

Google+

Shri Kanekal

Dpty. Mission Scientist, REPT Instrument Scientist



1
00:00:11,770 --> 00:00:09,280
now hello everybody welcome to this

2
00:00:13,120 --> 00:00:11,780
Google Plus hangout I'm Karen Fox with

3
00:00:15,999 --> 00:00:13,130
the Office of Communications at NASA

4
00:00:17,409 --> 00:00:16,009
Goddard and for the next hour we're

5
00:00:20,140 --> 00:00:17,419
going to be discussing the recent

6
00:00:22,810 --> 00:00:20,150
discovery of the third radiation belt

7
00:00:25,659 --> 00:00:22,820
surrounding Earth the radiation belts

8
00:00:27,490 --> 00:00:25,669
are officially known as the Van Allen

9
00:00:31,959 --> 00:00:27,500
belts and they were the first discovery

10
00:00:36,100 --> 00:00:31,969
of the space age in 1958 in August of

11
00:00:38,229 --> 00:00:36,110
2012 NASA launched two spacecraft called

12
00:00:40,270 --> 00:00:38,239
the Van Allen probes to examine the

13
00:00:43,419 --> 00:00:40,280

belts in the best detail that we'd ever

14

00:00:45,459 --> 00:00:43,429

seen and within days of launch they had

15

00:00:48,430 --> 00:00:45,469

gathered information that really could

16

00:00:51,639 --> 00:00:48,440

be rewriting textbooks instead expected

17

00:00:54,220 --> 00:00:51,649

two belts they watched a third belt form

18

00:00:55,689 --> 00:00:54,230

and persist for a full month the

19

00:00:58,119 --> 00:00:55,699

discovery was published in science

20

00:01:00,759 --> 00:00:58,129

magazine yesterday and today we have

21

00:01:02,860 --> 00:01:00,769

five people talk about it we have David

22

00:01:05,710 --> 00:01:02,870

Tsai back who is the project scientist

23

00:01:07,899 --> 00:01:05,720

for the Van Allen probes Shree conical

24

00:01:10,030 --> 00:01:07,909

who is the deputy project scientist and

25

00:01:10,690 --> 00:01:10,040

one of the authors on the paper another

26

00:01:15,790 --> 00:01:10,700

on the paper

27

00:01:20,560 --> 00:01:15,800

us Sasha mikorski of the Johns Hopkins

28

00:01:23,050 --> 00:01:20,570

Applied Physics lab Alex Young is with

29

00:01:24,850 --> 00:01:23,060

us he's a scientist at NASA Goddard who

30

00:01:26,200 --> 00:01:24,860

will speak about how the radiation belts

31

00:01:29,680 --> 00:01:26,210

are part of a larger space weather

32

00:01:32,620 --> 00:01:29,690

system and finally we have Washington

33

00:01:34,890 --> 00:01:32,630

Post reporter Brian Vostok who covers

34

00:01:37,270 --> 00:01:34,900

science and space weather for the paper

35

00:01:39,010 --> 00:01:37,280

Brian will be helping to facilitate the

36

00:01:42,310 --> 00:01:39,020

conversation today so I'm going to turn

37

00:01:43,570 --> 00:01:42,320

it over to him in just a moment later on

38

00:01:46,480 --> 00:01:43,580

in the conversation we will be answering

39

00:01:49,390 --> 00:01:46,490

your questions you may send them in via

40

00:01:53,380 --> 00:01:49,400

via the Google hangout or Beyer the

41

00:01:59,080 --> 00:01:53,390

Twitter hashtag Van Allen that is the a

42

00:02:01,540 --> 00:01:59,090

and a llen and with that let's go to

43

00:02:03,600 --> 00:02:01,550

Brian thanks Karen

44

00:02:06,790 --> 00:02:03,610

happy to be here with everybody today

45

00:02:08,020 --> 00:02:06,800

excited to do this I wrote a story that

46

00:02:09,869 --> 00:02:08,030

was in today's Washington Post about

47

00:02:12,070 --> 00:02:09,879

this discovery it caught my attention

48

00:02:15,399 --> 00:02:12,080

because as you said we've known about

49

00:02:16,790 --> 00:02:15,409

these radiation belts for since 1958 I

50

00:02:18,380 --> 00:02:16,800

guess

51
00:02:19,520 --> 00:02:18,390
yet it seems like they're still kind of

52
00:02:22,100 --> 00:02:19,530
mysterious and we're learning all kinds

53
00:02:24,470 --> 00:02:22,110
of new things so I'm hoping that David

54
00:02:26,360 --> 00:02:24,480
we can start with you and you can just

55
00:02:28,430 --> 00:02:26,370
give us some background on the Van Allen

56
00:02:31,340 --> 00:02:28,440
radiation belts why they're important

57
00:02:31,820 --> 00:02:31,350
and kind of what they are okay Thank You

58
00:02:34,370 --> 00:02:31,830
Bryan

59
00:02:36,710 --> 00:02:34,380
as you mentioned we've known about the

60
00:02:39,920 --> 00:02:36,720
Van Allen radiation belts existed only

61
00:02:42,470 --> 00:02:39,930
since the late 1950s when dr. James Van

62
00:02:45,020 --> 00:02:42,480
Allen launched a series of rockets up

63
00:02:47,150 --> 00:02:45,030

into the Earth's upper atmosphere the

64

00:02:50,840 --> 00:02:47,160

surprising discovery he made was that

65

00:02:53,300 --> 00:02:50,850

space is radioactive those early rockets

66

00:02:55,820 --> 00:02:53,310

carried Geiger counters capable of

67

00:02:57,290 --> 00:02:55,830

measuring radiation in space as time

68

00:02:59,630 --> 00:02:57,300

went on we've realized they're quite

69

00:03:02,540 --> 00:02:59,640

extensive the Van Allen radiation belts

70

00:03:04,850 --> 00:03:02,550

cover several Earth radii from Earth and

71

00:03:07,100 --> 00:03:04,860

we've always thought until now that

72

00:03:10,280 --> 00:03:07,110

there were two of them one close to

73

00:03:12,620 --> 00:03:10,290

Earth about several several hundred

74

00:03:15,830 --> 00:03:12,630

miles above the Earth's surface and a

75

00:03:18,440 --> 00:03:15,840

second one further out tens of thousands

76

00:03:20,690 --> 00:03:18,450

of miles above the Earth's surface they

77

00:03:23,690 --> 00:03:20,700

pose a hazard to our spacecraft and they

78

00:03:26,570 --> 00:03:23,700

pose a hazard to our astronauts because

79

00:03:29,270 --> 00:03:26,580

radiation in space can cause cancer

80

00:03:32,090 --> 00:03:29,280

prolonged exposure and radiation in

81

00:03:35,060 --> 00:03:32,100

space can disrupt electronic circuits on

82

00:03:37,400 --> 00:03:35,070

spacecraft can cars charging up and

83

00:03:39,770 --> 00:03:37,410

discharging on the spacecraft they can

84

00:03:42,740 --> 00:03:39,780

simply ruin the spacecraft that we rely

85

00:03:44,780 --> 00:03:42,750

on what do we rely on the Oh question uh

86

00:03:46,490 --> 00:03:44,790

I was I'm sorry to interrupt you so soon

87

00:03:48,830 --> 00:03:46,500

but I was just wondering if you could

88

00:03:51,680 --> 00:03:48,840

just tell us how big of a discovery was

89

00:03:54,440 --> 00:03:51,690

this in 1958 was it a major deal at the

90

00:03:56,900 --> 00:03:54,450

time this was a major deal is put Van

91

00:03:59,570 --> 00:03:56,910

Alen on the cover of Time magazine and

92

00:04:01,190 --> 00:03:59,580

this spurred the part was part of the

93

00:04:03,530 --> 00:04:01,200

reason that spurred the u.s. space

94

00:04:05,180 --> 00:04:03,540

program NASA's program because we

95

00:04:07,670 --> 00:04:05,190

suddenly realized space wasn't empty

96

00:04:09,650 --> 00:04:07,680

there was a lot going on there and not

97

00:04:12,050 --> 00:04:09,660

only that the things that were going on

98

00:04:14,330 --> 00:04:12,060

there were hazardous they could disrupt

99

00:04:17,180 --> 00:04:14,340

our communication spacecraft they could

100

00:04:19,670 --> 00:04:17,190

disrupt our weather spacecraft things

101

00:04:22,390 --> 00:04:19,680

that we rely on every day that these

102

00:04:26,360 --> 00:04:22,400

spacecraft fly in the radiation belts

103

00:04:29,300 --> 00:04:26,370

right right in vain yet these belts have

104

00:04:30,740 --> 00:04:29,310

not been fully explored apparently right

105

00:04:32,480 --> 00:04:30,750

that's right

106

00:04:34,010 --> 00:04:32,490

a series of spacecraft have been there

107

00:04:36,530 --> 00:04:34,020

but they haven't been fully instrumented

108

00:04:38,320 --> 00:04:36,540

there's never been two identical

109

00:04:40,850 --> 00:04:38,330

spacecraft there at the same time

110

00:04:43,010 --> 00:04:40,860

capable of making the multi point

111

00:04:44,960 --> 00:04:43,020

measurements that we need to have to

112

00:04:47,180 --> 00:04:44,970

understand what's going on so we found a

113

00:04:49,280 --> 00:04:47,190

fragmentary knowledge we've had to put

114

00:04:52,130 --> 00:04:49,290

pieces together we've had to make

115

00:04:53,990 --> 00:04:52,140

guesses we'd had to make assumptions but

116

00:04:56,690 --> 00:04:54,000

now for the first time we've got two

117

00:04:59,150 --> 00:04:56,700

identical fully equipped spacecraft

118

00:05:01,340 --> 00:04:59,160

going in and out through the radiation

119

00:05:03,410 --> 00:05:01,350

belt several times per day to give us

120

00:05:05,750 --> 00:05:03,420

the picture we really need to understand

121

00:05:07,370 --> 00:05:05,760

what's going on right and now I think

122

00:05:10,490 --> 00:05:07,380

this is a good time to bring shriti into

123

00:05:12,680 --> 00:05:10,500

the conversation here and tell us about

124

00:05:14,600 --> 00:05:12,690

this discovery what fascinated me about

125

00:05:16,670 --> 00:05:14,610

this discovery is how serendipitous it

126
00:05:17,990 --> 00:05:16,680
was you know the annals of science are

127
00:05:20,480 --> 00:05:18,000
just filled with serendipitous

128
00:05:22,910 --> 00:05:20,490
discoveries but you guys you launch

129
00:05:25,370 --> 00:05:22,920
these probes last August and you decided

130
00:05:27,100 --> 00:05:25,380
to turn on your radiation detector about

131
00:05:28,580 --> 00:05:27,110
a month ahead of time is that right

132
00:05:29,890 --> 00:05:28,590
that's right

133
00:05:33,890 --> 00:05:29,900
you know there was another spacecraft

134
00:05:36,410 --> 00:05:33,900
called Sam tax which was orbiting in

135
00:05:38,840 --> 00:05:36,420
low-earth and we wanted it was just

136
00:05:41,720 --> 00:05:38,850
about to re-enter the atmosphere and we

137
00:05:45,620 --> 00:05:41,730
wanted to have overlap so that we could

138
00:05:48,440 --> 00:05:45,630

enhance the science return from Van

139

00:05:51,500 --> 00:05:48,450

Allen probes so we decided to turn on

140

00:05:54,230 --> 00:05:51,510

our instrument reps for relativistic

141

00:05:57,980 --> 00:05:54,240

electron proton Telescope which measures

142

00:06:00,740 --> 00:05:57,990

high-energy electrons whole month ahead

143

00:06:04,160 --> 00:06:00,750

of what we had planned just in order to

144

00:06:08,420 --> 00:06:04,170

overlap with the Sam pak spacecraft and

145

00:06:12,050 --> 00:06:08,430

to our surprise we found this third

146

00:06:14,330 --> 00:06:12,060

radiation belt and we were completely

147

00:06:17,630 --> 00:06:14,340

taken aback by it we were not expecting

148

00:06:21,620 --> 00:06:17,640

it at all and in the beginning we

149

00:06:23,330 --> 00:06:21,630

thought oh maybe there is a mistake in

150

00:06:26,180 --> 00:06:23,340

our instrument maybe something is wrong

151

00:06:29,050 --> 00:06:26,190

with it and as days went by we became

152

00:06:32,510 --> 00:06:29,060

more and more certain that indeed it was

153

00:06:38,060 --> 00:06:32,520

nothing wrong with our instrument Nature

154

00:06:41,660 --> 00:06:38,070

was giving us a spectacular show so it

155

00:06:43,129 --> 00:06:41,670

was a very serendipitous one I guess

156

00:06:44,420 --> 00:06:43,139

somebody famous

157

00:06:46,219 --> 00:06:44,430

said that you know scientific

158

00:06:48,890 --> 00:06:46,229

discoveries often start not with Eureka

159

00:06:50,300 --> 00:06:48,900

but with hey that's funny I guess you

160

00:06:52,309 --> 00:06:50,310

have one of those hey that's funny

161

00:06:53,300 --> 00:06:52,319

moments right absolutely I mean you know

162

00:06:55,820 --> 00:06:53,310

you suck

163

00:06:58,580 --> 00:06:55,830

wow this this looks strange this looks

164

00:07:01,760 --> 00:06:58,590

via this looks bizarre it can't really

165

00:07:03,969 --> 00:07:01,770

possibly be true but then you know as we

166

00:07:07,489 --> 00:07:03,979

look more and more at our data we

167

00:07:09,619 --> 00:07:07,499

realized yes it's true oh boy this is

168

00:07:12,260 --> 00:07:09,629

something really new it was very

169

00:07:15,200 --> 00:07:12,270

exciting for us and in this third band

170

00:07:17,540 --> 00:07:15,210

of radiation it was temporary right tell

171

00:07:22,490 --> 00:07:17,550

me about you know how you followed it in

172

00:07:25,610 --> 00:07:22,500

in how long it lasted so the third band

173

00:07:28,790 --> 00:07:25,620

or the storage ring or the radiation

174

00:07:32,510 --> 00:07:28,800

belts lasted for about four to four

175

00:07:36,050 --> 00:07:32,520

weeks I believe it started off from a

176
00:07:37,939 --> 00:07:36,060
prior electron energization event which

177
00:07:41,149 --> 00:07:37,949
we call when the electron fluxes

178
00:07:41,600 --> 00:07:41,159
increase and that comes from the CERN

179
00:07:45,010 --> 00:07:41,610
right

180
00:07:48,499 --> 00:07:45,020
that's a solar event yes the the solar

181
00:07:52,369 --> 00:07:48,509
solar event actually produces changes

182
00:07:55,369 --> 00:07:52,379
inside the magnetosphere which make

183
00:07:57,439 --> 00:07:55,379
these belts get pumped up so when these

184
00:08:01,429 --> 00:07:57,449
belts get pumped up the number of

185
00:08:05,779 --> 00:08:01,439
particles in it get energized they also

186
00:08:08,839 --> 00:08:05,789
increase in not in sheer number so this

187
00:08:11,329 --> 00:08:08,849
this is the radiation hazard that David

188
00:08:13,790 --> 00:08:11,339

was referring to just a while ago and

189

00:08:16,820 --> 00:08:13,800

when this event happened after his

190

00:08:20,059 --> 00:08:16,830

events then there was another event

191

00:08:22,550 --> 00:08:20,069

which emptied the outer belt but it

192

00:08:23,800 --> 00:08:22,560

obviously didn't empty the whole outer

193

00:08:27,139 --> 00:08:23,810

belt there was an inner

194

00:08:31,070 --> 00:08:27,149

sliver of the outer belt left however

195

00:08:34,399 --> 00:08:31,080

then the energization occurred and the

196

00:08:35,899 --> 00:08:34,409

second belt came back on and at this

197

00:08:38,659 --> 00:08:35,909

point it would it should have had all

198

00:08:42,439 --> 00:08:38,669

become like one single entity it did not

199

00:08:46,910 --> 00:08:42,449

the sliver continued to last so we have

200

00:08:50,319 --> 00:08:46,920

a three radiation belt structure lasting

201
00:08:52,809 --> 00:08:50,329
for more than a month right right and

202
00:08:55,950 --> 00:08:52,819
David can you maybe explain a little bit

203
00:08:58,630 --> 00:08:55,960
what why this was so

204
00:09:00,340 --> 00:08:58,640
unexpected to see to see this happen are

205
00:09:01,420 --> 00:09:00,350
you a good person to explain that I can

206
00:09:03,730 --> 00:09:01,430
give it a go

207
00:09:06,490 --> 00:09:03,740
we try to model the Earth's radiation

208
00:09:08,830 --> 00:09:06,500
belts we use our most complex computer

209
00:09:12,220 --> 00:09:08,840
simulations to know what's going on and

210
00:09:15,010 --> 00:09:12,230
no computer simulation no model has ever

211
00:09:18,010 --> 00:09:15,020
predicted three radiation belts - yes

212
00:09:20,950 --> 00:09:18,020
three no and a third one that comes and

213
00:09:22,900 --> 00:09:20,960

goes isn't there is there things get

214

00:09:25,360 --> 00:09:22,910

swept up things come back on these

215

00:09:27,460 --> 00:09:25,370

timescales in this way never happen

216

00:09:29,410 --> 00:09:27,470

before so we have something fundamental

217

00:09:32,260 --> 00:09:29,420

here that we need to try to understand

218

00:09:34,000 --> 00:09:32,270

so the physicist the plasma physicist

219

00:09:36,670 --> 00:09:34,010

and Helio physicists have to go back to

220

00:09:38,800 --> 00:09:36,680

work to try to figure out the physics of

221

00:09:43,690 --> 00:09:38,810

this phenomena right not back to the

222

00:09:46,300 --> 00:09:43,700

drawing board right well Alex maybe you

223

00:09:48,910 --> 00:09:46,310

can broaden out this conversation a

224

00:09:51,070 --> 00:09:48,920

little bit to talk about it how you know

225

00:09:52,990 --> 00:09:51,080

space weather is this term for you know

226

00:09:54,610 --> 00:09:53,000

what's happening with the Sun the

227

00:09:57,400 --> 00:09:54,620

energetic particles that are being shot

228

00:10:00,310 --> 00:09:57,410

out into space and I guess the Van Allen

229

00:10:01,510 --> 00:10:00,320

belts are kind of a reflection of the

230

00:10:03,580 --> 00:10:01,520

immediate space weather environment

231

00:10:07,830 --> 00:10:03,590

around Earth could you explain that a

232

00:10:10,330 --> 00:10:07,840

little bit well yes so the there is this

233

00:10:12,790 --> 00:10:10,340

constant stream of energy coming away

234

00:10:15,130 --> 00:10:12,800

from the Sun in the form of particles we

235

00:10:18,730 --> 00:10:15,140

call the solar wind but then

236

00:10:21,490 --> 00:10:18,740

occasionally the Sun spits out something

237

00:10:23,440 --> 00:10:21,500

in addition corrupt we call it a coronal

238

00:10:26,110 --> 00:10:23,450

mass ejection it's just a big blob of

239

00:10:28,570 --> 00:10:26,120

solar plasma that's threaded with

240

00:10:31,600 --> 00:10:28,580

magnetic field and this thing comes

241

00:10:34,330 --> 00:10:31,610

along and rides on the solar wind almost

242

00:10:37,660 --> 00:10:34,340

like a surfer and adds this extra punch

243

00:10:40,870 --> 00:10:37,670

and this all of this stuff comes along

244

00:10:45,430 --> 00:10:40,880

and if it's directed towards Earth it

245

00:10:47,350 --> 00:10:45,440

hits our magnetosphere and all of this

246

00:10:48,970 --> 00:10:47,360

energy and all these particles interact

247

00:10:51,820 --> 00:10:48,980

with it and this is an incredibly

248

00:10:53,560 --> 00:10:51,830

dynamic system and so one of the things

249

00:10:55,870 --> 00:10:53,570

that's the most exciting about the

250

00:10:58,360 --> 00:10:55,880

radiation bounces this is this is a

251
00:11:02,520 --> 00:10:58,370
result of this dynamic phenomenon of

252
00:11:06,340 --> 00:11:02,530
this injection of stuff of energy into

253
00:11:09,519 --> 00:11:06,350
our local environment and the problem

254
00:11:11,199 --> 00:11:09,529
we've always had in science is is the

255
00:11:13,179 --> 00:11:11,209
dynamics is always the difficult thing

256
00:11:17,170 --> 00:11:13,189
to understand it's always the thing

257
00:11:19,210 --> 00:11:17,180
that's hardest to model and this is an

258
00:11:22,989 --> 00:11:19,220
example where we have this incredibly

259
00:11:28,090 --> 00:11:22,999
dynamic transient structure and it's

260
00:11:31,389 --> 00:11:28,100
giving us a direct look at the complex

261
00:11:33,309 --> 00:11:31,399
physics that's going on and showing us

262
00:11:35,980 --> 00:11:33,319
the kinds of things that we really have

263
00:11:39,509 --> 00:11:35,990

to be able to understand because this

264

00:11:42,249 --> 00:11:39,519

whole system the space weather system is

265

00:11:44,530 --> 00:11:42,259

connected from the surface well actually

266

00:11:46,809 --> 00:11:44,540

from the inside of the Sun out to the

267

00:11:49,269 --> 00:11:46,819

surface all the way through the

268

00:11:51,249 --> 00:11:49,279

interplanetary medium to the earth so

269

00:11:54,249 --> 00:11:51,259

and this happens through the entire

270

00:11:57,100 --> 00:11:54,259

solar system so really we're living

271

00:11:59,230 --> 00:11:57,110

inside the the atmosphere of the star

272

00:12:01,030 --> 00:11:59,240

the entire solar system is inside this

273

00:12:03,579 --> 00:12:01,040

Apple we're inside the bubble all the

274

00:12:05,739 --> 00:12:03,589

time exactly and so the inner the inner

275

00:12:07,030 --> 00:12:05,749

mantle and ring is pretty stable that's

276

00:12:08,410 --> 00:12:07,040

what Shree told me yesterday when I

277

00:12:11,799 --> 00:12:08,420

interviewed him but this outer ring is

278

00:12:13,480 --> 00:12:11,809

this kind of roiling dynamic changing

279

00:12:14,470 --> 00:12:13,490

structure right it's a shriek can you

280

00:12:16,240 --> 00:12:14,480

explain that a little bit it's

281

00:12:20,559 --> 00:12:16,250

constantly expanding and contracting

282

00:12:24,759 --> 00:12:20,569

that kind of thing yes the outer Bell is

283

00:12:29,019 --> 00:12:24,769

made up mainly of particles very light

284

00:12:32,590 --> 00:12:29,029

particles called electrons which wax and

285

00:12:34,600 --> 00:12:32,600

wane in response to the solar inputs

286

00:12:37,090 --> 00:12:34,610

that Alex was just talking about coronal

287

00:12:39,670 --> 00:12:37,100

mass ejections there are other things

288

00:12:41,740 --> 00:12:39,680

called high speed streams when they

289

00:12:44,980 --> 00:12:41,750

impact the magnetosphere they compress

290

00:12:47,290 --> 00:12:44,990

the magnetosphere they create plasma

291

00:12:51,429 --> 00:12:47,300

waves they create other kinds of

292

00:12:54,819 --> 00:12:51,439

disturbances and they will actually act

293

00:12:58,869 --> 00:12:54,829

on the existing electron populations to

294

00:13:02,110 --> 00:12:58,879

pump them up to deplete them sometimes

295

00:13:04,030 --> 00:13:02,120

no change which is what makes prediction

296

00:13:06,759 --> 00:13:04,040

and understanding of these populations

297

00:13:09,549 --> 00:13:06,769

very difficult because there are

298

00:13:11,499 --> 00:13:09,559

multiple processes going on processes

299

00:13:13,739 --> 00:13:11,509

that will increase the number of

300

00:13:16,799 --> 00:13:13,749

electrons which we call energization

301

00:13:18,790 --> 00:13:16,809

processes that will deplete the

302

00:13:22,090 --> 00:13:18,800

radiation belts which we call loss

303

00:13:23,350 --> 00:13:22,100

processes and these two processes

304

00:13:26,500 --> 00:13:23,360

compete with each other

305

00:13:29,530 --> 00:13:26,510

to result in the net amount of electrons

306

00:13:31,480 --> 00:13:29,540

we see so if there is more energization

307

00:13:34,620 --> 00:13:31,490

if more particles are energized then you

308

00:13:38,280 --> 00:13:34,630

see an increased number of particles ie

309

00:13:42,280 --> 00:13:38,290

particle intensity goes up the loss is

310

00:13:46,030 --> 00:13:42,290

dominant then particle intensity goes

311

00:13:48,519 --> 00:13:46,040

down and the trick is the challenge is

312

00:13:50,829 --> 00:13:48,529

to figure out what happens in a

313

00:13:53,290 --> 00:13:50,839

particular event and to what extent

314

00:13:55,360 --> 00:13:53,300

right right and I think Sasha has been

315

00:13:57,389 --> 00:13:55,370

waiting patiently here and I think he

316

00:14:00,040 --> 00:13:57,399

can show us a little bit about a

317

00:14:01,720 --> 00:14:00,050

visualization of the three rings is that

318

00:14:04,750 --> 00:14:01,730

right do you have an image you can show

319

00:14:09,460 --> 00:14:04,760

us that is possible I can try and share

320

00:14:10,180 --> 00:14:09,470

it like you know if it works just one

321

00:14:19,110 --> 00:14:10,190

second

322

00:14:25,300 --> 00:14:19,120

Oh screen share and I hit the movie and

323

00:14:27,160 --> 00:14:25,310

can you see it well I'm not sure if we

324

00:14:29,259 --> 00:14:27,170

can but maybe you could at least

325

00:14:31,060 --> 00:14:29,269

describe the visualization techniques

326

00:14:32,199 --> 00:14:31,070

how you how you take the data I can see

327

00:14:40,980 --> 00:14:32,209

it in the thumbnails I don't know if the

328

00:14:44,579 --> 00:14:40,990

audience can see oh that is too bad so

329

00:14:47,590 --> 00:14:44,589

even if I speak there's no visual

330

00:14:49,660 --> 00:14:47,600

accompanying so I should try the screen

331

00:14:56,949 --> 00:14:49,670

share while you're talking it should I

332

00:14:59,470 --> 00:14:56,959

would think to test the technology and

333

00:15:01,060 --> 00:14:59,480

also Karl has turned it on the thumbnail

334

00:15:03,280 --> 00:15:01,070

anyone who's watching can click on that

335

00:15:05,860 --> 00:15:03,290

thumbnail in the bottom and it will open

336

00:15:08,019 --> 00:15:05,870

up for everyone to view and while sasha

337

00:15:11,170 --> 00:15:08,029

is looking through the screen share on

338

00:15:12,550 --> 00:15:11,180

his let me remind everybody that anyone

339

00:15:14,860 --> 00:15:12,560

who's just joined us recently we're

340

00:15:18,069 --> 00:15:14,870

talking today about the Van Allen probes

341

00:15:20,319 --> 00:15:18,079

and the recent discovery of a third

342

00:15:21,670 --> 00:15:20,329

radiation belt we will be taking

343

00:15:22,870 --> 00:15:21,680

questions over the course of the hour

344

00:15:25,420 --> 00:15:22,880

we'll be answering them a little bit

345

00:15:27,759 --> 00:15:25,430

later you may send your questions either

346

00:15:31,290 --> 00:15:27,769

via the Google hangout or using the

347

00:15:32,990 --> 00:15:31,300

Twitter hashtag Van Allen which is VA na

348

00:15:34,910 --> 00:15:33,000

llen

349

00:15:39,100 --> 00:15:34,920

thanks and I'll hand it back to Sasha

350

00:15:41,390 --> 00:15:39,110

and Brian all right okay so I'm hitting

351
00:15:43,970 --> 00:15:41,400
screenshot yeah all right no no I can

352
00:15:47,270 --> 00:15:43,980
see oh that's is great so basically

353
00:15:49,880 --> 00:15:47,280
before I hit the play button let me talk

354
00:15:51,860 --> 00:15:49,890
you know what we're looking at obviously

355
00:15:54,860 --> 00:15:51,870
there is a star background but these

356
00:15:58,070 --> 00:15:54,870
white lines that we're looking at this

357
00:16:00,200 --> 00:15:58,080
is a schematic representation of the

358
00:16:03,110 --> 00:16:00,210
magnetic field that actually controls

359
00:16:07,760 --> 00:16:03,120
the behavior of these high-energy

360
00:16:11,930 --> 00:16:07,770
particles that the radiation belts are

361
00:16:16,280 --> 00:16:11,940
consists of and you can see this stable

362
00:16:21,440 --> 00:16:16,290
inner belt which will not maybe be as

363
00:16:23,870 --> 00:16:21,450

stable during this simulation or

364

00:16:26,630 --> 00:16:23,880

animation that I am showing for reasons

365

00:16:29,750 --> 00:16:26,640

that I can go into but more importantly

366

00:16:34,190 --> 00:16:29,760

you are looking at the slaughter region

367

00:16:38,240 --> 00:16:34,200

and this second belt which actually is

368

00:16:41,590 --> 00:16:38,250

not the full second belt but but the

369

00:16:45,920 --> 00:16:41,600

storage ring that you guys introduced

370

00:16:48,380 --> 00:16:45,930

earlier and this animation starts and

371

00:16:53,750 --> 00:16:48,390

I'm going to hit the play button right

372

00:16:56,870 --> 00:16:53,760

after one of these systems from the Sun

373

00:17:01,430 --> 00:16:56,880

came and destroyed the outer portion of

374

00:17:05,390 --> 00:17:01,440

the outer belt and just left the storage

375

00:17:07,130 --> 00:17:05,400

ring sitting there and storage ring it

376

00:17:09,740 --> 00:17:07,140

is I we should tell people is lingo for

377

00:17:13,939 --> 00:17:09,750

the the third belt right that that is

378

00:17:16,520 --> 00:17:13,949

correct and the color in this animation

379

00:17:19,160 --> 00:17:16,530

basically represents the intensity of

380

00:17:21,770 --> 00:17:19,170

radiation in the belt the brighter the

381

00:17:24,170 --> 00:17:21,780

color the more red the colors are it

382

00:17:28,490 --> 00:17:24,180

means that the more intense radiation

383

00:17:32,600 --> 00:17:28,500

levels are in this specific place in the

384

00:17:36,380 --> 00:17:32,610

belt is this animation showing actual

385

00:17:38,330 --> 00:17:36,390

data from the probes from basically that

386

00:17:41,480 --> 00:17:38,340

that is correct so basically under the

387

00:17:45,190 --> 00:17:41,490

hood of this animation what we have is

388

00:17:46,919 --> 00:17:45,200

very sophisticated test particle

389

00:17:49,980 --> 00:17:46,929

physical model

390

00:17:51,930 --> 00:17:49,990

simulation model of dynamics of

391

00:17:55,320 --> 00:17:51,940

radiation belt particles that we've been

392

00:17:58,320 --> 00:17:55,330

developing at APL for a long time but

393

00:18:00,869 --> 00:17:58,330

it's driven what is more importantly a

394

00:18:03,989 --> 00:18:00,879

bit more important is driven by real

395

00:18:07,769 --> 00:18:03,999

data coming from Van Allen probes right

396

00:18:10,619 --> 00:18:07,779

that accurately shows us the spatial and

397

00:18:13,080 --> 00:18:10,629

temporal variations of radiation across

398

00:18:15,359 --> 00:18:13,090

the belt right so what we're seeing here

399

00:18:17,369 --> 00:18:15,369

is basically a cutaway view of two

400

00:18:18,600 --> 00:18:17,379

toroid Zoar two doughnuts that go all

401
00:18:20,639 --> 00:18:18,610
the way around the earth right this is

402
00:18:23,310 --> 00:18:20,649
like a sliced view yes that is correct

403
00:18:27,119 --> 00:18:23,320
so on your left this is where the Sun is

404
00:18:29,789 --> 00:18:27,129
and the opposite direction from the Sun

405
00:18:32,369 --> 00:18:29,799
is to the right and you are looking at

406
00:18:35,399 --> 00:18:32,379
this 2-dimensional cut the plane that

407
00:18:37,799 --> 00:18:35,409
cuts radiation belts in half and you can

408
00:18:40,169 --> 00:18:37,809
see this you know like you saw with me

409
00:18:43,859 --> 00:18:40,179
around the animation again that these

410
00:18:47,909 --> 00:18:43,869
white lines that represent the magnetic

411
00:18:49,830 --> 00:18:47,919
field they they kind of vibrate and this

412
00:18:53,399 --> 00:18:49,840
is because they directly respond to

413
00:18:56,100 --> 00:18:53,409

activity that is driven by the Sun and

414

00:18:57,869 --> 00:18:56,110

this is why you have difference on the

415

00:19:01,680 --> 00:18:57,879

levels left hand side and right hand

416

00:19:05,369 --> 00:19:01,690

side and this is what is affecting the

417

00:19:07,950 --> 00:19:05,379

dynamics of these particles that are

418

00:19:09,269 --> 00:19:07,960

forming radiation belts right well thank

419

00:19:10,619 --> 00:19:09,279

you for showing us that it's very cool

420

00:19:13,129 --> 00:19:10,629

animation and I think it helps people

421

00:19:16,669 --> 00:19:13,139

obviously visualize what's going on

422

00:19:19,109 --> 00:19:16,679

David can you tell us a little bit about

423

00:19:21,419 --> 00:19:19,119

you know or maybe this is a question for

424

00:19:23,340 --> 00:19:21,429

Alex you know I mentioned satellites

425

00:19:25,200 --> 00:19:23,350

being affected by these radiation belts

426

00:19:27,119 --> 00:19:25,210

I mean how serious of a threat are they

427

00:19:30,659 --> 00:19:27,129

to communication and weather satellites

428

00:19:32,129 --> 00:19:30,669

do they have to you know turn off

429

00:19:33,539 --> 00:19:32,139

instruments when they fly through these

430

00:19:35,930 --> 00:19:33,549

belts do they have to take other

431

00:19:39,090 --> 00:19:35,940

countermeasures to protect themselves

432

00:19:41,100 --> 00:19:39,100

that's certainly a possibility one thing

433

00:19:43,529 --> 00:19:41,110

the principal thing is they should be

434

00:19:45,600 --> 00:19:43,539

designed with thick enough shielding to

435

00:19:46,830 --> 00:19:45,610

protect the electronics within the

436

00:19:48,869 --> 00:19:46,840

instruments but the thick of their

437

00:19:50,909 --> 00:19:48,879

shielding the greater the mass of the

438

00:19:53,129 --> 00:19:50,919

spacecraft the heavier it is and the

439

00:19:54,720 --> 00:19:53,139

more it takes to launch it into space so

440

00:19:56,849 --> 00:19:54,730

we'd like to know what's the minimum

441

00:19:59,999 --> 00:19:56,859

requirement that will cut costs for

442

00:20:00,750 --> 00:20:00,009

spacecraft then second these are these

443

00:20:03,030 --> 00:20:00,760

effects are

444

00:20:05,940 --> 00:20:03,040

to knock out an entire spacecraft and

445

00:20:07,740 --> 00:20:05,950

ruin it so we have to have the knowledge

446

00:20:10,350 --> 00:20:07,750

of when and where these type of events

447

00:20:12,300 --> 00:20:10,360

will occur and third as you just said

448

00:20:15,120 --> 00:20:12,310

there are some spacecraft that carry

449

00:20:17,070 --> 00:20:15,130

instruments so sensitive that they would

450

00:20:19,260 --> 00:20:17,080

be ruined by these effects and those

451

00:20:21,990 --> 00:20:19,270

instruments have to turn off during a

452

00:20:25,590 --> 00:20:22,000

storm like this right right

453

00:20:26,670 --> 00:20:25,600

Alex says has there been a case or let

454

00:20:29,010 --> 00:20:26,680

me ask all of you has there ever been a

455

00:20:31,350 --> 00:20:29,020

case of a satellite being damaged or

456

00:20:36,060 --> 00:20:31,360

rendered inoperable by the radiation

457

00:20:38,700 --> 00:20:36,070

bills well I mean it's certainly the

458

00:20:43,340 --> 00:20:38,710

case that that satellites have been

459

00:20:47,400 --> 00:20:43,350

damaged and some critically damaged by

460

00:20:48,870 --> 00:20:47,410

energetic electrons right let me let me

461

00:20:51,090 --> 00:20:48,880

jump in for a minute

462

00:20:53,370 --> 00:20:51,100

we know we expect that will be the

463

00:20:55,920 --> 00:20:53,380

ultimate fate of these Van Allen probes

464

00:20:58,530 --> 00:20:55,930

spacecraft prolonged exposure to the

465

00:21:01,050 --> 00:20:58,540

radiation belts will one day kill them

466

00:21:04,830 --> 00:21:01,060

there in a most hazardous possible place

467

00:21:08,330 --> 00:21:04,840

do you tell your question Brian yes I

468

00:21:15,030 --> 00:21:08,340

can I certainly remember one instance

469

00:21:18,270 --> 00:21:15,040

which affected society fairly moderately

470

00:21:23,010 --> 00:21:18,280

I would say this was a loss of a

471

00:21:28,140 --> 00:21:23,020

Canadian communication satellite called

472

00:21:31,650 --> 00:21:28,150

an ik a n I K and I believe the Canadian

473

00:21:34,170 --> 00:21:31,660

newspapers carried a headline that by

474

00:21:39,600 --> 00:21:34,180

putting a P in front of it saying panic

475

00:21:41,790 --> 00:21:39,610

so it not of communications I cannot

476
00:21:45,390 --> 00:21:41,800
recall on the top of my head when

477
00:21:47,700 --> 00:21:45,400
exactly it was but I'm sure all the

478
00:21:49,890 --> 00:21:47,710
readers viewers on Google can

479
00:21:50,330 --> 00:21:49,900
immediately google Anik and they find

480
00:21:54,090 --> 00:21:50,340
out

481
00:21:58,610 --> 00:21:54,100
although the thing is it's difficult to

482
00:22:01,820 --> 00:21:58,620
associate to pinpoint the exact cause

483
00:22:04,590 --> 00:22:01,830
but the satellite died just when

484
00:22:07,320 --> 00:22:04,600
electron fluxes were very high so it's

485
00:22:10,530 --> 00:22:07,330
extremely likely that they will cause

486
00:22:12,000 --> 00:22:10,540
the failure so it's suspicious right and

487
00:22:13,380 --> 00:22:12,010
so that of course brings us back to the

488
00:22:14,310 --> 00:22:13,390

point that being able to predict the

489

00:22:16,769 --> 00:22:14,320

behavior of these

490

00:22:20,009 --> 00:22:16,779

is very important for commerce here on

491

00:22:23,460 --> 00:22:20,019

earth and I guess for astronauts too

492

00:22:25,649 --> 00:22:23,470

although the outer belt is beyond you

493

00:22:28,919 --> 00:22:25,659

know low-earth orbit but what are the

494

00:22:32,399 --> 00:22:28,929

risks to space travelers who wants to

495

00:22:35,120 --> 00:22:32,409

wants to answer that question I can take

496

00:22:37,169 --> 00:22:35,130

a crack at it if you are doing any

497

00:22:39,330 --> 00:22:37,179

interplanetary travel let's say for

498

00:22:40,799 --> 00:22:39,340

example you want to go to Mars so you

499

00:22:44,759 --> 00:22:40,809

would have to go through the radiation

500

00:22:48,269 --> 00:22:44,769

guns I mean the outer radiation when

501
00:22:51,720 --> 00:22:48,279
you're doing that if in case of man

502
00:22:54,450 --> 00:22:51,730
flight it's fine if you are inside the

503
00:22:56,730 --> 00:22:54,460
spacecraft which is well shielded but if

504
00:23:00,440 --> 00:22:56,740
you are outside the spacecraft and where

505
00:23:04,320 --> 00:23:00,450
for whatever purpose to do a EBA then

506
00:23:06,240 --> 00:23:04,330
you can be in serious danger because the

507
00:23:11,119 --> 00:23:06,250
only thing that separates you from space

508
00:23:13,560 --> 00:23:11,129
and radiation in it is a thin spacesuit

509
00:23:15,360 --> 00:23:13,570
in addition to that one has to wonder

510
00:23:17,909 --> 00:23:15,370
about the collective dose that

511
00:23:20,129 --> 00:23:17,919
accumulates as one travels through the

512
00:23:22,289 --> 00:23:20,139
radiation so in principle that could be

513
00:23:23,580 --> 00:23:22,299

a hazard right so you would want to

514

00:23:25,470 --> 00:23:23,590

touch you would want to time your space

515

00:23:28,019 --> 00:23:25,480

mission for when the belts are quiet

516

00:23:29,700 --> 00:23:28,029

right exactly if you can do that that's

517

00:23:31,529 --> 00:23:29,710

you know from the science point of view

518

00:23:34,230 --> 00:23:31,539

if we can understand the science enough

519

00:23:37,230 --> 00:23:34,240

to be able to predict when the most

520

00:23:42,269 --> 00:23:37,240

severe events will occur how long they

521

00:23:44,909 --> 00:23:42,279

will last and that will enable a safe

522

00:23:46,259 --> 00:23:44,919

passage for these astronauts right Alex

523

00:23:47,999 --> 00:23:46,269

it look like you wanted to jump in there

524

00:23:51,389 --> 00:23:48,009

yeah I just wanted to add something to

525

00:23:53,450 --> 00:23:51,399

what Shree said we were talking about

526

00:23:57,210 --> 00:23:53,460

energetic particles electrons protons

527

00:24:00,149 --> 00:23:57,220

that space travelers are exposed to it

528

00:24:04,470 --> 00:24:00,159

really is the the main concern is this

529

00:24:08,399 --> 00:24:04,480

long term dose astronauts have an

530

00:24:12,299 --> 00:24:08,409

allowed amount of radiations accumulated

531

00:24:14,730 --> 00:24:12,309

radiation over their their time as an

532

00:24:16,710 --> 00:24:14,740

astronaut and if an astronaut reaches

533

00:24:20,639 --> 00:24:16,720

that limit then that will be permanently

534

00:24:25,730 --> 00:24:20,649

grounded so so it is really critical to

535

00:24:27,850 --> 00:24:25,740

understand the this long term dosage

536

00:24:32,020 --> 00:24:27,860

that's that's a

537

00:24:36,220 --> 00:24:32,030

importance right I think some questions

538

00:24:37,780 --> 00:24:36,230

for us do I just want to remind everyone

539

00:24:41,140 --> 00:24:37,790

that we are taking questions over the

540

00:24:42,970 --> 00:24:41,150

course until two o'clock you can send

541

00:24:46,090 --> 00:24:42,980

them by Google hangout by the Twitter

542

00:24:48,610 --> 00:24:46,100

hashtag Van Alen and we'll start

543

00:24:50,110 --> 00:24:48,620

throwing some of them out now first one

544

00:24:53,289 --> 00:24:50,120

we're going with is from at nikka

545

00:24:56,470 --> 00:24:53,299

Potamus the question is what are the

546

00:24:58,750 --> 00:24:56,480

conditions that influence when the 3rd

547

00:25:00,220 --> 00:24:58,760

Van Allen belt is measurable and how is

548

00:25:02,740 --> 00:25:00,230

it that it has never been noticed before

549

00:25:04,900 --> 00:25:02,750

I'm gonna throw that question to Sasha

550

00:25:07,299 --> 00:25:04,910

for starters and if other people want to

551

00:25:09,669 --> 00:25:07,309

jump in they made you so - that is a

552

00:25:11,740 --> 00:25:09,679

very good question and I mean if we knew

553

00:25:15,490 --> 00:25:11,750

all the conditions probably we didn't

554

00:25:17,799 --> 00:25:15,500

need to fly Van Allen probes at all

555

00:25:20,440 --> 00:25:17,809

because then we would have known all the

556

00:25:23,710 --> 00:25:20,450

answers so this is basically up for the

557

00:25:27,190 --> 00:25:23,720

discussion in science papers and science

558

00:25:31,990 --> 00:25:27,200

analysis that we're running there isn't

559

00:25:34,590 --> 00:25:32,000

is that we don't really we didn't have

560

00:25:38,200 --> 00:25:34,600

this you know really comprehensive

561

00:25:40,450 --> 00:25:38,210

capability of going basically producing

562

00:25:43,560 --> 00:25:40,460

radial cuts that you saw in the

563

00:25:47,400 --> 00:25:43,570

visualization that appeared on my screen

564

00:25:50,980 --> 00:25:47,410

and getting these almost instantaneous

565

00:25:54,220 --> 00:25:50,990

snapshots of radiation intensity and its

566

00:25:57,430 --> 00:25:54,230

variability across the entire the entire

567

00:25:59,950 --> 00:25:57,440

system now actually after it was

568

00:26:04,060 --> 00:25:59,960

discovered to be profound several other

569

00:26:06,840 --> 00:26:04,070

datasets where we see indications of of

570

00:26:10,510 --> 00:26:06,850

similar structures but this will be

571

00:26:13,090 --> 00:26:10,520

definitely up for in-depth science

572

00:26:16,030 --> 00:26:13,100

analysis and discussion because that's

573

00:26:18,190 --> 00:26:16,040

tree and David mentioned multiple times

574

00:26:21,159 --> 00:26:18,200

there is a whole complexity and

575

00:26:23,950 --> 00:26:21,169

multitude of various acceleration and

576

00:26:26,440 --> 00:26:23,960

loss processes that can create this

577

00:26:29,380 --> 00:26:26,450

really complex profile and variable

578

00:26:34,630 --> 00:26:29,390

profile of radiation intensities across

579

00:26:36,790 --> 00:26:34,640

the building great I will add on another

580

00:26:39,610 --> 00:26:36,800

question here you'll notice down in your

581

00:26:41,409 --> 00:26:39,620

thumbnails there's a big image of a son

582

00:26:41,640 --> 00:26:41,419

if you anyone is watching wants to click

583

00:26:43,230 --> 00:26:41,650

on

584

00:26:45,290 --> 00:26:43,240

that it'll show up you can see it nice

585

00:26:50,130 --> 00:26:45,300

and large the middle of your screen

586

00:26:53,460 --> 00:26:50,140

that is an image of a prominence that

587

00:26:54,690 --> 00:26:53,470

occurred almost at the same time as the

588

00:26:57,780 --> 00:26:54,700

launch the Van Allen probes we have a

589

00:27:00,720 --> 00:26:57,790

question from David Saul who is

590

00:27:04,200 --> 00:27:00,730

wondering about that prominence he's

591

00:27:06,570 --> 00:27:04,210

asking how how long it is and and

592

00:27:07,890 --> 00:27:06,580

probably other information about what

593

00:27:10,110 --> 00:27:07,900

happened what it sent out I'm gonna

594

00:27:12,780 --> 00:27:10,120

throw that question to Alex Young

595

00:27:14,870 --> 00:27:12,790

because I know he has watched this

596

00:27:18,990 --> 00:27:14,880

prominence and commented on it before

597

00:27:20,460 --> 00:27:19,000

yes so so what you're looking at and the

598

00:27:22,710 --> 00:27:20,470

structure is a little bit hard to

599

00:27:24,600 --> 00:27:22,720

measure first because we're looking at

600

00:27:27,870 --> 00:27:24,610

it in a two-dimensional image and we're

601
00:27:33,140 --> 00:27:27,880
looking at an angle but just doing a

602
00:27:37,050 --> 00:27:33,150
rough estimate it's at least 30 plus

603
00:27:40,470 --> 00:27:37,060
Earth's side-by-side and turn in in

604
00:27:42,570 --> 00:27:40,480
length so hundreds of thousands of miles

605
00:27:46,320 --> 00:27:42,580
up to hundreds of thousands of miles so

606
00:27:49,650 --> 00:27:46,330
this is a incredibly huge structure and

607
00:27:53,700 --> 00:27:49,660
the earth itself would be completely

608
00:27:56,670 --> 00:27:53,710
dwarfed by this and what happens is we

609
00:28:00,690 --> 00:27:56,680
have this material on the surface of the

610
00:28:02,760 --> 00:28:00,700
Sun it's relatively cool compared to the

611
00:28:04,620 --> 00:28:02,770
surrounding atmosphere this is material

612
00:28:08,820 --> 00:28:04,630
from lower down in the solar atmosphere

613
00:28:11,580 --> 00:28:08,830

that sits up much higher in what we call

614

00:28:15,120 --> 00:28:11,590

the corona the outer atmosphere and it's

615

00:28:17,760 --> 00:28:15,130

supported by magnetic fields we don't

616

00:28:20,640 --> 00:28:17,770

exactly understand the full mechanism

617

00:28:22,650 --> 00:28:20,650

but in some ways you can sort of think

618

00:28:25,320 --> 00:28:22,660

of it like a long skinny balloon that's

619

00:28:26,820 --> 00:28:25,330

been held down by lots of strings and

620

00:28:29,910 --> 00:28:26,830

that's the magnetic field and

621

00:28:34,850 --> 00:28:29,920

occasionally those magnetic fields

622

00:28:37,440 --> 00:28:34,860

become unstable when they do that they

623

00:28:39,780 --> 00:28:37,450

basically pop they release energy and

624

00:28:42,900 --> 00:28:39,790

something we call so I pleasant is this

625

00:28:45,780 --> 00:28:42,910

called magnetic reconnection and that

626
00:28:50,130 --> 00:28:45,790
accelerates this big piece of solar

627
00:28:53,400 --> 00:28:50,140
material out in the space at millions of

628
00:28:55,470 --> 00:28:53,410
miles an hour and once it leaves the Sun

629
00:28:58,410 --> 00:28:55,480
and enters space we call

630
00:29:02,220 --> 00:28:58,420
a coronal mass ejection and so this is

631
00:29:04,410 --> 00:29:02,230
the material that eventually becomes

632
00:29:08,100 --> 00:29:04,420
that giant blob I was talking about that

633
00:29:11,280 --> 00:29:08,110
will travel and sometimes slams into the

634
00:29:12,980 --> 00:29:11,290
Earth's magnetic field or the Earth's

635
00:29:15,420 --> 00:29:12,990
magnetic system called the magnetosphere

636
00:29:17,190 --> 00:29:15,430
right and actually inject energy into

637
00:29:19,200 --> 00:29:17,200
the the outer ring is that is that right

638
00:29:21,930 --> 00:29:19,210

exactly well you remember you saw the

639

00:29:25,260 --> 00:29:21,940

video that Sachi was showing with the

640

00:29:27,840 --> 00:29:25,270

magnetic fields kind of wiggling when

641

00:29:30,540 --> 00:29:27,850

this coronal mass ejection slams into

642

00:29:33,300 --> 00:29:30,550

the magnetosphere it's almost like

643

00:29:35,910 --> 00:29:33,310

hitting a bell it causes it to ring the

644

00:29:39,660 --> 00:29:35,920

magnetic fields move back and forth and

645

00:29:41,070 --> 00:29:39,670

oscillate and that's that's putting

646

00:29:43,290 --> 00:29:41,080

energy in the system and one of the

647

00:29:46,320 --> 00:29:43,300

things that that's doing it's actually

648

00:29:49,680 --> 00:29:46,330

generating electrical currents if you

649

00:29:53,880 --> 00:29:49,690

take a magnetic field and change it

650

00:29:56,940 --> 00:29:53,890

quickly it generates a current and those

651

00:30:00,690 --> 00:29:56,950

currents build up in the upper

652

00:30:02,280 --> 00:30:00,700

atmosphere and can eventually be induced

653

00:30:04,580 --> 00:30:02,290

and can eventually induce currents on

654

00:30:10,350 --> 00:30:04,590

the ground and that's a huge concern

655

00:30:13,740 --> 00:30:10,360

because it can affect power grids long

656

00:30:15,930 --> 00:30:13,750

pipe lines that's that's one of the

657

00:30:20,040 --> 00:30:15,940

major impacts of space weather that were

658

00:30:22,680 --> 00:30:20,050

very concerned about great thanks do you

659

00:30:25,650 --> 00:30:22,690

have another question Karen absolutely

660

00:30:29,370 --> 00:30:25,660

um I actually I wouldn't mind doing a

661

00:30:31,590 --> 00:30:29,380

quick follow-up on that then I'll go to

662

00:30:34,050 --> 00:30:31,600

the next question but Shree do you think

663

00:30:37,920 --> 00:30:34,060

you could comment quickly about that

664

00:30:40,980 --> 00:30:37,930

particular prominence and the sámi since

665

00:30:43,250 --> 00:30:40,990

this obviously happened right when the

666

00:30:47,280 --> 00:30:43,260

launch happened it didn't necessarily

667

00:30:50,160 --> 00:30:47,290

cause the influx of energy that was the

668

00:30:51,960 --> 00:30:50,170

solar storm you launched into but it may

669

00:30:54,810 --> 00:30:51,970

have had some effect causing an

670

00:30:56,880 --> 00:30:54,820

interplanetary shock that that initiated

671

00:30:58,260 --> 00:30:56,890

that third radiation belt maybe you can

672

00:30:59,970 --> 00:30:58,270

comment on that whether or not they were

673

00:31:03,480 --> 00:30:59,980

connected or what you're thinking if

674

00:31:06,810 --> 00:31:03,490

they were active yeah so

675

00:31:08,460 --> 00:31:06,820

it's hard to say you know rather this

676

00:31:12,000 --> 00:31:08,470

particular one it caused it but in

677

00:31:15,270 --> 00:31:12,010

general when there is a interplanetary

678

00:31:19,770 --> 00:31:15,280

shock or a coronal mass ejection what

679

00:31:22,200 --> 00:31:19,780

often happens is that we see a loss of

680

00:31:26,130 --> 00:31:22,210

particles which we call a drop out and

681

00:31:28,560 --> 00:31:26,140

then they emerge again sometimes

682

00:31:33,480 --> 00:31:28,570

stronger sometimes more intense

683

00:31:39,990 --> 00:31:33,490

sometimes anemic sometimes to the same

684

00:31:42,260 --> 00:31:40,000

level in this case the event that caused

685

00:31:46,470 --> 00:31:42,270

the drop out and the subsequent

686

00:31:49,770 --> 00:31:46,480

energization resulted in this third belt

687

00:31:53,220 --> 00:31:49,780

and that is the puzzle we are trying to

688

00:31:55,950 --> 00:31:53,230

understand why it did not behave why the

689

00:31:59,850 --> 00:31:55,960

magnetosphere did not behave the way it

690

00:32:03,300 --> 00:31:59,860

usually does and you know this is also

691

00:32:05,630 --> 00:32:03,310

in response to the earlier question this

692

00:32:10,340 --> 00:32:05,640

is a clear case where I believe

693

00:32:12,630 --> 00:32:10,350

observation leads theory or models

694

00:32:15,540 --> 00:32:12,640

observations suddenly thrown out a

695

00:32:19,830 --> 00:32:15,550

challenge we have we have seen something

696

00:32:24,600 --> 00:32:19,840

in nature and now it's up to modelers

697

00:32:27,390 --> 00:32:24,610

like Sasha who can theorize and give us

698

00:32:32,370 --> 00:32:27,400

a theoretical a physical explanation as

699

00:32:34,080 --> 00:32:32,380

to what's going on and so the

700

00:32:39,630 --> 00:32:34,090

observation is really in this case

701
00:32:43,200 --> 00:32:39,640
leading the whole scene alright let me

702
00:32:45,600 --> 00:32:43,210
bring in question from Tommy Henley who

703
00:32:48,900 --> 00:32:45,610
sent in a question by a Facebook and

704
00:32:51,300 --> 00:32:48,910
he's asking about the instruments on the

705
00:32:53,490 --> 00:32:51,310
probes what they measure he asks does

706
00:32:57,120 --> 00:32:53,500
the did the instruments measure the

707
00:32:58,530 --> 00:32:57,130
intensity of the energy field and wants

708
00:33:00,360 --> 00:32:58,540
to know what they saw in the second

709
00:33:02,190 --> 00:33:00,370
radiation belt did the second radiation

710
00:33:04,620 --> 00:33:02,200
belt attain a fairly constant and

711
00:33:08,850 --> 00:33:04,630
maximum intensity during the existence

712
00:33:10,860 --> 00:33:08,860
of the third radiation belt and I would

713
00:33:12,360 --> 00:33:10,870

love to hear both from David about the

714

00:33:14,640 --> 00:33:12,370

instruments specifically on the Van

715

00:33:17,140 --> 00:33:14,650

Allen probes what they what they measure

716

00:33:19,240 --> 00:33:17,150

and and then

717

00:33:20,789 --> 00:33:19,250

sascha maybe you can tell us what what

718

00:33:23,260 --> 00:33:20,799

was seeing the second radiation belt

719

00:33:26,350 --> 00:33:23,270

okay I think that's a good division of

720

00:33:29,049 --> 00:33:26,360

labor the instruments on the Van Allen

721

00:33:32,049 --> 00:33:29,059

probes measure the magnetic fields that

722

00:33:34,750 --> 00:33:32,059

confine and trap these dangerous

723

00:33:37,419 --> 00:33:34,760

radiation particles in Earth's near

724

00:33:39,850 --> 00:33:37,429

environment they measure the electric

725

00:33:42,580 --> 00:33:39,860

fields that can give energy to the

726

00:33:44,830 --> 00:33:42,590

particles out in space and they measure

727

00:33:47,289 --> 00:33:44,840

the full range of particles from the

728

00:33:49,990 --> 00:33:47,299

lowest possible energies up to many

729

00:33:52,720 --> 00:33:50,000

millions of degrees of temperature or

730

00:33:56,950 --> 00:33:52,730

energy they measure the composition of

731

00:33:59,260 --> 00:33:56,960

the particles protons helium oxygen all

732

00:34:02,110 --> 00:33:59,270

these observations are needed to give us

733

00:34:04,539 --> 00:34:02,120

the clues about how particles are

734

00:34:06,070 --> 00:34:04,549

energized from the relatively cold

735

00:34:09,010 --> 00:34:06,080

energies that the Earth's ionosphere

736

00:34:11,409 --> 00:34:09,020

provides or a bit warmer from the solar

737

00:34:18,010 --> 00:34:11,419

wind up to these dangerous energies and

738

00:34:22,750 --> 00:34:18,020

with that I'll pass it to Sasha what I

739

00:34:25,359 --> 00:34:22,760

would like to also add to David Davis

740

00:34:28,210 --> 00:34:25,369

description is that we perhaps should be

741

00:34:31,119 --> 00:34:28,220

very clear that by radiation

742

00:34:33,730 --> 00:34:31,129

in this specific context of radiation

743

00:34:37,419 --> 00:34:33,740

belts we mean very very high-energy

744

00:34:39,879 --> 00:34:37,429

particles that can produce damaging

745

00:34:43,270 --> 00:34:39,889

effects the technology or to astronauts

746

00:34:45,460 --> 00:34:43,280

as we already have been discussing but

747

00:34:47,649 --> 00:34:45,470

the goal of our mission is not just

748

00:34:50,530 --> 00:34:47,659

measure these intensities the

749

00:34:52,659 --> 00:34:50,540

intensities of these particles basically

750

00:34:56,050 --> 00:34:52,669

how many at what energies these

751
00:35:00,700 --> 00:34:56,060
particles are but really understand what

752
00:35:04,170 --> 00:35:00,710
governs the basic increases or decreases

753
00:35:08,500 --> 00:35:04,180
and these intensities and this is why

754
00:35:11,170 --> 00:35:08,510
why we need to measure as David just

755
00:35:14,859 --> 00:35:11,180
pointed out all possible energies and

756
00:35:17,620 --> 00:35:14,869
all wave magnetic or electric fields

757
00:35:21,070 --> 00:35:17,630
that can contribute to both production

758
00:35:24,150 --> 00:35:21,080
and losses of this radiation across the

759
00:35:27,310 --> 00:35:24,160
entire inner magnetospheric system and

760
00:35:30,910 --> 00:35:27,320
as it was a very good question because

761
00:35:34,030 --> 00:35:30,920
it kind of led us to have

762
00:35:37,120 --> 00:35:34,040
to mention again that the inner most

763
00:35:40,650 --> 00:35:37,130

part of the magnetosphere which is the

764

00:35:43,089 --> 00:35:40,660

inner belt region is January stable

765

00:35:44,950 --> 00:35:43,099

usually and you know it's important to

766

00:35:47,680 --> 00:35:44,960

understand that sometimes we do have

767

00:35:50,440 --> 00:35:47,690

very dramatic effects that affect the

768

00:35:53,799 --> 00:35:50,450

entire system but usually the magnetic

769

00:35:56,710 --> 00:35:53,809

and electric fields in the inner belt

770

00:36:00,010 --> 00:35:56,720

are more or less quiet so that's why the

771

00:36:04,980 --> 00:36:00,020

inner belt system is more or less stable

772

00:36:07,210 --> 00:36:04,990

and this is what exactly what was shown

773

00:36:11,430 --> 00:36:07,220

bye-bye-bye-bye these measurements that

774

00:36:16,270 --> 00:36:11,440

while the outer belt dynamics was really

775

00:36:19,900 --> 00:36:16,280

you know dynamic and rapid and different

776

00:36:26,200 --> 00:36:19,910

at different radial distances the inner

777

00:36:29,380 --> 00:36:26,210

belt was very very quiet I think alex is

778

00:36:32,319 --> 00:36:29,390

gonna add on something to that too yeah

779

00:36:34,620 --> 00:36:32,329

I just wanted to mention that one of the

780

00:36:38,109 --> 00:36:34,630

areas that were very interested in is

781

00:36:40,990 --> 00:36:38,119

trying to predict the whole chain of

782

00:36:43,960 --> 00:36:41,000

events when the coronal mass ejection

783

00:36:46,299 --> 00:36:43,970

impacts the magnetosphere and understand

784

00:36:48,579 --> 00:36:46,309

exactly what is the impact for example

785

00:36:52,960 --> 00:36:48,589

on the ground and this inner area

786

00:36:54,609 --> 00:36:52,970

between the upper atmosphere atmosphere

787

00:36:57,250 --> 00:36:54,619

through into the ministry or this whole

788

00:36:59,859 --> 00:36:57,260

region is one of the hardest ones to

789

00:37:02,799 --> 00:36:59,869

understand but once we don't understand

790

00:37:05,620 --> 00:37:02,809

very well so this is just one more piece

791

00:37:07,530 --> 00:37:05,630

of this puzzle of connecting these

792

00:37:11,460 --> 00:37:07,540

different parts of the whole system

793

00:37:15,339 --> 00:37:11,470

and it's you know giving us an

794

00:37:20,020 --> 00:37:15,349

incredibly you know new dynamic look at

795

00:37:24,730 --> 00:37:20,030

this whole process great another

796

00:37:28,089 --> 00:37:24,740

question in a from at virtua Linda who

797

00:37:31,380 --> 00:37:28,099

is asking us do the Van Allen belts

798

00:37:34,839 --> 00:37:31,390

change when there is a CME from the Sun

799

00:37:36,520 --> 00:37:34,849

we talked about this a little bit but we

800

00:37:38,910 --> 00:37:36,530

have a couple of questions on this I

801
00:37:43,390 --> 00:37:38,920
want to go over it again that as well as

802
00:37:44,680 --> 00:37:43,400
as a question of what just one of the

803
00:37:46,630 --> 00:37:44,690
conditions in general

804
00:37:49,569 --> 00:37:46,640
that influence bringing on the third

805
00:37:51,940 --> 00:37:49,579
radiation belt and and is it just it's

806
00:37:54,730 --> 00:37:51,950
too small to see normally or or what's

807
00:37:59,079 --> 00:37:54,740
what's making it pump up into being

808
00:38:03,460 --> 00:37:59,089
something visible why don't I start with

809
00:38:08,040 --> 00:38:03,470
sri on that one okay

810
00:38:11,200 --> 00:38:08,050
yes in general coronal mass ejections

811
00:38:13,000 --> 00:38:11,210
disturbances from the sun which are

812
00:38:18,760 --> 00:38:13,010
headed towards Earth and impact the

813
00:38:21,370 --> 00:38:18,770

magnetosphere have results in some

814

00:38:24,670 --> 00:38:21,380

dynamically change in the radiation belt

815

00:38:27,599 --> 00:38:24,680

system most of the time the change is

816

00:38:32,380 --> 00:38:27,609

effected only in the outer radiation

817

00:38:35,589 --> 00:38:32,390

sometimes the disturbance and the impact

818

00:38:40,569 --> 00:38:35,599

is so strong that it it creates a whole

819

00:38:44,470 --> 00:38:40,579

slew of particles which will move

820

00:38:47,050 --> 00:38:44,480

inwards and even join the innermost belt

821

00:38:52,630 --> 00:38:47,060

the proton the general leader is stable

822

00:38:56,800 --> 00:38:52,640

the generally stable performance in as

823

00:38:58,210 --> 00:38:56,810

to what causes as to what caused the

824

00:39:00,609 --> 00:38:58,220

third radiation belt I have already

825

00:39:04,089 --> 00:39:00,619

mentioned you know we are trying to

826

00:39:07,300 --> 00:39:04,099

understand theoretically why the belt

827

00:39:10,410 --> 00:39:07,310

stayed stable why it did not just mix up

828

00:39:15,880 --> 00:39:10,420

and become we'd just back to two bells

829

00:39:19,059 --> 00:39:15,890

that we have to understand however the

830

00:39:22,270 --> 00:39:19,069

dynamical changes that are caused by

831

00:39:25,690 --> 00:39:22,280

these solar drivers the plasma blobs the

832

00:39:28,990 --> 00:39:25,700

coronal mass ejections they result in a

833

00:39:31,150 --> 00:39:29,000

very complex response by the

834

00:39:34,000 --> 00:39:31,160

magnetosphere as I mentioned sometimes

835

00:39:37,089 --> 00:39:34,010

the intensities increase and the

836

00:39:39,460 --> 00:39:37,099

increase is often orders of magnitude

837

00:39:42,760 --> 00:39:39,470

like ten thousand times the original

838

00:39:44,710 --> 00:39:42,770

level of electrons sometimes they don't

839

00:39:47,950 --> 00:39:44,720

change at all sometimes they actually

840

00:39:53,770 --> 00:39:47,960

get wiped away and why these things

841

00:39:58,040 --> 00:39:53,780

happen in a given particular in event is

842

00:40:04,040 --> 00:39:58,050

is the subject of scientific inquiry

843

00:40:10,870 --> 00:40:04,050

I hope that answers the question I think

844

00:40:13,100 --> 00:40:10,880

so we have a question from at NBC Cohen

845

00:40:15,500 --> 00:40:13,110

he's asking what percentage of the

846

00:40:17,840 --> 00:40:15,510

protection to earth comes from the new

847

00:40:20,630 --> 00:40:17,850

third belt compared to the other two now

848

00:40:22,670 --> 00:40:20,640

my understanding is of course that the

849

00:40:24,740 --> 00:40:22,680

radiation belts are not offering us

850

00:40:26,720 --> 00:40:24,750

protection or maybe they are are the

851

00:40:30,260 --> 00:40:26,730

radiation belts offering us protection

852

00:40:31,610 --> 00:40:30,270

from incoming events on the Sun and if

853

00:40:35,660 --> 00:40:31,620

it's not the radiation belts that are

854

00:40:40,040 --> 00:40:35,670

doing it what it is why don't I send

855

00:40:42,020 --> 00:40:40,050

that to the - Alex please actually I

856

00:40:43,930 --> 00:40:42,030

think that's probably the Dave should

857

00:40:48,080 --> 00:40:43,940

answer David should answer that

858

00:40:50,720 --> 00:40:48,090

okay well the radiation belts are

859

00:40:53,090 --> 00:40:50,730

confined in the immediate vicinity of

860

00:40:55,370 --> 00:40:53,100

the earth by the Earth's magnetic field

861

00:40:58,010 --> 00:40:55,380

they're not shielding us from anything

862

00:40:59,930 --> 00:40:58,020

they're trapped and circling around the

863

00:41:02,420 --> 00:40:59,940

earth and these doughnut shaped regions

864

00:41:04,790 --> 00:41:02,430

and they're posing a hazard to us they

865

00:41:06,920 --> 00:41:04,800

don't protect us from anything further

866

00:41:08,750 --> 00:41:06,930

out they're trapped by the Earth's

867

00:41:10,790 --> 00:41:08,760

magnetic field the Earth's magnetic

868

00:41:13,940 --> 00:41:10,800

field is a buffer that's trying to

869

00:41:15,920 --> 00:41:13,950

shield us from particles further out but

870

00:41:17,960 --> 00:41:15,930

some of those particles get in get

871

00:41:19,220 --> 00:41:17,970

energized and become the Earth's

872

00:41:25,430 --> 00:41:19,230

radiation belts

873

00:41:28,340 --> 00:41:25,440

I think Sasha may have more to say maybe

874

00:41:32,690 --> 00:41:28,350

just to add a little bit it's just it's

875

00:41:35,180 --> 00:41:32,700

important to emphasize that the inner

876

00:41:39,290 --> 00:41:35,190

magnetospheric system where radiation

877

00:41:42,770 --> 00:41:39,300

belts are embedded in X actually as an

878

00:41:46,430 --> 00:41:42,780

accelerator there there is an um there a

879

00:41:49,700 --> 00:41:46,440

number of wave or you know few of

880

00:41:52,010 --> 00:41:49,710

processes that accelerate particles and

881

00:41:54,170 --> 00:41:52,020

it's not particles that are coming

882

00:41:56,780 --> 00:41:54,180

directly from the Sun although of course

883

00:42:00,080 --> 00:41:56,790

ultimately the Sun is the driver of all

884

00:42:02,420 --> 00:42:00,090

the TVG that is affecting us but

885

00:42:05,960 --> 00:42:02,430

something else and some others are

886

00:42:08,440 --> 00:42:05,970

indicative of activities happen across

887

00:42:11,150 --> 00:42:08,450

the inner magnetosphere which sometimes

888

00:42:11,960 --> 00:42:11,160

accelerate particles at very large

889

00:42:15,200 --> 00:42:11,970

quantity

890

00:42:18,050 --> 00:42:15,210

two very large energies and this is what

891

00:42:21,680 --> 00:42:18,060

basically creates the inner belt and

892

00:42:23,839 --> 00:42:21,690

outer belt populations and we mentioned

893

00:42:26,570 --> 00:42:23,849

space weather a number of times but it's

894

00:42:28,400 --> 00:42:26,580

also is important to understand that you

895

00:42:30,620 --> 00:42:28,410

know these you know high-energy

896

00:42:33,310 --> 00:42:30,630

particles cannot be created at earth

897

00:42:37,160 --> 00:42:33,320

except you know in you know very

898

00:42:37,910 --> 00:42:37,170

expensive and very different laboratory

899

00:42:41,960 --> 00:42:37,920

conditions

900

00:42:44,390 --> 00:42:41,970

but having observations right inside of

901
00:42:47,480 --> 00:42:44,400
the inner magnetosphere where these

902
00:42:50,180 --> 00:42:47,490
radiation belts are basically provide us

903
00:42:52,370 --> 00:42:50,190
with natural laboratory for

904
00:42:54,589 --> 00:42:52,380
understanding how particles are

905
00:42:57,290 --> 00:42:54,599
accelerated across the universe which is

906
00:43:00,020 --> 00:42:57,300
really as a fundamental question that we

907
00:43:02,660 --> 00:43:00,030
did start extremely excited about and

908
00:43:06,500 --> 00:43:02,670
these are unprecedented observations

909
00:43:07,849 --> 00:43:06,510
that us means well okay okay can I ask a

910
00:43:11,210 --> 00:43:07,859
follow-up on that because that's a very

911
00:43:13,070 --> 00:43:11,220
interesting point there so you're saying

912
00:43:15,530 --> 00:43:13,080
that studying these belts complements

913
00:43:17,030 --> 00:43:15,540

you know this ten billion dollar Large

914

00:43:19,700 --> 00:43:17,040

Hadron Collider we built here on earth

915

00:43:24,050 --> 00:43:19,710

is that kind of what you're saying it

916

00:43:28,640 --> 00:43:24,060

actually in some sense yes in the sense

917

00:43:32,270 --> 00:43:28,650

that from both remote observations and

918

00:43:35,500 --> 00:43:32,280

direct observations at our other outer

919

00:43:38,480 --> 00:43:35,510

planets like Saturn and Jupiter or

920

00:43:41,210 --> 00:43:38,490

basic-cable active Center and other

921

00:43:44,240 --> 00:43:41,220

systems we know that if you have

922

00:43:47,270 --> 00:43:44,250

strongly magnetized and by that I mean

923

00:43:50,000 --> 00:43:47,280

systems with magnetic field it tends to

924

00:43:52,370 --> 00:43:50,010

create very high energy particle

925

00:43:54,650 --> 00:43:52,380

population which is basically important

926
00:43:59,150 --> 00:43:54,660
to understand for us to understand how

927
00:44:02,780 --> 00:43:59,160
the universe works and we cannot create

928
00:44:05,359 --> 00:44:02,790
a fly to Andromeda or to the galactic

929
00:44:07,820 --> 00:44:05,369
center or even to Jupiter it's very

930
00:44:11,000 --> 00:44:07,830
expensive but right you know here in our

931
00:44:14,420 --> 00:44:11,010
backyard would basically have perfect

932
00:44:16,790 --> 00:44:14,430
conditions for just stepping outside and

933
00:44:20,690 --> 00:44:16,800
looking how these particles are being

934
00:44:23,930 --> 00:44:20,700
produced and how these populations are

935
00:44:25,730 --> 00:44:23,940
affected by electric and magnetic waves

936
00:44:28,000 --> 00:44:25,740
that basically

937
00:44:31,430 --> 00:44:28,010
to shape them up which is an extremely

938
00:44:34,970 --> 00:44:31,440

fundamental question and yes ultimately

939

00:44:39,320 --> 00:44:34,980

maybe unlocking some some some mysteries

940

00:44:42,920 --> 00:44:39,330

related to two elementary particles I

941

00:44:46,790 --> 00:44:42,930

don't help it well if I may if I may

942

00:44:51,040 --> 00:44:46,800

jump in I I would I would say somewhat

943

00:44:54,109 --> 00:44:51,050

differently I would say the LHC and

944

00:44:57,710 --> 00:44:54,119

those sorts of endeavors are somewhat

945

00:44:59,930 --> 00:44:57,720

complementary to what we are doing they

946

00:45:02,270 --> 00:44:59,940

probe different energy regimes they

947

00:45:05,060 --> 00:45:02,280

probe different phenomena but what is

948

00:45:09,410 --> 00:45:05,070

interesting to to amplify what Sasha

949

00:45:12,950 --> 00:45:09,420

said the energization processes that

950

00:45:15,530 --> 00:45:12,960

occur in the radiation belts in our own

951
00:45:20,000 --> 00:45:15,540
backyard as it would occur throughout

952
00:45:23,390 --> 00:45:20,010
the universe and in order to understand

953
00:45:26,060 --> 00:45:23,400
if we understand processes completely

954
00:45:29,090 --> 00:45:26,070
fully here we would be able to

955
00:45:31,250 --> 00:45:29,100
understand these processes occurring if

956
00:45:40,460 --> 00:45:31,260
distant parts of the universe so from

957
00:45:41,150 --> 00:45:40,470
that sense what we do is important all

958
00:45:44,300 --> 00:45:41,160
right

959
00:45:45,980 --> 00:45:44,310
just reminder we have about 15 minutes

960
00:45:48,470 --> 00:45:45,990
left so we're still taking questions

961
00:45:50,300 --> 00:45:48,480
until 2:00 o'clock you can send them to

962
00:45:52,900 --> 00:45:50,310
us by the Goddard Facebook page you can

963
00:45:57,260 --> 00:45:52,910

send them to us via a Google+ Hangout or

964

00:46:00,680 --> 00:45:57,270

via the Twitter hashtag Van Allen VA n a

965

00:46:04,430 --> 00:46:00,690

a sorry VA na llen

966

00:46:09,920 --> 00:46:04,440

and we have a question from someone by a

967

00:46:13,730 --> 00:46:09,930

google+ andrew planet asks the planetary

968

00:46:15,950 --> 00:46:13,740

magnetic field alters the patterns in

969

00:46:18,290 --> 00:46:15,960

charged particles relative to the

970

00:46:20,720 --> 00:46:18,300

changing intensity to the energy applied

971

00:46:22,849 --> 00:46:20,730

to it I wonder if it'd be easy to

972

00:46:25,130 --> 00:46:22,859

replicate the conditions that produces

973

00:46:27,320 --> 00:46:25,140

the Van Allen belt in an experiment in a

974

00:46:29,599 --> 00:46:27,330

lab on earth this would be especially

975

00:46:31,310 --> 00:46:29,609

interesting with all the new data sort

976

00:46:35,120 --> 00:46:31,320

of the flip side to talking about using

977

00:46:38,489 --> 00:46:35,130

a space as a laboratory can you recreate

978

00:46:45,329 --> 00:46:38,499

that environment on earth in the lab

979

00:46:49,049 --> 00:46:45,339

and let I can throw that out who wants

980

00:46:51,630 --> 00:46:49,059

to take that way I'll start for a minute

981

00:46:53,729 --> 00:46:51,640

and then pass it on it's a great idea

982

00:46:55,470 --> 00:46:53,739

it's an idea that scientists are working

983

00:46:58,079 --> 00:46:55,480

on in fact it's an idea that they've

984

00:47:00,479 --> 00:46:58,089

been working on for many many years

985

00:47:02,549 --> 00:47:00,489

the earliest Torella experiments

986

00:47:05,700 --> 00:47:02,559

involves shooting beams of charged

987

00:47:07,739 --> 00:47:05,710

particles at a magnetic field simulating

988

00:47:09,749 --> 00:47:07,749

their Earth's magnetic field and saying

989

00:47:12,180 --> 00:47:09,759

which way those particles go and how

990

00:47:14,849 --> 00:47:12,190

they get trapped but the difficulty here

991

00:47:16,349 --> 00:47:14,859

is the change in scale size in your lab

992

00:47:18,960 --> 00:47:16,359

you can only have a little small

993

00:47:20,880 --> 00:47:18,970

magnetic field and you can't get all the

994

00:47:22,349 --> 00:47:20,890

phenomena on the right scales that

995

00:47:25,229 --> 00:47:22,359

happen out in space

996

00:47:27,239 --> 00:47:25,239

so we do conduct lab experiments put

997

00:47:29,370 --> 00:47:27,249

probes into them and measure waves

998

00:47:31,650 --> 00:47:29,380

measure their effect on the particles

999

00:47:33,749 --> 00:47:31,660

and we do our best and we also conduct

1000

00:47:35,819 --> 00:47:33,759

simulations where we put in all the

1001
00:47:37,799 --> 00:47:35,829
factors we believe are should be

1002
00:47:39,930 --> 00:47:37,809
occurring and then press the button and

1003
00:47:42,479 --> 00:47:39,940
let those simulations run and try to

1004
00:47:46,650 --> 00:47:42,489
predict what will happen maybe someone

1005
00:47:48,809 --> 00:47:46,660
else will comment - well I I wanted to

1006
00:47:51,120 --> 00:47:48,819
add to that and I guess kind of back to

1007
00:47:54,420 --> 00:47:51,130
what Sheree and Sasha was talking about

1008
00:47:56,849 --> 00:47:54,430
that the the one of the most exciting

1009
00:48:01,589 --> 00:47:56,859
things is that we do have a new

1010
00:48:03,900 --> 00:48:01,599
laboratory because plasma processes and

1011
00:48:06,329 --> 00:48:03,910
particle acceleration processes are

1012
00:48:09,210 --> 00:48:06,339
ubiquitous throughout the whole universe

1013
00:48:13,039 --> 00:48:09,220

we're always looking for different

1014

00:48:15,720 --> 00:48:13,049

places where we can sample different

1015

00:48:19,019 --> 00:48:15,730

time scales and spatial scales and

1016

00:48:21,180 --> 00:48:19,029

temporal scales to really understand all

1017

00:48:24,269 --> 00:48:21,190

the different aspects of the process so

1018

00:48:27,089 --> 00:48:24,279

this is just one more place that we have

1019

00:48:32,309 --> 00:48:27,099

a laboratory a laboratory very close to

1020

00:48:34,319 --> 00:48:32,319

us and when you think about processes in

1021

00:48:35,849 --> 00:48:34,329

the universe one of the things we're

1022

00:48:38,849 --> 00:48:35,859

trying to really understand on the Sun

1023

00:48:40,559 --> 00:48:38,859

is we know particles are accelerated to

1024

00:48:45,299 --> 00:48:40,569

create the solar wind we know particles

1025

00:48:47,970 --> 00:48:45,309

are accelerated during a solar flare so

1026

00:48:50,910 --> 00:48:47,980

we don't understand exactly how they're

1027

00:48:51,960 --> 00:48:50,920

accelerated so these particles are what

1028

00:48:55,050 --> 00:48:51,970

help

1029

00:48:57,839 --> 00:48:55,060

to create the radiation belts and we're

1030

00:48:59,760 --> 00:48:57,849

using the radiation belts now to

1031

00:49:02,730 --> 00:48:59,770

understand the acceleration processes

1032

00:49:07,020 --> 00:49:02,740

that then create the solar flares and

1033

00:49:12,920 --> 00:49:07,030

solar wind so the two are incredibly

1034

00:49:16,380 --> 00:49:12,930

complementary to each other all right

1035

00:49:20,339 --> 00:49:16,390

anyone else want to add to anything in

1036

00:49:22,980 --> 00:49:20,349

in the laboratory setting I can just

1037

00:49:25,800 --> 00:49:22,990

quickly add and basically echo what

1038

00:49:28,589 --> 00:49:25,810

David and Alex said that well there are

1039

00:49:32,220 --> 00:49:28,599

some absolutely fantastic efforts in

1040

00:49:35,730 --> 00:49:32,230

laboratory plasma the huge issue is a

1041

00:49:38,190 --> 00:49:35,740

scale size which it's almost impossible

1042

00:49:41,220 --> 00:49:38,200

to take the entire inner emergency this

1043

00:49:43,470 --> 00:49:41,230

fear you can put it you know down in one

1044

00:49:47,400 --> 00:49:43,480

room laboratory environment and

1045

00:49:50,820 --> 00:49:47,410

unfortunately processes and energetics

1046

00:49:53,310 --> 00:49:50,830

of the system don't easily scale down at

1047

00:49:55,620 --> 00:49:53,320

that level so that's why if we want to

1048

00:49:58,560 --> 00:49:55,630

really understand what happens in

1049

00:50:00,839 --> 00:49:58,570

natural Astrophysical systems would

1050

00:50:03,060 --> 00:50:00,849

really need to once again using the same

1051
00:50:05,970 --> 00:50:03,070
analogy go to our backyard and fly a

1052
00:50:08,609 --> 00:50:05,980
little bit out of the atmosphere and

1053
00:50:12,300 --> 00:50:08,619
start sampling the system there that's

1054
00:50:14,520 --> 00:50:12,310
all I think Sasha really hit the nail on

1055
00:50:20,430 --> 00:50:14,530
the head here by saying that phenomena

1056
00:50:24,570 --> 00:50:20,440
do not ask scale if you in size so if if

1057
00:50:27,300 --> 00:50:24,580
you just take and try to miniaturize and

1058
00:50:29,790 --> 00:50:27,310
recreate Van Allen belts on earth it's

1059
00:50:32,130 --> 00:50:29,800
no guarantee that the phenomena that we

1060
00:50:34,470 --> 00:50:32,140
observe in nature will also be present

1061
00:50:38,310 --> 00:50:34,480
in the scaled-down version that's the

1062
00:50:39,810 --> 00:50:38,320
key I can't help but wonder if you guys

1063
00:50:43,170 --> 00:50:39,820

have been talking with these folks who

1064

00:50:44,670 --> 00:50:43,180

are trying to make magnetic fusion work

1065

00:50:46,140 --> 00:50:44,680

as an energy source here on earth you

1066

00:50:48,150 --> 00:50:46,150

know they're trying to create plasmas

1067

00:50:50,430 --> 00:50:48,160

and magnetically contain them in the lab

1068

00:50:52,740 --> 00:50:50,440

have you talked any fusion researchers

1069

00:50:54,990 --> 00:50:52,750

about what you guys are doing it's

1070

00:50:59,250 --> 00:50:55,000

interesting you bring that up dry and

1071

00:51:01,380 --> 00:50:59,260

because I think there are many there are

1072

00:51:04,230 --> 00:51:01,390

some aspects which actually apply to

1073

00:51:06,079 --> 00:51:04,240

both fields things like plasma

1074

00:51:10,680 --> 00:51:06,089

instabilities and so on

1075

00:51:12,890 --> 00:51:10,690

indeed it's it's not unusual to see a

1076

00:51:16,289 --> 00:51:12,900

plasma physicist wandering into the

1077

00:51:19,620 --> 00:51:16,299

space science arena and vice-versa and I

1078

00:51:26,579 --> 00:51:19,630

think probably Sasha might actually have

1079

00:51:30,109 --> 00:51:26,589

more to add to this no I think you've

1080

00:51:33,210 --> 00:51:30,119

done a good job she in a sense that as

1081

00:51:35,760 --> 00:51:33,220

has been said before the processes that

1082

00:51:38,099 --> 00:51:35,770

accelerate particles are ubiquitous and

1083

00:51:40,710 --> 00:51:38,109

they're lots of lessons that we can

1084

00:51:45,530 --> 00:51:40,720

learn from each other however there are

1085

00:51:48,980 --> 00:51:45,540

some very basic differences between the

1086

00:51:53,190 --> 00:51:48,990

laboratory experiments that target a

1087

00:51:56,039 --> 00:51:53,200

controlled fusion and the regime's in

1088

00:51:57,720 --> 00:51:56,049

space plasma okay it's kind of a very

1089

00:52:02,069 --> 00:51:57,730

short version without getting into

1090

00:52:04,230 --> 00:52:02,079

technical right there a little bit my

1091

00:52:05,849 --> 00:52:04,240

curiosity got to me but maybe this is a

1092

00:52:08,789 --> 00:52:05,859

good time to just kind of remind the

1093

00:52:10,440 --> 00:52:08,799

viewers what this overall mission was

1094

00:52:13,530 --> 00:52:10,450

all about I mean you guys hit the

1095

00:52:15,870 --> 00:52:13,540

jackpot and made a regional discovery on

1096

00:52:17,640 --> 00:52:15,880

the third day of the mission but what

1097

00:52:19,140 --> 00:52:17,650

was the point of launching these two

1098

00:52:22,200 --> 00:52:19,150

probes in the first place

1099

00:52:24,960 --> 00:52:22,210

maybe I'll go for that it's pretty basic

1100

00:52:27,450 --> 00:52:24,970

where do these energetic particles come

1101
00:52:29,730 --> 00:52:27,460
from what what causes them to get those

1102
00:52:31,799 --> 00:52:29,740
energy what moves them around and what

1103
00:52:33,780 --> 00:52:31,809
gets rid of them we've seen all of these

1104
00:52:36,539 --> 00:52:33,790
within the first few days of the mission

1105
00:52:38,670 --> 00:52:36,549
in ways we didn't ever expect to see but

1106
00:52:40,650 --> 00:52:38,680
now the point is to figure it out to

1107
00:52:43,410 --> 00:52:40,660
understand it to be able to predict it

1108
00:52:45,240 --> 00:52:43,420
to put it to use for Humanity in the

1109
00:52:52,500 --> 00:52:45,250
sense of protecting astronauts and

1110
00:52:59,859 --> 00:52:55,210
so well said that I can hardly add

1111
00:53:02,500 --> 00:52:59,869
anything to it all right

1112
00:53:05,200 --> 00:53:02,510
just a reminder we'll get your last few

1113
00:53:08,589 --> 00:53:05,210

questions and we'll be ending promptly

1114

00:53:10,150 --> 00:53:08,599

at 2:00 so send your questions by a

1115

00:53:13,059 --> 00:53:10,160

Google hangout or the Twitter hashtag

1116

00:53:16,420 --> 00:53:13,069

Van Allen and once we're finished this

1117

00:53:17,680 --> 00:53:16,430

will be up on YouTube for all time so

1118

00:53:20,920 --> 00:53:17,690

you can keep watching it over and over

1119

00:53:24,160 --> 00:53:20,930

and over again if you wish I'm gonna

1120

00:53:26,829 --> 00:53:24,170

throw in a question here which is we're

1121

00:53:29,620 --> 00:53:26,839

talking about the effects of the

1122

00:53:30,970 --> 00:53:29,630

radiation belts Menaul the discovery of

1123

00:53:32,650 --> 00:53:30,980

the radiation belt just a sort of it's a

1124

00:53:35,049 --> 00:53:32,660

cool discovery and what can that mean

1125

00:53:36,519 --> 00:53:35,059

for space weather I'd like to go a

1126

00:53:38,799 --> 00:53:36,529

little deeper into what does that mean

1127

00:53:42,490 --> 00:53:38,809

for for modeling and predicting what

1128

00:53:44,170 --> 00:53:42,500

exactly does seeing this extra belt or

1129

00:53:46,539 --> 00:53:44,180

for that matter you can think of it as

1130

00:53:49,120 --> 00:53:46,549

seeing an extra space right an extra

1131

00:53:54,250 --> 00:53:49,130

slot region between the belts what does

1132

00:53:55,870 --> 00:53:54,260

having that slot region mean for for the

1133

00:54:02,490 --> 00:53:55,880

next steps of coming up with theories

1134

00:54:08,920 --> 00:54:05,499

well we have to go back to stretch and

1135

00:54:10,680 --> 00:54:08,930

ask why do these gaps appear where did

1136

00:54:13,089 --> 00:54:10,690

the particles going where they come from

1137

00:54:15,309 --> 00:54:13,099

it's not that we have a shortage of

1138

00:54:17,740 --> 00:54:15,319

theories in fact we have a surplus of

1139

00:54:19,599 --> 00:54:17,750

theories in fact as many scientists as

1140

00:54:21,460 --> 00:54:19,609

there are there are theories and that's

1141

00:54:23,349 --> 00:54:21,470

what makes going to a science meeting so

1142

00:54:25,690 --> 00:54:23,359

interesting because you see them arguing

1143

00:54:28,150 --> 00:54:25,700

about them saying no my theory my theory

1144

00:54:30,069 --> 00:54:28,160

is the right one but the way we're going

1145

00:54:32,650 --> 00:54:30,079

to test them all of them have plausible

1146

00:54:35,200 --> 00:54:32,660

ideas is turn to people like Sacha and

1147

00:54:37,359 --> 00:54:35,210

ask him can you put this in a model can

1148

00:54:39,609 --> 00:54:37,369

you tell if we tell you it's this strong

1149

00:54:41,710 --> 00:54:39,619

and this big and happening here and now

1150

00:54:44,230 --> 00:54:41,720

run your model and tell us what you see

1151
00:54:46,390 --> 00:54:44,240
do you see what was really observed if

1152
00:54:48,339 --> 00:54:46,400
that effect doesn't work try this effect

1153
00:54:50,140 --> 00:54:48,349
move on to the next one maybe it's a

1154
00:54:52,720 --> 00:54:50,150
combination of two or three or more

1155
00:54:54,400 --> 00:54:52,730
let's get it right when Sacha gets the

1156
00:54:56,710 --> 00:54:54,410
model running right and makes

1157
00:54:58,779 --> 00:54:56,720
predictions for us then that's the model

1158
00:55:03,930 --> 00:54:58,789
we want to run to make real space

1159
00:55:08,760 --> 00:55:05,940
maybe very quick one because that once

1160
00:55:11,370 --> 00:55:08,770
again I think that you'll be sure the

1161
00:55:13,200 --> 00:55:11,380
answer can kind of encompasses it but

1162
00:55:15,450 --> 00:55:13,210
going back to Brian's question this is

1163
00:55:18,840 --> 00:55:15,460

exactly why we cannot end the mission

1164

00:55:21,510 --> 00:55:18,850

now you know we had this you know cool

1165

00:55:24,810 --> 00:55:21,520

discovery of this really interesting in

1166

00:55:28,230 --> 00:55:24,820

dynamic structure but going kind of to

1167

00:55:30,710 --> 00:55:28,240

the reason for the press conference and

1168

00:55:33,060 --> 00:55:30,720

the science paper is that structure

1169

00:55:37,170 --> 00:55:33,070

perhaps has never been observed before

1170

00:55:39,060 --> 00:55:37,180

so we just points us to again the fact

1171

00:55:42,990 --> 00:55:39,070

that we're dealing with very very

1172

00:55:45,900 --> 00:55:43,000

dynamic system and we really need

1173

00:55:47,700 --> 00:55:45,910

comprehensive measurements to use for

1174

00:55:50,610 --> 00:55:47,710

this you know models and theories that

1175

00:55:53,490 --> 00:55:50,620

they would just mention before we can

1176
00:55:56,580 --> 00:55:53,500
really constrain them or make you know

1177
00:56:00,840 --> 00:55:56,590
more questions and get more puzzled for

1178
00:56:06,540 --> 00:56:00,850
future future space missions and future

1179
00:56:08,430 --> 00:56:06,550
experiments and discoveries great uh we

1180
00:56:10,860 --> 00:56:08,440
have what is probably gonna be our last

1181
00:56:15,780 --> 00:56:10,870
question just came in from Facebook from

1182
00:56:17,280 --> 00:56:15,790
Heidi can the question is what moved you

1183
00:56:19,680 --> 00:56:17,290
to use the instruments almost

1184
00:56:22,230 --> 00:56:19,690
immediately after launch rather than

1185
00:56:29,490 --> 00:56:22,240
later why don't I start with Shree on

1186
00:56:32,040 --> 00:56:29,500
that one okay so as I mentioned we on

1187
00:56:37,920 --> 00:56:32,050
the wrapped instrument which observed

1188
00:56:41,790 --> 00:56:37,930

these new radiation belts many of us who

1189

00:56:44,520 --> 00:56:41,800

are also part of a older satellite

1190

00:56:47,370 --> 00:56:44,530

mission called Sam packs now Sam packs

1191

00:56:51,300 --> 00:56:47,380

was the very first so-called small

1192

00:56:53,990 --> 00:56:51,310

explorers was launched in 92 and it was

1193

00:56:57,480 --> 00:56:54,000

expected to last nearly three years

1194

00:57:00,630 --> 00:56:57,490

however it lasted twenty years and it

1195

00:57:05,280 --> 00:57:00,640

was just about to come down late

1196

00:57:09,510 --> 00:57:05,290

November last year just a few months

1197

00:57:12,930 --> 00:57:09,520

after RB or Van Allen probes were

1198

00:57:17,660 --> 00:57:12,940

launched so we wanted to increase our

1199

00:57:20,040 --> 00:57:17,670

scientific return by making

1200

00:57:22,710 --> 00:57:20,050

simultaneous measurements while sand

1201
00:57:25,020 --> 00:57:22,720
packs was what we call in a low Earth

1202
00:57:28,350 --> 00:57:25,030
orbit it was close to the Earth's

1203
00:57:30,840 --> 00:57:28,360
surface and Van Allen probes are in an

1204
00:57:33,320 --> 00:57:30,850
equatorial orbit which is at a very high

1205
00:57:39,060 --> 00:57:33,330
altitude goes all the way to six times

1206
00:57:42,480 --> 00:57:39,070
radii so we decided to turn our

1207
00:57:47,190 --> 00:57:42,490
instrument on on day three instead of

1208
00:57:49,950 --> 00:57:47,200
day 30 and hoping to get some new

1209
00:57:53,430 --> 00:57:49,960
science by conjunction studies as we

1210
00:57:56,250 --> 00:57:53,440
call them with this other low-flying

1211
00:57:59,010 --> 00:57:56,260
satellite and by the way we are still

1212
00:58:00,870 --> 00:57:59,020
exploring that option we are gathering

1213
00:58:02,550 --> 00:58:00,880

we are analyzing the final data

1214

00:58:05,250 --> 00:58:02,560

collected by Centex

1215

00:58:09,270 --> 00:58:05,260

so that was the reason why we turned on

1216

00:58:13,680 --> 00:58:09,280

and then as it happened we were we got

1217

00:58:17,370 --> 00:58:13,690

lucky and the Sun was most benevolent to

1218

00:58:20,600 --> 00:58:17,380

us and provided us with this event which

1219

00:58:29,130 --> 00:58:20,610

turned out to be a completely unexpected

1220

00:58:31,530 --> 00:58:29,140

but a very exciting surprise well we are

1221

00:58:33,660 --> 00:58:31,540

just about up with our hour today I want

1222

00:58:35,820 --> 00:58:33,670

to thank everyone for being here thanks

1223

00:58:38,670 --> 00:58:35,830

everyone for watching and thank you to

1224

00:58:41,340 --> 00:58:38,680

all the people who participated Brian

1225

00:58:43,290 --> 00:58:41,350

vast egg from the Washington Post Alex

1226

00:58:46,380 --> 00:58:43,300

Young and Dave Stieb egg and tree

1227

00:58:51,660 --> 00:58:46,390

conical from Goddard from NASA Goddard

1228

00:58:55,200 --> 00:58:51,670

and Sasha from Johns Hopkins APL has

1229

00:58:58,170 --> 00:58:55,210

been a great discussion I this will live

1230

00:59:01,200 --> 00:58:58,180

on YouTube afterwards so if you enjoyed

1231

00:59:04,380 --> 00:59:01,210

watching us today feel free to send the

1232

00:59:05,660 --> 00:59:04,390

link to all of your friends and of

1233

00:59:10,290 --> 00:59:05,670

course you can watch it again and again

1234

00:59:13,470 --> 00:59:10,300

as well for more information in the

1235

00:59:18,540 --> 00:59:13,480

future on heliophysics research at NASA

1236

00:59:21,900 --> 00:59:18,550

you may go to nasa.gov slash Sun Earth

1237

00:59:24,750 --> 00:59:21,910

that's one word sun earth and a reminder

1238

00:59:29,670 --> 00:59:24,760

that youtube link will be available at

1239

00:59:30,270 --> 00:59:29,680

YouTube / NASA Explorer one word we've

1240

00:59:32,550 --> 00:59:30,280

had

1241

00:59:35,760 --> 00:59:32,560

great time with you all today thanks for

1242

00:59:37,890 --> 00:59:35,770

sharing in a new media attempt with us