



NASA HD

1
00:00:02,110 --> 00:00:06,040
you're about to hear discussion our
first in the history of exploration

2
00:00:06,040 --> 00:00:10,890
the most distant human-made object
nasa's Voyager 1 spacecraft

3
00:00:10,890 --> 00:00:15,349
is an interstellar space the space
between the stars

4
00:00:15,349 --> 00:00:18,369
this conclusion is possible

5
00:00:18,369 --> 00:00:22,720
because I've data from the spacecraft
plasma wave science instrument built and

6
00:00:22,720 --> 00:00:24,519
operated by the University of Iowa

7
00:00:24,519 --> 00:00:30,249
in a team led by Don Burnette the
36-year-old probe is now sailing

8
00:00:30,249 --> 00:00:34,280
the uncharted waters of a new cosmic see
and it has brought us along for the

9
00:00:34,280 --> 00:00:34,840
journey

10
00:00:34,840 --> 00:00:38,460
now let's talk about the details of this
historic announcement

11
00:00:38,460 --> 00:00:45,350
ladies and gentlemen as you just heard

12

00:00:45,350 --> 00:00:49,860

today is a historic moment for NASA the
Voyager team

13

00:00:49,860 --> 00:00:53,620

in effect humankind my name is Dwayne
brown

14

00:00:53,620 --> 00:00:56,840

but nasa's Office of Communications we
have a lot to cover

15

00:00:56,840 --> 00:01:01,550

when I get right into it but a reminder
that all the information you here today

16

00:01:01,550 --> 00:01:02,620

and much more

17

00:01:02,620 --> 00:01:05,719

is on our website at www

18

00:01:05,719 --> 00:01:10,729

[dot nasa dot gov slash voyager](http://dot.nasa.gov/slash/voyager) join the
conversation

19

00:01:10,729 --> 00:01:14,159

a lot will be talked about today

20

00:01:14,159 --> 00:01:18,859

Twitter Facebook and other social media
venues

21

00:01:18,859 --> 00:01:24,969

and joined the Q&A session send in your
question hash tag

22

00:01:24,969 --> 00:01:29,560

ask nasa before introduce our panel

23

00:01:29,560 --> 00:01:33,549

to give opening remarks you please
welcome

24

00:01:33,549 --> 00:01:37,200

and astrophysicists 5 time

25

00:01:37,200 --> 00:01:40,880

flown space shuttle astronaut and head

26

00:01:40,880 --> 00:01:44,420

or associate administrator for nasa's
science Mission Directorate

27

00:01:44,420 --> 00:01:47,719

ladies and gentlemen doctor John
Grunsfeld

28

00:01:47,719 --> 00:01:54,719

ok

29

00:01:56,799 --> 00:02:01,020

them space the final frontier

30

00:02:01,020 --> 00:02:04,320

these by the voyages of the Starship

31

00:02:04,320 --> 00:02:07,759

Voyager its 36-year mission

32

00:02:07,759 --> 00:02:13,000

to explore strange new worlds to seek
out anomalous cosmic rays

33

00:02:13,000 --> 00:02:17,400

and new plasmas to boldly go where no
probe

34

00:02:17,400 --> 00:02:22,400

has gone before those words from Star Trek of course have inspired

35

00:02:22,400 --> 00:02:27,069

so many of us and I think our you know characteristic up up the excitement and

36

00:02:27,069 --> 00:02:29,130

the discoveries were gonna talk about today

37

00:02:29,130 --> 00:02:33,450

Voyager like the ancient mariners is pushing out into new territory

38

00:02:33,450 --> 00:02:36,870

nasa science is all about exploring the earth

39

00:02:36,870 --> 00:02:40,590

the solar system the Galaxy and the universe itself

40

00:02:40,590 --> 00:02:44,870

someday humans will leave are cocooned in the solar system

41

00:02:44,870 --> 00:02:48,290

to explore beyond our home system four-hitter

42

00:02:48,290 --> 00:02:52,110

will it lead the way today's excited

43

00:02:52,110 --> 00:02:57,069

science science results reflect a dynamic and I suspect continuing

44
00:02:57,069 --> 00:03:00,790
debate about the nature of the heliosphere

45
00:03:00,790 --> 00:03:03,920
this story is this story of Science

46
00:03:03,920 --> 00:03:08,769
stories of exploration and a narrative
about over 40 years of hard work

47
00:03:08,769 --> 00:03:12,739
by one of our top teams of scientists and
engineers

48
00:03:12,739 --> 00:03:18,540
that's almost the entire history of the
space age

49
00:03:18,540 --> 00:03:23,050
I'd personally like to salute one member
of the team my former boss

50
00:03:23,050 --> 00:03:26,560
headstone of one of our country's greatest
scientists

51
00:03:26,560 --> 00:03:31,140
and my personal hero and to whom I say

52
00:03:31,140 --> 00:03:38,140
live long and prosper thank you sir

53
00:03:43,560 --> 00:03:48,090
okay now to a panel first up you were
here

54
00:03:48,090 --> 00:03:53,080
its tone of the Borg project scientists

55

00:03:53,080 --> 00:04:00,080

California Institute a technology

56

00:04:01,340 --> 00:04:05,630

duncan et 42 plasma wave investigation

57

00:04:05,630 --> 00:04:12,630

principal investigator University I work

58

00:04:14,079 --> 00:04:17,039

gary thank department of space sciences

59

00:04:17,039 --> 00:04:20,519

Center for space plasma error Aaron
omics

60

00:04:20,519 --> 00:04:24,330

research or cease bar at the University
of Alabama

61

00:04:24,330 --> 00:04:29,040

in Huntsville

62

00:04:29,040 --> 00:04:32,250

cancers and dot forge a project manager

63

00:04:32,250 --> 00:04:36,870

nasa's jet propulsion laboratory in
Pasadena Calif in with that

64

00:04:36,870 --> 00:04:42,320

upstart over you okay this is the
spacecraft

65

00:04:42,320 --> 00:04:46,630

the first interstellar space we made it
know is still add

66

00:04:46,630 --> 00:04:50,080
enough power to tickets sent back home

67
00:04:50,080 --> 00:04:53,700
what it was that we have now now
exploring in the

68
00:04:53,700 --> 00:04:57,440
this new regional space thirty-five
years

69
00:04:57,440 --> 00:05:00,810
9 a thirteen billion miles journey

70
00:05:00,810 --> 00:05:04,350
a it began in 1972 when the project
started

71
00:05:04,350 --> 00:05:07,900
July in 1972 are with launch in that

72
00:05:07,900 --> 00:05:11,419
to its two spacecraft in nineteen 77

73
00:05:11,419 --> 00:05:15,120
well for Jupiter Saturn Uranus and
Neptune

74
00:05:15,120 --> 00:05:18,950
that was 1989 and then in nineteen
ninety

75
00:05:18,950 --> 00:05:22,040
we began with now call the Voyager
interstellar mission

76
00:05:22,040 --> 00:05:26,910
are you might say well what is there to
discover beyond the plants

77

00:05:26,910 --> 00:05:32,000

are and that's what we were that was our
job was to discover what was beyond the

78

00:05:32,000 --> 00:05:33,100

planet's the Sun

79

00:05:33,100 --> 00:05:38,100

the win the the atmosphere the Sun
expand supersonic Lee million miles per

80

00:05:38,100 --> 00:05:40,020

hour creating a huge bubble

81

00:05:40,020 --> 00:05:44,190

around all the planets a that is called
the heliosphere

82

00:05:44,190 --> 00:05:47,900

and inside that bubble it's filled with
the

83

00:05:47,900 --> 00:05:51,340

are win from the Sun which a plasma
because I nice

84

00:05:51,340 --> 00:05:54,870

in that plasma carries out from the Sun
the sun's magnetic field

85

00:05:54,870 --> 00:05:58,229

and that bills this bubble outside the
bubble

86

00:05:58,229 --> 00:06:01,870

the plasma comes from the explosion has
from other

87

00:06:01,870 --> 00:06:06,080

giant stars millions of years ago and
that plasma

88

00:06:06,080 --> 00:06:10,500

carries with it the magnetic field of
the galaxy so that's what's inside

89

00:06:10,500 --> 00:06:14,080

in we are now outside the

90

00:06:14,080 --> 00:06:17,169

if I could have the first slide this is
a Hubble image

91

00:06:17,169 --> 00:06:21,310

one of these Astros fears around a
nearby store in the Orion Nebula

92

00:06:21,310 --> 00:06:25,110

I notice you can't see the they asked
the spirit self you see the star

93

00:06:25,110 --> 00:06:26,229

brightly shining

94

00:06:26,229 --> 00:06:29,990

with an orange Bioshock around it but
you can see the object

95

00:06:29,990 --> 00:06:33,150

which is a large invisible spear what
you see

96

00:06:33,150 --> 00:06:36,960

is a shock created as the interstellar
wind comes from the right side of that

97

00:06:36,960 --> 00:06:37,460

image

98

00:06:37,460 --> 00:06:41,070

and has diverted around the bubble that
you cannot see

99

00:06:41,070 --> 00:06:45,810

and it glows because it's been excited
by that that whole process

100

00:06:45,810 --> 00:06:48,960

we're inside a bubble like that and are
now

101

00:06:48,960 --> 00:06:53,640

out in that bright orangish yellowish
region out in front have our own

102

00:06:53,640 --> 00:06:57,460

bubble not now the

103

00:06:57,460 --> 00:07:01,520

if I could have the video please turns
out that voyagers been on sway for 35

104

00:07:01,520 --> 00:07:03,169

years thirty six years now

105

00:07:03,169 --> 00:07:06,580

it travels outward at a million miles
every day

106

00:07:06,580 --> 00:07:10,390

almost a million miles a day and it was
2004

107

00:07:10,390 --> 00:07:14,280

nine billion miles from the Sun before
it rat it big

108

00:07:14,280 --> 00:07:17,960

had any sense of being close to the edge
the heliosphere that's when it

109

00:07:17,960 --> 00:07:22,599

found that the solar wind itself had
slowed down from supersonic the subsonic

110

00:07:22,599 --> 00:07:23,460

speeds

111

00:07:23,460 --> 00:07:26,909

and in this picture you see the blue
area

112

00:07:26,909 --> 00:07:30,890

is the heliosphere the darker blue is
the supersonic part of the wind

113

00:07:30,890 --> 00:07:34,890

and Voyager 1 crossed into the layer
that's beyond that the dark

114

00:07:34,890 --> 00:07:39,260

the Bluebird somewhat darker blue area
and Duchess December 2004

115

00:07:39,260 --> 00:07:43,669

nine billion miles from the Sun it was
another \$4 billion miles

116

00:07:43,669 --> 00:07:46,710

before reach the edge the bubble and
that wasn't

117

00:07:46,710 --> 00:07:50,130

August 2012 that's when we saw that

118

00:07:50,130 --> 00:07:53,240

energetic particles inside the bubble
leak out

119

00:07:53,240 --> 00:07:56,690

and disappear and that's where we saw
for the first time the lowest energy

120

00:07:56,690 --> 00:07:59,650

galactic cosmic rays which are in the
space outside

121

00:07:59,650 --> 00:08:02,900

were suddenly could be seeing are and

122

00:08:02,900 --> 00:08:07,220

from that point of view it looked as
though we had crossed interstellar space

123

00:08:07,220 --> 00:08:11,360

but we did not in fact we're not able to
conclude that in my say

124

00:08:11,360 --> 00:08:16,020

why didn't we know in August last year
that in fact we crossed in interstellar

125

00:08:16,020 --> 00:08:16,640

space

126

00:08:16,640 --> 00:08:20,580

that's because the boundary really is
the boundary between these two plasmas

127

00:08:20,580 --> 00:08:22,320

the solar plasma the wind

128

00:08:22,320 --> 00:08:25,810

and the interstellar plasma and
unfortunately our plasma

129

00:08:25,810 --> 00:08:29,960

instrument does not work on Voyager 1 so
we could not directly measure

130

00:08:29,960 --> 00:08:33,360

these two plasmas so we try to use the
proxy

131

00:08:33,360 --> 00:08:37,039

in that proxy is the magnetic field
carried by the two plasmas

132

00:08:37,039 --> 00:08:41,000

the field carried by the Sun is directed
like this

133

00:08:41,000 --> 00:08:44,520

the field carried we thought carried by
the interstellar

134

00:08:44,520 --> 00:08:48,600

so we and was like this so we thought
when we cross the boundary we would see

135

00:08:48,600 --> 00:08:50,459

the field rotate

136

00:08:50,459 --> 00:08:54,209

well we cross the boundary and that's
what happen

137

00:08:54,209 --> 00:08:57,579

no change in direction just a increased

138

00:08:57,579 --> 00:09:01,540

strength the field so we couldn't
conclude that in fact we had changed

139

00:09:01,540 --> 00:09:03,930

plasma Department couldn't directly test

140

00:09:03,930 --> 00:09:06,959

that idea so what do we know now

141

00:09:06,959 --> 00:09:10,000

that we didn't know a year ago

142

00:09:10,000 --> 00:09:14,540

well we were very fortunate that the spacecraft has on it

143

00:09:14,540 --> 00:09:18,510

resize the magnetometer which is what we used as a proxy

144

00:09:18,510 --> 00:09:22,490

we also have these two 10-meter antennas which are part of the plasma wave

145

00:09:22,490 --> 00:09:25,290

science system at the Donald talk about in a moment

146

00:09:25,290 --> 00:09:28,630

and that was very important because it gave us another way

147

00:09:28,630 --> 00:09:32,480

to measure the plasma assuming there were some waves in the plasma

148

00:09:32,480 --> 00:09:36,570

the last time though that instrument so anyways was when we cross that

149

00:09:36,570 --> 00:09:37,630

termination shock

150

00:09:37,630 --> 00:09:40,760

at that nine billion miles there hasn't

been having been away

151

00:09:40,760 --> 00:09:45,380

for another seven years until the Sun basically had an eruption

152

00:09:45,380 --> 00:09:49,900

in March of 2012 which was sports Lee headed in the direction of Voyager

153

00:09:49,900 --> 00:09:54,170

in about four hundred days it fight like a tsunami it finally got to wear order

154

00:09:54,170 --> 00:09:54,699

is

155

00:09:54,699 --> 00:09:58,089

because the plasma to react in a way

156

00:09:58,089 --> 00:10:02,290

that it could be sensed and we knew for the first time we were in the dance

157

00:10:02,290 --> 00:10:07,040

plasma ok interstellar space not in the rarer plasma

158

00:10:07,040 --> 00:10:10,089

above the other part of the solar invoke

159

00:10:10,089 --> 00:10:14,589

so thats at the Badgers that's a major new piece a bigger

160

00:10:14,589 --> 00:10:18,829

and I think it convinced most was at least that we in dere an interstellar

161

00:10:18,829 --> 00:10:20,800

space for the first time

162

00:10:20,800 --> 00:10:24,089

about so there was a like a gift from
the Sun

163

00:10:24,089 --> 00:10:27,790

and we hope that there'll be more more
such eruptions so that

164

00:10:27,790 --> 00:10:30,839

week can measure the plasma as we
continue

165

00:10:30,839 --> 00:10:34,150

now now what does it mean to reach
interstellar space

166

00:10:34,150 --> 00:10:38,540

well first of all it's just we got there
any this is something we all hoped when

167

00:10:38,540 --> 00:10:42,690

we started on this forty years ago that
this would happen but none of us knew

168

00:10:42,690 --> 00:10:45,990

how big this mobile wasn't nervous knew
anything could last

169

00:10:45,990 --> 00:10:49,380

as long as the two Voyager spacecraft so
certainly luck

170

00:10:49,380 --> 00:10:53,300

is an important part of this but while
when we first saw that day a year ago

171

00:10:53,300 --> 00:10:57,839

was really quite stunning after having
in there on the way for so many years

172

00:10:57,839 --> 00:11:01,640

this remarkable journey eyes is clearly
a tribute

173

00:11:01,640 --> 00:11:05,920

to the many individuals responsible for
the successive or your mission over the

174

00:11:05,920 --> 00:11:07,770

last four decades

175

00:11:07,770 --> 00:11:11,190

in leaving the heliosphere and setting
sail

176

00:11:11,190 --> 00:11:14,780

the cosmic seas between the stores
Voyager

177

00:11:14,780 --> 00:11:18,110

has joined the other a historic

178

00:11:18,110 --> 00:11:22,440

journeys of exploration such as the
first time circumnavigation

179

00:11:22,440 --> 00:11:25,560

the earth and the first footprint on the
moon

180

00:11:25,560 --> 00:11:28,800

this historic step is even more exciting

181

00:11:28,800 --> 00:11:31,980

because it marks the beginning Avenue

182

00:11:31,980 --> 00:11:35,440

era exploration for a larger the
exploration

183

00:11:35,440 --> 00:11:40,079

this love this space between the stars
salt right over the doc

184

00:11:40,079 --> 00:11:44,620

thanks a lot it for the introduction and
for coming on the plaza Mwave instrument

185

00:11:44,620 --> 00:11:47,949

well as in said the the real issue here

186

00:11:47,949 --> 00:11:52,829

is plasmas a which prior plans where are
we in our way in the solar plasma or the

187

00:11:52,829 --> 00:11:54,530

interstellar plasma

188

00:11:54,530 --> 00:11:58,790

and now it's just unfortunate thing that
the instrument that was designed to

189

00:11:58,790 --> 00:12:00,350

measure plasmas

190

00:12:00,350 --> 00:12:04,839

a failed a a long time ago well 1980

191

00:12:04,839 --> 00:12:08,730

a now the instrument that I'm
responsible for the players or even

192

00:12:08,730 --> 00:12:09,690

instrument

193

00:12:09,690 --> 00:12:12,800

it's designed to measure waves
propagating in this

194

00:12:12,800 --> 00:12:16,040

ionized media out there we call plasma

195

00:12:16,040 --> 00:12:19,790

us cover the exotic subject but there's
a lot of different types of waves

196

00:12:19,790 --> 00:12:23,470

propagate somewhere just like sound
waves like I'm talking was here

197

00:12:23,470 --> 00:12:26,860

their call Diane Sawyer is they
propagate the good

198

00:12:26,860 --> 00:12:31,260

sometimes a great distances are also
ready always

199

00:12:31,260 --> 00:12:34,319

on our instrument consists love to

200

00:12:34,319 --> 00:12:38,050

long electric antennas if you bring up
the picture a Voyager

201

00:12:38,050 --> 00:12:42,270

you can see them there the 10 mir's law
and we essentially have a radio receiver

202

00:12:42,270 --> 00:12:46,089

at the base in those antennas I like
comment those antennas are kinda like

203

00:12:46,089 --> 00:12:47,079

the

204

00:12:47,079 --> 00:12:50,530

v-shaped and has used to a certain amount of your TV

205

00:12:50,530 --> 00:12:54,880

you know the rabbit ears a well we can detect radio emissions

206

00:12:54,880 --> 00:12:58,720

cue for senator he's our planet through a very intense real man

207

00:12:58,720 --> 00:13:02,450

the matters only learn a lot a researcher on radio emissions

208

00:13:02,450 --> 00:13:07,310

but as I said you can also detect waves propagating in the plasma

209

00:13:07,310 --> 00:13:10,880

now there's one type of waves is particularly important for us

210

00:13:10,880 --> 00:13:15,790

guys call electron Plaza Los lation you have an exam afterwards i quiz you on

211

00:13:15,790 --> 00:13:17,480

the properties

212

00:13:17,480 --> 00:13:22,339

if you displace the electrons from the ions and release them

213

00:13:22,339 --> 00:13:26,140

there's our attractive force in the electrons or Percy dos laid back and

214

00:13:26,140 --> 00:13:26,640

forth

215

00:13:26,640 --> 00:13:31,029

the characteristic frequency that we call the electron plasma frequency

216

00:13:31,029 --> 00:13:35,730

as it turns out this oscillation frequency is

217

00:13:35,730 --> 00:13:39,190

directly related to the plasma density

218

00:13:39,190 --> 00:13:42,360

the number of particles per cubic

219

00:13:42,360 --> 00:13:45,589

meter and that's a very important

220

00:13:45,589 --> 00:13:50,160

quality to try to distinguish between the interstellar plasma

221

00:13:50,160 --> 00:13:55,100

and the solar plasma because it turns up for reasons I'll try to explain shortly

222

00:13:55,100 --> 00:13:58,209

the interstellar plasma is actually considerably

223

00:13:58,209 --> 00:14:02,130

has considerably higher density than solar plasma

224

00:14:02,130 --> 00:14:05,250

and so we can detect these ways

225

00:14:05,250 --> 00:14:08,480

for when I oscillation occurs cut like a vibration

226

00:14:08,480 --> 00:14:11,769

a in the a plasma

227

00:14:11,769 --> 00:14:15,080

but unfortunately we don't do it all the time

228

00:14:15,080 --> 00:14:18,149

and are getting the Y for example when the

229

00:14:18,149 --> 00:14:21,870

when we saw the cosmic re changes unfortunately we didn't have a plasma

230

00:14:21,870 --> 00:14:22,500

oscillations

231

00:14:22,500 --> 00:14:27,040

so we couldn't tell you this the now okay so when can we measure the fires

232

00:14:27,040 --> 00:14:28,050

loss lations

233

00:14:28,050 --> 00:14:32,070

well it's got to do it the presence of electron be

234

00:14:32,070 --> 00:14:35,579

a you know it's like a wind instrument if you get air blowing in the wind

235

00:14:35,579 --> 00:14:37,110

instrument you sometimes good

236

00:14:37,110 --> 00:14:41,209

distinct pitch herself so sir like that

237

00:14:41,209 --> 00:14:45,529

okay where do we get electron beams we
get those four-story vans

238

00:14:45,529 --> 00:14:49,980

a big explosions on the Sun that he
checked plasma up from the Sun

239

00:14:49,980 --> 00:14:54,760

us all call for a lot less ejections and
you can run the soho image there

240

00:14:54,760 --> 00:14:58,880

will show some examples soho image hope
it's running

241

00:14:58,880 --> 00:15:04,579

I'll anyway these the rejections come
out at very high velocities million

242

00:15:04,579 --> 00:15:08,620

over a million miles an hour and %uh
sometimes are very dense

243

00:15:08,620 --> 00:15:11,620

her with blast the plasma coming out for
the Sun

244

00:15:11,620 --> 00:15:14,800

propagates great distances takes almost
a year

245

00:15:14,800 --> 00:15:20,310

to get out Voyager distances ahead of
those blast ways to electrons are

246

00:15:20,310 --> 00:15:21,740

accelerated aftershock

247

00:15:21,740 --> 00:15:25,790

itself rather yet they still really our
players lost lations

248

00:15:25,790 --> 00:15:29,440

a now it turned out after the cosmic re
change

249

00:15:29,440 --> 00:15:35,130

about a month and a half later and
october/november 2012 we detected

250

00:15:35,130 --> 00:15:39,070

a plasma oscillations I and it was

251

00:15:39,070 --> 00:15:43,279

created by a story that the frankly
we're still trying to study exactly what

252

00:15:43,279 --> 00:15:46,630

if it was just sort heard over such
great distances to make those

253

00:15:46,630 --> 00:15:47,839

connections

254

00:15:47,839 --> 00:15:50,899

then there is another revealed in the
this year

255

00:15:50,899 --> 00:15:54,820

april-may it was even stronger up now

256

00:15:54,820 --> 00:15:58,880

I'm going to show you shortly a
spectrogram a plot a frequency versus

257

00:15:58,880 --> 00:16:00,060
time

258

00:16:00,060 --> 00:16:04,380
and a on that spectrogram these
oscillations

259

00:16:04,380 --> 00:16:07,740
I'm talking about occur it audio
frequencies

260

00:16:07,740 --> 00:16:12,120
%uh so with our receiver we can actually
transmitting back to the ground actually

261

00:16:12,120 --> 00:16:13,589
what happens to get stored

262

00:16:13,589 --> 00:16:17,410
spacecraft tape recorder which we play
back every six months

263

00:16:17,410 --> 00:16:20,820
so there's a big time delays involved
here this was real or a little late

264

00:16:20,820 --> 00:16:22,430
reporting this

265

00:16:22,430 --> 00:16:25,720
up but they can play it back and then
you can actually

266

00:16:25,720 --> 00:16:29,010
listen to it us all I'm going to do is
the

267

00:16:29,010 --> 00:16:33,480

start this recording not yet our and
you'll see a cursor moving

268

00:16:33,480 --> 00:16:37,110

it I have a7 most general issue there
that we compressed

269

00:16:37,110 --> 00:16:40,610

fork slider 15 seconds where I sit here
and listen for seven months

270

00:16:40,610 --> 00:16:44,089

these things brought you what you're
here you'll hear the 1st October

271

00:16:44,089 --> 00:16:45,010

November

272

00:16:45,010 --> 00:16:50,410

a a 2012 and then there will be a little
bit over Gavriel hear anything then you

273

00:16:50,410 --> 00:16:51,800

hear the a

274

00:16:51,800 --> 00:16:55,850

the April may 2013 event

275

00:16:55,850 --> 00:16:59,290

a so when you here this recording

276

00:16:59,290 --> 00:17:02,290

fleas recognizes the historic event

277

00:17:02,290 --> 00:17:05,329

it's the first time that we've ever made
a recording

278

00:17:05,329 --> 00:17:12,179

up sounds interstellar space so play the recording

279

00:17:12,179 --> 00:17:19,179

okay

280

00:17:20,510 --> 00:17:27,510

p cells as I tried to explain from the frequency

281

00:17:27,850 --> 00:17:32,370

we can compute very accurately the plasma density and it turned out to be

282

00:17:32,370 --> 00:17:34,640

about a hundred thousand per QX L

283

00:17:34,640 --> 00:17:39,430

per cubic meter just almost exactly what we expected their stellar

284

00:17:39,430 --> 00:17:43,610

a a plasma fact we saw the first email I just

285

00:17:43,610 --> 00:17:46,800

the myself my colleague bill Kurth we said we're

286

00:17:46,800 --> 00:17:51,190

in the inner solar plasma now your nose another thing and that recording

287

00:17:51,190 --> 00:17:56,370

the frequency was increasing a let's play it again I put the dashed line on

288

00:17:56,370 --> 00:17:56,680

this

289

00:17:56,680 --> 00:18:00,610

on the spectrogram so you can cut your
idea how it's increasing

290

00:18:00,610 --> 00:18:07,610

also play the second recording

291

00:18:14,419 --> 00:18:18,989

p so this is evidence that work properly

292

00:18:18,989 --> 00:18:23,320

we're the spacecraft is moving into why
term a density ramp

293

00:18:23,320 --> 00:18:27,749

slowly increasing plasma density their
like are you over here

294

00:18:27,749 --> 00:18:30,960

agree saying quote shortly but not right
now a

295

00:18:30,960 --> 00:18:34,460

a explain that rail have to tell you

296

00:18:34,460 --> 00:18:38,600

that we made radio the detection so the
hilly cause

297

00:18:38,600 --> 00:18:42,720

about twenty years ago in 1993 and I

298

00:18:42,720 --> 00:18:45,720

detected that same ramp I

299

00:18:45,720 --> 00:18:49,190

as a shock wave propagating the
interstellar medium another

300

00:18:49,190 --> 00:18:53,230

and the radio frequency which is at the
Plaza the same frequency

301

00:18:53,230 --> 00:18:56,690

grizzly rose in those two observation
see the match

302

00:18:56,690 --> 00:19:00,039

almost perfectly well let me

303

00:19:00,039 --> 00:19:03,379

going a little more into what all this
means a

304

00:19:03,379 --> 00:19:07,489

if your show the next illustration this
is actually won a jury saying

305

00:19:07,489 --> 00:19:11,059

illustrations a and it shows there

306

00:19:11,059 --> 00:19:14,090

the I the sorta bullet shape

307

00:19:14,090 --> 00:19:17,999

he live 'cause and inside who opposes
that hot

308

00:19:17,999 --> 00:19:21,769

a files love solar wind it flows out
from the Sun

309

00:19:21,769 --> 00:19:25,029

at the very hardest part is out there
were it shows

310

00:19:25,029 --> 00:19:28,570

a red in that region the temperature

311

00:19:28,570 --> 00:19:32,989

is on the or million degrees or even
several million degrees

312

00:19:32,989 --> 00:19:39,019

extremely hot and then the the
Heliopolis occurs in the blue region is

313

00:19:43,039 --> 00:19:39,919

the interstellar

314

00:19:43,039 --> 00:19:46,580

a we have various reasons to think the
temperature is more modest

315

00:19:46,580 --> 00:19:50,889

a still high trust your standards but
about six thousand degrees

316

00:19:50,889 --> 00:19:55,460

so you have this tremendous temperature
difference across the hilly pause

317

00:19:55,460 --> 00:19:59,700

and to balance the pressure at the
loopholes you have to have a

318

00:19:59,700 --> 00:20:00,600

corresponding

319

00:20:00,600 --> 00:20:05,889

increase in the plasma density the
density has to go up

320

00:20:05,889 --> 00:20:09,529

when you go into the interstellar mean a
interstellar plasma

321

00:20:09,529 --> 00:20:13,049

me scene counter-intuitive you might think the interstellar

322

00:20:13,049 --> 00:20:16,809

for you know players was it's like a vacuum but it's not the density actually

323

00:20:16,809 --> 00:20:18,440

goes up some substantially

324

00:20:18,440 --> 00:20:22,289

and as I described we just measured the

325

00:20:22,289 --> 00:20:26,789

density on the on the interstellar side to go the next slide

326

00:20:26,789 --> 00:20:32,249

I show a plot above the plasma density is you come out from the Sun

327

00:20:32,249 --> 00:20:37,109

on the left and %uh the red areas are very hot gas from the Sun

328

00:20:37,109 --> 00:20:41,049

and on the other right is the interstellar

329

00:20:41,049 --> 00:20:44,590

plasma which I colored blue because it's cool

330

00:20:44,590 --> 00:20:49,190

and you'll notice a right at the heel because there's that very large dog a

331

00:20:49,190 --> 00:20:49,840

job

332

00:20:49,840 --> 00:20:53,359

which has got to do with the temperature differences that we've actually measured

333

00:20:53,359 --> 00:20:54,570

the plasma density

334

00:20:54,570 --> 00:20:58,299

on the source I that the termination shock by CID said:

335

00:20:58,299 --> 00:21:02,669

nine years ago we detected players lost lesions that the shock

336

00:21:02,669 --> 00:21:07,440

we often detect a lotta ways shockwave and the frequency there was

337

00:21:07,440 --> 00:21:12,230

300 hurts much lower than the frequency we're talking about now

338

00:21:12,230 --> 00:21:17,179

and I forgot to tell you but density goes is the frequency squared

339

00:21:17,179 --> 00:21:20,590

the school reported the quiz I'll give you and a

340

00:21:20,590 --> 00:21:25,129

so assist the frequency with up a factor 10 that meant the density

341

00:21:25,129 --> 00:21:28,639

when other factor a hundred so there's this huge density

342

00:21:28,639 --> 00:21:31,980

jump across the hilly a pause in fact we
buy

343

00:21:31,980 --> 00:21:35,119

X travelling our measurements with we
make an argument

344

00:21:35,119 --> 00:21:38,759

our papers that there's the jump
actually occurred on or around

345

00:21:38,759 --> 00:21:43,179

August 25th where the cosmic rays occur
so that's probably where we entered into

346

00:21:43,179 --> 00:21:48,609

well I'll call interstellar space anyway
a very exciting time for me I've

347

00:21:48,609 --> 00:21:53,779

I've work to well but working in space
research for 55 years I started working

348

00:21:53,779 --> 00:21:54,919

with Joe vendela

349

00:21:54,919 --> 00:21:58,799

is still a juvenile was very interested
in reaching the healing powers

350

00:21:58,799 --> 00:22:03,070

with the players 10 11 but firstly the
spacecraft to

351

00:22:03,070 --> 00:22:07,489

stopped operating first he died several
years ago I think he'd be very

352

00:22:07,489 --> 00:22:10,730
proud to a to hear this evening

353

00:22:10,730 --> 00:22:15,220
and maybe he's actually listening argues
carries a

354

00:22:15,220 --> 00:22:19,070
by calling here well thanks don that was
just

355

00:22:19,070 --> 00:22:23,279
I the news when done first called me
this was a little before the paper was

356

00:22:23,279 --> 00:22:27,669
I'm quite extraordinary he I think
called me to sound me out a little bit

357

00:22:27,669 --> 00:22:30,419
about some of some of the models that we
were developing

358

00:22:30,419 --> 00:22:33,759
and and he told me that the

359

00:22:33,759 --> 00:22:37,269
plasma frequency had suggested that the
am

360

00:22:37,269 --> 00:22:41,599
number density the plasma density that
they were measuring was on the order of

361

00:22:41,599 --> 00:22:45,230
of about point 08 particles per cubic
centimeter or not took

362

00:22:45,230 --> 00:22:48,909
I think it took us both what all have 10

seconds fifteen seconds

363

00:22:48,909 --> 00:22:52,909

to conclude that we had to be in the
interstellar medium and so why did we

364

00:22:52,909 --> 00:22:56,259

conclude that I think if we pull up the
first figure there's some

365

00:22:56,259 --> 00:22:59,960

a simulation these are the this looks
quite simple but it comes from an

366

00:22:59,960 --> 00:23:02,649

extraordinarily complex set of
simulations

367

00:23:02,649 --> 00:23:06,220

that that we run on on a lot of the sort
of pop and

368

00:23:06,220 --> 00:23:10,589

a super computers around the country but
what you can see in that blue side

369

00:23:10,589 --> 00:23:15,169

is is the interstellar medium region and
you'll notice on the left side is is

370

00:23:15,169 --> 00:23:18,070

quiet and the white and factors is the

371

00:23:18,070 --> 00:23:21,799

solar material the material that came
from the Sun

372

00:23:21,799 --> 00:23:25,769

and these computer shit simulations
illustrate very very clearly that there

373

00:23:25,769 --> 00:23:27,249
should be an enormous jump

374

00:23:27,249 --> 00:23:31,119
in going from the sole aside to the
interstellar side

375

00:23:31,119 --> 00:23:34,159
in the density of the of the plasma

376

00:23:34,159 --> 00:23:38,470
that plasma jump in fact is on the order
of a hundred times

377

00:23:38,470 --> 00:23:43,249
now you might ask why in fact was the
instrument not observing something that

378

00:23:43,249 --> 00:23:45,999
could have been in the so to me and in
the solar

379

00:23:45,999 --> 00:23:49,339
a.m. medium instead of the interstellar
medium

380

00:23:49,339 --> 00:23:54,190
for example these very strong tsunami
lack shocks that that had referred to

381

00:23:54,190 --> 00:23:58,679
well we've examined that and and we know
that from the simulations and from the

382

00:23:58,679 --> 00:24:02,149
expectations of the underlying theory
that in fact

383

00:24:02,149 --> 00:24:06,409
such huge enhancements have the number
density are impossible to get

384
00:24:06,409 --> 00:24:10,899
within the within the am within the a
soda medium it has to be

385
00:24:10,899 --> 00:24:13,989
that we crossed over the interstellar
medium the other thing that you'll

386
00:24:13,989 --> 00:24:17,249
notice interestingly about that figure
is that in fact although it looks very

387
00:24:17,249 --> 00:24:18,820
steep that line

388
00:24:18,820 --> 00:24:22,440
that jumps from the end so the side to
the interstellar side

389
00:24:22,440 --> 00:24:27,460
is in fact I'm somewhat gradual there is
a ramp there on that ground gradually

390
00:24:27,460 --> 00:24:30,730
increases and so that again is this very
consistent with

391
00:24:30,730 --> 00:24:35,200
I'm with the kind of observations that
that donna's reporting

392
00:24:35,200 --> 00:24:39,179
so that transition is called the he
opposes as don indicated

393
00:24:39,179 --> 00:24:44,019

I and and it has this hundredfold I am
increase and so consequently because

394

00:24:44,019 --> 00:24:47,989

there's no other possible explanation I
think we're forced and were obliged to

395

00:24:47,989 --> 00:24:51,249

conclude that we are in fact in the
interstellar medium

396

00:24:51,249 --> 00:24:56,259

I'm this is truly a remarkable
achievement I believe it's very hard for

397

00:24:56,259 --> 00:24:58,450

us as a said to comprehend that

398

00:24:58,450 --> 00:25:02,080

you know first the space-age start at
fifty five years ago

399

00:25:02,080 --> 00:25:07,149

and um in that period we've actually
exited the solar system we've we've

400

00:25:07,149 --> 00:25:07,849

exited

401

00:25:07,849 --> 00:25:12,099

the material that's created by the Sun
and we're in a truly alien environment

402

00:25:12,099 --> 00:25:13,710

the material in which

403

00:25:13,710 --> 00:25:17,869

Voyager finds itself is not created by
the Sun it's created in fact by

404

00:25:17,869 --> 00:25:22,980

by our neighboring stars I'm supernova
remnants and so forth and so Voyager ins

405

00:25:22,980 --> 00:25:28,070

and some very real sense is is material
that's not from the medium in which it

406

00:25:28,070 --> 00:25:31,109

finds itself so we've truly crossed over

407

00:25:31,109 --> 00:25:35,149

um nonetheless Voyager has and continues
and I

408

00:25:35,149 --> 00:25:40,549

expect will continue to do so has a
remarkable capacity to surprise and so

409

00:25:40,549 --> 00:25:44,589

even though in some sense the
observations that Voyager has presented

410

00:25:44,589 --> 00:25:46,710

us with in terms of the density

411

00:25:46,710 --> 00:25:50,629

and also in terms of the anomalous in
galactic cosmic rays

412

00:25:50,629 --> 00:25:54,259

those are all consistent with our
expectations theoretically

413

00:25:54,259 --> 00:25:58,299

it turns out that the magnetic field is
it alluded to is is still something that

414

00:25:58,299 --> 00:26:00,519

puzzles us considerably

415

00:26:00,519 --> 00:26:05,059

and if we go to the next and slide around our expectations were

416

00:26:05,059 --> 00:26:08,080

that the interstellar medium had a had a magnetic field that was

417

00:26:08,080 --> 00:26:11,339

re-entered in a certain direction and the

418

00:26:11,339 --> 00:26:15,330

interplanetary magnetic field which is effectively by like a big are comedians

419

00:26:15,330 --> 00:26:16,470

spiral

420

00:26:16,470 --> 00:26:21,700

I'm met that the re: and tation between the magnetic field on the sole aside and

421

00:26:21,700 --> 00:26:25,029

the orientation of the magnetic field on the interstellar side

422

00:26:25,029 --> 00:26:28,440

would be somewhat significantly different possibly by as much as about

423

00:26:28,440 --> 00:26:30,279

30 degrees

424

00:26:30,279 --> 00:26:34,480

and they were most likely be an increase or a significant change in the magnetic

425

00:26:34,480 --> 00:26:35,779

field strength

426

00:26:35,779 --> 00:26:39,499

what voyeur just saw is illustrated on
the right of that figure you can see the

427

00:26:39,499 --> 00:26:41,739

little red and the little green and the
little salsa

428

00:26:41,739 --> 00:26:45,149

Blatter colored I'm green curve

429

00:26:45,149 --> 00:26:49,220

and in fact there was almost no change
very little changed at all

430

00:26:49,220 --> 00:26:53,450

and so this is is is a real puzzled as
to what is happening what is the physics

431

00:26:53,450 --> 00:26:54,919

that underlies this this

432

00:26:54,919 --> 00:26:58,950

absence of of of sudden change in the
magnetic field

433

00:26:58,950 --> 00:27:02,869

I'm and the reason why this is so
puzzling is if we go to the next slide

434

00:27:02,869 --> 00:27:04,759

there's a series of three

435

00:27:04,759 --> 00:27:09,929

I'm figures these the top figure is
observations that were obtained by

436

00:27:09,929 --> 00:27:10,389

what's

437

00:27:10,389 --> 00:27:14,819

by the IBEX spacecraft into interstellar
boundary Explorer

438

00:27:14,819 --> 00:27:18,000

and what it shows is in a sense
messengers

439

00:27:18,000 --> 00:27:21,579

and a very energetic particles that are
created neutral particles that are

440

00:27:21,579 --> 00:27:24,200

created and the boundaries of this
region

441

00:27:24,200 --> 00:27:28,869

that come to us in a measured by the
spacecraft one astronomical unit

442

00:27:28,869 --> 00:27:32,500

and at the surprise on these
observations was there was the so-called

443

00:27:32,500 --> 00:27:33,259

ribbon that

444

00:27:33,259 --> 00:27:36,869

regional green and Hans meant that you
see in the figure

445

00:27:36,869 --> 00:27:40,369

that was completely unexpected we
managed to explain it or at least we

446

00:27:40,369 --> 00:27:42,440
thought we had managed to explain it

447
00:27:42,440 --> 00:27:47,139
I'm by I'm bye bye by creating a model
that essentially

448
00:27:47,139 --> 00:27:51,419
I'm relied very strongly on a certain
REM tation and strength of the

449
00:27:51,419 --> 00:27:53,309
interstellar magnetic field

450
00:27:53,309 --> 00:27:57,909
and when we use disorientation and we
ran these big computer simulations and

451
00:27:57,909 --> 00:28:01,579
we incorporated this additional physics
what we obtained was that figure on the

452
00:28:01,579 --> 00:28:02,769
lower left

453
00:28:02,769 --> 00:28:05,769
and you can see that in fact
theoretically it doesn't excellent job

454
00:28:05,769 --> 00:28:07,259
of agreeing with the Voyager

455
00:28:07,259 --> 00:28:10,349
with the IBEX observed River

456
00:28:10,349 --> 00:28:13,679
unfortunately if you change that
magnetic field around and change it

457

00:28:13,679 --> 00:28:14,859
sorry and tations

458
00:28:14,859 --> 00:28:18,289
and even its strength you end up with
something that looks more like

459
00:28:18,289 --> 00:28:22,069
at the bottom panel on the right which
is a ribbon that doesn't agree with the

460
00:28:22,069 --> 00:28:23,829
observations at all

461
00:28:23,829 --> 00:28:27,899
so we have now to constraints one as
were in the interstellar medium voyagers

462
00:28:27,899 --> 00:28:29,059
told us that

463
00:28:29,059 --> 00:28:33,399
the interstellar plasma density is a
significantly high and there's almost

464
00:28:33,399 --> 00:28:37,710
no other conclusion that we can come to
and on the other hand we have

465
00:28:37,710 --> 00:28:43,089
I'm a magnetic field that can explain
ibex observations

466
00:28:43,089 --> 00:28:47,819
and we have no theory what so ever to to
bridge this gap

467
00:28:47,819 --> 00:28:51,259
so we're in the fortunate position I'm
not sure of it and and don't agree but

468

00:28:51,259 --> 00:28:54,569

where the fortunate position of having
another good few years of trying to

469

00:28:54,569 --> 00:28:55,950

explain this and

470

00:28:55,950 --> 00:28:59,289

trying to persuade people that they need
to continue giving us a lot I've

471

00:28:59,289 --> 00:29:03,659

I'm computer time and and money and
effort to to allow us to figure out just

472

00:29:03,659 --> 00:29:06,539

exactly what is going on

473

00:29:06,539 --> 00:29:10,069

and in a sense this is only a really the
beginning

474

00:29:10,069 --> 00:29:14,319

Voyager as a set has the same in Iraq
rather remarkable capacity to surprise

475

00:29:14,319 --> 00:29:15,869

at every turn

476

00:29:15,869 --> 00:29:20,099

and we're now going into a completely
new environment it's truly alien it's

477

00:29:20,099 --> 00:29:24,039

not part of the solar system we stepped
into the galaxy where out of our solar

478

00:29:24,039 --> 00:29:25,450

environment

479

00:29:25,450 --> 00:29:29,819

and what voyagers going to discover
truly beggars the imagination

480

00:29:29,819 --> 00:29:34,399

I think that I'm at least for theorists
we've got ten twenty thirty years of

481

00:29:34,399 --> 00:29:37,089

great fun and excitement ahead of us

482

00:29:37,089 --> 00:29:42,169

I am and i'm looking forward to it it
for me it just turned on a personal note

483

00:29:42,169 --> 00:29:47,349

it's been truly remarkable I was in high
school in a different country altogether

484

00:29:47,349 --> 00:29:51,720

when Voyager was launched iight did not
know if their dad did not know Don

485

00:29:51,720 --> 00:29:55,509

I'm it's been a privilege to to get to
know both of them of course

486

00:29:55,509 --> 00:29:59,879

but Voyager has had this capacity not
only to do fantastic really

487

00:29:59,879 --> 00:30:02,899

groundbreaking and remarkable science
that

488

00:30:02,899 --> 00:30:06,369

I am is is as as as ed described

489

00:30:06,369 --> 00:30:09,929

a ranks with the greatest voyages of
discovery above

490

00:30:09,929 --> 00:30:14,329

of humankind but it's also bridged
generations of scientists

491

00:30:14,329 --> 00:30:18,970

across and and as I said this is a
mission that's almost as long as the

492

00:30:18,970 --> 00:30:22,230

space age itself and I've had the
opportunity of

493

00:30:22,230 --> 00:30:26,079

I and witnessing in a sense the launch
and now are being

494

00:30:26,079 --> 00:30:30,749

at at what to me is culturally and
historically changing moment

495

00:30:30,749 --> 00:30:33,940

in in humankind we've put something into

496

00:30:33,940 --> 00:30:37,809

into interstellar space itself first
step into the galaxy and for a

497

00:30:37,809 --> 00:30:41,319

younger person I'm told my daughter's
tell me not

498

00:30:41,319 --> 00:30:45,049

that I'm not a young person anymore but
for a younger person in any event

499

00:30:45,049 --> 00:30:50,639
its its its it's quite humbling to be
part of this

500
00:30:50,639 --> 00:30:54,200
sources and you gonna tell me why and
obsolete piece of equipment still

501
00:30:54,200 --> 00:30:55,549
continues to function

502
00:30:55,549 --> 00:30:58,710
yeah thank you Gary I'm what

503
00:30:58,710 --> 00:31:02,429
I'm thrilled to be here wow that's about
all I can say a

504
00:31:02,429 --> 00:31:07,009
are a bit like Gary I was in high school
when border is launched and I was a

505
00:31:07,009 --> 00:31:08,879
little more concerned about getting my

506
00:31:08,879 --> 00:31:13,819
driver's license that I was Sir about
watching border launch at the time

507
00:31:13,819 --> 00:31:17,389
but I'm I'm excited to be here in
intoxicated a

508
00:31:17,389 --> 00:31:20,460
as the project manager and I'll key
point I want to make

509
00:31:20,460 --> 00:31:23,649
is that a this mission is not over

510

00:31:23,649 --> 00:31:27,589

I think you've heard all the my previous speakers tell you how much more science

511

00:31:27,589 --> 00:31:28,440

is out there

512

00:31:28,440 --> 00:31:32,609

yet to come and many many more discoveries are out there yet to come

513

00:31:32,609 --> 00:31:36,589

as well I'm speaking role they %uh first graphic

514

00:31:36,589 --> 00:31:41,109

so up worried you're was launched at a time where it could take advantage of

515

00:31:41,109 --> 00:31:41,839

the unique

516

00:31:41,839 --> 00:31:45,859

trajectory which happens only 176 years

517

00:31:45,859 --> 00:31:50,149

I it could reach all the outer planets in a 12 year time period

518

00:31:50,149 --> 00:31:54,099

the last time that could have happened was during thomas jefferson

519

00:31:54,099 --> 00:31:57,139

administration cell I warrior one

520

00:31:57,139 --> 00:32:02,109

a went by said a Jupiter and Saturn that was the original mission

521

00:32:02,109 --> 00:32:05,589

an envoy 22 was able to continue on to
Uranus

522

00:32:05,589 --> 00:32:10,730

and Neptune I between the two order
spacecraft they discovered 23

523

00:32:10,730 --> 00:32:14,669

moon said the outer giant planets and
today Voyager

524

00:32:14,669 --> 00:32:18,329

his traveling away from us in
interstellar space

525

00:32:18,329 --> 00:32:21,940

at over 38,000 miles per hour

526

00:32:21,940 --> 00:32:25,019

now arm the boys spacecraft is all

527

00:32:25,019 --> 00:32:30,409

I and because of that a the science team
who works on it are what we like to call

528

00:32:30,409 --> 00:32:33,460

well-seasoned and if I can have the

529

00:32:33,460 --> 00:32:37,730

slide the team one slide I this is an
image takin

530

00:32:37,730 --> 00:32:42,220

from 1972 it's the first fine steering
group meeting held at the jet propulsion

531

00:32:42,220 --> 00:32:43,799

laboratory

532

00:32:43,799 --> 00:32:46,899

right after the project was started I

533

00:32:46,899 --> 00:32:51,069

you probably take out ads don't you see
in the front row the second from the

534

00:32:51,069 --> 00:32:53,409

left his here's a little darker and

535

00:32:53,409 --> 00:32:57,240

I you know if he's looking pretty good
as well as well as restless I is seen

536

00:32:57,240 --> 00:32:58,159

there

537

00:32:58,159 --> 00:33:01,710

and if I could have the next team
picture you'll see

538

00:33:01,710 --> 00:33:05,399

a how we look today okay so this image
was taken

539

00:33:05,399 --> 00:33:10,759

on Monday and its nearly forty years
after the previous image

540

00:33:10,759 --> 00:33:16,440

and I this is the science team there's
about 12 engineers back at JPL who

541

00:33:16,440 --> 00:33:19,009

operate both spacecraft

542

00:33:19,009 --> 00:33:23,629

and their they've been with the project
nearly as long as all the scientists and

543

00:33:23,629 --> 00:33:27,700

and what I can tell you about this group
is that they are extremely passionate

544

00:33:27,700 --> 00:33:31,049

about their science there are has
passionate today

545

00:33:31,049 --> 00:33:34,549

they argue they banter at each other
they go back and forth at it in the

546

00:33:34,549 --> 00:33:36,339

science team meetings and I and

547

00:33:36,339 --> 00:33:40,349

they're just as passionate today as they
were in 1972

548

00:33:40,349 --> 00:33:44,710

I'm so what are the things I want you I
give you a sense for is the

549

00:33:44,710 --> 00:33:47,720

technology and aged the voyager
spacecraft

550

00:33:47,720 --> 00:33:50,749

so the Voyager spacecraft has only

551

00:33:50,749 --> 00:33:53,919

68 kilobytes a memory on board now

552

00:33:53,919 --> 00:33:58,190

I am fought my smartphone whichever all
you have

553

00:33:58,190 --> 00:34:01,849

his SS two hundred and forty thousand
times more memory

554

00:34:01,849 --> 00:34:05,609

the voyager spacecraft not pay

555

00:34:05,609 --> 00:34:08,770

but we it's the little spacecraft that
could

556

00:34:08,770 --> 00:34:12,149

you know we keep on going I

557

00:34:12,149 --> 00:34:15,200

we talk communicate with the spacecraft

558

00:34:15,200 --> 00:34:18,750

everyday both spacecraft every day and

559

00:34:18,750 --> 00:34:21,829

we use the deep space network that's run
by

560

00:34:21,829 --> 00:34:27,299

at nasa and relieve I would say the
Voyager in the DSN have grown up

561

00:34:27,299 --> 00:34:30,500

together the DSN has been with us the
whole time

562

00:34:30,500 --> 00:34:36,909

I a Voyager is currently eleven point
six billion miles away from us

563

00:34:36,909 --> 00:34:40,069

and it true as the signal from voyager

564

00:34:40,069 --> 00:34:45,500

to the earth takes 17 hours and 22
minutes one way

565

00:34:45,500 --> 00:34:48,549

okay waver transmits with a 22 what

566

00:34:48,549 --> 00:34:53,309

transmitter I guess about the sides have
your refrigerator like all

567

00:34:53,309 --> 00:34:56,869

I'm when that signal comes down in a DSN
picks it up

568

00:34:56,869 --> 00:35:02,579

it's one tenth of a billion billion over
what

569

00:35:02,579 --> 00:35:05,589

now I I

570

00:35:05,589 --> 00:35:09,710

back in everywhere we were fortunate to
have another

571

00:35:09,710 --> 00:35:12,720

Observatory the very long baseline array

572

00:35:12,720 --> 00:35:16,579

which is operated by the National Radio
Astronomy Observatory

573

00:35:16,579 --> 00:35:20,520

try to look for voyagers radio signal

574

00:35:20,520 --> 00:35:23,890

at avoid your was eleven and a half
billion miles away

575

00:35:23,890 --> 00:35:28,250

last february and Vrba went out there
and look for the signal thing to bring

576

00:35:28,250 --> 00:35:30,430

up the next graphic

577

00:35:30,430 --> 00:35:34,029

they were able to see and a blue spec

578

00:35:34,029 --> 00:35:37,279

and this image represents the void your

579

00:35:37,279 --> 00:35:40,529

radio signal has seen by the world's
most

580

00:35:40,529 --> 00:35:43,819

sensitive ground-based telescope

581

00:35:43,819 --> 00:35:48,969

its just spec in amongst the sea in
darkness

582

00:35:48,969 --> 00:35:52,790

now I mentioned earlier that this
mission can continue for

583

00:35:52,790 --> 00:35:57,759

several more years I'll we use
radioisotope thermoelectric generators

584

00:35:57,759 --> 00:35:58,400

they were

585

00:35:58,400 --> 00:36:02,460

provided by the Department of Energy I'm

586

00:36:02,460 --> 00:36:05,609

and they DK at four what's

587

00:36:05,609 --> 00:36:09,069

per year in other words they lose for
water power per year

588

00:36:09,069 --> 00:36:12,770

so has a as a project manager and the
engineers on board we have to be very

589

00:36:12,770 --> 00:36:15,560

careful to manage that power source

590

00:36:15,560 --> 00:36:20,219

so that we can continue to operate
the instruments for as long as possible

591

00:36:20,219 --> 00:36:25,830

and we have enough power to operate the
fields and particles instruments

592

00:36:25,830 --> 00:36:29,580

I which are taking Nick the current
interstellar data

593

00:36:29,580 --> 00:36:34,020

out till the year 2020 so that seven
more years we can operate

594

00:36:34,020 --> 00:36:38,750

East instruments and then after the year
2020 will be turning off one instrument

595

00:36:38,750 --> 00:36:43,480

at a time until the year 2025 when all
the instruments will go off

596

00:36:43,480 --> 00:36:47,770

but that gives us a good 13 40 more
years to operate the voyager spacecraft

597

00:36:47,770 --> 00:36:50,910
get science data back from them

598

00:36:50,910 --> 00:36:55,049
we can operate the spacecraft about 10
more years afterwards

599

00:36:55,049 --> 00:36:59,420
I'm if we just want to take down
engineering data

600

00:36:59,420 --> 00:37:03,690
so where is where you're going I have
the King have the next graphic

601

00:37:03,690 --> 00:37:07,680
that's where borders going okay that
starr is

602

00:37:07,680 --> 00:37:11,069
a C-plus 7938 88

603

00:37:11,069 --> 00:37:14,130
borders on its way to a close approach
with it

604

00:37:14,130 --> 00:37:18,830
I in about 40,000 years it's gonna come
within one point seven

605

00:37:18,830 --> 00:37:22,380
lightyears this star and all swinging by
it

606

00:37:22,380 --> 00:37:28,830
and will continue to orbit around the
center of our Milky Way galaxy

607

00:37:28,830 --> 00:37:32,339

I'm in finally I just wanna a

608

00:37:32,339 --> 00:37:36,160

comments that I really feel the people
who are

609

00:37:36,160 --> 00:37:39,489

had the vision to create Voyager who

610

00:37:39,489 --> 00:37:42,640

job built it who centered on its way
they were

611

00:37:42,640 --> 00:37:46,989

they just had an extraordinary vision
about the discovery in the adventure

612

00:37:46,989 --> 00:37:50,869

and a Warrior was built for scientists

613

00:37:50,869 --> 00:37:55,109

but a it's really for all of us

614

00:37:55,109 --> 00:38:00,330

I Voyager contains on it its border has
a gold record

615

00:38:00,330 --> 00:38:03,330

this gold record was designed by Carl
Sagan

616

00:38:03,330 --> 00:38:06,509

and his team and on the school record

617

00:38:06,509 --> 00:38:10,330

our music and greeting

618

00:38:10,330 --> 00:38:13,390

and sounds and even images

619

00:38:13,390 --> 00:38:16,930

love the planet Earth from all over the
planet Earth

620

00:38:16,930 --> 00:38:20,469

and it's really a time capsule love us
you know this is

621

00:38:20,469 --> 00:38:24,079

this is us contained in this record and
now the Voyager

622

00:38:24,079 --> 00:38:28,239

particularly Voyager 1 is carrying this
time capsule of us

623

00:38:28,239 --> 00:38:32,670

into interstellar space were traveling
along with forger

624

00:38:32,670 --> 00:38:36,259

as it continues on this journey of
discovery

625

00:38:36,259 --> 00:38:39,270

love Plano and get back to you thank you
suzanne

626

00:38:39,270 --> 00:38:43,739

ladies and gentlemen clearly an
incredible team

627

00:38:43,739 --> 00:38:48,210

and I want to acknowledge the deputy
associate administrator

628

00:38:48,210 --> 00:38:52,170
for space communications navigation
scanned by G eunice

629
00:38:52,170 --> 00:38:55,259
are taken care listening to the
spacecraft but

630
00:38:55,259 --> 00:38:58,799
I believe these this team in all the
folks many in this room

631
00:38:58,799 --> 00:39:02,069
and now listening to his program was
given a round of applause great job

632
00:39:02,069 --> 00:39:08,170
fork

633
00:39:08,170 --> 00:39:11,910
okay here's how we gonna do this we're
gonna go to the phone lines but i wanna

634
00:39:11,910 --> 00:39:15,460
there are folks out there watching and
I'm here ima is there a lot of you all

635
00:39:15,460 --> 00:39:18,489
out there are buzzing about this news
about

636
00:39:18,489 --> 00:39:21,960
please stay with us because there is a
incredible video that we're gonna in the

637
00:39:21,960 --> 00:39:23,989
program with so don't go away

638
00:39:23,989 --> 00:39:27,130
when I go to the phone lines going to

take a few questions

639

00:39:27,130 --> 00:39:31,160

I'll allow the media around the world
have this story so we want to thank

640

00:39:31,160 --> 00:39:32,779

working with science

641

00:39:32,779 --> 00:39:37,089

magazine and of course all the work from
Jet Propulsion Laboratory and and again

642

00:39:37,089 --> 00:39:38,040

the team

643

00:39:38,040 --> 00:39:42,299

so let's %uh go to the phone lines and
then we're gonna take a couple questions

644

00:39:42,299 --> 00:39:45,480

from social media and then we're gonna
show the video

645

00:39:45,480 --> 00:39:49,950

I let me take one question from social
media

646

00:39:49,950 --> 00:39:54,219

I i think im gonna try to go there first
this is my colleague I am

647

00:39:54,219 --> 00:39:57,730

Jason counsel on the case %uh manager
for social media Jason

648

00:39:57,730 --> 00:40:01,440

what's going on out in the social media
or indeed there's lotsa bus today all

649

00:40:01,440 --> 00:40:04,099

over social media about this
announcement so first question comes

650

00:40:04,099 --> 00:40:04,989

from crew

651

00:40:04,989 --> 00:40:10,160

robot has voiced his path pretty well
met expectations or have unknown unseen

652

00:40:10,160 --> 00:40:11,380

gravitational sources

653

00:40:11,380 --> 00:40:14,849

modified its course

654

00:40:14,849 --> 00:40:19,109

I can I today its courses very
accurately determined by the

655

00:40:19,109 --> 00:40:23,960

gravitational forces were world

656

00:40:23,960 --> 00:40:28,440

okay okay now let's I will come back to
social media we're gonna now go to the

657

00:40:28,440 --> 00:40:29,520

phone line

658

00:40:29,520 --> 00:40:33,000

and I think we're gonna a to San
Francisco David Perlman

659

00:40:33,000 --> 00:40:37,190

San Francisco Chronicle David thanks
very much to take my

660

00:40:37,190 --> 00:40:40,650

bar put down their net acted you

661

00:40:40,650 --> 00:40:45,239

explain the a results for the plasma
oscillations

662

00:40:45,239 --> 00:40:48,969

in up to now ever Andy well

663

00:40:48,969 --> 00:40:53,859

and april/may 2013 where they both the
results of the CME

664

00:40:53,859 --> 00:40:57,040

Asano what but all I about

665

00:40:57,040 --> 00:41:00,210

yes I'm coming on that the

666

00:41:00,210 --> 00:41:03,500

the last event the April they

667

00:41:03,500 --> 00:41:07,150

2013 we're pretty sure that it started

668

00:41:07,150 --> 00:41:12,509

with the Saint Patrick's Day even which
was in March of 2012 in a really exactly

669

00:41:12,509 --> 00:41:13,549

eight

670

00:41:13,549 --> 00:41:17,660

a because the the there's a particular
instrument

671

00:41:17,660 --> 00:41:21,380

time for me just instrument he's here he
could come in if you like

672

00:41:21,380 --> 00:41:25,719

assault affect their that that had the
right timing

673

00:41:25,719 --> 00:41:29,099

are now the other event we've had more
trouble a

674

00:41:29,099 --> 00:41:32,140

identified just what it was on the Sun

675

00:41:32,140 --> 00:41:36,020

that produce that even I i think that's
a that's still under study

676

00:41:36,020 --> 00:41:39,339

although there are some interesting
things have happened in two spacecraft

677

00:41:39,339 --> 00:41:40,480

they're not your

678

00:41:40,480 --> 00:41:45,029

reported plea that story and put I might
come at that

679

00:41:45,029 --> 00:41:48,400

because the earth moves around the Sun
we are not

680

00:41:48,400 --> 00:41:52,369

always in the ideal position to see
something headed toward Voyager in fact

681

00:41:52,369 --> 00:41:53,239

in December

682

00:41:53,239 --> 00:41:56,710

we're on the opposite side of the Sun
from from voyager so something from the

683

00:41:56,710 --> 00:41:59,049

Sun heading out the Voyager we could not
see

684

00:41:59,049 --> 00:42:03,250

from Earth

685

00:42:03,250 --> 00:42:08,819

the next question is fun Jacqui Goddard
from the times of london

686

00:42:08,819 --> 00:42:13,650

techie a and congratulations is a
question set up to stone

687

00:42:13,650 --> 00:42:16,920

attend a conference like this last year
when he said I that

688

00:42:16,920 --> 00:42:20,500

voyage along with hearing yesterday he
is say he said that he didn't know how

689

00:42:20,500 --> 00:42:20,949

you would

690

00:42:20,949 --> 00:42:24,489

celebrate when the moment find K he's a
good puppy

691

00:42:24,489 --> 00:42:29,799

home with me I'm beyond just holding a
meeting in Houston to celebrate

692

00:42:29,799 --> 00:42:33,109

well we did hold the meeting in fact
we've held three meetings since they

693

00:42:33,109 --> 00:42:33,810
have does

694

00:42:33,810 --> 00:42:37,020
says the Plaza Way observations occurred
because

695

00:42:37,020 --> 00:42:40,099
this is a obviously an exciting
milestone for

696

00:42:40,099 --> 00:42:43,880
for all of us and I think we're looking
forward to

697

00:42:43,880 --> 00:42:47,049
a further meetings coming up with the
American Geophysical Union meeting in

698

00:42:47,049 --> 00:42:48,000
December so

699

00:42:48,000 --> 00:42:51,900
somewhere along the line we will really
celebrate but individually we're all

700

00:42:51,900 --> 00:42:54,910
overjoyed I like their

701

00:42:54,910 --> 00:43:01,910
actually I consider those meetings to be
inquisition if

702

00:43:02,710 --> 00:43:08,449
okay now we have have bill harwood CBS
News bill greetings

703

00:43:08,449 --> 00:43:12,190

thank you very much question for here
what about order to win with you

704

00:43:12,190 --> 00:43:14,449

expected to

705

00:43:14,449 --> 00:43:18,130

to get there and what will it bring to
the table with to require that you could

706

00:43:18,130 --> 00:43:18,829

have avoided

707

00:43:18,829 --> 00:43:22,210

West Bank well for small Voyager 1 is
headed up

708

00:43:22,210 --> 00:43:25,500

I in the toward the north and critique
at much in the nose

709

00:43:25,500 --> 00:43:28,890

were direction for you to is sorta down
here

710

00:43:28,890 --> 00:43:32,690

are in the south and somewhat off to the
flag so it's a different part

711

00:43:32,690 --> 00:43:35,960

the heliosphere are and SNC

712

00:43:35,960 --> 00:43:39,210

we do have a working solar wind
instruments or actually measuring the

713

00:43:39,210 --> 00:43:41,449

plasma density speed and temperature

714

00:43:41,449 --> 00:43:45,680

we will have that when we cross the area
pause on Voyager 2

715

00:43:45,680 --> 00:43:49,750

are in terms of timing I we don't know
for sure

716

00:43:49,750 --> 00:43:53,779

but it was it took three years a more
forward your tooth

717

00:43:53,779 --> 00:43:56,880

find the termination shock and larger
one so you might say

718

00:43:56,880 --> 00:44:00,869

another three years for voice to find he
oppose to first-order

719

00:44:00,869 --> 00:44:07,109

but in fact as usual voice your kids are
prices

720

00:44:07,109 --> 00:44:11,000

k'nex callers Clara Moskowitz from
Scientific American

721

00:44:11,000 --> 00:44:15,109

for yes hi thanks for taking my call

722

00:44:15,109 --> 00:44:18,109

think pocket a little bit point can
attest

723

00:44:18,109 --> 00:44:23,920

origin kid and iPad a what it made up
event

724

00:44:23,920 --> 00:44:29,609

well the interstellar plasma is judged
created by the explosion of stars so

725

00:44:34,750 --> 00:44:30,190

there's a

726

00:44:34,750 --> 00:44:37,810

new star it's so messy that starr has a
life

727

00:44:37,810 --> 00:44:42,299

only about a million years and it blows
up and puts all that stuff back out into

728

00:44:46,739 --> 00:44:43,660

the interstellar medium

729

00:44:46,739 --> 00:44:51,969

by exploding stars we do know there were
set up exploding stars near the earth

730

00:44:51,969 --> 00:44:55,489

a five to ten to fifteen million years
ago

731

00:44:55,489 --> 00:44:58,549

and the material we're currently
surrounded by

732

00:44:58,549 --> 00:45:05,549

is stuff that came from those explosions
plus what was there when they exploded

733

00:45:06,210 --> 00:45:09,810

next question is from Kelly Beatty Sky &
Telescope

734

00:45:09,810 --> 00:45:13,250

code yeah be a thank you very much and

735

00:45:13,250 --> 00:45:17,449

and the a great day I'm I'm a little
confused by this time line here

736

00:45:17,449 --> 00:45:20,770

um about a month ago

737

00:45:20,770 --> 00:45:23,829

the article came out by marks was back
at all but

738

00:45:23,829 --> 00:45:27,109

that they thought the border with them
they hear you

739

00:45:27,109 --> 00:45:30,190

I V minister will meet him in and at
going

740

00:45:30,190 --> 00:45:34,130

came out with a statement well little
probable at this point

741

00:45:34,130 --> 00:45:37,150

get you have a positive way about

742

00:45:37,150 --> 00:45:41,790

bikini kinda walk me through the my mind
of what you do when you knew it

743

00:45:41,790 --> 00:45:44,839

well I think Don you should talk about
the time it took

744

00:45:44,839 --> 00:45:48,819

to get the data down summer was on the
tape recorder in the spacecraft

745

00:45:48,819 --> 00:45:53,500

a and the time it took to us to have to really make sure this was plasma wave

746

00:45:53,500 --> 00:45:55,560

data and not radio data

747

00:45:55,560 --> 00:46:00,469

right yes what the the data the high-resolution data we get that type of

748

00:46:00,469 --> 00:46:01,180

thing the

749

00:46:01,180 --> 00:46:06,349

we played two sound so they're stored on the tape record space craft paper core

750

00:46:06,349 --> 00:46:10,089

and it can be up to six months so I play back every six months

751

00:46:10,089 --> 00:46:15,430

a but the I think I would also color maybe a year on the comment that I

752

00:46:15,430 --> 00:46:19,739

believed this was that people basically a theory paper and as a matter fact

753

00:46:19,739 --> 00:46:23,579

our paper was submitted least almost a month before there's the just got

754

00:46:23,579 --> 00:46:24,650

through the

755

00:46:24,650 --> 00:46:27,819

the review cycle faster than we do.

756

00:46:27,819 --> 00:46:33,210

so if you wanna talk about timing there
some other factors yeah

757

00:46:33,210 --> 00:46:37,210

okay we'll take a couple more questions
than the couple more from social media

758

00:46:37,210 --> 00:46:40,359

we're gonna try to close out a top
Italian but remember stay tuned for that

759

00:46:40,359 --> 00:46:41,529

video

760

00:46:41,529 --> 00:46:45,290

Mike wall space dot com Mike

761

00:46:45,290 --> 00:46:48,420

I'll PLO

762

00:46:48,420 --> 00:46:51,910

I got thanks again for but you don't
listen

763

00:46:51,910 --> 00:46:55,079

yeah a great job getting out that the
big moment for all over

764

00:46:55,079 --> 00:46:59,259

from for the question now the your
you're actually gonna miss dollar space

765

00:46:59,259 --> 00:47:03,160

me the there what you expect

766

00:47:03,160 --> 00:47:06,670

but to the hot spot where from the

question but it is on the trying to

767

00:47:06,670 --> 00:47:09,599

answer out there and I know it's
entirely new environment

768

00:47:09,599 --> 00:47:13,160

update for sure about what there was no
things like

769

00:47:13,160 --> 00:47:16,779

but that will be looking for prompted
mister

770

00:47:16,779 --> 00:47:21,329

send data back to Earth your very I
concur I can't comment on that

771

00:47:21,329 --> 00:47:25,660

well as they showed their where as:
voyagers moving out the density is

772

00:47:25,660 --> 00:47:27,719

slowly increasing

773

00:47:27,719 --> 00:47:32,049

and the well the there can be various
models for that

774

00:47:32,049 --> 00:47:36,319

we saw similar affect with the radio
emission twenty years ago in their paper

775

00:47:36,319 --> 00:47:36,719

I

776

00:47:36,719 --> 00:47:40,259

described as a pile up the fact that the

777

00:47:40,259 --> 00:47:44,880
a heliosphere is moving into the
interstellar medium in the

778

00:47:44,880 --> 00:47:49,270
plasma may so I say pilot factors a
paper by Braun of

779

00:47:49,270 --> 00:47:53,680
that suggested that for a simple
explanation I i've been telling some

780

00:47:53,680 --> 00:47:55,259
other media is like a snow plow

781

00:47:55,259 --> 00:47:59,199
going through the snow on the pulse of
the head but I'm sure that there's more

782

00:47:59,199 --> 00:48:00,380
sophisticated

783

00:48:00,380 --> 00:48:04,989
I explanations I actually know that
you're a sake as one

784

00:48:04,989 --> 00:48:09,650
there were how would you like to pick
the ball well i i concerti take the ball

785

00:48:09,650 --> 00:48:13,859
a not gonna continue or your explanation
or discussion further in that regard on

786

00:48:13,859 --> 00:48:14,420
but

787

00:48:14,420 --> 00:48:17,599
to answer the question that was asked in
part I'm

788

00:48:17,599 --> 00:48:20,599

that there is a great deal of very interesting science that the

789

00:48:20,599 --> 00:48:24,290

really opens up here for one and

790

00:48:24,290 --> 00:48:27,549

one of the things I think that will be %uh Vav tremendous interest and

791

00:48:27,549 --> 00:48:29,069

importance is to study

792

00:48:29,069 --> 00:48:33,339

more accurately the galactic cosmic rays the galactic cosmic rays of course a

793

00:48:33,339 --> 00:48:34,390

created in the

794

00:48:34,390 --> 00:48:38,270

I'm probably in supernova remnant I'm driven shocks

795

00:48:38,270 --> 00:48:43,079

and and so in order to study those we've always studied them from within the

796

00:48:43,079 --> 00:48:44,299

heliosphere and

797

00:48:44,299 --> 00:48:48,829

that mean studying the particles these and very very energetic galactic cosmic

798

00:48:48,829 --> 00:48:52,069

rays when they're very strongly

modulated by the

799

00:48:52,069 --> 00:48:55,630

by the presence of the solar wind and so
being outside

800

00:48:55,630 --> 00:48:59,310

the the heliosphere allows us an
opportunity to in a sense look at the

801

00:48:59,310 --> 00:49:00,400

undiluted

802

00:49:00,400 --> 00:49:04,719

galactic cosmic ray spectrum the and
I'll YouTube galactic cosmic rays

803

00:49:04,719 --> 00:49:08,390

so that'll tell us a great deal more
about the interstellar medium it very

804

00:49:14,000 --> 00:49:09,160

distant

805

00:49:14,000 --> 00:49:16,799

through this very complicated
interstellar medium the interstellar

806

00:49:16,799 --> 00:49:18,400

medium some extra pop

807

00:49:18,400 --> 00:49:22,040

warm I I and eyes partially ionized

808

00:49:22,040 --> 00:49:25,109

not ionized gases and arm

809

00:49:25,109 --> 00:49:28,500

and of course it also allows to study a

great deal about the nature of the

810

00:49:28,500 --> 00:49:32,589

fluctuations in the magnetic field in
the end in the interstellar medium

811

00:49:32,589 --> 00:49:36,819

and so already in some respects I
believe Voyager is probably and Tom

812

00:49:36,819 --> 00:49:39,009

creamy just as reported on this

813

00:49:39,009 --> 00:49:42,910

showing up a number of surprises and in
the nature of the Galactic anomalous

814

00:49:42,910 --> 00:49:46,359

cosmic rays the anomalous cosmic rays of
course disappeared but where did they

815

00:49:46,359 --> 00:49:48,960

disappear to and what affect have they
on the

816

00:49:48,960 --> 00:49:52,579

on the local interstellar medium so
that's going to be a very large area of

817

00:49:52,579 --> 00:49:55,099

study another very interesting area that
that

818

00:49:55,099 --> 00:49:58,390

that is worth with looking at closely as

819

00:49:58,390 --> 00:50:01,619

certainly were in the interstellar
medium but the interstellar medium ISM

820

00:50:01,619 --> 00:50:06,579

is itself affected by the by the solar
wind and its properties

821

00:50:06,579 --> 00:50:10,770

and so they're a very complicated
processes that that that

822

00:50:10,770 --> 00:50:16,779

I'm lead to the deposition up momentum
and energy into the very local

823

00:50:16,779 --> 00:50:21,130

I environment the very local
interstellar environment and one example

824

00:50:21,130 --> 00:50:25,529

is is the propagation of the shockwaves
that would driven off by the Sun

825

00:50:25,529 --> 00:50:29,810

into the interstellar medium how to
those propagate what do they look like

826

00:50:29,810 --> 00:50:33,630

what is the nature of the energy and
momentum transfer from the Sun to the

827

00:50:33,630 --> 00:50:34,719

interstellar medium

828

00:50:34,719 --> 00:50:38,380

there are other processes at work
associated with the deposition

829

00:50:38,380 --> 00:50:42,619

of energetic neutral atoms into the
local interstellar medium

830

00:50:42,619 --> 00:50:46,449
and that has enough tangible effect on
the nature of the interstellar medium

831
00:50:46,449 --> 00:50:50,130
so love that needs to be considered and
and explored

832
00:50:50,130 --> 00:50:53,640
and then of course there's just a very
basic questions of what other

833
00:50:53,640 --> 00:50:56,829
what is the nature of the interstellar
plasma

834
00:50:56,829 --> 00:51:00,299
proton and electron distribution
functions and

835
00:51:00,299 --> 00:51:05,009
how do those differ from the solar wind
we unfortunately can't get a composition

836
00:51:05,009 --> 00:51:06,349
but we can learn and

837
00:51:06,349 --> 00:51:10,219
enormous amount about the interstellar
medium that we previously only

838
00:51:10,219 --> 00:51:12,150
understood from looking at

839
00:51:12,150 --> 00:51:16,150
number about using remote observations
that a typically integrated over many

840
00:51:16,150 --> 00:51:17,299
past six

841

00:51:17,299 --> 00:51:21,319

so for the first time were actually
gonna be able to put our hands

842

00:51:21,319 --> 00:51:25,099

into the interstellar medium and look at
the stuff and ask what it does and what

843

00:51:38,969 --> 00:51:25,750

it

844

00:51:38,969 --> 00:51:42,589

okay we're getting close to the top now
we're gonna go to social media and

845

00:51:42,589 --> 00:51:45,989

would take one more and I believe you
have another social media event

846

00:51:45,989 --> 00:51:49,699

happening later on this afternoon you
may want to show that Jason

847

00:51:49,699 --> 00:51:53,150

indeed this question comes from Twitter
user case in major will Voyager

848

00:51:53,150 --> 00:51:56,819

ever be able to take a picture of our
son or solar system from beyond the

849

00:51:56,819 --> 00:51:58,810

heliosphere

850

00:51:58,810 --> 00:52:04,469

we I took a picture a porter the solar
system with Voyager 1 in 1990

851

00:52:04,469 --> 00:52:09,250
and after that we unloaded the software
on the spacecraft to run the cameras

852
00:52:09,250 --> 00:52:12,449
and we no longer have this computer
switcher quite all

853
00:52:12,449 --> 00:52:15,699
by now on the ground to process the data

854
00:52:15,699 --> 00:52:20,329
a and as we've our power supplies gotten
smaller and smaller we can

855
00:52:20,329 --> 00:52:23,400
we would not be have enough power to
turn those instruments back on at this

856
00:52:23,400 --> 00:52:24,240
point

857
00:52:24,240 --> 00:52:29,810
so no we cannot provide any more just

858
00:52:29,810 --> 00:52:32,720
wonderful thanks for asking if he's
there for media questions for everybody

859
00:52:32,720 --> 00:52:35,240
on social media here on the %uh platform
read it

860
00:52:35,240 --> 00:52:38,530
later today we are going to be having a
bunch of our scientists

861
00:52:38,530 --> 00:52:42,700
up and talking in answering questions in
an AMA on reddit that's an ask me

862

00:52:47,480 --> 00:52:43,430

anything

863

00:52:47,480 --> 00:52:49,240

be there later it's ready dot com

864

00:52:49,240 --> 00:52:53,050

thank you Jason solution gentleman
clearly

865

00:52:53,050 --> 00:52:56,050

wanna thank you for being here before we
get to the video coupler

866

00:52:56,050 --> 00:53:00,410

notes here again all this information
and more is available on www

867

00:53:00,410 --> 00:53:04,290

that nasa got cups less forger and

868

00:53:04,290 --> 00:53:07,470

a social media is jason said is deeply a
buzz

869

00:53:07,470 --> 00:53:11,440

on what's going on so let me set up this
video for you very cool

870

00:53:11,440 --> 00:53:16,200

over the past several months folks were
asked what message they would send

871

00:53:16,200 --> 00:53:20,450

to avoid you to commemorate its arrival
interstellar space what you're going to

872

00:53:20,450 --> 00:53:20,940

see

873

00:53:20,940 --> 00:53:24,790
some others messages lol doctor
Grantsville was up here

874

00:53:24,790 --> 00:53:28,500
a that Star Trek context %uh

875

00:53:28,500 --> 00:53:33,270
that the the audio was low here but he
created quite a buzz when the Star Trek

876

00:53:33,270 --> 00:53:36,200
team was playing while he was talking so
check the internet for that

877

00:53:36,200 --> 00:53:40,840
but will you will recognize faces here
for Star Trek and from other places

878

00:53:40,840 --> 00:53:45,010
and I think John maybe in a tricky I
think the trekkies and I know you

879

00:53:45,010 --> 00:53:46,110
trekkies out there

880

00:53:46,110 --> 00:53:50,610
if if mister Spock was here he would say
something like

881

00:53:50,610 --> 00:53:54,870
fascinating yeah thanks for joining us

882

00:53:54,870 --> 00:53:58,690
and enjoy the video thank you for
joining us on this historic moment

883

00:53:58,690 --> 00:54:05,690
the mine

884
00:54:07,260 --> 00:54:09,800
them

885
00:54:09,800 --> 00:54:14,640
and

886
00:54:14,640 --> 00:54:17,720
there's word crossing over to deter

887
00:54:17,720 --> 00:54:22,150
storage space is the farthest thing
we've ever sent

888
00:54:22,150 --> 00:54:26,320
anywhere wagner accomplished its mission
so brilliantly

889
00:54:26,320 --> 00:54:31,550
now goes on this bugle which was which
is too long past its expected

890
00:54:31,550 --> 00:54:34,560
a service life is still

891
00:54:34,560 --> 00:54:37,820
sending messages going beyond what we
know

892
00:54:37,820 --> 00:54:40,970
in our neighborhood we are boldly going

893
00:54:40,970 --> 00:54:44,460
where no one has gone before

894
00:54:44,460 --> 00:54:47,580
it's as simple as that just lost

895

00:54:47,580 --> 00:54:50,940

the void your

896

00:54:50,940 --> 00:54:54,050

record and really the Voyager mission

897

00:54:54,050 --> 00:54:57,830

X were conceived and executed on behalf
of all human

898

00:54:57,830 --> 00:55:01,190

with the second work X Wales

899

00:55:01,190 --> 00:55:05,810

towns in all the different languages in
the world welfare

900

00:55:05,810 --> 00:55:09,810

to painter lenin's mexican Sun

901

00:55:09,810 --> 00:55:14,090

Carl Sagan and seventies a record it
hosts the children's planet Earth

902

00:55:14,090 --> 00:55:18,810

Portugal record day would be enormously
proud to be a great celebration

903

00:55:18,810 --> 00:55:22,750

it's an amazing accomplishment spicy
food you should I just go

904

00:55:22,750 --> 00:55:26,220

I was selected to do Portuguese

905

00:55:26,220 --> 00:55:29,740

it's hard to imagine aliens

906

00:55:29,740 --> 00:55:34,470

being able to decipher the Golden Record
but if they can't decipher s

907

00:55:34,470 --> 00:55:39,830

I like to think that though though take
our message in a positive spirit

908

00:55:39,830 --> 00:55:42,880

we stand today at the threshold

909

00:55:42,880 --> 00:55:47,310

great at Bacchus instead potential for
discovery and exploration

910

00:55:47,310 --> 00:55:51,680

this is not science fiction this is
better than science fiction this is

911

00:55:51,680 --> 00:55:53,110

science reality

912

00:55:53,110 --> 00:55:56,320

its so bored right but you farewell and

913

00:55:56,320 --> 00:56:00,420

thank you for being our ambassador job
well done

914

00:56:00,420 --> 00:56:04,800

you should write you should maybe drop a
postcard

915

00:56:04,800 --> 00:56:08,030

let us know how you doing so we
shouldn't worry just

916

00:56:08,030 --> 00:56:11,880

congratulations to everyone on the four

GT but don't stop there

917

00:56:11,880 --> 00:56:15,370

many more routes to explore and thank
you

918

00:56:15,370 --> 00:56:18,740

for expanding humankind's