

1  
00:00:01,980 --> 00:00:06,759  
hello everybody welcome to our latest

2  
00:00:04,330 --> 00:00:08,830  
Hubble hangout my name is Tony Darnell I

3  
00:00:06,759 --> 00:00:11,740  
am at the Space Telescope Science

4  
00:00:08,830 --> 00:00:12,280  
Institute and it is that time of the

5  
00:00:11,740 --> 00:00:20,289  
month

6  
00:00:12,279 --> 00:00:22,479  
oh great phrasing Tony I love visit with

7  
00:00:20,289 --> 00:00:23,470  
dr. Frank summers the outreach

8  
00:00:22,480 --> 00:00:25,929  
astronomer at the Space Telescope

9  
00:00:23,469 --> 00:00:26,829  
Science Institute who keeps tabs on all

10  
00:00:25,928 --> 00:00:29,198  
of the really cool and interesting

11  
00:00:26,829 --> 00:00:33,429  
things going on with Hubble and shares

12  
00:00:29,199 --> 00:00:41,289  
them with us every every oh I did it

13  
00:00:33,429 --> 00:00:46,439  
again I had a dollar for every time I've

14  
00:00:41,289 --> 00:00:46,439  
done this okay

15  
00:00:46,859 --> 00:00:54,310  
you're the expert here Tony now I've got

16  
00:00:49,990 --> 00:01:04,570  
to figure out where it is darn it

17  
00:00:54,310 --> 00:01:06,070  
your echoes coming out somewhere and you

18  
00:01:04,569 --> 00:01:08,218  
get to hear your mistake coming at you

19  
00:01:06,069 --> 00:01:08,218  
twice

20  
00:01:08,759 --> 00:01:14,858  
so while Tony figures that out I'll just

21  
00:01:12,968 --> 00:01:17,349  
say that it's always fun for me to be

22  
00:01:14,858 --> 00:01:20,498  
here even if I am considered that time

23  
00:01:17,349 --> 00:01:22,688  
of the month for Tony but what we like

24  
00:01:20,498 --> 00:01:25,509  
to do here at the Space Telescope is we

25  
00:01:22,688 --> 00:01:27,998  
really get a lot of fun out of taking

26  
00:01:25,509 --> 00:01:30,579  
the deepest discoveries from a strong

27  
00:01:27,998 --> 00:01:32,318  
from Hubble and explaining them in

28  
00:01:30,578 --> 00:01:34,658  
detail because for me as an

29

00:01:32,319 --> 00:01:38,259  
astrophysicist the really difficult

30  
00:01:34,659 --> 00:01:41,469  
thing is to have a wide breadth of all

31  
00:01:38,259 --> 00:01:42,789  
these various ideas and then be able to

32  
00:01:41,468 --> 00:01:44,498  
explain them to the public I mean

33  
00:01:42,789 --> 00:01:45,579  
because you're taking something that's

34  
00:01:44,498 --> 00:01:47,199  
at the cutting edge of science what we

35  
00:01:45,578 --> 00:01:49,568  
do in our press release is we're really

36  
00:01:47,200 --> 00:01:51,280  
at the edge of science and we've got to

37  
00:01:49,569 --> 00:01:53,259  
provide all the context and all the

38  
00:01:51,280 --> 00:01:55,659  
background information to bring it out

39  
00:01:53,259 --> 00:01:57,579  
to the public and so this is what really

40  
00:01:55,659 --> 00:02:00,100  
you know Jazz's me about doing all of

41  
00:01:57,578 --> 00:02:01,029  
this stuff with Tony and with all the

42  
00:02:00,099 --> 00:02:04,149  
stuff we do in the office of public

43  
00:02:01,030 --> 00:02:06,459

outreach is that understanding not just

44

00:02:04,149 --> 00:02:09,039

the discovery but all the context and

45

00:02:06,459 --> 00:02:11,199

the background behind it so Tony did I

46

00:02:09,039 --> 00:02:14,419

vamp enough to cover up you did great

47

00:02:11,199 --> 00:02:18,379

thank you I tab that had the I YouTube

48

00:02:14,419 --> 00:02:20,059

and killed it I have like 300 tabs up on

49

00:02:18,379 --> 00:02:21,829

my desktop right now I know I'm I think

50

00:02:20,060 --> 00:02:23,900

I've get it there's always one that gets

51

00:02:21,830 --> 00:02:25,550

through me so again apologies for doing

52

00:02:23,900 --> 00:02:27,530

that yet again but you know what I don't

53

00:02:25,550 --> 00:02:29,480

think people would feel right if I

54

00:02:27,530 --> 00:02:33,500

didn't do that at least once during the

55

00:02:29,479 --> 00:02:35,119

Hangout so like it's live okay so anyway

56

00:02:33,500 --> 00:02:39,919

and it's free so you're getting what you

57

00:02:35,120 --> 00:02:42,439

pay for that's that's right so here we

58  
00:02:39,919 --> 00:02:46,549  
are another another month has gone by we

59  
00:02:42,439 --> 00:02:49,009  
have started by the way broadcasting the

60  
00:02:46,550 --> 00:02:51,230  
public lecture series that Frank hosts

61  
00:02:49,009 --> 00:02:53,030  
every month at the Institute of the

62  
00:02:51,229 --> 00:02:55,159  
first Tuesday of every month is now

63  
00:02:53,030 --> 00:02:56,860  
going on our YouTube channel so we hope

64  
00:02:55,159 --> 00:03:01,009  
that you guys will tune in to watch that

65  
00:02:56,860 --> 00:03:02,120  
as well with us because it's an easier

66  
00:03:01,009 --> 00:03:04,280  
way for you to interact

67  
00:03:02,120 --> 00:03:05,900  
I generally what we try to do is answer

68  
00:03:04,280 --> 00:03:09,379  
any questions and comments while it's

69  
00:03:05,900 --> 00:03:12,050  
going on I'll monitor the the

70  
00:03:09,379 --> 00:03:13,549  
Twitterverse and comments on on youtube

71  
00:03:12,050 --> 00:03:15,620  
and try to respond to him while the

72  
00:03:13,550 --> 00:03:17,180  
lecture is going on and Frank will do

73  
00:03:15,620 --> 00:03:18,860  
that to the extent that he can but he's

74  
00:03:17,180 --> 00:03:21,590  
also got to run the show so it's a

75  
00:03:18,860 --> 00:03:24,440  
little bit he me may or may not be able

76  
00:03:21,590 --> 00:03:26,930  
to respond to all comments ok Frank so

77  
00:03:24,439 --> 00:03:28,430  
what do we got we got what's the latest

78  
00:03:26,930 --> 00:03:30,680  
and greatest with Hubble this month

79  
00:03:28,430 --> 00:03:33,200  
alright so I know we did the I did it

80  
00:03:30,680 --> 00:03:35,659  
live last week during the public lecture

81  
00:03:33,199 --> 00:03:36,798  
series but I know a good honest audience

82  
00:03:35,659 --> 00:03:38,449  
probably hadn't seen it but I want to go

83  
00:03:36,799 --> 00:03:40,730  
quickly through the news from the

84  
00:03:38,449 --> 00:03:42,109  
universe that I did last week and then I

85  
00:03:40,729 --> 00:03:43,939  
want to take it will beyond what I did

86

00:03:42,110 --> 00:03:46,160  
with the news from the universe and talk

87  
00:03:43,939 --> 00:03:48,019  
about a new section on Hubble site that

88  
00:03:46,159 --> 00:03:49,759  
I had a lot to do with and I think is

89  
00:03:48,019 --> 00:03:53,299  
really really cool ok

90  
00:03:49,759 --> 00:03:59,840  
agreed okay so let me I gotta start my

91  
00:03:53,299 --> 00:04:03,129  
screen share there we go starting my

92  
00:03:59,840 --> 00:04:03,129  
screen share and I'll start the

93  
00:04:03,250 --> 00:04:08,629  
PowerPoint slides ok so when I present

94  
00:04:07,280 --> 00:04:10,849  
this to the public lecture series I call

95  
00:04:08,629 --> 00:04:12,859  
it news from the universe and this is

96  
00:04:10,849 --> 00:04:14,979  
the stuff this is the stories I chose

97  
00:04:12,859 --> 00:04:19,489  
for May 2014

98  
00:04:14,979 --> 00:04:22,189  
so my first story called five golden

99  
00:04:19,488 --> 00:04:24,529  
rings for those of you who know the

100  
00:04:22,189 --> 00:04:25,610

Christmas song well it doesn't have

101

00:04:24,529 --> 00:04:27,899

anything to do with the Christmas song

102

00:04:25,610 --> 00:04:31,229

so what we're talking about

103

00:04:27,899 --> 00:04:33,959

is looking at and discovering new

104

00:04:31,228 --> 00:04:35,849

information in old data now I bring up

105

00:04:33,959 --> 00:04:38,038

this image this is from the Keck

106

00:04:35,850 --> 00:04:42,030

telescope not from the Hubble this is of

107

00:04:38,038 --> 00:04:46,110

the star HR 8799 well actually it's of

108

00:04:42,029 --> 00:04:48,299

everything but the star HR 8799 because

109

00:04:46,110 --> 00:04:54,120

like a star from the 60s or something a

110

00:04:48,300 --> 00:04:57,689

little this this star with psychedelic

111

00:04:54,120 --> 00:05:00,750

on us know all that psychedelic glop in

112

00:04:57,689 --> 00:05:02,519

the middle is the residue after

113

00:05:00,750 --> 00:05:04,740

subtracting out the light of the star

114

00:05:02,519 --> 00:05:07,139

right if you're trying to look for



115  
00:05:04,740 --> 00:05:09,629  
things around a star you've got this

116  
00:05:07,139 --> 00:05:11,850  
honking bright star that you've got us

117  
00:05:09,629 --> 00:05:14,759  
to be able to subtract out so the folks

118  
00:05:11,850 --> 00:05:17,030  
at the Keck Observatory subtracted out

119  
00:05:14,759 --> 00:05:19,050  
the light of the star and that

120  
00:05:17,029 --> 00:05:21,000  
psychedelic residue in the in the middle

121  
00:05:19,050 --> 00:05:23,520  
is the result of that subtraction so you

122  
00:05:21,000 --> 00:05:27,810  
got the star mostly subtracted out but

123  
00:05:23,519 --> 00:05:32,219  
the red dots around it are three planets

124  
00:05:27,810 --> 00:05:33,689  
that why yeah the ones that well the the

125  
00:05:32,220 --> 00:05:36,210  
the red dots and then there are the

126  
00:05:33,689 --> 00:05:38,490  
pluses to show where the planets were

127  
00:05:36,209 --> 00:05:42,569  
observed in July 2004 Oh

128  
00:05:38,490 --> 00:05:44,668  
dots show where they were in 2008 got it

129  
00:05:42,569 --> 00:05:48,360  
okay and showing that they're moving

130  
00:05:44,668 --> 00:05:51,359  
around this star right and so this was

131  
00:05:48,360 --> 00:05:53,610  
one of the first discoveries of actually

132  
00:05:51,360 --> 00:05:56,038  
observing planets around another star

133  
00:05:53,610 --> 00:05:58,139  
and this was actually done with the Keck

134  
00:05:56,038 --> 00:06:03,269  
telescope from the ground in the

135  
00:05:58,139 --> 00:06:04,408  
infrared now we here at Hubble didn't do

136  
00:06:03,269 --> 00:06:07,139  
this this was again from the confirm

137  
00:06:04,408 --> 00:06:09,569  
Keck but what we did with Hubble is we

138  
00:06:07,139 --> 00:06:11,908  
came back a couple years later and we

139  
00:06:09,569 --> 00:06:15,180  
looked at h we looked not at a new image

140  
00:06:11,908 --> 00:06:17,550  
of HR 8799 but we looked at an old image

141  
00:06:15,180 --> 00:06:19,348  
that was in the hubble database

142  
00:06:17,550 --> 00:06:21,930  
all right the Hubble archives got lots

143

00:06:19,348 --> 00:06:24,389  
of cool data in it and so people went

144  
00:06:21,930 --> 00:06:27,509  
back to it and you see on the left the

145  
00:06:24,389 --> 00:06:30,750  
incredible brightness of the star HR

146  
00:06:27,509 --> 00:06:34,288  
8799 as it was observed in the Hubble

147  
00:06:30,750 --> 00:06:35,519  
database the Hubble archive well so you

148  
00:06:34,288 --> 00:06:36,569  
can see a bunch of so what you're

149  
00:06:35,519 --> 00:06:39,149  
looking at is a bunch of diffraction

150  
00:06:36,569 --> 00:06:40,680  
spikes from the telescope and then

151  
00:06:39,149 --> 00:06:41,758  
there's the saturation in the center

152  
00:06:40,680 --> 00:06:44,819  
that's the

153  
00:06:41,759 --> 00:06:46,800  
that's the star right right exactly and

154  
00:06:44,819 --> 00:06:49,710  
the thing about Hubble is that over the

155  
00:06:46,800 --> 00:06:52,168  
years we've learned the characteristics

156  
00:06:49,709 --> 00:06:53,519  
of Hubble incredibly carefully and one

157  
00:06:52,168 --> 00:06:55,680

of the most important characteristics is

158

00:06:53,519 --> 00:06:56,968

called the point spread function so

159

00:06:55,680 --> 00:06:58,259

here's some cool stuff that I can give

160

00:06:56,968 --> 00:07:00,389

you that I can't do the normal public

161

00:06:58,259 --> 00:07:02,158

audience and so the point spread

162

00:07:00,389 --> 00:07:04,559

function takes I mean stars or points of

163

00:07:02,158 --> 00:07:06,748

light and it's a very faint points light

164

00:07:04,559 --> 00:07:08,309

it appears as a circular dot and as it

165

00:07:06,749 --> 00:07:10,319

gets brighter and brighter it becomes

166

00:07:08,309 --> 00:07:11,939

bigger and bigger dot and then it starts

167

00:07:10,319 --> 00:07:14,278

to develop these diffraction spikes and

168

00:07:11,939 --> 00:07:17,520

all of these this just stuff around it

169

00:07:14,278 --> 00:07:20,189

and so with Hubble we've gotten very

170

00:07:17,519 --> 00:07:23,158

good at characterizing how that point

171

00:07:20,189 --> 00:07:25,169

spread function grows and what are the

172  
00:07:23,158 --> 00:07:28,228  
what is the shape of the light that is

173  
00:07:25,168 --> 00:07:30,870  
put onto the detector using that

174  
00:07:28,228 --> 00:07:33,978  
information we can very very carefully

175  
00:07:30,870 --> 00:07:36,930  
subtract out the point spread function

176  
00:07:33,978 --> 00:07:39,778  
due to the Hubble detector pull out that

177  
00:07:36,930 --> 00:07:42,870  
star and in the right hand image you

178  
00:07:39,778 --> 00:07:46,079  
again see three dots of light and those

179  
00:07:42,870 --> 00:07:48,418  
are the planets yes yeah

180  
00:07:46,079 --> 00:07:51,240  
those are the same planets that Keck had

181  
00:07:48,418 --> 00:07:52,978  
discovered a few years earlier but the

182  
00:07:51,240 --> 00:07:56,490  
important point was this image was taken

183  
00:07:52,978 --> 00:07:59,310  
I think it was eight years before the

184  
00:07:56,490 --> 00:08:02,129  
Keck discovery so it adds to the

185  
00:07:59,310 --> 00:08:05,158  
baseline of this discovery of the planet

186  
00:08:02,129 --> 00:08:07,439  
so we have more points in the orbit for

187  
00:08:05,158 --> 00:08:10,199  
these planets around its parent star and

188  
00:08:07,439 --> 00:08:11,999  
that's really important I mean when we

189  
00:08:10,199 --> 00:08:14,038  
discovered Uranus the first thing people

190  
00:08:11,999 --> 00:08:16,379  
did was go back into old data to see if

191  
00:08:14,038 --> 00:08:18,088  
you could you know determine its orbit

192  
00:08:16,379 --> 00:08:20,158  
more accurately by having a longer

193  
00:08:18,088 --> 00:08:22,110  
baseline of the data well we're doing

194  
00:08:20,158 --> 00:08:23,908  
the exact same thing here with

195  
00:08:22,110 --> 00:08:25,169  
extrasolar planets so now we know what

196  
00:08:23,908 --> 00:08:26,699  
to look for we now we know there's

197  
00:08:25,168 --> 00:08:29,008  
planets there they just went back and

198  
00:08:26,699 --> 00:08:30,689  
looked at what we previous observations

199  
00:08:29,009 --> 00:08:33,209  
of the Hubble and got this information

200

00:08:30,689 --> 00:08:35,639  
out okay so this is an old story

201  
00:08:33,208 --> 00:08:37,799  
we've may have talked about this before

202  
00:08:35,639 --> 00:08:39,750  
but the point is is that we've got this

203  
00:08:37,799 --> 00:08:41,698  
really good way of subtracting out the

204  
00:08:39,750 --> 00:08:44,190  
light of stars and we wanted to do that

205  
00:08:41,698 --> 00:08:47,458  
not just for planets but we also wanted

206  
00:08:44,190 --> 00:08:50,220  
to do it for dust disks around stars so

207  
00:08:47,458 --> 00:08:52,559  
these are two dust disks one on the left

208  
00:08:50,220 --> 00:08:55,759  
au microscopy one on the right

209  
00:08:52,559 --> 00:08:58,129  
HD 107 one force

210  
00:08:55,759 --> 00:09:00,950  
and you can see also the size of

211  
00:08:58,129 --> 00:09:02,629  
Neptune's orbit for scale again in each

212  
00:09:00,950 --> 00:09:05,930  
of these images the light of the star

213  
00:09:02,629 --> 00:09:08,210  
has been blocked out in this particular

214  
00:09:05,929 --> 00:09:12,109

characteristic not subtracted out later

215

00:09:08,210 --> 00:09:14,180

on but blocked by a spot of light on the

216

00:09:12,110 --> 00:09:16,940

despot a dark spot on the detector

217

00:09:14,179 --> 00:09:19,459

called a coronagraph so block the light

218

00:09:16,940 --> 00:09:21,620

out yeah so they they block the light of

219

00:09:19,460 --> 00:09:24,050

the star in the detector they have

220

00:09:21,620 --> 00:09:26,028

actually a place on the detector window

221

00:09:24,049 --> 00:09:28,609

where there is a dark spot and they can

222

00:09:26,028 --> 00:09:29,929

place that dark spot over the star to

223

00:09:28,610 --> 00:09:32,089

block out the light of the star and try

224

00:09:29,929 --> 00:09:34,849

and see the material around it now these

225

00:09:32,089 --> 00:09:36,620

of course are our two best examples the

226

00:09:34,850 --> 00:09:39,170

one on the left being an edge on disk

227

00:09:36,620 --> 00:09:40,639

these are flat as a pancake and they're

228

00:09:39,169 --> 00:09:43,309

discs of material spinning around the



229  
00:09:40,639 --> 00:09:45,199  
stars the one on the left being edge on

230  
00:09:43,309 --> 00:09:47,329  
the one on the right being face off and

231  
00:09:45,200 --> 00:09:48,740  
of course you know as press release

232  
00:09:47,330 --> 00:09:50,980  
images they are really gorgeous and

233  
00:09:48,740 --> 00:09:53,450  
beautiful and everything but most of our

234  
00:09:50,980 --> 00:09:56,720  
observations of disk aren't quite so

235  
00:09:53,450 --> 00:09:59,450  
good some of them are like we see in

236  
00:09:56,720 --> 00:10:04,100  
this next image here HD one eight one

237  
00:09:59,450 --> 00:10:06,470  
three two seven and on the left if we

238  
00:10:04,100 --> 00:10:07,700  
were trying to take out the star to try

239  
00:10:06,470 --> 00:10:10,490  
and see the disk

240  
00:10:07,700 --> 00:10:13,070  
okay this again is the PSF removal point

241  
00:10:10,490 --> 00:10:15,409  
spread function and removal the normal

242  
00:10:13,070 --> 00:10:17,060  
one that we have been using would show

243  
00:10:15,409 --> 00:10:20,059  
you that there is a ring of material

244  
00:10:17,059 --> 00:10:22,789  
around this star but there would be a

245  
00:10:20,059 --> 00:10:24,139  
lot of bleed of the star into that ring

246  
00:10:22,789 --> 00:10:25,338  
and you wouldn't be able to measure the

247  
00:10:24,139 --> 00:10:28,879  
characteristics of that ring very

248  
00:10:25,339 --> 00:10:31,940  
carefully well the new method they come

249  
00:10:28,879 --> 00:10:34,309  
up with they call it KL IP I don't know

250  
00:10:31,940 --> 00:10:36,670  
what that stands for but it's the new

251  
00:10:34,309 --> 00:10:39,399  
method of point spread function removal

252  
00:10:36,669 --> 00:10:42,649  
removes the star more carefully and more

253  
00:10:39,399 --> 00:10:44,929  
completely giving us the much clearer

254  
00:10:42,649 --> 00:10:47,389  
view of that ring on the right in the

255  
00:10:44,929 --> 00:10:49,309  
right hand picture so see it with the

256  
00:10:47,389 --> 00:10:50,899  
standard PSF removal but you get a much

257

00:10:49,309 --> 00:10:52,639  
better one with this new technique it

258  
00:10:50,899 --> 00:10:55,189  
looks like right and you're really

259  
00:10:52,639 --> 00:10:56,958  
getting rid of the star only so that the

260  
00:10:55,190 --> 00:10:59,089  
measurements of say the thickness and

261  
00:10:56,958 --> 00:11:00,769  
the density and how much material is in

262  
00:10:59,089 --> 00:11:02,990  
that ring which is really important for

263  
00:11:00,769 --> 00:11:05,569  
understanding you know what stage the

264  
00:11:02,990 --> 00:11:08,419  
the planet formation is in the system

265  
00:11:05,570 --> 00:11:10,280  
because I said does that mean little boy

266  
00:11:08,419 --> 00:11:12,649  
bright spots in the center there those

267  
00:11:10,279 --> 00:11:14,269  
were actually real then no I wouldn't

268  
00:11:12,649 --> 00:11:17,209  
trust the stuff inside the ring okay

269  
00:11:14,269 --> 00:11:19,669  
alright you know again you're getting

270  
00:11:17,210 --> 00:11:22,460  
really in close to the star there and

271  
00:11:19,669 --> 00:11:24,829

but you can see how you there the bleed

272

00:11:22,460 --> 00:11:26,420  
around the ring both in interior to the

273

00:11:24,830 --> 00:11:29,600  
ring and external to the Rings is

274

00:11:26,419 --> 00:11:32,809  
greatly reduced all those radial

275

00:11:29,600 --> 00:11:35,840  
striations the lines heading out in

276

00:11:32,809 --> 00:11:39,169  
radial directions are greatly reduced by

277

00:11:35,840 --> 00:11:41,330  
this new PSF removal technique okay and

278

00:11:39,169 --> 00:11:42,469  
that no let's do this folks I mean it

279

00:11:41,330 --> 00:11:45,259  
doesn't matter how perfect your

280

00:11:42,470 --> 00:11:47,000  
telescope is the PSF is this thing that

281

00:11:45,259 --> 00:11:49,700  
smears it out you could have a perfect

282

00:11:47,000 --> 00:11:51,049  
point source of light and all optical

283

00:11:49,700 --> 00:11:52,820  
systems are gonna smear it out a little

284

00:11:51,049 --> 00:11:55,609  
bit and the the manner in which it

285

00:11:52,820 --> 00:11:58,129  
smears that out is you can model that

286  
00:11:55,610 --> 00:11:59,930  
and and measure it and model it and that

287  
00:11:58,129 --> 00:12:01,100  
is what he's talking about it is called

288  
00:11:59,929 --> 00:12:03,349  
the point spread function and you can

289  
00:12:01,100 --> 00:12:05,810  
remove that effect so if you had a point

290  
00:12:03,350 --> 00:12:08,690  
of light that got smeared out into a

291  
00:12:05,809 --> 00:12:09,919  
circle a little bit and then you knew

292  
00:12:08,690 --> 00:12:11,720  
the point spread function you could

293  
00:12:09,919 --> 00:12:14,329  
remove that point spread function to get

294  
00:12:11,720 --> 00:12:14,899  
your point back so that's what's going

295  
00:12:14,330 --> 00:12:18,830  
on here

296  
00:12:14,899 --> 00:12:23,110  
right but my question Frank is how are

297  
00:12:18,830 --> 00:12:25,910  
they able do you know to determine which

298  
00:12:23,110 --> 00:12:27,740  
light it belongs to the star and what

299  
00:12:25,909 --> 00:12:29,929  
doesn't I mean how do you how do you

300  
00:12:27,740 --> 00:12:32,389  
figure that out okay well you're gonna

301  
00:12:29,929 --> 00:12:34,579  
calibrate your point spread function by

302  
00:12:32,389 --> 00:12:37,069  
looking at a sizing stars or perfect

303  
00:12:34,580 --> 00:12:39,320  
points of light right I mean the stars

304  
00:12:37,070 --> 00:12:41,600  
are so small compared to their distance

305  
00:12:39,320 --> 00:12:43,910  
away that they are a point of light and

306  
00:12:41,600 --> 00:12:46,460  
what you're gonna want to do is find a

307  
00:12:43,909 --> 00:12:48,949  
uncrowded field where you're observing

308  
00:12:46,460 --> 00:12:50,930  
just a star and not a star that has any

309  
00:12:48,950 --> 00:12:52,790  
and you want you know an older star that

310  
00:12:50,929 --> 00:12:55,399  
that wouldn't have a disk or such around

311  
00:12:52,789 --> 00:13:00,019  
it all right you want to be able to get

312  
00:12:55,399 --> 00:13:02,169  
get your with each detector you want to

313  
00:13:00,019 --> 00:13:04,879  
be able to get a set of calibration

314

00:13:02,169 --> 00:13:07,039  
images of various stars that are

315  
00:13:04,879 --> 00:13:09,460  
uncrowded fields so you can get a clean

316  
00:13:07,039 --> 00:13:12,919  
view of the point spread function and

317  
00:13:09,460 --> 00:13:15,200  
then you can by getting a whole suite of

318  
00:13:12,919 --> 00:13:17,569  
these and measuring them you can get an

319  
00:13:15,200 --> 00:13:20,660  
error you can do an average of those

320  
00:13:17,570 --> 00:13:21,830  
various calibration images to get a

321  
00:13:20,659 --> 00:13:22,819  
pattern

322  
00:13:21,830 --> 00:13:25,519  
develops through the point spread

323  
00:13:22,820 --> 00:13:29,120  
function yeah I can see how that helps

324  
00:13:25,519 --> 00:13:32,480  
you identify the star but not the flux

325  
00:13:29,120 --> 00:13:34,909  
or the pixel values of that star so how

326  
00:13:32,480 --> 00:13:38,240  
do you know when to stop removing and

327  
00:13:34,909 --> 00:13:40,730  
that's the art part of it okay if you've

328  
00:13:38,240 --> 00:13:41,720

got the where and if the the point

329

00:13:40,730 --> 00:13:44,149  
spread function changes with the

330

00:13:41,720 --> 00:13:46,610  
brightness of the star right yeah in

331

00:13:44,149 --> 00:13:49,100  
doing this PSF removal you're going to

332

00:13:46,610 --> 00:13:50,810  
have the spectral type of the star as a

333

00:13:49,100 --> 00:13:53,930  
variable you're going to have the

334

00:13:50,809 --> 00:13:55,338  
magnitude of the star the the apparent

335

00:13:53,929 --> 00:13:57,379  
magnitude of the star the brightness of

336

00:13:55,339 --> 00:13:58,779  
the star as another variable so you're

337

00:13:57,379 --> 00:14:01,009  
going to be eight you're going to

338

00:13:58,778 --> 00:14:03,200  
release squares fitting with the

339

00:14:01,009 --> 00:14:06,679  
different variables that you have that

340

00:14:03,200 --> 00:14:08,480  
make up your PSF and say where in if I

341

00:14:06,679 --> 00:14:10,549  
change these variables does the fit get

342

00:14:08,480 --> 00:14:13,070  
better or worse and then you find the



343  
00:14:10,549 --> 00:14:15,439  
one that gives you the least least

344  
00:14:13,070 --> 00:14:17,000  
amount of error okay that make sense

345  
00:14:15,440 --> 00:14:18,950  
sure and I guess that's another reason

346  
00:14:17,000 --> 00:14:20,839  
why you don't want to totally trust that

347  
00:14:18,950 --> 00:14:25,129  
area where you remove the point spread

348  
00:14:20,839 --> 00:14:27,079  
function because right totally look when

349  
00:14:25,129 --> 00:14:29,809  
I was doing my PhD thesis 20 years ago

350  
00:14:27,078 --> 00:14:31,669  
the PSF removal you see on the left here

351  
00:14:29,809 --> 00:14:32,809  
would have been fantastic I mean it

352  
00:14:31,669 --> 00:14:35,449  
would have been better than you could

353  
00:14:32,809 --> 00:14:36,469  
ever hope for at that point so we're

354  
00:14:35,450 --> 00:14:38,690  
getting better all the time

355  
00:14:36,470 --> 00:14:41,089  
sure sure no I'm this is amazing this is

356  
00:14:38,690 --> 00:14:43,100  
really nice so let me give you a couple

357  
00:14:41,089 --> 00:14:46,880  
more examples so what we're announcing

358  
00:14:43,100 --> 00:14:49,370  
what we announced last month was looking

359  
00:14:46,879 --> 00:14:51,980  
at some discs around it in archival data

360  
00:14:49,370 --> 00:14:54,200  
so again we're going into images that

361  
00:14:51,980 --> 00:14:56,450  
Hubble has already taken not

362  
00:14:54,200 --> 00:14:59,329  
partly to study discs but you know it's

363  
00:14:56,450 --> 00:15:01,339  
already in the archive and so here on

364  
00:14:59,328 --> 00:15:04,698  
the left you have HD one four one nine

365  
00:15:01,339 --> 00:15:06,589  
four three which is a mostly edge-on

366  
00:15:04,698 --> 00:15:09,469  
disc we've got the artists description

367  
00:15:06,589 --> 00:15:11,360  
artist's depiction below to sort of

368  
00:15:09,470 --> 00:15:14,149  
guide your eyes to seeing that disc and

369  
00:15:11,360 --> 00:15:17,000  
on the right a somewhat face on disc one

370  
00:15:14,149 --> 00:15:19,899  
ninety one oh eight nine and the here

371

00:15:17,000 --> 00:15:22,639  
are the the results using this new PSF

372  
00:15:19,899 --> 00:15:23,958  
retraction these aren't the only two

373  
00:15:22,639 --> 00:15:26,689  
these are the ones that we illustrated

374  
00:15:23,958 --> 00:15:32,208  
with artist depictions on the next one

375  
00:15:26,690 --> 00:15:34,399  
the final image of this story we have of

376  
00:15:32,208 --> 00:15:35,988  
course the five golden rings of the

377  
00:15:34,399 --> 00:15:40,730  
title

378  
00:15:35,989 --> 00:15:43,999  
we have five really good detailed images

379  
00:15:40,730 --> 00:15:45,678  
of rings that arise from this PSF

380  
00:15:43,999 --> 00:15:47,149  
subtraction that we could not have

381  
00:15:45,678 --> 00:15:50,269  
gotten otherwise and you can see they're

382  
00:15:47,149 --> 00:15:52,639  
still pretty ratty but without this PSF

383  
00:15:50,269 --> 00:15:54,110  
subtraction certainly the ones on the

384  
00:15:52,639 --> 00:16:00,139  
right would be very hard to tell that

385  
00:15:54,110 --> 00:16:03,619

there was a disc there at all cool yeah

386

00:16:00,139 --> 00:16:05,178

I'm with you usually jump in with some

387

00:16:03,619 --> 00:16:06,589

sort of comment as I that's because I'm

388

00:16:05,178 --> 00:16:08,958

paid I'm cutting and pasting something

389

00:16:06,589 --> 00:16:10,489

like okay

390

00:16:08,958 --> 00:16:11,988

it was the problem when I have my screen

391

00:16:10,489 --> 00:16:16,850

share on and I can't actually see yeah

392

00:16:11,989 --> 00:16:18,410

yeah adding some comments here so I can

393

00:16:16,850 --> 00:16:21,110

make sure I get them all that's all yeah

394

00:16:18,409 --> 00:16:23,808

I'm with you all right let's go to the

395

00:16:21,110 --> 00:16:28,278

second story second story I called a

396

00:16:23,808 --> 00:16:30,999

tail spin break up all right and that

397

00:16:28,278 --> 00:16:35,720

again is a play on words as I like to do

398

00:16:30,999 --> 00:16:40,069

but let's go back to last year 2013 and

399

00:16:35,720 --> 00:16:44,360

this was this has got to be one of my

400  
00:16:40,068 --> 00:16:46,368  
favorite images of Comet Ison alright

401  
00:16:44,360 --> 00:16:49,699  
this is from Damian peach I believe he's

402  
00:16:46,369 --> 00:16:52,119  
a British astrophotographer absolutely

403  
00:16:49,698 --> 00:16:54,618  
fantastic images of Comet Ison last year

404  
00:16:52,119 --> 00:16:56,749  
huge kudos to him because he did some

405  
00:16:54,619 --> 00:16:58,910  
fantastic shots this is one of the

406  
00:16:56,749 --> 00:17:01,399  
coolest ones this is from November 15th

407  
00:16:58,909 --> 00:17:04,879  
as Ison was heading into its perihelion

408  
00:17:01,399 --> 00:17:07,880  
and we all remember what happened or

409  
00:17:04,880 --> 00:17:10,669  
really what didn't happen during its

410  
00:17:07,880 --> 00:17:13,970  
perihelion passage this is the image

411  
00:17:10,669 --> 00:17:17,299  
from Soho a time-lapse image from so

412  
00:17:13,970 --> 00:17:20,649  
where comet Ison comes in swings past

413  
00:17:17,298 --> 00:17:25,189  
the Sun and it breaks up on its way out

414  
00:17:20,648 --> 00:17:28,609  
so we have seen comets break up

415  
00:17:25,189 --> 00:17:30,950  
comet Ison being the spectacular breakup

416  
00:17:28,609 --> 00:17:32,778  
that we that occurred last November as

417  
00:17:30,950 --> 00:17:35,298  
it passes the Sun but we've also seen

418  
00:17:32,778 --> 00:17:38,808  
comets break up not when they're passing

419  
00:17:35,298 --> 00:17:41,898  
right by the Sun comets Watchmen Walkman

420  
00:17:38,808 --> 00:17:45,490  
3 one of my favorite comments to say

421  
00:17:41,898 --> 00:17:48,379  
just just that it's named so cold

422  
00:17:45,490 --> 00:17:51,230  
this is the break-up captured by Hubble

423  
00:17:48,380 --> 00:17:58,700  
of wash wash man Walkman 3 or we'll just

424  
00:17:51,230 --> 00:18:03,620  
call it SW 3 and keep saying that three

425  
00:17:58,700 --> 00:18:03,980  
times so we've got April 18th on the

426  
00:18:03,619 --> 00:18:06,258  
left

427  
00:18:03,980 --> 00:18:08,750  
April 19th in the center and April 20th

428

00:18:06,259 --> 00:18:10,880  
on the right this was back in 2006 and

429  
00:18:08,750 --> 00:18:13,788  
you can see all the pieces that are

430  
00:18:10,880 --> 00:18:15,470  
broke off of that comet were flying off

431  
00:18:13,788 --> 00:18:18,378  
matter of fact this wasn't the whole

432  
00:18:15,470 --> 00:18:21,679  
comment this was just fragment B and I

433  
00:18:18,378 --> 00:18:24,308  
believe there were Oh 10 or 12 of these

434  
00:18:21,679 --> 00:18:26,960  
fragments this was just that this this

435  
00:18:24,308 --> 00:18:30,349  
fragment B out of I think it went up to

436  
00:18:26,960 --> 00:18:32,899  
J or K or something like that so we have

437  
00:18:30,349 --> 00:18:35,000  
seen comets break up elsewhere now this

438  
00:18:32,898 --> 00:18:37,819  
is sort of expected because comets are

439  
00:18:35,000 --> 00:18:39,619  
these snowballs and snowballs are you

440  
00:18:37,819 --> 00:18:42,259  
bringing the snow ball past the Sun it's

441  
00:18:39,619 --> 00:18:43,939  
gonna melt and its structure can break

442  
00:18:42,259 --> 00:18:47,750

it can can become brittle and it can

443

00:18:43,940 --> 00:18:50,058

break apart what we didn't expect to see

444

00:18:47,750 --> 00:18:53,628

is something that I'll show you on the

445

00:18:50,058 --> 00:18:57,918

very next image and this is the breakup

446

00:18:53,628 --> 00:18:58,959

of an object that's not a comet it's an

447

00:18:57,919 --> 00:19:04,639

asteroid

448

00:18:58,960 --> 00:19:07,759

this is asteroid P 2013 r3 and you'll

449

00:19:04,638 --> 00:19:10,609

notice that 2013 is it's name is in its

450

00:19:07,759 --> 00:19:14,419

name it was discovered just last year in

451

00:19:10,609 --> 00:19:16,548

September of last year and it was seen

452

00:19:14,419 --> 00:19:19,879

to have some interesting structure that

453

00:19:16,548 --> 00:19:22,849

they believe they saw three spots that

454

00:19:19,878 --> 00:19:24,469

it was a couple's fuzzy spots and here's

455

00:19:22,849 --> 00:19:26,719

what it looked like on a taupe so ha

456

00:19:24,470 --> 00:19:29,990

they got Hubble time to observe it based



457  
00:19:26,720 --> 00:19:33,710  
upon its unique characteristics and this

458  
00:19:29,990 --> 00:19:38,298  
is the image on October 29th and here is

459  
00:19:33,710 --> 00:19:41,808  
the image on November 15th and here is

460  
00:19:38,298 --> 00:19:46,069  
the image on December 13th and then

461  
00:19:41,808 --> 00:19:48,319  
again on January 14th so here's a

462  
00:19:46,069 --> 00:19:51,048  
composite of all four of those images

463  
00:19:48,319 --> 00:19:54,109  
and so over last fall and into the

464  
00:19:51,048 --> 00:19:59,558  
winter we watched the breakup of an

465  
00:19:54,109 --> 00:20:03,490  
asteroid not a comet how cool is that

466  
00:19:59,558 --> 00:20:05,079  
now you we don't expect asteroids to

467  
00:20:03,490 --> 00:20:08,259  
break up because we think of them as

468  
00:20:05,079 --> 00:20:11,589  
rocks right and that you know you would

469  
00:20:08,259 --> 00:20:13,329  
even if it's a rock is hurtling through

470  
00:20:11,589 --> 00:20:15,220  
space and you know you warmth you could

471  
00:20:13,329 --> 00:20:18,579  
heat up a rock and it's not gonna it's

472  
00:20:15,220 --> 00:20:21,278  
not volatile with the ices of a comment

473  
00:20:18,579 --> 00:20:26,470  
so if we didn't we wouldn't expect it to

474  
00:20:21,278 --> 00:20:28,690  
break up but there have been a couple to

475  
00:20:26,470 --> 00:20:31,269  
two major models of what the internal

476  
00:20:28,690 --> 00:20:33,429  
structure of an asteroid is now for the

477  
00:20:31,269 --> 00:20:34,690  
larger asteroids like Ceres and Vesta we

478  
00:20:33,429 --> 00:20:37,298  
believe that they are these

479  
00:20:34,690 --> 00:20:40,058  
differentiated very large objects you

480  
00:20:37,298 --> 00:20:43,450  
know like like planets there are many

481  
00:20:40,058 --> 00:20:47,829  
planets or moons etc but the smaller

482  
00:20:43,450 --> 00:20:49,360  
asteroids well they could be single

483  
00:20:47,829 --> 00:20:51,730  
objects that are you know have chemical

484  
00:20:49,359 --> 00:20:53,558  
bonds holding them together or they

485

00:20:51,730 --> 00:20:57,460  
could be what astronomers call rubble

486  
00:20:53,558 --> 00:20:59,378  
piles as in glommer ations of individual

487  
00:20:57,460 --> 00:21:02,110  
rocks that sort of are held together by

488  
00:20:59,378 --> 00:21:03,788  
their mutual gravity and that they don't

489  
00:21:02,109 --> 00:21:05,798  
have the chemical are there there aren't

490  
00:21:03,788 --> 00:21:07,269  
a single object all together but there

491  
00:21:05,798 --> 00:21:09,730  
are multiple objects together or they're

492  
00:21:07,269 --> 00:21:14,618  
loosely held together or the structure

493  
00:21:09,730 --> 00:21:18,429  
is not in some way fully fully coherent

494  
00:21:14,618 --> 00:21:20,259  
right mm-hmm so this is the question for

495  
00:21:18,429 --> 00:21:22,990  
this if this was a what we call the

496  
00:21:20,259 --> 00:21:25,690  
rubble pile model applied here how would

497  
00:21:22,990 --> 00:21:27,278  
you then get it to break up and the best

498  
00:21:25,690 --> 00:21:30,399  
guess for this and I'm gonna say this is

499  
00:21:27,278 --> 00:21:33,038

a hypothesis it's not proven yet is that

500

00:21:30,398 --> 00:21:34,959

if you have the rubble pile all right

501

00:21:33,038 --> 00:21:38,558

and it has this incoherent structure and

502

00:21:34,960 --> 00:21:43,119

you start it spinning and you can use

503

00:21:38,558 --> 00:21:45,970

the the the the tort there's a very

504

00:21:43,118 --> 00:21:47,199

small gravity a torque due to light that

505

00:21:45,970 --> 00:21:49,149

you can get on this you can get this

506

00:21:47,200 --> 00:21:51,730

asteroid spinning and spinning faster

507

00:21:49,148 --> 00:21:54,329

and faster then it could get to what we

508

00:21:51,730 --> 00:21:57,460

call the breakups velocity where the

509

00:21:54,329 --> 00:22:01,778

centrifugal central center pedal force

510

00:21:57,460 --> 00:22:06,669

pulls it apart can break it apart and

511

00:22:01,778 --> 00:22:10,200

pull apart this Robo pile and so the

512

00:22:06,669 --> 00:22:12,280

Dave Jewett from a from Hawaii is the

513

00:22:10,200 --> 00:22:14,559

the gentleman who's

514  
00:22:12,279 --> 00:22:16,720  
doing these observations and that is his

515  
00:22:14,559 --> 00:22:19,029  
best guess as to why we're seeing an

516  
00:22:16,720 --> 00:22:23,140  
asteroid for the first time falling

517  
00:22:19,029 --> 00:22:26,049  
apart that if you get spun up to - to

518  
00:22:23,140 --> 00:22:29,050  
break up velocity and the pieces started

519  
00:22:26,049 --> 00:22:31,329  
coming apart now we don't know that that

520  
00:22:29,049 --> 00:22:33,609  
is true yet we will continue to follow

521  
00:22:31,329 --> 00:22:37,059  
it and will continue to model it to see

522  
00:22:33,609 --> 00:22:38,859  
if the torques really can produce

523  
00:22:37,059 --> 00:22:41,679  
something to get it up to break up

524  
00:22:38,859 --> 00:22:45,579  
velocity is as an astronomer think about

525  
00:22:41,680 --> 00:22:47,259  
it go wow that's it's got a tap you kind

526  
00:22:45,579 --> 00:22:49,629  
of have that very very very small torque

527  
00:22:47,259 --> 00:22:52,269  
over a really really really long time in

528  
00:22:49,630 --> 00:22:53,830  
order to spin it up that fast but then I

529  
00:22:52,269 --> 00:22:55,089  
always recognize that well this

530  
00:22:53,829 --> 00:22:56,909  
asteroids probably been floating around

531  
00:22:55,089 --> 00:23:00,699  
the solar system for a few billion years

532  
00:22:56,910 --> 00:23:02,740  
so even a tiny did you already say what

533  
00:23:00,700 --> 00:23:04,569  
kind of orbit it had I might have missed

534  
00:23:02,740 --> 00:23:08,680  
that part I did not say what type of

535  
00:23:04,569 --> 00:23:12,250  
orbit it had I do know that it is not in

536  
00:23:08,680 --> 00:23:14,529  
the main asteroid belt i but it is not a

537  
00:23:12,250 --> 00:23:16,150  
sungrazer type thing where it goes in

538  
00:23:14,529 --> 00:23:17,619  
close to the Sun okay that was like

539  
00:23:16,150 --> 00:23:19,710  
that's where I was heading with that I

540  
00:23:17,619 --> 00:23:21,729  
wasn't sure if the Sun might have been

541  
00:23:19,710 --> 00:23:24,700  
involved in some way producing that

542

00:23:21,730 --> 00:23:25,839  
torque or not the Sun would be involved

543  
00:23:24,700 --> 00:23:27,940  
in curtain two in terms of the light

544  
00:23:25,839 --> 00:23:30,609  
pressure so the solar wind would do

545  
00:23:27,940 --> 00:23:35,440  
something it's just it's more this it's

546  
00:23:30,609 --> 00:23:38,619  
more this radiation and radiation to

547  
00:23:35,440 --> 00:23:42,100  
work on it especially if it's got

548  
00:23:38,619 --> 00:23:43,239  
different absorption because of

549  
00:23:42,099 --> 00:23:46,539  
different sort of different surface

550  
00:23:43,240 --> 00:23:48,190  
elements so yeah so you have highly

551  
00:23:46,539 --> 00:23:51,369  
reflective in some dark spots that's

552  
00:23:48,190 --> 00:23:53,950  
gonna exactly put some weird forces on

553  
00:23:51,369 --> 00:23:56,799  
the on the surface is this the same kind

554  
00:23:53,950 --> 00:23:58,509  
of torque that JWST has got to correct

555  
00:23:56,799 --> 00:24:01,419  
for with its momentum flap or is that

556  
00:23:58,509 --> 00:24:03,240

something else I can't I don't know

557

00:24:01,420 --> 00:24:06,789

enough about jus T's momentum flapped

558

00:24:03,240 --> 00:24:08,650

but there might it might be okay I

559

00:24:06,789 --> 00:24:11,710

wasn't sure if it was the same sort of

560

00:24:08,650 --> 00:24:12,940

force or not but in as much as the Solar

561

00:24:11,710 --> 00:24:14,860

shield is going to be absorbing

562

00:24:12,940 --> 00:24:16,450

radiation and if it absorbs more

563

00:24:14,859 --> 00:24:18,399

radiation on one side than on the other

564

00:24:16,450 --> 00:24:20,799

side then that could definitely throw a

565

00:24:18,400 --> 00:24:22,420

torque onto the whole spacecraft okay

566

00:24:20,799 --> 00:24:23,859

that's so may not necessarily be related

567

00:24:22,420 --> 00:24:25,730

I just it just came to my mind when you

568

00:24:23,859 --> 00:24:27,319

were talking about this and so I know

569

00:24:25,730 --> 00:24:31,220

these are the cool things that we get to

570

00:24:27,319 --> 00:24:33,409

talk about the how bright was this thing



571  
00:24:31,220 --> 00:24:34,460  
do you have any idea what was it

572  
00:24:33,410 --> 00:24:39,890  
something you needed a pretty big

573  
00:24:34,460 --> 00:24:41,990  
telescope to check this out or I don't

574  
00:24:39,890 --> 00:24:44,390  
have any I don't have a good idea but it

575  
00:24:41,990 --> 00:24:46,339  
was not particularly bright I mean no

576  
00:24:44,390 --> 00:24:46,640  
asteroid is very bright right right

577  
00:24:46,339 --> 00:24:48,949  
right

578  
00:24:46,640 --> 00:24:51,020  
so we're getting down toward 20 of them

579  
00:24:48,950 --> 00:24:53,240  
we're getting down 15th or 20th

580  
00:24:51,019 --> 00:24:55,430  
magnitude this is pretty much outside of

581  
00:24:53,240 --> 00:24:58,730  
most amateur scope that would be my

582  
00:24:55,430 --> 00:25:00,440  
guess on this I don't have the printout

583  
00:24:58,730 --> 00:25:02,420  
of the press release in front of me yeah

584  
00:25:00,440 --> 00:25:04,700  
yeah no I'm sorry I just was curious it

585  
00:25:02,420 --> 00:25:06,500  
was a hey people might have been able to

586  
00:25:04,700 --> 00:25:07,610  
check out themselves I love it when you

587  
00:25:06,500 --> 00:25:13,730  
ask questions that I don't know the

588  
00:25:07,609 --> 00:25:16,250  
answer to let's go to the third story

589  
00:25:13,730 --> 00:25:19,940  
here okay and I call this a Hubble

590  
00:25:16,250 --> 00:25:22,970  
anniversary present part two last month

591  
00:25:19,940 --> 00:25:26,120  
I talked about the Hubble anniversary

592  
00:25:22,970 --> 00:25:30,529  
present part one and just to remind you

593  
00:25:26,119 --> 00:25:32,619  
we talked about a April 24th 1990 one of

594  
00:25:30,529 --> 00:25:36,230  
my favorite shots of the Space Shuttle

595  
00:25:32,619 --> 00:25:37,149  
blasting off obey a very special day

596  
00:25:36,230 --> 00:25:40,670  
it's got the Hubble Space Telescope

597  
00:25:37,150 --> 00:25:42,820  
inside the payload bay and then an

598  
00:25:40,670 --> 00:25:45,560  
amazing shot from the very next day

599

00:25:42,819 --> 00:25:50,419  
taken by the IMAX camera in the payload

600  
00:25:45,559 --> 00:25:55,759  
Bay for the deployment that front cover

601  
00:25:50,420 --> 00:25:57,259  
closed - yeah I I don't I know very few

602  
00:25:55,759 --> 00:25:59,539  
others I mean except for ones being

603  
00:25:57,259 --> 00:26:02,839  
serviced though that is almost never

604  
00:25:59,539 --> 00:26:04,670  
closed yeah yeah this was this was a

605  
00:26:02,839 --> 00:26:06,109  
fantastic shot I love how they arranged

606  
00:26:04,670 --> 00:26:10,730  
to have the Sun in the background for

607  
00:26:06,109 --> 00:26:12,229  
this shot reflection of the earth and in

608  
00:26:10,730 --> 00:26:14,599  
the front cover there it's really neat

609  
00:26:12,230 --> 00:26:18,860  
that's right the cinematographer just

610  
00:26:14,599 --> 00:26:21,559  
you know just nailed that one you know I

611  
00:26:18,859 --> 00:26:23,329  
think the only thing harder to do I

612  
00:26:21,559 --> 00:26:25,190  
remember on top of the movie do you

613  
00:26:23,329 --> 00:26:28,279

remember the movie Top Gun right oh yeah

614

00:26:25,190 --> 00:26:32,299

yeah and Tony Scott directed that film

615

00:26:28,279 --> 00:26:34,339

and they were doing a shot on the flight

616

00:26:32,299 --> 00:26:36,889

deck where they the aircraft were

617

00:26:34,339 --> 00:26:39,169

landing and suddenly the boat starts to

618

00:26:36,890 --> 00:26:41,120

turn I mean this is a real Navy air

619

00:26:39,170 --> 00:26:43,000

craft carrier and it starts to turn to

620

00:26:41,119 --> 00:26:45,289

head towards wherever it's going to and

621

00:26:43,000 --> 00:26:47,450

the director calls up to the bridge

622

00:26:45,289 --> 00:26:50,119

saying no no you can't turn I need the

623

00:26:47,450 --> 00:26:51,710

Sun where it needs to be to hear for the

624

00:26:50,119 --> 00:26:55,729

shot you know you got to give me half an

625

00:26:51,710 --> 00:26:58,519

hour or more on this course oh so who's

626

00:26:55,730 --> 00:27:00,200

in charge I guess right oh the bridge

627

00:26:58,519 --> 00:27:02,139

called back down said well that'll cost

628  
00:27:00,200 --> 00:27:06,380  
you and he said I don't care I need it

629  
00:27:02,140 --> 00:27:07,730  
so they actually turn the ship back to

630  
00:27:06,380 --> 00:27:10,520  
its core so they could have the Sun

631  
00:27:07,730 --> 00:27:13,279  
where they needed it for the to finish

632  
00:27:10,519 --> 00:27:15,019  
filming that sequence I could imagine

633  
00:27:13,279 --> 00:27:17,839  
the only thing harder than turning an

634  
00:27:15,019 --> 00:27:20,750  
aircraft carrier just to get a shot

635  
00:27:17,839 --> 00:27:23,269  
would be to just to reposition the space

636  
00:27:20,750 --> 00:27:27,859  
shut the space space shuttles to get the

637  
00:27:23,269 --> 00:27:29,569  
shot like this yeah I can't imagine IMAX

638  
00:27:27,859 --> 00:27:31,789  
calling down to Houston no no we got a

639  
00:27:29,569 --> 00:27:33,379  
way to not for that you can't release

640  
00:27:31,789 --> 00:27:39,859  
just yet we have to wait till the Sun is

641  
00:27:33,380 --> 00:27:42,020  
in the right spot blue thing there's

642  
00:27:39,859 --> 00:27:47,409  
probably a that's either a lens flare or

643  
00:27:42,019 --> 00:27:49,369  
a blue dot with the red circle around it

644  
00:27:47,410 --> 00:27:53,240  
either that or it's one of Hubble's

645  
00:27:49,369 --> 00:27:58,549  
images of planetary nebulae that's

646  
00:27:53,240 --> 00:28:01,870  
definitely a lens artifact yeah okay so

647  
00:27:58,549 --> 00:28:07,279  
back to Hubble instead of other movies

648  
00:28:01,869 --> 00:28:13,149  
so that was 24 years ago and last month

649  
00:28:07,279 --> 00:28:15,170  
in Rome they had a the cover the

650  
00:28:13,150 --> 00:28:18,050  
scientific meeting called science with

651  
00:28:15,170 --> 00:28:20,029  
the Hubble Space Telescope for obviously

652  
00:28:18,049 --> 00:28:22,549  
a series of meetings about the Hubble

653  
00:28:20,029 --> 00:28:23,960  
Space Telescope so to celebrate that

654  
00:28:22,549 --> 00:28:26,240  
meeting and celebrate our 24th

655  
00:28:23,960 --> 00:28:28,910  
anniversary we actually released the

656

00:28:26,240 --> 00:28:31,630  
Hubble 24th anniversary image a month

657  
00:28:28,910 --> 00:28:33,950  
early we released it during this meeting

658  
00:28:31,630 --> 00:28:36,100  
so it could be unveiled at this meeting

659  
00:28:33,950 --> 00:28:39,170  
to the scientists at this meeting but

660  
00:28:36,099 --> 00:28:41,750  
what I showed you that image last month

661  
00:28:39,170 --> 00:28:45,830  
but what I didn't show you was the

662  
00:28:41,750 --> 00:28:50,299  
overview image so this is a visible

663  
00:28:45,829 --> 00:28:52,759  
light image of NGC 24 2174 also known as

664  
00:28:50,299 --> 00:28:54,919  
the monkey head nebula

665  
00:28:52,759 --> 00:28:56,869  
as noted here it is not from Hubble of

666  
00:28:54,920 --> 00:28:59,120  
course this is from an Astro

667  
00:28:56,869 --> 00:29:01,429  
photographer named Richard Crisp always

668  
00:28:59,119 --> 00:29:05,419  
want to credit our sources here and that

669  
00:29:01,430 --> 00:29:07,820  
square box up there is where Hubble took

670  
00:29:05,420 --> 00:29:09,380

the 24th anniversary image now this is a

671

00:29:07,819 --> 00:29:11,779

visible light image but Hubble took the

672

00:29:09,380 --> 00:29:14,360

24th anniversary image in infrared

673

00:29:11,779 --> 00:29:16,039

Hubble you know covers visible light a

674

00:29:14,359 --> 00:29:18,769

little bit of the ultraviolet and a

675

00:29:16,039 --> 00:29:22,269

little bit of the infrared and here was

676

00:29:18,769 --> 00:29:25,480

that really cool Hubble image of that

677

00:29:22,269 --> 00:29:30,440

these pillars in the monkey head nebula

678

00:29:25,480 --> 00:29:33,140

in infrared and it to me it reminds me a

679

00:29:30,440 --> 00:29:34,519

lot of the Horsehead Nebula image

680

00:29:33,140 --> 00:29:36,800

released for their Hubble's 23rd

681

00:29:34,519 --> 00:29:39,710

anniversary that you're getting this

682

00:29:36,799 --> 00:29:42,649

dark gas the stuff that's absolutely

683

00:29:39,710 --> 00:29:45,559

opaque in visible light and being able

684

00:29:42,650 --> 00:29:48,500

to see a beautiful glowing gaseous



685  
00:29:45,559 --> 00:29:50,960  
landscape by looking in the infrared

686  
00:29:48,500 --> 00:29:53,210  
the infrared has longer wavelengths so

687  
00:29:50,960 --> 00:29:56,539  
it penetrates deeper into the gas and

688  
00:29:53,210 --> 00:29:59,360  
also this gas is cool that's not hot

689  
00:29:56,539 --> 00:30:02,539  
enough to shine using invisible light

690  
00:29:59,359 --> 00:30:05,179  
but it is warm gas that's hot enough to

691  
00:30:02,539 --> 00:30:07,369  
shine an infrared light so we can

692  
00:30:05,180 --> 00:30:10,009  
actually observe more of the gas with

693  
00:30:07,369 --> 00:30:12,799  
the infrared for those two reasons no

694  
00:30:10,009 --> 00:30:14,930  
that's amazing so this was this was the

695  
00:30:12,799 --> 00:30:17,269  
small sub region in that over that

696  
00:30:14,930 --> 00:30:19,670  
larger picture you showed before right

697  
00:30:17,269 --> 00:30:22,069  
if isn't all is it this is not all

698  
00:30:19,670 --> 00:30:24,190  
because another thing I didn't tell you

699  
00:30:22,069 --> 00:30:28,099  
last month was that Hubble had observed

700  
00:30:24,190 --> 00:30:31,610  
this very pillar previously this

701  
00:30:28,099 --> 00:30:34,849  
subsection here was released oh five or

702  
00:30:31,609 --> 00:30:38,929  
six years ago five or six years ago as a

703  
00:30:34,849 --> 00:30:41,379  
visible light shot so here is that

704  
00:30:38,930 --> 00:30:44,539  
cropping - that on the Left we have the

705  
00:30:41,380 --> 00:30:48,620  
wide field planetary camera - image

706  
00:30:44,539 --> 00:30:49,430  
using visible light of the these pillars

707  
00:30:48,619 --> 00:30:52,129  
in the monkeyhead

708  
00:30:49,430 --> 00:30:54,650  
and on the right we have the infrared

709  
00:30:52,130 --> 00:30:57,110  
version of it so that's kind of cool

710  
00:30:54,650 --> 00:30:59,540  
we've got this visible and you can see

711  
00:30:57,109 --> 00:31:02,899  
the darkness that you see visible and

712  
00:30:59,539 --> 00:31:05,149  
the what you see more the way you look

713

00:31:02,900 --> 00:31:05,960  
through it one of the cool things to

714  
00:31:05,150 --> 00:31:08,090  
look for

715  
00:31:05,960 --> 00:31:10,610  
is just above the pillars on the right

716  
00:31:08,089 --> 00:31:13,490  
hand side I don't know if my mouth shows

717  
00:31:10,609 --> 00:31:16,849  
up on this but there is a galaxy sitting

718  
00:31:13,490 --> 00:31:19,609  
right here next guys sort of bullet

719  
00:31:16,849 --> 00:31:21,079  
trails right next to that top bullet

720  
00:31:19,609 --> 00:31:23,479  
trail just to the right there's a galaxy

721  
00:31:21,079 --> 00:31:26,389  
and actually two or three galaxies that

722  
00:31:23,480 --> 00:31:28,190  
you can see through the nebula and you

723  
00:31:26,390 --> 00:31:30,440  
can't see that at all using visible

724  
00:31:28,190 --> 00:31:32,110  
light that just shows you how much the

725  
00:31:30,440 --> 00:31:34,759  
infrared light penetrates through

726  
00:31:32,109 --> 00:31:36,769  
completely through the nebula here I

727  
00:31:34,759 --> 00:31:38,509

know you and to see what Frank's talking

728

00:31:36,769 --> 00:31:41,119

about it more do anything that's black

729

00:31:38,509 --> 00:31:42,829

on the left side image or a very dark as

730

00:31:41,119 --> 00:31:44,569

being the light is being completely

731

00:31:42,829 --> 00:31:46,819

blocked but here if you go to the right

732

00:31:44,569 --> 00:31:48,889

side you can see those regions are not

733

00:31:46,819 --> 00:31:51,079

dark any longer that's what he's talking

734

00:31:48,890 --> 00:31:53,059

about the the the longer wavelengths are

735

00:31:51,079 --> 00:31:55,398

able to pass through some of that

736

00:31:53,058 --> 00:31:58,879

material and those what do you call them

737

00:31:55,398 --> 00:32:02,538

that thing oh I call it a bullet trails

738

00:31:58,880 --> 00:32:04,220

I think it's a bullet really start you

739

00:32:02,538 --> 00:32:07,158

could those are really stark in visible

740

00:32:04,220 --> 00:32:09,380

light and their little s so here in the

741

00:32:07,159 --> 00:32:11,090

infrared but they're kind of glowing a

742  
00:32:09,380 --> 00:32:13,580  
little bit in the infrared - so that's

743  
00:32:11,089 --> 00:32:15,048  
kinda yeah i'm just called them sorta

744  
00:32:13,579 --> 00:32:16,879  
like the bullet trail simply because

745  
00:32:15,048 --> 00:32:20,210  
remember the movie matrix let's go back

746  
00:32:16,880 --> 00:32:22,669  
to old movies again and that the bullet

747  
00:32:20,210 --> 00:32:24,950  
trails in that the scenes of the bullets

748  
00:32:22,669 --> 00:32:26,059  
flying through the air that's what it

749  
00:32:24,950 --> 00:32:29,210  
sort of looks like here but these are

750  
00:32:26,058 --> 00:32:32,269  
actually the wind blowing past these

751  
00:32:29,210 --> 00:32:33,440  
dense knots of gas yeah that's true yeah

752  
00:32:32,269 --> 00:32:35,058  
that does look like that I would have

753  
00:32:33,440 --> 00:32:38,360  
called them tadpoles but you know I

754  
00:32:35,058 --> 00:32:41,240  
don't mind as imaginative you are we can

755  
00:32:38,359 --> 00:32:43,148  
do tadpoles - another name we have

756  
00:32:41,240 --> 00:32:46,429  
another thing that we call tadpoles

757  
00:32:43,148 --> 00:32:50,298  
Orion Nebula oh that's right no problems

758  
00:32:46,429 --> 00:32:51,919  
in Orion right okay so here's we're

759  
00:32:50,298 --> 00:32:53,418  
finished with the setup here now the set

760  
00:32:51,919 --> 00:32:55,190  
is that we've got this visible light

761  
00:32:53,419 --> 00:32:57,230  
image and we've got this infrared image

762  
00:32:55,190 --> 00:32:58,730  
and we got the contextual image that I

763  
00:32:57,230 --> 00:33:00,829  
showed you so what I really want to do

764  
00:32:58,730 --> 00:33:03,380  
is take you on a full exploration of it

765  
00:33:00,829 --> 00:33:05,178  
so I'm going to show you a movie and

766  
00:33:03,380 --> 00:33:08,330  
again this being a Hubble hangout it

767  
00:33:05,179 --> 00:33:12,980  
doesn't always show well so I'm actually

768  
00:33:08,329 --> 00:33:16,220  
going to let me just give you the URL

769  
00:33:12,980 --> 00:33:19,099  
first okay so here is the URL Hubble

770

00:33:16,220 --> 00:33:20,089  
site org slash new centers last archive

771  
00:33:19,099 --> 00:33:25,038  
slash

772  
00:33:20,089 --> 00:33:27,619  
lisa / 2014's last 18 / video /b yeah I

773  
00:33:25,038 --> 00:33:29,329  
put that by the way it's in the event

774  
00:33:27,619 --> 00:33:31,788  
description so you can just click on it

775  
00:33:29,329 --> 00:33:34,119  
right so I'll talk it through making

776  
00:33:31,788 --> 00:33:36,319  
sure you had time to drop it in there

777  
00:33:34,119 --> 00:33:39,259  
but yeah it's in there now it's in the

778  
00:33:36,319 --> 00:33:41,240  
hangout description okay alright and

779  
00:33:39,259 --> 00:33:43,009  
then this other UL Hubbell site toad org

780  
00:33:41,240 --> 00:33:44,509  
slash videos we'll talk about in just a

781  
00:33:43,009 --> 00:33:48,169  
second but I'm gonna escape out of

782  
00:33:44,509 --> 00:33:50,960  
PowerPoint because PowerPoint often has

783  
00:33:48,169 --> 00:33:53,028  
problems playing videos and I'm gonna

784  
00:33:50,960 --> 00:33:55,038

change my screen share there we go get

785

00:33:53,028 --> 00:33:59,538

rid of the screen share and I'm gonna

786

00:33:55,038 --> 00:34:01,730

screen share with you this right just

787

00:33:59,538 --> 00:34:04,099

the movie you know play it in QuickTime

788

00:34:01,730 --> 00:34:09,530

instead alright we up in the movie yep I

789

00:34:04,099 --> 00:34:10,250

can see it okay great so I need to

790

00:34:09,530 --> 00:34:12,980

rewind it

791

00:34:10,250 --> 00:34:15,648

I've shown you the end here we go from

792

00:34:12,980 --> 00:34:17,358

the beginning now I'm playing it so you

793

00:34:15,648 --> 00:34:19,460

can see the Orion constellation and the

794

00:34:17,358 --> 00:34:21,469

Gemini constellation here and we're

795

00:34:19,460 --> 00:34:23,199

gonna zoom into a reach into the monkey

796

00:34:21,469 --> 00:34:25,668

head nebula which is located between

797

00:34:23,199 --> 00:34:27,049

Orion and Gemini and it's I think it's

798

00:34:25,668 --> 00:34:30,829

technically in the constellation Orion



799  
00:34:27,050 --> 00:34:32,629  
so there's the whole view of the monkey

800  
00:34:30,829 --> 00:34:35,029  
head nebula then we're going to move

801  
00:34:32,628 --> 00:34:36,618  
into this very small pillar here section

802  
00:34:35,030 --> 00:34:38,690  
here and we're going to show you how

803  
00:34:36,619 --> 00:34:41,269  
balls visible light image now we're

804  
00:34:38,690 --> 00:34:45,710  
going to go from 2d image to 3d model in

805  
00:34:41,269 --> 00:34:49,369  
the infrared and we're gonna slowly pull

806  
00:34:45,710 --> 00:34:52,909  
back this is a 3d model that our team

807  
00:34:49,369 --> 00:34:55,460  
here of visualizers put together by

808  
00:34:52,909 --> 00:34:57,588  
taking apart the image and then putting

809  
00:34:55,460 --> 00:35:00,099  
it back together in a three-dimensional

810  
00:34:57,588 --> 00:35:03,440  
computer model and give you a

811  
00:35:00,099 --> 00:35:05,119  
three-dimensional feel for the structure

812  
00:35:03,440 --> 00:35:07,369  
you've talked about this technique

813  
00:35:05,119 --> 00:35:09,440  
before and in another talk we that that

814  
00:35:07,369 --> 00:35:10,820  
you had given to remember the

815  
00:35:09,440 --> 00:35:13,700  
visualization talks so that's on our

816  
00:35:10,820 --> 00:35:15,680  
youtube channel as well on how you some

817  
00:35:13,699 --> 00:35:17,149  
of these things right I think that was

818  
00:35:15,679 --> 00:35:19,549  
the truth and beauty talk I gave him

819  
00:35:17,150 --> 00:35:22,670  
Texas they also gave that as a public

820  
00:35:19,550 --> 00:35:25,640  
lecture series we didn't hang out cast

821  
00:35:22,670 --> 00:35:30,500  
that one on you Joe no but the one in

822  
00:35:25,639 --> 00:35:33,049  
Austin is so so what we did and you can

823  
00:35:30,500 --> 00:35:34,010  
you can take take you can go to the the

824  
00:35:33,050 --> 00:35:37,670  
length of Tony Post

825  
00:35:34,010 --> 00:35:41,510  
and see that but what I really wanted is

826  
00:35:37,670 --> 00:35:47,019  
to show you is if I go to my screen

827

00:35:41,510 --> 00:35:50,420  
share again and share my web browser

828  
00:35:47,019 --> 00:35:52,880  
there's my web browser all right that we

829  
00:35:50,420 --> 00:35:56,480  
have a new section on hubbell site for

830  
00:35:52,880 --> 00:35:59,059  
sharing these videos all right and so my

831  
00:35:56,480 --> 00:36:01,159  
web browser up no it's not up Tony's

832  
00:35:59,059 --> 00:36:06,108  
looking at me funny go to my screen

833  
00:36:01,159 --> 00:36:06,578  
share choose desktop to or no there we

834  
00:36:06,108 --> 00:36:10,400  
go

835  
00:36:06,579 --> 00:36:12,890  
and start screen share that better yeah

836  
00:36:10,400 --> 00:36:15,170  
that's better now I look okay so this is

837  
00:36:12,889 --> 00:36:19,179  
our Hubbell site web page Hubbell site

838  
00:36:15,170 --> 00:36:21,019  
dot o-r-g and you can see that up in the

839  
00:36:19,179 --> 00:36:23,179  
advertising box up here it says

840  
00:36:21,019 --> 00:36:24,679  
astronomy videos go to the page you can

841  
00:36:23,179 --> 00:36:28,338

click that go to the page and get there

842

00:36:24,679 --> 00:36:31,039

if you go down to the middle of the page

843

00:36:28,338 --> 00:36:32,480

you can see a link to videos astronomy

844

00:36:31,039 --> 00:36:34,759

features visualizations bring space

845

00:36:32,480 --> 00:36:36,619

science to life then we got it though

846

00:36:34,760 --> 00:36:39,530

there but we also have at the very top

847

00:36:36,619 --> 00:36:42,440

of the page along our menu bar we have

848

00:36:39,530 --> 00:36:44,569

that thing videos three ways to get to

849

00:36:42,440 --> 00:36:47,869

it from the home page or pushing it this

850

00:36:44,568 --> 00:36:50,409

month aren't we yeah I have I go to that

851

00:36:47,869 --> 00:36:53,030

page you can see that we have a

852

00:36:50,409 --> 00:36:55,848

collection of videos right now we are

853

00:36:53,030 --> 00:36:57,589

featuring this movie which I call the

854

00:36:55,849 --> 00:37:01,400

evaporating Peaks pillars in the monkey

855

00:36:57,588 --> 00:37:02,989

head nebula and if I scroll down you can

856  
00:37:01,400 --> 00:37:05,780  
see we have that horse head video from

857  
00:37:02,989 --> 00:37:08,809  
last year we have some star clusters we

858  
00:37:05,780 --> 00:37:11,869  
have some just actually along the left

859  
00:37:08,809 --> 00:37:14,929  
hand side here we've got categories so

860  
00:37:11,869 --> 00:37:17,539  
we've got videos about planets some

861  
00:37:14,929 --> 00:37:20,779  
Jupiter and Saturn videos we have some

862  
00:37:17,539 --> 00:37:23,480  
stars star clusters and the

863  
00:37:20,780 --> 00:37:25,430  
constellation of Orion we have the

864  
00:37:23,480 --> 00:37:27,079  
nebula which I gotta say our bread and

865  
00:37:25,429 --> 00:37:29,899  
butter because the nebula are really

866  
00:37:27,079 --> 00:37:33,490  
really cool we have amazing shots of

867  
00:37:29,900 --> 00:37:35,750  
nebula we have some galaxies stuff

868  
00:37:33,489 --> 00:37:38,149  
that's actually my favorite you could

869  
00:37:35,750 --> 00:37:39,980  
talk about that one that the galaxy

870  
00:37:38,150 --> 00:37:42,200  
collisions the simulations versus

871  
00:37:39,980 --> 00:37:44,599  
observations and okay that one's amazing

872  
00:37:42,199 --> 00:37:44,980  
that's why I will go into that and I

873  
00:37:44,599 --> 00:37:47,559  
will

874  
00:37:44,980 --> 00:37:50,559  
bring it up alright and you can see that

875  
00:37:47,559 --> 00:37:52,599  
on ah if you go to each page you can we

876  
00:37:50,559 --> 00:37:56,759  
have the youtube link to it so you can

877  
00:37:52,599 --> 00:37:59,109  
watch the the visualization from YouTube

878  
00:37:56,760 --> 00:38:00,130  
and you could make it fullscreen or I

879  
00:37:59,108 --> 00:38:03,250  
think I'll just let it play in the

880  
00:38:00,130 --> 00:38:05,410  
background while I talk here but you've

881  
00:38:03,250 --> 00:38:07,989  
also can see that we've got lots of

882  
00:38:05,409 --> 00:38:11,170  
information about this now this was one

883  
00:38:07,989 --> 00:38:14,078  
where we have a bunch of colliding

884

00:38:11,170 --> 00:38:16,570  
galaxies we had 59 galaxy images for

885  
00:38:14,079 --> 00:38:18,910  
this press release of images galaxies

886  
00:38:16,570 --> 00:38:22,030  
that were colliding and so I took a

887  
00:38:18,909 --> 00:38:25,118  
computer simulation of two galaxies

888  
00:38:22,030 --> 00:38:29,260  
colliding and I matched it to five

889  
00:38:25,119 --> 00:38:32,440  
different stages in the under galaxy

890  
00:38:29,260 --> 00:38:35,410  
collision so there are five different

891  
00:38:32,440 --> 00:38:37,570  
images from this set of 59 that I could

892  
00:38:35,409 --> 00:38:40,989  
match to one computer simulation and

893  
00:38:37,570 --> 00:38:45,099  
show you how that each image from Hubble

894  
00:38:40,989 --> 00:38:48,699  
is just one snapshot in a really long

895  
00:38:45,099 --> 00:38:51,910  
process and really long I mean a billion

896  
00:38:48,699 --> 00:38:53,588  
and a half years yeah that just blows me

897  
00:38:51,909 --> 00:38:55,210  
away because you think about what you're

898  
00:38:53,588 --> 00:38:57,250

what Hubble is showing us when we see

899

00:38:55,210 --> 00:38:59,199

galaxy collisions and then you run it

900

00:38:57,250 --> 00:39:01,420

with you put it in the context of that

901

00:38:59,199 --> 00:39:03,909

simulation you have this model that

902

00:39:01,420 --> 00:39:06,068

you're running really is a great vision

903

00:39:03,909 --> 00:39:08,379

is a great way to see that every single

904

00:39:06,068 --> 00:39:11,619

one of those 59 images are at some point

905

00:39:08,380 --> 00:39:13,780

a point in time of a much longer drama

906

00:39:11,619 --> 00:39:15,369

of these galaxies interacting and so

907

00:39:13,780 --> 00:39:17,079

that's my favorite thing that's one of

908

00:39:15,369 --> 00:39:18,730

my favorite ones you've ever made now

909

00:39:17,079 --> 00:39:21,700

this is a big effort you're going

910

00:39:18,730 --> 00:39:23,889

through that you're going through so

911

00:39:21,699 --> 00:39:25,929

people need to check back a lot on this

912

00:39:23,889 --> 00:39:28,150

website because Frank is adding to this



913  
00:39:25,929 --> 00:39:32,108  
all the time right I mean you're going

914  
00:39:28,150 --> 00:39:33,220  
back and putting visualizations up that

915  
00:39:32,108 --> 00:39:35,380  
you've had sitting around on your

916  
00:39:33,219 --> 00:39:36,429  
computer for a while right right what

917  
00:39:35,380 --> 00:39:38,650  
we're doing is we're going back through

918  
00:39:36,429 --> 00:39:42,789  
all of the videos that we've produced in

919  
00:39:38,650 --> 00:39:45,338  
the past 10 or 15 years and we're taking

920  
00:39:42,789 --> 00:39:48,809  
them and we're where we can we're

921  
00:39:45,338 --> 00:39:51,699  
rear-ending them at full HD 1920 by 1080

922  
00:39:48,809 --> 00:39:53,078  
you'll notice on News Center and in

923  
00:39:51,699 --> 00:39:55,299  
Hubble site that we generated these

924  
00:39:53,079 --> 00:39:58,269  
things only at 1280 by 720 at maximum

925  
00:39:55,300 --> 00:39:59,800  
resolution I've worked an

926  
00:39:58,269 --> 00:40:03,009  
axé films okay that's not good enough

927

00:39:59,800 --> 00:40:05,350

for me I want the full HD right and so

928

00:40:03,010 --> 00:40:07,270

we're making available and if you look

929

00:40:05,349 --> 00:40:09,519

on my web the web page here I'm going to

930

00:40:07,269 --> 00:40:12,369

just highlight the right hand side are

931

00:40:09,519 --> 00:40:13,989

these download options right whoops

932

00:40:12,369 --> 00:40:15,369

there we go on the right hand side

933

00:40:13,989 --> 00:40:18,429

you've got these download options

934

00:40:15,369 --> 00:40:21,099

QuickTime WebM and Windows Media you can

935

00:40:18,429 --> 00:40:23,309

get them at Full HD resolution to

936

00:40:21,099 --> 00:40:25,900

download and play on your computer

937

00:40:23,309 --> 00:40:27,849

astronomers also appreciate this because

938

00:40:25,900 --> 00:40:31,329

they download these and use them in

939

00:40:27,849 --> 00:40:33,369

their talks or in their classes when you

940

00:40:31,329 --> 00:40:36,969

say that you love this one I have to say

941

00:40:33,369 --> 00:40:39,699  
that my my colleagues love that because

942  
00:40:36,969 --> 00:40:41,739  
they it is used in so many astronomy 101

943  
00:40:39,699 --> 00:40:43,809  
classrooms where they can show off

944  
00:40:41,739 --> 00:40:47,559  
what's route what's happening and relate

945  
00:40:43,809 --> 00:40:49,570  
the simulation to the visual to the

946  
00:40:47,559 --> 00:40:50,980  
observations yeah I'm glad you said that

947  
00:40:49,570 --> 00:40:53,380  
I was gonna say this is a great resource

948  
00:40:50,980 --> 00:40:55,630  
for educators to do a walk of all ages

949  
00:40:53,380 --> 00:40:58,420  
all grades and stuff they can use these

950  
00:40:55,630 --> 00:40:59,950  
in their classes so yeah I'm gonna go go

951  
00:40:58,420 --> 00:41:02,500  
to the site guys download this stuff

952  
00:40:59,949 --> 00:41:04,960  
it's all free you can use it however you

953  
00:41:02,500 --> 00:41:07,360  
want and let me highlight one more thing

954  
00:41:04,960 --> 00:41:10,240  
because the other thing that we've got

955  
00:41:07,360 --> 00:41:14,320

on here are stereo 3d versions of these

956

00:41:10,239 --> 00:41:17,259

all right because we have been since we

957

00:41:14,320 --> 00:41:19,420

did the IMAX film Hubble 3d back in 2010

958

00:41:17,260 --> 00:41:22,450

we have been experimenting with stereo

959

00:41:19,420 --> 00:41:24,309

3d so as you can see we've got what is

960

00:41:22,449 --> 00:41:27,309

it six different visualizations right

961

00:41:24,309 --> 00:41:30,759

now on the website that have stereo 3d

962

00:41:27,309 --> 00:41:33,369

versions so if you own an HDTV with

963

00:41:30,760 --> 00:41:35,830

stereo 3d capabilities you can download

964

00:41:33,369 --> 00:41:37,809

these movies generally you play them for

965

00:41:35,829 --> 00:41:40,239

the Media Player of the television you

966

00:41:37,809 --> 00:41:42,400

put your TV into 3d mode this these are

967

00:41:40,239 --> 00:41:44,349

our side by side versions so you put

968

00:41:42,400 --> 00:41:46,809

your TV into the 3d side-by-side mode

969

00:41:44,349 --> 00:41:49,900

put on your glasses and then you'll see

970  
00:41:46,809 --> 00:41:52,420  
the the Hubble images pull out into into

971  
00:41:49,900 --> 00:41:54,610  
3d it's not just seeing a 2d version of

972  
00:41:52,420 --> 00:41:56,829  
our 3d models are actually seeing of

973  
00:41:54,610 --> 00:41:58,450  
them extend out both in front of the

974  
00:41:56,829 --> 00:42:01,569  
television set and behind the television

975  
00:41:58,449 --> 00:42:03,609  
set they're really beautiful so what

976  
00:42:01,570 --> 00:42:05,170  
what software do you I mean I get a lot

977  
00:42:03,610 --> 00:42:07,269  
of questions sometime about this what

978  
00:42:05,170 --> 00:42:09,400  
what software do you primarily use to

979  
00:42:07,269 --> 00:42:11,460  
put these together with well when we're

980  
00:42:09,400 --> 00:42:14,980  
doing the stereo 3d ones

981  
00:42:11,460 --> 00:42:17,619  
most of the ones here use a software

982  
00:42:14,980 --> 00:42:20,679  
that's called from Autodesk called Maya

983  
00:42:17,619 --> 00:42:24,009  
it's some same software that Hollywood

984  
00:42:20,679 --> 00:42:26,139  
uses for most most every blockbuster

985  
00:42:24,010 --> 00:42:28,810  
movie that you see that uses 3d

986  
00:42:26,139 --> 00:42:31,119  
visualization probably uses Maya there's

987  
00:42:28,809 --> 00:42:33,190  
others light wave and Houdini and a few

988  
00:42:31,119 --> 00:42:35,460  
other things and there's even the open

989  
00:42:33,190 --> 00:42:38,349  
source blender 3d modeling software

990  
00:42:35,460 --> 00:42:41,199  
that's available but we happen to be

991  
00:42:38,349 --> 00:42:42,849  
using Maya then of course we use all

992  
00:42:41,199 --> 00:42:47,079  
sorts of things to prepare the images

993  
00:42:42,849 --> 00:42:48,579  
whether it's GIMP or Photoshop or other

994  
00:42:47,079 --> 00:42:50,380  
things and you know since it's

995  
00:42:48,579 --> 00:42:53,529  
scientific data there's often times that

996  
00:42:50,380 --> 00:42:55,390  
I will need to use my own my own

997  
00:42:53,530 --> 00:42:58,030  
software or some scientific software

998

00:42:55,389 --> 00:43:01,599  
write code that transforms the science

999  
00:42:58,030 --> 00:43:05,019  
data into a suitable format for using in

1000  
00:43:01,599 --> 00:43:07,539  
the visualization if I've got you know

1001  
00:43:05,019 --> 00:43:10,059  
ten thousands galaxies in a

1002  
00:43:07,539 --> 00:43:11,920  
visualization I'm not going to go by

1003  
00:43:10,059 --> 00:43:14,170  
hand and place ten thousand galaxies at

1004  
00:43:11,920 --> 00:43:16,900  
ten thousand different 3d positions in

1005  
00:43:14,170 --> 00:43:19,360  
space instead I'm gonna write code that

1006  
00:43:16,900 --> 00:43:21,220  
will write out a script that will then

1007  
00:43:19,360 --> 00:43:23,710  
do that tenth those ten thousand

1008  
00:43:21,219 --> 00:43:25,480  
positionings for me so it's a it's a

1009  
00:43:23,710 --> 00:43:30,250  
good combination of scientific software

1010  
00:43:25,480 --> 00:43:31,690  
custom software off the show commercial

1011  
00:43:30,250 --> 00:43:33,940  
software that we use in our in our

1012  
00:43:31,690 --> 00:43:35,139

productions how did you get into this

1013

00:43:33,940 --> 00:43:37,179

Frank how did you get into the

1014

00:43:35,139 --> 00:43:39,730

visualization you started out as an

1015

00:43:37,179 --> 00:43:42,429

astronomer doing research and what and

1016

00:43:39,730 --> 00:43:44,590

you also but now you're I mean you you

1017

00:43:42,429 --> 00:43:46,239

you're huge and been making these big

1018

00:43:44,590 --> 00:43:50,200

you know these visualizations how did

1019

00:43:46,239 --> 00:43:52,719

you get into it well it was actually

1020

00:43:50,199 --> 00:43:55,719

kind of funny because it started when I

1021

00:43:52,719 --> 00:43:58,869

was doing a postdoc at Princeton after I

1022

00:43:55,719 --> 00:44:00,279

did my PhD at Berkeley I came to

1023

00:43:58,869 --> 00:44:03,969

Princeton to work with Jerry Ostriker

1024

00:44:00,280 --> 00:44:05,590

and David Spergel and we were part of

1025

00:44:03,969 --> 00:44:08,769

something we called the grand challenge

1026

00:44:05,590 --> 00:44:11,680

cosmology consortium doing computer



1027  
00:44:08,769 --> 00:44:15,340  
simulations of how galaxies form in the

1028  
00:44:11,679 --> 00:44:16,989  
universe and we were approached by of

1029  
00:44:15,340 --> 00:44:19,900  
some folks who are making an IMAX film

1030  
00:44:16,989 --> 00:44:21,879  
the IMAX film cosmic voyage and they

1031  
00:44:19,900 --> 00:44:24,250  
wanted to do an evolution of the

1032  
00:44:21,880 --> 00:44:25,010  
universe from the Big Bang to the

1033  
00:44:24,250 --> 00:44:28,070  
formation of

1034  
00:44:25,010 --> 00:44:29,870  
earth and so they came to us as the

1035  
00:44:28,070 --> 00:44:31,970  
cosmology consortium saying all right

1036  
00:44:29,869 --> 00:44:35,690  
well how do we draw the early stages the

1037  
00:44:31,969 --> 00:44:37,609  
universe tell our artists what to draw

1038  
00:44:35,690 --> 00:44:40,309  
to show the formation of galaxies and

1039  
00:44:37,610 --> 00:44:42,650  
then we sure showed them our computer

1040  
00:44:40,309 --> 00:44:43,969  
simulations and all the complexity and

1041  
00:44:42,650 --> 00:44:46,519  
all the detail that we have these

1042  
00:44:43,969 --> 00:44:49,489  
computer simulations and they said wow

1043  
00:44:46,519 --> 00:44:51,440  
that's kind of cool maybe we could use

1044  
00:44:49,489 --> 00:44:56,409  
your simulations instead of asking

1045  
00:44:51,440 --> 00:44:58,970  
artists to draw it so my PhD thesis I

1046  
00:44:56,409 --> 00:45:02,329  
scaled the simulation up by a factor of

1047  
00:44:58,969 --> 00:45:04,250  
10 ran it on the largest supercomputer

1048  
00:45:02,329 --> 00:45:07,969  
of the time at the National Center for

1049  
00:45:04,250 --> 00:45:12,099  
supercomputing applications and my data

1050  
00:45:07,969 --> 00:45:14,719  
appears in the IMAX film cosmic voyage

1051  
00:45:12,099 --> 00:45:18,710  
you were hooked from that point on well

1052  
00:45:14,719 --> 00:45:21,919  
during that process I served as not just

1053  
00:45:18,710 --> 00:45:24,050  
a data provider but also I became the

1054  
00:45:21,920 --> 00:45:27,769  
main liaison between the astronomers and

1055

00:45:24,050 --> 00:45:29,240  
the visualizers out at NCSA and I found

1056  
00:45:27,769 --> 00:45:31,579  
that I had National Center for

1057  
00:45:29,239 --> 00:45:34,159  
supercomputing applications exactly they

1058  
00:45:31,579 --> 00:45:35,809  
had a great wonderful help yeah

1059  
00:45:34,159 --> 00:45:40,609  
wonderful visualization group out there

1060  
00:45:35,809 --> 00:45:42,469  
run by Donna Cox and Donna and I found

1061  
00:45:40,610 --> 00:45:44,480  
that we could she was a she's an artist

1062  
00:45:42,469 --> 00:45:46,009  
I'm a scientist but we could meet in the

1063  
00:45:44,480 --> 00:45:47,780  
middle we could we could chat very well

1064  
00:45:46,010 --> 00:45:50,810  
and I found I was in a really good

1065  
00:45:47,780 --> 00:45:53,920  
translator of the science to the art

1066  
00:45:50,809 --> 00:45:55,880  
side and that you know working

1067  
00:45:53,920 --> 00:45:57,110  
understanding one and being able to

1068  
00:45:55,880 --> 00:46:01,430  
explain it to the other and vice versa

1069  
00:45:57,110 --> 00:46:05,110

it was a really good role for me so that

1070

00:46:01,429 --> 00:46:09,049

got me hired at the Hayden Planetarium

1071

00:46:05,110 --> 00:46:10,400

to work on the exhibits for the Rose

1072

00:46:09,050 --> 00:46:12,950

Center for the earth person space I

1073

00:46:10,400 --> 00:46:14,690

don't put in two thousand and it's been

1074

00:46:12,949 --> 00:46:20,239

in I've been doing lots of visualization

1075

00:46:14,690 --> 00:46:22,460

ever since then and so my job has moved

1076

00:46:20,239 --> 00:46:26,869

out of doing scientific research slowly

1077

00:46:22,460 --> 00:46:28,970

moved over the years from 1994 on my job

1078

00:46:26,869 --> 00:46:31,069

slowly moved from doing scientific

1079

00:46:28,969 --> 00:46:33,230

research in cosmology and how galaxies

1080

00:46:31,070 --> 00:46:36,440

formed to doing the public outreach and

1081

00:46:33,230 --> 00:46:38,630

doing the visualizations that that I

1082

00:46:36,440 --> 00:46:41,000

love to do so much now and now

1083

00:46:38,630 --> 00:46:43,789

how important do you think the

1084  
00:46:41,000 --> 00:46:45,318  
scientific background is for doing this

1085  
00:46:43,789 --> 00:46:47,089  
kind of thing I mean I'm trying to

1086  
00:46:45,318 --> 00:46:50,210  
imagine somebody who's very interested

1087  
00:46:47,088 --> 00:46:52,219  
in doing these visualizations but maybe

1088  
00:46:50,210 --> 00:46:54,829  
isn't a scientist how how would you

1089  
00:46:52,219 --> 00:46:57,098  
weigh that ability to be able to do like

1090  
00:46:54,829 --> 00:46:59,240  
you said but Donna Cox were to you know

1091  
00:46:57,099 --> 00:47:02,028  
translate the science into a more

1092  
00:46:59,239 --> 00:47:03,679  
artistic thing do you think that's a do

1093  
00:47:02,028 --> 00:47:05,358  
you think that's a very big part of what

1094  
00:47:03,679 --> 00:47:06,768  
you do and would you recommend that

1095  
00:47:05,358 --> 00:47:08,538  
anybody else wanting to get into that

1096  
00:47:06,768 --> 00:47:11,209  
have a pretty heavy science background

1097  
00:47:08,539 --> 00:47:14,028  
well if you want to do it right I think

1098  
00:47:11,210 --> 00:47:16,130  
you have to have to not have a science

1099  
00:47:14,028 --> 00:47:18,889  
background but be willing to collaborate

1100  
00:47:16,130 --> 00:47:22,568  
with someone who does this is what makes

1101  
00:47:18,889 --> 00:47:25,818  
Donna understand whatever it is he says

1102  
00:47:22,568 --> 00:47:28,969  
this is what as a start from the

1103  
00:47:25,818 --> 00:47:32,449  
beginning and what we strive for here at

1104  
00:47:28,969 --> 00:47:35,028  
Space Telescope is that we want to

1105  
00:47:32,449 --> 00:47:37,518  
achieve a verisimilitude of science

1106  
00:47:35,028 --> 00:47:38,778  
right we can't get an exact we're not

1107  
00:47:37,518 --> 00:47:41,808  
going to be perfectly scientifically

1108  
00:47:38,778 --> 00:47:44,449  
exact this is a movie as you know you

1109  
00:47:41,809 --> 00:47:46,490  
want it to be entertaining but we don't

1110  
00:47:44,449 --> 00:47:49,788  
want to miss teach we don't want to put

1111  
00:47:46,489 --> 00:47:53,328  
in misconceptions can I rag on cosmos

1112

00:47:49,789 --> 00:47:56,150  
Tony do you sure okay I mean a Neil

1113  
00:47:53,329 --> 00:47:57,890  
Tyson hired me at AMNH he's a great

1114  
00:47:56,150 --> 00:47:59,690  
friend of mine and everything I'm not

1115  
00:47:57,889 --> 00:48:01,808  
trying to rag on Neil but I'm gonna rag

1116  
00:47:59,690 --> 00:48:04,250  
on their computer graphics folks okay

1117  
00:48:01,809 --> 00:48:08,359  
because their very first episode of

1118  
00:48:04,250 --> 00:48:11,230  
cosmos had three howling errors of

1119  
00:48:08,358 --> 00:48:14,538  
computer graphics in the first you know

1120  
00:48:11,230 --> 00:48:16,940  
15 minutes and it really bothered me

1121  
00:48:14,539 --> 00:48:18,109  
because this is what I do for a living

1122  
00:48:16,940 --> 00:48:20,539  
okay this is what I really care about

1123  
00:48:18,108 --> 00:48:22,159  
and let me just give you a kiss to

1124  
00:48:20,539 --> 00:48:24,019  
glycin is a little too far then I'm

1125  
00:48:22,159 --> 00:48:25,879  
saying they had Hollywood computer

1126  
00:48:24,018 --> 00:48:27,469

graphics guys doing it and they didn't

1127

00:48:25,880 --> 00:48:31,039

have a scientist doing the oversight

1128

00:48:27,469 --> 00:48:33,528

okay so for example their spaceship of

1129

00:48:31,039 --> 00:48:35,809

the mind right that the old silver

1130

00:48:33,528 --> 00:48:39,139

flying wing was flying through the

1131

00:48:35,809 --> 00:48:41,990

asteroid belt right and it was dodging

1132

00:48:39,139 --> 00:48:44,750

asteroids as if the asteroid belt were

1133

00:48:41,989 --> 00:48:47,118

this you know you densely packed with

1134

00:48:44,750 --> 00:48:49,670

asteroids like in a Star Wars film right

1135

00:48:47,119 --> 00:48:52,280

exactly these are guys who grew up they

1136

00:48:49,670 --> 00:48:53,780

saw Empire Strikes Back they know that

1137

00:48:52,280 --> 00:48:55,610

no if you go into an asteroid belt it'll

1138

00:48:53,780 --> 00:48:57,620

be dangerous and you have to swerve the

1139

00:48:55,610 --> 00:49:01,039

ship back and forth through it that's

1140

00:48:57,619 --> 00:49:04,309

total BS the asteroid belt



1141  
00:49:01,039 --> 00:49:06,320  
is totally empty right you could fly

1142  
00:49:04,309 --> 00:49:11,529  
through the asteroid belt and never ever

1143  
00:49:06,320 --> 00:49:13,880  
see a single asteroid and that really

1144  
00:49:11,530 --> 00:49:16,490  
would you go so far as to say they were

1145  
00:49:13,880 --> 00:49:17,960  
miss teaching them yeah that is miss

1146  
00:49:16,489 --> 00:49:20,869  
teaching that is reinforcing a

1147  
00:49:17,960 --> 00:49:23,510  
misconception that has been around you

1148  
00:49:20,869 --> 00:49:25,819  
know certainly since a lot of the sci-fi

1149  
00:49:23,510 --> 00:49:27,320  
movies have adopted the idea that you

1150  
00:49:25,820 --> 00:49:28,789  
know the asteroid belt is dense it would

1151  
00:49:27,320 --> 00:49:30,800  
be dangerous you don't want to fly into

1152  
00:49:28,789 --> 00:49:32,539  
an asteroid belt and that's just wrong

1153  
00:49:30,800 --> 00:49:35,269  
at least in our solar system the

1154  
00:49:32,539 --> 00:49:38,509  
asteroid belt is really really sparse

1155  
00:49:35,269 --> 00:49:41,119  
and you have to work really really hard

1156  
00:49:38,510 --> 00:49:43,760  
to get anywhere near an asteroid and you

1157  
00:49:41,119 --> 00:49:45,679  
think of our missions the dawn mission

1158  
00:49:43,760 --> 00:49:48,140  
that's gonna approach Ceres next year

1159  
00:49:45,679 --> 00:49:51,289  
right we're working pretty damn hard to

1160  
00:49:48,139 --> 00:49:54,079  
get at anywhere near Ceres right that's

1161  
00:49:51,289 --> 00:49:57,650  
a complex trajectory just to get there

1162  
00:49:54,079 --> 00:49:59,509  
so you know it's you don't accidentally

1163  
00:49:57,650 --> 00:50:01,550  
come upon an asteroid very often right

1164  
00:49:59,510 --> 00:50:03,140  
yes true and we've sent many probes out

1165  
00:50:01,550 --> 00:50:05,090  
into the outer and will not many but we

1166  
00:50:03,139 --> 00:50:06,889  
have sent some out into the outer our

1167  
00:50:05,090 --> 00:50:08,450  
solar system and there's been nothing

1168  
00:50:06,889 --> 00:50:10,789  
really to worry about we just send them

1169

00:50:08,449 --> 00:50:12,559  
straight out there and they actually I

1170  
00:50:10,789 --> 00:50:14,989  
mean the one place we did have to worry

1171  
00:50:12,559 --> 00:50:17,509  
was the rings of Jupiter rings of

1172  
00:50:14,989 --> 00:50:19,939  
Saturn's all right there the ring plane

1173  
00:50:17,510 --> 00:50:22,310  
crossing of Saturn for Voyager we

1174  
00:50:19,940 --> 00:50:24,800  
worried an awful lot about that turned

1175  
00:50:22,309 --> 00:50:27,259  
out to be just fine but that was one

1176  
00:50:24,800 --> 00:50:29,510  
place where we know there are literally

1177  
00:50:27,260 --> 00:50:31,640  
millions to billions of particles in

1178  
00:50:29,510 --> 00:50:34,670  
those rings and that's someplace that

1179  
00:50:31,639 --> 00:50:36,710  
you do have to worry about it but not

1180  
00:50:34,670 --> 00:50:40,789  
the asteroid belt anyway that's just one

1181  
00:50:36,710 --> 00:50:43,849  
example of the carefulness that you want

1182  
00:50:40,789 --> 00:50:46,400  
to take with computer graphics that I

1183  
00:50:43,849 --> 00:50:48,380

want to make sure that the science is

1184

00:50:46,400 --> 00:50:50,720

presented accurately it doesn't miss

1185

00:50:48,380 --> 00:50:53,510

teach but it doesn't have to be

1186

00:50:50,719 --> 00:50:55,069

perfectly accurate right I mean your

1187

00:50:53,510 --> 00:50:57,500

cameras are always flying faster than

1188

00:50:55,070 --> 00:50:59,690

the speed of light you have to speed up

1189

00:50:57,500 --> 00:51:00,920

and slow down time you have to show some

1190

00:50:59,690 --> 00:51:03,019

things that are invisible that are

1191

00:51:00,920 --> 00:51:05,260

invisible to the human eye yeah there's

1192

00:51:03,019 --> 00:51:07,780

artistic license you can allow but you

1193

00:51:05,260 --> 00:51:10,990

want the main messages to be strong and

1194

00:51:07,780 --> 00:51:13,180

I really you know when professors say

1195

00:51:10,989 --> 00:51:15,099

hey I use your visualization in my

1196

00:51:13,179 --> 00:51:16,359

classroom that's one of the greatest

1197

00:51:15,099 --> 00:51:18,579

compliments they can ever give me

1198  
00:51:16,360 --> 00:51:21,070  
because it shows me I've got the basics

1199  
00:51:18,579 --> 00:51:23,199  
down and that it's worthy of using as as

1200  
00:51:21,070 --> 00:51:25,450  
a teaching device not just for

1201  
00:51:23,199 --> 00:51:26,619  
entertainment exactly so I would I mean

1202  
00:51:25,449 --> 00:51:28,599  
I would encourage anybody who's

1203  
00:51:26,619 --> 00:51:30,609  
interested in this and to take a look at

1204  
00:51:28,599 --> 00:51:32,199  
these visualizations of Frank's created

1205  
00:51:30,610 --> 00:51:33,490  
and he also worked with others at the

1206  
00:51:32,199 --> 00:51:35,669  
Institute to make these and he has a

1207  
00:51:33,489 --> 00:51:39,279  
great team of people and they are

1208  
00:51:35,670 --> 00:51:42,340  
astonishingly I just know these are like

1209  
00:51:39,280 --> 00:51:44,830  
I mean I my first video I made in 2006

1210  
00:51:42,340 --> 00:51:46,710  
was on the Hubble Deep Field and there

1211  
00:51:44,829 --> 00:51:48,610  
was this you know Frank had done a

1212  
00:51:46,710 --> 00:51:51,340  
visualization where we kind of flew

1213  
00:51:48,610 --> 00:51:53,349  
through the Ultra Deep Field and you

1214  
00:51:51,340 --> 00:51:55,960  
know that was that you know that was

1215  
00:51:53,349 --> 00:51:57,400  
just one example of the kind of stuff

1216  
00:51:55,960 --> 00:51:59,769  
that he did and even then he was careful

1217  
00:51:57,400 --> 00:52:01,840  
to say you know I had to squish to scale

1218  
00:51:59,769 --> 00:52:04,259  
all those galaxies you know those guys

1219  
00:52:01,840 --> 00:52:07,059  
aren't really that close together so

1220  
00:52:04,260 --> 00:52:09,460  
anyway they're amazing stuff they're the

1221  
00:52:07,059 --> 00:52:11,949  
source of a lot of good material for

1222  
00:52:09,460 --> 00:52:13,179  
videos that I make as well and I just I

1223  
00:52:11,949 --> 00:52:15,759  
just think everybody should show check

1224  
00:52:13,179 --> 00:52:17,079  
them out and let us know what you think

1225  
00:52:15,760 --> 00:52:19,900  
I mean you know give us some feedback

1226

00:52:17,079 --> 00:52:22,179  
that Frank know let me know and and keep

1227  
00:52:19,900 --> 00:52:23,349  
checking back because he's adding more

1228  
00:52:22,179 --> 00:52:25,509  
all the time right uh-huh

1229  
00:52:23,349 --> 00:52:28,239  
right just whenever you feel like it

1230  
00:52:25,510 --> 00:52:29,980  
haha I would like to be on a schedule of

1231  
00:52:28,239 --> 00:52:31,209  
every two weeks Kay to be honest with

1232  
00:52:29,980 --> 00:52:32,980  
you I'm trying to get a new one out

1233  
00:52:31,210 --> 00:52:36,130  
every two weeks matter of fact this week

1234  
00:52:32,980 --> 00:52:38,829  
we've got the stereo 3d version of the

1235  
00:52:36,130 --> 00:52:41,619  
monkey head nebula coming out okay the

1236  
00:52:38,829 --> 00:52:44,409  
evaporating Peaks in 3d we finished

1237  
00:52:41,619 --> 00:52:46,210  
rendering it there was one problem in

1238  
00:52:44,409 --> 00:52:48,219  
the in the compositing stage that we

1239  
00:52:46,210 --> 00:52:50,740  
have to fix but that should be out

1240  
00:52:48,219 --> 00:52:53,259

hopefully Friday although I am going

1241  
00:52:50,739 --> 00:52:58,659  
away tomorrow I'll try and get it out

1242  
00:52:53,260 --> 00:53:00,520  
Friday if not very early what's a

1243  
00:52:58,659 --> 00:53:03,879  
schedule but people should periodically

1244  
00:53:00,519 --> 00:53:05,860  
come back on order every two weeks maybe

1245  
00:53:03,880 --> 00:53:07,300  
three weeks or something and and of

1246  
00:53:05,860 --> 00:53:10,090  
course yeah the other thing they can do

1247  
00:53:07,300 --> 00:53:11,590  
is they can follow us on YouTube right

1248  
00:53:10,090 --> 00:53:13,620  
that's true they get po everything just

1249  
00:53:11,590 --> 00:53:16,769  
posted on our YouTube channel that's

1250  
00:53:13,619 --> 00:53:21,159  
youtube.com slash Hubble site channel

1251  
00:53:16,769 --> 00:53:28,358  
right there I pulled up the the page me

1252  
00:53:21,159 --> 00:53:30,309  
screen share this there we go so there

1253  
00:53:28,358 --> 00:53:31,779  
is I had to kill my bookmarks you don't

1254  
00:53:30,309 --> 00:53:33,880  
need to share my bookmarks across the



1255  
00:53:31,780 --> 00:53:36,910  
thing all right so there is our Hubbell

1256  
00:53:33,880 --> 00:53:39,519  
site channel on YouTube and you can see

1257  
00:53:36,909 --> 00:53:42,279  
that if I scroll down we have a whole

1258  
00:53:39,519 --> 00:53:44,409  
suite of astronomy visualizations this

1259  
00:53:42,280 --> 00:53:46,930  
is the playlists that are the new

1260  
00:53:44,409 --> 00:53:48,578  
visualizations get added to as well as

1261  
00:53:46,929 --> 00:53:50,710  
lots of other cool things that we post

1262  
00:53:48,579 --> 00:53:52,900  
right so if you want to know more about

1263  
00:53:50,710 --> 00:53:54,099  
just which new visualizations have been

1264  
00:53:52,900 --> 00:53:56,139  
added you want to subscribe to that

1265  
00:53:54,099 --> 00:53:57,730  
playlist you can subscribe to play less

1266  
00:53:56,139 --> 00:54:00,578  
and get notified when a new video comes

1267  
00:53:57,730 --> 00:54:02,530  
up so I highly recommend you doing that

1268  
00:54:00,579 --> 00:54:05,890  
and also while you're at it do the

1269  
00:54:02,530 --> 00:54:08,050  
Hubble Hangouts playlist as well so you

1270  
00:54:05,889 --> 00:54:11,618  
can get notified when we have a new

1271  
00:54:08,050 --> 00:54:13,720  
hangout posted as well so alright okay

1272  
00:54:11,619 --> 00:54:17,470  
well thank you Frank I guess we'll be

1273  
00:54:13,719 --> 00:54:20,318  
back next month for more news from you

1274  
00:54:17,469 --> 00:54:21,578  
on Hubble and across the universe I want

1275  
00:54:20,318 --> 00:54:24,759  
to remind everybody that our next

1276  
00:54:21,579 --> 00:54:26,740  
hangout is a week from tomorrow I was

1277  
00:54:24,760 --> 00:54:29,319  
hoping to get it done tomorrow but dr.

1278  
00:54:26,739 --> 00:54:32,189  
Amy Simon couldn't make it I can't

1279  
00:54:29,318 --> 00:54:35,349  
really talk much about what it is cuz

1280  
00:54:32,190 --> 00:54:37,630  
let me tell you it's really cool okay

1281  
00:54:35,349 --> 00:54:39,849  
you're gonna want to see this one that's

1282  
00:54:37,630 --> 00:54:41,710  
right you put on the press releases

1283

00:54:39,849 --> 00:54:44,500  
tomorrow that we're putting out it goes

1284  
00:54:41,710 --> 00:54:47,108  
live at 10:00 a.m. after that you'll see

1285  
00:54:44,500 --> 00:54:49,420  
an event on Google+ where are we going

1286  
00:54:47,108 --> 00:54:50,949  
to where I have scheduled a hangout for

1287  
00:54:49,420 --> 00:54:52,960  
the next Thursday dr. Carol Christian

1288  
00:54:50,949 --> 00:54:54,818  
and I will be talking with the principal

1289  
00:54:52,960 --> 00:54:56,889  
investigator and we will talk all about

1290  
00:54:54,818 --> 00:54:59,579  
that press release and that's all I'll

1291  
00:54:56,889 --> 00:55:01,659  
say for now that's next Thursday so I

1292  
00:54:59,579 --> 00:55:10,240  
guess that's it for this week space fans

1293  
00:55:01,659 --> 00:55:14,789  
I'm sorry I will thank you all for

1294  
00:55:10,239 --> 00:55:14,789  
watching and as always keep looking up