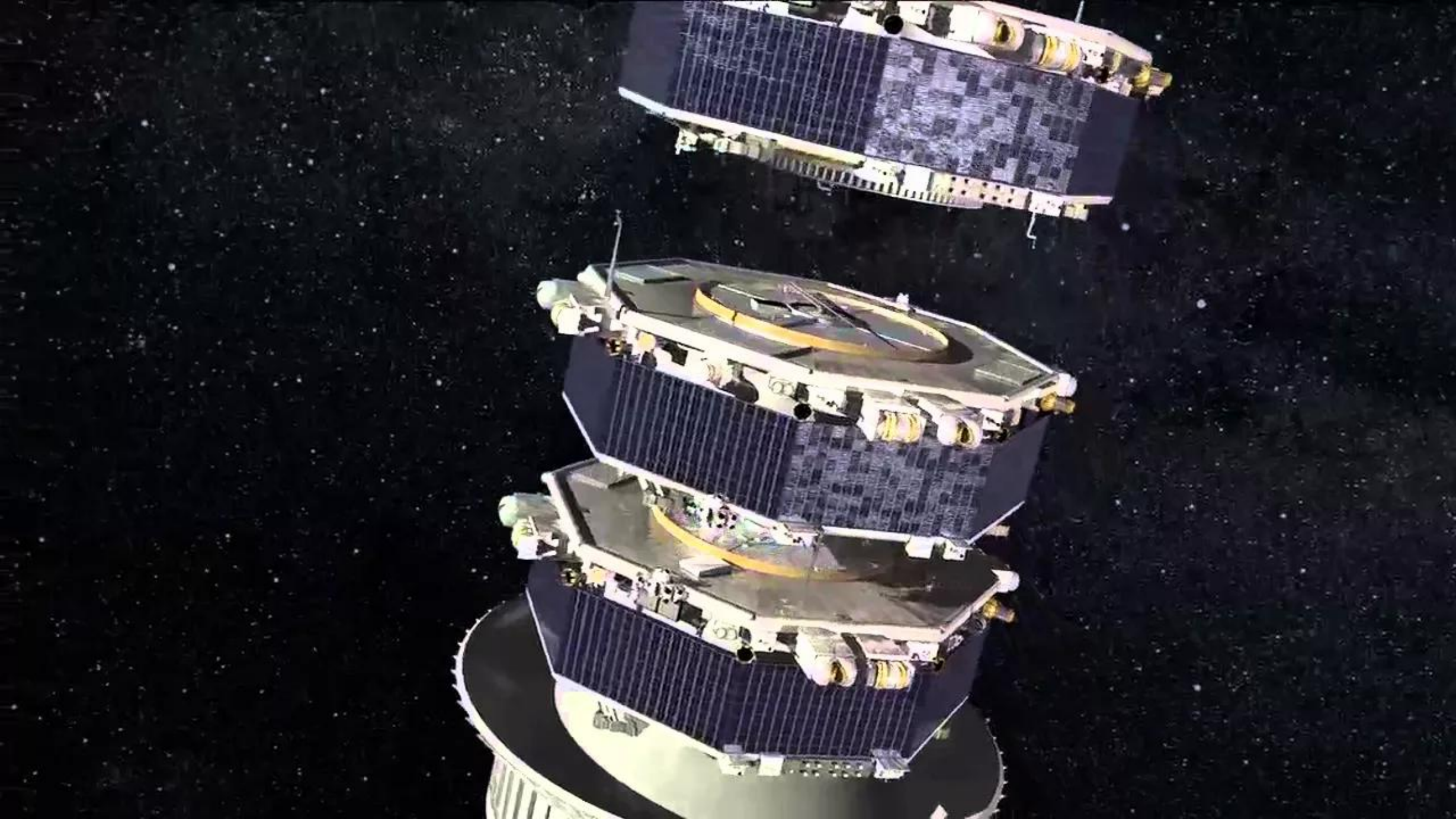

1
00:00:10,009 --> 00:00:04,849
good afternoon my name is Dwane Brown

2
00:00:12,379 --> 00:00:10,019
and welcome to NASA headquarters today's

3
00:00:14,089 --> 00:00:12,389
briefing will discuss the upcoming March

4
00:00:17,630 --> 00:00:14,099
12th launch of NASA's magnetospheric

5
00:00:20,240 --> 00:00:17,640
multiscale or MMS mission that will

6
00:00:25,390 --> 00:00:20,250
study magnetic reconnection around the

7
00:00:28,189 --> 00:00:25,400
earth now that's a lot to swallow but

8
00:00:31,490 --> 00:00:28,199
remember these two words magnetic

9
00:00:34,220 --> 00:00:31,500
reconnection what is it why is it

10
00:00:36,920 --> 00:00:34,230
important to study today you will get

11
00:00:39,350 --> 00:00:36,930
those answers all of the information you

12
00:01:00,279 --> 00:00:39,360
were here today and any updates will be

13
00:01:06,620 --> 00:01:03,590

science coming from this mission Twitter

14
00:01:09,620 --> 00:01:06,630
Facebook and other social media

15
00:01:11,539 --> 00:01:09,630
platforms will have brief presentations

16
00:01:13,310 --> 00:01:11,549
from our participants and then we're

17
00:01:15,350 --> 00:01:13,320
opening up for questions starting here

18
00:01:17,330 --> 00:01:15,360
in the NASA TV studio our phone lines

19
00:01:18,830 --> 00:01:17,340
and the questions from the public

20
00:01:21,410 --> 00:01:18,840
viewing this program on social media

21
00:01:24,890 --> 00:01:21,420
first let me introduce you to today's

22
00:01:25,960 --> 00:01:24,900
participants first you hear from Jeff

23
00:01:28,910 --> 00:01:25,970
Newmark

24
00:01:35,240 --> 00:01:28,920
interim director heliophysics division

25
00:01:42,470 --> 00:01:37,970
birch principal investigator MMS

26
00:01:48,130 --> 00:01:42,480
instrument suite science team Southwest

27
00:01:53,930 --> 00:01:52,490
Greg Dulli MMS project manager and

28
00:01:59,590 --> 00:01:53,940
NASA's Goddard Space Flight Center in

29
00:02:01,940 --> 00:01:59,600
Greenbelt Maryland and Paul casick

30
00:02:04,400 --> 00:02:01,950
associate professor West Virginia

31
00:02:07,880 --> 00:02:04,410
University in Morgantown and with that

32
00:02:10,460 --> 00:02:07,890
we'll start with Jeff Thank You Duane

33
00:02:11,710 --> 00:02:10,470
and good afternoon everyone I'm really

34
00:02:16,340 --> 00:02:11,720
thrilled to be here today to introduce

35
00:02:18,140 --> 00:02:16,350
MMS to you all before we talk about MMS

36
00:02:20,510 --> 00:02:18,150
in detail I wanna step back a little bit

37
00:02:22,280 --> 00:02:20,520
and talk about how it fits in with with

38
00:02:25,190 --> 00:02:22,290

the important work that NASA is doing on

39
00:02:27,860 --> 00:02:25,200
heliophysics physics it's kind of a

40
00:02:29,479 --> 00:02:27,870
strange horror trip to many of you but

41
00:02:31,910 --> 00:02:29,489
it deals with some of the most

42
00:02:34,070 --> 00:02:31,920
fundamental parts that we know starting

43
00:02:36,620 --> 00:02:34,080
with the Sun we all recognize the Sun

44
00:02:39,289 --> 00:02:36,630
and what we're doing is looking at the

45
00:02:40,820 --> 00:02:39,299
Sun and it's extended atmosphere that we

46
00:02:43,970 --> 00:02:40,830
call the heliosphere and how it

47
00:02:45,800 --> 00:02:43,980
interacts with the planets the space

48
00:02:47,509 --> 00:02:45,810
environment around the earth the space

49
00:02:51,710 --> 00:02:47,519
environment on all the planets out to

50
00:02:53,990 --> 00:02:51,720
the edges of our interstellar space this

51
00:02:56,600 --> 00:02:54,000
Sun is actually variable many of you

52
00:02:59,620 --> 00:02:56,610
think of the Sun as a constant but if

53
00:03:01,940 --> 00:02:59,630
you look at this first movie I have here

54
00:03:04,280 --> 00:03:01,950
you'll see what we actually when we look

55
00:03:07,640 --> 00:03:04,290
at national look at the Sun that you see

56
00:03:09,500 --> 00:03:07,650
it's these activity zones you see large

57
00:03:11,810 --> 00:03:09,510
eruptions of the Sun we call solar

58
00:03:14,990 --> 00:03:11,820
storms these storms travel throughout

59
00:03:17,840 --> 00:03:15,000
interests planetary space and at times

60
00:03:20,060 --> 00:03:17,850
the storms interact with the earth and

61
00:03:22,970 --> 00:03:20,070
that interaction can cause what we call

62
00:03:25,449 --> 00:03:22,980
space weather what's what starts these

63
00:03:28,520 --> 00:03:25,459

storms what causes the space weather

64
00:03:30,410 --> 00:03:28,530
around the earth this is a phenomenon

65
00:03:32,000 --> 00:03:30,420
that's wayne already mentioned magnetic

66
00:03:33,530 --> 00:03:32,010
reconnection magnetic reconnection

67
00:03:35,300 --> 00:03:33,540
actually occurs throughout the universe

68
00:03:37,430 --> 00:03:35,310
not just on the sun not just around the

69
00:03:39,470 --> 00:03:37,440
earth but on other planets at the edges

70
00:03:43,729 --> 00:03:39,480
of our solar system and in fact around

71
00:03:46,309 --> 00:03:43,739
black holes large other galaxies this is

72
00:03:48,680 --> 00:03:46,319
a fundamental process that occurs and

73
00:03:52,220 --> 00:03:48,690
MMS is going to revolutionize our

74
00:03:54,560 --> 00:03:52,230
standing of it if you in that movie we

75
00:03:56,210 --> 00:03:54,570
saw as a very large-scale system looking

76
00:03:57,950 --> 00:03:56,220
from the Sun all the way through space

77
00:04:01,700 --> 00:03:57,960
the earth how do we study that system

78
00:04:03,500 --> 00:04:01,710
the next graphic you see here shows you

79
00:04:05,560 --> 00:04:03,510
the our Healy physics system observatory

80
00:04:09,290 --> 00:04:05,570
the fleet of spacecraft that nASA uses

81
00:04:12,080 --> 00:04:09,300
to look at this connected system we're

82
00:04:14,540 --> 00:04:12,090
studying the Sun how the solar storms

83
00:04:18,830 --> 00:04:14,550
erupt from the Sun how they travel

84
00:04:22,009 --> 00:04:18,840
through space how they interact with the

85
00:04:25,310 --> 00:04:22,019
Earth's magnetic environment and and so

86
00:04:29,030 --> 00:04:25,320
we need this whole system together MMS

87
00:04:32,330 --> 00:04:29,040
is going to fill a key part of this new

88
00:04:34,610 --> 00:04:32,340

system you look at the my next view

89
00:04:37,400 --> 00:04:34,620
you'll start to see introduce you to MMS

90
00:04:39,260 --> 00:04:37,410
what does MMS doing it's going to

91
00:04:41,450 --> 00:04:39,270
actually fly in the Earth's

92
00:04:46,220 --> 00:04:41,460
magnetosphere this protective magnetic

93
00:04:49,910 --> 00:04:46,230
environment around the earth and you can

94
00:04:52,010 --> 00:04:49,920
see here the observatories we're using

95
00:04:54,290 --> 00:04:52,020
this environment around the earth as a

96
00:04:55,909 --> 00:04:54,300
natural laboratory we've actually rather

97
00:04:57,590 --> 00:04:55,919
than building one on earth we're going

98
00:05:00,380 --> 00:04:57,600
to wear these magnetic reconnection

99
00:05:03,050 --> 00:05:00,390
actually occurs in space so we can

100
00:05:05,930 --> 00:05:03,060
understand it you'll see here as you see

101
00:05:08,210 --> 00:05:05,940
we have four spacecraft which gives us a

102
00:05:09,710 --> 00:05:08,220
three-dimensional understanding and in

103
00:05:11,830 --> 00:05:09,720
fact a four dimensional understanding

104
00:05:14,630 --> 00:05:11,840
you'll hear about the instruments that

105
00:05:16,909 --> 00:05:14,640
revolutionize our ability to make

106
00:05:18,920 --> 00:05:16,919
measurements in time as well as in space

107
00:05:21,830 --> 00:05:18,930
to tell you some of the details about it

108
00:05:22,340 --> 00:05:21,840
I want to introduce dr. Jim birch thank

109
00:05:24,800 --> 00:05:22,350
you Jeff

110
00:05:26,960 --> 00:05:24,810
sunlight in starlight ionized as thin

111
00:05:29,420 --> 00:05:26,970
gases that fill the solar system and

112
00:05:31,550 --> 00:05:29,430
galaxies and this so-called plasma state

113
00:05:33,860 --> 00:05:31,560

electric and magnetic forces are

114
00:05:36,380 --> 00:05:33,870
stronger than gravity and many dynamic

115
00:05:39,290 --> 00:05:36,390
phenomena occur the most energetic of

116
00:05:40,970 --> 00:05:39,300
these is magnetic reconnection it occurs

117
00:05:43,730 --> 00:05:40,980
when magnetic fields and adjacent

118
00:05:46,220 --> 00:05:43,740
regions of space interconnect and the

119
00:05:48,560 --> 00:05:46,230
process magnetic energy is destroyed and

120
00:05:51,830 --> 00:05:48,570
heat and kinetic energy are released

121
00:05:53,930 --> 00:05:51,840
because of its explosive nature magnetic

122
00:05:57,380 --> 00:05:53,940
reconnection is often described as a

123
00:05:59,990 --> 00:05:57,390
magnetic explosion in space reconnection

124
00:06:02,659 --> 00:06:00,000
is important to us as the engine that

125
00:06:04,369 --> 00:06:02,669
drives space weather and a main dish

126
00:06:06,830 --> 00:06:04,379
- that is frustrating our attempts to

127
00:06:09,980 --> 00:06:06,840
harness nuclear fusion with magnetic

128
00:06:11,989 --> 00:06:09,990
containment devices the MMS mission will

129
00:06:14,749 --> 00:06:11,999
conduct a definitive experiment in space

130
00:06:17,300 --> 00:06:14,759
that will finally allow us to understand

131
00:06:20,089 --> 00:06:17,310
how magnetic reconnection works let's

132
00:06:22,429 --> 00:06:20,099
look at a video magnetic fields exists

133
00:06:25,089 --> 00:06:22,439
throughout the universe and energy is

134
00:06:27,980 --> 00:06:25,099
often released by magnetic reconnection

135
00:06:29,450 --> 00:06:27,990
in the outer parts of our galaxy or at

136
00:06:31,159 --> 00:06:29,460
the centre of our galaxy there's a black

137
00:06:32,959 --> 00:06:31,169
hole and these are x-ray flares that

138
00:06:35,600 --> 00:06:32,969

have been observed recently caused by

139
00:06:37,730 --> 00:06:35,610
reconnection in the sun's superheated

140
00:06:40,550 --> 00:06:37,740
corona magnetic fields create

141
00:06:42,700 --> 00:06:40,560
spectacular loops and arcades the energy

142
00:06:45,409 --> 00:06:42,710
stored in these structures can release

143
00:06:48,860 --> 00:06:45,419
creating explosive solar flares and

144
00:06:50,959 --> 00:06:48,870
coronal mass ejections intense fluxes of

145
00:06:53,390 --> 00:06:50,969
energetic particles and giant clouds of

146
00:06:55,850 --> 00:06:53,400
ionized gas and magnetic fields are

147
00:06:57,950 --> 00:06:55,860
ejected from the Sun and traveled

148
00:07:00,290 --> 00:06:57,960
throughout the solar system when these

149
00:07:02,570 --> 00:07:00,300
clouds impact other magnetic fields such

150
00:07:05,059 --> 00:07:02,580
as the Earth's similar reconnection

151
00:07:08,170 --> 00:07:05,069
events occur and these caused intense

152
00:07:11,540 --> 00:07:08,180
magnetic activity and the Aurora lights

153
00:07:14,749 --> 00:07:11,550
at the same time they accelerate charged

154
00:07:16,700 --> 00:07:14,759
particles to high energies creating a

155
00:07:19,459 --> 00:07:16,710
hazard to space travelers in spacecraft

156
00:07:23,510 --> 00:07:19,469
and even disrupting ground-based power

157
00:07:28,939 --> 00:07:23,520
grids magnetic reconnection also occurs

158
00:07:30,769 --> 00:07:28,949
in laboratory devices and this is a

159
00:07:32,929 --> 00:07:30,779
major magnetic storm at the earth

160
00:07:36,139 --> 00:07:32,939
producing the aurora in the laboratory

161
00:07:38,480 --> 00:07:36,149
devices that are designed to harness

162
00:07:40,309 --> 00:07:38,490
nuclear fusion by heating up the plasma

163
00:07:42,740 --> 00:07:40,319

confined by magnetic fields events

164
00:07:44,749 --> 00:07:42,750
called sawtooth crashes have thwarted

165
00:07:48,740 --> 00:07:44,759
efforts to permanently solve the energy

166
00:07:51,649 --> 00:07:48,750
crisis our next slide shows a simplified

167
00:07:54,230 --> 00:07:51,659
picture of reconnection a fundamental

168
00:07:57,050 --> 00:07:54,240
question is why and how does magnetic

169
00:07:59,659 --> 00:07:57,060
reconnection take place the answer is in

170
00:08:02,629 --> 00:07:59,669
one sense simple but in another sense

171
00:08:04,820 --> 00:08:02,639
complex and mysterious the simple part

172
00:08:06,649 --> 00:08:04,830
is that adjacent magnetic fields

173
00:08:08,990 --> 00:08:06,659
pointing in opposite directions tend to

174
00:08:11,180 --> 00:08:09,000
annihilate each other releasing their

175
00:08:13,009 --> 00:08:11,190
magnetic energy and heating the charged

176
00:08:15,129 --> 00:08:13,019
particles in the surrounding environment

177
00:08:16,370 --> 00:08:15,139
and this process magnetic reconnection

178
00:08:18,050 --> 00:08:16,380
the May

179
00:08:20,180 --> 00:08:18,060
kinetic fields are torn apart and

180
00:08:22,610 --> 00:08:20,190
reattached to their neighbors the

181
00:08:25,700 --> 00:08:22,620
mysterious part is what goes in on

182
00:08:28,130 --> 00:08:25,710
inside the box labeled effusion region

183
00:08:30,500 --> 00:08:28,140
with MMS we will be able to probe the

184
00:08:32,420 --> 00:08:30,510
diffusion region for the first time with

185
00:08:35,150 --> 00:08:32,430
measurements down to the smallest scale

186
00:08:36,760 --> 00:08:35,160
of the plasma the electrons scale to

187
00:08:39,950 --> 00:08:36,770
solve this mystery

188
00:08:42,020 --> 00:08:39,960

the next animation is going to show

189
00:08:44,089 --> 00:08:42,030
reconnection of simulations this is the

190
00:08:46,100 --> 00:08:44,099
magnetosphere solar wind coming in from

191
00:08:48,440 --> 00:08:46,110
the left there are two boxes these are

192
00:08:50,810 --> 00:08:48,450
our targets on the day side and one in

193
00:08:53,930 --> 00:08:50,820
the tail on the right inside these boxes

194
00:08:55,880 --> 00:08:53,940
reconnection is going on and this video

195
00:08:56,990 --> 00:08:55,890
shows how this animation shows one of

196
00:08:59,690 --> 00:08:57,000
the latest and most sophisticated

197
00:09:02,300 --> 00:08:59,700
computer simulations of the diffusion

198
00:09:04,880 --> 00:09:02,310
region we know what goes on outside of

199
00:09:06,950 --> 00:09:04,890
this box from some previous missions but

200
00:09:09,170 --> 00:09:06,960
what goes on inside the box is a mystery

201
00:09:11,990 --> 00:09:09,180
even with the simulations because they

202
00:09:14,540 --> 00:09:12,000
cannot simulate everything computers are

203
00:09:17,060 --> 00:09:14,550
not big enough and so we have to fly

204
00:09:19,220 --> 00:09:17,070
spacecraft in that box and we have to

205
00:09:20,780 --> 00:09:19,230
put four spacecraft in there and make

206
00:09:23,510 --> 00:09:20,790
particle measurements a hundred times

207
00:09:26,060 --> 00:09:23,520
faster that have been attempted in

208
00:09:28,580 --> 00:09:26,070
previous missions now this is our

209
00:09:30,650 --> 00:09:28,590
orbital strategy the videos showing the

210
00:09:32,900 --> 00:09:30,660
launch of the satellites the four

211
00:09:35,150 --> 00:09:32,910
spacecraft in a pyramid configuration

212
00:09:39,290 --> 00:09:35,160
lost on the night side we spend six

213
00:09:41,270 --> 00:09:39,300

months getting the instruments ready and

214
00:09:43,190 --> 00:09:41,280
then we scan through the day side along

215
00:09:45,830 --> 00:09:43,200
the magnetopause where reconnection is

216
00:09:48,230 --> 00:09:45,840
occurring adjusting the spacing between

217
00:09:50,480 --> 00:09:48,240
the spacecraft down to a minimum of 10

218
00:09:53,210 --> 00:09:50,490
kilometers and we make two scans to the

219
00:09:56,360 --> 00:09:53,220
day side at this point we raise the

220
00:09:59,150 --> 00:09:56,370
Apogee 225 Earth radii and make one scan

221
00:10:02,120 --> 00:09:59,160
through the magnetotail also adjusting

222
00:10:03,920 --> 00:10:02,130
the spacing between the spacecraft now

223
00:10:06,800 --> 00:10:03,930
to tell us how we accomplish this with

224
00:10:09,920 --> 00:10:06,810
the spacecraft is Greg Dulli project

225
00:10:12,050 --> 00:10:09,930
manager good afternoon I'm going to talk

226
00:10:14,240 --> 00:10:12,060
just a little bit about these incredible

227
00:10:15,560 --> 00:10:14,250
machines that we've built and how we're

228
00:10:17,750 --> 00:10:15,570
going to fly them to create this

229
00:10:20,420 --> 00:10:17,760
institute flying laboratory that the

230
00:10:23,560 --> 00:10:20,430
gentlemen have just described in my

231
00:10:26,990 --> 00:10:23,570
first photograph which you can see

232
00:10:28,820 --> 00:10:27,000
you'll see the four MMS observatories in

233
00:10:29,900 --> 00:10:28,830
there in the cleanroom at Goddard Space

234
00:10:31,310 --> 00:10:29,910
Flight Center and EDA God

235
00:10:34,780 --> 00:10:31,320
Space Flight Center where we designed

236
00:10:37,790 --> 00:10:34,790
and built and tested these observatories

237
00:10:41,030 --> 00:10:37,800
the instruments and there are a hundred

238
00:10:42,140 --> 00:10:41,040

of them were led and brought to goddard

239
00:10:44,060 --> 00:10:42,150
by the Southwest Research Institute

240
00:10:46,340 --> 00:10:44,070
where we then integrated them with these

241
00:10:49,070 --> 00:10:46,350
four observatories and you can see in

242
00:10:50,810 --> 00:10:49,080
the picture the red covers show you some

243
00:10:52,720 --> 00:10:50,820
examples of the instruments and such and

244
00:10:57,560 --> 00:10:52,730
there are covers on the solar arrays now

245
00:11:00,500 --> 00:10:57,570
in the next photograph we could bring

246
00:11:02,120 --> 00:11:00,510
the next time you see you see the stack

247
00:11:04,760 --> 00:11:02,130
where you can actually see the solar

248
00:11:07,520 --> 00:11:04,770
arrays and the instruments on the top

249
00:11:10,340 --> 00:11:07,530
edge of that octagonal perimeter and

250
00:11:12,320 --> 00:11:10,350
we're flanked there by the two halves of

251
00:11:14,690 --> 00:11:12,330
the Atlas fairing the four meter fairing

252
00:11:18,590 --> 00:11:14,700
each of those MMS spacecraft weighs just

253
00:11:20,810 --> 00:11:18,600
shy of 3,000 pounds about 900 pounds of

254
00:11:22,640 --> 00:11:20,820
that is fuel we carry and they measure

255
00:11:25,040 --> 00:11:22,650
each about four feet tall by about

256
00:11:27,620 --> 00:11:25,050
twelve feet across that octagonal

257
00:11:29,930 --> 00:11:27,630
cross-section a couple things that are

258
00:11:31,790 --> 00:11:29,940
very special about MMS and indeed some

259
00:11:33,890 --> 00:11:31,800
of the challenges we faced in building

260
00:11:36,320 --> 00:11:33,900
them and and some of the reason that we

261
00:11:38,660 --> 00:11:36,330
built them ourselves at NASA is in order

262
00:11:40,730 --> 00:11:38,670
to make the measurements that were

263
00:11:42,410 --> 00:11:40,740

described these very precise a magnetic

264
00:11:44,420 --> 00:11:42,420
field electric field and particle

265
00:11:46,400 --> 00:11:44,430
measurements our own spacecraft has to

266
00:11:49,430 --> 00:11:46,410
be very very clean meaning they can't

267
00:11:52,400 --> 00:11:49,440
have very much a significant electric

268
00:11:54,320 --> 00:11:52,410
field or magnetic moment of their own we

269
00:11:56,360 --> 00:11:54,330
don't want to see our own noise so we've

270
00:11:58,280 --> 00:11:56,370
built spacecraft in this case that are

271
00:12:01,490 --> 00:11:58,290
more than a lot more than a hundred

272
00:12:03,200 --> 00:12:01,500
times lower residual magnetism and more

273
00:12:04,700 --> 00:12:03,210
than a thousand times lower than what is

274
00:12:06,740 --> 00:12:04,710
typical for spacecraft to have in terms

275
00:12:08,300 --> 00:12:06,750
of electric charge so every aspect of

276
00:12:09,980 --> 00:12:08,310
these spacecraft was designed to be very

277
00:12:11,870 --> 00:12:09,990
clean so we can make these precision

278
00:12:13,610 --> 00:12:11,880
measurements the other aspect of these

279
00:12:15,320 --> 00:12:13,620
is these are spinning spacecraft as was

280
00:12:17,810 --> 00:12:15,330
mentioned so they have to be precisely

281
00:12:19,610 --> 00:12:17,820
balanced even as we deplete the fuel

282
00:12:21,530 --> 00:12:19,620
they have to be balanced because we need

283
00:12:22,730 --> 00:12:21,540
to keep an in this little model of MMS

284
00:12:25,040 --> 00:12:22,740
we have to keep these very precisely

285
00:12:27,260 --> 00:12:25,050
oriented with respect to the ecliptic

286
00:12:29,690 --> 00:12:27,270
north of our solar system all the while

287
00:12:31,250 --> 00:12:29,700
while spinning now lastly this is a

288
00:12:34,250 --> 00:12:31,260

fairly large stack and when we stack it

289
00:12:37,250 --> 00:12:34,260
up when you saw it that's about 16 feet

290
00:12:39,650 --> 00:12:37,260
tall but the in this picture what you

291
00:12:43,120 --> 00:12:39,660
can't see is when we when we deploy

292
00:12:47,580 --> 00:12:43,130
these we then extend sensor booms

293
00:12:49,270 --> 00:12:47,590
each one of these we deploy 16 feet of

294
00:12:51,280 --> 00:12:49,280
magnetometer booms you'll see those

295
00:12:54,280 --> 00:12:51,290
unfolding a video in a moment we then

296
00:12:56,890 --> 00:12:54,290
also extend 50 feet of booms out that

297
00:13:00,400 --> 00:12:56,900
along the spin axis this way and then we

298
00:13:02,470 --> 00:13:00,410
finally on four sides put out almost 200

299
00:13:04,360 --> 00:13:02,480
feet of wire booms with sensors on the

300
00:13:06,880 --> 00:13:04,370
end all of these booms then enable us to

301
00:13:08,950 --> 00:13:06,890
measure in three dimensions the electric

302
00:13:10,990 --> 00:13:08,960
fields in the magnetic fields we do all

303
00:13:13,060 --> 00:13:11,000
this with spinning spacecraft that we're

304
00:13:16,240 --> 00:13:13,070
flying in a formation as close as 10

305
00:13:19,620 --> 00:13:16,250
kilometers to give you some sense of

306
00:13:22,690 --> 00:13:19,630
scale once we've deployed these booms an

307
00:13:24,880 --> 00:13:22,700
MMS footprint is about the size of a

308
00:13:27,850 --> 00:13:24,890
full baseball field so we end up flying

309
00:13:29,350 --> 00:13:27,860
for baseball fields kind of in a

310
00:13:31,330 --> 00:13:29,360
distance that ends up being about the

311
00:13:34,540 --> 00:13:31,340
size of Washington DC separation when

312
00:13:36,430 --> 00:13:34,550
we're 10 kilometres apart in the video

313
00:13:38,050 --> 00:13:36,440

we'll show next and we can bring it up

314
00:13:40,000 --> 00:13:38,060
and I'll narrate it I'll describe a

315
00:13:41,200 --> 00:13:40,010
little bit about what are what are only

316
00:13:43,510 --> 00:13:41,210
a few weeks from now it's going to look

317
00:13:46,060 --> 00:13:43,520
like that's the Atlas rocket on the pad

318
00:13:49,090 --> 00:13:46,070
of course that's our launch vehicle in

319
00:13:51,100 --> 00:13:49,100
some aspects of this video are sped up

320
00:13:52,420 --> 00:13:51,110
otherwise this must come to be very long

321
00:13:54,550 --> 00:13:52,430
and I'll comment on that when you see

322
00:13:57,730 --> 00:13:54,560
them but there's our launch on the Atlas

323
00:14:00,520 --> 00:13:57,740
5 we then here you'll see the booster

324
00:14:02,860 --> 00:14:00,530
separate in the Centaur upper stage will

325
00:14:05,680 --> 00:14:02,870
carry us on our initial orbit that Jim

326
00:14:07,720 --> 00:14:05,690
showed you the fairing separates which

327
00:14:09,670 --> 00:14:07,730
we detect and there's our stack of four

328
00:14:11,890 --> 00:14:09,680
MMS spacecrafts already spun up by the

329
00:14:14,830 --> 00:14:11,900
Atlas centaur now you'll see them start

330
00:14:16,540 --> 00:14:14,840
to separate from the top down in in

331
00:14:18,610 --> 00:14:16,550
actuality it's about five minutes

332
00:14:20,320 --> 00:14:18,620
between the separation events as we get

333
00:14:22,030 --> 00:14:20,330
a the separation distance we want

334
00:14:25,830 --> 00:14:22,040
initially we sped it up here to show you

335
00:14:27,880 --> 00:14:25,840
and here you'll see that first 16-foot

336
00:14:29,380 --> 00:14:27,890
magnetometer pair of booms deploy

337
00:14:34,200 --> 00:14:29,390
outward on the bottom side of the

338
00:14:37,000 --> 00:14:34,210

spacecraft and then shortly we will see

339
00:14:40,270 --> 00:14:37,010
the example where we start releasing

340
00:14:41,590 --> 00:14:40,280
those 200-foot wire booms out the side

341
00:14:43,000 --> 00:14:41,600
all the while while spinning all the

342
00:14:46,060 --> 00:14:43,010
wobble keeping this thing very very

343
00:14:48,220 --> 00:14:46,070
stable and then finally in this in this

344
00:14:51,550 --> 00:14:48,230
in this video you'll see those both spin

345
00:14:53,710 --> 00:14:51,560
axis or axial booms deployed up where

346
00:14:57,010 --> 00:14:53,720
they uncoil their folded coil booms

347
00:14:59,740 --> 00:14:57,020
leaving us with with these very large

348
00:15:02,440 --> 00:14:59,750
spacecraft in a formation that forms

349
00:15:04,780 --> 00:15:02,450
this laboratory and as this video rolls

350
00:15:06,730 --> 00:15:04,790
on with another Liberty with the video

351
00:15:07,810 --> 00:15:06,740
as you can begin to see other MMS in the

352
00:15:09,760 --> 00:15:07,820
picture I don't think you'd see them

353
00:15:11,200 --> 00:15:09,770
quite this well at ten kilometres but

354
00:15:14,320 --> 00:15:11,210
you get the idea we are flying these

355
00:15:16,780 --> 00:15:14,330
four spinning very large once deployed

356
00:15:20,050 --> 00:15:16,790
spacecraft in formation we maintain that

357
00:15:22,510 --> 00:15:20,060
formation to an accuracy of a hundred

358
00:15:25,360 --> 00:15:22,520
meters so I'm flying ten kilometres

359
00:15:27,550 --> 00:15:25,370
apart using the GPS on the that is

360
00:15:29,290 --> 00:15:27,560
actually below us a GPS system we built

361
00:15:31,120 --> 00:15:29,300
we keep track and maneuver this

362
00:15:35,110 --> 00:15:31,130
formation to the to within a hundred

363
00:15:37,450 --> 00:15:35,120

meters now to talk a little bit more

364
00:15:39,310 --> 00:15:37,460
about the bigger picture of what we're

365
00:15:41,290 --> 00:15:39,320
doing with MMS and how it fits in the

366
00:15:44,890 --> 00:15:41,300
bigger picture of heliophysics I'll I'll

367
00:15:46,360 --> 00:15:44,900
turn it over to Paul Thank You Craig so

368
00:15:48,880 --> 00:15:46,370
I'm really excited to talk to you today

369
00:15:51,070 --> 00:15:48,890
about why scientists are waiting with

370
00:15:53,320 --> 00:15:51,080
bated breath for MMS to be launched and

371
00:15:55,300 --> 00:15:53,330
why everyone should also be excited

372
00:15:59,770 --> 00:15:55,310
about what we're going to be able to

373
00:16:01,870 --> 00:15:59,780
learn so the first M in MMS stands for

374
00:16:03,700 --> 00:16:01,880
my neato spheric the earth has a

375
00:16:06,310 --> 00:16:03,710
magnetic field that sticks out into

376
00:16:08,260 --> 00:16:06,320
space and a part of space where the

377
00:16:10,480 --> 00:16:08,270
magnetic field is dominant is called the

378
00:16:14,680 --> 00:16:10,490
magnetosphere outside the magnetosphere

379
00:16:16,450 --> 00:16:14,690
you have particles from the Sun being

380
00:16:19,360 --> 00:16:16,460
spewed out that's called the solar wind

381
00:16:21,220 --> 00:16:19,370
and those particles that would normally

382
00:16:22,930 --> 00:16:21,230
run into Earth instead they run into the

383
00:16:24,670 --> 00:16:22,940
Earth's magnetic field so the Earth's

384
00:16:27,820 --> 00:16:24,680
magnetic field is very important in

385
00:16:30,910 --> 00:16:27,830
protecting us from the particles from

386
00:16:33,220 --> 00:16:30,920
the Sun so shown here in my first

387
00:16:34,960 --> 00:16:33,230
graphic is a sketch of the Earth's

388
00:16:37,450 --> 00:16:34,970

magnetosphere which comes from a

389
00:16:38,890 --> 00:16:37,460
computer simulation the earth is the

390
00:16:40,600 --> 00:16:38,900
ball in the middle and the

391
00:16:42,850 --> 00:16:40,610
strange-looking yellow lines represent

392
00:16:45,580 --> 00:16:42,860
the magnetic field the lines connecting

393
00:16:48,460 --> 00:16:45,590
to the earth in the center are in our

394
00:16:50,230 --> 00:16:48,470
the magnetosphere and on the left you

395
00:16:53,470 --> 00:16:50,240
see a magnetic field line and that one

396
00:16:55,990 --> 00:16:53,480
is being pushed in away from the Sun by

397
00:16:57,820 --> 00:16:56,000
the solar wind towards the earth so as

398
00:16:59,830 --> 00:16:57,830
we've heard from the other panelists the

399
00:17:01,420 --> 00:16:59,840
MMS mission is designed to study

400
00:17:04,780 --> 00:17:01,430
magnetic reconnection using the

401
00:17:06,760 --> 00:17:04,790
magnetosphere as a laboratory it occurs

402
00:17:08,590 --> 00:17:06,770
when oppositely directed magnetic fields

403
00:17:10,840 --> 00:17:08,600
point in opposite directions and they

404
00:17:12,760 --> 00:17:10,850
come together and effectively break

405
00:17:15,039 --> 00:17:12,770
so we will see this in motion in a

406
00:17:17,169 --> 00:17:15,049
moment magnetic fields from the solar

407
00:17:19,000 --> 00:17:17,179
wind in this animation will come in from

408
00:17:20,620 --> 00:17:19,010
the left side and when they reach the

409
00:17:22,689 --> 00:17:20,630
magnetosphere they will break and that's

410
00:17:25,659 --> 00:17:22,699
what magnetic reconnection is so let's

411
00:17:27,549 --> 00:17:25,669
go ahead and roll the animation so you

412
00:17:29,380 --> 00:17:27,559
can see the field lines coming in from

413
00:17:31,930 --> 00:17:29,390

the left and breaking when they reach

414
00:17:34,570 --> 00:17:31,940
the magnetosphere and that's a magnetic

415
00:17:36,370 --> 00:17:34,580
reconnection but the process doesn't end

416
00:17:39,190 --> 00:17:36,380
there you see these magnetic fields

417
00:17:41,529 --> 00:17:39,200
being dragged away from the Sun and when

418
00:17:44,590 --> 00:17:41,539
they get to the the far side of the

419
00:17:46,090 --> 00:17:44,600
earth the field lines are oppositely

420
00:17:48,520 --> 00:17:46,100
directed again and they break again

421
00:17:50,260 --> 00:17:48,530
that's again the process of magnetic

422
00:17:51,899 --> 00:17:50,270
reconnection and you can see what

423
00:17:54,220 --> 00:17:51,909
happens is the magnetic field lines

424
00:17:57,430 --> 00:17:54,230
shoot back towards Earth and that's

425
00:17:59,110 --> 00:17:57,440
where it gets interesting for us so the

426
00:18:01,600 --> 00:17:59,120
magnetic fields snap back like rubber

427
00:18:04,720 --> 00:18:01,610
bands and blast these hot particles back

428
00:18:06,250 --> 00:18:04,730
towards the earth so as we saw in Jim's

429
00:18:09,190 --> 00:18:06,260
animation some of these particles

430
00:18:11,289 --> 00:18:09,200
harmlessly run into the atmosphere at

431
00:18:13,570 --> 00:18:11,299
earth and when they do they excite the

432
00:18:15,520 --> 00:18:13,580
gas up there and they the gas ends up

433
00:18:17,890 --> 00:18:15,530
giving off light and that's what we on

434
00:18:20,320 --> 00:18:17,900
earth see as the northern and southern

435
00:18:24,220 --> 00:18:20,330
lights also known as aurora as pictured

436
00:18:26,320 --> 00:18:24,230
here however as we've also heard from

437
00:18:28,180 --> 00:18:26,330
the other panelists the particles can

438
00:18:31,270 --> 00:18:28,190

cause problems too so there's a number

439
00:18:33,730 --> 00:18:31,280
of satellites in space that we use for

440
00:18:36,909 --> 00:18:33,740
very important things like cell phone

441
00:18:39,460 --> 00:18:36,919
communication and GPS so if these

442
00:18:42,909 --> 00:18:39,470
particles run into the satellites they

443
00:18:44,770 --> 00:18:42,919
can short out the circuits and can knock

444
00:18:47,770 --> 00:18:44,780
out the satellites and that would cause

445
00:18:50,020 --> 00:18:47,780
problems for cell phone reception the

446
00:18:52,390 --> 00:18:50,030
moving magnetic fields can also drive

447
00:18:56,169 --> 00:18:52,400
electric currents on the earth and that

448
00:18:58,600 --> 00:18:56,179
can overload transformers and lead to

449
00:19:00,640 --> 00:18:58,610
power outages which has happened in

450
00:19:03,250 --> 00:19:00,650
Canada and the United States and parts

451
00:19:05,890 --> 00:19:03,260
of Europe so all of these are aspects of

452
00:19:08,169 --> 00:19:05,900
what are known as what's known as space

453
00:19:10,299 --> 00:19:08,179
weather and so you can see that magnetic

454
00:19:13,960 --> 00:19:10,309
reconnection plays a very important part

455
00:19:15,340 --> 00:19:13,970
in space weather and that's why it's

456
00:19:17,590 --> 00:19:15,350
important for us to study the

457
00:19:19,419 --> 00:19:17,600
fundamental science of magnetic

458
00:19:21,880 --> 00:19:19,429
reconnection in order to understand it

459
00:19:23,950 --> 00:19:21,890
so that's just one reason that MMS is

460
00:19:25,630 --> 00:19:23,960
important to all of us

461
00:19:28,860 --> 00:19:25,640
so why is mms so important to science

462
00:19:31,950 --> 00:19:28,870
scientists so going back to the name mms

463
00:19:34,720 --> 00:19:31,960

ii M and the F stand for multi scale

464
00:19:37,480 --> 00:19:34,730
this signifies that reconnection happens

465
00:19:40,360 --> 00:19:37,490
at a very small region in space as we

466
00:19:42,760 --> 00:19:40,370
saw in the animation but it impacts a

467
00:19:44,980 --> 00:19:42,770
huge region of space of the whole

468
00:19:47,380 --> 00:19:44,990
magnetosphere which is a million miles

469
00:19:49,630 --> 00:19:47,390
long this makes it extremely difficult

470
00:19:52,150 --> 00:19:49,640
to study so like a cosmic version of

471
00:19:53,890 --> 00:19:52,160
finding a needle in a haystack the best

472
00:19:55,510 --> 00:19:53,900
we've been able to measure magnetic

473
00:19:57,490 --> 00:19:55,520
reconnection in the magnetosphere has

474
00:20:01,030 --> 00:19:57,500
been with a mission with four satellites

475
00:20:04,570 --> 00:20:01,040
in a pyramid and they were separated by

476
00:20:06,820 --> 00:20:04,580
600 kilometres or more so 600 kilometres

477
00:20:09,870 --> 00:20:06,830
is the distance from Washington DC to

478
00:20:12,610 --> 00:20:09,880
Boston but as we've heard from Craig the

479
00:20:14,470 --> 00:20:12,620
four spacecraft for MMS will be

480
00:20:16,660 --> 00:20:14,480
separated by only 10 kilometers which is

481
00:20:18,310 --> 00:20:16,670
about the size of Washington DC so much

482
00:20:21,460 --> 00:20:18,320
closer than we've ever been able to see

483
00:20:23,710 --> 00:20:21,470
before in addition as we've heard we'll

484
00:20:25,450 --> 00:20:23,720
get the data much faster than we have in

485
00:20:27,790 --> 00:20:25,460
the past a hundred times faster than

486
00:20:29,860 --> 00:20:27,800
previous missions so to get a feel for

487
00:20:31,960 --> 00:20:29,870
what this is like picture watching a

488
00:20:33,730 --> 00:20:31,970

football game and you can watch for a

489
00:20:35,680 --> 00:20:33,740
minute at a time but you have to wait an

490
00:20:37,390 --> 00:20:35,690
hour in between times that you can watch

491
00:20:39,670 --> 00:20:37,400
it would be really hard to figure out

492
00:20:41,140 --> 00:20:39,680
what's going on in the football game so

493
00:20:43,600 --> 00:20:41,150
these are the problems that have been

494
00:20:46,150 --> 00:20:43,610
plaguing researchers studying magnetic

495
00:20:49,480 --> 00:20:46,160
reconnection is that we can't see the

496
00:20:51,190 --> 00:20:49,490
smaller scales and we can't process the

497
00:20:52,570 --> 00:20:51,200
data fast enough to really understand

498
00:20:55,120 --> 00:20:52,580
what happens right at the place where

499
00:20:56,560 --> 00:20:55,130
magnetic reconnection happens so this

500
00:20:59,830 --> 00:20:56,570
makes it difficult to see for example

501
00:21:02,350 --> 00:20:59,840
how particles get accelerated and heated

502
00:21:04,600 --> 00:21:02,360
during magnetic reconnection events so

503
00:21:05,860 --> 00:21:04,610
you can see NASA's MMS mission is really

504
00:21:08,140 --> 00:21:05,870
going to give scientists an

505
00:21:11,890 --> 00:21:08,150
unprecedented opportunity to study

506
00:21:15,460 --> 00:21:11,900
reconnection go back to tween thank you

507
00:21:18,040 --> 00:21:15,470
Paul and in folks okay so let's see if

508
00:21:20,320 --> 00:21:18,050
we can go ahead and go take questions

509
00:21:22,540 --> 00:21:20,330
we're start with we're here in the NASA

510
00:21:23,920 --> 00:21:22,550
TV studio with the question here and

511
00:21:25,870 --> 00:21:23,930
then we'll go to the phone lines and

512
00:21:28,120 --> 00:21:25,880
then we'll go to social media if you can

513
00:21:31,480 --> 00:21:28,130

wait for the microphone say your name in

514
00:21:33,220 --> 00:21:31,490
you know affiliation please Adam interim

515
00:21:35,950 --> 00:21:33,230
until news service and actually a

516
00:21:37,330 --> 00:21:35,960
question for Greg you mentioned the four

517
00:21:39,430 --> 00:21:37,340
different

518
00:21:41,410 --> 00:21:39,440
shuttles that are being used can you

519
00:21:44,050 --> 00:21:41,420
explain why specifically there needed to

520
00:21:46,360 --> 00:21:44,060
be for and whether kind of these four

521
00:21:48,700 --> 00:21:46,370
shuttles flying so close together is a

522
00:21:54,040 --> 00:21:48,710
norm and something that typically is

523
00:21:55,630 --> 00:21:54,050
done but their spacecraft or

524
00:21:57,670 --> 00:21:55,640
observatories but I wouldn't I wouldn't

525
00:21:59,530 --> 00:21:57,680
call them shuttles I mean we have we

526
00:22:01,480 --> 00:21:59,540
have for MMS spacecraft we there's a

527
00:22:04,780 --> 00:22:01,490
model of them there but the reason we

528
00:22:06,970 --> 00:22:04,790
have four is is as we've talked about we

529
00:22:09,010 --> 00:22:06,980
want to measure this phenomenon we want

530
00:22:10,840 --> 00:22:09,020
to capture it in three dimensions and so

531
00:22:12,760 --> 00:22:10,850
if you just kind of imagine if I've got

532
00:22:15,460 --> 00:22:12,770
three things no matter how I put them

533
00:22:17,230 --> 00:22:15,470
down they'll define a plane I can only

534
00:22:18,820 --> 00:22:17,240
get two dimensions with three objects so

535
00:22:21,730 --> 00:22:18,830
in order to have four measurements

536
00:22:23,620 --> 00:22:21,740
simultaneously of whatever's going on I

537
00:22:25,030 --> 00:22:23,630
really need to have at least four points

538
00:22:27,100 --> 00:22:25,040

in space and that's what we talked about

539
00:22:28,930 --> 00:22:27,110
making a pyramid there's three of them

540
00:22:31,720 --> 00:22:28,940
and another one here so now we have a

541
00:22:33,430 --> 00:22:31,730
three dimensional shall we say sensor

542
00:22:35,920 --> 00:22:33,440
made up of four satellites so we can

543
00:22:42,790 --> 00:22:35,930
know what's going on in 3d and we also

544
00:22:47,470 --> 00:22:44,890
studies in the future know that this

545
00:22:49,660 --> 00:22:47,480
mission is this mission is is dedicated

546
00:22:51,550 --> 00:22:49,670
and indeed we we anticipate it will

547
00:22:53,470 --> 00:22:51,560
largely solve the mystery of magnetic

548
00:22:55,300 --> 00:22:53,480
reconnection but it's it's a mission

549
00:22:57,820 --> 00:22:55,310
dedicated to that they'll fly for two

550
00:22:59,980 --> 00:22:57,830
years possibly more if we if we decide

551
00:23:02,490 --> 00:22:59,990
to extend the mission but they're Persol

552
00:23:04,990 --> 00:23:02,500
purposes is to is to probe and really

553
00:23:11,110 --> 00:23:05,000
understand and solve the mysteries of

554
00:23:13,030 --> 00:23:11,120
magnetic reconnection okay we're gonna

555
00:23:17,770 --> 00:23:13,040
kind of switch gears here we're gonna go

556
00:23:20,140 --> 00:23:17,780
to social media and Karen Fox who's on

557
00:23:21,370 --> 00:23:20,150
the board there what's going on in

558
00:23:24,820 --> 00:23:21,380
community of course since they're coming

559
00:23:29,020 --> 00:23:24,830
up some questions for you at bone Drake

560
00:23:31,390 --> 00:23:29,030
has asked us she's been studying SMAP a

561
00:23:33,130 --> 00:23:31,400
recent NASA mission in her high school

562
00:23:34,960 --> 00:23:33,140
Global Studies class she's wondering

563
00:23:36,940 --> 00:23:34,970

whether MMS will be related to that and

564
00:23:39,430 --> 00:23:36,950
then the question is how will MMS data

565
00:23:43,840 --> 00:23:39,440
be connected to some of the other

566
00:23:46,150 --> 00:23:43,850
missions that we have so this is Jeff

567
00:23:48,640 --> 00:23:46,160
DeMarco I'll take that

568
00:23:50,700 --> 00:23:48,650
SMAP is an earth science mission looking

569
00:23:53,250 --> 00:23:50,710
at soil moisture

570
00:23:57,390 --> 00:23:53,260
and this mission is not really related

571
00:23:59,130 --> 00:23:57,400
to that it really is looking at a very

572
00:24:00,990 --> 00:23:59,140
different phenomenon no it's really

573
00:24:03,120 --> 00:24:01,000
looking at the environment our near

574
00:24:05,370 --> 00:24:03,130
space environment where SMAP is looking

575
00:24:09,000 --> 00:24:05,380
down at the soy so in the soil

576
00:24:14,790 --> 00:24:09,010
throughout the over the earth in terms

577
00:24:16,460 --> 00:24:14,800
of how the data works together again

578
00:24:20,400 --> 00:24:16,470
where I showed you earlier in the video

579
00:24:22,740 --> 00:24:20,410
we have today spacecraft that look at

580
00:24:25,860 --> 00:24:22,750
the Sun look at the initiation of those

581
00:24:28,050 --> 00:24:25,870
solar storms we watch those storms

582
00:24:31,410 --> 00:24:28,060
travel through interplanetary space

583
00:24:33,990 --> 00:24:31,420
going towards the earth and then we we

584
00:24:35,760 --> 00:24:34,000
don't really know what happens as they

585
00:24:39,120 --> 00:24:35,770
interact with the Earth's magnetic field

586
00:24:42,420 --> 00:24:39,130
so we use the other spacecraft to set up

587
00:24:44,520 --> 00:24:42,430
the contacts and that allows MMS to then

588
00:24:45,960 --> 00:24:44,530

study the details of what's going on in

589
00:24:49,530 --> 00:24:45,970
that magnetic reconnection zone that you

590
00:24:51,060 --> 00:24:49,540
heard so much about you have any other

591
00:24:52,350 --> 00:24:51,070
questions can but take two more from

592
00:24:54,930 --> 00:24:52,360
social media and we go to the phone line

593
00:24:57,600 --> 00:24:54,940
and we'll come back another question

594
00:25:00,210 --> 00:24:57,610
from at beastmode I wanted to follow up

595
00:25:03,000 --> 00:25:00,220
on the GPS that Craig Tooley mentioned

596
00:25:06,600 --> 00:25:03,010
can you describe how mms uses GPS and

597
00:25:08,160 --> 00:25:06,610
relies on it please sure our GPS system

598
00:25:10,790 --> 00:25:08,170
and and it's actually got a name it's

599
00:25:13,800 --> 00:25:10,800
called navigator which is quite fitting

600
00:25:15,840 --> 00:25:13,810
the way the way it works is what I mean

601
00:25:17,100 --> 00:25:15,850
much as we use GPS on the ground as you

602
00:25:19,080 --> 00:25:17,110
would use in your handheld or in your

603
00:25:21,180 --> 00:25:19,090
car or on your phone we use it to

604
00:25:22,890 --> 00:25:21,190
determine our location of each

605
00:25:25,500 --> 00:25:22,900
Observatory which is very important

606
00:25:27,840 --> 00:25:25,510
because that's that's how we you know we

607
00:25:29,490 --> 00:25:27,850
we begin to understand where we are in

608
00:25:32,390 --> 00:25:29,500
these orbits because essentially MMS

609
00:25:34,440 --> 00:25:32,400
flies for very similar but not identical

610
00:25:36,330 --> 00:25:34,450
orbits all the time in order to maintain

611
00:25:37,920 --> 00:25:36,340
that formation you can imagine for over

612
00:25:39,930 --> 00:25:37,930
the lines that are very close so we need

613
00:25:42,360 --> 00:25:39,940

to know precisely where each one is in

614
00:25:45,260 --> 00:25:42,370
relation to the earth now the thing it

615
00:25:48,060 --> 00:25:45,270
is very very novel and actually

616
00:25:51,090 --> 00:25:48,070
interesting about MMS is GPS system is

617
00:25:53,490 --> 00:25:51,100
the GPS constellation is far below us

618
00:25:55,860 --> 00:25:53,500
you know we are much higher than that

619
00:25:57,480 --> 00:25:55,870
constellation of GPS satellites and so

620
00:26:00,360 --> 00:25:57,490
our system is able to actually pick up

621
00:26:00,840 --> 00:26:00,370
very very weak signals from the side

622
00:26:03,720 --> 00:26:00,850
lobes

623
00:26:05,490 --> 00:26:03,730
you know from of those GPS

624
00:26:07,920 --> 00:26:05,500
satellites and from that it can

625
00:26:10,200 --> 00:26:07,930
triangulate and determine where each of

626
00:26:12,720 --> 00:26:10,210
our MMS satellites is it also gets very

627
00:26:14,850 --> 00:26:12,730
precise timing of when we're there and

628
00:26:17,970 --> 00:26:14,860
then we that is continually we send that

629
00:26:19,920 --> 00:26:17,980
to the ground we use that end to to

630
00:26:21,600 --> 00:26:19,930
design and plan the maneuvers that

631
00:26:23,910 --> 00:26:21,610
actually adjust the formation to

632
00:26:25,890 --> 00:26:23,920
maintain not too far apart not too close

633
00:26:28,650 --> 00:26:25,900
together and the right shape and

634
00:26:30,360 --> 00:26:28,660
instantly as we do that we get feedback

635
00:26:31,980 --> 00:26:30,370
from the science team it's it's not

636
00:26:33,210 --> 00:26:31,990
something we've known in advance some of

637
00:26:35,700 --> 00:26:33,220
the interesting things about the mission

638
00:26:39,210 --> 00:26:35,710

is will be fine-tuning that that

639
00:26:40,530 --> 00:26:39,220
separation in order to optimize as we

640
00:26:41,850 --> 00:26:40,540
see the data they'll be looking at this

641
00:26:43,500 --> 00:26:41,860
data real-time throughout the mission

642
00:26:46,190 --> 00:26:43,510
and we'll be tuning that that

643
00:26:48,570 --> 00:26:46,200
laboratories to collect the data

644
00:26:50,310 --> 00:26:48,580
one more Karen and then we'll go to the

645
00:26:53,130 --> 00:26:50,320
phone lines alright another question

646
00:26:55,740 --> 00:26:53,140
from at galaxy galius the question is

647
00:26:57,420 --> 00:26:55,750
what to expect to be the lifespan of MMS

648
00:26:59,340 --> 00:26:57,430
and do we think that the sun's radiation

649
00:27:04,650 --> 00:26:59,350
could have an effect either on the

650
00:27:07,800 --> 00:27:04,660
mission or on the data the MMS mission

651
00:27:10,050 --> 00:27:07,810
is actually nominally planned for two

652
00:27:13,440 --> 00:27:10,060
years of science gathering it's preceded

653
00:27:15,930 --> 00:27:13,450
by six months as as dr. Burch described

654
00:27:18,120 --> 00:27:15,940
as we wait for our orbit actually to get

655
00:27:20,070 --> 00:27:18,130
around into that region of interest in

656
00:27:21,450 --> 00:27:20,080
the magnetopause in front well we'll

657
00:27:24,300 --> 00:27:21,460
swing through that may need to pause

658
00:27:26,910 --> 00:27:24,310
twice and then we will double our orbit

659
00:27:28,620 --> 00:27:26,920
size our apogee our farthest point and

660
00:27:30,150 --> 00:27:28,630
we'll swing through the tail and that's

661
00:27:33,200 --> 00:27:30,160
the second year so but this is

662
00:27:36,300 --> 00:27:33,210
essentially a two-year science campaign

663
00:27:38,850 --> 00:27:36,310

we carry fuel so if if it makes sense

664
00:27:40,230 --> 00:27:38,860
and there's and and still something to

665
00:27:43,350 --> 00:27:40,240
be done we could potentially do some

666
00:27:45,090 --> 00:27:43,360
more work afterwards if NASA decides

667
00:27:47,190 --> 00:27:45,100
that's warranted so we won't run out of

668
00:27:51,030 --> 00:27:47,200
feel quite that soon in terms of the

669
00:27:52,980 --> 00:27:51,040
radiation it the although magnetic

670
00:27:54,600 --> 00:27:52,990
reconnection sounds very explosive and

671
00:27:56,760 --> 00:27:54,610
it is from the standpoint of the

672
00:27:59,250 --> 00:27:56,770
electronics and such we have built on

673
00:28:01,590 --> 00:27:59,260
the spacecraft these orbits this region

674
00:28:03,990 --> 00:28:01,600
in space is fairly typical of what we

675
00:28:06,360 --> 00:28:04,000
see for satellites it's in fact some of

676
00:28:08,370 --> 00:28:06,370
the time it's less severe than what

677
00:28:10,440 --> 00:28:08,380
geostationary satellites see as we pass

678
00:28:13,380 --> 00:28:10,450
in and out of the radiation belts so in

679
00:28:15,300 --> 00:28:13,390
terms of radiation this is a typical

680
00:28:17,160 --> 00:28:15,310
kind of environment for us to build

681
00:28:19,330 --> 00:28:17,170
science satellites in

682
00:28:21,040 --> 00:28:19,340
okay if you've just joined us again

683
00:28:24,040 --> 00:28:21,050
we're here NASA headquarters learning

684
00:28:26,140 --> 00:28:24,050
about the upcoming NASA mission to study

685
00:28:28,480 --> 00:28:26,150
magnetic reconnection around Earth and

686
00:28:32,200 --> 00:28:28,490
it is the first I believe dedicated

687
00:28:33,280 --> 00:28:32,210
project to do this very extraordinary

688
00:28:36,190 --> 00:28:33,290

science so we're going to go to the

689
00:28:38,650 --> 00:28:36,200
phone lines on to our media and I

690
00:28:42,400 --> 00:28:38,660
believe we have Ken Kramer from Universe

691
00:28:44,980 --> 00:28:42,410
Today Kim hi thanks for taking my

692
00:28:48,640 --> 00:28:44,990
question I wonder if you could talk a

693
00:28:50,050 --> 00:28:48,650
little bit about studying would it be

694
00:28:52,420 --> 00:28:50,060
worth studying the magnetosphere

695
00:28:55,540 --> 00:28:52,430
anywhere else in the solar system and

696
00:28:57,460 --> 00:28:55,550
any other planets and and how it does do

697
00:29:01,380 --> 00:28:57,470
the other planets compared to the earth

698
00:29:03,520 --> 00:29:01,390
thanks question in fact we are studying

699
00:29:07,330 --> 00:29:03,530
reconnection and other planets Cassini

700
00:29:09,700 --> 00:29:07,340
at Saturn for example and then Jupiter

701
00:29:11,560 --> 00:29:09,710
also reconnection is going on but the

702
00:29:13,990 --> 00:29:11,570
mode is different because these planets

703
00:29:16,030 --> 00:29:14,000
are dominated more by rotation of the

704
00:29:17,860 --> 00:29:16,040
planet and so the solar wind has an

705
00:29:19,800 --> 00:29:17,870
influence and reconnection as an

706
00:29:21,970 --> 00:29:19,810
influence but is not as strong as it is

707
00:29:24,430 --> 00:29:21,980
at the earth and so it's a different

708
00:29:26,950 --> 00:29:24,440
type of circulation that is set up in

709
00:29:28,720 --> 00:29:26,960
these planets but people like myself we

710
00:29:33,670 --> 00:29:28,730
work on reconnection we do that as

711
00:29:35,830 --> 00:29:33,680
Saturn as well there are other missions

712
00:29:37,900 --> 00:29:35,840
have observed and we've learned about

713
00:29:40,180 --> 00:29:37,910

REM and recondition other regions of our

714
00:29:42,460 --> 00:29:40,190
magnetosphere although we haven't flown

715
00:29:42,940 --> 00:29:42,470
into it they asked about other regions

716
00:29:45,310 --> 00:29:42,950
on the earth

717
00:29:47,170 --> 00:29:45,320
oh yeah well here we have two missions

718
00:29:49,120 --> 00:29:47,180
that have been up a while seven to ten

719
00:29:51,490 --> 00:29:49,130
years is the European cluster mission

720
00:29:54,130 --> 00:29:51,500
and the NASA Themis mission and those

721
00:29:55,420 --> 00:29:54,140
are still operating and they be

722
00:29:57,370 --> 00:29:55,430
operating in different parts of the

723
00:29:59,080 --> 00:29:57,380
magnetosphere and this is where we'd be

724
00:30:00,970 --> 00:29:59,090
able to do a global study of what

725
00:30:02,740 --> 00:30:00,980
reconnection causes as Paul mentioned

726
00:30:04,120 --> 00:30:02,750
reconnection happens in this small

727
00:30:06,490 --> 00:30:04,130
region but it affects the entire

728
00:30:09,010 --> 00:30:06,500
magnetosphere and by comparing our data

729
00:30:11,320 --> 00:30:09,020
to the thymus and cluster data we'll

730
00:30:13,090 --> 00:30:11,330
have a very powerful thing that we call

731
00:30:14,830 --> 00:30:13,100
the Heliospheric Observatory or this

732
00:30:18,160 --> 00:30:14,840
will be a major part of the Heliospheric

733
00:30:21,010 --> 00:30:18,170
Observatory it's Paul cassock just to

734
00:30:23,080 --> 00:30:21,020
add also the messenger satellite mission

735
00:30:26,260 --> 00:30:23,090
is measuring reconnection at mercury and

736
00:30:28,960 --> 00:30:26,270
mercury is a lot like Earth except it's

737
00:30:30,370 --> 00:30:28,970
smaller and so everything that we just

738
00:30:34,629 --> 00:30:30,380

described happens

739
00:30:37,659 --> 00:30:34,639
about 10 times faster okay yeah there's

740
00:30:39,039 --> 00:30:37,669
a lot of buzz in the associate media

741
00:30:41,440 --> 00:30:39,049
atmosphere we're gonna go back to Karen

742
00:30:45,129 --> 00:30:41,450
Fox again if you have any questions send

743
00:30:47,889 --> 00:30:45,139
in to hashtag a snåsa and I can't Fox

744
00:30:50,590 --> 00:30:47,899
what do we got going on coming in now we

745
00:30:53,470 --> 00:30:50,600
have a question from @m monitored who

746
00:30:55,749 --> 00:30:53,480
wants to know how does the spinning of

747
00:30:57,490 --> 00:30:55,759
the spacecraft interact with the sensors

748
00:31:00,779 --> 00:30:57,500
how do you control the data given that

749
00:31:06,190 --> 00:31:03,879
yes thank you for that question most of

750
00:31:08,289 --> 00:31:06,200
our measurements are independent of the

751
00:31:10,269 --> 00:31:08,299
spin and this is how we make these very

752
00:31:11,950 --> 00:31:10,279
fast particle measurements because we're

753
00:31:13,619 --> 00:31:11,960
not tied to the spin of the spacecraft

754
00:31:16,180 --> 00:31:13,629
like just about all previous

755
00:31:18,009 --> 00:31:16,190
magnetospheric missions have been so we

756
00:31:19,570 --> 00:31:18,019
have a lot of instruments and we don't

757
00:31:21,580 --> 00:31:19,580
care what the spin rate is for our

758
00:31:23,680 --> 00:31:21,590
particles a low-energy particles some of

759
00:31:26,379 --> 00:31:23,690
our measurements are do rely on the spin

760
00:31:29,049 --> 00:31:26,389
these long wire booms that Craig talked

761
00:31:30,879 --> 00:31:29,059
about need to spin for a certificate

762
00:31:32,799 --> 00:31:30,889
force because otherwise these wires

763
00:31:35,440 --> 00:31:32,809

wouldn't be stretched out like that so

764
00:31:38,169 --> 00:31:35,450
we need to the booms to deploy our

765
00:31:40,659 --> 00:31:38,179
antennas the spin of the spacecraft it's

766
00:31:46,690 --> 00:31:40,669
a pretty slow spin rate compared to most

767
00:31:48,690 --> 00:31:46,700
magnetospheric missions I don't know if

768
00:31:52,090 --> 00:31:48,700
that answered the question completely I

769
00:31:54,549 --> 00:31:52,100
think we're back to me we have some fun

770
00:31:55,990 --> 00:31:54,559
questions that are going a couple other

771
00:31:58,720 --> 00:31:56,000
directions but I'm going to throw them

772
00:32:03,249 --> 00:31:58,730
out to you all one of the questions from

773
00:32:06,090 --> 00:32:03,259
the raisin to 222 is is there a chance

774
00:32:08,799 --> 00:32:06,100
of the magnetosphere around Earth is

775
00:32:18,100 --> 00:32:08,809
connected to them a magnetosphere around

776
00:32:24,879 --> 00:32:21,759
I would say that the they're not

777
00:32:27,999 --> 00:32:24,889
connected in terms of being touching

778
00:32:30,009 --> 00:32:28,009
each other I think where we hope the

779
00:32:33,610 --> 00:32:30,019
connection is is that if we understand

780
00:32:36,249 --> 00:32:33,620
the physics of reconnection here near

781
00:32:39,549 --> 00:32:36,259
Earth and the magnetosphere then we can

782
00:32:41,080 --> 00:32:39,559
apply what we've learned here in the

783
00:32:43,330 --> 00:32:41,090
magnetosphere to other places that

784
00:32:44,380 --> 00:32:43,340
reconnection happens such as in solar

785
00:32:48,490 --> 00:32:44,390
flares like we

786
00:32:52,260 --> 00:32:48,500
the movies of other planets and even in

787
00:32:54,310 --> 00:32:52,270
you know black holes and neutron stars

788
00:32:55,210 --> 00:32:54,320

we'll take one more from social media

789
00:32:58,780 --> 00:32:55,220
great Karen

790
00:33:00,760 --> 00:32:58,790
great at bill Waldman 8:08 asks whether

791
00:33:02,020 --> 00:33:00,770
this mission is going to provide a model

792
00:33:08,590 --> 00:33:02,030
that can be used to predict space

793
00:33:11,049 --> 00:33:08,600
weather events in the future this is a

794
00:33:12,669 --> 00:33:11,059
research mission and what we learned

795
00:33:15,580 --> 00:33:12,679
from it will be an important part of

796
00:33:17,740 --> 00:33:15,590
models that will eventually be able to

797
00:33:19,510 --> 00:33:17,750
predict space weather we won't be

798
00:33:22,210 --> 00:33:19,520
predicting it from this mission but we

799
00:33:24,520 --> 00:33:22,220
will be coming up with theories and

800
00:33:26,950 --> 00:33:24,530
we'll be proving theories that then can

801
00:33:29,020 --> 00:33:26,960
be used in the end models to make them

802
00:33:30,280 --> 00:33:29,030
better in fact I think it's crucial that

803
00:33:32,710 --> 00:33:30,290
we understand magnetic reconnection

804
00:33:34,440 --> 00:33:32,720
because as I said earlier a reconnection

805
00:33:36,280 --> 00:33:34,450
is the engine that drives space weather

806
00:33:37,690 --> 00:33:36,290
so if you're going to predict what's

807
00:33:41,860 --> 00:33:37,700
happening you got to understand the

808
00:33:43,419 --> 00:33:41,870
engine not a comment to follow that up

809
00:33:48,130 --> 00:33:43,429
just more generalized people think about

810
00:33:50,650 --> 00:33:48,140
this is you know centuries ago as we as

811
00:33:51,909 --> 00:33:50,660
we became a seafaring species it became

812
00:33:53,230 --> 00:33:51,919
increasingly important that we figured

813
00:33:53,680 --> 00:33:53,240

out how to understand it predict the

814
00:33:55,720 --> 00:33:53,690
weather

815
00:33:58,780 --> 00:33:55,730
that's crucial you're gonna navigate the

816
00:34:00,190 --> 00:33:58,790
globe and you can see as a species as

817
00:34:02,289 --> 00:34:00,200
we're gonna move out into our own solar

818
00:34:04,960 --> 00:34:02,299
system indeed that we need to understand

819
00:34:09,639 --> 00:34:04,970
what drives all of that weather is

820
00:34:11,320 --> 00:34:09,649
equally important okay what we're gonna

821
00:34:15,940 --> 00:34:11,330
do here we're gonna go ahead and close

822
00:34:17,020 --> 00:34:15,950
out and before I do any final comments

823
00:34:21,419 --> 00:34:17,030
here I want to turn it over to Jeff

824
00:34:24,250 --> 00:34:21,429
Newmark for some final comments thanks

825
00:34:26,980 --> 00:34:24,260
well I hope we gave you a little bit of

826
00:34:30,639 --> 00:34:26,990
a taste of how exciting MMS is going to

827
00:34:34,300 --> 00:34:30,649
be the complexity of developing this

828
00:34:38,230 --> 00:34:34,310
mission is just really unprecedented for

829
00:34:40,560 --> 00:34:38,240
spacecraft 100 instruments each 100

830
00:34:43,720 --> 00:34:40,570
times better than we've done before

831
00:34:45,820 --> 00:34:43,730
really enabling us to revolutionize our

832
00:34:48,369 --> 00:34:45,830
understanding looking at this area that

833
00:34:49,629 --> 00:34:48,379
Jim shows you that of magnetic

834
00:34:52,540 --> 00:34:49,639
reconnection that we've never been able

835
00:34:55,119 --> 00:34:52,550
to sample before using our magnetosphere

836
00:34:58,210 --> 00:34:55,129
as a natural environment Ori to study

837
00:35:00,640 --> 00:34:58,220
this we're just we're just very excited

838
00:35:03,700 --> 00:35:00,650

and I hope you continue watching us on

839
00:35:05,500 --> 00:35:03,710
this journey and I want to thank our

840
00:35:07,839 --> 00:35:05,510
panelists I want to thank the folks

841
00:35:10,240 --> 00:35:07,849
joining us on the phones here and

842
00:35:14,349 --> 00:35:10,250
particularly social media join the

843
00:35:16,060 --> 00:35:14,359
conversation on Twitter Facebook and go

844
00:35:17,170 --> 00:35:16,070
to the website you'll be seeing a lot of

845
00:35:18,550 --> 00:35:17,180
updates and a lot of additional

846
00:35:24,420 --> 00:35:18,560
information as we get closer to launch

847
00:35:27,820 --> 00:35:24,430
down in Florida at WWDC Golf / MMS

848
00:35:29,890 --> 00:35:27,830
magnetic reconnection I like to call

849
00:35:32,050 --> 00:35:29,900
this class 101 the advanced classes will

850
00:35:33,849 --> 00:35:32,060
be down in Florida

851
00:35:36,190 --> 00:35:33,859
it's phenomenal science with a

852
00:35:37,260 --> 00:35:36,200
phenomenal team we will see you down in

853
00:35:39,790 --> 00:35:37,270
Florida

854
00:35:41,680 --> 00:35:39,800
thanks to contractor team and the in the

855
00:35:43,540 --> 00:35:41,690
launch team we're ready we'll see you in

856
00:35:50,710 --> 00:35:43,550
Florida March 12th thanks for joining us