Google+

Pillar in NGC 2174 ▪ *Hubble Space Telescope*

Visible ▪ WFPC2 ▪ 2001

Infrared ▪ WFC3/IR ▪ 2014

1
00:00:06,750 --> 00:00:04,320
hello everybody welcome to our latest

2
00:00:08,820 --> 00:00:06,760
Hubble hangout my name is Tony Darnell I

3
00:00:11,730 --> 00:00:08,830
am at the Space Telescope Science

4
00:00:12,270 --> 00:00:11,740
Institute and it is that time of the

5
00:00:20,279 --> 00:00:12,280
month

6
00:00:22,470 --> 00:00:20,289
oh great phrasing Tony I love visit with

7
00:00:23,460 --> 00:00:22,480
dr. Frank summers the outreach

8
00:00:25,919 --> 00:00:23,470
astronomer at the Space Telescope

9
00:00:26,820 --> 00:00:25,929
Science Institute who keeps tabs on all

10
00:00:29,189 --> 00:00:26,830
of the really cool and interesting

11
00:00:33,420 --> 00:00:29,199
things going on with Hubble and shares

12
00:00:41,280 --> 00:00:33,430
them with us every every oh I did it

13
00:00:46,850 --> 00:00:41,290

again I had a dollar for every time I've

14
00:00:54,300 --> 00:00:49,980
you're the expert here Tony now I've got

15
00:01:04,560 --> 00:00:54,310
to figure out where it is darn it

16
00:01:06,060 --> 00:01:04,570
your echoes coming out somewhere and you

17
00:01:08,749 --> 00:01:06,070
get to hear your mistake coming at you

18
00:01:14,849 --> 00:01:12,959
so while Tony figures that out I'll just

19
00:01:17,340 --> 00:01:14,859
say that it's always fun for me to be

20
00:01:20,489 --> 00:01:17,350
here even if I am considered that time

21
00:01:22,679 --> 00:01:20,499
of the month for Tony but what we like

22
00:01:25,499 --> 00:01:22,689
to do here at the Space Telescope is we

23
00:01:27,989 --> 00:01:25,509
really get a lot of fun out of taking

24
00:01:30,569 --> 00:01:27,999
the deepest discoveries from a strong

25
00:01:32,309 --> 00:01:30,579
from Hubble and explaining them in

26
00:01:34,649 --> 00:01:32,319
detail because for me as an

27
00:01:38,249 --> 00:01:34,659
astrophysicist the really difficult

28
00:01:41,459 --> 00:01:38,259
thing is to have a wide breadth of all

29
00:01:42,779 --> 00:01:41,469
these various ideas and then be able to

30
00:01:44,489 --> 00:01:42,789
explain them to the public I mean

31
00:01:45,569 --> 00:01:44,499
because you're taking something that's

32
00:01:47,190 --> 00:01:45,579
at the cutting edge of science what we

33
00:01:49,559 --> 00:01:47,200
do in our press release is we're really

34
00:01:51,270 --> 00:01:49,569
at the edge of science and we've got to

35
00:01:53,249 --> 00:01:51,280
provide all the context and all the

36
00:01:55,649 --> 00:01:53,259
background information to bring it out

37
00:01:57,569 --> 00:01:55,659
to the public and so this is what really

38
00:02:00,090 --> 00:01:57,579

you know Jazz's me about doing all of

39
00:02:01,020 --> 00:02:00,100
this stuff with Tony and with all the

40
00:02:04,139 --> 00:02:01,030
stuff we do in the office of public

41
00:02:06,449 --> 00:02:04,149
outreach is that understanding not just

42
00:02:09,030 --> 00:02:06,459
the discovery but all the context and

43
00:02:11,190 --> 00:02:09,040
the background behind it so Tony did I

44
00:02:14,410 --> 00:02:11,200
vamp enough to cover up you did great

45
00:02:18,370 --> 00:02:14,420
thank you I tab that had the I YouTube

46
00:02:20,050 --> 00:02:18,380
and killed it I have like 300 tabs up on

47
00:02:21,820 --> 00:02:20,060
my desktop right now I know I'm I think

48
00:02:23,890 --> 00:02:21,830
I've get it there's always one that gets

49
00:02:25,540 --> 00:02:23,900
through me so again apologies for doing

50
00:02:27,520 --> 00:02:25,550
that yet again but you know what I don't

51
00:02:29,470 --> 00:02:27,530
think people would feel right if I

52
00:02:33,490 --> 00:02:29,480
didn't do that at least once during the

53
00:02:35,110 --> 00:02:33,500
Hangout so like it's live okay so anyway

54
00:02:39,910 --> 00:02:35,120
and it's free so you're getting what you

55
00:02:42,430 --> 00:02:39,920
pay for that's that's right so here we

56
00:02:46,540 --> 00:02:42,440
are another another month has gone by we

57
00:02:49,000 --> 00:02:46,550
have started by the way broadcasting the

58
00:02:51,220 --> 00:02:49,010
public lecture series that Frank hosts

59
00:02:53,020 --> 00:02:51,230
every month at the Institute of the

60
00:02:55,150 --> 00:02:53,030
first Tuesday of every month is now

61
00:02:56,850 --> 00:02:55,160
going on our YouTube channel so we hope

62
00:03:01,000 --> 00:02:56,860
that you guys will tune in to watch that

63
00:03:02,110 --> 00:03:01,010

as well with us because it's an easier

64
00:03:04,270 --> 00:03:02,120
way for you to interact

65
00:03:05,890 --> 00:03:04,280
I generally what we try to do is answer

66
00:03:09,370 --> 00:03:05,900
any questions and comments while it's

67
00:03:12,040 --> 00:03:09,380
going on I'll monitor the the

68
00:03:13,540 --> 00:03:12,050
Twitterverse and comments on on youtube

69
00:03:15,610 --> 00:03:13,550
and try to respond to him while the

70
00:03:17,170 --> 00:03:15,620
lecture is going on and Frank will do

71
00:03:18,850 --> 00:03:17,180
that to the extent that he can but he's

72
00:03:21,580 --> 00:03:18,860
also got to run the show so it's a

73
00:03:24,430 --> 00:03:21,590
little bit he me may or may not be able

74
00:03:26,920 --> 00:03:24,440
to respond to all comments ok Frank so

75
00:03:28,420 --> 00:03:26,930
what do we got we got what's the latest

76
00:03:30,670 --> 00:03:28,430
and greatest with Hubble this month

77
00:03:33,190 --> 00:03:30,680
alright so I know we did the I did it

78
00:03:35,650 --> 00:03:33,200
live last week during the public lecture

79
00:03:36,789 --> 00:03:35,660
series but I know a good honest audience

80
00:03:38,440 --> 00:03:36,799
probably hadn't seen it but I want to go

81
00:03:40,720 --> 00:03:38,450
quickly through the news from the

82
00:03:42,100 --> 00:03:40,730
universe that I did last week and then I

83
00:03:43,930 --> 00:03:42,110
want to take it will beyond what I did

84
00:03:46,150 --> 00:03:43,940
with the news from the universe and talk

85
00:03:48,009 --> 00:03:46,160
about a new section on Hubble site that

86
00:03:49,750 --> 00:03:48,019
I had a lot to do with and I think is

87
00:03:53,289 --> 00:03:49,760
really really cool ok

88
00:03:59,830 --> 00:03:53,299

agreed okay so let me I gotta start my

89
00:04:03,240 --> 00:03:59,840
screen share there we go starting my

90
00:04:08,620 --> 00:04:07,270
PowerPoint slides ok so when I present

91
00:04:10,840 --> 00:04:08,630
this to the public lecture series I call

92
00:04:12,849 --> 00:04:10,850
it news from the universe and this is

93
00:04:14,970 --> 00:04:12,859
the stuff this is the stories I chose

94
00:04:19,479 --> 00:04:14,980
for May 2014

95
00:04:22,180 --> 00:04:19,489
so my first story called five golden

96
00:04:24,520 --> 00:04:22,190
rings for those of you who know the

97
00:04:25,600 --> 00:04:24,530
Christmas song well it doesn't have

98
00:04:27,890 --> 00:04:25,610
anything to do with the Christmas song

99
00:04:31,219 --> 00:04:27,900
so what we're talking about

100
00:04:33,950 --> 00:04:31,229
is looking at and discovering new

101
00:04:35,840 --> 00:04:33,960
information in old data now I bring up

102
00:04:38,029 --> 00:04:35,850
this image this is from the Keck

103
00:04:42,020 --> 00:04:38,039
telescope not from the Hubble this is of

104
00:04:46,100 --> 00:04:42,030
the star HR 8799 well actually it's of

105
00:04:48,290 --> 00:04:46,110
everything but the star HR 8799 because

106
00:04:54,110 --> 00:04:48,300
like a star from the 60s or something a

107
00:04:57,680 --> 00:04:54,120
little this this star with psychedelic

108
00:05:00,740 --> 00:04:57,690
on us know all that psychedelic glop in

109
00:05:02,510 --> 00:05:00,750
the middle is the residue after

110
00:05:04,730 --> 00:05:02,520
subtracting out the light of the star

111
00:05:07,129 --> 00:05:04,740
right if you're trying to look for

112
00:05:09,620 --> 00:05:07,139
things around a star you've got this

113
00:05:11,840 --> 00:05:09,630

honking bright star that you've got us

114
00:05:14,750 --> 00:05:11,850
to be able to subtract out so the folks

115
00:05:17,020 --> 00:05:14,760
at the Keck Observatory subtracted out

116
00:05:19,040 --> 00:05:17,030
the light of the star and that

117
00:05:20,990 --> 00:05:19,050
psychedelic residue in the in the middle

118
00:05:23,510 --> 00:05:21,000
is the result of that subtraction so you

119
00:05:27,800 --> 00:05:23,520
got the star mostly subtracted out but

120
00:05:32,210 --> 00:05:27,810
the red dots around it are three planets

121
00:05:33,680 --> 00:05:32,220
that why yeah the ones that well the the

122
00:05:36,200 --> 00:05:33,690
the red dots and then there are the

123
00:05:38,480 --> 00:05:36,210
pluses to show where the planets were

124
00:05:42,560 --> 00:05:38,490
observed in July 2004 Oh

125
00:05:44,659 --> 00:05:42,570
dots show where they were in 2008 got it

126
00:05:48,350 --> 00:05:44,669
okay and showing that they're moving

127
00:05:51,350 --> 00:05:48,360
around this star right and so this was

128
00:05:53,600 --> 00:05:51,360
one of the first discoveries of actually

129
00:05:56,029 --> 00:05:53,610
observing planets around another star

130
00:05:58,129 --> 00:05:56,039
and this was actually done with the Keck

131
00:06:03,260 --> 00:05:58,139
telescope from the ground in the

132
00:06:04,399 --> 00:06:03,270
infrared now we here at Hubble didn't do

133
00:06:07,129 --> 00:06:04,409
this this was again from the confirm

134
00:06:09,560 --> 00:06:07,139
Keck but what we did with Hubble is we

135
00:06:11,899 --> 00:06:09,570
came back a couple years later and we

136
00:06:15,170 --> 00:06:11,909
looked at h we looked not at a new image

137
00:06:17,540 --> 00:06:15,180
of HR 8799 but we looked at an old image

138
00:06:19,339 --> 00:06:17,550

that was in the hubble database

139
00:06:21,920 --> 00:06:19,349
all right the Hubble archives got lots

140
00:06:24,379 --> 00:06:21,930
of cool data in it and so people went

141
00:06:27,500 --> 00:06:24,389
back to it and you see on the left the

142
00:06:30,740 --> 00:06:27,510
incredible brightness of the star HR

143
00:06:34,279 --> 00:06:30,750
8799 as it was observed in the Hubble

144
00:06:35,510 --> 00:06:34,289
database the Hubble archive well so you

145
00:06:36,560 --> 00:06:35,520
can see a bunch of so what you're

146
00:06:39,140 --> 00:06:36,570
looking at is a bunch of diffraction

147
00:06:40,670 --> 00:06:39,150
spikes from the telescope and then

148
00:06:41,749 --> 00:06:40,680
there's the saturation in the center

149
00:06:46,790 --> 00:06:41,759
that's the

150
00:06:49,700 --> 00:06:46,800
the thing about Hubble is that over the

151
00:06:52,159 --> 00:06:49,710
years we've learned the characteristics

152
00:06:53,510 --> 00:06:52,169
of Hubble incredibly carefully and one

153
00:06:55,670 --> 00:06:53,520
of the most important characteristics is

154
00:06:56,959 --> 00:06:55,680
called the point spread function so

155
00:06:58,249 --> 00:06:56,969
here's some cool stuff that I can give

156
00:07:00,379 --> 00:06:58,259
you that I can't do the normal public

157
00:07:02,149 --> 00:07:00,389
audience and so the point spread

158
00:07:04,549 --> 00:07:02,159
function takes I mean stars or points of

159
00:07:06,739 --> 00:07:04,559
light and it's a very fate points light

160
00:07:08,299 --> 00:07:06,749
it appears as a circular dot and as it

161
00:07:10,309 --> 00:07:08,309
gets brighter and brighter it becomes

162
00:07:11,929 --> 00:07:10,319
bigger and bigger dot and then it starts

163
00:07:14,269 --> 00:07:11,939

to develop these diffraction spikes and

164
00:07:17,510 --> 00:07:14,279
all of these this just stuff around it

165
00:07:20,179 --> 00:07:17,520
and so with Hubble we've gotten very

166
00:07:23,149 --> 00:07:20,189
good at characterizing how that point

167
00:07:25,159 --> 00:07:23,159
spread function grows and what are the

168
00:07:28,219 --> 00:07:25,169
what is the shape of the light that is

169
00:07:30,860 --> 00:07:28,229
put onto the detector using that

170
00:07:33,969 --> 00:07:30,870
information we can very very carefully

171
00:07:36,920 --> 00:07:33,979
subtract out the point spread function

172
00:07:39,769 --> 00:07:36,930
due to the Hubble detector pull out that

173
00:07:42,860 --> 00:07:39,779
star and in the right hand image you

174
00:07:46,070 --> 00:07:42,870
again see three dots of light and those

175
00:07:48,409 --> 00:07:46,080
are the planets yes yeah

176
00:07:51,230 --> 00:07:48,419
those are the same planets that Keck had

177
00:07:52,969 --> 00:07:51,240
discovered a few years earlier but the

178
00:07:56,480 --> 00:07:52,979
important point was this image was taken

179
00:07:59,300 --> 00:07:56,490
I think it was eight years before the

180
00:08:02,119 --> 00:07:59,310
Keck discovery so it adds to the

181
00:08:05,149 --> 00:08:02,129
baseline of this discovery of the planet

182
00:08:07,429 --> 00:08:05,159
so we have more points in the orbit for

183
00:08:10,189 --> 00:08:07,439
these planets around its parent star and

184
00:08:11,989 --> 00:08:10,199
that's really important I mean when we

185
00:08:14,029 --> 00:08:11,999
discovered Uranus the first thing people

186
00:08:16,369 --> 00:08:14,039
did was go back into old data to see if

187
00:08:18,079 --> 00:08:16,379
you could you know determine its orbit

188
00:08:20,149 --> 00:08:18,089

more accurately by having a longer

189
00:08:22,100 --> 00:08:20,159
baseline of the data well we're doing

190
00:08:23,899 --> 00:08:22,110
the exact same thing here with

191
00:08:25,159 --> 00:08:23,909
extrasolar planets so now we know what

192
00:08:26,689 --> 00:08:25,169
to look for we now we know there's

193
00:08:28,999 --> 00:08:26,699
planets there they just went back and

194
00:08:30,679 --> 00:08:29,009
looked at what we previous observations

195
00:08:33,199 --> 00:08:30,689
of the Hubble and got this information

196
00:08:35,629 --> 00:08:33,209
out okay so this is an old story

197
00:08:37,790 --> 00:08:35,639
we've may have talked about this before

198
00:08:39,740 --> 00:08:37,800
but the point is is that we've got this

199
00:08:41,689 --> 00:08:39,750
really good way of subtracting out the

200
00:08:44,180 --> 00:08:41,699
light of stars and we wanted to do that

201
00:08:47,449 --> 00:08:44,190
not just for planets but we also wanted

202
00:08:50,210 --> 00:08:47,459
to do it for dust disks around stars so

203
00:08:52,550 --> 00:08:50,220
these are two dust disks one on the left

204
00:08:55,750 --> 00:08:52,560
au microscopy one on the right

205
00:08:58,120 --> 00:08:55,760
HD 107 one force

206
00:09:00,940 --> 00:08:58,130
and you can see also the size of

207
00:09:02,620 --> 00:09:00,950
Neptune's orbit for scale again in each

208
00:09:05,920 --> 00:09:02,630
of these images the light of the star

209
00:09:08,200 --> 00:09:05,930
has been blocked out in this particular

210
00:09:12,100 --> 00:09:08,210
characteristic not subtracted out later

211
00:09:14,170 --> 00:09:12,110
on but blocked by a spot of light on the

212
00:09:16,930 --> 00:09:14,180
despot a dark spot on the detector

213
00:09:19,450 --> 00:09:16,940

called a coronagraph so block the light

214
00:09:21,610 --> 00:09:19,460
out yeah so they they block the light of

215
00:09:24,040 --> 00:09:21,620
the star in the detector they have

216
00:09:26,019 --> 00:09:24,050
actually a place on the detector window

217
00:09:28,600 --> 00:09:26,029
where there is a dark spot and they can

218
00:09:29,920 --> 00:09:28,610
place that dark spot over the star to

219
00:09:32,079 --> 00:09:29,930
block out the light of the star and try

220
00:09:34,840 --> 00:09:32,089
and see the material around it now these

221
00:09:36,610 --> 00:09:34,850
of course are our two best examples the

222
00:09:39,160 --> 00:09:36,620
one on the left being an edge on disk

223
00:09:40,630 --> 00:09:39,170
these are flat as a pancake and they're

224
00:09:43,300 --> 00:09:40,640
discs of material spinning around the

225
00:09:45,190 --> 00:09:43,310
stars the one on the left being edge on

226
00:09:47,320 --> 00:09:45,200
the one on the right being face off and

227
00:09:48,730 --> 00:09:47,330
of course you know as press release

228
00:09:50,970 --> 00:09:48,740
images they are really gorgeous and

229
00:09:53,440 --> 00:09:50,980
beautiful and everything but most of our

230
00:09:56,710 --> 00:09:53,450
observations of disk aren't quite so

231
00:09:59,440 --> 00:09:56,720
good some of them are like we see in

232
00:10:04,090 --> 00:09:59,450
this next image here HD one eight one

233
00:10:06,460 --> 00:10:04,100
three two seven and on the left if we

234
00:10:07,690 --> 00:10:06,470
were trying to take out the star to try

235
00:10:10,480 --> 00:10:07,700
and see the disk

236
00:10:13,060 --> 00:10:10,490
okay this again is the PSF removal point

237
00:10:15,400 --> 00:10:13,070
spread function and removal the normal

238
00:10:17,050 --> 00:10:15,410

one that we have been using would show

239
00:10:20,050 --> 00:10:17,060
you that there is a ring of material

240
00:10:22,780 --> 00:10:20,060
around this star but there would be a

241
00:10:24,130 --> 00:10:22,790
lot of bleed of the star into that ring

242
00:10:25,329 --> 00:10:24,140
and you wouldn't be able to measure the

243
00:10:28,870 --> 00:10:25,339
characteristics of that ring very

244
00:10:31,930 --> 00:10:28,880
carefully well the new method they come

245
00:10:34,300 --> 00:10:31,940
up with they call it KL IP I don't know

246
00:10:36,660 --> 00:10:34,310
what that stands for but it's the new

247
00:10:39,390 --> 00:10:36,670
method of point spread function removal

248
00:10:42,640 --> 00:10:39,400
removes the star more carefully and more

249
00:10:44,920 --> 00:10:42,650
completely giving us the much clearer

250
00:10:47,380 --> 00:10:44,930
view of that ring on the right in the

251
00:10:49,300 --> 00:10:47,390
right hand picture so see it with the

252
00:10:50,890 --> 00:10:49,310
standard PSF removal but you get a much

253
00:10:52,630 --> 00:10:50,900
better one with this new technique it

254
00:10:55,180 --> 00:10:52,640
looks like right and you're really

255
00:10:56,949 --> 00:10:55,190
getting rid of the star only so that the

256
00:10:59,079 --> 00:10:56,959
measurements of say the thickness and

257
00:11:00,760 --> 00:10:59,089
the density and how much material is in

258
00:11:02,980 --> 00:11:00,770
that ring which is really important for

259
00:11:05,560 --> 00:11:02,990
understanding you know what stage the

260
00:11:08,410 --> 00:11:05,570
the planet formation is in the system

261
00:11:10,270 --> 00:11:08,420
because I said does that mean little boy

262
00:11:12,640 --> 00:11:10,280
bright spots in the center there those

263
00:11:14,260 --> 00:11:12,650

were actually real then no I wouldn't

264
00:11:17,200 --> 00:11:14,270
trust the stuff inside the ring okay

265
00:11:19,660 --> 00:11:17,210
alright you know again you're getting

266
00:11:22,450 --> 00:11:19,670
really in close to the star there and

267
00:11:24,820 --> 00:11:22,460
but you can see how you there the bleed

268
00:11:26,410 --> 00:11:24,830
around the ring both in interior to the

269
00:11:29,590 --> 00:11:26,420
ring and external to the Rings is

270
00:11:32,800 --> 00:11:29,600
greatly reduced all those radial

271
00:11:35,830 --> 00:11:32,810
striations the lines heading out in

272
00:11:39,160 --> 00:11:35,840
radial directions are greatly reduced by

273
00:11:41,320 --> 00:11:39,170
this new PSF removal technique okay and

274
00:11:42,460 --> 00:11:41,330
that no let's do this folks I mean it

275
00:11:45,250 --> 00:11:42,470
doesn't matter how perfect your

276
00:11:46,990 --> 00:11:45,260
telescope is the PSF is this thing that

277
00:11:49,690 --> 00:11:47,000
smears it out you could have a perfect

278
00:11:51,040 --> 00:11:49,700
point source of light and all optical

279
00:11:52,810 --> 00:11:51,050
systems are gonna smear it out a little

280
00:11:55,600 --> 00:11:52,820
bit and the the manner in which it

281
00:11:58,120 --> 00:11:55,610
smears that out is you can model that

282
00:11:59,920 --> 00:11:58,130
and and measure it and model it and that

283
00:12:01,090 --> 00:11:59,930
is what he's talking about it is called

284
00:12:03,340 --> 00:12:01,100
the point spread function and you can

285
00:12:05,800 --> 00:12:03,350
remove that effect so if you had a point

286
00:12:08,680 --> 00:12:05,810
of light that got smeared out into a

287
00:12:09,910 --> 00:12:08,690
circle a little bit and then you knew

288
00:12:11,710 --> 00:12:09,920

the point spread function you could

289
00:12:14,320 --> 00:12:11,720
remove that point spread function to get

290
00:12:14,890 --> 00:12:14,330
your point back so that's what's going

291
00:12:18,820 --> 00:12:14,900
on here

292
00:12:23,100 --> 00:12:18,830
right but my question Frank is how are

293
00:12:25,900 --> 00:12:23,110
they able do you know to determine which

294
00:12:27,730 --> 00:12:25,910
light it belongs to the star and what

295
00:12:29,920 --> 00:12:27,740
doesn't I mean how do you how do you

296
00:12:32,380 --> 00:12:29,930
figure that out okay well you're gonna

297
00:12:34,570 --> 00:12:32,390
calibrate your point spread function by

298
00:12:37,060 --> 00:12:34,580
looking at a sizing stars or perfect

299
00:12:39,310 --> 00:12:37,070
points of light right I mean the stars

300
00:12:41,590 --> 00:12:39,320
are so small compared to their distance

301
00:12:43,900 --> 00:12:41,600
away that they are a point of light and

302
00:12:46,450 --> 00:12:43,910
what you're gonna want to do is find a

303
00:12:48,940 --> 00:12:46,460
uncrowded field where you're observing

304
00:12:50,920 --> 00:12:48,950
just a star and not a star that has any

305
00:12:52,780 --> 00:12:50,930
and you want you know an older star that

306
00:12:55,390 --> 00:12:52,790
that wouldn't have a disk or such around

307
00:13:00,010 --> 00:12:55,400
it all right you want to be able to get

308
00:13:02,160 --> 00:13:00,020
get your with each detector you want to

309
00:13:04,870 --> 00:13:02,170
be able to get a set of calibration

310
00:13:07,030 --> 00:13:04,880
images of various stars that are

311
00:13:09,450 --> 00:13:07,040
uncrowded fields so you can get a clean

312
00:13:12,910 --> 00:13:09,460
view of the point spread function and

313
00:13:15,190 --> 00:13:12,920

then you can by getting a whole suite of

314
00:13:17,560 --> 00:13:15,200
these and measuring them you can get an

315
00:13:20,650 --> 00:13:17,570
error you can do an average of those

316
00:13:21,820 --> 00:13:20,660
various calibration images to get a

317
00:13:22,810 --> 00:13:21,830
pattern

318
00:13:25,509 --> 00:13:22,820
develops through the point spread

319
00:13:29,110 --> 00:13:25,519
function yeah I can see how that helps

320
00:13:32,470 --> 00:13:29,120
you identify the star but not the flux

321
00:13:34,900 --> 00:13:32,480
or the pixel values of that star so how

322
00:13:38,230 --> 00:13:34,910
do you know when to stop removing and

323
00:13:40,720 --> 00:13:38,240
that's the art part of it okay if you've

324
00:13:41,710 --> 00:13:40,730
got the where and if the the point

325
00:13:44,139 --> 00:13:41,720
spread function changes with the

326
00:13:46,600 --> 00:13:44,149
brightness of the star right yeah in

327
00:13:49,090 --> 00:13:46,610
doing this PSF removal you're going to

328
00:13:50,800 --> 00:13:49,100
have the spectral type of the star as a

329
00:13:53,920 --> 00:13:50,810
variable you're going to have the

330
00:13:55,329 --> 00:13:53,930
magnitude of the star the the apparent

331
00:13:57,370 --> 00:13:55,339
magnitude of the star the brightness of

332
00:13:58,769 --> 00:13:57,380
the star as another variable so you're

333
00:14:01,000 --> 00:13:58,779
going to be eight you're going to

334
00:14:03,190 --> 00:14:01,010
release squares fitting with the

335
00:14:06,670 --> 00:14:03,200
different variables that you have that

336
00:14:08,470 --> 00:14:06,680
make up your PSF and say where in if I

337
00:14:10,540 --> 00:14:08,480
change these variables does the fit get

338
00:14:13,060 --> 00:14:10,550

better or worse and then you find the

339
00:14:15,430 --> 00:14:13,070
one that gives you the least least

340
00:14:16,990 --> 00:14:15,440
amount of error okay that make sense

341
00:14:18,940 --> 00:14:17,000
sure and I guess that's another reason

342
00:14:20,829 --> 00:14:18,950
why you don't want to totally trust that

343
00:14:25,120 --> 00:14:20,839
area where you remove the point spread

344
00:14:27,069 --> 00:14:25,130
function because right totally look when

345
00:14:29,800 --> 00:14:27,079
I was doing my PhD thesis 20 years ago

346
00:14:31,660 --> 00:14:29,810
the PSF removal you see on the left here

347
00:14:32,800 --> 00:14:31,670
would have been fantastic I mean it

348
00:14:35,440 --> 00:14:32,810
would have been better than you could

349
00:14:36,460 --> 00:14:35,450
ever hope for at that point so we're

350
00:14:38,680 --> 00:14:36,470
getting better all the time

351
00:14:41,079 --> 00:14:38,690
sure sure no I'm this is amazing this is

352
00:14:43,090 --> 00:14:41,089
really nice so let me give you a couple

353
00:14:46,870 --> 00:14:43,100
more examples so what we're announcing

354
00:14:49,360 --> 00:14:46,880
what we announced last month was looking

355
00:14:51,970 --> 00:14:49,370
at some discs around it in archival data

356
00:14:54,190 --> 00:14:51,980
so again we're going into images that

357
00:14:56,440 --> 00:14:54,200
Hubble has already taken not

358
00:14:59,319 --> 00:14:56,450
partly to study discs but you know it's

359
00:15:01,329 --> 00:14:59,329
already in the archive and so here on

360
00:15:04,689 --> 00:15:01,339
the left you have HD one four one nine

361
00:15:06,579 --> 00:15:04,699
four three which is a mostly edge-on

362
00:15:09,460 --> 00:15:06,589
disc we've got the artists description

363
00:15:11,350 --> 00:15:09,470

artist's depiction below to sort of

364
00:15:14,139 --> 00:15:11,360
guide your eyes to seeing that disc and

365
00:15:16,990 --> 00:15:14,149
on the right a somewhat face on disc one

366
00:15:19,889 --> 00:15:17,000
ninety one oh eight nine and the here

367
00:15:22,630 --> 00:15:19,899
are the the results using this new PSF

368
00:15:23,949 --> 00:15:22,640
retraction these aren't the only two

369
00:15:26,680 --> 00:15:23,959
these are the ones that we illustrated

370
00:15:32,199 --> 00:15:26,690
with artist depictions on the next one

371
00:15:34,389 --> 00:15:32,209
the final image of this story we have of

372
00:15:35,979 --> 00:15:34,399
course the five golden rings of the

373
00:15:40,720 --> 00:15:35,989
title

374
00:15:43,989 --> 00:15:40,730
we have five really good detailed images

375
00:15:45,669 --> 00:15:43,999
of rings that arise from this PSF

376
00:15:47,139 --> 00:15:45,679
subtraction that we could not have

377
00:15:50,259 --> 00:15:47,149
gotten otherwise and you can see they're

378
00:15:52,629 --> 00:15:50,269
still pretty ratty but without this PSF

379
00:15:54,100 --> 00:15:52,639
subtraction certainly the ones on the

380
00:16:00,129 --> 00:15:54,110
right would be very hard to tell that

381
00:16:03,609 --> 00:16:00,139
there was a disc there at all cool yeah

382
00:16:05,169 --> 00:16:03,619
I'm with you usually jump in with some

383
00:16:06,579 --> 00:16:05,179
sort of comment as I that's because I'm

384
00:16:08,949 --> 00:16:06,589
paid I'm cutting and pasting something

385
00:16:10,479 --> 00:16:08,959
like okay

386
00:16:11,979 --> 00:16:10,489
it was the problem when I have my screen

387
00:16:16,840 --> 00:16:11,989
share on and I can't actually see yeah

388
00:16:18,400 --> 00:16:16,850

yeah adding some comments here so I can

389
00:16:21,100 --> 00:16:18,410
make sure I get them all that's all yeah

390
00:16:23,799 --> 00:16:21,110
I'm with you all right let's go to the

391
00:16:28,269 --> 00:16:23,809
second story second story I called a

392
00:16:30,989 --> 00:16:28,279
tail spin break up all right and that

393
00:16:35,710 --> 00:16:30,999
again is a play on words as I like to do

394
00:16:40,059 --> 00:16:35,720
but let's go back to last year 2013 and

395
00:16:44,350 --> 00:16:40,069
this was this has got to be one of my

396
00:16:46,359 --> 00:16:44,360
favorite images of Comet Ison alright

397
00:16:49,689 --> 00:16:46,369
this is from Damian peach I believe he's

398
00:16:52,109 --> 00:16:49,699
a British astrophotographer absolutely

399
00:16:54,609 --> 00:16:52,119
fantastic images of Comet Ison last year

400
00:16:56,739 --> 00:16:54,619
huge kudos to him because he did some

401
00:16:58,900 --> 00:16:56,749
fantastic shots this is one of the

402
00:17:01,389 --> 00:16:58,910
coolest ones this is from November 15th

403
00:17:04,870 --> 00:17:01,399
as Ison was heading into its perihelion

404
00:17:07,870 --> 00:17:04,880
and we all remember what happened or

405
00:17:10,659 --> 00:17:07,880
really what didn't happen during its

406
00:17:13,960 --> 00:17:10,669
perihelion passage this is the image

407
00:17:17,289 --> 00:17:13,970
from Soho a time-lapse image from so

408
00:17:20,639 --> 00:17:17,299
where comet Ison comes in swings past

409
00:17:25,179 --> 00:17:20,649
the Sun and it breaks up on its way out

410
00:17:28,600 --> 00:17:25,189
so we have seen comets break up

411
00:17:30,940 --> 00:17:28,610
comet Ison being the spectacular breakup

412
00:17:32,769 --> 00:17:30,950
that we that occurred last November as

413
00:17:35,289 --> 00:17:32,779

it passes the Sun but we've also seen

414
00:17:38,799 --> 00:17:35,299
comets break up not when they're passing

415
00:17:41,889 --> 00:17:38,809
right by the Sun comets Watchmen Walkman

416
00:17:45,480 --> 00:17:41,899
3 one of my favorite comments to say

417
00:17:48,370 --> 00:17:45,490
just just that it's named so cold

418
00:17:51,220 --> 00:17:48,380
this is the break-up captured by Hubble

419
00:17:58,690 --> 00:17:51,230
of wash wash man Walkman 3 or we'll just

420
00:18:03,610 --> 00:17:58,700
call it SW 3 and keep saying that three

421
00:18:03,970 --> 00:18:03,620
times so we've got April 18th on the

422
00:18:06,249 --> 00:18:03,980
left

423
00:18:08,740 --> 00:18:06,259
April 19th in the center and April 20th

424
00:18:10,870 --> 00:18:08,750
on the right this was back in 2006 and

425
00:18:13,779 --> 00:18:10,880
you can see all the pieces that are

426
00:18:15,460 --> 00:18:13,789
broke off of that comet were flying off

427
00:18:18,369 --> 00:18:15,470
matter of fact this wasn't the whole

428
00:18:21,669 --> 00:18:18,379
comment this was just fragment B and I

429
00:18:24,299 --> 00:18:21,679
believe there were Oh 10 or 12 of these

430
00:18:26,950 --> 00:18:24,309
fragments this was just that this this

431
00:18:30,340 --> 00:18:26,960
fragment B out of I think it went up to

432
00:18:32,889 --> 00:18:30,350
J or K or something like that so we have

433
00:18:34,990 --> 00:18:32,899
seen comets break up elsewhere now this

434
00:18:37,810 --> 00:18:35,000
is sort of expected because comets are

435
00:18:39,610 --> 00:18:37,820
these snowballs and snowballs are you

436
00:18:42,249 --> 00:18:39,620
bringing the snow ball past the Sun it's

437
00:18:43,930 --> 00:18:42,259
gonna melt and its structure can break

438
00:18:47,740 --> 00:18:43,940

it can can become brittle and it can

439
00:18:50,049 --> 00:18:47,750
break apart what we didn't expect to see

440
00:18:53,619 --> 00:18:50,059
is something that I'll show you on the

441
00:18:57,909 --> 00:18:53,629
very next image and this is the breakup

442
00:18:58,950 --> 00:18:57,919
of an object that's not a comet it's an

443
00:19:07,749 --> 00:18:58,960
asteroid

444
00:19:10,600 --> 00:19:07,759
notice that 2013 is it's name is in its

445
00:19:14,409 --> 00:19:10,610
name it was discovered just last year in

446
00:19:16,539 --> 00:19:14,419
September of last year and it was seen

447
00:19:19,869 --> 00:19:16,549
to have some interesting structure that

448
00:19:22,840 --> 00:19:19,879
they believe they saw three spots that

449
00:19:24,460 --> 00:19:22,850
it was a couple's fuzzy spots and here's

450
00:19:26,710 --> 00:19:24,470
what it looked like on a taupe so ha

451
00:19:29,980 --> 00:19:26,720
they got Hubble time to observe it based

452
00:19:33,700 --> 00:19:29,990
upon its unique characteristics and this

453
00:19:38,289 --> 00:19:33,710
is the image on October 29th and here is

454
00:19:41,799 --> 00:19:38,299
the image on November 15th and here is

455
00:19:46,060 --> 00:19:41,809
the image on December 13th and then

456
00:19:48,310 --> 00:19:46,070
again on January 14th so here's a

457
00:19:51,039 --> 00:19:48,320
composite of all four of those images

458
00:19:54,100 --> 00:19:51,049
and so over last fall and into the

459
00:19:59,549 --> 00:19:54,110
winter we watched the breakup of an

460
00:20:03,480 --> 00:19:59,559
asteroid not a comet how cool is that

461
00:20:05,070 --> 00:20:03,490
now you we don't expect asteroids to

462
00:20:08,249 --> 00:20:05,080
break up because we think of them as

463
00:20:11,580 --> 00:20:08,259

rocks right and that you know you would

464
00:20:13,320 --> 00:20:11,590
even if it's a rock is hurtling through

465
00:20:15,210 --> 00:20:13,330
space and you know you warmth you could

466
00:20:18,570 --> 00:20:15,220
heat up a rock and it's not gonna it's

467
00:20:21,269 --> 00:20:18,580
not volatile with the ices of a comment

468
00:20:26,460 --> 00:20:21,279
so it we didn't we wouldn't expect it to

469
00:20:28,680 --> 00:20:26,470
break up but there have been a couple to

470
00:20:31,259 --> 00:20:28,690
two major models of what the internal

471
00:20:33,419 --> 00:20:31,269
structure of an asteroid is now for the

472
00:20:34,680 --> 00:20:33,429
larger asteroids like Ceres and Vesta we

473
00:20:37,289 --> 00:20:34,690
believe that they are these

474
00:20:40,049 --> 00:20:37,299
differentiated very large objects you

475
00:20:43,440 --> 00:20:40,059
know like like planets there are many

476
00:20:47,820 --> 00:20:43,450
planets or moons etc but the smaller

477
00:20:49,350 --> 00:20:47,830
asteroids well they could be single

478
00:20:51,720 --> 00:20:49,360
objects that are you know have chemical

479
00:20:53,549 --> 00:20:51,730
bonds holding them together or they

480
00:20:57,450 --> 00:20:53,559
could be what astronomers call rubble

481
00:20:59,369 --> 00:20:57,460
piles as in glommer ations of individual

482
00:21:02,100 --> 00:20:59,379
rocks that sort of are held together by

483
00:21:03,779 --> 00:21:02,110
their mutual gravity and that they don't

484
00:21:05,789 --> 00:21:03,789
have the chemical are there there aren't

485
00:21:07,259 --> 00:21:05,799
a single object all together but there

486
00:21:09,720 --> 00:21:07,269
are multiple objects together or they're

487
00:21:14,609 --> 00:21:09,730
loosely held together or the structure

488
00:21:18,419 --> 00:21:14,619

is not in some way fully fully coherent

489
00:21:20,249 --> 00:21:18,429
right mm-hmm so this is the question for

490
00:21:22,980 --> 00:21:20,259
this if this was a what we call the

491
00:21:25,680 --> 00:21:22,990
rubble pile model applied here how would

492
00:21:27,269 --> 00:21:25,690
you then get it to break up and the best

493
00:21:30,389 --> 00:21:27,279
guess for this and I'm gonna say this is

494
00:21:33,029 --> 00:21:30,399
a hypothesis it's not proven yet is that

495
00:21:34,950 --> 00:21:33,039
if you have the rubble pile all right

496
00:21:38,549 --> 00:21:34,960
and it has this incoherent structure and

497
00:21:43,109 --> 00:21:38,559
you start it spinning and you can use

498
00:21:45,960 --> 00:21:43,119
the the the the tort there's a very

499
00:21:47,190 --> 00:21:45,970
small gravity a torque due to light that

500
00:21:49,139 --> 00:21:47,200
you can get on this you can get this

501
00:21:51,720 --> 00:21:49,149
asteroid spinning and spinning faster

502
00:21:54,320 --> 00:21:51,730
and faster then it could get to what we

503
00:21:57,450 --> 00:21:54,330
call the breakups velocity where the

504
00:22:01,769 --> 00:21:57,460
centrifugal central center pedal force

505
00:22:06,659 --> 00:22:01,779
pulls it apart can break it apart and

506
00:22:10,190 --> 00:22:06,669
pull apart this Robo pile and so the

507
00:22:12,270 --> 00:22:10,200
Dave Jewett from a from Hawaii is the

508
00:22:14,550 --> 00:22:12,280
the gentleman who's

509
00:22:16,710 --> 00:22:14,560
doing these observations and that is his

510
00:22:19,020 --> 00:22:16,720
best guess as to why we're seeing an

511
00:22:23,130 --> 00:22:19,030
asteroid for the first time falling

512
00:22:26,040 --> 00:22:23,140
apart that if you get spun up to - to

513
00:22:29,040 --> 00:22:26,050

break up velocity and the pieces started

514
00:22:31,320 --> 00:22:29,050
coming apart now we don't know that that

515
00:22:33,600 --> 00:22:31,330
is true yet we will continue to follow

516
00:22:37,050 --> 00:22:33,610
it and will continue to model it to see

517
00:22:38,850 --> 00:22:37,060
if the torques really can produce

518
00:22:41,670 --> 00:22:38,860
something to get it up to break up

519
00:22:45,570 --> 00:22:41,680
velocity is as an astronomer think about

520
00:22:47,250 --> 00:22:45,580
it go wow that's it's got a tap you kind

521
00:22:49,620 --> 00:22:47,260
of have that very very very small torque

522
00:22:52,260 --> 00:22:49,630
over a really really really long time in

523
00:22:53,820 --> 00:22:52,270
order to spin it up that fast but then I

524
00:22:55,080 --> 00:22:53,830
always recognize that well this

525
00:22:56,900 --> 00:22:55,090
asteroids probably been floating around

526
00:23:00,690 --> 00:22:56,910
the solar system for a few billion years

527
00:23:02,730 --> 00:23:00,700
so even a tiny did you already say what

528
00:23:04,560 --> 00:23:02,740
kind of orbit it had I might have missed

529
00:23:08,670 --> 00:23:04,570
that part I did not say what type of

530
00:23:12,240 --> 00:23:08,680
orbit it had I do know that it is not in

531
00:23:14,520 --> 00:23:12,250
the main asteroid belt i but it is not a

532
00:23:16,140 --> 00:23:14,530
sungrazer type thing where it goes in

533
00:23:17,610 --> 00:23:16,150
close to the Sun okay that was like

534
00:23:19,700 --> 00:23:17,620
that's where I was heading with that I

535
00:23:21,720 --> 00:23:19,710
wasn't sure if the Sun might have been

536
00:23:24,690 --> 00:23:21,730
involved in some way producing that

537
00:23:25,830 --> 00:23:24,700
torque or not the Sun would be involved

538
00:23:27,930 --> 00:23:25,840

in curtain two in terms of the light

539
00:23:30,600 --> 00:23:27,940
pressure so the solar wind would do

540
00:23:35,430 --> 00:23:30,610
something it's just it's more this it's

541
00:23:38,610 --> 00:23:35,440
more this radiation and radiation to

542
00:23:42,090 --> 00:23:38,620
work on it especially if it's got

543
00:23:43,230 --> 00:23:42,100
different absorption because of

544
00:23:46,530 --> 00:23:43,240
different sort of different surface

545
00:23:48,180 --> 00:23:46,540
elements so yeah so you have highly

546
00:23:51,360 --> 00:23:48,190
reflective in some dark spots that's

547
00:23:53,940 --> 00:23:51,370
gonna exactly put some weird forces on

548
00:23:56,790 --> 00:23:53,950
the on the surface is this the same kind

549
00:23:58,500 --> 00:23:56,800
of torque that JWST has got to correct

550
00:24:01,410 --> 00:23:58,510
for with its momentum flap or is that

551
00:24:03,230 --> 00:24:01,420
something else I can't I don't know

552
00:24:06,780 --> 00:24:03,240
enough about jus T's momentum flapped

553
00:24:08,640 --> 00:24:06,790
but there might it might be okay I

554
00:24:11,700 --> 00:24:08,650
wasn't sure if it was the same sort of

555
00:24:12,930 --> 00:24:11,710
force or not but in as much as the Solar

556
00:24:14,850 --> 00:24:12,940
shield is going to be absorbing

557
00:24:16,440 --> 00:24:14,860
radiation and if it absorbs more

558
00:24:18,390 --> 00:24:16,450
radiation on one side than on the other

559
00:24:20,790 --> 00:24:18,400
side then that could definitely throw a

560
00:24:22,410 --> 00:24:20,800
torque onto the whole spacecraft okay

561
00:24:23,850 --> 00:24:22,420
that's so may not necessarily be related

562
00:24:25,720 --> 00:24:23,860
I just it just came to my mind when you

563
00:24:27,310 --> 00:24:25,730

were talking about this and so I know

564
00:24:31,210 --> 00:24:27,320
these are the cool things that we get to

565
00:24:33,400 --> 00:24:31,220
talk about the how bright was this thing

566
00:24:34,450 --> 00:24:33,410
do you have any idea what was it

567
00:24:39,880 --> 00:24:34,460
something you needed a pretty big

568
00:24:41,980 --> 00:24:39,890
telescope to check this out or I don't

569
00:24:44,380 --> 00:24:41,990
have any I don't have a good idea but it

570
00:24:46,330 --> 00:24:44,390
was not particularly bright I mean no

571
00:24:46,630 --> 00:24:46,340
asteroid is very bright right right

572
00:24:48,940 --> 00:24:46,640
right

573
00:24:51,010 --> 00:24:48,950
so we're getting down toward 20 of them

574
00:24:53,230 --> 00:24:51,020
we're getting down 15th or 20th

575
00:24:55,420 --> 00:24:53,240
magnitude this is pretty much outside of

576
00:24:58,720 --> 00:24:55,430
most amateur scope that would be my

577
00:25:00,430 --> 00:24:58,730
guess on this I don't have the printout

578
00:25:02,410 --> 00:25:00,440
of the press release in front of me yeah

579
00:25:04,690 --> 00:25:02,420
yeah no I'm sorry I just was curious it

580
00:25:06,490 --> 00:25:04,700
was a hey people might have been able to

581
00:25:07,600 --> 00:25:06,500
check out themselves I love it when you

582
00:25:13,720 --> 00:25:07,610
ask questions that I don't know the

583
00:25:16,240 --> 00:25:13,730
answer to let's go to the third story

584
00:25:19,930 --> 00:25:16,250
here okay and I call this a Hubble

585
00:25:22,960 --> 00:25:19,940
anniversary present part two last month

586
00:25:26,110 --> 00:25:22,970
I talked about the Hubble anniversary

587
00:25:30,520 --> 00:25:26,120
present part one and just to remind you

588
00:25:32,610 --> 00:25:30,530

we talked about a April 24th 1990 one of

589
00:25:36,220 --> 00:25:32,620
my favorite shots of the Space Shuttle

590
00:25:37,140 --> 00:25:36,230
blasting off obey a very special day

591
00:25:40,660 --> 00:25:37,150
it's got the Hubble Space Telescope

592
00:25:42,810 --> 00:25:40,670
inside the payload bay and then an

593
00:25:45,550 --> 00:25:42,820
amazing shot from the very next day

594
00:25:50,410 --> 00:25:45,560
taken by the IMAX camera in the payload

595
00:25:55,750 --> 00:25:50,420
Bay for the deployment that front cover

596
00:25:57,250 --> 00:25:55,760
closed - yeah I I don't I know very few

597
00:25:59,530 --> 00:25:57,260
others I mean except for ones being

598
00:26:02,830 --> 00:25:59,540
serviced though that is almost never

599
00:26:04,660 --> 00:26:02,840
closed yeah yeah this was this was a

600
00:26:06,100 --> 00:26:04,670
fantastic shot I love how they arranged

601
00:26:10,720 --> 00:26:06,110
to have the Sun in the background for

602
00:26:12,220 --> 00:26:10,730
this shot reflection of the earth and in

603
00:26:14,590 --> 00:26:12,230
the front cover there it's really neat

604
00:26:18,850 --> 00:26:14,600
that's right the cinematographer just

605
00:26:21,550 --> 00:26:18,860
you know just nailed that one you know I

606
00:26:23,320 --> 00:26:21,560
think the only thing harder to do I

607
00:26:25,180 --> 00:26:23,330
remember on top of the movie do you

608
00:26:28,270 --> 00:26:25,190
remember the movie Top Gun right oh yeah

609
00:26:32,290 --> 00:26:28,280
yeah and Tony Scott directed that film

610
00:26:34,330 --> 00:26:32,300
and they were doing a shot on the flight

611
00:26:36,880 --> 00:26:34,340
deck where they the aircraft were

612
00:26:39,160 --> 00:26:36,890
landing and suddenly the boat starts to

613
00:26:41,110 --> 00:26:39,170

turn I mean this is a real Navy air

614
00:26:42,990 --> 00:26:41,120
craft carrier and it starts to turn to

615
00:26:45,280 --> 00:26:43,000
head towards wherever it's going to and

616
00:26:47,440 --> 00:26:45,290
the director calls up to the bridge

617
00:26:50,110 --> 00:26:47,450
saying no no you can't turn I need the

618
00:26:51,700 --> 00:26:50,120
Sun where it needs to be to hear for the

619
00:26:55,720 --> 00:26:51,710
shot you know you got to give me half an

620
00:26:58,510 --> 00:26:55,730
hour or more on this course oh so who's

621
00:27:00,190 --> 00:26:58,520
in charge I guess right oh the bridge

622
00:27:02,130 --> 00:27:00,200
called back down said well that'll cost

623
00:27:06,370 --> 00:27:02,140
you and he said I don't care I need it

624
00:27:07,720 --> 00:27:06,380
so they actually turn the ship back to

625
00:27:10,510 --> 00:27:07,730
its core so they could have the Sun

626
00:27:13,270 --> 00:27:10,520
where they needed it for the to finish

627
00:27:15,010 --> 00:27:13,280
filming that sequence I could imagine

628
00:27:17,830 --> 00:27:15,020
the only thing harder than turning an

629
00:27:20,740 --> 00:27:17,840
aircraft carrier just to get a shot

630
00:27:23,260 --> 00:27:20,750
would be to just to reposition the space

631
00:27:27,850 --> 00:27:23,270
shut the space space shuttles to get the

632
00:27:29,560 --> 00:27:27,860
shot like this yeah I can't imagine IMAX

633
00:27:31,780 --> 00:27:29,570
calling down to Houston no no we got a

634
00:27:33,370 --> 00:27:31,790
way to not for that you can't release

635
00:27:39,850 --> 00:27:33,380
just yet we have to wait till the Sun is

636
00:27:42,010 --> 00:27:39,860
in the right spot blue thing there's

637
00:27:47,400 --> 00:27:42,020
probably a that's either a lens flare or

638
00:27:49,360 --> 00:27:47,410

a blue got with the red circle around it

639
00:27:53,230 --> 00:27:49,370
either that or it's one of Hubble's

640
00:27:58,540 --> 00:27:53,240
images of planetary nebulae that's

641
00:28:01,860 --> 00:27:58,550
definitely a lens artifact yeah okay so

642
00:28:07,270 --> 00:28:01,870
back to Hubble instead of other movies

643
00:28:13,140 --> 00:28:07,280
so that was 24 years ago and last month

644
00:28:15,160 --> 00:28:13,150
in Rome they had a the cover the

645
00:28:18,040 --> 00:28:15,170
scientific meeting called science with

646
00:28:20,020 --> 00:28:18,050
the Hubble Space Telescope for obviously

647
00:28:22,540 --> 00:28:20,030
a series of meetings about the Hubble

648
00:28:23,950 --> 00:28:22,550
Space Telescope so to celebrate that

649
00:28:26,230 --> 00:28:23,960
meeting and celebrate our 24th

650
00:28:28,900 --> 00:28:26,240
anniversary we actually released the

651
00:28:31,620 --> 00:28:28,910
Hubble 24th anniversary image a month

652
00:28:33,940 --> 00:28:31,630
early we released it during this meeting

653
00:28:36,090 --> 00:28:33,950
so it could be unveiled at this meeting

654
00:28:39,160 --> 00:28:36,100
to the scientists at this meeting but

655
00:28:41,740 --> 00:28:39,170
what I showed you that image last month

656
00:28:45,820 --> 00:28:41,750
but what I didn't show you was the

657
00:28:50,290 --> 00:28:45,830
overview image so this is a visible

658
00:28:52,750 --> 00:28:50,300
light image of NGC 24 2174 also known as

659
00:28:54,910 --> 00:28:52,760
the monkey head nebula

660
00:28:56,860 --> 00:28:54,920
as noted here it is not from Hubble of

661
00:28:59,110 --> 00:28:56,870
course this is from an Astro

662
00:29:01,420 --> 00:28:59,120
photographer named Richard crisp always

663
00:29:05,410 --> 00:29:01,430

want to credit our sources here and that

664
00:29:07,810 --> 00:29:05,420
square box up there is where Hubble took

665
00:29:09,370 --> 00:29:07,820
the 24th anniversary image now this is a

666
00:29:11,770 --> 00:29:09,380
visible light image but Hubble took the

667
00:29:14,350 --> 00:29:11,780
24th anniversary image in infrared

668
00:29:16,030 --> 00:29:14,360
Hubble you know covers visible light a

669
00:29:18,760 --> 00:29:16,040
little bit of the ultraviolet and a

670
00:29:22,260 --> 00:29:18,770
little bit of the infrared and here was

671
00:29:25,470 --> 00:29:22,270
that really cool Hubble image of that

672
00:29:30,430 --> 00:29:25,480
these pillars in the monkey head nebula

673
00:29:33,130 --> 00:29:30,440
in infrared and it to me it reminds me a

674
00:29:34,510 --> 00:29:33,140
lot of the Horsehead Nebula image

675
00:29:36,790 --> 00:29:34,520
released for their Hubble's 23rd

676
00:29:39,700 --> 00:29:36,800
anniversary that you're getting this

677
00:29:42,640 --> 00:29:39,710
dark gas the stuff that's absolutely

678
00:29:45,550 --> 00:29:42,650
opaque in visible light and being able

679
00:29:48,490 --> 00:29:45,560
to see a beautiful glowing gaseous

680
00:29:50,950 --> 00:29:48,500
landscape by looking in the infrared

681
00:29:53,200 --> 00:29:50,960
the infrared has longer wavelengths so

682
00:29:56,530 --> 00:29:53,210
it penetrates deeper into the gas and

683
00:29:59,350 --> 00:29:56,540
also this gas is cool that's not hot

684
00:30:02,530 --> 00:29:59,360
enough to shine using invisible light

685
00:30:05,170 --> 00:30:02,540
but it is warm gas that's hot enough to

686
00:30:07,360 --> 00:30:05,180
shine an infrared light so we can

687
00:30:10,000 --> 00:30:07,370
actually observe more of the gas with

688
00:30:12,790 --> 00:30:10,010

the infrared for those two reasons no

689
00:30:14,920 --> 00:30:12,800
that's amazing so this was this was the

690
00:30:17,260 --> 00:30:14,930
small sub region in that over that

691
00:30:19,660 --> 00:30:17,270
larger picture you showed before right

692
00:30:22,060 --> 00:30:19,670
if isn't all is it this is not all

693
00:30:24,180 --> 00:30:22,070
because another thing I didn't tell you

694
00:30:28,090 --> 00:30:24,190
last month was that Hubble had observed

695
00:30:31,600 --> 00:30:28,100
this very pillar previously this

696
00:30:34,840 --> 00:30:31,610
subsection here was released oh five or

697
00:30:38,920 --> 00:30:34,850
six years ago five or six years ago as a

698
00:30:41,370 --> 00:30:38,930
visible light shot so here is that

699
00:30:44,530 --> 00:30:41,380
cropping - that on the Left we have the

700
00:30:48,610 --> 00:30:44,540
wide field planetary camera - image

701
00:30:49,420 --> 00:30:48,620
using visible light of the these pillars

702
00:30:52,120 --> 00:30:49,430
in the monkeyhead

703
00:30:54,640 --> 00:30:52,130
and on the right we have the infrared

704
00:30:57,100 --> 00:30:54,650
version of it so that's kind of cool

705
00:30:59,530 --> 00:30:57,110
we've got this visible and you can see

706
00:31:02,890 --> 00:30:59,540
the darkness that you see visible and

707
00:31:05,140 --> 00:31:02,900
the what you see more the way you look

708
00:31:05,950 --> 00:31:05,150
through it one of the cool things to

709
00:31:08,080 --> 00:31:05,960
look for

710
00:31:10,600 --> 00:31:08,090
is just above the pillars on the right

711
00:31:13,480 --> 00:31:10,610
hand side I don't know if my mouth shows

712
00:31:16,840 --> 00:31:13,490
up on this but there is a galaxy sitting

713
00:31:19,600 --> 00:31:16,850

right here next guys sort of bullet

714
00:31:21,070 --> 00:31:19,610
trails right next to that top bullet

715
00:31:23,470 --> 00:31:21,080
trail just to the right there's a galaxy

716
00:31:26,380 --> 00:31:23,480
and actually two or three galaxies that

717
00:31:28,180 --> 00:31:26,390
you can see through the nebula and you

718
00:31:30,430 --> 00:31:28,190
can't see that at all using visible

719
00:31:32,100 --> 00:31:30,440
light that just shows you how much the

720
00:31:34,750 --> 00:31:32,110
infrared light penetrates through

721
00:31:36,760 --> 00:31:34,760
completely through the nebula here I

722
00:31:38,500 --> 00:31:36,770
know you and to see what Frank's talking

723
00:31:41,110 --> 00:31:38,510
about it more do anything that's black

724
00:31:42,820 --> 00:31:41,120
on the left side image or a very dark as

725
00:31:44,560 --> 00:31:42,830
being the light is being completely

726
00:31:46,810 --> 00:31:44,570
blocked but here if you go to the right

727
00:31:48,880 --> 00:31:46,820
side you can see those regions are not

728
00:31:51,070 --> 00:31:48,890
dark any longer that's what he's talking

729
00:31:53,049 --> 00:31:51,080
about the the the longer wavelengths are

730
00:31:55,389 --> 00:31:53,059
able to pass through some of that

731
00:31:58,870 --> 00:31:55,399
material and those what do you call them

732
00:32:02,529 --> 00:31:58,880
that thing oh I call it a bullet trails

733
00:32:04,210 --> 00:32:02,539
I think it's a bullet really start you

734
00:32:07,149 --> 00:32:04,220
could those are really stark in visible

735
00:32:09,370 --> 00:32:07,159
light and their little s so here in the

736
00:32:11,080 --> 00:32:09,380
infrared but they're kind of glowing a

737
00:32:13,570 --> 00:32:11,090
little bit in the infrared - so that's

738
00:32:15,039 --> 00:32:13,580

kinda yeah i'm just called them sorta

739
00:32:16,870 --> 00:32:15,049
like the bullet trail simply because

740
00:32:20,200 --> 00:32:16,880
remember the movie matrix let's go back

741
00:32:22,659 --> 00:32:20,210
to old movies again and that the bullet

742
00:32:24,940 --> 00:32:22,669
trails in that the scenes of the bullets

743
00:32:26,049 --> 00:32:24,950
flying through the air that's what it

744
00:32:29,200 --> 00:32:26,059
sort of looks like here but these are

745
00:32:32,260 --> 00:32:29,210
actually the wind blowing past these

746
00:32:33,430 --> 00:32:32,270
dense knots of gas yeah that's true yeah

747
00:32:35,049 --> 00:32:33,440
that does look like that I would have

748
00:32:38,350 --> 00:32:35,059
called them tadpoles but you know I

749
00:32:41,230 --> 00:32:38,360
don't mind as imaginative you are we can

750
00:32:43,139 --> 00:32:41,240
do tadpoles - another name we have

751
00:32:46,419 --> 00:32:43,149
another thing that we call tadpoles

752
00:32:50,289 --> 00:32:46,429
Orion Nebula oh that's right no problems

753
00:32:51,909 --> 00:32:50,299
in Orion right okay so here's we're

754
00:32:53,409 --> 00:32:51,919
finished with the setup here now the set

755
00:32:55,180 --> 00:32:53,419
is that we've got this visible light

756
00:32:57,220 --> 00:32:55,190
image and we've got this infrared image

757
00:32:58,720 --> 00:32:57,230
and we got the contextual image that I

758
00:33:00,820 --> 00:32:58,730
showed you so what I really want to do

759
00:33:03,370 --> 00:33:00,830
is take you on a full exploration of it

760
00:33:05,169 --> 00:33:03,380
so I'm going to show you a movie and

761
00:33:08,320 --> 00:33:05,179
again this being a Hubble hangout it

762
00:33:12,970 --> 00:33:08,330
doesn't always show well so I'm actually

763
00:33:16,210 --> 00:33:12,980

going to let me just give you the URL

764
00:33:19,090 --> 00:33:16,220
first okay so here is the URL Hubble

765
00:33:20,080 --> 00:33:19,100
site org slash new centers last archive

766
00:33:25,029 --> 00:33:20,090
slash

767
00:33:27,610 --> 00:33:25,039
lisa / 2014's last 18 / video /b yeah I

768
00:33:29,320 --> 00:33:27,620
put that by the way it's in the event

769
00:33:31,779 --> 00:33:29,330
description so you can just click on it

770
00:33:34,110 --> 00:33:31,789
right so III talked it through making

771
00:33:36,310 --> 00:33:34,120
sure you had time to drop it in there

772
00:33:39,250 --> 00:33:36,320
but yeah it's in there now it's in the

773
00:33:41,230 --> 00:33:39,260
hangout description okay alright and

774
00:33:43,000 --> 00:33:41,240
then this other UL Hubbell site toad org

775
00:33:44,500 --> 00:33:43,010
slash videos we'll talk about in just a

776
00:33:48,159 --> 00:33:44,510
second but I'm gonna escape out of

777
00:33:50,950 --> 00:33:48,169
PowerPoint because PowerPoint often has

778
00:33:53,019 --> 00:33:50,960
problems playing videos and I'm gonna

779
00:33:55,029 --> 00:33:53,029
change my screen share there we go get

780
00:33:59,529 --> 00:33:55,039
rid of the screen share and I'm gonna

781
00:34:01,720 --> 00:33:59,539
screen share with you this right just

782
00:34:04,090 --> 00:34:01,730
the movie you know play it in QuickTime

783
00:34:09,520 --> 00:34:04,100
instead alright we up in the movie yep I

784
00:34:10,240 --> 00:34:09,530
can see it okay great so I need to

785
00:34:12,970 --> 00:34:10,250
rewind it

786
00:34:15,639 --> 00:34:12,980
I've shown you the end here we go from

787
00:34:17,349 --> 00:34:15,649
the beginning now I'm playing it so you

788
00:34:19,450 --> 00:34:17,359

can see the Orion constellation and the

789
00:34:21,460 --> 00:34:19,460
Gemini constellation here and we're

790
00:34:23,190 --> 00:34:21,470
gonna zoom into a reach into the monkey

791
00:34:25,659 --> 00:34:23,200
head nebula which is located between

792
00:34:27,040 --> 00:34:25,669
Orion and Gemini and it's I think it's

793
00:34:30,820 --> 00:34:27,050
technically in the constellation Orion

794
00:34:32,619 --> 00:34:30,830
so there's the whole view of the monkey

795
00:34:35,020 --> 00:34:32,629
head nebula then we're going to move

796
00:34:36,609 --> 00:34:35,030
into this very small pillar here section

797
00:34:38,680 --> 00:34:36,619
here and we're going to show you how

798
00:34:41,260 --> 00:34:38,690
balls visible light image now we're

799
00:34:45,700 --> 00:34:41,270
going to go from 2d image to 3d model in

800
00:34:49,359 --> 00:34:45,710
the infrared and we're gonna slowly pull

801
00:34:52,899 --> 00:34:49,369
back this is a 3d model that our team

802
00:34:55,450 --> 00:34:52,909
here of visualizers put together by

803
00:34:57,579 --> 00:34:55,460
taking apart the image and then putting

804
00:35:00,089 --> 00:34:57,589
it back together in a three-dimensional

805
00:35:03,430 --> 00:35:00,099
computer model and give you a

806
00:35:05,109 --> 00:35:03,440
three-dimensional feel for the structure

807
00:35:07,359 --> 00:35:05,119
you've talked about this technique

808
00:35:09,430 --> 00:35:07,369
before and in another talk we that that

809
00:35:10,810 --> 00:35:09,440
you had given to remember the

810
00:35:13,690 --> 00:35:10,820
visualization talks so that's on our

811
00:35:15,670 --> 00:35:13,700
youtube channel as well on how you some

812
00:35:17,140 --> 00:35:15,680
of these things right I think that was

813
00:35:19,540 --> 00:35:17,150

the truth and beauty talk I gave him

814
00:35:22,660 --> 00:35:19,550
Texas they also gave that as a public

815
00:35:25,630 --> 00:35:22,670
lecture series we didn't hang out cast

816
00:35:30,490 --> 00:35:25,640
that one on you Joe no but the one in

817
00:35:33,040 --> 00:35:30,500
Austin is so so what we did and you can

818
00:35:34,000 --> 00:35:33,050
you can take take you can go to the the

819
00:35:37,660 --> 00:35:34,010
length of Tony Post

820
00:35:41,500 --> 00:35:37,670
and see that but what I really wanted is

821
00:35:47,010 --> 00:35:41,510
to show you is if I go to my screen

822
00:35:50,410 --> 00:35:47,020
share again and share my web browser

823
00:35:52,870 --> 00:35:50,420
there's my web browser all right that we

824
00:35:56,470 --> 00:35:52,880
have a new section on hubbell site for

825
00:35:59,050 --> 00:35:56,480
sharing these videos all right and so my

826
00:36:01,150 --> 00:35:59,060
web browser up no it's not up Tony's

827
00:36:06,099 --> 00:36:01,160
looking at me funny go to my screen

828
00:36:06,569 --> 00:36:06,109
share choose desktop to or no there we

829
00:36:10,390 --> 00:36:06,579
go

830
00:36:12,880 --> 00:36:10,400
and start screen share that better yeah

831
00:36:15,160 --> 00:36:12,890
that's better now I look okay so this is

832
00:36:19,170 --> 00:36:15,170
our Hubbell site web page Hubbell site

833
00:36:21,010 --> 00:36:19,180
dot o-r-g and you can see that up in the

834
00:36:23,170 --> 00:36:21,020
advertising box up here it says

835
00:36:24,670 --> 00:36:23,180
astronomy videos go to the page you can

836
00:36:28,329 --> 00:36:24,680
click that go to the page and get there

837
00:36:31,030 --> 00:36:28,339
if you go down to the middle of the page

838
00:36:32,470 --> 00:36:31,040

you can see a link to videos astronomy

839
00:36:34,750 --> 00:36:32,480
features visualizations bring space

840
00:36:36,609 --> 00:36:34,760
science to life then we got it though

841
00:36:39,520 --> 00:36:36,619
there but we also have at the very top

842
00:36:42,430 --> 00:36:39,530
of the page along our menu bar we have

843
00:36:44,559 --> 00:36:42,440
that thing videos three ways to get to

844
00:36:47,859 --> 00:36:44,569
it from the home page or pushing it this

845
00:36:50,400 --> 00:36:47,869
month aren't we yeah I have I go to that

846
00:36:53,020 --> 00:36:50,410
page you can see that we have a

847
00:36:55,839 --> 00:36:53,030
collection of videos right now we are

848
00:36:57,579 --> 00:36:55,849
featuring this movie which I call the

849
00:37:01,390 --> 00:36:57,589
evaporating Peaks pillars in the monkey

850
00:37:02,980 --> 00:37:01,400
head nebula and if I scroll down you can

851
00:37:05,770 --> 00:37:02,990
see we have that horse head video from

852
00:37:08,800 --> 00:37:05,780
last year we have some star clusters we

853
00:37:11,859 --> 00:37:08,810
have some j ust actually along the left

854
00:37:14,920 --> 00:37:11,869
hand side here we've got categories so

855
00:37:17,530 --> 00:37:14,930
we've got videos about planets some

856
00:37:20,770 --> 00:37:17,540
Jupiter and Saturn videos we have some

857
00:37:23,470 --> 00:37:20,780
stars star clusters and the

858
00:37:25,420 --> 00:37:23,480
constellation of Orion we have the

859
00:37:27,069 --> 00:37:25,430
nebula which I gotta say our bread and

860
00:37:29,890 --> 00:37:27,079
butter because the nebula are really

861
00:37:33,480 --> 00:37:29,900
really cool we have amazing shots of

862
00:37:35,740 --> 00:37:33,490
nebula we have some galaxies stuff

863
00:37:38,140 --> 00:37:35,750

that's actually my favorite you could

864
00:37:39,970 --> 00:37:38,150
talk about that one that the galaxy

865
00:37:42,190 --> 00:37:39,980
collisions the simulations versus

866
00:37:44,589 --> 00:37:42,200
observations and okay that one's amazing

867
00:37:44,970 --> 00:37:44,599
that's why I will go into that and I

868
00:37:47,550 --> 00:37:44,980
will

869
00:37:50,550 --> 00:37:47,560
bring it up alright and you can see that

870
00:37:52,589 --> 00:37:50,560
on ah if you go to each page you can we

871
00:37:56,750 --> 00:37:52,599
have the youtube link to it so you can

872
00:37:59,099 --> 00:37:56,760
watch the the visualization from YouTube

873
00:38:00,120 --> 00:37:59,109
and you could make it fullscreen or I

874
00:38:03,240 --> 00:38:00,130
think I'll just let it play in the

875
00:38:05,400 --> 00:38:03,250
background while I talk here but you've

876
00:38:07,980 --> 00:38:05,410
also can see that we've got lots of

877
00:38:11,160 --> 00:38:07,990
information about this now this was one

878
00:38:14,069 --> 00:38:11,170
where we have a bunch of colliding

879
00:38:16,560 --> 00:38:14,079
galaxies we had 59 galaxy images for

880
00:38:18,900 --> 00:38:16,570
this press release of images galaxies

881
00:38:22,020 --> 00:38:18,910
that were colliding and so I took a

882
00:38:25,109 --> 00:38:22,030
computer simulation of two galaxies

883
00:38:29,250 --> 00:38:25,119
colliding and I matched it to five

884
00:38:32,430 --> 00:38:29,260
different stages in the under galaxy

885
00:38:35,400 --> 00:38:32,440
collision so there are five different

886
00:38:37,560 --> 00:38:35,410
images from this set of 59 that I could

887
00:38:40,980 --> 00:38:37,570
match to one computer simulation and

888
00:38:45,089 --> 00:38:40,990

show you how that each image from Hubble

889
00:38:48,690 --> 00:38:45,099
is just one snapshot in a really long

890
00:38:51,900 --> 00:38:48,700
process and really long I mean a billion

891
00:38:53,579 --> 00:38:51,910
and a half years yeah that just blows me

892
00:38:55,200 --> 00:38:53,589
away because you think about what you're

893
00:38:57,240 --> 00:38:55,210
what Hubble is showing us when we see

894
00:38:59,190 --> 00:38:57,250
galaxy collisions and then you run it

895
00:39:01,410 --> 00:38:59,200
with you put it in the context of that

896
00:39:03,900 --> 00:39:01,420
simulation you have this model that

897
00:39:06,059 --> 00:39:03,910
you're running really is a great vision

898
00:39:08,370 --> 00:39:06,069
is a great way to see that every single

899
00:39:11,609 --> 00:39:08,380
one of those 59 images are at some point

900
00:39:13,770 --> 00:39:11,619
a point in time of a much longer drama

901
00:39:15,359 --> 00:39:13,780
of these galaxies interacting and so

902
00:39:17,069 --> 00:39:15,369
that's my favorite thing that's one of

903
00:39:18,720 --> 00:39:17,079
my favorite ones you've ever made now

904
00:39:21,690 --> 00:39:18,730
this is a big effort you're going

905
00:39:23,880 --> 00:39:21,700
through that you're going through so

906
00:39:25,920 --> 00:39:23,890
people need to check back a lot on this

907
00:39:28,140 --> 00:39:25,930
website because Frank is adding to this

908
00:39:32,099 --> 00:39:28,150
all the time right I mean you're going

909
00:39:33,210 --> 00:39:32,109
back and putting visualizations up that

910
00:39:35,370 --> 00:39:33,220
you've had sitting around on your

911
00:39:36,420 --> 00:39:35,380
computer for a while right right what

912
00:39:38,640 --> 00:39:36,430
we're doing is we're going back through

913
00:39:42,780 --> 00:39:38,650

all of the videos that we've produced in

914
00:39:45,329 --> 00:39:42,790
the past 10 or 15 years and we're taking

915
00:39:48,800 --> 00:39:45,339
them and we're where we can we're

916
00:39:51,690 --> 00:39:48,810
rear-ending them at full HD 1920 by 1080

917
00:39:53,069 --> 00:39:51,700
you'll notice on News Center and in

918
00:39:55,290 --> 00:39:53,079
Hubble site that we generated these

919
00:39:58,260 --> 00:39:55,300
things only at 1280 by 720 at maximum

920
00:39:59,790 --> 00:39:58,270
resolution I've worked an

921
00:40:03,000 --> 00:39:59,800
axé films okay that's not good enough

922
00:40:05,340 --> 00:40:03,010
for me I want the full HD right and so

923
00:40:07,260 --> 00:40:05,350
we're making available and if you look

924
00:40:09,510 --> 00:40:07,270
on my web the web page here I'm going to

925
00:40:12,360 --> 00:40:09,520
just highlight the right hand side are

926
00:40:13,980 --> 00:40:12,370
these download options right whoops

927
00:40:15,360 --> 00:40:13,990
there we go on the right hand side

928
00:40:18,420 --> 00:40:15,370
you've got these download options

929
00:40:21,090 --> 00:40:18,430
QuickTime WebM and Windows Media you can

930
00:40:23,300 --> 00:40:21,100
get them at Full HD resolution to

931
00:40:25,890 --> 00:40:23,310
download and play on your computer

932
00:40:27,840 --> 00:40:25,900
astronomers also appreciate this because

933
00:40:31,320 --> 00:40:27,850
they download these and use them in

934
00:40:33,360 --> 00:40:31,330
their talks or in their classes when you

935
00:40:36,960 --> 00:40:33,370
say that you love this one I have to say

936
00:40:39,690 --> 00:40:36,970
that my my colleagues love that because

937
00:40:41,730 --> 00:40:39,700
they it is used in so many astronomy 101

938
00:40:43,800 --> 00:40:41,740

classrooms where they can show off

939
00:40:47,550 --> 00:40:43,810
what's route what's happening and relate

940
00:40:49,560 --> 00:40:47,560
the simulation to the visual to the

941
00:40:50,970 --> 00:40:49,570
observations yeah I'm glad you said that

942
00:40:53,370 --> 00:40:50,980
I was gonna say this is a great resource

943
00:40:55,620 --> 00:40:53,380
for educators to do a walk of all ages

944
00:40:58,410 --> 00:40:55,630
all grades and stuff they can use these

945
00:40:59,940 --> 00:40:58,420
in their classes so yeah I'm gonna go go

946
00:41:02,490 --> 00:40:59,950
to the site guys download this stuff

947
00:41:04,950 --> 00:41:02,500
it's all free you can use it however you

948
00:41:07,350 --> 00:41:04,960
want and let me highlight one more thing

949
00:41:10,230 --> 00:41:07,360
because the other thing that we've got

950
00:41:14,310 --> 00:41:10,240
on here are stereo 3d versions of these

951
00:41:17,250 --> 00:41:14,320
all right because we have been since we

952
00:41:19,410 --> 00:41:17,260
did the IMAX film Hubble 3d back in 2010

953
00:41:22,440 --> 00:41:19,420
we have been experimenting with stereo

954
00:41:24,300 --> 00:41:22,450
3d so as you can see we've got what is

955
00:41:27,300 --> 00:41:24,310
it six different visualizations right

956
00:41:30,750 --> 00:41:27,310
now on the website that have stereo 3d

957
00:41:33,360 --> 00:41:30,760
versions so if you own an HDTV with

958
00:41:35,820 --> 00:41:33,370
stereo 3d capabilities you can download

959
00:41:37,800 --> 00:41:35,830
these movies generally you play them for

960
00:41:40,230 --> 00:41:37,810
the Media Player of the television you

961
00:41:42,390 --> 00:41:40,240
put your TV into 3d mode this these are

962
00:41:44,340 --> 00:41:42,400
our side by side versions so you put

963
00:41:46,800 --> 00:41:44,350

your TV into the 3d side-by-side mode

964
00:41:49,890 --> 00:41:46,810
put on your glasses and then you'll see

965
00:41:52,410 --> 00:41:49,900
the the Hubble images pull out into into

966
00:41:54,600 --> 00:41:52,420
3d it's not just seeing a 2d version of

967
00:41:56,820 --> 00:41:54,610
our 3d models are actually seeing of

968
00:41:58,440 --> 00:41:56,830
them extend out both in front of the

969
00:42:01,560 --> 00:41:58,450
television set and behind the television

970
00:42:03,600 --> 00:42:01,570
set they're really beautiful so what

971
00:42:05,160 --> 00:42:03,610
what software do you I mean I get a lot

972
00:42:07,260 --> 00:42:05,170
of questions sometime about this what

973
00:42:09,390 --> 00:42:07,270
what software do you primarily use to

974
00:42:11,450 --> 00:42:09,400
put these together with well when we're

975
00:42:14,970 --> 00:42:11,460
doing the stereo 3d ones

976
00:42:17,610 --> 00:42:14,980
most of the ones here use a software

977
00:42:20,670 --> 00:42:17,620
that's called from Autodesk called Maya

978
00:42:24,000 --> 00:42:20,680
it's some same software that Hollywood

979
00:42:26,130 --> 00:42:24,010
uses for most most every blockbuster

980
00:42:28,800 --> 00:42:26,140
movie that you see that uses 3d

981
00:42:31,110 --> 00:42:28,810
visualization probably uses Maya there's

982
00:42:33,180 --> 00:42:31,120
others light wave and Houdini and a few

983
00:42:35,450 --> 00:42:33,190
other things and there's even the open

984
00:42:38,340 --> 00:42:35,460
source blender 3d modeling software

985
00:42:41,190 --> 00:42:38,350
that's available but we happen to be

986
00:42:42,840 --> 00:42:41,200
using Maya then of course we use all

987
00:42:47,070 --> 00:42:42,850
sorts of things to prepare the images

988
00:42:48,570 --> 00:42:47,080

whether it's or Photoshop or other

989
00:42:50,370 --> 00:42:48,580
things and you know since it's

990
00:42:53,520 --> 00:42:50,380
scientific data there's often times that

991
00:42:55,380 --> 00:42:53,530
I will need to use my own my own

992
00:42:58,020 --> 00:42:55,390
software or some scientific software

993
00:43:01,590 --> 00:42:58,030
write code that transforms the science

994
00:43:05,010 --> 00:43:01,600
data into a suitable format for using in

995
00:43:07,530 --> 00:43:05,020
the visualization if I've got you know

996
00:43:10,050 --> 00:43:07,540
ten thousands galaxies in a

997
00:43:11,910 --> 00:43:10,060
visualization I'm not going to go by

998
00:43:14,160 --> 00:43:11,920
hand and place ten thousand galaxies at

999
00:43:16,890 --> 00:43:14,170
ten thousand different 3d positions in

1000
00:43:19,350 --> 00:43:16,900
space instead I'm gonna write code that

1001
00:43:21,210 --> 00:43:19,360
will write out a script that will then

1002
00:43:23,700 --> 00:43:21,220
do that tenth those ten thousand

1003
00:43:25,470 --> 00:43:23,710
positionings for me so it's a it's a

1004
00:43:30,240 --> 00:43:25,480
good combination of scientific software

1005
00:43:31,680 --> 00:43:30,250
custom software off the show commercial

1006
00:43:33,930 --> 00:43:31,690
software that we use in our in our

1007
00:43:35,130 --> 00:43:33,940
productions how did you get into this

1008
00:43:37,170 --> 00:43:35,140
Frank how did you get into the

1009
00:43:39,720 --> 00:43:37,180
visualization you started out as an

1010
00:43:42,420 --> 00:43:39,730
astronomer doing research and what and

1011
00:43:44,580 --> 00:43:42,430
you also but now you're I mean you you

1012
00:43:46,230 --> 00:43:44,590
you're huge and been making these big

1013
00:43:50,190 --> 00:43:46,240

you know these visualizations how did

1014
00:43:52,710 --> 00:43:50,200
you get into it well it was actually

1015
00:43:55,710 --> 00:43:52,720
kind of funny because it started when I

1016
00:43:58,860 --> 00:43:55,720
was doing a postdoc at Princeton after I

1017
00:44:00,270 --> 00:43:58,870
did my PhD at Berkeley I came to

1018
00:44:03,960 --> 00:44:00,280
Princeton to work with Jerry Ostreicher

1019
00:44:05,580 --> 00:44:03,970
and David Spergel and we were part of

1020
00:44:08,760 --> 00:44:05,590
something we called the grand challenge

1021
00:44:11,670 --> 00:44:08,770
cosmology consortium doing computer

1022
00:44:15,330 --> 00:44:11,680
simulations of how galaxies form in the

1023
00:44:16,980 --> 00:44:15,340
universe and we were approached by of

1024
00:44:19,890 --> 00:44:16,990
some folks who are making an IMAX film

1025
00:44:21,870 --> 00:44:19,900
the IMAX film cosmic voyage and they

1026
00:44:24,240 --> 00:44:21,880
wanted to do an evolution of the

1027
00:44:25,000 --> 00:44:24,250
universe from the Big Bang to the

1028
00:44:28,060 --> 00:44:25,010
formation of

1029
00:44:29,860 --> 00:44:28,070
earth and so they came to us as the

1030
00:44:31,960 --> 00:44:29,870
cosmology consortium saying all right

1031
00:44:35,680 --> 00:44:31,970
well how do we draw the early stages the

1032
00:44:37,600 --> 00:44:35,690
universe tell our artists what to draw

1033
00:44:40,300 --> 00:44:37,610
to show the formation of galaxies and

1034
00:44:42,640 --> 00:44:40,310
then we sure showed them our computer

1035
00:44:43,960 --> 00:44:42,650
simulations and all the complexity and

1036
00:44:46,510 --> 00:44:43,970
all the detail that we have these

1037
00:44:49,480 --> 00:44:46,520
computer simulations and they said wow

1038
00:44:51,430 --> 00:44:49,490

that's kind of cool maybe we could use

1039
00:44:56,400 --> 00:44:51,440
your simulations instead of asking

1040
00:44:58,960 --> 00:44:56,410
artists to draw it so my PhD thesis I

1041
00:45:02,320 --> 00:44:58,970
scaled the simulation up by a factor of

1042
00:45:04,240 --> 00:45:02,330
10 ran it on the largest supercomputer

1043
00:45:07,960 --> 00:45:04,250
of the time at the National Center for

1044
00:45:12,090 --> 00:45:07,970
supercomputing applications and my data

1045
00:45:14,710 --> 00:45:12,100
appears in the IMAX film cosmic voyage

1046
00:45:18,700 --> 00:45:14,720
you were hooked from that point on well

1047
00:45:21,910 --> 00:45:18,710
during that process I served as not just

1048
00:45:24,040 --> 00:45:21,920
a data provider but also I became the

1049
00:45:27,760 --> 00:45:24,050
main liaison between the astronomers and

1050
00:45:29,230 --> 00:45:27,770
the visualizers out at NCSA and I found

1051
00:45:31,570 --> 00:45:29,240
that I had National Center for

1052
00:45:34,150 --> 00:45:31,580
supercomputing applications exactly they

1053
00:45:35,800 --> 00:45:34,160
had a great wonderful help yeah

1054
00:45:40,600 --> 00:45:35,810
wonderful visualization group out there

1055
00:45:42,460 --> 00:45:40,610
run by Donna Cox and Donna and I found

1056
00:45:44,470 --> 00:45:42,470
that we could she was a she's an artist

1057
00:45:46,000 --> 00:45:44,480
I'm a scientist but we could meet in the

1058
00:45:47,770 --> 00:45:46,010
middle we could we could chat very well

1059
00:45:50,800 --> 00:45:47,780
and I found I was in a really good

1060
00:45:53,910 --> 00:45:50,810
translator of the science to the art

1061
00:45:55,870 --> 00:45:53,920
side and that you know working

1062
00:45:57,100 --> 00:45:55,880
understanding one and being able to

1063
00:46:01,420 --> 00:45:57,110

explain it to the other and vice versa

1064
00:46:05,100 --> 00:46:01,430
it was a really good role for me so that

1065
00:46:09,040 --> 00:46:05,110
got me hired at the Hayden Planetarium

1066
00:46:10,390 --> 00:46:09,050
to work on the exhibits for the Rose

1067
00:46:12,940 --> 00:46:10,400
Center for the earth person space I

1068
00:46:14,680 --> 00:46:12,950
don't put in two thousand and it's been

1069
00:46:20,230 --> 00:46:14,690
in I've been doing lots of visualization

1070
00:46:22,450 --> 00:46:20,240
ever since then and so my job has moved

1071
00:46:26,860 --> 00:46:22,460
out of doing scientific research slowly

1072
00:46:28,960 --> 00:46:26,870
moved over the years from 1994 on my job

1073
00:46:31,060 --> 00:46:28,970
slowly moved from doing scientific

1074
00:46:33,220 --> 00:46:31,070
research in cosmology and how galaxies

1075
00:46:36,430 --> 00:46:33,230
formed to doing the public outreach and

1076
00:46:38,620 --> 00:46:36,440
doing the visualizations that that I

1077
00:46:40,990 --> 00:46:38,630
love to do so much now and now

1078
00:46:43,779 --> 00:46:41,000
how important do you think the

1079
00:46:45,309 --> 00:46:43,789
scientific background is for doing this

1080
00:46:47,079 --> 00:46:45,319
kind of thing I mean I'm trying to

1081
00:46:50,200 --> 00:46:47,089
imagine somebody who's very interested

1082
00:46:52,210 --> 00:46:50,210
in doing these visualizations but maybe

1083
00:46:54,819 --> 00:46:52,220
isn't a scientist how how would you

1084
00:46:57,089 --> 00:46:54,829
weigh that ability to be able to do like

1085
00:46:59,230 --> 00:46:57,099
you said but Donna Cox were to you know

1086
00:47:02,019 --> 00:46:59,240
translate the science into a more

1087
00:47:03,670 --> 00:47:02,029
artistic thing do you think that's a do

1088
00:47:05,349 --> 00:47:03,680

you think that's a very big part of what

1089
00:47:06,759 --> 00:47:05,359
you do and would you recommend that

1090
00:47:08,529 --> 00:47:06,769
anybody else wanting to get into that

1091
00:47:11,200 --> 00:47:08,539
have a pretty heavy science background

1092
00:47:14,019 --> 00:47:11,210
well if you want to do it right I think

1093
00:47:16,120 --> 00:47:14,029
you have to have to not have a science

1094
00:47:18,880 --> 00:47:16,130
background but be willing to collaborate

1095
00:47:22,559 --> 00:47:18,890
with someone who does this is what makes

1096
00:47:25,809 --> 00:47:22,569
Donna understand whatever it is he says

1097
00:47:28,960 --> 00:47:25,819
this is what as a start from the

1098
00:47:32,440 --> 00:47:28,970
beginning and what we strive for here at

1099
00:47:35,019 --> 00:47:32,450
Space Telescope is that we want to

1100
00:47:37,509 --> 00:47:35,029
achieve a verisimilitude of science

1101
00:47:38,769 --> 00:47:37,519
right we can't get an exact we're not

1102
00:47:41,799 --> 00:47:38,779
going to be perfectly scientifically

1103
00:47:44,440 --> 00:47:41,809
exact this is a movie as you know you

1104
00:47:46,480 --> 00:47:44,450
want it to be entertaining but we don't

1105
00:47:49,779 --> 00:47:46,490
want to miss teach we don't want to put

1106
00:47:53,319 --> 00:47:49,789
in misconceptions can I rag on cosmos

1107
00:47:56,140 --> 00:47:53,329
Tony do you sure okay I mean a Neil

1108
00:47:57,880 --> 00:47:56,150
Tyson hired me at AMNH he's a great

1109
00:47:59,680 --> 00:47:57,890
friend of mine and everything I'm not

1110
00:48:01,799 --> 00:47:59,690
trying to rag on Neil but I'm gonna rag

1111
00:48:04,240 --> 00:48:01,809
on their computer graphics folks okay

1112
00:48:08,349 --> 00:48:04,250
because their very first episode of

1113
00:48:11,220 --> 00:48:08,359

cosmos had three howling errors of

1114
00:48:14,529 --> 00:48:11,230
computer graphics in the first you know

1115
00:48:16,930 --> 00:48:14,539
15 minutes and it really bothered me

1116
00:48:18,099 --> 00:48:16,940
because this is what I do for a living

1117
00:48:20,529 --> 00:48:18,109
okay this is what I really care about

1118
00:48:22,150 --> 00:48:20,539
and let me just give you a kiss to

1119
00:48:24,009 --> 00:48:22,160
glycin is a little too far then I'm

1120
00:48:25,870 --> 00:48:24,019
saying they had Hollywood computer

1121
00:48:27,460 --> 00:48:25,880
graphics guys doing it and they didn't

1122
00:48:31,029 --> 00:48:27,470
have a scientist doing the oversight

1123
00:48:33,519 --> 00:48:31,039
okay so for example their spaceship of

1124
00:48:35,799 --> 00:48:33,529
the mind right that the old silver

1125
00:48:39,130 --> 00:48:35,809
flying wing was flying through the

1126
00:48:41,980 --> 00:48:39,140
asteroid belt right and it was dodging

1127
00:48:44,740 --> 00:48:41,990
asteroids as if the asteroid belt were

1128
00:48:47,109 --> 00:48:44,750
this you know you densely packed with

1129
00:48:49,660 --> 00:48:47,119
asteroids like in a Star Wars film right

1130
00:48:52,270 --> 00:48:49,670
exactly these are guys who grew up they

1131
00:48:53,770 --> 00:48:52,280
saw Empire Strikes Back they know that

1132
00:48:55,600 --> 00:48:53,780
no if you go into an asteroid belt it'll

1133
00:48:57,610 --> 00:48:55,610
be dangerous and you have to swerve the

1134
00:49:01,030 --> 00:48:57,620
ship back and forth through it that's

1135
00:49:04,300 --> 00:49:01,040
total BS the asteroid belt

1136
00:49:06,310 --> 00:49:04,310
is totally empty right you could fly

1137
00:49:11,520 --> 00:49:06,320
through the asteroid belt and never ever

1138
00:49:13,870 --> 00:49:11,530

see a single asteroid and that really

1139
00:49:16,480 --> 00:49:13,880
would you go so far as to say they were

1140
00:49:17,950 --> 00:49:16,490
miss teaching them yeah that is miss

1141
00:49:20,860 --> 00:49:17,960
teaching that is reinforcing a

1142
00:49:23,500 --> 00:49:20,870
misconception that has been around you

1143
00:49:25,810 --> 00:49:23,510
know certainly since a lot of the sci-fi

1144
00:49:27,310 --> 00:49:25,820
movies have adopted the idea that you

1145
00:49:28,780 --> 00:49:27,320
know the asteroid belt is dense it would

1146
00:49:30,790 --> 00:49:28,790
be dangerous you don't want to fly into

1147
00:49:32,530 --> 00:49:30,800
an asteroid belt and that's just wrong

1148
00:49:35,260 --> 00:49:32,540
at least in our solar system the

1149
00:49:38,500 --> 00:49:35,270
asteroid belt is really really sparse

1150
00:49:41,110 --> 00:49:38,510
and you have to work really really hard

1151
00:49:43,750 --> 00:49:41,120
to get anywhere near an asteroid and you

1152
00:49:45,670 --> 00:49:43,760
think of our missions the dawn mission

1153
00:49:48,130 --> 00:49:45,680
that's gonna approach Ceres next year

1154
00:49:51,280 --> 00:49:48,140
right we're working pretty damn hard to

1155
00:49:54,070 --> 00:49:51,290
get at anywhere near Ceres right that's

1156
00:49:57,640 --> 00:49:54,080
a complex trajectory just to get there

1157
00:49:59,500 --> 00:49:57,650
so you know it's you don't accidentally

1158
00:50:01,540 --> 00:49:59,510
come upon an asteroid very often right

1159
00:50:03,130 --> 00:50:01,550
yes true and we've sent many probes out

1160
00:50:05,080 --> 00:50:03,140
into the outer and will not manny but we

1161
00:50:06,880 --> 00:50:05,090
have sent some out into the outer our

1162
00:50:08,440 --> 00:50:06,890
solar system and there's been nothing

1163
00:50:10,780 --> 00:50:08,450

really to worry about we just send them

1164
00:50:12,550 --> 00:50:10,790
straight out there and they actually I

1165
00:50:14,980 --> 00:50:12,560
mean the one place we did have to worry

1166
00:50:17,500 --> 00:50:14,990
was the rings of Jupiter rings of

1167
00:50:19,930 --> 00:50:17,510
Saturn's all right there the ring plane

1168
00:50:22,300 --> 00:50:19,940
crossing of Saturn for Voyager we

1169
00:50:24,790 --> 00:50:22,310
worried an awful lot about that turned

1170
00:50:27,250 --> 00:50:24,800
out to be just fine but that was one

1171
00:50:29,500 --> 00:50:27,260
place where we know there are literally

1172
00:50:31,630 --> 00:50:29,510
millions to billions of particles in

1173
00:50:34,660 --> 00:50:31,640
those rings and that's someplace that

1174
00:50:36,700 --> 00:50:34,670
you do have to worry about it but not

1175
00:50:40,780 --> 00:50:36,710
the asteroid belt anyway that's just one

1176
00:50:43,840 --> 00:50:40,790
example of the carefulness that you want

1177
00:50:46,390 --> 00:50:43,850
to take with computer graphics that I

1178
00:50:48,370 --> 00:50:46,400
want to make sure that the science is

1179
00:50:50,710 --> 00:50:48,380
presented accurately it doesn't miss

1180
00:50:53,500 --> 00:50:50,720
teach but it doesn't have to be

1181
00:50:55,060 --> 00:50:53,510
perfectly accurate right I mean your

1182
00:50:57,490 --> 00:50:55,070
cameras are always flying faster than

1183
00:50:59,680 --> 00:50:57,500
the speed of light you have to speed up

1184
00:51:00,910 --> 00:50:59,690
and slow down time you have to show some

1185
00:51:03,010 --> 00:51:00,920
things that are invisible that are

1186
00:51:05,250 --> 00:51:03,020
invisible to the human eye yeah there's

1187
00:51:07,770 --> 00:51:05,260
artistic license you can allow but you

1188
00:51:10,980 --> 00:51:07,780

want the main messages to be strong and

1189
00:51:13,170 --> 00:51:10,990
I really you know when professors say

1190
00:51:15,090 --> 00:51:13,180
hey I use your visualization in my

1191
00:51:16,350 --> 00:51:15,100
classroom that's one of the greatest

1192
00:51:18,570 --> 00:51:16,360
compliments they can ever give me

1193
00:51:21,060 --> 00:51:18,580
because it shows me I've got the basics

1194
00:51:23,190 --> 00:51:21,070
down and that it's worthy of using as as

1195
00:51:25,440 --> 00:51:23,200
a teaching device not just for

1196
00:51:26,610 --> 00:51:25,450
entertainment exactly so I would I mean

1197
00:51:28,590 --> 00:51:26,620
I would encourage anybody who's

1198
00:51:30,600 --> 00:51:28,600
interested in this and to take a look at

1199
00:51:32,190 --> 00:51:30,610
these visualizations of Frank's created

1200
00:51:33,480 --> 00:51:32,200
and he also worked with others at the

1201
00:51:35,660 --> 00:51:33,490
Institute to make these and he has a

1202
00:51:39,270 --> 00:51:35,670
great team of people and they are

1203
00:51:42,330 --> 00:51:39,280
astonishingly I just know these are like

1204
00:51:44,820 --> 00:51:42,340
I mean I my first video I made in 2006

1205
00:51:46,700 --> 00:51:44,830
was on the Hubble Deep Field and there

1206
00:51:48,600 --> 00:51:46,710
was this you know Frank had done a

1207
00:51:51,330 --> 00:51:48,610
visualization where we kind of flew

1208
00:51:53,340 --> 00:51:51,340
through the Ultra Deep Field and you

1209
00:51:55,950 --> 00:51:53,350
know that was that you know that was

1210
00:51:57,390 --> 00:51:55,960
just one example of the kind of stuff

1211
00:51:59,760 --> 00:51:57,400
that he did and even then he was careful

1212
00:52:01,830 --> 00:51:59,770
to say you know I had to squish to scale

1213
00:52:04,250 --> 00:52:01,840

all those galaxies you know those guys

1214
00:52:07,050 --> 00:52:04,260
aren't really that close together so

1215
00:52:09,450 --> 00:52:07,060
anyway they're amazing stuff they're the

1216
00:52:11,940 --> 00:52:09,460
source of a lot of good material for

1217
00:52:13,170 --> 00:52:11,950
videos that I make as well and I just I

1218
00:52:15,750 --> 00:52:13,180
just think everybody should show check

1219
00:52:17,070 --> 00:52:15,760
them out and let us know what you think

1220
00:52:19,890 --> 00:52:17,080
I mean you know give us some feedback

1221
00:52:22,170 --> 00:52:19,900
that Frank know let me know and and keep

1222
00:52:23,340 --> 00:52:22,180
checking back because he's adding more

1223
00:52:25,500 --> 00:52:23,350
all the time right uh-huh

1224
00:52:28,230 --> 00:52:25,510
right just whenever you feel like it

1225
00:52:29,970 --> 00:52:28,240
haha I would like to be on a schedule of

1226
00:52:31,200 --> 00:52:29,980
every two weeks Kay to be honest with

1227
00:52:32,970 --> 00:52:31,210
you I'm trying to get a new one out

1228
00:52:36,120 --> 00:52:32,980
every two weeks matter of fact this week

1229
00:52:38,820 --> 00:52:36,130
we've got the stereo 3d version of the

1230
00:52:41,610 --> 00:52:38,830
monkey head nebula coming out okay the

1231
00:52:44,400 --> 00:52:41,620
evaporating Peaks in 3d we finished

1232
00:52:46,200 --> 00:52:44,410
rendering it there was one problem in

1233
00:52:48,210 --> 00:52:46,210
the in the compositing stage that we

1234
00:52:50,730 --> 00:52:48,220
have to fix but that should be out

1235
00:52:53,250 --> 00:52:50,740
hopefully Friday although I am going

1236
00:52:58,650 --> 00:52:53,260
away tomorrow I'll try and get it out

1237
00:53:00,510 --> 00:52:58,660
Friday if not very early what's a

1238
00:53:03,870 --> 00:53:00,520

schedule but people should periodically

1239
00:53:05,850 --> 00:53:03,880
come back on order every two weeks maybe

1240
00:53:07,290 --> 00:53:05,860
three weeks or something and and of

1241
00:53:10,080 --> 00:53:07,300
course yeah the other thing they can do

1242
00:53:11,580 --> 00:53:10,090
is they can follow us on YouTube right

1243
00:53:13,610 --> 00:53:11,590
that's true they get po everything just

1244
00:53:16,760 --> 00:53:13,620
posted on our YouTube channel that's

1245
00:53:21,150 --> 00:53:16,770
youtube.com slash Hubble site channel

1246
00:53:28,349 --> 00:53:21,160
right there I pulled up the the page me

1247
00:53:30,300 --> 00:53:28,359
screen share this there we go so there

1248
00:53:31,770 --> 00:53:30,310
is I had to kill my bookmarks you don't

1249
00:53:33,870 --> 00:53:31,780
need to share my bookmarks across the

1250
00:53:36,900 --> 00:53:33,880
thing all right so there is our Hubbell

1251
00:53:39,510 --> 00:53:36,910
site channel on YouTube and you can see

1252
00:53:42,270 --> 00:53:39,520
that if I scroll down we have a whole

1253
00:53:44,400 --> 00:53:42,280
suite of astronomy visualizations this

1254
00:53:46,920 --> 00:53:44,410
is the playlists that are the new

1255
00:53:48,569 --> 00:53:46,930
visualizations get added to as well as

1256
00:53:50,700 --> 00:53:48,579
lots of other cool things that we post

1257
00:53:52,890 --> 00:53:50,710
right so if you want to know more about

1258
00:53:54,089 --> 00:53:52,900
just which new visualizations have been

1259
00:53:56,130 --> 00:53:54,099
added you want to subscribe to that

1260
00:53:57,720 --> 00:53:56,140
playlist you can subscribe to play less

1261
00:54:00,569 --> 00:53:57,730
and get notified when a new video comes

1262
00:54:02,520 --> 00:54:00,579
up so I highly recommend you doing that

1263
00:54:05,880 --> 00:54:02,530

and also while you're at it do the

1264
00:54:08,040 --> 00:54:05,890
Hubble Hangouts playlist as well so you

1265
00:54:11,609 --> 00:54:08,050
can get notified when we have a new

1266
00:54:13,710 --> 00:54:11,619
hangout posted as well so alright okay

1267
00:54:17,460 --> 00:54:13,720
well thank you Frank I guess we'll be

1268
00:54:20,309 --> 00:54:17,470
back next month for more news from you

1269
00:54:21,569 --> 00:54:20,319
on Hubble and across the universe I want

1270
00:54:24,750 --> 00:54:21,579
to remind everybody that our next

1271
00:54:26,730 --> 00:54:24,760
hangout is a week from tomorrow I was

1272
00:54:29,309 --> 00:54:26,740
hoping to get it done tomorrow but dr.

1273
00:54:32,180 --> 00:54:29,319
Amy Simon couldn't make it I can't

1274
00:54:35,339 --> 00:54:32,190
really talk much about what it is cuz

1275
00:54:37,620 --> 00:54:35,349
let me tell you it's really cool okay

1276
00:54:39,839 --> 00:54:37,630
you're gonna want to see this one that's

1277
00:54:41,700 --> 00:54:39,849
right you put on the press releases

1278
00:54:44,490 --> 00:54:41,710
tomorrow that we're putting out it goes

1279
00:54:47,099 --> 00:54:44,500
live at 10:00 a.m. after that you'll see

1280
00:54:49,410 --> 00:54:47,109
an event on Google+ where are we going

1281
00:54:50,940 --> 00:54:49,420
to where I have scheduled a hangout for

1282
00:54:52,950 --> 00:54:50,950
the next Thursday dr. Carol Christian

1283
00:54:54,809 --> 00:54:52,960
and I will be talking with the principal

1284
00:54:56,880 --> 00:54:54,819
investigator and we will talk all about

1285
00:54:59,569 --> 00:54:56,890
that press release and that's all I'll

1286
00:55:01,650 --> 00:54:59,579
say for now that's next Thursday so I

1287
00:55:10,230 --> 00:55:01,660
guess that's it for this week space fans