
NASA
On Phone
Question from Media

1
00:00:07,990 --> 00:00:05,910
welcome and good afternoon my name is

2
00:00:11,190 --> 00:00:08,000
dwane brown with the office of

3
00:00:12,789 --> 00:00:11,200
communications here in washington d.c

4
00:00:15,669 --> 00:00:12,799
on november 4th

5
00:00:18,150 --> 00:00:15,679
nasa's epoxy mission spacecraft

6
00:00:19,910 --> 00:00:18,160
conducted a successful flyby of comet

7
00:00:22,070 --> 00:00:19,920
hartley 2.

8
00:00:23,189 --> 00:00:22,080
the spacecraft images were seen all over

9
00:00:25,029 --> 00:00:23,199
the world

10
00:00:27,109 --> 00:00:25,039
and the mission is providing scientists

11
00:00:28,950 --> 00:00:27,119
the most extensive observations of a

12
00:00:32,389 --> 00:00:28,960
comet in history

13
00:00:34,870 --> 00:00:32,399

well today is part two the science

14
00:00:37,510 --> 00:00:34,880
you hear brief presentations then we

15
00:00:38,869 --> 00:00:37,520
will open it up for questions

16
00:00:40,389 --> 00:00:38,879
let me introduce you to today's

17
00:00:43,670 --> 00:00:40,399
presenters

18
00:00:45,990 --> 00:00:43,680
first up will be michael o'hearn

19
00:00:47,750 --> 00:00:46,000
epoxy principal investigator

20
00:00:50,229 --> 00:00:47,760
university of maryland

21
00:00:52,229 --> 00:00:50,239
college park

22
00:00:54,310 --> 00:00:52,239
pete schultz

23
00:00:57,189 --> 00:00:54,320
proxy scientist

24
00:00:58,950 --> 00:00:57,199
brown university

25
00:01:00,150 --> 00:00:58,960
tim larson

26
00:01:02,229 --> 00:01:00,160
proxy

27
00:01:05,830 --> 00:01:02,239
project manager from jet propulsion

28
00:01:08,230 --> 00:01:05,840
laboratory in pasadena california

29
00:01:10,789 --> 00:01:08,240
and jessica sunshine

30
00:01:13,030 --> 00:01:10,799
proxy deputy principal investigation

31
00:01:14,149 --> 00:01:13,040
investigator also from the university of

32
00:01:16,230 --> 00:01:14,159
maryland

33
00:01:19,109 --> 00:01:16,240
but before we get started

34
00:01:20,950 --> 00:01:19,119
it's my pleasure to invite to the podium

35
00:01:21,910 --> 00:01:20,960
dr jim green

36
00:01:23,830 --> 00:01:21,920
he is

37
00:01:24,870 --> 00:01:23,840
the director of nasa's planetary science

38
00:01:27,590 --> 00:01:24,880

division

39
00:01:30,550 --> 00:01:27,600
and he has an incredible amount of

40
00:01:32,789 --> 00:01:30,560
planetary launches missions

41
00:01:34,710 --> 00:01:32,799
such as epoxy and other activities that

42
00:01:37,510 --> 00:01:34,720
are on the horizon he's going to set the

43
00:01:45,830 --> 00:01:37,520
stage put things in context so ladies

44
00:01:49,190 --> 00:01:47,590
well it's really a great pleasure at

45
00:01:50,950 --> 00:01:49,200
this time to be able to talk about some

46
00:01:53,429 --> 00:01:50,960
of the scientific results from a

47
00:01:55,830 --> 00:01:53,439
fabulous mission but before we do that i

48
00:01:59,510 --> 00:01:55,840
thought i'd give you a little background

49
00:02:00,789 --> 00:01:59,520
in january 2005 the deep impact mission

50
00:02:03,270 --> 00:02:00,799
was launched

51
00:02:06,230 --> 00:02:03,280
and by july of that year its impactor

52
00:02:09,029 --> 00:02:06,240
hit a comet temple one

53
00:02:10,790 --> 00:02:09,039
and evacuated the top layer surface and

54
00:02:12,710 --> 00:02:10,800
that mission was designed to be able to

55
00:02:15,190 --> 00:02:12,720
look at the below surface composition

56
00:02:17,990 --> 00:02:15,200
and was of a tremendous success

57
00:02:19,910 --> 00:02:18,000
upon the completion of that encounter

58
00:02:22,790 --> 00:02:19,920
the the spacecraft was in excellent

59
00:02:25,750 --> 00:02:22,800
health it had plenty of fuel and a new

60
00:02:28,150 --> 00:02:25,760
mission was devised and approved by nasa

61
00:02:29,830 --> 00:02:28,160
headquarters and that mission was named

62
00:02:31,430 --> 00:02:29,840
epoxy

63
00:02:33,910 --> 00:02:31,440

now the reuse of this particular

64
00:02:36,390 --> 00:02:33,920
spacecraft at a fraction of the cost

65
00:02:38,710 --> 00:02:36,400
that it would take to build a new one

66
00:02:40,869 --> 00:02:38,720
it's just a tremendous bargain for nasa

67
00:02:42,790 --> 00:02:40,879
the science the science team

68
00:02:44,710 --> 00:02:42,800
and the nation

69
00:02:47,990 --> 00:02:44,720
and as dwane mentioned on november 4th

70
00:02:50,949 --> 00:02:48,000
just two weeks ago epoxy flew by another

71
00:02:53,509 --> 00:02:50,959
beautiful comet hartley two

72
00:02:55,190 --> 00:02:53,519
and by the end of the day a press

73
00:02:57,190 --> 00:02:55,200
conference was held and talked about

74
00:02:59,270 --> 00:02:57,200
those initial results

75
00:03:00,869 --> 00:02:59,280
however it's only been over the last two

76
00:03:03,350 --> 00:03:00,879
weeks when the science team has actually

77
00:03:05,350 --> 00:03:03,360
had the detailed opportunity to sit down

78
00:03:07,990 --> 00:03:05,360
and look at the observations

79
00:03:09,190 --> 00:03:08,000
and come to some consensus and dig into

80
00:03:11,350 --> 00:03:09,200
the data

81
00:03:13,110 --> 00:03:11,360
that we're here to hear about today

82
00:03:14,630 --> 00:03:13,120
there's some tremendous results that

83
00:03:16,869 --> 00:03:14,640
they're going to present

84
00:03:18,390 --> 00:03:16,879
some astounding

85
00:03:20,229 --> 00:03:18,400
images that we will see

86
00:03:21,830 --> 00:03:20,239
and without further ado let me turn it

87
00:03:23,990 --> 00:03:21,840
over to michael

88
00:03:26,390 --> 00:03:24,000

thanks jim

89
00:03:30,390 --> 00:03:26,400
today we're going to talk about the ice

90
00:03:33,030 --> 00:03:30,400
that is spewing out of comet hartley 2.

91
00:03:35,110 --> 00:03:33,040
when we excavated 10 000 tons of

92
00:03:36,630 --> 00:03:35,120
material from comet temple one five

93
00:03:38,949 --> 00:03:36,640
years ago

94
00:03:40,229 --> 00:03:38,959
we looked really hard for the chunks of

95
00:03:42,550 --> 00:03:40,239
ice that we thought we would be

96
00:03:44,229 --> 00:03:42,560
excavating and we didn't find any big

97
00:03:46,229 --> 00:03:44,239
chunks of ice

98
00:03:50,789 --> 00:03:46,239
most of the water came out as ice but it

99
00:03:51,670 --> 00:03:50,799
was all in tiny micron sized grains

100
00:03:53,830 --> 00:03:51,680
so

101
00:03:55,990 --> 00:03:53,840
when we saw the images come down even in

102
00:03:58,710 --> 00:03:56,000
real time in the raw data

103
00:04:01,110 --> 00:03:58,720
and realized we had a cloud of snow

104
00:04:02,789 --> 00:04:01,120
around the nucleus we were astounded

105
00:04:04,390 --> 00:04:02,799
because it was so different from comet

106
00:04:06,710 --> 00:04:04,400
tempel one

107
00:04:09,350 --> 00:04:06,720
and it's driven by

108
00:04:10,630 --> 00:04:09,360
a large excess of dry ice in at least

109
00:04:12,869 --> 00:04:10,640
one end of

110
00:04:14,470 --> 00:04:12,879
comet hartley ii and possibly in the

111
00:04:16,310 --> 00:04:14,480
other end as well

112
00:04:19,349 --> 00:04:16,320
the first image

113
00:04:21,509 --> 00:04:19,359

shows an example and many people will

114
00:04:24,150 --> 00:04:21,519
know that our high resolution instrument

115
00:04:27,030 --> 00:04:24,160
is slightly out of focus so we have to

116
00:04:29,350 --> 00:04:27,040
process the image in order to

117
00:04:32,469 --> 00:04:29,360
resolve the details that should be there

118
00:04:34,469 --> 00:04:32,479
and that's in the next image

119
00:04:36,790 --> 00:04:34,479
and here you see a lot of things you see

120
00:04:39,909 --> 00:04:36,800
lots of detail on the nucleus

121
00:04:42,230 --> 00:04:39,919
we can trace individual jets down to

122
00:04:45,189 --> 00:04:42,240
discrete features on the surface of the

123
00:04:49,590 --> 00:04:46,950
but we have to be and we can also see

124
00:04:51,749 --> 00:04:49,600
that there are jets clearly coming from

125
00:04:53,189 --> 00:04:51,759
features on the night side of the comet

126
00:04:55,030 --> 00:04:53,199
in darkness

127
00:04:56,870 --> 00:04:55,040
that's an important result but today

128
00:04:58,950 --> 00:04:56,880
we're not going to focus on the nucleus

129
00:05:01,590 --> 00:04:58,960
we're going to focus on that swarm of

130
00:05:06,629 --> 00:05:01,600
points around the nucleus those are not

131
00:05:10,469 --> 00:05:06,639
stars those are all chunks of ice

132
00:05:12,550 --> 00:05:10,479
and to focus on those the next slide is

133
00:05:14,950 --> 00:05:12,560
just off the edge of the nucleus again

134
00:05:17,430 --> 00:05:14,960
this is the image before we manually

135
00:05:20,070 --> 00:05:17,440
process it to fix the focus

136
00:05:22,950 --> 00:05:20,080
in geek speak it's an scene-dependent

137
00:05:24,790 --> 00:05:22,960
iterative deconvolution but basically we

138
00:05:26,790 --> 00:05:24,800

just process the image to fix the fact

139
00:05:29,350 --> 00:05:26,800
that it's out of focus

140
00:05:34,390 --> 00:05:32,310
the next image is in focus

141
00:05:35,350 --> 00:05:34,400
every one of those pinpoints is a chunk

142
00:05:37,590 --> 00:05:35,360
of ice

143
00:05:38,390 --> 00:05:37,600
it's just a point of light to us so we

144
00:05:40,950 --> 00:05:38,400
can't

145
00:05:41,830 --> 00:05:40,960
measure the sizes directly

146
00:05:43,670 --> 00:05:41,840
but

147
00:05:45,830 --> 00:05:43,680
indirectly just from the brightness we

148
00:05:48,629 --> 00:05:45,840
think the biggest ones are at least the

149
00:05:51,189 --> 00:05:48,639
size of a golf ball and possibly up to

150
00:05:54,070 --> 00:05:51,199
the size of a basketball

151
00:05:55,749 --> 00:05:54,080
probably very porous

152
00:06:01,990 --> 00:05:55,759
and

153
00:06:03,830 --> 00:06:02,000
to pete schultz

154
00:06:05,830 --> 00:06:03,840
thanks mike i mean when i see that image

155
00:06:07,189 --> 00:06:05,840
it just looks like a snow storm and

156
00:06:09,189 --> 00:06:07,199
that's what i want to tell you about i

157
00:06:11,670 --> 00:06:09,199
want to find out how we i want to show

158
00:06:13,189 --> 00:06:11,680
you how we found out what these were how

159
00:06:15,749 --> 00:06:13,199
these were we detected they were

160
00:06:18,070 --> 00:06:15,759
snowballs where they are and we wanted

161
00:06:21,510 --> 00:06:18,080
to find out what they mean so if i can

162
00:06:22,950 --> 00:06:21,520
have that first closer look this shows a

163
00:06:25,590 --> 00:06:22,960

close-up look where you see on the

164
00:06:27,590 --> 00:06:25,600
left-hand side is that blurry image

165
00:06:30,550 --> 00:06:27,600
from the defocused instrument of the

166
00:06:32,070 --> 00:06:30,560
high resolution imager on the right is

167
00:06:33,510 --> 00:06:32,080
it's in focus now through that

168
00:06:35,350 --> 00:06:33,520
deconvolution

169
00:06:37,990 --> 00:06:35,360
and i've identified some of the streaks

170
00:06:40,390 --> 00:06:38,000
the bright ones are identified in red

171
00:06:42,390 --> 00:06:40,400
the faint ones are identified in blue

172
00:06:44,469 --> 00:06:42,400
and then the small specks that you see

173
00:06:45,990 --> 00:06:44,479
are circled in yellow so there's an

174
00:06:48,550 --> 00:06:46,000
assortment of different things we see

175
00:06:50,070 --> 00:06:48,560
when we look at very high resolution

176
00:06:51,589 --> 00:06:50,080
and what these are really indicating

177
00:06:53,990 --> 00:06:51,599
these streaks are telling us that in

178
00:06:55,510 --> 00:06:54,000
fact it's related not to their motion

179
00:06:58,230 --> 00:06:55,520
but the motion of the spacecraft we're

180
00:07:00,390 --> 00:06:58,240
going 27 000 miles per hour and as we're

181
00:07:02,950 --> 00:07:00,400
whizzing by this nucleus we're seeing

182
00:07:04,550 --> 00:07:02,960
these features the longer the streak

183
00:07:06,230 --> 00:07:04,560
probably the closer it is to the

184
00:07:07,830 --> 00:07:06,240
spacecraft the fainter it is probably

185
00:07:10,150 --> 00:07:07,840
the farther away so we're always getting

186
00:07:11,670 --> 00:07:10,160
a sense that we're seeing a lot of

187
00:07:13,510 --> 00:07:11,680
material

188
00:07:14,790 --> 00:07:13,520

in the field of view so let's take a

189
00:07:16,870 --> 00:07:14,800
different view and this is now the

190
00:07:19,270 --> 00:07:16,880
medium resolution imager

191
00:07:20,629 --> 00:07:19,280
and on the left you'll see this context

192
00:07:23,110 --> 00:07:20,639
view that's kind of important because

193
00:07:25,670 --> 00:07:23,120
you see this long shadow cast by the

194
00:07:27,909 --> 00:07:25,680
nucleus on the inner coma and that's

195
00:07:30,790 --> 00:07:27,919
dust because you can't cast a shadow in

196
00:07:32,230 --> 00:07:30,800
space it does cast it on the dust but if

197
00:07:34,070 --> 00:07:32,240
you look at the right you'll notice that

198
00:07:36,230 --> 00:07:34,080
there again all these specs and this is

199
00:07:38,550 --> 00:07:36,240
in the medium resolution imager

200
00:07:41,510 --> 00:07:38,560
so the question is which ones are

201
00:07:44,150 --> 00:07:41,520
actually stars which ones are dust and

202
00:07:45,909 --> 00:07:44,160
which one are artifacts and so that to

203
00:07:47,909 --> 00:07:45,919
do that we need to take one more step

204
00:07:49,909 --> 00:07:47,919
and so in the next

205
00:07:52,550 --> 00:07:49,919
time step i'll show you a flicker movie

206
00:07:54,550 --> 00:07:52,560
and this flicker movie allows you to see

207
00:07:57,430 --> 00:07:54,560
things in motion and when we first saw

208
00:07:59,589 --> 00:07:57,440
this our mouths just dropped a whole

209
00:08:00,950 --> 00:07:59,599
team just dropped because we could begin

210
00:08:03,189 --> 00:08:00,960
to see if you look very close to the

211
00:08:05,189 --> 00:08:03,199
nucleus you can see things that are

212
00:08:07,510 --> 00:08:05,199
slowly moving but then as you go farther

213
00:08:10,309 --> 00:08:07,520

away they are really migrating this is

214
00:08:12,790 --> 00:08:10,319
telling us that there's depth yeah and

215
00:08:14,550 --> 00:08:12,800
so we are seeing now with this imaging

216
00:08:16,790 --> 00:08:14,560
we are now seeing two different

217
00:08:18,230 --> 00:08:16,800
instruments the high resolution and the

218
00:08:19,830 --> 00:08:18,240
medium resolution

219
00:08:21,189 --> 00:08:19,840
we're seeing them with two different

220
00:08:22,230 --> 00:08:21,199
instruments and we're seeing the same

221
00:08:24,309 --> 00:08:22,240
objects

222
00:08:27,029 --> 00:08:24,319
to me this whole thing looks like a snow

223
00:08:28,629 --> 00:08:27,039
globe that you just simply shaken and

224
00:08:30,629 --> 00:08:28,639
watching it fly

225
00:08:31,749 --> 00:08:30,639
so now the question is where are they in

226
00:08:33,350 --> 00:08:31,759
space

227
00:08:34,389 --> 00:08:33,360
uh and to see that we've got to go to

228
00:08:35,670 --> 00:08:34,399
this next

229
00:08:38,070 --> 00:08:35,680
time step

230
00:08:39,909 --> 00:08:38,080
where here we actually track out

231
00:08:41,589 --> 00:08:39,919
particles and so you notice that red

232
00:08:44,790 --> 00:08:41,599
one's just zipping by

233
00:08:47,110 --> 00:08:44,800
and this is kind of like being in a car

234
00:08:49,430 --> 00:08:47,120
and with the signs just flying right by

235
00:08:51,590 --> 00:08:49,440
you with the other ones and distance

236
00:08:54,630 --> 00:08:51,600
like the trees in the distance staying

237
00:08:56,470 --> 00:08:54,640
pretty steady so this is it gives you a

238
00:08:58,310 --> 00:08:56,480

sense that we are seeing things from

239
00:08:59,750 --> 00:08:58,320
different distances away

240
00:09:02,389 --> 00:08:59,760
and the importance of this is that we

241
00:09:04,389 --> 00:09:02,399
can actually locate these objects and we

242
00:09:07,750 --> 00:09:04,399
might be able to tell where they are

243
00:09:10,230 --> 00:09:07,760
with respect to the nucleus in space

244
00:09:11,829 --> 00:09:10,240
now we now know that these particles as

245
00:09:13,350 --> 00:09:11,839
they're moving are still going less than

246
00:09:15,509 --> 00:09:13,360
about a meter per second so they're not

247
00:09:17,990 --> 00:09:15,519
going very fast again it's really the

248
00:09:20,070 --> 00:09:18,000
spacecraft doing the moving for us

249
00:09:21,509 --> 00:09:20,080
so with that it also tells us that we're

250
00:09:23,509 --> 00:09:21,519
seeing displacements and when you see

251
00:09:26,310 --> 00:09:23,519
displacements you can see things in

252
00:09:27,829 --> 00:09:26,320
stereo so if you will please put on your

253
00:09:29,030 --> 00:09:27,839
stair glasses and we'll take a look

254
00:09:30,949 --> 00:09:29,040
we'll go down

255
00:09:33,269 --> 00:09:30,959
into 3d

256
00:09:35,350 --> 00:09:33,279
i love this look now make be sure

257
00:09:37,829 --> 00:09:35,360
first of all that the blue filter is on

258
00:09:39,269 --> 00:09:37,839
your right and the red is on the left

259
00:09:41,670 --> 00:09:39,279
and i also suggest that if you're

260
00:09:43,670 --> 00:09:41,680
looking at this on tv move back to the

261
00:09:45,269 --> 00:09:43,680
monitor because i think that'll help you

262
00:09:46,550 --> 00:09:45,279
see this better

263
00:09:48,230 --> 00:09:46,560

notice that this is a slight different

264
00:09:50,070 --> 00:09:48,240
orientation we have to do this because

265
00:09:51,670 --> 00:09:50,080
the stereo is constructed by the motion

266
00:09:54,230 --> 00:09:51,680
of the spacecraft

267
00:09:56,550 --> 00:09:54,240
and and now the sun is really at the top

268
00:09:58,389 --> 00:09:56,560
now i've circled some of the particles

269
00:10:00,150 --> 00:09:58,399
and as you look at these particles even

270
00:10:02,069 --> 00:10:00,160
without stereo glasses you can see the

271
00:10:04,550 --> 00:10:02,079
depth some of the ones that are near the

272
00:10:05,829 --> 00:10:04,560
nucleus are pretty far back

273
00:10:07,670 --> 00:10:05,839
are actually kind of sticking out in

274
00:10:09,030 --> 00:10:07,680
front and then over to the left you'll

275
00:10:10,870 --> 00:10:09,040
see some that are staying way in the

276
00:10:13,350 --> 00:10:10,880
back and for those of you who don't have

277
00:10:14,949 --> 00:10:13,360
stereo glasses on

278
00:10:16,790 --> 00:10:14,959
you can do this later but you can see

279
00:10:18,710 --> 00:10:16,800
that there are some of these specs the

280
00:10:20,550 --> 00:10:18,720
green and red are far apart those are

281
00:10:22,150 --> 00:10:20,560
the ones that are close to us and those

282
00:10:23,430 --> 00:10:22,160
that are not far apart of the ones

283
00:10:24,790 --> 00:10:23,440
behind

284
00:10:26,710 --> 00:10:24,800
so we can still

285
00:10:28,310 --> 00:10:26,720
clearly see in this case just like with

286
00:10:31,430 --> 00:10:28,320
the streaks there's some way in the far

287
00:10:33,350 --> 00:10:31,440
ground some way in the far far ground

288
00:10:35,430 --> 00:10:33,360

uh so these objects are really

289
00:10:38,150 --> 00:10:35,440
surrounding the nucleus and now we have

290
00:10:39,990 --> 00:10:38,160
kind of this estimate of size which mike

291
00:10:41,430 --> 00:10:40,000
suggested somewhere between a couple of

292
00:10:43,430 --> 00:10:41,440
inches to as large

293
00:10:45,670 --> 00:10:43,440
as a couple of feet

294
00:10:47,269 --> 00:10:45,680
but we have the distribution as well the

295
00:10:48,790 --> 00:10:47,279
team members have estimated that for

296
00:10:50,310 --> 00:10:48,800
every 10 inch

297
00:10:52,630 --> 00:10:50,320
particle you might see there would be a

298
00:10:54,710 --> 00:10:52,640
thousand of the one inch particle so

299
00:10:56,790 --> 00:10:54,720
there's a whole range so when i look at

300
00:10:59,030 --> 00:10:56,800
this image especially in 3d this whole

301
00:11:03,590 --> 00:10:59,040
thing kind of appears to me

302
00:11:05,750 --> 00:11:03,600
as if this this nucleus has a posse of

303
00:11:06,870 --> 00:11:05,760
many comets surrounding it

304
00:11:08,550 --> 00:11:06,880
so

305
00:11:10,150 --> 00:11:08,560
jessica will describe how these things

306
00:11:12,949 --> 00:11:10,160
are lifted off the surface when she

307
00:11:15,269 --> 00:11:12,959
talks about the process but now let me

308
00:11:16,870 --> 00:11:15,279
pose a different question which is

309
00:11:18,790 --> 00:11:16,880
could any of these actually hit the

310
00:11:21,910 --> 00:11:18,800
spacecraft so if we go to the next time

311
00:11:23,509 --> 00:11:21,920
step here's an image of us approaching

312
00:11:24,790 --> 00:11:23,519
now as you see those two streaks that

313
00:11:26,710 --> 00:11:24,800

are circled

314
00:11:28,550 --> 00:11:26,720
realize that those are three times

315
00:11:30,150 --> 00:11:28,560
closer to the spacecraft than they are

316
00:11:32,630 --> 00:11:30,160
to the nucleus

317
00:11:35,190 --> 00:11:32,640
i also realized we're heading toward the

318
00:11:37,430 --> 00:11:35,200
comet at least offset from the comet

319
00:11:39,509 --> 00:11:37,440
that raises the question

320
00:11:41,350 --> 00:11:39,519
did we get hit should we be concerned

321
00:11:43,590 --> 00:11:41,360
and so with that i'll turn it over to

322
00:11:45,110 --> 00:11:43,600
tim thanks pete

323
00:11:46,870 --> 00:11:45,120
so talking about flying through this uh

324
00:11:48,389 --> 00:11:46,880
field of ice junks and snowballs and

325
00:11:50,389 --> 00:11:48,399
other hazardous objects for the

326
00:11:52,389 --> 00:11:50,399
spacecraft first i want to remind you

327
00:11:55,590 --> 00:11:52,399
what our flyby geometry was if you roll

328
00:11:57,590 --> 00:11:55,600
the animation it'll show you a rendering

329
00:11:59,350 --> 00:11:57,600
of what the flyby looked like as the

330
00:12:00,629 --> 00:11:59,360
spacecraft approached a comet went by it

331
00:12:02,629 --> 00:12:00,639
and then will be followed right after

332
00:12:04,790 --> 00:12:02,639
that by the review of the comet that we

333
00:12:06,470 --> 00:12:04,800
had from the spacecraft imagers and just

334
00:12:09,110 --> 00:12:06,480
reminding everyone we flew by the comet

335
00:12:10,870 --> 00:12:09,120
a distance of about 435 miles

336
00:12:13,829 --> 00:12:10,880
uh we flew by it at us at a speed of

337
00:12:15,350 --> 00:12:13,839
about 27 000 miles per hour and uh the

338
00:12:17,030 --> 00:12:15,360

spacecraft was slightly below the comet

339
00:12:19,190 --> 00:12:17,040
in the sun plane and that produced the

340
00:12:20,949 --> 00:12:19,200
views that you'll see here

341
00:12:22,790 --> 00:12:20,959
so as we look back and try to figure out

342
00:12:24,230 --> 00:12:22,800
whether or not uh whether or not we're

343
00:12:25,190 --> 00:12:24,240
the spacecraft was damaged at all or

344
00:12:27,430 --> 00:12:25,200
whether we were hit by any of these

345
00:12:29,350 --> 00:12:27,440
particles a first order look you can

346
00:12:30,790 --> 00:12:29,360
look at the health data and all the

347
00:12:32,949 --> 00:12:30,800
telemetry from the spacecraft to tell

348
00:12:35,110 --> 00:12:32,959
whether everything is still working fine

349
00:12:37,190 --> 00:12:35,120
after the flyby and that data we got

350
00:12:38,790 --> 00:12:37,200
down very shortly after the flyby the

351
00:12:40,230 --> 00:12:38,800
first set of data we brought back were

352
00:12:42,230 --> 00:12:40,240
telemetry files before we started

353
00:12:43,750 --> 00:12:42,240
bringing pictures down and so we were

354
00:12:45,190 --> 00:12:43,760
able to tell right away that we went by

355
00:12:47,110 --> 00:12:45,200
past the comet through the through the

356
00:12:48,870 --> 00:12:47,120
coma without any kind of discernible

357
00:12:50,470 --> 00:12:48,880
damage to the spacecraft all these all

358
00:12:51,910 --> 00:12:50,480
the instruments and all the equipment on

359
00:12:54,230 --> 00:12:51,920
board the spacecraft was working just

360
00:12:55,509 --> 00:12:54,240
fine so then the next step is to try to

361
00:12:57,509 --> 00:12:55,519
figure out whether or not we might have

362
00:12:59,509 --> 00:12:57,519
gotten hit by any small particles that

363
00:13:00,790 --> 00:12:59,519

we could detect and so to talk about

364
00:13:02,870 --> 00:13:00,800
that i'd like to refer to this model of

365
00:13:05,190 --> 00:13:02,880
the spacecraft if you look at this model

366
00:13:06,870 --> 00:13:05,200
here if you imagine being hit

367
00:13:08,550 --> 00:13:06,880
in in a part of the spacecraft that's

368
00:13:09,829 --> 00:13:08,560
away from the center of mass you can

369
00:13:11,590 --> 00:13:09,839
imagine that imparting a little bit of

370
00:13:12,790 --> 00:13:11,600
torque to the spacecraft and moving it

371
00:13:15,269 --> 00:13:12,800
and so those are the kind of clues that

372
00:13:17,110 --> 00:13:15,279
we'd be looking for and so the team

373
00:13:19,030 --> 00:13:17,120
undertook a pretty detailed examination

374
00:13:20,949 --> 00:13:19,040
of the attitude data on the spacecraft

375
00:13:23,190 --> 00:13:20,959
we have two different ways of sensing

376
00:13:24,790 --> 00:13:23,200
the attitude of the spacecraft and

377
00:13:26,550 --> 00:13:24,800
looking at both sets of data trying to

378
00:13:28,629 --> 00:13:26,560
pick out get rid of the noise and look

379
00:13:30,230 --> 00:13:28,639
at real attitude excursions

380
00:13:31,910 --> 00:13:30,240
that gives us an idea of where the

381
00:13:33,430 --> 00:13:31,920
spacecraft might have moved as we as we

382
00:13:34,629 --> 00:13:33,440
went through the through the flyby

383
00:13:37,190 --> 00:13:34,639
sequence

384
00:13:38,790 --> 00:13:37,200
then you have to take and rule out any

385
00:13:40,710 --> 00:13:38,800
any movements that are due to things

386
00:13:42,470 --> 00:13:40,720
going on on the spacecraft for example

387
00:13:44,389 --> 00:13:42,480
receiving position updates from the auto

388
00:13:46,069 --> 00:13:44,399

nav software

389
00:13:48,310 --> 00:13:46,079
filter wheel movements can be sensed in

390
00:13:49,829 --> 00:13:48,320
the attitude data and even the ir scans

391
00:13:52,150 --> 00:13:49,839
as the spacecraft

392
00:13:53,990 --> 00:13:52,160
would would move back and forth to to

393
00:13:55,509 --> 00:13:54,000
perform the ir scans all of those things

394
00:13:57,269 --> 00:13:55,519
you have to rule out because that that

395
00:13:58,710 --> 00:13:57,279
obviously then would not be a dust hit

396
00:14:00,870 --> 00:13:58,720
so after doing that and going through a

397
00:14:03,509 --> 00:14:00,880
fair amount of detailed analysis we've

398
00:14:05,030 --> 00:14:03,519
identified nine events in the in the 10

399
00:14:07,430 --> 00:14:05,040
minutes around closest approach that

400
00:14:08,870 --> 00:14:07,440
could possibly have been dust hits once

401
00:14:10,710 --> 00:14:08,880
you identify those then you have to try

402
00:14:13,350 --> 00:14:10,720
to bound well what size particle was it

403
00:14:14,829 --> 00:14:13,360
that might have hit us and uh so so for

404
00:14:16,790 --> 00:14:14,839
that you have to make some kind of

405
00:14:18,230 --> 00:14:16,800
assumption the assumption that we used

406
00:14:19,910 --> 00:14:18,240
in this analysis is basically assuming

407
00:14:22,389 --> 00:14:19,920
something to hit the spacecraft about a

408
00:14:24,710 --> 00:14:22,399
meter away from the center of mass to

409
00:14:26,230 --> 00:14:24,720
try to bound the size of the particles

410
00:14:29,430 --> 00:14:26,240
based on that we estimate that these

411
00:14:31,030 --> 00:14:29,440
nine events the particles that hit us

412
00:14:33,189 --> 00:14:31,040
looking at the attitude excuse

413
00:14:35,350 --> 00:14:33,199

excursions that we saw ranged from about

414
00:14:36,389 --> 00:14:35,360
point zero two to point two milligrams

415
00:14:38,389 --> 00:14:36,399
in weight

416
00:14:40,069 --> 00:14:38,399
um point two milligrams that's about the

417
00:14:41,670 --> 00:14:40,079
about the weight of an eyelash so you

418
00:14:42,790 --> 00:14:41,680
can imagine something that small that

419
00:14:44,550 --> 00:14:42,800
light hitting you and causing an

420
00:14:45,990 --> 00:14:44,560
attitude disturbance well

421
00:14:47,829 --> 00:14:46,000
traveling at those kind of velocities

422
00:14:49,910 --> 00:14:47,839
you can impart a fair amount of energy

423
00:14:52,389 --> 00:14:49,920
when you hit an object with that so

424
00:14:54,310 --> 00:14:52,399
that's based on our analysis

425
00:14:56,310 --> 00:14:54,320
um and the telemetry we have from the

426
00:14:57,750 --> 00:14:56,320
spacecraft we can conclude that yes we

427
00:14:59,590 --> 00:14:57,760
may have been hit by some of these small

428
00:15:00,790 --> 00:14:59,600
particles but none of them were large

429
00:15:02,150 --> 00:15:00,800
enough to cause any damage to the

430
00:15:03,670 --> 00:15:02,160
spacecraft that's an important point

431
00:15:05,509 --> 00:15:03,680
here

432
00:15:07,590 --> 00:15:05,519
i also like to

433
00:15:09,030 --> 00:15:07,600
emphasize the point that november 4th

434
00:15:10,949 --> 00:15:09,040
wasn't the end of the story for this uh

435
00:15:13,110 --> 00:15:10,959
for this flyby we're still continuing to

436
00:15:15,590 --> 00:15:13,120
collect data we've collected about 32

437
00:15:17,670 --> 00:15:15,600
000 images of the comet since november

438
00:15:19,910 --> 00:15:17,680

4th uh we continue to to look at it

439
00:15:22,629 --> 00:15:19,920
about every two minutes and acquire data

440
00:15:24,230 --> 00:15:22,639
uh returning over 3000 images a day of

441
00:15:26,230 --> 00:15:24,240
data by the time we're all finished with

442
00:15:27,910 --> 00:15:26,240
this uh with this science mission around

443
00:15:30,389 --> 00:15:27,920
thanksgiving is our last uh our last

444
00:15:32,230 --> 00:15:30,399
imaging session we will return about 120

445
00:15:34,790 --> 00:15:32,240
000 images of the comet and that

446
00:15:36,870 --> 00:15:34,800
represents about 22 gigabytes of data so

447
00:15:39,670 --> 00:15:36,880
this uh undoubtedly gives us an

448
00:15:41,030 --> 00:15:39,680
exhaustive view of of this comet more

449
00:15:42,870 --> 00:15:41,040
than we've ever been able to return

450
00:15:44,870 --> 00:15:42,880
before from any other comet

451
00:15:46,470 --> 00:15:44,880
and uh so after that we'll do a final

452
00:15:47,749 --> 00:15:46,480
calibration of the instruments and the

453
00:15:49,030 --> 00:15:47,759
spacecraft will be on a fairly quiet

454
00:15:50,310 --> 00:15:49,040
mode in december waiting for the

455
00:15:51,829 --> 00:15:50,320
instructions

456
00:15:53,509 --> 00:15:51,839
so to talk a little bit more about all

457
00:15:55,030 --> 00:15:53,519
these chunks and uh different things

458
00:15:55,829 --> 00:15:55,040
that we might or might not have been hit

459
00:15:57,189 --> 00:15:55,839
with

460
00:15:59,910 --> 00:15:57,199
jessica sunshine is going to tell us

461
00:16:02,310 --> 00:15:59,920
about the composition thanks tim so what

462
00:16:04,069 --> 00:16:02,320
i'd like to do first is explain uh how

463
00:16:06,389 --> 00:16:04,079

is it that we know these snowballs or

464
00:16:08,150 --> 00:16:06,399
snowflakes are actually made of ice

465
00:16:10,069 --> 00:16:08,160
and second of all show you that while

466
00:16:12,069 --> 00:16:10,079
they appear to be quite large in the

467
00:16:13,350 --> 00:16:12,079
context of the imagers they're actually

468
00:16:14,710 --> 00:16:13,360
quite small

469
00:16:17,110 --> 00:16:14,720
so with that let me start with

470
00:16:18,710 --> 00:16:17,120
explaining that in the same way that we

471
00:16:21,030 --> 00:16:18,720
can use a prism

472
00:16:23,430 --> 00:16:21,040
to break light into colors of the

473
00:16:25,430 --> 00:16:23,440
rainbow our high resolution instrument

474
00:16:27,509 --> 00:16:25,440
includes an ir spectrometer that

475
00:16:30,949 --> 00:16:27,519
actually uses a double prism and allows

476
00:16:33,350 --> 00:16:30,959
us to measure materials in the infrared

477
00:16:35,590 --> 00:16:33,360
which is redder than we can see but is a

478
00:16:38,310 --> 00:16:35,600
domain in which we can identify some

479
00:16:39,350 --> 00:16:38,320
very important materials uh as well as

480
00:16:40,710 --> 00:16:39,360
map them

481
00:16:42,310 --> 00:16:40,720
so if i could have the first slide

482
00:16:45,430 --> 00:16:42,320
please

483
00:16:47,670 --> 00:16:45,440
so here in white is a measurement of the

484
00:16:49,189 --> 00:16:47,680
coma or the atmosphere of comet hartley

485
00:16:52,550 --> 00:16:49,199
2 taken just

486
00:16:54,230 --> 00:16:52,560
off the nucleus on the co2 rich end

487
00:16:56,949 --> 00:16:54,240
and you can see in this image that the

488
00:16:58,389 --> 00:16:56,959

gases appear as positive features that's

489
00:17:01,110 --> 00:16:58,399
that is peaks

490
00:17:03,110 --> 00:17:01,120
water vapor is denoted in blue we have a

491
00:17:06,390 --> 00:17:03,120
very strong carbon dioxide signature in

492
00:17:07,909 --> 00:17:06,400
green and a weak but important

493
00:17:09,350 --> 00:17:07,919
signature due to the vaporized

494
00:17:10,710 --> 00:17:09,360
hydrocarbons

495
00:17:11,829 --> 00:17:10,720
in red

496
00:17:13,429 --> 00:17:11,839
but for the purposes of this

497
00:17:15,590 --> 00:17:13,439
conversation we're really interested in

498
00:17:18,069 --> 00:17:15,600
the ice and the ice is actually things

499
00:17:19,590 --> 00:17:18,079
that appear negative in this measurement

500
00:17:21,350 --> 00:17:19,600
and if i could have the next slide i'll

501
00:17:23,590 --> 00:17:21,360
emphasize that a little bit

502
00:17:25,829 --> 00:17:23,600
same measurement of hartley 2 but now

503
00:17:29,270 --> 00:17:25,839
you see that there are three regions

504
00:17:31,270 --> 00:17:29,280
denoted by the blue boxes that where

505
00:17:33,350 --> 00:17:31,280
light is absorbed

506
00:17:35,830 --> 00:17:33,360
and these three signatures i'm comparing

507
00:17:38,470 --> 00:17:35,840
in purple to laboratory measurements of

508
00:17:39,590 --> 00:17:38,480
ices at different sized crystals and you

509
00:17:41,830 --> 00:17:39,600
can see there's a one-to-one

510
00:17:43,590 --> 00:17:41,840
correspondence and that this in fact is

511
00:17:44,549 --> 00:17:43,600
how we identify the presence of water

512
00:17:46,630 --> 00:17:44,559
ice

513
00:17:48,390 --> 00:17:46,640

what's also interesting here is that if

514
00:17:50,870 --> 00:17:48,400
you look at the different sizes these

515
00:17:53,510 --> 00:17:50,880
are all very small 1 micron up to 100

516
00:17:55,510 --> 00:17:53,520
microns you can see that the 3 micron

517
00:17:58,310 --> 00:17:55,520
band that's the area with the largest

518
00:18:00,549 --> 00:17:58,320
box uh actually starts to disappear and

519
00:18:02,630 --> 00:18:00,559
by 100 microns it's gone

520
00:18:04,630 --> 00:18:02,640
and yet if you look at hartley ii it has

521
00:18:06,310 --> 00:18:04,640
a very strong three micron absorption in

522
00:18:08,549 --> 00:18:06,320
fact it's about fifty percent of the

523
00:18:09,590 --> 00:18:08,559
light that hits the ice grains are

524
00:18:11,270 --> 00:18:09,600
absorbed

525
00:18:13,590 --> 00:18:11,280
and because of the strength of that band

526
00:18:15,990 --> 00:18:13,600
the depth of that band uh we know that

527
00:18:17,990 --> 00:18:16,000
the the ice on a fundamental level can't

528
00:18:20,390 --> 00:18:18,000
be bigger than one or maybe somewhere

529
00:18:21,909 --> 00:18:20,400
between one and ten microns in size and

530
00:18:22,870 --> 00:18:21,919
so that's about the thickness of our

531
00:18:25,110 --> 00:18:22,880
hair

532
00:18:27,990 --> 00:18:25,120
these are very fine particles

533
00:18:29,510 --> 00:18:28,000
so what that means is that the snowballs

534
00:18:31,590 --> 00:18:29,520
are not what we might have thought to

535
00:18:33,830 --> 00:18:31,600
begin with we're not seeing hail sized

536
00:18:35,110 --> 00:18:33,840
particles softballs or even ice cubes

537
00:18:37,750 --> 00:18:35,120
what we're seeing

538
00:18:39,510 --> 00:18:37,760

are fluffy aggregates of very small

539
00:18:40,950 --> 00:18:39,520
pieces of ice

540
00:18:44,470 --> 00:18:40,960
and so

541
00:18:45,669 --> 00:18:44,480
they're akin more to maybe a dandelion

542
00:18:47,830 --> 00:18:45,679
puff

543
00:18:50,150 --> 00:18:47,840
that is very hot empty air that can

544
00:18:51,990 --> 00:18:50,160
easily be broken apart than an ice cube

545
00:18:53,830 --> 00:18:52,000
and that might explain why we didn't see

546
00:18:55,029 --> 00:18:53,840
any hits on the spacecraft among other

547
00:18:56,710 --> 00:18:55,039
reasons

548
00:18:58,070 --> 00:18:56,720
so let me move on

549
00:18:59,909 --> 00:18:58,080
to show you the distribution of these

550
00:19:01,270 --> 00:18:59,919
materials around the comet if i could

551
00:19:03,750 --> 00:19:01,280
have the next slide

552
00:19:05,350 --> 00:19:03,760
okay on your left is an image from the

553
00:19:06,390 --> 00:19:05,360
medium resolution imager like pete

554
00:19:09,270 --> 00:19:06,400
showed

555
00:19:11,669 --> 00:19:09,280
but this time it's enhanced to show

556
00:19:13,350 --> 00:19:11,679
the material jetting off the nucleus

557
00:19:15,510 --> 00:19:13,360
that is in the in the coma and you can

558
00:19:17,430 --> 00:19:15,520
see there's a very strong jet on the

559
00:19:20,070 --> 00:19:17,440
sunward side on the right and some

560
00:19:23,029 --> 00:19:20,080
weaker jets uh on the anti-sunward side

561
00:19:25,750 --> 00:19:23,039
where we were sewing before in the dark

562
00:19:28,150 --> 00:19:25,760
on your right in green is a map of the

563
00:19:31,510 --> 00:19:28,160

relative abundance of carbon dioxide or

564
00:19:32,470 --> 00:19:31,520
co2 that is uh vapor that's come off dry

565
00:19:34,470 --> 00:19:32,480
ice

566
00:19:37,750 --> 00:19:34,480
and you can see it's very enhanced in

567
00:19:39,590 --> 00:19:37,760
the same places as the the mri image

568
00:19:41,750 --> 00:19:39,600
that is the jets that we're seeing are

569
00:19:43,590 --> 00:19:41,760
actually composed of carbon dioxide so

570
00:19:45,750 --> 00:19:43,600
you can stream a strong signature off

571
00:19:47,669 --> 00:19:45,760
the sunward end weaker signatures off

572
00:19:48,950 --> 00:19:47,679
the anti-sunward end but nothing in the

573
00:19:51,590 --> 00:19:48,960
middle

574
00:19:53,510 --> 00:19:51,600
in the next slide you'll see the dust

575
00:19:55,430 --> 00:19:53,520
that pete was talking about here the

576
00:19:57,430 --> 00:19:55,440
nucleus itself is white but if you look

577
00:19:59,190 --> 00:19:57,440
at the red parts you can see the dust

578
00:20:01,590 --> 00:19:59,200
coming off and there's a very good

579
00:20:04,149 --> 00:20:01,600
correlation between where the dust is

580
00:20:05,590 --> 00:20:04,159
these bulk solids and the carbon dioxide

581
00:20:07,430 --> 00:20:05,600
is and in the next slide i'm going to

582
00:20:09,430 --> 00:20:07,440
show you the ice

583
00:20:11,590 --> 00:20:09,440
here in blue and again the areas that

584
00:20:13,350 --> 00:20:11,600
are white in this area that are the most

585
00:20:15,110 --> 00:20:13,360
intense are the areas where we see what

586
00:20:17,190 --> 00:20:15,120
we map water ice

587
00:20:19,909 --> 00:20:17,200
and you can see it once more time along

588
00:20:21,750 --> 00:20:19,919

the the sunward side and if i could go

589
00:20:24,549 --> 00:20:21,760
back one please

590
00:20:27,430 --> 00:20:24,559
thanks uh the sunward side uh and in the

591
00:20:29,430 --> 00:20:27,440
upper the uh underneath side in the dark

592
00:20:31,909 --> 00:20:29,440
on the upward side and so what we're

593
00:20:33,669 --> 00:20:31,919
seeing here is this story that we've

594
00:20:37,029 --> 00:20:33,679
noticed when we started getting data

595
00:20:39,029 --> 00:20:37,039
from this comet that it is the co2 that

596
00:20:41,990 --> 00:20:39,039
is driving the materials the dust and

597
00:20:44,630 --> 00:20:42,000
the ice so ice grains and dust are being

598
00:20:46,710 --> 00:20:44,640
pulled from the inside of the comet with

599
00:20:49,669 --> 00:20:46,720
the carbon dioxide as it sublimes and

600
00:20:50,710 --> 00:20:49,679
heats up so when we looked at this we

601
00:20:52,149 --> 00:20:50,720
thought all right well we might as well

602
00:20:53,590 --> 00:20:52,159
look at water but it should be pretty

603
00:20:55,669 --> 00:20:53,600
straightforward you're going to see

604
00:20:57,510 --> 00:20:55,679
water evaporating and subliming where

605
00:20:59,190 --> 00:20:57,520
the ice is

606
00:21:00,870 --> 00:20:59,200
well that turned out to be really not

607
00:21:03,270 --> 00:21:00,880
the story at all and to our great

608
00:21:05,110 --> 00:21:03,280
surprise if i may have the last slide

609
00:21:07,510 --> 00:21:05,120
if you see the distribution of water

610
00:21:09,430 --> 00:21:07,520
vapor while it's true that water is

611
00:21:11,510 --> 00:21:09,440
where the ice is in fact it's everywhere

612
00:21:13,190 --> 00:21:11,520
particularly on the sunward side

613
00:21:15,669 --> 00:21:13,200

of the image there's a tremendous

614
00:21:17,029 --> 00:21:15,679
enhancement of water vapor coming out of

615
00:21:19,029 --> 00:21:17,039
the waste

616
00:21:21,270 --> 00:21:19,039
of this body

617
00:21:22,710 --> 00:21:21,280
we wouldn't expect this at all

618
00:21:25,350 --> 00:21:22,720
and so what we're seeing

619
00:21:27,590 --> 00:21:25,360
is an indication that here the ice is

620
00:21:30,230 --> 00:21:27,600
still on the inside it's being heated up

621
00:21:31,990 --> 00:21:30,240
by the sun and that drives the water off

622
00:21:35,750 --> 00:21:32,000
and so this comet is doing two things at

623
00:21:37,669 --> 00:21:35,760
once on its ends the co2 is evaporating

624
00:21:40,149 --> 00:21:37,679
and dragging the ice cranes with it and

625
00:21:41,669 --> 00:21:40,159
that produces water in the coma in the

626
00:21:43,590 --> 00:21:41,679
atmosphere

627
00:21:45,750 --> 00:21:43,600
while in the middle the smooth dust

628
00:21:47,669 --> 00:21:45,760
ridden region of the center

629
00:21:49,430 --> 00:21:47,679
of this comet we're seeing subsurface

630
00:21:50,950 --> 00:21:49,440
ice evaporating

631
00:21:52,630 --> 00:21:50,960
and i'm going to turn it over to mike

632
00:21:54,470 --> 00:21:52,640
who's going to explain that the

633
00:21:56,070 --> 00:21:54,480
subsurface ice is something we're very

634
00:21:58,390 --> 00:21:56,080
familiar with

635
00:21:59,750 --> 00:21:58,400
thanks jess the next picture

636
00:22:02,630 --> 00:21:59,760
shows

637
00:22:05,430 --> 00:22:02,640
the two comets that the deep impact

638
00:22:07,110 --> 00:22:05,440

flyby spacecraft has visited

639
00:22:09,029 --> 00:22:07,120
on the left temple one and on the right

640
00:22:10,950 --> 00:22:09,039
hartley two obviously they're very

641
00:22:12,789 --> 00:22:10,960
different sizes

642
00:22:14,549 --> 00:22:12,799
but there's one other very obvious

643
00:22:16,870 --> 00:22:14,559
difference

644
00:22:18,710 --> 00:22:16,880
we know there are jets surrounding comet

645
00:22:20,630 --> 00:22:18,720
temple 1 but you can't see them in this

646
00:22:22,470 --> 00:22:20,640
picture because they're too faint

647
00:22:25,270 --> 00:22:22,480
whereas the jets coming off the end of

648
00:22:27,270 --> 00:22:25,280
hartley 2 are really obvious and they're

649
00:22:29,270 --> 00:22:27,280
really obvious because those jets are

650
00:22:32,310 --> 00:22:29,280
filled with ice crystals

651
00:22:35,750 --> 00:22:32,320
and ice as you know or snow

652
00:22:38,230 --> 00:22:35,760
reflects light very efficiently

653
00:22:42,390 --> 00:22:41,510
next slide gives us an indication of how

654
00:22:44,149 --> 00:22:42,400
the

655
00:22:45,590 --> 00:22:44,159
sublimation works

656
00:22:47,430 --> 00:22:45,600
on temple one

657
00:22:49,190 --> 00:22:47,440
there's ice somewhere between a few

658
00:22:50,789 --> 00:22:49,200
inches and a couple of feet under the

659
00:22:53,990 --> 00:22:50,799
surface we know that because we

660
00:22:58,070 --> 00:22:54,000
excavated it and we saw it in temple one

661
00:23:00,470 --> 00:22:58,080
and the ice gets warm by the sun

662
00:23:02,470 --> 00:23:00,480
sun's heat percolating down through the

663
00:23:04,310 --> 00:23:02,480

thin layer of dust

664
00:23:07,029 --> 00:23:04,320
and evaporating and coming up through

665
00:23:10,390 --> 00:23:07,039
the porous material on top

666
00:23:13,669 --> 00:23:10,400
and on comet hartley 2 we have this

667
00:23:19,830 --> 00:23:17,830
got a nice smooth waist rough ends

668
00:23:21,510 --> 00:23:19,840
an excess of car of dry ice on the

669
00:23:24,149 --> 00:23:21,520
inside

670
00:23:26,950 --> 00:23:24,159
and in the smooth waist lots of water

671
00:23:29,270 --> 00:23:26,960
ice frost i wasn't able to get the dust

672
00:23:32,390 --> 00:23:29,280
layer on top

673
00:23:36,470 --> 00:23:32,400
but we have water ice coming out of here

674
00:23:37,909 --> 00:23:36,480
and we have dry ice subliming and

675
00:23:40,149 --> 00:23:37,919
dragging

676
00:23:42,310 --> 00:23:40,159
water ice out the ends as the comet

677
00:23:44,789 --> 00:23:42,320
turns around

678
00:23:47,110 --> 00:23:44,799
i wasn't allowed to put water and

679
00:23:48,149 --> 00:23:47,120
water ice in with the dry ice because of

680
00:23:53,669 --> 00:23:48,159
fear of

681
00:23:57,430 --> 00:23:54,870
but this is

682
00:23:59,990 --> 00:23:57,440
basically our idea of what's going on so

683
00:24:01,669 --> 00:24:00,000
the waste behaves like comet temple one

684
00:24:03,830 --> 00:24:01,679
and the next slide

685
00:24:05,350 --> 00:24:03,840
shows more what's happening with comet

686
00:24:07,110 --> 00:24:05,360
hartley too

687
00:24:09,510 --> 00:24:07,120
there are real jets coming out of

688
00:24:11,350 --> 00:24:09,520

identifiable features on the surface

689
00:24:13,430 --> 00:24:11,360
they're dragging out

690
00:24:15,590 --> 00:24:13,440
ice crystals with them the ice crystals

691
00:24:16,630 --> 00:24:15,600
are later evaporating

692
00:24:18,549 --> 00:24:16,640
those

693
00:24:19,430 --> 00:24:18,559
ice huge snowflakes

694
00:24:21,669 --> 00:24:19,440
are

695
00:24:23,909 --> 00:24:21,679
producing more than half the water that

696
00:24:25,350 --> 00:24:23,919
comes out of hartley 2.

697
00:24:27,190 --> 00:24:25,360
but it's just it comes out as a very

698
00:24:28,950 --> 00:24:27,200
diffuse cloud so the water you see

699
00:24:31,590 --> 00:24:28,960
coming from the nucleus you see only

700
00:24:33,990 --> 00:24:31,600
from the waste here

701
00:24:35,750 --> 00:24:34,000
so what does all this mean

702
00:24:37,110 --> 00:24:35,760
uh

703
00:24:39,029 --> 00:24:37,120
why do we care that they work

704
00:24:40,149 --> 00:24:39,039
differently they work differently

705
00:24:42,230 --> 00:24:40,159
because

706
00:24:44,549 --> 00:24:42,240
they have different composition inside

707
00:24:46,230 --> 00:24:44,559
comet hartley 2 probably has more dry

708
00:24:47,110 --> 00:24:46,240
ice than any of the other comets for

709
00:24:50,390 --> 00:24:47,120
which

710
00:24:52,149 --> 00:24:50,400
is only

711
00:24:54,310 --> 00:24:52,159
a dozen or so actually fewer than a

712
00:24:55,909 --> 00:24:54,320
dozen

713
00:24:58,390 --> 00:24:55,919

does that say that

714
00:25:01,110 --> 00:24:58,400
these comets formed further

715
00:25:02,870 --> 00:25:01,120
from the sun then did temple one so

716
00:25:05,269 --> 00:25:02,880
there would be more dry ice relative to

717
00:25:06,470 --> 00:25:05,279
water ice could form that's the next

718
00:25:08,549 --> 00:25:06,480
step that we have to take in

719
00:25:10,470 --> 00:25:08,559
understanding that and the

720
00:25:12,149 --> 00:25:10,480
last picture shows you

721
00:25:15,190 --> 00:25:12,159
reminds you what we're talking about

722
00:25:17,590 --> 00:25:15,200
i'll leave that up while i wrap up

723
00:25:19,590 --> 00:25:17,600
we really want to understand how things

724
00:25:22,230 --> 00:25:19,600
got mixed up in the early solar system

725
00:25:25,110 --> 00:25:22,240
when the planets were being made

726
00:25:26,470 --> 00:25:25,120
we would really like to know is the co2

727
00:25:28,390 --> 00:25:26,480
at this end

728
00:25:29,750 --> 00:25:28,400
the same concentration as it is at the

729
00:25:31,669 --> 00:25:29,760
other end that's going to take a lot

730
00:25:33,430 --> 00:25:31,679
more analysis of our data but we should

731
00:25:36,070 --> 00:25:33,440
be able to get that out

732
00:25:37,990 --> 00:25:36,080
uh by looking at the at the jets when

733
00:25:39,590 --> 00:25:38,000
opposite ends are facing at the sun pete

734
00:25:40,470 --> 00:25:39,600
is now the sun

735
00:25:41,590 --> 00:25:40,480
and

736
00:25:43,909 --> 00:25:41,600
thanks thanks

737
00:25:45,430 --> 00:25:43,919
we have much more work to do in this

738
00:25:47,029 --> 00:25:45,440

area

739
00:25:48,950 --> 00:25:47,039
and ultimately

740
00:25:51,190 --> 00:25:48,960
we want to use this to constrain how the

741
00:25:52,149 --> 00:25:51,200
planets formed in other words how we got

742
00:25:53,990 --> 00:25:52,159
here

743
00:25:54,830 --> 00:25:54,000
and with that i'll leave it and we can

744
00:25:59,430 --> 00:25:54,840
take

745
00:26:01,190 --> 00:25:59,440
think it's certainly appropriate uh i

746
00:26:03,269 --> 00:26:01,200
want to say congratulations to you all

747
00:26:05,190 --> 00:26:03,279
and for folks here in the studios please

748
00:26:07,029 --> 00:26:05,200
give these folks and the entire team a

749
00:26:17,110 --> 00:26:07,039
lot of folks involved in it's a round of

750
00:26:21,269 --> 00:26:18,789
with that we're going to open the phone

751
00:26:23,110 --> 00:26:21,279
lines and for the media we have a number

752
00:26:25,190 --> 00:26:23,120
of folks on the line

753
00:26:26,230 --> 00:26:25,200
we'll see if we can just start with one

754
00:26:28,470 --> 00:26:26,240
question

755
00:26:30,549 --> 00:26:28,480
and a follow-up and if we have time

756
00:26:32,149 --> 00:26:30,559
certainly we can come back and if you

757
00:26:34,070 --> 00:26:32,159
can

758
00:26:35,590 --> 00:26:34,080
address your question to a particular

759
00:26:37,510 --> 00:26:35,600
individual on the panel that would be

760
00:26:47,029 --> 00:26:37,520
helpful so we will turn it over to the

761
00:26:53,669 --> 00:26:49,029
first call is from emily

762
00:26:53,679 --> 00:26:57,029
i can hear me yes

763
00:27:00,230 --> 00:26:57,990

okay

764
00:27:02,549 --> 00:27:00,240
i've gotten a lot of reader questions

765
00:27:05,110 --> 00:27:02,559
that are confused about

766
00:27:06,710 --> 00:27:05,120
how we can see the jets being

767
00:27:07,830 --> 00:27:06,720
lit up at the surface i know that

768
00:27:08,950 --> 00:27:07,840
there's things like forward scattering

769
00:27:10,470 --> 00:27:08,960
going on but i'm wondering if you can

770
00:27:16,310 --> 00:27:10,480
just explain that in terms that the

771
00:27:21,190 --> 00:27:17,909
okay you cut off a little bit but did

772
00:27:22,710 --> 00:27:21,200
you get those questions

773
00:27:24,549 --> 00:27:22,720
i think i understood

774
00:27:26,789 --> 00:27:24,559
it before you got cut off

775
00:27:29,110 --> 00:27:26,799
the

776
00:27:30,870 --> 00:27:29,120
gases that come out you don't generally

777
00:27:32,710 --> 00:27:30,880
see when we take pictures because most

778
00:27:35,669 --> 00:27:32,720
of the pictures we take are white light

779
00:27:37,350 --> 00:27:35,679
sometimes we take pictures in the ga

780
00:27:38,870 --> 00:27:37,360
that are sensitive only to the gas of a

781
00:27:39,990 --> 00:27:38,880
particular molecule but usually they're

782
00:27:41,190 --> 00:27:40,000
white light

783
00:27:43,669 --> 00:27:41,200
and

784
00:27:45,909 --> 00:27:43,679
the we see the jets because sunlight is

785
00:27:47,830 --> 00:27:45,919
reflecting off the tiny particles of

786
00:27:50,549 --> 00:27:47,840
dust and ice that are being carried up

787
00:27:53,110 --> 00:27:50,559
by the jet of gas

788
00:27:55,990 --> 00:27:53,120

if a jet is being produced on the dark

789
00:27:57,830 --> 00:27:56,000
side we in fact don't quite see the base

790
00:27:59,590 --> 00:27:57,840
of the jet we only see the jet when it

791
00:28:01,830 --> 00:27:59,600
gets up above

792
00:28:05,510 --> 00:28:01,840
the edge of the nucleus so that the sun

793
00:28:10,230 --> 00:28:07,830
next question is from kelly

794
00:28:11,830 --> 00:28:10,240
from sky and telescope

795
00:28:13,909 --> 00:28:11,840
uh yeah thanks

796
00:28:15,590 --> 00:28:13,919
thanks very much this is for jessica i

797
00:28:17,909 --> 00:28:15,600
think

798
00:28:20,630 --> 00:28:17,919
comet halley when was visited back in

799
00:28:23,350 --> 00:28:20,640
the 1980s its particles were largely

800
00:28:25,110 --> 00:28:23,360
dominated by organic material i think

801
00:28:28,070 --> 00:28:25,120
and i'm wondering if you're seeing

802
00:28:31,510 --> 00:28:28,080
anything comparable or is this really a

803
00:28:33,110 --> 00:28:31,520
comet of a very different composition

804
00:28:35,269 --> 00:28:33,120
well the organics are a little harder

805
00:28:37,269 --> 00:28:35,279
for us to get at um there i think i

806
00:28:39,110 --> 00:28:37,279
showed some evidence that we're seeing a

807
00:28:41,909 --> 00:28:39,120
sort of a bulk organic peak at this

808
00:28:44,149 --> 00:28:41,919
point and uh we've quite frankly not had

809
00:28:47,190 --> 00:28:44,159
enough time to look at it to really tell

810
00:28:49,669 --> 00:28:47,200
you too much about its organics

811
00:28:51,110 --> 00:28:49,679
so i hate to

812
00:28:53,110 --> 00:28:51,120
not answer the question but we really

813
00:28:54,549 --> 00:28:53,120

don't know yet

814
00:28:56,470 --> 00:28:54,559
and i have to confess i don't know as

815
00:28:58,389 --> 00:28:56,480
much about holly as certainly mike does

816
00:28:59,830 --> 00:28:58,399
is there something i should just

817
00:29:01,990 --> 00:28:59,840
more obvious

818
00:29:04,630 --> 00:29:02,000
there no it's clear it's clear that we

819
00:29:06,789 --> 00:29:04,640
have organics right it'll take a lot of

820
00:29:09,590 --> 00:29:06,799
work to estimate either what kind of

821
00:29:11,990 --> 00:29:09,600
organics they are or how many uh

822
00:29:14,070 --> 00:29:12,000
molecules we're getting whether they're

823
00:29:15,750 --> 00:29:14,080
very abundant compared to the water ice

824
00:29:17,590 --> 00:29:15,760
cranes

825
00:29:21,110 --> 00:29:17,600
or compared to the dust grains that are

826
00:29:22,710 --> 00:29:21,120
also there the refractory dust

827
00:29:27,350 --> 00:29:22,720
next call is from mike wall from

828
00:29:32,389 --> 00:29:29,750
oh yeah hi this question is probably for

829
00:29:34,149 --> 00:29:32,399
tim i guess um yeah like i just wonder i

830
00:29:35,990 --> 00:29:34,159
mean yeah you actually talked about it

831
00:29:37,669 --> 00:29:36,000
just a little bit but but do you know

832
00:29:40,149 --> 00:29:37,679
any more about the ultimate fate of the

833
00:29:41,750 --> 00:29:40,159
spacecraft like what's actually going to

834
00:29:43,190 --> 00:29:41,760
happen to it now or is that still being

835
00:29:45,830 --> 00:29:43,200
decided

836
00:29:47,269 --> 00:29:45,840
mike we're going to get jim green a

837
00:29:49,350 --> 00:29:47,279
microphone and he will be the

838
00:29:52,470 --> 00:29:49,360

appropriate person that can answer that

839
00:29:54,389 --> 00:29:52,480
yes this is jim green we have

840
00:29:56,870 --> 00:29:54,399
went out to the community with a request

841
00:30:00,310 --> 00:29:56,880
for information and interest in uh

842
00:30:03,430 --> 00:30:00,320
potentially a follow-on activity

843
00:30:05,350 --> 00:30:03,440
with uh this particular spacecraft and

844
00:30:07,510 --> 00:30:05,360
that has closed we've received that

845
00:30:09,510 --> 00:30:07,520
input and we're currently in the process

846
00:30:12,230 --> 00:30:09,520
of reviewing that material

847
00:30:20,470 --> 00:30:12,240
and so no announcement is to be made at

848
00:30:25,510 --> 00:30:23,669
we have one question that uh i have here

849
00:30:27,029 --> 00:30:25,520
from one of the dot coms and actually

850
00:30:28,710 --> 00:30:27,039
they want to hear from each one of you

851
00:30:31,190 --> 00:30:28,720
on your personal

852
00:30:34,310 --> 00:30:31,200
thoughts uh with the data that you have

853
00:30:37,110 --> 00:30:34,320
thus far how has it personally changed

854
00:30:39,830 --> 00:30:37,120
from what you have done in the past to

855
00:30:42,230 --> 00:30:39,840
now and what you hope to probably do

856
00:30:44,310 --> 00:30:42,240
in the future so that's a

857
00:30:45,590 --> 00:30:44,320
personal thoughts on what you've really

858
00:30:47,750 --> 00:30:45,600
discovered at this point so we'll start

859
00:30:49,590 --> 00:30:47,760
with you mike well we could down the

860
00:30:51,350 --> 00:30:49,600
table in order perhaps

861
00:30:52,549 --> 00:30:51,360
for me

862
00:30:55,590 --> 00:30:52,559
it has

863
00:30:56,950 --> 00:30:55,600

emphasized how different comets are from

864
00:30:59,509 --> 00:30:56,960
one another

865
00:31:01,509 --> 00:30:59,519
and how understanding them is a much

866
00:31:03,590 --> 00:31:01,519
more complex problem than the rather

867
00:31:04,549 --> 00:31:03,600
simplistic approach i like to normally

868
00:31:06,070 --> 00:31:04,559
take

869
00:31:07,750 --> 00:31:06,080
and clearly when you want to understand

870
00:31:08,870 --> 00:31:07,760
how things happen you want the simple

871
00:31:10,950 --> 00:31:08,880
overview

872
00:31:13,029 --> 00:31:10,960
but you have to understand the details

873
00:31:16,470 --> 00:31:13,039
as well and things have just gotten much

874
00:31:20,789 --> 00:31:19,190
yeah i guess for me and and some of the

875
00:31:23,190 --> 00:31:20,799
listeners will understand this but i was

876
00:31:25,269 --> 00:31:23,200
an amateur astronomer as a kid

877
00:31:27,269 --> 00:31:25,279
and so i saw two comments cometh mercos

878
00:31:29,110 --> 00:31:27,279
and commenter aaron roland

879
00:31:31,350 --> 00:31:29,120
and you know who would have thought that

880
00:31:33,269 --> 00:31:31,360
we'd actually get to see a comet close

881
00:31:34,950 --> 00:31:33,279
up like we just did

882
00:31:36,789 --> 00:31:34,960
so that's one thing that just looking

883
00:31:38,389 --> 00:31:36,799
back in terms of my personal

884
00:31:39,350 --> 00:31:38,399
feeling it was really sort of very

885
00:31:41,190 --> 00:31:39,360
internal

886
00:31:42,789 --> 00:31:41,200
in terms of where we're going i'm really

887
00:31:44,389 --> 00:31:42,799
really curious about

888
00:31:46,149 --> 00:31:44,399

where these particles are how big they

889
00:31:48,149 --> 00:31:46,159
are where they're going i'm hoping we

890
00:31:50,630 --> 00:31:48,159
can actually determine something more

891
00:31:54,149 --> 00:31:50,640
about the particles and

892
00:31:55,990 --> 00:31:54,159
i'll be a happy camper then

893
00:31:57,669 --> 00:31:56,000
from an engineer's viewpoint

894
00:31:59,029 --> 00:31:57,679
i've been working on small bodies

895
00:32:00,310 --> 00:31:59,039
missions for about the last six years

896
00:32:02,149 --> 00:32:00,320
starting with the first deep impact

897
00:32:06,230 --> 00:32:02,159
mission and then working on dawn and

898
00:32:07,509 --> 00:32:06,240
then back to this mission and uh

899
00:32:09,750 --> 00:32:07,519
getting to these small bodies and

900
00:32:12,149 --> 00:32:09,760
getting to comets is hugely exciting and

901
00:32:14,070 --> 00:32:12,159
satisfying for me um and then just on

902
00:32:15,430 --> 00:32:14,080
top of that

903
00:32:17,590 --> 00:32:15,440
the incredible data that we're finding

904
00:32:18,710 --> 00:32:17,600
when we fly by these and get up close

905
00:32:20,389 --> 00:32:18,720
and are able to really start

906
00:32:21,990 --> 00:32:20,399
understanding what these are like and

907
00:32:23,750 --> 00:32:22,000
just understanding that

908
00:32:25,669 --> 00:32:23,760
so far anyway we've never been to any

909
00:32:27,750 --> 00:32:25,679
two comets that are the same

910
00:32:29,669 --> 00:32:27,760
every time we have new surprises amazing

911
00:32:31,590 --> 00:32:29,679
new things that we find uh those kinds

912
00:32:33,190 --> 00:32:31,600
of things i find uh just very exciting

913
00:32:35,029 --> 00:32:33,200

as as an engineer to be able to

914
00:32:36,070 --> 00:32:35,039
participate in those and so i look

915
00:32:39,190 --> 00:32:36,080
forward to

916
00:32:42,070 --> 00:32:39,200
future missions to these kinds of bodies

917
00:32:44,389 --> 00:32:42,080
well i think for me uh it's the

918
00:32:45,909 --> 00:32:44,399
wonderful chance to see hartley 2 and

919
00:32:48,149 --> 00:32:45,919
you know i used to have a favorite comet

920
00:32:49,990 --> 00:32:48,159
it was called temple one and we have a

921
00:32:51,430 --> 00:32:50,000
new favorite comet hartley two and well

922
00:32:53,430 --> 00:32:51,440
like a good parent they both have their

923
00:32:54,870 --> 00:32:53,440
strengths and weaknesses and it's an

924
00:32:56,789 --> 00:32:54,880
incredible opportunity to be able to

925
00:32:58,710 --> 00:32:56,799
take the same exact instruments

926
00:33:01,750 --> 00:32:58,720
especially the spectrometer and compare

927
00:33:04,230 --> 00:33:01,760
one for one one place to the other and

928
00:33:06,789 --> 00:33:04,240
uh my personal interest lies in the

929
00:33:09,110 --> 00:33:06,799
geology and trying to understand the

930
00:33:11,110 --> 00:33:09,120
features that we see

931
00:33:13,350 --> 00:33:11,120
both uh quite

932
00:33:15,110 --> 00:33:13,360
in quite detail on temple one and now

933
00:33:17,590 --> 00:33:15,120
with hartley two the amazing difference

934
00:33:19,590 --> 00:33:17,600
is that we have the jets there

935
00:33:21,509 --> 00:33:19,600
and so we can ask the question what if

936
00:33:23,750 --> 00:33:21,519
these features are caused by the jets or

937
00:33:25,509 --> 00:33:23,760
which is cause which is effect and

938
00:33:26,950 --> 00:33:25,519

comparing the two surfaces i think is

939
00:33:28,230 --> 00:33:26,960
really going to let us understand how

940
00:33:30,549 --> 00:33:28,240
these work

941
00:33:32,710 --> 00:33:30,559
and as far as the future i love fly

942
00:33:33,990 --> 00:33:32,720
flybys and jim this has been a wonderful

943
00:33:36,230 --> 00:33:34,000
experience i wouldn't do it any other

944
00:33:37,669 --> 00:33:36,240
way but i sure as how heck like to get a

945
00:33:39,990 --> 00:33:37,679
little closer to these guys and actually

946
00:33:41,590 --> 00:33:40,000
land on one of these so and that's going

947
00:33:43,750 --> 00:33:41,600
to happen soon with a result i'd rather

948
00:33:45,430 --> 00:33:43,760
hit one well that too

949
00:33:46,710 --> 00:33:45,440
we could do both pete we'll talk offline

950
00:33:48,230 --> 00:33:46,720
right okay

951
00:33:50,549 --> 00:33:48,240
okay thank you all let's go back to the

952
00:33:55,110 --> 00:33:50,559
phone to kelly beatty again from sky and

953
00:33:58,950 --> 00:33:57,110
thanks very much i guess i want to try

954
00:34:00,710 --> 00:33:58,960
this spectra question uh from a

955
00:34:02,870 --> 00:34:00,720
different angle um

956
00:34:05,350 --> 00:34:02,880
mike and jessica can you give me a sense

957
00:34:06,710 --> 00:34:05,360
give us a sense of what kinds of other

958
00:34:08,389 --> 00:34:06,720
observations

959
00:34:10,710 --> 00:34:08,399
were done at the same time during this

960
00:34:12,950 --> 00:34:10,720
flyby that might help you constrain the

961
00:34:14,230 --> 00:34:12,960
spectroscopic nature of what's coming

962
00:34:16,149 --> 00:34:14,240
off the comet

963
00:34:18,950 --> 00:34:16,159

spitzer ground-based observatories and

964
00:34:23,750 --> 00:34:21,750
uh this is mike kelly

965
00:34:25,669 --> 00:34:23,760
uh there were a lot of ground-based

966
00:34:29,109 --> 00:34:25,679
observations for example both keck

967
00:34:30,790 --> 00:34:29,119
telescopes were being used and they

968
00:34:34,149 --> 00:34:30,800
were being used with high resolution

969
00:34:36,389 --> 00:34:34,159
spectrographs irtf was being used and

970
00:34:39,109 --> 00:34:36,399
all these instruments have much higher

971
00:34:41,510 --> 00:34:39,119
spectral resolution so they can

972
00:34:44,550 --> 00:34:41,520
more easily separate out the different

973
00:34:45,270 --> 00:34:44,560
kinds of organics that are present

974
00:34:46,790 --> 00:34:45,280
our

975
00:34:49,349 --> 00:34:46,800
spectrometer where we're trying to cover

976
00:34:51,430 --> 00:34:49,359
one to five microns all at once you

977
00:34:54,790 --> 00:34:51,440
can't get high resolution everywhere on

978
00:34:56,550 --> 00:34:54,800
a finite number of pixels

979
00:34:58,230 --> 00:34:56,560
so i think the

980
00:35:00,390 --> 00:34:58,240
key to

981
00:35:03,109 --> 00:35:00,400
unraveling it will be the observations

982
00:35:06,630 --> 00:35:03,119
from a wide variety of telescopes like

983
00:35:09,510 --> 00:35:06,640
the 2kx and the irtf but also including

984
00:35:12,069 --> 00:35:09,520
the european facilities and various

985
00:35:15,030 --> 00:35:12,079
telescopes in space space telescope

986
00:35:18,630 --> 00:35:15,040
was making uv measurements to measure

987
00:35:21,349 --> 00:35:18,640
carbon monoxide for example

988
00:35:23,030 --> 00:35:21,359

and the vlt was being used and i i don't

989
00:35:24,470 --> 00:35:23,040
know the details of all the other ones

990
00:35:29,349 --> 00:35:24,480
we have measurements from the odin

991
00:35:34,470 --> 00:35:32,870
i i can't give you a complete list

992
00:35:36,150 --> 00:35:34,480
jessica did you want to add something no

993
00:35:38,230 --> 00:35:36,160
he mike knows more than i do for sure on

994
00:35:40,550 --> 00:35:38,240
that topic so okay

995
00:35:42,829 --> 00:35:40,560
now we'll go to ken kramer from space

996
00:35:44,390 --> 00:35:42,839
flight now

997
00:35:49,430 --> 00:35:44,400
again

998
00:35:51,510 --> 00:35:49,440
on a fantastic mission um two quick

999
00:35:53,990 --> 00:35:51,520
questions um

1000
00:35:55,829 --> 00:35:54,000
first uh for mike i wonder if you could

1001
00:35:58,230 --> 00:35:55,839
compare the relative amount of water and

1002
00:36:01,430 --> 00:35:58,240
carbon dioxide in all the comets that we

1003
00:36:03,910 --> 00:36:01,440
have uh investigated the five so far

1004
00:36:05,750 --> 00:36:03,920
and a question for everyone um

1005
00:36:07,109 --> 00:36:05,760
did you expect to see these particles

1006
00:36:09,109 --> 00:36:07,119
and i wonder if the cameras were

1007
00:36:12,470 --> 00:36:09,119
retargeted to try to catch those

1008
00:36:15,510 --> 00:36:12,480
pictures thanks

1009
00:36:18,390 --> 00:36:15,520
uh i think this comet probably has more

1010
00:36:19,750 --> 00:36:18,400
co2 more dry ice than any one that's

1011
00:36:21,589 --> 00:36:19,760
been measured

1012
00:36:23,349 --> 00:36:21,599
however uh

1013
00:36:26,310 --> 00:36:23,359

much of the information i have on the

1014
00:36:28,790 --> 00:36:26,320
other measurements is unpublished

1015
00:36:31,109 --> 00:36:28,800
measurements by our japanese colleagues

1016
00:36:31,990 --> 00:36:31,119
using the akari spacecraft so i'd rather

1017
00:36:33,670 --> 00:36:32,000
not

1018
00:36:37,349 --> 00:36:33,680
talk about that in any detail because

1019
00:36:41,190 --> 00:36:37,359
they haven't published their results yet

1020
00:36:43,510 --> 00:36:41,200
we did not expect these particles

1021
00:36:46,150 --> 00:36:43,520
as i said at the beginning the fact that

1022
00:36:48,470 --> 00:36:46,160
we had this experience in tempo one of

1023
00:36:50,230 --> 00:36:48,480
excavating material and not seeing the

1024
00:36:52,470 --> 00:36:50,240
particles

1025
00:36:54,069 --> 00:36:52,480
led us to not really be thinking about

1026
00:36:56,550 --> 00:36:54,079
them when we got to this comet even

1027
00:36:59,030 --> 00:36:56,560
though theoreticians have drawn lots of

1028
00:37:02,150 --> 00:36:59,040
cartoons showing this kind of phenomenon

1029
00:37:04,470 --> 00:37:02,160
they were completely out of our

1030
00:37:08,870 --> 00:37:04,480
point of view because of the experience

1031
00:37:13,670 --> 00:37:11,349
and we'll go through the call from emily

1032
00:37:16,630 --> 00:37:13,680
lock the wallet from planetary society

1033
00:37:21,990 --> 00:37:19,270
hi this one's for jessica i know that um

1034
00:37:23,589 --> 00:37:22,000
i i think that there were some albedo

1035
00:37:25,190 --> 00:37:23,599
variations or maybe even some color

1036
00:37:26,470 --> 00:37:25,200
variations on the surface i'm wondering

1037
00:37:28,790 --> 00:37:26,480
if you're if you're seeing that in your

1038
00:37:30,550 --> 00:37:28,800

data if you've gotten anything from your

1039
00:37:32,390 --> 00:37:30,560
spectroscopy on the composition of the

1040
00:37:34,550 --> 00:37:32,400
surface yet

1041
00:37:36,630 --> 00:37:34,560
uh there are albedo variations you can

1042
00:37:38,230 --> 00:37:36,640
see them in the initial images we

1043
00:37:39,910 --> 00:37:38,240
released

1044
00:37:42,150 --> 00:37:39,920
but we have not yet had a chance to look

1045
00:37:43,990 --> 00:37:42,160
at the surface in any detail

1046
00:37:46,230 --> 00:37:44,000
it's a much more complicated problem

1047
00:37:48,069 --> 00:37:46,240
than the coma because of the the

1048
00:37:49,430 --> 00:37:48,079
background it's physically complicated

1049
00:37:51,430 --> 00:37:49,440
and it's a little more complicated for

1050
00:37:53,510 --> 00:37:51,440
our instrument

1051
00:37:55,349 --> 00:37:53,520
and we've been focused on this ice story

1052
00:37:58,230 --> 00:37:55,359
to be perfectly honest

1053
00:38:03,829 --> 00:37:58,240
and that's next for sure so again i have

1054
00:38:06,950 --> 00:38:05,349
okay i think that's going to do it for

1055
00:38:09,990 --> 00:38:06,960
the questions i have a couple of

1056
00:38:10,870 --> 00:38:10,000
comments um first of all on september

1057
00:38:12,790 --> 00:38:10,880
10th

1058
00:38:14,630 --> 00:38:12,800
there was an incredible symposium comet

1059
00:38:16,550 --> 00:38:14,640
discoveries and encounters held at the

1060
00:38:18,550 --> 00:38:16,560
museum here in washington where some of

1061
00:38:19,910 --> 00:38:18,560
the folks here on the stage participated

1062
00:38:22,150 --> 00:38:19,920
in i'd like to tell our television

1063
00:38:24,910 --> 00:38:22,160

audience that you can go to the nasa

1064
00:38:26,790 --> 00:38:24,920
youtube site and also

1065
00:38:28,870 --> 00:38:26,800
solarsystem.nasa.gov and you can take a

1066
00:38:31,190 --> 00:38:28,880
comparison from september 10th that was

1067
00:38:34,550 --> 00:38:31,200
said about comments to now and you can

1068
00:38:36,390 --> 00:38:34,560
go in a little deeper more context

1069
00:38:37,910 --> 00:38:36,400
and actually i was wrapping this up but

1070
00:38:39,589 --> 00:38:37,920
now we have another question someone

1071
00:38:41,109 --> 00:38:39,599
said no i want to talk

1072
00:38:45,589 --> 00:38:41,119
so

1073
00:38:50,069 --> 00:38:47,670
fill play go ahead from

1074
00:38:51,990 --> 00:38:50,079
uh astronomer

1075
00:38:54,150 --> 00:38:52,000
good phil

1076
00:38:56,230 --> 00:38:54,160
uh for any of the three who can answer

1077
00:38:58,150 --> 00:38:56,240
this i may have missed it but the comet

1078
00:38:59,589 --> 00:38:58,160
is a peanut shape with two lobes and a

1079
00:39:02,150 --> 00:38:59,599
smooth

1080
00:39:05,109 --> 00:39:02,160
core connecting them and you say water

1081
00:39:06,630 --> 00:39:05,119
vapor is coming from the connector while

1082
00:39:08,950 --> 00:39:06,640
more carbon dioxide is coming from the

1083
00:39:10,390 --> 00:39:08,960
lobes why would that be what is it about

1084
00:39:11,750 --> 00:39:10,400
the structure of the comet that we're

1085
00:39:12,829 --> 00:39:11,760
seeing that differentiation of the

1086
00:39:15,270 --> 00:39:12,839
material

1087
00:39:17,589 --> 00:39:15,280
ejected well i don't think we know yet

1088
00:39:19,910 --> 00:39:17,599

there's a couple of

1089
00:39:21,670 --> 00:39:19,920
big picture ideas

1090
00:39:24,230 --> 00:39:21,680
one is that

1091
00:39:26,950 --> 00:39:24,240
material is being redistributed over the

1092
00:39:29,030 --> 00:39:26,960
comet so you have dust and

1093
00:39:30,790 --> 00:39:29,040
in particular coming out with the co2 it

1094
00:39:31,990 --> 00:39:30,800
gets redeposited

1095
00:39:33,670 --> 00:39:32,000
in the low

1096
00:39:36,710 --> 00:39:33,680
and gravity low in the middle that

1097
00:39:38,470 --> 00:39:36,720
creates a smooth dust covering

1098
00:39:41,190 --> 00:39:38,480
now that's going to affect how the

1099
00:39:42,630 --> 00:39:41,200
sunlight is able to reach the bottom

1100
00:39:44,550 --> 00:39:42,640
the interior of not the bottom but the

1101
00:39:47,030 --> 00:39:44,560
interior of the nucleus

1102
00:39:49,510 --> 00:39:47,040
and so it's possible

1103
00:39:52,230 --> 00:39:49,520
that that middle either

1104
00:39:53,589 --> 00:39:52,240
just doesn't have any co2 and it has

1105
00:39:55,190 --> 00:39:53,599
been used up

1106
00:39:56,790 --> 00:39:55,200
or it never did

1107
00:39:59,349 --> 00:39:56,800
or it's also possible that the dust

1108
00:40:01,109 --> 00:39:59,359
coating is preventing uh the sunlight

1109
00:40:02,390 --> 00:40:01,119
from reaching the co2 that's actually in

1110
00:40:04,790 --> 00:40:02,400
the middle

1111
00:40:07,349 --> 00:40:04,800
so if we did another impact experiment

1112
00:40:10,390 --> 00:40:07,359
we could tell the difference

1113
00:40:12,710 --> 00:40:10,400

told you i'd get back to it pete

1114
00:40:14,150 --> 00:40:12,720
okay what i'm going to do here is i'm

1115
00:40:15,829 --> 00:40:14,160
going to pause a little bit because we

1116
00:40:16,630 --> 00:40:15,839
have reporters joining

1117
00:40:19,109 --> 00:40:16,640
and

1118
00:40:20,950 --> 00:40:19,119
we may get some late comers again but

1119
00:40:22,069 --> 00:40:20,960
before we do that i want to turn it over

1120
00:40:23,990 --> 00:40:22,079
to jim green i think you have some

1121
00:40:25,990 --> 00:40:24,000
comments sir go ahead yeah i just have a

1122
00:40:28,470 --> 00:40:26,000
question i'd like to know

1123
00:40:30,309 --> 00:40:28,480
and now that you're seeing the material

1124
00:40:33,510 --> 00:40:30,319
leaving and perhaps can get an estimate

1125
00:40:35,670 --> 00:40:33,520
of its mass perhaps you can tell us

1126
00:40:38,230 --> 00:40:35,680
is this comment

1127
00:40:40,630 --> 00:40:38,240
sublimating and expelling gas faster

1128
00:40:43,910 --> 00:40:40,640
than the others and and perhaps for you

1129
00:40:45,910 --> 00:40:43,920
know what's its uh future life is it uh

1130
00:40:47,510 --> 00:40:45,920
in the last stages of its life will we

1131
00:40:50,150 --> 00:40:47,520
see it again in six years when it comes

1132
00:40:53,510 --> 00:40:50,160
around or what

1133
00:40:56,390 --> 00:40:53,520
okay i'll i will attempt to answer that

1134
00:41:00,790 --> 00:40:58,069
it is certainly

1135
00:41:03,190 --> 00:41:00,800
producing more total water vapor per

1136
00:41:07,190 --> 00:41:03,200
second than comet tempel one even though

1137
00:41:08,710 --> 00:41:07,200
kama temple one is much bigger

1138
00:41:13,270 --> 00:41:08,720

it's roughly

1139
00:41:17,510 --> 00:41:15,670
i think that roughly at least half and

1140
00:41:19,589 --> 00:41:17,520
maybe two-thirds of that

1141
00:41:22,470 --> 00:41:19,599
is coming from the chunks of ice that

1142
00:41:23,829 --> 00:41:22,480
come out and then gradually sublime

1143
00:41:25,589 --> 00:41:23,839
and only

1144
00:41:27,510 --> 00:41:25,599
something like one third of it is coming

1145
00:41:30,230 --> 00:41:27,520
directly from the nucleus probably

1146
00:41:31,910 --> 00:41:30,240
mostly near the waste

1147
00:41:33,990 --> 00:41:31,920
and

1148
00:41:35,349 --> 00:41:34,000
that says it's very active comet for its

1149
00:41:37,829 --> 00:41:35,359
size

1150
00:41:40,790 --> 00:41:37,839
if you try to integrate how much mass is

1151
00:41:43,270 --> 00:41:40,800
lost as it goes through perihelion

1152
00:41:46,550 --> 00:41:43,280
the comet should be losing

1153
00:41:49,510 --> 00:41:46,560
on average over the entire surface

1154
00:41:52,069 --> 00:41:49,520
something like a meter

1155
00:41:53,670 --> 00:41:52,079
of surface material every perihelion

1156
00:41:54,870 --> 00:41:53,680
passage

1157
00:41:56,069 --> 00:41:54,880
so

1158
00:41:57,750 --> 00:41:56,079
at the waist

1159
00:41:59,990 --> 00:41:57,760
there's maybe a hundred perihelion

1160
00:42:04,550 --> 00:42:00,000
passages left

1161
00:42:08,630 --> 00:42:06,870
jim did you have a follow-up

1162
00:42:10,309 --> 00:42:08,640
no it just sounds like in six years when

1163
00:42:12,069 --> 00:42:10,319

it comes around we'll be able to see it

1164
00:42:13,990 --> 00:42:12,079
again

1165
00:42:16,790 --> 00:42:14,000
okay thanks jim

1166
00:42:18,550 --> 00:42:16,800
okay let's try this again um any other

1167
00:42:20,390 --> 00:42:18,560
questions before i

1168
00:42:22,470 --> 00:42:20,400
wrap it up

1169
00:42:23,910 --> 00:42:22,480
going once going twice

1170
00:42:25,829 --> 00:42:23,920
okay again

1171
00:42:28,069 --> 00:42:25,839
ladies and gentlemen on the tv audience

1172
00:42:30,150 --> 00:42:28,079
september 10th symposium go to

1173
00:42:32,069 --> 00:42:30,160
solarsystem.nasa.gov

1174
00:42:35,589 --> 00:42:32,079
compare what you heard about comments

1175
00:42:38,630 --> 00:42:35,599
then at that event to now

1176
00:42:42,230 --> 00:42:38,640
deep comparison deep context

1177
00:42:44,150 --> 00:42:42,240
always go to www.nasa.gov

1178
00:42:45,589 --> 00:42:44,160
for all of nasa's missions and of course

1179
00:42:47,270 --> 00:42:45,599
for epoxy

1180
00:42:49,750 --> 00:42:47,280
nasa.gov

1181
00:42:51,589 --> 00:42:49,760
epoxy and as i say it once and i'll say

1182
00:42:53,270 --> 00:42:51,599
it a thousand times because it is

1183
00:42:55,030 --> 00:42:53,280
absolutely true