
NASA
On Phone
Question from Media

1
00:00:06,309 --> 00:00:04,789
hello i'm jd harrington public affairs

2
00:00:08,150 --> 00:00:06,319
officer for nasa's science mission

3
00:00:10,230 --> 00:00:08,160
directorate i'd like to welcome you

4
00:00:12,310 --> 00:00:10,240
today to this news conference where

5
00:00:14,549 --> 00:00:12,320
we'll discuss a new hubble space

6
00:00:16,950 --> 00:00:14,559
telescope observation that allows

7
00:00:18,870 --> 00:00:16,960
astronomers to predict with certainty

8
00:00:22,150 --> 00:00:18,880
the next major cosmic event to affect

9
00:00:23,830 --> 00:00:22,160
our entire galaxy sun and solar system

10
00:00:25,990 --> 00:00:23,840
before we get started though a few house

11
00:00:28,230 --> 00:00:26,000
keeping duties we have four panelists

12
00:00:29,830 --> 00:00:28,240
joining us today each will give a short

13
00:00:32,150 --> 00:00:29,840

three to five minute briefing on their

14
00:00:34,150 --> 00:00:32,160
specific topic next we will move to the

15
00:00:35,910 --> 00:00:34,160
question and answer session

16
00:00:38,310 --> 00:00:35,920
accepting questions from media here at

17
00:00:39,990 --> 00:00:38,320
nasa headquarters those at the centers

18
00:00:41,590 --> 00:00:40,000
and also those that dial into the

19
00:00:43,350 --> 00:00:41,600
telephone bridge

20
00:00:44,549 --> 00:00:43,360
questions can also be submitted via the

21
00:00:47,750 --> 00:00:44,559
twitter sphere

22
00:00:49,830 --> 00:00:47,760
by using the hashtag asknasa

23
00:00:52,389 --> 00:00:49,840
the panelists will also host a web chat

24
00:00:53,990 --> 00:00:52,399
this afternoon at 3 pm to take questions

25
00:00:55,910 --> 00:00:54,000
from the general public

26
00:00:58,150 --> 00:00:55,920
i'll give the url later on in the

27
00:01:00,790 --> 00:00:58,160
presentation this media conference will

28
00:01:02,709 --> 00:01:00,800
be limited to 55 minutes

29
00:01:05,350 --> 00:01:02,719
today's panelists include

30
00:01:07,109 --> 00:01:05,360
roland vandemarl an astronomer at the

31
00:01:09,030 --> 00:01:07,119
space telescope science institute in

32
00:01:10,550 --> 00:01:09,040
baltimore maryland and the principal

33
00:01:13,510 --> 00:01:10,560
investigator of the science team that

34
00:01:17,030 --> 00:01:13,520
performed the study described today

35
00:01:18,710 --> 00:01:17,040
segmo tony sohn the astronomer at the

36
00:01:21,109 --> 00:01:18,720
space telescope science institute in

37
00:01:22,870 --> 00:01:21,119
baltimore is also a key member of the

38
00:01:25,270 --> 00:01:22,880

science team

39
00:01:26,870 --> 00:01:25,280
next we have rosemary wise professor of

40
00:01:29,350 --> 00:01:26,880
physics and astronomy at the johns

41
00:01:31,830 --> 00:01:29,360
hopkins university in baltimore maryland

42
00:01:34,069 --> 00:01:31,840
and a renowned expert in formulation and

43
00:01:37,190 --> 00:01:34,079
evolution of galaxies she is not

44
00:01:38,950 --> 00:01:37,200
associated with the science team

45
00:01:40,789 --> 00:01:38,960
and next to rosemary we have john

46
00:01:42,550 --> 00:01:40,799
grunsfeld nasa science mission

47
00:01:44,950 --> 00:01:42,560
directorate associate administrator in

48
00:01:46,789 --> 00:01:44,960
washington dc and three-time hubble

49
00:01:48,469 --> 00:01:46,799
repair astronaut

50
00:01:51,910 --> 00:01:48,479
and with that let's hear about our

51
00:01:54,870 --> 00:01:51,920
science finding today here's roland

52
00:01:56,709 --> 00:01:54,880
thank you so much jg our son resides in

53
00:02:00,310 --> 00:01:56,719
the milky way galaxy

54
00:02:02,469 --> 00:02:00,320
we can see this in the first graphic

55
00:02:05,510 --> 00:02:02,479
the andromeda galaxy is the nearest big

56
00:02:06,950 --> 00:02:05,520
galaxy to our milky way in the universe

57
00:02:08,469 --> 00:02:06,960
it is at a distance of two and a half

58
00:02:10,150 --> 00:02:08,479
million light years but it's one of the

59
00:02:11,910 --> 00:02:10,160
few galaxies that can be seen with the

60
00:02:14,229 --> 00:02:11,920
naked eye

61
00:02:16,470 --> 00:02:14,239
exactly 100 years ago the andromeda

62
00:02:18,309 --> 00:02:16,480
galaxy was the first galaxy for which it

63
00:02:21,110 --> 00:02:18,319

was possible to measure its relative

64
00:02:22,390 --> 00:02:21,120
motion with respect to us

65
00:02:24,710 --> 00:02:22,400
as it turns out

66
00:02:28,630 --> 00:02:24,720
the andromeda galaxy is coming towards

67
00:02:30,550 --> 00:02:28,640
us at 250 000 miles per hour

68
00:02:32,550 --> 00:02:30,560
this is unusual because we live in an

69
00:02:35,350 --> 00:02:32,560
expanding universe and almost all other

70
00:02:37,509 --> 00:02:35,360
galaxies are moving away from us

71
00:02:39,030 --> 00:02:37,519
this measurement 100 years ago was

72
00:02:41,110 --> 00:02:39,040
obtained using the so-called doppler

73
00:02:43,270 --> 00:02:41,120
effect which is also used in many modern

74
00:02:45,270 --> 00:02:43,280
technologies for example the measurement

75
00:02:47,430 --> 00:02:45,280
of the speeds of vehicles on the highway

76
00:02:49,509 --> 00:02:47,440
using radar

77
00:02:51,509 --> 00:02:49,519
because andromeda is getting closer to

78
00:02:53,589 --> 00:02:51,519
us astronomers have speculated for a

79
00:02:55,430 --> 00:02:53,599
long time whether it might collide with

80
00:02:57,270 --> 00:02:55,440
our milky way and whether the galaxies

81
00:02:59,270 --> 00:02:57,280
might merge together

82
00:03:02,229 --> 00:02:59,280
however to know whether this will in

83
00:03:05,190 --> 00:03:02,239
fact happen it is necessary to know not

84
00:03:07,589 --> 00:03:05,200
only how andromeda is moving in our

85
00:03:09,670 --> 00:03:07,599
direction but also what its sideways

86
00:03:11,670 --> 00:03:09,680
motion is because that will determine

87
00:03:13,350 --> 00:03:11,680
whether andromeda will misses at a

88
00:03:15,509 --> 00:03:13,360

distance or whether it might be heading

89
00:03:17,110 --> 00:03:15,519
straight for us

90
00:03:19,509 --> 00:03:17,120
astronomers have tried to measure the

91
00:03:21,110 --> 00:03:19,519
sideways motion of andromeda for over a

92
00:03:23,430 --> 00:03:21,120
century

93
00:03:24,949 --> 00:03:23,440
however this was always unsuccessful

94
00:03:26,309 --> 00:03:24,959
because the available techniques were

95
00:03:27,990 --> 00:03:26,319
not sufficient to perform the

96
00:03:29,990 --> 00:03:28,000
measurement

97
00:03:31,670 --> 00:03:30,000
we are here today to announce that for

98
00:03:32,390 --> 00:03:31,680
the very first time we've been able to

99
00:03:34,550 --> 00:03:32,400
measure

100
00:03:36,390 --> 00:03:34,560
the sideways motion in astronomy also

101
00:03:38,710 --> 00:03:36,400
known as proper motion of the andromeda

102
00:03:40,550 --> 00:03:38,720
galaxy using the unique observational

103
00:03:42,390 --> 00:03:40,560
capabilities of the hubble space

104
00:03:43,910 --> 00:03:42,400
telescope

105
00:03:45,990 --> 00:03:43,920
how we perform this measurement will be

106
00:03:49,030 --> 00:03:46,000
described later by my colleague dr sohn

107
00:03:51,110 --> 00:03:49,040
who is sitting next to me here

108
00:03:53,110 --> 00:03:51,120
we find that to within the precision of

109
00:03:56,309 --> 00:03:53,120
our measurements the andromeda galaxy is

110
00:03:58,470 --> 00:03:56,319
heading straight in our direction

111
00:04:00,229 --> 00:03:58,480
what this means is that the galaxies

112
00:04:03,990 --> 00:04:00,239
will collide and they will merge

113
00:04:05,750 --> 00:04:04,000

together to form one new galaxy

114
00:04:07,910 --> 00:04:05,760
if we look at the graphic again that we

115
00:04:10,390 --> 00:04:07,920
showed before you see that there is a

116
00:04:13,750 --> 00:04:10,400
third galaxy the triangulum galaxy also

117
00:04:16,550 --> 00:04:13,760
known as m33 which may also be involved

118
00:04:17,990 --> 00:04:16,560
in this smash up

119
00:04:20,150 --> 00:04:18,000
so what this all means is that we can

120
00:04:22,550 --> 00:04:20,160
now predict with certainty the next

121
00:04:24,870 --> 00:04:22,560
major cosmic event to affect our entire

122
00:04:26,950 --> 00:04:24,880
galaxy and which will drastically change

123
00:04:29,830 --> 00:04:26,960
the environment of our sun and solar

124
00:04:31,270 --> 00:04:29,840
system

125
00:04:33,189 --> 00:04:31,280
to calculate how these events will

126
00:04:36,710 --> 00:04:33,199
unfold we perform detailed computer

127
00:04:38,390 --> 00:04:36,720
simulations of the future collision

128
00:04:40,469 --> 00:04:38,400
this part of the project was performed

129
00:04:42,790 --> 00:04:40,479
by my colleague dr bezla who is here in

130
00:04:44,469 --> 00:04:42,800
the audience today and if there are any

131
00:04:46,070 --> 00:04:44,479
questions later about this part of our

132
00:04:48,310 --> 00:04:46,080
work she will be happy to answer any

133
00:04:50,870 --> 00:04:48,320
questions

134
00:04:53,110 --> 00:04:50,880
what we will show next is a movie of how

135
00:04:56,550 --> 00:04:53,120
the evolution may proceed over the next

136
00:04:58,310 --> 00:04:56,560
eight billion years

137
00:05:00,469 --> 00:04:58,320
if we can start the movie you will see

138
00:05:03,110 --> 00:05:00,479

that we first see

139
00:05:04,950 --> 00:05:03,120
the milky way galaxy from above

140
00:05:07,909 --> 00:05:04,960
stars rotate around the center of the

141
00:05:10,710 --> 00:05:07,919
milky way on circular orbits

142
00:05:13,029 --> 00:05:10,720
after about 1 billion years the camera

143
00:05:14,310 --> 00:05:13,039
angle moves so we see the milky way from

144
00:05:16,150 --> 00:05:14,320
the side

145
00:05:20,550 --> 00:05:16,160
it is now clear that the milky way is a

146
00:05:24,629 --> 00:05:22,150
as the camera zooms out we see the

147
00:05:26,469 --> 00:05:24,639
andromeda galaxy approaching us

148
00:05:28,469 --> 00:05:26,479
the approach takes several billions of

149
00:05:30,230 --> 00:05:28,479
years because of andromeda's great

150
00:05:32,550 --> 00:05:30,240
distance from us

151
00:05:34,950 --> 00:05:32,560
but after about 4 billion years the

152
00:05:37,189 --> 00:05:34,960
galaxies will have a direct collision or

153
00:05:39,270 --> 00:05:37,199
a very close encounter

154
00:05:40,950 --> 00:05:39,280
the galaxies will get distorted and some

155
00:05:42,550 --> 00:05:40,960
of the stars will be thrown out into

156
00:05:44,550 --> 00:05:42,560
tidal tails

157
00:05:46,550 --> 00:05:44,560
the galaxies will also be slowed down so

158
00:05:48,150 --> 00:05:46,560
that they fall back together which will

159
00:05:51,430 --> 00:05:48,160
lead to a complete merger of the two

160
00:05:53,510 --> 00:05:51,440
systems six billion years from now

161
00:05:56,309 --> 00:05:53,520
if you continue to watch the movie you

162
00:05:58,230 --> 00:05:56,319
will see that the merged galaxy will

163
00:06:00,309 --> 00:05:58,240

have a different shape it has a more of

164
00:06:01,670 --> 00:06:00,319
a three-dimensional structure and it is

165
00:06:03,350 --> 00:06:01,680
what is known in astronomy as an

166
00:06:05,110 --> 00:06:03,360
elliptical galaxy

167
00:06:07,189 --> 00:06:05,120
we know of such galaxies in the universe

168
00:06:08,790 --> 00:06:07,199
around us and many elliptical galaxies

169
00:06:11,990 --> 00:06:08,800
that we see might have formed in this

170
00:06:15,510 --> 00:06:13,590
you will also see that the galaxy

171
00:06:20,150 --> 00:06:15,520
appears rather owing to the fact that

172
00:06:25,110 --> 00:06:23,189
our measurements and computations show

173
00:06:28,309 --> 00:06:25,120
that the first passage does not need to

174
00:06:29,590 --> 00:06:28,319
be as direct a hit as shown in the movie

175
00:06:31,270 --> 00:06:29,600
we just showed

176
00:06:33,590 --> 00:06:31,280
however we do find that in all

177
00:06:36,710 --> 00:06:33,600
simulations we've run the galaxies do

178
00:06:38,150 --> 00:06:36,720
ultimately merge together

179
00:06:39,909 --> 00:06:38,160
we do know of other galaxies in the

180
00:06:42,070 --> 00:06:39,919
local universe around us that are in the

181
00:06:45,350 --> 00:06:42,080
process of colliding and merging as my

182
00:06:47,430 --> 00:06:45,360
colleague dr wise will describe later

183
00:06:49,270 --> 00:06:47,440
however what makes the future merger of

184
00:06:50,550 --> 00:06:49,280
the andromeda galaxy and the milky way

185
00:06:52,629 --> 00:06:50,560
so special

186
00:06:56,230 --> 00:06:52,639
is that it'll happen to us

187
00:06:57,909 --> 00:06:56,240
it will be our galaxy our sun our planet

188
00:07:00,390 --> 00:06:57,919

and not some distant object in the

189
00:07:04,469 --> 00:07:02,790
if i can have the next graphic please

190
00:07:06,230 --> 00:07:04,479
this shows how the environment of our

191
00:07:08,629 --> 00:07:06,240
sun will change

192
00:07:10,950 --> 00:07:08,639
on the left you see the sun currently

193
00:07:13,510 --> 00:07:10,960
moving around in a circle in a flat

194
00:07:15,510 --> 00:07:13,520
spiral galaxy our milky way

195
00:07:17,749 --> 00:07:15,520
this is how our sun was born 5 billion

196
00:07:19,189 --> 00:07:17,759
years ago and what it's been doing ever

197
00:07:20,629 --> 00:07:19,199
since

198
00:07:22,390 --> 00:07:20,639
after the collision with the andromeda

199
00:07:23,749 --> 00:07:22,400
galaxy the environment of our sun will

200
00:07:25,189 --> 00:07:23,759
be very different

201
00:07:27,350 --> 00:07:25,199
our sun will live in an elliptical

202
00:07:29,270 --> 00:07:27,360
galaxy which is somewhat bigger and is

203
00:07:31,510 --> 00:07:29,280
also somewhat redder

204
00:07:34,390 --> 00:07:31,520
moreover most likely the sun will find

205
00:07:36,550 --> 00:07:34,400
itself on a much wider orbit in this

206
00:07:41,270 --> 00:07:36,560
galaxy that takes it much further from

207
00:07:45,189 --> 00:07:43,270
when andromeda arrives here

208
00:07:47,909 --> 00:07:45,199
the sun will still be a regular star

209
00:07:49,909 --> 00:07:47,919
with its planetary system as it is today

210
00:07:52,150 --> 00:07:49,919
the sun will not run out of its nuclear

211
00:07:55,110 --> 00:07:52,160
fuel for another 2 billions of years

212
00:07:58,469 --> 00:07:56,869
the distances between stars and galaxies

213
00:08:00,790 --> 00:07:58,479

are vast so when the two galaxies

214
00:08:03,189 --> 00:08:00,800
collide the individual stars will not

215
00:08:05,110 --> 00:08:03,199
actually run into each other

216
00:08:07,430 --> 00:08:05,120
no individual star in andromeda will

217
00:08:09,670 --> 00:08:07,440
directly hit our sun and in fact it is

218
00:08:11,510 --> 00:08:09,680
unlikely that any star would even come

219
00:08:15,670 --> 00:08:11,520
close enough to significantly perturb

220
00:08:19,830 --> 00:08:17,430
it is possible that four billion years

221
00:08:21,830 --> 00:08:19,840
from now our or some other civilization

222
00:08:23,990 --> 00:08:21,840
may still be around

223
00:08:27,110 --> 00:08:24,000
if so they will witness spectacular and

224
00:08:28,790 --> 00:08:27,120
slow changes of the night sky

225
00:08:31,270 --> 00:08:28,800
if i can see the beginning of the next

226
00:08:33,110 --> 00:08:31,280
movie this will show how the night sky

227
00:08:34,870 --> 00:08:33,120
will evolve

228
00:08:37,110 --> 00:08:34,880
the beginning of the movie shows what

229
00:08:38,949 --> 00:08:37,120
the sky looks like today

230
00:08:41,589 --> 00:08:38,959
on the right you see the majestic milky

231
00:08:43,350 --> 00:08:41,599
way galaxy because it is a flat galaxy

232
00:08:46,150 --> 00:08:43,360
that we see from the side it appears to

233
00:08:48,310 --> 00:08:46,160
us as the luminous band on the sky

234
00:08:50,389 --> 00:08:48,320
and also just left of that you see a

235
00:08:51,590 --> 00:08:50,399
small fudge which is the andromeda

236
00:08:53,590 --> 00:08:51,600
galaxy

237
00:08:55,829 --> 00:08:53,600
if we can start the movie now we will

238
00:08:58,070 --> 00:08:55,839

see that as andromeda moves towards us

239
00:09:00,310 --> 00:08:58,080
it'll get bigger on the sky and it gets

240
00:09:02,230 --> 00:09:00,320
close enough to destroy the milky way as

241
00:09:03,910 --> 00:09:02,240
the galaxies pass each other

242
00:09:05,750 --> 00:09:03,920
bright new regions of star formation

243
00:09:08,710 --> 00:09:05,760
will light up the sky as gas gets

244
00:09:10,389 --> 00:09:08,720
compressed and forms new stars over time

245
00:09:13,030 --> 00:09:10,399
the gas and dust will be lost from the

246
00:09:15,110 --> 00:09:13,040
system the star formation ceases and all

247
00:09:17,430 --> 00:09:15,120
that's left will be a bright elliptical

248
00:09:20,070 --> 00:09:17,440
galaxy filling much of our night sky

249
00:09:23,430 --> 00:09:20,080
having replaced today's familiar view of

250
00:09:25,910 --> 00:09:23,440
the milky way

251
00:09:28,310 --> 00:09:25,920
today the andromeda galaxy

252
00:09:30,550 --> 00:09:28,320
appears to us on the sky as a small

253
00:09:32,150 --> 00:09:30,560
fuzzy object that was first seen by

254
00:09:35,030 --> 00:09:32,160
ancient astronomers more than one

255
00:09:37,430 --> 00:09:35,040
thousand years ago

256
00:09:39,350 --> 00:09:37,440
few things fascinate us humans more than

257
00:09:41,910 --> 00:09:39,360
to know what our cosmic destiny and

258
00:09:43,990 --> 00:09:41,920
future fate will be

259
00:09:46,389 --> 00:09:44,000
the fact that we can predict that this

260
00:09:48,870 --> 00:09:46,399
small fuzzy object will one day come to

261
00:09:51,350 --> 00:09:48,880
engulf and enshroud our sun and solar

262
00:09:53,590 --> 00:09:51,360
system is a truly remarkable and

263
00:09:55,030 --> 00:09:53,600

fascinating finding

264
00:09:57,030 --> 00:09:55,040
with that i would like to hand it over

265
00:09:58,790 --> 00:09:57,040
to another member from my team which

266
00:10:02,710 --> 00:09:58,800
next to myself consists of several other

267
00:10:07,110 --> 00:10:02,720
people namely doctors son anderson besla

268
00:10:10,310 --> 00:10:07,120
fardahl beaton cox brown and guata curta

269
00:10:13,430 --> 00:10:10,320
dr stone will describe how we used the

270
00:10:16,150 --> 00:10:13,440
data and the measurements to obtain

271
00:10:17,030 --> 00:10:16,160
these new results tony thank you dr van

272
00:10:18,630 --> 00:10:17,040
gaal

273
00:10:20,949 --> 00:10:18,640
in the next few minutes i'll describe

274
00:10:22,630 --> 00:10:20,959
how we use the hubble space telescope to

275
00:10:24,790 --> 00:10:22,640
measure the sideways motion of the

276
00:10:28,310 --> 00:10:24,800
andromeda galaxy

277
00:10:32,870 --> 00:10:30,310
the displayed image shows the andromeda

278
00:10:34,949 --> 00:10:32,880
galaxy covering a region several times

279
00:10:37,110 --> 00:10:34,959
the size of the full moon

280
00:10:39,350 --> 00:10:37,120
and the small box indicates one of the

281
00:10:42,310 --> 00:10:39,360
three regions for which we took pictures

282
00:10:46,630 --> 00:10:44,710
andromeda contains a halo of stars that

283
00:10:47,590 --> 00:10:46,640
extends well beyond the main disk-like

284
00:10:49,269 --> 00:10:47,600
body

285
00:10:51,030 --> 00:10:49,279
so even though the box appears to be

286
00:10:52,870 --> 00:10:51,040
outside of andromeda it actually

287
00:10:55,509 --> 00:10:52,880
contains tens of thousands of andromeda

288
00:11:00,710 --> 00:10:57,430

the blow-up image on the left shows the

289
00:11:03,509 --> 00:11:00,720
actual view of this field with hubble

290
00:11:06,069 --> 00:11:03,519
in addition to andromeda stars the image

291
00:11:08,069 --> 00:11:06,079
shows many small fuzzy objects and these

292
00:11:10,949 --> 00:11:08,079
are far away galaxies in the distant

293
00:11:14,550 --> 00:11:12,949
as pointed out earlier it has been known

294
00:11:16,470 --> 00:11:14,560
for a while that andromeda is

295
00:11:18,069 --> 00:11:16,480
approaching us at a great speed

296
00:11:19,910 --> 00:11:18,079
and our project

297
00:11:22,870 --> 00:11:19,920
school was to measure the sideways

298
00:11:25,110 --> 00:11:22,880
motion of andromeda

299
00:11:28,550 --> 00:11:25,120
the next image illustrates how we

300
00:11:30,230 --> 00:11:28,560
accomplish this goal

301
00:11:32,550 --> 00:11:30,240
the box on the right shows andromeda

302
00:11:35,829 --> 00:11:32,560
again with the small box indicating the

303
00:11:38,470 --> 00:11:35,839
field we observed with hubble

304
00:11:40,150 --> 00:11:38,480
we observed this field on two occasions

305
00:11:43,990 --> 00:11:40,160
one in 2002

306
00:11:48,630 --> 00:11:45,829
the background galaxies shown in the

307
00:11:51,030 --> 00:11:48,640
first blow up are in fact so far away

308
00:11:52,150 --> 00:11:51,040
that they have no sideways motion

309
00:11:54,069 --> 00:11:52,160
and therefore

310
00:11:56,230 --> 00:11:54,079
they serve as fixed beacons in the

311
00:11:58,790 --> 00:11:56,240
distance

312
00:12:00,710 --> 00:11:58,800
by contrast the andromeda stars shift

313
00:12:03,269 --> 00:12:00,720

their positions over time

314
00:12:07,590 --> 00:12:03,279
due to the sideways motion of andromeda

315
00:12:11,350 --> 00:12:09,350
so by measuring the relative shift of

316
00:12:13,509 --> 00:12:11,360
andromeda stars with respect to the

317
00:12:15,110 --> 00:12:13,519
background galaxies we were able to

318
00:12:18,629 --> 00:12:15,120
determine the sideways motion of

319
00:12:23,829 --> 00:12:20,389
what made this project so challenging

320
00:12:25,910 --> 00:12:23,839
was that the shift is extremely

321
00:12:27,509 --> 00:12:25,920
but with sophisticated data analysis

322
00:12:29,509 --> 00:12:27,519
techniques we developed

323
00:12:32,389 --> 00:12:29,519
we found that the motion can be measured

324
00:12:36,389 --> 00:12:34,550
ultimately the location of hubble space

325
00:12:38,230 --> 00:12:36,399
telescope above the earth's atmosphere

326
00:12:40,790 --> 00:12:38,240
made the measurement possible by

327
00:12:43,670 --> 00:12:40,800
providing the required image quality and

328
00:12:49,509 --> 00:12:45,269
the next movie further illustrates our

329
00:12:53,269 --> 00:12:51,110
we start with the view of the night sky

330
00:12:57,350 --> 00:12:53,279
you saw before

331
00:13:01,110 --> 00:12:59,590
the milky way and andromeda galaxy are

332
00:13:06,710 --> 00:13:01,120
highlighted together with the visible

333
00:13:10,550 --> 00:13:08,949
we now zoom into andromeda and

334
00:13:14,389 --> 00:13:10,560
eventually to the small field we

335
00:13:18,470 --> 00:13:16,710
from the measured sideways motion we

336
00:13:23,910 --> 00:13:18,480
projected the motion of stars into the

337
00:13:29,030 --> 00:13:25,670
first you see what the field looked like

338
00:13:33,910 --> 00:13:31,590

and now we show an animation of how the

339
00:13:37,269 --> 00:13:33,920
field will change over a period of 30

340
00:13:41,509 --> 00:13:39,430
this movie illustrates how how the

341
00:13:45,509 --> 00:13:41,519
andromeda stars move relative to the

342
00:13:48,389 --> 00:13:46,949
of course our measurements were taken

343
00:13:50,150 --> 00:13:48,399
only seven years apart

344
00:13:51,750 --> 00:13:50,160
so the motion was a lot more difficult

345
00:13:53,829 --> 00:13:51,760
to detect than what the movie may

346
00:13:55,350 --> 00:13:53,839
suggest

347
00:13:58,069 --> 00:13:55,360
so that concludes how we measure the

348
00:14:00,310 --> 00:13:58,079
sideways motion of andromeda

349
00:14:02,389 --> 00:14:00,320
professor wise will now

350
00:14:04,949 --> 00:14:02,399
describe some of the broader context of

351
00:14:06,629 --> 00:14:04,959
these results professor okay thank you

352
00:14:09,509 --> 00:14:06,639
dr son

353
00:14:11,990 --> 00:14:09,519
of course we're fascinated by the future

354
00:14:13,829 --> 00:14:12,000
of our galaxy of the milky way galaxy

355
00:14:16,629 --> 00:14:13,839
but these observations have added

356
00:14:19,910 --> 00:14:16,639
significance and importance because

357
00:14:22,389 --> 00:14:19,920
both the milky way and m31 are examples

358
00:14:24,949 --> 00:14:22,399
of the typical galaxy that we see around

359
00:14:27,269 --> 00:14:24,959
us today and we'd like to know how the

360
00:14:29,430 --> 00:14:27,279
typical galaxy evolved and we have two

361
00:14:31,750 --> 00:14:29,440
great examples nearby

362
00:14:33,990 --> 00:14:31,760
if i could see my first slide

363
00:14:36,470 --> 00:14:34,000

this is a wonderful picture taken by the

364
00:14:38,870 --> 00:14:36,480
hubble space telescope if you look at

365
00:14:41,030 --> 00:14:38,880
the large galaxies in this image these

366
00:14:43,829 --> 00:14:41,040
are the ones that are nearby and you can

367
00:14:47,269 --> 00:14:43,839
see that they are predominantly spiral

368
00:14:49,590 --> 00:14:47,279
disc galaxies like the milky way and m31

369
00:14:52,230 --> 00:14:49,600
the smaller galaxies in this image are

370
00:14:53,590 --> 00:14:52,240
the ones that are more distant

371
00:14:55,990 --> 00:14:53,600
at much

372
00:14:59,030 --> 00:14:56,000
earlier stages of the expansion of the

373
00:15:00,949 --> 00:14:59,040
universe galaxies were much less regular

374
00:15:03,670 --> 00:15:00,959
at early times

375
00:15:06,710 --> 00:15:03,680
we don't actually know why galaxies

376
00:15:08,629 --> 00:15:06,720
nearby us are predominantly disks and we

377
00:15:10,470 --> 00:15:08,639
don't understand how disc galaxies

378
00:15:13,110 --> 00:15:10,480
evolve and of course that's one of the

379
00:15:15,030 --> 00:15:13,120
goals of modern astrophysics

380
00:15:16,790 --> 00:15:15,040
the unique capabilities of the hubble

381
00:15:19,350 --> 00:15:16,800
space telescope

382
00:15:22,550 --> 00:15:19,360
allow astronomers to tackle this problem

383
00:15:25,910 --> 00:15:22,560
in two complementary ways one is to look

384
00:15:28,870 --> 00:15:25,920
at these small distance systems and

385
00:15:31,829 --> 00:15:28,880
identify them at a range of times and

386
00:15:35,590 --> 00:15:31,839
try and see how the mix of galaxies

387
00:15:37,350 --> 00:15:35,600
types changes as a function of time

388
00:15:40,150 --> 00:15:37,360

the other approach which is the one

389
00:15:42,870 --> 00:15:40,160
taken by the astronomers we have here

390
00:15:45,910 --> 00:15:42,880
today is instead to look at the end

391
00:15:48,790 --> 00:15:45,920
point look at a large galaxy nearby and

392
00:15:51,030 --> 00:15:48,800
try to identify the signatures of galaxy

393
00:15:53,509 --> 00:15:51,040
assembly

394
00:15:56,470 --> 00:15:53,519
when we study

395
00:15:58,710 --> 00:15:56,480
galaxies with both techniques they each

396
00:16:01,350 --> 00:15:58,720
tell us that mergers between galaxies

397
00:16:03,670 --> 00:16:01,360
happen but we really want to know

398
00:16:05,030 --> 00:16:03,680
what were the systems that merged when

399
00:16:07,350 --> 00:16:05,040
did they merge and what was the

400
00:16:08,790 --> 00:16:07,360
consequence of that merger

401
00:16:11,269 --> 00:16:08,800
by studying

402
00:16:14,949 --> 00:16:11,279
large samples of individual stars in

403
00:16:17,350 --> 00:16:14,959
both our galaxy and in m31 i mean the

404
00:16:18,949 --> 00:16:17,360
stars are in separate galaxies but for

405
00:16:22,550 --> 00:16:18,959
both of those galaxies we have

406
00:16:25,110 --> 00:16:22,560
identified streams of stars which have

407
00:16:27,590 --> 00:16:25,120
been torn out of satellite galaxies

408
00:16:29,189 --> 00:16:27,600
which have ventured on their orbits too

409
00:16:32,069 --> 00:16:29,199
close to the center of their parent

410
00:16:34,269 --> 00:16:32,079
galaxy this is illustrated in my next

411
00:16:36,790 --> 00:16:34,279
slide which is an artist's

412
00:16:38,550 --> 00:16:36,800
interpretation of some streams that have

413
00:16:41,590 --> 00:16:38,560

been detected among

414
00:16:44,470 --> 00:16:41,600
about the milky way galaxy

415
00:16:47,110 --> 00:16:44,480
so we've known for a while that galaxies

416
00:16:50,230 --> 00:16:47,120
typical galaxies disc galaxies

417
00:16:53,910 --> 00:16:50,240
do evolve by snacking on small satellite

418
00:16:56,550 --> 00:16:53,920
galaxies the importance of the research

419
00:16:58,870 --> 00:16:56,560
that we've just had presented is that

420
00:17:02,150 --> 00:16:58,880
the appetite of both the milky way and

421
00:17:03,749 --> 00:17:02,160
m31 has not been satisfied and in fact

422
00:17:04,710 --> 00:17:03,759
they're going to end up devouring each

423
00:17:06,710 --> 00:17:04,720
other

424
00:17:09,590 --> 00:17:06,720
and when they do so the milky way and

425
00:17:12,150 --> 00:17:09,600
m31 are going to join the pantheon of

426
00:17:14,549 --> 00:17:12,160
galaxies that we see in my next slide

427
00:17:17,270 --> 00:17:14,559
which again is beautiful images from the

428
00:17:20,949 --> 00:17:17,280
hubble space telescope of large

429
00:17:23,590 --> 00:17:20,959
colliding spiral galaxies

430
00:17:24,630 --> 00:17:23,600
small mergers with satellite galaxies we

431
00:17:27,669 --> 00:17:24,640
call

432
00:17:30,870 --> 00:17:27,679
minor mergers are quite common

433
00:17:35,270 --> 00:17:30,880
the major mergers those between galaxies

434
00:17:38,230 --> 00:17:35,280
of of approximately equal mass are much

435
00:17:40,549 --> 00:17:38,240
more profound for the system can really

436
00:17:42,789 --> 00:17:40,559
change the morphological type which is

437
00:17:45,590 --> 00:17:42,799
what one of the major goals is to

438
00:17:46,870 --> 00:17:45,600

understand how does morphological type

439
00:17:49,350 --> 00:17:46,880
change

440
00:17:52,270 --> 00:17:49,360
and the results that we've heard today

441
00:17:54,950 --> 00:17:52,280
which have allowed the full

442
00:17:56,870 --> 00:17:54,960
three-dimensional motion of m31 to be

443
00:17:59,190 --> 00:17:56,880
measured for the first time

444
00:18:02,630 --> 00:17:59,200
tell us that there will be a major

445
00:18:05,029 --> 00:18:02,640
merger between the milky way and m31

446
00:18:07,669 --> 00:18:05,039
a much more profound statement and i

447
00:18:10,789 --> 00:18:07,679
think it gives unique insight into how

448
00:18:11,669 --> 00:18:10,799
typical large galaxies evolve

449
00:18:14,070 --> 00:18:11,679
thank you

450
00:18:16,549 --> 00:18:14,080
and i turn to dr grunsfeld who's going

451
00:18:18,390 --> 00:18:16,559
to i hope describe

452
00:18:20,470 --> 00:18:18,400
how he managed to

453
00:18:22,789 --> 00:18:20,480
allow hubble space telescope to take

454
00:18:25,430 --> 00:18:22,799
these amazing images well the hubble

455
00:18:27,110 --> 00:18:25,440
space telescope is this amazing machine

456
00:18:29,190 --> 00:18:27,120
that we've come to know and love over

457
00:18:31,430 --> 00:18:29,200
the past 22 years

458
00:18:33,029 --> 00:18:31,440
when we think of the observations that

459
00:18:35,350 --> 00:18:33,039
hubble has made that have been really

460
00:18:37,190 --> 00:18:35,360
you know change the world types of

461
00:18:38,789 --> 00:18:37,200
observations they're observations that

462
00:18:40,870 --> 00:18:38,799
typically are looking back in time

463
00:18:43,110 --> 00:18:40,880

looking back to the earliest moments of

464
00:18:45,430 --> 00:18:43,120
the universe to see the earliest

465
00:18:46,549 --> 00:18:45,440
galaxies and they appear misshapen and

466
00:18:47,990 --> 00:18:46,559
irregular

467
00:18:50,710 --> 00:18:48,000
at these very high redshifts looking

468
00:18:52,549 --> 00:18:50,720
back 13 billion years in history and we

469
00:18:54,710 --> 00:18:52,559
study you know back in history because

470
00:18:55,669 --> 00:18:54,720
it takes light a long time to travel to

471
00:18:58,549 --> 00:18:55,679
us

472
00:19:00,230 --> 00:18:58,559
edwin hubble of course started this

473
00:19:02,870 --> 00:19:00,240
inquiry into what are these fuzzy

474
00:19:05,430 --> 00:19:02,880
objects that we now call galaxies and so

475
00:19:07,510 --> 00:19:05,440
this has been a very long trek if you

476
00:19:09,430 --> 00:19:07,520
will to try and understand the history

477
00:19:11,350 --> 00:19:09,440
of the universe and it's a very human

478
00:19:13,270 --> 00:19:11,360
story because we want to know about

479
00:19:15,909 --> 00:19:13,280
fundamental questions where did we come

480
00:19:17,909 --> 00:19:15,919
from you know how did you know the the

481
00:19:20,230 --> 00:19:17,919
universe form in the way that created

482
00:19:21,669 --> 00:19:20,240
galaxies that created solar systems that

483
00:19:23,430 --> 00:19:21,679
created earth's

484
00:19:26,789 --> 00:19:23,440
and we think of astronomy very much in

485
00:19:28,950 --> 00:19:26,799
this historical context

486
00:19:31,029 --> 00:19:28,960
a little bit of local history is hubble

487
00:19:34,630 --> 00:19:31,039
was launched 22 years ago we celebrated

488
00:19:37,190 --> 00:19:34,640

hubble's 22nd birthday in in april

489
00:19:40,230 --> 00:19:37,200
just three years ago i was up on the

490
00:19:42,950 --> 00:19:40,240
hubble space telescope may of 2009 on

491
00:19:45,909 --> 00:19:42,960
space shuttle mission sts 125 that's why

492
00:19:47,669 --> 00:19:45,919
i'm wearing this jacket today

493
00:19:50,310 --> 00:19:47,679
repairing an instrument called the

494
00:19:52,390 --> 00:19:50,320
advanced camera for surveys

495
00:19:55,430 --> 00:19:52,400
it had failed a few years earlier

496
00:19:58,310 --> 00:19:55,440
but it was installed in 2002 another

497
00:20:00,310 --> 00:19:58,320
mission i had the privilege to fly on

498
00:20:01,909 --> 00:20:00,320
and on that mission we installed this

499
00:20:04,149 --> 00:20:01,919
incredible camera the advanced camera

500
00:20:06,230 --> 00:20:04,159
for surveys and that's one of the

501
00:20:08,310 --> 00:20:06,240
resources that was used here and it's

502
00:20:10,070 --> 00:20:08,320
because hubble has been serviced by the

503
00:20:12,630 --> 00:20:10,080
space shuttle that's why i'm wearing my

504
00:20:13,830 --> 00:20:12,640
space shuttle tie

505
00:20:15,990 --> 00:20:13,840
that it was

506
00:20:18,070 --> 00:20:16,000
uh that longevity that allowed it to

507
00:20:20,310 --> 00:20:18,080
make these very sensitive measurements

508
00:20:22,789 --> 00:20:20,320
it's just amazing that over just a seven

509
00:20:24,630 --> 00:20:22,799
year span you know this team has been

510
00:20:26,950 --> 00:20:24,640
able to record the proper motion the

511
00:20:29,110 --> 00:20:26,960
tiny motion of the stars

512
00:20:31,590 --> 00:20:29,120
in andromeda against the background sky

513
00:20:32,630 --> 00:20:31,600

but against background galaxies

514
00:20:34,310 --> 00:20:32,640
that we were able to make this

515
00:20:37,270 --> 00:20:34,320
measurement and in the meantime that

516
00:20:40,149 --> 00:20:37,280
camera had failed and it was a crew of

517
00:20:41,990 --> 00:20:40,159
astronauts myself included who went up

518
00:20:43,029 --> 00:20:42,000
and repaired the advanced camera for

519
00:20:45,669 --> 00:20:43,039
surveys

520
00:20:46,630 --> 00:20:45,679
that enabled this work to be done and i

521
00:20:49,350 --> 00:20:46,640
think

522
00:20:51,510 --> 00:20:49,360
the great thing about hubble is in 2009

523
00:20:53,110 --> 00:20:51,520
we did a hubble complete makeover we

524
00:20:54,549 --> 00:20:53,120
fixed the space telescope imaging

525
00:20:56,630 --> 00:20:54,559
spectrograph the advanced camera for

526
00:20:58,950 --> 00:20:56,640
surveys put in the cosmic origin

527
00:21:00,950 --> 00:20:58,960
spectrograph did a whole host of repairs

528
00:21:03,350 --> 00:21:00,960
such that hubble is now you know

529
00:21:05,190 --> 00:21:03,360
practically a brand new telescope and so

530
00:21:06,950 --> 00:21:05,200
what's really exciting about the current

531
00:21:08,549 --> 00:21:06,960
measurements is it's not about

532
00:21:10,310 --> 00:21:08,559
historical astronomy it's not about

533
00:21:12,310 --> 00:21:10,320
looking back in time

534
00:21:14,310 --> 00:21:12,320
understanding you know the expansion of

535
00:21:15,190 --> 00:21:14,320
the universe it's looking forward in

536
00:21:17,110 --> 00:21:15,200
time

537
00:21:18,710 --> 00:21:17,120
which is another very human story we

538
00:21:19,990 --> 00:21:18,720

like to know about our past where did we

539
00:21:21,510 --> 00:21:20,000
come from

540
00:21:23,669 --> 00:21:21,520
we very much like to know where we're

541
00:21:25,750 --> 00:21:23,679
going and so this even though it's

542
00:21:27,990 --> 00:21:25,760
billions of years in the future it gives

543
00:21:29,430 --> 00:21:28,000
us some portrait of what the night sky

544
00:21:31,590 --> 00:21:29,440
will look like

545
00:21:34,230 --> 00:21:31,600
a really amazing event for whatever you

546
00:21:35,669 --> 00:21:34,240
know life exists on earth at that time

547
00:21:37,750 --> 00:21:35,679
of you know

548
00:21:39,110 --> 00:21:37,760
things that will transpire in the cosmos

549
00:21:41,510 --> 00:21:39,120
in the future and i think that's a very

550
00:21:42,630 --> 00:21:41,520
exciting thing for hubble to be doing

551
00:21:43,990 --> 00:21:42,640
jd

552
00:21:45,909 --> 00:21:44,000
thanks john and with that we'll start

553
00:21:47,430 --> 00:21:45,919
our question and answer session because

554
00:21:49,110 --> 00:21:47,440
we have a large number of people joining

555
00:21:51,350 --> 00:21:49,120
us from a variety of locations we'll

556
00:21:53,190 --> 00:21:51,360
need to re limit reporters to one

557
00:21:54,789 --> 00:21:53,200
question and one follow-up

558
00:21:56,710 --> 00:21:54,799
once everyone has had a chance to ask a

559
00:21:58,789 --> 00:21:56,720
question and if time permits we'll go

560
00:22:01,350 --> 00:21:58,799
around for a second round i ask that you

561
00:22:02,470 --> 00:22:01,360
identify yourself your media affiliation

562
00:22:05,270 --> 00:22:02,480
and then direct your question to a

563
00:22:06,390 --> 00:22:05,280

specific panelist to avoid any confusion

564
00:22:08,230 --> 00:22:06,400
for those who would like to ask a

565
00:22:10,390 --> 00:22:08,240
question on the phone bridge push the

566
00:22:12,950 --> 00:22:10,400
star one keys on your telephone to be

567
00:22:14,950 --> 00:22:12,960
placed in the queue and to use twitter

568
00:22:18,950 --> 00:22:14,960
send your questions to

569
00:22:21,270 --> 00:22:18,960
ask nasa and with that let's get started

570
00:22:23,590 --> 00:22:21,280
all right we have seth bornstein here in

571
00:22:26,070 --> 00:22:23,600
headquarters seth bornstein associated

572
00:22:28,710 --> 00:22:26,080
press i guess for rowan

573
00:22:30,630 --> 00:22:28,720
in terms of this merger here

574
00:22:33,270 --> 00:22:30,640
you often have a bigger and a smaller

575
00:22:35,750 --> 00:22:33,280
actor i know these are almost equal

576
00:22:38,789 --> 00:22:35,760
in terms of the end result and and the

577
00:22:40,630 --> 00:22:38,799
speeds it's coming at 250 000 miles per

578
00:22:41,990 --> 00:22:40,640
hour what's our relative speed to

579
00:22:43,990 --> 00:22:42,000
andromeda

580
00:22:45,830 --> 00:22:44,000
and is there sort of

581
00:22:48,789 --> 00:22:45,840
of the two is there one sort of the

582
00:22:51,190 --> 00:22:48,799
bigger brother bigger nastier you know

583
00:22:53,270 --> 00:22:51,200
the the bully in the in this in this

584
00:22:54,950 --> 00:22:53,280
crash the truck in the crash

585
00:22:57,510 --> 00:22:54,960
um versus the car

586
00:22:59,270 --> 00:22:57,520
and in and and in terms of

587
00:23:01,110 --> 00:22:59,280
where the sun you know obviously you

588
00:23:03,110 --> 00:23:01,120

said we'll survive

589
00:23:03,990 --> 00:23:03,120
but are we going to be in

590
00:23:57,510 --> 00:23:04,000
a

591
00:23:58,870 --> 00:23:57,520
objects you know their current

592
00:24:00,310 --> 00:23:58,880
velocities you can figure out what's

593
00:24:02,149 --> 00:24:00,320
going to happen in the future

594
00:24:04,870 --> 00:24:02,159
so in our simulations we have to account

595
00:24:07,430 --> 00:24:04,880
for any uncertainties in those masses

596
00:24:10,149 --> 00:24:07,440
so but by and large this is a merger of

597
00:24:12,310 --> 00:24:10,159
two roughly equal mass systems now

598
00:24:14,390 --> 00:24:12,320
regarding the fate of the sun i think dr

599
00:24:16,310 --> 00:24:14,400
bessler can take that question

600
00:24:18,789 --> 00:24:16,320
so within the simulations what we do is

601
00:24:21,110 --> 00:24:18,799
we tag certain particles to be potential

602
00:24:22,630 --> 00:24:21,120
sun analogs so these are particles that

603
00:24:24,390 --> 00:24:22,640
are sitting at right roughly the right

604
00:24:25,990 --> 00:24:24,400
spot location in our galaxy and we're

605
00:24:27,350 --> 00:24:26,000
moving at roughly the right speeds and

606
00:24:29,350 --> 00:24:27,360
then we track what happens to them

607
00:24:31,029 --> 00:24:29,360
throughout the simulation we find is

608
00:24:32,710 --> 00:24:31,039
that the vast majority of them are going

609
00:24:35,029 --> 00:24:32,720
to be at much larger distances than they

610
00:24:36,390 --> 00:24:35,039
are today and so

611
00:24:38,149 --> 00:24:36,400
the most of them are going to be within

612
00:24:40,390 --> 00:24:38,159
so the most the largest satellite of the

613
00:24:42,230 --> 00:24:40,400

milky way is the large magellanic cloud

614
00:24:44,230 --> 00:24:42,240
and so that's roughly what's uh you know

615
00:24:46,070 --> 00:24:44,240
the distance between us and that galaxy

616
00:24:47,990 --> 00:24:46,080
is basically as far as the sun could

617
00:24:49,909 --> 00:24:48,000
potentially go so it's not going to be

618
00:24:51,830 --> 00:24:49,919
lost to the system entirely it'll still

619
00:24:53,830 --> 00:24:51,840
be part of this remnant galaxy in the

620
00:24:58,149 --> 00:24:53,840
end but it certainly will be most likely

621
00:25:03,990 --> 00:25:00,710
and a follow-up from seth

622
00:25:05,350 --> 00:25:04,000
in terms of follow-up i guess the speeds

623
00:25:08,149 --> 00:25:05,360
uh um

624
00:25:09,110 --> 00:25:08,159
the the speed and um

625
00:25:10,710 --> 00:25:09,120
and

626
00:25:11,669 --> 00:25:10,720
i guess the other part of the sideway

627
00:25:13,510 --> 00:25:11,679
motion

628
00:25:15,590 --> 00:25:13,520
that you determined here is how much

629
00:25:17,830 --> 00:25:15,600
more sideway motion would have been

630
00:25:19,430 --> 00:25:17,840
required for it to be a miss or a

631
00:25:20,870 --> 00:25:19,440
glancing blow

632
00:25:22,630 --> 00:25:20,880
right

633
00:25:25,350 --> 00:25:22,640
so um

634
00:25:26,789 --> 00:25:25,360
in terms of the the sideways motion so

635
00:25:29,990 --> 00:25:26,799
let me first answer your first question

636
00:25:32,310 --> 00:25:30,000
so the the current approach velocity of

637
00:25:33,909 --> 00:25:32,320
between these two galaxies is 250 000

638
00:25:35,750 --> 00:25:33,919

miles per hour

639
00:25:37,029 --> 00:25:35,760
but because they are attracting each

640
00:25:38,630 --> 00:25:37,039
other and they're falling towards each

641
00:25:39,909 --> 00:25:38,640
other they're speeding up in the same

642
00:25:41,750 --> 00:25:39,919
way that something else that you drop

643
00:25:43,430 --> 00:25:41,760
towards the earth will speed up by the

644
00:25:44,870 --> 00:25:43,440
time they get

645
00:25:46,549 --> 00:25:44,880
more or less at their closest approach

646
00:25:48,310 --> 00:25:46,559
they're about going at five times as

647
00:25:50,870 --> 00:25:48,320
fast as they're going now

648
00:25:52,630 --> 00:25:50,880
so they'll be quite fast in terms of the

649
00:25:57,029 --> 00:25:52,640
sideways motion

650
00:25:59,510 --> 00:25:57,039
to within some precision because it's a

651
00:26:02,230 --> 00:25:59,520
very hard measurement we find that to

652
00:26:05,350 --> 00:26:02,240
within our precision the sideways motion

653
00:26:07,190 --> 00:26:05,360
is smaller than about you know one-third

654
00:26:09,590 --> 00:26:07,200
one-quarter of

655
00:26:11,110 --> 00:26:09,600
the approach velocity but the sideways

656
00:26:13,029 --> 00:26:11,120
motion will not actually change much

657
00:26:14,070 --> 00:26:13,039
with time the approach velocity will get

658
00:26:15,510 --> 00:26:14,080
bigger and bigger because of the

659
00:26:17,350 --> 00:26:15,520
attraction but the sideways motion will

660
00:26:19,110 --> 00:26:17,360
remain the same so by the time they

661
00:26:19,909 --> 00:26:19,120
approach each other the sideways motion

662
00:26:21,430 --> 00:26:19,919
is

663
00:26:22,789 --> 00:26:21,440

very much significantly less than the

664
00:26:24,310 --> 00:26:22,799
approach velocity

665
00:26:26,630 --> 00:26:24,320
how much it would have taken for them

666
00:26:27,990 --> 00:26:26,640
not to merge is a bit of a complicated

667
00:26:29,350 --> 00:26:28,000
question because it depends on many

668
00:26:31,190 --> 00:26:29,360
assumptions you make in these computer

669
00:26:33,190 --> 00:26:31,200
models but

670
00:26:35,669 --> 00:26:33,200
what we do know is that

671
00:26:37,590 --> 00:26:35,679
past understanding of our local universe

672
00:26:38,470 --> 00:26:37,600
indicated it would be unlikely for these

673
00:26:42,789 --> 00:26:38,480
galaxies

674
00:26:45,190 --> 00:26:42,799
to have a sideways motion of more than

675
00:26:46,630 --> 00:26:45,200
200 kilometers per second which you know

676
00:26:49,029 --> 00:26:46,640
is not quite the same units we're using

677
00:26:51,029 --> 00:26:49,039
before but that's about twice as fast as

678
00:26:52,710 --> 00:26:51,039
the approach velocity if in fact it had

679
00:26:54,630 --> 00:26:52,720
gone that fast gone that fast which

680
00:26:56,549 --> 00:26:54,640
might have been very well possible based

681
00:26:58,549 --> 00:26:56,559
on what we know about the local universe

682
00:27:00,870 --> 00:26:58,559
probably they would not have merged or

683
00:27:02,710 --> 00:27:00,880
it would have been way way way way into

684
00:27:04,710 --> 00:27:02,720
the future when many other things would

685
00:27:06,149 --> 00:27:04,720
have happened as well um you know if you

686
00:27:07,669 --> 00:27:06,159
integrate these things too far forward

687
00:27:10,310 --> 00:27:07,679
in time there's all other sorts of other

688
00:27:12,149 --> 00:27:10,320

uncertainties that come in

689
00:27:14,710 --> 00:27:12,159
thanks roland we're moving now to a

690
00:27:16,870 --> 00:27:14,720
twitter question from john mason how do

691
00:27:18,549 --> 00:27:16,880
you know that none of adronama's stars

692
00:27:20,310 --> 00:27:18,559
and planets will run into any of our

693
00:27:22,549 --> 00:27:20,320
stars and planets including our own sun

694
00:27:24,630 --> 00:27:22,559
and earth

695
00:27:26,950 --> 00:27:24,640
shall i take this question sure

696
00:27:28,950 --> 00:27:26,960
so um

697
00:27:31,029 --> 00:27:28,960
we cannot rule out that some star in

698
00:27:32,630 --> 00:27:31,039
andromeda may hit our sun or that some

699
00:27:34,549 --> 00:27:32,640
planets in andromeda if there exists

700
00:27:36,630 --> 00:27:34,559
some which may well be the case may hit

701
00:27:38,630 --> 00:27:36,640
a planet in our own solar system

702
00:27:40,310 --> 00:27:38,640
but these are very very small objects

703
00:27:42,230 --> 00:27:40,320
and there's a lot of space between them

704
00:27:44,389 --> 00:27:42,240
so what we can say that the probability

705
00:27:46,950 --> 00:27:44,399
that this will happen is really really

706
00:27:49,029 --> 00:27:46,960
really really small to the point that i

707
00:27:50,549 --> 00:27:49,039
would call it vanishingly small so we

708
00:27:53,190 --> 00:27:50,559
can't really rule it out but it would be

709
00:27:55,110 --> 00:27:53,200
a very unlikely event

710
00:27:57,190 --> 00:27:55,120
okay thanks roland we're now going to

711
00:28:02,950 --> 00:27:57,200
telephone bridge with ian thompson from

712
00:28:07,269 --> 00:28:05,190
a question on a similar point you said

713
00:28:09,350 --> 00:28:07,279

that the study by four in four billion

714
00:28:11,190 --> 00:28:09,360
years time women used a fair amount of

715
00:28:16,310 --> 00:28:11,200
its fuel what would the environment be

716
00:28:19,110 --> 00:28:17,830
can you repeat that question because it

717
00:28:25,430 --> 00:28:19,120
was very difficult to hear you were

718
00:28:29,510 --> 00:28:27,590
um okay sorry

719
00:28:31,110 --> 00:28:29,520
four billion years down the line the sun

720
00:28:32,789 --> 00:28:31,120
would have changed a certain amount of

721
00:28:34,310 --> 00:28:32,799
the environment of the earth would have

722
00:28:37,510 --> 00:28:34,320
changed you're saying this would have

723
00:28:39,669 --> 00:28:37,520
been unaffected by the collision

724
00:28:40,950 --> 00:28:39,679
yeah so let me expand on that a little

725
00:28:42,149 --> 00:28:40,960
bit um

726
00:28:47,990 --> 00:28:42,159
so

727
00:28:49,510 --> 00:28:48,000
and it has fuel left to perform nuclear

728
00:28:50,789 --> 00:28:49,520
fusion with for about another six

729
00:28:52,710 --> 00:28:50,799
billion years

730
00:28:55,029 --> 00:28:52,720
so when andromeda arrives our sun will

731
00:28:57,510 --> 00:28:55,039
still be a regular star and as such we

732
00:28:59,029 --> 00:28:57,520
don't expect our solar system and the

733
00:29:00,870 --> 00:28:59,039
earth is placed in it will have changed

734
00:29:02,470 --> 00:29:00,880
very significantly

735
00:29:05,029 --> 00:29:02,480
however what we do know and which i

736
00:29:07,430 --> 00:29:05,039
didn't mention before is that due to the

737
00:29:09,909 --> 00:29:07,440
natural evolution of the sun it'll get

738
00:29:11,350 --> 00:29:09,919

slightly hotter over time and a few

739
00:29:13,830 --> 00:29:11,360
billion years from now it'll actually

740
00:29:16,389 --> 00:29:13,840
have gotten sufficiently hotter to make

741
00:29:18,630 --> 00:29:16,399
life as we know it on earth today

742
00:29:20,070 --> 00:29:18,640
impossible because it would be too hot

743
00:29:22,310 --> 00:29:20,080
but since we're talking billions of

744
00:29:23,590 --> 00:29:22,320
years into the future i personally do

745
00:29:25,510 --> 00:29:23,600
not think that that necessarily means

746
00:29:27,750 --> 00:29:25,520
that our civilization will not be there

747
00:29:29,510 --> 00:29:27,760
for example if we find a smart way to

748
00:29:31,510 --> 00:29:29,520
use solar energy and turn it into air

749
00:29:33,190 --> 00:29:31,520
conditioning we may still be able to

750
00:29:35,669 --> 00:29:33,200
live on this planet even though our

751
00:29:38,230 --> 00:29:35,679
planet by normal measures would be too

752
00:29:40,630 --> 00:29:38,240
hot to live on so the environment will

753
00:29:42,549 --> 00:29:40,640
change for other reasons as well but by

754
00:29:44,310 --> 00:29:42,559
and large when andromeda gets here you

755
00:29:45,830 --> 00:29:44,320
know our sun and the solar system will

756
00:29:47,190 --> 00:29:45,840
still be pretty much in the same state

757
00:29:49,110 --> 00:29:47,200
there will be the same number of planets

758
00:29:51,350 --> 00:29:49,120
that will be still going around more or

759
00:29:52,789 --> 00:29:51,360
less in circles and you know we can't

760
00:29:54,389 --> 00:29:52,799
rule out that other things may happen in

761
00:29:57,510 --> 00:29:54,399
the meantime but i think by and large

762
00:29:59,590 --> 00:29:57,520
that's not necessarily the expectation

763
00:30:02,389 --> 00:29:59,600

thanks roland we have a question here

764
00:30:09,110 --> 00:30:04,630
john can answer how much longer do you

765
00:30:11,669 --> 00:30:09,120
think we'll get service out of hubble

766
00:30:13,110 --> 00:30:11,679
well the the warranty was five years so

767
00:30:14,389 --> 00:30:13,120
we still have two years on the on the

768
00:30:15,750 --> 00:30:14,399
crew warranty

769
00:30:17,590 --> 00:30:15,760
but

770
00:30:19,350 --> 00:30:17,600
it's very hard to say because so few

771
00:30:21,669 --> 00:30:19,360
things have failed on hubble to

772
00:30:24,149 --> 00:30:21,679
accumulate statistics so that we can

773
00:30:25,990 --> 00:30:24,159
predict how long hubble will last

774
00:30:27,590 --> 00:30:26,000
but i'm certainly hoping that we get you

775
00:30:29,830 --> 00:30:27,600
know another six eight maybe even ten

776
00:30:31,510 --> 00:30:29,840
years of life out of hubble there are

777
00:30:33,909 --> 00:30:31,520
things that we know will start failing

778
00:30:35,909 --> 00:30:33,919
eventually gyroscopes will start wearing

779
00:30:39,029 --> 00:30:35,919
out other things that you know have

780
00:30:40,230 --> 00:30:39,039
moving parts might start wearing out

781
00:30:41,669 --> 00:30:40,240
you know but i'm very hopeful that we

782
00:30:42,789 --> 00:30:41,679
can keep hubble going as long as

783
00:30:43,990 --> 00:30:42,799
possible

784
00:30:45,510 --> 00:30:44,000
thanks john

785
00:30:47,110 --> 00:30:45,520
uh we're now going back to the uh

786
00:30:52,549 --> 00:30:47,120
telephone bridge with mike wahl from

787
00:30:56,389 --> 00:30:54,310
oh yeah do you guys have any idea i mean

788
00:30:59,029 --> 00:30:56,399

how many of these sorts of huge kind of

789
00:31:01,190 --> 00:30:59,039
galaxy crashes um we have endured and

790
00:31:02,710 --> 00:31:01,200
the milky way has endured and it's i

791
00:31:04,470 --> 00:31:02,720
don't know 13

792
00:31:06,470 --> 00:31:04,480
like the kind of billion year history or

793
00:31:08,230 --> 00:31:06,480
so i mean is this something that is

794
00:31:09,750 --> 00:31:08,240
unprecedented for the milky way or is

795
00:31:11,750 --> 00:31:09,760
this what has this sort of thing

796
00:31:13,909 --> 00:31:11,760
happened before

797
00:31:15,830 --> 00:31:13,919
i think i'll take that this is professor

798
00:31:17,669 --> 00:31:15,840
wise from hopkins

799
00:31:19,430 --> 00:31:17,679
we can actually

800
00:31:20,870 --> 00:31:19,440
trace

801
00:31:23,830 --> 00:31:20,880
the past

802
00:31:26,470 --> 00:31:23,840
major mergers in the milky way by

803
00:31:29,389 --> 00:31:26,480
looking at the kinematics of stars and

804
00:31:32,389 --> 00:31:29,399
what we find is that this will indeed be

805
00:31:35,750 --> 00:31:32,399
unprecedented we can trace the past

806
00:31:39,269 --> 00:31:35,760
major merger history because in a major

807
00:31:42,070 --> 00:31:39,279
merger basically discs get destroyed as

808
00:31:44,870 --> 00:31:42,080
you saw you take two disc galaxies

809
00:31:47,190 --> 00:31:44,880
smash them together the orbital energy

810
00:31:49,830 --> 00:31:47,200
goes somewhere and the main place the

811
00:31:51,830 --> 00:31:49,840
orbital energy goes into is to changing

812
00:31:54,389 --> 00:31:51,840
the orbits of the stars in the disks

813
00:31:57,029 --> 00:31:54,399

putting them on much more energetic

814
00:31:58,149 --> 00:31:57,039
orbits not nice circular orbits in the

815
00:31:59,830 --> 00:31:58,159
disk

816
00:32:03,110 --> 00:31:59,840
changing them to three-dimensional

817
00:32:06,310 --> 00:32:03,120
orbits when we look at stars in the disk

818
00:32:09,509 --> 00:32:06,320
of our galaxy we can identify that there

819
00:32:11,909 --> 00:32:09,519
actually is a more energetic component

820
00:32:14,950 --> 00:32:11,919
of the disk a thick disk

821
00:32:16,870 --> 00:32:14,960
but basically all the stars in the thick

822
00:32:19,269 --> 00:32:16,880
disk are very old

823
00:32:22,230 --> 00:32:19,279
there has been ongoing star formation in

824
00:32:23,669 --> 00:32:22,240
the thin disk over the past 10 12

825
00:32:26,389 --> 00:32:23,679
billion years

826
00:32:29,350 --> 00:32:26,399
if there had been a significant merger

827
00:32:32,230 --> 00:32:29,360
it would have puffed up younger stars so

828
00:32:35,110 --> 00:32:32,240
we can take the last significant merger

829
00:32:37,909 --> 00:32:35,120
that our galaxy has had by looking at

830
00:32:39,990 --> 00:32:37,919
the edges of stars that are not in the

831
00:32:43,669 --> 00:32:40,000
thin disk but have been puffed up into a

832
00:32:46,950 --> 00:32:43,679
thick disk and because that age is old

833
00:32:49,750 --> 00:32:46,960
it tells us that that's the time ago

834
00:32:52,789 --> 00:32:49,760
that there was a last significant merger

835
00:32:55,590 --> 00:32:52,799
so the milky way has had probably quite

836
00:32:59,669 --> 00:32:55,600
a lot of small minor mergers but this

837
00:33:01,430 --> 00:32:59,679
major merger will be unprecedented

838
00:33:02,710 --> 00:33:01,440

thanks rosemary once again if you'd like

839
00:33:04,950 --> 00:33:02,720
to

840
00:33:07,430 --> 00:33:04,960
place a call on the telephone bridge

841
00:33:09,430 --> 00:33:07,440
push the star one key to get placed in

842
00:33:10,549 --> 00:33:09,440
the queue we're back to the twitter page

843
00:33:13,269 --> 00:33:10,559
right now

844
00:33:15,430 --> 00:33:13,279
we have a question from uh

845
00:33:17,029 --> 00:33:15,440
joshua sun he's asking what is the

846
00:33:20,549 --> 00:33:17,039
effect of the two black holes in

847
00:33:22,310 --> 00:33:20,559
relation to the merging of the galaxies

848
00:33:24,630 --> 00:33:22,320
let me pass that question on to my

849
00:33:26,230 --> 00:33:24,640
colleague dr bessler

850
00:33:27,750 --> 00:33:26,240
so definitely one of the most dramatic

851
00:33:30,630 --> 00:33:27,760
things that happens in

852
00:33:32,070 --> 00:33:30,640
galaxies is the the two massive black

853
00:33:34,230 --> 00:33:32,080
holes in both of those galaxies will

854
00:33:35,750 --> 00:33:34,240
merge and we've seen this in actions we

855
00:33:37,269 --> 00:33:35,760
know that there's it's a very energetic

856
00:33:39,509 --> 00:33:37,279
event but the thing is that with the

857
00:33:42,230 --> 00:33:39,519
milky way and andromeda these two black

858
00:33:44,549 --> 00:33:42,240
holes are not expec especially massive

859
00:33:46,710 --> 00:33:44,559
and also there isn't a lot of gas around

860
00:33:48,149 --> 00:33:46,720
so when black holes merge it's an

861
00:33:49,990 --> 00:33:48,159
energetic event but they also eat up a

862
00:33:51,110 --> 00:33:50,000
lot of gas and that's what we really see

863
00:33:53,350 --> 00:33:51,120

in terms of the amount of energy that's

864
00:33:54,710 --> 00:33:53,360
produced there isn't a lot of gas around

865
00:33:56,630 --> 00:33:54,720
these galaxies so we don't expect it to

866
00:33:58,310 --> 00:33:56,640
be extremely dramatic but there will be

867
00:34:00,549 --> 00:33:58,320
a merger between these two massive black

868
00:34:01,990 --> 00:34:00,559
holes it's unclear how much radiation

869
00:34:03,509 --> 00:34:02,000
will come out from that for example and

870
00:34:05,509 --> 00:34:03,519
whether that would affect

871
00:34:07,990 --> 00:34:05,519
our local environment but it certainly

872
00:34:10,149 --> 00:34:08,000
should be a merger

873
00:34:12,470 --> 00:34:10,159
can i follow up on that sure

874
00:34:14,470 --> 00:34:12,480
so um one thing to note is that the the

875
00:34:16,069 --> 00:34:14,480
merger of the black holes if and when

876
00:34:18,310 --> 00:34:16,079
that happens will be very interesting in

877
00:34:20,069 --> 00:34:18,320
its own right but the mass of these

878
00:34:21,829 --> 00:34:20,079
black holes is very small compared to

879
00:34:23,990 --> 00:34:21,839
the total mass of these galaxies it's

880
00:34:26,389 --> 00:34:24,000
only of the order of you know one part

881
00:34:28,710 --> 00:34:26,399
in a hundred thousand or so so in terms

882
00:34:31,109 --> 00:34:28,720
of the overall orbits of these galaxies

883
00:34:32,869 --> 00:34:31,119
the black holes have almost no influence

884
00:34:34,470 --> 00:34:32,879
so they don't change anything we've said

885
00:34:35,589 --> 00:34:34,480
before but they might add some

886
00:34:38,230 --> 00:34:35,599
interesting

887
00:34:41,430 --> 00:34:38,240
you know sideshow in their own right

888
00:34:42,550 --> 00:34:41,440

that we haven't discussed here yet

889
00:34:44,950 --> 00:34:42,560
thanks roland

890
00:34:47,589 --> 00:34:44,960
back to the twitter feeds here got a

891
00:34:49,589 --> 00:34:47,599
question from dagmty during the merger

892
00:34:51,669 --> 00:34:49,599
will some stars be permanently ejected

893
00:34:54,710 --> 00:34:51,679
into intergalactic space if so what

894
00:34:57,109 --> 00:34:54,720
fraction of the galaxy is lost

895
00:34:59,270 --> 00:34:57,119
let me take that question um so in the

896
00:35:01,349 --> 00:34:59,280
simulations as

897
00:35:03,990 --> 00:35:01,359
dr bezlar discussed before we did

898
00:35:06,950 --> 00:35:04,000
specifically look at particles like our

899
00:35:09,589 --> 00:35:06,960
sun to see what will happen to our sun

900
00:35:12,230 --> 00:35:09,599
we find that in none of the simulations

901
00:35:14,870 --> 00:35:12,240
that we have run

902
00:35:17,589 --> 00:35:14,880
it is possible for the sun to totally

903
00:35:20,150 --> 00:35:17,599
escape the gravitational pull of these

904
00:35:22,470 --> 00:35:20,160
two galaxies so when andromeda and milky

905
00:35:25,109 --> 00:35:22,480
way merge our star

906
00:35:27,670 --> 00:35:25,119
our sun will remain part of that galaxy

907
00:35:29,990 --> 00:35:27,680
our sun will move very far out but it

908
00:35:31,349 --> 00:35:30,000
won't escape altogether there is one

909
00:35:33,270 --> 00:35:31,359
interesting thing though is that we did

910
00:35:35,510 --> 00:35:33,280
look at this third galaxy the triangulum

911
00:35:38,150 --> 00:35:35,520
galaxy which is a smaller companion of

912
00:35:39,910 --> 00:35:38,160
the andromeda galaxy it's about 10 of

913
00:35:41,750 --> 00:35:39,920

the mass of the andromeda galaxy and it

914
00:35:42,710 --> 00:35:41,760
essentially follows andromeda through

915
00:35:44,870 --> 00:35:42,720
space

916
00:35:47,109 --> 00:35:44,880
but because andromeda is heading our way

917
00:35:49,990 --> 00:35:47,119
the triangulum galaxy is moved pooled

918
00:35:52,470 --> 00:35:50,000
with it and is also coming our way

919
00:35:54,310 --> 00:35:52,480
we find that this triangulum galaxy may

920
00:35:57,030 --> 00:35:54,320
actually hit us first there is a nine

921
00:35:59,589 --> 00:35:57,040
percent probability in our computations

922
00:36:00,630 --> 00:35:59,599
that the triangulum galaxy m33 might hit

923
00:36:02,870 --> 00:36:00,640
us first

924
00:36:04,390 --> 00:36:02,880
that won't have as much of an impact but

925
00:36:06,470 --> 00:36:04,400
we may actually get a one-two punch of

926
00:36:08,950 --> 00:36:06,480
two galaxies hitting us in a row

927
00:36:11,430 --> 00:36:08,960
now the other thing is that even if the

928
00:36:13,910 --> 00:36:11,440
galaxy m33 doesn't hit us first there's

929
00:36:16,150 --> 00:36:13,920
actually a probability significant 20

930
00:36:18,710 --> 00:36:16,160
percent that at some point in the next

931
00:36:21,190 --> 00:36:18,720
10 billion years our sun will actually

932
00:36:23,349 --> 00:36:21,200
find itself inside of m33

933
00:36:25,990 --> 00:36:23,359
so even though dynamically will still be

934
00:36:28,390 --> 00:36:26,000
part of the milky way andromeda merger

935
00:36:29,829 --> 00:36:28,400
remnant we might actually spatially find

936
00:36:32,470 --> 00:36:29,839
ourselves temporarily moving through

937
00:36:33,910 --> 00:36:32,480
this third galaxy before we then fall

938
00:36:35,589 --> 00:36:33,920

back towards the center of the merger

939
00:36:36,950 --> 00:36:35,599
remnant so there's a lot of interesting

940
00:36:39,190 --> 00:36:36,960
things that can happen in terms of what

941
00:36:41,430 --> 00:36:39,200
may happen to the sun and we have only

942
00:36:42,950 --> 00:36:41,440
modeled the three most massive galaxies

943
00:36:45,349 --> 00:36:42,960
in our local universe

944
00:36:46,710 --> 00:36:45,359
our the milky way and andromeda dominate

945
00:36:48,950 --> 00:36:46,720
what is known as the local group of

946
00:36:50,870 --> 00:36:48,960
galaxies and in that local group there

947
00:36:53,990 --> 00:36:50,880
is actually about 50 galaxies most of

948
00:36:56,069 --> 00:36:54,000
them are much smaller but 47 of those we

949
00:36:58,710 --> 00:36:56,079
haven't modeled so some of these smaller

950
00:37:00,150 --> 00:36:58,720
galaxies may also you know provide

951
00:37:02,069 --> 00:37:00,160
interesting things when this whole

952
00:37:03,670 --> 00:37:02,079
collision will occur and there's

953
00:37:06,230 --> 00:37:03,680
certainly a lot of you know opportunity

954
00:37:07,589 --> 00:37:06,240
here for further study uh to delve into

955
00:37:09,510 --> 00:37:07,599
those issues

956
00:37:11,190 --> 00:37:09,520
thanks roland i want to get another

957
00:37:13,109 --> 00:37:11,200
question from twitter any plans of

958
00:37:15,109 --> 00:37:13,119
making hubble redo the deep field

959
00:37:19,670 --> 00:37:15,119
experiment in different locations of

960
00:37:24,870 --> 00:37:22,150
well the observations on hubble are done

961
00:37:26,470 --> 00:37:24,880
on a competitive basis so people propose

962
00:37:29,190 --> 00:37:26,480
and we've just finished going through a

963
00:37:31,750 --> 00:37:29,200

proposal cycle uh that proposal reviewed

964
00:37:33,349 --> 00:37:31,760
and rated but i know there are you know

965
00:37:35,829 --> 00:37:33,359
certain fields in space that have been

966
00:37:37,990 --> 00:37:35,839
studied in great detail and there are

967
00:37:39,589 --> 00:37:38,000
you know folks who think we should redo

968
00:37:41,510 --> 00:37:39,599
uh the current deep field or other deep

969
00:37:43,430 --> 00:37:41,520
fields to look either further on or in

970
00:37:45,990 --> 00:37:43,440
other areas i think one of the more

971
00:37:48,069 --> 00:37:46,000
interesting questions that

972
00:37:50,310 --> 00:37:48,079
folks are talking about now is we have

973
00:37:52,470 --> 00:37:50,320
the next towel hubble 2.0 called the

974
00:37:54,069 --> 00:37:52,480
james webb space telescope coming up

975
00:37:55,910 --> 00:37:54,079
it's an infrared telescope it will

976
00:37:58,390 --> 00:37:55,920
actually go where no hubble has gone

977
00:37:59,750 --> 00:37:58,400
before deeper into the universe

978
00:38:01,030 --> 00:37:59,760
and be able to see lots of things that

979
00:38:02,710 --> 00:38:01,040
hubble can't see because it's an

980
00:38:04,630 --> 00:38:02,720
infrared telescope

981
00:38:05,990 --> 00:38:04,640
and while we still have hubble you know

982
00:38:07,430 --> 00:38:06,000
folks are asking scientists are asking

983
00:38:09,349 --> 00:38:07,440
the question are there things we should

984
00:38:10,630 --> 00:38:09,359
observe with hubble now

985
00:38:12,390 --> 00:38:10,640
that we're going to want when we have

986
00:38:14,390 --> 00:38:12,400
james webb space telescope in case

987
00:38:16,069 --> 00:38:14,400
hubble doesn't last that long and so

988
00:38:18,069 --> 00:38:16,079

that may be some other deep fields or

989
00:38:20,150 --> 00:38:18,079
some other kind of observations you know

990
00:38:21,990 --> 00:38:20,160
perhaps even of andromeda

991
00:38:24,310 --> 00:38:22,000
that will help guide us in future

992
00:38:27,109 --> 00:38:24,320
science

993
00:38:29,109 --> 00:38:27,119
okay we have another question here how

994
00:38:30,950 --> 00:38:29,119
can you predict with certainty which

995
00:38:32,790 --> 00:38:30,960
you've mentioned several times

996
00:38:35,190 --> 00:38:32,800
the actions that are so far into the

997
00:38:37,349 --> 00:38:35,200
future

998
00:38:39,750 --> 00:38:37,359
well so the

999
00:38:41,349 --> 00:38:39,760
as i try to mention before the

1000
00:38:43,030 --> 00:38:41,359
calculating these things into the future

1001
00:38:44,630 --> 00:38:43,040
isn't actually that complicated so what

1002
00:38:45,990 --> 00:38:44,640
you need is newton's laws of motion

1003
00:38:47,589 --> 00:38:46,000
which have been known from hundreds of

1004
00:38:49,990 --> 00:38:47,599
years in which you know students learn

1005
00:38:51,750 --> 00:38:50,000
in high school and with newton's laws of

1006
00:38:53,750 --> 00:38:51,760
motions and you have two big things

1007
00:38:55,270 --> 00:38:53,760
moving you need to know only two things

1008
00:38:57,030 --> 00:38:55,280
you need to know their mass and you need

1009
00:38:58,790 --> 00:38:57,040
to know their velocity

1010
00:39:00,470 --> 00:38:58,800
and we've measured their velocity and

1011
00:39:02,790 --> 00:39:00,480
we've measured their mass

1012
00:39:04,230 --> 00:39:02,800
so it's a deterministic problem you can

1013
00:39:05,270 --> 00:39:04,240

just put those numbers in and you can

1014
00:39:07,750 --> 00:39:05,280
solve it

1015
00:39:10,710 --> 00:39:07,760
now as it turns out

1016
00:39:13,270 --> 00:39:10,720
in our universe most things happen on

1017
00:39:15,109 --> 00:39:13,280
size scales and time scales that are

1018
00:39:17,829 --> 00:39:15,119
just much bigger than our human

1019
00:39:19,589 --> 00:39:17,839
perception normally allows for us you

1020
00:39:21,990 --> 00:39:19,599
know a hundred thousand years sounds

1021
00:39:23,589 --> 00:39:22,000
long billions of years sounds so much

1022
00:39:24,470 --> 00:39:23,599
longer that it's hard to grasp the

1023
00:39:25,670 --> 00:39:24,480
difference

1024
00:39:27,510 --> 00:39:25,680
but

1025
00:39:28,550 --> 00:39:27,520
the dynamics of this system of these two

1026
00:39:30,069 --> 00:39:28,560
galaxies

1027
00:39:32,069 --> 00:39:30,079
really isn't that different than many

1028
00:39:34,150 --> 00:39:32,079
other dynamical systems we study for

1029
00:39:35,910 --> 00:39:34,160
example you know the solar system we

1030
00:39:37,589 --> 00:39:35,920
have the earth going around the sun once

1031
00:39:39,270 --> 00:39:37,599
every year it's been doing that for

1032
00:39:41,030 --> 00:39:39,280
billions of years you know we can

1033
00:39:43,910 --> 00:39:41,040
calculate how this works we understand

1034
00:39:45,109 --> 00:39:43,920
it we can calculate when we launch

1035
00:39:46,790 --> 00:39:45,119
uh you know

1036
00:39:48,150 --> 00:39:46,800
rockets when we lost spain ships you

1037
00:39:50,230 --> 00:39:48,160
know they basically are subject to the

1038
00:39:52,550 --> 00:39:50,240

same laws of motion we can figure out

1039
00:39:54,470 --> 00:39:52,560
quite exactly how to do that and these

1040
00:39:56,069 --> 00:39:54,480
are all things one can calculate the

1041
00:39:57,990 --> 00:39:56,079
thing that's different here is that

1042
00:40:00,390 --> 00:39:58,000
because these galaxies are bigger and

1043
00:40:02,870 --> 00:40:00,400
they're more massive things take a lot

1044
00:40:04,790 --> 00:40:02,880
longer but in terms of the underlying

1045
00:40:07,510 --> 00:40:04,800
physics and the underlying equations of

1046
00:40:09,270 --> 00:40:07,520
the problem it's really no different and

1047
00:40:11,510 --> 00:40:09,280
we do know of many other things in the

1048
00:40:13,349 --> 00:40:11,520
universe around us today and there

1049
00:40:15,430 --> 00:40:13,359
really isn't anything else around that

1050
00:40:16,630 --> 00:40:15,440
is massive enough to perturb this so

1051
00:40:17,990 --> 00:40:16,640
it's not that we could have missed

1052
00:40:19,510 --> 00:40:18,000
something major

1053
00:40:21,030 --> 00:40:19,520
because if there were some other galaxy

1054
00:40:23,190 --> 00:40:21,040
that were 10 times as big as our milky

1055
00:40:24,870 --> 00:40:23,200
way and andromeda and close enough to

1056
00:40:27,430 --> 00:40:24,880
perturb this we would have known about

1057
00:40:29,589 --> 00:40:27,440
it a long long time ago so i do think

1058
00:40:30,550 --> 00:40:29,599
that this is a totally calculable

1059
00:40:32,150 --> 00:40:30,560
problem

1060
00:40:34,870 --> 00:40:32,160
once you know the masses and the

1061
00:40:36,309 --> 00:40:34,880
velocities of these galaxies

1062
00:40:37,829 --> 00:40:36,319
thanks roland once again the telephone

1063
00:40:40,230 --> 00:40:37,839

lines are open if you have a question

1064
00:40:42,710 --> 00:40:40,240
just push star one on your phone

1065
00:40:44,390 --> 00:40:42,720
uh back to the twitter sphere here

1066
00:40:46,550 --> 00:40:44,400
are there any similar mergers happening

1067
00:40:49,510 --> 00:40:46,560
that we can today observe and perhaps

1068
00:40:55,270 --> 00:40:51,990
well perhaps i can take that one i did

1069
00:40:58,470 --> 00:40:55,280
show a montage of colliding galaxies so

1070
00:41:01,349 --> 00:40:58,480
we do know that there have been there

1071
00:41:05,750 --> 00:41:01,359
are ongoing and there will be similar

1072
00:41:07,829 --> 00:41:05,760
mergers between similar spiral galaxies

1073
00:41:11,270 --> 00:41:07,839
but as roland was just pointing out

1074
00:41:13,510 --> 00:41:11,280
these mergers happen on extremely long

1075
00:41:16,230 --> 00:41:13,520
time scales so of course we can't

1076
00:41:19,430 --> 00:41:16,240
actually watch them happening what we

1077
00:41:21,910 --> 00:41:19,440
can do is try to put together all these

1078
00:41:24,470 --> 00:41:21,920
different snapshots in some kind of an

1079
00:41:27,190 --> 00:41:24,480
evolutionary sequence so that we can

1080
00:41:29,510 --> 00:41:27,200
understand which galaxies are just

1081
00:41:31,990 --> 00:41:29,520
approaching which ones have passed the

1082
00:41:35,109 --> 00:41:32,000
center which ones are coming back this

1083
00:41:38,230 --> 00:41:35,119
is ongoing research but the merger

1084
00:41:41,349 --> 00:41:38,240
that we now have predicted between m31

1085
00:41:43,430 --> 00:41:41,359
and the milky way is not that unusual

1086
00:41:46,150 --> 00:41:43,440
it's very unusual for each of those two

1087
00:41:48,150 --> 00:41:46,160
galaxies but in terms of what else is

1088
00:41:50,430 --> 00:41:48,160

going on in the universe it's not that

1089
00:41:52,309 --> 00:41:50,440
unusual in fact if you go on

1090
00:41:53,990 --> 00:41:52,319
hubblesite.org you can find a whole

1091
00:41:55,270 --> 00:41:54,000
collection of images similar to the

1092
00:41:56,950 --> 00:41:55,280
montage

1093
00:41:58,710 --> 00:41:56,960
that was shown earlier and in fact

1094
00:42:02,230 --> 00:41:58,720
there's also some animations that will

1095
00:42:03,750 --> 00:42:02,240
show you you know examples of galaxies

1096
00:42:04,790 --> 00:42:03,760
doing the dance

1097
00:42:07,430 --> 00:42:04,800
merging

1098
00:42:09,750 --> 00:42:07,440
and then the equivalent hubble image you

1099
00:42:12,069 --> 00:42:09,760
know that compares to that particular

1100
00:42:15,030 --> 00:42:12,079
animation

1101
00:42:15,040 --> 00:42:15,990
of um

1102
00:42:19,829 --> 00:42:17,910
specify why this particular observation

1103
00:42:21,990 --> 00:42:19,839
is just so special from a simulator's

1104
00:42:24,470 --> 00:42:22,000
point of view when we try and um

1105
00:42:25,990 --> 00:42:24,480
simulate these mergers of galaxies what

1106
00:42:27,670 --> 00:42:26,000
we find is that there's a huge error

1107
00:42:29,750 --> 00:42:27,680
space in the velocities and the masses

1108
00:42:31,190 --> 00:42:29,760
we choose so this is an example of a way

1109
00:42:33,030 --> 00:42:31,200
of simulating an

1110
00:42:35,109 --> 00:42:33,040
upcoming merger where we actually know a

1111
00:42:36,710 --> 00:42:35,119
lot of the parameters we have very now

1112
00:42:38,150 --> 00:42:36,720
very small error bars on the velocities

1113
00:42:40,069 --> 00:42:38,160

and this is what's so special about this

1114
00:42:41,589 --> 00:42:40,079
observation is that we now can actually

1115
00:42:43,109 --> 00:42:41,599
simulate this with a degree of accuracy

1116
00:42:46,710 --> 00:42:43,119
that we cannot do for any other

1117
00:42:51,030 --> 00:42:48,470
uh getting some excellent questions here

1118
00:42:52,470 --> 00:42:51,040
on the twitter feed what are other ways

1119
00:42:55,270 --> 00:42:52,480
that we are observing these movements

1120
00:42:59,589 --> 00:42:57,270
you want to talk about that tony well

1121
00:43:02,150 --> 00:42:59,599
yes i'll take that question um there are

1122
00:43:03,990 --> 00:43:02,160
some other programs that say um

1123
00:43:06,230 --> 00:43:04,000
these measuring the sideways motion of

1124
00:43:07,510 --> 00:43:06,240
stars from the ground-based telescopes

1125
00:43:09,270 --> 00:43:07,520
are um

1126
00:43:11,109 --> 00:43:09,280
they're also like programs

1127
00:43:13,910 --> 00:43:11,119
you using hubble to actually measure

1128
00:43:16,870 --> 00:43:13,920
proper sideways motion of other galaxies

1129
00:43:18,950 --> 00:43:16,880
but um this this project was the one

1130
00:43:20,950 --> 00:43:18,960
that actually um

1131
00:43:23,109 --> 00:43:20,960
it's it's a

1132
00:43:25,270 --> 00:43:23,119
the accuracy of measuring the sideways

1133
00:43:27,430 --> 00:43:25,280
motion has never been this actually i'm

1134
00:43:29,670 --> 00:43:27,440
good so this is the

1135
00:43:32,069 --> 00:43:29,680
this has been the best um accuracy we

1136
00:43:33,589 --> 00:43:32,079
achieved with hubble and in with any

1137
00:43:35,109 --> 00:43:33,599
other telescopes

1138
00:43:37,990 --> 00:43:35,119

so

1139
00:43:39,589 --> 00:43:38,000
yeah if i can just follow on on that um

1140
00:43:41,990 --> 00:43:39,599
as we've mentioned before this is the

1141
00:43:44,390 --> 00:43:42,000
first measurement of the sideways motion

1142
00:43:46,309 --> 00:43:44,400
of andromeda there are other techniques

1143
00:43:49,030 --> 00:43:46,319
to measure sideways motion that use

1144
00:43:50,550 --> 00:43:49,040
radio observations and this does require

1145
00:43:52,870 --> 00:43:50,560
that you have a radio source in this

1146
00:43:55,589 --> 00:43:52,880
galaxy you can look at

1147
00:43:57,270 --> 00:43:55,599
but radio observations can yield very

1148
00:43:59,030 --> 00:43:57,280
high positional accuracies because you

1149
00:44:01,510 --> 00:43:59,040
can use what are called interferometric

1150
00:44:03,109 --> 00:44:01,520
techniques so you can use radio

1151
00:44:05,510 --> 00:44:03,119
telescopes on different parts of our

1152
00:44:07,109 --> 00:44:05,520
earth and put the results together to

1153
00:44:09,430 --> 00:44:07,119
make it look like you have a telescope

1154
00:44:12,790 --> 00:44:09,440
almost the size of the whole earth

1155
00:44:14,309 --> 00:44:12,800
so in a few years it is likely that

1156
00:44:16,630 --> 00:44:14,319
such measurement will become available

1157
00:44:19,109 --> 00:44:16,640
for andromeda because just last year for

1158
00:44:21,030 --> 00:44:19,119
the first time good radio sources were

1159
00:44:23,670 --> 00:44:21,040
detected for which such measurements can

1160
00:44:25,270 --> 00:44:23,680
be done so likely in a couple of years

1161
00:44:28,230 --> 00:44:25,280
there will be other ways to look at this

1162
00:44:30,069 --> 00:44:28,240
problem which may refine this work and

1163
00:44:31,190 --> 00:44:30,079

may you know provide further additional

1164
00:44:32,790 --> 00:44:31,200
details

1165
00:44:34,790 --> 00:44:32,800
both on what might happen and also on

1166
00:44:36,790 --> 00:44:34,800
the structure of the andromeda galaxy so

1167
00:44:38,550 --> 00:44:36,800
this is definitely you know an ongoing

1168
00:44:39,829 --> 00:44:38,560
field with you know different ways of

1169
00:44:41,030 --> 00:44:39,839
looking at it

1170
00:44:42,550 --> 00:44:41,040
thanks roland

1171
00:44:46,550 --> 00:44:42,560
uh the next question we have is could

1172
00:44:51,990 --> 00:44:50,470
let me pass that on to gartina

1173
00:44:53,109 --> 00:44:52,000
that we ran we didn't actually include

1174
00:44:54,630 --> 00:44:53,119
any gas

1175
00:44:56,710 --> 00:44:54,640
and so we couldn't actually test

1176
00:44:58,630 --> 00:44:56,720
specifically how much the black holes

1177
00:45:00,630 --> 00:44:58,640
when they merge and they form this one

1178
00:45:02,550 --> 00:45:00,640
larger structure uh how much gasoline

1179
00:45:04,390 --> 00:45:02,560
should be eating but this work has been

1180
00:45:05,589 --> 00:45:04,400
done before people have tried to

1181
00:45:07,750 --> 00:45:05,599
simulate whether or not what would

1182
00:45:10,230 --> 00:45:07,760
happen if the milky way and m31 collided

1183
00:45:11,430 --> 00:45:10,240
and in simulations with get with gas and

1184
00:45:13,589 --> 00:45:11,440
they found that there just isn't enough

1185
00:45:15,270 --> 00:45:13,599
gas around to really fuel this black

1186
00:45:17,990 --> 00:45:15,280
hole merger and this is when we talk

1187
00:45:20,309 --> 00:45:18,000
about active galaxies and we talk about

1188
00:45:22,309 --> 00:45:20,319

quasars we're talking about black holes

1189
00:45:24,069 --> 00:45:22,319
that are very actively accreting gas and

1190
00:45:25,589 --> 00:45:24,079
so it's a very energetic event and so

1191
00:45:29,670 --> 00:45:25,599
that's most likely will not happen with

1192
00:45:33,910 --> 00:45:31,510
all right thanks

1193
00:45:35,510 --> 00:45:33,920
we have another question here and i'm i

1194
00:45:37,510 --> 00:45:35,520
think i know the answer but i might be

1195
00:45:39,670 --> 00:45:37,520
wrong once these two galaxies have

1196
00:45:41,430 --> 00:45:39,680
collided what's the new galaxy going to

1197
00:45:43,990 --> 00:45:41,440
be called

1198
00:45:45,670 --> 00:45:44,000
well so we haven't specifically tried to

1199
00:45:47,829 --> 00:45:45,680
assign a name to this new galaxy but

1200
00:45:49,990 --> 00:45:47,839
there was a previous group that did

1201
00:45:52,230 --> 00:45:50,000
calculations of

1202
00:45:54,550 --> 00:45:52,240
what might happen under assumptions of

1203
00:45:56,069 --> 00:45:54,560
the sideways motion so before no one had

1204
00:45:58,309 --> 00:45:56,079
measurements but that certainly didn't

1205
00:46:00,150 --> 00:45:58,319
stop people from calculating what could

1206
00:46:02,870 --> 00:46:00,160
happen if they were to be running into

1207
00:46:05,829 --> 00:46:02,880
each other and that particular group uh

1208
00:46:08,470 --> 00:46:05,839
adopted the name milk comeda as a you

1209
00:46:09,670 --> 00:46:08,480
know as a mixture of milky way and

1210
00:46:10,950 --> 00:46:09,680
andromeda

1211
00:46:12,470 --> 00:46:10,960
personally i think i would like

1212
00:46:13,910 --> 00:46:12,480
lactometer better

1213
00:46:15,670 --> 00:46:13,920

because if it's you know it's a more

1214
00:46:17,109 --> 00:46:15,680
classical mix of terms and doesn't mix

1215
00:46:19,430 --> 00:46:17,119
you know classical languages and

1216
00:46:21,109 --> 00:46:19,440
germanic languages but i think you know

1217
00:46:23,109 --> 00:46:21,119
one could name it various things but i

1218
00:46:24,710 --> 00:46:23,119
think ultimately you know we just call

1219
00:46:26,710 --> 00:46:24,720
it you know the milky way andromeda

1220
00:46:28,309 --> 00:46:26,720
merger remnant and as long as we all

1221
00:46:29,190 --> 00:46:28,319
know what we're talking about i think

1222
00:46:32,630 --> 00:46:29,200
you know

1223
00:46:38,630 --> 00:46:33,510
uh

1224
00:46:44,550 --> 00:46:40,710
well so i i think i sort of touched on

1225
00:46:49,829 --> 00:46:45,670
so

1226
00:46:51,430 --> 00:46:49,839
motion into the future you need the

1227
00:46:53,990 --> 00:46:51,440
velocities and you need the masses of

1228
00:46:56,150 --> 00:46:54,000
these systems so assuming we have in

1229
00:46:57,990 --> 00:46:56,160
fact determined those correctly the

1230
00:46:59,750 --> 00:46:58,000
problem is quite deterministic but what

1231
00:47:01,910 --> 00:46:59,760
we haven't modeled is other bodies so we

1232
00:47:03,829 --> 00:47:01,920
have modeled these two galaxies

1233
00:47:06,550 --> 00:47:03,839
and this third galaxy the triangulum

1234
00:47:08,870 --> 00:47:06,560
galaxy m33 which we know are the three

1235
00:47:11,829 --> 00:47:08,880
most massive galaxies in our local group

1236
00:47:13,990 --> 00:47:11,839
of galaxies so to significantly perturb

1237
00:47:15,510 --> 00:47:14,000
this you need something with a whole lot

1238
00:47:17,910 --> 00:47:15,520

of gravity

1239
00:47:19,270 --> 00:47:17,920
and if there were something and usually

1240
00:47:21,829 --> 00:47:19,280
something with a whole lot of gravity is

1241
00:47:23,510 --> 00:47:21,839
a galaxy and all the galaxies have stars

1242
00:47:26,390 --> 00:47:23,520
in them that we see so we've mapped all

1243
00:47:28,630 --> 00:47:26,400
the galaxies in the local universe

1244
00:47:29,910 --> 00:47:28,640
so we know what's out there so we're

1245
00:47:31,430 --> 00:47:29,920
pretty sure there isn't anything out

1246
00:47:32,710 --> 00:47:31,440
there that is humongously massive that

1247
00:47:34,950 --> 00:47:32,720
we might have missed

1248
00:47:37,750 --> 00:47:34,960
now you might say well suppose there is

1249
00:47:39,750 --> 00:47:37,760
something out there that is like a whole

1250
00:47:40,549 --> 00:47:39,760
ball of dark matter but there's no stars

1251
00:47:43,190 --> 00:47:40,559
in it

1252
00:47:44,870 --> 00:47:43,200
that could actually be the case and in

1253
00:47:46,630 --> 00:47:44,880
fact you know there was you know a lot

1254
00:47:49,109 --> 00:47:46,640
of attention 10 or 20 years ago to a

1255
00:47:51,430 --> 00:47:49,119
concept called the great attractor

1256
00:47:52,549 --> 00:47:51,440
which was you know a concentration of

1257
00:47:54,710 --> 00:47:52,559
dark matter

1258
00:47:56,790 --> 00:47:54,720
further away not specifically affecting

1259
00:47:58,470 --> 00:47:56,800
this but it does illustrate the point

1260
00:48:00,870 --> 00:47:58,480
that if there was a concentration of

1261
00:48:02,630 --> 00:48:00,880
dark matter somewhere and you can't see

1262
00:48:04,390 --> 00:48:02,640
it in terms of its light

1263
00:48:05,910 --> 00:48:04,400

you can actually notice it because that

1264
00:48:07,910 --> 00:48:05,920
dark matter is going to affect the

1265
00:48:09,750 --> 00:48:07,920
motions of other things around it and

1266
00:48:11,190 --> 00:48:09,760
those other things around it we can see

1267
00:48:13,430 --> 00:48:11,200
and we can measure the emotions and we

1268
00:48:15,030 --> 00:48:13,440
have measured their emotions so because

1269
00:48:17,030 --> 00:48:15,040
people have done this over the past

1270
00:48:18,549 --> 00:48:17,040
decades we actually have a pretty good

1271
00:48:20,950 --> 00:48:18,559
sense of the mass distribution of the

1272
00:48:22,950 --> 00:48:20,960
local universe even aside from our

1273
00:48:24,710 --> 00:48:22,960
knowledge of where the galaxies are

1274
00:48:26,630 --> 00:48:24,720
and based on all of this work which

1275
00:48:27,589 --> 00:48:26,640
astronomers have pursued for many many

1276
00:48:29,030 --> 00:48:27,599
years

1277
00:48:30,790 --> 00:48:29,040
you know we don't really think there is

1278
00:48:32,390 --> 00:48:30,800
anything out there that is both close

1279
00:48:34,470 --> 00:48:32,400
and you know much more massive than

1280
00:48:36,309 --> 00:48:34,480
these two galaxies so based on that

1281
00:48:38,309 --> 00:48:36,319
assessment no there is nothing that can

1282
00:48:39,990 --> 00:48:38,319
perturb this um of course you know

1283
00:48:41,750 --> 00:48:40,000
there's always a chance

1284
00:48:43,030 --> 00:48:41,760
we may have missed something you know

1285
00:48:45,430 --> 00:48:43,040
spectacular but then that will

1286
00:48:46,870 --> 00:48:45,440
undoubtedly be a you know a future topic

1287
00:48:48,150 --> 00:48:46,880
for a press conference that will garner

1288
00:48:50,950 --> 00:48:48,160

great attention because it would be a

1289
00:48:52,230 --> 00:48:50,960
wild surprise to all astronomers

1290
00:48:53,910 --> 00:48:52,240
thanks roland

1291
00:48:55,430 --> 00:48:53,920
i think we've got time for one more but

1292
00:48:58,390 --> 00:48:55,440
we will be able to continue this

1293
00:48:59,670 --> 00:48:58,400
conversation at 3 p.m with a web chat

1294
00:49:01,510 --> 00:48:59,680
and we'll give you the url for that in

1295
00:49:03,109 --> 00:49:01,520
just a few moments i think the last

1296
00:49:05,829 --> 00:49:03,119
question we've got here

1297
00:49:07,750 --> 00:49:05,839
for the team is when andromeda comes do

1298
00:49:10,390 --> 00:49:07,760
we expect the local stellar neighborhood

1299
00:49:13,990 --> 00:49:10,400
to be significantly more populated i.e

1300
00:49:20,069 --> 00:49:17,349
well so um that's a good question so

1301
00:49:21,829 --> 00:49:20,079
what we do know is that

1302
00:49:23,510 --> 00:49:21,839
if you define you can define the solar

1303
00:49:25,990 --> 00:49:23,520
neighborhood as the other stars that are

1304
00:49:26,710 --> 00:49:26,000
around the sun and the gas

1305
00:49:30,150 --> 00:49:26,720
so

1306
00:49:31,670 --> 00:49:30,160
once andromeda arrives we merge we do

1307
00:49:33,030 --> 00:49:31,680
know that there will be less gas in the

1308
00:49:34,630 --> 00:49:33,040
solar neighborhood than there is now

1309
00:49:36,390 --> 00:49:34,640
because there'll be less gas in general

1310
00:49:38,630 --> 00:49:36,400
in this new galaxy

1311
00:49:40,950 --> 00:49:38,640
we also know that most likely based on

1312
00:49:44,150 --> 00:49:40,960
our simulations the sun will find itself

1313
00:49:46,549 --> 00:49:44,160

further out in this new galaxy and the

1314
00:49:49,190 --> 00:49:46,559
density the number of stars in galaxies

1315
00:49:51,109 --> 00:49:49,200
drops with distance so if that's true

1316
00:49:52,950 --> 00:49:51,119
the sun will find itself in in a

1317
00:49:55,270 --> 00:49:52,960
neighborhood that is less than c

1318
00:49:58,630 --> 00:49:55,280
populated it'll move from say from the

1319
00:50:00,870 --> 00:49:58,640
suburbs to you know downtown north

1320
00:50:02,069 --> 00:50:00,880
dakota and you know the neighborhood

1321
00:50:04,230 --> 00:50:02,079
will be different

1322
00:50:05,829 --> 00:50:04,240
um but we can't prove this it is

1323
00:50:07,349 --> 00:50:05,839
possible that the sun might actually

1324
00:50:09,670 --> 00:50:07,359
move closer to the center of this new

1325
00:50:11,589 --> 00:50:09,680
galaxy or it might be on an orbit where

1326
00:50:12,950 --> 00:50:11,599
it spends a lot of time with large radii

1327
00:50:15,030 --> 00:50:12,960
but then every now and then quickly

1328
00:50:16,710 --> 00:50:15,040
plunges to the center so there might be

1329
00:50:18,790 --> 00:50:16,720
times when it finds itself very close to

1330
00:50:21,030 --> 00:50:18,800
the center where the density of stars is

1331
00:50:23,430 --> 00:50:21,040
much higher it might make an occasional

1332
00:50:25,349 --> 00:50:23,440
visit to say manhattan

1333
00:50:26,790 --> 00:50:25,359
and if it's really unlucky it may

1334
00:50:28,390 --> 00:50:26,800
actually get really really close to the

1335
00:50:30,150 --> 00:50:28,400
central black hole in the center of this

1336
00:50:31,829 --> 00:50:30,160
merger remnant and it could even be

1337
00:50:33,750 --> 00:50:31,839
totally torn apart

1338
00:50:36,150 --> 00:50:33,760

but that is a likelihood that again i

1339
00:50:37,910 --> 00:50:36,160
would call vanishingly small but it's

1340
00:50:40,230 --> 00:50:37,920
certainly one other interesting thing

1341
00:50:43,910 --> 00:50:40,240
that one can speculate about that might

1342
00:50:45,270 --> 00:50:43,920
happen as future events unfold

1343
00:50:46,790 --> 00:50:45,280
thanks roland and that's going to have

1344
00:50:48,870 --> 00:50:46,800
to do it for today's hubble media

1345
00:50:51,349 --> 00:50:48,880
telecon or conference rather i'd like to

1346
00:50:53,109 --> 00:50:51,359
thank our panelists for joining us today

1347
00:50:54,390 --> 00:50:53,119
uh you're cordially invited to join us

1348
00:50:56,309 --> 00:50:54,400
for a web chat

1349
00:50:57,990 --> 00:50:56,319
to talk with our panelists at 3 pm

1350
00:50:59,270 --> 00:50:58,000
eastern by visiting the url that's on

1351
00:51:02,470 --> 00:50:59,280
the screen and i'll read it to you real

1352
00:51:04,030 --> 00:51:02,480
quick http colon forward slash forward

1353
00:51:05,670 --> 00:51:04,040
slash

1354
00:51:08,470 --> 00:51:05,680
go.nasa.gov

1355
00:51:10,150 --> 00:51:08,480
slash m31 m31chat

1356
00:51:11,990 --> 00:51:10,160
for more information about this hubble

1357
00:51:14,230 --> 00:51:12,000
finding or more information about any of

1358
00:51:17,190 --> 00:51:14,240
nasa's various projects visit us on the

1359
00:51:19,750 --> 00:51:17,200
web at www.nasa.gov

1360
00:51:22,230 --> 00:51:19,760
or via any of the media

1361
00:51:25,109 --> 00:51:22,240
many social media venues such as

1362
00:51:27,190 --> 00:51:25,119
facebook google plus twitter and youtube

1363
00:51:29,430 --> 00:51:27,200

and many more coming up next a live

1364
00:51:31,510 --> 00:51:29,440
spacex dragon post splashdown news

1365
00:51:32,870 --> 00:51:31,520
conference at the top of the hour again