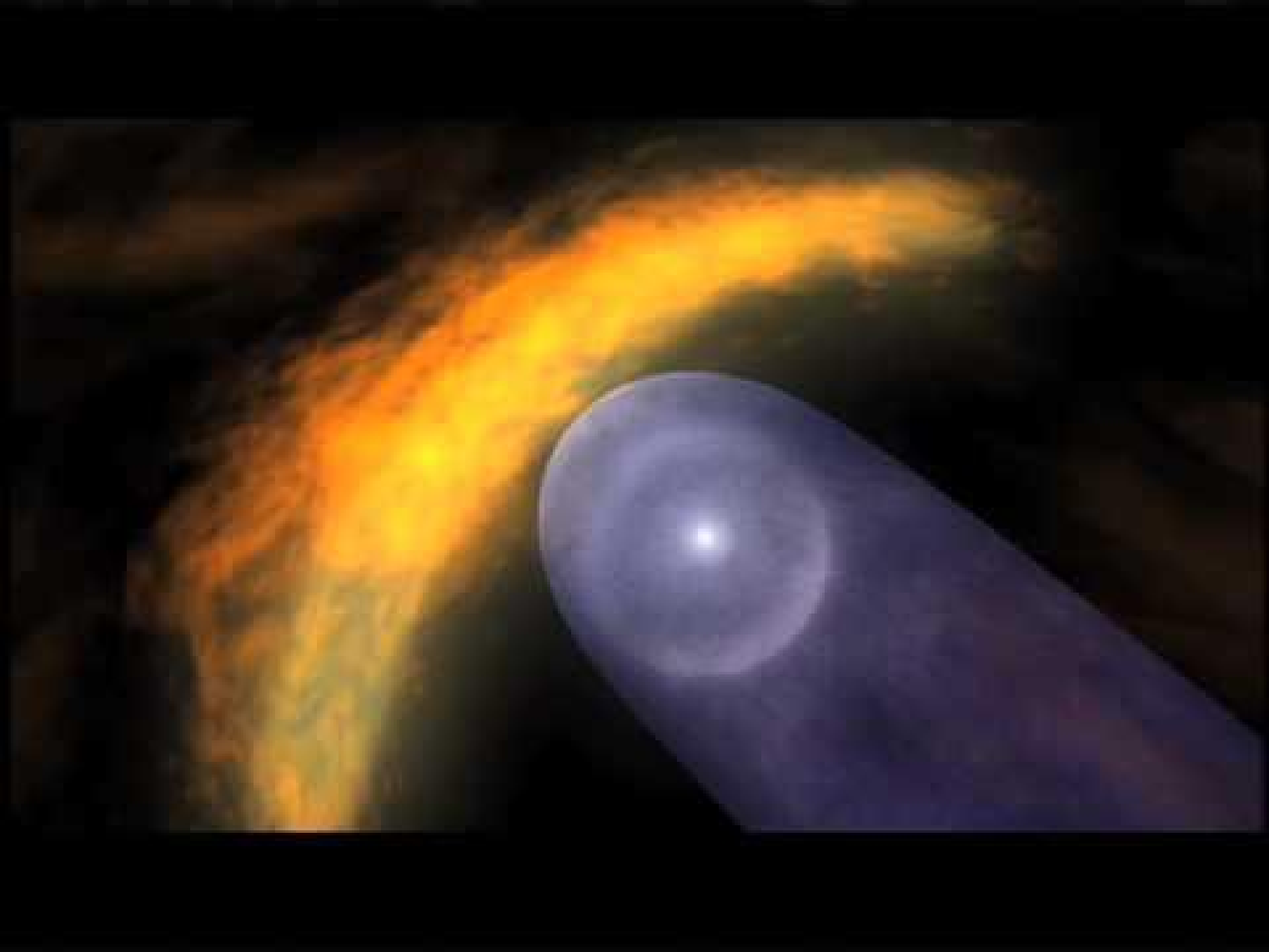

1
00:00:04,710 --> 00:00:03,429
our topic today is a new discovery

2
00:00:06,389 --> 00:00:04,720
that's been made by the interstellar

3
00:00:09,589 --> 00:00:06,399
boundary explorer

4
00:00:12,789 --> 00:00:09,599
which is uh put into uh nasa speak by

5
00:00:14,629 --> 00:00:12,799
calling it ibex admission this

6
00:00:17,750 --> 00:00:14,639
mission has produced some brand new

7
00:00:19,750 --> 00:00:17,760
results that give us our very first look

8
00:00:21,269 --> 00:00:19,760
at our home in the galaxy

9
00:00:22,870 --> 00:00:21,279
now the results that you're going to see

10
00:00:24,870 --> 00:00:22,880
today

11
00:00:27,589 --> 00:00:24,880
come from a very broad collaboration

12
00:00:29,669 --> 00:00:27,599
between several nasa missions

13
00:00:31,589 --> 00:00:29,679

a fusion of industry academic and

14
00:00:34,150 --> 00:00:31,599
government resources

15
00:00:36,069 --> 00:00:34,160
and international partnerships

16
00:00:39,190 --> 00:00:36,079
now in my view this collaboration while

17
00:00:41,030 --> 00:00:39,200
not our main story is a remarkable model

18
00:00:42,150 --> 00:00:41,040
of how current space physics research is

19
00:00:43,750 --> 00:00:42,160
conducted

20
00:00:45,830 --> 00:00:43,760
with the twin goals

21
00:00:48,150 --> 00:00:45,840
of achieving both excellence and

22
00:00:49,830 --> 00:00:48,160
integrity in the scientific research

23
00:00:52,869 --> 00:00:49,840
now today's panel

24
00:00:55,029 --> 00:00:52,879
uh reflects this broad collaboration

25
00:00:57,270 --> 00:00:55,039
with us today is a distinguished group

26
00:00:59,510 --> 00:00:57,280
of experimenters investigators who

27
00:01:01,430 --> 00:00:59,520
present this newest result of our home

28
00:01:03,590 --> 00:01:01,440
in the galaxy and they are

29
00:01:05,350 --> 00:01:03,600
eric christian

30
00:01:06,789 --> 00:01:05,360
uh who is the ibex deputy mission

31
00:01:07,990 --> 00:01:06,799
scientist and he's from goddard space

32
00:01:09,830 --> 00:01:08,000
flight center

33
00:01:11,910 --> 00:01:09,840
david mccomas

34
00:01:14,070 --> 00:01:11,920
dr mccomas is the interstellar boundary

35
00:01:16,230 --> 00:01:14,080
explorer ibex

36
00:01:18,789 --> 00:01:16,240
spacecraft principal investigator and he

37
00:01:20,149 --> 00:01:18,799
is also an assistant vice president of

38
00:01:21,910 --> 00:01:20,159

the space science and engineering

39
00:01:24,950 --> 00:01:21,920
division of the southwest research

40
00:01:28,310 --> 00:01:24,960
institute in san antonio texas

41
00:01:30,069 --> 00:01:28,320
next to david is rosine dr rosine lalmon

42
00:01:32,789 --> 00:01:30,079
she's the senior scientist at the french

43
00:01:35,109 --> 00:01:32,799
national center for space research

44
00:01:37,830 --> 00:01:35,119
sitting next to rosine

45
00:01:39,749 --> 00:01:37,840
is lindsey barlone

46
00:01:41,510 --> 00:01:39,759
she's the ibex education and public

47
00:01:43,990 --> 00:01:41,520
outreach lead and is with the adler

48
00:01:47,990 --> 00:01:44,000
planetarium in chicago illinois and

49
00:01:49,109 --> 00:01:48,000
at the end the far end we have a dual uh

50
00:01:51,670 --> 00:01:49,119
kind of a

51
00:01:53,510 --> 00:01:51,680
a defensive offensive player two

52
00:01:56,069 --> 00:01:53,520
two sides of the same coin he is a

53
00:01:58,389 --> 00:01:56,079
cassini spacecraft instrument scientist

54
00:02:00,069 --> 00:01:58,399
and ibex co-investigator it's dr don

55
00:02:01,830 --> 00:02:00,079
mitchell from the johns hopkins

56
00:02:04,630 --> 00:02:01,840
university applied physics laboratory in

57
00:02:06,950 --> 00:02:04,640
laurel maryland and i'm going to ask um

58
00:02:09,190 --> 00:02:06,960
eric if he would start our today's

59
00:02:10,869 --> 00:02:09,200
presentation thanks dick

60
00:02:13,190 --> 00:02:10,879
well this is an amazing time to be

61
00:02:16,150 --> 00:02:13,200
studying the outer heliosphere in the

62
00:02:18,470 --> 00:02:16,160
last few years both voyager spacecrafts

63
00:02:20,309 --> 00:02:18,480

have passed through the first boundary

64
00:02:22,790 --> 00:02:20,319
between our solar system and

65
00:02:26,309 --> 00:02:22,800
interstellar space

66
00:02:27,750 --> 00:02:26,319
and they're out there now measuring

67
00:02:28,949 --> 00:02:27,760
this this interaction region they're

68
00:02:30,949 --> 00:02:28,959
measuring

69
00:02:32,869 --> 00:02:30,959
solar wind pressure

70
00:02:35,509 --> 00:02:32,879
temperature velocity

71
00:02:38,229 --> 00:02:35,519
in this interaction region and now ibex

72
00:02:40,550 --> 00:02:38,239
comes along and fills in

73
00:02:43,190 --> 00:02:40,560
all the places that voyager isn't now

74
00:02:46,390 --> 00:02:43,200
what is the heliosphere

75
00:02:48,949 --> 00:02:46,400
if you watch this movie here

76
00:02:51,589 --> 00:02:48,959
there's a million mile per hour solar

77
00:02:53,430 --> 00:02:51,599
wind hot gas that blows out from the sun

78
00:02:56,150 --> 00:02:53,440
in all directions

79
00:02:59,110 --> 00:02:56,160
and that solar wind is actually blown a

80
00:03:00,630 --> 00:02:59,120
bubble in interstellar space

81
00:03:02,869 --> 00:03:00,640
that bubble has a bunch of different

82
00:03:05,190 --> 00:03:02,879
layers there's an inner region mostly

83
00:03:07,509 --> 00:03:05,200
spherical that where the solar wind is

84
00:03:08,869 --> 00:03:07,519
moving very quickly and then it slows

85
00:03:12,149 --> 00:03:08,879
down drastically what's called the

86
00:03:14,390 --> 00:03:12,159
termination shock and flows down into a

87
00:03:16,869 --> 00:03:14,400
long comet shaped tail

88
00:03:19,750 --> 00:03:16,879

it's in between this termination shock

89
00:03:21,509 --> 00:03:19,760
and the boundary that the voyages are

90
00:03:23,910 --> 00:03:21,519
right now measuring and then there's

91
00:03:26,710 --> 00:03:23,920
actually an interstellar wind that's

92
00:03:28,789 --> 00:03:26,720
pushing on the heliosphere from outside

93
00:03:31,430 --> 00:03:28,799
and flowing around this comet shaped

94
00:03:32,630 --> 00:03:31,440
heliosphere

95
00:03:38,390 --> 00:03:32,640
so

96
00:03:41,350 --> 00:03:38,400
from ibex and to set the context

97
00:03:44,309 --> 00:03:41,360
um i'd like to show this picture here

98
00:03:47,350 --> 00:03:44,319
we've got to take this map where we're

99
00:03:49,990 --> 00:03:47,360
looking out from in very close to the

100
00:03:51,670 --> 00:03:50,000
sun on this entire region and the way we

101
00:03:54,869 --> 00:03:51,680
do that is we flatten it out with the

102
00:03:56,149 --> 00:03:54,879
two-dimensional map projection

103
00:03:58,949 --> 00:03:56,159
this picture

104
00:04:01,190 --> 00:03:58,959
is the way the night sky would look if

105
00:04:03,509 --> 00:04:01,200
you could see the entire night sky the

106
00:04:05,030 --> 00:04:03,519
earth wasn't blocking half of it

107
00:04:10,229 --> 00:04:05,040
and

108
00:04:12,309 --> 00:04:10,239
is the milky way galaxy

109
00:04:15,990 --> 00:04:12,319
what's called the galactic plain

110
00:04:18,069 --> 00:04:16,000
and it's a ring in space it goes around

111
00:04:20,789 --> 00:04:18,079
the your sphere that you're looking out

112
00:04:23,189 --> 00:04:20,799
on but the map projection turns it into

113
00:04:25,350 --> 00:04:23,199

this s-shaped band

114
00:04:27,749 --> 00:04:25,360
so you can see the local stars and now

115
00:04:29,590 --> 00:04:27,759
if you run it the

116
00:04:31,590 --> 00:04:29,600
we can show you where the two voyager

117
00:04:35,270 --> 00:04:31,600
spacecraft are

118
00:04:36,629 --> 00:04:35,280
on this projection and

119
00:04:38,629 --> 00:04:36,639
here you see

120
00:04:41,670 --> 00:04:38,639
voyager 1 and voyager 2 where their

121
00:04:43,749 --> 00:04:41,680
positions are and the nose is the

122
00:04:46,469 --> 00:04:43,759
direction that the sun is moving

123
00:04:49,510 --> 00:04:46,479
relative to interstellar gas it's the

124
00:04:51,030 --> 00:04:49,520
upstream direction and all of our map

125
00:04:53,189 --> 00:04:51,040
projections coming up we're going to

126
00:04:55,430 --> 00:04:53,199
have pretty much the nose centered

127
00:04:57,830 --> 00:04:55,440
and be in this form

128
00:04:59,510 --> 00:04:57,840
but so we have voyager 1 and voyager 2

129
00:05:01,749 --> 00:04:59,520
and they're like

130
00:05:03,189 --> 00:05:01,759
weather stations but can you imagine

131
00:05:06,310 --> 00:05:03,199
trying to determine the weather in the

132
00:05:07,590 --> 00:05:06,320
entire earth from two weather stations

133
00:05:10,150 --> 00:05:07,600
can't do it

134
00:05:12,550 --> 00:05:10,160
ibex is like our first weather satellite

135
00:05:14,870 --> 00:05:12,560
and gives us the full picture

136
00:05:17,590 --> 00:05:14,880
and so to fill in all the stuff that you

137
00:05:19,270 --> 00:05:17,600
don't see on this picture here

138
00:05:21,590 --> 00:05:19,280

david

139
00:05:23,430 --> 00:05:21,600
thanks eric and good afternoon

140
00:05:25,830 --> 00:05:23,440
so i'll pick up the story exactly where

141
00:05:27,350 --> 00:05:25,840
eric left it off we have these fabulous

142
00:05:29,430 --> 00:05:27,360
observations from the two voyager

143
00:05:31,110 --> 00:05:29,440
spacecraft out in this interaction

144
00:05:33,110 --> 00:05:31,120
region at the edge of our solar system

145
00:05:34,870 --> 00:05:33,120
our heliosphere but there are only these

146
00:05:36,469 --> 00:05:34,880
two locations these two very specific

147
00:05:38,790 --> 00:05:36,479
locations in space

148
00:05:41,110 --> 00:05:38,800
and so what you see on this graphic is

149
00:05:43,270 --> 00:05:41,120
the picture of our heliosphere the

150
00:05:45,590 --> 00:05:43,280
global picture of our heliosphere as it

151
00:05:46,950 --> 00:05:45,600
as it was yesterday with just these two

152
00:05:49,749 --> 00:05:46,960
two points

153
00:05:51,749 --> 00:05:49,759
and now if we run the the fade you'll

154
00:05:54,230 --> 00:05:51,759
see the new picture the picture of what

155
00:05:56,469 --> 00:05:54,240
we know of our heliosphere today

156
00:05:58,950 --> 00:05:56,479
these results are from ibex

157
00:06:00,469 --> 00:05:58,960
they're neutral particles neutral atoms

158
00:06:01,830 --> 00:06:00,479
coming in from the very edge of the

159
00:06:04,150 --> 00:06:01,840
heliosphere

160
00:06:07,189 --> 00:06:04,160
what you see is a very bright and very

161
00:06:09,350 --> 00:06:07,199
very narrow ribbon of particles coming

162
00:06:11,350 --> 00:06:09,360
in neutral atoms coming in the

163
00:06:12,710 --> 00:06:11,360

expectations from theories theorists and

164
00:06:16,150 --> 00:06:12,720
modelers were that there'd be small

165
00:06:18,070 --> 00:06:16,160
variations uh uh tens of percent across

166
00:06:21,189 --> 00:06:18,080
uh these sorts of regions of space but

167
00:06:23,430 --> 00:06:21,199
instead we see two 300 variations across

168
00:06:24,469 --> 00:06:23,440
this across this ribbon

169
00:06:26,629 --> 00:06:24,479
and so

170
00:06:29,189 --> 00:06:26,639
this is a shocking new result for us and

171
00:06:31,029 --> 00:06:29,199
one that's even as we speak now not

172
00:06:33,029 --> 00:06:31,039
entirely understood and not entirely

173
00:06:34,629 --> 00:06:33,039
explained but it's a very exciting

174
00:06:36,710 --> 00:06:34,639
result for us and it shows that what we

175
00:06:39,029 --> 00:06:36,720
thought we understood before about this

176
00:06:40,469 --> 00:06:39,039
interaction is definitely not right and

177
00:06:42,230 --> 00:06:40,479
we have to kind of go back and start

178
00:06:43,749 --> 00:06:42,240
over so i'm going to talk a lot more

179
00:06:45,430 --> 00:06:43,759
about the observations and about the

180
00:06:46,710 --> 00:06:45,440
ribbon but before i do that let me give

181
00:06:48,469 --> 00:06:46,720
you a little bit of background about

182
00:06:49,589 --> 00:06:48,479
ibex and and the spacecraft and how we

183
00:06:50,629 --> 00:06:49,599
take the measurements because it's

184
00:06:51,589 --> 00:06:50,639
important to understand what we're

185
00:06:53,830 --> 00:06:51,599
seeing

186
00:06:55,830 --> 00:06:53,840
so in this movie you'll see the ibex

187
00:06:57,270 --> 00:06:55,840
spacecraft this is an artist rendition

188
00:06:59,430 --> 00:06:57,280

the ibex spacecraft is very small

189
00:07:00,950 --> 00:06:59,440
spacecraft this is actually a full a

190
00:07:02,790 --> 00:07:00,960
full-sized model over here it's about

191
00:07:05,189 --> 00:07:02,800
three feet in diameter a foot and a half

192
00:07:07,749 --> 00:07:05,199
tall it weighs about 200 pounds it's got

193
00:07:10,870 --> 00:07:07,759
one side that points towards the sun it

194
00:07:13,830 --> 00:07:10,880
spins at four rpms four rotations per

195
00:07:15,270 --> 00:07:13,840
minute and the the top side blue and the

196
00:07:17,589 --> 00:07:15,280
blue in the movie you're basically

197
00:07:20,629 --> 00:07:17,599
seeing the solar panels we have two very

198
00:07:22,309 --> 00:07:20,639
large sensors cameras uh actually

199
00:07:23,909 --> 00:07:22,319
cameras not of light but cameras of

200
00:07:25,749 --> 00:07:23,919
neutral atoms

201
00:07:27,270 --> 00:07:25,759
and we look out the two sides

202
00:07:29,110 --> 00:07:27,280
perpendicular to the spin axis and we

203
00:07:31,029 --> 00:07:29,120
view these two these two directions in

204
00:07:32,150 --> 00:07:31,039
space and every time the spacecraft

205
00:07:33,749 --> 00:07:32,160
spins

206
00:07:35,189 --> 00:07:33,759
we're able to uh we're able to make

207
00:07:36,629 --> 00:07:35,199
these observations

208
00:07:38,070 --> 00:07:36,639
before i get into that in more detail

209
00:07:40,550 --> 00:07:38,080
let me talk a little bit about where

210
00:07:42,230 --> 00:07:40,560
these neutral particles come from

211
00:07:44,469 --> 00:07:42,240
ultimately these particles mostly come

212
00:07:45,830 --> 00:07:44,479
from the sun from the solar wind eric

213
00:07:47,990 --> 00:07:45,840

already mentioned the solar wind this

214
00:07:50,230 --> 00:07:48,000
million mile an hour gas that goes

215
00:07:51,749 --> 00:07:50,240
spreading out from the sun all the time

216
00:07:53,110 --> 00:07:51,759
if we run the movie here we'll start

217
00:07:55,110 --> 00:07:53,120
with the sun

218
00:07:57,029 --> 00:07:55,120
so here you see a picture of the sun we

219
00:07:59,270 --> 00:07:57,039
move in close into the solar corona

220
00:08:01,110 --> 00:07:59,280
million degree corona and this

221
00:08:03,189 --> 00:08:01,120
atmosphere this corona boils off into

222
00:08:05,830 --> 00:08:03,199
space and produces this million mile an

223
00:08:08,070 --> 00:08:05,840
hour wind all the time of hot ionized

224
00:08:09,909 --> 00:08:08,080
gas as those particles flow radially

225
00:08:11,589 --> 00:08:09,919
outward they drag out the magnetic field

226
00:08:14,070 --> 00:08:11,599
from the sun and when they get out into

227
00:08:15,909 --> 00:08:14,080
this interaction region as you see here

228
00:08:17,350 --> 00:08:15,919
and we'll blow that region up they

229
00:08:18,790 --> 00:08:17,360
actually are tied to magnetic field

230
00:08:20,629 --> 00:08:18,800
lines because all charged particles are

231
00:08:22,390 --> 00:08:20,639
tied to magnetic field lines so they go

232
00:08:24,469 --> 00:08:22,400
around and around gyrating around the

233
00:08:26,790 --> 00:08:24,479
field and sometimes they come close to

234
00:08:28,309 --> 00:08:26,800
another particle and steal an electron

235
00:08:29,909 --> 00:08:28,319
and when they can steal an electron they

236
00:08:32,149 --> 00:08:29,919
go zipping off in whatever direction

237
00:08:34,070 --> 00:08:32,159
they they were going and some of them go

238
00:08:36,149 --> 00:08:34,080

right back in towards us and go right in

239
00:08:38,149 --> 00:08:36,159
the aperture of the ibex spacecraft and

240
00:08:40,469 --> 00:08:38,159
i like to think of that as sort of a 10

241
00:08:42,070 --> 00:08:40,479
billion mile away hole in one for one of

242
00:08:44,630 --> 00:08:42,080
these neutral atoms coming in from the

243
00:08:46,470 --> 00:08:44,640
boundary of the solar system

244
00:08:48,310 --> 00:08:46,480
so

245
00:08:50,070 --> 00:08:48,320
we talked a little bit about how the ena

246
00:08:52,470 --> 00:08:50,080
cameras energetic neutral atom cameras

247
00:08:54,710 --> 00:08:52,480
look off the two sides that allows us to

248
00:08:56,389 --> 00:08:54,720
to see a swath of the sky

249
00:08:57,829 --> 00:08:56,399
as the spacecraft spins and in the

250
00:09:00,230 --> 00:08:57,839
graphic that we have here go ahead and

251
00:09:01,910 --> 00:09:00,240
run that please you can see the two

252
00:09:03,750 --> 00:09:01,920
fields of view these two pixel fields of

253
00:09:06,070 --> 00:09:03,760
view looking off to the two sides and as

254
00:09:08,230 --> 00:09:06,080
the spacecraft spins around each of ibex

255
00:09:10,550 --> 00:09:08,240
high and low views all the way around in

256
00:09:12,389 --> 00:09:10,560
this great circle and and takes

257
00:09:14,230 --> 00:09:12,399
excellent measurements of the ena's

258
00:09:16,470 --> 00:09:14,240
coming in in this circle

259
00:09:17,829 --> 00:09:16,480
okay but that's not a sky map we had to

260
00:09:20,550 --> 00:09:17,839
find a way with the small cheap

261
00:09:22,310 --> 00:09:20,560
spacecraft to to actually see all of the

262
00:09:24,470 --> 00:09:22,320
sky and so we use something that we

263
00:09:27,030 --> 00:09:24,480

naturally had we only have one side that

264
00:09:29,269 --> 00:09:27,040
has solar panels on it and so what we do

265
00:09:31,030 --> 00:09:29,279
is we point that side towards the sun

266
00:09:33,030 --> 00:09:31,040
and as the earth goes around the sun and

267
00:09:35,590 --> 00:09:33,040
let's run this next graphic as the earth

268
00:09:37,350 --> 00:09:35,600
goes around the sun we keep re-pointing

269
00:09:39,509 --> 00:09:37,360
the spacecraft so it's pointing towards

270
00:09:40,790 --> 00:09:39,519
the sun if you can roll this uh movie

271
00:09:43,269 --> 00:09:40,800
please

272
00:09:45,190 --> 00:09:43,279
and as we re-point the spacecraft the

273
00:09:47,269 --> 00:09:45,200
swath of the sky that you observe

274
00:09:49,269 --> 00:09:47,279
rotates around and so you end up

275
00:09:50,790 --> 00:09:49,279
basically over the course of half a year

276
00:09:52,310 --> 00:09:50,800
by the spinning of the spacecraft and

277
00:09:56,389 --> 00:09:52,320
the repointing of the spacecraft

278
00:09:59,829 --> 00:09:58,230
okay so that's how we view these

279
00:10:03,110 --> 00:09:59,839
energetic neutral atoms how we can see

280
00:10:04,949 --> 00:10:03,120
them coming from all directions in space

281
00:10:07,430 --> 00:10:04,959
i'd like to start the next movie it

282
00:10:08,870 --> 00:10:07,440
shows ibex in orbit around the earth

283
00:10:10,870 --> 00:10:08,880
ibex is actually making these

284
00:10:12,870 --> 00:10:10,880
measurements from an earth orbit it's a

285
00:10:14,870 --> 00:10:12,880
very high altitude earth orbit we go

286
00:10:16,630 --> 00:10:14,880
almost all the way out to the moon about

287
00:10:18,710 --> 00:10:16,640
50 earth radii and then come back in it

288
00:10:19,670 --> 00:10:18,720

takes about a week for ibex to orbit

289
00:10:21,509 --> 00:10:19,680
around

290
00:10:22,949 --> 00:10:21,519
the earth and make and make a full a

291
00:10:24,310 --> 00:10:22,959
full orbit

292
00:10:25,990 --> 00:10:24,320
over that week we're at high altitude

293
00:10:27,430 --> 00:10:26,000
for most of the time measuring these

294
00:10:30,069 --> 00:10:27,440
neutral particles and then we come in

295
00:10:31,509 --> 00:10:30,079
close we we downlink our data

296
00:10:33,829 --> 00:10:31,519
now we're going to back away from this

297
00:10:34,949 --> 00:10:33,839
view and as we back away from this view

298
00:10:36,949 --> 00:10:34,959
you're going to see that that's the

299
00:10:40,230 --> 00:10:36,959
earth we're going to now see the orbits

300
00:10:41,829 --> 00:10:40,240
of venus of mercury the sun itself and

301
00:10:43,430 --> 00:10:41,839
you can see the direction of motion

302
00:10:45,590 --> 00:10:43,440
through the local interstellar medium

303
00:10:47,110 --> 00:10:45,600
and painted in the backdrop you can see

304
00:10:49,269 --> 00:10:47,120
the these measurements that we've that

305
00:10:51,269 --> 00:10:49,279
we've just made of of the ribbon so

306
00:10:52,870 --> 00:10:51,279
we're inside a sphere looking around in

307
00:10:54,790 --> 00:10:52,880
all directions and measuring these

308
00:10:57,670 --> 00:10:54,800
particles coming from all directions if

309
00:10:59,509 --> 00:10:57,680
we back out of that sphere and see it

310
00:11:01,430 --> 00:10:59,519
from the outside you can imagine taking

311
00:11:03,829 --> 00:11:01,440
a knife and cutting through that sphere

312
00:11:05,509 --> 00:11:03,839
and opening it up and flattening it out

313
00:11:07,030 --> 00:11:05,519

onto onto a page

314
00:11:08,470 --> 00:11:07,040
and that's the sky map that you're

315
00:11:10,470 --> 00:11:08,480
seeing and all of the observations we're

316
00:11:12,069 --> 00:11:10,480
going to talk about are in this format

317
00:11:13,750 --> 00:11:12,079
so the nose is at the middle that's the

318
00:11:15,750 --> 00:11:13,760
direction we're going through the galaxy

319
00:11:19,350 --> 00:11:15,760
the tail is on the far right and left

320
00:11:21,990 --> 00:11:19,360
north and south poles are where they are

321
00:11:23,350 --> 00:11:22,000
so ibex doesn't only measure

322
00:11:24,870 --> 00:11:23,360
particles at one energy but actually

323
00:11:25,990 --> 00:11:24,880
measures particles over a broad range of

324
00:11:27,670 --> 00:11:26,000
energies

325
00:11:29,750 --> 00:11:27,680
from about 10 electron volts all the way

326
00:11:31,670 --> 00:11:29,760
up to 6000 electron volts

327
00:11:33,030 --> 00:11:31,680
and uh this next

328
00:11:35,030 --> 00:11:33,040
graphic that you're going to see is

329
00:11:36,550 --> 00:11:35,040
actually a set of five sky maps not just

330
00:11:39,269 --> 00:11:36,560
one but five sky maps at different

331
00:11:40,949 --> 00:11:39,279
energies and they correspond to neutral

332
00:11:43,030 --> 00:11:40,959
hydrogen atoms coming in with speeds

333
00:11:44,630 --> 00:11:43,040
between half a million miles an hour and

334
00:11:45,509 --> 00:11:44,640
about two and a half million miles an

335
00:11:47,269 --> 00:11:45,519
hour

336
00:11:48,550 --> 00:11:47,279
and what you see as we sort of go

337
00:11:51,590 --> 00:11:48,560
through fade through the different

338
00:11:53,350 --> 00:11:51,600

energies is this ribbon changes and

339
00:11:55,030 --> 00:11:53,360
appears to get broader as you move away

340
00:11:57,190 --> 00:11:55,040
from one kilovolt about a million mile

341
00:11:58,870 --> 00:11:57,200
an hour particles um it's actually not

342
00:12:00,949 --> 00:11:58,880
getting broader what's happening is it's

343
00:12:02,470 --> 00:12:00,959
it's not as it's not as uh

344
00:12:04,629 --> 00:12:02,480
as bright compared to the background and

345
00:12:06,629 --> 00:12:04,639
so you sort of see the background uh the

346
00:12:08,150 --> 00:12:06,639
distributed flux from around there uh

347
00:12:09,670 --> 00:12:08,160
coming up there are a lot of really

348
00:12:11,190 --> 00:12:09,680
fascinating things in these in these

349
00:12:13,110 --> 00:12:11,200
measurements you can see in this one for

350
00:12:15,269 --> 00:12:13,120
example a bright spot up up at high

351
00:12:17,350 --> 00:12:15,279
latitudes on the left hand side

352
00:12:19,030 --> 00:12:17,360
which has a very different sort of a

353
00:12:20,790 --> 00:12:19,040
feature than than much of the rest of

354
00:12:22,470 --> 00:12:20,800
the ribbon so there's a lot of really

355
00:12:24,629 --> 00:12:22,480
great detailed information in in these

356
00:12:26,069 --> 00:12:24,639
sky maps

357
00:12:27,350 --> 00:12:26,079
another thing that we scientists always

358
00:12:28,629 --> 00:12:27,360
want to do is we want to be able to

359
00:12:29,990 --> 00:12:28,639
confirm our results and that's

360
00:12:31,990 --> 00:12:30,000
especially important when we find

361
00:12:33,430 --> 00:12:32,000
something that's not what we expected

362
00:12:34,949 --> 00:12:33,440
that doesn't agree with theory doesn't

363
00:12:36,389 --> 00:12:34,959

agree with model how do you know you're

364
00:12:38,470 --> 00:12:36,399
right how do you know that you can

365
00:12:40,629 --> 00:12:38,480
really trust these results

366
00:12:42,629 --> 00:12:40,639
and so ibex by its very design from the

367
00:12:43,910 --> 00:12:42,639
beginning has these two sensors ibex

368
00:12:45,910 --> 00:12:43,920
high and low measuring two different

369
00:12:47,750 --> 00:12:45,920
energy ranges but we overlapped the

370
00:12:49,350 --> 00:12:47,760
energy ranges in a way that we were able

371
00:12:51,190 --> 00:12:49,360
to measure in the most important energy

372
00:12:52,870 --> 00:12:51,200
range at about a kilovolt we're able to

373
00:12:55,350 --> 00:12:52,880
measure independently with the two uh

374
00:12:57,670 --> 00:12:55,360
with the two uh instruments and so the

375
00:13:00,069 --> 00:12:57,680
graphics that we've put up now shows on

376
00:13:02,389 --> 00:13:00,079
the top the ibex high sky map at one

377
00:13:04,389 --> 00:13:02,399
kilovolt 1.1 kilovolts and the ibex low

378
00:13:06,069 --> 00:13:04,399
sky map at about a kilovolt very similar

379
00:13:08,310 --> 00:13:06,079
energies and while there's much better

380
00:13:11,430 --> 00:13:08,320
statistics in the ibex high sky map on

381
00:13:12,870 --> 00:13:11,440
top clearly the ribbon is is present is

382
00:13:14,949 --> 00:13:12,880
in the same place and has the same sort

383
00:13:16,790 --> 00:13:14,959
of characteristics as measured by ibex

384
00:13:19,110 --> 00:13:16,800
low so these measurements are completely

385
00:13:20,230 --> 00:13:19,120
independently confirmed by ibex itself

386
00:13:21,670 --> 00:13:20,240
and you're going to hear a little later

387
00:13:23,430 --> 00:13:21,680
in this press conference they're also

388
00:13:25,350 --> 00:13:23,440

confirmed and in fact extended with the

389
00:13:27,269 --> 00:13:25,360
cassini observations which don will talk

390
00:13:28,790 --> 00:13:27,279
about shortly

391
00:13:30,629 --> 00:13:28,800
so it'll be shocking

392
00:13:32,550 --> 00:13:30,639
shocking enough if what we found was a

393
00:13:34,870 --> 00:13:32,560
ribbon that was tens of degrees wide 10

394
00:13:36,710 --> 00:13:34,880
20 degrees wide but it's even more

395
00:13:39,030 --> 00:13:36,720
shocking than that because when we look

396
00:13:41,430 --> 00:13:39,040
with really high resolution and ibex has

397
00:13:44,310 --> 00:13:41,440
the the sensitivity to really look at

398
00:13:46,310 --> 00:13:44,320
very very narrow angular resolution we

399
00:13:47,750 --> 00:13:46,320
actually see fine structure

400
00:13:49,750 --> 00:13:47,760
and the graphic that we've put up here

401
00:13:52,710 --> 00:13:49,760
takes a piece of this ribbon south of

402
00:13:54,069 --> 00:13:52,720
the equator and and and and blows it up

403
00:13:55,990 --> 00:13:54,079
and in addition what we've done now is

404
00:13:57,990 --> 00:13:56,000
we've bend up the individual particles

405
00:13:59,590 --> 00:13:58,000
that we observe coming in in half degree

406
00:14:01,990 --> 00:13:59,600
bins and we've summed those half degree

407
00:14:03,670 --> 00:14:02,000
bins until we get about 100 counts in a

408
00:14:04,790 --> 00:14:03,680
bin which is good a good statistical

409
00:14:06,389 --> 00:14:04,800
number

410
00:14:08,150 --> 00:14:06,399
when you do that what you see is the

411
00:14:09,350 --> 00:14:08,160
ribbon itself has got a lot of fine

412
00:14:10,470 --> 00:14:09,360
structure in it that there are actually

413
00:14:11,990 --> 00:14:10,480

structures in there that are much

414
00:14:13,509 --> 00:14:12,000
brighter than the adjacent things that

415
00:14:15,670 --> 00:14:13,519
are only a degree or two or three

416
00:14:17,590 --> 00:14:15,680
degrees wide that's really shocking when

417
00:14:19,829 --> 00:14:17,600
these things are coming from a region

418
00:14:21,269 --> 00:14:19,839
that's so large and so distributed and

419
00:14:23,350 --> 00:14:21,279
nobody expected to see anything like

420
00:14:24,870 --> 00:14:23,360
that find structure

421
00:14:26,470 --> 00:14:24,880
so i just wanted to mention uh there are

422
00:14:28,550 --> 00:14:26,480
a lot of other great results coming out

423
00:14:29,910 --> 00:14:28,560
of ibex we have five papers that are

424
00:14:31,509 --> 00:14:29,920
just coming out in science right now

425
00:14:33,590 --> 00:14:31,519
posted online right now with this press

426
00:14:35,509 --> 00:14:33,600
conference a sixth from the from the

427
00:14:37,590 --> 00:14:35,519
cassini measurements they cover a lot of

428
00:14:39,269 --> 00:14:37,600
different areas i wanted to mention one

429
00:14:41,829 --> 00:14:39,279
more area for you and that's the direct

430
00:14:43,509 --> 00:14:41,839
detection of interstellar neutrals

431
00:14:45,030 --> 00:14:43,519
in addition to these neutral atoms which

432
00:14:46,550 --> 00:14:45,040
are created in the interaction region at

433
00:14:48,389 --> 00:14:46,560
the boundaries of the heliosphere

434
00:14:49,670 --> 00:14:48,399
they're also very low energy neutrals

435
00:14:52,710 --> 00:14:49,680
that are just wandering into the

436
00:14:54,629 --> 00:14:52,720
heliosphere as we move through uh move

437
00:14:56,710 --> 00:14:54,639
through the galaxy and previously

438
00:14:59,189 --> 00:14:56,720

spacecraft observations had seen helium

439
00:15:01,350 --> 00:14:59,199
directly but with ibex we've now made

440
00:15:03,750 --> 00:15:01,360
and have just published the very first

441
00:15:06,550 --> 00:15:03,760
observations direct observations of

442
00:15:08,470 --> 00:15:06,560
interstellar uh helium uh sorry hydrogen

443
00:15:10,389 --> 00:15:08,480
and oxygen in addition to observing

444
00:15:12,150 --> 00:15:10,399
helium and in the graphic that's put up

445
00:15:14,310 --> 00:15:12,160
now you can see those those three these

446
00:15:16,389 --> 00:15:14,320
are from the low energy detector ibex

447
00:15:18,470 --> 00:15:16,399
low and you can see these quite

448
00:15:20,389 --> 00:15:18,480
localized bright spots that are produced

449
00:15:22,470 --> 00:15:20,399
by the different species and they come

450
00:15:23,990 --> 00:15:22,480
from a time when ibex isn't exactly the

451
00:15:25,030 --> 00:15:24,000
right spot in the orbit that the

452
00:15:26,550 --> 00:15:25,040
particles coming in from the

453
00:15:28,629 --> 00:15:26,560
interstellar medium feel the force of

454
00:15:30,150 --> 00:15:28,639
gravity or bent around and come right

455
00:15:31,749 --> 00:15:30,160
into the aperture and so it's yet

456
00:15:34,310 --> 00:15:31,759
another type of observation of this

457
00:15:36,870 --> 00:15:34,320
interaction that we're making

458
00:15:38,150 --> 00:15:36,880
so with my final graphic i i want to

459
00:15:40,230 --> 00:15:38,160
answer the question

460
00:15:41,509 --> 00:15:40,240
so what is this ribbon uh and what does

461
00:15:42,870 --> 00:15:41,519
it mean

462
00:15:44,230 --> 00:15:42,880
unfortunately i can't answer that

463
00:15:45,829 --> 00:15:44,240

question because we don't know what this

464
00:15:48,389 --> 00:15:45,839
ribbon really is we know some

465
00:15:49,670 --> 00:15:48,399
interesting things about it though uh as

466
00:15:51,189 --> 00:15:49,680
soon as we saw this and you know we're

467
00:15:52,710 --> 00:15:51,199
building up the sky maps week by week

468
00:15:54,550 --> 00:15:52,720
and we see this bright thing like wow

469
00:15:56,949 --> 00:15:54,560
what's that you know and it goes around

470
00:15:59,030 --> 00:15:56,959
and it starts to wind up and holy moly

471
00:16:00,550 --> 00:15:59,040
so as we're looking at that and as it's

472
00:16:02,230 --> 00:16:00,560
building up people start to say what

473
00:16:03,829 --> 00:16:02,240
could it be what could it correlate with

474
00:16:05,670 --> 00:16:03,839
and we pretty quickly realized that the

475
00:16:07,509 --> 00:16:05,680
external magnetic field in the galaxy

476
00:16:09,269 --> 00:16:07,519
the local part of the galaxy uh what's

477
00:16:11,670 --> 00:16:09,279
called the uh the local interstellar

478
00:16:14,470 --> 00:16:11,680
magnetic field was oriented in just such

479
00:16:16,550 --> 00:16:14,480
a way that it seemed to organize these

480
00:16:18,389 --> 00:16:16,560
data and and and correlate with the

481
00:16:21,110 --> 00:16:18,399
ribbon and in the graphic that we've put

482
00:16:22,629 --> 00:16:21,120
up here you can see the the sort of a

483
00:16:24,710 --> 00:16:22,639
picture from the outside looking in

484
00:16:26,870 --> 00:16:24,720
we've painted the ribbon and the and the

485
00:16:29,189 --> 00:16:26,880
particle fluxes on this boundary of the

486
00:16:32,710 --> 00:16:29,199
heliosphere and then we've put in the

487
00:16:34,710 --> 00:16:32,720
the the the expected orientation of the

488
00:16:36,150 --> 00:16:34,720

external magnetic field and you can sort

489
00:16:37,430 --> 00:16:36,160
of think of that external magnet feel

490
00:16:38,870 --> 00:16:37,440
like a bunch of bungee cords if you're

491
00:16:40,870 --> 00:16:38,880
pushing a beach ball through bungee

492
00:16:42,870 --> 00:16:40,880
cords it kind of drapes around and

493
00:16:44,710 --> 00:16:42,880
pushes in on the beach ball but it also

494
00:16:46,310 --> 00:16:44,720
it also changes the shape of the bungee

495
00:16:48,230 --> 00:16:46,320
cords and that's sort of what magnetic

496
00:16:49,990 --> 00:16:48,240
field lines are like and so what you see

497
00:16:52,150 --> 00:16:50,000
here is the external magnetic field

498
00:16:54,470 --> 00:16:52,160
pushing in in the southern hemisphere of

499
00:16:56,710 --> 00:16:54,480
the of the heliosphere and also pushing

500
00:16:58,629 --> 00:16:56,720
in and squeezing it from the sides and

501
00:17:01,030 --> 00:16:58,639
just exactly where it's most bent and

502
00:17:03,430 --> 00:17:01,040
most draped around the outside

503
00:17:05,350 --> 00:17:03,440
is exactly where the ribbon is lying

504
00:17:07,669 --> 00:17:05,360
really a remarkable correlation and

505
00:17:09,189 --> 00:17:07,679
almost surely telling us that somehow

506
00:17:11,270 --> 00:17:09,199
this external magnetic field is really

507
00:17:13,189 --> 00:17:11,280
dominant and is playing another dominant

508
00:17:14,870 --> 00:17:13,199
role in the interaction but we don't

509
00:17:16,630 --> 00:17:14,880
understand the physical connection we

510
00:17:18,309 --> 00:17:16,640
don't know why

511
00:17:19,750 --> 00:17:18,319
having an external field that drapes

512
00:17:22,309 --> 00:17:19,760
around that way and pushes on the outer

513
00:17:24,710 --> 00:17:22,319

boundary that way really produces these

514
00:17:27,029 --> 00:17:24,720
200 300 percent higher fluxes than the

515
00:17:29,190 --> 00:17:27,039
surrounding regions and that's a really

516
00:17:30,710 --> 00:17:29,200
exciting and interesting part where we

517
00:17:33,110 --> 00:17:30,720
now have to go back and try to figure

518
00:17:35,110 --> 00:17:33,120
out what physics we're missing uh in all

519
00:17:36,470 --> 00:17:35,120
our models and understanding

520
00:17:38,470 --> 00:17:36,480
and so with that i'd like to pass it

521
00:17:41,669 --> 00:17:38,480
over to razeen lalima who's an expert in

522
00:17:43,590 --> 00:17:41,679
the environment around our heliosphere

523
00:17:45,990 --> 00:17:43,600
thank you dave

524
00:17:49,510 --> 00:17:46,000
let's go go back to the location of the

525
00:17:53,270 --> 00:17:49,520
sun in our galaxy and you may wonder

526
00:17:55,909 --> 00:17:53,280
whether such a galactic wind able to

527
00:17:58,789 --> 00:17:55,919
stop the solar wind and confine it

528
00:18:02,150 --> 00:17:58,799
within our heliosphere is a common

529
00:18:03,669 --> 00:18:02,160
situation and the answer is yes and as

530
00:18:05,750 --> 00:18:03,679
you can see

531
00:18:09,190 --> 00:18:05,760
in this movie showing the galaxy the

532
00:18:12,150 --> 00:18:09,200
galaxy is rotating but it is not

533
00:18:15,270 --> 00:18:12,160
rotating rigidly like a solid body

534
00:18:17,990 --> 00:18:15,280
instead all the stars and the clouds of

535
00:18:20,150 --> 00:18:18,000
gas and dust they are all moving with

536
00:18:22,789 --> 00:18:20,160
respect to each other this is due to the

537
00:18:27,110 --> 00:18:22,799
constant recycling of the matter stellar

538
00:18:29,990 --> 00:18:27,120

formation explosion etc so this is

539
00:18:31,909 --> 00:18:30,000
this is a as a consequence our sun is

540
00:18:33,110 --> 00:18:31,919
moving with respect to the ambient

541
00:18:36,390 --> 00:18:33,120
medium

542
00:18:39,750 --> 00:18:36,400
presently uh our star is crossing a very

543
00:18:42,870 --> 00:18:39,760
small uh interstellar cloud and this is

544
00:18:45,510 --> 00:18:42,880
this cloud is shaping us our heliosphere

545
00:18:46,549 --> 00:18:45,520
for the other stars of course there are

546
00:18:48,870 --> 00:18:46,559
also

547
00:18:51,990 --> 00:18:48,880
same structures same types of structure

548
00:18:54,710 --> 00:18:52,000
they are called astrospheres and in this

549
00:18:57,190 --> 00:18:54,720
picture here you can see three nice

550
00:19:00,549 --> 00:18:57,200
examples of such astrospheres

551
00:19:02,390 --> 00:19:00,559
recently imaged by the best telescopes

552
00:19:05,669 --> 00:19:02,400
and you can see from these three

553
00:19:08,789 --> 00:19:05,679
examples the big diversity i mean all

554
00:19:11,669 --> 00:19:08,799
these astrospheres are different because

555
00:19:14,310 --> 00:19:11,679
they are governed by

556
00:19:16,310 --> 00:19:14,320
the stellar type the type of medium

557
00:19:18,310 --> 00:19:16,320
which is the star is going through and

558
00:19:19,590 --> 00:19:18,320
the speed of the of the star the

559
00:19:22,310 --> 00:19:19,600
environment

560
00:19:24,950 --> 00:19:22,320
so all are different here as an example

561
00:19:26,950 --> 00:19:24,960
you can see on the top left

562
00:19:28,789 --> 00:19:26,960
a young star which is

563
00:19:31,750 --> 00:19:28,799

going very fast driving very fast

564
00:19:33,909 --> 00:19:31,760
through the orion nebula and you can see

565
00:19:37,510 --> 00:19:33,919
the very nicely the structure this is

566
00:19:39,750 --> 00:19:37,520
hst and on the top right you can see a

567
00:19:42,070 --> 00:19:39,760
very different example of a complex

568
00:19:45,669 --> 00:19:42,080
binary system where

569
00:19:47,110 --> 00:19:45,679
this system is ejecting a very dense

570
00:19:47,909 --> 00:19:47,120
wind

571
00:19:49,830 --> 00:19:47,919
we

572
00:19:53,510 --> 00:19:49,840
forming a

573
00:19:56,390 --> 00:19:53,520
peculiar shape and at the bottom you see

574
00:19:59,510 --> 00:19:56,400
the tail which is as long as 10 light

575
00:20:02,070 --> 00:19:59,520
years which is left behind the nearby

576
00:20:04,870 --> 00:20:02,080
star mira which is seen by the it has

577
00:20:07,350 --> 00:20:04,880
been imaged by the galaxy spacecraft in

578
00:20:08,390 --> 00:20:07,360
the far uv but

579
00:20:11,190 --> 00:20:08,400
these

580
00:20:14,870 --> 00:20:11,200
three cases and all the image cases of

581
00:20:16,470 --> 00:20:14,880
astrosphere are extreme cases there is

582
00:20:19,590 --> 00:20:16,480
no way

583
00:20:21,830 --> 00:20:19,600
to get such images for our heliosphere

584
00:20:24,149 --> 00:20:21,840
and the reason is where there are many

585
00:20:26,549 --> 00:20:24,159
reasons is that first

586
00:20:27,990 --> 00:20:26,559
the solar wind is very weak is among the

587
00:20:30,470 --> 00:20:28,000
weakest winds

588
00:20:33,909 --> 00:20:30,480

the the speed of the sun through the

589
00:20:36,470 --> 00:20:33,919
ambient medium is low is small and

590
00:20:38,310 --> 00:20:36,480
especially we are going through a very

591
00:20:39,350 --> 00:20:38,320
tenuous

592
00:20:42,070 --> 00:20:39,360
uh

593
00:20:44,470 --> 00:20:42,080
interstellar cloud and that we are in a

594
00:20:47,190 --> 00:20:44,480
very quiet environment no bright star

595
00:20:51,029 --> 00:20:47,200
around to illuminate the scene

596
00:20:53,350 --> 00:20:51,039
so this is why we we are unable to get

597
00:20:54,310 --> 00:20:53,360
those images but this is where

598
00:20:55,270 --> 00:20:54,320
uh

599
00:20:58,230 --> 00:20:55,280
having

600
00:20:59,190 --> 00:20:58,240
images of the heliosphere by gale pyre

601
00:21:03,510 --> 00:20:59,200
sorry

602
00:21:05,190 --> 00:21:03,520
by ibex is such a is so exciting

603
00:21:07,510 --> 00:21:05,200
because uh

604
00:21:09,909 --> 00:21:07,520
well i mean thanks to this beautiful

605
00:21:12,950 --> 00:21:09,919
idea to replace the photons by energetic

606
00:21:15,029 --> 00:21:12,960
neutral atoms as allowed to get such an

607
00:21:17,990 --> 00:21:15,039
image

608
00:21:19,909 --> 00:21:18,000
okay going back to this uh

609
00:21:24,070 --> 00:21:19,919
image that you have seen previously

610
00:21:26,470 --> 00:21:24,080
maybe the most exciting is the ribbon

611
00:21:30,630 --> 00:21:26,480
the spectacular ribbon that you can see

612
00:21:33,029 --> 00:21:30,640
this ribbon was totally unexpected and

613
00:21:35,190 --> 00:21:33,039

this the central the the axis of the

614
00:21:37,990 --> 00:21:35,200
ribbon as they've mentioned

615
00:21:39,590 --> 00:21:38,000
is corresponds to the direction which

616
00:21:40,549 --> 00:21:39,600
has been inferred

617
00:21:43,430 --> 00:21:40,559
to be

618
00:21:45,669 --> 00:21:43,440
very likely the direction of the ambient

619
00:21:47,750 --> 00:21:45,679
interstellar magnetic field

620
00:21:49,110 --> 00:21:47,760
the magnetic field around the

621
00:21:49,909 --> 00:21:49,120
heliosphere

622
00:21:52,470 --> 00:21:49,919
and

623
00:21:54,870 --> 00:21:52,480
as a matter of fact the an experiment on

624
00:21:57,669 --> 00:21:54,880
board the soho spacecraft

625
00:22:01,590 --> 00:21:57,679
called swan has demonstrated that our

626
00:22:03,750 --> 00:22:01,600
heliosphere is very strongly distorted

627
00:22:06,710 --> 00:22:03,760
and very lightly under the action of

628
00:22:08,070 --> 00:22:06,720
such an inclined magnetic field

629
00:22:10,070 --> 00:22:08,080
and if you

630
00:22:12,310 --> 00:22:10,080
see that this direction of the magnetic

631
00:22:15,590 --> 00:22:12,320
field is offset is completely different

632
00:22:18,950 --> 00:22:15,600
from the direction of motion you can see

633
00:22:21,750 --> 00:22:18,960
our heliosphere here as a gigantic

634
00:22:24,390 --> 00:22:21,760
interstellar magnetic compass i mean in

635
00:22:26,870 --> 00:22:24,400
the same way a needle is orientated by

636
00:22:29,590 --> 00:22:26,880
the earth's magnetic field here the

637
00:22:32,070 --> 00:22:29,600
orientation taken by the nose of our

638
00:22:34,950 --> 00:22:32,080

heliosphere gives you the direction of

639
00:22:35,669 --> 00:22:34,960
the ambient interstellar magnetic field

640
00:22:39,029 --> 00:22:35,679
so

641
00:22:42,549 --> 00:22:39,039
even if this ribbon is organized around

642
00:22:44,390 --> 00:22:42,559
the ambient field as dave said it is not

643
00:22:48,070 --> 00:22:44,400
understood and this is also very

644
00:22:49,190 --> 00:22:48,080
exciting because it is calling for a new

645
00:22:55,830 --> 00:22:49,200
physics

646
00:22:57,750 --> 00:22:55,840
evidently apply to the other

647
00:23:01,190 --> 00:22:57,760
system to the other astrosphere and this

648
00:23:04,710 --> 00:23:01,200
is extremely interesting too

649
00:23:06,549 --> 00:23:04,720
okay lindsay now will tell us about

650
00:23:09,669 --> 00:23:06,559
our heliosphere and how it is a

651
00:23:12,390 --> 00:23:09,679
comfortable location

652
00:23:13,669 --> 00:23:12,400
okay so the heliosphere is our home in

653
00:23:14,710 --> 00:23:13,679
the galaxy

654
00:23:16,630 --> 00:23:14,720
and

655
00:23:19,830 --> 00:23:16,640
our sun actually

656
00:23:22,070 --> 00:23:19,840
does orbit the center of the galaxy

657
00:23:25,110 --> 00:23:22,080
please roll the movie and i'm going to

658
00:23:27,190 --> 00:23:25,120
show you how the sun and all the stars

659
00:23:29,669 --> 00:23:27,200
actually bob up and down through the

660
00:23:31,350 --> 00:23:29,679
galaxy as they orbit

661
00:23:35,430 --> 00:23:31,360
taking hundreds of millions of years to

662
00:23:39,190 --> 00:23:37,190
the heliosphere comes up you'll see it

663
00:23:41,669 --> 00:23:39,200

in just a moment and

664
00:23:43,350 --> 00:23:41,679
as dave and rosine have said it it

665
00:23:44,870 --> 00:23:43,360
orbits around the center of the galaxy

666
00:23:47,269 --> 00:23:44,880
here it is here it's going to pass

667
00:23:49,510 --> 00:23:47,279
through regions that are denser and less

668
00:23:52,789 --> 00:23:49,520
dense as it passes through regions that

669
00:23:54,310 --> 00:23:52,799
are denser the heliosphere shrinks and

670
00:23:56,070 --> 00:23:54,320
then as it passes through regions that

671
00:23:57,510 --> 00:23:56,080
are less dense it's actually able to

672
00:24:00,149 --> 00:23:57,520
expand

673
00:24:02,470 --> 00:24:00,159
so these regions that it passes through

674
00:24:05,990 --> 00:24:02,480
help change the size and shape of the

675
00:24:08,390 --> 00:24:06,000
heliosphere over long periods of time

676
00:24:10,149 --> 00:24:08,400
also the sun's solar wind actually

677
00:24:12,149 --> 00:24:10,159
varies causing the heliosphere to

678
00:24:13,830 --> 00:24:12,159
breathe periodically

679
00:24:16,310 --> 00:24:13,840
that along with the magnetic field that

680
00:24:18,789 --> 00:24:16,320
we've just been discussing all of those

681
00:24:20,789 --> 00:24:18,799
factors and possibly other ones

682
00:24:22,710 --> 00:24:20,799
contribute to the shape of our home in

683
00:24:25,590 --> 00:24:22,720
the galaxy

684
00:24:28,549 --> 00:24:25,600
now this heliosphere is very important

685
00:24:30,470 --> 00:24:28,559
to us because it helps protect us from

686
00:24:32,230 --> 00:24:30,480
dangerous cosmic rays that come from

687
00:24:34,870 --> 00:24:32,240
outside of the gala

688
00:24:37,269 --> 00:24:34,880

outside of the heliosphere and

689
00:24:39,510 --> 00:24:37,279
those cosmic rays as they

690
00:24:40,950 --> 00:24:39,520
come near by are deflected so if you

691
00:24:43,750 --> 00:24:40,960
show the graph

692
00:24:45,350 --> 00:24:43,760
you can see on this picture the fraction

693
00:24:47,909 --> 00:24:45,360
of cosmic rays that are able to

694
00:24:49,909 --> 00:24:47,919
penetrate into the solar system it

695
00:24:53,110 --> 00:24:49,919
starts out at a very high percent and

696
00:24:54,630 --> 00:24:53,120
then as it moves through the heliosphere

697
00:24:56,630 --> 00:24:54,640
many of them are deflected and only a

698
00:24:57,990 --> 00:24:56,640
small percentage are able to make it

699
00:24:59,350 --> 00:24:58,000
into the inner

700
00:25:01,830 --> 00:24:59,360
solar system

701
00:25:04,070 --> 00:25:01,840
fortunately for us uh earth's magnetic

702
00:25:06,149 --> 00:25:04,080
field is usually able to protect life on

703
00:25:09,110 --> 00:25:06,159
earth uh from these dangerous cosmic

704
00:25:10,549 --> 00:25:09,120
rays however uh astronauts on deep space

705
00:25:13,190 --> 00:25:10,559
missions aren't able to bring the

706
00:25:16,630 --> 00:25:13,200
earth's protection with them

707
00:25:20,630 --> 00:25:16,640
so having the ibex data and

708
00:25:23,190 --> 00:25:20,640
being able to understand this protection

709
00:25:25,350 --> 00:25:23,200
around us is really going to be critical

710
00:25:26,390 --> 00:25:25,360
now this is a snapshot as as we are

711
00:25:28,470 --> 00:25:26,400
today

712
00:25:31,750 --> 00:25:28,480
and nasa has actually been observing

713
00:25:34,310 --> 00:25:31,760

higher and higher levels of cosmic rays

714
00:25:35,669 --> 00:25:34,320
but in the distant past and in the far

715
00:25:37,909 --> 00:25:35,679
future

716
00:25:39,269 --> 00:25:37,919
since the heliosphere may change in size

717
00:25:41,830 --> 00:25:39,279
and shape

718
00:25:44,950 --> 00:25:41,840
the heliosphere might one day or maybe

719
00:25:46,710 --> 00:25:44,960
in the past has shrunk down so small

720
00:25:49,110 --> 00:25:46,720
that it's inside of the earth's orbit

721
00:25:51,990 --> 00:25:49,120
exposing the earth to many more cosmic

722
00:25:57,510 --> 00:25:54,630
having all these new data and being able

723
00:25:59,190 --> 00:25:57,520
to come up with new ideas about how the

724
00:26:01,350 --> 00:25:59,200
heliosphere works

725
00:26:04,310 --> 00:26:01,360
is is really exciting and helping us

726
00:26:06,549 --> 00:26:04,320
understand our home in the galaxy

727
00:26:09,190 --> 00:26:06,559
with that uh don is now going to tell us

728
00:26:10,149 --> 00:26:09,200
about some other observations

729
00:26:12,710 --> 00:26:10,159
that

730
00:26:14,070 --> 00:26:12,720
complement the ibex observations thanks

731
00:26:15,110 --> 00:26:14,080
lindsey

732
00:26:16,310 --> 00:26:15,120
well

733
00:26:20,070 --> 00:26:16,320
while

734
00:26:21,350 --> 00:26:20,080
ibex was being built and

735
00:26:23,190 --> 00:26:21,360
put together

736
00:26:25,029 --> 00:26:23,200
there was another mission already in

737
00:26:29,190 --> 00:26:25,039
flight the cassini mission which was

738
00:26:31,510 --> 00:26:29,200

orbiting saturn it was launched in 1997

739
00:26:33,510 --> 00:26:31,520
cassini has on board an

740
00:26:34,950 --> 00:26:33,520
energetic neutral atom imager which was

741
00:26:35,909 --> 00:26:34,960
designed to

742
00:26:39,029 --> 00:26:35,919
to

743
00:26:39,750 --> 00:26:39,039
of saturn

744
00:26:42,149 --> 00:26:39,760
but

745
00:26:44,310 --> 00:26:42,159
it's not particular it'll image any ena

746
00:26:47,510 --> 00:26:44,320
that happened to come its way

747
00:26:51,190 --> 00:26:47,520
if you the graphic we have here shows

748
00:26:53,110 --> 00:26:51,200
saturn and cassini's relationship to the

749
00:26:55,029 --> 00:26:53,120
heliosphere

750
00:26:57,669 --> 00:26:55,039
the earth is at one astronomical unit

751
00:26:59,190 --> 00:26:57,679
from the sun saturn's at 10 astronomical

752
00:27:01,909 --> 00:26:59,200
units

753
00:27:03,830 --> 00:27:01,919
it's it's a long ways from the sun but

754
00:27:05,830 --> 00:27:03,840
it's not very far from the center of the

755
00:27:08,789 --> 00:27:05,840
heliosphere on heliospheric

756
00:27:11,350 --> 00:27:08,799
distances so the perspective from saturn

757
00:27:12,870 --> 00:27:11,360
from cassini is very similar to to that

758
00:27:15,029 --> 00:27:12,880
that ibex has

759
00:27:16,070 --> 00:27:15,039
the operations of that spacecraft were

760
00:27:17,430 --> 00:27:16,080
different

761
00:27:18,630 --> 00:27:17,440
its

762
00:27:20,470 --> 00:27:18,640
main

763
00:27:22,310 --> 00:27:20,480

object of interest is saturn in the

764
00:27:24,549 --> 00:27:22,320
saturn system so it was doing a lot of

765
00:27:26,470 --> 00:27:24,559
pointing at saturn not a very good place

766
00:27:29,430 --> 00:27:26,480
to look if you're trying to image enas

767
00:27:31,269 --> 00:27:29,440
from the heliosphere but uh over the

768
00:27:33,750 --> 00:27:31,279
course of the years that we've been

769
00:27:35,350 --> 00:27:33,760
there this spacecraft's been that in or

770
00:27:37,590 --> 00:27:35,360
orbit saturn since

771
00:27:39,110 --> 00:27:37,600
mid 2004 and we actually began this

772
00:27:42,070 --> 00:27:39,120
process a little before that in late

773
00:27:45,269 --> 00:27:42,080
2003 until the present we've been able

774
00:27:48,549 --> 00:27:45,279
to get enough snapshots of the sky from

775
00:27:50,950 --> 00:27:48,559
looking away to get the next graphic

776
00:27:53,669 --> 00:27:50,960
which is an image which is built up over

777
00:27:56,070 --> 00:27:53,679
those years using the iron the neutral

778
00:27:58,389 --> 00:27:56,080
camera on the cassini spacecraft now

779
00:28:00,470 --> 00:27:58,399
this is in the same general format as

780
00:28:03,590 --> 00:28:00,480
the ibex data was shown to you before a

781
00:28:06,230 --> 00:28:03,600
little different color bar you can see

782
00:28:07,669 --> 00:28:06,240
that central bar of of emission coming

783
00:28:10,470 --> 00:28:07,679
down through

784
00:28:11,350 --> 00:28:10,480
the the nose of the heliosphere in this

785
00:28:13,510 --> 00:28:11,360
image

786
00:28:15,909 --> 00:28:13,520
it's uh it's a little different from the

787
00:28:18,630 --> 00:28:15,919
ibex but actually very similar to the

788
00:28:21,269 --> 00:28:18,640

highest energy channels on ibex the

789
00:28:23,110 --> 00:28:21,279
incus sensor starts off at about eight

790
00:28:25,350 --> 00:28:23,120
kilovolts which is about a factor of two

791
00:28:27,830 --> 00:28:25,360
higher in energy than the lowest than

792
00:28:30,230 --> 00:28:27,840
the highest energy channel on ibex so

793
00:28:31,909 --> 00:28:30,240
this is very complementary to ibex and

794
00:28:33,510 --> 00:28:31,919
the fact that we see a structure that's

795
00:28:36,710 --> 00:28:33,520
extremely similar to what the high

796
00:28:38,710 --> 00:28:36,720
energy channels on ibex show is a very

797
00:28:41,029 --> 00:28:38,720
good confirmation of those results right

798
00:28:42,149 --> 00:28:41,039
off the bat now

799
00:28:44,149 --> 00:28:42,159
you can see

800
00:28:45,430 --> 00:28:44,159
if you squint that there's a voyager 1

801
00:28:47,430 --> 00:28:45,440
in voyager 2 they're in the same

802
00:28:49,750 --> 00:28:47,440
position in this in this diagram as they

803
00:28:52,789 --> 00:28:49,760
were shown earlier and

804
00:28:54,950 --> 00:28:52,799
those those two are actually uh

805
00:28:56,149 --> 00:28:54,960
seeing on the fringes of this broader

806
00:28:58,149 --> 00:28:56,159
feature that you see at the high

807
00:29:00,470 --> 00:28:58,159
energies but the other interesting

808
00:29:02,549 --> 00:29:00,480
feature of this diagram are the two blue

809
00:29:04,149 --> 00:29:02,559
areas those are voids where there's very

810
00:29:05,830 --> 00:29:04,159
little emission

811
00:29:08,230 --> 00:29:05,840
and this is where we think that the

812
00:29:10,070 --> 00:29:08,240
local interstellar magnetic field points

813
00:29:11,350 --> 00:29:10,080

is very similar to what dave was talking

814
00:29:13,750 --> 00:29:11,360
about earlier

815
00:29:16,789 --> 00:29:13,760
if we look at the next graphic

816
00:29:18,870 --> 00:29:16,799
this is the same data but now displayed

817
00:29:20,789 --> 00:29:18,880
in galactic coordinates

818
00:29:22,230 --> 00:29:20,799
and in galactic

819
00:29:25,430 --> 00:29:22,240
if if we were to

820
00:29:27,110 --> 00:29:25,440
show the the galaxy that

821
00:29:28,870 --> 00:29:27,120
lindsey showed and that eric showed

822
00:29:30,630 --> 00:29:28,880
earlier in this coordinate system it

823
00:29:33,669 --> 00:29:30,640
would just be a horizontal line you'd be

824
00:29:36,549 --> 00:29:33,679
looking at it edge on but so our data is

825
00:29:38,549 --> 00:29:36,559
broader than that feature and it's also

826
00:29:40,470 --> 00:29:38,559
at a bit of an angle it's not exactly

827
00:29:43,029 --> 00:29:40,480
aligned with the galaxy but neither is

828
00:29:44,070 --> 00:29:43,039
the local interstellar magnetic field

829
00:29:45,909 --> 00:29:44,080
exactly

830
00:29:47,669 --> 00:29:45,919
lined with the poles of of the galactic

831
00:29:49,909 --> 00:29:47,679
plane so

832
00:29:51,510 --> 00:29:49,919
so this is again consistent with that

833
00:29:53,350 --> 00:29:51,520
what it also shows is that we have a

834
00:29:55,750 --> 00:29:53,360
fairly continuous belt of emission of

835
00:29:57,750 --> 00:29:55,760
these energies that goes all the way

836
00:29:59,269 --> 00:29:57,760
around the globe

837
00:30:02,149 --> 00:29:59,279
and if i can go then back to the

838
00:30:03,190 --> 00:30:02,159

previous graphic i wanted to also point

839
00:30:05,830 --> 00:30:03,200
out that

840
00:30:07,990 --> 00:30:05,840
the voyagers are there they're in these

841
00:30:10,710 --> 00:30:08,000
energies the emission is broad enough to

842
00:30:12,389 --> 00:30:10,720
include the voyagers so it's entirely

843
00:30:15,830 --> 00:30:12,399
relevant to

844
00:30:18,870 --> 00:30:15,840
uh consider this to be a global map of

845
00:30:21,510 --> 00:30:18,880
what voyages see we have with the inca

846
00:30:23,430 --> 00:30:21,520
sensor energies that go up to the

847
00:30:26,549 --> 00:30:23,440
energies that the voyager sensors

848
00:30:28,789 --> 00:30:26,559
measure in situ so we are

849
00:30:29,990 --> 00:30:28,799
we essentially bridge the energy gap

850
00:30:32,230 --> 00:30:30,000
between

851
00:30:34,789 --> 00:30:32,240
where ibex leaves off and where voyager

852
00:30:36,549 --> 00:30:34,799
picks up measuring the particles

853
00:30:39,110 --> 00:30:36,559
the energetic particles that are

854
00:30:41,510 --> 00:30:39,120
producing pressure out in this medium

855
00:30:42,630 --> 00:30:41,520
and the combined information from all

856
00:30:43,590 --> 00:30:42,640
three

857
00:30:45,990 --> 00:30:43,600
missions

858
00:30:48,230 --> 00:30:46,000
allows us to get a pressure

859
00:30:50,710 --> 00:30:48,240
uh of those particles out there and

860
00:30:52,789 --> 00:30:50,720
therefore understand better the

861
00:30:54,630 --> 00:30:52,799
relationship of the of the magnetic

862
00:30:57,669 --> 00:30:54,640
field containment of the interstellar

863
00:30:59,909 --> 00:30:57,679

magnetic field uh to the the particle

864
00:31:02,389 --> 00:30:59,919
pressure that that's outside the

865
00:31:04,470 --> 00:31:02,399
termination shock of the heliosphere so

866
00:31:06,470 --> 00:31:04,480
dave i'd like to turn it back to you

867
00:31:08,630 --> 00:31:06,480
thanks don these are all really exciting

868
00:31:10,310 --> 00:31:08,640
results i just wanted to bring you back

869
00:31:11,669 --> 00:31:10,320
to the main discoveries

870
00:31:13,590 --> 00:31:11,679
so

871
00:31:15,750 --> 00:31:13,600
what we've observed with ibex is this

872
00:31:18,070 --> 00:31:15,760
really narrow ribbon

873
00:31:20,389 --> 00:31:18,080
of strong emission lots of particles

874
00:31:21,750 --> 00:31:20,399
lots of neutral atoms coming in from the

875
00:31:23,990 --> 00:31:21,760
interaction at the edge of our

876
00:31:25,750 --> 00:31:24,000
heliosphere the edge of our solar system

877
00:31:27,909 --> 00:31:25,760
this ribbon winds between the two

878
00:31:29,269 --> 00:31:27,919
voyager spacecraft and wasn't observed

879
00:31:31,269 --> 00:31:29,279
by either of them they were both out

880
00:31:33,590 --> 00:31:31,279
there making these local observations

881
00:31:35,350 --> 00:31:33,600
and had no idea that the main storm in

882
00:31:37,110 --> 00:31:35,360
some sense was running right down

883
00:31:39,110 --> 00:31:37,120
between them

884
00:31:40,950 --> 00:31:39,120
the ribbon is very narrow has a lot of

885
00:31:43,110 --> 00:31:40,960
fine structure in it meaning that

886
00:31:44,950 --> 00:31:43,120
somehow the particles are confined in

887
00:31:47,029 --> 00:31:44,960
very very localized regions we have no

888
00:31:49,430 --> 00:31:47,039

idea how that can happen

889
00:31:51,430 --> 00:31:49,440
it's aligned by and dominated by the

890
00:31:53,110 --> 00:31:51,440
external magnetic field as rosin talked

891
00:31:55,269 --> 00:31:53,120
about at some length

892
00:31:57,029 --> 00:31:55,279
that's a huge that's a huge clue as to

893
00:31:58,710 --> 00:31:57,039
what's going on but even when we put

894
00:32:00,630 --> 00:31:58,720
that magnetic field into our models and

895
00:32:02,070 --> 00:32:00,640
our theories it doesn't produce this

896
00:32:04,310 --> 00:32:02,080
bright ena

897
00:32:06,070 --> 00:32:04,320
ribbon so still we're missing some

898
00:32:07,990 --> 00:32:06,080
really fundamental aspect of the

899
00:32:09,269 --> 00:32:08,000
interaction some fundamental physics

900
00:32:10,630 --> 00:32:09,279
that's missing from from our

901
00:32:13,110 --> 00:32:10,640
understanding

902
00:32:14,549 --> 00:32:13,120
so what's next we're obviously working

903
00:32:16,389 --> 00:32:14,559
on that the theorists and modelers are

904
00:32:17,990 --> 00:32:16,399
going like crazy trying to make this

905
00:32:19,830 --> 00:32:18,000
connection and figuring out figure out

906
00:32:21,990 --> 00:32:19,840
what got left out and and how it's

907
00:32:23,669 --> 00:32:22,000
really working at the same time ibex

908
00:32:25,350 --> 00:32:23,679
continues to spin away and keep

909
00:32:27,110 --> 00:32:25,360
repointing around the sun like we talked

910
00:32:28,789 --> 00:32:27,120
about we're already part way through the

911
00:32:29,990 --> 00:32:28,799
second sky map and while the ribbon is

912
00:32:31,430 --> 00:32:30,000
still there

913
00:32:32,870 --> 00:32:31,440

there's some suggestion that it's

914
00:32:34,549 --> 00:32:32,880
actually slightly different and and

915
00:32:36,470 --> 00:32:34,559
maybe evolving over the six months

916
00:32:38,230 --> 00:32:36,480
between the image that we've published

917
00:32:39,750 --> 00:32:38,240
now and and the next images so it's

918
00:32:42,230 --> 00:32:39,760
really going to be fascinating to watch

919
00:32:44,549 --> 00:32:42,240
this feature potentially change over

920
00:32:46,310 --> 00:32:44,559
over over the years and and maybe over

921
00:32:48,549 --> 00:32:46,320
the solar cycle

922
00:32:50,950 --> 00:32:48,559
and so with that dwayne okay thank you

923
00:32:53,430 --> 00:32:50,960
all um and again um

924
00:32:55,590 --> 00:32:53,440
we will open it up for questions and my

925
00:32:57,909 --> 00:32:55,600
apologies to the tv audience and our

926
00:32:59,909 --> 00:32:57,919
presenters for the construction noise uh

927
00:33:01,509 --> 00:32:59,919
when you have live tv sometimes things

928
00:33:02,950 --> 00:33:01,519
happen but perhaps we can send that

929
00:33:04,070 --> 00:33:02,960
drill out to the heliosphere i don't

930
00:33:04,950 --> 00:33:04,080
know so

931
00:33:06,789 --> 00:33:04,960
um

932
00:33:07,830 --> 00:33:06,799
let's see well i have some uh some

933
00:33:10,950 --> 00:33:07,840
questions that have come in on my

934
00:33:13,029 --> 00:33:10,960
monitor here and uh the three from one

935
00:33:15,110 --> 00:33:13,039
of the several space.coms out there in

936
00:33:17,590 --> 00:33:15,120
tv land so dave i think this one's for

937
00:33:19,590 --> 00:33:17,600
you and maybe to the team members what's

938
00:33:21,029 --> 00:33:19,600

the next step with this data for for the

939
00:33:22,470 --> 00:33:21,039
science team

940
00:33:24,389 --> 00:33:22,480
so the next step with this data that

941
00:33:26,389 --> 00:33:24,399
we've published today in science and in

942
00:33:28,310 --> 00:33:26,399
this coordinated set of papers is to

943
00:33:30,630 --> 00:33:28,320
really go through all of the detailed

944
00:33:32,630 --> 00:33:30,640
observations and rack them up against

945
00:33:33,990 --> 00:33:32,640
the different theories and models to try

946
00:33:35,669 --> 00:33:34,000
to really come to an understanding of

947
00:33:38,149 --> 00:33:35,679
which of these theories and models you

948
00:33:39,990 --> 00:33:38,159
know are a good starting point for the

949
00:33:42,470 --> 00:33:40,000
understanding that we have and which

950
00:33:45,110 --> 00:33:42,480
which need more modification and really

951
00:33:47,269 --> 00:33:45,120
to go try to find what piece what thing

952
00:33:48,950 --> 00:33:47,279
it is that we've all just kind of been i

953
00:33:50,630 --> 00:33:48,960
bet it'll be obvious in retrospect just

954
00:33:52,710 --> 00:33:50,640
so often these things are but that we've

955
00:33:54,710 --> 00:33:52,720
been leaving out of of of this sort of

956
00:33:56,789 --> 00:33:54,720
interaction so that's that's really the

957
00:33:58,070 --> 00:33:56,799
next uh the next main effort i think for

958
00:34:00,230 --> 00:33:58,080
the team

959
00:34:03,909 --> 00:34:00,240
and i believe this question comes in uh

960
00:34:13,190 --> 00:34:05,509
the

961
00:34:14,790 --> 00:34:13,200
portfolio that's a good question let me

962
00:34:17,109 --> 00:34:14,800
start out by saying that

963
00:34:17,909 --> 00:34:17,119

in the heliophysics portfolio we try to

964
00:34:20,470 --> 00:34:17,919
have

965
00:34:22,710 --> 00:34:20,480
a mix of missions and these range from

966
00:34:23,589 --> 00:34:22,720
things like sounding rockets which are

967
00:34:28,790 --> 00:34:23,599
are

968
00:34:30,069 --> 00:34:28,800
up to uh major uh missions and perhaps

969
00:34:32,550 --> 00:34:30,079
even someday

970
00:34:34,310 --> 00:34:32,560
uh a flagship type mission that will

971
00:34:36,389 --> 00:34:34,320
explore the inner part of the

972
00:34:37,349 --> 00:34:36,399
heliosphere around the sun

973
00:34:40,389 --> 00:34:37,359
and

974
00:34:43,190 --> 00:34:40,399
ibex is from a class of missions called

975
00:34:45,510 --> 00:34:43,200
smacks small explorers

976
00:34:47,829 --> 00:34:45,520
there was a cap emission cap

977
00:34:48,869 --> 00:34:47,839
set on this one i i'm gonna look at dave

978
00:34:51,109 --> 00:34:48,879
and i'm gonna i'm gonna say there's

979
00:34:52,790 --> 00:34:51,119
around 90 million dollars am i

980
00:34:55,349 --> 00:34:52,800
about right at that and the cost of our

981
00:34:57,270 --> 00:34:55,359
launchers are rounding around 40 million

982
00:34:59,349 --> 00:34:57,280
dollars so the total cost is in the

983
00:35:00,790 --> 00:34:59,359
neighborhood of 130 million dollars this

984
00:35:03,109 --> 00:35:00,800
is a this is a

985
00:35:05,349 --> 00:35:03,119
a small space space flight mission for

986
00:35:07,670 --> 00:35:06,470
okay

987
00:35:10,069 --> 00:35:07,680
a question here from one of the

988
00:35:11,670 --> 00:35:10,079

network.coms and i believe this is

989
00:35:13,670 --> 00:35:11,680
going to give everyone an opportunity

990
00:35:14,870 --> 00:35:13,680
they want to know what is your

991
00:35:17,109 --> 00:35:14,880
personal

992
00:35:19,750 --> 00:35:17,119
feelings reaction when you

993
00:35:21,910 --> 00:35:19,760
saw this data

994
00:35:24,310 --> 00:35:21,920
and the possibility so eric you want a

995
00:35:25,190 --> 00:35:24,320
personal reaction and

996
00:35:27,030 --> 00:35:25,200
well

997
00:35:29,030 --> 00:35:27,040
as a scientist having worked on voyager

998
00:35:33,349 --> 00:35:29,040
for many years i mean my first reaction

999
00:35:36,630 --> 00:35:34,390
we

1000
00:35:39,510 --> 00:35:36,640
the most interesting part of this

1001
00:35:40,630 --> 00:35:39,520
interaction region the voyagers miss

1002
00:35:43,990 --> 00:35:40,640
and

1003
00:35:46,470 --> 00:35:44,000
that was surprising exciting we've got a

1004
00:35:48,550 --> 00:35:46,480
lot to learn

1005
00:35:50,790 --> 00:35:48,560
should i go next yeah

1006
00:35:53,030 --> 00:35:50,800
so um

1007
00:35:55,349 --> 00:35:53,040
i guess my first reaction was

1008
00:35:56,870 --> 00:35:55,359
terror

1009
00:35:58,710 --> 00:35:56,880
because we

1010
00:35:59,990 --> 00:35:58,720
as we started to get these swaths back

1011
00:36:02,390 --> 00:36:00,000
and you know it's sort of like it's sort

1012
00:36:04,310 --> 00:36:02,400
of like you get mail once a week and in

1013
00:36:06,230 --> 00:36:04,320

the mail you get the next swath and you

1014
00:36:08,710 --> 00:36:06,240
look and you go no

1015
00:36:10,550 --> 00:36:08,720
that that cannot be right there's some

1016
00:36:12,390 --> 00:36:10,560
background there's some noise we haven't

1017
00:36:13,910 --> 00:36:12,400
done something right something's wrong

1018
00:36:15,270 --> 00:36:13,920
you know what's wrong how do we fix it

1019
00:36:16,950 --> 00:36:15,280
so that we can actually do the mission

1020
00:36:19,190 --> 00:36:16,960
that we're supposed to be doing and it

1021
00:36:22,310 --> 00:36:19,200
was actually over many many weeks and in

1022
00:36:24,150 --> 00:36:22,320
fact months as these new swaths came in

1023
00:36:26,470 --> 00:36:24,160
and as they started not to all be at the

1024
00:36:29,030 --> 00:36:26,480
same spin phase for the spacecraft but

1025
00:36:30,790 --> 00:36:29,040
wind up along at different at different

1026
00:36:32,230 --> 00:36:30,800
angles and have different fine structure

1027
00:36:33,990 --> 00:36:32,240
and all that it was actually quite a

1028
00:36:36,069 --> 00:36:34,000
long time before we convinced ourselves

1029
00:36:37,430 --> 00:36:36,079
that we were right

1030
00:36:38,470 --> 00:36:37,440
and that all of what we thought before

1031
00:36:40,230 --> 00:36:38,480
was wrong

1032
00:36:42,150 --> 00:36:40,240
but but there was a long time there

1033
00:36:43,910 --> 00:36:42,160
where that was that was not where we

1034
00:36:44,950 --> 00:36:43,920
started and it was kind of a scary time

1035
00:36:45,990 --> 00:36:44,960
for me

1036
00:36:48,150 --> 00:36:46,000
rosie

1037
00:36:49,829 --> 00:36:48,160
well very shortly my first reaction was

1038
00:36:51,910 --> 00:36:49,839

wrong

1039
00:36:55,990 --> 00:36:51,920
because i thought that the we were

1040
00:36:57,829 --> 00:36:56,000
seeing uh something i worked on which is

1041
00:37:00,230 --> 00:36:57,839
we know that the sun will

1042
00:37:03,270 --> 00:37:00,240
leave our small cloud and there is a

1043
00:37:05,829 --> 00:37:03,280
next cloud it will enter very well soon

1044
00:37:08,870 --> 00:37:05,839
it should enter one day and we don't

1045
00:37:11,190 --> 00:37:08,880
know if the two clouds are touching each

1046
00:37:13,349 --> 00:37:11,200
other if if they do because one is

1047
00:37:15,109 --> 00:37:13,359
faster than the than our cloud there

1048
00:37:17,030 --> 00:37:15,119
must be an interstellar shock so when i

1049
00:37:18,310 --> 00:37:17,040
saw that uh maybe we see

1050
00:37:20,310 --> 00:37:18,320
some uh

1051
00:37:22,870 --> 00:37:20,320
feature apparently to this interstellar

1052
00:37:26,630 --> 00:37:22,880
shock but that was for five minutes only

1053
00:37:27,670 --> 00:37:26,640
then i realized it has nothing to do

1054
00:37:30,230 --> 00:37:27,680
okay

1055
00:37:32,630 --> 00:37:30,240
i certainly looked at it and because it

1056
00:37:35,109 --> 00:37:32,640
looked nothing like any of the

1057
00:37:37,349 --> 00:37:35,119
initial predicted maps

1058
00:37:39,510 --> 00:37:37,359
i said what is that and how am i going

1059
00:37:41,750 --> 00:37:39,520
to explain it to people because as the

1060
00:37:44,230 --> 00:37:41,760
education person on the team

1061
00:37:46,230 --> 00:37:44,240
i know that my job is going to be

1062
00:37:47,750 --> 00:37:46,240
explaining this ribbon and i of course

1063
00:37:50,950 --> 00:37:47,760

have to wait for people to figure out

1064
00:37:54,069 --> 00:37:50,960
what it is but then um to to come up

1065
00:37:56,630 --> 00:37:54,079
with some easy ways to explain it uh to

1066
00:37:58,630 --> 00:37:56,640
show it in our planetarium show uh to

1067
00:38:01,430 --> 00:37:58,640
make a model of it that people can touch

1068
00:38:04,790 --> 00:38:01,440
and feel and experiment with so

1069
00:38:07,030 --> 00:38:04,800
my questions are still going

1070
00:38:09,510 --> 00:38:07,040
well i think my reaction was somewhat

1071
00:38:11,990 --> 00:38:09,520
similar to dave's in that i didn't see

1072
00:38:13,430 --> 00:38:12,000
it coming in day by day but but i was

1073
00:38:15,109 --> 00:38:13,440
doing this independent measurement with

1074
00:38:16,950 --> 00:38:15,119
the cassini

1075
00:38:18,790 --> 00:38:16,960
spacecraft and and trying to put

1076
00:38:21,510 --> 00:38:18,800
together this sky map and

1077
00:38:23,589 --> 00:38:21,520
uh it was quite a job

1078
00:38:25,190 --> 00:38:23,599
it's a different kind of a mission we're

1079
00:38:26,790 --> 00:38:25,200
pointing all over the place we have to

1080
00:38:28,790 --> 00:38:26,800
motion compensate everything on the

1081
00:38:30,550 --> 00:38:28,800
spacecraft we've got to get the right

1082
00:38:32,390 --> 00:38:30,560
frame it was it was quite a lot of

1083
00:38:35,109 --> 00:38:32,400
software to develop and so every time

1084
00:38:37,910 --> 00:38:35,119
i'd see a new map i'd say that can't be

1085
00:38:39,349 --> 00:38:37,920
right and a lot of times it wasn't but

1086
00:38:41,109 --> 00:38:39,359
toward the end we started getting very

1087
00:38:42,950 --> 00:38:41,119
consistent results and then we started

1088
00:38:45,190 --> 00:38:42,960

comparing them with with ibex and we're

1089
00:38:47,190 --> 00:38:45,200
getting very consistent results with

1090
00:38:48,870 --> 00:38:47,200
ibex that's when my confidence grew in

1091
00:38:51,270 --> 00:38:48,880
what we were doing and it's it's really

1092
00:38:52,230 --> 00:38:51,280
turned out to be a treasure so

1093
00:38:53,589 --> 00:38:52,240
uh

1094
00:38:55,589 --> 00:38:53,599
very happy with it

1095
00:38:57,430 --> 00:38:55,599
well uh lindsay from there when i can

1096
00:38:59,829 --> 00:38:57,440
hear my earpiece you guys are doing a

1097
00:39:01,670 --> 00:38:59,839
really good job explaining it so

1098
00:39:03,589 --> 00:39:01,680
i believe we're going to go uh take a

1099
00:39:05,109 --> 00:39:03,599
question on the phone from irene from

1100
00:39:08,550 --> 00:39:05,119
discover

1101
00:39:12,710 --> 00:39:10,950
hi thanks very much um i just had a

1102
00:39:14,710 --> 00:39:12,720
question for lindsay i was struck by

1103
00:39:17,510 --> 00:39:14,720
your comment about the

1104
00:39:19,589 --> 00:39:17,520
possible changes in the heliosphere and

1105
00:39:22,069 --> 00:39:19,599
i was just wondering if you or some of

1106
00:39:23,670 --> 00:39:22,079
your colleagues there might elaborate on

1107
00:39:25,910 --> 00:39:23,680
what sort of

1108
00:39:28,550 --> 00:39:25,920
what would have to happen to the sun to

1109
00:39:30,710 --> 00:39:28,560
have the heliosphere smaller within the

1110
00:39:32,950 --> 00:39:30,720
orbit of um or even

1111
00:39:36,230 --> 00:39:32,960
shorter shorter

1112
00:39:38,310 --> 00:39:36,240
shorter ex length than the earth's orbit

1113
00:39:40,230 --> 00:39:38,320

thanks

1114
00:39:41,510 --> 00:39:40,240
okay well i'll start

1115
00:39:43,430 --> 00:39:41,520
what would really have to happen as

1116
00:39:45,990 --> 00:39:43,440
rosine was mentioning is that we would

1117
00:39:49,030 --> 00:39:46,000
have to uh clear out of our our current

1118
00:39:50,150 --> 00:39:49,040
environment and pass into an area of gas

1119
00:39:52,470 --> 00:39:50,160
and dust

1120
00:39:54,950 --> 00:39:52,480
that is much much denser than the part

1121
00:39:57,990 --> 00:39:54,960
we're currently in and that would cause

1122
00:39:59,829 --> 00:39:58,000
the heliosphere to shrink in um and

1123
00:40:01,990 --> 00:39:59,839
after that i don't know dave if you have

1124
00:40:03,910 --> 00:40:02,000
yes i'd like to comment too i mean the

1125
00:40:06,630 --> 00:40:03,920
size and shape of this heliosphere is

1126
00:40:08,790 --> 00:40:06,640
driven by two things it's inflated from

1127
00:40:11,349 --> 00:40:08,800
the inside by the solar wind

1128
00:40:13,349 --> 00:40:11,359
and it's squeezed from the outside by

1129
00:40:15,030 --> 00:40:13,359
the magnetic field and by and by the

1130
00:40:17,030 --> 00:40:15,040
motion through through the local

1131
00:40:18,870 --> 00:40:17,040
environment and so it's sort of a

1132
00:40:20,710 --> 00:40:18,880
balance between those two

1133
00:40:22,069 --> 00:40:20,720
and so while the sun could change and

1134
00:40:23,910 --> 00:40:22,079
put out much much less solar wind

1135
00:40:25,190 --> 00:40:23,920
theoretically possible the most likely

1136
00:40:27,109 --> 00:40:25,200
thing and i think it's happened probably

1137
00:40:29,030 --> 00:40:27,119
many times over the history of our solar

1138
00:40:30,550 --> 00:40:29,040

system as we've gone around the galaxy

1139
00:40:32,710 --> 00:40:30,560
up and down and passed through the dense

1140
00:40:33,910 --> 00:40:32,720
regions reasons with stronger fields and

1141
00:40:35,829 --> 00:40:33,920
that sort of thing is that this

1142
00:40:37,750 --> 00:40:35,839
heliosphere has shrunk and grown and

1143
00:40:39,030 --> 00:40:37,760
change shape and really change the

1144
00:40:41,190 --> 00:40:39,040
amount of shielding that we get from the

1145
00:40:42,870 --> 00:40:41,200
galactic cosmic rays uh out in the

1146
00:40:44,309 --> 00:40:42,880
galaxy

1147
00:40:46,309 --> 00:40:44,319
anybody else want to comment on that

1148
00:40:49,349 --> 00:40:46,319
well just sort of one interesting thing

1149
00:40:50,630 --> 00:40:49,359
when when the voyagers launched in 1977

1150
00:40:52,550 --> 00:40:50,640
they actually thought that the

1151
00:40:54,950 --> 00:40:52,560
heliosphere wasn't much bigger

1152
00:40:56,950 --> 00:40:54,960
than the orbit of jupiter was very much

1153
00:40:59,109 --> 00:40:56,960
smaller and and the joke in the

1154
00:41:01,270 --> 00:40:59,119
community was that the estimates of the

1155
00:41:02,790 --> 00:41:01,280
size were getting bigger and almost

1156
00:41:04,710 --> 00:41:02,800
exactly the rate the voyagers were

1157
00:41:06,069 --> 00:41:04,720
moving away from the sun because we kept

1158
00:41:09,670 --> 00:41:06,079
on not getting it but we were going to

1159
00:41:12,470 --> 00:41:09,680
get there real soon now so

1160
00:41:14,630 --> 00:41:12,480
it's only when the voyager 1 actually

1161
00:41:17,750 --> 00:41:14,640
crossed the termination track the first

1162
00:41:19,670 --> 00:41:17,760
boundary that in 2005 that we really

1163
00:41:23,270 --> 00:41:19,680

knew that

1164
00:41:27,109 --> 00:41:25,270
okay i think that's going to do it you

1165
00:41:29,190 --> 00:41:27,119
guys definitely did a great job

1166
00:41:31,750 --> 00:41:29,200
explaining it um

1167
00:41:34,230 --> 00:41:31,760
for further information as always go to

1168
00:41:36,390 --> 00:41:34,240
www.nasa.gov

1169
00:41:39,030 --> 00:41:36,400
my congratulations to the team

1170
00:41:40,470 --> 00:41:39,040
and of course as i said with all of the

1171
00:41:42,710 --> 00:41:40,480
science

1172
00:41:45,349 --> 00:41:42,720
mission divisions and it especially