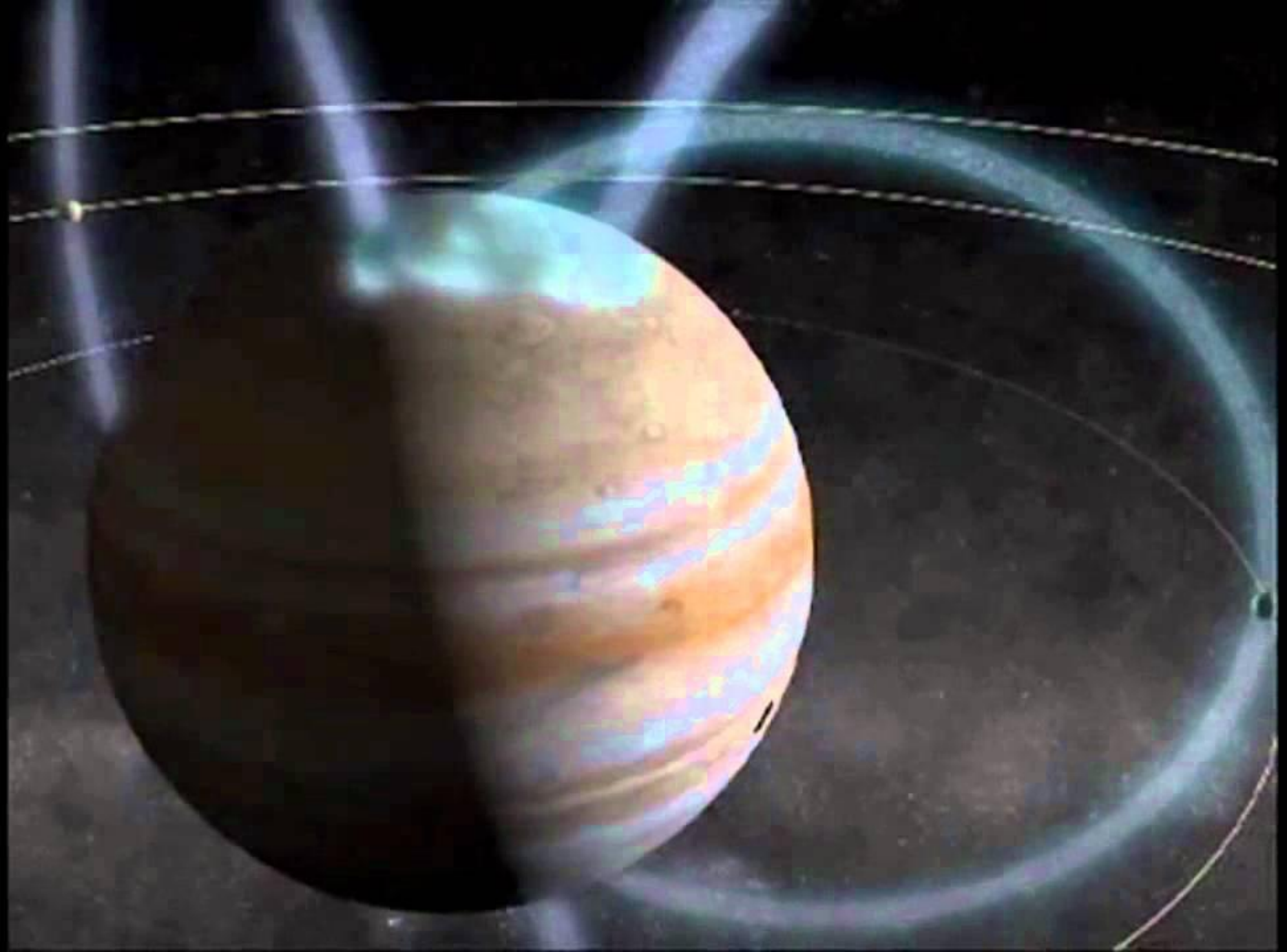

1
00:00:07,990 --> 00:00:05,349
good afternoon once again everyone this

2
00:00:10,709 --> 00:00:08,000
is the mission science briefing for the

3
00:00:13,190 --> 00:00:10,719
juno spacecraft being launched on friday

4
00:00:16,550 --> 00:00:13,200
morning aboard an atlas rocket

5
00:00:18,550 --> 00:00:16,560
we'll begin with scott bolton the juno

6
00:00:21,029 --> 00:00:18,560
principal investigator from the

7
00:00:23,750 --> 00:00:21,039
southwest research institute

8
00:00:26,630 --> 00:00:23,760
in san antonio

9
00:00:29,910 --> 00:00:26,640
next we will hear from toby owen the

10
00:00:33,590 --> 00:00:29,920
juno co-investigator from the university

11
00:00:41,110 --> 00:00:36,470
jack canerny the juno mag instrument

12
00:00:45,430 --> 00:00:43,590
steve levin the juno project scientist

13
00:00:49,670 --> 00:00:45,440

from the jet propulsion laboratory in

14
00:00:53,029 --> 00:00:51,270
fran bagano

15
00:00:58,229 --> 00:00:53,039
the juno co-investigator from the

16
00:01:02,069 --> 00:01:00,150
and candy hanson the juno

17
00:01:05,350 --> 00:01:02,079
co-investigator from the planetary

18
00:01:07,350 --> 00:01:05,360
science institute in tucson

19
00:01:10,950 --> 00:01:07,360
and we'll begin now with our principal

20
00:01:12,870 --> 00:01:10,960
investigator scott bolton scott

21
00:01:15,190 --> 00:01:12,880
good afternoon thanks for having me here

22
00:01:19,109 --> 00:01:15,200
it's very exciting we're just two days

23
00:01:20,550 --> 00:01:19,119
away from launching juno uh and we head

24
00:01:22,950 --> 00:01:20,560
off to jupiter

25
00:01:25,910 --> 00:01:22,960
we go into polar orbit around jupiter

26
00:01:27,990 --> 00:01:25,920
and uh what we're really going after is

27
00:01:30,630 --> 00:01:28,000
some of the most fundamental questions

28
00:01:33,109 --> 00:01:30,640
of of our solar system

29
00:01:34,950 --> 00:01:33,119
how jupiter formed how it evolved

30
00:01:37,590 --> 00:01:34,960
what really happened early in the solar

31
00:01:39,030 --> 00:01:37,600
system that eventually led to all of us

32
00:01:40,630 --> 00:01:39,040
and the terrestrial planets and the

33
00:01:43,190 --> 00:01:40,640
earth

34
00:01:45,109 --> 00:01:43,200
these are really basic questions who are

35
00:01:46,310 --> 00:01:45,119
we where do we come from how do we get

36
00:01:48,870 --> 00:01:46,320
here

37
00:01:51,350 --> 00:01:48,880
we go back to jupiter because it's it's

38
00:01:55,510 --> 00:01:51,360

the most massive and the largest of all

39
00:01:57,109 --> 00:01:55,520
the planets and so after the sun formed

40
00:01:58,789 --> 00:01:57,119
jupiter actually got most of the

41
00:02:01,429 --> 00:01:58,799
leftovers if you take everything in the

42
00:02:03,270 --> 00:02:01,439
solar system it fits inside jupiter

43
00:02:05,109 --> 00:02:03,280
everything else other than the sun

44
00:02:08,150 --> 00:02:05,119
and you take all of this and it's still

45
00:02:09,910 --> 00:02:08,160
twice as massive as everything else and

46
00:02:11,350 --> 00:02:09,920
so when we're looking at that history

47
00:02:13,270 --> 00:02:11,360
trying to understand what happened in

48
00:02:15,510 --> 00:02:13,280
the early solar system

49
00:02:18,229 --> 00:02:15,520
and what were the elements what state

50
00:02:19,750 --> 00:02:18,239
were they in how are they distributed

51
00:02:21,990 --> 00:02:19,760
you really go back to jupiter it's kind

52
00:02:24,390 --> 00:02:22,000
of like this time capsule because of its

53
00:02:26,470 --> 00:02:24,400
size it got most of the leftovers so we

54
00:02:29,110 --> 00:02:26,480
know that whatever happened after the

55
00:02:30,309 --> 00:02:29,120
sun is recorded in jupiter and because

56
00:02:32,630 --> 00:02:30,319
of its

57
00:02:34,630 --> 00:02:32,640
giant gravity field it's been able to

58
00:02:36,150 --> 00:02:34,640
hold on to that material unlike the

59
00:02:37,750 --> 00:02:36,160
earth which has lost a lot of its

60
00:02:39,670 --> 00:02:37,760
original material

61
00:02:42,390 --> 00:02:39,680
so it's it's a great place for us to go

62
00:02:44,869 --> 00:02:42,400
back and get that first step after the

63
00:02:46,949 --> 00:02:44,879

solar system first form the sun forms

64
00:02:49,589 --> 00:02:46,959
what happens that allows the planets to

65
00:02:51,670 --> 00:02:49,599
form a little bit different than the sun

66
00:02:53,750 --> 00:02:51,680
and it's and this composition we're kind

67
00:02:55,910 --> 00:02:53,760
of going after this recipe

68
00:02:57,670 --> 00:02:55,920
of how planets are made we're back at

69
00:02:59,509 --> 00:02:57,680
the ingredient list we're getting

70
00:03:01,110 --> 00:02:59,519
ingredients of jupiter we're going to

71
00:03:03,910 --> 00:03:01,120
understand what the structure is like

72
00:03:05,830 --> 00:03:03,920
inside how is it built and that'll kind

73
00:03:08,869 --> 00:03:05,840
of give us guidance as to what happened

74
00:03:10,630 --> 00:03:08,879
in that early time that eventually led

75
00:03:11,509 --> 00:03:10,640
to us

76
00:03:13,910 --> 00:03:11,519
so

77
00:03:16,790 --> 00:03:13,920
let me get the first image which is a

78
00:03:18,149 --> 00:03:16,800
cassini image of jupiter

79
00:03:19,910 --> 00:03:18,159
and you see the beautiful zones and

80
00:03:22,229 --> 00:03:19,920
belts in the red spot there this is

81
00:03:24,869 --> 00:03:22,239
taken by cassini as it flew by jupiter

82
00:03:26,949 --> 00:03:24,879
which coincidentally is about the time

83
00:03:29,190 --> 00:03:26,959
that we sort of put together some of the

84
00:03:30,630 --> 00:03:29,200
ideas that eventually led to the juno

85
00:03:33,110 --> 00:03:30,640
mission

86
00:03:34,710 --> 00:03:33,120
and behind those clouds

87
00:03:36,869 --> 00:03:34,720
are some of the secrets for our early

88
00:03:39,030 --> 00:03:36,879

solar system we have three different

89
00:03:41,910 --> 00:03:39,040
techniques that try to see inside that

90
00:03:43,509 --> 00:03:41,920
planet one is the gravity field and

91
00:03:45,110 --> 00:03:43,519
another is the magnetic field those are

92
00:03:46,710 --> 00:03:45,120
two invisible force fields we have

93
00:03:48,470 --> 00:03:46,720
special instruments that go down and

94
00:03:49,270 --> 00:03:48,480
look in deep

95
00:03:51,110 --> 00:03:49,280
uh

96
00:03:52,949 --> 00:03:51,120
jupiter the other is a microwave

97
00:03:54,630 --> 00:03:52,959
experiment that looks at thermal

98
00:03:56,869 --> 00:03:54,640
emission coming from the atmosphere but

99
00:03:58,309 --> 00:03:56,879
beneath those clouds that you see we're

100
00:04:00,309 --> 00:03:58,319
going to see down deep and we're going

101
00:04:02,789 --> 00:04:00,319
to go after the water abundance there

102
00:04:05,030 --> 00:04:02,799
which is one of the key discriminators

103
00:04:07,830 --> 00:04:05,040
for us to understand how jupiter formed

104
00:04:10,869 --> 00:04:07,840
it basically tells us about the oxygen

105
00:04:12,789 --> 00:04:10,879
oxygen is a fundamental element to us

106
00:04:14,869 --> 00:04:12,799
not only does it help us with life as we

107
00:04:16,870 --> 00:04:14,879
know it you know the search for water is

108
00:04:18,629 --> 00:04:16,880
sort of the search for life

109
00:04:20,469 --> 00:04:18,639
but in fact oxygen is the third most

110
00:04:22,230 --> 00:04:20,479
abundant element in the universe and so

111
00:04:24,310 --> 00:04:22,240
it's it's a very important element to

112
00:04:26,230 --> 00:04:24,320
understand after hydrogen helium being

113
00:04:27,749 --> 00:04:26,240

the most abundant elements so we don't

114
00:04:29,030 --> 00:04:27,759
really know that about jupiter and

115
00:04:31,030 --> 00:04:29,040
that's one of the key pieces of

116
00:04:33,030 --> 00:04:31,040
information that we need to unravel

117
00:04:36,390 --> 00:04:33,040
these mysteries

118
00:04:38,550 --> 00:04:36,400
so i have an animation that just shows

119
00:04:40,310 --> 00:04:38,560
the juno

120
00:04:42,310 --> 00:04:40,320
approaching earth you see

121
00:04:44,390 --> 00:04:42,320
approaching jupiter you see our solar

122
00:04:46,469 --> 00:04:44,400
arrays they're huge each one's about

123
00:04:47,990 --> 00:04:46,479
eight and a half meters long

124
00:04:50,390 --> 00:04:48,000
it's a giant spacecraft on the end of

125
00:04:52,469 --> 00:04:50,400
one of those is the magnetometer boom we

126
00:04:54,310 --> 00:04:52,479
cartwheel through space twice per minute

127
00:04:56,390 --> 00:04:54,320
this is how we spin

128
00:04:58,870 --> 00:04:56,400
when we get to jupiter we go into polar

129
00:05:00,870 --> 00:04:58,880
orbit not just any polar but we go

130
00:05:02,629 --> 00:05:00,880
really close to the planet this is what

131
00:05:04,629 --> 00:05:02,639
enables our science we get special

132
00:05:06,070 --> 00:05:04,639
instruments in a special vantage point

133
00:05:07,990 --> 00:05:06,080
and that's how we're going to

134
00:05:10,390 --> 00:05:08,000
accomplish our objectives

135
00:05:12,550 --> 00:05:10,400
we go into a very close polar orbit only

136
00:05:15,909 --> 00:05:12,560
about 5 000 kilometers above the cloud

137
00:05:17,350 --> 00:05:15,919
tops a close approach we orbit 30 times

138
00:05:19,590 --> 00:05:17,360

each time as

139
00:05:21,590 --> 00:05:19,600
each time we orbit we've carefully

140
00:05:23,189 --> 00:05:21,600
orchestrated this so that it passes

141
00:05:25,189 --> 00:05:23,199
through a different longitude and at the

142
00:05:27,830 --> 00:05:25,199
end of the 30 orbits we just essentially

143
00:05:29,430 --> 00:05:27,840
dropped a net around the planet with all

144
00:05:31,670 --> 00:05:29,440
of our measurements and that's what

145
00:05:33,830 --> 00:05:31,680
gives us both latitudinal and la and

146
00:05:35,510 --> 00:05:33,840
longitudinal coverage very important for

147
00:05:36,710 --> 00:05:35,520
understanding these these invisible

148
00:05:40,629 --> 00:05:36,720
force fields

149
00:05:42,230 --> 00:05:40,639
that polar orbit also turns out to be uh

150
00:05:44,950 --> 00:05:42,240
perfect to understand the polar

151
00:05:46,870 --> 00:05:44,960
magnetosphere and the and the incredibly

152
00:05:48,629 --> 00:05:46,880
strong aurora that are at jupiter

153
00:05:50,390 --> 00:05:48,639
jupiter has the most powerful aurora in

154
00:05:52,310 --> 00:05:50,400
the solar system they're virtually

155
00:05:53,990 --> 00:05:52,320
unexplored the previous missions like

156
00:05:56,070 --> 00:05:54,000
galileo have only been able to go around

157
00:05:58,950 --> 00:05:56,080
near the equator we'll go over the poles

158
00:06:00,390 --> 00:05:58,960
we'll go right over those aurora and and

159
00:06:01,990 --> 00:06:00,400
we'll learn quite a bit about those and

160
00:06:04,710 --> 00:06:02,000
be able to compare that back to what we

161
00:06:07,350 --> 00:06:04,720
know how aurora work on the earth and

162
00:06:09,189 --> 00:06:07,360
saturn which is uh we're learning from

163
00:06:11,590 --> 00:06:09,199

cassini

164
00:06:13,189 --> 00:06:11,600
so uh in a few minutes in the next talks

165
00:06:16,070 --> 00:06:13,199
you'll hear from my colleagues about the

166
00:06:17,510 --> 00:06:16,080
details of some of these uh observations

167
00:06:19,830 --> 00:06:17,520
that we're going to make in our science

168
00:06:22,150 --> 00:06:19,840
objectives and at the end

169
00:06:23,270 --> 00:06:22,160
you'll also hear from my colleague candy

170
00:06:25,590 --> 00:06:23,280
hanson

171
00:06:28,309 --> 00:06:25,600
who will tell you about our juno cam our

172
00:06:30,150 --> 00:06:28,319
camera which is dedicated to public

173
00:06:31,830 --> 00:06:30,160
outreach and education and so i'm very

174
00:06:33,990 --> 00:06:31,840
excited about that part of the of the

175
00:06:35,110 --> 00:06:34,000
mission we'll get the first pictures of

176
00:06:36,550 --> 00:06:35,120
the polls

177
00:06:38,070 --> 00:06:36,560
and

178
00:06:39,670 --> 00:06:38,080
we're all curious to see what those look

179
00:06:41,749 --> 00:06:39,680
like especially after the surprises that

180
00:06:43,430 --> 00:06:41,759
cassini showed us at saturn

181
00:06:44,710 --> 00:06:43,440
so back to you george all right thank

182
00:06:46,550 --> 00:06:44,720
you scott

183
00:06:48,629 --> 00:06:46,560
and now to toby owen the juno

184
00:06:51,749 --> 00:06:48,639
co-investigator from the university of

185
00:06:53,430 --> 00:06:51,759
hawaii toby thank you

186
00:06:55,830 --> 00:06:53,440
i'd like to pick up some of the things

187
00:06:57,430 --> 00:06:55,840
that scott was talking about

188
00:06:59,029 --> 00:06:57,440

starting with

189
00:07:00,469 --> 00:06:59,039
the big question

190
00:07:02,150 --> 00:07:00,479
you have to think of our ancient

191
00:07:05,270 --> 00:07:02,160
ancestors

192
00:07:07,990 --> 00:07:05,280
standing out under the great big sky

193
00:07:09,990 --> 00:07:08,000
dark night seeing those stars and

194
00:07:12,790 --> 00:07:10,000
wondering if there's any connection

195
00:07:14,550 --> 00:07:12,800
between those stars and themselves

196
00:07:17,589 --> 00:07:14,560
and this is such a big question that it

197
00:07:19,270 --> 00:07:17,599
has still it still influences the things

198
00:07:21,749 --> 00:07:19,280
that happen here on earth

199
00:07:23,589 --> 00:07:21,759
it's had an influence on religions all

200
00:07:27,589 --> 00:07:23,599
around the planet

201
00:07:29,189 --> 00:07:27,599
it has inspired art architecture

202
00:07:31,430 --> 00:07:29,199
literature

203
00:07:33,830 --> 00:07:31,440
and it has created a number of wonderful

204
00:07:35,589 --> 00:07:33,840
arguments among scientists as to what

205
00:07:36,390 --> 00:07:35,599
really was going on

206
00:07:41,110 --> 00:07:36,400
so

207
00:07:42,830 --> 00:07:41,120
many of them are not true

208
00:07:46,230 --> 00:07:42,840
but we don't know that yet

209
00:07:48,629 --> 00:07:46,240
so you come back and uh talk to us after

210
00:07:51,110 --> 00:07:48,639
we've been to jupiter we may have some

211
00:07:55,110 --> 00:07:51,120
very different things to say

212
00:07:57,909 --> 00:07:55,120
so how do we believe we got to jupiter

213
00:08:00,710 --> 00:07:57,919

our idea can be started with the first

214
00:08:03,270 --> 00:08:00,720
image which tells us something about

215
00:08:05,110 --> 00:08:03,280
what's out there among the stars

216
00:08:08,469 --> 00:08:05,120
and for our purposes the interesting

217
00:08:11,110 --> 00:08:08,479
things are the gases

218
00:08:12,469 --> 00:08:11,120
and you see here illuminated by their

219
00:08:14,309 --> 00:08:12,479
own emissions

220
00:08:15,510 --> 00:08:14,319
and the dust which is the dark material

221
00:08:17,909 --> 00:08:15,520
there so we've got

222
00:08:19,270 --> 00:08:17,919
gas and dust out in the interstellar

223
00:08:21,749 --> 00:08:19,280
medium

224
00:08:25,110 --> 00:08:21,759
a fragment of one of those clouds

225
00:08:28,550 --> 00:08:25,120
condensed it spun up and made a disc

226
00:08:30,150 --> 00:08:28,560
and the planets formed within that disk

227
00:08:31,749 --> 00:08:30,160
and we're going to be looking at the

228
00:08:33,909 --> 00:08:31,759
biggest of those in our solar system

229
00:08:35,829 --> 00:08:33,919
which is jupiter

230
00:08:37,670 --> 00:08:35,839
now there are some small planets that

231
00:08:39,589 --> 00:08:37,680
formed as well and i think that's

232
00:08:42,230 --> 00:08:39,599
illustrated in the next image

233
00:08:44,310 --> 00:08:42,240
if we can have that please

234
00:08:47,030 --> 00:08:44,320
no i'm sorry this is how we

235
00:08:49,430 --> 00:08:47,040
this is after we get down to the planet

236
00:08:51,430 --> 00:08:49,440
stage we get to the earth and we see

237
00:08:53,030 --> 00:08:51,440
things like this okay

238
00:08:55,910 --> 00:08:53,040

so our

239
00:08:58,790 --> 00:08:55,920
our problem our challenge is to get from

240
00:09:01,910 --> 00:08:58,800
out there in interstellar space down to

241
00:09:03,509 --> 00:09:01,920
botticelli and it's a big job and we

242
00:09:04,870 --> 00:09:03,519
haven't done it yet

243
00:09:07,509 --> 00:09:04,880
but we're going to show you how we get

244
00:09:09,350 --> 00:09:07,519
there how we might get there

245
00:09:10,870 --> 00:09:09,360
so here's the solar system

246
00:09:12,710 --> 00:09:10,880
as we see it and if you were looking at

247
00:09:14,630 --> 00:09:12,720
the solar system from alpha centauri for

248
00:09:17,350 --> 00:09:14,640
example and you're by star

249
00:09:20,550 --> 00:09:17,360
what you would see would be the sun

250
00:09:23,430 --> 00:09:20,560
four planets and some debris

251
00:09:25,269 --> 00:09:23,440
okay we're down in the debris

252
00:09:28,230 --> 00:09:25,279
so it's like being an archaeologist and

253
00:09:29,829 --> 00:09:28,240
you're surrounded by chips and pieces

254
00:09:31,509 --> 00:09:29,839
of marble

255
00:09:32,790 --> 00:09:31,519
some pots

256
00:09:34,470 --> 00:09:32,800
and you're trying to figure out where

257
00:09:36,389 --> 00:09:34,480
they came from what kind of a

258
00:09:37,990 --> 00:09:36,399
civilization produced them

259
00:09:39,269 --> 00:09:38,000
and we're sort of in that situation with

260
00:09:40,230 --> 00:09:39,279
jupiter

261
00:09:42,630 --> 00:09:40,240
we

262
00:09:44,630 --> 00:09:42,640
with the solar system i should say

263
00:09:46,470 --> 00:09:44,640

we're in the debris those chip bits and

264
00:09:49,030 --> 00:09:46,480
pieces and the reason we want to go to

265
00:09:49,990 --> 00:09:49,040
jupiter as scott said is that it should

266
00:09:54,389 --> 00:09:50,000
have

267
00:09:56,710 --> 00:09:54,399
material from that disk from that solar

268
00:09:58,310 --> 00:09:56,720
nebula as we call it and so if we can

269
00:09:59,829 --> 00:09:58,320
study jupiter we have a chance of

270
00:10:02,470 --> 00:09:59,839
getting back in time

271
00:10:04,790 --> 00:10:02,480
and looking at conditions composition

272
00:10:06,310 --> 00:10:04,800
that existed then

273
00:10:09,269 --> 00:10:06,320
so

274
00:10:11,670 --> 00:10:09,279
what what do we find

275
00:10:14,389 --> 00:10:11,680
the interesting part scott has mentioned

276
00:10:16,710 --> 00:10:14,399
is that because jupiter is so large

277
00:10:18,389 --> 00:10:16,720
it has collected the gas and dust from

278
00:10:20,550 --> 00:10:18,399
that original cloud

279
00:10:23,750 --> 00:10:20,560
we think the way it formed is that it

280
00:10:26,710 --> 00:10:23,760
began with a big solid object which we

281
00:10:29,190 --> 00:10:26,720
would call a super earth say about 10

282
00:10:30,630 --> 00:10:29,200
earth masses or so and it got big enough

283
00:10:32,949 --> 00:10:30,640
so it could attract

284
00:10:33,990 --> 00:10:32,959
the surrounding material the gases and

285
00:10:35,750 --> 00:10:34,000
the dust

286
00:10:38,310 --> 00:10:35,760
and that formed the huge atmosphere that

287
00:10:40,230 --> 00:10:38,320
we see today that's our model for what

288
00:10:41,350 --> 00:10:40,240

could have happened and we want to test

289
00:10:43,190 --> 00:10:41,360
that model

290
00:10:46,069 --> 00:10:43,200
with the observations that we could make

291
00:10:47,829 --> 00:10:46,079
some of them right now with juno

292
00:10:51,110 --> 00:10:47,839
so one of the key observations is going

293
00:10:52,150 --> 00:10:51,120
to be to look for oxygen as scott has

294
00:10:54,470 --> 00:10:52,160
mentioned

295
00:10:56,470 --> 00:10:54,480
the oxygen on jupiter is going to

296
00:10:58,790 --> 00:10:56,480
combine with the hydrogen and make water

297
00:11:00,310 --> 00:10:58,800
our famous h2o

298
00:11:01,269 --> 00:11:00,320
so it's the water that we're really

299
00:11:04,150 --> 00:11:01,279
after

300
00:11:06,710 --> 00:11:04,160
and as god said we've got to get below

301
00:11:08,870 --> 00:11:06,720
those clouds to see it the visible

302
00:11:10,470 --> 00:11:08,880
clouds the one we see from earth because

303
00:11:13,269 --> 00:11:10,480
down below they're going to be water

304
00:11:15,509 --> 00:11:13,279
clouds there may even be rain

305
00:11:17,990 --> 00:11:15,519
that's where the oxygen is

306
00:11:19,670 --> 00:11:18,000
to find that oxygen we have to use

307
00:11:21,509 --> 00:11:19,680
radiation from the interior we're going

308
00:11:23,030 --> 00:11:21,519
to hear more of that later

309
00:11:24,949 --> 00:11:23,040
we look at that radiation in the

310
00:11:27,590 --> 00:11:24,959
spectrum and in it we're going to see an

311
00:11:30,230 --> 00:11:27,600
absorption which is caused by the water

312
00:11:32,470 --> 00:11:30,240
by measuring that absorption we can

313
00:11:34,870 --> 00:11:32,480

derive the abundance of water and that

314
00:11:36,790 --> 00:11:34,880
gives us the oxygen

315
00:11:38,790 --> 00:11:36,800
that's important very important for a

316
00:11:40,949 --> 00:11:38,800
number of different reasons one of them

317
00:11:43,190 --> 00:11:40,959
is that oxygen is missing in our

318
00:11:46,150 --> 00:11:43,200
observations of jupiter so far we see a

319
00:11:48,310 --> 00:11:46,160
little bit of it in the water vapor

320
00:11:50,470 --> 00:11:48,320
up above the clouds that our probe was

321
00:11:52,550 --> 00:11:50,480
able to detect

322
00:11:55,350 --> 00:11:52,560
but the big amount in the clouds i'm

323
00:11:57,829 --> 00:11:55,360
talking to talk to you about the water

324
00:12:00,389 --> 00:11:57,839
clouds we don't we don't know

325
00:12:02,150 --> 00:12:00,399
we will know after juno so then we will

326
00:12:04,870 --> 00:12:02,160
have nitrogen which we already know

327
00:12:07,990 --> 00:12:04,880
carbon and finally oxygen

328
00:12:10,150 --> 00:12:08,000
so those three with the hydrogen are the

329
00:12:12,470 --> 00:12:10,160
big four in the universe we see them

330
00:12:13,670 --> 00:12:12,480
everywhere in all the stars the distant

331
00:12:15,590 --> 00:12:13,680
galaxies

332
00:12:17,829 --> 00:12:15,600
now we've got them on jupiter and we can

333
00:12:22,069 --> 00:12:17,839
compare jupiter's composition with that

334
00:12:24,069 --> 00:12:22,079
of the sun a nice star nearby

335
00:12:25,829 --> 00:12:24,079
we think that if things happen the way

336
00:12:27,030 --> 00:12:25,839
i've described to you

337
00:12:28,870 --> 00:12:27,040
jupiter ought to have the same

338
00:12:30,710 --> 00:12:28,880

composition as the sun

339
00:12:33,110 --> 00:12:30,720
they both formed out at the same solar

340
00:12:34,949 --> 00:12:33,120
nebula jupiter is big enough so the

341
00:12:38,150 --> 00:12:34,959
stuff it attracted should be the

342
00:12:39,750 --> 00:12:38,160
original unmodified solar material solar

343
00:12:41,110 --> 00:12:39,760
nebula material

344
00:12:42,710 --> 00:12:41,120
but it isn't

345
00:12:45,110 --> 00:12:42,720
that's one of the interesting surprises

346
00:12:47,750 --> 00:12:45,120
that the galileo probe gave us

347
00:12:50,310 --> 00:12:47,760
some of the heavy elements carbon and

348
00:12:52,550 --> 00:12:50,320
nitrogen in particular are enriched in

349
00:12:54,550 --> 00:12:52,560
jupiter's atmosphere above the level

350
00:12:57,030 --> 00:12:54,560
that they have in the sun

351
00:12:58,870 --> 00:12:57,040
oxygen may or may not be and that's one

352
00:12:59,750 --> 00:12:58,880
of the reasons we're so anxious to find

353
00:13:03,670 --> 00:12:59,760
it

354
00:13:04,870 --> 00:13:03,680
atmosphere than the carbon and the

355
00:13:06,550 --> 00:13:04,880
nitrogen

356
00:13:07,670 --> 00:13:06,560
we have to figure out how it got that

357
00:13:11,030 --> 00:13:07,680
way

358
00:13:13,509 --> 00:13:11,040
and the reason would be we think is that

359
00:13:16,150 --> 00:13:13,519
jupiter formed farther out in the solar

360
00:13:18,550 --> 00:13:16,160
system instead of where we find it today

361
00:13:21,030 --> 00:13:18,560
because out around uranus and neptune

362
00:13:23,910 --> 00:13:21,040
it's going to collect much more ice

363
00:13:25,509 --> 00:13:23,920

meaning more water meaning more oxygen

364
00:13:27,670 --> 00:13:25,519
so we would see

365
00:13:29,829 --> 00:13:27,680
a much higher abundance of oxygen than

366
00:13:32,069 --> 00:13:29,839
the carbon and nitrogen

367
00:13:34,230 --> 00:13:32,079
if jupiter formed where it is today then

368
00:13:36,150 --> 00:13:34,240
the oxygen carbon and nitrogen should

369
00:13:37,350 --> 00:13:36,160
all have pretty nearly the same

370
00:13:39,030 --> 00:13:37,360
amount

371
00:13:41,670 --> 00:13:39,040
same abundance

372
00:13:43,509 --> 00:13:41,680
if on the other hand the oxygen is lower

373
00:13:45,430 --> 00:13:43,519
than carbon and nitrogen

374
00:13:47,750 --> 00:13:45,440
then we would expect that the carb that

375
00:13:49,110 --> 00:13:47,760
the oxygen has combined with silicon to

376
00:13:51,189 --> 00:13:49,120
make rocks

377
00:13:54,470 --> 00:13:51,199
the rocks would have settled out

378
00:13:55,350 --> 00:13:54,480
and joined that big mass the ten earth

379
00:13:58,150 --> 00:13:55,360
mass

380
00:14:00,150 --> 00:13:58,160
in the core in making a core

381
00:14:02,310 --> 00:14:00,160
we don't know if that happened

382
00:14:04,470 --> 00:14:02,320
but we have an experiment the gravity

383
00:14:06,150 --> 00:14:04,480
experiment which will tell us

384
00:14:08,230 --> 00:14:06,160
may tell us about a concentration of

385
00:14:10,310 --> 00:14:08,240
matter at the center if we also have

386
00:14:12,230 --> 00:14:10,320
this information from the oxygen about

387
00:14:14,470 --> 00:14:12,240
the formation of rocks

388
00:14:17,430 --> 00:14:14,480

then we'll be pretty much

389
00:14:18,389 --> 00:14:17,440
zooming in on the fact that jupiter has

390
00:14:20,389 --> 00:14:18,399
a core

391
00:14:21,990 --> 00:14:20,399
and this will be a very important result

392
00:14:24,949 --> 00:14:22,000
because that will tell us that this

393
00:14:26,629 --> 00:14:24,959
model for making jupiter from starting

394
00:14:29,030 --> 00:14:26,639
from a tenerife mass

395
00:14:31,509 --> 00:14:29,040
object is probably right

396
00:14:33,590 --> 00:14:31,519
but that's not all oxygen will do for us

397
00:14:36,389 --> 00:14:33,600
we need to know the interior of jupiter

398
00:14:38,389 --> 00:14:36,399
how it's formed the different layers

399
00:14:40,949 --> 00:14:38,399
and in order to do that we need to know

400
00:14:42,949 --> 00:14:40,959
the oxygen abundance because

401
00:14:45,670 --> 00:14:42,959
it's the third most element third most

402
00:14:47,350 --> 00:14:45,680
abundant element in the universe and so

403
00:14:49,509 --> 00:14:47,360
it's going to be a key component of

404
00:14:51,990 --> 00:14:49,519
putting this giant planet together

405
00:14:54,949 --> 00:14:52,000
so far we haven't had it that means our

406
00:14:56,550 --> 00:14:54,959
models to date are inadequate at some

407
00:14:58,389 --> 00:14:56,560
level we don't know how much because we

408
00:15:00,150 --> 00:14:58,399
don't know how much oxygen there is

409
00:15:02,790 --> 00:15:00,160
but that's another major

410
00:15:04,629 --> 00:15:02,800
advantage that this particular

411
00:15:06,629 --> 00:15:04,639
element is going to give us once we get

412
00:15:08,870 --> 00:15:06,639
those numbers

413
00:15:11,350 --> 00:15:08,880

so let me stop there and turn it back to

414
00:15:13,350 --> 00:15:11,360
george all right thank you toby

415
00:15:15,110 --> 00:15:13,360
now to jack canary the juno mag

416
00:15:17,030 --> 00:15:15,120
instrument lead from goddard space

417
00:15:18,790 --> 00:15:17,040
flight center jack

418
00:15:20,470 --> 00:15:18,800
thank you george

419
00:15:22,470 --> 00:15:20,480
now we have two ways

420
00:15:23,829 --> 00:15:22,480
to probe the deep interior

421
00:15:25,189 --> 00:15:23,839
of the planet

422
00:15:27,750 --> 00:15:25,199
one is to study the planet's

423
00:15:30,949 --> 00:15:27,760
gravitational field and the other is to

424
00:15:33,509 --> 00:15:30,959
study its magnetic field

425
00:15:36,949 --> 00:15:33,519
if i could have the first video clip

426
00:15:39,189 --> 00:15:36,959
we'll look down inside jupiter

427
00:15:40,629 --> 00:15:39,199
beneath the colorful but thin cloud

428
00:15:43,269 --> 00:15:40,639
layer

429
00:15:45,269 --> 00:15:43,279
you have a helium and hydrogen largely

430
00:15:46,949 --> 00:15:45,279
hydrogen atmosphere of increasing

431
00:15:48,629 --> 00:15:46,959
pressure and density

432
00:15:51,110 --> 00:15:48,639
by the time you get about a quarter of

433
00:15:52,710 --> 00:15:51,120
the way down to the center of the planet

434
00:15:55,670 --> 00:15:52,720
the pressure is so great that the

435
00:15:57,670 --> 00:15:55,680
electrons squeeze off of the atoms

436
00:16:00,870 --> 00:15:57,680
and it becomes a metallic conductor it

437
00:16:02,389 --> 00:16:00,880
transitions to a metallic hydrogen state

438
00:16:04,389 --> 00:16:02,399

and that's a very good electrical

439
00:16:05,910 --> 00:16:04,399
conductor and then in the very center

440
00:16:07,990 --> 00:16:05,920
you may have seen the

441
00:16:11,030 --> 00:16:08,000
the inner core that toby was talking

442
00:16:14,230 --> 00:16:11,040
about it may have as much as 15 earth

443
00:16:15,030 --> 00:16:14,240
masses in heavy elements

444
00:16:16,629 --> 00:16:15,040
so

445
00:16:18,870 --> 00:16:16,639
how do we measure the

446
00:16:21,269 --> 00:16:18,880
gravitational field well we have an

447
00:16:23,430 --> 00:16:21,279
experiment actually we have a

448
00:16:25,829 --> 00:16:23,440
subsystem on the spacecraft the telecom

449
00:16:28,069 --> 00:16:25,839
system that does that for us

450
00:16:30,470 --> 00:16:28,079
if we can have the next clip

451
00:16:32,150 --> 00:16:30,480
the spacecraft communicates with a dish

452
00:16:34,069 --> 00:16:32,160
on earth

453
00:16:35,910 --> 00:16:34,079
receives a radio signal to receive

454
00:16:36,790 --> 00:16:35,920
commands and it sends a radio signal

455
00:16:38,470 --> 00:16:36,800
back

456
00:16:41,509 --> 00:16:38,480
those two you see in the bottom of this

457
00:16:43,910 --> 00:16:41,519
graphic align perfectly if there's no

458
00:16:45,829 --> 00:16:43,920
differential gravitation acceleration

459
00:16:48,069 --> 00:16:45,839
but as the spacecraft travels over the

460
00:16:50,470 --> 00:16:48,079
surface it feels a lesser or greater

461
00:16:52,870 --> 00:16:50,480
gravitational acceleration and those two

462
00:16:55,189 --> 00:16:52,880
signals come out of alignment

463
00:16:57,509 --> 00:16:55,199

by studying those signals we can the

464
00:16:59,990 --> 00:16:57,519
science team can infer the distribution

465
00:17:01,990 --> 00:17:00,000
of mass throughout the entire planet

466
00:17:04,150 --> 00:17:02,000
and that's one of the puzzle pieces that

467
00:17:06,789 --> 00:17:04,160
we have to put together along with the

468
00:17:09,270 --> 00:17:06,799
composition that toby mentioned

469
00:17:12,309 --> 00:17:09,280
to figure out what the interior state of

470
00:17:16,150 --> 00:17:14,549
so we have a we have another way to

471
00:17:18,710 --> 00:17:16,160
probe the deep interior and that's by

472
00:17:20,470 --> 00:17:18,720
studying the magnetic field

473
00:17:22,390 --> 00:17:20,480
we've learned over the past

474
00:17:24,789 --> 00:17:22,400
four or five decades that

475
00:17:27,029 --> 00:17:24,799
by and large with few exceptions all the

476
00:17:28,710 --> 00:17:27,039
planets have magnetic fields much like

477
00:17:31,669 --> 00:17:28,720
the earth

478
00:17:33,830 --> 00:17:31,679
and jupiter being a very large planet

479
00:17:36,150 --> 00:17:33,840
has a very very large magnetic field

480
00:17:38,549 --> 00:17:36,160
it's about twenty thousand times the

481
00:17:40,630 --> 00:17:38,559
strength of the earth's magnetic field

482
00:17:42,630 --> 00:17:40,640
we have a clip here to show you what the

483
00:17:44,470 --> 00:17:42,640
magnetic field would look like

484
00:17:47,909 --> 00:17:44,480
if we could

485
00:17:50,630 --> 00:17:47,919
lines with light

486
00:17:52,789 --> 00:17:50,640
and you see the uh the bright aurora on

487
00:17:54,710 --> 00:17:52,799
the northern and southern hemisphere and

488
00:17:57,029 --> 00:17:54,720

my colleague fran began i will talk

489
00:17:59,270 --> 00:17:57,039
about that in a minute

490
00:18:00,390 --> 00:17:59,280
but it's not surprising as large as

491
00:18:02,950 --> 00:18:00,400
jupiter is

492
00:18:05,990 --> 00:18:02,960
and as short as as the jupiter

493
00:18:09,029 --> 00:18:06,000
day is only 10 hours the rotation period

494
00:18:10,870 --> 00:18:09,039
that it has an enormous magnetic field

495
00:18:13,350 --> 00:18:10,880
jupiter is so large however that the

496
00:18:15,510 --> 00:18:13,360
magnetic field on the surface is only

497
00:18:18,150 --> 00:18:15,520
about 20 times as intense as the

498
00:18:19,590 --> 00:18:18,160
magnetic field on the earth's surface

499
00:18:22,150 --> 00:18:19,600
but even so

500
00:18:24,549 --> 00:18:22,160
juno in its orbit about jupiter will

501
00:18:26,390 --> 00:18:24,559
traverse a magnetic field that's about

502
00:18:28,789 --> 00:18:26,400
10 times more intense

503
00:18:30,070 --> 00:18:28,799
than any spacecraft launched previously

504
00:18:31,990 --> 00:18:30,080
as experienced

505
00:18:33,029 --> 00:18:32,000
and so for that very reason we've tested

506
00:18:35,669 --> 00:18:33,039
some of the

507
00:18:40,470 --> 00:18:35,679
spacecraft components to make sure they

508
00:18:45,350 --> 00:18:43,190
okay if we could have the uh

509
00:18:47,590 --> 00:18:45,360
the next clip

510
00:18:49,510 --> 00:18:47,600
um this is uh how we measure the

511
00:18:52,390 --> 00:18:49,520
magnetic field you may have noticed at

512
00:18:54,230 --> 00:18:52,400
the outer end of jupiter's very large

513
00:18:57,029 --> 00:18:54,240

solar arrays we have an appendage this

514
00:18:59,270 --> 00:18:57,039
a-shaped appendage at the very outer end

515
00:19:00,950 --> 00:18:59,280
of that is a suite of instruments a flux

516
00:19:02,950 --> 00:19:00,960
gate magnetometer

517
00:19:05,510 --> 00:19:02,960
and you see light baffles there peeking

518
00:19:07,510 --> 00:19:05,520
through the the thermal blanket and they

519
00:19:09,430 --> 00:19:07,520
define the field of view of two cameras

520
00:19:10,470 --> 00:19:09,440
that fly with each of the magnetic field

521
00:19:12,470 --> 00:19:10,480
sensors

522
00:19:13,510 --> 00:19:12,480
those cameras take a picture of the

523
00:19:15,590 --> 00:19:13,520
stars

524
00:19:17,830 --> 00:19:15,600
and by comparing that image with a

525
00:19:19,750 --> 00:19:17,840
catalog of known stars we can determine

526
00:19:22,230 --> 00:19:19,760
the attitude of these sensors the

527
00:19:24,710 --> 00:19:22,240
orientation of these sensors in space

528
00:19:27,110 --> 00:19:24,720
with great accuracy and so that's part

529
00:19:29,430 --> 00:19:27,120
of the reason why this uh

530
00:19:30,710 --> 00:19:29,440
juno spacecraft is carrying the most

531
00:19:32,390 --> 00:19:30,720
capable

532
00:19:34,630 --> 00:19:32,400
magnetic field investigation that we've

533
00:19:36,870 --> 00:19:34,640
ever launched

534
00:19:38,470 --> 00:19:36,880
now hopefully

535
00:19:40,470 --> 00:19:38,480
when we uh

536
00:19:42,470 --> 00:19:40,480
when we are able to get observations

537
00:19:45,029 --> 00:19:42,480
around the entire planet

538
00:19:48,390 --> 00:19:45,039

uh as it's illustrated in the next clip

539
00:19:50,390 --> 00:19:48,400
we'll be able to image jupiter's dynamo

540
00:19:52,470 --> 00:19:50,400
with a clarity that uh

541
00:19:54,789 --> 00:19:52,480
that will be unprecedented

542
00:19:57,350 --> 00:19:54,799
you see here the successive orbits being

543
00:19:59,270 --> 00:19:57,360
laid down by the juno spacecraft and by

544
00:20:02,149 --> 00:19:59,280
the time we're done we will have

545
00:20:04,390 --> 00:20:02,159
established a dense net of observations

546
00:20:06,630 --> 00:20:04,400
completely encircling the planet

547
00:20:08,789 --> 00:20:06,640
and separated by only about 12 degrees

548
00:20:10,870 --> 00:20:08,799
in longitude

549
00:20:13,190 --> 00:20:10,880
this is one of the

550
00:20:15,510 --> 00:20:13,200
the unique features of the juno mission

551
00:20:17,909 --> 00:20:15,520
we orbit pole to pole

552
00:20:19,669 --> 00:20:17,919
previous missions were largely confined

553
00:20:21,430 --> 00:20:19,679
to the equator plane

554
00:20:23,350 --> 00:20:21,440
where the satellites the moons of

555
00:20:25,590 --> 00:20:23,360
jupiter are located because they wanted

556
00:20:28,070 --> 00:20:25,600
to rendezvous with these moons

557
00:20:30,070 --> 00:20:28,080
we're the first mission to

558
00:20:32,710 --> 00:20:30,080
essentially sample the entire three

559
00:20:35,510 --> 00:20:32,720
dimensions of volume around jupiter

560
00:20:37,750 --> 00:20:35,520
and this gives us the ability to resolve

561
00:20:39,750 --> 00:20:37,760
what the magnetic field looks like down

562
00:20:44,149 --> 00:20:39,760
at the surface of the dynamo

563
00:20:49,270 --> 00:20:45,909

that's it for gravity and magnetic

564
00:20:51,190 --> 00:20:49,280
george thanks jack steve levin is the

565
00:20:55,110 --> 00:20:51,200
juno project scientist from the jet

566
00:20:55,909 --> 00:20:55,120
propulsion laboratory in pasadena steve

567
00:20:57,990 --> 00:20:55,919
hi

568
00:20:59,830 --> 00:20:58,000
why don't we start with that

569
00:21:01,270 --> 00:20:59,840
first animation

570
00:21:06,950 --> 00:21:01,280
what you

571
00:21:09,669 --> 00:21:06,960
basically the tops of jupiter's enormous

572
00:21:11,669 --> 00:21:09,679
dynamic atmosphere and we can take a

573
00:21:13,590 --> 00:21:11,679
look at that and we can see with our

574
00:21:14,630 --> 00:21:13,600
infrared cameras for example or visible

575
00:21:16,870 --> 00:21:14,640
light

576
00:21:18,950 --> 00:21:16,880
we can see a lot about the weather and

577
00:21:21,350 --> 00:21:18,960
the motions that are going on

578
00:21:23,270 --> 00:21:21,360
in jupiter's atmosphere but when you

579
00:21:25,350 --> 00:21:23,280
look at these structures these enormous

580
00:21:28,070 --> 00:21:25,360
belts and zones that you can see moving

581
00:21:30,149 --> 00:21:28,080
in the animation or the

582
00:21:32,149 --> 00:21:30,159
storms like the giant red spot that's

583
00:21:34,630 --> 00:21:32,159
twice as big as the entire earth there's

584
00:21:36,230 --> 00:21:34,640
a lot going on in jupiter's atmosphere

585
00:21:38,230 --> 00:21:36,240
that we'd like to understand in greater

586
00:21:40,230 --> 00:21:38,240
depth and what we're seeing

587
00:21:41,830 --> 00:21:40,240
with that with previous measurements and

588
00:21:44,149 --> 00:21:41,840

with visible light and with our infrared

589
00:21:46,070 --> 00:21:44,159
camera is the top of that atmosphere in

590
00:21:48,789 --> 00:21:46,080
order to understand what's deep inside

591
00:21:51,350 --> 00:21:48,799
the atmosphere we need to probe further

592
00:21:52,470 --> 00:21:51,360
if you go to that first slide

593
00:21:54,710 --> 00:21:52,480
that one

594
00:21:56,630 --> 00:21:54,720
for example the belts and zones are

595
00:21:58,230 --> 00:21:56,640
enormous jet streams that encircle the

596
00:22:00,070 --> 00:21:58,240
planet but we don't know how deep they

597
00:22:01,990 --> 00:22:00,080
go this just shows an artist's

598
00:22:03,909 --> 00:22:02,000
conception of two possibilities they

599
00:22:05,990 --> 00:22:03,919
could be relatively shallow or they

600
00:22:08,710 --> 00:22:06,000
could go quite deep and that would have

601
00:22:10,549 --> 00:22:08,720
a big effect on our understanding of how

602
00:22:13,270 --> 00:22:10,559
they work

603
00:22:14,710 --> 00:22:13,280
so what we need to do is probe deep into

604
00:22:16,789 --> 00:22:14,720
the atmosphere and if you look at the

605
00:22:19,830 --> 00:22:16,799
next slide it shows how we're going to

606
00:22:20,789 --> 00:22:19,840
do that with the microwave receiver on

607
00:22:22,950 --> 00:22:20,799
juno

608
00:22:24,950 --> 00:22:22,960
and basically what mwr the microwave

609
00:22:26,549 --> 00:22:24,960
receiver does is it has six different

610
00:22:27,990 --> 00:22:26,559
channels so we can look into the

611
00:22:29,430 --> 00:22:28,000
atmosphere with six different

612
00:22:31,190 --> 00:22:29,440
frequencies

613
00:22:33,190 --> 00:22:31,200

and we look at the natural radio

614
00:22:34,470 --> 00:22:33,200
emission from jupiter everything gives

615
00:22:37,029 --> 00:22:34,480
off

616
00:22:38,870 --> 00:22:37,039
radiation depending on the temperature

617
00:22:40,789 --> 00:22:38,880
different hotter temperature gives off

618
00:22:42,149 --> 00:22:40,799
more radiation the amount of radio waves

619
00:22:44,549 --> 00:22:42,159
we get from jupiter depend on its

620
00:22:46,549 --> 00:22:44,559
temperature because jupiter is hotter on

621
00:22:48,230 --> 00:22:46,559
the inside than the outside since it's

622
00:22:50,390 --> 00:22:48,240
still cooling off four and a half

623
00:22:51,909 --> 00:22:50,400
billion years after it formed

624
00:22:54,070 --> 00:22:51,919
what we look at with the microwave

625
00:22:56,390 --> 00:22:54,080
receiver at six different channels that

626
00:22:58,549 --> 00:22:56,400
see six different depths is going to be

627
00:23:01,270 --> 00:22:58,559
six different temperatures

628
00:23:03,029 --> 00:23:01,280
how far into the atmosphere we can see

629
00:23:05,270 --> 00:23:03,039
depends on what the atmosphere is made

630
00:23:07,350 --> 00:23:05,280
of and in particular water is a key

631
00:23:09,190 --> 00:23:07,360
element to affect that

632
00:23:10,630 --> 00:23:09,200
so the depth and therefore the

633
00:23:12,230 --> 00:23:10,640
temperature that we see with each of

634
00:23:14,390 --> 00:23:12,240
those channels will depend in part on

635
00:23:16,230 --> 00:23:14,400
how much water is in the atmosphere then

636
00:23:18,630 --> 00:23:16,240
on top of that we need the temperature

637
00:23:20,549 --> 00:23:18,640
profile of the atmosphere how hot it is

638
00:23:22,390 --> 00:23:20,559

in the middle compared to the the upper

639
00:23:25,190 --> 00:23:22,400
layers is affected by what it's made out

640
00:23:27,110 --> 00:23:25,200
of and we can disentangle that both by

641
00:23:29,190 --> 00:23:27,120
looking at the six different channels

642
00:23:31,430 --> 00:23:29,200
and by looking at a wide range of angles

643
00:23:34,070 --> 00:23:31,440
because the way our orbit works we cover

644
00:23:35,990 --> 00:23:34,080
the planet as we as we go from latitude

645
00:23:37,909 --> 00:23:36,000
to latitude with a spinning spacecraft

646
00:23:40,390 --> 00:23:37,919
we can look at any point in jupiter's

647
00:23:42,630 --> 00:23:40,400
atmosphere from a wide range of angles

648
00:23:44,149 --> 00:23:42,640
so now we have six channels and a whole

649
00:23:47,510 --> 00:23:44,159
range of different angles we can do sort

650
00:23:49,110 --> 00:23:47,520
of a cat scan to disentangle all of that

651
00:23:51,269 --> 00:23:49,120
and understand what the atmosphere is

652
00:23:53,430 --> 00:23:51,279
made out of what the temperature profile

653
00:23:55,909 --> 00:23:53,440
looks like for jupiter's atmosphere so

654
00:23:57,750 --> 00:23:55,919
combine that with the infrared camera

655
00:23:59,190 --> 00:23:57,760
the gerum instrument that tells us about

656
00:24:01,190 --> 00:23:59,200
the tops of the atmosphere and lets us

657
00:24:02,950 --> 00:24:01,200
to study the dynamics and the water in

658
00:24:04,789 --> 00:24:02,960
the upper layers of the atmosphere and

659
00:24:07,190 --> 00:24:04,799
we can learn a whole lot more about this

660
00:24:08,390 --> 00:24:07,200
giant dynamic atmosphere that belongs to

661
00:24:10,230 --> 00:24:08,400
jupiter

662
00:24:12,390 --> 00:24:10,240
jordan thanks steve

663
00:24:14,870 --> 00:24:12,400

frank bagenal is one of the juno

664
00:24:18,870 --> 00:24:14,880
co-investigators from the university of

665
00:24:21,750 --> 00:24:18,880
colorado at boulder fran

666
00:24:24,230 --> 00:24:21,760
so as scott said juno's special orbit

667
00:24:25,110 --> 00:24:24,240
over the poles gives us a really special

668
00:24:27,350 --> 00:24:25,120
view

669
00:24:29,110 --> 00:24:27,360
of the magnetosphere of jupiter and

670
00:24:31,750 --> 00:24:29,120
really what we can do is we can look

671
00:24:34,870 --> 00:24:31,760
down on the poles and observe the bright

672
00:24:37,269 --> 00:24:34,880
aurora and at the same time fly through

673
00:24:39,830 --> 00:24:37,279
the region where the particles that

674
00:24:41,590 --> 00:24:39,840
generate the aurora are accelerated and

675
00:24:43,990 --> 00:24:41,600
excited and then

676
00:24:46,549 --> 00:24:44,000
fly zooming down and bombard the

677
00:24:49,029 --> 00:24:46,559
atmosphere and make it glow so let's

678
00:24:51,190 --> 00:24:49,039
have the first uh animation that shows

679
00:24:51,909 --> 00:24:51,200
you an idea of what we're really looking

680
00:24:54,789 --> 00:24:51,919
at

681
00:24:57,269 --> 00:24:54,799
we have this very bright aurora

682
00:25:00,390 --> 00:24:57,279
they are so bright that the energy that

683
00:25:02,149 --> 00:25:00,400
hits the polar regions of jupiter is

684
00:25:04,310 --> 00:25:02,159
coming from the auroral process is much

685
00:25:05,750 --> 00:25:04,320
stronger than all the sunlight

686
00:25:06,950 --> 00:25:05,760
that comes from the sun and hits the

687
00:25:09,190 --> 00:25:06,960
atmosphere

688
00:25:10,950 --> 00:25:09,200

so um we're interested in these

689
00:25:13,110 --> 00:25:10,960
energetic particles that bombard the

690
00:25:14,549 --> 00:25:13,120
atmosphere excite these aurora across

691
00:25:16,870 --> 00:25:14,559
the spectrum

692
00:25:19,990 --> 00:25:16,880
not only in the visible region but also

693
00:25:22,789 --> 00:25:20,000
all the way from x-rays through uv and

694
00:25:24,950 --> 00:25:22,799
then into infrared and radio emissions

695
00:25:26,710 --> 00:25:24,960
so all sorts of wavelengths we see

696
00:25:29,750 --> 00:25:26,720
emissions uh coming from this polar

697
00:25:32,070 --> 00:25:29,760
region not only that but the magnetic

698
00:25:34,789 --> 00:25:32,080
field of jupiter is so strong that it

699
00:25:37,430 --> 00:25:34,799
extends beyond the orbits of the moons

700
00:25:40,789 --> 00:25:37,440
so if the next animation you'll see

701
00:25:43,269 --> 00:25:40,799
that the big moons eo europa ganymede

702
00:25:46,070 --> 00:25:43,279
and callisto all orbit jupiter and as

703
00:25:48,230 --> 00:25:46,080
they do so they generate very strong

704
00:25:49,669 --> 00:25:48,240
electrical currents that go along the

705
00:25:52,950 --> 00:25:49,679
magnetic field

706
00:25:54,870 --> 00:25:52,960
and uh send currents and particles into

707
00:25:57,430 --> 00:25:54,880
the atmosphere and produce spots of

708
00:26:00,310 --> 00:25:57,440
aurora associated with these moons

709
00:26:02,390 --> 00:26:00,320
moving through the magnetic field

710
00:26:03,510 --> 00:26:02,400
now if we look at the next animation i

711
00:26:05,750 --> 00:26:03,520
want to show it's not really an

712
00:26:07,750 --> 00:26:05,760
animation it's real movies taken by

713
00:26:10,710 --> 00:26:07,760

hubble these are pictures taken by the

714
00:26:12,870 --> 00:26:10,720
hubble space telescope in the uv part of

715
00:26:15,110 --> 00:26:12,880
the spectrum and this was from a big

716
00:26:17,669 --> 00:26:15,120
campaign that john clark and his

717
00:26:20,230 --> 00:26:17,679
colleagues university of uh boston

718
00:26:20,950 --> 00:26:20,240
university took with hubble and you can

719
00:26:22,950 --> 00:26:20,960
see

720
00:26:24,230 --> 00:26:22,960
various features what we're doing is

721
00:26:26,549 --> 00:26:24,240
we're looking from the earth and we're

722
00:26:29,190 --> 00:26:26,559
seeing jupiter spin jupiter spins every

723
00:26:30,710 --> 00:26:29,200
10 hours we can see aurora come round

724
00:26:34,149 --> 00:26:30,720
into field of view

725
00:26:37,269 --> 00:26:34,159
and you can see various kinds of aurora

726
00:26:39,510 --> 00:26:37,279
you can see a fairly steady auroral ring

727
00:26:41,510 --> 00:26:39,520
and uh we don't know

728
00:26:43,830 --> 00:26:41,520
exactly what causes that but it's steady

729
00:26:46,470 --> 00:26:43,840
and doesn't change unlike the earth's

730
00:26:48,630 --> 00:26:46,480
auroral ring which changes with the

731
00:26:51,430 --> 00:26:48,640
solar wind buffeting and affecting the

732
00:26:54,230 --> 00:26:51,440
earth's magnetosphere you also see spots

733
00:26:56,470 --> 00:26:54,240
associated with those moons and in fact

734
00:26:59,830 --> 00:26:56,480
a long wake behind the spot uh with the

735
00:27:02,390 --> 00:26:59,840
moon eo uh and then in the inner

736
00:27:04,149 --> 00:27:02,400
part of the poles uh inside the mineral

737
00:27:06,390 --> 00:27:04,159
oval we see all this

738
00:27:09,750 --> 00:27:06,400

bright uh dazzling

739
00:27:12,230 --> 00:27:09,760
changing aurora and we have no idea what

740
00:27:13,830 --> 00:27:12,240
causes that it's a complete mystery

741
00:27:16,230 --> 00:27:13,840
if we said that jupiter was like the

742
00:27:18,789 --> 00:27:16,240
earth we'd say oh that's the solar wind

743
00:27:21,430 --> 00:27:18,799
buffeting and changing the magnetosphere

744
00:27:22,870 --> 00:27:21,440
as it as it goes past the planet but we

745
00:27:25,110 --> 00:27:22,880
have a feeling that things are very

746
00:27:28,470 --> 00:27:25,120
different at jupiter the magnetosphere

747
00:27:30,389 --> 00:27:28,480
of jupiter is huge it's vast it extends

748
00:27:33,510 --> 00:27:30,399
about a hundred times the size of the

749
00:27:35,350 --> 00:27:33,520
planet out uh towards the sun and so it

750
00:27:37,590 --> 00:27:35,360
sort of insulates the planet from the

751
00:27:38,630 --> 00:27:37,600
effect of the solar wind so it's very

752
00:27:40,870 --> 00:27:38,640
different

753
00:27:42,389 --> 00:27:40,880
we have some sense of what causes the

754
00:27:43,510 --> 00:27:42,399
aurora

755
00:27:46,070 --> 00:27:43,520
from

756
00:27:48,870 --> 00:27:46,080
our ideas of the earth we have a sense

757
00:27:51,350 --> 00:27:48,880
from ideas of of earlier flybys that

758
00:27:53,990 --> 00:27:51,360
were confined to the equator but without

759
00:27:56,470 --> 00:27:54,000
fly over the poles as juno will do we

760
00:27:58,789 --> 00:27:56,480
really don't understand the physics so

761
00:28:00,789 --> 00:27:58,799
we're going to be flying a

762
00:28:03,110 --> 00:28:00,799
magnetic field instrument jack's

763
00:28:05,430 --> 00:28:03,120

magnetometer we'll fly the waves

764
00:28:07,269 --> 00:28:05,440
instrument that measures electric fields

765
00:28:09,990 --> 00:28:07,279
we'll measure particles the energetic

766
00:28:11,990 --> 00:28:10,000
particles with jedi and the lower energy

767
00:28:13,990 --> 00:28:12,000
particles with jade

768
00:28:16,630 --> 00:28:14,000
and then we'll look down on the aurora

769
00:28:19,029 --> 00:28:16,640
and see with the uvs and the durum

770
00:28:21,190 --> 00:28:19,039
instruments the glow that comes out when

771
00:28:22,789 --> 00:28:21,200
these particles hit the atmosphere so

772
00:28:23,830 --> 00:28:22,799
we'll try and work out what on earth is

773
00:28:26,950 --> 00:28:23,840
going on

774
00:28:29,510 --> 00:28:26,960
thank you very much thank you fran

775
00:28:31,830 --> 00:28:29,520
candy hanson is also one of the

776
00:28:34,549 --> 00:28:31,840
juno co-investigators she's from the

777
00:28:35,830 --> 00:28:34,559
planetary science institute in tucson

778
00:28:38,070 --> 00:28:35,840
candy

779
00:28:39,669 --> 00:28:38,080
i'll be talking about junocam i have a

780
00:28:43,029 --> 00:28:39,679
model right here

781
00:28:46,149 --> 00:28:43,039
uh this camera's purpose one of the main

782
00:28:48,149 --> 00:28:46,159
purposes is to give the public the

783
00:28:49,590 --> 00:28:48,159
general public the chance

784
00:28:51,110 --> 00:28:49,600
to see what it's like to be a

785
00:28:53,909 --> 00:28:51,120
participant

786
00:28:57,510 --> 00:28:53,919
in a space mission what does it take to

787
00:28:59,350 --> 00:28:57,520
operate a scientific instrument

788
00:29:01,430 --> 00:28:59,360

so i'll talk about some of our

789
00:29:03,909 --> 00:29:01,440
challenges and how we're going to

790
00:29:04,950 --> 00:29:03,919
involve the public in this endeavor

791
00:29:06,389 --> 00:29:04,960
the first

792
00:29:09,269 --> 00:29:06,399
slide

793
00:29:10,950 --> 00:29:09,279
this is the polar view that we will be

794
00:29:13,430 --> 00:29:10,960
getting with junocam

795
00:29:15,669 --> 00:29:13,440
and the design of the instrument was

796
00:29:16,470 --> 00:29:15,679
driven by this view we wanted to make

797
00:29:19,190 --> 00:29:16,480
sure

798
00:29:21,909 --> 00:29:19,200
that our images of the pole were as good

799
00:29:24,789 --> 00:29:21,919
as they could be and so for example

800
00:29:26,710 --> 00:29:24,799
the field of view of the camera is 58

801
00:29:29,029 --> 00:29:26,720
degrees across so that we could capture

802
00:29:30,070 --> 00:29:29,039
the whole thing

803
00:29:31,190 --> 00:29:30,080
the next

804
00:29:35,909 --> 00:29:31,200
movie

805
00:29:37,590 --> 00:29:35,919
was actually a set of data collect

806
00:29:40,470 --> 00:29:37,600
images collected by the cassini

807
00:29:43,350 --> 00:29:40,480
spacecraft the cassini spacecraft flew

808
00:29:45,750 --> 00:29:43,360
by jupiter in the year 2000

809
00:29:46,710 --> 00:29:45,760
and in the equatorial plane

810
00:29:49,029 --> 00:29:46,720
so

811
00:29:51,269 --> 00:29:49,039
the images of the pole are quite oblique

812
00:29:53,269 --> 00:29:51,279
even though this is a polar projection

813
00:29:55,669 --> 00:29:53,279

so we're going to fill in that blank

814
00:29:57,269 --> 00:29:55,679
spot in the lower right there

815
00:29:59,269 --> 00:29:57,279
and as you can see it's also quite

816
00:30:01,590 --> 00:29:59,279
dynamic the polar regions are quite

817
00:30:03,110 --> 00:30:01,600
dynamic so we'll be able to

818
00:30:05,430 --> 00:30:03,120
see what the pole looks like and we'll

819
00:30:09,029 --> 00:30:05,440
see it as at a resolution and a viewing

820
00:30:11,110 --> 00:30:09,039
geometry far better than cassini

821
00:30:13,350 --> 00:30:11,120
we surpassed cassini resolution when

822
00:30:14,710 --> 00:30:13,360
we're about an hour away from closest

823
00:30:16,389 --> 00:30:14,720
approach

824
00:30:20,310 --> 00:30:16,399
the

825
00:30:21,110 --> 00:30:20,320
shows what it would look like if you

826
00:30:23,029 --> 00:30:21,120
were

827
00:30:24,230 --> 00:30:23,039
riding along on the spacecraft looking

828
00:30:26,149 --> 00:30:24,240
at jupiter

829
00:30:28,149 --> 00:30:26,159
through the junocam optics and you can

830
00:30:31,110 --> 00:30:28,159
see because we have our wide field of

831
00:30:33,350 --> 00:30:31,120
view for most of the 11 day orbit

832
00:30:36,149 --> 00:30:33,360
we're pretty far away and jupiter is

833
00:30:38,549 --> 00:30:36,159
pretty tiny watch closely now you'll see

834
00:30:41,110 --> 00:30:38,559
what happens in the plus and minus an

835
00:30:43,750 --> 00:30:41,120
hour around closest approach

836
00:30:45,430 --> 00:30:43,760
so that's the key time frame

837
00:30:47,510 --> 00:30:45,440
and

838
00:30:48,789 --> 00:30:47,520

we're going to have the public help us

839
00:30:51,510 --> 00:30:48,799
decide

840
00:30:52,549 --> 00:30:51,520
what images we should take when

841
00:30:54,149 --> 00:30:52,559
the

842
00:30:55,430 --> 00:30:54,159
next still

843
00:30:57,590 --> 00:30:55,440
is

844
00:30:59,110 --> 00:30:57,600
these are two images

845
00:31:02,149 --> 00:30:59,120
that are

846
00:31:04,630 --> 00:31:02,159
were acquired by amateur astronomers so

847
00:31:08,310 --> 00:31:04,640
the first step is that we are going to

848
00:31:10,870 --> 00:31:08,320
engage the amateur astronomy community

849
00:31:12,230 --> 00:31:10,880
to supply us with their data send us

850
00:31:14,789 --> 00:31:12,240
their pictures

851
00:31:16,789 --> 00:31:14,799
and uh the image on the left was taken

852
00:31:19,509 --> 00:31:16,799
about a year ago

853
00:31:21,430 --> 00:31:19,519
the astronomer's name is damien peach

854
00:31:22,549 --> 00:31:21,440
the one on the right was taken about a

855
00:31:24,789 --> 00:31:22,559
week ago

856
00:31:27,269 --> 00:31:24,799
and it was acquired by freddie williams

857
00:31:29,990 --> 00:31:27,279
and so we'll be reaching out to the

858
00:31:31,669 --> 00:31:30,000
amateur astronomy community so that we

859
00:31:33,830 --> 00:31:31,679
can see because of the dynamic

860
00:31:35,269 --> 00:31:33,840
atmosphere we need to see what is

861
00:31:39,430 --> 00:31:35,279
jupiter doing

862
00:31:42,070 --> 00:31:39,440
in 2016 not what it's doing in 2011.

863
00:31:45,669 --> 00:31:42,080

and then my final slide

864
00:31:47,590 --> 00:31:45,679
shows after the images are acquired

865
00:31:48,470 --> 00:31:47,600
there are a number of folks

866
00:31:51,029 --> 00:31:48,480
that

867
00:31:52,630 --> 00:31:51,039
process images as a hobby

868
00:31:53,590 --> 00:31:52,640
and

869
00:31:56,710 --> 00:31:53,600
there

870
00:31:59,190 --> 00:31:56,720
we hope to engage that group

871
00:32:02,549 --> 00:31:59,200
we will put our raw images out

872
00:32:04,870 --> 00:32:02,559
and we will invite the public to process

873
00:32:06,230 --> 00:32:04,880
that data if we can return to the still

874
00:32:08,950 --> 00:32:06,240
just for a minute

875
00:32:11,830 --> 00:32:08,960
this is a mosaic that was

876
00:32:15,110 --> 00:32:11,840
of the cloud tops maybe we can't go back

877
00:32:18,630 --> 00:32:15,120
the cloud tops around the great red spot

878
00:32:20,950 --> 00:32:18,640
it was put together from voyager images

879
00:32:23,350 --> 00:32:20,960
by bjorn johnson so these are just a

880
00:32:24,630 --> 00:32:23,360
couple of examples

881
00:32:27,110 --> 00:32:24,640
of what

882
00:32:29,909 --> 00:32:27,120
we think we have in store with our

883
00:32:32,310 --> 00:32:29,919
partnership with the public

884
00:32:34,310 --> 00:32:32,320
thank you thank you candy

885
00:32:36,389 --> 00:32:34,320
before we take questions and answers

886
00:32:37,990 --> 00:32:36,399
we're going to go back to scott bolton

887
00:32:39,830 --> 00:32:38,000
the principal investigator from

888
00:32:41,190 --> 00:32:39,840

southwest research institute he's got

889
00:32:43,350 --> 00:32:41,200
some additional

890
00:32:45,029 --> 00:32:43,360
comments to make as part of

891
00:32:47,750 --> 00:32:45,039
an announcement scott

892
00:32:50,149 --> 00:32:47,760
yeah so i'm happy to make uh some

893
00:32:51,509 --> 00:32:50,159
special announcements here um you know

894
00:32:53,269 --> 00:32:51,519
we're carrying all these instruments

895
00:32:55,190 --> 00:32:53,279
that you heard from our colleagues and

896
00:32:57,750 --> 00:32:55,200
of course our primary goal is to get all

897
00:32:59,269 --> 00:32:57,760
this new science data

898
00:33:00,870 --> 00:32:59,279
bring it back to earth help us

899
00:33:02,710 --> 00:33:00,880
understand

900
00:33:04,950 --> 00:33:02,720
how we got here and

901
00:33:07,190 --> 00:33:04,960
what's going on and answer our

902
00:33:08,470 --> 00:33:07,200
children's questions

903
00:33:11,350 --> 00:33:08,480
and

904
00:33:13,430 --> 00:33:11,360
along that way we also wanted to um

905
00:33:14,310 --> 00:33:13,440
commemorate and take a little piece of

906
00:33:16,389 --> 00:33:14,320
of us

907
00:33:17,750 --> 00:33:16,399
with jupiter so there's a couple two

908
00:33:19,190 --> 00:33:17,760
jupiter there's a couple of things on

909
00:33:19,990 --> 00:33:19,200
the spacecraft that i want to tell you

910
00:33:22,149 --> 00:33:20,000
about

911
00:33:24,950 --> 00:33:22,159
can i get the first uh

912
00:33:27,350 --> 00:33:24,960
image so this is a plaque honoring

913
00:33:29,909 --> 00:33:27,360

galileo um

914
00:33:32,789 --> 00:33:29,919
from uh his discoveries and

915
00:33:36,149 --> 00:33:32,799
it's about the 400th anniversary juno is

916
00:33:38,230 --> 00:33:36,159
launching in 1611. there was some people

917
00:33:41,990 --> 00:33:38,240
have celebrated galileo's 400th

918
00:33:44,310 --> 00:33:42,000
anniversary in 1610 from 16 10 400 years

919
00:33:46,630 --> 00:33:44,320
but in fact his discoveries were

920
00:33:47,750 --> 00:33:46,640
spanned uh many years and of course

921
00:33:49,509 --> 00:33:47,760
he

922
00:33:52,230 --> 00:33:49,519
made a lot of very important

923
00:33:54,230 --> 00:33:52,240
contributions to our society he was

924
00:33:56,870 --> 00:33:54,240
really the first that took a telescope

925
00:33:59,029 --> 00:33:56,880
pointed it up at the sky realized that

926
00:34:00,710 --> 00:33:59,039
he could do astro astronomical this is

927
00:34:02,389 --> 00:34:00,720
after he managed to

928
00:34:04,070 --> 00:34:02,399
sell the idea to a bunch of people that

929
00:34:05,750 --> 00:34:04,080
wanted to watch ships coming at him to

930
00:34:07,269 --> 00:34:05,760
attack

931
00:34:10,550 --> 00:34:07,279
got a little money and said let's point

932
00:34:12,069 --> 00:34:10,560
it up and and lo and behold he saw

933
00:34:14,069 --> 00:34:12,079
jupiter's moons

934
00:34:15,990 --> 00:34:14,079
and in fact the inscription on that

935
00:34:19,270 --> 00:34:16,000
plaque this came from the italian space

936
00:34:21,669 --> 00:34:19,280
agency who you've heard is one of our

937
00:34:22,869 --> 00:34:21,679
big partners uh probably the largest of

938
00:34:25,109 --> 00:34:22,879

the international partners they

939
00:34:27,750 --> 00:34:25,119
contributed both the duram infrared

940
00:34:30,230 --> 00:34:27,760
instrument as well as a a major piece of

941
00:34:32,710 --> 00:34:30,240
our gravity experiment called the kat

942
00:34:35,669 --> 00:34:32,720
they developed this uh commemorative

943
00:34:37,909 --> 00:34:35,679
plaque to honor galileo i think it's a

944
00:34:38,790 --> 00:34:37,919
great thing to keep going and help the

945
00:34:41,270 --> 00:34:38,800
public

946
00:34:42,790 --> 00:34:41,280
understand the contributions that this

947
00:34:45,510 --> 00:34:42,800
great discovery during the italian

948
00:34:46,550 --> 00:34:45,520
renaissance brought to our society um

949
00:34:48,710 --> 00:34:46,560
the

950
00:34:51,669 --> 00:34:48,720
revelations that occurred from that

951
00:34:53,589 --> 00:34:51,679
discovery uh are still with us uh you

952
00:34:55,109 --> 00:34:53,599
know first understanding that we are not

953
00:34:57,829 --> 00:34:55,119
the center that in fact there were

954
00:35:00,790 --> 00:34:57,839
things going around uh jupiter another

955
00:35:03,190 --> 00:35:00,800
planet uh certainly uh affected all of

956
00:35:04,630 --> 00:35:03,200
us both technologically as well as

957
00:35:06,069 --> 00:35:04,640
philosophically

958
00:35:07,910 --> 00:35:06,079
the next one

959
00:35:09,349 --> 00:35:07,920
is a little bit in the same theme but

960
00:35:11,190 --> 00:35:09,359
we're reaching out to a little bit

961
00:35:13,750 --> 00:35:11,200
younger audience

962
00:35:17,910 --> 00:35:13,760
nasa has a long-standing

963
00:35:19,750 --> 00:35:17,920

partnership and with the lego company

964
00:35:22,630 --> 00:35:19,760
any of you that have children know that

965
00:35:24,790 --> 00:35:22,640
legos are very popular with kids as well

966
00:35:27,430 --> 00:35:24,800
as really helps teach them about

967
00:35:29,589 --> 00:35:27,440
building and engineering and and can

968
00:35:31,910 --> 00:35:29,599
conveniently

969
00:35:33,990 --> 00:35:31,920
fits in with the whole stem program i

970
00:35:36,150 --> 00:35:34,000
think very very well so i was happy to

971
00:35:39,190 --> 00:35:36,160
be part of that partnership that nasa

972
00:35:43,109 --> 00:35:39,200
had started and you see on here three

973
00:35:45,109 --> 00:35:43,119
lego minifigures that are on board juno

974
00:35:47,430 --> 00:35:45,119
they're made out of a special

975
00:35:49,910 --> 00:35:47,440
uh space grade aluminum they've gone

976
00:35:52,390 --> 00:35:49,920
through all the testing and to make sure

977
00:35:54,630 --> 00:35:52,400
that they fit on our spacecraft and in a

978
00:35:56,310 --> 00:35:54,640
way that you know is like our other

979
00:35:57,990 --> 00:35:56,320
science instruments

980
00:36:00,630 --> 00:35:58,000
there's three figures the figures that

981
00:36:02,950 --> 00:36:00,640
you see there um the one on the far

982
00:36:05,349 --> 00:36:02,960
right i'll uh start with is actually

983
00:36:06,790 --> 00:36:05,359
galileo holding his telescope and

984
00:36:08,150 --> 00:36:06,800
jupiter

985
00:36:11,589 --> 00:36:08,160
um

986
00:36:14,550 --> 00:36:11,599
the next one is juno which is uh is from

987
00:36:17,430 --> 00:36:14,560
roman mythology but in fact hera is the

988
00:36:19,990 --> 00:36:17,440

greek mythological name so that's juno

989
00:36:22,069 --> 00:36:20,000
herself uh the wife and sister of

990
00:36:24,950 --> 00:36:22,079
jupiter and jupiter resides just to the

991
00:36:28,230 --> 00:36:24,960
left in greek that zeus and so you have

992
00:36:30,710 --> 00:36:28,240
both the juno jupiter and galileo there

993
00:36:33,030 --> 00:36:30,720
and we hope that that will increase the

994
00:36:35,430 --> 00:36:33,040
awareness of children about the space

995
00:36:36,870 --> 00:36:35,440
program get them interested

996
00:36:38,870 --> 00:36:36,880
there's a lego

997
00:36:40,950 --> 00:36:38,880
build your future event that

998
00:36:43,030 --> 00:36:40,960
actually is going on at kennedy as well

999
00:36:45,030 --> 00:36:43,040
during the time period of our launch

1000
00:36:46,790 --> 00:36:45,040
that's also happened during the um the

1001
00:36:49,910 --> 00:36:46,800
shuttle launches recently

1002
00:36:51,750 --> 00:36:49,920
and i've personally witnessed kids

1003
00:36:53,109 --> 00:36:51,760
really getting into the engineering and

1004
00:36:54,630 --> 00:36:53,119
building stuff and so i think it's a

1005
00:36:57,030 --> 00:36:54,640
great partnership and i'm happy to be

1006
00:37:00,310 --> 00:36:57,040
part of it and this will also help them

1007
00:37:02,310 --> 00:37:00,320
to understand both the mythological uh

1008
00:37:04,790 --> 00:37:02,320
studies that went on which of course

1009
00:37:07,190 --> 00:37:04,800
also ancient greek led to our

1010
00:37:09,190 --> 00:37:07,200
society as we see today

1011
00:37:10,310 --> 00:37:09,200
and also the contributions that galileo

1012
00:37:11,670 --> 00:37:10,320
made so

1013
00:37:13,109 --> 00:37:11,680

i think it fits with everything that

1014
00:37:15,589 --> 00:37:13,119
we're doing in them

1015
00:37:17,190 --> 00:37:15,599
hope you guys appreciate that

1016
00:37:19,270 --> 00:37:17,200
thank you scott we're going to take

1017
00:37:20,550 --> 00:37:19,280
questions now once again please give

1018
00:37:22,550 --> 00:37:20,560
your name an affiliation when the

1019
00:37:24,470 --> 00:37:22,560
microphone comes to you

1020
00:37:29,190 --> 00:37:24,480
we're gonna if we could let's go to the

1021
00:37:32,950 --> 00:37:31,430
hi ken kramer for space flight magazine

1022
00:37:36,230 --> 00:37:32,960
for um

1023
00:37:37,589 --> 00:37:36,240
scott and toby you talk about how um

1024
00:37:40,069 --> 00:37:37,599
looking at jupiter will give us the

1025
00:37:42,790 --> 00:37:40,079
ingredient list for how the solar system

1026
00:37:44,550 --> 00:37:42,800
formed and jupiter evolves over time

1027
00:37:46,390 --> 00:37:44,560
also so i'm wondering how do you back

1028
00:37:49,829 --> 00:37:46,400
out that effect to figure out the

1029
00:37:51,430 --> 00:37:49,839
original ingredient list thanks

1030
00:37:53,589 --> 00:37:51,440
actually there isn't much evolution as

1031
00:37:55,589 --> 00:37:53,599
far as the composition is concerned

1032
00:37:57,510 --> 00:37:55,599
because jupiter is too small to have any

1033
00:37:59,190 --> 00:37:57,520
nuclear energy going in nuclear

1034
00:38:00,630 --> 00:37:59,200
reactions going on in the center the way

1035
00:38:02,310 --> 00:38:00,640
the sun does

1036
00:38:03,990 --> 00:38:02,320
so once you've got something out there

1037
00:38:05,829 --> 00:38:04,000
it pretty much stays there there's a

1038
00:38:08,630 --> 00:38:05,839

little chemistry at the top that's what

1039
00:38:11,270 --> 00:38:08,640
makes those colors in the in the bands

1040
00:38:14,069 --> 00:38:11,280
but down below it's pretty much the way

1041
00:38:17,990 --> 00:38:15,990
yeah i think i can add to that in the

1042
00:38:19,670 --> 00:38:18,000
sense that jupiter's gravity field is so

1043
00:38:21,030 --> 00:38:19,680
powerful also that it's been able to

1044
00:38:23,109 --> 00:38:21,040
hold on

1045
00:38:24,790 --> 00:38:23,119
to its hydrogen and helium as far as we

1046
00:38:26,870 --> 00:38:24,800
know so it so its composition has

1047
00:38:28,870 --> 00:38:26,880
remained as toby said

1048
00:38:30,790 --> 00:38:28,880
uh pretty much intact and what you're

1049
00:38:33,829 --> 00:38:30,800
seeing is certainly a dynamic place the

1050
00:38:35,589 --> 00:38:33,839
atmosphere wins and so forth but we're

1051
00:38:37,109 --> 00:38:35,599
looking at the state of jupiter in fact

1052
00:38:38,069 --> 00:38:37,119
most of our experiments are all about

1053
00:38:41,510 --> 00:38:38,079
that

1054
00:38:43,670 --> 00:38:41,520
about the the basic state of jupiter

1055
00:38:45,750 --> 00:38:43,680
except for what fran talked about where

1056
00:38:47,349 --> 00:38:45,760
the polar magnetosphere which is a very

1057
00:38:48,550 --> 00:38:47,359
dynamic place and you need to look at

1058
00:38:49,750 --> 00:38:48,560
the time variability of that to

1059
00:38:51,829 --> 00:38:49,760
understand it

1060
00:38:53,829 --> 00:38:51,839
i'll have one more footnote and that is

1061
00:38:55,750 --> 00:38:53,839
that there is a change that occurs but

1062
00:38:57,910 --> 00:38:55,760
it's on a microscopic level and that's

1063
00:38:59,270 --> 00:38:57,920

when jupiter gets hit by a comet but

1064
00:39:01,750 --> 00:38:59,280
that's sort of like throwing a few

1065
00:39:03,109 --> 00:39:01,760
grains of sand into the ocean it uh it

1066
00:39:04,870 --> 00:39:03,119
happens but it doesn't really have much

1067
00:39:05,990 --> 00:39:04,880
effect

1068
00:39:07,430 --> 00:39:06,000
marcia

1069
00:39:09,750 --> 00:39:07,440
marshall done associated press for a

1070
00:39:12,069 --> 00:39:09,760
couple questions for dr bolton um

1071
00:39:13,510 --> 00:39:12,079
jupiter is such a planet of superlatives

1072
00:39:15,190 --> 00:39:13,520
and i'm wondering if you could transfer

1073
00:39:17,030 --> 00:39:15,200
that to juno

1074
00:39:19,349 --> 00:39:17,040
how much better how much greater is it

1075
00:39:21,270 --> 00:39:19,359
going to be than all eight previous

1076
00:39:22,230 --> 00:39:21,280
probes that have mostly just flown by

1077
00:39:23,670 --> 00:39:22,240
really

1078
00:39:25,750 --> 00:39:23,680
i mean could you just sort of compare

1079
00:39:27,510 --> 00:39:25,760
how much more this mission is going to

1080
00:39:29,589 --> 00:39:27,520
offer than all eight previous ones put

1081
00:39:31,589 --> 00:39:29,599
together well let me let me first say

1082
00:39:34,150 --> 00:39:31,599
that they're all were great

1083
00:39:36,069 --> 00:39:34,160
um from my perspective um

1084
00:39:37,910 --> 00:39:36,079
each of the missions that we do

1085
00:39:39,270 --> 00:39:37,920
are providing unique and and very

1086
00:39:42,710 --> 00:39:39,280
important information for us to

1087
00:39:45,750 --> 00:39:42,720
understand ourselves and the universe

1088
00:39:47,990 --> 00:39:45,760

and very much uh juno is building on

1089
00:39:51,750 --> 00:39:48,000
what we've learned from those previous

1090
00:39:52,790 --> 00:39:51,760
uh flybys as well as the galileo mission

1091
00:39:54,790 --> 00:39:52,800
so

1092
00:39:56,710 --> 00:39:54,800
while you know i

1093
00:39:58,790 --> 00:39:56,720
would like to say it's greater i you

1094
00:40:01,190 --> 00:39:58,800
know it's not really any greater what it

1095
00:40:03,190 --> 00:40:01,200
is is it's the it's the next step

1096
00:40:04,230 --> 00:40:03,200
and so what it's it's all of the

1097
00:40:06,150 --> 00:40:04,240
questions

1098
00:40:08,870 --> 00:40:06,160
that we've had uh answered by the

1099
00:40:11,589 --> 00:40:08,880
previous exploration have honed our our

1100
00:40:13,270 --> 00:40:11,599
knowledge and and let us focus in on on

1101
00:40:14,150 --> 00:40:13,280
questions that remain

1102
00:40:16,309 --> 00:40:14,160
that

1103
00:40:19,030 --> 00:40:16,319
in some ways are very very important now

1104
00:40:21,510 --> 00:40:19,040
we've gotten clever enough

1105
00:40:23,670 --> 00:40:21,520
to now know more specifically what we

1106
00:40:25,670 --> 00:40:23,680
want to know about jupiter to unravel

1107
00:40:27,109 --> 00:40:25,680
the mysteries of the early solar system

1108
00:40:29,430 --> 00:40:27,119
some of those early missions were

1109
00:40:31,430 --> 00:40:29,440
reconnaissance almost where we're just

1110
00:40:33,589 --> 00:40:31,440
getting our first looks they were very

1111
00:40:35,349 --> 00:40:33,599
important they were outfitted in a way

1112
00:40:36,870 --> 00:40:35,359
so that we could gather lots of

1113
00:40:38,550 --> 00:40:36,880

different information so that we could

1114
00:40:39,990 --> 00:40:38,560
figure out what are the right questions

1115
00:40:41,030 --> 00:40:40,000
what's left

1116
00:40:43,430 --> 00:40:41,040
and they

1117
00:40:46,630 --> 00:40:43,440
essentially led us to ask the the

1118
00:40:48,550 --> 00:40:46,640
questions that we have uh with juno and

1119
00:40:51,589 --> 00:40:48,560
so

1120
00:40:53,270 --> 00:40:51,599
juno does does more in certain areas but

1121
00:40:54,710 --> 00:40:53,280
it's because of the fact that we're

1122
00:40:57,349 --> 00:40:54,720
riding on those

1123
00:41:01,750 --> 00:40:57,359
previous missions and so we

1124
00:41:03,190 --> 00:41:01,760
we look deeper we go much closer

1125
00:41:04,950 --> 00:41:03,200
we're going over the polls so we're

1126
00:41:06,630 --> 00:41:04,960
doing a lot of new things that have

1127
00:41:08,950 --> 00:41:06,640
never been done and we're going to get

1128
00:41:10,630 --> 00:41:08,960
all this brand new information but in

1129
00:41:12,309 --> 00:41:10,640
fact it's only in the context of all the

1130
00:41:14,150 --> 00:41:12,319
previous discoveries that it makes sense

1131
00:41:16,710 --> 00:41:14,160
to us

1132
00:41:19,349 --> 00:41:16,720
and how big are those little

1133
00:41:21,109 --> 00:41:19,359
quasi-lego figures and where did you are

1134
00:41:24,150 --> 00:41:21,119
they buried in the spacecraft so where

1135
00:41:27,109 --> 00:41:24,160
are they they are not buried um they are

1136
00:41:27,990 --> 00:41:27,119
under uh protection of blankets

1137
00:41:29,990 --> 00:41:28,000
um

1138
00:41:30,950 --> 00:41:30,000

as is most of the spacecraft if you look

1139
00:41:33,670 --> 00:41:30,960
at it

1140
00:41:35,190 --> 00:41:33,680
so those photos were taken before we

1141
00:41:36,710 --> 00:41:35,200
finalized everything they're about an

1142
00:41:39,270 --> 00:41:36,720
inch and a half they're basically are

1143
00:41:40,870 --> 00:41:39,280
the size of the normal lego minifigures

1144
00:41:44,150 --> 00:41:40,880
that you'll see but they're made out of

1145
00:41:45,750 --> 00:41:44,160
aluminum very special aluminum

1146
00:41:47,829 --> 00:41:45,760
and they've been prepared in a very

1147
00:41:49,750 --> 00:41:47,839
special way but they're basically the

1148
00:41:51,829 --> 00:41:49,760
size of the of the normal lego

1149
00:41:56,230 --> 00:41:51,839
minifigures that you would get through a

1150
00:41:59,510 --> 00:41:58,069
they're all together right next to each

1151
00:42:01,670 --> 00:41:59,520
other

1152
00:42:02,870 --> 00:42:01,680
being friendly

1153
00:42:06,150 --> 00:42:02,880
and they're and they're the they're the

1154
00:42:09,510 --> 00:42:07,750
stefano

1155
00:42:11,510 --> 00:42:09,520
yes thank you stephanie coledan for

1156
00:42:13,510 --> 00:42:11,520
italian state radio and tv

1157
00:42:15,510 --> 00:42:13,520
um i noticed that the

1158
00:42:17,270 --> 00:42:15,520
parabolic antenna on the spacecraft

1159
00:42:18,470 --> 00:42:17,280
doesn't really look like a

1160
00:42:19,510 --> 00:42:18,480
parabola

1161
00:42:21,589 --> 00:42:19,520
so

1162
00:42:24,470 --> 00:42:21,599
is that a cover that is on top and is

1163
00:42:26,790 --> 00:42:24,480

that to protect it from

1164
00:42:29,349 --> 00:42:26,800
micrometeorites or also from

1165
00:42:31,750 --> 00:42:29,359
some magnetic

1166
00:42:33,910 --> 00:42:31,760
i don't know storm or

1167
00:42:35,030 --> 00:42:33,920
lightning that could happen around

1168
00:42:36,950 --> 00:42:35,040
jupiter

1169
00:42:39,109 --> 00:42:36,960
uh well it's both protection and but it

1170
00:42:40,790 --> 00:42:39,119
is a a parabola underneath and that's a

1171
00:42:43,270 --> 00:42:40,800
cover over it

1172
00:42:48,230 --> 00:42:45,990
it's uh i'm not

1173
00:42:50,390 --> 00:42:48,240
sure i remember now all the details we

1174
00:42:52,550 --> 00:42:50,400
would we've been maybe tim can answer

1175
00:42:54,150 --> 00:42:52,560
that question for us more specifically

1176
00:42:55,990 --> 00:42:54,160
that's a radome it's a thermal blanket

1177
00:42:57,670 --> 00:42:56,000
if you look at a lot of the spacecraft

1178
00:42:59,270 --> 00:42:57,680
that we fly we put those over to keep

1179
00:43:00,870 --> 00:42:59,280
the

1180
00:43:04,470 --> 00:43:00,880
antenna from getting

1181
00:43:06,069 --> 00:43:04,480
too cold but um also as a way to you

1182
00:43:08,710 --> 00:43:06,079
know protect it from micro meteorites as

1183
00:43:12,390 --> 00:43:10,309
i had the same question when i first saw

1184
00:43:13,910 --> 00:43:12,400
it

1185
00:43:16,069 --> 00:43:13,920
and as far as the

1186
00:43:18,870 --> 00:43:16,079
the orbit are you going to try to get as

1187
00:43:22,390 --> 00:43:18,880
much data as you can as far as this

1188
00:43:24,390 --> 00:43:22,400

spacecraft can go before being crushed

1189
00:43:26,390 --> 00:43:24,400
uh you mean on the at the last

1190
00:43:28,230 --> 00:43:26,400
during planetary protection maneuver is

1191
00:43:30,390 --> 00:43:28,240
that what you're referring to

1192
00:43:32,230 --> 00:43:30,400
yeah so we we'll get all the data that

1193
00:43:35,510 --> 00:43:32,240
we can possibly get

1194
00:43:37,030 --> 00:43:35,520
um and then we haven't designed the last

1195
00:43:39,190 --> 00:43:37,040
run during planetary protection we

1196
00:43:41,270 --> 00:43:39,200
dispose of the spacecraft in jupiter for

1197
00:43:43,349 --> 00:43:41,280
those of you that just to know what he's

1198
00:43:44,230 --> 00:43:43,359
asking about we dispose of it in order

1199
00:43:46,069 --> 00:43:44,240
to make sure that it doesn't

1200
00:43:48,069 --> 00:43:46,079
accidentally crash into europa or some

1201
00:43:50,630 --> 00:43:48,079
other moon which we may want to explore

1202
00:43:52,230 --> 00:43:50,640
later we don't want to contaminate it

1203
00:43:54,150 --> 00:43:52,240
so um

1204
00:43:56,069 --> 00:43:54,160
the plans have not been completely set

1205
00:43:58,230 --> 00:43:56,079
except that we can deorbit and get and

1206
00:44:00,710 --> 00:43:58,240
dispose of the spacecraft properly

1207
00:44:02,390 --> 00:44:00,720
uh we will certainly try to get the data

1208
00:44:04,550 --> 00:44:02,400
all the way to the last possible moment

1209
00:44:07,190 --> 00:44:04,560
but it will be limited by the power

1210
00:44:08,950 --> 00:44:07,200
available as well as the the link

1211
00:44:11,750 --> 00:44:08,960
you know we may not be completely earth

1212
00:44:14,390 --> 00:44:11,760
or sun pointed during that time period

1213
00:44:15,270 --> 00:44:14,400

and one quick one uh i remember reading

1214
00:44:17,349 --> 00:44:15,280
a few

1215
00:44:18,150 --> 00:44:17,359
well i mean actually several years ago

1216
00:44:19,109 --> 00:44:18,160
that

1217
00:44:21,030 --> 00:44:19,119
there are

1218
00:44:24,790 --> 00:44:21,040
light there's lightning on on jupiter

1219
00:44:28,150 --> 00:44:24,800
that is i don't know billions of times

1220
00:44:29,270 --> 00:44:28,160
stronger than on earth is that is that

1221
00:44:31,270 --> 00:44:29,280
true

1222
00:44:33,510 --> 00:44:31,280
there's very very powerful lightning on

1223
00:44:36,790 --> 00:44:33,520
on jupiter we know that we've known it i

1224
00:44:39,109 --> 00:44:36,800
think since voyager

1225
00:44:41,430 --> 00:44:39,119
so the wave instrument the waves

1226
00:44:43,030 --> 00:44:41,440
instrument it's usually detected using

1227
00:44:44,550 --> 00:44:43,040
from the from the

1228
00:44:47,670 --> 00:44:44,560
radio emissions that come off

1229
00:44:49,349 --> 00:44:47,680
electrostatic discharges producing radio

1230
00:44:50,710 --> 00:44:49,359
and we'll be having the waves instrument

1231
00:44:52,950 --> 00:44:50,720
will be

1232
00:44:56,230 --> 00:44:52,960
we're listening for that as we go over

1233
00:44:59,750 --> 00:44:56,240
it's usually the middle attitudes

1234
00:45:01,030 --> 00:44:59,760
where the storms are generated and i'm

1235
00:45:03,030 --> 00:45:01,040
sure as we go over them we'll be

1236
00:45:05,349 --> 00:45:03,040
listening and trying to see

1237
00:45:07,670 --> 00:45:05,359
whether or not those lightning strikes

1238
00:45:09,349 --> 00:45:07,680

are happening yeah

1239
00:45:10,630 --> 00:45:09,359
here we've got a question on the phone

1240
00:45:18,150 --> 00:45:10,640
and then we'll come back here and take a

1241
00:45:22,950 --> 00:45:20,550
who wants to take it i understand a lot

1242
00:45:24,950 --> 00:45:22,960
of you have been uh working on this

1243
00:45:26,710 --> 00:45:24,960
mission for many years and i wonder just

1244
00:45:29,190 --> 00:45:26,720
what does it feel like to be now days

1245
00:45:30,710 --> 00:45:29,200
away from launch

1246
00:45:34,309 --> 00:45:30,720
i'll let you guys take that because i've

1247
00:45:37,109 --> 00:45:34,319
answered one right it's pretty wonderful

1248
00:45:39,270 --> 00:45:37,119
what i'd say also is you got to kind of

1249
00:45:41,510 --> 00:45:39,280
keep it in check you can't stay

1250
00:45:43,990 --> 00:45:41,520
excited for all of a five-year mission

1251
00:45:45,349 --> 00:45:44,000
and you can't stay nervous for all of a

1252
00:45:46,470 --> 00:45:45,359
five-year mission and for that matter

1253
00:45:49,349 --> 00:45:46,480
the the

1254
00:45:51,670 --> 00:45:49,359
decade leading up to it so it's exciting

1255
00:45:53,190 --> 00:45:51,680
and it's also kind of

1256
00:45:57,190 --> 00:45:53,200
maintain an even keel and get this thing

1257
00:46:03,430 --> 00:46:01,829
and not get too nervous at the end right

1258
00:46:04,470 --> 00:46:03,440
all right we'll come back here for a

1259
00:46:06,950 --> 00:46:04,480
question

1260
00:46:08,710 --> 00:46:06,960
leo enright uh with irish television uh

1261
00:46:10,790 --> 00:46:08,720
not to diminish the value of knowledge

1262
00:46:12,309 --> 00:46:10,800
for the sake of knowledge but uh for a

1263
00:46:13,750 --> 00:46:12,319

general audience i was wondering is

1264
00:46:16,630 --> 00:46:13,760
there anything particularly maybe in the

1265
00:46:18,870 --> 00:46:16,640
in the uh the microwave receiver uh

1266
00:46:21,349 --> 00:46:18,880
experiment that would contribute to our

1267
00:46:23,750 --> 00:46:21,359
understanding of climate and weather uh

1268
00:46:25,990 --> 00:46:23,760
here on earth and maybe also with the uh

1269
00:46:28,710 --> 00:46:26,000
the aurora are are there things from

1270
00:46:30,390 --> 00:46:28,720
this mission that directly translate to

1271
00:46:31,829 --> 00:46:30,400
our own planet

1272
00:46:33,829 --> 00:46:31,839
i guess the way i would answer that is

1273
00:46:35,589 --> 00:46:33,839
it depends how directly you want it to

1274
00:46:37,349 --> 00:46:35,599
translate it's certainly true that

1275
00:46:39,109 --> 00:46:37,359
understanding the weather on jupiter

1276
00:46:41,349 --> 00:46:39,119
will help us understand the weather on

1277
00:46:43,109 --> 00:46:41,359
the earth i wouldn't say that i'd draw

1278
00:46:44,550 --> 00:46:43,119
one-to-one correspondence and say if you

1279
00:46:46,470 --> 00:46:44,560
understand this piece that will teach

1280
00:46:49,349 --> 00:46:46,480
you about that piece on the earth but

1281
00:46:51,109 --> 00:46:49,359
rather as with any planetary comparison

1282
00:46:53,510 --> 00:46:51,119
understanding another example tells you

1283
00:46:55,349 --> 00:46:53,520
a lot about the general process and how

1284
00:46:57,430 --> 00:46:55,359
we can get it and i wonder if fran might

1285
00:46:59,750 --> 00:46:57,440
want to come in a bit further

1286
00:47:02,550 --> 00:46:59,760
yeah i philosophically believe that you

1287
00:47:05,670 --> 00:47:02,560
can't claim to understand one system or

1288
00:47:07,829 --> 00:47:05,680

one the underlying physics that controls

1289
00:47:10,470 --> 00:47:07,839
one system if you only look at that one

1290
00:47:12,069 --> 00:47:10,480
place and so i think we really need to

1291
00:47:14,309 --> 00:47:12,079
to understand the processes that drive

1292
00:47:16,230 --> 00:47:14,319
the aurora and earth i mean we think we

1293
00:47:18,069 --> 00:47:16,240
know how they all work

1294
00:47:20,069 --> 00:47:18,079
but i don't think you really know until

1295
00:47:22,150 --> 00:47:20,079
you take that same physics and apply it

1296
00:47:23,750 --> 00:47:22,160
to a very different situation and so

1297
00:47:25,349 --> 00:47:23,760
that's what we're going to be doing with

1298
00:47:29,190 --> 00:47:25,359
juno is to try and test our

1299
00:47:31,430 --> 00:47:29,200
understanding by going somewhere else

1300
00:47:33,589 --> 00:47:31,440
if i may just one follow-up on the

1301
00:47:35,270 --> 00:47:33,599
radiometric experiments that have been

1302
00:47:37,030 --> 00:47:35,280
done for students

1303
00:47:38,790 --> 00:47:37,040
i wondered if

1304
00:47:41,510 --> 00:47:38,800
if this is something that could actually

1305
00:47:43,430 --> 00:47:41,520
contribute directly to the the value of

1306
00:47:45,270 --> 00:47:43,440
of what you're doing and whether it's

1307
00:47:46,549 --> 00:47:45,280
something since a lot of institutions

1308
00:47:49,270 --> 00:47:46,559
around the world

1309
00:47:52,069 --> 00:47:49,280
uh like to listen to jupiter i wondered

1310
00:47:53,270 --> 00:47:52,079
if uh if in fact people in ireland and

1311
00:47:55,670 --> 00:47:53,280
elsewhere

1312
00:47:57,430 --> 00:47:55,680
would actually be able to contribute

1313
00:47:58,710 --> 00:47:57,440

to the project or whether this is really

1314
00:48:00,790 --> 00:47:58,720
just

1315
00:48:02,950 --> 00:48:00,800
for the sake of it

1316
00:48:05,430 --> 00:48:02,960
i'd say the answer is yes

1317
00:48:07,349 --> 00:48:05,440
i want to point out two things one is we

1318
00:48:09,190 --> 00:48:07,359
have a partnership with the gavit

1319
00:48:12,230 --> 00:48:09,200
project goldstone apple valley radio

1320
00:48:14,309 --> 00:48:12,240
telescope in which students use over the

1321
00:48:15,829 --> 00:48:14,319
internet they use a large radio

1322
00:48:17,910 --> 00:48:15,839
telescope out at goldstone to do

1323
00:48:20,069 --> 00:48:17,920
observations of among other things

1324
00:48:22,549 --> 00:48:20,079
observations of jupiter and we will use

1325
00:48:24,790 --> 00:48:22,559
that data that data has been already

1326
00:48:27,349 --> 00:48:24,800
used a bit as one of the contributing

1327
00:48:29,190 --> 00:48:27,359
factors to determining the radiation

1328
00:48:31,109 --> 00:48:29,200
models at jupiter it's not the entire

1329
00:48:34,309 --> 00:48:31,119
thing but it's it's a

1330
00:48:35,829 --> 00:48:34,319
contribution to that process and now

1331
00:48:38,230 --> 00:48:35,839
those observations are also going to be

1332
00:48:40,069 --> 00:48:38,240
useful when we get to jupiter with juno

1333
00:48:42,150 --> 00:48:40,079
and we're using the microwave receiver

1334
00:48:44,950 --> 00:48:42,160
to observe the planet to understand the

1335
00:48:46,950 --> 00:48:44,960
context the radio emission from

1336
00:48:48,870 --> 00:48:46,960
jupiter's radiation belts which can be

1337
00:48:51,430 --> 00:48:48,880
seen from the ground

1338
00:48:53,109 --> 00:48:51,440

is a contributing background to the

1339
00:48:55,030 --> 00:48:53,119
measurement we're trying to make

1340
00:48:58,309 --> 00:48:55,040
and it would be very helpful to

1341
00:49:00,069 --> 00:48:58,319
understand when we're at jupiter whether

1342
00:49:03,270 --> 00:49:00,079
the emission that we see from those

1343
00:49:05,750 --> 00:49:03,280
radiation belts is the same or

1344
00:49:08,470 --> 00:49:05,760
completely different from what it's been

1345
00:49:09,589 --> 00:49:08,480
days months or years previous

1346
00:49:14,150 --> 00:49:09,599
the

1347
00:49:16,549 --> 00:49:14,160
goldstone apple valley radio telescope

1348
00:49:17,750 --> 00:49:16,559
are observing jupiter day in and day out

1349
00:49:20,390 --> 00:49:17,760
so we'll be able to take their

1350
00:49:23,109 --> 00:49:20,400
observations in 2016 and compare to

1351
00:49:25,910 --> 00:49:23,119
their observations today to see whether

1352
00:49:27,829 --> 00:49:25,920
the context we're looking at is the same

1353
00:49:29,829 --> 00:49:27,839
again it's not

1354
00:49:31,190 --> 00:49:29,839
an essential contribution that we can't

1355
00:49:33,109 --> 00:49:31,200
live without but it's certainly a

1356
00:49:34,230 --> 00:49:33,119
helpful piece of information we can

1357
00:49:35,829 --> 00:49:34,240
gather

1358
00:49:37,589 --> 00:49:35,839
in addition to that there's a program

1359
00:49:40,790 --> 00:49:37,599
called radio jove

1360
00:49:41,750 --> 00:49:40,800
in which people use a

1361
00:49:46,150 --> 00:49:41,760
lower

1362
00:49:47,109 --> 00:49:46,160
observations to look at jupiter

1363
00:49:48,710 --> 00:49:47,119

and

1364
00:49:51,190 --> 00:49:48,720
while that's not a direct contribution

1365
00:49:53,349 --> 00:49:51,200
to juno per se my understanding is those

1366
00:49:55,589 --> 00:49:53,359
observations as well contribute to our

1367
00:49:58,470 --> 00:49:55,599
general knowledge of jupiter and can be

1368
00:50:00,150 --> 00:49:58,480
real observations not just trying to

1369
00:50:02,710 --> 00:50:00,160
duplicate something other people have

1370
00:50:04,470 --> 00:50:02,720
done just for the the sake of repeating

1371
00:50:08,710 --> 00:50:04,480
it

1372
00:50:10,069 --> 00:50:08,720
kiwi space foundation i just had a

1373
00:50:11,109 --> 00:50:10,079
question about

1374
00:50:13,750 --> 00:50:11,119
the core

1375
00:50:16,630 --> 00:50:13,760
of jupiter um determining whether or not

1376
00:50:19,030 --> 00:50:16,640
um jupiter has a core of heavy elements

1377
00:50:20,710 --> 00:50:19,040
how definitively would you but would you

1378
00:50:22,950 --> 00:50:20,720
know be able to do this

1379
00:50:25,270 --> 00:50:22,960
and what you mentioned measuring oxygen

1380
00:50:26,549 --> 00:50:25,280
abundances but i was wondering what if

1381
00:50:28,870 --> 00:50:26,559
there are other instruments like

1382
00:50:31,109 --> 00:50:28,880
gravitational um measurements that are

1383
00:50:32,470 --> 00:50:31,119
also important to that and if you can

1384
00:50:34,549 --> 00:50:32,480
determine that how

1385
00:50:37,270 --> 00:50:34,559
how much will you be able to constrain

1386
00:50:39,190 --> 00:50:37,280
the mass of that core

1387
00:50:41,109 --> 00:50:39,200
so um

1388
00:50:44,230 --> 00:50:41,119

first i i want to thank you for saying

1389
00:50:46,549 --> 00:50:44,240
core of heavy elements that was um

1390
00:50:49,349 --> 00:50:46,559
a key piece so because i often say you

1391
00:50:51,030 --> 00:50:49,359
know people ask about rocky core and uh

1392
00:50:53,670 --> 00:50:51,040
and while it may be solids and rocky

1393
00:50:55,430 --> 00:50:53,680
it's not like the rocks you have outside

1394
00:50:56,950 --> 00:50:55,440
on the earth it's it would be very

1395
00:50:58,549 --> 00:50:56,960
different under under those great

1396
00:50:59,670 --> 00:50:58,559
pressures

1397
00:51:01,670 --> 00:50:59,680
so

1398
00:51:03,430 --> 00:51:01,680
that measurement

1399
00:51:05,910 --> 00:51:03,440
is one that

1400
00:51:07,510 --> 00:51:05,920
we make a very accurate gravitational

1401
00:51:09,190 --> 00:51:07,520
field model

1402
00:51:10,150 --> 00:51:09,200
and we make measurements of that gravity

1403
00:51:12,230 --> 00:51:10,160
field

1404
00:51:14,150 --> 00:51:12,240
and we are able to say something about

1405
00:51:16,950 --> 00:51:14,160
the distribution of matter inside

1406
00:51:19,750 --> 00:51:16,960
jupiter and whether there may be a

1407
00:51:21,349 --> 00:51:19,760
discrete or a sharp transition or is it

1408
00:51:23,270 --> 00:51:21,359
just gradual and that will kind of give

1409
00:51:25,270 --> 00:51:23,280
us the clues as to how much mass is in

1410
00:51:27,349 --> 00:51:25,280
the middle versus

1411
00:51:29,910 --> 00:51:27,359
on the way out

1412
00:51:30,790 --> 00:51:29,920
the interpretation of that data

1413
00:51:33,109 --> 00:51:30,800

is

1414
00:51:35,829 --> 00:51:33,119
somewhat limited by our understanding of

1415
00:51:36,790 --> 00:51:35,839
how hydrogen behaves at incredibly high

1416
00:51:38,230 --> 00:51:36,800
pressures

1417
00:51:40,790 --> 00:51:38,240
they're much higher than the ones that

1418
00:51:42,230 --> 00:51:40,800
we have here today and so

1419
00:51:45,190 --> 00:51:42,240
there's something called the equation of

1420
00:51:47,030 --> 00:51:45,200
state which is often studied during time

1421
00:51:48,549 --> 00:51:47,040
periods when people are doing fusion

1422
00:51:51,270 --> 00:51:48,559
experiments and there's some fundamental

1423
00:51:53,190 --> 00:51:51,280
physicists hanging around watching what

1424
00:51:55,910 --> 00:51:53,200
happens at the point where these this

1425
00:51:58,150 --> 00:51:55,920
pellet of deuterium or whatever is um

1426
00:52:00,390 --> 00:51:58,160
is bombarded and goes under this

1427
00:52:01,990 --> 00:52:00,400
incredible pressure and they get points

1428
00:52:04,710 --> 00:52:02,000
on that equation of state and as they

1429
00:52:06,069 --> 00:52:04,720
make progress on that equation of state

1430
00:52:08,710 --> 00:52:06,079
we will be able to go back in and

1431
00:52:10,470 --> 00:52:08,720
reinterpret juno's gravitational field

1432
00:52:11,750 --> 00:52:10,480
data because it will be further

1433
00:52:13,270 --> 00:52:11,760
constrained

1434
00:52:14,790 --> 00:52:13,280
there's also

1435
00:52:16,870 --> 00:52:14,800
a likelihood

1436
00:52:19,190 --> 00:52:16,880
or some probability that our

1437
00:52:20,470 --> 00:52:19,200
measurements will actually make some

1438
00:52:22,230 --> 00:52:20,480

progress on our understanding of

1439
00:52:25,109 --> 00:52:22,240
equation of state as well

1440
00:52:27,109 --> 00:52:25,119
so while we can constrain the core mass

1441
00:52:29,349 --> 00:52:27,119
that type of knowledge and how well we

1442
00:52:31,109 --> 00:52:29,359
constrain it will constantly involve as

1443
00:52:33,670 --> 00:52:31,119
our knowledge of fundamental physics and

1444
00:52:34,630 --> 00:52:33,680
this equation of state evolves

1445
00:52:36,150 --> 00:52:34,640
and so

1446
00:52:38,069 --> 00:52:36,160
in that sense that experiment will

1447
00:52:41,829 --> 00:52:38,079
continue to become more and more precise

1448
00:52:46,630 --> 00:52:43,829
the tie to oxygen is an important one

1449
00:52:50,230 --> 00:52:46,640
toby mentioned it and he can add to this

1450
00:52:51,190 --> 00:52:50,240
but the interior models of of jupiter

1451
00:52:52,309 --> 00:52:51,200
have

1452
00:52:54,870 --> 00:52:52,319
in them

1453
00:52:57,030 --> 00:52:54,880
molecular envelopes and and pressure

1454
00:52:59,589 --> 00:52:57,040
moving down and as we learn more about

1455
00:53:01,829 --> 00:52:59,599
that oxygen abundance since it's the

1456
00:53:04,069 --> 00:53:01,839
third most abundant element that it will

1457
00:53:06,230 --> 00:53:04,079
be the most it's expected to be the most

1458
00:53:08,230 --> 00:53:06,240
abundant of all the elements after

1459
00:53:11,109 --> 00:53:08,240
helium in jupiter

1460
00:53:13,589 --> 00:53:11,119
um that will help constrain that model

1461
00:53:14,790 --> 00:53:13,599
of the interior uh mass

1462
00:53:16,710 --> 00:53:14,800
and the

1463
00:53:18,870 --> 00:53:16,720

rotation inside

1464
00:53:20,710 --> 00:53:18,880
um along with that gravity field and in

1465
00:53:22,230 --> 00:53:20,720
fact the magnetic field as it goes

1466
00:53:23,910 --> 00:53:22,240
through and we understand the metallic

1467
00:53:25,430 --> 00:53:23,920
hydrogen will also play a role so all

1468
00:53:27,430 --> 00:53:25,440
three of those come together to say

1469
00:53:29,750 --> 00:53:27,440
something about the interior model you

1470
00:53:31,589 --> 00:53:29,760
want to add anything i think

1471
00:53:33,829 --> 00:53:31,599
one thing everybody ought to understand

1472
00:53:35,910 --> 00:53:33,839
is we keep saying that oxygen is very

1473
00:53:37,990 --> 00:53:35,920
abundant it's a thousand times less

1474
00:53:39,750 --> 00:53:38,000
abundant than the hydrogen but it's the

1475
00:53:40,710 --> 00:53:39,760
most abundant of the heavy heavy

1476
00:53:44,390 --> 00:53:40,720
elements

1477
00:53:45,270 --> 00:53:44,400
then comes carbon and then nitrogen

1478
00:53:47,589 --> 00:53:45,280
so

1479
00:53:49,829 --> 00:53:47,599
when i talked about uh oxygen combining

1480
00:53:51,990 --> 00:53:49,839
with silicon and making rocks the rocks

1481
00:53:53,589 --> 00:53:52,000
go down but as scott is saying when they

1482
00:53:54,950 --> 00:53:53,599
get down toward the middle the pressure

1483
00:53:57,109 --> 00:53:54,960
is so enormous that you're really

1484
00:53:59,670 --> 00:53:57,119
compressing things in a way that that we

1485
00:54:01,109 --> 00:53:59,680
don't understand yet

1486
00:54:02,950 --> 00:54:01,119
all right we're going to take one

1487
00:54:05,030 --> 00:54:02,960
question here from todd and then we'll

1488
00:54:06,950 --> 00:54:05,040

have one one more over here

1489
00:54:08,630 --> 00:54:06,960
todd halverson of florida today for

1490
00:54:10,549 --> 00:54:08,640
whoever once have fielded i'm wondering

1491
00:54:14,710 --> 00:54:10,559
if someone can characterize the

1492
00:54:17,430 --> 00:54:14,720
environment you expect the spacecraft to

1493
00:54:18,790 --> 00:54:17,440
encounter particularly a closest

1494
00:54:20,870 --> 00:54:18,800
approach whether

1495
00:54:23,589 --> 00:54:20,880
it's going to be quiescent a smooth

1496
00:54:25,990 --> 00:54:23,599
cruise or dynamic turbulent how you

1497
00:54:27,750 --> 00:54:26,000
would characterize it and how are you

1498
00:54:31,349 --> 00:54:27,760
going to manage to thread your way

1499
00:54:33,030 --> 00:54:31,359
through the radiation belts without um

1500
00:54:36,150 --> 00:54:33,040
you know doing real harm to the

1501
00:54:41,990 --> 00:54:39,829
um i guess that's for me so the um

1502
00:54:44,069 --> 00:54:42,000
the spacecraft is outfitted with a with

1503
00:54:45,349 --> 00:54:44,079
a titanium vault there's a box in the

1504
00:54:47,430 --> 00:54:45,359
middle of it that where we put our

1505
00:54:48,870 --> 00:54:47,440
sensitive electronics

1506
00:54:51,589 --> 00:54:48,880
which would get

1507
00:54:53,030 --> 00:54:51,599
eaten by high-energy particles if we did

1508
00:54:54,150 --> 00:54:53,040
not do that so

1509
00:54:57,990 --> 00:54:54,160
so

1510
00:54:59,589 --> 00:54:58,000
jupiter and

1511
00:55:01,510 --> 00:54:59,599
and even with that you know we're

1512
00:55:04,309 --> 00:55:01,520
avoiding the most intense radiation

1513
00:55:05,990 --> 00:55:04,319

regions jupiter by far has the most

1514
00:55:07,990 --> 00:55:06,000
hazardous region in the solar system

1515
00:55:11,510 --> 00:55:08,000
other than just going to the sun and

1516
00:55:12,950 --> 00:55:11,520
going into it so um it has its radiation

1517
00:55:15,510 --> 00:55:12,960
belts around it they're very much like

1518
00:55:18,069 --> 00:55:15,520
the van allen radiation belts

1519
00:55:19,589 --> 00:55:18,079
we except much more powerful

1520
00:55:20,710 --> 00:55:19,599
much more hazardous

1521
00:55:22,549 --> 00:55:20,720
now

1522
00:55:25,030 --> 00:55:22,559
so not only is our spacecraft designed

1523
00:55:27,030 --> 00:55:25,040
to withstand the radiation that we have

1524
00:55:30,230 --> 00:55:27,040
modeled and believed we uh will

1525
00:55:32,710 --> 00:55:30,240
encounter with with margin uh of course

1526
00:55:35,589 --> 00:55:32,720
um we also are sort of threading the

1527
00:55:38,470 --> 00:55:35,599
needle we're going there's a gap

1528
00:55:40,230 --> 00:55:38,480
between the upper atmosphere

1529
00:55:41,829 --> 00:55:40,240
and the most intense part of the

1530
00:55:44,150 --> 00:55:41,839
radiation belts

1531
00:55:45,990 --> 00:55:44,160
and we're going right between that gap

1532
00:55:48,309 --> 00:55:46,000
when we come down through the poles over

1533
00:55:51,109 --> 00:55:48,319
the poles you're on what's called open

1534
00:55:53,270 --> 00:55:51,119
field lines the magnetic field is open

1535
00:55:55,990 --> 00:55:53,280
and and doesn't have a bunch of trapped

1536
00:55:57,430 --> 00:55:56,000
uh high energy particles on them

1537
00:55:59,430 --> 00:55:57,440
and then as you get in closer to the

1538
00:56:01,670 --> 00:55:59,440

lower latitudes those trapped uh

1539
00:56:03,430 --> 00:56:01,680
particles are around and so you go you

1540
00:56:05,190 --> 00:56:03,440
go between them and the atmosphere

1541
00:56:07,990 --> 00:56:05,200
there's a little gap and we're threading

1542
00:56:09,190 --> 00:56:08,000
that gap and that gap exists at the

1543
00:56:11,510 --> 00:56:09,200
earth as well

1544
00:56:14,390 --> 00:56:11,520
so we it may be a feature of radiation

1545
00:56:16,789 --> 00:56:14,400
belts in general but we also have direct

1546
00:56:18,470 --> 00:56:16,799
evidence of that gap from galileo

1547
00:56:20,950 --> 00:56:18,480
as well as um

1548
00:56:22,549 --> 00:56:20,960
radio maps of the radio emission coming

1549
00:56:25,750 --> 00:56:22,559
from the radiation belts here on the

1550
00:56:30,710 --> 00:56:25,760
earth particularly the vla

1551
00:56:35,829 --> 00:56:33,910
russian council in hawaii and squad told

1552
00:56:38,549 --> 00:56:35,839
us about the wonderful discoveries of

1553
00:56:41,109 --> 00:56:38,559
galileo i would like to mention that one

1554
00:56:43,270 --> 00:56:41,119
of the members of the science team toby

1555
00:56:46,069 --> 00:56:43,280
owen discovered the rings of jupiter

1556
00:56:51,270 --> 00:56:47,829
it's nice to have applause from the

1557
00:56:54,789 --> 00:56:52,549
all right

1558
00:56:56,710 --> 00:56:54,799
let's see a couple of programming notes

1559
00:56:58,950 --> 00:56:56,720
first of all our websites for more

1560
00:57:02,069 --> 00:56:58,960
information on jupiter you can go to

1561
00:57:04,390 --> 00:57:03,190
juno

1562
00:57:10,870 --> 00:57:04,400
or

1563
00:57:16,069 --> 00:57:13,270

and as far as programming on our launch

1564
00:57:18,549 --> 00:57:16,079
coverage that starts at 9 a.m

1565
00:57:20,230 --> 00:57:18,559
eastern time on friday morning it will

1566
00:57:23,670 --> 00:57:20,240
be on all three

1567
00:57:25,430 --> 00:57:23,680
nasa tv channels and will conclude after

1568
00:57:28,230 --> 00:57:25,440
spacecraft separation

1569
00:57:30,309 --> 00:57:28,240
and we will go out now with a live shot