04:50,080
techniques that we'll need in future in

137
00:04:54,710 --> 00:04:53,600
space eva as well as low gravity body

138
00:04:58,150 --> 00:04:54,720

sampling

139
00:05:00,790 --> 00:04:58,950
we're

140
00:05:02,790 --> 00:05:00,800
actually leveraging several ongoing

141
00:05:03,670 --> 00:05:02,800
activities across the agency you see

142
00:05:06,390 --> 00:05:03,680
here

143
00:05:09,350 --> 00:05:06,400
uh two advanced solar array systems

144
00:05:11,350 --> 00:05:09,360
technology developments which are both

145
00:05:12,629 --> 00:05:11,360
actually wrapping up their current work

146
00:05:14,230 --> 00:05:12,639
at

147
00:05:16,390 --> 00:05:14,240
vendors through the glenn research

148
00:05:18,870 --> 00:05:16,400
center in ohio

149
00:05:20,390 --> 00:05:18,880
next slide

150
00:05:23,510 --> 00:05:20,400
several activities here on the

151
00:05:26,310 --> 00:05:23,520
international space station including

152
00:05:29,110 --> 00:05:26,320
some robotic district advanced dextrous

153
00:05:31,830 --> 00:05:29,120
robotic manipulator activities there's a

154
00:05:34,469 --> 00:05:31,840
refueling demonstration

155
00:05:37,350 --> 00:05:34,479
the international docking mechanism

156
00:05:40,550 --> 00:05:37,360
we're also looking at a common

157
00:05:41,990 --> 00:05:40,560
rendezvous sensor suites and

158
00:05:43,670 --> 00:05:42,000
mechanics for

159
00:05:45,909 --> 00:05:43,680
boulder extraction

160
00:05:47,749 --> 00:05:45,919
next slide

161
00:05:49,830 --> 00:05:47,759
our astronauts and

162
00:05:51,990 --> 00:05:49,840
test crews have been busy this year

163
00:05:55,270 --> 00:05:52,000

working in the neutral buoyancy lab at

164
00:05:57,749 --> 00:05:55,280
jsc testing out some of our concepts

165
00:05:59,990 --> 00:05:57,759
techniques and tools for implementing

166
00:06:03,189 --> 00:06:00,000
this mission we've actually spent the

167
00:06:06,390 --> 00:06:03,199
last year and will continue to advance

168
00:06:08,469 --> 00:06:06,400
the plans for our in-space eva suit

169
00:06:11,909 --> 00:06:08,479
as well as the primary life support

170
00:06:15,670 --> 00:06:11,919
system translation aids and techniques

171
00:06:18,309 --> 00:06:15,680
that we'll use on orbit next slide

172
00:06:21,110 --> 00:06:18,319
our nasa extreme environment mission

173
00:06:23,110 --> 00:06:21,120
operations activity has two mission

174
00:06:25,590 --> 00:06:23,120
operations activities planned this

175
00:06:28,309 --> 00:06:25,600
summer to investigate for the human

176
00:06:29,430 --> 00:06:28,319
research program human and behavioral

177
00:06:32,150 --> 00:06:29,440
health

178
00:06:34,790 --> 00:06:32,160
habitability and also something we call

179
00:06:37,189 --> 00:06:34,800
telementoring which is the execution of

180
00:06:43,110 --> 00:06:37,199
expert tasks

181
00:06:47,990 --> 00:06:45,830
we also wanted to announce today the

182
00:06:51,189 --> 00:06:48,000
selection of our broad agency

183
00:06:53,909 --> 00:06:51,199
announcements we have plans to award 4.9

184
00:06:56,629 --> 00:06:53,919
million dollars in response to the baa

185
00:06:59,350 --> 00:06:56,639
release that was in march we received

186
00:07:02,790 --> 00:06:59,360
excuse me 108 proposals

187
00:07:06,070 --> 00:07:02,800
and have selected 18 for award there are

188
00:07:08,070 --> 00:07:06,080

four proposals in capture systems two in

189
00:07:10,629 --> 00:07:08,080
rendezvous sensors

190
00:07:13,189 --> 00:07:10,639
four in the adaptation of commercially

191
00:07:16,150 --> 00:07:13,199
available spacecraft buses

192
00:07:17,990 --> 00:07:16,160
five in the potential partnerships of

193
00:07:20,629 --> 00:07:18,000
secondary payloads on the robotic

194
00:07:22,070 --> 00:07:20,639
spacecraft and three in potential

195
00:07:24,150 --> 00:07:22,080
partnerships

196
00:07:25,990 --> 00:07:24,160
for the crude mission and extensibility

197
00:07:28,070 --> 00:07:26,000
activities

198
00:07:29,909 --> 00:07:28,080
coming up this winter and

199
00:07:32,469 --> 00:07:29,919
early at late fall and early winter

200
00:07:35,110 --> 00:07:32,479
excuse me we'll actually be receiving

201
00:07:37,670 --> 00:07:35,120
our initial inputs from that baa

202
00:07:39,670 --> 00:07:37,680
concept development work as well as

203
00:07:42,150 --> 00:07:39,680
folding in our internal reference

204
00:07:44,390 --> 00:07:42,160
concept activities to choose

205
00:07:47,270 --> 00:07:44,400
from one of the two robotic capture

206
00:07:49,990 --> 00:07:47,280
options which um many folks are already

207
00:07:51,990 --> 00:07:50,000
aware of but the first we call option a

208
00:07:54,710 --> 00:07:52,000
which is the extraction

209
00:07:56,230 --> 00:07:54,720
and redirection of a single small

210
00:07:57,909 --> 00:07:56,240
asteroid

211
00:08:00,150 --> 00:07:57,919
from the um

212
00:08:03,270 --> 00:08:00,160
near-earth vicinity and the second is

213
00:08:07,990 --> 00:08:03,280

actually the acquisition of a

214
00:08:10,469 --> 00:08:08,000
coherent mass be it a boulder or a um

215
00:08:12,869 --> 00:08:10,479
loosely connected asteroid from a larger

216
00:08:15,510 --> 00:08:12,879
asteroid and either of these options we

217
00:08:18,070 --> 00:08:15,520
will demonstrate planetary defense

218
00:08:18,950 --> 00:08:18,080
deflection basic techniques and of

219
00:08:20,469 --> 00:08:18,960
course

220
00:08:22,550 --> 00:08:20,479
continue to

221
00:08:24,710 --> 00:08:22,560
benefit from the important and exciting

222
00:08:28,309 --> 00:08:24,720
work in the grand challenge as well as

223
00:08:29,510 --> 00:08:28,319
the observation program thank you

224
00:08:31,909 --> 00:08:29,520
thank you very much michelle now we'll

225
00:08:34,469 --> 00:08:31,919
hear from lindley johnson lindley

226
00:08:36,230 --> 00:08:34,479
thanks trent michelle

227
00:08:38,949 --> 00:08:36,240
nasa's near-earth object observation

228
00:08:41,110 --> 00:08:38,959
program is a network of

229
00:08:43,750 --> 00:08:41,120
observatories and facilities around the

230
00:08:45,430 --> 00:08:43,760
world that are trying to find the

231
00:08:48,070 --> 00:08:45,440
population of those

232
00:08:50,310 --> 00:08:48,080
small objects asteroids and comets which

233
00:08:52,389 --> 00:08:50,320
come near the earth and

234
00:08:55,269 --> 00:08:52,399
some of them could

235
00:08:57,030 --> 00:08:55,279
pose a potential impact hazard to the

236
00:09:00,710 --> 00:08:57,040
earth in the future so we are trying to

237
00:09:01,750 --> 00:09:00,720
find that population before they find us

238
00:09:05,910 --> 00:09:01,760

the

239
00:09:07,750 --> 00:09:05,920
good sense of

240
00:09:09,269 --> 00:09:07,760
worldwide effort that this is with all

241
00:09:10,470 --> 00:09:09,279
the locations we're going to talk to you

242
00:09:11,190 --> 00:09:10,480
today

243
00:09:13,509 --> 00:09:11,200
and

244
00:09:15,190 --> 00:09:13,519
telling you about the process that we go

245
00:09:16,230 --> 00:09:15,200
through to find

246
00:09:18,949 --> 00:09:16,240
track

247
00:09:20,389 --> 00:09:18,959
and characterize these objects both

248
00:09:23,030 --> 00:09:20,399
for the purpose of determining where

249
00:09:25,829 --> 00:09:23,040
they do represent an impact hazard to

250
00:09:27,990 --> 00:09:25,839
the earth and then in support of

251
00:09:30,230 --> 00:09:28,000
missions like the armed mission

252
00:09:32,070 --> 00:09:30,240
both robotic and human space flight

253
00:09:33,350 --> 00:09:32,080
missions

254
00:09:37,030 --> 00:09:33,360
our network

255
00:09:39,990 --> 00:09:37,040
currently is finding about 100

256
00:09:41,829 --> 00:09:40,000
near earth objects each each month so

257
00:09:43,990 --> 00:09:41,839
our pace at finding these objects

258
00:09:45,110 --> 00:09:44,000
continues to increase we've found about

259
00:09:46,870 --> 00:09:45,120
a thousand

260
00:09:48,710 --> 00:09:46,880
in 2013

261
00:09:52,710 --> 00:09:48,720
so we're on a pace to

262
00:09:55,350 --> 00:09:52,720
improve that discovery rate with finding

263
00:09:57,350 --> 00:09:55,360

about 100 a month now

264
00:09:59,990 --> 00:09:57,360
as we find these objects

265
00:10:02,389 --> 00:10:00,000
we look examine their orbits and there's

266
00:10:05,190 --> 00:10:02,399
a small subset of them that are in

267
00:10:06,550 --> 00:10:05,200
very close uh earth-like orbits

268
00:10:09,030 --> 00:10:06,560
that are good

269
00:10:10,949 --> 00:10:09,040
candidates then for

270
00:10:13,269 --> 00:10:10,959
both robotic and human space flight

271
00:10:15,829 --> 00:10:13,279
missions and for the arm mission so as

272
00:10:16,829 --> 00:10:15,839
we identify those we

273
00:10:19,350 --> 00:10:16,839
increase

274
00:10:21,190 --> 00:10:19,360
our looks at them with other

275
00:10:23,590 --> 00:10:21,200
observatories to characterize them

276
00:10:25,030 --> 00:10:23,600
determine size and nature of them to

277
00:10:25,990 --> 00:10:25,040
really determine

278
00:10:27,750 --> 00:10:26,000
uh

279
00:10:30,150 --> 00:10:27,760
whether they would make a good candidate

280
00:10:31,750 --> 00:10:30,160
or not and paul chodesh is going to talk

281
00:10:32,389 --> 00:10:31,760
to you about that process that we go

282
00:10:36,389 --> 00:10:32,399
through

283
00:10:40,949 --> 00:10:39,430
so uh as we as we find these objects uh

284
00:10:44,310 --> 00:10:40,959
several of them we've actually found

285
00:10:46,150 --> 00:10:44,320
before the arm mission uh was announced

286
00:10:48,870 --> 00:10:46,160
uh and there's one that we're going to

287
00:10:50,870 --> 00:10:48,880
talk about today 2011 md

288
00:10:52,069 --> 00:10:50,880

is such an object it was found back in

289
00:10:52,870 --> 00:10:52,079
2011

290
00:10:54,949 --> 00:10:52,880
and

291
00:10:57,350 --> 00:10:54,959
so as opportunities come up to further

292
00:10:59,509 --> 00:10:57,360
examine those uh like we will talk about

293
00:11:02,630 --> 00:10:59,519
today with the spitzer telescope we do

294
00:11:04,310 --> 00:11:02,640
so to better understand their size and

295
00:11:06,870 --> 00:11:04,320
characteristics

296
00:11:08,389 --> 00:11:06,880
this is all good practice for us though

297
00:11:11,269 --> 00:11:08,399
for

298
00:11:13,430 --> 00:11:11,279
the occasion when we might find a

299
00:11:15,110 --> 00:11:13,440
potentially hazardous impactor because

300
00:11:17,190 --> 00:11:15,120
this allows us to

301
00:11:18,389 --> 00:11:17,200
exercise our observatories and

302
00:11:20,550 --> 00:11:18,399
techniques

303
00:11:24,150 --> 00:11:20,560
that we would need to do to

304
00:11:26,870 --> 00:11:24,160
fully characterize a potential threat so

305
00:11:28,870 --> 00:11:26,880
it all fits together in the overall

306
00:11:30,389 --> 00:11:28,880
objectives and mission of the near earth

307
00:11:31,990 --> 00:11:30,399
object program

308
00:11:33,990 --> 00:11:32,000
uh so with that why don't we get on with

309
00:11:35,750 --> 00:11:34,000
the detail and uh hand it off to paul

310
00:11:40,710 --> 00:11:35,760
chodes all right thank you lindley so

311
00:11:45,269 --> 00:11:42,949
hi thanks trent um i'm going to provide

312
00:11:47,670 --> 00:11:45,279
some of the details to elaborate on on

313
00:11:49,910 --> 00:11:47,680

what lindley was just talking about uh

314
00:11:52,150 --> 00:11:49,920
give some progress on our finding of

315
00:11:54,550 --> 00:11:52,160
potential targets for the armed mission

316
00:11:56,870 --> 00:11:54,560
and uh i'll say a few words on one

317
00:11:58,310 --> 00:11:56,880
particular candidate that later speakers

318
00:12:01,030 --> 00:11:58,320
will be talking about

319
00:12:03,509 --> 00:12:01,040
my first slide is a slide off of our web

320
00:12:06,550 --> 00:12:03,519
page actually which shows the discovery

321
00:12:08,629 --> 00:12:06,560
rate of uh of near earth objects the

322
00:12:10,230 --> 00:12:08,639
number of known near earth objects

323
00:12:11,590 --> 00:12:10,240
versus time and you'll see the year on

324
00:12:13,910 --> 00:12:11,600
the bottom there

325
00:12:16,069 --> 00:12:13,920
and along the vertical axis is the

326
00:12:17,670 --> 00:12:16,079
number of known objects if you look at

327
00:12:20,069 --> 00:12:17,680
the very right side we're up at around

328
00:12:22,150 --> 00:12:20,079
11 000 now which is the current total

329
00:12:24,550 --> 00:12:22,160
number of known near-earth objects

330
00:12:26,230 --> 00:12:24,560
that's the blue curve the red curve is

331
00:12:28,150 --> 00:12:26,240
just for the large objects those are the

332
00:12:30,710 --> 00:12:28,160
ones that are one kilometer and larger

333
00:12:32,629 --> 00:12:30,720
about us 0.6 of a mile or larger those

334
00:12:33,750 --> 00:12:32,639
are the ones that could if they hit the

335
00:12:36,389 --> 00:12:33,760
earth could

336
00:12:38,470 --> 00:12:36,399
lead to global catastrophe so that just

337
00:12:40,389 --> 00:12:38,480
indicates what lindley was just saying

338
00:12:42,389 --> 00:12:40,399

that we're finding objects about 100

339
00:12:44,230 --> 00:12:42,399
near earth objects about 100 per month

340
00:12:46,150 --> 00:12:44,240
we're finding them at a good rate the in

341
00:12:49,430 --> 00:12:46,160
fact there's a bit of an acceleration

342
00:12:51,430 --> 00:12:49,440
since 1998 nasa's neo observations

343
00:12:53,670 --> 00:12:51,440
program has led the international effort

344
00:12:55,590 --> 00:12:53,680
to discover and characterize these

345
00:12:58,550 --> 00:12:55,600
asteroids you can see how the curves

346
00:13:01,030 --> 00:12:58,560
turned rapidly upwards when the neo

347
00:13:03,990 --> 00:13:01,040
program started in 1998.

348
00:13:07,030 --> 00:13:04,000
the total number by the way of blue

349
00:13:08,949 --> 00:13:07,040
of all neas near-earth asteroids the

350
00:13:10,629 --> 00:13:08,959
total number would be in the in like

351
00:13:12,389 --> 00:13:10,639
tens of millions or hundreds of millions

352
00:13:14,550 --> 00:13:12,399
if you go down to the some of the small

353
00:13:16,870 --> 00:13:14,560
sizes that we're talking about

354
00:13:17,750 --> 00:13:16,880
the next slide talks about

355
00:13:19,350 --> 00:13:17,760
the

356
00:13:21,829 --> 00:13:19,360
observation

357
00:13:23,910 --> 00:13:21,839
programs the asteroid search facilities

358
00:13:26,389 --> 00:13:23,920
that nasa is funding these are wide

359
00:13:29,269 --> 00:13:26,399
field telescopes that search the

360
00:13:31,910 --> 00:13:29,279
dark sky every dark night of the month

361
00:13:35,030 --> 00:13:31,920
looking for moving objects they uh they

362
00:13:39,030 --> 00:13:35,040
scan essentially the full sky

363
00:13:40,790 --> 00:13:39,040

in over a few days in time

364
00:13:42,870 --> 00:13:40,800
the first one catalina sky survey is

365
00:13:45,030 --> 00:13:42,880
located in arizona panstarrs is in

366
00:13:46,949 --> 00:13:45,040
hawaii the space surveillance telescope

367
00:13:49,110 --> 00:13:46,959
is in new mexico that's a new

368
00:13:51,269 --> 00:13:49,120
observatory that is just coming online

369
00:13:54,069 --> 00:13:51,279
and and is very has a very large

370
00:13:56,069 --> 00:13:54,079
aperture and should provide a lot of neo

371
00:13:58,150 --> 00:13:56,079
discoveries it will be providing those

372
00:14:00,710 --> 00:13:58,160
in test mode

373
00:14:03,030 --> 00:14:00,720
and on the bottom is neowise nasa re

374
00:14:04,790 --> 00:14:03,040
recently reactivated neo-wise and it is

375
00:14:07,110 --> 00:14:04,800
a space-based survey that is finding

376
00:14:08,790 --> 00:14:07,120
asteroids it is has the advantage of

377
00:14:09,990 --> 00:14:08,800
being in space avoiding weather and

378
00:14:12,870 --> 00:14:10,000
searching in the infrared where

379
00:14:14,710 --> 00:14:12,880
asteroids are particularly

380
00:14:16,710 --> 00:14:14,720
easy to find now all of these

381
00:14:19,269 --> 00:14:16,720
observatories work with the minor planet

382
00:14:20,470 --> 00:14:19,279
center in coordination they they send in

383
00:14:22,870 --> 00:14:20,480
their object

384
00:14:24,470 --> 00:14:22,880
their measurements of moving objects and

385
00:14:26,470 --> 00:14:24,480
the minor planet center then determines

386
00:14:28,550 --> 00:14:26,480
whether we're looking at an old object

387
00:14:30,389 --> 00:14:28,560
or whether it's a new object

388
00:14:32,470 --> 00:14:30,399

so i wanted to mention that they are an

389
00:14:36,629 --> 00:14:32,480
important part of this within a day or

390
00:14:39,189 --> 00:14:36,639
two of finding a new object these um

391
00:14:41,189 --> 00:14:39,199
uh we'll know roughly where

392
00:14:42,629 --> 00:14:41,199
the uh orbit is we'll get a good idea of

393
00:14:45,590 --> 00:14:42,639
the orbit and we'll have a very rough

394
00:14:47,990 --> 00:14:45,600
idea of the size of the object that that

395
00:14:49,990 --> 00:14:48,000
happens really very quickly

396
00:14:52,629 --> 00:14:50,000
there's a second process though and

397
00:14:54,550 --> 00:14:52,639
that's the next slide

398
00:14:56,310 --> 00:14:54,560
discovery is not enough we also have to

399
00:14:57,750 --> 00:14:56,320
consider characterization that is

400
00:14:59,910 --> 00:14:57,760
learning about the physical properties

401
00:15:03,189 --> 00:14:59,920
of asteroids and on this slide you'll

402
00:15:05,350 --> 00:15:03,199
see goldstone and arecibo on the top the

403
00:15:07,750 --> 00:15:05,360
these are two radar facilities that are

404
00:15:09,590 --> 00:15:07,760
really important and very capable of

405
00:15:12,710 --> 00:15:09,600
establishing things like the shape the

406
00:15:14,629 --> 00:15:12,720
size the spin rate um of and even

407
00:15:16,710 --> 00:15:14,639
surface features on near earth asteroids

408
00:15:20,629 --> 00:15:16,720
there was one ten days ago that neowise

409
00:15:22,310 --> 00:15:20,639
found actually called 2014 hq 124 which

410
00:15:23,990 --> 00:15:22,320
which was observed by radar and we could

411
00:15:25,829 --> 00:15:24,000
actually see boulders on the surface of

412
00:15:27,269 --> 00:15:25,839
that asteroid

413
00:15:29,030 --> 00:15:27,279

however

414
00:15:30,550 --> 00:15:29,040
radar is only useful when the asteroid

415
00:15:32,069 --> 00:15:30,560
is near enough

416
00:15:33,910 --> 00:15:32,079
on the upper right there is are the

417
00:15:35,509 --> 00:15:33,920
large optical telescopes they are very

418
00:15:36,870 --> 00:15:35,519
useful for tracking the asteroids

419
00:15:39,189 --> 00:15:36,880
getting more orbit information they're

420
00:15:41,269 --> 00:15:39,199
useful for photometry and determining

421
00:15:43,590 --> 00:15:41,279
the brightness and the variations versus

422
00:15:45,749 --> 00:15:43,600
time will indicate the rotation rate of

423
00:15:48,230 --> 00:15:45,759
these asteroids on the lower right is

424
00:15:50,310 --> 00:15:48,240
the nasa's infrared telescope facility

425
00:15:52,470 --> 00:15:50,320
it provides some ground-based infrared

426
00:15:54,069 --> 00:15:52,480
measurements of asteroids that will tell

427
00:15:55,430 --> 00:15:54,079
us things like the colors of the

428
00:15:56,790 --> 00:15:55,440
asteroid and give us an idea of the

429
00:15:58,550 --> 00:15:56,800
spectral class

430
00:15:59,910 --> 00:15:58,560
finally on the lower left is the spitzer

431
00:16:01,670 --> 00:15:59,920
space telescope which you'll be hearing

432
00:16:04,150 --> 00:16:01,680
a little bit more about that that's also

433
00:16:05,590 --> 00:16:04,160
an infrared telescope it's not near the

434
00:16:07,590 --> 00:16:05,600
earth as shown in this diagram it's

435
00:16:08,870 --> 00:16:07,600
actually about 100 million miles or more

436
00:16:10,550 --> 00:16:08,880
away from the earth right now it's

437
00:16:11,910 --> 00:16:10,560
orbiting the sun

438
00:16:14,230 --> 00:16:11,920

we'll hear a little bit later about how

439
00:16:16,069 --> 00:16:14,240
it has just recently observed one of the

440
00:16:17,509 --> 00:16:16,079
arm candidates

441
00:16:19,670 --> 00:16:17,519
so how do we put all this information

442
00:16:21,829 --> 00:16:19,680
together the next slide indicates

443
00:16:23,829 --> 00:16:21,839
roughly how it all fits together

444
00:16:25,269 --> 00:16:23,839
starting with

445
00:16:27,430 --> 00:16:25,279
observations which are in the light

446
00:16:29,030 --> 00:16:27,440
green there on the upper left we have

447
00:16:30,550 --> 00:16:29,040
the initial detection the tracking the

448
00:16:32,470 --> 00:16:30,560
photometry all of this happens very

449
00:16:35,269 --> 00:16:32,480
early we have a rough orbit we get an

450
00:16:37,269 --> 00:16:35,279
absolute magnitude within a few days we

451
00:16:38,949 --> 00:16:37,279
have additional tracking when the when

452
00:16:41,590 --> 00:16:38,959
available when the asteroid is bright

453
00:16:43,269 --> 00:16:41,600
enough and then there are other

454
00:16:45,749 --> 00:16:43,279
these of these other characterization

455
00:16:47,910 --> 00:16:45,759
means which give us more information the

456
00:16:49,829 --> 00:16:47,920
desired information is shown in yellow

457
00:16:52,069 --> 00:16:49,839
we want to know uh in particular the

458
00:16:53,910 --> 00:16:52,079
rotation rate the spin rate the shape

459
00:16:55,910 --> 00:16:53,920
there's the precise orbit we want to

460
00:16:57,590 --> 00:16:55,920
know the size and in the bottom right we

461
00:16:59,269 --> 00:16:57,600
want to know the mass of these objects

462
00:17:02,069 --> 00:16:59,279
so the characterization

463
00:17:03,430 --> 00:17:02,079

efforts and facilities are used to get

464
00:17:04,630 --> 00:17:03,440
us this information and that's what

465
00:17:06,069 --> 00:17:04,640
we'll be talking about a little bit

466
00:17:07,350 --> 00:17:06,079
later in the following speakers we'll be

467
00:17:09,669 --> 00:17:07,360
talking about

468
00:17:11,750 --> 00:17:09,679
that this characterization effort though

469
00:17:13,510 --> 00:17:11,760
um it takes a little bit more effort and

470
00:17:15,990 --> 00:17:13,520
and uh more

471
00:17:17,990 --> 00:17:16,000
work to get that information so let me

472
00:17:19,990 --> 00:17:18,000
move to the next slide and talk about

473
00:17:21,750 --> 00:17:20,000
the candidates for arm

474
00:17:23,669 --> 00:17:21,760
now you'll you heard in michelle's talk

475
00:17:26,710 --> 00:17:23,679
how there are two options we have option

476
00:17:28,789 --> 00:17:26,720
a which is to find and envelop and

477
00:17:30,789 --> 00:17:28,799
capture a small asteroid and bring the

478
00:17:32,549 --> 00:17:30,799
entire thing back into orbit around the

479
00:17:34,070 --> 00:17:32,559
moon and that's what i'll talk about

480
00:17:36,549 --> 00:17:34,080
first here

481
00:17:38,470 --> 00:17:36,559
the parameters that we're looking at for

482
00:17:39,350 --> 00:17:38,480
good candidates for option a are first

483
00:17:41,909 --> 00:17:39,360
of all

484
00:17:43,029 --> 00:17:41,919
that the we have a very accessible orbit

485
00:17:44,789 --> 00:17:43,039
around the sun and that's kind of

486
00:17:46,630 --> 00:17:44,799
indicated in the upper left here where

487
00:17:48,150 --> 00:17:46,640
red is the orbit of the earth and blue

488
00:17:50,710 --> 00:17:48,160

is the orbit of the asteroid and you can

489
00:17:53,110 --> 00:17:50,720
see it's very similar and this makes it

490
00:17:55,430 --> 00:17:53,120
very accessible and easy to put into

491
00:17:56,950 --> 00:17:55,440
orbit around the moon the middle diagram

492
00:17:59,590 --> 00:17:56,960
there indicates we need to have a close

493
00:18:01,350 --> 00:17:59,600
approach to the earth in the early 2020s

494
00:18:03,270 --> 00:18:01,360
that's basically the opportunity that

495
00:18:05,510 --> 00:18:03,280
will be modified and we'll move that

496
00:18:08,150 --> 00:18:05,520
blue line over so that the asteroid will

497
00:18:10,710 --> 00:18:08,160
be captured into orbit around the moon

498
00:18:12,390 --> 00:18:10,720
and in the lower left and lower right

499
00:18:14,549 --> 00:18:12,400
rather we have the final step the

500
00:18:16,390 --> 00:18:14,559
characterization step where we want to

501
00:18:17,590 --> 00:18:16,400
get the detailed information we want to

502
00:18:20,230 --> 00:18:17,600
have

503
00:18:21,430 --> 00:18:20,240
the size of the asteroid less than about

504
00:18:22,150 --> 00:18:21,440
10 meters

505
00:18:23,909 --> 00:18:22,160
now

506
00:18:25,830 --> 00:18:23,919
initially on the day of discovery we

507
00:18:28,470 --> 00:18:25,840
know more or less what its size is

508
00:18:29,990 --> 00:18:28,480
within a factor of several maybe a

509
00:18:31,990 --> 00:18:30,000
factor of 10 actually but the

510
00:18:34,710 --> 00:18:32,000
characterization step that final step

511
00:18:37,190 --> 00:18:34,720
that i talked about is necessary to to

512
00:18:38,870 --> 00:18:37,200
establish the size and whether it's

513
00:18:40,470 --> 00:18:38,880

less than 10 meters or not and that will

514
00:18:43,990 --> 00:18:40,480
indicate then also the mass which is

515
00:18:45,750 --> 00:18:44,000
another important parameter so so far

516
00:18:47,190 --> 00:18:45,760
there are probably thousands of

517
00:18:48,789 --> 00:18:47,200
candidates out there but they are very

518
00:18:51,190 --> 00:18:48,799
hard to detect because they are small

519
00:18:53,830 --> 00:18:51,200
and so far we have discovered and

520
00:18:55,430 --> 00:18:53,840
characterized a few of them there i'll

521
00:18:57,190 --> 00:18:55,440
talk about potential candidates and

522
00:18:59,110 --> 00:18:57,200
those are the candidates that uh

523
00:19:00,870 --> 00:18:59,120
satisfied like the first two of those

524
00:19:03,990 --> 00:19:00,880
requirements but that characterization

525
00:19:05,830 --> 00:19:04,000
step um if if can if a canada asteroid

526
00:19:07,110 --> 00:19:05,840
satisfies that then we call it a valid

527
00:19:09,510 --> 00:19:07,120
candidate so i'll be using those two

528
00:19:12,070 --> 00:19:09,520
terms potential and valid the next slide

529
00:19:14,230 --> 00:19:12,080
is for the other option option b

530
00:19:16,390 --> 00:19:14,240
where we will go to a larger asteroid

531
00:19:18,870 --> 00:19:16,400
one that's maybe 100 to 500 meters the

532
00:19:21,110 --> 00:19:18,880
size is not quite so important

533
00:19:23,110 --> 00:19:21,120
and it has its orbit can it doesn't have

534
00:19:24,630 --> 00:19:23,120
to be quite so accessible i'm showing

535
00:19:27,430 --> 00:19:24,640
the orbit of itakawa here and that's an

536
00:19:29,430 --> 00:19:27,440
image of hidakawa the asteroid

537
00:19:31,590 --> 00:19:29,440
and the orbit but the characterization

538
00:19:33,909 --> 00:19:31,600

for the option b candidates which is a

539
00:19:35,990 --> 00:19:33,919
completely different set of course is to

540
00:19:37,510 --> 00:19:36,000
get observational evidence that there

541
00:19:38,470 --> 00:19:37,520
are boulders on the surface of the

542
00:19:40,549 --> 00:19:38,480
asteroid

543
00:19:42,870 --> 00:19:40,559
and i show on the right here an actual

544
00:19:45,029 --> 00:19:42,880
image of the surface of itakawa and some

545
00:19:48,230 --> 00:19:45,039
of those boulders are on the order of

546
00:19:50,150 --> 00:19:48,240
two three six feet perhaps

547
00:19:52,789 --> 00:19:50,160
almost ten feet in diameter and and

548
00:19:54,310 --> 00:19:52,799
those boulders would be appropriate for

549
00:19:56,710 --> 00:19:54,320
option b

550
00:19:58,549 --> 00:19:56,720
so far we have

551
00:20:00,549 --> 00:19:58,559
discovered and characterized

552
00:20:01,430 --> 00:20:00,559
we have observational evidence for a few

553
00:20:07,750 --> 00:20:01,440
of

554
00:20:10,230 --> 00:20:07,760
to go to but that getting that last step

555
00:20:12,549 --> 00:20:10,240
getting the evidence for boulders is um

556
00:20:15,110 --> 00:20:12,559
is a difficult one so let me go to the

557
00:20:16,470 --> 00:20:15,120
summary of what we have currently

558
00:20:18,390 --> 00:20:16,480
on the next slide here the summary of

559
00:20:20,149 --> 00:20:18,400
current and future armed candidates so

560
00:20:22,070 --> 00:20:20,159
for option a

561
00:20:23,510 --> 00:20:22,080
by our tally we have nine potential

562
00:20:25,510 --> 00:20:23,520
candidates those are the ones that

563
00:20:27,510 --> 00:20:25,520

looked good roughly and had the roughly

564
00:20:29,590 --> 00:20:27,520
the right size but in fact three of

565
00:20:31,990 --> 00:20:29,600
those were found just last year but the

566
00:20:33,990 --> 00:20:32,000
valid ones we have three so far the

567
00:20:35,909 --> 00:20:34,000
valid ones are those that we know the

568
00:20:36,870 --> 00:20:35,919
size accurately enough we and we know

569
00:20:39,110 --> 00:20:36,880
the mass and they're within the

570
00:20:41,029 --> 00:20:39,120
capabilities of the asteroid retrieval

571
00:20:45,029 --> 00:20:41,039
vehicle to bring back and those are

572
00:20:47,270 --> 00:20:45,039
named 9 2009 bd 2013 ec which is ec20

573
00:20:49,510 --> 00:20:47,280
which is on a rather small one and now

574
00:20:50,870 --> 00:20:49,520
as of today we're talking about 2011 md

575
00:20:52,070 --> 00:20:50,880
and you'll hear a little bit more about

576
00:20:54,390 --> 00:20:52,080
that in the in

577
00:20:56,630 --> 00:20:54,400
from the next speakers additional valid

578
00:20:58,789 --> 00:20:56,640
candidates for option a are being uh

579
00:21:01,669 --> 00:20:58,799
added to this list at the rate of about

580
00:21:04,149 --> 00:21:01,679
one to two per year as as we get more

581
00:21:05,830 --> 00:21:04,159
and more observational facilities um

582
00:21:08,870 --> 00:21:05,840
we're we're spending more time looking

583
00:21:10,870 --> 00:21:08,880
for these objects uh we'll we'll get we

584
00:21:12,870 --> 00:21:10,880
expect one to two per year

585
00:21:14,710 --> 00:21:12,880
for option b there are lots of potential

586
00:21:16,950 --> 00:21:14,720
candidates out there which are about the

587
00:21:18,789 --> 00:21:16,960
right size but of those that have their

588
00:21:20,870 --> 00:21:18,799

surfaces characterized we have three

589
00:21:23,990 --> 00:21:20,880
itakawa which is characterized by the

590
00:21:25,909 --> 00:21:24,000
hayabusa 2 mission we have 2008 ev5

591
00:21:28,070 --> 00:21:25,919
which was characterized by radar it came

592
00:21:29,990 --> 00:21:28,080
close enough that we could actually see

593
00:21:32,230 --> 00:21:30,000
evidence of boulders on the surface and

594
00:21:33,590 --> 00:21:32,240
bennu which was characterized by radar

595
00:21:35,590 --> 00:21:33,600
in the past and which will be

596
00:21:38,390 --> 00:21:35,600
characterized by the osiris-rex mission

597
00:21:39,750 --> 00:21:38,400
in the year 2018. so they will be

598
00:21:41,830 --> 00:21:39,760
they are the current list of valid

599
00:21:43,669 --> 00:21:41,840
candidates for option b and if we look

600
00:21:45,510 --> 00:21:43,679
at the rate at which

601
00:21:47,669 --> 00:21:45,520
asteroids of this size come close enough

602
00:21:50,710 --> 00:21:47,679
to the earth that we can see boulders on

603
00:21:52,470 --> 00:21:50,720
the surface that's about one per year

604
00:21:53,350 --> 00:21:52,480
okay the next slide

605
00:21:55,669 --> 00:21:53,360
then

606
00:21:57,190 --> 00:21:55,679
is i'm gonna i'm gonna move on to talk

607
00:21:59,669 --> 00:21:57,200
about one particular object and that's

608
00:22:01,190 --> 00:21:59,679
2011 md which will be talked about by

609
00:22:03,190 --> 00:22:01,200
the following speakers and i wanted to

610
00:22:04,470 --> 00:22:03,200
just say a few words about the orbit of

611
00:22:06,310 --> 00:22:04,480
this object

612
00:22:09,830 --> 00:22:06,320
um you see

613
00:22:11,430 --> 00:22:09,840

the earth and the asteroid 2011 md in

614
00:22:13,990 --> 00:22:11,440
the lower right there that is where they

615
00:22:16,149 --> 00:22:14,000
were located in the year in august of

616
00:22:17,830 --> 00:22:16,159
2011 which was just a month or so after

617
00:22:19,750 --> 00:22:17,840
the discovery the two orbits get really

618
00:22:21,110 --> 00:22:19,760
close together just a little bit

619
00:22:23,190 --> 00:22:21,120
below that

620
00:22:25,029 --> 00:22:23,200
um the asteroid was discovered in june

621
00:22:27,669 --> 00:22:25,039
2011 by the linear

622
00:22:29,909 --> 00:22:27,679
telescope it uh you'll hear more about

623
00:22:32,710 --> 00:22:29,919
it in the in the later

624
00:22:34,710 --> 00:22:32,720
speakers but what i wanted to say was

625
00:22:36,789 --> 00:22:34,720
that you see how close the asteroid is

626
00:22:38,470 --> 00:22:36,799
to the earth that is where

627
00:22:40,710 --> 00:22:38,480
dave tholen who will be speaking shortly

628
00:22:42,630 --> 00:22:40,720
observed it it the asteroid being small

629
00:22:44,149 --> 00:22:42,640
has to be very close to the earth if

630
00:22:45,350 --> 00:22:44,159
it's not it's simply too faint to be

631
00:22:47,029 --> 00:22:45,360
observed

632
00:22:50,390 --> 00:22:47,039
i wanted to say a few words about the

633
00:22:52,630 --> 00:22:50,400
orbit now this particular asteroid is

634
00:22:55,669 --> 00:22:52,640
very close to the earth in the year 2011

635
00:22:57,270 --> 00:22:55,679
but if we now but it's on a larger track

636
00:22:59,029 --> 00:22:57,280
you see the blue orbit is the orbit of

637
00:23:00,950 --> 00:22:59,039
the asteroid we can ignore the red which

638
00:23:02,470 --> 00:23:00,960

is spitzer for now the blue orbit is the

639
00:23:04,230 --> 00:23:02,480
orbit of the asteroid it's on a farther

640
00:23:06,470 --> 00:23:04,240
track and it actually takes a little

641
00:23:09,029 --> 00:23:06,480
longer so the net effect is that it will

642
00:23:11,590 --> 00:23:09,039
fall behind the earth the next slide now

643
00:23:13,110 --> 00:23:11,600
flash forward two and a half years

644
00:23:14,950 --> 00:23:13,120
and the earth has moved over to that

645
00:23:17,510 --> 00:23:14,960
side of the sun and you'll see that the

646
00:23:20,470 --> 00:23:17,520
asteroid has fallen back about a quarter

647
00:23:21,909 --> 00:23:20,480
of an orbit and that's um how far it has

648
00:23:23,669 --> 00:23:21,919
moved away from the earth it's certainly

649
00:23:26,230 --> 00:23:23,679
not visible from the earth anymore but

650
00:23:28,149 --> 00:23:26,240
it's near spitzer and that is

651
00:23:30,310 --> 00:23:28,159
we took advantage of that opportunity to

652
00:23:32,070 --> 00:23:30,320
have it observed by spitzer i want to

653
00:23:33,669 --> 00:23:32,080
say one last thing and that is that this

654
00:23:36,230 --> 00:23:33,679
falling back behind the earth will

655
00:23:37,990 --> 00:23:36,240
continue with time and the asteroid will

656
00:23:39,909 --> 00:23:38,000
eventually fall all the way back and the

657
00:23:43,110 --> 00:23:39,919
earth will lap it and that happens in

658
00:23:45,029 --> 00:23:43,120
2024 and that's the opportunity that we

659
00:23:46,789 --> 00:23:45,039
could use to capture the asteroid into

660
00:23:50,070 --> 00:23:46,799
orbit around the earth

661
00:23:53,110 --> 00:23:51,430
you so much for that excellent summary

662
00:23:55,190 --> 00:23:53,120
paul now we'll go to

663
00:23:56,710 --> 00:23:55,200

uh the university of hawaii where dave

664
00:23:59,269 --> 00:23:56,720
dolan who's an astronomer will tell us a

665
00:24:01,110 --> 00:23:59,279
little bit more about 2011 md and his

666
00:24:03,110 --> 00:24:01,120
colleague uh marco michelle who's

667
00:24:06,950 --> 00:24:03,120
joining us by phone dave and marco the

668
00:24:12,549 --> 00:24:09,669
hello okay good morning

669
00:24:15,830 --> 00:24:12,559
um as paul chotis just mentioned the

670
00:24:18,470 --> 00:24:15,840
size of asteroid that nasa is interested

671
00:24:21,669 --> 00:24:18,480
in for a retrieval mission is fairly

672
00:24:23,110 --> 00:24:21,679
small about 10 meters or smaller about

673
00:24:24,390 --> 00:24:23,120
30 feet

674
00:24:25,430 --> 00:24:24,400
or smaller

675
00:24:27,510 --> 00:24:25,440
and

676
00:24:30,630 --> 00:24:27,520
that size of object

677
00:24:32,230 --> 00:24:30,640
is bright enough to be detected by

678
00:24:33,750 --> 00:24:32,240
the telescopes that we have here on

679
00:24:36,310 --> 00:24:33,760
earth

680
00:24:39,669 --> 00:24:36,320
only when the asteroid is relatively

681
00:24:42,789 --> 00:24:39,679
close to the earth so if the asteroid is

682
00:24:44,870 --> 00:24:42,799
on an orbit that is rather dissimilar

683
00:24:46,870 --> 00:24:44,880
from the earth's orbit it will whiz past

684
00:24:47,909 --> 00:24:46,880
the earth in just a few days

685
00:24:48,789 --> 00:24:47,919
uh

686
00:24:51,350 --> 00:24:48,799
the

687
00:24:53,029 --> 00:24:51,360
number of observations that you can get

688
00:24:54,710 --> 00:24:53,039

the the length of time over which you

689
00:24:56,549 --> 00:24:54,720
can observe the asteroid is so short you

690
00:24:57,590 --> 00:24:56,559
really can't establish the orbit very

691
00:25:01,350 --> 00:24:57,600
well

692
00:25:02,870 --> 00:25:01,360
and uh in order to send a spacecraft to

693
00:25:05,590 --> 00:25:02,880
one of these small asteroids you

694
00:25:07,590 --> 00:25:05,600
definitely need to know the orbit uh

695
00:25:10,549 --> 00:25:07,600
reasonably well so

696
00:25:13,350 --> 00:25:10,559
what you need to have is the the kind of

697
00:25:15,390 --> 00:25:13,360
asteroid orbit that is very similar to

698
00:25:18,950 --> 00:25:15,400
the earth's orbit and

699
00:25:22,590 --> 00:25:18,960
2011 md is one of those uh type of

700
00:25:24,149 --> 00:25:22,600
asteroids uh when it came by in june

701
00:25:27,590 --> 00:25:24,159
2011

702
00:25:30,870 --> 00:25:27,600
we realized that it was on a fairly

703
00:25:32,310 --> 00:25:30,880
earth similar orbit and as a result

704
00:25:34,310 --> 00:25:32,320
we

705
00:25:37,669 --> 00:25:34,320
put in our observing plan

706
00:25:39,909 --> 00:25:37,679
uh several observations uh into the

707
00:25:41,990 --> 00:25:39,919
future to try and get that orbit pinned

708
00:25:43,909 --> 00:25:42,000
down somewhat better

709
00:25:48,950 --> 00:25:43,919
in this particular case we were able to

710
00:25:50,549 --> 00:25:48,960
track 2011 md for an additional 73 days

711
00:25:52,630 --> 00:25:50,559
after discovery

712
00:25:54,470 --> 00:25:52,640
whereas most of these small asteroids

713
00:25:56,710 --> 00:25:54,480

that are found by the sky surveys you

714
00:25:57,510 --> 00:25:56,720
know just three or four days uh and and

715
00:25:59,110 --> 00:25:57,520
they're

716
00:26:01,510 --> 00:25:59,120
uh gone

717
00:26:03,669 --> 00:26:01,520
unable to observe just just too far away

718
00:26:05,190 --> 00:26:03,679
and to fame but this one stayed close to

719
00:26:07,029 --> 00:26:05,200
the earth for a

720
00:26:08,070 --> 00:26:07,039
reasonably long time

721
00:26:10,310 --> 00:26:08,080
so

722
00:26:12,630 --> 00:26:10,320
the important point here is that the

723
00:26:14,070 --> 00:26:12,640
orbit of this asteroid is reasonably

724
00:26:18,470 --> 00:26:14,080
well established

725
00:26:19,190 --> 00:26:18,480
and we can send a spacecraft to it

726
00:26:20,310 --> 00:26:19,200
but

727
00:26:22,230 --> 00:26:20,320
in the course of doing these

728
00:26:24,390 --> 00:26:22,240
observations

729
00:26:26,950 --> 00:26:24,400
we noticed that there was a very

730
00:26:28,470 --> 00:26:26,960
slight discrepancy

731
00:26:29,510 --> 00:26:28,480
between

732
00:26:34,870 --> 00:26:29,520
the

733
00:26:37,830 --> 00:26:34,880
predict

734
00:26:39,669 --> 00:26:37,840
on the basis of the orbit determination

735
00:26:41,190 --> 00:26:39,679
in other words there was a a slight

736
00:26:43,029 --> 00:26:41,200
departure

737
00:26:46,630 --> 00:26:43,039
from the motion you would expect just

738
00:26:47,510 --> 00:26:46,640

from the influence of gravity alone

739
00:26:50,870 --> 00:26:47,520
and

740
00:26:54,149 --> 00:26:50,880
the the reason for that is

741
00:26:57,830 --> 00:26:54,159
the sunlight falling on the surface

742
00:27:00,870 --> 00:26:57,840
imparts a very slight acceleration very

743
00:27:02,149 --> 00:27:00,880
very tiny acceleration

744
00:27:04,390 --> 00:27:02,159
this

745
00:27:07,750 --> 00:27:04,400
tiny acceleration is really only

746
00:27:09,909 --> 00:27:07,760
detectable on small asteroids as you get

747
00:27:12,390 --> 00:27:09,919
larger and larger asteroids the

748
00:27:15,830 --> 00:27:12,400
gravitational force becomes dominant

749
00:27:17,590 --> 00:27:15,840
as you go to smaller and smaller objects

750
00:27:20,070 --> 00:27:17,600
eventually the

751
00:27:21,430 --> 00:27:20,080
effect of sunlight becomes the dominant

752
00:27:23,510 --> 00:27:21,440
uh force

753
00:27:26,149 --> 00:27:23,520
and perhaps the best illustration of

754
00:27:29,350 --> 00:27:26,159
that is a comet tail

755
00:27:31,669 --> 00:27:29,360
the actual nucleus of the comet is a

756
00:27:32,789 --> 00:27:31,679
much larger object and it's much harder

757
00:27:33,750 --> 00:27:32,799
to move

758
00:27:36,389 --> 00:27:33,760
with

759
00:27:39,269 --> 00:27:36,399
the effect of sunlight but the dust

760
00:27:42,789 --> 00:27:39,279
particles that get emitted as a comet

761
00:27:45,990 --> 00:27:42,799
out gases can be very very tiny

762
00:27:47,669 --> 00:27:46,000
just small grains of

763
00:27:49,190 --> 00:27:47,679

rocky material

764
00:27:51,990 --> 00:27:49,200
perhaps

765
00:27:53,430 --> 00:27:52,000
only a few microns in size

766
00:27:56,470 --> 00:27:53,440
and

767
00:27:59,590 --> 00:27:56,480
those have such a small mass that

768
00:28:02,230 --> 00:27:59,600
gravity is is almost negligible whereas

769
00:28:03,269 --> 00:28:02,240
the sunlight that falls on them can push

770
00:28:06,070 --> 00:28:03,279
them around

771
00:28:08,630 --> 00:28:06,080
very easily and that's why you see the

772
00:28:11,510 --> 00:28:08,640
tail of a comet usually stream in a

773
00:28:12,230 --> 00:28:11,520
direction away from the sun

774
00:28:13,909 --> 00:28:12,240
so

775
00:28:15,110 --> 00:28:13,919
we're in a transition region here

776
00:28:17,350 --> 00:28:15,120
between

777
00:28:20,149 --> 00:28:17,360
objects that are very small like the

778
00:28:23,909 --> 00:28:20,159
dust particles in a comet's tail and

779
00:28:25,909 --> 00:28:23,919
larger asteroids so the the acceleration

780
00:28:28,389 --> 00:28:25,919
on the asteroid is is very very small

781
00:28:31,590 --> 00:28:28,399
very difficult to detect but on these

782
00:28:34,950 --> 00:28:31,600
really small ones it is possible to uh

783
00:28:36,389 --> 00:28:34,960
to measure that effect and that is uh a

784
00:28:39,510 --> 00:28:36,399
very useful

785
00:28:41,029 --> 00:28:39,520
thing for physical characterization

786
00:28:43,029 --> 00:28:41,039
and uh

787
00:28:44,470 --> 00:28:43,039
it's been done now for

788
00:28:47,510 --> 00:28:44,480

about four

789
00:28:48,950 --> 00:28:47,520
asteroids in this size range and it

790
00:28:50,870 --> 00:28:48,960
actually became

791
00:28:53,029 --> 00:28:50,880
a uh

792
00:28:55,190 --> 00:28:53,039
one of the uh one of the key parts of

793
00:28:59,269 --> 00:28:55,200
the doctoral dissertation

794
00:29:01,590 --> 00:28:59,279
uh of marco mckelle so i'd like to

795
00:29:03,909 --> 00:29:01,600
turn the discussion over to him right

796
00:29:06,549 --> 00:29:03,919
now and uh he can tell you a little bit

797
00:29:08,230 --> 00:29:06,559
more about

798
00:29:10,950 --> 00:29:08,240
the type of

799
00:29:13,110 --> 00:29:10,960
observations that we made to

800
00:29:16,310 --> 00:29:13,120
determine this

801
00:29:18,470 --> 00:29:16,320
acceleration by the force of sunlight

802
00:29:19,669 --> 00:29:18,480
falling on the asteroid and

803
00:29:22,149 --> 00:29:19,679
some of the

804
00:29:23,750 --> 00:29:22,159
physical results that we got as a result

805
00:29:26,549 --> 00:29:23,760
of those observations

806
00:29:28,950 --> 00:29:26,559
so marco are you on the line

807
00:29:31,590 --> 00:29:28,960
yes i am thank you dave for the

808
00:29:35,110 --> 00:29:31,600
introduction hope you can hear me

809
00:29:36,230 --> 00:29:35,120
uh well dave already introduced uh most

810
00:29:38,710 --> 00:29:36,240
of the

811
00:29:40,630 --> 00:29:38,720
technical part of what we did and why it

812
00:29:43,590 --> 00:29:40,640
was so interesting to observe this

813
00:29:45,110 --> 00:29:43,600

particular object 2011 md and a couple

814
00:29:45,990 --> 00:29:45,120
other ones that we observed over the

815
00:29:47,990 --> 00:29:46,000
years

816
00:29:50,710 --> 00:29:48,000
uh but they are small enough that we can

817
00:29:54,630 --> 00:29:50,720
actually see a departure of the motion

818
00:29:56,470 --> 00:29:54,640
from a typical orbital on the sun

819
00:29:58,710 --> 00:29:56,480
caused only by gravity because of this

820
00:30:01,110 --> 00:29:58,720
effect of the sunlight which is actually

821
00:30:02,230 --> 00:30:01,120
pushing the asteroid slightly away from

822
00:30:04,870 --> 00:30:02,240
its orbit

823
00:30:06,950 --> 00:30:04,880
so what we did was to observe this

824
00:30:08,710 --> 00:30:06,960
particular object as 11d for a long

825
00:30:11,830 --> 00:30:08,720
enough time that

826
00:30:14,149 --> 00:30:11,840
made this small displacement

827
00:30:16,789 --> 00:30:14,159
apparent in our observations

828
00:30:17,669 --> 00:30:16,799
and why is that important well as dave

829
00:30:21,029 --> 00:30:17,679
said

830
00:30:24,549 --> 00:30:21,039
if an object is light enough to

831
00:30:27,110 --> 00:30:24,559
see to be affected by this

832
00:30:29,350 --> 00:30:27,120
pressure pressure of sunlight well we

833
00:30:32,070 --> 00:30:29,360
can measure how much it is affected and

834
00:30:33,269 --> 00:30:32,080
have an idea of how big and how light it

835
00:30:34,389 --> 00:30:33,279
is

836
00:30:36,710 --> 00:30:34,399
and

837
00:30:39,110 --> 00:30:36,720
what we actually get is a measure of the

838
00:30:40,710 --> 00:30:39,120

cross section of the object so how

839
00:30:42,070 --> 00:30:40,720
like the area that's supposed to

840
00:30:44,710 --> 00:30:42,080
sunlight

841
00:30:45,669 --> 00:30:44,720
and if we know something else like if we

842
00:30:46,789 --> 00:30:45,679
know

843
00:30:58,630 --> 00:30:46,799
the

844
00:31:01,430 --> 00:30:58,640
asteroids

845
00:31:03,430 --> 00:31:01,440
and obviously transport it with a

846
00:31:05,750 --> 00:31:03,440
spacecraft it's extremely important to

847
00:31:07,269 --> 00:31:05,760
know the mass of the object so what we

848
00:31:08,950 --> 00:31:07,279
did was to get

849
00:31:12,070 --> 00:31:08,960
measurements for the position of this

850
00:31:13,110 --> 00:31:12,080
asteroid for a few months and use this

851
00:31:20,950 --> 00:31:13,120
to

852
00:31:22,470 --> 00:31:20,960
and then when you have the mass you can

853
00:31:24,470 --> 00:31:22,480
actually combine that again with the

854
00:31:25,750 --> 00:31:24,480
size and have an idea of the density of

855
00:31:27,990 --> 00:31:25,760
the asteroid

856
00:31:29,509 --> 00:31:28,000
and two main things actually came out of

857
00:31:32,230 --> 00:31:29,519
this well the first one which is

858
00:31:34,470 --> 00:31:32,240
actually relevant for a possible space

859
00:31:36,710 --> 00:31:34,480
mission to an asteroid is that the

860
00:31:37,750 --> 00:31:36,720
density was actually heavy enough to

861
00:31:39,909 --> 00:31:37,760
exclude

862
00:31:42,310 --> 00:31:39,919
that this object was artificial because

863
00:31:44,149 --> 00:31:42,320

as you may imagine if an object is in an

864
00:31:45,110 --> 00:31:44,159
orbit that is similar to the orbit of

865
00:31:47,110 --> 00:31:45,120
the earth

866
00:31:48,710 --> 00:31:47,120
it may be just an interesting asteroid

867
00:31:51,190 --> 00:31:48,720
easy to reach but there is also a chance

868
00:31:53,190 --> 00:31:51,200
there is actually an artificial object

869
00:31:55,509 --> 00:31:53,200
so we first wanted to exclude that it

870
00:31:57,830 --> 00:31:55,519
was artificial and that is done by

871
00:31:59,750 --> 00:31:57,840
measuring the density and seeing that

872
00:32:02,310 --> 00:31:59,760
it's not light enough to be compatible

873
00:32:04,470 --> 00:32:02,320
with being a hollow metal cylinder or

874
00:32:06,950 --> 00:32:04,480
something that may look like a

875
00:32:08,549 --> 00:32:06,960
spacecraft or an upper stage of a rocket

876
00:32:10,630 --> 00:32:08,559
or something like that

877
00:32:12,789 --> 00:32:10,640
the second thing we noticed on the other

878
00:32:15,110 --> 00:32:12,799
hand is that although the density is

879
00:32:17,269 --> 00:32:15,120
heavy enough to be compatible with being

880
00:32:18,870 --> 00:32:17,279
an asteroid like a rocky object

881
00:32:19,909 --> 00:32:18,880
is actually much lighter than what we

882
00:32:21,830 --> 00:32:19,919
expected

883
00:32:23,590 --> 00:32:21,840
it's not very easy to precisely

884
00:32:25,590 --> 00:32:23,600
constrain the density of an asteroid

885
00:32:28,149 --> 00:32:25,600
with this technique but we can get you

886
00:32:30,630 --> 00:32:28,159
know within a factor of two and our

887
00:32:31,669 --> 00:32:30,640
result was that it's actually very light

888
00:32:34,149 --> 00:32:31,679

it's

889
00:32:36,310 --> 00:32:34,159
possibly lighter than water so it has a

890
00:32:38,470 --> 00:32:36,320
density of less than one in the usual

891
00:32:40,549 --> 00:32:38,480
units which is telling us a lot it's

892
00:32:43,909 --> 00:32:40,559
telling us that this object is peculiar

893
00:32:46,549 --> 00:32:43,919
in the way it's made and it probably has

894
00:32:48,549 --> 00:32:46,559
a lot of empty spaces inside the rock

895
00:32:49,590 --> 00:32:48,559
that makes it so this is telling us that

896
00:32:51,909 --> 00:32:49,600
it's not

897
00:32:53,350 --> 00:32:51,919
a huge big heavy rock but it's something

898
00:32:55,190 --> 00:32:53,360
more complex

899
00:32:57,350 --> 00:32:55,200
which is another very important

900
00:32:59,590 --> 00:32:57,360
information for a possible

901
00:33:02,230 --> 00:32:59,600
future mass emissions to it

902
00:33:03,830 --> 00:33:02,240
so well this was all based on our

903
00:33:05,430 --> 00:33:03,840
observations from the ground with the

904
00:33:07,990 --> 00:33:05,440
telescopes in hawaii

905
00:33:09,350 --> 00:33:08,000
the main thing that we couldn't directly

906
00:33:10,389 --> 00:33:09,360
get from that

907
00:33:13,830 --> 00:33:10,399
is

908
00:33:14,710 --> 00:33:13,840
the actual size that then we combine

909
00:33:16,950 --> 00:33:14,720
with

910
00:33:19,350 --> 00:33:16,960
the measure of this radiation effect to

911
00:33:21,110 --> 00:33:19,360
figure out the mass and then the density

912
00:33:22,789 --> 00:33:21,120
so this is because it's really hard to

913
00:33:25,110 --> 00:33:22,799

get the size of an asteroid from the

914
00:33:27,509 --> 00:33:25,120
ground with all the observations done

915
00:33:29,350 --> 00:33:27,519
with telescopes on earth it's actually

916
00:33:31,029 --> 00:33:29,360
much easier if you use a telescope light

917
00:33:31,909 --> 00:33:31,039
splitter that was mentioned before by

918
00:33:34,710 --> 00:33:31,919
paul

919
00:33:36,789 --> 00:33:34,720
and that's a

920
00:33:39,669 --> 00:33:36,799
perfect point to give

921
00:33:41,269 --> 00:33:39,679
to lead the speaker the talk to the

922
00:33:43,909 --> 00:33:41,279
people at northern arizona which will

923
00:33:46,149 --> 00:33:43,919
tell us how to use speak 12 to

924
00:33:48,710 --> 00:33:46,159
actually measure something more on this

925
00:33:50,149 --> 00:33:48,720
asteroid and help constraining how it's

926
00:33:52,789 --> 00:33:50,159
made

927
00:33:55,269 --> 00:33:52,799
okay so i think the people of arizona

928
00:33:58,549 --> 00:33:55,279
can continue from here on thank you very

929
00:34:02,710 --> 00:34:00,310
dave and marco thank you very much for

930
00:34:05,430 --> 00:34:02,720
that that presentation so mystery was

931
00:34:06,870 --> 00:34:05,440
deepening here on 2011 md and now we'll

932
00:34:08,710 --> 00:34:06,880
go to the team we use spitzer to help

933
00:34:10,389 --> 00:34:08,720
answer some of those questions we go to

934
00:34:12,310 --> 00:34:10,399
northern arizona university where we're

935
00:34:26,950 --> 00:34:12,320
joined by david trilling and michael

936
00:34:31,030 --> 00:34:28,470
i'm david drilling here at northern

937
00:34:33,109 --> 00:34:31,040
arizona university we're going to take a

938
00:34:35,990 --> 00:34:33,119

few minutes and tell you about our

939
00:34:39,589 --> 00:34:36,000
results that we've obtained on 2011 md

940
00:34:41,669 --> 00:34:39,599
with the spitzer space telescope

941
00:34:43,589 --> 00:34:41,679
the first image that i want to show you

942
00:34:45,669 --> 00:34:43,599
is our final image that we obtained with

943
00:34:48,710 --> 00:34:45,679
the spitzer space telescope of this

944
00:34:50,869 --> 00:34:48,720
asteroid 2011 md what you're looking at

945
00:34:53,190 --> 00:34:50,879
this square image here and the asteroid

946
00:34:54,710 --> 00:34:53,200
is the bright spot right in the middle

947
00:34:57,589 --> 00:34:54,720
of the image of several bright pixels

948
00:34:59,750 --> 00:34:57,599
together this is a composite of about 20

949
00:35:02,310 --> 00:34:59,760
hours of staring at the asteroid with

950
00:35:03,990 --> 00:35:02,320
the spitzer space telescope that was

951
00:35:06,310 --> 00:35:04,000
earlier this year as paul showed in

952
00:35:08,550 --> 00:35:06,320
february of 2014

953
00:35:09,750 --> 00:35:08,560
we stared at the asteroid for 20 hours

954
00:35:11,589 --> 00:35:09,760
and the image you're looking at is

955
00:35:13,990 --> 00:35:11,599
actually a stack of about six or more

956
00:35:15,910 --> 00:35:14,000
than 600 individual images all stacked

957
00:35:17,510 --> 00:35:15,920
together to make this final composite

958
00:35:20,150 --> 00:35:17,520
image where we can measure the

959
00:35:21,589 --> 00:35:20,160
brightness of the asteroid

960
00:35:23,589 --> 00:35:21,599
now why do we use the spitzer space

961
00:35:25,670 --> 00:35:23,599
telescope at all that's shown on the

962
00:35:26,710 --> 00:35:25,680
next figure which is a two panel figure

963
00:35:28,790 --> 00:35:26,720

it has

964
00:35:30,870 --> 00:35:28,800
visible light on the left side infrared

965
00:35:32,790 --> 00:35:30,880
light on the right side

966
00:35:34,630 --> 00:35:32,800
as marco mentioned when you look at an

967
00:35:36,069 --> 00:35:34,640
asteroid only in visible light the light

968
00:35:38,630 --> 00:35:36,079
that most telescopes work in and that

969
00:35:40,870 --> 00:35:38,640
you can see with your eyes you cannot

970
00:35:42,870 --> 00:35:40,880
directly measure the diameter of the

971
00:35:44,470 --> 00:35:42,880
asteroid and that's indicated on the

972
00:35:46,550 --> 00:35:44,480
visible light side of this panel these

973
00:35:48,310 --> 00:35:46,560
three circles at the top

974
00:35:50,310 --> 00:35:48,320
you could imagine an asteroid could be

975
00:35:52,390 --> 00:35:50,320
small and highly reflective that's the

976
00:35:54,069 --> 00:35:52,400
left circle it could be large and have a

977
00:35:56,230 --> 00:35:54,079
low reflectivity that's the right circle

978
00:35:57,349 --> 00:35:56,240
it could be an intermediate case and all

979
00:35:59,910 --> 00:35:57,359
three of those would give you the same

980
00:36:01,750 --> 00:35:59,920
apparent brightness in visible light so

981
00:36:04,310 --> 00:36:01,760
you can't tell the diameter of the

982
00:36:05,829 --> 00:36:04,320
asteroid using visible light only

983
00:36:08,230 --> 00:36:05,839
however if we go to the right side of

984
00:36:09,589 --> 00:36:08,240
this and in in this figure the right

985
00:36:11,510 --> 00:36:09,599
panel

986
00:36:13,750 --> 00:36:11,520
where we observe an infrared light as we

987
00:36:16,310 --> 00:36:13,760
do with the spitzer space telescope in

988
00:36:17,910 --> 00:36:16,320

infrared light the measurement of the

989
00:36:20,390 --> 00:36:17,920
brightness of the asteroid tells you

990
00:36:22,710 --> 00:36:20,400
directly the diameter of the asteroid

991
00:36:23,829 --> 00:36:22,720
so we use spitzer we measure the

992
00:36:25,670 --> 00:36:23,839
brightness of the asteroid that

993
00:36:28,630 --> 00:36:25,680
immediately tells us the diameter of the

994
00:36:30,310 --> 00:36:28,640
asteroid which then allows us to derive

995
00:36:31,430 --> 00:36:30,320
additional physical properties of this

996
00:36:33,670 --> 00:36:31,440
asteroid

997
00:36:35,670 --> 00:36:33,680
and one thing i want to mention is that

998
00:36:37,589 --> 00:36:35,680
spitzer the spitzer space telescope is

999
00:36:39,190 --> 00:36:37,599
the only facility that can make this

1000
00:36:41,109 --> 00:36:39,200
kind of measurement that we're talking

1001
00:36:42,790 --> 00:36:41,119
about here

1002
00:36:44,790 --> 00:36:42,800
so my name is michael mohmert i'm a

1003
00:36:46,310 --> 00:36:44,800
postdoc here at neu

1004
00:36:48,310 --> 00:36:46,320
and

1005
00:36:50,230 --> 00:36:48,320
so from our spitzer observations we

1006
00:36:51,990 --> 00:36:50,240
derive the

1007
00:36:57,430 --> 00:36:52,000
infrared brightness of this object and

1008
00:37:01,910 --> 00:36:59,510
combined it with a measurement of the

1009
00:37:04,069 --> 00:37:01,920
brightness in the visible light

1010
00:37:06,310 --> 00:37:04,079
and we put both those numbers into a

1011
00:37:09,030 --> 00:37:06,320
computational model which gives us the

1012
00:37:11,270 --> 00:37:09,040
size and the surface reflectivity of

1013
00:37:13,270 --> 00:37:11,280

this object

1014
00:37:15,270 --> 00:37:13,280
we did this as part of our analysis

1015
00:37:17,270 --> 00:37:15,280
which has been published as of today in

1016
00:37:19,750 --> 00:37:17,280
the astrophysical journal letters and

1017
00:37:21,990 --> 00:37:19,760
the main result of this analysis is that

1018
00:37:24,470 --> 00:37:22,000
the diameter of the object so the

1019
00:37:27,910 --> 00:37:24,480
diameter or most likely diameter of 2011

1020
00:37:29,910 --> 00:37:27,920
md is 6 meters which is about 20 feet or

1021
00:37:31,349 --> 00:37:29,920
the size of a delivery truck so you

1022
00:37:33,910 --> 00:37:31,359
might actually be able to put this

1023
00:37:36,230 --> 00:37:33,920
asteroid into your garage at home

1024
00:37:38,550 --> 00:37:36,240
as a second step in our analysis we

1025
00:37:39,990 --> 00:37:38,560
combined our diameter measurement with

1026
00:37:42,390 --> 00:37:40,000
the uh

1027
00:37:43,990 --> 00:37:42,400
precise positional measurements of our

1028
00:37:45,510 --> 00:37:44,000
colleagues in hawaii they thought and

1029
00:37:46,790 --> 00:37:45,520
marco michelli

1030
00:37:50,390 --> 00:37:46,800
and

1031
00:37:51,750 --> 00:37:50,400
we found a density which is pretty

1032
00:37:54,470 --> 00:37:51,760
which is a little higher than their

1033
00:37:56,550 --> 00:37:54,480
density estimate budget but it is

1034
00:37:58,470 --> 00:37:56,560
consistent with their result and the

1035
00:38:00,630 --> 00:37:58,480
density we find is about one-third the

1036
00:38:02,870 --> 00:38:00,640
density of solid rock

1037
00:38:04,950 --> 00:38:02,880
which is about the density of water so

1038
00:38:07,910 --> 00:38:04,960

this object might actually swim if you

1039
00:38:10,230 --> 00:38:07,920
put it in a swimming pool

1040
00:38:11,910 --> 00:38:10,240
we derive the mass of this object as 100

1041
00:38:14,710 --> 00:38:11,920
tons which is just a

1042
00:38:16,870 --> 00:38:14,720
function of the diameter and the density

1043
00:38:18,870 --> 00:38:16,880
and the fact that the density we find is

1044
00:38:20,390 --> 00:38:18,880
lower than the density of solid rock

1045
00:38:21,510 --> 00:38:20,400
tells us something about the internal

1046
00:38:23,670 --> 00:38:21,520
structure

1047
00:38:26,150 --> 00:38:23,680
so on the next slide there is an

1048
00:38:27,670 --> 00:38:26,160
illustration of the porosity porosity

1049
00:38:29,829 --> 00:38:27,680
means

1050
00:38:32,390 --> 00:38:29,839
or porosity is a measure of how much

1051
00:38:33,990 --> 00:38:32,400
empty space there is in an object so

1052
00:38:36,150 --> 00:38:34,000
there are three different objects on

1053
00:38:37,430 --> 00:38:36,160
this slide on the left hand side there

1054
00:38:42,870 --> 00:38:37,440
is a

1055
00:38:45,430 --> 00:38:42,880
thermal sorry which has a very low

1056
00:38:47,190 --> 00:38:45,440
density or porosity sorry it has a very

1057
00:38:49,349 --> 00:38:47,200
low porosity

1058
00:38:51,030 --> 00:38:49,359
because it's just a solid piece of rock

1059
00:38:51,990 --> 00:38:51,040
if you would shatter this object you

1060
00:38:57,670 --> 00:38:52,000
would

1061
00:39:02,150 --> 00:38:57,680
the

1062
00:39:03,829 --> 00:39:02,160
particles and you would

1063
00:39:05,910 --> 00:39:03,839

increase the porosity

1064
00:39:09,030 --> 00:39:05,920
so in the case of 2011 md we found a

1065
00:39:11,750 --> 00:39:09,040
porosity of about 65 percent which tells

1066
00:39:14,230 --> 00:39:11,760
us that about two-thirds of the object

1067
00:39:17,990 --> 00:39:14,240
or the volume of the object is empty

1068
00:39:22,069 --> 00:39:19,270
is rock

1069
00:39:24,550 --> 00:39:22,079
so this is as marco already said this is

1070
00:39:26,390 --> 00:39:24,560
pretty unexpected because traditionally

1071
00:39:29,349 --> 00:39:26,400
people thought that

1072
00:39:31,510 --> 00:39:29,359
small asteroids like 2011 md are

1073
00:39:33,589 --> 00:39:31,520
just single pieces of rock or single

1074
00:39:35,910 --> 00:39:33,599
boulders floating in space

1075
00:39:38,550 --> 00:39:35,920
so our last slide shows an artist's

1076
00:39:42,230 --> 00:39:38,560
conception of what 2011 md might look

1077
00:39:44,230 --> 00:39:42,240
like so on the left hand side there is a

1078
00:39:45,750 --> 00:39:44,240
structure which we refer to as a rubble

1079
00:39:48,069 --> 00:39:45,760
pile structure

1080
00:39:49,750 --> 00:39:48,079
which shows the

1081
00:39:52,150 --> 00:39:49,760
asteroid as

1082
00:39:54,790 --> 00:39:52,160
basically a cloud of

1083
00:39:57,510 --> 00:39:54,800
objects a cloud of boulders that are

1084
00:39:59,030 --> 00:39:57,520
confined to limited space float around

1085
00:40:00,470 --> 00:39:59,040
in space together

1086
00:40:03,270 --> 00:40:00,480
and they are bound by their

1087
00:40:04,470 --> 00:40:03,280
gravitational forces or other forces

1088
00:40:06,150 --> 00:40:04,480

on the right hand side there is a

1089
00:40:09,430 --> 00:40:06,160
different concept which shows the

1090
00:40:11,670 --> 00:40:09,440
asteroid as a solid piece of rock as a

1091
00:40:13,589 --> 00:40:11,680
nucleus that is surrounded by a cloud of

1092
00:40:15,829 --> 00:40:13,599
dust and pebbles

1093
00:40:17,589 --> 00:40:15,839
so those are just two possible

1094
00:40:19,430 --> 00:40:17,599
possibilities what the object might look

1095
00:40:20,550 --> 00:40:19,440
like there might be other ones

1096
00:40:22,630 --> 00:40:20,560
and

1097
00:40:24,309 --> 00:40:22,640
so what we would need to con to really

1098
00:40:27,030 --> 00:40:24,319
find out what it really looks like we

1099
00:40:29,990 --> 00:40:27,040
would need more observations either from

1100
00:40:31,430 --> 00:40:30,000
telescope observations or from space

1101
00:40:34,150 --> 00:40:31,440
mission data

1102
00:40:36,309 --> 00:40:34,160
but as paul already said this won't

1103
00:40:38,550 --> 00:40:36,319
happen in the next decade so

1104
00:40:40,710 --> 00:40:38,560
yeah we will have to wait for decade to

1105
00:40:44,790 --> 00:40:40,720
find out what it really looks like and

1106
00:40:47,910 --> 00:40:46,470
great david michael thank you so much so

1107
00:40:49,750 --> 00:40:47,920
now we'll come back here to washington

1108
00:40:51,910 --> 00:40:49,760
before going to ames to hear from jason

1109
00:40:54,550 --> 00:40:51,920
kessler talk about the asteroid green

1110
00:40:55,990 --> 00:40:54,560
challenge and we'll soon take q a from

1111
00:40:58,550 --> 00:40:56,000
from media and just reminder to those of

1112
00:41:00,230 --> 00:40:58,560
you watching online you can of course

1113
00:41:02,710 --> 00:41:00,240

ask your questions on twitter using the

1114
00:41:04,630 --> 00:41:02,720
hashtag ask nasa but first i'd like to

1115
00:41:06,550 --> 00:41:04,640
come back here to headquarters to hear

1116
00:41:08,390 --> 00:41:06,560
from lindley johnson michelle gates uh

1117
00:41:10,230 --> 00:41:08,400
for uh any their analysis on the

1118
00:41:12,790 --> 00:41:10,240
implications of what we just heard for

1119
00:41:14,390 --> 00:41:12,800
uh nasa's either detection of asteroids

1120
00:41:16,470 --> 00:41:14,400
or specifically the asteroid redirect

1121
00:41:18,470 --> 00:41:16,480
mission

1122
00:41:19,589 --> 00:41:18,480
well uh let me take it trent uh it's

1123
00:41:21,910 --> 00:41:19,599
just so

1124
00:41:23,910 --> 00:41:21,920
uh over the last uh several minutes

1125
00:41:26,950 --> 00:41:23,920
you've heard the process that we go

1126
00:41:27,829 --> 00:41:26,960
through or once we uh find an object uh

1127
00:41:30,710 --> 00:41:27,839
to

1128
00:41:33,030 --> 00:41:30,720
determine uh what its size uh what is

1129
00:41:34,870 --> 00:41:33,040
composition what it is that

1130
00:41:37,349 --> 00:41:34,880
we might actually be looking at if we

1131
00:41:39,109 --> 00:41:37,359
were to go uh with the spacecraft

1132
00:41:41,750 --> 00:41:39,119
everything we can do short of actually

1133
00:41:45,270 --> 00:41:41,760
sending a spacecraft to it uh so you see

1134
00:41:46,790 --> 00:41:45,280
it's it's a a process that uh you know

1135
00:41:48,390 --> 00:41:46,800
one observation

1136
00:41:51,510 --> 00:41:48,400
leverages off another

1137
00:41:53,430 --> 00:41:51,520
observation to build up this uh

1138
00:41:55,589 --> 00:41:53,440

story or understanding

1139
00:41:56,710 --> 00:41:55,599
of what kind of object we may be looking

1140
00:41:57,750 --> 00:41:56,720
at

1141
00:41:59,510 --> 00:41:57,760
so

1142
00:42:01,190 --> 00:41:59,520
this is what we have as far as

1143
00:42:02,710 --> 00:42:01,200
information on this particular object

1144
00:42:04,069 --> 00:42:02,720
2011

1145
00:42:04,950 --> 00:42:04,079
md

1146
00:42:10,790 --> 00:42:04,960
it

1147
00:42:12,150 --> 00:42:10,800
characteristics that that could be

1148
00:42:15,030 --> 00:42:12,160
captured

1149
00:42:17,910 --> 00:42:15,040
by our our option a

1150
00:42:19,190 --> 00:42:17,920
but we will continue to to look for

1151
00:42:20,870 --> 00:42:19,200
objects

1152
00:42:22,550 --> 00:42:20,880
through our program and

1153
00:42:24,390 --> 00:42:22,560
and when we find ones that are in the

1154
00:42:26,710 --> 00:42:24,400
right orbit

1155
00:42:27,750 --> 00:42:26,720
we'll do this characterization project

1156
00:42:29,829 --> 00:42:27,760
to

1157
00:42:31,990 --> 00:42:29,839
understand as much as we can about the

1158
00:42:33,750 --> 00:42:32,000
object and add it to our pool of

1159
00:42:37,349 --> 00:42:33,760
potential candidates

1160
00:42:40,470 --> 00:42:38,870
so as only said there's much more

1161
00:42:42,150 --> 00:42:40,480
observation to come and of course there

1162
00:42:43,990 --> 00:42:42,160
are ways for the public to participate

1163
00:42:46,390 --> 00:42:44,000

in that hunt for asteroids and next

1164
00:42:47,589 --> 00:42:46,400
we'll go to jason kessler at the ames

1165
00:42:49,349 --> 00:42:47,599
research center in moffett field

1166
00:42:51,270 --> 00:42:49,359
california to tell us a little bit more

1167
00:42:54,069 --> 00:42:51,280
about nasa's asteroid grand challenge

1168
00:42:59,270 --> 00:42:56,390
thank you so much trent it's great to be

1169
00:43:02,150 --> 00:42:59,280
with you here from ames and

1170
00:43:05,109 --> 00:43:02,160
a big thanks to the

1171
00:43:06,950 --> 00:43:05,119
members that have spoken before me it's

1172
00:43:09,430 --> 00:43:06,960
always such a thrill for me to be able

1173
00:43:12,230 --> 00:43:09,440
to hear the progress that's being made

1174
00:43:13,829 --> 00:43:12,240
in the asteroid redirect mission and a

1175
00:43:16,069 --> 00:43:13,839
real big thanks

1176
00:43:18,150 --> 00:43:16,079
uh and congratulations to michelle and

1177
00:43:19,109 --> 00:43:18,160
lindley for the incredible job they're

1178
00:43:19,910 --> 00:43:19,119
doing

1179
00:43:23,190 --> 00:43:19,920
in

1180
00:43:25,750 --> 00:43:23,200
the efforts so far

1181
00:43:27,829 --> 00:43:25,760
so if we can transition now into the

1182
00:43:31,030 --> 00:43:27,839
asteroid grand challenge

1183
00:43:35,190 --> 00:43:31,040
if we could get the first slide

1184
00:43:37,750 --> 00:43:35,200
we announced on june 18 2013

1185
00:43:39,990 --> 00:43:37,760
the asteroid grand challenge to find all

1186
00:43:42,309 --> 00:43:40,000
asteroid threats to human populations

1187
00:43:45,030 --> 00:43:42,319
and know what to do about them

1188
00:43:46,390 --> 00:43:45,040

and i think as as we clearly heard

1189
00:43:49,990 --> 00:43:46,400
uh

1190
00:43:51,670 --> 00:43:50,000
just now there is a a strong group

1191
00:43:52,630 --> 00:43:51,680
an international group that's that's

1192
00:43:53,589 --> 00:43:52,640
working

1193
00:43:55,270 --> 00:43:53,599
on

1194
00:43:56,390 --> 00:43:55,280
the asteroid

1195
00:43:59,109 --> 00:43:56,400
problem

1196
00:44:00,710 --> 00:43:59,119
and the reason we announced this grand

1197
00:44:04,230 --> 00:44:00,720
challenge was not because there was an

1198
00:44:06,950 --> 00:44:04,240
impending threat or because we

1199
00:44:09,670 --> 00:44:06,960
didn't feel like we were doing the job

1200
00:44:11,589 --> 00:44:09,680
it was a recognition that nasa has used

1201
00:44:13,910 --> 00:44:11,599
open innovation tools in the past very

1202
00:44:16,470 --> 00:44:13,920
successfully and we thought

1203
00:44:18,150 --> 00:44:16,480
might be an interesting way to engage

1204
00:44:20,069 --> 00:44:18,160
the public to to see if we could

1205
00:44:24,630 --> 00:44:20,079
accelerate some of the great work that's

1206
00:44:26,790 --> 00:44:24,640
already being done and it is a testament

1207
00:44:28,870 --> 00:44:26,800
to the the folks on the front lines that

1208
00:44:29,829 --> 00:44:28,880
are doing this work it is it is not easy

1209
00:44:32,630 --> 00:44:29,839
work

1210
00:44:34,550 --> 00:44:32,640
and so if we go to the next slide

1211
00:44:35,589 --> 00:44:34,560
we'll see that the first year has really

1212
00:44:38,069 --> 00:44:35,599
been

1213
00:44:40,710 --> 00:44:38,079

around creating awareness because this

1214
00:44:42,550 --> 00:44:40,720
work is not easy and when we think about

1215
00:44:44,790 --> 00:44:42,560
engaging the public

1216
00:44:47,670 --> 00:44:44,800
we wanted to begin the conversation and

1217
00:44:48,950 --> 00:44:47,680
let people know what the issues were

1218
00:44:51,109 --> 00:44:48,960
and

1219
00:44:53,109 --> 00:44:51,119
start to feel out what communities might

1220
00:44:56,150 --> 00:44:53,119
be interested and

1221
00:44:57,670 --> 00:44:56,160
appropriate for us to engage with

1222
00:44:59,190 --> 00:44:57,680
one of the

1223
00:45:00,550 --> 00:44:59,200
more exciting things we've done in the

1224
00:45:02,470 --> 00:45:00,560
last year

1225
00:45:05,030 --> 00:45:02,480
trent mentioned the solar system

1226
00:45:07,670 --> 00:45:05,040
exploration research virtual institute

1227
00:45:09,829 --> 00:45:07,680
or survey which is based here at ames

1228
00:45:12,870 --> 00:45:09,839
survey put together a

1229
00:45:14,069 --> 00:45:12,880
a number of workshops

1230
00:45:15,750 --> 00:45:14,079
we had

1231
00:45:18,630 --> 00:45:15,760
in fact a couple of the panelists

1232
00:45:20,470 --> 00:45:18,640
lindley and paul were a part of uh

1233
00:45:22,470 --> 00:45:20,480
speaking through the asteroid grand

1234
00:45:25,829 --> 00:45:22,480
challenge seminar series

1235
00:45:28,069 --> 00:45:25,839
and we had 40 minutes from asteroid

1236
00:45:30,630 --> 00:45:28,079
experts sharing their perspective and

1237
00:45:33,190 --> 00:45:30,640
their work and then open it up to 20

1238
00:45:34,309 --> 00:45:33,200

minutes of conver of questions from the

1239
00:45:36,150 --> 00:45:34,319
public

1240
00:45:38,470 --> 00:45:36,160
and recorded all that so we were

1241
00:45:40,550 --> 00:45:38,480
building a library of information that

1242
00:45:43,109 --> 00:45:40,560
will be continually available and

1243
00:45:45,349 --> 00:45:43,119
accessible to the public online so they

1244
00:45:47,750 --> 00:45:45,359
can figure out are there areas that they

1245
00:45:49,589 --> 00:45:47,760
want to plug into

1246
00:45:52,470 --> 00:45:49,599
moving to the next slide

1247
00:45:53,750 --> 00:45:52,480
another area that we got excited about

1248
00:45:56,870 --> 00:45:53,760
was

1249
00:45:59,190 --> 00:45:56,880
tying into the already very successful

1250
00:46:02,790 --> 00:45:59,200
international space apps challenge

1251
00:46:05,910 --> 00:46:02,800
nearly 100 cities across the globe

1252
00:46:07,670 --> 00:46:05,920
participated in a week weekend long

1253
00:46:09,270 --> 00:46:07,680
hackathon if you will

1254
00:46:11,670 --> 00:46:09,280
and asteroids

1255
00:46:12,790 --> 00:46:11,680
was one of the themes and

1256
00:46:14,550 --> 00:46:12,800
we had

1257
00:46:15,829 --> 00:46:14,560
about five projects that people could

1258
00:46:20,550 --> 00:46:15,839
work on

1259
00:46:22,950 --> 00:46:20,560
and and surprisingly we got 163

1260
00:46:26,150 --> 00:46:22,960
projects developed by this community

1261
00:46:28,150 --> 00:46:26,160
that got forwarded into global judging

1262
00:46:30,069 --> 00:46:28,160
so these were projects that were deemed

1263
00:46:32,150 --> 00:46:30,079

worthy by

1264
00:46:34,150 --> 00:46:32,160
the local communities there

1265
00:46:37,510 --> 00:46:34,160
as being

1266
00:46:39,270 --> 00:46:37,520
reviewable by a larger audience

1267
00:46:41,510 --> 00:46:39,280
unfortunately the competition was quite

1268
00:46:43,030 --> 00:46:41,520
steep and none of those projects did

1269
00:46:44,470 --> 00:46:43,040
move on

1270
00:46:45,670 --> 00:46:44,480
to

1271
00:46:47,430 --> 00:46:45,680
finalists

1272
00:46:49,430 --> 00:46:47,440
but i think it's a testament to the

1273
00:46:52,230 --> 00:46:49,440
interest of the public

1274
00:46:54,870 --> 00:46:52,240
around asteroids that we saw so many

1275
00:46:57,750 --> 00:46:54,880
projects voted up

1276
00:46:59,349 --> 00:46:57,760
moving on to the next slide

1277
00:47:01,589 --> 00:46:59,359
you'll see on the right there space

1278
00:47:04,710 --> 00:47:01,599
gambit we have a space act agreement

1279
00:47:07,510 --> 00:47:04,720
with space gamut and they are

1280
00:47:09,510 --> 00:47:07,520
engaged in

1281
00:47:11,510 --> 00:47:09,520
helping the maker community open up the

1282
00:47:13,430 --> 00:47:11,520
frontiers of space

1283
00:47:14,230 --> 00:47:13,440
and one of the really exciting things

1284
00:47:15,910 --> 00:47:14,240
that

1285
00:47:17,670 --> 00:47:15,920
has happened with space gambit we had

1286
00:47:19,190 --> 00:47:17,680
reached out with them to try and figure

1287
00:47:22,230 --> 00:47:19,200
out how to build some educational

1288
00:47:24,790 --> 00:47:22,240

materials they've in fact now

1289
00:47:25,910 --> 00:47:24,800
received 28 proposals all asteroid

1290
00:47:28,069 --> 00:47:25,920
related

1291
00:47:30,470 --> 00:47:28,079
and they've down selected to fund 11 of

1292
00:47:32,870 --> 00:47:30,480
those that will be uh

1293
00:47:35,670 --> 00:47:32,880
worked on this summer and and reported

1294
00:47:37,829 --> 00:47:35,680
out on in september two of those uh

1295
00:47:40,950 --> 00:47:37,839
winners came from the space app so we're

1296
00:47:43,109 --> 00:47:40,960
starting to see that connection from uh

1297
00:47:45,510 --> 00:47:43,119
activities nasa is already doing tying

1298
00:47:46,309 --> 00:47:45,520
it into the asteroid work

1299
00:47:47,829 --> 00:47:46,319
and

1300
00:47:49,510 --> 00:47:47,839
seeing ways to take it a little bit

1301
00:47:52,069 --> 00:47:49,520
further

1302
00:47:55,109 --> 00:47:52,079
in the middle of that slide

1303
00:47:57,589 --> 00:47:55,119
if we can go back you'll see slu

1304
00:47:58,950 --> 00:47:57,599
slu is a really interesting membership

1305
00:48:00,390 --> 00:47:58,960
model

1306
00:48:03,030 --> 00:48:00,400
it enables

1307
00:48:04,870 --> 00:48:03,040
citizens that don't have a backyard or

1308
00:48:07,430 --> 00:48:04,880
don't want to invest lots of dollars in

1309
00:48:09,109 --> 00:48:07,440
a telescope to get access to

1310
00:48:10,470 --> 00:48:09,119
professional class

1311
00:48:12,790 --> 00:48:10,480
observatories

1312
00:48:15,829 --> 00:48:12,800
primarily in the canary islands

1313
00:48:18,309 --> 00:48:15,839

we've engaged with slu to try to

1314
00:48:21,829 --> 00:48:18,319
increase the number of amateurs that are

1315
00:48:23,349 --> 00:48:21,839
contributing to characterization work

1316
00:48:24,309 --> 00:48:23,359
and expect

1317
00:48:26,790 --> 00:48:24,319
some

1318
00:48:28,390 --> 00:48:26,800
curriculum development to to follow

1319
00:48:30,630 --> 00:48:28,400
along with that as well

1320
00:48:33,349 --> 00:48:30,640
and then finally you'll see planetary

1321
00:48:35,750 --> 00:48:33,359
resources we announced the space act

1322
00:48:37,589 --> 00:48:35,760
agreement with them back at the idea

1323
00:48:40,230 --> 00:48:37,599
synthesis rfi

1324
00:48:43,270 --> 00:48:40,240
workshop in the fall

1325
00:48:46,630 --> 00:48:43,280
the goal in that space act agreement was

1326
00:48:47,750 --> 00:48:46,640
to develop a algorithm initially that

1327
00:48:50,790 --> 00:48:47,760
was

1328
00:48:53,589 --> 00:48:50,800
as good as the current algorithms in in

1329
00:48:55,990 --> 00:48:53,599
determining false positives

1330
00:48:58,390 --> 00:48:56,000
we have closed that first round of

1331
00:49:00,630 --> 00:48:58,400
competition

1332
00:49:03,349 --> 00:49:00,640
it ran through the nasa tournament lab

1333
00:49:05,750 --> 00:49:03,359
and on top coder and ten thousand

1334
00:49:07,670 --> 00:49:05,760
dollars in award money has

1335
00:49:10,069 --> 00:49:07,680
been made available to the top five

1336
00:49:12,710 --> 00:49:10,079
winners of that challenge

1337
00:49:16,069 --> 00:49:12,720
and the second phase which is moving

1338
00:49:18,950 --> 00:49:16,079

into uh developing a brand new algorithm

1339
00:49:21,349 --> 00:49:18,960
to search through existing data sets to

1340
00:49:22,230 --> 00:49:21,359
find uh asteroids that might have been

1341
00:49:25,270 --> 00:49:22,240
missed

1342
00:49:27,030 --> 00:49:25,280
that that challenge will go live in in

1343
00:49:30,390 --> 00:49:27,040
july

1344
00:49:32,470 --> 00:49:30,400
in addition to that asteroid data hunter

1345
00:49:33,430 --> 00:49:32,480
challenge with planetary resources we

1346
00:49:36,549 --> 00:49:33,440
also

1347
00:49:39,190 --> 00:49:36,559
have currently a live asteroid tracker

1348
00:49:40,950 --> 00:49:39,200
challenge running on topcoder as well

1349
00:49:43,349 --> 00:49:40,960
and that's an effort to try and figure

1350
00:49:45,349 --> 00:49:43,359
out how best to place

1351
00:49:49,270 --> 00:49:45,359
radar dishes

1352
00:49:50,630 --> 00:49:49,280
to help when neos are flying nearby

1353
00:49:51,430 --> 00:49:50,640
earth

1354
00:49:52,470 --> 00:49:51,440
so

1355
00:49:54,710 --> 00:49:52,480
that

1356
00:49:57,430 --> 00:49:54,720
algorithm challenge will go live

1357
00:49:59,910 --> 00:49:57,440
in july as well so you can see there

1358
00:50:02,069 --> 00:49:59,920
there are already a handful of of ways

1359
00:50:03,670 --> 00:50:02,079
for people to be participating and

1360
00:50:07,109 --> 00:50:03,680
actually win money

1361
00:50:09,750 --> 00:50:07,119
as they help us uh with our work

1362
00:50:12,630 --> 00:50:09,760
if we go to the next slide

1363
00:50:15,670 --> 00:50:12,640

so now we're moving into year two

1364
00:50:18,950 --> 00:50:15,680
we've already had lots of conversations

1365
00:50:21,670 --> 00:50:18,960
we've attended two maker faires

1366
00:50:23,190 --> 00:50:21,680
we've spoken to numerous

1367
00:50:25,270 --> 00:50:23,200
communities

1368
00:50:26,549 --> 00:50:25,280
had online forums

1369
00:50:28,630 --> 00:50:26,559
and

1370
00:50:31,430 --> 00:50:28,640
we're really interested in taking a lot

1371
00:50:33,829 --> 00:50:31,440
of the better ideas that we got

1372
00:50:34,790 --> 00:50:33,839
from this past year and figuring out how

1373
00:50:36,549 --> 00:50:34,800
to move

1374
00:50:39,109 --> 00:50:36,559
forward

1375
00:50:42,069 --> 00:50:39,119
with the community to co-create an

1376
00:50:43,910 --> 00:50:42,079
implementation plan and so

1377
00:50:47,430 --> 00:50:43,920
that will really kick off

1378
00:50:49,030 --> 00:50:47,440
as as we wind down this session at 3 pm

1379
00:50:51,430 --> 00:50:49,040
eastern we're going to

1380
00:50:54,950 --> 00:50:51,440
start the asteroid grand challenge

1381
00:50:57,750 --> 00:50:54,960
anniversary seminar series we have an

1382
00:50:59,829 --> 00:50:57,760
asteroid data hunter session it will be

1383
00:51:01,190 --> 00:50:59,839
a 90-minute session with professional

1384
00:51:02,470 --> 00:51:01,200
and amateur

1385
00:51:05,030 --> 00:51:02,480
astronomers

1386
00:51:06,870 --> 00:51:05,040
coming together to think about how can

1387
00:51:09,270 --> 00:51:06,880
we do characterization work with

1388
00:51:11,430 --> 00:51:09,280

amateurs to help with the follow-up

1389
00:51:13,270 --> 00:51:11,440
it was mentioned a number of times

1390
00:51:14,630 --> 00:51:13,280
earlier today just how critical the

1391
00:51:15,430 --> 00:51:14,640
characterization

1392
00:51:17,910 --> 00:51:15,440
is

1393
00:51:19,510 --> 00:51:17,920
and we want to figure out a really solid

1394
00:51:21,510 --> 00:51:19,520
plan to engage

1395
00:51:24,150 --> 00:51:21,520
amateurs to help with the new

1396
00:51:25,510 --> 00:51:24,160
discoveries as as paul mentioned the

1397
00:51:29,190 --> 00:51:25,520
rate is

1398
00:51:32,470 --> 00:51:29,200
increasing over time of new discoveries

1399
00:51:35,910 --> 00:51:32,480
after that session we'll move into a

1400
00:51:38,710 --> 00:51:35,920
minor planet center and a data usage

1401
00:51:40,710 --> 00:51:38,720
session we've recognized that there is a

1402
00:51:43,109 --> 00:51:40,720
fair amount of data out there that maybe

1403
00:51:44,470 --> 00:51:43,119
not in the the easiest format for people

1404
00:51:46,790 --> 00:51:44,480
to work with

1405
00:51:49,030 --> 00:51:46,800
we've seen lots of great visualizations

1406
00:51:52,230 --> 00:51:49,040
that have helped people understand what

1407
00:51:55,030 --> 00:51:52,240
the situation is and and imagine

1408
00:51:57,589 --> 00:51:55,040
a different future and so we're going to

1409
00:52:00,390 --> 00:51:57,599
talk with coders and designers and and

1410
00:52:02,069 --> 00:52:00,400
my good friend jose luis galache from

1411
00:52:03,430 --> 00:52:02,079
the minor planet center to think about

1412
00:52:06,150 --> 00:52:03,440
how might we

1413
00:52:09,430 --> 00:52:06,160

utilize those data sets in ways that are

1414
00:52:11,589 --> 00:52:09,440
useful in communicating to folks

1415
00:52:13,109 --> 00:52:11,599
that will wrap up today's activities and

1416
00:52:16,390 --> 00:52:13,119
we'll move into

1417
00:52:18,790 --> 00:52:16,400
a session tomorrow morning david

1418
00:52:20,630 --> 00:52:18,800
morrison the survey senior scientist

1419
00:52:24,069 --> 00:52:20,640
will be giving a

1420
00:52:26,630 --> 00:52:24,079
approximately a 40-minute talk about the

1421
00:52:28,790 --> 00:52:26,640
near-earth objects

1422
00:52:30,710 --> 00:52:28,800
problem and why this is a grand

1423
00:52:31,750 --> 00:52:30,720
challenge and that will then be opened

1424
00:52:33,910 --> 00:52:31,760
up to

1425
00:52:36,230 --> 00:52:33,920
questions for the public to ask and get

1426
00:52:37,270 --> 00:52:36,240
a deeper understanding of what's going

1427
00:52:49,430 --> 00:52:37,280
on

1428
00:52:51,829 --> 00:52:49,440
energy and ingenuity of this community

1429
00:52:54,870 --> 00:52:51,839
as a really great opportunity for us to

1430
00:52:56,950 --> 00:52:54,880
figure out how can we

1431
00:52:58,710 --> 00:52:56,960
partner with makers to come up with

1432
00:52:59,510 --> 00:52:58,720
solutions that we haven't yet thought

1433
00:53:01,990 --> 00:52:59,520
about

1434
00:53:03,829 --> 00:53:02,000
and so we'll have a number of luminaries

1435
00:53:05,750 --> 00:53:03,839
in the maker community

1436
00:53:07,750 --> 00:53:05,760
talking about issues that they have and

1437
00:53:09,910 --> 00:53:07,760
trying to to map out some reasonable

1438
00:53:12,710 --> 00:53:09,920

plans that would deliver something

1439
00:53:14,549 --> 00:53:12,720
tangible that would help

1440
00:53:18,069 --> 00:53:14,559
solve this grand challenge

1441
00:53:19,270 --> 00:53:18,079
and then finally we'll close out the

1442
00:53:21,990 --> 00:53:19,280
seminar

1443
00:53:23,270 --> 00:53:22,000
series with a next generation engagement

1444
00:53:26,390 --> 00:53:23,280
session we're going to have

1445
00:53:28,390 --> 00:53:26,400
communicators educators uh coming

1446
00:53:30,390 --> 00:53:28,400
together to try to

1447
00:53:32,870 --> 00:53:30,400
think through what would

1448
00:53:36,150 --> 00:53:32,880
uh we need to do over the next coming

1449
00:53:39,190 --> 00:53:36,160
years to to really communicate to folks

1450
00:53:39,990 --> 00:53:39,200
and enroll them uh and their assistance

1451
00:53:50,309 --> 00:53:40,000
in

1452
00:53:53,349 --> 00:53:50,319
on this

1453
00:53:56,870 --> 00:53:53,359
potentially very real threat

1454
00:53:59,670 --> 00:53:56,880
we can move to the final slide

1455
00:54:01,910 --> 00:53:59,680
there you can see the the url

1456
00:54:03,910 --> 00:54:01,920
for the seminar series i i hope you'll

1457
00:54:05,349 --> 00:54:03,920
stick around and join us

1458
00:54:07,510 --> 00:54:05,359
we expect to have really lively

1459
00:54:09,270 --> 00:54:07,520
conversation that will be open uh

1460
00:54:11,270 --> 00:54:09,280
through the adobe connect chat window

1461
00:54:14,230 --> 00:54:11,280
for people ask questions as well as on

1462
00:54:16,150 --> 00:54:14,240
the hashtag asteroid gc

1463
00:54:17,910 --> 00:54:16,160

and it really is an opportunity for all

1464
00:54:19,750 --> 00:54:17,920
of us to

1465
00:54:23,109 --> 00:54:19,760
prove that we are smarter than the

1466
00:54:25,109 --> 00:54:23,119
dinosaurs and see what we can do to help

1467
00:54:28,069 --> 00:54:25,119
this expert community that is already

1468
00:54:29,910 --> 00:54:28,079
doing a really outstanding job

1469
00:54:32,069 --> 00:54:29,920
looking out for us

1470
00:54:37,030 --> 00:54:32,079
with that i will turn it back to trent

1471
00:54:39,990 --> 00:54:38,870
thanks very much jason and just help

1472
00:54:41,430 --> 00:54:40,000
punctuate that there's some really

1473
00:54:43,430 --> 00:54:41,440
incredible opportunities for the public

1474
00:54:45,430 --> 00:54:43,440
to get engaged uh in the search for

1475
00:54:47,470 --> 00:54:45,440
asteroids uh jason just recounted them

1476
00:54:50,230 --> 00:54:47,480
so again more information at

1477
00:54:52,630 --> 00:54:50,240
www.nasa.gov slash asteroid initiative

1478
00:54:54,470 --> 00:54:52,640
very exciting two-day workshop about to

1479
00:54:56,150 --> 00:54:54,480
start after this event and continue on

1480
00:54:58,150 --> 00:54:56,160
to tomorrow if you'd like to find out

1481
00:55:00,630 --> 00:54:58,160
the ways that you can help participate

1482
00:55:03,190 --> 00:55:00,640
in the in the search for asteroids so

1483
00:55:05,430 --> 00:55:03,200
with that we'll circle back and we will

1484
00:55:07,589 --> 00:55:05,440
begin a q a i think we have some

1485
00:55:08,710 --> 00:55:07,599
reporter questions here in the room on

1486
00:55:10,549 --> 00:55:08,720
the line and then we'll go to your

1487
00:55:12,230 --> 00:55:10,559
questions on twitter and again you can

1488
00:55:15,349 --> 00:55:12,240

ask questions of our panelists using the

1489
00:55:19,430 --> 00:55:15,359
hashtag asknasa and we'll start here in

1490
00:55:23,430 --> 00:55:21,270
everybody dan leone with space news

1491
00:55:25,510 --> 00:55:23,440
please excuse my voice

1492
00:55:27,430 --> 00:55:25,520
so my questions are for lindley and

1493
00:55:29,430 --> 00:55:27,440
michelle here in the studio

1494
00:55:31,430 --> 00:55:29,440
uh the latest candidate asteroids when

1495
00:55:33,589 --> 00:55:31,440
would those be retrievable to the

1496
00:55:35,750 --> 00:55:33,599
desired lunar parking orbit

1497
00:55:37,510 --> 00:55:35,760
and when will you select one of the two

1498
00:55:39,990 --> 00:55:37,520
mission concepts and then as a

1499
00:55:41,910 --> 00:55:40,000
parenthetical what's the most important

1500
00:55:43,670 --> 00:55:41,920
selection criteria in there is it going

1501
00:55:45,430 --> 00:55:43,680
to be the cost of the mission the

1502
00:55:47,910 --> 00:55:45,440
relative ease of the mission the

1503
00:55:52,390 --> 00:55:47,920
extensibility of the retrieval craft to

1504
00:55:52,400 --> 00:55:55,109
part one

1505
00:56:01,510 --> 00:55:59,670
well um as far as when these candidates

1506
00:56:04,710 --> 00:56:01,520
would be

1507
00:56:05,829 --> 00:56:04,720
accessible for the redirect mission it

1508
00:56:12,230 --> 00:56:05,839
it

1509
00:56:13,349 --> 00:56:12,240
when they

1510
00:56:15,510 --> 00:56:13,359
come back

1511
00:56:17,109 --> 00:56:15,520
to the vicinity of the earth

1512
00:56:19,030 --> 00:56:17,119
but all of the candidates that we've

1513
00:56:21,190 --> 00:56:19,040

talked about uh we've determined that

1514
00:56:23,589 --> 00:56:21,200
their orbits are such that uh

1515
00:56:26,069 --> 00:56:23,599
they are in that uh positions you know

1516
00:56:28,309 --> 00:56:26,079
sometime in the early 20s that

1517
00:56:30,870 --> 00:56:28,319
by candidate it varies from

1518
00:56:33,349 --> 00:56:30,880
2021 to 2024

1519
00:56:35,190 --> 00:56:33,359
uh 2011 md which we specifically talked

1520
00:56:38,150 --> 00:56:35,200
about its opportunity

1521
00:56:42,150 --> 00:56:38,160
uh to uh uh redirect it into the lunar

1522
00:56:48,150 --> 00:56:45,349
but it does uh it uh it depends on on

1523
00:56:50,549 --> 00:56:48,160
the orbit uh the size of the object uh

1524
00:56:51,510 --> 00:56:50,559
and what option is used uh uh quite

1525
00:56:54,630 --> 00:56:51,520
frankly

1526
00:56:57,829 --> 00:56:54,640
uh as to when the robotic spacecraft uh

1527
00:57:00,150 --> 00:56:57,839
has to arrive at at the asteroid and

1528
00:57:03,109 --> 00:57:00,160
begin the redirection and then how long

1529
00:57:05,190 --> 00:57:03,119
it takes to uh to move it into the into

1530
00:57:07,030 --> 00:57:05,200
the lunar orbit but all the candidates

1531
00:57:09,270 --> 00:57:07,040
we talk about they are

1532
00:57:12,950 --> 00:57:09,280
viable candidates because uh they fit

1533
00:57:14,309 --> 00:57:12,960
within that window of the early 20

1534
00:57:17,510 --> 00:57:14,319
early 20s

1535
00:57:20,789 --> 00:57:19,430
yeah so all the candidates on our target

1536
00:57:22,630 --> 00:57:20,799
list

1537
00:57:25,030 --> 00:57:22,640
fit in that on our

1538
00:57:28,390 --> 00:57:25,040

valid target and candidate target list

1539
00:57:32,710 --> 00:57:30,470
the schedule for

1540
00:57:33,910 --> 00:57:32,720
down selection of the robotic mission

1541
00:57:36,150 --> 00:57:33,920
concept

1542
00:57:37,829 --> 00:57:36,160
is currently for that decision point to

1543
00:57:40,470 --> 00:57:37,839
take place

1544
00:57:42,630 --> 00:57:40,480
late this year likely mid-december

1545
00:57:45,990 --> 00:57:42,640
and would feed into our mission concept

1546
00:57:48,630 --> 00:57:46,000
review in february of next year

1547
00:57:51,030 --> 00:57:48,640
we don't plan to

1548
00:57:52,309 --> 00:57:51,040
nor do we want to stop actually looking

1549
00:57:54,710 --> 00:57:52,319
for targets

1550
00:57:56,549 --> 00:57:54,720
at that time our current schedule shows

1551
00:57:59,589 --> 00:57:56,559
that we wouldn't need to

1552
00:58:02,789 --> 00:57:59,599
actually um make a final selection of a

1553
00:58:05,510 --> 00:58:02,799
target until one year before launch

1554
00:58:07,990 --> 00:58:05,520
and we'd like to actually keep looking

1555
00:58:10,470 --> 00:58:08,000
and allow our esteemed colleagues and

1556
00:58:12,309 --> 00:58:10,480
the assets that they're bringing online

1557
00:58:15,109 --> 00:58:12,319
to continue to find potentially better

1558
00:58:17,910 --> 00:58:15,119
and better targets

1559
00:58:20,309 --> 00:58:17,920
so the criteria of which the

1560
00:58:22,069 --> 00:58:20,319
final selection would take place is

1561
00:58:23,510 --> 00:58:22,079
still under development and we actually

1562
00:58:25,510 --> 00:58:23,520
plan to share

1563
00:58:27,030 --> 00:58:25,520

that thinking um throughout the year

1564
00:58:29,030 --> 00:58:27,040
with the community

1565
00:58:33,109 --> 00:58:29,040
uh and um

1566
00:58:37,349 --> 00:58:35,030
thank you okay so we'll go to the phone

1567
00:58:38,710 --> 00:58:37,359
lines now and for the reporters there uh

1568
00:58:40,710 --> 00:58:38,720
if you wouldn't mind trying to direct

1569
00:58:42,549 --> 00:58:40,720
your question to uh specific any of the

1570
00:58:44,230 --> 00:58:42,559
specific speakers that you've heard from

1571
00:58:46,309 --> 00:58:44,240
today that'll help us with the the video

1572
00:58:47,829 --> 00:58:46,319
and the audio sources but we'll begin on

1573
00:58:49,750 --> 00:58:47,839
the phone line with seth bornstein the

1574
00:58:52,069 --> 00:58:49,760
associated press go ahead seth

1575
00:58:54,470 --> 00:58:52,079
yes thanks for doing this this is for uh

1576
00:58:57,750 --> 00:58:54,480
michelle and lemley there in d.c

1577
00:59:00,230 --> 00:58:57,760
um first the the option b is not one

1578
00:59:02,549 --> 00:59:00,240
that was originally talked about uh is

1579
00:59:04,630 --> 00:59:02,559
it more of a secondary option than the

1580
00:59:06,870 --> 00:59:04,640
first um because i mean you're not

1581
00:59:09,109 --> 00:59:06,880
actually redirecting an entire asteroid

1582
00:59:11,270 --> 00:59:09,119
is i mean why even bring up the whole

1583
00:59:14,150 --> 00:59:11,280
concept of option b is it a safety a

1584
00:59:15,270 --> 00:59:14,160
money issue and then my second question

1585
00:59:17,430 --> 00:59:15,280
then please

1586
00:59:19,750 --> 00:59:17,440
answer this don't don't avoid that since

1587
00:59:21,910 --> 00:59:19,760
it's a by two-part question

1588
00:59:23,829 --> 00:59:21,920

have you got a cost estimate

1589
00:59:25,910 --> 00:59:23,839
um either for a

1590
00:59:27,829 --> 00:59:25,920
and the cost estimate for b or just a

1591
00:59:30,069 --> 00:59:27,839
cost estimate you know how much is this

1592
00:59:32,870 --> 00:59:30,079
going to cost taxpayers

1593
00:59:36,309 --> 00:59:32,880
and and finally if it's this rubble pile

1594
00:59:39,910 --> 00:59:36,319
how do astronauts uh not get hurt with

1595
00:59:41,349 --> 00:59:39,920
all the schmutz hanging around thank you

1596
00:59:43,109 --> 00:59:41,359
uh sure

1597
00:59:46,630 --> 00:59:43,119
so i might need a little help actually

1598
00:59:48,230 --> 00:59:46,640
with with reminding me what one was

1599
00:59:49,910 --> 00:59:48,240
oh i remember

1600
00:59:51,190 --> 00:59:49,920
so you might remember from last year

1601
00:59:53,990 --> 00:59:51,200
that the

1602
00:59:56,470 --> 00:59:54,000
what we called the reference concept for

1603
00:59:58,789 --> 00:59:56,480
the redirect mission was the

1604
01:00:01,750 --> 00:59:58,799
enveloping of a single

1605
01:00:03,510 --> 01:00:01,760
free-floating small asteroid as part of

1606
01:00:05,430 --> 01:00:03,520
our trade studies and analysis of

1607
01:00:07,750 --> 01:00:05,440
alternatives that we did over the summer

1608
01:00:09,510 --> 01:00:07,760
we looked at several other

1609
01:00:11,190 --> 01:00:09,520
both system and

1610
01:00:12,390 --> 01:00:11,200
mission concepts

1611
01:00:15,829 --> 01:00:12,400
and

1612
01:00:18,950 --> 01:00:15,839
the uh what we're now calling option b

1613
01:00:20,950 --> 01:00:18,960

uh an option a as a result of the

1614
01:00:23,109 --> 01:00:20,960
programmatic and technical risk

1615
01:00:25,910 --> 01:00:23,119
assessment that we did

1616
01:00:29,829 --> 01:00:25,920
over the fall and presented

1617
01:00:32,630 --> 01:00:29,839
much of it at the opportunities forum

1618
01:00:34,630 --> 01:00:32,640
are equally weighed at this time we're

1619
01:00:36,230 --> 01:00:34,640
going through

1620
01:00:38,150 --> 01:00:36,240
additional technical

1621
01:00:40,829 --> 01:00:38,160
risk understanding and risk reduction

1622
01:00:43,829 --> 01:00:40,839
for both capture options as well as the

1623
01:00:44,549 --> 01:00:43,839
continued search and characterization of

1624
01:00:47,030 --> 01:00:44,559
the

1625
01:00:49,109 --> 01:00:47,040
potential candidates to come to that

1626
01:00:51,430 --> 01:00:49,119
down select decision late this year that

1627
01:00:52,870 --> 01:00:51,440
i talked about earlier

1628
01:00:54,309 --> 01:00:52,880
on the cost

1629
01:00:57,270 --> 01:00:54,319
of course our

1630
01:00:59,510 --> 01:00:57,280
internal studies have resulted in

1631
01:01:01,510 --> 01:00:59,520
increasingly refined cost estimates for

1632
01:01:03,670 --> 01:01:01,520
both options

1633
01:01:06,230 --> 01:01:03,680
and we do consider them both to be

1634
01:01:09,190 --> 01:01:06,240
equally on the table

1635
01:01:10,870 --> 01:01:09,200
and both within the overall cost

1636
01:01:13,030 --> 01:01:10,880
envelope that the associate

1637
01:01:15,270 --> 01:01:13,040
administrator actually mentioned

1638
01:01:17,270 --> 01:01:15,280

in one of the forms the strategy forum

1639
01:01:19,109 --> 01:01:17,280
or the opportunities forum

1640
01:01:21,109 --> 01:01:19,119
uh in spring of this year i think it was

1641
01:01:24,069 --> 01:01:21,119
the one in april

1642
01:01:26,789 --> 01:01:24,079
which was approximately um half the

1643
01:01:29,910 --> 01:01:26,799
estimated value the estimated cost of

1644
01:01:32,549 --> 01:01:29,920
the keck study concept

1645
01:01:34,390 --> 01:01:32,559
and then what was so it was it was 1.25

1646
01:01:36,630 --> 01:01:34,400
billion roughly right if the original

1647
01:01:39,430 --> 01:01:36,640
concept study was 2.5 billion and half

1648
01:01:42,069 --> 01:01:39,440
would be about 1.25 and and so we still

1649
01:01:44,390 --> 01:01:42,079
fully expect i mean as robert lightfoot

1650
01:01:46,309 --> 01:01:44,400
said that um that development estimate

1651
01:01:49,270 --> 01:01:46,319
would come within that within that range

1652
01:01:51,510 --> 01:01:49,280
or or less right so can you in seth what

1653
01:01:53,349 --> 01:01:51,520
was number three third question

1654
01:01:57,510 --> 01:01:53,359
was was about the rubble pile

1655
01:02:03,829 --> 01:02:00,870
okay well what you saw depicted by the

1656
01:02:06,630 --> 01:02:03,839
folks at northern arizona university is

1657
01:02:08,789 --> 01:02:06,640
is uh some of their idea of what the

1658
01:02:10,789 --> 01:02:08,799
object might look like just a couple of

1659
01:02:13,430 --> 01:02:10,799
examples i i

1660
01:02:16,390 --> 01:02:13,440
would kind of uh

1661
01:02:18,230 --> 01:02:16,400
describe those as maybe kind of extreme

1662
01:02:20,470 --> 01:02:18,240
examples

1663
01:02:21,349 --> 01:02:20,480

it all depends on what the

1664
01:02:25,750 --> 01:02:21,359
uh

1665
01:02:27,750 --> 01:02:25,760
material is

1666
01:02:30,950 --> 01:02:27,760
uh they gave some depictions of if it

1667
01:02:32,069 --> 01:02:30,960
were solid rock uh you see this uh

1668
01:02:35,349 --> 01:02:32,079
um

1669
01:02:37,589 --> 01:02:35,359
a bunch of of rocks uh rather large

1670
01:02:38,630 --> 01:02:37,599
uh rocks uh uh flying together if

1671
01:02:40,549 --> 01:02:38,640
they're more

1672
01:02:41,589 --> 01:02:40,559
of a porous rock

1673
01:02:44,789 --> 01:02:41,599
um

1674
01:02:47,029 --> 01:02:44,799
uh then uh it would be a tighter tighter

1675
01:02:50,150 --> 01:02:47,039
coupling now but this rubble pile

1676
01:02:51,670 --> 01:02:50,160
structure uh which you see by the way on

1677
01:02:54,630 --> 01:02:51,680
on the on the slide that's up with

1678
01:02:56,870 --> 01:02:54,640
itakawa that's that's a larger

1679
01:02:58,150 --> 01:02:56,880
asteroid that is what we consider a

1680
01:03:02,630 --> 01:02:58,160
rubble pile

1681
01:03:05,430 --> 01:03:02,640
and the uh the density of that object is

1682
01:03:07,910 --> 01:03:05,440
not uh it's not uh solid rock either

1683
01:03:11,589 --> 01:03:07,920
because it is a

1684
01:03:13,670 --> 01:03:11,599
conglomeration of of smaller rocks

1685
01:03:16,470 --> 01:03:13,680
and uh pebbles and dust that is just

1686
01:03:17,190 --> 01:03:16,480
held together by their mutual gravity

1687
01:03:19,190 --> 01:03:17,200
so

1688
01:03:20,950 --> 01:03:19,200

the depiction images that you saw i

1689
01:03:22,870 --> 01:03:20,960
think are maybe

1690
01:03:25,190 --> 01:03:22,880
on the extreme

1691
01:03:27,109 --> 01:03:25,200
side of what might be

1692
01:03:31,190 --> 01:03:27,119
what might be encountered

1693
01:03:33,750 --> 01:03:31,200
i would expect it to be more closely

1694
01:03:36,950 --> 01:03:33,760
consolidated object that

1695
01:03:39,510 --> 01:03:36,960
for the option a could be encapsulated

1696
01:03:41,990 --> 01:03:39,520
in this inflatable structure inflatable

1697
01:03:43,430 --> 01:03:42,000
bag if you want to call it that and all

1698
01:03:45,910 --> 01:03:43,440
contained

1699
01:03:47,430 --> 01:03:45,920
within that bag

1700
01:03:50,069 --> 01:03:47,440
let's go back to the phone line and we

1701
01:03:51,589 --> 01:03:50,079
will go to alan boyle msnbc go ahead

1702
01:03:53,829 --> 01:03:51,599
allen

1703
01:03:55,750 --> 01:03:53,839
yes hi i think

1704
01:03:58,390 --> 01:03:55,760
this is probably for lindley

1705
01:04:00,710 --> 01:03:58,400
i think a lot of people are when they

1706
01:04:03,910 --> 01:04:00,720
hear asteroids they are thinking

1707
01:04:05,270 --> 01:04:03,920
armageddon or deep impact and

1708
01:04:06,789 --> 01:04:05,280
want to hear

1709
01:04:10,870 --> 01:04:06,799
what

1710
01:04:12,789 --> 01:04:10,880
terms of addressing the potential threat

1711
01:04:14,390 --> 01:04:12,799
from asteroids maybe you could provide a

1712
01:04:17,029 --> 01:04:14,400
little more information on this subject

1713
01:04:20,230 --> 01:04:17,039

and and perhaps there are ways that

1714
01:04:22,549 --> 01:04:20,240
the asteroid retrieval mission could uh

1715
01:04:24,309 --> 01:04:22,559
could pursue those goals i know that uh

1716
01:04:26,390 --> 01:04:24,319
you mentioned one of the one of the

1717
01:04:27,990 --> 01:04:26,400
targets is asteroid bennu which is

1718
01:04:31,029 --> 01:04:28,000
considered a potentially hazardous

1719
01:04:33,589 --> 01:04:31,039
asteroid so uh is that the sort of thing

1720
01:04:35,910 --> 01:04:33,599
that you want to address in in the

1721
01:04:37,670 --> 01:04:35,920
mission ahead and in the initiatives

1722
01:04:40,230 --> 01:04:37,680
that you're following for

1723
01:04:41,589 --> 01:04:40,240
uh for learning more about asteroids

1724
01:04:43,029 --> 01:04:41,599
thank you

1725
01:04:45,670 --> 01:04:43,039
question

1726
01:04:47,670 --> 01:04:45,680
um sure uh if you're doing the movies do

1727
01:04:49,109 --> 01:04:47,680
a wonderful job of planting in people's

1728
01:04:51,589 --> 01:04:49,119
heads an image of what we're talking

1729
01:04:53,430 --> 01:04:51,599
about uh unfortunately it's not always

1730
01:04:55,910 --> 01:04:53,440
uh what's uh what you see in hollywood

1731
01:04:56,950 --> 01:04:55,920
is uh not always reality

1732
01:05:00,549 --> 01:04:56,960
uh but

1733
01:05:03,109 --> 01:05:00,559
uh uh these uh uh uh what we're doing

1734
01:05:06,150 --> 01:05:03,119
here for the arm mission is uh what we

1735
01:05:07,990 --> 01:05:06,160
consider sort of a subset of what we're

1736
01:05:10,950 --> 01:05:08,000
trying to accomplish with the near-earth

1737
01:05:13,349 --> 01:05:10,960
object observation mission

1738
01:05:16,470 --> 01:05:13,359

because we are trying to find the

1739
01:05:18,390 --> 01:05:16,480
population of of asteroids that could

1740
01:05:20,870 --> 01:05:18,400
potentially

1741
01:05:22,710 --> 01:05:20,880
be a hazard of impacting the earth

1742
01:05:24,789 --> 01:05:22,720
some someday in the future

1743
01:05:26,069 --> 01:05:24,799
we're naturally looking for all the

1744
01:05:27,510 --> 01:05:26,079
objects that

1745
01:05:29,910 --> 01:05:27,520
that come into

1746
01:05:31,829 --> 01:05:29,920
close to the earth and have earth-like

1747
01:05:33,910 --> 01:05:31,839
orbits they're a subset of that overall

1748
01:05:37,510 --> 01:05:33,920
population

1749
01:05:40,470 --> 01:05:37,520
so in doing our uh larger mission of

1750
01:05:43,430 --> 01:05:40,480
finding the neo population we are

1751
01:05:46,309 --> 01:05:43,440
finding the subset of potential targets

1752
01:05:49,270 --> 01:05:46,319
now in uh talking about

1753
01:05:50,870 --> 01:05:49,280
so what does the r mission do the other

1754
01:05:54,710 --> 01:05:50,880
direction for

1755
01:05:58,150 --> 01:05:55,829
the

1756
01:05:59,910 --> 01:05:58,160
capabilities that we're looking at

1757
01:06:03,190 --> 01:05:59,920
for demonstration

1758
01:06:06,390 --> 01:06:03,200
by the robotic spacecraft

1759
01:06:08,789 --> 01:06:06,400
are um adding to our uh

1760
01:06:11,589 --> 01:06:08,799
uh knowledge and techniques of what

1761
01:06:14,789 --> 01:06:11,599
might be done uh for an asteroid that's

1762
01:06:16,549 --> 01:06:14,799
on a uh hazardous trajectory and in fact

1763
01:06:18,789 --> 01:06:16,559

that's one of the reasons why we started

1764
01:06:20,870 --> 01:06:18,799
looking at option b

1765
01:06:21,589 --> 01:06:20,880
because with option a

1766
01:06:26,069 --> 01:06:21,599
the

1767
01:06:28,630 --> 01:06:26,079
less than 10 meters in size

1768
01:06:30,390 --> 01:06:28,640
that would never represent a hazard to

1769
01:06:32,150 --> 01:06:30,400
the earth because that's such a small

1770
01:06:34,470 --> 01:06:32,160
size that the earth's atmosphere does a

1771
01:06:36,230 --> 01:06:34,480
very good job of protecting us from any

1772
01:06:37,109 --> 01:06:36,240
object that small they

1773
01:06:41,829 --> 01:06:37,119
they

1774
01:06:44,150 --> 01:06:41,839
will be some meteorites that would

1775
01:06:45,349 --> 01:06:44,160
survive the energy but there's really no

1776
01:06:48,230 --> 01:06:45,359
great hazard

1777
01:06:50,390 --> 01:06:48,240
we see those kind of events

1778
01:06:52,950 --> 01:06:50,400
in earth's atmosphere at least

1779
01:06:55,510 --> 01:06:52,960
you know several times a year

1780
01:07:00,710 --> 01:06:57,910
for testing of planetary defense

1781
01:07:03,270 --> 01:07:00,720
techniques redefine direction or

1782
01:07:04,309 --> 01:07:03,280
deflection of an asteroid that is a true

1783
01:07:05,750 --> 01:07:04,319
hazard

1784
01:07:07,750 --> 01:07:05,760
uh that

1785
01:07:09,750 --> 01:07:07,760
we would want to prevent it from

1786
01:07:12,309 --> 01:07:09,760
impacting the earth

1787
01:07:14,630 --> 01:07:12,319
that's what led us to looking at uh

1788
01:07:17,430 --> 01:07:14,640

maybe we could do uh something on this

1789
01:07:18,710 --> 01:07:17,440
mission uh with a larger asteroid and

1790
01:07:20,870 --> 01:07:18,720
before

1791
01:07:23,510 --> 01:07:20,880
we pick up a large boulder from this

1792
01:07:26,710 --> 01:07:23,520
larger asteroid do some demonstration of

1793
01:07:27,430 --> 01:07:26,720
uh deflection techniques uh one that uh

1794
01:07:29,589 --> 01:07:27,440
is

1795
01:07:31,430 --> 01:07:29,599
uh certainly on the table and looks very

1796
01:07:33,430 --> 01:07:31,440
attractive as a demonstration of a

1797
01:07:35,109 --> 01:07:33,440
gravity tractor

1798
01:07:37,109 --> 01:07:35,119
which is the

1799
01:07:38,870 --> 01:07:37,119
by the gravity mutual attraction between

1800
01:07:40,950 --> 01:07:38,880
the spacecraft

1801
01:07:43,190 --> 01:07:40,960
and the asteroid

1802
01:07:45,430 --> 01:07:43,200
gravitational attraction

1803
01:07:48,549 --> 01:07:45,440
you can slowly

1804
01:07:49,829 --> 01:07:48,559
tug the asteroid off that hazardous

1805
01:07:51,829 --> 01:07:49,839
trajectory

1806
01:07:54,150 --> 01:07:51,839
now we could do that demonstration

1807
01:07:56,630 --> 01:07:54,160
before we pick up the boulder or even

1808
01:07:58,789 --> 01:07:56,640
better we can do it after we pick up the

1809
01:08:00,549 --> 01:07:58,799
boulder and do what we are calling an

1810
01:08:01,829 --> 01:08:00,559
enhanced gravity tractor demonstration

1811
01:08:03,670 --> 01:08:01,839
where we are

1812
01:08:05,990 --> 01:08:03,680
using that mass of the boulder to

1813
01:08:07,910 --> 01:08:06,000

enhance the mass of the spacecraft and

1814
01:08:10,390 --> 01:08:07,920
we have an even more

1815
01:08:12,870 --> 01:08:10,400
a greater uh gravity attraction between

1816
01:08:16,630 --> 01:08:12,880
those two objects and therefore you can

1817
01:08:18,550 --> 01:08:16,640
effect the uh trajectory

1818
01:08:19,590 --> 01:08:18,560
difference uh in a shorter period of

1819
01:08:21,030 --> 01:08:19,600
time

1820
01:08:24,309 --> 01:08:21,040
so that's how

1821
01:08:25,110 --> 01:08:24,319
these two things are are kind of related

1822
01:08:25,990 --> 01:08:25,120
and

1823
01:08:28,149 --> 01:08:26,000
they

1824
01:08:30,550 --> 01:08:28,159
you know we're we're supporting the arm

1825
01:08:32,950 --> 01:08:30,560
mission with our observation program and

1826
01:08:35,030 --> 01:08:32,960
in turn the arm mission can support our

1827
01:08:36,870 --> 01:08:35,040
planetary defense objectives by doing

1828
01:08:39,510 --> 01:08:36,880
some demonstration of the

1829
01:08:41,189 --> 01:08:39,520
the techniques and technology that uh

1830
01:08:45,349 --> 01:08:41,199
would would be used

1831
01:08:46,550 --> 01:08:45,359
uh to deflect a hazardous asteroid

1832
01:08:48,709 --> 01:08:46,560
that's a great

1833
01:08:50,070 --> 01:08:48,719
additional distinction between option a

1834
01:08:51,269 --> 01:08:50,080
and option b

1835
01:08:53,590 --> 01:08:51,279
and was

1836
01:08:54,550 --> 01:08:53,600
in fact one of the driving interests for

1837
01:08:56,870 --> 01:08:54,560
um

1838
01:08:59,910 --> 01:08:56,880

pursuing the detailed study of option b

1839
01:09:03,910 --> 01:09:01,749
okay thank you alan let's take a few

1840
01:09:04,829 --> 01:09:03,920
questions from social media and we'll

1841
01:09:07,110 --> 01:09:04,839
start here

1842
01:09:09,829 --> 01:09:07,120
jason wonderful this question comes from

1843
01:09:13,030 --> 01:09:09,839
twitter user jason who asks the artist

1844
01:09:15,749 --> 01:09:13,040
conception of 2011 md was a rubble pile

1845
01:09:20,309 --> 01:09:15,759
would you snag the entire pile using arm

1846
01:09:23,990 --> 01:09:21,990
uh so

1847
01:09:26,550 --> 01:09:24,000
um just again

1848
01:09:27,669 --> 01:09:26,560
emphasizing on a couple points lonely

1849
01:09:29,990 --> 01:09:27,679
just made

1850
01:09:33,189 --> 01:09:30,000
the option a

1851
01:09:35,189 --> 01:09:33,199
inflatable structure is actually

1852
01:09:40,070 --> 01:09:35,199
designed to envelop

1853
01:09:40,080 --> 01:09:43,749
mechanical

1854
01:09:47,269 --> 01:09:44,950
different configurations different

1855
01:09:48,870 --> 01:09:47,279
configurations of the ass candidate

1856
01:09:52,229 --> 01:09:48,880
asteroid and so

1857
01:09:55,669 --> 01:09:52,239
uh ideally we'd be able to capture

1858
01:09:57,030 --> 01:09:55,679
all of the large portions uh if indeed

1859
01:09:59,990 --> 01:09:57,040
one of those

1860
01:10:04,390 --> 01:10:00,000
artists conceptions is accurate

1861
01:10:07,270 --> 01:10:04,400
uh and you know the dust um components

1862
01:10:08,870 --> 01:10:07,280
um and those would probably

1863
01:10:11,189 --> 01:10:08,880

um we think

1864
01:10:13,270 --> 01:10:11,199
potentially um

1865
01:10:15,430 --> 01:10:13,280
be uh

1866
01:10:16,709 --> 01:10:15,440
remind me again of actually paul had the

1867
01:10:18,470 --> 01:10:16,719
answer i don't know if we can go back

1868
01:10:20,630 --> 01:10:18,480
and forth but paul mentioned last week

1869
01:10:22,310 --> 01:10:20,640
well um

1870
01:10:24,310 --> 01:10:22,320
it wouldn't be dust

1871
01:10:26,550 --> 01:10:24,320
that would be around the object because

1872
01:10:29,350 --> 01:10:26,560
as we were talking earlier

1873
01:10:31,830 --> 01:10:31,030
uh interviews that

1874
01:10:32,709 --> 01:10:31,840
uh

1875
01:10:35,910 --> 01:10:32,719
um

1876
01:10:39,270 --> 01:10:35,920
solar pressure uh uh will quickly blow

1877
01:10:41,510 --> 01:10:39,280
the dust away from uh from an object so

1878
01:10:43,510 --> 01:10:41,520
it's it's more likely

1879
01:10:44,790 --> 01:10:43,520
a small pebble-like structure

1880
01:10:47,030 --> 01:10:44,800
that's around it

1881
01:10:49,669 --> 01:10:47,040
but you need to keep in mind that this

1882
01:10:52,149 --> 01:10:49,679
is all material that is that is orbiting

1883
01:10:54,790 --> 01:10:52,159
together so it has the same

1884
01:10:57,590 --> 01:10:54,800
relative velocity and with the capture

1885
01:10:59,030 --> 01:10:57,600
spacecraft we are matching the velocity

1886
01:11:00,950 --> 01:10:59,040
to uh

1887
01:11:02,950 --> 01:11:00,960
to move up on it and and capture that

1888
01:11:04,470 --> 01:11:02,960

material so it's not like this material

1889
01:11:05,510 --> 01:11:04,480
is moving at

1890
01:11:09,910 --> 01:11:05,520
even

1891
01:11:12,390 --> 01:11:09,920
different uh

1892
01:11:15,270 --> 01:11:12,400
different velocity so it's its ability

1893
01:11:17,990 --> 01:11:15,280
to to really do any damages

1894
01:11:18,950 --> 01:11:18,000
is negligible

1895
01:11:20,470 --> 01:11:18,960
but

1896
01:11:24,390 --> 01:11:20,480
with the option a

1897
01:11:27,430 --> 01:11:24,400
concept it is to envelop the entire

1898
01:11:29,590 --> 01:11:27,440
material and our estimates on the the

1899
01:11:33,990 --> 01:11:29,600
size and mass of that material

1900
01:11:37,430 --> 01:11:34,000
is shows that is it's it's within the

1901
01:11:38,550 --> 01:11:37,440
bounds of what the option a can uh can

1902
01:11:41,030 --> 01:11:38,560
achieve

1903
01:11:42,149 --> 01:11:41,040
so yes and we do intend to encapsulate

1904
01:11:44,070 --> 01:11:42,159
the entire

1905
01:11:45,990 --> 01:11:44,080
entire object

1906
01:11:47,430 --> 01:11:46,000
uh let's take another

1907
01:11:50,390 --> 01:11:47,440
wonderful this question comes from

1908
01:11:52,470 --> 01:11:50,400
twitter user jp who asks how will the

1909
01:11:56,229 --> 01:11:52,480
arm help to deflect potentially

1910
01:11:58,790 --> 01:11:57,910
so yeah could you maybe recap a little

1911
01:12:00,870 --> 01:11:58,800
bit

1912
01:12:03,110 --> 01:12:00,880
right yeah i went into that in the in

1913
01:12:04,229 --> 01:12:03,120

the previous answer but uh

1914
01:12:07,270 --> 01:12:04,239
uh

1915
01:12:09,430 --> 01:12:07,280
we do intend to demonstrate a couple of

1916
01:12:11,590 --> 01:12:09,440
different techniques one would be what

1917
01:12:12,470 --> 01:12:11,600
was called the gravity tractor

1918
01:12:16,950 --> 01:12:12,480
uh

1919
01:12:21,030 --> 01:12:16,960
between the spacecraft and and the

1920
01:12:23,990 --> 01:12:21,040
asteroid either before or after it has

1921
01:12:26,390 --> 01:12:24,000
the mass uh but also another technique

1922
01:12:29,189 --> 01:12:26,400
uh that uh is being talked about is what

1923
01:12:32,310 --> 01:12:29,199
is called a an ion uh beam deflection

1924
01:12:34,709 --> 01:12:32,320
where we use the ion thrusters that are

1925
01:12:36,229 --> 01:12:34,719
on this uh solar electric propulsion

1926
01:12:38,870 --> 01:12:36,239
spacecraft

1927
01:12:40,149 --> 01:12:38,880
and uh we usually turn around and

1928
01:12:41,750 --> 01:12:40,159
actually

1929
01:12:43,990 --> 01:12:41,760
blow against the

1930
01:12:44,790 --> 01:12:44,000
clinch the asteroid

1931
01:12:47,830 --> 01:12:44,800
and

1932
01:12:49,510 --> 01:12:47,840
the ions impacting on the on the

1933
01:12:51,350 --> 01:12:49,520
asteroid surface

1934
01:12:52,950 --> 01:12:51,360
is like sunlight

1935
01:12:56,070 --> 01:12:52,960
it gives it a

1936
01:12:58,709 --> 01:12:56,080
momentum transfer and will slowly move

1937
01:13:01,270 --> 01:12:58,719
that off of its uh off of its natural

1938
01:13:03,669 --> 01:13:01,280

trajectory and that technique could be

1939
01:13:05,030 --> 01:13:03,679
demonstrated either with option a or or

1940
01:13:06,470 --> 01:13:05,040
option b

1941
01:13:07,669 --> 01:13:06,480
so there are

1942
01:13:08,950 --> 01:13:07,679
you know several things that are being

1943
01:13:11,590 --> 01:13:08,960
looked at here

1944
01:13:14,229 --> 01:13:11,600
that offer a demonstration of planetary

1945
01:13:16,070 --> 01:13:14,239
defense techniques

1946
01:13:19,030 --> 01:13:16,080
let's go back to the phone line and

1947
01:13:20,550 --> 01:13:19,040
we'll begin with alexandra whitsey i

1948
01:13:22,070 --> 01:13:20,560
think it is with nature go ahead

1949
01:13:24,310 --> 01:13:22,080
alexandra

1950
01:13:26,550 --> 01:13:24,320
yes great thanks for your time i wanted

1951
01:13:27,669 --> 01:13:26,560
to ask about the future of spitzer it

1952
01:13:28,950 --> 01:13:27,679
came out

1953
01:13:29,990 --> 01:13:28,960
sort of on the cutting block and the

1954
01:13:32,149 --> 01:13:30,000
recent

1955
01:13:34,310 --> 01:13:32,159
astrophysics senior review what are the

1956
01:13:36,070 --> 01:13:34,320
implications for follow-up studies of

1957
01:13:39,270 --> 01:13:36,080
some of these objects if spitzer is no

1958
01:13:39,280 --> 01:13:42,870
i guess this is really john

1959
01:13:49,669 --> 01:13:46,790
our take that uh well with uh the senior

1960
01:13:50,950 --> 01:13:49,679
review of the astrophysics uh divisions

1961
01:13:53,430 --> 01:13:50,960
senior review

1962
01:13:54,149 --> 01:13:53,440
uh they would certainly like to

1963
01:13:56,229 --> 01:13:54,159

keep

1964
01:13:58,390 --> 01:13:56,239
operations going on on all of their

1965
01:13:59,189 --> 01:13:58,400
available spacecraft but

1966
01:14:04,790 --> 01:13:59,199
uh

1967
01:14:07,430 --> 01:14:04,800
the missions are budgeted for a certain

1968
01:14:10,550 --> 01:14:07,440
period uh period of time of which uh

1969
01:14:13,430 --> 01:14:10,560
spitzer uh fiscal year 2014 is where

1970
01:14:15,510 --> 01:14:13,440
that uh that budget uh

1971
01:14:17,830 --> 01:14:15,520
ended

1972
01:14:19,510 --> 01:14:17,840
but uh the spitcher spacecraft is still

1973
01:14:22,070 --> 01:14:19,520
a viable spacecraft and we're in the

1974
01:14:24,870 --> 01:14:22,080
lucky situation where the uh spacecraft

1975
01:14:26,870 --> 01:14:24,880
continues to have a good life

1976
01:14:29,350 --> 01:14:26,880
and uh

1977
01:14:31,110 --> 01:14:29,360
you know could could continue operations

1978
01:14:32,950 --> 01:14:31,120
and we'd certainly like to be in that

1979
01:14:34,950 --> 01:14:32,960
situation versus the other situation

1980
01:14:36,070 --> 01:14:34,960
where the spacecraft dies before we

1981
01:14:38,790 --> 01:14:36,080
wanted to

1982
01:14:40,630 --> 01:14:38,800
um but uh because uh

1983
01:14:43,189 --> 01:14:40,640
it's not in the in the future budget

1984
01:14:44,870 --> 01:14:43,199
plan we have to look at alternatives

1985
01:14:47,030 --> 01:14:44,880
other ways that we could continue to

1986
01:14:49,910 --> 01:14:47,040
defend the operations as pitcher and

1987
01:14:50,790 --> 01:14:49,920
that is what is being done

1988
01:14:52,470 --> 01:14:50,800

we are

1989
01:14:54,630 --> 01:14:52,480
the astrophysics division within the

1990
01:14:56,390 --> 01:14:54,640
science mission directorate is looking

1991
01:14:58,870 --> 01:14:56,400
at other opportunities

1992
01:15:00,790 --> 01:14:58,880
as to how the operations could be funded

1993
01:15:02,470 --> 01:15:00,800
uh i know the next question is probably

1994
01:15:04,870 --> 01:15:02,480
going to be so how much a year does it

1995
01:15:06,470 --> 01:15:04,880
cost to uh to operate spitzer

1996
01:15:09,510 --> 01:15:06,480
the uh

1997
01:15:11,189 --> 01:15:09,520
budget in 2014 for spitzer was 17

1998
01:15:14,390 --> 01:15:11,199
million dollars

1999
01:15:17,510 --> 01:15:14,400
now that you could

2000
01:15:19,110 --> 01:15:17,520
see in planning on operations of

2001
01:15:21,510 --> 01:15:19,120
maybe we don't operate it full time

2002
01:15:23,590 --> 01:15:21,520
maybe we only operated part time so that

2003
01:15:25,750 --> 01:15:23,600
the cost could be reduced

2004
01:15:28,229 --> 01:15:25,760
we could bring in other

2005
01:15:30,709 --> 01:15:28,239
institutions and sources of

2006
01:15:32,630 --> 01:15:30,719
funding so all those options are being

2007
01:15:36,630 --> 01:15:32,640
looked at for continued operations of

2008
01:15:40,790 --> 01:15:38,070
okay uh we'll take our next question

2009
01:15:42,950 --> 01:15:40,800
with irene klotz reuters go ahead irene

2010
01:15:44,470 --> 01:15:42,960
thanks very much uh two two questions

2011
01:15:47,669 --> 01:15:44,480
the first is um

2012
01:15:49,590 --> 01:15:47,679
the total amount of uh money that nasa

2013
01:15:51,189 --> 01:15:49,600

expects to spend on those concept

2014
01:15:53,830 --> 01:15:51,199
studies i think when the

2015
01:15:56,790 --> 01:15:53,840
va was announced it was uh up to six

2016
01:15:58,950 --> 01:15:56,800
million dollars for up to 25

2017
01:16:01,270 --> 01:15:58,960
so if that number is still valid and

2018
01:16:04,470 --> 01:16:01,280
then i i wasn't really understanding if

2019
01:16:06,630 --> 01:16:04,480
this 2011 md is actually like the

2020
01:16:08,550 --> 01:16:06,640
leading candidate now or

2021
01:16:10,149 --> 01:16:08,560
um are you all just kind of emphasizing

2022
01:16:12,470 --> 01:16:10,159
it because you have these new results

2023
01:16:14,630 --> 01:16:12,480
from spitzer thanks

2024
01:16:18,470 --> 01:16:14,640
good question i'll take the cost

2025
01:16:23,110 --> 01:16:21,110
so yes originally uh in the announcement

2026
01:16:25,510 --> 01:16:23,120
of the baa uh

2027
01:16:26,709 --> 01:16:25,520
nasa had allocated up to six million

2028
01:16:29,590 --> 01:16:26,719
dollars

2029
01:16:30,870 --> 01:16:29,600
to fund um the thought was up to 25

2030
01:16:34,310 --> 01:16:30,880
proposals

2031
01:16:36,709 --> 01:16:34,320
there was a two-step review process

2032
01:16:38,870 --> 01:16:36,719
which actually dr chris moore in the

2033
01:16:41,030 --> 01:16:38,880
human exploration and operation mission

2034
01:16:42,070 --> 01:16:41,040
directorate deserves a huge amount of

2035
01:16:42,950 --> 01:16:42,080
credit for

2036
01:16:45,510 --> 01:16:42,960
the

2037
01:16:46,550 --> 01:16:45,520
comprehensive high quality and very

2038
01:16:48,550 --> 01:16:46,560

quick

2039
01:16:50,149 --> 01:16:48,560
review process that he led and all the

2040
01:16:52,550 --> 01:16:50,159
teams

2041
01:16:55,030 --> 01:16:52,560
for their work and so

2042
01:16:58,229 --> 01:16:55,040
as a result of the looking at uh

2043
01:17:00,470 --> 01:16:58,239
evaluation against the criteria

2044
01:17:02,630 --> 01:17:00,480
through both the first step which is the

2045
01:17:04,390 --> 01:17:02,640
peer review process and then the second

2046
01:17:05,510 --> 01:17:04,400
step which was the programmatic review

2047
01:17:08,630 --> 01:17:05,520
process

2048
01:17:11,830 --> 01:17:08,640
uh there were 18 proposals that were uh

2049
01:17:13,430 --> 01:17:11,840
ultimately selected uh at a total of 4.9

2050
01:17:14,830 --> 01:17:13,440
million

2051
01:17:16,870 --> 01:17:14,840
you want to take the

2052
01:17:17,590 --> 01:17:16,880
sure um

2053
01:17:20,310 --> 01:17:17,600
well

2054
01:17:22,470 --> 01:17:20,320
in uh talking about uh 2011 md and where

2055
01:17:23,990 --> 01:17:22,480
does it fall in our list of list of

2056
01:17:25,430 --> 01:17:24,000
candidates um

2057
01:17:26,950 --> 01:17:25,440
uh

2058
01:17:28,149 --> 01:17:26,960
people keep asking us well what's the

2059
01:17:30,310 --> 01:17:28,159
target for the mission what's the target

2060
01:17:31,990 --> 01:17:30,320
for the mission well

2061
01:17:33,990 --> 01:17:32,000
what we want to have is a lot of

2062
01:17:35,910 --> 01:17:34,000
potential candidate targets for the

2063
01:17:37,110 --> 01:17:35,920

mission when it uh comes time to make

2064
01:17:38,950 --> 01:17:37,120
the decision

2065
01:17:42,149 --> 01:17:38,960
we don't want to be restricted to just

2066
01:17:45,750 --> 01:17:42,159
one because the the risk of that one

2067
01:17:48,630 --> 01:17:45,760
object being uh

2068
01:17:50,390 --> 01:17:48,640
exactly right for the mission and and uh

2069
01:17:51,669 --> 01:17:50,400
all the all the risk

2070
01:17:53,270 --> 01:17:51,679
of being

2071
01:17:55,030 --> 01:17:53,280
being minimal is

2072
01:17:57,270 --> 01:17:55,040
for one object is

2073
01:18:00,790 --> 01:17:57,280
probably not good so if you have a list

2074
01:18:01,590 --> 01:18:00,800
of various candidates you could go to

2075
01:18:05,669 --> 01:18:01,600
plus

2076
01:18:07,189 --> 01:18:05,679
if you run into a lawn slip or something

2077
01:18:08,790 --> 01:18:07,199
it could eliminate

2078
01:18:09,990 --> 01:18:08,800
the one target that you were looking at

2079
01:18:11,110 --> 01:18:10,000
so if you have a list of these

2080
01:18:13,430 --> 01:18:11,120
candidates

2081
01:18:15,830 --> 01:18:13,440
that's certainly of the advent

2082
01:18:18,870 --> 01:18:15,840
advantageous and we

2083
01:18:20,709 --> 01:18:18,880
are working to have a fairly uh large

2084
01:18:23,910 --> 01:18:20,719
list uh it won't be

2085
01:18:27,430 --> 01:18:23,920
it won't be dozens but uh it it may be

2086
01:18:31,590 --> 01:18:27,440
10 or so by the time we get to the time

2087
01:18:36,070 --> 01:18:33,990
list of candidates to

2088
01:18:38,709 --> 01:18:36,080

to select from

2089
01:18:40,550 --> 01:18:38,719
people were asking us about that the

2090
01:18:43,270 --> 01:18:40,560
occasion of the results from the

2091
01:18:45,990 --> 01:18:43,280
spitcher observations at 2011 md

2092
01:18:47,830 --> 01:18:46,000
provided us the opportunity to talk to

2093
01:18:49,669 --> 01:18:47,840
you about the process by which we are

2094
01:18:51,990 --> 01:18:49,679
selecting

2095
01:18:53,030 --> 01:18:52,000
candidates and looking at them

2096
01:18:55,669 --> 01:18:53,040
of which

2097
01:18:58,709 --> 01:18:55,679
2011 md now is uh one of those

2098
01:19:02,870 --> 01:19:00,870
thanks irene let's go back to uh one or

2099
01:19:04,310 --> 01:19:02,880
two more social questions before we wrap

2100
01:19:06,070 --> 01:19:04,320
up go ahead jason

2101
01:19:07,430 --> 01:19:06,080
sure so there's a couple of questions

2102
01:19:10,790 --> 01:19:07,440
here that have come in from different

2103
01:19:13,510 --> 01:19:10,800
twitter users uh josalita asks what are

2104
01:19:16,229 --> 01:19:13,520
you planning to redirect the asteroid to

2105
01:19:18,310 --> 01:19:16,239
um and then in the same vein charlotte

2106
01:19:20,790 --> 01:19:18,320
asks how big is this that you're

2107
01:19:23,110 --> 01:19:20,800
planning on redirecting

2108
01:19:24,070 --> 01:19:23,120
so i'll take the first part again

2109
01:19:25,990 --> 01:19:24,080
uh

2110
01:19:29,030 --> 01:19:26,000
we're planning to redirect the asteroid

2111
01:19:32,390 --> 01:19:29,040
to um a stable orbit in the earth moon

2112
01:19:36,070 --> 01:19:32,400
vicinity and it's actually a family of

2113
01:19:40,550 --> 01:19:36,080

orbits called distant retrograde orbits

2114
01:19:42,070 --> 01:19:40,560
the particular one that we have in mind

2115
01:19:44,470 --> 01:19:42,080
is

2116
01:19:46,070 --> 01:19:44,480
about 75 000 kilometers above the

2117
01:19:46,950 --> 01:19:46,080
surface of the moon

2118
01:19:49,110 --> 01:19:46,960
where

2119
01:19:51,350 --> 01:19:49,120
both the asteroid and the

2120
01:19:53,030 --> 01:19:51,360
high-powered solar electric propulsion

2121
01:19:54,950 --> 01:19:53,040
driven spacecraft

2122
01:19:57,350 --> 01:19:54,960
would be anticipated to be stable for

2123
01:19:59,030 --> 01:19:57,360
over 100 years

2124
01:20:03,189 --> 01:19:59,040
so it is

2125
01:20:07,510 --> 01:20:05,510
stable orbit

2126
01:20:09,830 --> 01:20:07,520
you want to take this the size was yeah

2127
01:20:13,669 --> 01:20:09,840
this size

2128
01:20:15,590 --> 01:20:13,679
uh well sure i mean the size uh

2129
01:20:17,189 --> 01:20:15,600
is uh

2130
01:20:18,629 --> 01:20:17,199
i mean the real factor that has to be

2131
01:20:21,030 --> 01:20:18,639
looked at as far as redirecting the

2132
01:20:22,229 --> 01:20:21,040
asteroid is you know what mass

2133
01:20:24,790 --> 01:20:22,239
can the

2134
01:20:25,910 --> 01:20:24,800
spacecraft handle out

2135
01:20:28,470 --> 01:20:25,920
redirect

2136
01:20:30,229 --> 01:20:28,480
to this this lunar orbit

2137
01:20:32,790 --> 01:20:30,239
but and

2138
01:20:36,310 --> 01:20:32,800

looking at the sizes that could be done

2139
01:20:38,070 --> 01:20:36,320
for a one whole asteroid it has to be

2140
01:20:39,750 --> 01:20:38,080
something that's less than about 10

2141
01:20:41,030 --> 01:20:39,760
meters in size

2142
01:20:42,950 --> 01:20:41,040
the particular

2143
01:20:45,350 --> 01:20:42,960
object that we talked about today

2144
01:20:47,750 --> 01:20:45,360
our best estimate of its size is about

2145
01:20:50,470 --> 01:20:47,760
six meters in size

2146
01:20:52,790 --> 01:20:50,480
if we were to get a large boulder off of

2147
01:20:54,070 --> 01:20:52,800
a larger asteroid it's going to be

2148
01:20:56,950 --> 01:20:54,080
something in the

2149
01:20:59,030 --> 01:20:56,960
two to four or five meters in size it

2150
01:21:03,030 --> 01:20:59,040
all depends on what orbit

2151
01:21:06,790 --> 01:21:05,350
asteroid is in initially its natural

2152
01:21:08,950 --> 01:21:06,800
orbit

2153
01:21:11,270 --> 01:21:08,960
to determine how much mass could then be

2154
01:21:12,830 --> 01:21:11,280
brought into the distant

2155
01:21:15,430 --> 01:21:12,840
lunar retrograde

2156
01:21:18,149 --> 01:21:15,440
orbit but less than less than 10 meters

2157
01:21:21,430 --> 01:21:19,990
well i want to thank everyone for their

2158
01:21:23,910 --> 01:21:21,440
participation today we had a lot of

2159
01:21:25,590 --> 01:21:23,920
participants with us virtually and and

2160
01:21:27,669 --> 01:21:25,600
here in washington and i just thank you

2161
01:21:29,430 --> 01:21:27,679
all to all the speakers we covered a lot

2162
01:21:32,310 --> 01:21:29,440
of news today uh certainly we talked

2163
01:21:34,790 --> 01:21:32,320

about broad agency announcement uh

2164
01:21:37,030 --> 01:21:34,800
awards to contracts to come some of the

2165
01:21:38,390 --> 01:21:37,040
proposals that were accepted to advance

2166
01:21:39,510 --> 01:21:38,400
the asteroid redirect mission we've

2167
01:21:41,270 --> 01:21:39,520
talked about

2168
01:21:42,390 --> 01:21:41,280
our observation of asteroids we've

2169
01:21:44,229 --> 01:21:42,400
talked about the asteroid green

2170
01:21:46,790 --> 01:21:44,239
challenge that are ways that the public

2171
01:21:48,390 --> 01:21:46,800
can help in the participation uh help

2172
01:21:50,470 --> 01:21:48,400
participate in the in the search for

2173
01:21:53,270 --> 01:21:50,480
asteroids and we talked about asteroid

2174
01:21:55,270 --> 01:21:53,280
2011 md and spitzer's observations of it

2175
01:21:57,910 --> 01:21:55,280
and now why that's a target an

2176
01:21:59,350 --> 01:21:57,920
interesting valid candidate i should say

2177
01:22:01,270 --> 01:21:59,360
for one of the options being considered

2178
01:22:03,910 --> 01:22:01,280
for the ashford redirect mission all of

2179
01:22:06,229 --> 01:22:03,920
that will be recapped on nasa.gov slash

2180
01:22:08,390 --> 01:22:06,239
asteroid initiative we'll have content

2181
01:22:10,149 --> 01:22:08,400
that goes through the who when where why

2182
01:22:11,910 --> 01:22:10,159
and some of the basics on that for you

2183
01:22:13,110 --> 01:22:11,920
if you look at the website a little bit

2184
01:22:15,270 --> 01:22:13,120
later today

2185
01:22:17,430 --> 01:22:15,280
for now i just want to thank thank

2186
01:22:18,870 --> 01:22:17,440
everyone again for their participation

2187
01:22:20,870 --> 01:22:18,880
thank you for joining and especially

2188
01:22:23,189 --> 01:22:20,880

thanks to everyone behind the scenes who

2189
01:22:25,590 --> 01:22:23,199
helped us make all that work