

1
00:00:01,520 --> 00:00:07,019
okay hello everybody welcome to this

2
00:00:05,129 --> 00:00:08,849
month's installment of news from Hubble

3
00:00:07,019 --> 00:00:11,189
and across the universe my name is Tony

4
00:00:08,849 --> 00:00:13,320
Darnell and joining me this month as he

5
00:00:11,189 --> 00:00:16,259
does every month is dr. Frank summers

6
00:00:13,320 --> 00:00:17,698
hey telly ain't good to say again thank

7
00:00:16,260 --> 00:00:19,890
you welcome Frank it's good talk to you

8
00:00:17,699 --> 00:00:21,420
again welcome before we get started let

9
00:00:19,890 --> 00:00:23,490
me just tell you guys that you can

10
00:00:21,420 --> 00:00:24,750
interact with us by what we're hoping

11
00:00:23,489 --> 00:00:27,149
you'll believe us some comments and

12
00:00:24,750 --> 00:00:28,920
questions as the Hangout progresses you

13
00:00:27,149 --> 00:00:31,320
can do that with the Hubble hang out

14
00:00:28,920 --> 00:00:33,600
hashtag on twitter you can also use the

15
00:00:31,320 --> 00:00:34,890
Q&A app on YouTube and G+ as well as the

16
00:00:33,600 --> 00:00:38,850
comment sections on both of those areas

17
00:00:34,890 --> 00:00:39,870
and so we're hoping that you will ask us

18
00:00:38,850 --> 00:00:41,879
some questions and leave us some

19
00:00:39,869 --> 00:00:45,988
comments will read read them and get to

20
00:00:41,878 --> 00:00:47,579
him as the Hangout progresses also I

21
00:00:45,988 --> 00:00:49,439
wanted to kind of give a shout out and

22
00:00:47,579 --> 00:00:52,530
Frank as you know this word get we're

23
00:00:49,439 --> 00:00:55,229
gearing up for Hubble's 25th anniversary

24
00:00:52,530 --> 00:00:57,600
25 years being his face can you believe

25
00:00:55,229 --> 00:01:00,148
it you know Tony I was just out of lunch

26
00:00:57,600 --> 00:01:03,510
with somebody today and she was born in

27
00:01:00,149 --> 00:01:05,700
nineteen ninety I mean she she has never

28
00:01:03,509 --> 00:01:08,879
known a time when there wasn't a Hubble

29

00:01:05,700 --> 00:01:12,000
Space Telescope haha those of us who now

30
00:01:08,879 --> 00:01:14,879
feel like old guys uh yeah the idea that

31
00:01:12,000 --> 00:01:17,280
you know Hubble is as long as a lifetime

32
00:01:14,879 --> 00:01:20,158
for these these youngsters these

33
00:01:17,280 --> 00:01:21,570
20-somethings is really impressive yeah

34
00:01:20,159 --> 00:01:22,770
work I'm kind of calling it the Hubble

35
00:01:21,569 --> 00:01:25,139
generation and we're going to have some

36
00:01:22,769 --> 00:01:27,000
social media campaigns are geared toward

37
00:01:25,140 --> 00:01:28,769
that in the coming year so look for

38
00:01:27,000 --> 00:01:32,280
those but i wanted to mention too i

39
00:01:28,769 --> 00:01:34,140
think tomorrow uh the intrepid museum if

40
00:01:32,280 --> 00:01:37,409
you're in New York the intrepid museum

41
00:01:34,140 --> 00:01:39,478
is opening their Hubble at 25 exhibit so

42
00:01:37,409 --> 00:01:42,479
I would encourage you guys if you're in

43
00:01:39,478 --> 00:01:43,739

the area or throughout the time when the

44

00:01:42,478 --> 00:01:45,060

exhibit is on and I think it's going to

45

00:01:43,739 --> 00:01:47,849

be up for the whole year right you know

46

00:01:45,060 --> 00:01:49,799

Frank I know it's at least six months so

47

00:01:47,849 --> 00:01:51,599

yeah try to get down there and see it's

48

00:01:49,799 --> 00:01:56,130

at the intrepid museum and you could go

49

00:01:51,599 --> 00:01:58,259

to attribute intrepid museum org to uh

50

00:01:56,129 --> 00:01:59,368

to learn more about it and get

51

00:01:58,259 --> 00:02:00,780

directions and all that kinda stuff I

52

00:01:59,368 --> 00:02:03,149

just wanted to get a shout out that

53

00:02:00,780 --> 00:02:05,129

opens tomorrow so I will also say that

54

00:02:03,149 --> 00:02:07,379

IP I assisted a little bit on the

55

00:02:05,129 --> 00:02:09,269

exhibits there the exhibit designer

56

00:02:07,379 --> 00:02:11,639

called me for various pieces of

57

00:02:09,270 --> 00:02:13,469

information and things and he even used

58
00:02:11,639 --> 00:02:14,219
a quote of mine oh good what so I

59
00:02:13,469 --> 00:02:16,169
understand

60
00:02:14,219 --> 00:02:18,090
haven't seen the exhibit but the the

61
00:02:16,169 --> 00:02:19,399
exhibit ends with actually a quote about

62
00:02:18,090 --> 00:02:22,319
the James Webb Space Telescope

63
00:02:19,400 --> 00:02:24,390
attributed to me oh good Willie right

64
00:02:22,319 --> 00:02:25,919
awesome so yeah we've got a hand just

65
00:02:24,389 --> 00:02:28,799
about everything have all the seams and

66
00:02:25,919 --> 00:02:30,059
that's that's as it should be so okay

67
00:02:28,800 --> 00:02:32,040
Frank I guess we'll go ahead and get

68
00:02:30,060 --> 00:02:33,689
started you've got some cool stories for

69
00:02:32,039 --> 00:02:35,099
us in case you don't know what we're

70
00:02:33,689 --> 00:02:37,379
doing folks this is something Frank and

71
00:02:35,099 --> 00:02:39,120
I do each month and Frank it gathers up

72
00:02:37,379 --> 00:02:40,859
some really interesting stories that are

73
00:02:39,120 --> 00:02:42,629
both related to Hubble and sometimes

74
00:02:40,860 --> 00:02:46,100
they're not but their depth are

75
00:02:42,629 --> 00:02:49,530
definitely topical areas in astronomy so

76
00:02:46,099 --> 00:02:51,209
what do you got for us Frank ok so as I

77
00:02:49,530 --> 00:02:53,459
said we usually I try to do the news

78
00:02:51,209 --> 00:02:55,469
from Hubble but there's always lots of

79
00:02:53,459 --> 00:02:57,930
cool stuff out there so we end up going

80
00:02:55,469 --> 00:03:01,409
we ended it extended it to and across

81
00:02:57,930 --> 00:03:05,459
the universe ok so our first story

82
00:03:01,409 --> 00:03:07,799
tonight hidden by a super nova all right

83
00:03:05,459 --> 00:03:12,090
so we're going to talk about this galaxy

84
00:03:07,800 --> 00:03:14,790
this is the galaxy m83 & M 83 is this

85
00:03:12,090 --> 00:03:16,830
beautiful spiral galaxies out there um

86

00:03:14,789 --> 00:03:18,509
it's actually relatively nearby it's

87
00:03:16,830 --> 00:03:22,019
only about 10 million light-years away

88
00:03:18,509 --> 00:03:24,269
so it's a relatively nearby galaxies and

89
00:03:22,019 --> 00:03:28,370
one of the famous things that happened

90
00:03:24,269 --> 00:03:32,939
in m83 was the observation of supernovae

91
00:03:28,370 --> 00:03:35,280
1993 J now you might say well I would

92
00:03:32,939 --> 00:03:37,859
1990 3 j.b of any real importance it's

93
00:03:35,280 --> 00:03:40,919
just another supernova well because it's

94
00:03:37,860 --> 00:03:44,190
relatively nearby supernova one can

95
00:03:40,919 --> 00:03:46,039
actually study it in in more detail but

96
00:03:44,189 --> 00:03:48,659
can actually see the details of it okay

97
00:03:46,039 --> 00:03:50,340
and when we look at our supernova I

98
00:03:48,659 --> 00:03:52,469
guess I should explain the on this image

99
00:03:50,340 --> 00:03:54,360
on the left hand side you can see an

100
00:03:52,469 --> 00:03:56,370

image before the supernova occurred and

101

00:03:54,360 --> 00:03:57,870

on the right-hand side you can see the

102

00:03:56,370 --> 00:03:59,099

image when the supernova occurred with

103

00:03:57,870 --> 00:04:02,219

the along with the arrow the arrow

104

00:03:59,099 --> 00:04:03,959

occurred 10 then to see yes it's

105

00:04:02,219 --> 00:04:06,060

wonderful when we look out into space

106

00:04:03,959 --> 00:04:07,560

that somebody puts these big arrows

107

00:04:06,060 --> 00:04:10,080

pointing towards what we should look at

108

00:04:07,560 --> 00:04:13,530

its I'm know it's a turtle dove but I

109

00:04:10,080 --> 00:04:17,489

gotta do it okay so that's super nova

110

00:04:13,530 --> 00:04:21,329

1993 chain um and we classify supernova

111

00:04:17,488 --> 00:04:24,060

based upon their light curve okay so

112

00:04:21,329 --> 00:04:26,339

this is a kind of complex diagram but

113

00:04:24,060 --> 00:04:28,329

what you're getting colors lots of

114

00:04:26,339 --> 00:04:32,019

different colors okay so on the x

115
00:04:28,329 --> 00:04:34,779
we have is measured in days okay and the

116
00:04:32,019 --> 00:04:37,718
peak luminosity is considered day zero

117
00:04:34,779 --> 00:04:39,818
alright so there are days before the

118
00:04:37,718 --> 00:04:42,250
peak luminosity in days after the peak

119
00:04:39,819 --> 00:04:43,990
luminosity and you can see by the legend

120
00:04:42,250 --> 00:04:45,310
at the very top that they're all these

121
00:04:43,990 --> 00:04:47,769
different types of supernovas and

122
00:04:45,310 --> 00:04:50,530
actually that the two highest curves are

123
00:04:47,769 --> 00:04:52,478
for hyper Nova's okay so I didn't know

124
00:04:50,529 --> 00:04:54,638
that why do they why is it the bright

125
00:04:52,478 --> 00:04:58,538
why is it when the supernova actually

126
00:04:54,639 --> 00:05:00,699
occurred day 0 um just because we don't

127
00:04:58,538 --> 00:05:03,818
have we can't tell the exact day it

128
00:05:00,699 --> 00:05:05,740
occurs we never catch it oh yeah yeah

129
00:05:03,819 --> 00:05:07,419
that makes perfect and so the brightness

130
00:05:05,740 --> 00:05:09,400
of the supernova gets brighter and

131
00:05:07,418 --> 00:05:11,139
brighter and brighter and the only point

132
00:05:09,399 --> 00:05:13,718
that we can say ah here's here's a

133
00:05:11,139 --> 00:05:16,718
fiducial point2 to sync everything to is

134
00:05:13,718 --> 00:05:18,189
the peak luminosity day okay look at

135
00:05:16,718 --> 00:05:21,098
those hypernova those are really bright

136
00:05:18,189 --> 00:05:23,829
yeah almost one-and-a-half to two

137
00:05:21,098 --> 00:05:27,009
magnitudes brighter than the type 1 a's

138
00:05:23,829 --> 00:05:29,889
hmm okay so there are two basic types of

139
00:05:27,009 --> 00:05:33,848
supernovae do you know them Tony here is

140
00:05:29,889 --> 00:05:36,939
it there are type 1 and type 2 yes of

141
00:05:33,848 --> 00:05:41,228
course mr. I win what do I we ordered

142
00:05:36,939 --> 00:05:43,718
that and the idea is that type 1a

143

00:05:41,228 --> 00:05:46,838
supernovae come from the explosion of a

144
00:05:43,718 --> 00:05:48,490
white dwarf star and type 2 supernovae

145
00:05:46,838 --> 00:05:50,709
come from the explosion of a massive

146
00:05:48,490 --> 00:05:53,228
star a very massive star near the end of

147
00:05:50,709 --> 00:05:57,278
its life but it's not that simple is it

148
00:05:53,228 --> 00:05:59,978
it's never that okay and used to be that

149
00:05:57,278 --> 00:06:02,288
okay well a white dwarf has had all its

150
00:05:59,978 --> 00:06:04,658
hydrogen burned into helium and carbon

151
00:06:02,288 --> 00:06:07,598
and nitrogen oxygen so it doesn't have

152
00:06:04,658 --> 00:06:09,490
any hydrogen lines in it ok so just

153
00:06:07,598 --> 00:06:11,978
spectroscopically the type ones have no

154
00:06:09,490 --> 00:06:16,269
hydrogen lines the type to have hydrogen

155
00:06:11,978 --> 00:06:20,310
lines now type 2 b's of which supernova

156
00:06:16,269 --> 00:06:23,948
1993 j is one of the classic examples

157
00:06:20,310 --> 00:06:26,050

they are this pink line here okay and

158

00:06:23,949 --> 00:06:29,110

they have two interesting factors about

159

00:06:26,050 --> 00:06:31,990

them one the hydrogen lines are weak

160

00:06:29,110 --> 00:06:33,490

okay there's not much hydrogen in that

161

00:06:31,990 --> 00:06:36,009

initial spectrum their present so

162

00:06:33,490 --> 00:06:39,519

they're hordes of type 2 but they aren't

163

00:06:36,009 --> 00:06:41,259

very strong and eventually they go away

164

00:06:39,519 --> 00:06:43,180

and

165

00:06:41,259 --> 00:06:46,449

crazy thing as you can see in this pink

166

00:06:43,180 --> 00:06:48,519

line is that there's a second peak in

167

00:06:46,449 --> 00:06:50,110

the supernova light curve you look at

168

00:06:48,519 --> 00:06:52,269

all the others there are bumps and

169

00:06:50,110 --> 00:06:54,340

Wiggles but there's no second peak in

170

00:06:52,269 --> 00:06:57,699

any of the light curve hmmm well the two

171

00:06:54,339 --> 00:06:59,679

supernova type to be must have hydrogen

172
00:06:57,699 --> 00:07:02,349
out there right there's some hydrogen

173
00:06:59,680 --> 00:07:04,750
out there but it goes away pretty

174
00:07:02,350 --> 00:07:07,600
quickly so what's the explanation for

175
00:07:04,750 --> 00:07:11,350
this type to be supernova all right well

176
00:07:07,600 --> 00:07:13,660
here is our our idea for so the scenario

177
00:07:11,350 --> 00:07:15,490
is that you have two massive stars

178
00:07:13,660 --> 00:07:18,610
orbiting around each other you know

179
00:07:15,490 --> 00:07:20,680
binary stars are very common if you look

180
00:07:18,610 --> 00:07:23,230
up the night sky half the stars you see

181
00:07:20,680 --> 00:07:25,470
in the night sky are in multiple star

182
00:07:23,230 --> 00:07:28,330
systems binaries or triples or even more

183
00:07:25,470 --> 00:07:32,410
okay and these are really really close

184
00:07:28,329 --> 00:07:34,779
and as the first star the more massive

185
00:07:32,410 --> 00:07:37,630
star evolves to become a red giant or

186
00:07:34,779 --> 00:07:40,059
red supergiant some of the material is

187
00:07:37,629 --> 00:07:44,290
sucked off that star and onto the

188
00:07:40,060 --> 00:07:47,620
companion star okay mm-hmm that leaves

189
00:07:44,290 --> 00:07:49,620
much less hydrogen in the envelope to

190
00:07:47,620 --> 00:07:52,300
appear when that star goes supernova

191
00:07:49,620 --> 00:07:55,709
okay so that explains the weak hydrogen

192
00:07:52,300 --> 00:08:00,220
lines in the supernova explosion right

193
00:07:55,709 --> 00:08:02,469
plus as that hydrogen material expands

194
00:08:00,220 --> 00:08:05,380
away you start to see deeper into the

195
00:08:02,470 --> 00:08:07,780
star you start to see hotter regions of

196
00:08:05,379 --> 00:08:10,719
of the stuff of us of the supernova and

197
00:08:07,779 --> 00:08:13,659
therefore you can get that extra like

198
00:08:10,720 --> 00:08:16,030
bump in the light curve okay so that's

199
00:08:13,660 --> 00:08:18,220
supernova explosion if you pull off

200

00:08:16,029 --> 00:08:20,589
material off of the outer part of the

201
00:08:18,220 --> 00:08:22,840
start before it goes supernova then

202
00:08:20,589 --> 00:08:25,349
you'll get weak hydrogen lines and as

203
00:08:22,839 --> 00:08:27,459
you as you look through the opacity

204
00:08:25,350 --> 00:08:29,379
decreases you look through and see the

205
00:08:27,459 --> 00:08:32,409
hotter regions and you can get a second

206
00:08:29,379 --> 00:08:36,099
bump a peak in the light curve all right

207
00:08:32,409 --> 00:08:40,179
but the interesting thing is this will

208
00:08:36,099 --> 00:08:43,030
leave behind another massive star that

209
00:08:40,179 --> 00:08:45,219
has had a fresh helping of hydrogen

210
00:08:43,029 --> 00:08:47,919
given to it okay and hydrogen is what

211
00:08:45,220 --> 00:08:49,540
them what powers does the first nuclear

212
00:08:47,919 --> 00:08:51,939
fusion that powers the star which

213
00:08:49,539 --> 00:08:54,849
actually if as it mixes in will

214
00:08:51,940 --> 00:08:56,649

regenerate the star well so it doesn't

215

00:08:54,850 --> 00:08:59,470

blow away with with the explosion the

216

00:08:56,649 --> 00:09:01,958

first one that we found that stars are

217

00:08:59,470 --> 00:09:03,670

so compact that even a supernova

218

00:09:01,958 --> 00:09:06,818

explosion going off relatively nearby

219

00:09:03,669 --> 00:09:08,948

doesn't blow the star away Wow all right

220

00:09:06,818 --> 00:09:11,379

so it's got this fresh hydrogen on to it

221

00:09:08,948 --> 00:09:14,258

and it should be rejuvenated and become

222

00:09:11,379 --> 00:09:16,600

a bluer star again so maybe that star

223

00:09:14,259 --> 00:09:18,850

was getting old and was it was starting

224

00:09:16,600 --> 00:09:20,740

towards the red giant track I starting

225

00:09:18,850 --> 00:09:23,050

to become old but it's got this fresh

226

00:09:20,740 --> 00:09:24,430

helping of hydrogen and it had it's

227

00:09:23,049 --> 00:09:27,849

become rejuvenating it should be blue

228

00:09:24,429 --> 00:09:29,649

right okay you know and what's left

229
00:09:27,850 --> 00:09:30,970
behind there that red dot that's with

230
00:09:29,649 --> 00:09:32,528
that's just the remnant that's supposed

231
00:09:30,970 --> 00:09:36,699
to be a supernova remnant hey I'm Keri

232
00:09:32,528 --> 00:09:40,318
diagram okay okay all right so we want

233
00:09:36,698 --> 00:09:43,719
to be able to look for this companion as

234
00:09:40,318 --> 00:09:45,479
evidence that the site to be supernovas

235
00:09:43,720 --> 00:09:48,819
go the way that we think they should

236
00:09:45,480 --> 00:09:54,449
okay so I mean we're going to look at

237
00:09:48,818 --> 00:10:00,188
his m83 image but Hubble's m83 image is

238
00:09:54,448 --> 00:10:02,379
384 megapixels hey I I know I know their

239
00:10:00,188 --> 00:10:05,289
money evers have lots of pixels but this

240
00:10:02,379 --> 00:10:08,230
is even bigger than not that many okay

241
00:10:05,289 --> 00:10:12,938
Oh 20,000 by 15 down I think my phone

242
00:10:08,230 --> 00:10:15,610
has 10 I still got an old phone it's

243
00:10:12,938 --> 00:10:18,399
only got like three or four ah Wow good

244
00:10:15,610 --> 00:10:23,318
so if we look into that region where

245
00:10:18,399 --> 00:10:24,850
supernova 1993 J exists existed if we

246
00:10:23,318 --> 00:10:26,860
look at it today we don't see that

247
00:10:24,850 --> 00:10:28,300
bright star or that yellow arrow you

248
00:10:26,860 --> 00:10:32,620
know somebody erased that yellow arrow

249
00:10:28,299 --> 00:10:34,929
for darn but with all this resolution

250
00:10:32,620 --> 00:10:37,659
from Hubble we can actually look in and

251
00:10:34,929 --> 00:10:40,659
follow and try and see can we see that

252
00:10:37,659 --> 00:10:43,088
companion star and this is what we found

253
00:10:40,659 --> 00:10:46,240
boom that yellow arrow pops back out and

254
00:10:43,089 --> 00:10:48,670
it is a tiny little dot and one of these

255
00:10:46,240 --> 00:10:52,209
blue little dots in this image it wasn't

256
00:10:48,669 --> 00:10:54,009
actually specified to my certainty which

257

00:10:52,208 --> 00:10:55,869
one it was but yeah cuz I like the arrow

258
00:10:54,009 --> 00:10:58,120
to be in that smoking at both of their

259
00:10:55,870 --> 00:11:00,578
wonder which one it is and and I wanted

260
00:10:58,120 --> 00:11:02,019
to put that arrow in there but the press

261
00:11:00,578 --> 00:11:03,759
release I couldn't figure out exactly

262
00:11:02,019 --> 00:11:05,889
which one it was so it's one of those

263
00:11:03,759 --> 00:11:06,870
being the blue one right near the center

264
00:11:05,889 --> 00:11:09,210
yeah

265
00:11:06,870 --> 00:11:12,600
this is what we find at the site of

266
00:11:09,210 --> 00:11:17,070
super non over 1993 Jay today you do

267
00:11:12,600 --> 00:11:19,230
find a blue star right we see that same

268
00:11:17,070 --> 00:11:21,990
in the exact same spot where we saw the

269
00:11:19,230 --> 00:11:24,480
supernova goes this is very juvenile in

270
00:11:21,990 --> 00:11:26,669
star with hmm this is I'm sorry that's

271
00:11:24,480 --> 00:11:29,129

this is that rejuvenated star the one

272

00:11:26,669 --> 00:11:31,799

that's done or GOP a star and it's blue

273

00:11:29,129 --> 00:11:34,559

okay like I should be right it should be

274

00:11:31,799 --> 00:11:36,929

if it's if it's rejuvenated okay so we

275

00:11:34,559 --> 00:11:41,099

have finally answered the question to be

276

00:11:36,929 --> 00:11:45,359

or not to be a heavenly supernova 1983

277

00:11:41,100 --> 00:11:51,480

oh god this is gonna be one of those

278

00:11:45,360 --> 00:11:54,720

days isn't it Frank supernova 1983 jay

279

00:11:51,480 --> 00:11:56,159

is a to be super nova and it has the

280

00:11:54,720 --> 00:11:57,300

companion that we've been looking for

281

00:11:56,159 --> 00:11:59,009

this is the first time we've ever been

282

00:11:57,299 --> 00:12:04,259

able to confirm that any idea of its

283

00:11:59,009 --> 00:12:06,659

mass no I come here I was just curious

284

00:12:04,259 --> 00:12:08,370

my recollection was and I'm not sure

285

00:12:06,659 --> 00:12:11,639

about that both of them were meant to be

286
00:12:08,370 --> 00:12:14,009
very massive stars or so on order 10

287
00:12:11,639 --> 00:12:15,929
solar masses and possibility at this

288
00:12:14,009 --> 00:12:19,139
star will go supernova itself in the

289
00:12:15,929 --> 00:12:21,719
future that was my impression but I

290
00:12:19,139 --> 00:12:23,399
can't remember exactly that's really

291
00:12:21,720 --> 00:12:25,259
cool though i do these these so these

292
00:12:23,399 --> 00:12:26,458
stars can feed off of each other and I

293
00:12:25,259 --> 00:12:28,169
guess ways we're only just now

294
00:12:26,458 --> 00:12:30,329
discovering that's really a cool theory

295
00:12:28,169 --> 00:12:33,360
though are a good good confirmation of a

296
00:12:30,330 --> 00:12:36,240
theory and so a to be super nova is is

297
00:12:33,360 --> 00:12:38,850
like a you know 1a supernova in that a

298
00:12:36,240 --> 00:12:42,209
white dwarf in a 1a supernova feeds off

299
00:12:38,850 --> 00:12:44,250
of a giant star to to undergo with

300
00:12:42,208 --> 00:12:45,958
supernova explosion but here you're

301
00:12:44,250 --> 00:12:49,289
actually pulling star off the star that

302
00:12:45,958 --> 00:12:50,879
goes supernova what guys think okay yeah

303
00:12:49,289 --> 00:12:52,559
before you go to your next door you

304
00:12:50,879 --> 00:12:54,720
about to go to your next story sure go

305
00:12:52,559 --> 00:12:56,609
ahead I just want to give you a question

306
00:12:54,720 --> 00:12:58,528
from Adam synergy he's asking and I'm

307
00:12:56,610 --> 00:13:00,750
not highlighted here on the Q&A app I

308
00:12:58,528 --> 00:13:02,278
recently entered into a discussion with

309
00:13:00,750 --> 00:13:04,620
someone who argued that computer

310
00:13:02,278 --> 00:13:07,289
simulations of this of the large-scale

311
00:13:04,620 --> 00:13:10,049
universe are meaningless because quote

312
00:13:07,289 --> 00:13:13,049
they're only simulations uncool what

313
00:13:10,049 --> 00:13:14,879
does dr. summers think have the biggest

314

00:13:13,049 --> 00:13:17,159
contributions from this area of research

315
00:13:14,879 --> 00:13:18,899
and I'm actually that are the Hubble

316
00:13:17,159 --> 00:13:21,149
public like I would say

317
00:13:18,899 --> 00:13:26,909
yeah yeah and I would say of course my

318
00:13:21,149 --> 00:13:28,110
PhD thesis okay yes oh yeah only

319
00:13:26,909 --> 00:13:30,868
something you're interested in a good

320
00:13:28,110 --> 00:13:33,749
question too I my PhD thesis was in

321
00:13:30,869 --> 00:13:35,910
computer simulations I did hydrodynamics

322
00:13:33,749 --> 00:13:40,800
simulations of the formation of galaxies

323
00:13:35,909 --> 00:13:43,889
Oh about 20 years ago or so and what

324
00:13:40,799 --> 00:13:46,458
computer simulations do for you is they

325
00:13:43,889 --> 00:13:49,619
allow you to explore a range of ideas

326
00:13:46,458 --> 00:13:52,258
okay one of the things I often say is

327
00:13:49,619 --> 00:13:55,769
that astronomy is not a laboratory

328
00:13:52,259 --> 00:13:57,839

science you can't go out and grab a star

329

00:13:55,769 --> 00:14:00,240

or nebula bring it into your lab slice

330

00:13:57,839 --> 00:14:03,389

it dice it look under the hood see what

331

00:14:00,240 --> 00:14:05,759

it's made of but we do know the

332

00:14:03,389 --> 00:14:08,339

equations of physics and we can program

333

00:14:05,759 --> 00:14:10,350

them accurately into a computer and we

334

00:14:08,339 --> 00:14:12,360

can simulate the behavior of matter

335

00:14:10,350 --> 00:14:16,528

according to those equations of physics

336

00:14:12,360 --> 00:14:17,938

and what the simulations have done for

337

00:14:16,528 --> 00:14:20,669

us over the years especially in terms of

338

00:14:17,938 --> 00:14:23,308

cosmology is they have narrowed down our

339

00:14:20,669 --> 00:14:26,849

range of options in terms of the

340

00:14:23,308 --> 00:14:29,730

cosmology when the 1980s when I started

341

00:14:26,850 --> 00:14:31,589

working in this field the main results

342

00:14:29,730 --> 00:14:33,749

were that well first of all you could

343
00:14:31,589 --> 00:14:37,649
collapse material to get you know

344
00:14:33,749 --> 00:14:39,120
structures and you have a range of

345
00:14:37,649 --> 00:14:41,639
dainik see perturbations in the early

346
00:14:39,120 --> 00:14:43,259
universe and how do they do they

347
00:14:41,639 --> 00:14:46,470
collapse to form the galaxy distribution

348
00:14:43,259 --> 00:14:50,068
we see today so this focused on the cold

349
00:14:46,470 --> 00:14:52,769
dark matter scenario and able to see how

350
00:14:50,068 --> 00:14:56,039
the dark matter forms the seeds from

351
00:14:52,769 --> 00:14:59,129
which the normal matter could collapse

352
00:14:56,039 --> 00:15:02,998
to form galaxies and so we've been able

353
00:14:59,129 --> 00:15:05,100
to really refine and constrain how the

354
00:15:02,999 --> 00:15:07,528
large-scale galaxy distribution are

355
00:15:05,100 --> 00:15:09,720
formed as well as what Greg Snyder

356
00:15:07,528 --> 00:15:11,568
showed just a few weeks ago was that

357
00:15:09,720 --> 00:15:14,189
we're getting down to really making

358
00:15:11,568 --> 00:15:16,678
individual galaxies that look somewhat

359
00:15:14,188 --> 00:15:18,208
realistic you know my PhD thesis

360
00:15:16,678 --> 00:15:20,188
simulation we got galaxies and they had

361
00:15:18,208 --> 00:15:22,018
disks but you really couldn't see any

362
00:15:20,188 --> 00:15:25,230
spiral arms or anything and the stuff

363
00:15:22,019 --> 00:15:27,808
Greg was showing was definitely several

364
00:15:25,230 --> 00:15:29,548
quantum levels above it quantum advances

365
00:15:27,808 --> 00:15:31,708
over it because you really could see

366
00:15:29,548 --> 00:15:32,429
galaxies that look like other galaxies

367
00:15:31,708 --> 00:15:35,789
and then you could

368
00:15:32,429 --> 00:15:39,419
test out ideas about how galaxies formed

369
00:15:35,789 --> 00:15:41,639
with these simulations and then and then

370
00:15:39,419 --> 00:15:43,559
an answer to that person who said oh

371

00:15:41,639 --> 00:15:46,139
they're only simulations you must

372
00:15:43,559 --> 00:15:48,778
compare them against observations in

373
00:15:46,139 --> 00:15:50,699
order to make a valid point that's right

374
00:15:48,778 --> 00:15:52,350
and once you've got these models sort of

375
00:15:50,700 --> 00:15:54,060
constrained a little bit and you know

376
00:15:52,350 --> 00:15:56,790
what makes sense in which doesn't make

377
00:15:54,059 --> 00:15:59,669
sense you can you can more intelligently

378
00:15:56,789 --> 00:16:01,980
plan for those observation is it's like

379
00:15:59,669 --> 00:16:04,769
you said it with dear previous story if

380
00:16:01,980 --> 00:16:06,959
they're right about the theories of what

381
00:16:04,769 --> 00:16:08,819
this what the supernovae are like then

382
00:16:06,958 --> 00:16:11,159
we should see the following thing and so

383
00:16:08,820 --> 00:16:12,990
when Hubble got good enough to get the

384
00:16:11,159 --> 00:16:14,549
resolution they were they looked at it

385
00:16:12,990 --> 00:16:15,990

and they were able to confirm things

386

00:16:14,549 --> 00:16:17,159

they thought in the past now i don't

387

00:16:15,990 --> 00:16:20,669

know if that particular thing was ever

388

00:16:17,159 --> 00:16:22,079

simulated but but it's an example so

389

00:16:20,669 --> 00:16:24,389

that was a good question Adam and I have

390

00:16:22,080 --> 00:16:26,820

one more question it's from I was

391

00:16:24,389 --> 00:16:29,789

related to the story that you just you

392

00:16:26,820 --> 00:16:32,040

just did Hans milling on QA is going as

393

00:16:29,789 --> 00:16:36,958

asking what is the green dot in the

394

00:16:32,039 --> 00:16:38,039

upper right Krypton yeah so so he's

395

00:16:36,958 --> 00:16:40,739

talking about I don't know if you can

396

00:16:38,039 --> 00:16:42,299

see the mouse on this Yeah right there

397

00:16:40,740 --> 00:16:44,990

there so it's a green dot there's also a

398

00:16:42,299 --> 00:16:47,789

red dot above that and some yellow dots

399

00:16:44,990 --> 00:16:50,519

since I don't know the man passes that

400
00:16:47,789 --> 00:16:54,659
these were observed in I'm going to

401
00:16:50,519 --> 00:16:57,419
assume that the green dot is is either a

402
00:16:54,659 --> 00:17:03,000
cosmic ray hit that came only in the

403
00:16:57,419 --> 00:17:05,970
green the green observation it wouldn't

404
00:17:03,000 --> 00:17:07,679
be a there are no things that are small

405
00:17:05,970 --> 00:17:09,929
discreet and completely green like that

406
00:17:07,679 --> 00:17:12,600
yeah it's pretty weird looking all right

407
00:17:09,929 --> 00:17:14,730
nebulae things that we found if you

408
00:17:12,599 --> 00:17:17,159
remember Hani's for me from a few years

409
00:17:14,730 --> 00:17:19,470
ago oh yeah yeah nebula type things that

410
00:17:17,160 --> 00:17:21,630
show up mostly in green light but not

411
00:17:19,470 --> 00:17:24,449
small discreet things so I would assume

412
00:17:21,630 --> 00:17:26,520
that's just a cosmic very hit for

413
00:17:24,449 --> 00:17:27,808
something like that cool all right yep

414
00:17:26,519 --> 00:17:28,920
Thank You Hans and I'll get to your

415
00:17:27,808 --> 00:17:31,859
other question in just a bit but I

416
00:17:28,920 --> 00:17:35,460
Monell that Franco or the next story all

417
00:17:31,859 --> 00:17:37,709
right to Pluto and beyond part two

418
00:17:35,460 --> 00:17:41,130
because Tony you remember we talked

419
00:17:37,710 --> 00:17:43,410
about this in July right mm-hmm yep are

420
00:17:41,130 --> 00:17:44,940
the New Horizons mission it were aizen's

421
00:17:43,410 --> 00:17:46,019
mission which I want us to remind

422
00:17:44,940 --> 00:17:48,570
everybody what we talked about

423
00:17:46,019 --> 00:17:52,710
they're just little tiny bit launched in

424
00:17:48,569 --> 00:17:56,159
January nineteenth of 2006 okay and that

425
00:17:52,710 --> 00:18:01,140
was just before Hubble found the two

426
00:17:56,160 --> 00:18:02,850
other moons of Pluto Nix and Hydra ok so

427
00:18:01,140 --> 00:18:06,780
this image you can see Pluto Charon Nix

428

00:18:02,849 --> 00:18:08,339
and Hydra notice NH New Horizons they

429
00:18:06,779 --> 00:18:12,420
worked very hard to make sure they could

430
00:18:08,339 --> 00:18:17,909
name these moons and an H it is it so

431
00:18:12,420 --> 00:18:20,430
important to you and of course that was

432
00:18:17,910 --> 00:18:22,350
good because now that new verizon has

433
00:18:20,430 --> 00:18:24,060
launched we astronomers were okay to

434
00:18:22,349 --> 00:18:26,279
kick pluto out of the solar system or

435
00:18:24,059 --> 00:18:28,200
demoted to a dwarf planet because hey

436
00:18:26,279 --> 00:18:32,149
once the mission to Pluto was launched

437
00:18:28,200 --> 00:18:32,150
Congress can't take back the funding no

438
00:18:32,660 --> 00:18:38,220
that's not the real reason I want to say

439
00:18:35,279 --> 00:18:40,289
I'm joking before this comes after you

440
00:18:38,220 --> 00:18:45,210
without yo yo here comes out here Nassif

441
00:18:40,289 --> 00:18:48,299
calling now anyway um but that occurred

442
00:18:45,210 --> 00:18:51,240

that summer that Pluto was demoted from

443

00:18:48,299 --> 00:18:53,909

its planetary status all right Hubble

444

00:18:51,240 --> 00:18:56,430

also played a role in 2010 and 2012

445

00:18:53,910 --> 00:18:58,440

looking for other possible things in the

446

00:18:56,430 --> 00:19:01,320

Pluto system before numerous ins got

447

00:18:58,440 --> 00:19:04,200

there and we discovered sticks and

448

00:19:01,319 --> 00:19:07,379

kerberos ok so now we've got this system

449

00:19:04,200 --> 00:19:10,170

with sort of a planet and five moons or

450

00:19:07,380 --> 00:19:12,420

a binary planet and four moons whatever

451

00:19:10,170 --> 00:19:13,680

you want to do it well Pluto doesn't

452

00:19:12,420 --> 00:19:16,769

need us it's got its own solar system

453

00:19:13,680 --> 00:19:19,350

it's got quite a system should be a

454

00:19:16,769 --> 00:19:21,869

really cool interest system to study so

455

00:19:19,349 --> 00:19:23,939

here is the overview of this new horizon

456

00:19:21,869 --> 00:19:28,679

mission in 10 years and 3 billion miles

457
00:19:23,940 --> 00:19:32,820
as they say launched in 2006 we're here

458
00:19:28,680 --> 00:19:36,150
in fall 2014 next next summer will be

459
00:19:32,819 --> 00:19:37,769
the encounter ok then a real it's a long

460
00:19:36,150 --> 00:19:40,070
way to go what's out in the middle of

461
00:19:37,769 --> 00:19:42,480
bloody nowhere in the solar system ok

462
00:19:40,069 --> 00:19:44,460
that's going to be zooming when it goes

463
00:19:42,480 --> 00:19:46,950
to gets to Pluto it can be very much

464
00:19:44,460 --> 00:19:50,009
assuming but here's important ideas for

465
00:19:46,950 --> 00:19:52,019
you in January 2015 we will finally be

466
00:19:50,009 --> 00:19:55,069
able to improve on these pictures right

467
00:19:52,019 --> 00:19:57,420
these are Hubble images of Pluto they're

468
00:19:55,069 --> 00:19:59,279
essentially the best we can do we can

469
00:19:57,420 --> 00:19:59,620
computer process them to try and you

470
00:19:59,279 --> 00:20:01,839
know

471
00:19:59,619 --> 00:20:04,779
look for better things and create maps

472
00:20:01,839 --> 00:20:07,240
but these are the actual pixels and will

473
00:20:04,779 --> 00:20:09,460
get better starting in January so every

474
00:20:07,240 --> 00:20:11,769
pixel from January to December of next

475
00:20:09,460 --> 00:20:14,079
year is precious because that will be

476
00:20:11,769 --> 00:20:15,609
the only time we'll ever get better than

477
00:20:14,079 --> 00:20:17,439
Hubble that's interesting point because

478
00:20:15,609 --> 00:20:20,289
of yet these are the best images of

479
00:20:17,440 --> 00:20:23,350
Pluto so far and we can ever hope to do

480
00:20:20,289 --> 00:20:24,609
yeah after this when Jaso in January New

481
00:20:23,349 --> 00:20:27,490
Horizons will be close enough to do a

482
00:20:24,609 --> 00:20:30,039
better job yep and so what's the plan

483
00:20:27,490 --> 00:20:33,670
are they gonna be like okay they will be

484
00:20:30,039 --> 00:20:35,440
x dot action picture taking and hey I'm

485

00:20:33,670 --> 00:20:37,000
sure they have a complete schedule think

486
00:20:35,440 --> 00:20:40,240
that 10 years to plan the schedule yeah

487
00:20:37,000 --> 00:20:42,220
yeah so they have a complete schedule

488
00:20:40,240 --> 00:20:45,308
the most important date is July

489
00:20:42,220 --> 00:20:48,640
fourteenth Bastille Day next summer at

490
00:20:45,308 --> 00:20:51,339
749 and 59 seconds a.m. it will have its

491
00:20:48,640 --> 00:20:54,070
close to sproates Newtonian physics I

492
00:20:51,339 --> 00:20:56,319
get alone so I took this from their

493
00:20:54,069 --> 00:20:58,269
website that's I haven't checked it's

494
00:20:56,319 --> 00:21:01,480
been updated but that's the current plan

495
00:20:58,269 --> 00:21:03,190
okay so that is when we will have our

496
00:21:01,480 --> 00:21:05,679
closest approach that's the midpoint it

497
00:21:03,190 --> 00:21:07,259
will continue to be able to take data of

498
00:21:05,679 --> 00:21:09,190
the Pluto system all the way through

499
00:21:07,259 --> 00:21:11,920

December of next year and still have

500

00:21:09,190 --> 00:21:13,960

better views and Hubble would get all

501

00:21:11,920 --> 00:21:17,140

right but the question we asked last

502

00:21:13,960 --> 00:21:19,660

time was what happens afterwards okay

503

00:21:17,140 --> 00:21:21,340

we've been to Pluto now what we just

504

00:21:19,660 --> 00:21:23,259

sort of fly out like voyagers throughout

505

00:21:21,339 --> 00:21:28,740

the solar system I'm going to Disney

506

00:21:23,259 --> 00:21:31,359

World and see goofy right right yeah

507

00:21:28,740 --> 00:21:34,079

buddy so New Horizons you've just been

508

00:21:31,359 --> 00:21:37,839

to puto what are you gonna do next I am

509

00:21:34,079 --> 00:21:40,089

okay so the idea is that we want to try

510

00:21:37,839 --> 00:21:45,029

and explore another object in the Kuiper

511

00:21:40,089 --> 00:21:48,609

belt okay here's a plot from the summer

512

00:21:45,029 --> 00:21:50,500

1274 Kuiper belt objects out there let's

513

00:21:48,609 --> 00:21:52,569

see the blue eyes here starting at the

514
00:21:50,500 --> 00:21:54,730
inner one is Jupiter Saturn Uranus and

515
00:21:52,569 --> 00:21:57,819
Neptune you can see those blue circles

516
00:21:54,730 --> 00:21:59,650
are the orbits of the giant planets and

517
00:21:57,819 --> 00:22:01,359
all of these red and white dots out

518
00:21:59,650 --> 00:22:02,710
there are Kuiper belt objects that have

519
00:22:01,359 --> 00:22:06,819
been discovered in the last 20 years

520
00:22:02,710 --> 00:22:08,230
okay and of course this family here is

521
00:22:06,819 --> 00:22:10,599
the reason why I Pluto is no longer a

522
00:22:08,230 --> 00:22:11,799
planet because hey it's now part that's

523
00:22:10,599 --> 00:22:12,639
one of the largest objects in the Kuiper

524
00:22:11,799 --> 00:22:15,159
belt now

525
00:22:12,640 --> 00:22:19,090
there's a lot of them too all right so

526
00:22:15,160 --> 00:22:20,259
Hubble has what we announced in July was

527
00:22:19,089 --> 00:22:23,259
that Hubble had been given the go-ahead

528
00:22:20,259 --> 00:22:25,660
to do a comprehensive search for other

529
00:22:23,259 --> 00:22:27,430
Kuiper belt objects to look for and so

530
00:22:25,660 --> 00:22:32,110
here's an example here's what we did we

531
00:22:27,430 --> 00:22:34,539
did 83 hovell with see three fields okay

532
00:22:32,109 --> 00:22:37,179
wide field camera 3 wipeouts I yeah

533
00:22:34,539 --> 00:22:38,799
thank you why field camera 3 and so in

534
00:22:37,180 --> 00:22:41,560
the lower left you can see the full moon

535
00:22:38,799 --> 00:22:43,419
at to scale alright so we're we're

536
00:22:41,559 --> 00:22:45,940
actually covering an area almost as

537
00:22:43,420 --> 00:22:48,070
large as the entire full moon those blue

538
00:22:45,940 --> 00:22:50,170
squares are all the places Hubble looked

539
00:22:48,069 --> 00:22:52,419
the squares are all the places that

540
00:22:50,170 --> 00:22:54,850
Hubble looked and Hubble opened its

541
00:22:52,420 --> 00:22:58,480
camera all right and took multiple

542

00:22:54,849 --> 00:23:01,089
exposures of the same region ok so these

543
00:22:58,480 --> 00:23:03,009
ones is just a few multiple exposures it

544
00:23:01,089 --> 00:23:04,899
was still only one orbit basically but

545
00:23:03,009 --> 00:23:07,690
they got 83 it looks like they got 83

546
00:23:04,900 --> 00:23:11,980
orbits a bubble 83 pointings to try and

547
00:23:07,690 --> 00:23:14,680
look for these kb oats and so in the

548
00:23:11,980 --> 00:23:17,230
center we have a single whip whip c3

549
00:23:14,680 --> 00:23:18,789
filled with a camera three field ok and

550
00:23:17,230 --> 00:23:22,089
then there's a blow-up of the region

551
00:23:18,789 --> 00:23:24,940
containing what's called PT 1 which is a

552
00:23:22,089 --> 00:23:27,519
potential target number one oh I love it

553
00:23:24,940 --> 00:23:29,860
potential target ok and so you can see

554
00:23:27,519 --> 00:23:32,829
that this is actually a compendium of

555
00:23:29,859 --> 00:23:34,449
five exposures right and that inside

556
00:23:32,829 --> 00:23:37,000

that little blue circle are five

557

00:23:34,450 --> 00:23:39,340

different images of the same Kuiper belt

558

00:23:37,000 --> 00:23:40,809

object okay because the Kuiper belt

559

00:23:39,339 --> 00:23:43,389

object being within the solar system

560

00:23:40,809 --> 00:23:45,009

moves quickly across the frame whereas

561

00:23:43,390 --> 00:23:48,700

of course the distant stars don't move

562

00:23:45,009 --> 00:23:51,460

right so if we blow that up on the next

563

00:23:48,700 --> 00:23:54,750

image you can see this Kuiper belt

564

00:23:51,460 --> 00:23:59,590

object is normal number is 1 million

565

00:23:54,750 --> 00:24:02,019

10,000 113 why and of course why means

566

00:23:59,589 --> 00:24:05,829

why would you ever call it that way to

567

00:24:02,019 --> 00:24:08,740

view this as kb opt one potential target

568

00:24:05,829 --> 00:24:10,689

number one all right and so this you can

569

00:24:08,740 --> 00:24:13,359

see that left the five different images

570

00:24:10,690 --> 00:24:15,640

of it and so they went through this you

571
00:24:13,359 --> 00:24:18,549
can see a tiny region of one exposure

572
00:24:15,640 --> 00:24:20,470
and there are 83 different exposures so

573
00:24:18,549 --> 00:24:23,230
you can imagine the computer processing

574
00:24:20,470 --> 00:24:24,549
necessary to find these objects so let

575
00:24:23,230 --> 00:24:26,028
me just interject real quick nicholas

576
00:24:24,549 --> 00:24:27,858
grader is asking a question on the q

577
00:24:26,028 --> 00:24:30,079
if it's relevant how how long does it

578
00:24:27,858 --> 00:24:32,569
take to look at all those eighty three

579
00:24:30,079 --> 00:24:33,949
areas for Hubble how it so you want each

580
00:24:32,569 --> 00:24:36,678
one was in orbit right or at least

581
00:24:33,950 --> 00:24:40,788
generally when we do a pointings we

582
00:24:36,679 --> 00:24:42,320
don't slew in between pointings so i

583
00:24:40,788 --> 00:24:44,329
would say that i'd say they probably had

584
00:24:42,319 --> 00:24:46,158
to get eighty three orbits unless they

585
00:24:44,329 --> 00:24:48,648
could do some some sub swing within

586
00:24:46,159 --> 00:24:49,849
within an orbit okay thank you thanks

587
00:24:48,648 --> 00:24:52,848
Nicholas house a good question right

588
00:24:49,848 --> 00:24:56,658
yeah okay and so each orbit is like 96

589
00:24:52,848 --> 00:24:59,028
97 minutes and only half the orbit is

590
00:24:56,659 --> 00:25:00,528
general usable but depending upon how

591
00:24:59,028 --> 00:25:02,898
quickly they can slew between them if

592
00:25:00,528 --> 00:25:05,329
they could do multiple pointings in 11

593
00:25:02,898 --> 00:25:08,209
in one orbit that would be that would be

594
00:25:05,329 --> 00:25:11,718
cool I'm not observer so i don't know if

595
00:25:08,210 --> 00:25:13,940
that's possible okay okay so we got this

596
00:25:11,719 --> 00:25:17,239
stuff here and that's really nice all

597
00:25:13,940 --> 00:25:19,308
right um and so Hubble the kbo

598
00:25:17,239 --> 00:25:22,278
candidates that we found our three

599

00:25:19,308 --> 00:25:24,048
potential targets PT 1 PT 2 and PT 3

600
00:25:22,278 --> 00:25:26,179
again we astronomers are pretty

601
00:25:24,048 --> 00:25:29,778
straightforward were this yeah I met you

602
00:25:26,179 --> 00:25:33,589
two bunch the size estimates are from 25

603
00:25:29,778 --> 00:25:35,808
to 55 kilometers or 15 to 35 miles for

604
00:25:33,588 --> 00:25:42,408
those of you and the point is as bad as

605
00:25:35,808 --> 00:25:45,940
of you miles for those people whatever I

606
00:25:42,409 --> 00:25:49,339
i think in kilometers you're right

607
00:25:45,940 --> 00:25:51,849
anyway so this is really really small

608
00:25:49,338 --> 00:25:54,168
like most Kuiper belt objects are okay

609
00:25:51,848 --> 00:25:59,148
Pluto is around two thousand kilometers

610
00:25:54,169 --> 00:26:01,399
in diameter and PT 1 is quote according

611
00:25:59,148 --> 00:26:04,338
to one guy definitely reachable ok and

612
00:26:01,398 --> 00:26:06,288
reachable is constraint in terms of the

613
00:26:04,338 --> 00:26:07,848

amount of fuel they have onboard the

614

00:26:06,288 --> 00:26:09,739

spacecraft no good i was gonna ask you

615

00:26:07,848 --> 00:26:11,838

about that so ok so it's already going

616

00:26:09,739 --> 00:26:13,700

in a third direction after it leaves

617

00:26:11,838 --> 00:26:16,128

pluto and it's going to be able to do

618

00:26:13,700 --> 00:26:18,588

some moving around but small amount of

619

00:26:16,128 --> 00:26:20,209

maneuverability to make sure that it

620

00:26:18,588 --> 00:26:22,940

passes close by and as you said

621

00:26:20,210 --> 00:26:26,028

Newtonian dynamics we can figure out the

622

00:26:22,940 --> 00:26:29,119

exact orbit no problem ok Newton was

623

00:26:26,028 --> 00:26:30,919

pretty much right and you know actually

624

00:26:29,118 --> 00:26:32,718

there was a question we got in a

625

00:26:30,919 --> 00:26:34,879

workshop I gave recently is do we need

626

00:26:32,719 --> 00:26:37,970

the general relativistic Corrections for

627

00:26:34,878 --> 00:26:39,740

this and generally know there's very

628
00:26:37,970 --> 00:26:41,360
very very very few times

629
00:26:39,740 --> 00:26:44,599
the source software we need gr

630
00:26:41,359 --> 00:26:46,428
corrections I remember JPL saying well

631
00:26:44,599 --> 00:26:50,419
we include them but they're actually not

632
00:26:46,429 --> 00:26:52,400
really relevant ok and then the other

633
00:26:50,420 --> 00:26:54,679
two are considered potentially

634
00:26:52,400 --> 00:26:57,290
accessible and they will require some

635
00:26:54,679 --> 00:26:59,210
study to make sure that if they are

636
00:26:57,289 --> 00:27:01,149
chosen that they are molten resin is the

637
00:26:59,210 --> 00:27:04,759
most interesting one to go visit that

638
00:27:01,150 --> 00:27:06,320
just the the rough calculations say yes

639
00:27:04,759 --> 00:27:09,619
we can get there they of course have to

640
00:27:06,319 --> 00:27:12,799
go through it in detail ok however I

641
00:27:09,619 --> 00:27:14,419
must note okay that this extension of

642
00:27:12,799 --> 00:27:16,308
the new horizons mission to visit

643
00:27:14,420 --> 00:27:19,400
another Kuiper belt object while it's

644
00:27:16,308 --> 00:27:20,899
been as an idea since the beginning of

645
00:27:19,400 --> 00:27:24,380
New Horizons mission it's not been

646
00:27:20,900 --> 00:27:27,559
funded by NASA okay so what will happen

647
00:27:24,380 --> 00:27:29,360
is that the new horizons team sometime

648
00:27:27,558 --> 00:27:31,369
next year the year after I think

649
00:27:29,359 --> 00:27:34,909
probably in 2016 will submit an

650
00:27:31,369 --> 00:27:38,869
application to NASA for extension

651
00:27:34,910 --> 00:27:42,050
funding to do a flyby of one of these

652
00:27:38,869 --> 00:27:44,089
kbos and then NASA depending upon

653
00:27:42,049 --> 00:27:46,190
budgetary situations and whatever's

654
00:27:44,089 --> 00:27:48,740
going on within the agency at the time

655
00:27:46,190 --> 00:27:50,090
will then approve or disapprove that so

656

00:27:48,740 --> 00:27:52,910
I suppose it'll be based a lot on the

657
00:27:50,089 --> 00:27:54,949
science case to be made and the pay the

658
00:27:52,910 --> 00:27:56,779
trade the payoffs versus you know what

659
00:27:54,950 --> 00:27:58,819
it's going to cost to get there as an

660
00:27:56,779 --> 00:28:00,920
astronomer you're already there okay

661
00:27:58,819 --> 00:28:02,869
yeah oh yeah I know the guy he's in

662
00:28:00,920 --> 00:28:05,480
charge right now so there's no extra

663
00:28:02,869 --> 00:28:07,359
money to be put into the spacecraft but

664
00:28:05,480 --> 00:28:09,829
the money is actually for the

665
00:28:07,359 --> 00:28:11,599
astronomers and the technicians to run

666
00:28:09,829 --> 00:28:14,419
the spacecraft and do all the planning

667
00:28:11,599 --> 00:28:16,789
etc so it sets more salary work and as

668
00:28:14,420 --> 00:28:18,170
an astronomer I mean this is our really

669
00:28:16,789 --> 00:28:22,009
the only opportunity we're going to get

670
00:28:18,170 --> 00:28:24,110

from my lifetime tooks to examine Kuiper

671

00:28:22,009 --> 00:28:27,289

belt objects in detail so I of course

672

00:28:24,109 --> 00:28:29,389

would approve it because it's really a

673

00:28:27,289 --> 00:28:32,210

unique opportunity I'll see why we I

674

00:28:29,390 --> 00:28:33,020

can't imagine why we wouldn't the amount

675

00:28:32,210 --> 00:28:35,120

the amount of money's gonna be

676

00:28:33,019 --> 00:28:36,740

relatively small compared to you know

677

00:28:35,119 --> 00:28:38,599

the money it took to get it there right

678

00:28:36,740 --> 00:28:40,640

run Arella exactly yeah it just seems

679

00:28:38,599 --> 00:28:41,750

like a smart thing to do i I don't you

680

00:28:40,640 --> 00:28:44,059

may have said it when i was looking at

681

00:28:41,750 --> 00:28:46,759

four egg comments and stuff but uh did

682

00:28:44,058 --> 00:28:49,519

you say how much these three targets how

683

00:28:46,759 --> 00:28:54,278

long after it passes pluto will it take

684

00:28:49,519 --> 00:29:00,168

to reach a i got there yet Oh

685
00:28:54,278 --> 00:29:03,439
I'll get get there okay so so here but

686
00:29:00,169 --> 00:29:07,249
for example is a good good diagram that

687
00:29:03,439 --> 00:29:09,949
was on the APL website where so here is

688
00:29:07,249 --> 00:29:11,899
the idea of the PT 1 size and they've

689
00:29:09,949 --> 00:29:14,079
estimated thirty five thirty to forty

690
00:29:11,898 --> 00:29:18,378
five kilometers in diameter okay

691
00:29:14,078 --> 00:29:21,648
asteroid eros which near shoemaker of

692
00:29:18,378 --> 00:29:24,528
which point x is 35 by 12 kilometers and

693
00:29:21,648 --> 00:29:27,288
of course the other comet that's in the

694
00:29:24,528 --> 00:29:31,578
news comment rubber ducky or cheerio

695
00:29:27,288 --> 00:29:33,858
mall Jeremy Semenko rubber ducky which

696
00:29:31,578 --> 00:29:36,678
will be landing on in December so we'll

697
00:29:33,858 --> 00:29:37,908
talk about that next month right you can

698
00:29:36,679 --> 00:29:40,489
see how small that is only four

699
00:29:37,909 --> 00:29:43,189
kilometers in diameter right yep so

700
00:29:40,489 --> 00:29:45,399
they're already been destroyed and their

701
00:29:43,189 --> 00:29:48,949
asteroid asteroid and comet nuclei size

702
00:29:45,398 --> 00:29:52,458
they're not of small moon sizes or even

703
00:29:48,949 --> 00:29:54,949
small planet sizes good all right so

704
00:29:52,459 --> 00:29:58,459
finally it will take several years to

705
00:29:54,949 --> 00:30:00,139
get there the take taken ten years to

706
00:29:58,459 --> 00:30:04,129
get to Pluto take another couple years

707
00:30:00,138 --> 00:30:07,458
to travel further and this is a diagram

708
00:30:04,128 --> 00:30:09,348
showing a possible artist conception of

709
00:30:07,459 --> 00:30:12,859
what it might look like looking back on

710
00:30:09,348 --> 00:30:14,628
the Sun however those bright dots there

711
00:30:12,858 --> 00:30:17,598
are not stars they are supposed to be

712
00:30:14,628 --> 00:30:20,718
the planets okay so Jupiter Saturn

713

00:30:17,598 --> 00:30:24,739
Uranus Neptune and Pluto are shown in

714
00:30:20,719 --> 00:30:26,449
this diagram no ever as somebody who

715
00:30:24,739 --> 00:30:30,639
does astronomers realizations I have to

716
00:30:26,449 --> 00:30:33,589
say the position of the kbo is wrong

717
00:30:30,638 --> 00:30:35,838
okay because first of all New Horizons

718
00:30:33,588 --> 00:30:39,318
is flying past Pluto almost directly on

719
00:30:35,838 --> 00:30:41,479
up from the Sun and it can't change

720
00:30:39,318 --> 00:30:45,709
course it can't take a huge left like

721
00:30:41,479 --> 00:30:48,828
this would be furthermore Pluto is about

722
00:30:45,709 --> 00:30:51,288
3 billion miles from the Sun right this

723
00:30:48,828 --> 00:30:53,058
object is another billion miles farther

724
00:30:51,288 --> 00:30:55,489
that's why it's going to take another

725
00:30:53,058 --> 00:30:57,408
couple years to get there you know

726
00:30:55,489 --> 00:31:00,558
because it's another billion miles that

727
00:30:57,409 --> 00:31:02,209

has got to travel and so if you take a

728

00:31:00,558 --> 00:31:04,759

straight line from the Sun through Pluto

729

00:31:02,209 --> 00:31:06,500

if you can adding in for shortening of

730

00:31:04,759 --> 00:31:08,569

this because of

731

00:31:06,500 --> 00:31:11,720

active this object would have to be way

732

00:31:08,569 --> 00:31:13,639

over there and a lot closer in put it

733

00:31:11,720 --> 00:31:15,110

would be right along with along the site

734

00:31:13,640 --> 00:31:17,210

between the subject and Pluto so you

735

00:31:15,109 --> 00:31:22,099

have you have problems with the artist

736

00:31:17,210 --> 00:31:24,259

liberties then um nice drawing but this

737

00:31:22,099 --> 00:31:27,619

object is way too hot too far away to be

738

00:31:24,259 --> 00:31:29,299

one of the capsule targets okay I just

739

00:31:27,619 --> 00:31:31,459

don't I just thought i would show people

740

00:31:29,299 --> 00:31:32,990

that you know even as an astronomer i

741

00:31:31,460 --> 00:31:36,110

look at these diagrams that's a nice

742
00:31:32,990 --> 00:31:37,549
diagram but I immediately flash on whoa

743
00:31:36,109 --> 00:31:39,829
wait a minute it should be here and

744
00:31:37,549 --> 00:31:41,419
there and the perspective it's very very

745
00:31:39,829 --> 00:31:44,329
hard to get that kind of thing correct

746
00:31:41,420 --> 00:31:46,160
yeah okay okay ya know a couple years

747
00:31:44,329 --> 00:31:47,839
from New Horizons it's gonna be out

748
00:31:46,160 --> 00:31:50,090
there blunt phone off the universe and

749
00:31:47,839 --> 00:31:51,409
it's not gonna be singing 100 bottles of

750
00:31:50,089 --> 00:31:54,079
beer on the wall as it travels across

751
00:31:51,410 --> 00:31:59,150
there god you're was gonna see Tony I'm

752
00:31:54,079 --> 00:32:01,909
I'd lemon I told you are you using I'm

753
00:31:59,150 --> 00:32:05,509
gonna be song from The Pretenders and I

754
00:32:01,910 --> 00:32:09,529
would fly three billion rounds and I

755
00:32:05,509 --> 00:32:13,039
would fly up billion you just to be the

756
00:32:09,529 --> 00:32:18,259
mission that flew for feeling get miles

757
00:32:13,039 --> 00:32:20,629
on a Kuiper belt hey I gotta hand a

758
00:32:18,259 --> 00:32:23,180
change you did it I go the way I was

759
00:32:20,630 --> 00:32:24,680
gonna do it oh that's great okay and i

760
00:32:23,180 --> 00:32:26,509
like i like how you did it you did a

761
00:32:24,680 --> 00:32:29,840
good job with the words and stuff so it

762
00:32:26,509 --> 00:32:31,549
really fits nice it was just you know

763
00:32:29,839 --> 00:32:33,109
listening to the whole thing about it's

764
00:32:31,549 --> 00:32:35,359
going 3 billion miles I was asked to

765
00:32:33,109 --> 00:32:37,309
play a billion more and just subtly that

766
00:32:35,359 --> 00:32:38,959
hit my head feels like it stuck in my

767
00:32:37,309 --> 00:32:40,909
head all right I gotta use that for the

768
00:32:38,960 --> 00:32:43,910
Hangout can I just say though Frank um

769
00:32:40,910 --> 00:32:49,580
let's go glad you're an astronomer stick

770

00:32:43,910 --> 00:32:51,140
to stick to your day job there was great

771
00:32:49,579 --> 00:32:54,049
thanks alright said you've got any

772
00:32:51,140 --> 00:32:56,770
questions let's see here's one from Hans

773
00:32:54,049 --> 00:32:59,599
milling on the Q&A app giggling will

774
00:32:56,769 --> 00:33:02,750
jwst be able to make better pictures of

775
00:32:59,599 --> 00:33:04,549
Pluto uh j ust will have a similar

776
00:33:02,750 --> 00:33:07,549
resolution to Hubble but in the infrared

777
00:33:04,549 --> 00:33:10,369
and Pluto will be brighter in the

778
00:33:07,549 --> 00:33:13,250
infrared than it is in visible light so

779
00:33:10,369 --> 00:33:16,039
yes James T will be able to see it

780
00:33:13,250 --> 00:33:19,190
better but will not get higher

781
00:33:16,039 --> 00:33:20,460
resolution alright so Hubble has about

782
00:33:19,190 --> 00:33:23,130
20 pixels across

783
00:33:20,460 --> 00:33:25,170
Pluto's disk Jada's T will also have

784
00:33:23,130 --> 00:33:28,740

about 20 pixels across those discs in

785

00:33:25,170 --> 00:33:31,200

the infrared pack and Michael jobin is

786

00:33:28,740 --> 00:33:34,680

asking on the Q&A app so will the

787

00:33:31,200 --> 00:33:36,690

sensors work in that way uh in that way

788

00:33:34,680 --> 00:33:38,880

out low light for the new horizons in

789

00:33:36,690 --> 00:33:41,730

other words will be bright enough out

790

00:33:38,880 --> 00:33:44,730

that far out for okay that is a valid

791

00:33:41,730 --> 00:33:47,400

question because the object four billion

792

00:33:44,730 --> 00:33:51,000

miles out there is going to receive you

793

00:33:47,400 --> 00:33:53,580

know less light and it's only tens of

794

00:33:51,000 --> 00:33:56,430

kilometers across so it's not going to

795

00:33:53,579 --> 00:33:58,619

reflect that much light also most Kuiper

796

00:33:56,430 --> 00:34:02,400

belt objects are pretty much pitch black

797

00:33:58,619 --> 00:34:03,869

I'm serious the surface of them they've

798

00:34:02,400 --> 00:34:06,060

been flying around the solar system for

799

00:34:03,869 --> 00:34:08,000
four billion years they hit tiny little

800

00:34:06,059 --> 00:34:10,619
particles the solar wind hits them etc

801

00:34:08,000 --> 00:34:14,489
their surfaces all of the bright stuff

802

00:34:10,619 --> 00:34:16,500
on the surfaces has been pushed away and

803

00:34:14,489 --> 00:34:18,839
you have sort of a at are like colored

804

00:34:16,500 --> 00:34:20,460
service every time we see a comment it

805

00:34:18,840 --> 00:34:25,620
ends up having a coal-black surface

806

00:34:20,460 --> 00:34:30,030
right so the the brightness of the

807

00:34:25,619 --> 00:34:31,889
object will be is in question however we

808

00:34:30,030 --> 00:34:33,600
are going through the Pluto system where

809

00:34:31,889 --> 00:34:37,949
we're kind of pre trying to look at Nix

810

00:34:33,599 --> 00:34:39,869
and Hydra and the other two every 30

811

00:34:37,949 --> 00:34:42,449
days blanking on their names right now

812

00:34:39,869 --> 00:34:44,609
but anyways we're looking those moments

813
00:34:42,449 --> 00:34:48,059
which aren't much bigger if at all

814
00:34:44,610 --> 00:34:50,400
bigger than these in this object so we

815
00:34:48,059 --> 00:34:52,110
will have experience with the numerals

816
00:34:50,400 --> 00:34:55,559
and sensors in looking at those types of

817
00:34:52,110 --> 00:34:58,110
objects and I don't and we can also do

818
00:34:55,559 --> 00:34:59,639
this take longer exposures this is the

819
00:34:58,110 --> 00:35:01,710
one of the things we have to do is

820
00:34:59,639 --> 00:35:03,690
calibrate and so we can use our

821
00:35:01,710 --> 00:35:06,750
long-range one I think it's called New

822
00:35:03,690 --> 00:35:09,510
Horizons called Laurie lor RI is the

823
00:35:06,750 --> 00:35:11,610
long-range imager to look at it in

824
00:35:09,510 --> 00:35:13,500
advance and then we get a close that

825
00:35:11,610 --> 00:35:15,900
will calibrate the exposures will need

826
00:35:13,500 --> 00:35:17,550
for the up-close cameras ok awesome good

827

00:35:15,900 --> 00:35:18,960
question ok thank you and i think that's

828
00:35:17,550 --> 00:35:20,789
it for this particular story i have some

829
00:35:18,960 --> 00:35:21,869
other questions i'll get to after your

830
00:35:20,789 --> 00:35:25,519
after you were able to get through the

831
00:35:21,869 --> 00:35:27,599
stories so ok now I want to switch gears

832
00:35:25,519 --> 00:35:29,309
and tell you guys something that you

833
00:35:27,599 --> 00:35:31,019
usually don't get to hear all right

834
00:35:29,309 --> 00:35:33,119
because Tony and I working at Space

835
00:35:31,019 --> 00:35:33,929
Telescope we get these me emails every

836
00:35:33,119 --> 00:35:36,058
now and then say

837
00:35:33,929 --> 00:35:39,838
okay there's been there's been a hiccup

838
00:35:36,059 --> 00:35:41,730
okay and this happened this week where

839
00:35:39,838 --> 00:35:43,949
we had a hiccup in the science

840
00:35:41,730 --> 00:35:48,990
instrument control and data handling

841
00:35:43,949 --> 00:35:52,679

unit or the SI C and D H so this is the

842

00:35:48,989 --> 00:35:55,139

SI c and d h and actually this is a

843

00:35:52,679 --> 00:35:56,818

ground base unit this is a picture of it

844

00:35:55,139 --> 00:35:59,098

from Goddard Space Flight Center the

845

00:35:56,818 --> 00:36:02,099

ground base unit in outer space by

846

00:35:59,099 --> 00:36:05,338

center but there is a version of this up

847

00:36:02,099 --> 00:36:08,430

on the hubble space telescope and the SI

848

00:36:05,338 --> 00:36:12,058

c and d h was actually very famous about

849

00:36:08,429 --> 00:36:15,239

five years ago because here is the image

850

00:36:12,059 --> 00:36:17,660

of the space shuttles on the launch pad

851

00:36:15,239 --> 00:36:22,828

getting ready for servicing mission for

852

00:36:17,659 --> 00:36:25,139

this was in September of 2008 and you

853

00:36:22,829 --> 00:36:27,690

may remember that the servicing mission

854

00:36:25,139 --> 00:36:31,469

for didn't actually go until may of 2009

855

00:36:27,690 --> 00:36:33,630

he's right it was at this point with the

856
00:36:31,469 --> 00:36:36,719
two shuttles on the launch pads down at

857
00:36:33,630 --> 00:36:39,990
Kennedy that we had a problem in the SI

858
00:36:36,719 --> 00:36:42,239
c and d h on hon board help the a-side

859
00:36:39,989 --> 00:36:45,598
electronics failed and we had to switch

860
00:36:42,239 --> 00:36:48,209
to the b-side electronics and that was

861
00:36:45,599 --> 00:36:49,950
fine because we have backup electronics

862
00:36:48,210 --> 00:36:52,260
but we realized this is the last

863
00:36:49,949 --> 00:36:55,949
servicing mission to Hubble we want to

864
00:36:52,260 --> 00:36:59,430
leave Hubble in the best possible shape

865
00:36:55,949 --> 00:37:02,009
and to have the SI casi C and D H

866
00:36:59,429 --> 00:37:03,989
science instrument control right it

867
00:37:02,010 --> 00:37:07,020
controls all of the science instruments

868
00:37:03,989 --> 00:37:08,578
d h data handling all of the data from

869
00:37:07,019 --> 00:37:10,650
those scientists then route through this

870
00:37:08,579 --> 00:37:13,859
yeah the best cameras in the world if

871
00:37:10,650 --> 00:37:15,869
that stuff doesn't work critical hit p

872
00:37:13,858 --> 00:37:18,719
it is in the critical path of getting

873
00:37:15,869 --> 00:37:21,390
the science data back home okay without

874
00:37:18,719 --> 00:37:23,098
the si si in th we can't get any science

875
00:37:21,389 --> 00:37:24,900
data back okay we can't tell the cameras

876
00:37:23,099 --> 00:37:27,000
what to do we can't get the data off the

877
00:37:24,900 --> 00:37:29,338
camera so it's a really crucial piece of

878
00:37:27,000 --> 00:37:31,949
equipment and it had been up there and

879
00:37:29,338 --> 00:37:34,230
worked fine for 18 years but they

880
00:37:31,949 --> 00:37:36,779
decided all right we're going to take

881
00:37:34,230 --> 00:37:38,710
the time to take the ground spare which

882
00:37:36,780 --> 00:37:42,760
is the picture I showed you in there

883
00:37:38,710 --> 00:37:45,429
and make it flight ready and replace the

884

00:37:42,760 --> 00:37:49,089
SI c and d h at the same time in

885
00:37:45,429 --> 00:37:51,098
servicing mission for so they did they

886
00:37:49,088 --> 00:37:53,619
did that they took the SI c and d h they

887
00:37:51,099 --> 00:37:56,200
made it flight ready and we took an

888
00:37:53,619 --> 00:37:58,510
extra six months or so before servicing

889
00:37:56,199 --> 00:38:03,730
mission for and it finally went in May

890
00:37:58,510 --> 00:38:06,310
of 2009 well this week there was a what

891
00:38:03,730 --> 00:38:08,530
we call a lock-up and the SI c and d h

892
00:38:06,309 --> 00:38:11,799
and i hadn't heard of this before head

893
00:38:08,530 --> 00:38:13,810
you Tony mm-hmm no yeah but apparently

894
00:38:11,800 --> 00:38:16,450
it's a known issue and a known thing it

895
00:38:13,809 --> 00:38:18,130
does according to exactly her since this

896
00:38:16,449 --> 00:38:19,750
SI c and d h was installed during

897
00:38:18,130 --> 00:38:22,630
servicing mission for there have been

898
00:38:19,750 --> 00:38:24,099

five lockups yeah now they say oh it's

899

00:38:22,630 --> 00:38:27,670

on average one or two once or twice a

900

00:38:24,099 --> 00:38:29,019

year and it seems like you know well you

901

00:38:27,670 --> 00:38:31,240

know how your computer gets gets gets

902

00:38:29,019 --> 00:38:36,280

all hey wiring you have to reboot right

903

00:38:31,239 --> 00:38:38,079

oh no my it never happens oh it sounded

904

00:38:36,280 --> 00:38:41,349

like that and the way to describe it it

905

00:38:38,079 --> 00:38:44,199

just get left gets locked up gets if you

906

00:38:41,349 --> 00:38:46,990

reboot it boom everything's okay and so

907

00:38:44,199 --> 00:38:49,838

that happened on let's see what is today

908

00:38:46,989 --> 00:38:52,029

wednesday so it happened on monday yeah

909

00:38:49,838 --> 00:38:54,130

ternoon and what's fixer look at a cup

910

00:38:52,030 --> 00:38:55,720

on tuesday ryan geo so tuesday morning

911

00:38:54,130 --> 00:38:57,880

we got an email saying hey the SI c and

912

00:38:55,719 --> 00:38:59,858

d h has had a lock up we're on it

913
00:38:57,880 --> 00:39:01,750
everything nothing nothing looks out of

914
00:38:59,858 --> 00:39:03,880
ordinary except for the anomaly and the

915
00:39:01,750 --> 00:39:05,530
SI c and d h and this morning we got

916
00:39:03,880 --> 00:39:07,750
another email saying hey everything's

917
00:39:05,530 --> 00:39:09,760
good we're back toward science stuff and

918
00:39:07,750 --> 00:39:13,300
i just want to give you an example of

919
00:39:09,760 --> 00:39:15,849
how the folks who work on hubble here in

920
00:39:13,300 --> 00:39:19,359
our building along with folks at goddard

921
00:39:15,849 --> 00:39:20,500
space flight center are really there on

922
00:39:19,358 --> 00:39:23,139
it then they can take care of these

923
00:39:20,500 --> 00:39:25,300
things really well and we do have these

924
00:39:23,139 --> 00:39:27,579
anomalies we do have these small breaks

925
00:39:25,300 --> 00:39:29,140
in the Hubble observing schedule matter

926
00:39:27,579 --> 00:39:30,819
of fact I think that small break in the

927
00:39:29,139 --> 00:39:32,379
Hubble observable has had a little

928
00:39:30,820 --> 00:39:37,450
problem in getting the comet siding

929
00:39:32,380 --> 00:39:38,680
spring observations back so no yeah well

930
00:39:37,449 --> 00:39:40,480
that's what sort of the Hubble

931
00:39:38,679 --> 00:39:44,618
equivalent of a spinning beachball I

932
00:39:40,480 --> 00:39:45,969
guess yes there you go they're trying to

933
00:39:44,619 --> 00:39:47,050
download the siding Springs of inches

934
00:39:45,969 --> 00:39:48,109
and all they got was this spinning

935
00:39:47,050 --> 00:39:53,630
beachball

936
00:39:48,110 --> 00:39:55,579
I hate that thing anyway so but Hubble

937
00:39:53,630 --> 00:39:57,650
is back it's working it's doing science

938
00:39:55,579 --> 00:39:59,090
again just want to let you know hey

939
00:39:57,650 --> 00:40:01,099
small little hiccup occurred this week

940
00:39:59,090 --> 00:40:03,230
it's nothing out of the ordinary but

941

00:40:01,099 --> 00:40:05,029
it's it's fun to let you guys in on

942
00:40:03,230 --> 00:40:06,980
what's happening behind the scenes yeah

943
00:40:05,030 --> 00:40:08,510
thanks Franken Michael jobin is

944
00:40:06,980 --> 00:40:11,090
commenting I still think we could have

945
00:40:08,510 --> 00:40:13,940
done one more HST rehab using the soft

946
00:40:11,090 --> 00:40:15,470
docking ring yeah maybe but it's a

947
00:40:13,940 --> 00:40:17,090
little unlikely i think that would ever

948
00:40:15,469 --> 00:40:20,899
happen but it might I mean I hold out

949
00:40:17,090 --> 00:40:23,690
hope but um you know what it is possible

950
00:40:20,900 --> 00:40:24,920
yeah what a lot of people I and a lot of

951
00:40:23,690 --> 00:40:27,139
people at NASA would have loved to have

952
00:40:24,920 --> 00:40:29,750
seen is trying to use that as an excuse

953
00:40:27,139 --> 00:40:31,969
to develop robotic servicing yeah

954
00:40:29,750 --> 00:40:33,889
there's a lot of interest all across

955
00:40:31,969 --> 00:40:36,469

NASA not just for Hubble I mean all

956

00:40:33,889 --> 00:40:38,920

across NASA about trying to do robotic

957

00:40:36,469 --> 00:40:42,049

servicing robotic missions in space and

958

00:40:38,920 --> 00:40:44,720

advancing that and that one of the

959

00:40:42,050 --> 00:40:48,140

possible uses of that docking ring okay

960

00:40:44,719 --> 00:40:51,169

so yeah all right I'm gonna finish up

961

00:40:48,139 --> 00:40:56,869

with a close encounter of the fourth

962

00:40:51,170 --> 00:40:59,329

planet kind oh boy yeah your titles Tony

963

00:40:56,869 --> 00:41:01,880

you should be used to this but I don't

964

00:40:59,329 --> 00:41:04,190

think I'll ever get used to it is that

965

00:41:01,880 --> 00:41:07,099

all or summer comet siding spring for

966

00:41:04,190 --> 00:41:10,429

planet Mars and comet siding spring and

967

00:41:07,099 --> 00:41:12,250

this is a picture I a I don't know if I

968

00:41:10,429 --> 00:41:14,989

talk about siding spring and a hangouts

969

00:41:12,250 --> 00:41:16,849

mmm I don't believe so no I think we

970
00:41:14,989 --> 00:41:19,159
might have alluded to it than the last

971
00:41:16,849 --> 00:41:21,500
ones I okay well this is uh Damien

972
00:41:19,159 --> 00:41:25,069
peaches and Damien peach got some of the

973
00:41:21,500 --> 00:41:26,840
really best images of Comet Ison he's

974
00:41:25,070 --> 00:41:29,630
coming through again showing really cool

975
00:41:26,840 --> 00:41:32,090
images of Comet sightings beautiful as

976
00:41:29,630 --> 00:41:33,349
from februari of earlier this year you

977
00:41:32,090 --> 00:41:35,150
can see the cluster of galaxies in the

978
00:41:33,349 --> 00:41:37,039
background it isn't that a great

979
00:41:35,150 --> 00:41:38,780
composition on it's beautiful house

980
00:41:37,039 --> 00:41:40,190
losing it any people just sort of

981
00:41:38,780 --> 00:41:42,800
noticing that look at the comment but

982
00:41:40,190 --> 00:41:44,389
look at the GALEX night now oh yeah as a

983
00:41:42,800 --> 00:41:48,170
comic can you move that come out of the

984
00:41:44,389 --> 00:41:50,210
way on alright so and of course I think

985
00:41:48,170 --> 00:41:53,090
spring the major thing about it is that

986
00:41:50,210 --> 00:41:56,929
it was going to pass very close to Mars

987
00:41:53,090 --> 00:41:58,519
on october 19th of this year how close

988
00:41:56,929 --> 00:42:00,799
tomorrow I mean this is actually kind of

989
00:41:58,519 --> 00:42:01,300
crazy because siding spring is coming in

990
00:42:00,800 --> 00:42:03,700
from

991
00:42:01,300 --> 00:42:06,580
cloud right it's got this incredibly

992
00:42:03,699 --> 00:42:08,710
long orbit the estimate is that it would

993
00:42:06,579 --> 00:42:12,219
take like two or three million years to

994
00:42:08,710 --> 00:42:16,449
complete an orbit okay so its perihelion

995
00:42:12,219 --> 00:42:19,000
and the inclination is it's inclined to

996
00:42:16,449 --> 00:42:21,179
the plane so it's not in the plane it's

997
00:42:19,000 --> 00:42:24,250
actually heavily inclined to the plane

998

00:42:21,179 --> 00:42:27,009
but it actually is going to be passing

999
00:42:24,250 --> 00:42:29,079
very close to Mars this is an amazing

1000
00:42:27,010 --> 00:42:30,820
coincidence but we discovered it well in

1001
00:42:29,079 --> 00:42:34,659
advance in order to be able to prepare

1002
00:42:30,820 --> 00:42:37,000
for it just to talk about how close it

1003
00:42:34,659 --> 00:42:38,319
is I put together this scale diagram

1004
00:42:37,000 --> 00:42:40,320
that it's going to be one hundred

1005
00:42:38,320 --> 00:42:44,789
thirty-five thousand kilometers or

1006
00:42:40,320 --> 00:42:50,740
86,000 miles but the ease of you people

1007
00:42:44,789 --> 00:42:52,360
for you people oh anyways but easy

1008
00:42:50,739 --> 00:42:56,049
before you understand that is that it's

1009
00:42:52,360 --> 00:42:59,320
20 Mars diameters okay so 20 times the

1010
00:42:56,050 --> 00:43:01,720
diameter of Mars is the true scale and I

1011
00:42:59,320 --> 00:43:03,940
like to give that because well you've

1012
00:43:01,719 --> 00:43:05,669

seen a lot of visualizations of comet

1013

00:43:03,940 --> 00:43:08,650

siding Springs on Mars this week and

1014

00:43:05,670 --> 00:43:11,139

none of them have actually got the comet

1015

00:43:08,650 --> 00:43:13,059

and Mars at the proper scale relative to

1016

00:43:11,139 --> 00:43:14,349

one another right they always have the

1017

00:43:13,059 --> 00:43:18,159

comet looking like it's going to brush

1018

00:43:14,349 --> 00:43:20,589

across the brush across the atmosphere

1019

00:43:18,159 --> 00:43:22,960

of Mars but it's really going to be it's

1020

00:43:20,590 --> 00:43:25,720

going to be 20 Mars diners cross away

1021

00:43:22,960 --> 00:43:28,329

from and so the question is how large

1022

00:43:25,719 --> 00:43:31,359

was its coma going to be with the coma

1023

00:43:28,329 --> 00:43:33,340

of a comet be hundreds of thousands of

1024

00:43:31,360 --> 00:43:35,500

kilometers across so that it would sweep

1025

00:43:33,340 --> 00:43:38,019

across Mars and we might have an

1026

00:43:35,500 --> 00:43:40,719

interesting interaction all right so

1027
00:43:38,019 --> 00:43:42,550
Hubble looked at it Hubble has the fine

1028
00:43:40,719 --> 00:43:44,739
resolution still can't see the nucleus a

1029
00:43:42,550 --> 00:43:46,690
comma then accommodate yourself is only

1030
00:43:44,739 --> 00:43:48,489
a few kilometers across this was less

1031
00:43:46,690 --> 00:43:52,150
per me so we're just seeing that the

1032
00:43:48,489 --> 00:43:54,250
coma but on the Left we see the image

1033
00:43:52,150 --> 00:43:56,639
and on the right we see a processed

1034
00:43:54,250 --> 00:44:00,070
version of it where we subtracted off a

1035
00:43:56,639 --> 00:44:02,319
roughly symmetrical model of gamma

1036
00:44:00,070 --> 00:44:04,750
emission so the material coming off of

1037
00:44:02,320 --> 00:44:07,600
the nucleus to form the coma if it comes

1038
00:44:04,750 --> 00:44:10,239
off smoothly you know it would be

1039
00:44:07,599 --> 00:44:11,769
roughly spherical okay so subtract that

1040
00:44:10,239 --> 00:44:14,229
off and what do you get on the right

1041
00:44:11,769 --> 00:44:14,949
hand side it looks like there are twin

1042
00:44:14,230 --> 00:44:17,710
to

1043
00:44:14,949 --> 00:44:19,750
oppositely directed jets okay you can

1044
00:44:17,710 --> 00:44:22,240
see that try to look for sub structure

1045
00:44:19,750 --> 00:44:24,219
in the emission of the coma and it

1046
00:44:22,239 --> 00:44:26,229
appears there are some Jetson Hubble has

1047
00:44:24,219 --> 00:44:30,299
been monitoring that over the course of

1048
00:44:26,230 --> 00:44:32,409
months to try from from a year ago on

1049
00:44:30,300 --> 00:44:34,630
through the spring to try and

1050
00:44:32,409 --> 00:44:36,819
characterize you know what's going on is

1051
00:44:34,630 --> 00:44:39,338
there lots of Jets of material is it

1052
00:44:36,820 --> 00:44:41,320
generally smooth is it you know might it

1053
00:44:39,338 --> 00:44:43,210
be breaking up how will can actually see

1054
00:44:41,320 --> 00:44:46,329
it if it does break up I things like

1055

00:44:43,210 --> 00:44:50,820
that so it's been monitored and here is

1056
00:44:46,329 --> 00:44:53,769
a image from September of 2014 and

1057
00:44:50,820 --> 00:44:55,539
unfortunately as we got through the late

1058
00:44:53,769 --> 00:44:57,789
summer and into September we expected it

1059
00:44:55,539 --> 00:45:01,659
to dim a little bit but it actually

1060
00:44:57,789 --> 00:45:05,980
dimmed a lot more than we expected as if

1061
00:45:01,659 --> 00:45:09,309
as if Idzik it as it came in and so I

1062
00:45:05,980 --> 00:45:11,889
honestly wasn't expecting much okay just

1063
00:45:09,309 --> 00:45:13,779
because the coma wasn't this hundreds

1064
00:45:11,889 --> 00:45:16,230
hundred thousand kilometer across comma

1065
00:45:13,780 --> 00:45:19,060
comas maybe 10,000 kilometers across

1066
00:45:16,230 --> 00:45:23,108
didn't see they're going to be a huge

1067
00:45:19,059 --> 00:45:25,989
interaction okay but we have missions at

1068
00:45:23,108 --> 00:45:28,328
Mars and this is the Maven mission which

1069
00:45:25,989 --> 00:45:29,828

just arrived at cars okay so it arrives

1070

00:45:28,329 --> 00:45:35,859

at Mars and first thing that's got to do

1071

00:45:29,829 --> 00:45:39,609

is go oh oh so head I'm not making this

1072

00:45:35,858 --> 00:45:45,429

up NASA called for what they call a duck

1073

00:45:39,608 --> 00:45:47,588

and cover like from the 50s yes Becca so

1074

00:45:45,429 --> 00:45:51,098

there are three orbiting missions around

1075

00:45:47,588 --> 00:45:53,889

Mars and they adjusted the orbits so

1076

00:45:51,099 --> 00:45:56,859

that when siding spring came by they

1077

00:45:53,889 --> 00:45:58,059

would be on the far side of Mars as much

1078

00:45:56,858 --> 00:46:00,670

as possible and of course they're

1079

00:45:58,059 --> 00:46:02,440

orbiting around Mars continuously so I

1080

00:46:00,670 --> 00:46:04,990

can't stay over there it's not like they

1081

00:46:02,440 --> 00:46:08,079

can park them over there but during the

1082

00:46:04,989 --> 00:46:12,429

what they presumed would be the maximum

1083

00:46:08,079 --> 00:46:13,510

chance of danger they had made sure that

1084
00:46:12,429 --> 00:46:17,409
the missions were on the far side of

1085
00:46:13,510 --> 00:46:19,329
Mars and after this weekend they the

1086
00:46:17,409 --> 00:46:23,078
post comments spacecraft status is that

1087
00:46:19,329 --> 00:46:25,960
everybody's in good health Oh fuels yes

1088
00:46:23,079 --> 00:46:28,269
you not that I was terribly worried

1089
00:46:25,960 --> 00:46:28,929
you right up to you do have to put these

1090
00:46:28,269 --> 00:46:30,550
things and say

1091
00:46:28,929 --> 00:46:32,799
mode intent and take care of just in

1092
00:46:30,550 --> 00:46:34,420
case right right there's no reason that

1093
00:46:32,800 --> 00:46:37,809
there's something couldn't dispute out

1094
00:46:34,420 --> 00:46:40,300
and and you get a 1 good serious hit on

1095
00:46:37,809 --> 00:46:44,050
these things could really damage them

1096
00:46:40,300 --> 00:46:46,750
and may even just got there so no maven

1097
00:46:44,050 --> 00:46:49,119
needs to start doing it's a it's science

1098
00:46:46,750 --> 00:46:51,550
okay you know talk about bad timing your

1099
00:46:49,119 --> 00:46:52,838
dad got nailed by that thing the

1100
00:46:51,550 --> 00:46:55,539
previous image that's Mars

1101
00:46:52,838 --> 00:46:57,969
Reconnaissance Orbiter I was wrong ok I

1102
00:46:55,539 --> 00:46:59,769
wanna check check that I realized that

1103
00:46:57,969 --> 00:47:02,588
you know maven I remember has this

1104
00:46:59,769 --> 00:47:05,318
really funky shape and that was mro not

1105
00:47:02,588 --> 00:47:08,650
me then I know trans okay all right

1106
00:47:05,318 --> 00:47:11,650
refrigerants we have the Mars missions

1107
00:47:08,650 --> 00:47:13,180
on the ground and so what are they going

1108
00:47:11,650 --> 00:47:15,670
to see if there's all this debris

1109
00:47:13,179 --> 00:47:16,868
hitting the Martian atmosphere well what

1110
00:47:15,670 --> 00:47:19,960
happens when comet debris hits the

1111
00:47:16,869 --> 00:47:23,650
Earth's atmosphere we get a meteor

1112

00:47:19,960 --> 00:47:26,800
shower all right could we see a meteor

1113
00:47:23,650 --> 00:47:29,858
shower on Mars that would be really cool

1114
00:47:26,800 --> 00:47:32,589
could we see a comet from the surface of

1115
00:47:29,858 --> 00:47:35,139
another planet that would be cool what'd

1116
00:47:32,588 --> 00:47:39,880
be cool what have been cool we didn't

1117
00:47:35,139 --> 00:47:41,949
see a meteor shower from oh we did get

1118
00:47:39,880 --> 00:47:45,160
this image this is from the opportunity

1119
00:47:41,949 --> 00:47:46,568
rover and you can see pointed out in

1120
00:47:45,159 --> 00:47:47,889
this image are stars that have been

1121
00:47:46,568 --> 00:47:50,710
trailed a little bit because it's a

1122
00:47:47,889 --> 00:47:52,980
longer exposure and a few cosmic rays

1123
00:47:50,710 --> 00:47:56,289
which are just you know detector hits

1124
00:47:52,980 --> 00:47:59,380
but right in the center there is a

1125
00:47:56,289 --> 00:48:02,259
picture of comet siding Springs from the

1126
00:47:59,380 --> 00:48:04,358

surface of Mars alright still awesome

1127

00:48:02,260 --> 00:48:07,540
it's still awesome it's still kind of

1128

00:48:04,358 --> 00:48:10,179
awesome with yeah it was awesome when we

1129

00:48:07,539 --> 00:48:12,699
saw the solar eclipse for Mars it's

1130

00:48:10,179 --> 00:48:14,558
awesome to see a comet from Mars it's

1131

00:48:12,699 --> 00:48:16,838
just nice to sort of think about doing

1132

00:48:14,559 --> 00:48:19,240
astronomy from the surface of another

1133

00:48:16,838 --> 00:48:21,308
planet yeah it's also important to note

1134

00:48:19,239 --> 00:48:23,019
that the camera is on these Rovers are

1135

00:48:21,309 --> 00:48:24,490
not optimally suited for looking up at

1136

00:48:23,019 --> 00:48:26,588
the sky like this so that's a pretty

1137

00:48:24,489 --> 00:48:28,659
nice a nice image given what it was

1138

00:48:26,588 --> 00:48:32,099
designed to do so my takeaway from the

1139

00:48:28,659 --> 00:48:34,629
weekend is that didn't really do much

1140

00:48:32,099 --> 00:48:35,859
wasn't as big an interaction I'm sure

1141
00:48:34,630 --> 00:48:38,140
there are some science that's going to

1142
00:48:35,858 --> 00:48:40,298
be get come out of it I haven't heard

1143
00:48:38,139 --> 00:48:43,159
any details of it but maybe we'll hear

1144
00:48:40,298 --> 00:48:45,150
some tomorrow or in the coming weeks

1145
00:48:43,159 --> 00:48:48,509
but if you really want a good picture

1146
00:48:45,150 --> 00:48:51,660
where do we go we go back to the peach

1147
00:48:48,510 --> 00:48:53,790
of a picture from Damien peach and this

1148
00:48:51,659 --> 00:48:57,989
is one of the cool images i found out on

1149
00:48:53,789 --> 00:49:00,989
the net very nice that is Mars Mars of

1150
00:48:57,989 --> 00:49:03,239
course is blown out right but he's been

1151
00:49:00,989 --> 00:49:05,369
able to control Mars's blow out a little

1152
00:49:03,239 --> 00:49:07,139
bit and you can see comet siding spring

1153
00:49:05,369 --> 00:49:10,049
yeah you can see how much fainter it is

1154
00:49:07,139 --> 00:49:12,179
too yeah all of the in the normal

1155
00:49:10,050 --> 00:49:13,769
pictures you know have Mars blown out

1156
00:49:12,179 --> 00:49:15,449
and the detector noise is all over the

1157
00:49:13,769 --> 00:49:18,420
place they're just a few of these that

1158
00:49:15,449 --> 00:49:21,149
are able to keep that dynamic range and

1159
00:49:18,420 --> 00:49:23,250
control it and not have Mars blow all

1160
00:49:21,150 --> 00:49:26,550
over the place I'll still be in common

1161
00:49:23,250 --> 00:49:29,369
so uh on the QA app sev dust bunny is

1162
00:49:26,550 --> 00:49:30,660
this is comment they are asking Frank's

1163
00:49:29,369 --> 00:49:31,859
just kind of answered your question but

1164
00:49:30,659 --> 00:49:34,319
I'll read it out has there been any

1165
00:49:31,860 --> 00:49:36,660
fallout from the comet's tail into the

1166
00:49:34,320 --> 00:49:40,260
Mars atmosphere creating things like

1167
00:49:36,659 --> 00:49:41,579
Aurora and you but you said most of that

1168
00:49:40,260 --> 00:49:43,980
and not I don't think they've noticed

1169

00:49:41,579 --> 00:49:46,079
much going on right I know that they

1170
00:49:43,980 --> 00:49:48,449
were looking at ultraviolet to see if

1171
00:49:46,079 --> 00:49:51,329
there was Aurora on Mars now how can

1172
00:49:48,449 --> 00:49:53,609
there be Aurora if that is charged

1173
00:49:51,329 --> 00:49:56,309
particles in a magnetosphere and Mars

1174
00:49:53,610 --> 00:49:59,039
doesn't have one ah well simply

1175
00:49:56,309 --> 00:50:03,029
Augustine molecules streaming through an

1176
00:49:59,039 --> 00:50:05,820
atmosphere okay as they slow down will

1177
00:50:03,030 --> 00:50:07,500
give off a green glow okay okay sure

1178
00:50:05,820 --> 00:50:10,230
sure so it's not a magnetic phenomenon

1179
00:50:07,500 --> 00:50:12,389
it's a it's a particle hitting the

1180
00:50:10,230 --> 00:50:15,210
atmosphere kind of thought on earth that

1181
00:50:12,389 --> 00:50:16,920
it the magnetic field funnels those

1182
00:50:15,210 --> 00:50:19,409
particles towards North Pole and South

1183
00:50:16,920 --> 00:50:21,450

Poles right and that's why the Aurora

1184
00:50:19,409 --> 00:50:23,549
occurred the North and South Poles but

1185
00:50:21,449 --> 00:50:26,189
if those particles had hit anywhere on

1186
00:50:23,550 --> 00:50:28,050
her on ours on Earth's atmosphere they

1187
00:50:26,190 --> 00:50:31,019
would give off that glow but okay

1188
00:50:28,050 --> 00:50:32,610
they're concentrated right now cuz my

1189
00:50:31,019 --> 00:50:36,199
that was microphone oh that's why you

1190
00:50:32,610 --> 00:50:39,210
get this continued at this this Aurora

1191
00:50:36,199 --> 00:50:42,539
phenomenon there I haven't heard of any

1192
00:50:39,210 --> 00:50:46,220
Aurora stories yet yeah okay alright

1193
00:50:42,539 --> 00:50:50,309
cool and can we do a plug for tomorrow

1194
00:50:46,219 --> 00:50:51,929
we can you okay so so we're going to

1195
00:50:50,309 --> 00:50:54,599
follow up on this a little bit more guys

1196
00:50:51,929 --> 00:50:58,710
Hubble as Frank mentioned with uh with

1197
00:50:54,599 --> 00:51:01,979
the issues with Hubble earlier in the

1198
00:50:58,710 --> 00:51:03,929
week we it did observe siding spring

1199
00:51:01,978 --> 00:51:06,538
comet' siding spring over the weekend

1200
00:51:03,929 --> 00:51:08,788
and we we are hopefully going to have

1201
00:51:06,539 --> 00:51:10,140
those pictures out and release tomorrow

1202
00:51:08,789 --> 00:51:12,479
we're going to have a hangout on it

1203
00:51:10,139 --> 00:51:14,759
we're going to have John yang Lee as

1204
00:51:12,478 --> 00:51:16,710
well as Max Mutchler and result of the

1205
00:51:14,759 --> 00:51:18,088
soul of a and others and a hangout to

1206
00:51:16,710 --> 00:51:19,588
talk about this observation so that's

1207
00:51:18,088 --> 00:51:24,108
tomorrow at three we hope you will join

1208
00:51:19,588 --> 00:51:26,460
us as we talk more about this then okay

1209
00:51:24,108 --> 00:51:28,710
and while we're in the process of

1210
00:51:26,460 --> 00:51:31,588
advertising can I'll advertise the

1211
00:51:28,710 --> 00:51:33,659
upcoming public lectures we mentioned

1212
00:51:31,588 --> 00:51:37,170
them on our Google+ accounts as our

1213
00:51:33,659 --> 00:51:38,460
Facebook account but the Space Telescope

1214
00:51:37,170 --> 00:51:41,430
Science Institute has a public lecture

1215
00:51:38,460 --> 00:51:42,478
series that I run and next month we're

1216
00:51:41,429 --> 00:51:44,669
going to do it on the second tuesday

1217
00:51:42,478 --> 00:51:47,308
because election day is the first

1218
00:51:44,670 --> 00:51:50,309
tuesday so we're doing the second

1219
00:51:47,309 --> 00:51:52,589
tuesday and the topic is a telegram from

1220
00:51:50,309 --> 00:51:55,589
the early universe speakers mark a

1221
00:51:52,588 --> 00:51:59,009
Minkowski of Johns Hopkins mark is one

1222
00:51:55,588 --> 00:52:01,528
of the v-world experts on the Cosmic

1223
00:51:59,009 --> 00:52:03,028
Microwave Background I was a postdoc

1224
00:52:01,528 --> 00:52:06,539
with Mark kamionkowski epic Columbia

1225
00:52:03,028 --> 00:52:10,619
University Oh 15-20 years ago something

1226

00:52:06,539 --> 00:52:12,900
like that he's really great and he's

1227
00:52:10,619 --> 00:52:16,588
going to come talk to us and also about

1228
00:52:12,900 --> 00:52:20,190
the CMB polarization results that were

1229
00:52:16,588 --> 00:52:22,288
claimed to in as proof of income in the

1230
00:52:20,190 --> 00:52:24,028
inflationary epoch of the universe yeah

1231
00:52:22,289 --> 00:52:25,499
that was yeah that was big it was a big

1232
00:52:24,028 --> 00:52:29,009
deal early on and it was highly

1233
00:52:25,498 --> 00:52:30,209
contested and disputed and so this is

1234
00:52:29,009 --> 00:52:31,769
the guy who's gonna be able to tell you

1235
00:52:30,210 --> 00:52:33,989
the full deal on it okay you have

1236
00:52:31,768 --> 00:52:35,308
definitely worth going to I'm looked at

1237
00:52:33,989 --> 00:52:36,659
saying we there and of course we're

1238
00:52:35,309 --> 00:52:39,390
gonna record that and put that up on

1239
00:52:36,659 --> 00:52:41,429
YouTube up that yellow and I mean like

1240
00:52:39,389 --> 00:52:42,900

Frank and I also monitor the comments

1241
00:52:41,429 --> 00:52:44,578
during that too so if you guys want to

1242
00:52:42,900 --> 00:52:47,369
comment during that will be there and

1243
00:52:44,579 --> 00:52:49,440
then just an upcoming idea in December

1244
00:52:47,369 --> 00:52:50,969
Joshua peak said he was talking about

1245
00:52:49,440 --> 00:52:54,028
the interstellar medium but he didn't

1246
00:52:50,969 --> 00:52:56,608
give me a full title yet okay great just

1247
00:52:54,028 --> 00:52:59,608
other things all right okay finish by

1248
00:52:56,608 --> 00:53:03,268
putting up my contacts if you want to if

1249
00:52:59,608 --> 00:53:04,679
anybody wants to ask me questions or

1250
00:53:03,268 --> 00:53:07,699
other things here's what I do okay

1251
00:53:04,679 --> 00:53:10,250
awesome and hopefully so after the

1252
00:53:07,699 --> 00:53:12,169
next month's public lecture series in

1253
00:53:10,250 --> 00:53:14,480
the second week we will also be back

1254
00:53:12,170 --> 00:53:15,769
with news from Hubble and across the

1255
00:53:14,480 --> 00:53:18,588
universe so we'll have we'll be back

1256
00:53:15,769 --> 00:53:20,389
doing our thing then too here's a couple

1257
00:53:18,588 --> 00:53:21,650
of want to get to a few of these

1258
00:53:20,389 --> 00:53:23,389
questions because we're starting to

1259
00:53:21,650 --> 00:53:26,088
stack we've got a lot of them Hans mills

1260
00:53:23,389 --> 00:53:28,250
milling is asked asked early on I wanted

1261
00:53:26,088 --> 00:53:30,139
to answer this one I always wanted to

1262
00:53:28,250 --> 00:53:32,630
ask both of you if you have your own

1263
00:53:30,139 --> 00:53:34,759
backyard telescope you have a backyard

1264
00:53:32,630 --> 00:53:38,180
telescope Frank I do not I own

1265
00:53:34,760 --> 00:53:40,640
binoculars so I have never been an

1266
00:53:38,179 --> 00:53:41,809
observational astronomer people think

1267
00:53:40,639 --> 00:53:43,368
that you know if you grow up to me

1268
00:53:41,809 --> 00:53:44,509
astronomer you had a telescope and you

1269
00:53:43,369 --> 00:53:47,420
were kidding you really love looking the

1270
00:53:44,510 --> 00:53:48,950
stars I was really into Napa like some

1271
00:53:47,420 --> 00:53:51,349
problem-solving and puzzles and stuff

1272
00:53:48,949 --> 00:53:52,848
like that you had a trs-80 computer you

1273
00:53:51,349 --> 00:53:56,359
were running simulations on it you know

1274
00:53:52,849 --> 00:53:59,030
it yeah I was doing I was into computers

1275
00:53:56,358 --> 00:54:02,420
and they like I'm not interested on me

1276
00:53:59,030 --> 00:54:04,490
growing up it was as I got to advanced

1277
00:54:02,420 --> 00:54:06,079
math and the word problems the best word

1278
00:54:04,489 --> 00:54:07,939
problems were in physics and the best

1279
00:54:06,079 --> 00:54:10,579
physics problems weren't astronomy that

1280
00:54:07,940 --> 00:54:14,000
I ended up in astronomy but i do have

1281
00:54:10,579 --> 00:54:16,039
binoculars are fantastic for per se

1282
00:54:14,000 --> 00:54:17,900
surveying the night sky yeah i agree i

1283

00:54:16,039 --> 00:54:19,460
have a pair of those i have always been

1284
00:54:17,900 --> 00:54:20,930
an amateur astronomer I've always had

1285
00:54:19,460 --> 00:54:23,630
telescopes I started out with a

1286
00:54:20,929 --> 00:54:26,719
criterion 6-inch Newtonian reflector

1287
00:54:23,630 --> 00:54:31,039
which I have kept for many many years

1288
00:54:26,719 --> 00:54:34,279
and I've I might I speak with a lx200

1289
00:54:31,039 --> 00:54:36,800
go-to telescope in the 90s I sold that

1290
00:54:34,280 --> 00:54:40,160
and now really all I have is my Astro

1291
00:54:36,800 --> 00:54:41,900
scan two thousand and a hof a telescope

1292
00:54:40,159 --> 00:54:44,318
that I used to look at the solar disk

1293
00:54:41,900 --> 00:54:48,470
with and it's one of those up corona

1294
00:54:44,318 --> 00:54:51,829
Coronado PST's personal solar telescopes

1295
00:54:48,469 --> 00:54:53,838
are really nice h alpha used to be

1296
00:54:51,829 --> 00:54:55,849
expensive he used to cost four thousand

1297
00:54:53,838 --> 00:54:58,578

dollars to get an H off of filter now

1298

00:54:55,849 --> 00:55:01,910

one of those four five hundred dollars i

1299

00:54:58,579 --> 00:55:03,260

mean including the telescope so that's

1300

00:55:01,909 --> 00:55:05,449

what i currently have and i highly

1301

00:55:03,260 --> 00:55:07,760

recommend all of those telescopes and

1302

00:55:05,449 --> 00:55:11,078

course celestron i had a c8 in the 80s

1303

00:55:07,760 --> 00:55:13,940

which i sold because i needed money so

1304

00:55:11,079 --> 00:55:15,019

but I've had I've had a lot of I've had

1305

00:55:13,940 --> 00:55:16,550

a lot of tells while doing my

1306

00:55:15,019 --> 00:55:19,579

undergraduate at Virginia Tech I took

1307

00:55:16,550 --> 00:55:20,410

care of the c16 up at the Virginia Tech

1308

00:55:19,579 --> 00:55:23,589

observant

1309

00:55:20,409 --> 00:55:25,788

okay here's a good question from lyosha

1310

00:55:23,588 --> 00:55:28,519

shooting I think from the queue and I am

1311

00:55:25,789 --> 00:55:31,730

could Pluto's gravity be used to change

1312
00:55:28,519 --> 00:55:35,269
course like Voyager did with Saturn to

1313
00:55:31,730 --> 00:55:37,490
my new horizons the answer is no Pluto

1314
00:55:35,269 --> 00:55:42,889
doesn't have much of gravity the NASA

1315
00:55:37,489 --> 00:55:45,618
Pluto is point two percent of points or

1316
00:55:42,889 --> 00:55:47,808
0.02 percent of the mass of Earth it's

1317
00:55:45,619 --> 00:55:50,420
really it's it's significantly smaller

1318
00:55:47,809 --> 00:55:54,859
than our Moon smash okay so there's not

1319
00:55:50,420 --> 00:55:56,990
a ton of mass to play off of also New

1320
00:55:54,858 --> 00:56:00,469
Horizons is moving at a tremendous rate

1321
00:55:56,989 --> 00:56:03,439
it's covered three billion miles in 10

1322
00:56:00,469 --> 00:56:05,509
years I'm using miles hi billion

1323
00:56:03,440 --> 00:56:08,329
kilometers one of those people I can't

1324
00:56:05,510 --> 00:56:11,510
believe it well that's because for the

1325
00:56:08,329 --> 00:56:14,750
story had to do the three Billy you

1326
00:56:11,510 --> 00:56:16,970
people I don't know about you anyway um

1327
00:56:14,750 --> 00:56:19,039
since it's moving at such a tremendous

1328
00:56:16,969 --> 00:56:21,558
velocity and there's time only a tiny

1329
00:56:19,039 --> 00:56:23,599
bit of mass it will of course change the

1330
00:56:21,559 --> 00:56:25,940
orbit by a tiny tiny tiny tiny amount

1331
00:56:23,599 --> 00:56:29,720
but nothing like when Voyager went past

1332
00:56:25,940 --> 00:56:32,329
Jupiter Jupiter is 317 times the mass of

1333
00:56:29,719 --> 00:56:34,578
Earth so it has a lot of mass to change

1334
00:56:32,329 --> 00:56:36,099
the orbit awesome okay good question and

1335
00:56:34,579 --> 00:56:39,470
here's one directly for you Frank

1336
00:56:36,099 --> 00:56:41,660
Nicholas greater is asking will there be

1337
00:56:39,469 --> 00:56:45,139
another and we ask this question often

1338
00:56:41,659 --> 00:56:49,639
will there be another episode and if so

1339
00:56:45,139 --> 00:56:54,108
when Thank You Nicholas is going to our

1340

00:56:49,639 --> 00:56:58,009
meetings Nicholas yes it's been a while

1341
00:56:54,108 --> 00:57:00,469
and we got some new technology and such

1342
00:56:58,010 --> 00:57:02,960
and we tested out the new technology on

1343
00:57:00,469 --> 00:57:05,808
three videos that I did for educators so

1344
00:57:02,960 --> 00:57:08,690
everything's working we got what we need

1345
00:57:05,809 --> 00:57:11,000
to do it's just finding my time to do it

1346
00:57:08,690 --> 00:57:12,769
I can do these hangouts more easily

1347
00:57:11,000 --> 00:57:14,389
because I don't have to actually know

1348
00:57:12,769 --> 00:57:17,659
what I'm going to say if I stumble over

1349
00:57:14,389 --> 00:57:21,469
my words on a hangout it's okay i do

1350
00:57:17,659 --> 00:57:22,909
think Mike I appreciate that yeah you

1351
00:57:21,469 --> 00:57:24,618
would I keep me I'm advantage of that

1352
00:57:22,909 --> 00:57:26,838
yeah yeah I know I was just giving her

1353
00:57:24,619 --> 00:57:28,180
time okay good well thank you dickless

1354
00:57:26,838 --> 00:57:32,869

I'm glad you're giving him a hard time

1355

00:57:28,179 --> 00:57:33,929

okay we did we do to Lucien again as was

1356

00:57:32,869 --> 00:57:36,150

asking earlier when

1357

00:57:33,929 --> 00:57:38,190

companion star steals maths from a star

1358

00:57:36,150 --> 00:57:40,800

what would be the actual trigger for the

1359

00:57:38,190 --> 00:57:42,960

star to go Nova mass is taken away from

1360

00:57:40,800 --> 00:57:45,180

the so the pressure from the core gets

1361

00:57:42,960 --> 00:57:48,599

the chance to wreak havoc no longer

1362

00:57:45,179 --> 00:57:50,969

constrained by gravity okay so would

1363

00:57:48,599 --> 00:57:53,400

that be the actual trigger no all right

1364

00:57:50,969 --> 00:57:55,858

so really good question leo okay first

1365

00:57:53,400 --> 00:57:57,809

of all the what we're talking about is

1366

00:57:55,858 --> 00:58:00,719

really massive stars these are stars

1367

00:57:57,809 --> 00:58:02,790

greater than eight solar masses and the

1368

00:58:00,719 --> 00:58:05,308

supernova trigger is in the core and

1369
00:58:02,789 --> 00:58:07,500
what happens is hydrogen gets burned to

1370
00:58:05,309 --> 00:58:10,530
helium and when runs out of helium

1371
00:58:07,500 --> 00:58:12,539
helium gets burned to carbon and then to

1372
00:58:10,530 --> 00:58:14,970
nitrogen and then to oxygen and

1373
00:58:12,539 --> 00:58:18,058
magnesium and phosphorus and so on all

1374
00:58:14,969 --> 00:58:21,779
the way up to iron okay so you're you're

1375
00:58:18,059 --> 00:58:23,220
doing a nuclear fusion to build heavier

1376
00:58:21,780 --> 00:58:26,819
and heavier elements in the core and

1377
00:58:23,219 --> 00:58:29,699
when you get to iron you can't do a

1378
00:58:26,818 --> 00:58:33,750
fusion and create energy okay it's

1379
00:58:29,699 --> 00:58:36,568
endothermic not exothermic it brings in

1380
00:58:33,750 --> 00:58:38,909
energy rather than releasing energy so

1381
00:58:36,568 --> 00:58:40,858
when you get to iron you build up what's

1382
00:58:38,909 --> 00:58:43,649
called a Chandrasekhar mass of iron in

1383
00:58:40,858 --> 00:58:46,259
the core and that when you have that

1384
00:58:43,650 --> 00:58:49,639
much mass at that high density and

1385
00:58:46,260 --> 00:58:52,230
pressure the atomic structure collapses

1386
00:58:49,639 --> 00:58:54,118
protons and electrons combine to form

1387
00:58:52,230 --> 00:58:56,068
neutrons the whole thing goes into a

1388
00:58:54,119 --> 00:58:58,440
freefall collapse and then explodes

1389
00:58:56,068 --> 00:59:01,949
apart with by releasing this flood of

1390
00:58:58,440 --> 00:59:03,539
neutrinos okay that is relatively

1391
00:59:01,949 --> 00:59:05,548
independent of what's happening on the

1392
00:59:03,539 --> 00:59:07,259
outer layers because by this time the

1393
00:59:05,548 --> 00:59:09,568
Stars bloated and it's become the

1394
00:59:07,260 --> 00:59:11,480
supergiant star and you can steal

1395
00:59:09,568 --> 00:59:14,279
hydrogen from the outer layers and

1396
00:59:11,480 --> 00:59:17,490
deposited onto another star without

1397

00:59:14,280 --> 00:59:19,740
really affecting the nuclear catastrophe

1398
00:59:17,489 --> 00:59:21,029
that's going on in the core okay so

1399
00:59:19,739 --> 00:59:24,118
you've got this runaway nuclear

1400
00:59:21,030 --> 00:59:25,619
catastrophe going on the core and but

1401
00:59:24,119 --> 00:59:27,059
the outer layers are being pulled off

1402
00:59:25,619 --> 00:59:29,670
onto another star that doesn't really

1403
00:59:27,059 --> 00:59:31,440
affect it that much okay awesome thank

1404
00:59:29,670 --> 00:59:32,608
you Frank okay we're out of time but I'm

1405
00:59:31,440 --> 00:59:35,039
going to end it with this comment from

1406
00:59:32,608 --> 00:59:39,318
Michael jobin who says I think he should

1407
00:59:35,039 --> 00:59:41,699
record that song do not encourage him I

1408
00:59:39,318 --> 00:59:43,858
go all the rest of my life without

1409
00:59:41,699 --> 00:59:46,618
hearing that song again I bof be odd you

1410
00:59:43,858 --> 00:59:47,380
just all right guys well Islands stern

1411
00:59:46,619 --> 00:59:50,230

would appreciate it

1412

00:59:47,380 --> 00:59:52,630

how about that avoided me for kicking

1413

00:59:50,230 --> 00:59:53,829

Pluto at the Hayden Planetarium at least

1414

00:59:52,630 --> 00:59:57,068

I could get back in his good graces with

1415

00:59:53,829 --> 00:59:58,809

a song like that how about that oh by

1416

00:59:57,068 --> 01:00:00,389

the way Alan Stern is the principal

1417

00:59:58,809 --> 01:00:03,039

investigator of the New Horizons mission

1418

01:00:00,389 --> 01:00:04,328

okay so folks I guess that'll we're

1419

01:00:03,039 --> 01:00:06,250

going to if it's been an hour we're

1420

01:00:04,329 --> 01:00:07,480

going to stop there thank you Frank this

1421

01:00:06,250 --> 01:00:08,829

has been a lot of fun i love doing these

1422

01:00:07,480 --> 01:00:11,469

with you so it look forward to doing it

1423

01:00:08,829 --> 01:00:14,349

next month middle of some time around

1424

01:00:11,469 --> 01:00:16,209

middle of november about november 15th

1425

01:00:14,349 --> 01:00:18,309

the Ides of November okay sounds great

1426

01:00:16,210 --> 01:00:20,019

Todd all right that's it that's it

1427

01:00:18,309 --> 01:00:24,180

everybody thank you all for watching and

1428

01:00:20,018 --> 01:00:24,179

as always keep looking up