

1
00:00:01,500 --> 00:00:07,269
hello everybody welcome to our latest

2
00:00:03,968 --> 00:00:09,548
Hubble hangout and this is our monthly

3
00:00:07,269 --> 00:00:10,870
installment of news from Hubble and

4
00:00:09,548 --> 00:00:13,449
across the universe with doctor Frank

5
00:00:10,869 --> 00:00:15,419
summers so we are we had a really great

6
00:00:13,449 --> 00:00:17,949
hangout plan for you today so welcome

7
00:00:15,419 --> 00:00:20,530
nominally I have to apologize first off

8
00:00:17,949 --> 00:00:23,919
nominally we try to do these on a on a

9
00:00:20,530 --> 00:00:26,500
on the same time roughly after the the

10
00:00:23,920 --> 00:00:27,700
as soon as we can after the public

11
00:00:26,500 --> 00:00:29,379
lecture series is held on the first

12
00:00:27,699 --> 00:00:31,359
tuesday of each month but sometimes

13
00:00:29,379 --> 00:00:33,219
let's get in the way and we can't always

14
00:00:31,359 --> 00:00:35,049
do it exactly when we'd like so thank

15
00:00:33,219 --> 00:00:37,870
you for your patience we've pushed it

16
00:00:35,049 --> 00:00:40,718
back a little bit into the month of July

17
00:00:37,869 --> 00:00:42,159
but we're here and Frank is with us and

18
00:00:40,719 --> 00:00:44,259
I'm excited to talk about all this time

19
00:00:42,159 --> 00:00:45,459
I've seen is I've seen the outline of

20
00:00:44,259 --> 00:00:47,710
some of the things he's going to show us

21
00:00:45,460 --> 00:00:49,329
today so I'm very excited about this but

22
00:00:47,710 --> 00:00:51,609
before I get started with Frank let me

23
00:00:49,329 --> 00:00:53,399
remind you that we are monitoring that

24
00:00:51,609 --> 00:00:55,539
we are inviting and we hope you will

25
00:00:53,399 --> 00:00:57,629
communicate with us we're ask us

26
00:00:55,539 --> 00:01:00,129
questions leave us comments tweet at us

27
00:00:57,628 --> 00:01:03,518
in the following ways you've got the QA

28
00:01:00,128 --> 00:01:06,370
a pop on YouTube and G+ you can also

29

00:01:03,518 --> 00:01:08,799
tweet using the hashtag hubble hang out

30
00:01:06,370 --> 00:01:11,290
I finally did it without stuttering and

31
00:01:08,799 --> 00:01:13,539
we are also monitoring the comments on

32
00:01:11,290 --> 00:01:14,800
the Google+ event page so please let us

33
00:01:13,540 --> 00:01:16,359
know if you have any questions for

34
00:01:14,799 --> 00:01:19,689
Franco or I will be happy to talk about

35
00:01:16,359 --> 00:01:22,150
them and so without that any more ado

36
00:01:19,689 --> 00:01:24,489
let's go ahead and get started Frank

37
00:01:22,150 --> 00:01:25,990
summers the he is the outreach

38
00:01:24,489 --> 00:01:27,280
astronomer for the hubble space

39
00:01:25,989 --> 00:01:30,369
telescope in space telescope science

40
00:01:27,280 --> 00:01:32,739
institute and he every month joins he

41
00:01:30,370 --> 00:01:33,939
gets together with us to talk about some

42
00:01:32,739 --> 00:01:36,849
of the greatest things that not only

43
00:01:33,939 --> 00:01:38,859

helpful is doing but also great science

44
00:01:36,849 --> 00:01:40,899
across the universe so welcome Frank how

45
00:01:38,859 --> 00:01:44,109
are you doing hey chunyu good to be with

46
00:01:40,900 --> 00:01:46,510
you this month we did we miss did we

47
00:01:44,109 --> 00:01:51,129
miss June we miss June I just checked it

48
00:01:46,510 --> 00:01:53,230
i checked my my my talk listings and i

49
00:01:51,129 --> 00:01:54,789
was like oh we miss june because i was

50
00:01:53,230 --> 00:01:58,150
at the double-a s remember in june

51
00:01:54,790 --> 00:01:59,920
that's right alright and then the reason

52
00:01:58,150 --> 00:02:03,160
why this is late is because every summer

53
00:01:59,920 --> 00:02:04,570
i do a ton of teacher workshops we have

54
00:02:03,159 --> 00:02:06,939
a partnership with penn state university

55
00:02:04,569 --> 00:02:10,090
where we teach hundreds of teachers in

56
00:02:06,939 --> 00:02:13,370
the first part of the summer so i have a

57
00:02:10,090 --> 00:02:16,549
lot of talks to prepare and give and

58
00:02:13,370 --> 00:02:20,269
was unable to prep this for June and

59
00:02:16,549 --> 00:02:21,739
even last week I just got swamped by

60
00:02:20,269 --> 00:02:24,379
things and ones had to push it back a

61
00:02:21,739 --> 00:02:26,689
week but I'm here I got some fun stuff

62
00:02:24,378 --> 00:02:28,370
to talk about I actually I think I went

63
00:02:26,689 --> 00:02:30,949
a little overboard today tony is because

64
00:02:28,370 --> 00:02:32,569
i have another for two months now okay

65
00:02:30,949 --> 00:02:33,859
well before we get you started now that

66
00:02:32,568 --> 00:02:35,419
you were talking about the teacher stuff

67
00:02:33,860 --> 00:02:37,760
i just want to ask you real quick before

68
00:02:35,419 --> 00:02:39,589
we get going on what you prepared when

69
00:02:37,759 --> 00:02:41,689
you do a lot of work for teachers and

70
00:02:39,590 --> 00:02:43,189
educators up for the educate for the

71
00:02:41,689 --> 00:02:44,539
teachers who might be watching this is

72
00:02:43,189 --> 00:02:47,049
there a way in which they can get

73
00:02:44,539 --> 00:02:49,400
involved in what you're doing in those

74
00:02:47,049 --> 00:02:51,200
presentations or you know do we have

75
00:02:49,400 --> 00:02:53,269
resources we could point them to at some

76
00:02:51,199 --> 00:02:54,530
point well this is something that i

77
00:02:53,269 --> 00:02:56,450
think we need to develop a little bit

78
00:02:54,530 --> 00:02:59,900
better we have of course our amazing

79
00:02:56,449 --> 00:03:03,500
space website amazing hyphen space stsci

80
00:02:59,900 --> 00:03:06,709
edu and that is a tremendous educational

81
00:03:03,500 --> 00:03:08,870
resource people from all 50 states use

82
00:03:06,709 --> 00:03:10,870
it it's used by lots and lots of

83
00:03:08,870 --> 00:03:14,000
teachers and students around the country

84
00:03:10,870 --> 00:03:16,879
however the workshops that we do we

85
00:03:14,000 --> 00:03:21,139
generally do in partnership with various

86

00:03:16,878 --> 00:03:23,030
universities or schools or groups that

87
00:03:21,139 --> 00:03:25,549
can we can provide we can work with

88
00:03:23,030 --> 00:03:27,680
teachers over and over again and because

89
00:03:25,549 --> 00:03:29,750
we've already set up things that are

90
00:03:27,680 --> 00:03:31,549
better preview arranged right because

91
00:03:29,750 --> 00:03:34,729
the most important thing for us to do is

92
00:03:31,549 --> 00:03:36,319
to create our materials and try them out

93
00:03:34,729 --> 00:03:39,578
with select groups of teachers and

94
00:03:36,318 --> 00:03:41,839
students and then get feedback on

95
00:03:39,579 --> 00:03:43,909
whether they worked or how well they

96
00:03:41,840 --> 00:03:45,199
worked you know because if i go to if i

97
00:03:43,909 --> 00:03:46,489
do a teacher workshop and i tell

98
00:03:45,199 --> 00:03:47,810
teachers hey here's this really cool

99
00:03:46,489 --> 00:03:49,699
thing you can do in your classroom and

100
00:03:47,810 --> 00:03:51,259

then they get back to the classroom and

101

00:03:49,699 --> 00:03:53,150

say well it doesn't really quite work

102

00:03:51,259 --> 00:03:54,948

that way that's what gives us the

103

00:03:53,150 --> 00:03:57,889

feedback to help us help make sure it

104

00:03:54,949 --> 00:04:00,410

works now a lot of our old projects are

105

00:03:57,889 --> 00:04:02,599

being used in all 50 states we're

106

00:04:00,409 --> 00:04:05,650

actually recommended by something like

107

00:04:02,598 --> 00:04:07,878

25 or 30 State Department of Education

108

00:04:05,650 --> 00:04:09,709

right the Department of Education

109

00:04:07,878 --> 00:04:13,189

innings in these states are specifying

110

00:04:09,709 --> 00:04:14,780

here this is material you should use so

111

00:04:13,189 --> 00:04:17,149

we know some of our material is being

112

00:04:14,780 --> 00:04:18,709

used an awful lot and we're constantly

113

00:04:17,149 --> 00:04:20,448

creating some new stuff we have actually

114

00:04:18,709 --> 00:04:23,629

a lot of fun with some gravitational

115
00:04:20,449 --> 00:04:25,038
lensing stuff this summer good so if

116
00:04:23,629 --> 00:04:27,089
you're a teacher watching this and you

117
00:04:25,038 --> 00:04:29,699
need some resources amazing that hyphens

118
00:04:27,089 --> 00:04:32,250
a start Hubble cyborg is the place to go

119
00:04:29,699 --> 00:04:35,160
and as DCI that eating out sorry I

120
00:04:32,250 --> 00:04:37,350
apologize up ssed you and look around

121
00:04:35,160 --> 00:04:40,080
for there and also i will just plug a

122
00:04:37,350 --> 00:04:42,419
brief preview there we are talking about

123
00:04:40,079 --> 00:04:44,698
and perhaps doing hangouts in a

124
00:04:42,418 --> 00:04:46,560
classroom with Frank and Bonnie when

125
00:04:44,699 --> 00:04:47,879
maybe we're working on it so hopefully

126
00:04:46,560 --> 00:04:49,978
that might be something that comes in

127
00:04:47,879 --> 00:04:52,290
our future as well so right lots of

128
00:04:49,978 --> 00:04:55,889
educational materials available right

129
00:04:52,290 --> 00:04:58,110
and we will we will hope to be able to

130
00:04:55,889 --> 00:04:59,970
do educational hangouts develop a list

131
00:04:58,110 --> 00:05:02,639
of teachers who want to participate in

132
00:04:59,970 --> 00:05:04,650
hangouts like this and start doing

133
00:05:02,639 --> 00:05:06,689
hangouts especially as the Hubble's 25th

134
00:05:04,649 --> 00:05:08,279
anniversary comes up next year we want

135
00:05:06,689 --> 00:05:11,189
to try and do some you know how old

136
00:05:08,279 --> 00:05:14,219
teachings or something via hangouts or

137
00:05:11,189 --> 00:05:15,269
such great ok thanks Frank I wanted it

138
00:05:14,220 --> 00:05:16,560
just popped into my mind when you were

139
00:05:15,269 --> 00:05:17,789
talking about educational materials I

140
00:05:16,560 --> 00:05:19,800
wanted to just what I'd get the word out

141
00:05:17,790 --> 00:05:21,270
that we do have quite a bit available

142
00:05:19,800 --> 00:05:23,939
for teachers ok so what do you have for

143

00:05:21,269 --> 00:05:26,339
us this month ok so if we switch to the

144
00:05:23,939 --> 00:05:30,209
PowerPoint it's news from Hubble and

145
00:05:26,339 --> 00:05:32,788
across the universe and up until this

146
00:05:30,209 --> 00:05:34,589
afternoon it was going to be only just

147
00:05:32,788 --> 00:05:36,389
across the solar system but then I

148
00:05:34,589 --> 00:05:39,329
realized oh wait a minute I hadn't there

149
00:05:36,389 --> 00:05:43,110
was a toss to story I had missed so our

150
00:05:39,329 --> 00:05:47,069
first story tonight c-spot watch Spot

151
00:05:43,110 --> 00:05:49,288
shrink shrink Spot shrink see talk about

152
00:05:47,069 --> 00:05:51,209
education materials yes we can do

153
00:05:49,288 --> 00:05:52,860
educational materials now Tony you have

154
00:05:51,209 --> 00:05:56,339
to recognize of course we have a large

155
00:05:52,860 --> 00:05:59,870
international contingent and they won't

156
00:05:56,339 --> 00:06:02,699
get the joke what this is a book that

157
00:05:59,870 --> 00:06:04,168

people of mine I guess our generation

158

00:06:02,699 --> 00:06:05,430

Frank you actually both for our

159

00:06:04,168 --> 00:06:07,288

generation because these started being

160

00:06:05,430 --> 00:06:09,840

coming out in nineteen thirty I found

161

00:06:07,288 --> 00:06:13,709

out today but research this I feel old

162

00:06:09,839 --> 00:06:17,129

okay from the 30s through the 60s into

163

00:06:13,709 --> 00:06:19,228

the 70s fun with Dick and Jane by two

164

00:06:17,129 --> 00:06:22,348

authors gray and sharp did these things

165

00:06:19,228 --> 00:06:24,779

and you can see in this this picture

166

00:06:22,348 --> 00:06:26,430

from the book they have a dog named spot

167

00:06:24,779 --> 00:06:28,769

and they do all these you know basic

168

00:06:26,430 --> 00:06:31,410

easy reading stuff and you know spots a

169

00:06:28,769 --> 00:06:34,589

good dog right but i'm not sure spots a

170

00:06:31,410 --> 00:06:37,560

great spot I mean really what a great

171

00:06:34,589 --> 00:06:40,579

spot okay you need to go to astronomy

172
00:06:37,560 --> 00:06:44,100
and of course to the planet Jupiter

173
00:06:40,579 --> 00:06:46,560
okay is the Great Red Spot on Jupiter

174
00:06:44,100 --> 00:06:48,870
actually right below it is a white oval

175
00:06:46,560 --> 00:06:51,420
that's actually pretty good too but the

176
00:06:48,870 --> 00:06:55,019
Great Red Spot on Jupiter is an amazing

177
00:06:51,420 --> 00:06:57,420
storm that is just well how great is it

178
00:06:55,019 --> 00:07:01,589
well if i switch to the next slide

179
00:06:57,420 --> 00:07:05,160
there's earth to the same scale this is

180
00:07:01,589 --> 00:07:09,269
a storm that is the same size as our

181
00:07:05,160 --> 00:07:12,360
entire planet okay I mean they got a

182
00:07:09,269 --> 00:07:16,049
giant storms on Jupiter and not only

183
00:07:12,360 --> 00:07:18,389
that it's a long-lived storm okay this

184
00:07:16,050 --> 00:07:21,480
is an Assad I think it's technically an

185
00:07:18,389 --> 00:07:23,339
anticyclone because the way it rotates

186
00:07:21,480 --> 00:07:25,770
this is a giant storm that has been

187
00:07:23,339 --> 00:07:27,750
there for many years we have

188
00:07:25,769 --> 00:07:31,259
observations back to the eight late

189
00:07:27,750 --> 00:07:34,649
1800s here is an image from elder in

190
00:07:31,259 --> 00:07:37,769
1881 where you see that Great Red Spot

191
00:07:34,649 --> 00:07:40,739
we have continuous observations for at

192
00:07:37,769 --> 00:07:43,469
least a hundred and fifty years of this

193
00:07:40,740 --> 00:07:47,100
Great Red Spot on Jupiter but that's not

194
00:07:43,470 --> 00:07:50,340
it that's not all we actually have this

195
00:07:47,100 --> 00:07:54,390
image this next image here from Giovanni

196
00:07:50,339 --> 00:07:56,939
Cassini in 1677 I had to go to the

197
00:07:54,389 --> 00:07:59,339
French National Library the bibliothèque

198
00:07:56,939 --> 00:08:01,620
nationale de France and they had

199
00:07:59,339 --> 00:08:05,299
digitized their archives and the journal

200

00:08:01,620 --> 00:08:09,509
de Sava in 1677 published this image of

201
00:08:05,300 --> 00:08:10,800
Jupiter by Cassini and that looks a lot

202
00:08:09,509 --> 00:08:13,170
like the red spot to me I don't know

203
00:08:10,800 --> 00:08:15,600
what you think but yeah yeah yeah it

204
00:08:13,170 --> 00:08:17,129
looks very neatly on top of it sitting

205
00:08:15,600 --> 00:08:20,100
neatly on top of that band but yes I

206
00:08:17,129 --> 00:08:22,019
read by the same planet so we don't have

207
00:08:20,100 --> 00:08:24,530
continuous operations but it might be

208
00:08:22,019 --> 00:08:27,779
that this is a storm that has lasted for

209
00:08:24,529 --> 00:08:30,389
350 years and of course Hubble has

210
00:08:27,779 --> 00:08:33,740
observed it Hubble has been up for 24

211
00:08:30,389 --> 00:08:37,049
years now and this is a Hubble heritage

212
00:08:33,740 --> 00:08:38,250
image of Jupiter's Great Red several

213
00:08:37,049 --> 00:08:40,799
several images of Jupiter's Great Red

214
00:08:38,250 --> 00:08:42,779

Spot over the 1990s okay this actually

215

00:08:40,799 --> 00:08:44,729

doesn't even include the the 2000s in

216

00:08:42,779 --> 00:08:47,970

here this is just Hubble's first ten

217

00:08:44,730 --> 00:08:50,639

years of observing the red spot and if

218

00:08:47,970 --> 00:08:52,170

you look at those images in detail you

219

00:08:50,639 --> 00:08:53,710

can see that the red spot is pretty

220

00:08:52,169 --> 00:08:56,620

constant it stay

221

00:08:53,710 --> 00:08:58,780

is roughly the same all right and so you

222

00:08:56,620 --> 00:09:01,360

know we've used to having the Great Red

223

00:08:58,779 --> 00:09:05,980

Spot around and being able to look at it

224

00:09:01,360 --> 00:09:08,620

and watch it continuously however the

225

00:09:05,980 --> 00:09:10,509

Red Spot has been slowly shrinking okay

226

00:09:08,620 --> 00:09:11,799

it has been shrinking over the decades

227

00:09:10,509 --> 00:09:14,710

when you compared to the other old

228

00:09:11,799 --> 00:09:18,490

observations right and even over

229
00:09:14,710 --> 00:09:21,700
Hubble's era it has been shrinking but

230
00:09:18,490 --> 00:09:24,250
that shrinking accelerated around the

231
00:09:21,700 --> 00:09:26,830
year two thousand nine or so so this

232
00:09:24,250 --> 00:09:31,840
image here has the Great Red Spot on the

233
00:09:26,830 --> 00:09:33,730
left as seen in april 2014 as well as

234
00:09:31,840 --> 00:09:38,080
these three images on the right that

235
00:09:33,730 --> 00:09:41,440
show the 1995 2009 and 2014 images all

236
00:09:38,080 --> 00:09:43,870
calibrated to be at the same scale and

237
00:09:41,440 --> 00:09:45,400
you can definitely see that it's you

238
00:09:43,870 --> 00:09:47,830
know it's got twenty thirty percent of

239
00:09:45,399 --> 00:09:51,549
it of its size seems to have gone away

240
00:09:47,830 --> 00:09:53,700
and that's really interesting okay

241
00:09:51,549 --> 00:09:56,409
because this has been around for so long

242
00:09:53,700 --> 00:09:58,900
and it seems like it's a relatively

243
00:09:56,409 --> 00:10:01,419
constant feature but the size of it

244
00:09:58,899 --> 00:10:04,329
isn't constant and I wanted to include

245
00:10:01,419 --> 00:10:06,819
this next image here and my thanks go

246
00:10:04,330 --> 00:10:09,910
out to a guy named Astro Bob because he

247
00:10:06,820 --> 00:10:16,000
found these two images one is from a

248
00:10:09,909 --> 00:10:19,449
book 1879 from clerk and it's a very

249
00:10:16,000 --> 00:10:22,450
very fuzzy image of the odor that's the

250
00:10:19,450 --> 00:10:24,520
photo Oh God 2408 1879 you couldn't do

251
00:10:22,450 --> 00:10:27,390
very good photos remember yeah because

252
00:10:24,519 --> 00:10:30,490
photography came about the 1850s 1860s

253
00:10:27,389 --> 00:10:32,350
and so this is pretty darn impressive

254
00:10:30,490 --> 00:10:35,470
though with those slow cameras and those

255
00:10:32,350 --> 00:10:38,379
glass plates and yeah and you can see

256
00:10:35,470 --> 00:10:41,590
that yellow it's fuzzy you can see that

257

00:10:38,379 --> 00:10:44,019
there is a big large blob there that's

258
00:10:41,590 --> 00:10:46,389
much much larger than a same size image

259
00:10:44,019 --> 00:10:49,319
from this year this is an image from

260
00:10:46,389 --> 00:10:51,250
Damien peach one of the great amateur

261
00:10:49,320 --> 00:10:53,440
astrophotographers he's in England I

262
00:10:51,250 --> 00:10:57,820
believe so you can see the amazing

263
00:10:53,440 --> 00:10:59,530
change in the Great Red Spot the kind of

264
00:10:57,820 --> 00:11:02,350
worrisome thing is is we don't actually

265
00:10:59,529 --> 00:11:06,129
know why the size of the red spot is

266
00:11:02,350 --> 00:11:07,570
changing and when we if you read our

267
00:11:06,129 --> 00:11:10,360
press release we talk about

268
00:11:07,570 --> 00:11:11,890
we say well you know it we know that

269
00:11:10,360 --> 00:11:14,110
this trend is happening but we don't

270
00:11:11,889 --> 00:11:15,639
have a really good reason for it but I

271
00:11:14,110 --> 00:11:18,610

wanted to throw out one thing for

272

00:11:15,639 --> 00:11:22,090
everybody just to think about it this is

273

00:11:18,610 --> 00:11:23,950
an infrared view of mo brat I love that

274

00:11:22,090 --> 00:11:26,350
this is this all right now this is a

275

00:11:23,950 --> 00:11:28,120
ground-based observation Tony okay this

276

00:11:26,350 --> 00:11:31,000
is from the Gemini telescope using

277

00:11:28,120 --> 00:11:33,669
adaptive optics okay and also probably

278

00:11:31,000 --> 00:11:36,159
also some sharpening masks applied in

279

00:11:33,669 --> 00:11:38,469
the processing of the image but isn't it

280

00:11:36,159 --> 00:11:40,600
cool of the Damned in topics are you

281

00:11:38,470 --> 00:11:42,250
know red yeah and so let's talk about

282

00:11:40,600 --> 00:11:45,700
adaptive optics for just a little bit

283

00:11:42,250 --> 00:11:47,379
okay sure way of ground is its unique to

284

00:11:45,700 --> 00:11:49,650
ground-based telescopes as we all know

285

00:11:47,379 --> 00:11:52,480
what the atmosphere causes things to

286
00:11:49,649 --> 00:11:54,549
twinkle and and you know we were looking

287
00:11:52,480 --> 00:11:56,289
through this giant boiling atmosphere

288
00:11:54,549 --> 00:11:59,169
essentially at these magnifications and

289
00:11:56,289 --> 00:11:59,919
so what a ground-based telescopes try to

290
00:11:59,169 --> 00:12:02,289
do is they have these really

291
00:11:59,919 --> 00:12:05,379
sophisticated optical arrangements where

292
00:12:02,289 --> 00:12:07,329
they compensate for that and they cancel

293
00:12:05,379 --> 00:12:10,450
out whatever distortions maybe in the

294
00:12:07,330 --> 00:12:11,950
atmosphere so all right the guidestar

295
00:12:10,450 --> 00:12:13,450
like a laser or something to kind of

296
00:12:11,950 --> 00:12:14,860
give them an idea what the wave front is

297
00:12:13,450 --> 00:12:16,810
and then by the time the photons get

298
00:12:14,860 --> 00:12:19,060
there they're able to actually correct

299
00:12:16,809 --> 00:12:21,519
the telescope renders that they're like

300
00:12:19,059 --> 00:12:24,519
measuring the atmospheric distortion 60

301
00:12:21,519 --> 00:12:27,789
to 120 times a second okay and then we

302
00:12:24,519 --> 00:12:29,740
can apply those those strikes this is to

303
00:12:27,789 --> 00:12:32,139
of usually have a primary mirror and a

304
00:12:29,740 --> 00:12:34,480
secondary mirror well the AO puts in a

305
00:12:32,139 --> 00:12:36,610
third mirror a tertiary mirror that

306
00:12:34,480 --> 00:12:39,789
actually is deformable and they can

307
00:12:36,610 --> 00:12:42,330
deform that mirror in real time by

308
00:12:39,789 --> 00:12:45,129
measuring that laser guide star or a

309
00:12:42,330 --> 00:12:47,440
thing so that they can measure the

310
00:12:45,129 --> 00:12:50,379
distortion the atmosphere re correct for

311
00:12:47,440 --> 00:12:52,690
it and are able to do it really well in

312
00:12:50,379 --> 00:12:54,490
the infrared now unfortunately adaptive

313
00:12:52,690 --> 00:12:57,070
optics hasn't gotten down to being able

314

00:12:54,490 --> 00:12:58,750
to use visible light I think one

315
00:12:57,070 --> 00:13:00,190
prediction I saw said that will be able

316
00:12:58,750 --> 00:13:03,730
to do adaptive optics in visible light

317
00:13:00,190 --> 00:13:06,310
maybe by 2020 will get will get down to

318
00:13:03,730 --> 00:13:08,560
the red end but it's very hard because

319
00:13:06,309 --> 00:13:11,469
its wavelength dependent right yeah

320
00:13:08,559 --> 00:13:12,849
right you've got you know yes so I just

321
00:13:11,470 --> 00:13:14,860
wanted to point out that Hubble doesn't

322
00:13:12,850 --> 00:13:16,960
have to worry about this novel does not

323
00:13:14,860 --> 00:13:19,149
doesn't need it but it but ground-based

324
00:13:16,960 --> 00:13:19,950
observatories do okay but anyway so this

325
00:13:19,149 --> 00:13:21,449
is a really

326
00:13:19,950 --> 00:13:23,850
cool ground-based image from Gemini

327
00:13:21,450 --> 00:13:26,700
using adaptive optics that looks in the

328
00:13:23,850 --> 00:13:28,860

infrared and the fact that it's really

329

00:13:26,700 --> 00:13:32,400

clear isn't the most important point but

330

00:13:28,860 --> 00:13:35,159

what is really bright in this image well

331

00:13:32,399 --> 00:13:37,279

it's the Great Red Spot and actually Red

332

00:13:35,159 --> 00:13:41,039

Spot junior which is just below it yeah

333

00:13:37,279 --> 00:13:43,860

folks remember Red Spot jr. is the first

334

00:13:41,039 --> 00:13:46,409

red spot we've ever seen form it formed

335

00:13:43,860 --> 00:13:49,019

in two thousand and three out of three

336

00:13:46,409 --> 00:13:51,899

white ovals three white ovals merged

337

00:13:49,019 --> 00:13:54,000

over like four or five years and then

338

00:13:51,899 --> 00:13:56,699

formed another red spot the first time

339

00:13:54,000 --> 00:13:57,929

we'd ever seen a red spot form but what

340

00:13:56,700 --> 00:14:00,870

you can see in this image is that

341

00:13:57,929 --> 00:14:04,379

there's a lot of infrared energy coming

342

00:14:00,870 --> 00:14:07,799

out of both a great red spot and red

343
00:14:04,379 --> 00:14:12,000
spot jr. so these are actually regions

344
00:14:07,799 --> 00:14:14,849
where energy is escaping from Jupiter so

345
00:14:12,000 --> 00:14:18,000
the perhaps the idea that red spot is

346
00:14:14,850 --> 00:14:19,649
shrinking indicate some sort of energy

347
00:14:18,000 --> 00:14:21,710
change in how the energy is being

348
00:14:19,649 --> 00:14:24,449
released from the interior of Jupiter

349
00:14:21,710 --> 00:14:26,519
Jupiter actually gives off more infrared

350
00:14:24,450 --> 00:14:29,070
energy then it gets invisible light

351
00:14:26,519 --> 00:14:30,720
energy from the Sun so jus / is actually

352
00:14:29,070 --> 00:14:33,830
slow still slowly cooling four and a

353
00:14:30,720 --> 00:14:36,269
half billion years after it formed so

354
00:14:33,830 --> 00:14:38,220
that's about the only thing I can give

355
00:14:36,269 --> 00:14:40,379
you so there must be some sort of energy

356
00:14:38,220 --> 00:14:42,210
balance that's changing within the

357
00:14:40,379 --> 00:14:44,879
interior of Jupiter and that's changing

358
00:14:42,210 --> 00:14:46,230
on decades long timescales so that's

359
00:14:44,879 --> 00:14:48,990
kind of that's kind of cool that's much

360
00:14:46,230 --> 00:14:50,670
my one bit of intuition i can say into

361
00:14:48,990 --> 00:14:53,100
saying oh here's what a physicist thinks

362
00:14:50,669 --> 00:14:56,159
you know might be happening even though

363
00:14:53,100 --> 00:14:58,259
the truth is we don't actually know so

364
00:14:56,159 --> 00:15:00,569
yeah and i would just point out that you

365
00:14:58,259 --> 00:15:03,179
know these we had a hangout on this this

366
00:15:00,570 --> 00:15:05,160
this topic Oh a few weeks ago and they

367
00:15:03,179 --> 00:15:07,559
were one of the surprising things came

368
00:15:05,159 --> 00:15:09,329
out of it was that there really isn't a

369
00:15:07,559 --> 00:15:11,399
lot known about the dynamics of these

370
00:15:09,330 --> 00:15:13,440
spots and what exactly is making them

371

00:15:11,399 --> 00:15:14,879
caught rotate in the first place so to

372
00:15:13,440 --> 00:15:18,150
be able to answer the question why is

373
00:15:14,879 --> 00:15:18,990
this ranking is even harder because we

374
00:15:18,149 --> 00:15:20,879
don't even know why it's there in the

375
00:15:18,990 --> 00:15:22,080
first place so at least there's not a

376
00:15:20,879 --> 00:15:23,669
lot of good explanations for why it's

377
00:15:22,080 --> 00:15:24,840
there in the first place in this image

378
00:15:23,669 --> 00:15:29,339
Frank do you know what's going on at the

379
00:15:24,840 --> 00:15:30,720
poles there I assume that's just that

380
00:15:29,340 --> 00:15:33,930
would be limb brightening as you're

381
00:15:30,720 --> 00:15:36,210
looking through I think I'm thicker

382
00:15:33,929 --> 00:15:37,620
to the atmosphere and such okay all

383
00:15:36,210 --> 00:15:39,778
right I was right and there's also a

384
00:15:37,620 --> 00:15:43,230
little miss registration if you notice

385
00:15:39,778 --> 00:15:44,700

because they'll take one image in 11

386

00:15:43,230 --> 00:15:46,740

band-pass and other image in another

387

00:15:44,700 --> 00:15:49,350

band pass and Jupiter rotates in 10

388

00:15:46,740 --> 00:15:51,089

hours I'm sure you take an image for

389

00:15:49,350 --> 00:15:54,269

that one point and take another image

390

00:15:51,089 --> 00:15:55,800

you know half an hour or later juba will

391

00:15:54,269 --> 00:15:58,319

rotate it a little bit so there's always

392

00:15:55,799 --> 00:16:00,929

a slight miss registration of the cut

393

00:15:58,320 --> 00:16:02,640

the colors with Jupiter cool okay all

394

00:16:00,929 --> 00:16:06,689

right let's move on to our second story

395

00:16:02,639 --> 00:16:13,110

all right the HUD f version for like

396

00:16:06,690 --> 00:16:16,250

that Oh with Oh violet blue yeah I I

397

00:16:13,110 --> 00:16:18,690

have fun with this one because of all

398

00:16:16,250 --> 00:16:19,889

these are amazing images okay let's

399

00:16:18,690 --> 00:16:23,399

let's go all the way back to the

400
00:16:19,889 --> 00:16:27,088
beginning okay yay yay the great Hubble

401
00:16:23,399 --> 00:16:30,028
Deep Field 1996 and I was at the

402
00:16:27,089 --> 00:16:33,839
double-a s meeting in i think it was

403
00:16:30,028 --> 00:16:35,669
austin texas when they released this one

404
00:16:33,839 --> 00:16:37,620
no San Antonio Texas when we released

405
00:16:35,669 --> 00:16:39,689
this and it was just jaw-dropping

406
00:16:37,620 --> 00:16:42,299
because we had never seen anything like

407
00:16:39,690 --> 00:16:44,459
this at the time okay deepest image

408
00:16:42,299 --> 00:16:46,620
visible item into the universe seeing

409
00:16:44,458 --> 00:16:49,079
more galaxies in that tinier galaxies

410
00:16:46,620 --> 00:16:51,269
and we didn't actually expect that such

411
00:16:49,080 --> 00:16:55,379
tiny galaxies would actually be visible

412
00:16:51,269 --> 00:16:57,778
with Hubble it was a unknown at the time

413
00:16:55,379 --> 00:16:59,159
so that was really clear list i wanted i

414
00:16:57,778 --> 00:17:02,070
want to press you on this for a minute

415
00:16:59,159 --> 00:17:03,778
because I've always told people that it

416
00:17:02,070 --> 00:17:06,058
was kind of risky taking this first

417
00:17:03,778 --> 00:17:07,709
picture because you know Hubble time is

418
00:17:06,058 --> 00:17:09,660
expensive people wanted to point it at

419
00:17:07,709 --> 00:17:11,220
nothing was it really what was it was

420
00:17:09,660 --> 00:17:13,230
there any controversy about that and

421
00:17:11,220 --> 00:17:15,539
where there really any apprehensions

422
00:17:13,230 --> 00:17:18,420
about it returning up just a blank

423
00:17:15,539 --> 00:17:20,159
nothing well alright we knew it would

424
00:17:18,420 --> 00:17:22,890
return a few hundred galaxies right

425
00:17:20,160 --> 00:17:24,209
because there are the galaxies to a

426
00:17:22,890 --> 00:17:27,509
certain distance in the universe are

427
00:17:24,209 --> 00:17:29,370
certain of certain of size but the main

428

00:17:27,509 --> 00:17:32,900
question because you're looking out into

429
00:17:29,369 --> 00:17:36,000
space and also looking back into time is

430
00:17:32,900 --> 00:17:38,970
how do galaxies develop how quickly do

431
00:17:36,000 --> 00:17:41,579
they develop if you looked 8 billion

432
00:17:38,970 --> 00:17:43,440
light years into the into the past with

433
00:17:41,579 --> 00:17:46,470
their actually be galaxies of enough

434
00:17:43,440 --> 00:17:47,370
size that you Hubble could see them know

435
00:17:46,470 --> 00:17:49,529
Iraq then

436
00:17:47,369 --> 00:17:51,659
too dim to fame we didn't know that we

437
00:17:49,529 --> 00:17:54,299
didn't know back then whether they be

438
00:17:51,660 --> 00:17:56,970
too small to faint it's we had

439
00:17:54,299 --> 00:18:00,779
relatively poor understanding of the

440
00:17:56,970 --> 00:18:02,279
formation of galaxies so that the as you

441
00:18:00,779 --> 00:18:03,509
go out into space it's not just that

442
00:18:02,279 --> 00:18:05,399

fact that they're getting smaller

443

00:18:03,509 --> 00:18:07,500

actually after a certain redshift they

444

00:18:05,400 --> 00:18:10,740

stop getting smaller due to the warping

445

00:18:07,500 --> 00:18:14,069

do the cosmo cosmo cosmology and and the

446

00:18:10,740 --> 00:18:16,769

expansion of the universe but as you go

447

00:18:14,069 --> 00:18:18,839

further out Howard did they develop how

448

00:18:16,769 --> 00:18:21,720

big to the how big did they get and how

449

00:18:18,839 --> 00:18:24,419

quickly and a lot of the hypotheses

450

00:18:21,720 --> 00:18:26,819

based upon our computer models at the

451

00:18:24,420 --> 00:18:28,769

time said you know they're gonna they

452

00:18:26,819 --> 00:18:30,359

are going to be bright enough there can

453

00:18:28,769 --> 00:18:32,730

be too small and too faint and you won't

454

00:18:30,359 --> 00:18:35,299

see them and Bob Williams you know sort

455

00:18:32,730 --> 00:18:38,069

of you know risked his position as the

456

00:18:35,299 --> 00:18:40,829

he was the director of the Institute at

457
00:18:38,069 --> 00:18:44,939
the time and he it was quite a gamble

458
00:18:40,829 --> 00:18:48,299
but it paid off like like crazy um all

459
00:18:44,940 --> 00:18:50,400
right and it was a story so just be

460
00:18:48,299 --> 00:18:53,099
clear also this is not the same area of

461
00:18:50,400 --> 00:18:54,750
the sky as the second be field it was it

462
00:18:53,099 --> 00:18:56,879
now this is the what we could actually

463
00:18:54,750 --> 00:18:58,440
this is the first one called the Hubble

464
00:18:56,880 --> 00:19:00,750
Deep Field and then it caught we call

465
00:18:58,440 --> 00:19:02,519
the Hubble Deep Field north ok and then

466
00:19:00,750 --> 00:19:03,779
we also did the Hubble Deep Field south

467
00:19:02,519 --> 00:19:06,058
once the Hubble Deep Field North

468
00:19:03,779 --> 00:19:07,950
produced great results they said ok

469
00:19:06,058 --> 00:19:10,440
let's try it again in a southern part of

470
00:19:07,950 --> 00:19:12,240
the sky to try and say hey is it does it

471
00:19:10,440 --> 00:19:13,890
look the same in two different places in

472
00:19:12,240 --> 00:19:17,370
the sky and they did they got the same

473
00:19:13,890 --> 00:19:19,410
result a similar image like this this is

474
00:19:17,369 --> 00:19:22,019
the famous one because it was first but

475
00:19:19,410 --> 00:19:24,330
there's also a second one and then the

476
00:19:22,019 --> 00:19:27,210
area near the Big Dipper correct yeah

477
00:19:24,329 --> 00:19:30,089
this one's just off the off the handle

478
00:19:27,210 --> 00:19:31,380
of the Big Dipper and so this is as good

479
00:19:30,089 --> 00:19:33,449
as you could do with wide field

480
00:19:31,380 --> 00:19:35,100
planetary camera 2 and so you can see

481
00:19:33,450 --> 00:19:37,500
that the characteristic Chevron shape

482
00:19:35,099 --> 00:19:40,469
and so in two thousand when we had the

483
00:19:37,500 --> 00:19:43,970
servicing mission three be a jacket you

484
00:19:40,470 --> 00:19:47,069
and me guys I asked the Jag jagged ok

485

00:19:43,970 --> 00:19:48,600
the jagged shape there when we got a new

486
00:19:47,069 --> 00:19:51,839
camera on how all the advanced camera

487
00:19:48,599 --> 00:19:53,789
surveys the next director Steve Beckwith

488
00:19:51,839 --> 00:19:57,329
said ok we got to repeat the D field

489
00:19:53,789 --> 00:20:00,240
experiment and in 2004 we got this image

490
00:19:57,329 --> 00:20:01,250
the Hubble Ultra Deep Field because you

491
00:20:00,240 --> 00:20:03,859
can't just call it a

492
00:20:01,250 --> 00:20:08,240
field it's now ultra d that's right i

493
00:20:03,859 --> 00:20:11,629
think one omega by now and so the the

494
00:20:08,240 --> 00:20:14,990
HUD f as we like to call it was taken in

495
00:20:11,630 --> 00:20:16,460
2003 and released in 2004 and whereas

496
00:20:14,990 --> 00:20:18,500
the hdf did about three thousand

497
00:20:16,460 --> 00:20:21,110
galaxies this one has about 10,000

498
00:20:18,500 --> 00:20:23,750
galaxies in it and again pressing

499
00:20:21,109 --> 00:20:27,199

further out into space farther back into

500

00:20:23,750 --> 00:20:30,799

time seeing the the very small very

501

00:20:27,200 --> 00:20:33,529

distant galaxies and it also acs had

502

00:20:30,799 --> 00:20:37,339

more sensitivity in the infrared then

503

00:20:33,529 --> 00:20:40,399

why field planetary camera 2 so because

504

00:20:37,339 --> 00:20:42,259

as light crosses space the light gets

505

00:20:40,400 --> 00:20:44,750

stretched with the expansion of space

506

00:20:42,259 --> 00:20:46,309

the light from distant galaxies actually

507

00:20:44,750 --> 00:20:48,680

gets stretched towards the red end of

508

00:20:46,309 --> 00:20:51,049

the spectrum okay and actually can go

509

00:20:48,680 --> 00:20:52,940

from visible light into infrared light

510

00:20:51,049 --> 00:20:56,089

so to see the really distant galaxies

511

00:20:52,940 --> 00:20:59,269

you want to do the infrared better well

512

00:20:56,089 --> 00:21:01,789

ACS was good at the infrared but wide

513

00:20:59,269 --> 00:21:03,230

field camera 3 was even better the

514
00:21:01,789 --> 00:21:04,879
infrared because that had a few more

515
00:21:03,230 --> 00:21:06,829
years of technology development and

516
00:21:04,880 --> 00:21:09,260
optical coating development and infrared

517
00:21:06,829 --> 00:21:12,500
detector development and so why field

518
00:21:09,259 --> 00:21:14,539
camera 3 was installed in 2009 so of

519
00:21:12,500 --> 00:21:16,309
course we redid this field and this is

520
00:21:14,539 --> 00:21:17,899
actually the same field well actually

521
00:21:16,309 --> 00:21:20,149
it's a smaller part of it because the

522
00:21:17,900 --> 00:21:22,610
infrared camera has a smaller field of

523
00:21:20,150 --> 00:21:23,930
view so this red box shows you the

524
00:21:22,609 --> 00:21:28,009
smaller field of view of the infrared

525
00:21:23,930 --> 00:21:29,900
camera and then in 2009 very end of 2009

526
00:21:28,009 --> 00:21:35,390
december two thousand nine rereleased

527
00:21:29,900 --> 00:21:37,430
this image the HUD f ir ok so the Ultra

528
00:21:35,390 --> 00:21:39,290
Deep Field augmented by infrared

529
00:21:37,430 --> 00:21:43,130
observations with wide field camera 3

530
00:21:39,289 --> 00:21:44,809
and again here the the differences

531
00:21:43,130 --> 00:21:47,510
aren't quite as strong as they were

532
00:21:44,809 --> 00:21:50,000
between the Deep Field and the Ultra

533
00:21:47,509 --> 00:21:51,769
Deep Field simply because you know

534
00:21:50,000 --> 00:21:54,559
you're just authentic the infrared and

535
00:21:51,769 --> 00:21:57,619
you're really pushing the tiny galaxies

536
00:21:54,559 --> 00:22:01,429
so on the gross characteristics it looks

537
00:21:57,619 --> 00:22:03,289
roughly the same but it's the important

538
00:22:01,430 --> 00:22:05,000
points are all in the details seeing

539
00:22:03,289 --> 00:22:06,649
galaxies that you couldn't see any

540
00:22:05,000 --> 00:22:08,660
further also the difference between the

541
00:22:06,650 --> 00:22:10,519
two thousand four in the 2009 eltra d

542

00:22:08,660 --> 00:22:12,860
fields would be more galaxies right

543
00:22:10,519 --> 00:22:14,869
because you've got more sensitivity but

544
00:22:12,859 --> 00:22:17,419
just a bit more galaxies not

545
00:22:14,869 --> 00:22:19,609
no maybe five ten percent more galaxies

546
00:22:17,420 --> 00:22:21,110
not double when you went on three

547
00:22:19,609 --> 00:22:22,579
thousand to ten thousand year you

548
00:22:21,109 --> 00:22:25,729
tripled the number of galaxies yeah

549
00:22:22,579 --> 00:22:28,490
you're only increasing it by a few by a

550
00:22:25,730 --> 00:22:30,500
few percent and actually we did even

551
00:22:28,490 --> 00:22:33,558
more infrared observations over the next

552
00:22:30,500 --> 00:22:37,599
couple years and so we didn't actually

553
00:22:33,558 --> 00:22:41,029
release this as a thing but the HUD f ir

554
00:22:37,599 --> 00:22:43,459
2011 you can consider you know version

555
00:22:41,029 --> 00:22:45,769
2.1 of the Hubble Ultra Deep Field

556
00:22:43,460 --> 00:22:50,960

because this is just adding more and

557

00:22:45,769 --> 00:22:52,460

more observations then in 2012 one of

558

00:22:50,960 --> 00:22:54,200

the researchers said hey wait a minute

559

00:22:52,460 --> 00:22:56,120

there's been a lot of other observations

560

00:22:54,200 --> 00:22:59,269

that weren't done for the ultra deep

561

00:22:56,119 --> 00:23:00,619

field campaign and other campaigns that

562

00:22:59,269 --> 00:23:02,690

have been done for lots of various

563

00:23:00,619 --> 00:23:05,299

campaigns so he said let's go back

564

00:23:02,690 --> 00:23:06,679

through all of the various observations

565

00:23:05,299 --> 00:23:09,440

in the archive let's pull them all

566

00:23:06,679 --> 00:23:12,769

together alright and then they released

567

00:23:09,440 --> 00:23:14,240

another version in 2012 all right and if

568

00:23:12,769 --> 00:23:15,740

I blink back and forth i'm going to go

569

00:23:14,240 --> 00:23:19,839

back and forth very slowly i'm going to

570

00:23:15,740 --> 00:23:23,829

go back to the 2011 and then the 2012

571
00:23:19,839 --> 00:23:29,029
and then i'll go back to the 2011 and

572
00:23:23,829 --> 00:23:32,000
then the 2012 ok binkley redder in the

573
00:23:29,029 --> 00:23:34,490
2012 one yeah and that's possible that's

574
00:23:32,000 --> 00:23:35,990
also a little bit of the image

575
00:23:34,490 --> 00:23:39,170
processing might have chosen slightly

576
00:23:35,990 --> 00:23:40,970
different different color because we're

577
00:23:39,170 --> 00:23:42,860
taking different bands and applying

578
00:23:40,970 --> 00:23:44,960
different colors to them it's a little

579
00:23:42,859 --> 00:23:46,969
cleaner in 2012 this one was really

580
00:23:44,960 --> 00:23:49,009
cleaned up and carefully and so the

581
00:23:46,970 --> 00:23:51,589
noise is suppressed and it's a cleaner

582
00:23:49,009 --> 00:23:55,579
image but it's not a distinctly strongly

583
00:23:51,589 --> 00:24:00,289
distinguish however ax is what now X is

584
00:23:55,579 --> 00:24:02,869
now ok however they wanted the the P the

585
00:24:00,289 --> 00:24:05,000
P I wanted to make it sound incredible

586
00:24:02,869 --> 00:24:09,500
so it's now you want to call it the

587
00:24:05,000 --> 00:24:11,150
extreme deep field 630 I was one who

588
00:24:09,500 --> 00:24:14,929
said fly plane come on this is a test

589
00:24:11,150 --> 00:24:17,000
HUD f version 3 come on guys well all

590
00:24:14,929 --> 00:24:18,259
sure doing is just taking the IR and

591
00:24:17,000 --> 00:24:20,179
something you're just compiling it

592
00:24:18,259 --> 00:24:21,740
together all right but you know hey he

593
00:24:20,179 --> 00:24:25,790
went out he got to call it the extreme

594
00:24:21,740 --> 00:24:27,289
deep field so the H XD f here mom I'm

595
00:24:25,789 --> 00:24:28,339
going to call it what it is HUD f

596
00:24:27,289 --> 00:24:30,619
version 3

597
00:24:28,339 --> 00:24:32,808
so throughout all this there's only been

598
00:24:30,619 --> 00:24:34,849
one thing really missing right and

599

00:24:32,808 --> 00:24:37,069
that's that we've gone to longer

600
00:24:34,849 --> 00:24:40,908
wavelengths but not to shorter

601
00:24:37,069 --> 00:24:43,849
wavelengths okay so a wide field camera

602
00:24:40,909 --> 00:24:47,000
3 also when it was installed in 2009

603
00:24:43,849 --> 00:24:49,278
improved our infrared capability but

604
00:24:47,000 --> 00:24:54,190
also improved our ultra violet

605
00:24:49,278 --> 00:24:57,740
capability and so in 2014 we added in

606
00:24:54,190 --> 00:25:01,360
extra images taken in the ultraviolet

607
00:24:57,740 --> 00:25:06,950
and so now we have the HUD f 2014

608
00:25:01,359 --> 00:25:09,589
version for now with ultraviolet and

609
00:25:06,950 --> 00:25:14,929
again if I pop back and forth i go back

610
00:25:09,589 --> 00:25:18,019
to 2012 to 2014 you can see that there

611
00:25:14,929 --> 00:25:20,690
is a distinct number of extra small blue

612
00:25:18,019 --> 00:25:22,038
things right yeah one of those so what

613
00:25:20,690 --> 00:25:23,929

are the characteristics of what are we

614

00:25:22,038 --> 00:25:25,669
saying now an ultra violet that we

615

00:25:23,929 --> 00:25:27,860
couldn't see alright so what you're

616

00:25:25,669 --> 00:25:31,309
going to see in ultraviolet is the in

617

00:25:27,859 --> 00:25:32,778
the star-forming regions okay with the

618

00:25:31,308 --> 00:25:35,418
only galaxies themselves right within

619

00:25:32,778 --> 00:25:38,329
the galaxies the star forage only the

620

00:25:35,419 --> 00:25:40,610
biggest and brightest stars emit much

621

00:25:38,329 --> 00:25:42,379
ultraviolet okay stars like our Sun

622

00:25:40,609 --> 00:25:43,849
although we think it's a lot of

623

00:25:42,380 --> 00:25:46,340
ultraviolet and especially those of us

624

00:25:43,849 --> 00:25:48,168
who sunburn easily we think it's a lot

625

00:25:46,339 --> 00:25:50,928
of ultraviolet it really isn't on a

626

00:25:48,169 --> 00:25:54,140
cosmic scale and so the really massive

627

00:25:50,929 --> 00:25:55,788
stars the ones that only live for 10 50

628
00:25:54,140 --> 00:25:59,990
million years are the ones that produce

629
00:25:55,788 --> 00:26:02,538
a lot of ultraviolet so that those are

630
00:25:59,990 --> 00:26:04,700
the stars those that only exists in the

631
00:26:02,538 --> 00:26:07,129
star-forming regions so if you're seeing

632
00:26:04,700 --> 00:26:09,558
ultraviolet from a galaxy you're

633
00:26:07,130 --> 00:26:12,590
generally seeing just the star-forming

634
00:26:09,558 --> 00:26:14,690
regions okay and oftentimes if you're

635
00:26:12,589 --> 00:26:16,220
seeing that at really high redshift well

636
00:26:14,690 --> 00:26:18,440
then that ultraviolet lights get shifted

637
00:26:16,220 --> 00:26:20,298
to visible light and it doesn't show up

638
00:26:18,440 --> 00:26:21,980
in the ultraviolet so you're seeing the

639
00:26:20,298 --> 00:26:24,798
star-forming regions and generally the

640
00:26:21,980 --> 00:26:26,240
nearer star forming regions because the

641
00:26:24,798 --> 00:26:27,980
more distant star forming regions would

642
00:26:26,240 --> 00:26:31,069
actually get pushed into the visible

643
00:26:27,980 --> 00:26:32,808
light so you're seeing you're completing

644
00:26:31,069 --> 00:26:35,089
a census and the nearby things

645
00:26:32,808 --> 00:26:38,690
understanding star formation so you'll

646
00:26:35,089 --> 00:26:41,720
get a better handle on star formation by

647
00:26:38,690 --> 00:26:43,340
having the ultraviolet in this image now

648
00:26:41,720 --> 00:26:45,769
I wish I could give you a scientific

649
00:26:43,339 --> 00:26:48,019
result about this but there wasn't any

650
00:26:45,769 --> 00:26:50,179
in the press release the press release

651
00:26:48,019 --> 00:26:52,389
basically said hey cool we now have a

652
00:26:50,179 --> 00:26:56,090
pan chromatic Ultra Deep Field

653
00:26:52,390 --> 00:26:58,009
ultraviolet visible infrared we've got

654
00:26:56,089 --> 00:27:00,109
all three wave bands covered as much as

655
00:26:58,009 --> 00:27:02,529
public and covered this is you know the

656

00:27:00,109 --> 00:27:06,079
ps2 resistance of the ultra deep field

657
00:27:02,529 --> 00:27:08,569
of course until a few more observations

658
00:27:06,079 --> 00:27:11,329
are added and we call have version 5 in

659
00:27:08,569 --> 00:27:12,740
2 2016 or something like that yes I

660
00:27:11,329 --> 00:27:15,168
sound like you're saying we did it

661
00:27:12,740 --> 00:27:16,788
because we could when we just wanted to

662
00:27:15,169 --> 00:27:19,520
fill in one more piece of the puzzle to

663
00:27:16,788 --> 00:27:21,980
one of the most studied regions of the

664
00:27:19,519 --> 00:27:23,808
sky by Hubble Space tells well we've got

665
00:27:21,980 --> 00:27:26,779
so much information about these galaxies

666
00:27:23,808 --> 00:27:28,819
at the longer wavelengths adding in the

667
00:27:26,779 --> 00:27:31,369
shorter wavelength regions will give us

668
00:27:28,819 --> 00:27:33,529
a bigger a clearer picture so what I

669
00:27:31,369 --> 00:27:35,029
really liked was then I took all of them

670
00:27:33,529 --> 00:27:39,279

together well actually helps our way out

671

00:27:35,029 --> 00:27:42,288

here um listen up and didn't post

672

00:27:39,279 --> 00:27:43,788

responded I just wanted to I included

673

00:27:42,288 --> 00:27:46,640

this just to say that you know even

674

00:27:43,788 --> 00:27:48,648

though ninety ninety percent of the data

675

00:27:46,640 --> 00:27:50,990

had already been released when you

676

00:27:48,648 --> 00:27:53,178

release a new image like this and the

677

00:27:50,990 --> 00:27:55,730

the mass media press gets ahold of it

678

00:27:53,179 --> 00:27:58,220

they can still react in in strong ways

679

00:27:55,730 --> 00:28:00,200

because these are just gorgeous images

680

00:27:58,220 --> 00:28:02,538

and so seeing them over and over again

681

00:28:00,200 --> 00:28:05,149

you still react and say wow what an

682

00:28:02,538 --> 00:28:06,908

amazing view of the universe seeing to

683

00:28:05,148 --> 00:28:09,908

that you know the depths of the universe

684

00:28:06,909 --> 00:28:13,039

but what I liked was this image here

685
00:28:09,909 --> 00:28:16,490
where I put them all together so upper

686
00:28:13,038 --> 00:28:21,888
left is 2004 H the original HUD f upper

687
00:28:16,490 --> 00:28:27,710
right is a 2009 adding the IR lower left

688
00:28:21,888 --> 00:28:29,839
is 2012 the HUD f I the albums are the

689
00:28:27,710 --> 00:28:34,159
extreme deep field and the lower right

690
00:28:29,839 --> 00:28:36,619
is the multi the panchromatic HUD f 2014

691
00:28:34,159 --> 00:28:38,270
and so you can see when you put the four

692
00:28:36,619 --> 00:28:40,509
of them together that you're just adding

693
00:28:38,269 --> 00:28:44,480
more and more data more and more

694
00:28:40,509 --> 00:28:46,190
signal-to-noise you're adding in Abel's

695
00:28:44,480 --> 00:28:48,380
you to just a little bit better science

696
00:28:46,190 --> 00:28:50,570
with each generation of it I think it

697
00:28:48,380 --> 00:28:52,940
also shows that the science is a

698
00:28:50,569 --> 00:28:54,740
progressive attack on a problem you

699
00:28:52,940 --> 00:28:55,670
don't get the answer you don't get all

700
00:28:54,740 --> 00:28:58,160
the answers the first

701
00:28:55,670 --> 00:29:00,050
time yeah the HUD f is probably still

702
00:28:58,160 --> 00:29:02,110
one of the most if not the most

703
00:29:00,049 --> 00:29:05,299
important images Hubble has ever taken

704
00:29:02,109 --> 00:29:08,149
but we can still add to it and augment

705
00:29:05,299 --> 00:29:10,220
it with subsequent observations and

706
00:29:08,150 --> 00:29:12,080
still learn more so that the

707
00:29:10,220 --> 00:29:14,150
progressiveness of science I think comes

708
00:29:12,079 --> 00:29:15,529
out in these four images I agree and I

709
00:29:14,150 --> 00:29:17,600
and i'd be interested i can't wait to

710
00:29:15,529 --> 00:29:19,789
see the for the astronomers who were

711
00:29:17,599 --> 00:29:21,709
studying star forming regions and

712
00:29:19,789 --> 00:29:23,960
galaxies especially in early galaxies

713

00:29:21,710 --> 00:29:26,720
what they can do with this result or

714
00:29:23,960 --> 00:29:29,210
with it with this UV image so keep our

715
00:29:26,720 --> 00:29:31,880
eyes out for that too and it's not too

716
00:29:29,210 --> 00:29:34,789
early to say hey look forward to 20 19

717
00:29:31,880 --> 00:29:36,950
when we have JD Wisty out there and we

718
00:29:34,789 --> 00:29:38,750
can really add to the the infrared and

719
00:29:36,950 --> 00:29:40,610
then AJ misty will have similar

720
00:29:38,750 --> 00:29:41,930
resolution the Hubble and really go into

721
00:29:40,609 --> 00:29:45,049
the infrared and then we'll have yet

722
00:29:41,930 --> 00:29:48,140
another really even wider wavelength

723
00:29:45,049 --> 00:29:49,039
region in about 20 19 deep infrared so

724
00:29:48,140 --> 00:29:50,660
you think they're going to look at the

725
00:29:49,039 --> 00:29:52,670
spot too with all with the most

726
00:29:50,660 --> 00:29:55,070
definitely absolutely i think we've

727
00:29:52,670 --> 00:29:57,890

invested so much a scientific effort

728

00:29:55,069 --> 00:30:01,849

into this spot on the sky that it would

729

00:29:57,890 --> 00:30:03,140

be silly not to just do i sound like

730

00:30:01,849 --> 00:30:04,609

you're about to wrap this up but before

731

00:30:03,140 --> 00:30:06,800

we leave it can we say a few words about

732

00:30:04,609 --> 00:30:10,119

this area this guy and why it's

733

00:30:06,799 --> 00:30:12,619

important why was it why is this such

734

00:30:10,119 --> 00:30:15,889

why are we looking at this spot so much

735

00:30:12,619 --> 00:30:19,339

ok so this spot which is actually in the

736

00:30:15,890 --> 00:30:21,560

constellation Fornax if you go to Orion

737

00:30:19,339 --> 00:30:24,529

on the sky and head south past the

738

00:30:21,559 --> 00:30:27,200

constellation of air Donna's and just

739

00:30:24,529 --> 00:30:30,889

between air Adonis and Fornax is a

740

00:30:27,200 --> 00:30:34,100

nothing spot on this guy did you see the

741

00:30:30,890 --> 00:30:36,590

lego movie Tony no okay so does the

742
00:30:34,099 --> 00:30:39,379
state the hero the lego movie is so

743
00:30:36,589 --> 00:30:42,980
bloody ordinary that he has nothing

744
00:30:39,380 --> 00:30:45,710
special about him okay um and that's

745
00:30:42,980 --> 00:30:47,390
part of what makes in the hero right is

746
00:30:45,710 --> 00:30:50,000
that he's just totally absolutely

747
00:30:47,390 --> 00:30:53,150
ordinary well this spot in the sky is

748
00:30:50,000 --> 00:30:55,130
totally boring right there are no near

749
00:30:53,150 --> 00:30:57,710
right near nearby bright stars there are

750
00:30:55,130 --> 00:31:00,280
no nearby bright galaxies we tried to

751
00:30:57,710 --> 00:31:03,140
find something with very little

752
00:31:00,279 --> 00:31:04,430
obscuration of nearby stuff remember

753
00:31:03,140 --> 00:31:05,750
we're looking out for the stars of our

754
00:31:04,430 --> 00:31:07,789
galaxy we're looking out through the gas

755
00:31:05,750 --> 00:31:09,559
and dust of our galaxy looking out

756
00:31:07,789 --> 00:31:11,480
through our local Group of galaxies and

757
00:31:09,559 --> 00:31:13,129
cluster of galaxies supercluster of

758
00:31:11,480 --> 00:31:14,750
galaxies we're trying to make sure that

759
00:31:13,130 --> 00:31:17,510
we're looking at a spaten sky that isn't

760
00:31:14,750 --> 00:31:21,259
obscured by much of that at all in

761
00:31:17,509 --> 00:31:23,930
particular the the infrared obscuration

762
00:31:21,259 --> 00:31:25,730
due to gas and dust that's very faint

763
00:31:23,930 --> 00:31:27,160
that you wouldn't actually normally

764
00:31:25,730 --> 00:31:29,750
notice with visible-light observations

765
00:31:27,160 --> 00:31:31,640
so they went through lots and lots of

766
00:31:29,750 --> 00:31:34,730
different sky surveys to try and say

767
00:31:31,640 --> 00:31:37,150
what we're in the sky can we point so

768
00:31:34,730 --> 00:31:40,670
that we have as little as possible

769
00:31:37,150 --> 00:31:43,880
obscuring us that's nearby and so this

770

00:31:40,670 --> 00:31:46,550
is our mr. a dredge mr. ordinary boring

771
00:31:43,880 --> 00:31:47,840
nothing spot on the sky well and I

772
00:31:46,549 --> 00:31:49,369
wanted to make that point because I

773
00:31:47,839 --> 00:31:51,649
don't think a lot of people realize that

774
00:31:49,369 --> 00:31:53,509
that's the case and while we're on the

775
00:31:51,650 --> 00:31:56,690
topic before we switch out Hugo Burnham

776
00:31:53,509 --> 00:31:58,490
has a comment here in the Q&A app that

777
00:31:56,690 --> 00:31:59,990
basically goes as a matter of areas that

778
00:31:58,490 --> 00:32:02,870
he's asking as a matter of interest

779
00:31:59,990 --> 00:32:05,299
Frank how long would it take for HST to

780
00:32:02,869 --> 00:32:08,269
image the entire sky at the detail and

781
00:32:05,299 --> 00:32:13,279
resolution of the original Hubble Deep

782
00:32:08,269 --> 00:32:16,279
Field ok so the good question the Hubble

783
00:32:13,279 --> 00:32:18,230
Deep Field was like seven days right the

784
00:32:16,279 --> 00:32:20,960

Hubble Ultra Deep Field was around 11

785

00:32:18,230 --> 00:32:22,849

days of exposure time all right so i

786

00:32:20,960 --> 00:32:25,039

have a have just it just happened to

787

00:32:22,849 --> 00:32:27,609

have off the top of my head the numbers

788

00:32:25,039 --> 00:32:29,750

for the ultra deep field okay because

789

00:32:27,609 --> 00:32:34,519

when you look at this is such a small

790

00:32:29,750 --> 00:32:38,089

patch in the sky Hubble can look at the

791

00:32:34,519 --> 00:32:42,200

sky 12 million seven hundred and sixty

792

00:32:38,089 --> 00:32:45,259

four thousand times at this scale and

793

00:32:42,200 --> 00:32:48,440

never look at the same place twice there

794

00:32:45,259 --> 00:32:51,740

are more than 12 million matches on the

795

00:32:48,440 --> 00:32:54,830

sky the same size as the Hubble Ultra

796

00:32:51,740 --> 00:32:56,509

Deep Field so if we wanted to count

797

00:32:54,829 --> 00:32:58,519

every galaxy in the universe out there

798

00:32:56,509 --> 00:33:00,710

by looking to the depth of the Hubble

799

00:32:58,519 --> 00:33:04,819

Ultra Deep Field it would be 11 days

800

00:33:00,710 --> 00:33:07,610

times 12.7 million which is longer than

801

00:33:04,819 --> 00:33:09,829

I think we have left with Hubble angry

802

00:33:07,609 --> 00:33:11,240

and it also could include all the stuff

803

00:33:09,829 --> 00:33:13,970

that's going to get in the way so their

804

00:33:11,240 --> 00:33:17,180

own gala good question thanks you girls

805

00:33:13,970 --> 00:33:19,850

good ok ok Frank go ahead now for our

806

00:33:17,180 --> 00:33:21,850

third story and one that I probably went

807

00:33:19,849 --> 00:33:24,428

a little overboard with so how

808

00:33:21,849 --> 00:33:28,629

I gotta come to this one moving to Pluto

809

00:33:24,429 --> 00:33:30,580

and beyond but when I started doing this

810

00:33:28,630 --> 00:33:31,780

I said look you know what we got to

811

00:33:30,579 --> 00:33:34,329

start at the beginning we got to really

812

00:33:31,779 --> 00:33:36,519

understand what we're getting in for

813
00:33:34,329 --> 00:33:38,109
because the New Horizons mission is one

814
00:33:36,519 --> 00:33:39,879
year out it's going to be going to get

815
00:33:38,109 --> 00:33:42,668
us some fantastic stuff but let's go

816
00:33:39,880 --> 00:33:45,130
back to the beginning okay so if we go

817
00:33:42,669 --> 00:33:46,870
back to the very beginning these are the

818
00:33:45,130 --> 00:33:49,480
images from the Lowell Observatory in

819
00:33:46,869 --> 00:33:52,119
Flagstaff Arizona where Clyde Tombaugh

820
00:33:49,480 --> 00:33:56,380
discovered Pluto yeah I only had little

821
00:33:52,119 --> 00:33:58,119
little white arrows we have barrels in

822
00:33:56,380 --> 00:33:59,860
just because you know this is going out

823
00:33:58,119 --> 00:34:01,869
over the web you know you can't

824
00:33:59,859 --> 00:34:03,399
necessarily see it and you may be able

825
00:34:01,869 --> 00:34:04,808
to see the big red arrows and still not

826
00:34:03,400 --> 00:34:07,809
be able to see the dot that's Pluto

827

00:34:04,808 --> 00:34:09,789
they're okay and it's just absolutely

828
00:34:07,808 --> 00:34:11,259
amazing it's always flabbergasting to

829
00:34:09,789 --> 00:34:13,480
look at this and go clyde tombaugh

830
00:34:11,260 --> 00:34:15,669
noticed a spot that was here one week

831
00:34:13,480 --> 00:34:18,519
and there the next week he was blinking

832
00:34:15,668 --> 00:34:21,579
back and forth between the images the

833
00:34:18,519 --> 00:34:23,739
guy was an incredible observer okay all

834
00:34:21,579 --> 00:34:27,878
kudos did clyde tombaugh for being able

835
00:34:23,739 --> 00:34:30,099
to discover this okay and then after

836
00:34:27,878 --> 00:34:34,599
that well the next major thing happens

837
00:34:30,099 --> 00:34:37,529
in 1978 well this on the left is the

838
00:34:34,599 --> 00:34:41,049
discovery image of Pluto's moon Charon

839
00:34:37,530 --> 00:34:43,540
okay and the reason it's a discovery

840
00:34:41,050 --> 00:34:45,760
image is because well it's the Hunchback

841
00:34:43,539 --> 00:34:48,128

of the solar system you've noticed that

842

00:34:45,760 --> 00:34:50,679

there's a little lump on one side of it

843

00:34:48,128 --> 00:34:53,889

instead of it being circular well James

844

00:34:50,679 --> 00:34:55,750

Christian eyval Observatory was looking

845

00:34:53,889 --> 00:34:58,000

at Pluto and he noticed a couple images

846

00:34:55,750 --> 00:34:59,889

where there were humps on on Pluto and

847

00:34:58,000 --> 00:35:01,719

he checked all the stars around it made

848

00:34:59,889 --> 00:35:03,039

sure they were circle circles and he

849

00:35:01,719 --> 00:35:04,659

checked two other images of Pluto's and

850

00:35:03,039 --> 00:35:06,400

made sure those were circles he said

851

00:35:04,659 --> 00:35:09,368

okay well that means there must be

852

00:35:06,400 --> 00:35:10,920

another object there okay he they

853

00:35:09,369 --> 00:35:13,269

weren't able to confirm it until

854

00:35:10,920 --> 00:35:15,970

nineteen eighty-five in terms of

855

00:35:13,269 --> 00:35:18,280

actually measuring the distance of Pluto

856
00:35:15,969 --> 00:35:20,108
and Charon and by the way they were able

857
00:35:18,280 --> 00:35:21,970
to sense Pluto and Charon occulted each

858
00:35:20,108 --> 00:35:25,440
other they were able to get both sizes

859
00:35:21,969 --> 00:35:28,929
relative sizes and distances for it and

860
00:35:25,440 --> 00:35:31,869
get masses of Pluto and Charon there but

861
00:35:28,929 --> 00:35:35,349
that is the that's the amazing image

862
00:35:31,869 --> 00:35:38,500
that got us the discovery of Karen okay

863
00:35:35,349 --> 00:35:40,719
well Hubble launched in 1990 at the time

864
00:35:38,500 --> 00:35:43,059
in 1990 upper left you can see a

865
00:35:40,719 --> 00:35:45,159
ground-based image of Pluto and Charon

866
00:35:43,059 --> 00:35:47,159
so they got a little better by then you

867
00:35:45,159 --> 00:35:51,730
can see we were using digital imagery of

868
00:35:47,159 --> 00:35:55,599
an improvement from 1978 but Hubble in

869
00:35:51,730 --> 00:35:57,130
1990 even with the flaw uncorrect it ok

870
00:35:55,599 --> 00:35:59,219
this is with the flaw in the mirror that

871
00:35:57,130 --> 00:36:01,530
hasn't been corrected you can see boom

872
00:35:59,219 --> 00:36:05,199
Hubble's view from above the atmosphere

873
00:36:01,530 --> 00:36:06,970
gets you Pluto and Charon much cleanly

874
00:36:05,199 --> 00:36:08,559
separated all right you can see that

875
00:36:06,969 --> 00:36:10,389
sort of ring around Pluto that that's

876
00:36:08,559 --> 00:36:12,719
that's due to the flaw on the mirror but

877
00:36:10,389 --> 00:36:16,239
that would be fixed relatively soon and

878
00:36:12,719 --> 00:36:18,489
after the servicing mission in 93 we're

879
00:36:16,239 --> 00:36:21,219
able to get this image of Pluto and

880
00:36:18,489 --> 00:36:23,739
Charon and this is actually an infrared

881
00:36:21,219 --> 00:36:25,659
image of Pluto and Charon I Pluto is

882
00:36:23,739 --> 00:36:28,149
obviously the large splotch on the left

883
00:36:25,659 --> 00:36:30,579
and karen is the the smaller splotch on

884

00:36:28,150 --> 00:36:32,110
the right these look sort of like the

885
00:36:30,579 --> 00:36:35,500
the two are resolved but they actually

886
00:36:32,110 --> 00:36:37,750
aren't resolved they are separated but

887
00:36:35,500 --> 00:36:39,820
they aren't resolved into into

888
00:36:37,750 --> 00:36:42,789
individual pixels a lot of these things

889
00:36:39,820 --> 00:36:45,160
that means to be resolved versus not

890
00:36:42,789 --> 00:36:46,900
okay well the point is is that when you

891
00:36:45,159 --> 00:36:48,819
want to look at an object you want to

892
00:36:46,900 --> 00:36:51,789
have multiple pixels across the width of

893
00:36:48,820 --> 00:36:54,550
the object alright so we're used to

894
00:36:51,789 --> 00:36:56,259
seeing high-resolution images of the of

895
00:36:54,550 --> 00:36:58,330
the of the planets from satellites that

896
00:36:56,260 --> 00:37:00,910
have been there right and so you may

897
00:36:58,329 --> 00:37:03,549
have you know five hundred to a thousand

898
00:37:00,909 --> 00:37:06,909

to several thousand images pixels that

899

00:37:03,550 --> 00:37:09,100

span the width of the of the planet or

900

00:37:06,909 --> 00:37:12,009

moon that you're looking at well Pluto

901

00:37:09,099 --> 00:37:14,559

is so small that its entire size fits

902

00:37:12,010 --> 00:37:16,630

within one pixel and what you're seeing

903

00:37:14,559 --> 00:37:18,250

here is actually just the bleed of that

904

00:37:16,630 --> 00:37:22,539

love the brightness of that one pixel

905

00:37:18,250 --> 00:37:24,639

spreading across the the detector so

906

00:37:22,539 --> 00:37:26,860

this while it looks like it's resolved

907

00:37:24,639 --> 00:37:29,319

into a nice circular spot that's

908

00:37:26,860 --> 00:37:31,150

actually just detector bleed and really

909

00:37:29,320 --> 00:37:34,840

doesn't indicate it indicates the

910

00:37:31,150 --> 00:37:36,789

brightness but not the true size if you

911

00:37:34,840 --> 00:37:39,750

want to see real it resolved images of

912

00:37:36,789 --> 00:37:44,710

Pluto we finally got them with Hubble

913
00:37:39,750 --> 00:37:48,010
also in 1994 now what you're seeing the

914
00:37:44,710 --> 00:37:48,909
big circles here are not the images of

915
00:37:48,010 --> 00:37:52,600
Pluto

916
00:37:48,909 --> 00:37:55,989
these are maps of Pluto coming from the

917
00:37:52,599 --> 00:37:58,509
images the images themselves are these

918
00:37:55,989 --> 00:38:01,809
tiny little speck Lee things in the

919
00:37:58,510 --> 00:38:04,870
upper left up in the top so the top row

920
00:38:01,809 --> 00:38:06,880
are the real images of Pluto okay and

921
00:38:04,869 --> 00:38:09,609
these are the best images we've ever

922
00:38:06,880 --> 00:38:10,930
gotten a Pluto to this point and really

923
00:38:09,610 --> 00:38:14,079
the best we have until today because

924
00:38:10,929 --> 00:38:15,250
these are Hubble's images that you can

925
00:38:14,079 --> 00:38:17,170
see that you can start to see the

926
00:38:15,250 --> 00:38:20,710
pixelation okay you can actually get

927
00:38:17,170 --> 00:38:23,170
pixels across Pluto right and that is

928
00:38:20,710 --> 00:38:26,470
the resolution but this shows you just

929
00:38:23,170 --> 00:38:28,570
how small and how far away Pluto is that

930
00:38:26,469 --> 00:38:31,569
even with Hubble that's the best

931
00:38:28,570 --> 00:38:34,930
resolution we can do alright so the the

932
00:38:31,570 --> 00:38:39,970
saga of Pluto goes on in from 1994 we

933
00:38:34,929 --> 00:38:42,279
move on to 2008 the build of the

934
00:38:39,969 --> 00:38:44,469
building of the Rose Center for Earth

935
00:38:42,280 --> 00:38:47,350
and space at the American Museum of

936
00:38:44,469 --> 00:38:49,149
Natural History in New York and I

937
00:38:47,349 --> 00:38:50,949
actually was one of the curators Neil

938
00:38:49,150 --> 00:38:53,289
Tyson Steve Sodor and myself were the

939
00:38:50,949 --> 00:38:55,809
three curators there and when we built

940
00:38:53,289 --> 00:38:59,050
the exhibits there we recognize that

941

00:38:55,809 --> 00:39:02,079
Pluto wasn't going to stay in the class

942
00:38:59,050 --> 00:39:03,789
of planets and so what we did there is

943
00:39:02,079 --> 00:39:06,159
we actually talked about the four rocky

944
00:39:03,789 --> 00:39:08,320
planets we talked about the four giant

945
00:39:06,159 --> 00:39:11,289
planets we talked about the Kuiper belt

946
00:39:08,320 --> 00:39:13,180
we talked about the asteroid belt and we

947
00:39:11,289 --> 00:39:16,150
talked about Pluto where it belongs

948
00:39:13,179 --> 00:39:18,279
within the Kuiper belt now I actually

949
00:39:16,150 --> 00:39:20,619
edited the text I made sure we never

950
00:39:18,280 --> 00:39:22,080
said Pluto wasn't a planet because that

951
00:39:20,619 --> 00:39:24,759
would be going against the IAE

952
00:39:22,079 --> 00:39:27,340
definition that it was but we never said

953
00:39:24,760 --> 00:39:28,840
that it was a planet alright we talked

954
00:39:27,340 --> 00:39:30,809
about it in the context of what it was

955
00:39:28,840 --> 00:39:34,780

so we walked a fine line basically

956

00:39:30,809 --> 00:39:37,449

however some reporter actually for the

957

00:39:34,780 --> 00:39:39,940

architecture of near of the New York

958

00:39:37,449 --> 00:39:45,359

Times came in and said what Pluto's not

959

00:39:39,940 --> 00:39:47,679

a planet only in New York and basically

960

00:39:45,360 --> 00:39:49,120

noted that we had talked about the rocky

961

00:39:47,679 --> 00:39:52,089

planets we talked about the giant

962

00:39:49,119 --> 00:39:53,650

planets and we hadn't talked about Pluto

963

00:39:52,090 --> 00:39:55,570

in either one of those categories of

964

00:39:53,650 --> 00:39:57,280

course it doesn't fit into either one of

965

00:39:55,570 --> 00:40:00,670

those categories but that caused a

966

00:39:57,280 --> 00:40:02,710

firestorm of stuff and you know it was

967

00:40:00,670 --> 00:40:04,809

just our way of saying look

968

00:40:02,710 --> 00:40:07,329

we know the times they are changing and

969

00:40:04,809 --> 00:40:10,960

our exhibits we expect them to stand for

970
00:40:07,329 --> 00:40:12,389
20 20 years or so and we were just kind

971
00:40:10,960 --> 00:40:14,530
of trying to get ahead of the curve

972
00:40:12,389 --> 00:40:17,319
turns out we actually were ahead of the

973
00:40:14,530 --> 00:40:19,510
curve ok we'll take credit for that all

974
00:40:17,320 --> 00:40:23,170
right Hubble came back to look at Pluto

975
00:40:19,510 --> 00:40:25,660
in 2002 and got more maps and for some

976
00:40:23,170 --> 00:40:29,200
reason they colored these maps yellow

977
00:40:25,659 --> 00:40:31,750
and black because there is a yellowish

978
00:40:29,199 --> 00:40:33,250
probably from an astronomers point of

979
00:40:31,750 --> 00:40:36,579
view there's a yellowish tinge to the

980
00:40:33,250 --> 00:40:38,409
surface of Pluto in terms of measuring

981
00:40:36,579 --> 00:40:40,539
its colors red versus blue and stuff

982
00:40:38,409 --> 00:40:42,399
like that but I really don't think the

983
00:40:40,539 --> 00:40:44,739
yellowish here is actually the yellowish

984
00:40:42,400 --> 00:40:47,170
color the human eye would see all right

985
00:40:44,739 --> 00:40:48,729
so I I worry about these things

986
00:40:47,170 --> 00:40:50,858
appearing in textbooks and kids thinking

987
00:40:48,730 --> 00:40:52,750
Oh Pluto is going to look like that yeah

988
00:40:50,858 --> 00:40:54,579
it's always good to mention that a lot

989
00:40:52,750 --> 00:40:56,349
of astronomical images are using color

990
00:40:54,579 --> 00:40:58,449
tables to bring out detail they wouldn't

991
00:40:56,349 --> 00:40:59,950
see these color tables are kind of

992
00:40:58,449 --> 00:41:02,199
specialized depending on what they're

993
00:40:59,949 --> 00:41:04,059
trying to bring out what details so

994
00:41:02,199 --> 00:41:05,769
that's a good point that's right but

995
00:41:04,059 --> 00:41:08,529
really the sites that came out of it

996
00:41:05,769 --> 00:41:11,920
came out of the surface maps okay so

997
00:41:08,530 --> 00:41:14,099
this is a surface map of Pluto sort of

998

00:41:11,920 --> 00:41:16,570
like you would see a spread-out map of

999
00:41:14,099 --> 00:41:19,150
Earth right with all the continents laid

1000
00:41:16,570 --> 00:41:22,838
well this is a very low resolution one

1001
00:41:19,150 --> 00:41:24,880
of Pluto and this is the 2002 map and

1002
00:41:22,838 --> 00:41:29,380
what was interesting is if you compare

1003
00:41:24,880 --> 00:41:32,440
the 2002 map to the 2,000 of the 1994

1004
00:41:29,380 --> 00:41:35,108
map all right you can see that there's a

1005
00:41:32,440 --> 00:41:38,260
bright region down bottom in the 1994

1006
00:41:35,108 --> 00:41:41,409
map but if I switch back to the 2002 map

1007
00:41:38,260 --> 00:41:43,330
the bright region is towards the top all

1008
00:41:41,409 --> 00:41:47,230
right and so what we're seeing here a

1009
00:41:43,329 --> 00:41:50,730
bit is a change in the brightness of the

1010
00:41:47,230 --> 00:41:53,588
surface of Pluto which may indicate

1011
00:41:50,730 --> 00:41:56,199
surmise to indicate the deposition of

1012
00:41:53,588 --> 00:42:01,659

fresh I don't like all its snow but

1013

00:41:56,199 --> 00:42:05,199

fresh condensate okay Pluto has a very

1014

00:42:01,659 --> 00:42:07,420

very thin atmosphere okay and it can the

1015

00:42:05,199 --> 00:42:09,460

material could actually move from one

1016

00:42:07,420 --> 00:42:12,400

could actually evaporate at one area

1017

00:42:09,460 --> 00:42:13,389

andrey condense on another area i'm not

1018

00:42:12,400 --> 00:42:14,680

sure that that's what's it what's

1019

00:42:13,389 --> 00:42:16,150

happened here that that's a supposition

1020

00:42:14,679 --> 00:42:18,909

that that might have happened here

1021

00:42:16,150 --> 00:42:22,389

but what really this shows is that the

1022

00:42:18,909 --> 00:42:25,838

stuff that was right in 1994 has become

1023

00:42:22,389 --> 00:42:28,629

dark by 2002 and a new region has had

1024

00:42:25,838 --> 00:42:31,750

new condensate in 2002 so it does show

1025

00:42:28,630 --> 00:42:33,010

that as pluto heads heads away from the

1026

00:42:31,750 --> 00:42:35,260

Sun it's heading away from the Sun right

1027
00:42:33,010 --> 00:42:36,700
now its surface features at least the

1028
00:42:35,260 --> 00:42:38,680
brightness of his search features are

1029
00:42:36,699 --> 00:42:40,419
changing and that's something we hadn't

1030
00:42:38,679 --> 00:42:41,949
known before so that's that's a

1031
00:42:40,420 --> 00:42:47,650
brand-new result that Hubble was able to

1032
00:42:41,949 --> 00:42:50,199
do hell let's see then in 2006 this is a

1033
00:42:47,650 --> 00:42:52,690
picture a great picture from NASA of a

1034
00:42:50,199 --> 00:42:54,759
launch of the New Horizons mission all

1035
00:42:52,690 --> 00:42:57,369
right we had sent Voyager past Jupiter

1036
00:42:54,760 --> 00:42:59,589
Saturn and voyager 2 past Jupiter Saturn

1037
00:42:57,369 --> 00:43:03,400
Uranus and Neptune but we had never

1038
00:42:59,588 --> 00:43:05,798
visited Pluto and Alan Stern is the p.i

1039
00:43:03,400 --> 00:43:08,588
on this project and he finally got his

1040
00:43:05,798 --> 00:43:09,969
his lifelong dream to send a mission out

1041
00:43:08,588 --> 00:43:13,690
to Pluto the new horizon missions

1042
00:43:09,969 --> 00:43:15,699
launched in January 2006 and in support

1043
00:43:13,690 --> 00:43:17,829
of the New Horizons mission Hubble was

1044
00:43:15,699 --> 00:43:19,719
going to survey the Pluto system to see

1045
00:43:17,829 --> 00:43:21,760
was there anything else there that's

1046
00:43:19,719 --> 00:43:23,409
worthy of study or was there anything

1047
00:43:21,760 --> 00:43:26,319
else there that could actually pose a

1048
00:43:23,409 --> 00:43:28,480
threat to New Horizons mission and we

1049
00:43:26,318 --> 00:43:31,900
actually discovered some things in 2005

1050
00:43:28,480 --> 00:43:34,298
but we released them in 2006 and in

1051
00:43:31,900 --> 00:43:39,039
February 2006 we released this picture

1052
00:43:34,298 --> 00:43:42,278
of two new moons around Pluto they were

1053
00:43:39,039 --> 00:43:44,260
designated p1 and p2 but later the

1054
00:43:42,278 --> 00:43:46,989
discoverers got the name them and they

1055

00:43:44,260 --> 00:43:49,000
named them Nix and Hydra that wasn't

1056
00:43:46,989 --> 00:43:53,949
take moment euros other names p1 and p2

1057
00:43:49,000 --> 00:43:56,858
were so great well Nix and Hydra NH New

1058
00:43:53,949 --> 00:44:03,818
Horizons so there was not a coincidence

1059
00:43:56,858 --> 00:44:06,219
I never knew that okay know that so they

1060
00:44:03,818 --> 00:44:08,048
worked really hard to find some names

1061
00:44:06,219 --> 00:44:10,328
that are within the mythology of the

1062
00:44:08,048 --> 00:44:13,119
underworld and Pluto that will come with

1063
00:44:10,329 --> 00:44:16,240
it and they found Nix and Hydra NH New

1064
00:44:13,119 --> 00:44:18,130
Horizons okay that was februari 2006 so

1065
00:44:16,239 --> 00:44:20,500
we got new horizons launch we got some

1066
00:44:18,130 --> 00:44:25,269
new moons and then august two thousand

1067
00:44:20,500 --> 00:44:26,980
six boom Pluto's no longer a planet so

1068
00:44:25,269 --> 00:44:29,500
finally the rest of the world caught up

1069
00:44:26,980 --> 00:44:31,990

to what we had done in two thousand

1070

00:44:29,500 --> 00:44:34,420

and recognize that Pluto didn't really

1071

00:44:31,989 --> 00:44:36,729

fit in amongst the planets it wasn't a

1072

00:44:34,420 --> 00:44:38,920

rocky planet wasn't a giant planet it

1073

00:44:36,730 --> 00:44:40,960

actually did fit in with these other

1074

00:44:38,920 --> 00:44:44,559

objects which I'll discuss in just a bit

1075

00:44:40,960 --> 00:44:47,170

so that was you know a big year for

1076

00:44:44,559 --> 00:44:48,969

Pluto there in terms of getting the

1077

00:44:47,170 --> 00:44:53,050

mission getting the new moons and then

1078

00:44:48,969 --> 00:44:56,859

change in status flash forward to 2007

1079

00:44:53,050 --> 00:44:59,710

and New Horizons has already past

1080

00:44:56,860 --> 00:45:01,930

Jupiter okay and this this is what

1081

00:44:59,710 --> 00:45:04,420

always brings back to me the scale of

1082

00:45:01,929 --> 00:45:06,519

the solar system that essentially in a

1083

00:45:04,420 --> 00:45:10,539

year a little over a year it could get

1084
00:45:06,519 --> 00:45:12,670
out to Jupiter right and but that's

1085
00:45:10,539 --> 00:45:14,590
really only a few percent of the way to

1086
00:45:12,670 --> 00:45:16,690
get to where it's really going because

1087
00:45:14,590 --> 00:45:18,970
it's going to travel if the earth-sun

1088
00:45:16,690 --> 00:45:21,190
distance is one AU right and then

1089
00:45:18,969 --> 00:45:23,639
Jupiter's out at like 58 you so that's

1090
00:45:21,190 --> 00:45:27,190
that's it's traveled almost for a you in

1091
00:45:23,639 --> 00:45:31,119
2007 tub by 2007 but it has to travel

1092
00:45:27,190 --> 00:45:33,070
30a you so Jupiter is actually really

1093
00:45:31,119 --> 00:45:36,460
close in comparison to how distant

1094
00:45:33,070 --> 00:45:38,559
Neptune and Pluto are so it sort of

1095
00:45:36,460 --> 00:45:41,800
gives you a feeling for the scale solar

1096
00:45:38,559 --> 00:45:44,529
system that it was there in 2007 and I

1097
00:45:41,800 --> 00:45:46,510
have to mention this because when New

1098
00:45:44,530 --> 00:45:48,340
Horizons past Jupiter who is able to

1099
00:45:46,510 --> 00:45:51,310
take very shots of Jupiter which were

1100
00:45:48,340 --> 00:45:54,309
nice but it got the most amazing shot of

1101
00:45:51,309 --> 00:45:58,650
Jupiter's moon Io and again one of my

1102
00:45:54,309 --> 00:46:03,639
favorite shots and in astronomy is this

1103
00:45:58,650 --> 00:46:06,039
animated gif of Cooper's moon Io and on

1104
00:46:03,639 --> 00:46:09,940
the very top of it you can see the

1105
00:46:06,039 --> 00:46:14,590
volcano too vast are actually see five

1106
00:46:09,940 --> 00:46:17,019
images of de bashed are erupting just

1107
00:46:14,590 --> 00:46:18,850
how cool is that I know now while Frank

1108
00:46:17,019 --> 00:46:21,009
is talking I've been uploading some of

1109
00:46:18,849 --> 00:46:22,630
these images to the event page but

1110
00:46:21,010 --> 00:46:25,120
unfortunately that's not going to come

1111
00:46:22,630 --> 00:46:27,039
through so the animated gif part so

1112

00:46:25,119 --> 00:46:29,139
you'll just get the image that got

1113
00:46:27,039 --> 00:46:31,389
captured from the PowerPoint export but

1114
00:46:29,139 --> 00:46:36,369
all right well if you look if you do a

1115
00:46:31,389 --> 00:46:39,190
Google search for TV a sh t AR to Wash

1116
00:46:36,369 --> 00:46:40,869
star this will come up because you know

1117
00:46:39,190 --> 00:46:43,088
it's it's there on Wikipedia such as a

1118
00:46:40,869 --> 00:46:46,440
public domain image and such

1119
00:46:43,088 --> 00:46:48,998
I'm one of my favorites yeah that is all

1120
00:46:46,440 --> 00:46:52,028
ok so that's a little bit of a side

1121
00:46:48,998 --> 00:46:54,278
point but you know new horizons did good

1122
00:46:52,028 --> 00:46:56,048
science good observations while it was

1123
00:46:54,278 --> 00:46:59,259
passing by Jupiter and getting a good

1124
00:46:56,048 --> 00:47:00,579
gravity assist from Jupiter in addition

1125
00:46:59,259 --> 00:47:04,088
to the science it will do when it gets

1126
00:47:00,579 --> 00:47:07,930

to Pluto alright well fast forward to

1127

00:47:04,088 --> 00:47:10,420

2012 Hubble continued to look made some

1128

00:47:07,929 --> 00:47:12,608

more look check checking around there we

1129

00:47:10,420 --> 00:47:14,318

you'll notice this image has got two

1130

00:47:12,608 --> 00:47:17,588

exposures it's got the exposure down the

1131

00:47:14,318 --> 00:47:19,298

center which is Pluto and Charon um on

1132

00:47:17,588 --> 00:47:20,798

the left-hand side you can see the

1133

00:47:19,298 --> 00:47:23,829

previously discovered moons Nix and

1134

00:47:20,798 --> 00:47:28,239

Hydra but in 2010 we discovered another

1135

00:47:23,829 --> 00:47:30,278

moon and 2011 or 2012 we discovered yet

1136

00:47:28,239 --> 00:47:33,460

another moon and these ended up being

1137

00:47:30,278 --> 00:47:35,318

named sticks and kerberos so now we've

1138

00:47:33,460 --> 00:47:38,559

got this amazing system all right with

1139

00:47:35,318 --> 00:47:40,538

Pluto Karen and then for new moons that

1140

00:47:38,559 --> 00:47:41,739

we didn't know about out there so Hubble

1141
00:47:40,539 --> 00:47:43,930
is saying alright this is going to be

1142
00:47:41,739 --> 00:47:45,728
really cool and because Hubble had

1143
00:47:43,929 --> 00:47:47,889
discovered it on the way to Pluto while

1144
00:47:45,728 --> 00:47:50,409
New Horizons is still on its way the

1145
00:47:47,889 --> 00:47:52,838
astronomers could then bring this into

1146
00:47:50,409 --> 00:47:54,998
their planning and plan scientific

1147
00:47:52,838 --> 00:47:56,858
observations to try and cover the whole

1148
00:47:54,998 --> 00:47:59,949
Pluto system all right when it was

1149
00:47:56,858 --> 00:48:01,929
launched we only had two objects to to

1150
00:47:59,949 --> 00:48:05,439
examine in the Pluto system now we got

1151
00:48:01,929 --> 00:48:08,348
six so Hubble has provided a really good

1152
00:48:05,440 --> 00:48:11,798
bonanza for the New Horizons mission to

1153
00:48:08,349 --> 00:48:13,778
look at ok well now we're up to today ok

1154
00:48:11,798 --> 00:48:16,018
and this is something i downloaded today

1155
00:48:13,778 --> 00:48:20,199
from the New Horizons website it shows

1156
00:48:16,018 --> 00:48:22,808
the path of New Horizons on its way out

1157
00:48:20,199 --> 00:48:25,509
to Pluto and show you where it is it has

1158
00:48:22,809 --> 00:48:27,969
traveled about 29 astronomical units and

1159
00:48:25,509 --> 00:48:30,728
still has a little less than three to go

1160
00:48:27,969 --> 00:48:33,130
and that three will take place over the

1161
00:48:30,728 --> 00:48:37,078
next year all right but a really

1162
00:48:33,130 --> 00:48:41,410
important point comes up in January of

1163
00:48:37,079 --> 00:48:42,940
2015 so these are those Hubble images ok

1164
00:48:41,409 --> 00:48:45,639
these are the Hubble these are the best

1165
00:48:42,940 --> 00:48:49,239
images we've got from Hubble New

1166
00:48:45,639 --> 00:48:53,139
Horizons will equal Hubble's resolution

1167
00:48:49,239 --> 00:48:55,298
in January of 2015 so for the first time

1168
00:48:53,139 --> 00:48:56,920
will actually start to get better images

1169

00:48:55,298 --> 00:48:59,230
that Hubble can take

1170
00:48:56,920 --> 00:49:01,599
um beginning beginning next year so for

1171
00:48:59,230 --> 00:49:04,960
about six months before and six months

1172
00:49:01,599 --> 00:49:06,610
after its encounter with with Pluto New

1173
00:49:04,960 --> 00:49:09,250
Horizons will have time to take pictures

1174
00:49:06,610 --> 00:49:10,450
that exceed Hubble's resolution and i

1175
00:49:09,250 --> 00:49:12,099
almost put a little question marks over

1176
00:49:10,449 --> 00:49:14,199
top of these because i don't know what

1177
00:49:12,099 --> 00:49:16,839
they're going to be like but it'll be

1178
00:49:14,199 --> 00:49:20,589
nice to finally exceed these uh these

1179
00:49:16,840 --> 00:49:23,200
rather i want to call it right there

1180
00:49:20,590 --> 00:49:24,820
kind of pathetic here okay it says a lot

1181
00:49:23,199 --> 00:49:26,739
about Hubble come on me well we had to

1182
00:49:24,820 --> 00:49:28,480
get these get something better than that

1183
00:49:26,739 --> 00:49:30,279

it sends something way the heck out

1184

00:49:28,480 --> 00:49:31,809

there and that's actually that's a great

1185

00:49:30,280 --> 00:49:33,940

point Tony I mean there's a lot that

1186

00:49:31,809 --> 00:49:36,250

Hubble can do that can only be exceeded

1187

00:49:33,940 --> 00:49:38,530

by satellites that actually fly across

1188

00:49:36,250 --> 00:49:41,019

the space satellites to fly across the

1189

00:49:38,530 --> 00:49:43,660

solar system and visit the planets

1190

00:49:41,019 --> 00:49:45,670

that's right awesome that's great Frank

1191

00:49:43,659 --> 00:49:48,219

ok so wait a minute but we still haven't

1192

00:49:45,670 --> 00:49:50,769

gotten things so the actual encounter

1193

00:49:48,219 --> 00:49:55,119

with Pluto will and it's listed on the

1194

00:49:50,769 --> 00:49:58,900

website is 7 49 59 seconds a.m. eastern

1195

00:49:55,119 --> 00:50:01,420

daylight time July 14 2015 so we are

1196

00:49:58,900 --> 00:50:04,200

just under his one-year announcing

1197

00:50:01,420 --> 00:50:07,090

that's right 300 left three days I guess

1198
00:50:04,199 --> 00:50:09,819
363 days from now we will have the

1199
00:50:07,090 --> 00:50:10,930
closest approach to Pluto and that will

1200
00:50:09,820 --> 00:50:13,450
be kind of cool this is of course an

1201
00:50:10,929 --> 00:50:15,279
artist's rendition with Pluto and its

1202
00:50:13,449 --> 00:50:18,699
kind of interesting they they they drew

1203
00:50:15,280 --> 00:50:21,090
some ice geysers in this in this thing

1204
00:50:18,699 --> 00:50:24,669
sort of like the ice geysers we see on

1205
00:50:21,090 --> 00:50:26,559
Triton Neptune's moon Triton and then

1206
00:50:24,670 --> 00:50:28,510
there's a Karen in the background I

1207
00:50:26,559 --> 00:50:30,279
don't know if this was drawn after Nixon

1208
00:50:28,510 --> 00:50:31,480
Hydra and sticks and kerberos were

1209
00:50:30,280 --> 00:50:33,280
discovered but I don't see them in the

1210
00:50:31,480 --> 00:50:36,309
image all right so we got that all right

1211
00:50:33,280 --> 00:50:39,190
so New Horizons were one year away here

1212
00:50:36,309 --> 00:50:40,900
is the timeline of the mission and you

1213
00:50:39,190 --> 00:50:43,990
can see the process of passing by

1214
00:50:40,900 --> 00:50:46,660
Jupiter getting out to Pluto but the

1215
00:50:43,989 --> 00:50:48,699
really cool thing about it is that we

1216
00:50:46,659 --> 00:50:52,089
now have so much more information out

1217
00:50:48,699 --> 00:50:55,299
there what is New Horizons going to do a

1218
00:50:52,090 --> 00:50:57,460
fertilized by Pluto Pluto does not have

1219
00:50:55,300 --> 00:51:00,760
enough mass okay we certainly don't have

1220
00:50:57,460 --> 00:51:03,280
enough thrusters on this small satellite

1221
00:51:00,760 --> 00:51:05,410
on a small space mission to pull it into

1222
00:51:03,280 --> 00:51:07,060
an orbit around Pluto right because we

1223
00:51:05,409 --> 00:51:09,339
you know messenger is sitting around

1224
00:51:07,059 --> 00:51:10,750
mercury and it's orbiting mercury okay

1225
00:51:09,340 --> 00:51:13,329
Cassini has been orbiting

1226

00:51:10,750 --> 00:51:15,550
for several years and we can do detailed

1227
00:51:13,329 --> 00:51:18,190
studies of those of those planets

1228
00:51:15,550 --> 00:51:21,490
because they go into orbit and can stay

1229
00:51:18,190 --> 00:51:23,110
for several years well New Horizons is

1230
00:51:21,489 --> 00:51:27,489
booking across the solar system there's

1231
00:51:23,110 --> 00:51:28,809
no way it could stop to to look at Pluto

1232
00:51:27,489 --> 00:51:32,349
for very long it's going to be a very

1233
00:51:28,809 --> 00:51:34,480
quick you know coupled a flyby of Pluto

1234
00:51:32,349 --> 00:51:36,630
and its system and that's all we're

1235
00:51:34,480 --> 00:51:40,769
going to get so what do we do after that

1236
00:51:36,630 --> 00:51:44,349
well the reason Pluto was demoted is

1237
00:51:40,769 --> 00:51:47,230
specified by this image right here this

1238
00:51:44,349 --> 00:51:49,569
is the Kuiper belt okay and so these

1239
00:51:47,230 --> 00:51:51,519
green circles in here starting from the

1240
00:51:49,570 --> 00:51:54,130

inside it's Jupiter Saturn Uranus and

1241

00:51:51,519 --> 00:51:56,920

Neptune okay these are the giant planets

1242

00:51:54,130 --> 00:51:59,860

and those are the orbits of the giant

1243

00:51:56,920 --> 00:52:03,070

planets the green the blue green circles

1244

00:51:59,860 --> 00:52:07,840

there but all of the red and white dots

1245

00:52:03,070 --> 00:52:09,760

the 1274 red and white dots out beyond

1246

00:52:07,840 --> 00:52:13,450

and just slightly covering Neptune's

1247

00:52:09,760 --> 00:52:18,970

orbit our new objects we have discovered

1248

00:52:13,449 --> 00:52:21,219

since 1992 this is a new region of the

1249

00:52:18,969 --> 00:52:24,579

solar system that has been discovered in

1250

00:52:21,219 --> 00:52:26,919

our lifetimes the reason Pluto was

1251

00:52:24,579 --> 00:52:29,650

demoted from being a planet is not

1252

00:52:26,920 --> 00:52:32,559

because of its particular size or it or

1253

00:52:29,650 --> 00:52:35,829

its particular characteristics but that

1254

00:52:32,559 --> 00:52:38,440

it now has a family of objects that are

1255
00:52:35,829 --> 00:52:40,599
just like it that are small that are icy

1256
00:52:38,440 --> 00:52:42,820
have these elongated orbits have these

1257
00:52:40,599 --> 00:52:45,730
tilted orbits they have all the same

1258
00:52:42,820 --> 00:52:47,530
characteristics as Pluto and Pluto is

1259
00:52:45,730 --> 00:52:49,750
one of the largest of these objects that

1260
00:52:47,530 --> 00:52:51,370
you know we can call them Kuiper belt

1261
00:52:49,750 --> 00:52:54,880
objects or some people call them

1262
00:52:51,369 --> 00:52:56,250
trans-neptunian objects I just I stick

1263
00:52:54,880 --> 00:53:00,369
with Kuiper belt is because it's easier

1264
00:52:56,250 --> 00:53:02,079
for people to recognize so if you have

1265
00:53:00,369 --> 00:53:04,659
all these other objects out there and

1266
00:53:02,079 --> 00:53:07,569
you've got this mission streaming

1267
00:53:04,659 --> 00:53:08,949
through them doesn't it make sense to

1268
00:53:07,570 --> 00:53:12,160
try and find something else to look at

1269
00:53:08,949 --> 00:53:15,339
right so that's what Howell has been

1270
00:53:12,159 --> 00:53:17,440
doing and Hubble started a mission and

1271
00:53:15,340 --> 00:53:18,579
so the new science this is I'm finally

1272
00:53:17,440 --> 00:53:20,200
getting to the new science after about

1273
00:53:18,579 --> 00:53:23,840
20 minutes of talking about Pluto right

1274
00:53:20,199 --> 00:53:26,719
you did go over for you

1275
00:53:23,840 --> 00:53:28,430
and you know but this is the new science

1276
00:53:26,719 --> 00:53:32,569
that we released is that Hubble has

1277
00:53:28,429 --> 00:53:36,829
started this search for objects in the

1278
00:53:32,570 --> 00:53:39,769
Kuiper belt that could be targets for

1279
00:53:36,829 --> 00:53:40,880
New Horizons so New Horizons is going to

1280
00:53:39,769 --> 00:53:44,360
go past Pluto it's going to have a

1281
00:53:40,880 --> 00:53:46,700
really serious amazing science fest for

1282
00:53:44,360 --> 00:53:48,620
a very short time as it passes Pluto and

1283

00:53:46,699 --> 00:53:50,449
then it's got to look for another target

1284
00:53:48,619 --> 00:53:52,819
well it can't go look for another target

1285
00:53:50,449 --> 00:53:54,649
on its own it needs the help of Hubble

1286
00:53:52,820 --> 00:53:57,050
and Hubble has started this search here

1287
00:53:54,650 --> 00:54:00,440
are two examples and these two examples

1288
00:53:57,050 --> 00:54:02,769
showed that Hubble really is capable of

1289
00:54:00,440 --> 00:54:05,269
doing this it was a proof of concept

1290
00:54:02,769 --> 00:54:08,570
yeah this is a proof of concept on these

1291
00:54:05,269 --> 00:54:11,480
things and Hubble has been approved to

1292
00:54:08,570 --> 00:54:12,590
do the full target search okay I don't

1293
00:54:11,480 --> 00:54:15,199
know how many orbits that's going to

1294
00:54:12,590 --> 00:54:18,620
take to do this but continue to do a

1295
00:54:15,199 --> 00:54:21,230
much larger target search for objects

1296
00:54:18,619 --> 00:54:22,579
for New Horizons to look at and so it's

1297
00:54:21,230 --> 00:54:24,559

going to search the part of the sky that

1298

00:54:22,579 --> 00:54:27,079

New Horizons will be flying through and

1299

00:54:24,559 --> 00:54:29,630

Hubble will be able to have been able to

1300

00:54:27,079 --> 00:54:31,670

not only help new horizons by looking at

1301

00:54:29,630 --> 00:54:33,829

the Pluto system and all the objects in

1302

00:54:31,670 --> 00:54:36,650

it but also to now examine the Kuiper

1303

00:54:33,829 --> 00:54:39,139

belt and find new targets printing

1304

00:54:36,650 --> 00:54:42,470

horizons to look at so let me get this

1305

00:54:39,139 --> 00:54:45,079

try so as New Horizons flies after it's

1306

00:54:42,469 --> 00:54:46,579

done its flyby of Pluto Hubble is going

1307

00:54:45,079 --> 00:54:48,199

to very quickly go out there say okay

1308

00:54:46,579 --> 00:54:50,059

now go over here look at this thing this

1309

00:54:48,199 --> 00:54:52,460

one's pretty cool and it's gonna sort of

1310

00:54:50,059 --> 00:54:54,909

gauge in real time what it's going to

1311

00:54:52,460 --> 00:54:57,980

look at or how is that going to work I

1312
00:54:54,909 --> 00:54:59,599
my expectation I'm not involved in the

1313
00:54:57,980 --> 00:55:03,320
planning of it but my expectation is

1314
00:54:59,599 --> 00:55:05,449
that they have a limited amount of

1315
00:55:03,320 --> 00:55:07,789
thruster that they do to change course

1316
00:55:05,449 --> 00:55:11,509
and to get near one of these objects is

1317
00:55:07,789 --> 00:55:14,150
always trying to hit you know a dime on

1318
00:55:11,510 --> 00:55:15,920
the other side of the country and so you

1319
00:55:14,150 --> 00:55:19,240
know your true really trying to do vary

1320
00:55:15,920 --> 00:55:21,800
so a object when Hubble will go through

1321
00:55:19,239 --> 00:55:25,009
assemble a list of candidates possible

1322
00:55:21,800 --> 00:55:27,140
targets the investigators with New

1323
00:55:25,010 --> 00:55:28,520
Horizons will choose one of them and say

1324
00:55:27,139 --> 00:55:30,259
okay this is the object we're going to

1325
00:55:28,519 --> 00:55:32,840
try and study and they will calculate

1326
00:55:30,260 --> 00:55:34,370
what kind of thrust do they need to get

1327
00:55:32,840 --> 00:55:36,860
to maneuver the spaceship after it

1328
00:55:34,369 --> 00:55:37,759
passes through the Pluto system what

1329
00:55:36,860 --> 00:55:40,309
kind of thrust

1330
00:55:37,760 --> 00:55:42,170
does it need to then do a course

1331
00:55:40,309 --> 00:55:44,059
correction to try and get it to go past

1332
00:55:42,170 --> 00:55:45,769
one of these objects and then all of

1333
00:55:44,059 --> 00:55:48,170
their focus will be on got that one

1334
00:55:45,769 --> 00:55:49,460
selected object no I don't think we I

1335
00:55:48,170 --> 00:55:51,409
don't think we'll be able to get more

1336
00:55:49,460 --> 00:55:53,750
than one if we got really really really

1337
00:55:51,409 --> 00:55:55,849
really lucky maybe two of them would

1338
00:55:53,750 --> 00:56:00,409
line up that you can't go past one and

1339
00:55:55,849 --> 00:56:01,759
then go past another but you know this

1340

00:56:00,409 --> 00:56:05,149
is not like Hollywood's view of the

1341
00:56:01,760 --> 00:56:06,890
asteroid belt okay if we always go back

1342
00:56:05,150 --> 00:56:09,470
to what was at the empire strikes back

1343
00:56:06,889 --> 00:56:11,210
oh yeah the important my name Falcon

1344
00:56:09,469 --> 00:56:15,079
zooming bass through the asteroids

1345
00:56:11,210 --> 00:56:18,559
that's BS sorry the asteroid belt is so

1346
00:56:15,079 --> 00:56:22,309
bloody empty that work extremely hard

1347
00:56:18,559 --> 00:56:24,710
just to find any asteroids um the Kuiper

1348
00:56:22,309 --> 00:56:26,420
belt is even worse okay there are more

1349
00:56:24,710 --> 00:56:27,800
objects in the Kuiper belt but their

1350
00:56:26,420 --> 00:56:30,920
father apart i mean we're talking

1351
00:56:27,800 --> 00:56:33,500
millions of miles apart really so you

1352
00:56:30,920 --> 00:56:35,090
got to work really really really hard to

1353
00:56:33,500 --> 00:56:38,000
get anywhere near any one of these

1354
00:56:35,090 --> 00:56:39,530

objects sorry it's not like the cat the

1355

00:56:38,000 --> 00:56:43,849

New Horizons mission is going to have a

1356

00:56:39,530 --> 00:56:45,740

you know a video game trying to slalom

1357

00:56:43,849 --> 00:56:47,119

through all these objects really it's

1358

00:56:45,739 --> 00:56:49,129

going to have to work really hard just

1359

00:56:47,119 --> 00:56:51,469

to find one of them in order to look

1360

00:56:49,130 --> 00:56:56,210

forward well this always built into the

1361

00:56:51,469 --> 00:56:59,059

New Horizons mission plan for couple to

1362

00:56:56,210 --> 00:57:02,420

do this well having Hubble do this I

1363

00:56:59,059 --> 00:57:04,130

don't believe so but having the

1364

00:57:02,420 --> 00:57:07,159

opportunity to look at the Kuiper belt

1365

00:57:04,130 --> 00:57:08,360

has always been there but it wasn't part

1366

00:57:07,159 --> 00:57:09,889

of the original funding the original

1367

00:57:08,360 --> 00:57:12,530

funding for new horizons was just to go

1368

00:57:09,889 --> 00:57:14,750

out and examine Pluto and it's always

1369
00:57:12,530 --> 00:57:16,250
been in the P eyes mind and all the sign

1370
00:57:14,750 --> 00:57:17,900
all the astronomers I know who work on

1371
00:57:16,250 --> 00:57:19,039
the mission always have said yeah we got

1372
00:57:17,900 --> 00:57:20,780
a look at the Kuiper belt it just seems

1373
00:57:19,039 --> 00:57:23,300
reasonable you spend all this money to

1374
00:57:20,780 --> 00:57:25,940
get out to Pluto you can't tell me we're

1375
00:57:23,300 --> 00:57:28,550
not going to look further but when they

1376
00:57:25,940 --> 00:57:30,530
proposed it the Kuiper belt was not well

1377
00:57:28,550 --> 00:57:33,800
known we didn't have these 1,200 objects

1378
00:57:30,530 --> 00:57:36,920
we maybe had a you know 50 or 100 when

1379
00:57:33,800 --> 00:57:39,530
it first got funded so that you couldn't

1380
00:57:36,920 --> 00:57:41,059
plan on it but now the idea now that our

1381
00:57:39,530 --> 00:57:43,370
knowledge has grown over the years that

1382
00:57:41,059 --> 00:57:46,190
New Horizons has been built and has been

1383
00:57:43,369 --> 00:57:49,099
flying we now have I think it's a

1384
00:57:46,190 --> 00:57:50,840
no-brainer that we should try and try

1385
00:57:49,099 --> 00:57:51,460
and do this and Hubble really has turned

1386
00:57:50,840 --> 00:57:55,440
out to be

1387
00:57:51,460 --> 00:57:58,119
one of the good one of the good

1388
00:57:55,440 --> 00:58:00,610
telescopes for finding the possible

1389
00:57:58,119 --> 00:58:02,319
targets and I think we're planning on

1390
00:58:00,610 --> 00:58:03,490
trying to organize a hang out with the

1391
00:58:02,320 --> 00:58:06,190
guys that might be doing that

1392
00:58:03,489 --> 00:58:08,289
observation in the coming year so so

1393
00:58:06,190 --> 00:58:11,110
look for that as well so okay cool okay

1394
00:58:08,289 --> 00:58:14,050
well she got Frank um that's it but we

1395
00:58:11,110 --> 00:58:16,240
just wanted to remind people that we do

1396
00:58:14,050 --> 00:58:18,460
more that we do a lots of other things

1397

00:58:16,239 --> 00:58:21,279
for the public and in particular I host

1398
00:58:18,460 --> 00:58:25,119
the public lecture series and remind me

1399
00:58:21,280 --> 00:58:27,040
on August fifth 2014 we have dr.

1400
00:58:25,119 --> 00:58:29,380
Jennifer lots from the Space Telescope

1401
00:58:27,039 --> 00:58:32,529
Science Institute talking about frontier

1402
00:58:29,380 --> 00:58:35,470
fields a sneak peek at the first billion

1403
00:58:32,530 --> 00:58:41,200
years of i miss the s in that one first

1404
00:58:35,469 --> 00:58:43,419
billion years of the universe year yeah

1405
00:58:41,199 --> 00:58:45,039
now you've had Jenna on some hangouts

1406
00:58:43,420 --> 00:58:46,990
haven't you that's true now anybody

1407
00:58:45,039 --> 00:58:48,369
who's watched Hubble hangouts and with

1408
00:58:46,989 --> 00:58:50,169
if for any length of time has seen

1409
00:58:48,369 --> 00:58:52,630
several now we've had several frontier

1410
00:58:50,170 --> 00:58:54,880
fields hangouts but we've all we've

1411
00:58:52,630 --> 00:58:57,640

targeted on specific ideas and subjects

1412

00:58:54,880 --> 00:58:59,950

and so this will be a good overview of

1413

00:58:57,639 --> 00:59:01,299

what the science and and and what

1414

00:58:59,949 --> 00:59:03,009

they're what we're doing how they're

1415

00:59:01,300 --> 00:59:05,230

making Hubble more powerful by using

1416

00:59:03,010 --> 00:59:06,670

gravity gravitational lenses so that'll

1417

00:59:05,230 --> 00:59:09,519

be it should be a really good one and it

1418

00:59:06,670 --> 00:59:12,849

will be in addition to being webcast on

1419

00:59:09,519 --> 00:59:14,889

our one webcast is DSD i dot edu it will

1420

00:59:12,849 --> 00:59:16,719

also be on youtube on this channel so

1421

00:59:14,889 --> 00:59:19,059

right well Tony does a fantastic job of

1422

00:59:16,719 --> 00:59:21,609

taking the streams that we film inside

1423

00:59:19,059 --> 00:59:23,559

the auditorium and they're up on youtube

1424

00:59:21,610 --> 00:59:25,360

and we got a great response we want to

1425

00:59:23,559 --> 00:59:27,579

thank you all for coming and watching

1426
00:59:25,360 --> 00:59:30,070
those on the YouTube channel most of its

1427
00:59:27,579 --> 00:59:32,079
really it's nice that the speakers

1428
00:59:30,070 --> 00:59:33,970
really appreciate it because they get

1429
00:59:32,079 --> 00:59:35,529
the you know we may have a hundred

1430
00:59:33,969 --> 00:59:38,649
hundred and fifty people in the audience

1431
00:59:35,530 --> 00:59:40,930
but when you then get 5,000 hits 3000

1432
00:59:38,650 --> 00:59:42,760
5000 hits on YouTube you realize wow I'm

1433
00:59:40,929 --> 00:59:45,429
hitting a much bigger audience too and

1434
00:59:42,760 --> 00:59:48,010
that's right and while sometimes Frank

1435
00:59:45,429 --> 00:59:50,199
tries to look at the comments that you

1436
00:59:48,010 --> 00:59:51,730
guys are doing live while the talk has

1437
00:59:50,199 --> 00:59:52,989
happened he's also having to moderate

1438
00:59:51,730 --> 00:59:54,849
the talk so he doesn't always get a

1439
00:59:52,989 --> 00:59:56,409
chance to I will also be there though

1440
00:59:54,849 --> 00:59:58,360
looking at comments so it's okay to

1441
00:59:56,409 --> 00:59:59,949
leave comments on YouTube and Twitter

1442
00:59:58,360 --> 01:00:01,510
and anything else and we will try and

1443
00:59:59,949 --> 01:00:04,529
respond during that during the lecture

1444
01:00:01,510 --> 01:00:06,420
itself if you happen to catch it live so

1445
01:00:04,530 --> 01:00:10,140
we got any questions for today well

1446
01:00:06,420 --> 01:00:14,220
let's see um so from the I mean look

1447
01:00:10,139 --> 01:00:16,769
here from the UH from YouTube we have uh

1448
01:00:14,219 --> 01:00:18,389
this is from galaxia that goes maybe

1449
01:00:16,769 --> 01:00:21,780
when you were talking about the red spot

1450
01:00:18,389 --> 01:00:24,960
said maybe baby red spot and Big Brother

1451
01:00:21,780 --> 01:00:26,490
red spot will become one red spot what

1452
01:00:24,960 --> 01:00:31,970
do you think of that well these these

1453
01:00:26,489 --> 01:00:34,729
spots merge okay so red spot junior and

1454

01:00:31,969 --> 01:00:40,409
the Great Red Spot have been coexisting

1455
01:00:34,730 --> 01:00:42,480
for what over a decade now red spot

1456
01:00:40,409 --> 01:00:44,279
junior is at a different latitude and it

1457
01:00:42,480 --> 01:00:49,019
passes underneath as I showed that one

1458
01:00:44,280 --> 01:00:54,600
image it passes underneath the this the

1459
01:00:49,019 --> 01:00:58,170
the latitude of Great Red Spot so based

1460
01:00:54,599 --> 01:01:00,110
on ten years of evidence no they're not

1461
01:00:58,170 --> 01:01:02,070
going to merge to become one red spot

1462
01:01:00,110 --> 01:01:04,289
and that's one of the things you might

1463
01:01:02,070 --> 01:01:06,780
be thinking of that somebody else's I

1464
01:01:04,289 --> 01:01:08,610
would be thinking well maybe that the

1465
01:01:06,780 --> 01:01:10,290
Great Red Spot is shrunk because some of

1466
01:01:08,610 --> 01:01:12,870
the energy is now coming out through red

1467
01:01:10,289 --> 01:01:14,940
spot jr. and that could account for some

1468
01:01:12,869 --> 01:01:17,639

of it but certainly not all of the

1469

01:01:14,940 --> 01:01:19,650

shrinking of the of the of the red spot

1470

01:01:17,639 --> 01:01:21,480

yeah there you go yeah here's what we're

1471

01:01:19,650 --> 01:01:23,789

talking about so this was this was the

1472

01:01:21,480 --> 01:01:27,389

image that Frank was showing from from

1473

01:01:23,789 --> 01:01:28,710

Gemini so yeah it's still it's amazing

1474

01:01:27,389 --> 01:01:30,659

to me i remember when i was in solar

1475

01:01:28,710 --> 01:01:32,670

physics was amazing to me when I always

1476

01:01:30,659 --> 01:01:34,500

said you know it's amazing what we don't

1477

01:01:32,670 --> 01:01:35,849

know about the Sun and now the same is

1478

01:01:34,500 --> 01:01:37,349

true about some of these features on our

1479

01:01:35,849 --> 01:01:40,019

own planets but it's amazing what we

1480

01:01:37,349 --> 01:01:41,549

don't know about some of the features of

1481

01:01:40,019 --> 01:01:43,590

the of the of the planets in our solar

1482

01:01:41,550 --> 01:01:47,039

system so good question and thank you

1483
01:01:43,590 --> 01:01:48,600
for that stargazer nation is saying also

1484
01:01:47,039 --> 01:01:50,190
from YouTube and I find this funny that

1485
01:01:48,599 --> 01:01:54,509
he's able to get the little trademark in

1486
01:01:50,190 --> 01:01:57,030
his username that time again T darnet

1487
01:01:54,510 --> 01:01:59,460
Tony Darnell also I cannot believe these

1488
01:01:57,030 --> 01:02:02,850
images are near on 20 years old already

1489
01:01:59,460 --> 01:02:04,650
it's crazy and and I well it's worse

1490
01:02:02,849 --> 01:02:05,869
this better than that out where is in

1491
01:02:04,650 --> 01:02:09,300
the coming year we're celebrating

1492
01:02:05,869 --> 01:02:12,089
Hubble's 25th anniversary there's over

1493
01:02:09,300 --> 01:02:13,950
cutely that's right we're talking we're

1494
01:02:12,090 --> 01:02:16,170
emphasizing something called a Hubble

1495
01:02:13,949 --> 01:02:18,239
generation where there are people out

1496
01:02:16,170 --> 01:02:20,280
there now who

1497
01:02:18,239 --> 01:02:21,989
no overtime who don't know of a life

1498
01:02:20,280 --> 01:02:24,060
where there was not a Hubble Space

1499
01:02:21,989 --> 01:02:27,000
Telescope and my son is only 18 years

1500
01:02:24,059 --> 01:02:29,880
old he has never known a time when there

1501
01:02:27,000 --> 01:02:33,510
wasn't a Hubble Space Telescope that's

1502
01:02:29,880 --> 01:02:35,579
right both of my sons are 19 and 21 and

1503
01:02:33,510 --> 01:02:38,250
they don't either so it's amazing to

1504
01:02:35,579 --> 01:02:40,139
think about it really is Jordan Raines

1505
01:02:38,250 --> 01:02:42,030
is asking from YouTube I'm being good

1506
01:02:40,139 --> 01:02:44,309
Hubble can photograph galaxies that are

1507
01:02:42,030 --> 01:02:46,410
light-years away in vivid color do you

1508
01:02:44,309 --> 01:02:49,590
think we will ever get a clear up close

1509
01:02:46,409 --> 01:02:53,039
vivid photo of our own moon or is that

1510
01:02:49,590 --> 01:02:55,070
off limits okay thanks Jordan for this

1511

01:02:53,039 --> 01:02:58,769
question because we get this a lot

1512
01:02:55,070 --> 01:03:01,530
Hubble doesn't look at the moon simply

1513
01:02:58,769 --> 01:03:04,860
because it can only look at a very small

1514
01:03:01,530 --> 01:03:08,040
portion of the moon all right Hubble's

1515
01:03:04,860 --> 01:03:09,720
field of view on the skies I said there

1516
01:03:08,039 --> 01:03:13,409
are 12 million patches about the same

1517
01:03:09,719 --> 01:03:15,989
size and there are other telescopes the

1518
01:03:13,409 --> 01:03:18,710
moon is so bright that other telescopes

1519
01:03:15,989 --> 01:03:22,979
can get the moon better than Hubble can

1520
01:03:18,710 --> 01:03:25,970
it's not off limits in terms of can we

1521
01:03:22,980 --> 01:03:29,070
make observations of the moon but

1522
01:03:25,969 --> 01:03:31,500
scientifically you can get there are

1523
01:03:29,070 --> 01:03:33,840
missions like the LRO the Lunar

1524
01:03:31,500 --> 01:03:35,280
Reconnaissance Orbiter there we've been

1525
01:03:33,840 --> 01:03:37,650

to the moon you know with the Apollo

1526

01:03:35,280 --> 01:03:39,150

missions the other missions ground-based

1527

01:03:37,650 --> 01:03:40,559

telescopes can get really good

1528

01:03:39,150 --> 01:03:43,170

observations of the moon because it's so

1529

01:03:40,559 --> 01:03:44,940

bright and so big that Hubble doesn't

1530

01:03:43,170 --> 01:03:48,420

provide a significant advantage in

1531

01:03:44,940 --> 01:03:51,119

looking at the moon the one point that

1532

01:03:48,420 --> 01:03:54,690

you say is a clear up close photo of our

1533

01:03:51,119 --> 01:03:57,869

mo our own moon even app even with

1534

01:03:54,690 --> 01:04:01,019

Hubble Hubble's pixel resolution at the

1535

01:03:57,869 --> 01:04:04,170

distance of the moon one pixel is about

1536

01:04:01,019 --> 01:04:06,000

the size of a football field so we

1537

01:04:04,170 --> 01:04:08,760

people always say oh can the Hubble go

1538

01:04:06,000 --> 01:04:11,940

see the Apollo Landers no we can't see

1539

01:04:08,760 --> 01:04:14,430

the pollo lenders it have to be the size

1540
01:04:11,940 --> 01:04:17,280
of a football field or larger before

1541
01:04:14,429 --> 01:04:19,889
Hubble can start to resolve it good

1542
01:04:17,280 --> 01:04:22,109
question ok so i'm going to go switch

1543
01:04:19,889 --> 01:04:26,219
real quick see what's over the Q&A app i

1544
01:04:22,108 --> 01:04:29,369
was looking at youtube ron smith is

1545
01:04:26,219 --> 01:04:31,289
asking from the youtube app if nope no

1546
01:04:29,369 --> 01:04:31,840
object can be found to fly by after

1547
01:04:31,289 --> 01:04:34,289
Pluto

1548
01:04:31,840 --> 01:04:37,840
where will it go this is from Ronson

1549
01:04:34,289 --> 01:04:39,489
well we do have the two Voyager

1550
01:04:37,840 --> 01:04:41,829
satellites that are continuing out of

1551
01:04:39,489 --> 01:04:44,259
the solar system and New Horizons will

1552
01:04:41,829 --> 01:04:46,989
continue on a similar trajectory heading

1553
01:04:44,260 --> 01:04:51,220
out of the solar system New Horizons has

1554
01:04:46,989 --> 01:04:54,189
gotten 30a you right 30 astronomical

1555
01:04:51,219 --> 01:04:58,509
units in 10 years a little less than 10

1556
01:04:54,190 --> 01:05:03,070
years the voyagers are at what about 105

1557
01:04:58,510 --> 01:05:05,860
au and 120 a you don't mozilla yeah and

1558
01:05:03,070 --> 01:05:08,680
a few decades then New Horizons will

1559
01:05:05,860 --> 01:05:10,480
also go through the the outer parts of

1560
01:05:08,679 --> 01:05:12,549
the solar system into the heliopause and

1561
01:05:10,480 --> 01:05:14,829
the heliosheath and make it into

1562
01:05:12,550 --> 01:05:16,510
interstellar space so that is its

1563
01:05:14,829 --> 01:05:19,569
ultimate fate no matter what even if it

1564
01:05:16,510 --> 01:05:21,670
does find something else to look at the

1565
01:05:19,570 --> 01:05:23,650
question is what scientists observe

1566
01:05:21,670 --> 01:05:26,590
ations can it make while it's on its way

1567
01:05:23,650 --> 01:05:28,809
out there the Voyager satellites are

1568

01:05:26,590 --> 01:05:30,820
still sending back tiny tiny tiny bits

1569
01:05:28,809 --> 01:05:35,529
of data but it is still sending back

1570
01:05:30,820 --> 01:05:38,470
some data about the magnetic field as we

1571
01:05:35,530 --> 01:05:40,060
pass from the magnetic the region of

1572
01:05:38,469 --> 01:05:43,329
space is dominated by the sun's magnetic

1573
01:05:40,059 --> 01:05:44,980
field and the sun's solar wind and the

1574
01:05:43,329 --> 01:05:46,900
region that's dominated by the winds

1575
01:05:44,980 --> 01:05:49,059
from interstellar stars the magnetic

1576
01:05:46,900 --> 01:05:51,670
fields from center stellar stars that's

1577
01:05:49,059 --> 01:05:54,059
what we call the heliopause and so I

1578
01:05:51,670 --> 01:05:56,349
don't know whether New Horizons

1579
01:05:54,059 --> 01:06:00,309
batteries will last long enough for it

1580
01:05:56,349 --> 01:06:02,799
to be able to transmit good information

1581
01:06:00,309 --> 01:06:04,380
there but I'm sure if it's possible the

1582
01:06:02,800 --> 01:06:07,330

astronomers will make sure it happens

1583

01:06:04,380 --> 01:06:09,670

great good one great question so Hugo

1584

01:06:07,329 --> 01:06:12,400

Burnham actually did the math when we

1585

01:06:09,670 --> 01:06:13,960

were talking about the the area of sky

1586

01:06:12,400 --> 01:06:16,180

for the Hubble Deep Field and he said

1587

01:06:13,960 --> 01:06:18,789

that be three hundred and seventy six

1588

01:06:16,179 --> 01:06:21,069

thousand seven hundred years okay I

1589

01:06:18,789 --> 01:06:23,590

calculations are correct for HST to

1590

01:06:21,070 --> 01:06:25,510

image the entire sky like the Hubble

1591

01:06:23,590 --> 01:06:26,440

Ultra Deep Field so thank you go for

1592

01:06:25,510 --> 01:06:28,690

going through the trouble of doing the

1593

01:06:26,440 --> 01:06:30,610

math that's why you're a space fan I

1594

01:06:28,690 --> 01:06:34,119

mean that's what we do we do the math oh

1595

01:06:30,610 --> 01:06:36,220

yeah that's great I think it's a little

1596

01:06:34,119 --> 01:06:39,309

bit longer than Hubble's been scheduled

1597
01:06:36,219 --> 01:06:41,829
to operate but it's a little longer than

1598
01:06:39,309 --> 01:06:45,099
I'm scheduled to operate oh come on

1599
01:06:41,829 --> 01:06:45,590
doubt it me too actually so one final

1600
01:06:45,099 --> 01:06:47,420
question

1601
01:06:45,590 --> 01:06:50,000
we will have to do a sign-off will this

1602
01:06:47,420 --> 01:06:51,950
is from Adam synergy on the Q&A app will

1603
01:06:50,000 --> 01:06:54,230
new horizons be able to look back an

1604
01:06:51,949 --> 01:06:57,109
image the solar system in a similar way

1605
01:06:54,230 --> 01:06:58,219
to Voyager ask a question can I do that

1606
01:06:57,110 --> 01:07:00,890
will it be able to turn around and look

1607
01:06:58,219 --> 01:07:03,199
at us it has already done a little bit

1608
01:07:00,889 --> 01:07:09,440
of turning around and looking after it

1609
01:07:03,199 --> 01:07:11,449
passed by Jupiter the lor RI instrument

1610
01:07:09,440 --> 01:07:16,010
the lorry instrument long-range

1611
01:07:11,449 --> 01:07:17,689
something anyways look back at Jupiter

1612
01:07:16,010 --> 01:07:23,180
and was able to look at Jupiter and its

1613
01:07:17,690 --> 01:07:27,019
moons uh and looking back I'm sure that

1614
01:07:23,179 --> 01:07:29,989
as a target of opportunity that the P is

1615
01:07:27,019 --> 01:07:31,759
there would want to do that the the

1616
01:07:29,989 --> 01:07:34,189
shots looking back toward the Sun and

1617
01:07:31,760 --> 01:07:36,710
seeing the various planets are around

1618
01:07:34,190 --> 01:07:39,829
the Sun done with Voyager the the pale

1619
01:07:36,710 --> 01:07:44,360
blue dot shot I don't think it will

1620
01:07:39,829 --> 01:07:47,420
offer any amazingly improved level of an

1621
01:07:44,360 --> 01:07:49,910
observation there but I don't know we'll

1622
01:07:47,420 --> 01:07:53,119
see it would be it would be a fun thing

1623
01:07:49,909 --> 01:07:54,859
to do and send your letters to Alan

1624
01:07:53,119 --> 01:07:57,349
Stern and say Alan we really need

1625

01:07:54,860 --> 01:07:58,519
another pale blue dot image okay of

1626
01:07:57,349 --> 01:07:59,779
course he's going to be pretty busy for

1627
01:07:58,519 --> 01:08:01,759
the next year plant you make sure the

1628
01:07:59,780 --> 01:08:04,550
Pluto encounter goes well so he probably

1629
01:08:01,760 --> 01:08:05,990
won't respond right away all right

1630
01:08:04,550 --> 01:08:09,019
thanks adam has a good question or good

1631
01:08:05,989 --> 01:08:11,029
kind of good questions so i guess we

1632
01:08:09,019 --> 01:08:12,769
will stop here thank you Frank this was

1633
01:08:11,030 --> 01:08:14,720
a great one a lot of good information so

1634
01:08:12,769 --> 01:08:16,460
thanks for taking the time out and and

1635
01:08:14,719 --> 01:08:19,189
hanging out with us and getting getting

1636
01:08:16,460 --> 01:08:21,319
this at this news out we will try to do

1637
01:08:19,189 --> 01:08:23,149
we're going to do this again next next

1638
01:08:21,319 --> 01:08:25,539
in August you're going to be able to do

1639
01:08:23,149 --> 01:08:28,250

it in the likes what is it August sixth

1640

01:08:25,539 --> 01:08:30,050

let's see I guess fifth will be of

1641

01:08:28,250 --> 01:08:31,909

course the public battery solid lecture

1642

01:08:30,050 --> 01:08:33,920

so will you may be the next day you

1643

01:08:31,909 --> 01:08:35,930

think or the next day august six that

1644

01:08:33,920 --> 01:08:37,338

will work fine all right so we'll look

1645

01:08:35,930 --> 01:08:39,200

forward to talking to you then so don't

1646

01:08:37,338 --> 01:08:41,630

forget I like Frank said August fifth is

1647

01:08:39,199 --> 01:08:43,519

the next public lecture the Hubble

1648

01:08:41,630 --> 01:08:45,470

public lecture series I will if you

1649

01:08:43,520 --> 01:08:48,140

subscribe to Hubble site channel on

1650

01:08:45,470 --> 01:08:50,329

YouTube you'll get notified when the

1651

01:08:48,140 --> 01:08:52,010

event is set up so you'll you won't have

1652

01:08:50,329 --> 01:08:54,500

to remember it so we hope you guys will

1653

01:08:52,010 --> 01:08:57,050

check it out tomorrow i want to remind

1654
01:08:54,500 --> 01:08:57,509
everybody is our next weekly Hubble hang

1655
01:08:57,050 --> 01:08:59,909
out

1656
01:08:57,509 --> 01:09:05,429
that one will be about planetary irori

1657
01:08:59,908 --> 01:09:07,798
with dr. Laurent Lambie from from the

1658
01:09:05,429 --> 01:09:09,509
from France I forget the exact uh I

1659
01:09:07,798 --> 01:09:11,038
don't have it in front of me his his

1660
01:09:09,509 --> 01:09:12,809
organization but we hope you will be

1661
01:09:11,038 --> 01:09:14,788
able to watch and learn about Aurora

1662
01:09:12,809 --> 01:09:16,920
from other planets in our solar system

1663
01:09:14,788 --> 01:09:18,658
not just Earth's he's done a lot of good

1664
01:09:16,920 --> 01:09:21,509
research in that area and that will be

1665
01:09:18,658 --> 01:09:24,658
tomorrow at three p.m. eastern daylight

1666
01:09:21,509 --> 01:09:26,609
time and seven o'clock out in for our

1667
01:09:24,658 --> 01:09:28,649
friends out in the UK so we hope you

1668
01:09:26,609 --> 01:09:30,630
guys can join us Frank thank you again

1669
01:09:28,649 --> 01:09:33,568
so much it's always a lot of fun and we

1670
01:09:30,630 --> 01:09:35,578
will see you guys next next month for

1671
01:09:33,569 --> 01:09:37,349
news you know we should we should make

1672
01:09:35,578 --> 01:09:39,268
our own that make our own hang out you

1673
01:09:37,349 --> 01:09:40,798
know news from Hubble and across the

1674
01:09:39,269 --> 01:09:43,969
universe with Parker Frank summers how

1675
01:09:40,798 --> 01:09:46,828
the bump bump uh-huh gotta have to

1676
01:09:43,969 --> 01:09:48,359
forget that theme music right ok thanks

1677
01:09:46,828 --> 01:09:50,130
tony is a lot of fun thanks everybody

1678
01:09:48,359 --> 01:09:51,809
the great questions yeah thank you guys

1679
01:09:50,130 --> 01:09:55,548
thank you all for watching and as always

1680
01:09:51,809 --> 01:09:55,548
keep looking up