
HUBBLE
hangouts
News from Hubble and Across the Universe
With Dr. Frank Summers
Wednesday, July 9, 2014, 4pm EDT, 8pm UTC

1
00:00:07,259 --> 00:00:03,959
hello everybody welcome to our latest

2
00:00:09,539 --> 00:00:07,269
Hubble hangout and this is our monthly

3
00:00:10,860 --> 00:00:09,549
installment of news from Hubble and

4
00:00:13,440 --> 00:00:10,870
across the universe with doctor Frank

5
00:00:15,410 --> 00:00:13,450
summers so we are we had a really great

6
00:00:17,940 --> 00:00:15,420
hangout plan for you today so welcome

7
00:00:20,520 --> 00:00:17,950
nominally I have to apologize first off

8
00:00:23,910 --> 00:00:20,530
nominally we try to do these on a on a

9
00:00:26,490 --> 00:00:23,920
on the same time roughly after the the

10
00:00:27,690 --> 00:00:26,500
as soon as we can after the public

11
00:00:29,370 --> 00:00:27,700
lecture series is held on the first

12
00:00:31,350 --> 00:00:29,380
tuesday of each month but sometimes

13
00:00:33,209 --> 00:00:31,360

let's get in the way and we can't always

14
00:00:35,040 --> 00:00:33,219
do it exactly when we'd like so thank

15
00:00:37,860 --> 00:00:35,050
you for your patience we've pushed it

16
00:00:40,709 --> 00:00:37,870
back a little bit into the month of july

17
00:00:42,150 --> 00:00:40,719
but we're here and frank is with us and

18
00:00:44,250 --> 00:00:42,160
i'm excited to talk about all this time

19
00:00:45,450 --> 00:00:44,260
I've seen is I've seen the outline of

20
00:00:47,700 --> 00:00:45,460
some of the things he's going to show us

21
00:00:49,319 --> 00:00:47,710
today so I'm very excited about this but

22
00:00:51,599 --> 00:00:49,329
before I get started with Frank let me

23
00:00:53,389 --> 00:00:51,609
remind you that we are monitoring that

24
00:00:55,529 --> 00:00:53,399
we are inviting and we hope you will

25
00:00:57,619 --> 00:00:55,539
communicate with us we're ask us

26
00:01:00,119 --> 00:00:57,629
questions leave us comments tweet at us

27
00:01:03,509 --> 00:01:00,129
in the following ways you've got the QA

28
00:01:06,360 --> 00:01:03,519
a pop on YouTube and G+ you can also

29
00:01:08,790 --> 00:01:06,370
tweet using the hashtag hubble hang out

30
00:01:11,280 --> 00:01:08,800
I finally did it without stuttering and

31
00:01:13,530 --> 00:01:11,290
we are also monitoring the comments on

32
00:01:14,790 --> 00:01:13,540
the Google+ event page so please let us

33
00:01:16,350 --> 00:01:14,800
know if you have any questions for

34
00:01:19,680 --> 00:01:16,360
Franco or I will be happy to talk about

35
00:01:22,140 --> 00:01:19,690
them and so without that any more ado

36
00:01:24,480 --> 00:01:22,150
let's go ahead and get started Frank

37
00:01:25,980 --> 00:01:24,490
summers the he is the outreach

38
00:01:27,270 --> 00:01:25,990

astronomer for the hubble space

39
00:01:30,360 --> 00:01:27,280
telescope in space telescope science

40
00:01:32,730 --> 00:01:30,370
institute and he every month joins he

41
00:01:33,930 --> 00:01:32,740
gets together with us to talk about some

42
00:01:36,840 --> 00:01:33,940
of the greatest things that not only

43
00:01:38,850 --> 00:01:36,850
helpful is doing but also great science

44
00:01:40,890 --> 00:01:38,860
across the universe so welcome Frank how

45
00:01:44,100 --> 00:01:40,900
are you doing hey chuny good to be with

46
00:01:46,500 --> 00:01:44,110
you this month we did we miss did we

47
00:01:51,120 --> 00:01:46,510
miss June we miss June I just checked it

48
00:01:53,220 --> 00:01:51,130
i checked my my my talk listings and i

49
00:01:54,780 --> 00:01:53,230
was like oh we miss june because i was

50
00:01:58,140 --> 00:01:54,790
at the double-a s remember in june

51
00:01:59,910 --> 00:01:58,150
that's right alright and then the reason

52
00:02:03,150 --> 00:01:59,920
why this is late is because every summer

53
00:02:04,560 --> 00:02:03,160
i do a ton of teacher workshops we have

54
00:02:06,930 --> 00:02:04,570
a partnership with penn state university

55
00:02:10,080 --> 00:02:06,940
where we teach hundreds of teachers in

56
00:02:13,360 --> 00:02:10,090
the first part of the summer so i have a

57
00:02:16,539 --> 00:02:13,370
lot of talks to prepare and give and

58
00:02:20,259 --> 00:02:16,549
was unable to prep this for June and

59
00:02:21,729 --> 00:02:20,269
even last week I just got swamped by

60
00:02:24,369 --> 00:02:21,739
things and ones had to push it back a

61
00:02:26,680 --> 00:02:24,379
week but I'm here I got some fun stuff

62
00:02:28,360 --> 00:02:26,690
to talk about I actually I think I went

63
00:02:30,940 --> 00:02:28,370

a little overboard today tony is because

64
00:02:32,559 --> 00:02:30,950
i have another for two months now okay

65
00:02:33,850 --> 00:02:32,569
well before we get you started now that

66
00:02:35,410 --> 00:02:33,860
you were talking about the teacher stuff

67
00:02:37,750 --> 00:02:35,420
i just want to ask you real quick before

68
00:02:39,580 --> 00:02:37,760
we get going on what you prepared when

69
00:02:41,680 --> 00:02:39,590
you do a lot of work for teachers and

70
00:02:43,180 --> 00:02:41,690
educators up for the educate for the

71
00:02:44,530 --> 00:02:43,190
teachers who might be watching this is

72
00:02:47,039 --> 00:02:44,540
there a way in which they can get

73
00:02:49,390 --> 00:02:47,049
involved in what you're doing in those

74
00:02:51,190 --> 00:02:49,400
presentations or you know do we have

75
00:02:53,259 --> 00:02:51,200
resources we could point them to at some

76
00:02:54,520 --> 00:02:53,269
point well this is something that i

77
00:02:56,440 --> 00:02:54,530
think we need to develop a little bit

78
00:02:59,890 --> 00:02:56,450
better we have of course our amazing

79
00:03:03,490 --> 00:02:59,900
space website amazing hyphen space stsci

80
00:03:06,699 --> 00:03:03,500
edu and that is a tremendous educational

81
00:03:08,860 --> 00:03:06,709
resource people from all 50 states use

82
00:03:10,860 --> 00:03:08,870
it it's used by lots and lots of

83
00:03:13,990 --> 00:03:10,870
teachers and students around the country

84
00:03:16,869 --> 00:03:14,000
however the workshops that we do we

85
00:03:21,129 --> 00:03:16,879
generally do in partnership with various

86
00:03:23,020 --> 00:03:21,139
universities or schools or groups that

87
00:03:25,539 --> 00:03:23,030
can we can provide we can work with

88
00:03:27,670 --> 00:03:25,549

teachers over and over again and because

89
00:03:29,740 --> 00:03:27,680
we've already set up things that are

90
00:03:31,539 --> 00:03:29,750
better preview arranged right because

91
00:03:34,720 --> 00:03:31,549
the most important thing for us to do is

92
00:03:36,309 --> 00:03:34,730
to create our materials and try them out

93
00:03:39,569 --> 00:03:36,319
with select groups of teachers and

94
00:03:41,830 --> 00:03:39,579
students and then get feedback on

95
00:03:43,900 --> 00:03:41,840
whether they worked or how well they

96
00:03:45,189 --> 00:03:43,910
worked you know because if i go to if i

97
00:03:46,479 --> 00:03:45,199
do a teacher workshop and i tell

98
00:03:47,800 --> 00:03:46,489
teachers hey here's this really cool

99
00:03:49,689 --> 00:03:47,810
thing you can do in your classroom and

100
00:03:51,250 --> 00:03:49,699
then they get back to the classroom and

101
00:03:53,140 --> 00:03:51,260
say well it doesn't really quite work

102
00:03:54,939 --> 00:03:53,150
that way that's what gives us the

103
00:03:57,879 --> 00:03:54,949
feedback to help us help make sure it

104
00:04:00,400 --> 00:03:57,889
works now a lot of our old projects are

105
00:04:02,589 --> 00:04:00,410
being used in all 50 states we're

106
00:04:05,640 --> 00:04:02,599
actually recommended by something like

107
00:04:07,869 --> 00:04:05,650
25 or 30 State Department of Education

108
00:04:09,699 --> 00:04:07,879
right the Department of Education

109
00:04:13,180 --> 00:04:09,709
innings in these states are specifying

110
00:04:14,770 --> 00:04:13,190
here this is material you should use so

111
00:04:17,140 --> 00:04:14,780
we know some of our material is being

112
00:04:18,699 --> 00:04:17,150
used an awful lot and we're constantly

113
00:04:20,439 --> 00:04:18,709

creating some new stuff we have actually

114
00:04:23,620 --> 00:04:20,449
a lot of fun with some gravitational

115
00:04:25,029 --> 00:04:23,630
lensing stuff this summer good so if

116
00:04:27,080 --> 00:04:25,039
you're a teacher watching this and you

117
00:04:29,689 --> 00:04:27,090
need some resources amazing that hyphens

118
00:04:32,240 --> 00:04:29,699
a start Hubble cyborg is the place to go

119
00:04:35,150 --> 00:04:32,250
and as DCI that eating out sorry I

120
00:04:37,340 --> 00:04:35,160
apologize up ssed you and look around

121
00:04:40,070 --> 00:04:37,350
for there and also i will just plug a

122
00:04:42,409 --> 00:04:40,080
brief preview there we are talking about

123
00:04:44,689 --> 00:04:42,419
and perhaps doing hangouts in a

124
00:04:46,550 --> 00:04:44,699
classroom with Frank and Bonnie when

125
00:04:47,870 --> 00:04:46,560
maybe we're working on it so hopefully

126
00:04:49,969 --> 00:04:47,880
that might be something that comes in

127
00:04:52,280 --> 00:04:49,979
our future as well so right lots of

128
00:04:55,879 --> 00:04:52,290
educational materials available right

129
00:04:58,100 --> 00:04:55,889
and we will we will hope to be able to

130
00:04:59,960 --> 00:04:58,110
do educational hangouts develop a list

131
00:05:02,629 --> 00:04:59,970
of teachers who want to participate in

132
00:05:04,640 --> 00:05:02,639
hangouts like this and start doing

133
00:05:06,680 --> 00:05:04,650
hangouts especially as the Hubble's 25th

134
00:05:08,270 --> 00:05:06,690
anniversary comes up next year we want

135
00:05:11,180 --> 00:05:08,280
to try and do some you know how old

136
00:05:14,210 --> 00:05:11,190
teachings or something via hangouts or

137
00:05:15,260 --> 00:05:14,220
such great ok thanks Frank I wanted it

138
00:05:16,550 --> 00:05:15,270

just popped into my mind when you were

139
00:05:17,780 --> 00:05:16,560
talking about educational materials I

140
00:05:19,790 --> 00:05:17,790
wanted to just what I'd get the word out

141
00:05:21,260 --> 00:05:19,800
that we do have quite a bit available

142
00:05:23,930 --> 00:05:21,270
for teachers ok so what do you have for

143
00:05:26,330 --> 00:05:23,940
us this month ok so if we switch to the

144
00:05:30,200 --> 00:05:26,340
PowerPoint it's news from Hubble and

145
00:05:32,779 --> 00:05:30,210
across the universe and up until this

146
00:05:34,580 --> 00:05:32,789
afternoon it was going to be only just

147
00:05:36,379 --> 00:05:34,590
across the solar system but then I

148
00:05:39,320 --> 00:05:36,389
realized oh wait a minute I hadn't there

149
00:05:43,100 --> 00:05:39,330
was a toss to story I had missed so our

150
00:05:47,060 --> 00:05:43,110
first story tonight c-spot watch Spot

151
00:05:49,279 --> 00:05:47,070
shrink shrink Spot shrink see talk about

152
00:05:51,200 --> 00:05:49,289
education materials yes we can do

153
00:05:52,850 --> 00:05:51,210
educational materials now Tony you have

154
00:05:56,330 --> 00:05:52,860
to recognize of course we have a large

155
00:05:59,860 --> 00:05:56,340
international contingent and they won't

156
00:06:02,690 --> 00:05:59,870
get the joke what this is a book that

157
00:06:04,159 --> 00:06:02,700
people of mine I guess our generation

158
00:06:05,420 --> 00:06:04,169
Frank you actually both for our

159
00:06:07,279 --> 00:06:05,430
generation because these started being

160
00:06:09,830 --> 00:06:07,289
coming out in nineteen thirty I found

161
00:06:13,700 --> 00:06:09,840
out today but research this I feel old

162
00:06:17,120 --> 00:06:13,710
okay from the 30s through the 60s into

163
00:06:19,219 --> 00:06:17,130

the 70s fun with Dick and Jane by two

164
00:06:22,339 --> 00:06:19,229
authors gray and sharp did these things

165
00:06:24,770 --> 00:06:22,349
and you can see in this this picture

166
00:06:26,420 --> 00:06:24,780
from the book they have a dog named spot

167
00:06:28,760 --> 00:06:26,430
and they do all these you know basic

168
00:06:31,400 --> 00:06:28,770
easy reading stuff and you know spots a

169
00:06:34,580 --> 00:06:31,410
good dog right but i'm not sure spots a

170
00:06:37,550 --> 00:06:34,590
great spot I mean really what a great

171
00:06:40,570 --> 00:06:37,560
spot okay you need to go to astronomy

172
00:06:44,090 --> 00:06:40,580
and of course to the planet Jupiter

173
00:06:46,550 --> 00:06:44,100
okay is the Great Red Spot on Jupiter

174
00:06:48,860 --> 00:06:46,560
actually right below it is a white oval

175
00:06:51,410 --> 00:06:48,870
that's actually pretty good too but the

176
00:06:55,010 --> 00:06:51,420
Great Red Spot on Jupiter is an amazing

177
00:06:57,410 --> 00:06:55,020
storm that is just well how great is it

178
00:07:01,580 --> 00:06:57,420
well if i switch to the next slide

179
00:07:05,150 --> 00:07:01,590
there's earth to the same scale this is

180
00:07:09,260 --> 00:07:05,160
a storm that is the same size as our

181
00:07:12,350 --> 00:07:09,270
entire planet okay I mean they got a

182
00:07:16,040 --> 00:07:12,360
giant storms on Jupiter and not only

183
00:07:18,380 --> 00:07:16,050
that it's a long-lived storm okay this

184
00:07:21,470 --> 00:07:18,390
is an Assad I think it's technically an

185
00:07:23,330 --> 00:07:21,480
anticyclone because the way it rotates

186
00:07:25,760 --> 00:07:23,340
this is a giant storm that has been

187
00:07:27,740 --> 00:07:25,770
there for many years we have

188
00:07:31,250 --> 00:07:27,750

observations back to the eight late

189
00:07:34,640 --> 00:07:31,260
1800s here is an image from elder in

190
00:07:37,760 --> 00:07:34,650
1881 where you see that Great Red Spot

191
00:07:40,730 --> 00:07:37,770
we have continuous observations for at

192
00:07:43,460 --> 00:07:40,740
least a hundred and fifty years of this

193
00:07:47,090 --> 00:07:43,470
Great Red Spot on Jupiter but that's not

194
00:07:50,330 --> 00:07:47,100
it that's not all we actually have this

195
00:07:54,380 --> 00:07:50,340
image this next image here from Giovanni

196
00:07:56,930 --> 00:07:54,390
Cassini in 1677 I had to go to the

197
00:07:59,330 --> 00:07:56,940
French National Library the bibliothèque

198
00:08:01,610 --> 00:07:59,340
nationale de France and they had

199
00:08:05,290 --> 00:08:01,620
digitized their archives and the journal

200
00:08:09,500 --> 00:08:05,300
de Sava in 1677 published this image of

201
00:08:10,790 --> 00:08:09,510
Jupiter by Cassini and that looks a lot

202
00:08:13,160 --> 00:08:10,800
like the red spot to me I don't know

203
00:08:15,590 --> 00:08:13,170
what you think but yeah yeah yeah it

204
00:08:17,120 --> 00:08:15,600
looks very neatly on top of it sitting

205
00:08:20,090 --> 00:08:17,130
neatly on top of that band but yes I

206
00:08:22,010 --> 00:08:20,100
read by the same planet so we don't have

207
00:08:24,520 --> 00:08:22,020
continuous operations but it might be

208
00:08:27,770 --> 00:08:24,530
that this is a storm that has lasted for

209
00:08:30,380 --> 00:08:27,780
350 years and of course Hubble has

210
00:08:33,730 --> 00:08:30,390
observed it Hubble has been up for 24

211
00:08:37,040 --> 00:08:33,740
years now and this is a Hubble heritage

212
00:08:38,240 --> 00:08:37,050
image of Jupiter's Great Red several

213
00:08:40,790 --> 00:08:38,250

several images of Jupiter's Great Red

214
00:08:42,770 --> 00:08:40,800
Spot over the 1990s okay this actually

215
00:08:44,720 --> 00:08:42,780
doesn't even include the the 2000s in

216
00:08:47,960 --> 00:08:44,730
here this is just Hubble's first ten

217
00:08:50,630 --> 00:08:47,970
years of observing the red spot and if

218
00:08:52,160 --> 00:08:50,640
you look at those images in detail you

219
00:08:53,700 --> 00:08:52,170
can see that the red spot is pretty

220
00:08:56,610 --> 00:08:53,710
constant it stay

221
00:08:58,770 --> 00:08:56,620
is roughly the same all right and so you

222
00:09:01,350 --> 00:08:58,780
know we've used to having the Great Red

223
00:09:05,970 --> 00:09:01,360
Spot around and being able to look at it

224
00:09:08,610 --> 00:09:05,980
and watch it continuously however the

225
00:09:10,500 --> 00:09:08,620
Red Spot has been slowly shrinking okay

226
00:09:11,790 --> 00:09:10,510
it has been shrinking over the decades

227
00:09:14,700 --> 00:09:11,800
when you compared to the other old

228
00:09:18,480 --> 00:09:14,710
observations right and even over

229
00:09:21,690 --> 00:09:18,490
Hubble's era it has been shrinking but

230
00:09:24,240 --> 00:09:21,700
that shrinking accelerated around the

231
00:09:26,820 --> 00:09:24,250
year two thousand nine or so so this

232
00:09:31,830 --> 00:09:26,830
image here has the Great Red Spot on the

233
00:09:33,720 --> 00:09:31,840
left as seen in april 2014 as well as

234
00:09:38,070 --> 00:09:33,730
these three images on the right that

235
00:09:41,430 --> 00:09:38,080
show the 1995 2009 and 2014 images all

236
00:09:43,860 --> 00:09:41,440
calibrated to be at the same scale and

237
00:09:45,390 --> 00:09:43,870
you can definitely see that it's you

238
00:09:47,820 --> 00:09:45,400

know it's got twenty thirty percent of

239
00:09:51,540 --> 00:09:47,830
it of its size seems to have gone away

240
00:09:53,690 --> 00:09:51,550
and that's really interesting okay

241
00:09:56,400 --> 00:09:53,700
because this has been around for so long

242
00:09:58,890 --> 00:09:56,410
and it seems like it's a relatively

243
00:10:01,410 --> 00:09:58,900
constant feature but the size of it

244
00:10:04,320 --> 00:10:01,420
isn't constant and I wanted to include

245
00:10:06,810 --> 00:10:04,330
this next image here and my thanks go

246
00:10:09,900 --> 00:10:06,820
out to a guy named Astro Bob because he

247
00:10:15,990 --> 00:10:09,910
found these two images one is from a

248
00:10:19,440 --> 00:10:16,000
book 1879 from clerk and it's a very

249
00:10:22,440 --> 00:10:19,450
very fuzzy image of the odor that's the

250
00:10:24,510 --> 00:10:22,450
photo Oh God 2408 1879 you couldn't do

251
00:10:27,380 --> 00:10:24,520
very good photos remember yeah because

252
00:10:30,480 --> 00:10:27,390
photography came about the 1850s 1860s

253
00:10:32,340 --> 00:10:30,490
and so this is pretty darn impressive

254
00:10:35,460 --> 00:10:32,350
though with those slow cameras and those

255
00:10:38,370 --> 00:10:35,470
glass plates and yeah and you can see

256
00:10:41,580 --> 00:10:38,380
that yellow it's fuzzy you can see that

257
00:10:44,010 --> 00:10:41,590
there is a big large blob there that's

258
00:10:46,380 --> 00:10:44,020
much much larger than a same size image

259
00:10:49,310 --> 00:10:46,390
from this year this is an image from

260
00:10:51,240 --> 00:10:49,320
Damien peach one of the great amateur

261
00:10:53,430 --> 00:10:51,250
astrophotographers he's in England I

262
00:10:57,810 --> 00:10:53,440
believe so you can see the amazing

263
00:10:59,520 --> 00:10:57,820

change in the Great Red Spot the kind of

264
00:11:02,340 --> 00:10:59,530
worrisome thing is is we don't actually

265
00:11:06,120 --> 00:11:02,350
know why the size of the red spot is

266
00:11:07,560 --> 00:11:06,130
changing and when we if you read our

267
00:11:10,350 --> 00:11:07,570
press release we talk about

268
00:11:11,880 --> 00:11:10,360
we say well you know it we know that

269
00:11:14,100 --> 00:11:11,890
this trend is happening but we don't

270
00:11:15,630 --> 00:11:14,110
have a really good reason for it but I

271
00:11:18,600 --> 00:11:15,640
wanted to throw out one thing for

272
00:11:22,080 --> 00:11:18,610
everybody just to think about it this is

273
00:11:23,940 --> 00:11:22,090
an infrared view of mo brat I love that

274
00:11:26,340 --> 00:11:23,950
this is this all right now this is a

275
00:11:28,110 --> 00:11:26,350
ground-based observation Tony okay this

276
00:11:30,990 --> 00:11:28,120
is from the Gemini telescope using

277
00:11:33,660 --> 00:11:31,000
adaptive optics okay and also probably

278
00:11:36,150 --> 00:11:33,670
also some sharpening masks applied in

279
00:11:38,460 --> 00:11:36,160
the processing of the image but isn't it

280
00:11:40,590 --> 00:11:38,470
cool of the Damned in topics are you

281
00:11:42,240 --> 00:11:40,600
know red yeah and so let's talk about

282
00:11:45,690 --> 00:11:42,250
adaptive optics for just a little bit

283
00:11:47,370 --> 00:11:45,700
okay sure way of ground is its unique to

284
00:11:49,640 --> 00:11:47,380
ground-based telescopes as we all know

285
00:11:52,470 --> 00:11:49,650
what the atmosphere causes things to

286
00:11:54,540 --> 00:11:52,480
twinkle and and you know we were looking

287
00:11:56,280 --> 00:11:54,550
through this giant boiling atmosphere

288
00:11:59,160 --> 00:11:56,290

essentially at these magnifications and

289
00:11:59,910 --> 00:11:59,170
so what a ground-based telescopes try to

290
00:12:02,280 --> 00:11:59,920
do is they have these really

291
00:12:05,370 --> 00:12:02,290
sophisticated optical arrangements where

292
00:12:07,320 --> 00:12:05,380
they compensate for that and they cancel

293
00:12:10,440 --> 00:12:07,330
out whatever distortions maybe in the

294
00:12:11,940 --> 00:12:10,450
atmosphere so all right the guidestar

295
00:12:13,440 --> 00:12:11,950
like a laser or something to kind of

296
00:12:14,850 --> 00:12:13,450
give them an idea what the wave front is

297
00:12:16,800 --> 00:12:14,860
and then by the time the photons get

298
00:12:19,050 --> 00:12:16,810
there they're able to actually correct

299
00:12:21,510 --> 00:12:19,060
the telescope renders that they're like

300
00:12:24,510 --> 00:12:21,520
measuring the atmospheric distortion 60

301
00:12:27,780 --> 00:12:24,520
to 120 times a second okay and then we

302
00:12:29,730 --> 00:12:27,790
can apply those those strikes this is to

303
00:12:32,130 --> 00:12:29,740
of usually have a primary mirror and a

304
00:12:34,470 --> 00:12:32,140
secondary mirror well the AO puts in a

305
00:12:36,600 --> 00:12:34,480
third mirror a tertiary mirror that

306
00:12:39,780 --> 00:12:36,610
actually is deformable and they can

307
00:12:42,320 --> 00:12:39,790
deform that mirror in real time by

308
00:12:45,120 --> 00:12:42,330
measuring that laser guide star or a

309
00:12:47,430 --> 00:12:45,130
thing so that they can measure the

310
00:12:50,370 --> 00:12:47,440
distortion the atmosphere re correct for

311
00:12:52,680 --> 00:12:50,380
it and are able to do it really well in

312
00:12:54,480 --> 00:12:52,690
the infrared now unfortunately adaptive

313
00:12:57,060 --> 00:12:54,490

optics hasn't gotten down to being able

314
00:12:58,740 --> 00:12:57,070
to use visible light I think one

315
00:13:00,180 --> 00:12:58,750
prediction I saw said that will be able

316
00:13:03,720 --> 00:13:00,190
to do adaptive optics in visible light

317
00:13:06,300 --> 00:13:03,730
maybe by 2020 will get will get down to

318
00:13:08,550 --> 00:13:06,310
the red end but it's very hard because

319
00:13:11,460 --> 00:13:08,560
its wavelength dependent right yeah

320
00:13:12,840 --> 00:13:11,470
right you've got you know yes so I just

321
00:13:14,850 --> 00:13:12,850
wanted to point out that Hubble doesn't

322
00:13:16,950 --> 00:13:14,860
have to worry about this novel does not

323
00:13:19,140 --> 00:13:16,960
doesn't need it but it but ground-based

324
00:13:19,940 --> 00:13:19,150
observatories do okay but anyway so this

325
00:13:21,440 --> 00:13:19,950
is a really

326
00:13:23,840 --> 00:13:21,450
cool ground-based image from Gemini

327
00:13:26,690 --> 00:13:23,850
using adaptive optics that looks in the

328
00:13:28,850 --> 00:13:26,700
infrared and the fact that it's really

329
00:13:32,390 --> 00:13:28,860
clear isn't the most important point but

330
00:13:35,150 --> 00:13:32,400
what is really bright in this image well

331
00:13:37,270 --> 00:13:35,160
it's the Great Red Spot and actually Red

332
00:13:41,030 --> 00:13:37,280
Spot junior which is just below it yeah

333
00:13:43,850 --> 00:13:41,040
folks remember Red Spot jr. is the first

334
00:13:46,400 --> 00:13:43,860
red spot we've ever seen form it formed

335
00:13:49,010 --> 00:13:46,410
in two thousand and three out of three

336
00:13:51,890 --> 00:13:49,020
white ovals three white ovals merged

337
00:13:53,990 --> 00:13:51,900
over like four or five years and then

338
00:13:56,690 --> 00:13:54,000

formed another red spot the first time

339
00:13:57,920 --> 00:13:56,700
we'd ever seen a red spot form but what

340
00:14:00,860 --> 00:13:57,930
you can see in this image is that

341
00:14:04,370 --> 00:14:00,870
there's a lot of infrared energy coming

342
00:14:07,790 --> 00:14:04,380
out of both a great red spot and red

343
00:14:11,990 --> 00:14:07,800
spot jr. so these are actually regions

344
00:14:14,840 --> 00:14:12,000
where energy is escaping from Jupiter so

345
00:14:17,990 --> 00:14:14,850
the perhaps the idea that red spot is

346
00:14:19,640 --> 00:14:18,000
shrinking indicate some sort of energy

347
00:14:21,700 --> 00:14:19,650
change in how the energy is being

348
00:14:24,440 --> 00:14:21,710
released from the interior of Jupiter

349
00:14:26,510 --> 00:14:24,450
Jupiter actually gives off more infrared

350
00:14:29,060 --> 00:14:26,520
energy then it gets invisible light

351
00:14:30,710 --> 00:14:29,070
energy from the Sun so jus / is actually

352
00:14:33,820 --> 00:14:30,720
slow still slowly cooling four and a

353
00:14:36,260 --> 00:14:33,830
half billion years after it formed so

354
00:14:38,210 --> 00:14:36,270
that's about the only thing I can give

355
00:14:40,370 --> 00:14:38,220
you so there must be some sort of energy

356
00:14:42,200 --> 00:14:40,380
balance that's changing within the

357
00:14:44,870 --> 00:14:42,210
interior of Jupiter and that's changing

358
00:14:46,220 --> 00:14:44,880
on decades long timescales so that's

359
00:14:48,980 --> 00:14:46,230
kind of that's kind of cool that's much

360
00:14:50,660 --> 00:14:48,990
my one bit of intuition i can say into

361
00:14:53,090 --> 00:14:50,670
saying oh here's what a physicist thinks

362
00:14:56,150 --> 00:14:53,100
you know might be happening even though

363
00:14:58,250 --> 00:14:56,160

the truth is we don't actually know so

364
00:15:00,560 --> 00:14:58,260
yeah and i would just point out that you

365
00:15:03,170 --> 00:15:00,570
know these we had a hangout on this this

366
00:15:05,150 --> 00:15:03,180
this topic Oh a few weeks ago and they

367
00:15:07,550 --> 00:15:05,160
were one of the surprising things came

368
00:15:09,320 --> 00:15:07,560
out of it was that there really isn't a

369
00:15:11,390 --> 00:15:09,330
lot known about the dynamics of these

370
00:15:13,430 --> 00:15:11,400
spots and what exactly is making them

371
00:15:14,870 --> 00:15:13,440
caught rotate in the first place so to

372
00:15:18,140 --> 00:15:14,880
be able to answer the question why is

373
00:15:18,980 --> 00:15:18,150
this ranking is even harder because we

374
00:15:20,870 --> 00:15:18,990
don't even know why it's there in the

375
00:15:22,070 --> 00:15:20,880
first place so at least there's not a

376
00:15:23,660 --> 00:15:22,080
lot of good explanations for why it's

377
00:15:24,830 --> 00:15:23,670
there in the first place in this image

378
00:15:29,330 --> 00:15:24,840
Frank do you know what's going on at the

379
00:15:30,710 --> 00:15:29,340
poles there I assume that's just that

380
00:15:33,920 --> 00:15:30,720
would be limb brightening as you're

381
00:15:36,200 --> 00:15:33,930
looking through I think I'm thicker

382
00:15:37,610 --> 00:15:36,210
to the atmosphere and such okay all

383
00:15:39,769 --> 00:15:37,620
right I was right and there's also a

384
00:15:43,220 --> 00:15:39,779
little miss registration if you notice

385
00:15:44,690 --> 00:15:43,230
because they'll take one image in 11

386
00:15:46,730 --> 00:15:44,700
band-pass and other image in another

387
00:15:49,340 --> 00:15:46,740
band pass and Jupiter rotates in 10

388
00:15:51,079 --> 00:15:49,350

hours I'm sure you take an image for

389
00:15:54,260 --> 00:15:51,089
that one point and take another image

390
00:15:55,790 --> 00:15:54,270
you know half an hour or later juba will

391
00:15:58,310 --> 00:15:55,800
rotate it a little bit so there's always

392
00:16:00,920 --> 00:15:58,320
a slight miss registration of the cut

393
00:16:02,630 --> 00:16:00,930
the colors with Jupiter cool okay all

394
00:16:06,680 --> 00:16:02,640
right let's move on to our second story

395
00:16:13,100 --> 00:16:06,690
all right the HUD f version for like

396
00:16:16,240 --> 00:16:13,110
that Oh with Oh violet blue yeah I I

397
00:16:18,680 --> 00:16:16,250
have fun with this one because of all

398
00:16:19,880 --> 00:16:18,690
these are amazing images okay let's

399
00:16:23,389 --> 00:16:19,890
let's go all the way back to the

400
00:16:27,079 --> 00:16:23,399
beginning okay yay yay the great Hubble

401
00:16:30,019 --> 00:16:27,089
Deep Field 1996 and I was at the

402
00:16:33,829 --> 00:16:30,029
double-a s meeting in i think it was

403
00:16:35,660 --> 00:16:33,839
austin texas when they released this one

404
00:16:37,610 --> 00:16:35,670
no San Antonio Texas when we released

405
00:16:39,680 --> 00:16:37,620
this and it was just jaw-dropping

406
00:16:42,290 --> 00:16:39,690
because we had never seen anything like

407
00:16:44,449 --> 00:16:42,300
this at the time okay deepest image

408
00:16:46,610 --> 00:16:44,459
visible item into the universe seeing

409
00:16:49,070 --> 00:16:46,620
more galaxies in that tinier galaxies

410
00:16:51,260 --> 00:16:49,080
and we didn't actually expect that such

411
00:16:55,370 --> 00:16:51,270
tiny galaxies would actually be visible

412
00:16:57,769 --> 00:16:55,380
with Hubble it was a unknown at the time

413
00:16:59,150 --> 00:16:57,779

so that was really clear list i wanted i

414
00:17:02,060 --> 00:16:59,160
want to press you on this for a minute

415
00:17:03,769 --> 00:17:02,070
because I've always told people that it

416
00:17:06,049 --> 00:17:03,779
was kind of risky taking this first

417
00:17:07,699 --> 00:17:06,059
picture because you know Hubble time is

418
00:17:09,650 --> 00:17:07,709
expensive people wanted to point it at

419
00:17:11,210 --> 00:17:09,660
nothing was it really what was it was

420
00:17:13,220 --> 00:17:11,220
there any controversy about that and

421
00:17:15,530 --> 00:17:13,230
where there really any apprehensions

422
00:17:18,410 --> 00:17:15,540
about it returning up just a blank

423
00:17:20,150 --> 00:17:18,420
nothing well alright we knew it would

424
00:17:22,880 --> 00:17:20,160
return a few hundred galaxies right

425
00:17:24,199 --> 00:17:22,890
because there are the galaxies to a

426
00:17:27,500 --> 00:17:24,209
certain distance in the universe are

427
00:17:29,360 --> 00:17:27,510
certain of certain of size but the main

428
00:17:32,890 --> 00:17:29,370
question because you're looking out into

429
00:17:35,990 --> 00:17:32,900
space and also looking back into time is

430
00:17:38,960 --> 00:17:36,000
how do galaxies develop how quickly do

431
00:17:41,570 --> 00:17:38,970
they develop if you looked 8 billion

432
00:17:43,430 --> 00:17:41,580
light years into the into the past with

433
00:17:46,460 --> 00:17:43,440
their actually be galaxies of enough

434
00:17:47,360 --> 00:17:46,470
size that you Hubble could see them know

435
00:17:49,520 --> 00:17:47,370
Iraq then

436
00:17:51,650 --> 00:17:49,530
too dim to fame we didn't know that we

437
00:17:54,290 --> 00:17:51,660
didn't know back then whether they be

438
00:17:56,960 --> 00:17:54,300

too small to faint it's we had

439
00:18:00,770 --> 00:17:56,970
relatively poor understanding of the

440
00:18:02,270 --> 00:18:00,780
formation of galaxies so that the as you

441
00:18:03,500 --> 00:18:02,280
go out into space it's not just that

442
00:18:05,390 --> 00:18:03,510
fact that they're getting smaller

443
00:18:07,490 --> 00:18:05,400
actually after a certain redshift they

444
00:18:10,730 --> 00:18:07,500
stop getting smaller due to the warping

445
00:18:14,060 --> 00:18:10,740
do the cosmo cosmo cosmology and and the

446
00:18:16,760 --> 00:18:14,070
expansion of the universe but as you go

447
00:18:18,830 --> 00:18:16,770
further out Howard did they develop how

448
00:18:21,710 --> 00:18:18,840
big to the how big did they get and how

449
00:18:24,410 --> 00:18:21,720
quickly and a lot of the hypotheses

450
00:18:26,810 --> 00:18:24,420
based upon our computer models at the

451
00:18:28,760 --> 00:18:26,820
time said you know they're gonna they

452
00:18:30,350 --> 00:18:28,770
are going to be bright enough there can

453
00:18:32,720 --> 00:18:30,360
be too small and too faint and you won't

454
00:18:35,290 --> 00:18:32,730
see them and Bob Williams you know sort

455
00:18:38,060 --> 00:18:35,300
of you know risked his position as the

456
00:18:40,820 --> 00:18:38,070
he was the director of the Institute at

457
00:18:44,930 --> 00:18:40,830
the time and he it was quite a gamble

458
00:18:48,290 --> 00:18:44,940
but it paid off like like crazy um all

459
00:18:50,390 --> 00:18:48,300
right and it was a story so just be

460
00:18:53,090 --> 00:18:50,400
clear also this is not the same area of

461
00:18:54,740 --> 00:18:53,100
the sky as the second be field it was it

462
00:18:56,870 --> 00:18:54,750
now this is the what we could actually

463
00:18:58,430 --> 00:18:56,880

this is the first one called the Hubble

464
00:19:00,740 --> 00:18:58,440
Deep Field and then it caught we call

465
00:19:02,510 --> 00:19:00,750
the Hubble Deep Field north ok and then

466
00:19:03,770 --> 00:19:02,520
we also did the Hubble Deep Field south

467
00:19:06,049 --> 00:19:03,780
once the Hubble Deep Field North

468
00:19:07,940 --> 00:19:06,059
produced great results they said ok

469
00:19:10,430 --> 00:19:07,950
let's try it again in a southern part of

470
00:19:12,230 --> 00:19:10,440
the sky to try and say hey is it does it

471
00:19:13,880 --> 00:19:12,240
look the same in two different places in

472
00:19:17,360 --> 00:19:13,890
the sky and they did they got the same

473
00:19:19,400 --> 00:19:17,370
result a similar image like this this is

474
00:19:22,010 --> 00:19:19,410
the famous one because it was first but

475
00:19:24,320 --> 00:19:22,020
there's also a second one and then the

476
00:19:27,200 --> 00:19:24,330
area near the Big Dipper correct yeah

477
00:19:30,080 --> 00:19:27,210
this one's just off the off the handle

478
00:19:31,370 --> 00:19:30,090
of the Big Dipper and so this is as good

479
00:19:33,440 --> 00:19:31,380
as you could do with wide field

480
00:19:35,090 --> 00:19:33,450
planetary camera 2 and so you can see

481
00:19:37,490 --> 00:19:35,100
that the characteristic Chevron shape

482
00:19:40,460 --> 00:19:37,500
and so in two thousand when we had the

483
00:19:43,960 --> 00:19:40,470
servicing mission three be a jacket you

484
00:19:47,060 --> 00:19:43,970
and me guys I asked the Jag jagged ok

485
00:19:48,590 --> 00:19:47,070
the jagged shape there when we got a new

486
00:19:51,830 --> 00:19:48,600
camera on how all the advanced camera

487
00:19:53,780 --> 00:19:51,840
surveys the next director Steve Beckwith

488
00:19:57,320 --> 00:19:53,790

said ok we got to repeat the D field

489
00:20:00,230 --> 00:19:57,330
experiment and in 2004 we got this image

490
00:20:01,240 --> 00:20:00,240
the Hubble Ultra Deep Field because you

491
00:20:03,850 --> 00:20:01,250
can't just call it a

492
00:20:08,230 --> 00:20:03,860
field it's now ultra d that's right i

493
00:20:11,620 --> 00:20:08,240
think one omega by now and so the the

494
00:20:14,980 --> 00:20:11,630
HUD f as we like to call it was taken in

495
00:20:16,450 --> 00:20:14,990
2003 and released in 2004 and whereas

496
00:20:18,490 --> 00:20:16,460
the hdf did about three thousand

497
00:20:21,100 --> 00:20:18,500
galaxies this one has about 10,000

498
00:20:23,740 --> 00:20:21,110
galaxies in it and again pressing

499
00:20:27,190 --> 00:20:23,750
further out into space farther back into

500
00:20:30,790 --> 00:20:27,200
time seeing the the very small very

501
00:20:33,520 --> 00:20:30,800
distant galaxies and it also acs had

502
00:20:37,330 --> 00:20:33,530
more sensitivity in the infrared then

503
00:20:40,390 --> 00:20:37,340
why field planetary camera 2 so because

504
00:20:42,250 --> 00:20:40,400
as light crosses space the light gets

505
00:20:44,740 --> 00:20:42,260
stretched with the expansion of space

506
00:20:46,300 --> 00:20:44,750
the light from distant galaxies actually

507
00:20:48,670 --> 00:20:46,310
gets stretched towards the red end of

508
00:20:51,040 --> 00:20:48,680
the spectrum okay and actually can go

509
00:20:52,930 --> 00:20:51,050
from visible light into infrared light

510
00:20:56,080 --> 00:20:52,940
so to see the really distant galaxies

511
00:20:59,260 --> 00:20:56,090
you want to do the infrared better well

512
00:21:01,780 --> 00:20:59,270
ACS was good at the infrared but wide

513
00:21:03,220 --> 00:21:01,790

field camera 3 was even better the

514
00:21:04,870 --> 00:21:03,230
infrared because that had a few more

515
00:21:06,820 --> 00:21:04,880
years of technology development and

516
00:21:09,250 --> 00:21:06,830
optical coating development and infrared

517
00:21:12,490 --> 00:21:09,260
detector development and so why field

518
00:21:14,530 --> 00:21:12,500
camera 3 was installed in 2009 so of

519
00:21:16,300 --> 00:21:14,540
course we redid this field and this is

520
00:21:17,890 --> 00:21:16,310
actually the same field well actually

521
00:21:20,140 --> 00:21:17,900
it's a smaller part of it because the

522
00:21:22,600 --> 00:21:20,150
infrared camera has a smaller field of

523
00:21:23,920 --> 00:21:22,610
view so this red box shows you the

524
00:21:28,000 --> 00:21:23,930
smaller field of view of the infrared

525
00:21:29,890 --> 00:21:28,010
camera and then in 2009 very end of 2009

526
00:21:35,380 --> 00:21:29,900
december two thousand nine rereleased

527
00:21:37,420 --> 00:21:35,390
this image the HUD f ir ok so the Ultra

528
00:21:39,280 --> 00:21:37,430
Deep Field augmented by infrared

529
00:21:43,120 --> 00:21:39,290
observations with wide field camera 3

530
00:21:44,800 --> 00:21:43,130
and again here the the differences

531
00:21:47,500 --> 00:21:44,810
aren't quite as strong as they were

532
00:21:49,990 --> 00:21:47,510
between the Deep Field and the Ultra

533
00:21:51,760 --> 00:21:50,000
Deep Field simply because you know

534
00:21:54,550 --> 00:21:51,770
you're just authentic the infrared and

535
00:21:57,610 --> 00:21:54,560
you're really pushing the tiny galaxies

536
00:22:01,420 --> 00:21:57,620
so on the gross characteristics it looks

537
00:22:03,280 --> 00:22:01,430
roughly the same but it's the important

538
00:22:04,990 --> 00:22:03,290

points are all in the details seeing

539
00:22:06,640 --> 00:22:05,000
galaxies that you couldn't see any

540
00:22:08,650 --> 00:22:06,650
further also the difference between the

541
00:22:10,510 --> 00:22:08,660
two thousand four in the 2009 eltra d

542
00:22:12,850 --> 00:22:10,520
fields would be more galaxies right

543
00:22:14,860 --> 00:22:12,860
because you've got more sensitivity but

544
00:22:17,410 --> 00:22:14,870
just a bit more galaxies not

545
00:22:19,600 --> 00:22:17,420
no maybe five ten percent more galaxies

546
00:22:21,100 --> 00:22:19,610
not double when you went on three

547
00:22:22,570 --> 00:22:21,110
thousand to ten thousand year you

548
00:22:25,720 --> 00:22:22,580
tripled the number of galaxies yeah

549
00:22:28,480 --> 00:22:25,730
you're only increasing it by a few by a

550
00:22:30,490 --> 00:22:28,490
few percent and actually we did even

551
00:22:33,549 --> 00:22:30,500
more infrared observations over the next

552
00:22:37,590 --> 00:22:33,559
couple years and so we didn't actually

553
00:22:41,020 --> 00:22:37,600
release this as a thing but the HUD f ir

554
00:22:43,450 --> 00:22:41,030
2011 you can consider you know version

555
00:22:45,760 --> 00:22:43,460
2.1 of the Hubble Ultra Deep Field

556
00:22:50,950 --> 00:22:45,770
because this is just adding more and

557
00:22:52,450 --> 00:22:50,960
more observations then in 2012 one of

558
00:22:54,190 --> 00:22:52,460
the researchers said hey wait a minute

559
00:22:56,110 --> 00:22:54,200
there's been a lot of other observations

560
00:22:59,260 --> 00:22:56,120
that weren't done for the ultra deep

561
00:23:00,610 --> 00:22:59,270
field campaign and other campaigns that

562
00:23:02,680 --> 00:23:00,620
have been done for lots of various

563
00:23:05,290 --> 00:23:02,690

campaigns so he said let's go back

564
00:23:06,669 --> 00:23:05,300
through all of the various observations

565
00:23:09,430 --> 00:23:06,679
in the archive let's pull them all

566
00:23:12,760 --> 00:23:09,440
together alright and then they released

567
00:23:14,230 --> 00:23:12,770
another version in 2012 all right and if

568
00:23:15,730 --> 00:23:14,240
I blink back and forth i'm going to go

569
00:23:19,830 --> 00:23:15,740
back and forth very slowly i'm going to

570
00:23:23,820 --> 00:23:19,840
go back to the 2011 and then the 2012

571
00:23:29,020 --> 00:23:23,830
and then i'll go back to the 2011 and

572
00:23:31,990 --> 00:23:29,030
then the 2012 ok binkley redder in the

573
00:23:34,480 --> 00:23:32,000
2012 one yeah and that's possible that's

574
00:23:35,980 --> 00:23:34,490
also a little bit of the image

575
00:23:39,160 --> 00:23:35,990
processing might have chosen slightly

576
00:23:40,960 --> 00:23:39,170
different different color because we're

577
00:23:42,850 --> 00:23:40,970
taking different bands and applying

578
00:23:44,950 --> 00:23:42,860
different colors to them it's a little

579
00:23:46,960 --> 00:23:44,960
cleaner in 2012 this one was really

580
00:23:49,000 --> 00:23:46,970
cleaned up and carefully and so the

581
00:23:51,580 --> 00:23:49,010
noise is suppressed and it's a cleaner

582
00:23:55,570 --> 00:23:51,590
image but it's not a distinctly strongly

583
00:24:00,280 --> 00:23:55,580
distinguish however ax is what now X is

584
00:24:02,860 --> 00:24:00,290
now ok however they wanted the the P the

585
00:24:04,990 --> 00:24:02,870
P I wanted to make it sound incredible

586
00:24:09,490 --> 00:24:05,000
so it's now you want to call it the

587
00:24:11,140 --> 00:24:09,500
extreme deep field 630 I was one who

588
00:24:14,919 --> 00:24:11,150

said fly plane come on this is a test

589
00:24:16,990 --> 00:24:14,929
HUD f version 3 come on guys well all

590
00:24:18,250 --> 00:24:17,000
sure doing is just taking the IR and

591
00:24:20,169 --> 00:24:18,260
something you're just compiling it

592
00:24:21,730 --> 00:24:20,179
together all right but you know hey he

593
00:24:25,780 --> 00:24:21,740
went out he got to call it the extreme

594
00:24:27,280 --> 00:24:25,790
deep field so the H XD f here mom I'm

595
00:24:28,330 --> 00:24:27,290
going to call it what it is HUD f

596
00:24:30,610 --> 00:24:28,340
version 3

597
00:24:32,799 --> 00:24:30,620
so throughout all this there's only been

598
00:24:34,840 --> 00:24:32,809
one thing really missing right and

599
00:24:37,060 --> 00:24:34,850
that's that we've gone to longer

600
00:24:40,899 --> 00:24:37,070
wavelengths but not to shorter

601
00:24:43,840 --> 00:24:40,909
wavelengths okay so a wide field camera

602
00:24:46,990 --> 00:24:43,850
3 also when it was installed in 2009

603
00:24:49,269 --> 00:24:47,000
improved our infrared capability but

604
00:24:54,180 --> 00:24:49,279
also improved our ultra violet

605
00:24:57,730 --> 00:24:54,190
capability and so in 2014 we added in

606
00:25:01,350 --> 00:24:57,740
extra images taken in the ultraviolet

607
00:25:06,940 --> 00:25:01,360
and so now we have the HUD f 2014

608
00:25:09,580 --> 00:25:06,950
version for now with ultraviolet and

609
00:25:14,919 --> 00:25:09,590
again if I pop back and forth i go back

610
00:25:18,010 --> 00:25:14,929
to 2012 to 2014 you can see that there

611
00:25:20,680 --> 00:25:18,020
is a distinct number of extra small blue

612
00:25:22,029 --> 00:25:20,690
things right yeah one of those so what

613
00:25:23,919 --> 00:25:22,039

are the characteristics of what are we

614
00:25:25,659 --> 00:25:23,929
saying now an ultra violet that we

615
00:25:27,850 --> 00:25:25,669
couldn't see alright so what you're

616
00:25:31,299 --> 00:25:27,860
going to see in ultraviolet is the in

617
00:25:32,769 --> 00:25:31,309
the star-forming regions okay with the

618
00:25:35,409 --> 00:25:32,779
only galaxies themselves right within

619
00:25:38,320 --> 00:25:35,419
the galaxies the star forage only the

620
00:25:40,600 --> 00:25:38,330
biggest and brightest stars emit much

621
00:25:42,370 --> 00:25:40,610
ultraviolet okay stars like our Sun

622
00:25:43,840 --> 00:25:42,380
although we think it's a lot of

623
00:25:46,330 --> 00:25:43,850
ultraviolet and especially those of us

624
00:25:48,159 --> 00:25:46,340
who sunburn easily we think it's a lot

625
00:25:50,919 --> 00:25:48,169
of ultraviolet it really isn't on a

626
00:25:54,130 --> 00:25:50,929
cosmic scale and so the really massive

627
00:25:55,779 --> 00:25:54,140
stars the ones that only live for 10 50

628
00:25:59,980 --> 00:25:55,789
million years are the ones that produce

629
00:26:02,529 --> 00:25:59,990
a lot of ultraviolet so that those are

630
00:26:04,690 --> 00:26:02,539
the stars those that only exists in the

631
00:26:07,120 --> 00:26:04,700
star-forming regions so if you're seeing

632
00:26:09,549 --> 00:26:07,130
ultraviolet from a galaxy you're

633
00:26:12,580 --> 00:26:09,559
generally seeing just the star-forming

634
00:26:14,680 --> 00:26:12,590
regions okay and oftentimes if you're

635
00:26:16,210 --> 00:26:14,690
seeing that at really high redshift well

636
00:26:18,430 --> 00:26:16,220
then that ultraviolet lights get shifted

637
00:26:20,289 --> 00:26:18,440
to visible light and it doesn't show up

638
00:26:21,970 --> 00:26:20,299

in the ultraviolet so you're seeing the

639
00:26:24,789 --> 00:26:21,980
star-forming regions and generally the

640
00:26:26,230 --> 00:26:24,799
nearer star forming regions because the

641
00:26:27,970 --> 00:26:26,240
more distant star forming regions would

642
00:26:31,060 --> 00:26:27,980
actually get pushed into the visible

643
00:26:32,799 --> 00:26:31,070
light so you're seeing you're completing

644
00:26:35,080 --> 00:26:32,809
a census and the nearby things

645
00:26:38,680 --> 00:26:35,090
understanding star formation so you'll

646
00:26:41,710 --> 00:26:38,690
get a better handle on star formation by

647
00:26:43,330 --> 00:26:41,720
having the ultraviolet in this image now

648
00:26:45,760 --> 00:26:43,340
I wish I could give you a scientific

649
00:26:48,010 --> 00:26:45,770
result about this but there wasn't any

650
00:26:50,169 --> 00:26:48,020
in the press release the press release

651
00:26:52,380 --> 00:26:50,179
basically said hey cool we now have a

652
00:26:56,080 --> 00:26:52,390
pan chromatic Ultra Deep Field

653
00:26:58,000 --> 00:26:56,090
ultraviolet visible infrared we've got

654
00:27:00,100 --> 00:26:58,010
all three wave bands covered as much as

655
00:27:02,520 --> 00:27:00,110
public and covered this is you know the

656
00:27:06,070 --> 00:27:02,530
ps2 resistance of the ultra deep field

657
00:27:08,560 --> 00:27:06,080
of course until a few more observations

658
00:27:11,320 --> 00:27:08,570
are added and we call have version 5 in

659
00:27:12,730 --> 00:27:11,330
2 2016 or something like that yes I

660
00:27:15,159 --> 00:27:12,740
sound like you're saying we did it

661
00:27:16,779 --> 00:27:15,169
because we could when we just wanted to

662
00:27:19,510 --> 00:27:16,789
fill in one more piece of the puzzle to

663
00:27:21,970 --> 00:27:19,520

one of the most studied regions of the

664
00:27:23,799 --> 00:27:21,980
sky by Hubble Space tells well we've got

665
00:27:26,770 --> 00:27:23,809
so much information about these galaxies

666
00:27:28,810 --> 00:27:26,780
at the longer wavelengths adding in the

667
00:27:31,360 --> 00:27:28,820
shorter wavelength regions will give us

668
00:27:33,520 --> 00:27:31,370
a bigger a clearer picture so what I

669
00:27:35,020 --> 00:27:33,530
really liked was then I took all of them

670
00:27:39,270 --> 00:27:35,030
together well actually helps our way out

671
00:27:42,279 --> 00:27:39,280
here um listen up and didn't post

672
00:27:43,779 --> 00:27:42,289
responded I just wanted to I included

673
00:27:46,630 --> 00:27:43,789
this just to say that you know even

674
00:27:48,639 --> 00:27:46,640
though ninety ninety percent of the data

675
00:27:50,980 --> 00:27:48,649
had already been released when you

676
00:27:53,169 --> 00:27:50,990
release a new image like this and the

677
00:27:55,720 --> 00:27:53,179
the mass media press gets ahold of it

678
00:27:58,210 --> 00:27:55,730
they can still react in in strong ways

679
00:28:00,190 --> 00:27:58,220
because these are just gorgeous images

680
00:28:02,529 --> 00:28:00,200
and so seeing them over and over again

681
00:28:05,139 --> 00:28:02,539
you still react and say wow what an

682
00:28:06,899 --> 00:28:05,149
amazing view of the universe seeing to

683
00:28:09,899 --> 00:28:06,909
that you know the depths of the universe

684
00:28:13,029 --> 00:28:09,909
but what I liked was this image here

685
00:28:16,480 --> 00:28:13,039
where I put them all together so upper

686
00:28:21,879 --> 00:28:16,490
left is 2004 H the original HUD f upper

687
00:28:27,700 --> 00:28:21,889
right is a 2009 adding the IR lower left

688
00:28:29,830 --> 00:28:27,710

is 2012 the HUD f I the albums are the

689
00:28:34,149 --> 00:28:29,840
extreme deep field and the lower right

690
00:28:36,610 --> 00:28:34,159
is the multi the panchromatic HUD f 2014

691
00:28:38,260 --> 00:28:36,620
and so you can see when you put the four

692
00:28:40,500 --> 00:28:38,270
of them together that you're just adding

693
00:28:44,470 --> 00:28:40,510
more and more data more and more

694
00:28:46,180 --> 00:28:44,480
signal-to-noise you're adding in Abel's

695
00:28:48,370 --> 00:28:46,190
you to just a little bit better science

696
00:28:50,560 --> 00:28:48,380
with each generation of it I think it

697
00:28:52,930 --> 00:28:50,570
also shows that the science is a

698
00:28:54,730 --> 00:28:52,940
progressive attack on a problem you

699
00:28:55,660 --> 00:28:54,740
don't get the answer you don't get all

700
00:28:58,150 --> 00:28:55,670
the answers the first

701
00:29:00,040 --> 00:28:58,160
time yeah the HUD f is probably still

702
00:29:02,100 --> 00:29:00,050
one of the most if not the most

703
00:29:05,290 --> 00:29:02,110
important images Hubble has ever taken

704
00:29:08,140 --> 00:29:05,300
but we can still add to it and augment

705
00:29:10,210 --> 00:29:08,150
it with subsequent observations and

706
00:29:12,070 --> 00:29:10,220
still learn more so that the

707
00:29:14,140 --> 00:29:12,080
progressiveness of science I think comes

708
00:29:15,520 --> 00:29:14,150
out in these four images I agree and I

709
00:29:17,590 --> 00:29:15,530
and i'd be interested i can't wait to

710
00:29:19,780 --> 00:29:17,600
see the for the astronomers who were

711
00:29:21,700 --> 00:29:19,790
studying star forming regions and

712
00:29:23,950 --> 00:29:21,710
galaxies especially in early galaxies

713
00:29:26,710 --> 00:29:23,960

what they can do with this result or

714
00:29:29,200 --> 00:29:26,720
with it with this UV image so keep our

715
00:29:31,870 --> 00:29:29,210
eyes out for that too and it's not too

716
00:29:34,780 --> 00:29:31,880
early to say hey look forward to 20 19

717
00:29:36,940 --> 00:29:34,790
when we have JD Wisty out there and we

718
00:29:38,740 --> 00:29:36,950
can really add to the the infrared and

719
00:29:40,600 --> 00:29:38,750
then AJ misty will have similar

720
00:29:41,920 --> 00:29:40,610
resolution the Hubble and really go into

721
00:29:45,040 --> 00:29:41,930
the infrared and then we'll have yet

722
00:29:48,130 --> 00:29:45,050
another really even wider wavelength

723
00:29:49,030 --> 00:29:48,140
region in about 20 19 deep infrared so

724
00:29:50,650 --> 00:29:49,040
you think they're going to look at the

725
00:29:52,660 --> 00:29:50,660
spot too with all with the most

726
00:29:55,060 --> 00:29:52,670
definitely absolutely i think we've

727
00:29:57,880 --> 00:29:55,070
invested so much a scientific effort

728
00:30:01,840 --> 00:29:57,890
into this spot on the sky that it would

729
00:30:03,130 --> 00:30:01,850
be silly not to just do i sound like

730
00:30:04,600 --> 00:30:03,140
you're about to wrap this up but before

731
00:30:06,790 --> 00:30:04,610
we leave it can we say a few words about

732
00:30:10,110 --> 00:30:06,800
this area this guy and why it's

733
00:30:12,610 --> 00:30:10,120
important why was it why is this such

734
00:30:15,880 --> 00:30:12,620
why are we looking at this spot so much

735
00:30:19,330 --> 00:30:15,890
ok so this spot which is actually in the

736
00:30:21,550 --> 00:30:19,340
constellation Fornax if you go to Orion

737
00:30:24,520 --> 00:30:21,560
on the sky and head south past the

738
00:30:27,190 --> 00:30:24,530

constellation of air Donna's and just

739
00:30:30,880 --> 00:30:27,200
between air Adonis and Fornax is a

740
00:30:34,090 --> 00:30:30,890
nothing spot on this guy did you see the

741
00:30:36,580 --> 00:30:34,100
lego movie Tony no okay so does the

742
00:30:39,370 --> 00:30:36,590
state the hero the lego movie is so

743
00:30:42,970 --> 00:30:39,380
bloody ordinary that he has nothing

744
00:30:45,700 --> 00:30:42,980
special about him okay um and that's

745
00:30:47,380 --> 00:30:45,710
part of what makes in the hero right is

746
00:30:49,990 --> 00:30:47,390
that he's just totally absolutely

747
00:30:53,140 --> 00:30:50,000
ordinary well this spot in the sky is

748
00:30:55,120 --> 00:30:53,150
totally boring right there are no near

749
00:30:57,700 --> 00:30:55,130
right near nearby bright stars there are

750
00:31:00,270 --> 00:30:57,710
no nearby bright galaxies we tried to

751
00:31:03,130 --> 00:31:00,280
find something with very little

752
00:31:04,420 --> 00:31:03,140
obscuration of nearby stuff remember

753
00:31:05,740 --> 00:31:04,430
we're looking out for the stars of our

754
00:31:07,780 --> 00:31:05,750
galaxy we're looking out through the gas

755
00:31:09,550 --> 00:31:07,790
and dust of our galaxy looking out

756
00:31:11,470 --> 00:31:09,560
through our local Group of galaxies and

757
00:31:13,120 --> 00:31:11,480
cluster of galaxies supercluster of

758
00:31:14,740 --> 00:31:13,130
galaxies we're trying to make sure that

759
00:31:17,500 --> 00:31:14,750
we're looking at a spaten sky that isn't

760
00:31:21,250 --> 00:31:17,510
obscured by much of that at all in

761
00:31:23,920 --> 00:31:21,260
particular the the infrared obscuration

762
00:31:25,720 --> 00:31:23,930
due to gas and dust that's very faint

763
00:31:27,150 --> 00:31:25,730

that you wouldn't actually normally

764
00:31:29,740 --> 00:31:27,160
notice with visible-light observations

765
00:31:31,630 --> 00:31:29,750
so they went through lots and lots of

766
00:31:34,720 --> 00:31:31,640
different sky surveys to try and say

767
00:31:37,140 --> 00:31:34,730
what we're in the sky can we point so

768
00:31:40,660 --> 00:31:37,150
that we have as little as possible

769
00:31:43,870 --> 00:31:40,670
obscuring us that's nearby and so this

770
00:31:46,540 --> 00:31:43,880
is our mr. a dredge mr. ordinary boring

771
00:31:47,830 --> 00:31:46,550
nothing spot on the sky well and I

772
00:31:49,360 --> 00:31:47,840
wanted to make that point because I

773
00:31:51,640 --> 00:31:49,370
don't think a lot of people realize that

774
00:31:53,500 --> 00:31:51,650
that's the case and while we're on the

775
00:31:56,680 --> 00:31:53,510
topic before we switch out Hugo Burnham

776
00:31:58,480 --> 00:31:56,690
has a comment here in the Q&A app that

777
00:31:59,980 --> 00:31:58,490
basically goes as a matter of areas that

778
00:32:02,860 --> 00:31:59,990
he's asking as a matter of interest

779
00:32:05,290 --> 00:32:02,870
Frank how long would it take for HST to

780
00:32:08,260 --> 00:32:05,300
image the entire sky at the detail and

781
00:32:13,270 --> 00:32:08,270
resolution of the original Hubble Deep

782
00:32:16,270 --> 00:32:13,280
Field ok so the good question the Hubble

783
00:32:18,220 --> 00:32:16,280
Deep Field was like seven days right the

784
00:32:20,950 --> 00:32:18,230
Hubble Ultra Deep Field was around 11

785
00:32:22,840 --> 00:32:20,960
days of exposure time all right so i

786
00:32:25,030 --> 00:32:22,850
have a have just it just happened to

787
00:32:27,600 --> 00:32:25,040
have off the top of my head the numbers

788
00:32:29,740 --> 00:32:27,610

for the ultra deep field okay because

789
00:32:34,510 --> 00:32:29,750
when you look at this is such a small

790
00:32:38,080 --> 00:32:34,520
patch in the sky Hubble can look at the

791
00:32:42,190 --> 00:32:38,090
sky 12 million seven hundred and sixty

792
00:32:45,250 --> 00:32:42,200
four thousand times at this scale and

793
00:32:48,430 --> 00:32:45,260
never look at the same place twice there

794
00:32:51,730 --> 00:32:48,440
are more than 12 million matches on the

795
00:32:54,820 --> 00:32:51,740
sky the same size as the Hubble Ultra

796
00:32:56,500 --> 00:32:54,830
Deep Field so if we wanted to count

797
00:32:58,510 --> 00:32:56,510
every galaxy in the universe out there

798
00:33:00,700 --> 00:32:58,520
by looking to the depth of the Hubble

799
00:33:04,810 --> 00:33:00,710
Ultra Deep Field it would be 11 days

800
00:33:07,600 --> 00:33:04,820
times 12.7 million which is longer than

801
00:33:09,820 --> 00:33:07,610
I think we have left with Hubble angry

802
00:33:11,230 --> 00:33:09,830
and it also could include all the stuff

803
00:33:13,960 --> 00:33:11,240
that's going to get in the way so their

804
00:33:17,170 --> 00:33:13,970
own gala good question thanks you girls

805
00:33:19,840 --> 00:33:17,180
good ok ok Frank go ahead now for our

806
00:33:21,840 --> 00:33:19,850
third story and one that I probably went

807
00:33:24,419 --> 00:33:21,850
a little overboard with so how

808
00:33:28,620 --> 00:33:24,429
I gotta come to this one moving to Pluto

809
00:33:30,570 --> 00:33:28,630
and beyond but when I started doing this

810
00:33:31,770 --> 00:33:30,580
I said look you know what we got to

811
00:33:34,320 --> 00:33:31,780
start at the beginning we got to really

812
00:33:36,510 --> 00:33:34,330
understand what we're getting in for

813
00:33:38,100 --> 00:33:36,520

because the New Horizons mission is one

814
00:33:39,870 --> 00:33:38,110
year out it's going to be going to get

815
00:33:42,659 --> 00:33:39,880
us some fantastic stuff but let's go

816
00:33:45,120 --> 00:33:42,669
back to the beginning okay so if we go

817
00:33:46,860 --> 00:33:45,130
back to the very beginning these are the

818
00:33:49,470 --> 00:33:46,870
images from the Lowell Observatory in

819
00:33:52,110 --> 00:33:49,480
Flagstaff Arizona where Clyde Tombaugh

820
00:33:56,370 --> 00:33:52,120
discovered Pluto yeah I only had little

821
00:33:58,110 --> 00:33:56,380
little white arrows we have barrels in

822
00:33:59,850 --> 00:33:58,120
just because you know this is going out

823
00:34:01,860 --> 00:33:59,860
over the web you know you can't

824
00:34:03,390 --> 00:34:01,870
necessarily see it and you may be able

825
00:34:04,799 --> 00:34:03,400
to see the big red arrows and still not

826
00:34:07,799 --> 00:34:04,809
be able to see the dot that's Pluto

827
00:34:09,780 --> 00:34:07,809
they're okay and it's just absolutely

828
00:34:11,250 --> 00:34:09,790
amazing it's always flabbergasting to

829
00:34:13,470 --> 00:34:11,260
look at this and go clyde tombaugh

830
00:34:15,659 --> 00:34:13,480
noticed a spot that was here one week

831
00:34:18,510 --> 00:34:15,669
and there the next week he was blinking

832
00:34:21,570 --> 00:34:18,520
back and forth between the images the

833
00:34:23,730 --> 00:34:21,580
guy was an incredible observer okay all

834
00:34:27,869 --> 00:34:23,740
kudos did clyde tombaugh for being able

835
00:34:30,090 --> 00:34:27,879
to discover this okay and then after

836
00:34:34,590 --> 00:34:30,100
that well the next major thing happens

837
00:34:37,520 --> 00:34:34,600
in 1978 well this on the left is the

838
00:34:41,040 --> 00:34:37,530

discovery image of Pluto's moon Charon

839
00:34:43,530 --> 00:34:41,050
okay and the reason it's a discovery

840
00:34:45,750 --> 00:34:43,540
image is because well it's the Hunchback

841
00:34:48,119 --> 00:34:45,760
of the solar system you've noticed that

842
00:34:50,669 --> 00:34:48,129
there's a little lump on one side of it

843
00:34:53,879 --> 00:34:50,679
instead of it being circular well James

844
00:34:55,740 --> 00:34:53,889
Christian eyval Observatory was looking

845
00:34:57,990 --> 00:34:55,750
at Pluto and he noticed a couple images

846
00:34:59,880 --> 00:34:58,000
where there were humps on on Pluto and

847
00:35:01,710 --> 00:34:59,890
he checked all the stars around it made

848
00:35:03,030 --> 00:35:01,720
sure they were circle circles and he

849
00:35:04,650 --> 00:35:03,040
checked two other images of Pluto's and

850
00:35:06,390 --> 00:35:04,660
made sure those were circles he said

851
00:35:09,359 --> 00:35:06,400
okay well that means there must be

852
00:35:10,910 --> 00:35:09,369
another object there okay he they

853
00:35:13,260 --> 00:35:10,920
weren't able to confirm it until

854
00:35:15,960 --> 00:35:13,270
nineteen eighty-five in terms of

855
00:35:18,270 --> 00:35:15,970
actually measuring the distance of Pluto

856
00:35:20,099 --> 00:35:18,280
and Charon and by the way they were able

857
00:35:21,960 --> 00:35:20,109
to sense Pluto and Charon occulted each

858
00:35:25,430 --> 00:35:21,970
other they were able to get both sizes

859
00:35:28,920 --> 00:35:25,440
relative sizes and distances for it and

860
00:35:31,859 --> 00:35:28,930
get masses of Pluto and Charon there but

861
00:35:35,340 --> 00:35:31,869
that is the that's the amazing image

862
00:35:38,490 --> 00:35:35,350
that got us the discovery of Karen okay

863
00:35:40,710 --> 00:35:38,500

well Hubble launched in 1990 at the time

864
00:35:43,050 --> 00:35:40,720
in 1990 upper left you can see a

865
00:35:45,150 --> 00:35:43,060
ground-based image of Pluto and Charon

866
00:35:47,150 --> 00:35:45,160
so they got a little better by then you

867
00:35:51,720 --> 00:35:47,160
can see we were using digital imagery of

868
00:35:55,590 --> 00:35:51,730
an improvement from 1978 but Hubble in

869
00:35:57,120 --> 00:35:55,600
1990 even with the flaw uncorrect it ok

870
00:35:59,210 --> 00:35:57,130
this is with the flaw in the mirror that

871
00:36:01,520 --> 00:35:59,220
hasn't been corrected you can see boom

872
00:36:05,190 --> 00:36:01,530
Hubble's view from above the atmosphere

873
00:36:06,960 --> 00:36:05,200
gets you Pluto and Charon much cleanly

874
00:36:08,550 --> 00:36:06,970
separated all right you can see that

875
00:36:10,380 --> 00:36:08,560
sort of ring around Pluto that that's

876
00:36:12,710 --> 00:36:10,390
that's due to the flaw on the mirror but

877
00:36:16,230 --> 00:36:12,720
that would be fixed relatively soon and

878
00:36:18,480 --> 00:36:16,240
after the servicing mission in 93 we're

879
00:36:21,210 --> 00:36:18,490
able to get this image of Pluto and

880
00:36:23,730 --> 00:36:21,220
Charon and this is actually an infrared

881
00:36:25,650 --> 00:36:23,740
image of Pluto and Charon I Pluto is

882
00:36:28,140 --> 00:36:25,660
obviously the large splotch on the left

883
00:36:30,570 --> 00:36:28,150
and karen is the the smaller splotch on

884
00:36:32,100 --> 00:36:30,580
the right these look sort of like the

885
00:36:35,490 --> 00:36:32,110
the two are resolved but they actually

886
00:36:37,740 --> 00:36:35,500
aren't resolved they are separated but

887
00:36:39,810 --> 00:36:37,750
they aren't resolved into into

888
00:36:42,780 --> 00:36:39,820

individual pixels a lot of these things

889
00:36:45,150 --> 00:36:42,790
that means to be resolved versus not

890
00:36:46,890 --> 00:36:45,160
okay well the point is is that when you

891
00:36:48,810 --> 00:36:46,900
want to look at an object you want to

892
00:36:51,780 --> 00:36:48,820
have multiple pixels across the width of

893
00:36:54,540 --> 00:36:51,790
the object alright so we're used to

894
00:36:56,250 --> 00:36:54,550
seeing high-resolution images of the of

895
00:36:58,320 --> 00:36:56,260
the of the planets from satellites that

896
00:37:00,900 --> 00:36:58,330
have been there right and so you may

897
00:37:03,540 --> 00:37:00,910
have you know five hundred to a thousand

898
00:37:06,900 --> 00:37:03,550
to several thousand images pixels that

899
00:37:09,090 --> 00:37:06,910
span the width of the of the planet or

900
00:37:12,000 --> 00:37:09,100
moon that you're looking at well Pluto

901
00:37:14,550 --> 00:37:12,010
is so small that its entire size fits

902
00:37:16,620 --> 00:37:14,560
within one pixel and what you're seeing

903
00:37:18,240 --> 00:37:16,630
here is actually just the bleed of that

904
00:37:22,530 --> 00:37:18,250
love the brightness of that one pixel

905
00:37:24,630 --> 00:37:22,540
spreading across the the detector so

906
00:37:26,850 --> 00:37:24,640
this while it looks like it's resolved

907
00:37:29,310 --> 00:37:26,860
into a nice circular spot that's

908
00:37:31,140 --> 00:37:29,320
actually just detector bleed and really

909
00:37:34,830 --> 00:37:31,150
doesn't indicate it indicates the

910
00:37:36,780 --> 00:37:34,840
brightness but not the true size if you

911
00:37:39,740 --> 00:37:36,790
want to see real it resolved images of

912
00:37:44,700 --> 00:37:39,750
Pluto we finally got them with Hubble

913
00:37:48,000 --> 00:37:44,710

also in 1994 now what you're seeing the

914
00:37:48,900 --> 00:37:48,010
big circles here are not the images of

915
00:37:55,980 --> 00:37:48,910
Pluto

916
00:37:58,500 --> 00:37:55,990
images the images themselves are these

917
00:38:01,800 --> 00:37:58,510
tiny little speck Lee things in the

918
00:38:04,860 --> 00:38:01,810
upper left up in the top so the top row

919
00:38:06,870 --> 00:38:04,870
are the real images of Pluto okay and

920
00:38:09,600 --> 00:38:06,880
these are the best images we've ever

921
00:38:10,920 --> 00:38:09,610
gotten a Pluto to this point and really

922
00:38:14,070 --> 00:38:10,930
the best we have until today because

923
00:38:15,240 --> 00:38:14,080
these are Hubble's images that you can

924
00:38:17,160 --> 00:38:15,250
see that you can start to see the

925
00:38:20,700 --> 00:38:17,170
pixelation okay you can actually get

926
00:38:23,160 --> 00:38:20,710
pixels across Pluto right and that is

927
00:38:26,460 --> 00:38:23,170
the resolution but this shows you just

928
00:38:28,560 --> 00:38:26,470
how small and how far away Pluto is that

929
00:38:31,560 --> 00:38:28,570
even with Hubble that's the best

930
00:38:34,920 --> 00:38:31,570
resolution we can do alright so the the

931
00:38:39,960 --> 00:38:34,930
saga of Pluto goes on in from 1994 we

932
00:38:42,270 --> 00:38:39,970
move on to 2008 the build of the

933
00:38:44,460 --> 00:38:42,280
building of the Rose Center for Earth

934
00:38:47,340 --> 00:38:44,470
and space at the American Museum of

935
00:38:49,140 --> 00:38:47,350
Natural History in New York and I

936
00:38:50,940 --> 00:38:49,150
actually was one of the curators Neil

937
00:38:53,280 --> 00:38:50,950
Tyson Steve Sodor and myself were the

938
00:38:55,800 --> 00:38:53,290

three curators there and when we built

939
00:38:59,040 --> 00:38:55,810
the exhibits there we recognize that

940
00:39:02,070 --> 00:38:59,050
Pluto wasn't going to stay in the class

941
00:39:03,780 --> 00:39:02,080
of planets and so what we did there is

942
00:39:06,150 --> 00:39:03,790
we actually talked about the four rocky

943
00:39:08,310 --> 00:39:06,160
planets we talked about the four giant

944
00:39:11,280 --> 00:39:08,320
planets we talked about the Kuiper belt

945
00:39:13,170 --> 00:39:11,290
we talked about the asteroid belt and we

946
00:39:16,140 --> 00:39:13,180
talked about Pluto where it belongs

947
00:39:18,270 --> 00:39:16,150
within the Kuiper belt now I actually

948
00:39:20,610 --> 00:39:18,280
edited the text I made sure we never

949
00:39:22,070 --> 00:39:20,620
said Pluto wasn't a planet because that

950
00:39:24,750 --> 00:39:22,080
would be going against the IAE

951
00:39:27,330 --> 00:39:24,760
definition that it was but we never said

952
00:39:28,830 --> 00:39:27,340
that it was a planet alright we talked

953
00:39:30,800 --> 00:39:28,840
about it in the context of what it was

954
00:39:34,770 --> 00:39:30,810
so we walked a fine line basically

955
00:39:37,440 --> 00:39:34,780
however some reporter actually for the

956
00:39:39,930 --> 00:39:37,450
architecture of near of the New York

957
00:39:45,350 --> 00:39:39,940
Times came in and said what Pluto's not

958
00:39:47,670 --> 00:39:45,360
a planet only in New York and basically

959
00:39:49,110 --> 00:39:47,680
noted that we had talked about the rocky

960
00:39:52,080 --> 00:39:49,120
planets we talked about the giant

961
00:39:53,640 --> 00:39:52,090
planets and we hadn't talked about Pluto

962
00:39:55,560 --> 00:39:53,650
in either one of those categories of

963
00:39:57,270 --> 00:39:55,570

course it doesn't fit into either one of

964
00:40:00,660 --> 00:39:57,280
those categories but that caused a

965
00:40:02,700 --> 00:40:00,670
firestorm of stuff and you know it was

966
00:40:04,800 --> 00:40:02,710
just our way of saying look

967
00:40:07,320 --> 00:40:04,810
we know the times they are changing and

968
00:40:10,950 --> 00:40:07,330
our exhibits we expect them to stand for

969
00:40:12,380 --> 00:40:10,960
20 20 years or so and we were just kind

970
00:40:14,520 --> 00:40:12,390
of trying to get ahead of the curve

971
00:40:17,310 --> 00:40:14,530
turns out we actually were ahead of the

972
00:40:19,500 --> 00:40:17,320
curve ok we'll take credit for that all

973
00:40:23,160 --> 00:40:19,510
right Hubble came back to look at Pluto

974
00:40:25,650 --> 00:40:23,170
in 2002 and got more maps and for some

975
00:40:29,190 --> 00:40:25,660
reason they colored these maps yellow

976
00:40:31,740 --> 00:40:29,200
and black because there is a yellowish

977
00:40:33,240 --> 00:40:31,750
probably from an astronomers point of

978
00:40:36,570 --> 00:40:33,250
view there's a yellowish tinge to the

979
00:40:38,400 --> 00:40:36,580
surface of Pluto in terms of measuring

980
00:40:40,530 --> 00:40:38,410
its colors red versus blue and stuff

981
00:40:42,390 --> 00:40:40,540
like that but I really don't think the

982
00:40:44,730 --> 00:40:42,400
yellowish here is actually the yellowish

983
00:40:47,160 --> 00:40:44,740
color the human eye would see all right

984
00:40:48,720 --> 00:40:47,170
so I I worry about these things

985
00:40:50,849 --> 00:40:48,730
appearing in textbooks and kids thinking

986
00:40:52,740 --> 00:40:50,859
Oh Pluto is going to look like that yeah

987
00:40:54,570 --> 00:40:52,750
it's always good to mention that a lot

988
00:40:56,339 --> 00:40:54,580

of astronomical images are using color

989
00:40:58,440 --> 00:40:56,349
tables to bring out detail they wouldn't

990
00:40:59,940 --> 00:40:58,450
see these color tables are kind of

991
00:41:02,190 --> 00:40:59,950
specialized depending on what they're

992
00:41:04,050 --> 00:41:02,200
trying to bring out what details so

993
00:41:05,760 --> 00:41:04,060
that's a good point that's right but

994
00:41:08,520 --> 00:41:05,770
really the sites that came out of it

995
00:41:11,910 --> 00:41:08,530
came out of the surface maps okay so

996
00:41:14,089 --> 00:41:11,920
this is a surface map of Pluto sort of

997
00:41:16,560 --> 00:41:14,099
like you would see a spread-out map of

998
00:41:19,140 --> 00:41:16,570
Earth right with all the continents raid

999
00:41:22,829 --> 00:41:19,150
well this is a very low resolution one

1000
00:41:24,870 --> 00:41:22,839
of Pluto and this is the 2002 map and

1001
00:41:29,370 --> 00:41:24,880
what was interesting is if you compare

1002
00:41:32,430 --> 00:41:29,380
the 2002 map to the 2,000 of the 1994

1003
00:41:35,099 --> 00:41:32,440
map all right you can see that there's a

1004
00:41:38,250 --> 00:41:35,109
bright region down bottom in the 1994

1005
00:41:41,400 --> 00:41:38,260
map but if I switch back to the 2002 map

1006
00:41:43,320 --> 00:41:41,410
the bright region is towards the top all

1007
00:41:47,220 --> 00:41:43,330
right and so what we're seeing here a

1008
00:41:50,720 --> 00:41:47,230
bit is a change in the brightness of the

1009
00:41:53,579 --> 00:41:50,730
surface of Pluto which may indicate

1010
00:41:56,190 --> 00:41:53,589
surmise to indicate the deposition of

1011
00:42:01,650 --> 00:41:56,200
fresh I don't like all its snow but

1012
00:42:05,190 --> 00:42:01,660
fresh condensate okay Pluto has a very

1013
00:42:07,410 --> 00:42:05,200

very thin atmosphere okay and it can the

1014
00:42:09,450 --> 00:42:07,420
material could actually move from one

1015
00:42:12,390 --> 00:42:09,460
could actually evaporate at one area

1016
00:42:13,380 --> 00:42:12,400
andrey condense on another area i'm not

1017
00:42:14,670 --> 00:42:13,390
sure that that's what's it what's

1018
00:42:16,140 --> 00:42:14,680
happened here that that's a supposition

1019
00:42:18,900 --> 00:42:16,150
that that might have happened here

1020
00:42:22,380 --> 00:42:18,910
but what really this shows is that the

1021
00:42:25,829 --> 00:42:22,390
stuff that was right in 1994 has become

1022
00:42:28,620 --> 00:42:25,839
dark by 2002 and a new region has had

1023
00:42:31,740 --> 00:42:28,630
new condensate in 2002 so it does show

1024
00:42:33,000 --> 00:42:31,750
that as pluto heads heads away from the

1025
00:42:35,250 --> 00:42:33,010
Sun it's heading away from the Sun right

1026
00:42:36,690 --> 00:42:35,260
now its surface features at least the

1027
00:42:38,670 --> 00:42:36,700
brightness of his search features are

1028
00:42:40,410 --> 00:42:38,680
changing and that's something we hadn't

1029
00:42:41,940 --> 00:42:40,420
known before so that's that's a

1030
00:42:47,640 --> 00:42:41,950
brand-new result that Hubble was able to

1031
00:42:50,190 --> 00:42:47,650
do hell let's see then in 2006 this is a

1032
00:42:52,680 --> 00:42:50,200
picture a great picture from NASA of a

1033
00:42:54,750 --> 00:42:52,690
launch of the New Horizons mission all

1034
00:42:57,359 --> 00:42:54,760
right we had sent Voyager past Jupiter

1035
00:42:59,579 --> 00:42:57,369
Saturn and voyager 2 past Jupiter Saturn

1036
00:43:03,390 --> 00:42:59,589
Uranus and Neptune but we had never

1037
00:43:05,789 --> 00:43:03,400
visited Pluto and Alan Stern is the p.i

1038
00:43:08,579 --> 00:43:05,799

on this project and he finally got his

1039
00:43:09,960 --> 00:43:08,589
his lifelong dream to send a mission out

1040
00:43:13,680 --> 00:43:09,970
to Pluto the new horizon missions

1041
00:43:15,690 --> 00:43:13,690
launched in January 2006 and in support

1042
00:43:17,819 --> 00:43:15,700
of the New Horizons mission Hubble was

1043
00:43:19,710 --> 00:43:17,829
going to survey the Pluto system to see

1044
00:43:21,750 --> 00:43:19,720
was there anything else there that's

1045
00:43:23,400 --> 00:43:21,760
worthy of study or was there anything

1046
00:43:26,309 --> 00:43:23,410
else there that could actually pose a

1047
00:43:28,470 --> 00:43:26,319
threat to New Horizons mission and we

1048
00:43:31,890 --> 00:43:28,480
actually discovered some things in 2005

1049
00:43:34,289 --> 00:43:31,900
but we released them in 2006 and in

1050
00:43:39,029 --> 00:43:34,299
February 2006 we released this picture

1051
00:43:42,269 --> 00:43:39,039
of two new moons around Pluto they were

1052
00:43:44,250 --> 00:43:42,279
designated p1 and p2 but later the

1053
00:43:46,980 --> 00:43:44,260
discoverers got the name them and they

1054
00:43:48,990 --> 00:43:46,990
named them Nix and Hydra that wasn't

1055
00:43:53,940 --> 00:43:49,000
take moment euros other names p1 and p2

1056
00:43:56,849 --> 00:43:53,950
were so great well Nix and Hydra NH New

1057
00:44:03,809 --> 00:43:56,859
Horizons so there was not a coincidence

1058
00:44:06,210 --> 00:44:03,819
I never knew that okay know that so they

1059
00:44:08,039 --> 00:44:06,220
worked really hard to find some names

1060
00:44:10,319 --> 00:44:08,049
that are within the mythology of the

1061
00:44:13,109 --> 00:44:10,329
underworld and Pluto that will come with

1062
00:44:16,230 --> 00:44:13,119
it and they found Nix and Hydra NH New

1063
00:44:18,120 --> 00:44:16,240

Horizons okay that was februari 2006 so

1064
00:44:20,490 --> 00:44:18,130
we got new horizons launch we got some

1065
00:44:25,260 --> 00:44:20,500
new moons and then august two thousand

1066
00:44:26,970 --> 00:44:25,270
six boom Pluto's no longer a planet so

1067
00:44:29,490 --> 00:44:26,980
finally the rest of the world caught up

1068
00:44:31,980 --> 00:44:29,500
to what we had done in two thousand

1069
00:44:34,410 --> 00:44:31,990
and recognize that Pluto didn't really

1070
00:44:36,720 --> 00:44:34,420
fit in amongst the planets it wasn't a

1071
00:44:38,910 --> 00:44:36,730
rocky planet wasn't a giant planet it

1072
00:44:40,950 --> 00:44:38,920
actually did fit in with these other

1073
00:44:44,550 --> 00:44:40,960
objects which I'll discuss in just a bit

1074
00:44:47,160 --> 00:44:44,560
so that was you know a big year for

1075
00:44:48,960 --> 00:44:47,170
Pluto there in terms of getting the

1076
00:44:53,040 --> 00:44:48,970
mission getting the new moons and then

1077
00:44:56,850 --> 00:44:53,050
change in status flash forward to 2007

1078
00:44:59,700 --> 00:44:56,860
and New Horizons has already past

1079
00:45:01,920 --> 00:44:59,710
Jupiter okay and this this is what

1080
00:45:04,410 --> 00:45:01,930
always brings back to me the scale of

1081
00:45:06,510 --> 00:45:04,420
the solar system that essentially in a

1082
00:45:10,530 --> 00:45:06,520
year a little over a year it could get

1083
00:45:12,660 --> 00:45:10,540
out to Jupiter right and but that's

1084
00:45:14,580 --> 00:45:12,670
really only a few percent of the way to

1085
00:45:16,680 --> 00:45:14,590
get to where it's really going because

1086
00:45:18,960 --> 00:45:16,690
it's going to travel if the earth-sun

1087
00:45:21,180 --> 00:45:18,970
distance is one AU right and then

1088
00:45:23,630 --> 00:45:21,190

Jupiter's out at like 58 you so that's

1089
00:45:27,180 --> 00:45:23,640
that's it's traveled almost for a you in

1090
00:45:31,110 --> 00:45:27,190
2007 tub by 2007 but it has to travel

1091
00:45:33,060 --> 00:45:31,120
30a you so Jupiter is actually really

1092
00:45:36,450 --> 00:45:33,070
close in comparison to how distant

1093
00:45:38,550 --> 00:45:36,460
Neptune and Pluto are so it sort of

1094
00:45:41,790 --> 00:45:38,560
gives you a feeling for the scale solar

1095
00:45:44,520 --> 00:45:41,800
system that it was there in 2007 and I

1096
00:45:46,500 --> 00:45:44,530
have to mention this because when New

1097
00:45:48,330 --> 00:45:46,510
Horizons past Jupiter who is able to

1098
00:45:51,300 --> 00:45:48,340
take very shots of Jupiter which were

1099
00:45:54,300 --> 00:45:51,310
nice but it got the most amazing shot of

1100
00:45:58,640 --> 00:45:54,310
Jupiter's moon Io and again one of my

1101
00:46:03,630 --> 00:45:58,650
favorite shots and in astronomy is this

1102
00:46:06,030 --> 00:46:03,640
animated gif of Cooper's moon Io and on

1103
00:46:09,930 --> 00:46:06,040
the very top of it you can see the

1104
00:46:14,580 --> 00:46:09,940
volcano too vast are actually see five

1105
00:46:17,010 --> 00:46:14,590
images of de bashed are erupting just

1106
00:46:18,840 --> 00:46:17,020
how cool is that I know now while Frank

1107
00:46:21,000 --> 00:46:18,850
is talking I've been uploading some of

1108
00:46:22,620 --> 00:46:21,010
these images to the event page but

1109
00:46:25,110 --> 00:46:22,630
unfortunately that's not going to come

1110
00:46:27,030 --> 00:46:25,120
through so the animated gif part so

1111
00:46:29,130 --> 00:46:27,040
you'll just get the image that got

1112
00:46:31,380 --> 00:46:29,140
captured from the PowerPoint export but

1113
00:46:36,360 --> 00:46:31,390

all right well if you look if you do a

1114
00:46:39,180 --> 00:46:36,370
Google search for TV a sh t AR to Vash

1115
00:46:40,860 --> 00:46:39,190
star this will come up because you know

1116
00:46:43,079 --> 00:46:40,870
it's it's there on Wikipedia such as a

1117
00:46:46,430 --> 00:46:43,089
public domain image and such

1118
00:46:48,989 --> 00:46:46,440
I'm one of my favorites yeah that is all

1119
00:46:52,019 --> 00:46:48,999
ok so that's a little bit of a side

1120
00:46:54,269 --> 00:46:52,029
point but you know new horizons did good

1121
00:46:56,039 --> 00:46:54,279
science good observations while it was

1122
00:46:59,249 --> 00:46:56,049
passing by Jupiter and getting a good

1123
00:47:00,569 --> 00:46:59,259
gravity assist from Jupiter in addition

1124
00:47:04,079 --> 00:47:00,579
to the science it will do when it gets

1125
00:47:07,920 --> 00:47:04,089
to Pluto alright well fast forward to

1126
00:47:10,410 --> 00:47:07,930
2012 Hubble continued to look made some

1127
00:47:12,599 --> 00:47:10,420
more look check checking around there we

1128
00:47:14,309 --> 00:47:12,609
you'll notice this image has got two

1129
00:47:17,579 --> 00:47:14,319
exposures it's got the exposure down the

1130
00:47:19,289 --> 00:47:17,589
center which is Pluto and Charon um on

1131
00:47:20,789 --> 00:47:19,299
the left-hand side you can see the

1132
00:47:23,819 --> 00:47:20,799
previously discovered moons Nix and

1133
00:47:28,229 --> 00:47:23,829
Hydra but in 2010 we discovered another

1134
00:47:30,269 --> 00:47:28,239
moon and 2011 or 2012 we discovered yet

1135
00:47:33,450 --> 00:47:30,279
another moon and these ended up being

1136
00:47:35,309 --> 00:47:33,460
named sticks and kerberos so now we've

1137
00:47:38,549 --> 00:47:35,319
got this amazing system all right with

1138
00:47:40,529 --> 00:47:38,559

Pluto Karen and then for new moons that

1139
00:47:41,729 --> 00:47:40,539
we didn't know about out there so Hubble

1140
00:47:43,920 --> 00:47:41,739
is saying alright this is going to be

1141
00:47:45,719 --> 00:47:43,930
really cool and because Hubble had

1142
00:47:47,880 --> 00:47:45,729
discovered it on the way to Pluto while

1143
00:47:50,400 --> 00:47:47,890
New Horizons is still on its way the

1144
00:47:52,829 --> 00:47:50,410
astronomers could then bring this into

1145
00:47:54,989 --> 00:47:52,839
their planning and plan scientific

1146
00:47:56,849 --> 00:47:54,999
observations to try and cover the whole

1147
00:47:59,940 --> 00:47:56,859
Pluto system all right when it was

1148
00:48:01,920 --> 00:47:59,950
launched we only had two objects to to

1149
00:48:05,430 --> 00:48:01,930
examine in the Pluto system now we got

1150
00:48:08,339 --> 00:48:05,440
six so Hubble has provided a really good

1151
00:48:11,789 --> 00:48:08,349
bonanza for the New Horizons mission to

1152
00:48:13,769 --> 00:48:11,799
look at ok well now we're up to today ok

1153
00:48:16,009 --> 00:48:13,779
and this is something i downloaded today

1154
00:48:20,190 --> 00:48:16,019
from the New Horizons website it shows

1155
00:48:22,799 --> 00:48:20,200
the path of New Horizons on its way out

1156
00:48:25,499 --> 00:48:22,809
to Pluto and show you where it is it has

1157
00:48:27,959 --> 00:48:25,509
traveled about 29 astronomical units and

1158
00:48:30,719 --> 00:48:27,969
still has a little less than three to go

1159
00:48:33,120 --> 00:48:30,729
and that three will take place over the

1160
00:48:37,069 --> 00:48:33,130
next year all right but a really

1161
00:48:41,400 --> 00:48:37,079
important point comes up in January of

1162
00:48:42,930 --> 00:48:41,410
2015 so these are those Hubble images ok

1163
00:48:45,630 --> 00:48:42,940

these are the Hubble these are the best

1164
00:48:49,229 --> 00:48:45,640
images we've got from Hubble New

1165
00:48:53,130 --> 00:48:49,239
Horizons will equal Hubble's resolution

1166
00:48:55,289 --> 00:48:53,140
in January of 2015 so for the first time

1167
00:48:56,910 --> 00:48:55,299
will actually start to get better images

1168
00:48:59,220 --> 00:48:56,920
that Hubble can take

1169
00:49:01,590 --> 00:48:59,230
um beginning beginning next year so for

1170
00:49:04,950 --> 00:49:01,600
about six months before and six months

1171
00:49:06,600 --> 00:49:04,960
after its encounter with with Pluto New

1172
00:49:09,240 --> 00:49:06,610
Horizons will have time to take pictures

1173
00:49:10,440 --> 00:49:09,250
that exceed Hubble's resolution and i

1174
00:49:12,090 --> 00:49:10,450
almost put a little question marks over

1175
00:49:14,190 --> 00:49:12,100
top of these because i don't know what

1176
00:49:16,830 --> 00:49:14,200
they're going to be like but it'll be

1177
00:49:20,580 --> 00:49:16,840
nice to finally exceed these uh these

1178
00:49:23,190 --> 00:49:20,590
rather i want to call it right there

1179
00:49:24,810 --> 00:49:23,200
kind of pathetic here okay it says a lot

1180
00:49:26,730 --> 00:49:24,820
about Hubble come on me well we had to

1181
00:49:28,470 --> 00:49:26,740
get these get something better than that

1182
00:49:30,270 --> 00:49:28,480
it sends something way the heck out

1183
00:49:31,800 --> 00:49:30,280
there and that's actually that's a great

1184
00:49:33,930 --> 00:49:31,810
point Tony I mean there's a lot that

1185
00:49:36,240 --> 00:49:33,940
Hubble can do that can only be exceeded

1186
00:49:38,520 --> 00:49:36,250
by satellites that actually fly across

1187
00:49:41,010 --> 00:49:38,530
the space satellites to fly across the

1188
00:49:43,650 --> 00:49:41,020

solar system and visit the planets

1189
00:49:45,660 --> 00:49:43,660
that's right awesome that's great Frank

1190
00:49:48,210 --> 00:49:45,670
ok so wait a minute but we still haven't

1191
00:49:50,760 --> 00:49:48,220
gotten things so the actual encounter

1192
00:49:55,110 --> 00:49:50,770
with Pluto will and it's listed on the

1193
00:49:58,890 --> 00:49:55,120
website is 7 49 59 seconds a.m. eastern

1194
00:50:01,410 --> 00:49:58,900
daylight time July 14 2015 so we are

1195
00:50:04,190 --> 00:50:01,420
just under his one-year announcing

1196
00:50:07,080 --> 00:50:04,200
that's right 300 left three days I guess

1197
00:50:09,810 --> 00:50:07,090
363 days from now we will have the

1198
00:50:10,920 --> 00:50:09,820
closest approach to Pluto and that will

1199
00:50:13,440 --> 00:50:10,930
be kind of cool this is of course an

1200
00:50:15,270 --> 00:50:13,450
artist's rendition with Pluto and its

1201
00:50:18,690 --> 00:50:15,280
kind of interesting they they they drew

1202
00:50:21,080 --> 00:50:18,700
some ice geysers in this in this thing

1203
00:50:24,660 --> 00:50:21,090
sort of like the ice geysers we see on

1204
00:50:26,550 --> 00:50:24,670
Triton Neptune's moon Triton and then

1205
00:50:28,500 --> 00:50:26,560
there's a Karen in the background I

1206
00:50:30,270 --> 00:50:28,510
don't know if this was drawn after Nixon

1207
00:50:31,470 --> 00:50:30,280
Hydra and sticks and kerberos were

1208
00:50:33,270 --> 00:50:31,480
discovered but I don't see them in the

1209
00:50:36,300 --> 00:50:33,280
image all right so we got that all right

1210
00:50:39,180 --> 00:50:36,310
so New Horizons were one year away here

1211
00:50:40,890 --> 00:50:39,190
is the timeline of the mission and you

1212
00:50:43,980 --> 00:50:40,900
can see the process of passing by

1213
00:50:46,650 --> 00:50:43,990

Jupiter getting out to Pluto but the

1214
00:50:48,690 --> 00:50:46,660
really cool thing about it is that we

1215
00:50:52,080 --> 00:50:48,700
now have so much more information out

1216
00:50:55,290 --> 00:50:52,090
there what is New Horizons going to do a

1217
00:50:57,450 --> 00:50:55,300
fertilized by Pluto Pluto does not have

1218
00:51:00,750 --> 00:50:57,460
enough mass okay we certainly don't have

1219
00:51:03,270 --> 00:51:00,760
enough thrusters on this small satellite

1220
00:51:05,400 --> 00:51:03,280
on a small space mission to pull it into

1221
00:51:07,050 --> 00:51:05,410
an orbit around Pluto right because we

1222
00:51:09,330 --> 00:51:07,060
you know messenger is sitting around

1223
00:51:10,740 --> 00:51:09,340
mercury and it's orbiting mercury okay

1224
00:51:13,320 --> 00:51:10,750
Cassini has been orbiting

1225
00:51:15,540 --> 00:51:13,330
for several years and we can do detailed

1226
00:51:18,180 --> 00:51:15,550
studies of those of those planets

1227
00:51:21,480 --> 00:51:18,190
because they go into orbit and can stay

1228
00:51:23,100 --> 00:51:21,490
for several years well New Horizons is

1229
00:51:27,480 --> 00:51:23,110
booking across the solar system there's

1230
00:51:28,800 --> 00:51:27,490
no way it could stop to to look at Pluto

1231
00:51:32,340 --> 00:51:28,810
for very long it's going to be a very

1232
00:51:34,470 --> 00:51:32,350
quick you know coupled a flyby of Pluto

1233
00:51:36,620 --> 00:51:34,480
and its system and that's all we're

1234
00:51:40,760 --> 00:51:36,630
going to get so what do we do after that

1235
00:51:44,340 --> 00:51:40,770
well the reason Pluto was demoted is

1236
00:51:47,220 --> 00:51:44,350
specified by this image right here this

1237
00:51:49,560 --> 00:51:47,230
is the Kuiper belt okay and so these

1238
00:51:51,510 --> 00:51:49,570

green circles in here starting from the

1239
00:51:54,120 --> 00:51:51,520
inside it's Jupiter Saturn Uranus and

1240
00:51:56,910 --> 00:51:54,130
Neptune okay these are the giant planets

1241
00:51:59,850 --> 00:51:56,920
and those are the orbits of the giant

1242
00:52:03,060 --> 00:51:59,860
planets the green the blue green circles

1243
00:52:07,830 --> 00:52:03,070
there but all of the red and white dots

1244
00:52:09,750 --> 00:52:07,840
the 1274 red and white dots out beyond

1245
00:52:13,440 --> 00:52:09,760
and just slightly covering Neptune's

1246
00:52:18,960 --> 00:52:13,450
orbit our new objects we have discovered

1247
00:52:21,210 --> 00:52:18,970
since 1992 this is a new region of the

1248
00:52:24,570 --> 00:52:21,220
solar system that has been discovered in

1249
00:52:26,910 --> 00:52:24,580
our lifetimes the reason Pluto was

1250
00:52:29,640 --> 00:52:26,920
demoted from being a planet is not

1251
00:52:32,550 --> 00:52:29,650
because of its particular size or it or

1252
00:52:35,820 --> 00:52:32,560
its particular characteristics but that

1253
00:52:38,430 --> 00:52:35,830
it now has a family of objects that are

1254
00:52:40,590 --> 00:52:38,440
just like it that are small that are icy

1255
00:52:42,810 --> 00:52:40,600
have these elongated orbits have these

1256
00:52:45,720 --> 00:52:42,820
tilted orbits they have all the same

1257
00:52:47,520 --> 00:52:45,730
characteristics as Pluto and Pluto is

1258
00:52:49,740 --> 00:52:47,530
one of the largest of these objects that

1259
00:52:51,360 --> 00:52:49,750
you know we can call them Kuiper belt

1260
00:52:54,870 --> 00:52:51,370
objects or some people call them

1261
00:52:56,240 --> 00:52:54,880
trans-neptunian objects I just I stick

1262
00:53:00,360 --> 00:52:56,250
with Kuiper belt is because it's easier

1263
00:53:02,070 --> 00:53:00,370

for people to recognize so if you have

1264
00:53:04,650 --> 00:53:02,080
all these other objects out there and

1265
00:53:07,560 --> 00:53:04,660
you've got this mission streaming

1266
00:53:08,940 --> 00:53:07,570
through them doesn't it make sense to

1267
00:53:12,150 --> 00:53:08,950
try and find something else to look at

1268
00:53:15,330 --> 00:53:12,160
right so that's what Howell has been

1269
00:53:17,430 --> 00:53:15,340
doing and Hubble started a mission and

1270
00:53:18,570 --> 00:53:17,440
so the new science this is I'm finally

1271
00:53:20,190 --> 00:53:18,580
getting to the new science after about

1272
00:53:23,830 --> 00:53:20,200
20 minutes of talking about Pluto right

1273
00:53:26,710 --> 00:53:23,840
you did go over for you

1274
00:53:28,420 --> 00:53:26,720
and you know but this is the new science

1275
00:53:32,560 --> 00:53:28,430
that we released is that Hubble has

1276
00:53:36,820 --> 00:53:32,570
started this search for objects in the

1277
00:53:39,760 --> 00:53:36,830
Kuiper belt that could be targets for

1278
00:53:40,870 --> 00:53:39,770
New Horizons so New Horizons is going to

1279
00:53:44,350 --> 00:53:40,880
go past Pluto it's going to have a

1280
00:53:46,690 --> 00:53:44,360
really serious amazing science fest for

1281
00:53:48,610 --> 00:53:46,700
a very short time as it passes Pluto and

1282
00:53:50,440 --> 00:53:48,620
then it's got to look for another target

1283
00:53:52,810 --> 00:53:50,450
well it can't go look for another target

1284
00:53:54,640 --> 00:53:52,820
on its own it needs the help of Hubble

1285
00:53:57,040 --> 00:53:54,650
and Hubble has started this search here

1286
00:54:00,430 --> 00:53:57,050
are two examples and these two examples

1287
00:54:02,760 --> 00:54:00,440
showed that Hubble really is capable of

1288
00:54:05,260 --> 00:54:02,770

doing this it was a proof of concept

1289
00:54:08,560 --> 00:54:05,270
yeah this is a proof of concept on these

1290
00:54:11,470 --> 00:54:08,570
things and Hubble has been approved to

1291
00:54:12,580 --> 00:54:11,480
do the full target search okay I don't

1292
00:54:15,190 --> 00:54:12,590
know how many orbits that's going to

1293
00:54:18,610 --> 00:54:15,200
take to do this but continue to do a

1294
00:54:21,220 --> 00:54:18,620
much larger target search for objects

1295
00:54:22,570 --> 00:54:21,230
for New Horizons to look at and so it's

1296
00:54:24,550 --> 00:54:22,580
going to search the part of the sky that

1297
00:54:27,070 --> 00:54:24,560
New Horizons will be flying through and

1298
00:54:29,620 --> 00:54:27,080
Hubble will be able to have been able to

1299
00:54:31,660 --> 00:54:29,630
not only help new horizons by looking at

1300
00:54:33,820 --> 00:54:31,670
the Pluto system and all the objects in

1301
00:54:36,640 --> 00:54:33,830
it but also to now examine the Kuiper

1302
00:54:39,130 --> 00:54:36,650
belt and find new targets printing

1303
00:54:42,460 --> 00:54:39,140
horizons to look at so let me get this

1304
00:54:45,070 --> 00:54:42,470
try so as New Horizons flies after it's

1305
00:54:46,570 --> 00:54:45,080
done its flyby of Pluto Hubble is going

1306
00:54:48,190 --> 00:54:46,580
to very quickly go out there say okay

1307
00:54:50,050 --> 00:54:48,200
now go over here look at this thing this

1308
00:54:52,450 --> 00:54:50,060
one's pretty cool and it's gonna sort of

1309
00:54:54,900 --> 00:54:52,460
gauge in real time what it's going to

1310
00:54:57,970 --> 00:54:54,910
look at or how is that going to work I

1311
00:54:59,590 --> 00:54:57,980
my expectation I'm not involved in the

1312
00:55:03,310 --> 00:54:59,600
planning of it but my expectation is

1313
00:55:05,440 --> 00:55:03,320

that they have a limited amount of

1314
00:55:07,780 --> 00:55:05,450
thruster that they do to change course

1315
00:55:11,500 --> 00:55:07,790
and to get near one of these objects is

1316
00:55:14,140 --> 00:55:11,510
always trying to hit you know a dime on

1317
00:55:15,910 --> 00:55:14,150
the other side of the country and so you

1318
00:55:19,230 --> 00:55:15,920
know your true really trying to do vary

1319
00:55:21,790 --> 00:55:19,240
so a object when Hubble will go through

1320
00:55:25,000 --> 00:55:21,800
assemble a list of candidates possible

1321
00:55:27,130 --> 00:55:25,010
targets the investigators with New

1322
00:55:28,510 --> 00:55:27,140
Horizons will choose one of them and say

1323
00:55:30,250 --> 00:55:28,520
okay this is the object we're going to

1324
00:55:32,830 --> 00:55:30,260
try and study and they will calculate

1325
00:55:34,360 --> 00:55:32,840
what kind of thrust do they need to get

1326
00:55:36,850 --> 00:55:34,370
to maneuver the spaceship after it

1327
00:55:37,750 --> 00:55:36,860
passes through the Pluto system what

1328
00:55:40,300 --> 00:55:37,760
kind of thrust

1329
00:55:42,160 --> 00:55:40,310
does it need to then do a course

1330
00:55:44,050 --> 00:55:42,170
correction to try and get it to go past

1331
00:55:45,760 --> 00:55:44,060
one of these objects and then all of

1332
00:55:48,160 --> 00:55:45,770
their focus will be on got that one

1333
00:55:49,450 --> 00:55:48,170
selected object no I don't think we I

1334
00:55:51,400 --> 00:55:49,460
don't think we'll be able to get more

1335
00:55:53,740 --> 00:55:51,410
than one if we got really really really

1336
00:55:55,840 --> 00:55:53,750
really lucky maybe two of them would

1337
00:56:00,400 --> 00:55:55,850
line up that you can't go past one and

1338
00:56:01,750 --> 00:56:00,410

then go past another but you know this

1339
00:56:05,140 --> 00:56:01,760
is not like Hollywood's view of the

1340
00:56:06,880 --> 00:56:05,150
asteroid belt okay if we always go back

1341
00:56:09,460 --> 00:56:06,890
to what was at the empire strikes back

1342
00:56:11,200 --> 00:56:09,470
oh yeah the important my name Falcon

1343
00:56:15,070 --> 00:56:11,210
zooming bass through the asteroids

1344
00:56:18,550 --> 00:56:15,080
that's BS sorry the asteroid belt is so

1345
00:56:22,300 --> 00:56:18,560
bloody empty that work extremely hard

1346
00:56:24,700 --> 00:56:22,310
just to find any asteroids um the Kuiper

1347
00:56:26,410 --> 00:56:24,710
belt is even worse okay there are more

1348
00:56:27,790 --> 00:56:26,420
objects in the Kuiper belt but their

1349
00:56:30,910 --> 00:56:27,800
father apart i mean we're talking

1350
00:56:33,490 --> 00:56:30,920
millions of miles apart really so you

1351
00:56:35,080 --> 00:56:33,500
got to work really really really hard to

1352
00:56:37,990 --> 00:56:35,090
get anywhere near any one of these

1353
00:56:39,520 --> 00:56:38,000
objects sorry it's not like the cat the

1354
00:56:43,840 --> 00:56:39,530
New Horizons mission is going to have a

1355
00:56:45,730 --> 00:56:43,850
you know a video game trying to slalom

1356
00:56:47,110 --> 00:56:45,740
through all these objects really it's

1357
00:56:49,120 --> 00:56:47,120
going to have to work really hard just

1358
00:56:51,460 --> 00:56:49,130
to find one of them in order to look

1359
00:56:56,200 --> 00:56:51,470
forward well this always built into the

1360
00:56:59,050 --> 00:56:56,210
New Horizons mission plan for couple to

1361
00:57:02,410 --> 00:56:59,060
do this well having Hubble do this I

1362
00:57:04,120 --> 00:57:02,420
don't believe so but having the

1363
00:57:07,150 --> 00:57:04,130

opportunity to look at the Kuiper belt

1364
00:57:08,350 --> 00:57:07,160
has always been there but it wasn't part

1365
00:57:09,880 --> 00:57:08,360
of the original funding the original

1366
00:57:12,520 --> 00:57:09,890
funding for new horizons was just to go

1367
00:57:14,740 --> 00:57:12,530
out and examine Pluto and it's always

1368
00:57:16,240 --> 00:57:14,750
been in the P eyes mind and all the sign

1369
00:57:17,890 --> 00:57:16,250
all the astronomers I know who work on

1370
00:57:19,030 --> 00:57:17,900
the mission always have said yeah we got

1371
00:57:20,770 --> 00:57:19,040
a look at the Kuiper belt it just seems

1372
00:57:23,290 --> 00:57:20,780
reasonable you spend all this money to

1373
00:57:25,930 --> 00:57:23,300
get out to Pluto you can't tell me we're

1374
00:57:28,540 --> 00:57:25,940
not going to look further but when they

1375
00:57:30,520 --> 00:57:28,550
proposed it the Kuiper belt was not well

1376
00:57:33,790 --> 00:57:30,530
known we didn't have these 1,200 objects

1377
00:57:36,910 --> 00:57:33,800
we maybe had a you know 50 or 100 when

1378
00:57:39,520 --> 00:57:36,920
it first got funded so that you couldn't

1379
00:57:41,050 --> 00:57:39,530
plan on it but now the idea now that our

1380
00:57:43,360 --> 00:57:41,060
knowledge has grown over the years that

1381
00:57:46,180 --> 00:57:43,370
New Horizons has been built and has been

1382
00:57:49,090 --> 00:57:46,190
flying we now have I think it's a

1383
00:57:50,830 --> 00:57:49,100
no-brainer that we should try and try

1384
00:57:51,450 --> 00:57:50,840
and do this and Hubble really has turned

1385
00:57:55,430 --> 00:57:51,460
out to be

1386
00:57:58,110 --> 00:57:55,440
one of the good one of the good

1387
00:58:00,600 --> 00:57:58,120
telescopes for finding the possible

1388
00:58:02,310 --> 00:58:00,610

targets and I think we're planning on

1389
00:58:03,480 --> 00:58:02,320
trying to organize a hang out with the

1390
00:58:06,180 --> 00:58:03,490
guys that might be doing that

1391
00:58:08,280 --> 00:58:06,190
observation in the coming year so so

1392
00:58:11,100 --> 00:58:08,290
look for that as well so okay cool okay

1393
00:58:14,040 --> 00:58:11,110
well she got Frank um that's it but we

1394
00:58:16,230 --> 00:58:14,050
just wanted to remind people that we do

1395
00:58:18,450 --> 00:58:16,240
more that we do a lots of other things

1396
00:58:21,270 --> 00:58:18,460
for the public and in particular I host

1397
00:58:25,110 --> 00:58:21,280
the public lecture series and remind me

1398
00:58:27,030 --> 00:58:25,120
on August fifth 2014 we have dr.

1399
00:58:29,370 --> 00:58:27,040
Jennifer lots from the Space Telescope

1400
00:58:32,520 --> 00:58:29,380
Science Institute talking about frontier

1401
00:58:35,460 --> 00:58:32,530
fields a sneak peek at the first billion

1402
00:58:41,190 --> 00:58:35,470
years of i miss the s in that one first

1403
00:58:43,410 --> 00:58:41,200
billion years of the universe year yeah

1404
00:58:45,030 --> 00:58:43,420
now you've had Jenna on some hangouts

1405
00:58:46,980 --> 00:58:45,040
haven't you that's true now anybody

1406
00:58:48,360 --> 00:58:46,990
who's watched Hubble hangouts and with

1407
00:58:50,160 --> 00:58:48,370
if for any length of time has seen

1408
00:58:52,620 --> 00:58:50,170
several now we've had several frontier

1409
00:58:54,870 --> 00:58:52,630
fields hangouts but we've all we've

1410
00:58:57,630 --> 00:58:54,880
targeted on specific ideas and subjects

1411
00:58:59,940 --> 00:58:57,640
and so this will be a good overview of

1412
00:59:01,290 --> 00:58:59,950
what the science and and and what

1413
00:59:03,000 --> 00:59:01,300

they're what we're doing how they're

1414
00:59:05,220 --> 00:59:03,010
making Hubble more powerful by using

1415
00:59:06,660 --> 00:59:05,230
gravity gravitational lenses so that'll

1416
00:59:09,510 --> 00:59:06,670
be it should be a really good one and it

1417
00:59:12,840 --> 00:59:09,520
will be in addition to being webcast on

1418
00:59:14,880 --> 00:59:12,850
our one webcast is DSD i dot edu it will

1419
00:59:16,710 --> 00:59:14,890
also be on youtube on this channel so

1420
00:59:19,050 --> 00:59:16,720
right well Tony does a fantastic job of

1421
00:59:21,600 --> 00:59:19,060
taking the streams that we film inside

1422
00:59:23,550 --> 00:59:21,610
the auditorium and they're up on youtube

1423
00:59:25,350 --> 00:59:23,560
and we got a great response we want to

1424
00:59:27,570 --> 00:59:25,360
thank you all for coming and watching

1425
00:59:30,060 --> 00:59:27,580
those on the YouTube channel most of its

1426
00:59:32,070 --> 00:59:30,070
really it's nice that the speakers

1427
00:59:33,960 --> 00:59:32,080
really appreciate it because they get

1428
00:59:35,520 --> 00:59:33,970
the you know we may have a hundred

1429
00:59:38,640 --> 00:59:35,530
hundred and fifty people in the audience

1430
00:59:40,920 --> 00:59:38,650
but when you then get 5,000 hits 3000

1431
00:59:42,750 --> 00:59:40,930
5000 hits on YouTube you realize wow I'm

1432
00:59:45,420 --> 00:59:42,760
hitting a much bigger audience too and

1433
00:59:48,000 --> 00:59:45,430
that's right and while sometimes Frank

1434
00:59:50,190 --> 00:59:48,010
tries to look at the comments that you

1435
00:59:51,720 --> 00:59:50,200
guys are doing live while the talk has

1436
00:59:52,980 --> 00:59:51,730
happened he's also having to moderate

1437
00:59:54,840 --> 00:59:52,990
the talk so he doesn't always get a

1438
00:59:56,400 --> 00:59:54,850

chance to I will also be there though

1439
00:59:58,350 --> 00:59:56,410
looking at comments so it's okay to

1440
00:59:59,940 --> 00:59:58,360
leave comments on YouTube and Twitter

1441
01:00:01,500 --> 00:59:59,950
and anything else and we will try and

1442
01:00:04,520 --> 01:00:01,510
respond during that during the lecture

1443
01:00:06,410 --> 01:00:04,530
itself if you happen to catch it live so

1444
01:00:10,130 --> 01:00:06,420
we got any questions for today well

1445
01:00:14,210 --> 01:00:10,140
let's see um so from the I mean look

1446
01:00:16,760 --> 01:00:14,220
here from the UH from YouTube we have uh

1447
01:00:18,380 --> 01:00:16,770
this is from galaxia that goes maybe

1448
01:00:21,770 --> 01:00:18,390
when you were talking about the red spot

1449
01:00:24,950 --> 01:00:21,780
said maybe baby red spot and Big Brother

1450
01:00:26,480 --> 01:00:24,960
red spot will become one red spot what

1451
01:00:31,960 --> 01:00:26,490
do you think of that well these these

1452
01:00:34,720 --> 01:00:31,970
spots merge okay so red spot junior and

1453
01:00:40,400 --> 01:00:34,730
the Great Red Spot have been coexisting

1454
01:00:42,470 --> 01:00:40,410
for what over a decade now red spot

1455
01:00:44,270 --> 01:00:42,480
junior is at a different latitude and it

1456
01:00:49,010 --> 01:00:44,280
passes underneath as I showed that one

1457
01:00:54,590 --> 01:00:49,020
image it passes underneath the this the

1458
01:00:58,160 --> 01:00:54,600
the latitude of Great Red Spot so based

1459
01:01:00,100 --> 01:00:58,170
on ten years of evidence no they're not

1460
01:01:02,060 --> 01:01:00,110
going to merge to become one red spot

1461
01:01:04,280 --> 01:01:02,070
and that's one of the things you might

1462
01:01:06,770 --> 01:01:04,290
be thinking of that somebody else's I

1463
01:01:08,600 --> 01:01:06,780

would be thinking well maybe that the

1464
01:01:10,280 --> 01:01:08,610
Great Red Spot is shrunk because some of

1465
01:01:12,860 --> 01:01:10,290
the energy is now coming out through red

1466
01:01:14,930 --> 01:01:12,870
spot jr. and that could account for some

1467
01:01:17,630 --> 01:01:14,940
of it but certainly not all of the

1468
01:01:19,640 --> 01:01:17,640
shrinking of the of the of the red spot

1469
01:01:21,470 --> 01:01:19,650
yeah there you go yeah here's what we're

1470
01:01:23,780 --> 01:01:21,480
talking about so this was this was the

1471
01:01:27,380 --> 01:01:23,790
image that Frank was showing from from

1472
01:01:28,700 --> 01:01:27,390
Gemini so yeah it's still it's amazing

1473
01:01:30,650 --> 01:01:28,710
to me i remember when i was in solar

1474
01:01:32,660 --> 01:01:30,660
physics was amazing to me when I always

1475
01:01:34,490 --> 01:01:32,670
said you know it's amazing what we don't

1476
01:01:35,840 --> 01:01:34,500
know about the Sun and now the same is

1477
01:01:37,340 --> 01:01:35,850
true about some of these features on our

1478
01:01:40,010 --> 01:01:37,350
own planets but it's amazing what we

1479
01:01:41,540 --> 01:01:40,020
don't know about some of the features of

1480
01:01:43,580 --> 01:01:41,550
the of the of the planets in our solar

1481
01:01:47,030 --> 01:01:43,590
system so good question and thank you

1482
01:01:48,590 --> 01:01:47,040
for that stargazer nation is saying also

1483
01:01:50,180 --> 01:01:48,600
from YouTube and I find this funny that

1484
01:01:54,500 --> 01:01:50,190
he's able to get the little trademark in

1485
01:01:57,020 --> 01:01:54,510
his username that time again T darnet

1486
01:01:59,450 --> 01:01:57,030
Tony Darnell also I cannot believe these

1487
01:02:02,840 --> 01:01:59,460
images are near on 20 years old already

1488
01:02:04,640 --> 01:02:02,850

it's crazy and and I well it's worse

1489
01:02:05,860 --> 01:02:04,650
this better than that out where is in

1490
01:02:09,290 --> 01:02:05,870
the coming year we're celebrating

1491
01:02:12,080 --> 01:02:09,300
Hubble's 25th anniversary there's over

1492
01:02:13,940 --> 01:02:12,090
cutely that's right we're talking we're

1493
01:02:16,160 --> 01:02:13,950
emphasizing something called a Hubble

1494
01:02:18,230 --> 01:02:16,170
generation where there are people out

1495
01:02:20,270 --> 01:02:18,240
there now who

1496
01:02:21,980 --> 01:02:20,280
no overtime who don't know of a life

1497
01:02:24,050 --> 01:02:21,990
where there was not a Hubble Space

1498
01:02:26,990 --> 01:02:24,060
Telescope and my son is only 18 years

1499
01:02:29,870 --> 01:02:27,000
old he has never known a time when there

1500
01:02:33,500 --> 01:02:29,880
wasn't a Hubble Space Telescope that's

1501
01:02:35,570 --> 01:02:33,510
right both of my sons are 19 and 21 and

1502
01:02:38,240 --> 01:02:35,580
they don't either so it's amazing to

1503
01:02:40,130 --> 01:02:38,250
think about it really is Jordan Raines

1504
01:02:42,020 --> 01:02:40,140
is asking from YouTube I'm being good

1505
01:02:44,300 --> 01:02:42,030
Hubble can photograph galaxies that are

1506
01:02:46,400 --> 01:02:44,310
light-years away in vivid color do you

1507
01:02:49,580 --> 01:02:46,410
think we will ever get a clear up close

1508
01:02:53,030 --> 01:02:49,590
vivid photo of our own moon or is that

1509
01:02:55,060 --> 01:02:53,040
off limits okay thanks Jordan for this

1510
01:02:58,760 --> 01:02:55,070
question because we get this a lot

1511
01:03:01,520 --> 01:02:58,770
Hubble doesn't look at the moon simply

1512
01:03:04,850 --> 01:03:01,530
because it can only look at a very small

1513
01:03:08,030 --> 01:03:04,860

portion of the moon all right Hubble's

1514
01:03:09,710 --> 01:03:08,040
field of view on the skies I said there

1515
01:03:13,400 --> 01:03:09,720
are 12 million patches about the same

1516
01:03:15,980 --> 01:03:13,410
size and there are other telescopes the

1517
01:03:18,700 --> 01:03:15,990
moon is so bright that other telescopes

1518
01:03:22,970 --> 01:03:18,710
can get the moon better than Hubble can

1519
01:03:25,960 --> 01:03:22,980
it's not off limits in terms of can we

1520
01:03:29,060 --> 01:03:25,970
make observations of the moon but

1521
01:03:31,490 --> 01:03:29,070
scientifically you can get there are

1522
01:03:33,830 --> 01:03:31,500
missions like the LRO the Lunar

1523
01:03:35,270 --> 01:03:33,840
Reconnaissance Orbiter there we've been

1524
01:03:37,640 --> 01:03:35,280
to the moon you know with the Apollo

1525
01:03:39,140 --> 01:03:37,650
missions the other missions ground-based

1526
01:03:40,550 --> 01:03:39,150
telescopes can get really good

1527
01:03:43,160 --> 01:03:40,560
observations of the moon because it's so

1528
01:03:44,930 --> 01:03:43,170
bright and so big that Hubble doesn't

1529
01:03:48,410 --> 01:03:44,940
provide a significant advantage in

1530
01:03:51,109 --> 01:03:48,420
looking at the moon the one point that

1531
01:03:54,680 --> 01:03:51,119
you say is a clear up close photo of our

1532
01:03:57,859 --> 01:03:54,690
mo our own moon even app even with

1533
01:04:01,010 --> 01:03:57,869
Hubble Hubble's pixel resolution at the

1534
01:04:04,160 --> 01:04:01,020
distance of the moon one pixel is about

1535
01:04:05,990 --> 01:04:04,170
the size of a football field so we

1536
01:04:08,750 --> 01:04:06,000
people always say oh can the Hubble go

1537
01:04:11,930 --> 01:04:08,760
see the Apollo Landers no we can't see

1538
01:04:14,420 --> 01:04:11,940

the pollo lenders it have to be the size

1539
01:04:17,270 --> 01:04:14,430
of a football field or larger before

1540
01:04:19,880 --> 01:04:17,280
Hubble can start to resolve it good

1541
01:04:22,099 --> 01:04:19,890
question ok so i'm going to go switch

1542
01:04:26,210 --> 01:04:22,109
real quick see what's over the Q&A app i

1543
01:04:29,359 --> 01:04:26,220
was looking at youtube ron smith is

1544
01:04:31,280 --> 01:04:29,369
asking from the youtube app if nope no

1545
01:04:31,830 --> 01:04:31,290
object can be found to fly by after

1546
01:04:34,280 --> 01:04:31,840
Pluto

1547
01:04:37,830 --> 01:04:34,290
where will it go this is from Ronson

1548
01:04:39,480 --> 01:04:37,840
well we do have the two Voyager

1549
01:04:41,820 --> 01:04:39,490
satellites that are continuing out of

1550
01:04:44,250 --> 01:04:41,830
the solar system and New Horizons will

1551
01:04:46,980 --> 01:04:44,260
continue on a similar trajectory heading

1552
01:04:51,210 --> 01:04:46,990
out of the solar system New Horizons has

1553
01:04:54,180 --> 01:04:51,220
gotten 30a you right 30 astronomical

1554
01:04:58,500 --> 01:04:54,190
units in 10 years a little less than 10

1555
01:05:03,060 --> 01:04:58,510
years the voyagers are at what about 105

1556
01:05:05,850 --> 01:05:03,070
au and 120 a you don't mozilla yeah and

1557
01:05:08,670 --> 01:05:05,860
a few decades then New Horizons will

1558
01:05:10,470 --> 01:05:08,680
also go through the the outer parts of

1559
01:05:12,540 --> 01:05:10,480
the solar system into the heliopause and

1560
01:05:14,820 --> 01:05:12,550
the heliosheath and make it into

1561
01:05:16,500 --> 01:05:14,830
interstellar space so that is its

1562
01:05:19,560 --> 01:05:16,510
ultimate fate no matter what even if it

1563
01:05:21,660 --> 01:05:19,570

does find something else to look at the

1564
01:05:23,640 --> 01:05:21,670
question is what scientists observe

1565
01:05:26,580 --> 01:05:23,650
ations can it make while it's on its way

1566
01:05:28,800 --> 01:05:26,590
out there the Voyager satellites are

1567
01:05:30,810 --> 01:05:28,810
still sending back tiny tiny tiny bits

1568
01:05:35,520 --> 01:05:30,820
of data but it is still sending back

1569
01:05:38,460 --> 01:05:35,530
some data about the magnetic field as we

1570
01:05:40,050 --> 01:05:38,470
pass from the magnetic the region of

1571
01:05:43,320 --> 01:05:40,060
space is dominated by the sun's magnetic

1572
01:05:44,970 --> 01:05:43,330
field and the sun's solar wind and the

1573
01:05:46,890 --> 01:05:44,980
region that's dominated by the winds

1574
01:05:49,050 --> 01:05:46,900
from interstellar stars the magnetic

1575
01:05:51,660 --> 01:05:49,060
fields from center stellar stars that's

1576
01:05:54,050 --> 01:05:51,670
what we call the heliopause and so I

1577
01:05:56,340 --> 01:05:54,060
don't know whether New Horizons

1578
01:06:00,300 --> 01:05:56,350
batteries will last long enough for it

1579
01:06:02,790 --> 01:06:00,310
to be able to transmit good information

1580
01:06:04,370 --> 01:06:02,800
there but I'm sure if it's possible the

1581
01:06:07,320 --> 01:06:04,380
astronomers will make sure it happens

1582
01:06:09,660 --> 01:06:07,330
great good one great question so Hugo

1583
01:06:12,390 --> 01:06:09,670
Burnham actually did the math when we

1584
01:06:13,950 --> 01:06:12,400
were talking about the the area of sky

1585
01:06:16,170 --> 01:06:13,960
for the Hubble Deep Field and he said

1586
01:06:18,780 --> 01:06:16,180
that be three hundred and seventy six

1587
01:06:21,060 --> 01:06:18,790
thousand seven hundred years okay I

1588
01:06:23,580 --> 01:06:21,070

calculations are correct for HST to

1589
01:06:25,500 --> 01:06:23,590
image the entire sky like the Hubble

1590
01:06:26,430 --> 01:06:25,510
Ultra Deep Field so thank you go for

1591
01:06:28,680 --> 01:06:26,440
going through the trouble of doing the

1592
01:06:30,600 --> 01:06:28,690
math that's why you're a space fan I

1593
01:06:34,110 --> 01:06:30,610
mean that's what we do we do the math oh

1594
01:06:36,210 --> 01:06:34,120
yeah that's great I think it's a little

1595
01:06:39,300 --> 01:06:36,220
bit longer than Hubble's been scheduled

1596
01:06:41,820 --> 01:06:39,310
to operate but it's a little longer than

1597
01:06:45,090 --> 01:06:41,830
I'm scheduled to operate oh come on

1598
01:06:45,580 --> 01:06:45,100
doubt it me too actually so one final

1599
01:06:47,410 --> 01:06:45,590
question

1600
01:06:49,990 --> 01:06:47,420
we will have to do a sign-off will this

1601
01:06:51,940 --> 01:06:50,000
is from Adam synergy on the Q&A app will

1602
01:06:54,220 --> 01:06:51,950
new horizons be able to look back an

1603
01:06:57,100 --> 01:06:54,230
image the solar system in a similar way

1604
01:06:58,210 --> 01:06:57,110
to Voyager ask a question can I do that

1605
01:07:00,880 --> 01:06:58,220
will it be able to turn around and look

1606
01:07:03,190 --> 01:07:00,890
at us it has already done a little bit

1607
01:07:09,430 --> 01:07:03,200
of turning around and looking after it

1608
01:07:11,440 --> 01:07:09,440
passed by Jupiter the lor RI instrument

1609
01:07:16,000 --> 01:07:11,450
the lorry instrument long-range

1610
01:07:17,680 --> 01:07:16,010
something anyways look back at Jupiter

1611
01:07:23,170 --> 01:07:17,690
and was able to look at Jupiter and its

1612
01:07:27,010 --> 01:07:23,180
moons uh and looking back I'm sure that

1613
01:07:29,980 --> 01:07:27,020

as a target of opportunity that the P is

1614
01:07:31,750 --> 01:07:29,990
there would want to do that the the

1615
01:07:34,180 --> 01:07:31,760
shots looking back toward the Sun and

1616
01:07:36,700 --> 01:07:34,190
seeing the various planets are around

1617
01:07:39,820 --> 01:07:36,710
the Sun done with Voyager the the pale

1618
01:07:44,350 --> 01:07:39,830
blue dot shot I don't think it will

1619
01:07:47,410 --> 01:07:44,360
offer any amazingly improved level of an

1620
01:07:49,900 --> 01:07:47,420
observation there but I don't know we'll

1621
01:07:53,110 --> 01:07:49,910
see it would be it would be a fun thing

1622
01:07:54,850 --> 01:07:53,120
to do and send your letters to Alan

1623
01:07:57,340 --> 01:07:54,860
Stern and say Alan we really need

1624
01:07:58,510 --> 01:07:57,350
another pale blue dot image okay of

1625
01:07:59,770 --> 01:07:58,520
course he's going to be pretty busy for

1626
01:08:01,750 --> 01:07:59,780
the next year plant you make sure the

1627
01:08:04,540 --> 01:08:01,760
Pluto encounter goes well so he probably

1628
01:08:05,980 --> 01:08:04,550
won't respond right away all right

1629
01:08:09,010 --> 01:08:05,990
thanks adam has a good question or good

1630
01:08:11,020 --> 01:08:09,020
kind of good questions so i guess we

1631
01:08:12,760 --> 01:08:11,030
will stop here thank you Frank this was

1632
01:08:14,710 --> 01:08:12,770
a great one a lot of good information so

1633
01:08:16,450 --> 01:08:14,720
thanks for taking the time out and and

1634
01:08:19,180 --> 01:08:16,460
hanging out with us and getting getting

1635
01:08:21,310 --> 01:08:19,190
this at this news out we will try to do

1636
01:08:23,140 --> 01:08:21,320
we're going to do this again next next

1637
01:08:25,530 --> 01:08:23,150
in August you're going to be able to do

1638
01:08:28,240 --> 01:08:25,540

it in the likes what is it August sixth

1639
01:08:30,040 --> 01:08:28,250
let's see I guess fifth will be of

1640
01:08:31,900 --> 01:08:30,050
course the public battery solid lecture

1641
01:08:33,910 --> 01:08:31,910
so will you may be the next day you

1642
01:08:35,920 --> 01:08:33,920
think or the next day august six that

1643
01:08:37,329 --> 01:08:35,930
will work fine all right so we'll look

1644
01:08:39,190 --> 01:08:37,339
forward to talking to you then so don't

1645
01:08:41,620 --> 01:08:39,200
forget I like Frank said August fifth is

1646
01:08:43,510 --> 01:08:41,630
the next public lecture the Hubble

1647
01:08:45,460 --> 01:08:43,520
public lecture series I will if you

1648
01:08:48,130 --> 01:08:45,470
subscribe to Hubble site channel on

1649
01:08:50,320 --> 01:08:48,140
YouTube you'll get notified when the

1650
01:08:52,000 --> 01:08:50,330
event is set up so you'll you won't have

1651
01:08:54,490 --> 01:08:52,010
to remember it so we hope you guys will

1652
01:08:57,040 --> 01:08:54,500
check it out tomorrow i want to remind

1653
01:08:57,499 --> 01:08:57,050
everybody is our next weekly Hubble hang

1654
01:09:05,419 --> 01:08:57,509
out

1655
01:09:07,789 --> 01:09:05,429
with dr. Laurent Lambie from from the

1656
01:09:09,499 --> 01:09:07,799
from France I forget the exact uh I

1657
01:09:11,029 --> 01:09:09,509
don't have it in front of me his his

1658
01:09:12,799 --> 01:09:11,039
organization but we hope you will be

1659
01:09:14,779 --> 01:09:12,809
able to watch and learn about Aurora

1660
01:09:16,910 --> 01:09:14,789
from other planets in our solar system

1661
01:09:18,649 --> 01:09:16,920
not just Earth's he's done a lot of good

1662
01:09:21,499 --> 01:09:18,659
research in that area and that will be

1663
01:09:24,649 --> 01:09:21,509

tomorrow at three p.m. eastern daylight

1664
01:09:26,599 --> 01:09:24,659
time and seven o'clock out in for our

1665
01:09:28,640 --> 01:09:26,609
friends out in the UK so we hope you

1666
01:09:30,620 --> 01:09:28,650
guys can join us Frank thank you again

1667
01:09:33,559 --> 01:09:30,630
so much it's always a lot of fun and we

1668
01:09:35,569 --> 01:09:33,569
will see you guys next next month for

1669
01:09:37,339 --> 01:09:35,579
news you know we should we should make

1670
01:09:39,259 --> 01:09:37,349
our own that make our own hang out you

1671
01:09:40,789 --> 01:09:39,269
know news from Hubble and across the

1672
01:09:43,959 --> 01:09:40,799
universe with Parker Frank summers how

1673
01:09:46,819 --> 01:09:43,969
the bump bump uh-huh gotta have to

1674
01:09:48,349 --> 01:09:46,829
forget that theme music right ok thanks

1675
01:09:50,120 --> 01:09:48,359
tony is a lot of fun thanks everybody

1676
01:09:51,799 --> 01:09:50,130
the great questions yeah thank you guys