

1
00:00:00,030 --> 00:00:06,299
field if you didn't get one grab one on

2
00:00:03,330 --> 00:00:08,879
the way out we have a picture of the the

3
00:00:06,299 --> 00:00:10,888
ultra-deep field on the front and a

4
00:00:08,880 --> 00:00:13,769
description on the back telling you

5
00:00:10,888 --> 00:00:15,838
about it and our online audience can

6
00:00:13,769 --> 00:00:19,528
find it at the amazing space tour

7
00:00:15,839 --> 00:00:21,329
website its lithograph number 36 some of

8
00:00:19,528 --> 00:00:23,660
our resources there so it's actually one

9
00:00:21,329 --> 00:00:27,149
of our earlier ones that we produced

10
00:00:23,660 --> 00:00:30,480
tonight we have an astrophysicist guide

11
00:00:27,149 --> 00:00:33,359
to the film deep field the impossible

12
00:00:30,480 --> 00:00:37,109
magnitude of our universe by Frank

13
00:00:33,359 --> 00:00:39,058
summers from space telescope so I am NOT

14
00:00:37,109 --> 00:00:44,039
just your host tonight I'm also your

15
00:00:39,058 --> 00:00:50,189
speaker you guys are needy you guys are

16
00:00:44,039 --> 00:00:52,769
an easy audience April we had a change

17
00:00:50,189 --> 00:00:55,320
of plans for April I had two speakers

18
00:00:52,770 --> 00:00:57,899
who were possible available for the

19
00:00:55,320 --> 00:01:00,960
early April talk both of them had to

20
00:00:57,899 --> 00:01:04,739
cancel on me but we have a symposium

21
00:01:00,960 --> 00:01:07,379
here on April 23rd on the week of April

22
00:01:04,739 --> 00:01:10,350
23rd and they wanted to bring a special

23
00:01:07,379 --> 00:01:12,899
guest speaker from the symposium to do a

24
00:01:10,349 --> 00:01:15,569
public lecture and so I said great I'll

25
00:01:12,900 --> 00:01:19,170
just move the April date until April

26
00:01:15,569 --> 00:01:21,449
23rd okay so I think the normal date

27
00:01:19,170 --> 00:01:23,490
would be like April 2nd yeah we're gonna

28
00:01:21,450 --> 00:01:26,129
be three weeks late next month I'm sorry

29

00:01:23,489 --> 00:01:28,408
we're gonna do April 23rd a special date

30
00:01:26,129 --> 00:01:31,259
but I promise you a special guest

31
00:01:28,409 --> 00:01:33,810
speaker this speaker is so special that

32
00:01:31,259 --> 00:01:37,469
they haven't even told me who it is

33
00:01:33,810 --> 00:01:38,820
okay they've been I've been in

34
00:01:37,469 --> 00:01:40,200
communication with him this month and

35
00:01:38,819 --> 00:01:41,548
they said oh yeah we got it we got it

36
00:01:40,200 --> 00:01:43,109
we're good

37
00:01:41,549 --> 00:01:45,689
but we haven't confirmed so we're not

38
00:01:43,109 --> 00:01:47,640
going to tell you yet okay as soon as I

39
00:01:45,688 --> 00:01:51,618
know you'll know it'll be up on the

40
00:01:47,640 --> 00:01:52,909
website in May we have the fiery fate of

41
00:01:51,618 --> 00:01:55,228
exoplanets

42
00:01:52,909 --> 00:01:58,320
sounds like planets that wander too

43
00:01:55,228 --> 00:02:01,200

close to their star by Joleen Karlberg

44

00:01:58,319 --> 00:02:04,078

and in June the question that everyone

45

00:02:01,200 --> 00:02:08,039

has been asking can pulsar recycling

46

00:02:04,078 --> 00:02:09,419

produce a gamma-ray excess yeah I'll

47

00:02:08,038 --> 00:02:11,469

figure out what that means before next

48

00:02:09,419 --> 00:02:14,000

month okay

49

00:02:11,469 --> 00:02:15,560

this is a new astronomer in the office

50

00:02:14,000 --> 00:02:18,169

of public outreach he arrived about a

51

00:02:15,560 --> 00:02:21,280

year ago Christopher Britt and I finally

52

00:02:18,169 --> 00:02:24,409

have wrangled him into doing our talk

53

00:02:21,280 --> 00:02:26,030

for the other talks upcoming we can go

54

00:02:24,409 --> 00:02:28,099

find our website go to your favorite

55

00:02:26,030 --> 00:02:30,169

search engine type in Hubble public

56

00:02:28,099 --> 00:02:32,659

talks and you should find this webpage

57

00:02:30,169 --> 00:02:35,959

with our upcoming lectures over here on

58
00:02:32,659 --> 00:02:39,379
the right links to our webcasting both

59
00:02:35,960 --> 00:02:41,030
alive and the archives okay we go back

60
00:02:39,379 --> 00:02:44,599
to 2014

61
00:02:41,030 --> 00:02:47,110
I guess that's five years now Wow five

62
00:02:44,599 --> 00:02:51,680
years of Space Telescope webcast of

63
00:02:47,110 --> 00:02:54,680
YouTube webcasting and back to 2005 so

64
00:02:51,680 --> 00:02:57,710
that's of Wow that's about 14 years of

65
00:02:54,680 --> 00:03:00,290
Space Telescope webcasting if you'd like

66
00:02:57,710 --> 00:03:03,620
to get on our email list you can also do

67
00:03:00,289 --> 00:03:05,539
there our email are basically just the

68
00:03:03,620 --> 00:03:07,909
announcements of the lectures and when

69
00:03:05,539 --> 00:03:09,109
the webcasts are posted on YouTube we

70
00:03:07,909 --> 00:03:10,759
let you know about it

71
00:03:09,110 --> 00:03:12,770
if you don't like signing up on our

72
00:03:10,759 --> 00:03:14,419
website you can write your email address

73
00:03:12,770 --> 00:03:16,159
down on a piece of paper hand it to me

74
00:03:14,419 --> 00:03:18,409
after the lecture and I'll make sure you

75
00:03:16,159 --> 00:03:20,270
get on there if you have comments or

76
00:03:18,409 --> 00:03:25,430
questions you can send them to our email

77
00:03:20,270 --> 00:03:28,070
public lecture at STScI edu and finally

78
00:03:25,430 --> 00:03:29,719
if you are on social media if you want

79
00:03:28,069 --> 00:03:32,419
to follow the Hubble Space Telescope the

80
00:03:29,719 --> 00:03:34,000
Webb Space Telescope or the Space

81
00:03:32,419 --> 00:03:36,799
Telescope Science Institute we have

82
00:03:34,000 --> 00:03:40,729
Facebook Twitter YouTube and Instagram

83
00:03:36,800 --> 00:03:42,920
for you to follow I myself do a little

84
00:03:40,729 --> 00:03:46,329
bit of Facebook and Twitter if you're

85
00:03:42,919 --> 00:03:48,799
interested in my latest thoughts

86

00:03:46,330 --> 00:03:52,880
oftentimes after this we have the

87
00:03:48,800 --> 00:03:54,770
observatory was the was it cloudy clouds

88
00:03:52,879 --> 00:03:56,389
are moving in okay I did not receive a

89
00:03:54,770 --> 00:03:59,240
notification from the Maryland space

90
00:03:56,389 --> 00:04:01,039
based grant folks so I put a question

91
00:03:59,240 --> 00:04:04,400
mark here I was assuming it probably was

92
00:04:01,039 --> 00:04:07,909
a no all right anybody from Maryland

93
00:04:04,400 --> 00:04:09,500
Space Grant here No okay I'll ask remind

94
00:04:07,909 --> 00:04:11,359
me to ask again at the end just in case

95
00:04:09,500 --> 00:04:13,789
because you know not often we get a

96
00:04:11,360 --> 00:04:15,530
chance to go across but you do get

97
00:04:13,789 --> 00:04:18,199
chances on Friday evenings when they're

98
00:04:15,530 --> 00:04:21,350
open houses if you go to MD dot Space

99
00:04:18,199 --> 00:04:23,610
Grant o RG you can they have you can

100
00:04:21,350 --> 00:04:26,009

find this webpage over here

101

00:04:23,610 --> 00:04:27,750
on Fridays by 5 or 6 p.m. they will

102

00:04:26,009 --> 00:04:30,270
announced whether or not they're going

103

00:04:27,750 --> 00:04:34,408
to open the observatory Friday evenings

104

00:04:30,269 --> 00:04:36,240
for observing ok all right we are not

105

00:04:34,408 --> 00:04:38,279
going to have the news from the universe

106

00:04:36,240 --> 00:04:41,009
that I usually do since I am your

107

00:04:38,279 --> 00:04:43,258
speaker tonight I didn't have time to

108

00:04:41,009 --> 00:04:48,110
prepare the news of universe so I will

109

00:04:43,259 --> 00:04:51,210
now introduce our speaker our speaker

110

00:04:48,110 --> 00:04:52,830
our speaker is Frank summers of the

111

00:04:51,209 --> 00:04:55,408
office of public outreach here at Space

112

00:04:52,829 --> 00:04:59,968
Telescope Science Institute he's been

113

00:04:55,408 --> 00:05:03,478
here since 2001 working on all aspects

114

00:04:59,968 --> 00:05:05,250
of Hubble Space Telescope public

115
00:05:03,478 --> 00:05:07,468
outreach whether it's websites or

116
00:05:05,250 --> 00:05:10,408
educational materials or the news

117
00:05:07,468 --> 00:05:13,259
releases or his specialty which is

118
00:05:10,408 --> 00:05:16,259
scientific visualizations and because

119
00:05:13,259 --> 00:05:18,360
he's an astronomer who makes movies who

120
00:05:16,259 --> 00:05:22,319
does visualizations he likes to call

121
00:05:18,360 --> 00:05:24,528
himself an astrophysicist he also thinks

122
00:05:22,319 --> 00:05:27,120
it sounds kind of cool

123
00:05:24,528 --> 00:05:30,538
it's just a play on astrophysicist who

124
00:05:27,120 --> 00:05:32,278
does visualizations let's see I usually

125
00:05:30,538 --> 00:05:34,740
tell you something special about myself

126
00:05:32,278 --> 00:05:37,528
when I give the talks I didn't prepare

127
00:05:34,740 --> 00:05:40,468
anything special before I was here at

128
00:05:37,528 --> 00:05:42,060
the Space Telescope I was at the

129
00:05:40,468 --> 00:05:44,939
American Museum of Natural History in

130
00:05:42,060 --> 00:05:46,740
New York where Neil Tyson Steve Souter

131
00:05:44,939 --> 00:05:50,550
and I built the Rose Center for Earth

132
00:05:46,740 --> 00:05:52,918
and space that opened in 2000 and before

133
00:05:50,550 --> 00:05:56,218
that I did postdocs at Columbia and

134
00:05:52,918 --> 00:05:59,338
Princeton and my PhD came from you Cal

135
00:05:56,218 --> 00:06:02,209
Berkeley so ladies and gentlemen while I

136
00:05:59,338 --> 00:06:02,209
switched my slides

137
00:06:11,680 --> 00:06:20,860
mr. Frank summers all right can we get

138
00:06:19,629 --> 00:06:23,430
the lights down a little in the audience

139
00:06:20,860 --> 00:06:23,430
down a little bit please

140
00:06:23,490 --> 00:06:28,750
all right it is really fun to be here

141
00:06:27,879 --> 00:06:30,879
tonight okay

142
00:06:28,750 --> 00:06:36,000
being able to show you this project that

143

00:06:30,879 --> 00:06:38,918
we worked on for about 18 months just a

144
00:06:36,000 --> 00:06:42,009
there sometimes you get to work on

145
00:06:38,918 --> 00:06:45,279
really special projects and this is one

146
00:06:42,009 --> 00:06:47,889
of them it's gonna give you my guide to

147
00:06:45,279 --> 00:06:51,399
deep field the impossible magnitude of

148
00:06:47,889 --> 00:06:54,160
universe this film that is based on a

149
00:06:51,399 --> 00:06:55,599
symphony called Deep Field by the

150
00:06:54,160 --> 00:06:58,990
composer Eric Whitacre

151
00:06:55,600 --> 00:07:04,240
and the first question that people often

152
00:06:58,990 --> 00:07:08,490
have is why would a Hubble image be

153
00:07:04,240 --> 00:07:10,269
deserving of a 24-minute symphony huh

154
00:07:08,490 --> 00:07:13,090
what's going on here

155
00:07:10,269 --> 00:07:14,948
so let's start with the Deep Field and

156
00:07:13,089 --> 00:07:17,888
to explain the Deep Field we're gonna

157
00:07:14,949 --> 00:07:20,439

start here this is the constellation of

158

00:07:17,889 --> 00:07:23,530

Ursa Major most of you know it as the

159

00:07:20,439 --> 00:07:25,060

Big Dipper okay we're going to zoom in

160

00:07:23,529 --> 00:07:28,119

all right so we're gonna zoom into this

161

00:07:25,060 --> 00:07:29,439

region go in a little closer all right

162

00:07:28,120 --> 00:07:32,439

and then we're gonna zoom into this

163

00:07:29,439 --> 00:07:34,629

region and go a little closer and then

164

00:07:32,439 --> 00:07:36,990

we're gonna zoom into this region and go

165

00:07:34,629 --> 00:07:41,199

a little closer and we'll go soon

166

00:07:36,990 --> 00:07:44,620

further get a little closer at one more

167

00:07:41,199 --> 00:07:49,060

time going in down to this field of view

168

00:07:44,620 --> 00:07:52,689

ah isn't that amazing yeah we're talking

169

00:07:49,060 --> 00:07:54,970

about this rectangle right there what

170

00:07:52,689 --> 00:07:58,959

can you guys see there I can see like

171

00:07:54,970 --> 00:08:01,479

two fuzzy nothing's there it's in this

172
00:07:58,959 --> 00:08:05,019
ground-based survey there's nothing

173
00:08:01,478 --> 00:08:08,550
there basically right okay so what would

174
00:08:05,019 --> 00:08:12,639
you say if prominent astronomers

175
00:08:08,550 --> 00:08:17,020
proposed to stare at this empty region

176
00:08:12,639 --> 00:08:20,348
and use eleven days of Hubble observing

177
00:08:17,019 --> 00:08:24,129
a total of a hundred and forty hours of

178
00:08:20,348 --> 00:08:26,519
observing looking at nothing what would

179
00:08:24,129 --> 00:08:26,519
you say

180
00:08:27,589 --> 00:08:35,098
it sounds like a crazy idea okay and you

181
00:08:32,339 --> 00:08:37,020
know what a few astronomers at the time

182
00:08:35,099 --> 00:08:39,960
would have agreed with you all right

183
00:08:37,019 --> 00:08:42,028
so the idea behind this was to use the

184
00:08:39,960 --> 00:08:43,440
incredible resolution of Hubble and the

185
00:08:42,028 --> 00:08:46,259
fact that it's up above Earth's

186
00:08:43,440 --> 00:08:48,839
atmosphere and has this clear view to

187
00:08:46,259 --> 00:08:51,059
see as far out into the universe as we

188
00:08:48,839 --> 00:08:54,540
could see alright we want to see

189
00:08:51,059 --> 00:08:55,979
galaxies at their most distant but the

190
00:08:54,539 --> 00:08:58,528
folks who said this was a crazy idea

191
00:08:55,980 --> 00:09:00,000
said well wait a bit wait galaxies as

192
00:08:58,528 --> 00:09:02,120
they get further and further away are

193
00:09:00,000 --> 00:09:05,730
gonna get smaller and smaller and

194
00:09:02,120 --> 00:09:08,820
fainter and fainter and eventually you

195
00:09:05,730 --> 00:09:11,519
won't be able to see them and you could

196
00:09:08,820 --> 00:09:14,010
end up wasting a tremendous amount of

197
00:09:11,519 --> 00:09:16,139
Hubble time and Hubble time is really

198
00:09:14,009 --> 00:09:19,319
valuable here to spend six days

199
00:09:16,139 --> 00:09:22,679
integrative integration time on a blank

200

00:09:19,320 --> 00:09:24,240
field but the director of the Space

201
00:09:22,679 --> 00:09:28,709
Telescope Science Institute at the time

202
00:09:24,240 --> 00:09:31,139
Bob Williams was convinced that if we

203
00:09:28,710 --> 00:09:33,870
saw something it would be fantastic and

204
00:09:31,139 --> 00:09:35,639
if we didn't see something it would

205
00:09:33,870 --> 00:09:37,919
still be really good because it would

206
00:09:35,639 --> 00:09:40,409
show us the limitations of astronomy

207
00:09:37,919 --> 00:09:42,449
so as the director and using his

208
00:09:40,409 --> 00:09:45,000
director's discretionary time he

209
00:09:42,450 --> 00:09:52,050
approved the original Hubble Deep Field

210
00:09:45,000 --> 00:09:57,379
project the results were astounding in

211
00:09:52,049 --> 00:10:00,559
this small tiny field they found over

212
00:09:57,379 --> 00:10:04,320
3,000 galaxies stretching out to

213
00:10:00,559 --> 00:10:07,799
distances beyond where galaxies had ever

214
00:10:04,320 --> 00:10:10,650

been seen this was the original Hubble

215

00:10:07,799 --> 00:10:14,278

Deep Field done in 1996 and it was so

216

00:10:10,649 --> 00:10:17,250

successful it changed cosmology that we

217

00:10:14,278 --> 00:10:19,439

not only have this but we had follow-on

218

00:10:17,250 --> 00:10:22,589

projects on the right you see the Hubble

219

00:10:19,440 --> 00:10:25,260

ultra-deep field that was taken in 2003

220

00:10:22,589 --> 00:10:27,600

and released in 2004 it covered a

221

00:10:25,259 --> 00:10:30,629

slightly larger field with a new camera

222

00:10:27,600 --> 00:10:33,420

on Hubble went even deeper than the

223

00:10:30,629 --> 00:10:37,689

original one and found about 10,000

224

00:10:33,419 --> 00:10:40,839

galaxies and a very tiny region of sky

225

00:10:37,690 --> 00:10:42,490

how small well I sort of did the zoom

226

00:10:40,840 --> 00:10:44,560

but you sort of get lost on the scale of

227

00:10:42,490 --> 00:10:47,409

it let's compare the size of the Hubble

228

00:10:44,559 --> 00:10:50,919

ultra-deep field to the size of the full

229
00:10:47,409 --> 00:10:54,100
moon okay it's really about the size of

230
00:10:50,919 --> 00:10:57,129
oh one of these moiré over here on the

231
00:10:54,100 --> 00:10:58,720
moon now I know some of you probably

232
00:10:57,129 --> 00:11:02,080
think that the full moon is actually

233
00:10:58,720 --> 00:11:04,300
really really large and I have no idea

234
00:11:02,080 --> 00:11:07,780
where you could possibly have gotten

235
00:11:04,299 --> 00:11:10,750
such a silly idea but if you take a real

236
00:11:07,779 --> 00:11:12,339
view of the full moon and you look at it

237
00:11:10,750 --> 00:11:15,389
you can see that the full moon is only

238
00:11:12,340 --> 00:11:18,100
half a degree across on the sky and

239
00:11:15,389 --> 00:11:21,759
Hubble ultra-deep field being about you

240
00:11:18,100 --> 00:11:27,360
know one third or one tenth of size of

241
00:11:21,759 --> 00:11:30,939
it there are over 12 million patches

242
00:11:27,360 --> 00:11:31,779
entire night sky the size of the Hubble

243

00:11:30,940 --> 00:11:34,870

ultra-deep field

244

00:11:31,779 --> 00:11:40,419

it is 112 millionth of the entire night

245

00:11:34,870 --> 00:11:42,490

sky but in it we see galaxies across the

246

00:11:40,419 --> 00:11:44,589

universe and here are some details from

247

00:11:42,490 --> 00:11:46,930

the Hubble Ultra Deep Field we can see

248

00:11:44,590 --> 00:11:48,519

big galaxies that are nearby like here

249

00:11:46,929 --> 00:11:50,739

in the upper right we can see

250

00:11:48,519 --> 00:11:53,110

medium-sized galaxies we can the smaller

251

00:11:50,740 --> 00:11:55,360

and smaller galaxies we can see flotsam

252

00:11:53,110 --> 00:11:57,340

and jetsam galaxies and so this is a

253

00:11:55,360 --> 00:11:59,289

core sample through the universe

254

00:11:57,340 --> 00:12:02,259

stretching out billions of light-years

255

00:11:59,289 --> 00:12:05,589

through the universe studying galaxies

256

00:12:02,259 --> 00:12:06,189

and if you want to study galaxies in the

257

00:12:05,590 --> 00:12:10,090
universe

258
00:12:06,190 --> 00:12:13,120
this is your rosetta stone this is how

259
00:12:10,090 --> 00:12:16,870
we transformed our understanding of

260
00:12:13,120 --> 00:12:19,389
galaxies in the universe so that's the

261
00:12:16,870 --> 00:12:22,029
story of why the Hubble Deep Field is so

262
00:12:19,389 --> 00:12:24,879
important and it caught the attention of

263
00:12:22,029 --> 00:12:28,179
this man composer and conductor Eric

264
00:12:24,879 --> 00:12:32,049
Whitacre and he decided that he was

265
00:12:28,179 --> 00:12:35,829
going to write a symphony expressing

266
00:12:32,049 --> 00:12:40,089
some of this all and you know immensity

267
00:12:35,830 --> 00:12:42,850
of the of the deep field now I can't

268
00:12:40,090 --> 00:12:44,350
explain his reasoning as well as he can

269
00:12:42,850 --> 00:12:46,870
I've heard him present this several

270
00:12:44,350 --> 00:12:50,769
times but he gave me this slide here

271
00:12:46,870 --> 00:12:51,519

that is one of his drawings of how he

272

00:12:50,769 --> 00:12:53,860
sort of died

273

00:12:51,519 --> 00:12:56,110
out his ideas for the Deep Field

274

00:12:53,860 --> 00:12:58,990
Symphony and you can see that it has

275

00:12:56,110 --> 00:13:02,289
this opening up starting small and

276

00:12:58,990 --> 00:13:04,659
rising up and making it big and he talks

277

00:13:02,289 --> 00:13:07,689
about it being muddy and out of focus in

278

00:13:04,659 --> 00:13:09,759
the beginning which is to him to sort of

279

00:13:07,690 --> 00:13:11,740
reflect the fact that the Hubble Space

280

00:13:09,759 --> 00:13:14,139
Telescope was as you remember

281

00:13:11,740 --> 00:13:15,909
out-of-focus to begin until after

282

00:13:14,139 --> 00:13:18,009
servicing mission one when it was

283

00:13:15,909 --> 00:13:20,769
repaired and we had brought it into

284

00:13:18,009 --> 00:13:22,929
focus so one of his themes in his music

285

00:13:20,769 --> 00:13:24,490
is gonna be take things that the music

286
00:13:22,929 --> 00:13:27,789
is gonna be slightly out of focus and

287
00:13:24,490 --> 00:13:30,700
then come into focus it's gonna grow and

288
00:13:27,789 --> 00:13:32,500
and you know progress forward and pull

289
00:13:30,700 --> 00:13:36,900
back progress forward and pull back

290
00:13:32,500 --> 00:13:39,580
until it reaches this triumphant chord

291
00:13:36,899 --> 00:13:43,600
at the presentation of the Ultra Deep

292
00:13:39,580 --> 00:13:45,100
Field and you'll I'll explain some of

293
00:13:43,600 --> 00:13:46,690
the other things things about it as I'm

294
00:13:45,100 --> 00:13:49,360
going through here but he really has

295
00:13:46,690 --> 00:13:51,700
this full complete idea of all these

296
00:13:49,360 --> 00:13:54,009
themes that he wants to do and certain

297
00:13:51,700 --> 00:13:57,100
notes and presentations and this this

298
00:13:54,009 --> 00:13:59,950
golden brick idea of the the repeating

299
00:13:57,100 --> 00:14:02,409
themes that he works through in order to

300
00:13:59,950 --> 00:14:05,440
try and express some of the majesty that

301
00:14:02,409 --> 00:14:09,209
you are presented with in this field so

302
00:14:05,440 --> 00:14:11,650
he wrote this 24 minutes Symphony and he

303
00:14:09,210 --> 00:14:14,460
conducted it and it's had its world

304
00:14:11,649 --> 00:14:17,949
premiere in Minneapolis Minnesota and

305
00:14:14,460 --> 00:14:22,379
attending that performance was Bob

306
00:14:17,950 --> 00:14:24,520
Williams the stsci director who had

307
00:14:22,379 --> 00:14:27,879
allowed the deep field to happen to

308
00:14:24,519 --> 00:14:30,850
begin with and Bob amongst others I'm

309
00:14:27,879 --> 00:14:33,580
going to understand met Eric afterwards

310
00:14:30,850 --> 00:14:36,370
and said you must combine this Symphony

311
00:14:33,580 --> 00:14:39,970
with the Hubble visuals to make an

312
00:14:36,370 --> 00:14:43,570
incredible fusion of science and music

313
00:14:39,970 --> 00:14:45,340
together so that's what Eric did I

314

00:14:43,570 --> 00:14:48,060
actually think Eric probably wanted to

315
00:14:45,340 --> 00:14:50,830
do this already he assembled a team

316
00:14:48,059 --> 00:14:52,809
first starting with 59 productions a

317
00:14:50,830 --> 00:14:57,310
london-based production company that

318
00:14:52,809 --> 00:14:59,369
does unbelievable presentations this is

319
00:14:57,309 --> 00:15:02,559
from their website where they put video

320
00:14:59,370 --> 00:15:05,409
onto the Sydney Opera House the entire

321
00:15:02,559 --> 00:15:07,268
Sydney Opera House covered in

322
00:15:05,409 --> 00:15:09,879
video projections right they put

323
00:15:07,269 --> 00:15:13,269
projections on castles and on 747

324
00:15:09,879 --> 00:15:16,360
airplanes they do amazing work in

325
00:15:13,269 --> 00:15:18,100
combining art and technology and then of

326
00:15:16,360 --> 00:15:20,769
course he also came here to the Space

327
00:15:18,100 --> 00:15:22,389
Telescope Science Institute because we

328
00:15:20,769 --> 00:15:26,620

are the ones who have the Hubble images

329

00:15:22,389 --> 00:15:28,539

and we have the the visual of scientific

330

00:15:26,620 --> 00:15:32,519

visualizations of those Hubble images

331

00:15:28,539 --> 00:15:32,519

that can put they bring things to life

332

00:15:32,698 --> 00:15:38,528

so we just met with Eric we showed him a

333

00:15:36,519 --> 00:15:40,209

variety of our work and we started to

334

00:15:38,528 --> 00:15:43,000

talk through what we could do because

335

00:15:40,208 --> 00:15:45,278

look you can't show that Ultra Deep

336

00:15:43,000 --> 00:15:47,828

Field for 24 minutes okay this this

337

00:15:45,278 --> 00:15:50,528

movie can't be just about what image

338

00:15:47,828 --> 00:15:52,958

okay what it really needs to be about is

339

00:15:50,528 --> 00:15:55,568

that journey to understand that image

340

00:15:52,958 --> 00:15:57,669

that progression from what we see here

341

00:15:55,568 --> 00:16:01,539

on earth out through the solar system

342

00:15:57,669 --> 00:16:03,938

and stars and nebulae and galaxies until

343
00:16:01,539 --> 00:16:05,889
you can get out to the farthest edge of

344
00:16:03,938 --> 00:16:08,250
the universe and so we developed in

345
00:16:05,889 --> 00:16:10,750
collaboration with 59 productions and

346
00:16:08,250 --> 00:16:12,970
music production is limited this story

347
00:16:10,750 --> 00:16:15,639
line of various ideas and everything and

348
00:16:12,970 --> 00:16:19,240
it was all taking the music first and

349
00:16:15,639 --> 00:16:22,899
then trying to craft visuals that would

350
00:16:19,240 --> 00:16:24,370
do justice to this music I will say here

351
00:16:22,899 --> 00:16:27,240
at the Space Telescope Science Institute

352
00:16:24,370 --> 00:16:29,198
we contributed 11 sequences to this film

353
00:16:27,240 --> 00:16:31,480
seven of which we it had already

354
00:16:29,198 --> 00:16:34,659
produced and four of which were brand

355
00:16:31,480 --> 00:16:37,449
new this is our team that worked on the

356
00:16:34,659 --> 00:16:38,730
four new ones - one person that you'll

357
00:16:37,448 --> 00:16:43,448
see in just a minute

358
00:16:38,730 --> 00:16:45,850
this is myself Joe Danny and Greg we're

359
00:16:43,448 --> 00:16:48,519
down at NASA Kennedy Space Center last

360
00:16:45,850 --> 00:16:51,879
fall for the grand or the world premiere

361
00:16:48,519 --> 00:16:55,720
of this film so we don't have a huge

362
00:16:51,879 --> 00:16:58,659
staff ok this is not like your latest

363
00:16:55,720 --> 00:17:00,519
Avengers blockbuster CGI fest where

364
00:16:58,659 --> 00:17:03,068
there's five hundred people working on

365
00:17:00,519 --> 00:17:07,480
the computer graphics okay we got five

366
00:17:03,068 --> 00:17:10,109
here guys okay but that's part of what

367
00:17:07,480 --> 00:17:13,779
made it such a special project for us

368
00:17:10,109 --> 00:17:16,838
because it was audacious and ambitious

369
00:17:13,779 --> 00:17:18,578
so let me talk you through a variety of

370
00:17:16,838 --> 00:17:19,658
the sequences of

371

00:17:18,578 --> 00:17:21,099
the deep field matter fact I'm gonna

372
00:17:19,659 --> 00:17:24,370
talk you through all of the astronomy

373
00:17:21,099 --> 00:17:26,859
sequences because when people sit down

374
00:17:24,369 --> 00:17:30,879
and watch it I'm always getting people

375
00:17:26,859 --> 00:17:32,528
with suing mere Oh what's this

376
00:17:30,880 --> 00:17:34,330
and I don't want you doing that during

377
00:17:32,528 --> 00:17:35,829
the film okay I want you to know what

378
00:17:34,329 --> 00:17:37,960
you're looking at so I'm gonna tell you

379
00:17:35,829 --> 00:17:39,220
all of the sign all of the astronomy

380
00:17:37,960 --> 00:17:42,788
sequences that you're gonna look at all

381
00:17:39,220 --> 00:17:46,690
right so the film begins with a view of

382
00:17:42,788 --> 00:17:52,000
the night sky and actually it starts out

383
00:17:46,690 --> 00:17:53,710
of focus and slowly can we get it can

384
00:17:52,000 --> 00:17:56,079
you guys see this well I'm not sure that

385
00:17:53,710 --> 00:17:58,538

this light is too bright

386

00:17:56,079 --> 00:18:00,638

I need the light off the screen as much

387

00:17:58,538 --> 00:18:02,589

as possible nobody needs to see me by

388

00:18:00,638 --> 00:18:05,638

the way okay we they need to see the

389

00:18:02,589 --> 00:18:07,869

screen though so take some lights down

390

00:18:05,638 --> 00:18:09,609

astronomy has it has a major problem

391

00:18:07,869 --> 00:18:13,569

because we do a lot of black in our

392

00:18:09,609 --> 00:18:16,898

night skies I think it's probably this

393

00:18:13,569 --> 00:18:23,769

one that that's coming the panel one

394

00:18:16,898 --> 00:18:25,239

that's I need on me all right

395

00:18:23,769 --> 00:18:27,669

well I guess you guess you can see it up

396

00:18:25,240 --> 00:18:28,240

on that screen okay there we go thank

397

00:18:27,669 --> 00:18:30,460

you

398

00:18:28,240 --> 00:18:33,509

whatever that did that worked all right

399

00:18:30,460 --> 00:18:36,788

and slowly it starts coming into focus

400
00:18:33,509 --> 00:18:37,288
until you can see the stars of the night

401
00:18:36,788 --> 00:18:39,849
sky

402
00:18:37,288 --> 00:18:42,579
now that was what fifty-nine productions

403
00:18:39,849 --> 00:18:45,158
wanted to do to mirror the ideas in

404
00:18:42,579 --> 00:18:48,970
Eric's music of the music slowly coming

405
00:18:45,159 --> 00:18:52,389
into focus Hubble the flaw coming into

406
00:18:48,970 --> 00:18:55,960
focus and the major transitions in the

407
00:18:52,388 --> 00:19:00,219
film include that change out of OD focus

408
00:18:55,960 --> 00:19:03,970
too focused and then this sequence leads

409
00:19:00,220 --> 00:19:06,429
on into showing you the milky way that

410
00:19:03,970 --> 00:19:08,409
goes across the night sky and one of the

411
00:19:06,429 --> 00:19:10,720
other really great things that I love

412
00:19:08,409 --> 00:19:12,340
that they did was that as the music

413
00:19:10,720 --> 00:19:14,528
slowly built it starts off with these

414
00:19:12,339 --> 00:19:17,308
hanging notes that are thin and just

415
00:19:14,528 --> 00:19:20,648
free and as this music builds and builds

416
00:19:17,308 --> 00:19:24,158
they build the exposure okay so you

417
00:19:20,648 --> 00:19:26,558
start off seeing just the stars but they

418
00:19:24,159 --> 00:19:31,028
increase the exposure so that you can

419
00:19:26,558 --> 00:19:32,379
see the full milky milky way as as the

420
00:19:31,028 --> 00:19:35,710
as music builds and it's

421
00:19:32,380 --> 00:19:39,400
just increases along with it this

422
00:19:35,710 --> 00:19:42,460
sequence here was shot by our own very

423
00:19:39,400 --> 00:19:45,280
very own astronomical image processors

424
00:19:42,460 --> 00:19:47,350
Olave he has been our master image

425
00:19:45,279 --> 00:19:51,099
processor on Hubble images for many

426
00:19:47,349 --> 00:19:54,339
years and retired last fall just before

427
00:19:51,099 --> 00:19:56,649
this film was released and not only

428

00:19:54,339 --> 00:20:01,089
dealing with astronomical images he is a

429
00:19:56,650 --> 00:20:02,980
avid Astro photographer himself such

430
00:20:01,089 --> 00:20:05,679
that he was given an artist-in-residence

431
00:20:02,980 --> 00:20:09,160
at Capitol Reef National Park last

432
00:20:05,680 --> 00:20:11,440
summer and while he was there he spent

433
00:20:09,160 --> 00:20:14,980
several nights tracking getting these

434
00:20:11,440 --> 00:20:18,340
time-lapse of imagery of the Milky Way

435
00:20:14,980 --> 00:20:22,660
this is old in his national park

436
00:20:18,339 --> 00:20:25,419
official volunteer outfit they told him

437
00:20:22,660 --> 00:20:27,130
he did he got to keep the shirt but not

438
00:20:25,420 --> 00:20:31,420
the Hat or vice versa I can't remember

439
00:20:27,130 --> 00:20:34,000
which all right

440
00:20:31,420 --> 00:20:36,100
also this shot over here on the right is

441
00:20:34,000 --> 00:20:38,829
from Capitol Reef and it shows a very

442
00:20:36,099 --> 00:20:40,449

important thing that right there now

443

00:20:38,829 --> 00:20:43,809

many of you might look at that and go oh

444

00:20:40,450 --> 00:20:45,460

that's a meteor trail no it's not it's

445

00:20:43,809 --> 00:20:47,799

an airplane okay

446

00:20:45,460 --> 00:20:49,600

Capitol Reef National Park is out in the

447

00:20:47,799 --> 00:20:50,649

middle of nowhere but it's not so far

448

00:20:49,599 --> 00:20:54,669

out in the middle of nowhere that

449

00:20:50,650 --> 00:20:58,509

airplanes don't fly through so in zoltes

450

00:20:54,670 --> 00:21:01,360

time-lapse over 70 airplanes flew

451

00:20:58,509 --> 00:21:04,660

through his time-lapse there was an

452

00:21:01,359 --> 00:21:08,229

intern at 59 productions who spent his

453

00:21:04,660 --> 00:21:11,620

entire work on the project removing

454

00:21:08,230 --> 00:21:14,620

those airplanes from the Milky Way from

455

00:21:11,619 --> 00:21:17,289

thing so the fact that there are no

456

00:21:14,619 --> 00:21:19,769

airplanes in the Milky Way sequence you

457
00:21:17,289 --> 00:21:22,180
can thank that intern at 59 productions

458
00:21:19,769 --> 00:21:25,480
the other cool thing about the milky way

459
00:21:22,180 --> 00:21:27,250
shot is the D focus at the end of it and

460
00:21:25,480 --> 00:21:28,839
they D focus out you can start to see

461
00:21:27,250 --> 00:21:31,089
there's this funky little pattern here

462
00:21:28,839 --> 00:21:35,470
that they use for the D focus it's not

463
00:21:31,089 --> 00:21:38,470
just a circular blur this is in fact the

464
00:21:35,470 --> 00:21:42,279
point spread function of Hubble before

465
00:21:38,470 --> 00:21:46,269
the flaw was fixed so this is actually a

466
00:21:42,279 --> 00:21:50,858
typical would take of a point

467
00:21:46,269 --> 00:21:52,269
in 1990 before the the flaw was fixed

468
00:21:50,858 --> 00:21:54,189
after the services servicing mission one

469
00:21:52,269 --> 00:21:55,628
so that's like just a cute little thing

470
00:21:54,190 --> 00:21:57,609
that they threw in in one of the

471
00:21:55,628 --> 00:21:59,829
defocusing things to throw in the point

472
00:21:57,608 --> 00:22:02,528
spread function from Hubble all right

473
00:21:59,829 --> 00:22:03,398
the next set of sequences is the solar

474
00:22:02,528 --> 00:22:05,138
system

475
00:22:03,398 --> 00:22:07,329
we here at Space Telescope did not work

476
00:22:05,138 --> 00:22:10,928
on them because these are all NASA

477
00:22:07,329 --> 00:22:13,259
missions that go through it begins with

478
00:22:10,929 --> 00:22:14,440
the moon from Lunar Reconnaissance

479
00:22:13,259 --> 00:22:18,429
Orbiter

480
00:22:14,440 --> 00:22:20,308
these are wonderful wonderful pans and I

481
00:22:18,429 --> 00:22:22,359
will say that while that was it AMNH

482
00:22:20,308 --> 00:22:25,928
people would come to me and say wait a

483
00:22:22,358 --> 00:22:28,928
minute we went to the moon and also we

484
00:22:25,929 --> 00:22:31,089
took we're black-and-white cameras and

485

00:22:28,929 --> 00:22:35,079
then of course you show them all right

486
00:22:31,088 --> 00:22:37,868
well yeah we went to the moon but these

487
00:22:35,078 --> 00:22:38,918
are color photographs of a black and

488
00:22:37,868 --> 00:22:42,519
white world

489
00:22:38,919 --> 00:22:44,229
all right so yes the moon is just black

490
00:22:42,519 --> 00:22:46,118
and white but that's the way the moon

491
00:22:44,229 --> 00:22:48,429
really is not because we're not

492
00:22:46,118 --> 00:22:51,398
colorizing these things if you want

493
00:22:48,429 --> 00:22:54,309
color you get in the next sequence from

494
00:22:51,398 --> 00:22:56,908
Mars a whole sequence of images from

495
00:22:54,308 --> 00:22:59,319
Viking and from Mars Global Surveyor

496
00:22:56,909 --> 00:23:03,820
incredible details of the surface of

497
00:22:59,319 --> 00:23:06,848
Mars the Jupiter sequence comes from the

498
00:23:03,819 --> 00:23:09,759
mission Juno and Juno I don't know if

499
00:23:06,848 --> 00:23:11,888

you know is a mission that's designed to

500

00:23:09,759 --> 00:23:14,469

study the magnetosphere and the

501

00:23:11,888 --> 00:23:19,388

atmosphere and the interior of Jupiter

502

00:23:14,469 --> 00:23:22,298

it really isn't a imager it doesn't take

503

00:23:19,388 --> 00:23:25,388

pictures none of the science data from

504

00:23:22,298 --> 00:23:28,179

the Juno mission are pictures what we

505

00:23:25,388 --> 00:23:32,008

see from Juno is actually a instrument

506

00:23:28,179 --> 00:23:35,159

called Juno cam which is essentially a

507

00:23:32,009 --> 00:23:37,868

webcam added to the scientific mission

508

00:23:35,159 --> 00:23:39,190

they recognize that we're going to get

509

00:23:37,868 --> 00:23:41,408

this incredible data about the

510

00:23:39,190 --> 00:23:44,288

magnetosphere of jupiter but the public

511

00:23:41,409 --> 00:23:48,070

loves our images so they put a space

512

00:23:44,288 --> 00:23:50,739

hardened web cam type apparatus on it

513

00:23:48,069 --> 00:23:52,838

and when judo makes these gorgeous flow

514
00:23:50,739 --> 00:23:55,450
these flybys they get these gorgeous

515
00:23:52,838 --> 00:23:58,569
images of the cloud tops of Jupiter and

516
00:23:55,450 --> 00:24:00,190
really has been produced much more

517
00:23:58,569 --> 00:24:02,679
amazing images than I ever

518
00:24:00,190 --> 00:24:04,630
would be possible with the level of

519
00:24:02,680 --> 00:24:07,200
camera that they put on it and you'll

520
00:24:04,630 --> 00:24:10,290
see tonight that they're just amazing

521
00:24:07,200 --> 00:24:13,509
finally the last platter that glass

522
00:24:10,289 --> 00:24:15,490
planet visited is Saturn and you might

523
00:24:13,509 --> 00:24:18,549
look at this and say well why did they

524
00:24:15,490 --> 00:24:20,589
put in a still shot of Saturn it's not a

525
00:24:18,549 --> 00:24:23,529
still shot you must watch for these

526
00:24:20,589 --> 00:24:25,480
objects right there those are the moons

527
00:24:23,529 --> 00:24:27,849
of Saturn and you will see them move

528
00:24:25,480 --> 00:24:30,400
through it Saturn itself doesn't change

529
00:24:27,849 --> 00:24:32,829
much in the shot in the film but there

530
00:24:30,400 --> 00:24:34,560
are five moons four here there's a fifth

531
00:24:32,829 --> 00:24:37,419
one that enters at the top of the screen

532
00:24:34,559 --> 00:24:41,049
that will be part of it okay and that's

533
00:24:37,420 --> 00:24:43,750
the movement that covers the planets the

534
00:24:41,049 --> 00:24:47,289
next movement in the film covers these

535
00:24:43,750 --> 00:24:50,109
stars and nebulae so the symphony you

536
00:24:47,289 --> 00:24:51,819
know changes a bit and introduced brings

537
00:24:50,109 --> 00:24:55,449
in our nearest star which is of course

538
00:24:51,819 --> 00:24:56,679
our Sun this is the Sun in ultraviolet

539
00:24:55,450 --> 00:25:00,670
light from the Solar Dynamics

540
00:24:56,680 --> 00:25:03,880
Observatory and when you he see that and

541
00:25:00,670 --> 00:25:06,310
hear the chord that comes with it you

542

00:25:03,880 --> 00:25:08,770
will start to hear the priests aging of

543
00:25:06,309 --> 00:25:11,679
the Magnificent chord that will happen

544
00:25:08,769 --> 00:25:15,670
with the deep field and this one comes

545
00:25:11,680 --> 00:25:17,560
in and it's slightly out of focus when I

546
00:25:15,670 --> 00:25:20,529
first heard it I was like what's he

547
00:25:17,559 --> 00:25:22,690
doing here I didn't really I like this

548
00:25:20,529 --> 00:25:25,720
is is this out of key or what it's

549
00:25:22,690 --> 00:25:28,360
intentionally slightly out of focus so

550
00:25:25,720 --> 00:25:31,269
that the music clarifies over the course

551
00:25:28,359 --> 00:25:34,419
of its development all right and so this

552
00:25:31,269 --> 00:25:36,309
is a really nice a nice way of

553
00:25:34,420 --> 00:25:39,670
appreciating what he's going to come up

554
00:25:36,309 --> 00:25:42,190
with we pull out of the Sun and then we

555
00:25:39,670 --> 00:25:44,080
start to fly through a star filled with

556
00:25:42,190 --> 00:25:46,539

the Milky Way in the background so

557

00:25:44,079 --> 00:25:48,460

escape out of our solar system starts

558

00:25:46,539 --> 00:25:51,460

flying through a star field and this

559

00:25:48,460 --> 00:25:54,400

shot here was based on a shot that I did

560

00:25:51,460 --> 00:25:57,069

for a documentary filmmaker flying

561

00:25:54,400 --> 00:25:58,600

towards the Orion constellation and I

562

00:25:57,069 --> 00:26:00,119

just want to mention one thing about it

563

00:25:58,599 --> 00:26:03,969

because it's going to come up in

564

00:26:00,119 --> 00:26:05,739

different pattern later that the Milky

565

00:26:03,970 --> 00:26:08,230

Way is so big that when you're flying

566

00:26:05,740 --> 00:26:10,210

through the local stars the Milky Way

567

00:26:08,230 --> 00:26:12,970

doesn't change that much so we use a

568

00:26:10,210 --> 00:26:14,049

standard technique where we have a star

569

00:26:12,970 --> 00:26:16,539

field

570

00:26:14,049 --> 00:26:17,859

and the starfield is rendered in 3d and

571
00:26:16,539 --> 00:26:20,740
we fly through it and the stars are all

572
00:26:17,859 --> 00:26:21,969
flying past you but the background is

573
00:26:20,740 --> 00:26:25,720
just a Milky Way

574
00:26:21,970 --> 00:26:27,940
that's a static 2d image okay so we have

575
00:26:25,720 --> 00:26:30,250
this foreground background thing to make

576
00:26:27,940 --> 00:26:32,049
our computation easier because trying to

577
00:26:30,250 --> 00:26:34,599
build out a full Milky Way that could be

578
00:26:32,049 --> 00:26:37,089
a difficult project right yeah you'll

579
00:26:34,599 --> 00:26:38,469
see in just a minute so this foreground

580
00:26:37,089 --> 00:26:41,139
background I just want you to keep that

581
00:26:38,470 --> 00:26:43,839
in mind for later we fly through the

582
00:26:41,140 --> 00:26:47,170
stars and we come up upon the star

583
00:26:43,839 --> 00:26:49,799
forming region sharpless 2 - 106 which

584
00:26:47,170 --> 00:26:49,800
we just call SCCT

585
00:26:51,039 --> 00:26:56,409
of a sequence of four massive star

586
00:26:54,069 --> 00:26:58,299
sequences all right in the center of

587
00:26:56,410 --> 00:27:01,000
this this is a star forming region we've

588
00:26:58,299 --> 00:27:04,569
just formed a very massive star at the

589
00:27:01,000 --> 00:27:07,359
core of this nebula and the winds from

590
00:27:04,569 --> 00:27:10,419
this star and the ultraviolet radiation

591
00:27:07,359 --> 00:27:12,879
from this star have carved this nebula

592
00:27:10,420 --> 00:27:15,250
there's a probably a disc of material

593
00:27:12,880 --> 00:27:17,410
around this star here in the center

594
00:27:15,250 --> 00:27:19,960
which constrains things in that

595
00:27:17,410 --> 00:27:22,360
direction and allows the winds to blow

596
00:27:19,960 --> 00:27:25,600
out in opposite directions creating this

597
00:27:22,359 --> 00:27:27,250
hourglass shape to it and we knew enough

598
00:27:25,599 --> 00:27:29,019
about the 3d structure of this that we

599

00:27:27,250 --> 00:27:32,440
could build the model and we actually

600
00:27:29,019 --> 00:27:34,900
fly down onto it 59 production then

601
00:27:32,440 --> 00:27:37,539
takes us flying through it transfers

602
00:27:34,900 --> 00:27:40,679
over to the next nebula which is the

603
00:27:37,539 --> 00:27:41,859
bubble nebula a visualization we did in

604
00:27:40,679 --> 00:27:44,440
2016

605
00:27:41,859 --> 00:27:49,479
another massive star in the core of it

606
00:27:44,440 --> 00:27:51,670
and it has had ejection of a wind and

607
00:27:49,480 --> 00:27:53,558
that wind has got this bubble that is

608
00:27:51,670 --> 00:27:55,960
being blown in the center of this nebula

609
00:27:53,558 --> 00:27:58,329
and you may look at this bubble and say

610
00:27:55,960 --> 00:28:02,529
hey wait a minute how come the star is

611
00:27:58,329 --> 00:28:03,519
off-center that is actually correct that

612
00:28:02,529 --> 00:28:06,579
it is off-center

613
00:28:03,519 --> 00:28:09,639

because the nebula is on the left and

614

00:28:06,579 --> 00:28:12,369

the nebula has a pressure from it that

615

00:28:09,640 --> 00:28:14,890

resists the flow of the bubble the wind

616

00:28:12,369 --> 00:28:17,529

that's pushing making this bubble on the

617

00:28:14,890 --> 00:28:20,650

right the nebula is not there and it is

618

00:28:17,529 --> 00:28:23,470

able to expand more freely and expand so

619

00:28:20,650 --> 00:28:25,990

that this star actually is off-center

620

00:28:23,470 --> 00:28:27,548

within this gorgeous glowing bubble of

621

00:28:25,990 --> 00:28:31,960

the nebula

622

00:28:27,548 --> 00:28:34,990

next nebula is the Lagoon Nebula this

623

00:28:31,960 --> 00:28:37,960

was a visualization we did in 2018 and

624

00:28:34,990 --> 00:28:40,569

again you see a massive star here this

625

00:28:37,960 --> 00:28:43,600

one is actually hidden behind a lot of

626

00:28:40,569 --> 00:28:46,898

dark gas but it's a radiation is causing

627

00:28:43,599 --> 00:28:50,109

all of the the cool colors within the

628
00:28:46,898 --> 00:28:52,509
nebula this visualization also then

629
00:28:50,109 --> 00:28:54,548
rises up through the rest of the Lagoon

630
00:28:52,509 --> 00:28:57,669
Nebula and shows you some gorgeous

631
00:28:54,548 --> 00:28:59,829
ionization fronts there red ridges along

632
00:28:57,669 --> 00:29:02,559
the edge of the dark gas where the

633
00:28:59,829 --> 00:29:05,740
ionizing radiation hits the gas and

634
00:29:02,558 --> 00:29:07,269
causes the gas to to ionize gorgeous

635
00:29:05,740 --> 00:29:10,058
little ionization fronts look for them

636
00:29:07,269 --> 00:29:13,569
in that sequence and the last of our

637
00:29:10,058 --> 00:29:15,609
massive star sequences is a massive star

638
00:29:13,569 --> 00:29:19,269
cluster a cluster of massive stars

639
00:29:15,609 --> 00:29:22,000
called westerlyn - and Westerlund - has

640
00:29:19,269 --> 00:29:24,639
more the largest collections of massive

641
00:29:22,000 --> 00:29:27,880
stars in a cluster within a nebula

642
00:29:24,640 --> 00:29:29,830
that's called gum 29 and I'm going to

643
00:29:27,880 --> 00:29:31,620
tell you a bit about this one so you can

644
00:29:29,829 --> 00:29:33,579
get understanding of how we visualize

645
00:29:31,619 --> 00:29:36,729
sequences like this all of these

646
00:29:33,579 --> 00:29:39,939
sequences are visualized using a similar

647
00:29:36,730 --> 00:29:42,399
technique so here is the Westerlund -

648
00:29:39,940 --> 00:29:45,159
image that do we used for the

649
00:29:42,398 --> 00:29:47,798
visualization the central region is the

650
00:29:45,159 --> 00:29:49,480
Hubble image and the outer regions come

651
00:29:47,798 --> 00:29:52,898
from a European Southern Observatory

652
00:29:49,480 --> 00:29:54,460
larger image of gum 29 and the first

653
00:29:52,898 --> 00:29:57,278
thing we're gonna do to visualize this

654
00:29:54,460 --> 00:30:00,548
is we're gonna get rid of all those

655
00:29:57,278 --> 00:30:04,869
stars I love being able to do that with

656

00:30:00,548 --> 00:30:07,839
one click that as you might guess is a

657
00:30:04,869 --> 00:30:10,288
tremendous amount of work by our image

658
00:30:07,839 --> 00:30:13,089
processors they do some fantastic work

659
00:30:10,288 --> 00:30:15,940
but we got to get those stars back okay

660
00:30:13,089 --> 00:30:17,259
and we're not going to go in and cut out

661
00:30:15,940 --> 00:30:19,538
images of every single one of those

662
00:30:17,259 --> 00:30:21,908
stars and and paste them back into our

663
00:30:19,538 --> 00:30:24,879
3d model instead we're gonna use

664
00:30:21,909 --> 00:30:27,549
something that I like to call PSF stars

665
00:30:24,880 --> 00:30:30,090
or synthetic stars all right so we can

666
00:30:27,548 --> 00:30:32,679
go through with our astronomical image

667
00:30:30,089 --> 00:30:34,449
astronomical software and identify all

668
00:30:32,679 --> 00:30:36,750
the stars in the images and we've got

669
00:30:34,450 --> 00:30:39,639
them in several different filters okay

670
00:30:36,750 --> 00:30:40,990

the five five five is in the middle of

671

00:30:39,638 --> 00:30:44,289
the visible this is

672

00:30:40,990 --> 00:30:46,929
the red and this is in the infrared okay

673

00:30:44,289 --> 00:30:49,990
and so here's an image of all the stars

674

00:30:46,929 --> 00:30:52,570
in the Hubble image that are that there

675

00:30:49,990 --> 00:30:55,509
and their colors so we can measure the

676

00:30:52,569 --> 00:30:57,399
brightness --is and colors of every star

677

00:30:55,509 --> 00:31:01,480
in the image and put them into a catalog

678

00:30:57,400 --> 00:31:05,170
okay we also know a lot about the point

679

00:31:01,480 --> 00:31:08,620
spread function of a star we know how it

680

00:31:05,170 --> 00:31:11,170
goes from a very small dot to a larger

681

00:31:08,619 --> 00:31:13,869
and larger and larger and how the light

682

00:31:11,170 --> 00:31:16,179
spreads out across the Hubble detector

683

00:31:13,869 --> 00:31:18,219
so if we know the brightness of the star

684

00:31:16,179 --> 00:31:21,670
we can predict an we can predict

685
00:31:18,220 --> 00:31:23,558
accurately what it will look like on the

686
00:31:21,670 --> 00:31:26,679
Hubble image alright so using this

687
00:31:23,558 --> 00:31:29,049
catalog together we can create the

688
00:31:26,679 --> 00:31:31,600
colors of the stars and we can create

689
00:31:29,049 --> 00:31:33,819
the look of those stars synthetically

690
00:31:31,599 --> 00:31:36,219
without having to reap go back through

691
00:31:33,819 --> 00:31:38,769
an photoshop and cut things out we can

692
00:31:36,220 --> 00:31:40,450
do it scientifically all right the other

693
00:31:38,769 --> 00:31:42,730
thing we need to do is actually separate

694
00:31:40,450 --> 00:31:46,058
out which stars are in the foreground

695
00:31:42,730 --> 00:31:48,099
and which stars are in the cluster and

696
00:31:46,058 --> 00:31:49,210
we do this with a scientific measurement

697
00:31:48,099 --> 00:31:52,599
which we call the color magnitude

698
00:31:49,210 --> 00:31:54,759
diagram a CMD and it's basically a color

699
00:31:52,599 --> 00:31:57,399
color diagram and you can see the ones

700
00:31:54,759 --> 00:31:59,679
highlighted in red here are the ones

701
00:31:57,400 --> 00:32:01,480
that scientists we were working with

702
00:31:59,679 --> 00:32:03,730
identified as these are the ones that

703
00:32:01,480 --> 00:32:06,400
are in the cluster and this big long

704
00:32:03,730 --> 00:32:08,620
white swath of Owens these are the ones

705
00:32:06,400 --> 00:32:11,350
in the foreground and so we're able to

706
00:32:08,619 --> 00:32:13,259
map out and we subtract out the cluster

707
00:32:11,349 --> 00:32:16,269
stars you can see there's a little

708
00:32:13,259 --> 00:32:19,299
residual but overall pretty good and

709
00:32:16,269 --> 00:32:20,679
that takes care of the Hubble stars the

710
00:32:19,299 --> 00:32:23,649
other thing we can do is we can go to

711
00:32:20,679 --> 00:32:25,420
the 2mass catalog and pull in the stars

712
00:32:23,650 --> 00:32:28,350
in the rest of the field all of these

713

00:32:25,420 --> 00:32:31,029
white stars here use the 2mass catalog

714
00:32:28,349 --> 00:32:33,279
match them to the Hubble band passes and

715
00:32:31,029 --> 00:32:36,190
reproduce stars in the external part of

716
00:32:33,279 --> 00:32:41,799
the field so we can recreate all the

717
00:32:36,190 --> 00:32:45,640
stars and statistically distribute them

718
00:32:41,799 --> 00:32:47,950
around the nebula for for the thing so

719
00:32:45,640 --> 00:32:51,850
now we've got to get back to the nebula

720
00:32:47,950 --> 00:32:54,558
itself and this nebula is done with what

721
00:32:51,849 --> 00:32:57,199
process that we call sculpted decoupage

722
00:32:54,558 --> 00:32:59,148
alright illustrate that I'm going to

723
00:32:57,200 --> 00:33:00,200
take this image the great wave of Ken

724
00:32:59,148 --> 00:33:03,678
Agha

725
00:33:00,200 --> 00:33:05,569
and if you cut it up we make multiple

726
00:33:03,679 --> 00:33:07,129
versions of it and you cut it up into

727
00:33:05,569 --> 00:33:10,038

its various pieces and you put little

728

00:33:07,128 --> 00:33:13,128

spacers between them you create what is

729

00:33:10,038 --> 00:33:16,519

called a decoupage box and it gives you

730

00:33:13,128 --> 00:33:20,240

a 3d look and feel by having multiple

731

00:33:16,519 --> 00:33:23,298

flat layers so we do the same sort of

732

00:33:20,240 --> 00:33:26,028

thing but we do it digitally in a 3d

733

00:33:23,298 --> 00:33:28,099

modeling program and we also instead of

734

00:33:26,028 --> 00:33:30,589

using flat layers we sculpt the various

735

00:33:28,099 --> 00:33:35,719

layers to give them texture and feel so

736

00:33:30,589 --> 00:33:37,819

in our digital program we have this type

737

00:33:35,720 --> 00:33:40,339

of configuration all right so the camera

738

00:33:37,819 --> 00:33:43,519

is up here looking down at the nebula

739

00:33:40,339 --> 00:33:45,470

year and what's highlighted white here

740

00:33:43,519 --> 00:33:48,528

are these are the background layers of

741

00:33:45,470 --> 00:33:50,569

the nebula then we have the pieces that

742
00:33:48,528 --> 00:33:53,569
are inside the nebula the pillars and

743
00:33:50,569 --> 00:33:55,638
all of the structures inside the nebula

744
00:33:53,569 --> 00:33:58,158
then we have the layers that are at the

745
00:33:55,638 --> 00:34:00,168
front side of the nebula the the dark

746
00:33:58,159 --> 00:34:03,139
gas and such that and the gas that's

747
00:34:00,169 --> 00:34:06,440
being irradiated by the stars as well as

748
00:34:03,138 --> 00:34:07,969
there is this small little fluffy stuff

749
00:34:06,440 --> 00:34:09,889
in front of it which we call the veil of

750
00:34:07,970 --> 00:34:11,960
the nebula it's sort of gas that's been

751
00:34:09,889 --> 00:34:14,750
blown out of the nebula in the direction

752
00:34:11,960 --> 00:34:16,849
toward where we are looking plus we've

753
00:34:14,750 --> 00:34:20,088
got in this model the cluster stars down

754
00:34:16,849 --> 00:34:22,039
here Hubble stars here

755
00:34:20,088 --> 00:34:24,648
statistically distributed in front of

756
00:34:22,039 --> 00:34:27,199
the nebula and then the two mass stars

757
00:34:24,648 --> 00:34:31,118
the ESO stars statistically distributed

758
00:34:27,199 --> 00:34:33,318
around those and this is how we create

759
00:34:31,119 --> 00:34:36,289
well I guess I call this the Christmas

760
00:34:33,318 --> 00:34:40,250
tree of our model we've got about 25

761
00:34:36,289 --> 00:34:42,918
layers of the nebula and about 25,000

762
00:34:40,250 --> 00:34:46,099
individual stars floating in 3d that

763
00:34:42,918 --> 00:34:48,799
we're gonna pass the camera through but

764
00:34:46,099 --> 00:34:51,019
that visually this is the build sequence

765
00:34:48,800 --> 00:34:53,990
starting from the back to the front so

766
00:34:51,019 --> 00:34:56,659
the background behind the nebula pulling

767
00:34:53,989 --> 00:35:00,129
in the cluster stars all the pieces are

768
00:34:56,659 --> 00:35:02,210
inside the nebula many of these the

769
00:35:00,130 --> 00:35:04,548
pillars that are pointing toward the

770

00:35:02,210 --> 00:35:06,349
cluster at the center so we get to the

771
00:35:04,548 --> 00:35:07,559
front part of the nebula and then the

772
00:35:06,349 --> 00:35:10,920
veil

773
00:35:07,559 --> 00:35:13,709
bring in the Hubble Stars and the stars

774
00:35:10,920 --> 00:35:16,680
this is the full 3d model as you watch

775
00:35:13,708 --> 00:35:21,379
it that we then fly through to build for

776
00:35:16,679 --> 00:35:24,389
it so this same sort of sequence of

777
00:35:21,380 --> 00:35:26,278
sculpted decoupage procedure is what we

778
00:35:24,389 --> 00:35:28,048
use for all of these nebula sequences

779
00:35:26,278 --> 00:35:29,608
and we'll actually also use it for one

780
00:35:28,048 --> 00:35:33,349
of the galaxy sequences I'll show you in

781
00:35:29,608 --> 00:35:37,018
just a minute all right back to the film

782
00:35:33,349 --> 00:35:40,048
the nebula the nebula movement ends and

783
00:35:37,018 --> 00:35:42,568
we go into the galaxy movement and the

784
00:35:40,048 --> 00:35:45,900

galaxy movement begins with probably the

785

00:35:42,568 --> 00:35:49,588

toughest shot in the entire film

786

00:35:45,900 --> 00:35:52,439

this was the galaxy Traverse sequence in

787

00:35:49,588 --> 00:35:54,838

which we had to fly through a Milky Way

788

00:35:52,438 --> 00:35:56,670

galaxy we flew out of our solar system

789

00:35:54,838 --> 00:35:58,588

and through the stars of the galaxy now

790

00:35:56,670 --> 00:36:02,670

we want to escape the galaxy and go out

791

00:35:58,588 --> 00:36:04,858

and explore other galaxies and I gotta

792

00:36:02,670 --> 00:36:07,798

say I probably spent 4 to 6 weeks

793

00:36:04,858 --> 00:36:10,199

working on this sequence so I'm gonna

794

00:36:07,798 --> 00:36:13,978

tell you about it cuz it was a quite a

795

00:36:10,199 --> 00:36:15,900

lot of work it began at the Astro VA's

796

00:36:13,978 --> 00:36:17,998

conference that was held in Pasadena

797

00:36:15,900 --> 00:36:19,769

last summer where the astronomy

798

00:36:17,998 --> 00:36:22,528

visualization experts got together and

799
00:36:19,768 --> 00:36:26,068
chatted about things and somebody showed

800
00:36:22,528 --> 00:36:28,798
this image this is gas and dust in a

801
00:36:26,068 --> 00:36:31,739
spiral galaxy but it's not an

802
00:36:28,798 --> 00:36:35,670
observation this is a computer

803
00:36:31,739 --> 00:36:37,708
simulation that looks so realistic ok

804
00:36:35,670 --> 00:36:40,289
this is the fire simulations that

805
00:36:37,708 --> 00:36:42,659
feedback and realistic environment by

806
00:36:40,289 --> 00:36:45,239
Hummels Hopkins and Wetzel and Cameron

807
00:36:42,659 --> 00:36:47,909
Hummels who presented it I said oh I

808
00:36:45,239 --> 00:36:49,889
gotta get this data this is so cool I

809
00:36:47,909 --> 00:36:52,949
can use that the visualizations of this

810
00:36:49,889 --> 00:36:55,139
could be fantastic so if they had this

811
00:36:52,949 --> 00:36:57,688
one as a Milky Way analog with 150

812
00:36:55,139 --> 00:36:59,400
million points and all the details of

813
00:36:57,688 --> 00:37:01,288
the star formation going on there I said

814
00:36:59,400 --> 00:37:03,298
great let's take a look at this and I

815
00:37:01,289 --> 00:37:06,390
played with it and I got to visualizing

816
00:37:03,298 --> 00:37:09,869
it and I said fantastic look at this

817
00:37:06,389 --> 00:37:11,969
this just feels like a galaxy look at

818
00:37:09,869 --> 00:37:16,349
all the dust and all the stuff it's just

819
00:37:11,969 --> 00:37:18,179
oh wow all I got to do you know I got I

820
00:37:16,349 --> 00:37:20,300
got a I got to do is just fly through

821
00:37:18,179 --> 00:37:22,910
this and I said to myself hey

822
00:37:20,300 --> 00:37:24,680
Sunset Boulevard we're ready for your

823
00:37:22,909 --> 00:37:26,259
cult our close-up okay

824
00:37:24,679 --> 00:37:30,519
I always thinking this is gonna be the

825
00:37:26,260 --> 00:37:33,830
simplest sequence at all and then I

826
00:37:30,519 --> 00:37:35,750
tried it and it looks okay here and as

827

00:37:33,829 --> 00:37:40,460
you get closer it starts to break down

828
00:37:35,750 --> 00:37:44,030
and as you get inside it it's blue it

829
00:37:40,460 --> 00:37:45,679
looked and I could adjust the parameters

830
00:37:44,030 --> 00:37:47,900
and play with it and I could get okay I

831
00:37:45,679 --> 00:37:49,429
can get the foreground star stuff here

832
00:37:47,900 --> 00:37:52,550
but look at that background stuff it's

833
00:37:49,429 --> 00:37:54,529
just all muddy and disgusting and I was

834
00:37:52,550 --> 00:37:56,600
going back and forth and back and forth

835
00:37:54,530 --> 00:37:59,030
because I wasn't getting what I needed

836
00:37:56,599 --> 00:38:00,650
which is this this is an image of our

837
00:37:59,030 --> 00:38:02,990
Milky Way okay

838
00:38:00,650 --> 00:38:05,570
and you can see this beautiful structure

839
00:38:02,989 --> 00:38:07,969
of the dark gas and all the light the

840
00:38:05,570 --> 00:38:10,220
the the the brightness of the halo in

841
00:38:07,969 --> 00:38:12,649

behind it and stuff like I couldn't get

842

00:38:10,219 --> 00:38:16,730

it until I smacked myself in the head

843

00:38:12,650 --> 00:38:22,099

you go on dude you can't see that dark

844

00:38:16,730 --> 00:38:23,840

stuff unless you got backlight right you

845

00:38:22,099 --> 00:38:27,019

really need to make sure you get the

846

00:38:23,840 --> 00:38:29,210

full backlight in behind your dark gas

847

00:38:27,019 --> 00:38:31,820

otherwise the dark gas is just you know

848

00:38:29,210 --> 00:38:33,320

it doesn't add to your picture so

849

00:38:31,820 --> 00:38:35,720

remember that foreground background

850

00:38:33,320 --> 00:38:38,809

stuff I had to go back to that

851

00:38:35,719 --> 00:38:39,949

foreground background and reinterpret it

852

00:38:38,809 --> 00:38:42,949

in two new ways

853

00:38:39,949 --> 00:38:44,689

so my multi-layered starv is had to have

854

00:38:42,949 --> 00:38:46,759

the foreground okay which was the same

855

00:38:44,690 --> 00:38:48,440

as I did for the star thing this is the

856
00:38:46,760 --> 00:38:50,300
Hipparcos catalog of the other

857
00:38:48,440 --> 00:38:53,000
foreground stars these are the bright

858
00:38:50,300 --> 00:38:55,430
stars that are in the near ground and

859
00:38:53,000 --> 00:38:57,199
for that you know I basically I only

860
00:38:55,429 --> 00:38:59,210
generated those stars along the camera

861
00:38:57,199 --> 00:39:00,859
path because there's like a hundred

862
00:38:59,210 --> 00:39:01,849
billion stars in the Milky Way I'm not

863
00:39:00,860 --> 00:39:02,480
going to generate a hundred billion

864
00:39:01,849 --> 00:39:04,190
stars

865
00:39:02,480 --> 00:39:06,530
I only generate the ones that I need

866
00:39:04,190 --> 00:39:09,440
that are along the camera path so I get

867
00:39:06,530 --> 00:39:11,630
you know tens of millions instead then I

868
00:39:09,440 --> 00:39:13,220
created in the mid ground which was that

869
00:39:11,630 --> 00:39:15,170
standard point cloud viz that I just

870
00:39:13,219 --> 00:39:16,909
showed you and that all worked but I

871
00:39:15,170 --> 00:39:19,340
recognized that when doing the

872
00:39:16,909 --> 00:39:21,920
mid-ground there's a lot of stars that

873
00:39:19,340 --> 00:39:23,990
were too faint and too small that you

874
00:39:21,920 --> 00:39:26,119
just ignored because they weren't they

875
00:39:23,989 --> 00:39:28,219
weren't bright enough to be seen but

876
00:39:26,119 --> 00:39:30,920
that light was getting lost in the

877
00:39:28,219 --> 00:39:33,058
procedure and so I collected all that

878
00:39:30,920 --> 00:39:36,358
light that was

879
00:39:33,059 --> 00:39:39,989
individually too faint to see but adding

880
00:39:36,358 --> 00:39:41,909
it together provided this 3d background

881
00:39:39,989 --> 00:39:44,130
so instead of having a 2d background for

882
00:39:41,909 --> 00:39:46,169
my galaxy I added in a full

883
00:39:44,130 --> 00:39:49,229
three-dimensional background that could

884

00:39:46,168 --> 00:39:51,900
then illuminate those dark dust clouds

885
00:39:49,228 --> 00:39:54,658
all right and then I was able to produce

886
00:39:51,900 --> 00:39:56,369
a test image like this I said yes I'm

887
00:39:54,659 --> 00:39:59,189
starting to get some dark dust clouds I

888
00:39:56,369 --> 00:40:00,989
can deal with this this is great and

889
00:39:59,188 --> 00:40:04,199
then we worked for several a couple more

890
00:40:00,989 --> 00:40:06,568
weeks and got to hear of the procedure

891
00:40:04,199 --> 00:40:09,659
for this is this is a shot from the film

892
00:40:06,568 --> 00:40:12,449
and one of the cool things about it was

893
00:40:09,659 --> 00:40:14,459
that in the simulations they had all the

894
00:40:12,449 --> 00:40:16,709
information on the star formation so

895
00:40:14,458 --> 00:40:18,958
these red clouds here and these blue

896
00:40:16,708 --> 00:40:22,288
clouds here these are emission and

897
00:40:18,958 --> 00:40:25,168
reflection nebulae that are tied to

898
00:40:22,289 --> 00:40:27,419

where stars have recently formed in the

899

00:40:25,168 --> 00:40:29,009

simulation because I got the information

900

00:40:27,418 --> 00:40:31,228

about when stars have formed in the

901

00:40:29,009 --> 00:40:33,469

simulation and the gas around the room

902

00:40:31,228 --> 00:40:36,808

newly forming stars will be illuminated

903

00:40:33,469 --> 00:40:38,880

up and will glow red or will if it's a

904

00:40:36,809 --> 00:40:41,669

little older will actually reflect the

905

00:40:38,880 --> 00:40:44,729

light of the newborn stars and glow blue

906

00:40:41,668 --> 00:40:46,650

and I know that no one will ever notice

907

00:40:44,728 --> 00:40:49,198

that that these are actually the correct

908

00:40:46,650 --> 00:40:51,719

star forming places in the galaxy but I

909

00:40:49,199 --> 00:40:53,608

know and it's really geeky cool to be

910

00:40:51,719 --> 00:40:56,159

able to say that yes these are the right

911

00:40:53,608 --> 00:40:57,358

places for those h2 regions and h1

912

00:40:56,159 --> 00:41:00,449

regions in the galaxy

913
00:40:57,358 --> 00:41:03,058
alright so we fly out of our galaxy in

914
00:41:00,449 --> 00:41:05,249
this sequence and we come upon one of

915
00:41:03,059 --> 00:41:08,969
Hubble's most famous galaxy observations

916
00:41:05,248 --> 00:41:11,158
the Whirlpool Galaxy ok and this is the

917
00:41:08,969 --> 00:41:12,358
Hubble visualization of it and I'll go

918
00:41:11,159 --> 00:41:13,979
through this just relatively quickly

919
00:41:12,358 --> 00:41:16,768
because this was another major project

920
00:41:13,978 --> 00:41:19,108
here so this is Hubble's observation of

921
00:41:16,768 --> 00:41:21,988
the whirlpool and we didn't want to deal

922
00:41:19,108 --> 00:41:25,828
with the satellite galaxies so goodbye

923
00:41:21,989 --> 00:41:27,329
we erased it for this and then we had to

924
00:41:25,829 --> 00:41:29,429
separate this into its various

925
00:41:27,329 --> 00:41:31,499
components and you can see you've got

926
00:41:29,429 --> 00:41:34,739
these old stars here that are sort of

927
00:41:31,498 --> 00:41:37,198
yellowish the young stars here which are

928
00:41:34,739 --> 00:41:38,668
sort of bluish and greenish and then

929
00:41:37,199 --> 00:41:41,369
you've got these red star forming

930
00:41:38,668 --> 00:41:43,558
regions here and we first tried doing

931
00:41:41,369 --> 00:41:45,030
the standard RGB separation red green

932
00:41:43,559 --> 00:41:47,880
blue separation

933
00:41:45,030 --> 00:41:50,970
and it really didn't work and then I hit

934
00:41:47,880 --> 00:41:53,309
my head oh we've got sort of cyan and

935
00:41:50,969 --> 00:41:56,819
sort of magenta and yellow we're gonna

936
00:41:53,309 --> 00:41:58,860
do the CMYK separation color separation

937
00:41:56,820 --> 00:41:59,340
you've never heard of it don't worry

938
00:41:58,860 --> 00:42:01,500
about it

939
00:41:59,340 --> 00:42:05,130
it's a standard color separation using

940
00:42:01,500 --> 00:42:08,369
cyan magenta and yellow and black and

941

00:42:05,130 --> 00:42:10,380
these were the three the cyan magenta

942
00:42:08,369 --> 00:42:13,259
and yellow separations of the image

943
00:42:10,380 --> 00:42:15,210
which we could then transform into the

944
00:42:13,260 --> 00:42:17,910
young stars from the blue from the cyan

945
00:42:15,210 --> 00:42:20,699
the emission nebula from the magenta and

946
00:42:17,909 --> 00:42:23,399
these are pink on the old stars that are

947
00:42:20,699 --> 00:42:24,750
yellowish and whitish and so now we have

948
00:42:23,400 --> 00:42:27,240
two-dimensional images that sort of

949
00:42:24,750 --> 00:42:30,300
separate out the various components of

950
00:42:27,239 --> 00:42:34,319
that galaxy we also could use the black

951
00:42:30,300 --> 00:42:36,840
to do the dust lanes in the galaxy and

952
00:42:34,320 --> 00:42:38,250
Hubble's dust lanes are fine but really

953
00:42:36,840 --> 00:42:40,559
if you want to look at dust you want to

954
00:42:38,250 --> 00:42:43,440
go really into the infrared so we also

955
00:42:40,559 --> 00:42:46,529

use the spitzer image here to get the

956

00:42:43,440 --> 00:42:49,440

dust lanes for the the Whirlpool Galaxy

957

00:42:46,530 --> 00:42:51,440

alright combining these we had to use

958

00:42:49,440 --> 00:42:55,139

what we call point cloud visualizations

959

00:42:51,440 --> 00:42:57,150

taking those images and creating point

960

00:42:55,139 --> 00:42:58,379

clouds above and below those images so

961

00:42:57,150 --> 00:43:00,539

these are you know two-dimensional

962

00:42:58,380 --> 00:43:01,950

images so you make them 3d and give them

963

00:43:00,539 --> 00:43:03,119

the right density structure in the

964

00:43:01,949 --> 00:43:04,829

printer and the presentation and

965

00:43:03,119 --> 00:43:07,619

everything and we ended up creating

966

00:43:04,829 --> 00:43:09,150

about a hundred million point clouds and

967

00:43:07,619 --> 00:43:13,170

we have custom software called

968

00:43:09,150 --> 00:43:16,050

pointillism to to handle it and these

969

00:43:13,170 --> 00:43:18,030

sequences were a little heavy on the hit

970
00:43:16,050 --> 00:43:20,789
my maximum which is about three CPU

971
00:43:18,030 --> 00:43:23,250
hours per frame that's not frames per

972
00:43:20,789 --> 00:43:26,159
second it's hours per frame three hours

973
00:43:23,250 --> 00:43:29,519
to render one frame of this sequence at

974
00:43:26,159 --> 00:43:31,409
4k that's usually my maximum I well I

975
00:43:29,519 --> 00:43:32,880
don't like to go beyond that fortunately

976
00:43:31,409 --> 00:43:35,670
a hundred million point clouds was it

977
00:43:32,880 --> 00:43:38,070
was doable in that for this project okay

978
00:43:35,670 --> 00:43:40,409
we rendered all of them separately so we

979
00:43:38,070 --> 00:43:42,930
have the old stars here we have the

980
00:43:40,409 --> 00:43:45,719
young stars here we have the emission

981
00:43:42,929 --> 00:43:48,989
nebula here along with the cluster stars

982
00:43:45,719 --> 00:43:52,259
inside those things and boom together

983
00:43:48,989 --> 00:43:54,089
they form the Whirlpool Galaxy now I'm

984
00:43:52,260 --> 00:43:56,190
going to digress for one little second

985
00:43:54,090 --> 00:43:58,680
here okay because we went further than

986
00:43:56,190 --> 00:44:00,210
this with the universe of learning

987
00:43:58,679 --> 00:44:02,069
we have our educational project here

988
00:44:00,210 --> 00:44:04,470
called the universe of learning and

989
00:44:02,070 --> 00:44:06,330
Hubble isn't the only one that has

990
00:44:04,469 --> 00:44:08,789
observed the Whirlpool Galaxy as I've

991
00:44:06,329 --> 00:44:10,679
already used the Spitzer image and the

992
00:44:08,789 --> 00:44:13,409
Chandra x-ray Observatory observed it as

993
00:44:10,679 --> 00:44:16,289
well so we went further and we took the

994
00:44:13,409 --> 00:44:19,829
Spitzer data and the Chandra data and we

995
00:44:16,289 --> 00:44:22,829
made 3d models for them as well so we've

996
00:44:19,829 --> 00:44:25,769
got the two wavelengths of infrared and

997
00:44:22,829 --> 00:44:27,750
two energies for the x-ray combining

998

00:44:25,769 --> 00:44:32,099
them we can cross compare between

999
00:44:27,750 --> 00:44:34,289
infrared visible and x-ray in a short

1000
00:44:32,099 --> 00:44:36,869
little film that we called shedding new

1001
00:44:34,289 --> 00:44:40,860
light on the Whirlpool Galaxy giving you

1002
00:44:36,869 --> 00:44:43,230
a visual representation of the value of

1003
00:44:40,860 --> 00:44:45,000
all these NASA observatories and the

1004
00:44:43,230 --> 00:44:47,490
strength of doing multi-wavelength

1005
00:44:45,000 --> 00:44:49,320
astronomy this is an example of one of

1006
00:44:47,489 --> 00:44:51,209
the sort of educational the learning

1007
00:44:49,320 --> 00:44:53,070
projects that we can do with NASA's

1008
00:44:51,210 --> 00:44:55,340
universe of learning based on some of

1009
00:44:53,070 --> 00:44:58,050
these visualization projects all right

1010
00:44:55,340 --> 00:45:00,510
back to the film all right

1011
00:44:58,050 --> 00:45:02,490
the galaxies sequence continues with a

1012
00:45:00,510 --> 00:45:05,790

new visualization we did a Stephan's

1013

00:45:02,489 --> 00:45:07,259

quintet of galaxies and this over here

1014

00:45:05,789 --> 00:45:09,090

on the right hand side those five

1015

00:45:07,260 --> 00:45:12,000

galaxies are what's usually called the

1016

00:45:09,090 --> 00:45:14,519

quintet although they are actually just

1017

00:45:12,000 --> 00:45:17,309

a quartet because this blue galaxy here

1018

00:45:14,519 --> 00:45:20,070

is a foreground galaxy that happens to

1019

00:45:17,309 --> 00:45:22,230

be projected along the line of sight but

1020

00:45:20,070 --> 00:45:25,080

while working on this project I also

1021

00:45:22,230 --> 00:45:27,150

learned that this galaxy over here is on

1022

00:45:25,079 --> 00:45:31,049

the left is that the same distance as

1023

00:45:27,150 --> 00:45:33,660

the main grouping so this quintet that's

1024

00:45:31,050 --> 00:45:35,190

actually a quartet is really a sextet

1025

00:45:33,659 --> 00:45:37,920

that's really actually really is a

1026

00:45:35,190 --> 00:45:40,619

quintet all right so the point of all

1027
00:45:37,920 --> 00:45:43,559
this is that galaxies can be found in

1028
00:45:40,619 --> 00:45:45,299
these groups together we fly through the

1029
00:45:43,559 --> 00:45:48,559
quintet of galaxies in the movie and

1030
00:45:45,300 --> 00:45:51,090
take us into the candles galaxies survey

1031
00:45:48,559 --> 00:45:54,420
one of the largest visualizations we've

1032
00:45:51,090 --> 00:45:58,470
ever done thirty-five thousand galaxies

1033
00:45:54,420 --> 00:46:01,740
stretched out across across space we did

1034
00:45:58,469 --> 00:46:04,709
this in 2017 and we fly through this as

1035
00:46:01,739 --> 00:46:07,259
a preparation for seeing the Hubble

1036
00:46:04,710 --> 00:46:09,780
Ultra Deep Field and we hit the climax

1037
00:46:07,260 --> 00:46:11,160
of the film and you get that resplendent

1038
00:46:09,780 --> 00:46:15,210
chord

1039
00:46:11,159 --> 00:46:16,529
Eric has been building up to and when

1040
00:46:15,210 --> 00:46:18,960
you're flying through the Hubble

1041
00:46:16,530 --> 00:46:21,210
ultra-deep field we want to tell you a

1042
00:46:18,960 --> 00:46:24,389
story and it's a story I think you all

1043
00:46:21,210 --> 00:46:29,550
are familiar with the story is a long

1044
00:46:24,389 --> 00:46:33,000
time ago in a galaxy far far away now

1045
00:46:29,550 --> 00:46:35,910
this is one of the things that George

1046
00:46:33,000 --> 00:46:39,599
Lucas accidentally got right in Star

1047
00:46:35,909 --> 00:46:40,199
Wars because galaxies that are far far

1048
00:46:39,599 --> 00:46:43,920
away

1049
00:46:40,199 --> 00:46:47,009
are galaxies that are seen a long time

1050
00:46:43,920 --> 00:46:48,840
ago the light from a galaxy can take

1051
00:46:47,010 --> 00:46:52,830
billions of years to cross the

1052
00:46:48,840 --> 00:46:55,440
intervening space before we see it so if

1053
00:46:52,829 --> 00:46:58,980
the light from the galaxy left it 5

1054
00:46:55,440 --> 00:47:03,119
billion years ago we're seeing that

1055

00:46:58,980 --> 00:47:05,070
galaxy as it was 5 billion years ago all

1056
00:47:03,119 --> 00:47:07,380
right a galaxy that's 10 million light

1057
00:47:05,070 --> 00:47:10,769
years away we're seeing as it was 10

1058
00:47:07,380 --> 00:47:15,059
billion years ago if we look at galaxies

1059
00:47:10,769 --> 00:47:18,090
nearby and further away and further away

1060
00:47:15,059 --> 00:47:20,789
their morphology changes because

1061
00:47:18,090 --> 00:47:24,600
galaxies develop over these billion year

1062
00:47:20,789 --> 00:47:28,199
timescales we can see the development of

1063
00:47:24,599 --> 00:47:31,559
galaxies we look out into space we look

1064
00:47:28,199 --> 00:47:34,230
back into time and we can see how

1065
00:47:31,559 --> 00:47:37,049
galaxies have developed over the history

1066
00:47:34,230 --> 00:47:39,929
of the universe and that's one of the

1067
00:47:37,050 --> 00:47:43,950
most powerful things that we find in

1068
00:47:39,929 --> 00:47:45,509
this Hubble ultra-deep field so to do do

1069
00:47:43,949 --> 00:47:47,699

this we actually have to have the

1070

00:47:45,510 --> 00:47:50,010

individual galaxies so we take this

1071

00:47:47,699 --> 00:47:52,079

Hubble ultra-deep field and effectively

1072

00:47:50,010 --> 00:47:54,750

we just cut little postage stamps around

1073

00:47:52,079 --> 00:47:56,579

every single one of these galaxies now

1074

00:47:54,750 --> 00:47:58,710

we're not going to do this by hand okay

1075

00:47:56,579 --> 00:48:00,750

you're just somebody would go crazy

1076

00:47:58,710 --> 00:48:03,240

we actually have scientific software

1077

00:48:00,750 --> 00:48:04,800

that does all this and we pull out those

1078

00:48:03,239 --> 00:48:08,639

little postage stamps and we bring it

1079

00:48:04,800 --> 00:48:09,900

into our 3d software now this dense

1080

00:48:08,639 --> 00:48:11,730

region in here that's the Hubble

1081

00:48:09,900 --> 00:48:14,070

ultra-deep field within the much larger

1082

00:48:11,730 --> 00:48:16,619

great observatories origins deep survey

1083

00:48:14,070 --> 00:48:20,250

or the goods field in our 3d and these

1084
00:48:16,619 --> 00:48:22,380
are just the the rectangles representing

1085
00:48:20,250 --> 00:48:24,019
the galaxies images and if we look at it

1086
00:48:22,380 --> 00:48:25,640
from the side

1087
00:48:24,019 --> 00:48:28,099
the cameras over here we're looking down

1088
00:48:25,639 --> 00:48:31,309
through it and you can see this this big

1089
00:48:28,099 --> 00:48:33,920
long pyramid of galaxies stretching out

1090
00:48:31,309 --> 00:48:35,599
across the universe and I wanted to show

1091
00:48:33,920 --> 00:48:38,809
you this because I wanted to admit to

1092
00:48:35,599 --> 00:48:41,750
you that we cheated here okay I like to

1093
00:48:38,809 --> 00:48:43,519
tell you when we when we cheat this

1094
00:48:41,750 --> 00:48:47,179
pyramid should be about five hundred

1095
00:48:43,519 --> 00:48:49,400
times longer than it is okay

1096
00:48:47,179 --> 00:48:51,769
the universe is a really really really

1097
00:48:49,400 --> 00:48:55,639
big place this is a very long and thin

1098
00:48:51,769 --> 00:48:57,588
pyramid but if I did it correct

1099
00:48:55,639 --> 00:48:59,420
scientifically correctly instead of

1100
00:48:57,588 --> 00:49:02,029
flying through in a minute it would take

1101
00:48:59,420 --> 00:49:03,530
about eight hours to fly through it and

1102
00:49:02,030 --> 00:49:05,000
I don't think you guys would want to sit

1103
00:49:03,530 --> 00:49:07,160
around and wait eight hours to fly

1104
00:49:05,000 --> 00:49:08,719
through the altitude field so we

1105
00:49:07,159 --> 00:49:10,309
scrunched it up so that we could fly

1106
00:49:08,719 --> 00:49:13,608
through it in a reasonable amount of

1107
00:49:10,309 --> 00:49:15,710
time plus there's one other cheat that

1108
00:49:13,608 --> 00:49:16,159
we did but it has a really good reason

1109
00:49:15,710 --> 00:49:18,050
for it

1110
00:49:16,159 --> 00:49:21,319
because when you look at the most

1111
00:49:18,050 --> 00:49:23,359
distant objects in the Deep Field they

1112

00:49:21,320 --> 00:49:25,880
are the galaxies that are the farthest

1113
00:49:23,358 --> 00:49:28,338
away seen at the earliest times of the

1114
00:49:25,880 --> 00:49:31,730
universe and the earliest development

1115
00:49:28,338 --> 00:49:34,250
and they are these red dots okay

1116
00:49:31,730 --> 00:49:35,750
they are the galaxies who are redshifted

1117
00:49:34,250 --> 00:49:37,579
the most so their light is all the way

1118
00:49:35,750 --> 00:49:39,409
into the infrared and they're just

1119
00:49:37,579 --> 00:49:41,239
beginning to develop there could be even

1120
00:49:39,409 --> 00:49:44,629
called proto galaxies so they're just

1121
00:49:41,239 --> 00:49:47,179
blobs all right these are the most

1122
00:49:44,630 --> 00:49:48,650
important galaxies that we find in the

1123
00:49:47,179 --> 00:49:52,039
Ultra Deep Field because they show us

1124
00:49:48,650 --> 00:49:54,530
the earliest stages that we can find in

1125
00:49:52,039 --> 00:49:58,250
the Hubble Ultra Deep Field of galaxies

1126
00:49:54,530 --> 00:50:01,070

and I wanted a red dot galaxy to be the

1127

00:49:58,250 --> 00:50:02,900

last thing that you see so in this front

1128

00:50:01,070 --> 00:50:05,869

of this shot as we exit the Deep Field

1129

00:50:02,900 --> 00:50:08,210

this galaxy right here doesn't belong

1130

00:50:05,869 --> 00:50:11,480

there it's actually in the Ultra Deep

1131

00:50:08,210 --> 00:50:12,889

Field okay but I had the guys at 59

1132

00:50:11,480 --> 00:50:15,380

productions take it from where it was

1133

00:50:12,889 --> 00:50:17,569

and push it into our field so that we

1134

00:50:15,380 --> 00:50:20,088

could fly past and this would be the

1135

00:50:17,570 --> 00:50:21,530

last galaxy you see okay so I cheated

1136

00:50:20,088 --> 00:50:24,108

but there's a scientific reason behind

1137

00:50:21,530 --> 00:50:26,660

that cheat so that a red dot galaxy

1138

00:50:24,108 --> 00:50:28,338

would be the last thing you see alright

1139

00:50:26,659 --> 00:50:30,469

so we've taken you through the whole

1140

00:50:28,338 --> 00:50:32,088

universe right and we're sitting out the

1141
00:50:30,469 --> 00:50:34,250
edge of the inner edge of yours and

1142
00:50:32,088 --> 00:50:37,039
we're just gonna leave you there no no

1143
00:50:34,250 --> 00:50:37,730
no now we bring in Eric's pet project

1144
00:50:37,039 --> 00:50:40,279
the virtual

1145
00:50:37,730 --> 00:50:42,590
choir all right and so after we get

1146
00:50:40,280 --> 00:50:45,980
through the whole universe and suddenly

1147
00:50:42,590 --> 00:50:47,750
these swirls start appearing and they're

1148
00:50:45,980 --> 00:50:50,240
really cool this is a cool graphic

1149
00:50:47,750 --> 00:50:52,460
effect I honestly you know when I first

1150
00:50:50,239 --> 00:50:54,199
saw these they reminded me of the the

1151
00:50:52,460 --> 00:50:57,800
trails left in old particle physics

1152
00:50:54,199 --> 00:51:01,309
experiments but they're not they are

1153
00:50:57,800 --> 00:51:05,300
actually eric whitacre conducting the

1154
00:51:01,309 --> 00:51:08,449
universe when he conducted the orchestra

1155
00:51:05,300 --> 00:51:10,910
to record this symphony a second time

1156
00:51:08,449 --> 00:51:15,439
they put Eric in a motion capture suit

1157
00:51:10,909 --> 00:51:18,259
they recorded his motions and Eric is a

1158
00:51:15,440 --> 00:51:20,179
performer okay he is a performer okay

1159
00:51:18,260 --> 00:51:22,010
and I think you can sort of like see can

1160
00:51:20,179 --> 00:51:24,919
you imagine his baton here in his arms

1161
00:51:22,010 --> 00:51:27,290
wailing and swishing these were

1162
00:51:24,920 --> 00:51:29,840
generated from the motion capture of

1163
00:51:27,289 --> 00:51:31,550
Eric conducting the symphony let's get

1164
00:51:29,840 --> 00:51:33,680
that kind of cool thing that you'd never

1165
00:51:31,550 --> 00:51:37,340
know unless you came to this talk okay

1166
00:51:33,679 --> 00:51:40,279
and then this segues into the virtual

1167
00:51:37,340 --> 00:51:43,250
choir okay and all of these P all of

1168
00:51:40,280 --> 00:51:45,830
these singers floating through space now

1169

00:51:43,250 --> 00:51:49,460
Eric started the virtual choir after

1170
00:51:45,829 --> 00:51:51,889
this woman named Britten posted a video

1171
00:51:49,460 --> 00:51:54,170
on youtube of her seeing one of Eric's

1172
00:51:51,889 --> 00:51:55,339
song as a dedication to him and of

1173
00:51:54,170 --> 00:51:59,510
course he was flattered and everything

1174
00:51:55,340 --> 00:52:02,180
but he said wait a minute if I got a

1175
00:51:59,510 --> 00:52:05,060
bunch of people to record themselves

1176
00:52:02,179 --> 00:52:06,949
singing I could sort of put them

1177
00:52:05,059 --> 00:52:09,019
together into this virtual choir of

1178
00:52:06,949 --> 00:52:11,868
people who never met each other but

1179
00:52:09,019 --> 00:52:14,389
we're all singing in unison so he

1180
00:52:11,869 --> 00:52:18,350
uploaded a video of him conducting one

1181
00:52:14,389 --> 00:52:21,469
of his pieces looks a room quay and the

1182
00:52:18,349 --> 00:52:23,239
singers sat in their living rooms or

1183
00:52:21,469 --> 00:52:26,029

dining rooms or bedrooms or whatever and

1184

00:52:23,239 --> 00:52:28,669

recorded themselves singing to his

1185

00:52:26,030 --> 00:52:32,210

conduction and then submitted his videos

1186

00:52:28,670 --> 00:52:33,740

and his team put it together for his

1187

00:52:32,210 --> 00:52:36,670

virtual choir here's Eric doing the

1188

00:52:33,739 --> 00:52:39,739

conducting and hear all the people

1189

00:52:36,670 --> 00:52:43,970

singing their various parts from her

1190

00:52:39,739 --> 00:52:47,089

from you know totally distant places all

1191

00:52:43,969 --> 00:52:48,649

right he such a success the choral

1192

00:52:47,090 --> 00:52:51,619

people absolutely loved it he did it

1193

00:52:48,650 --> 00:52:53,869

again with a whole bunch more people

1194

00:52:51,619 --> 00:52:55,969

separate across all various countries

1195

00:52:53,869 --> 00:52:58,068

and did it again with thousands of

1196

00:52:55,969 --> 00:53:00,920

people and then upped it so that we had

1197

00:52:58,068 --> 00:53:02,088

a 3d they had a 3d eric conducting all

1198
00:53:00,920 --> 00:53:05,298
these people okay

1199
00:53:02,088 --> 00:53:08,630
so deep field was to be the fifth Arkin

1200
00:53:05,298 --> 00:53:12,288
incarnation of his virtual choir and he

1201
00:53:08,630 --> 00:53:16,940
got more than 8,000 singers around the

1202
00:53:12,289 --> 00:53:19,369
globe to submit so you will see 8,000

1203
00:53:16,940 --> 00:53:22,298
singers in this film and this is a

1204
00:53:19,369 --> 00:53:24,619
reason why the credits take six minutes

1205
00:53:22,298 --> 00:53:27,889
every single one of these virtual choir

1206
00:53:24,619 --> 00:53:30,469
singers is in the credits okay but

1207
00:53:27,889 --> 00:53:32,748
because they were working with us and I

1208
00:53:30,469 --> 00:53:35,539
gotta give music productions a huge and

1209
00:53:32,748 --> 00:53:38,298
they wanted to include science and

1210
00:53:35,539 --> 00:53:40,069
technology in it so not only did you

1211
00:53:38,298 --> 00:53:42,469
upload your video you also had a chance

1212
00:53:40,068 --> 00:53:45,228
to earn these badges on their on their

1213
00:53:42,469 --> 00:53:46,369
website there were 18 badges anybody

1214
00:53:45,228 --> 00:53:48,228
recognize this pattern

1215
00:53:46,369 --> 00:53:51,048
yeah the James Webb Space Telescope

1216
00:53:48,228 --> 00:53:54,228
pattern of hexagons each one of these is

1217
00:53:51,048 --> 00:53:56,509
a separate badge involving science

1218
00:53:54,228 --> 00:53:59,509
technology engineering art and design

1219
00:53:56,509 --> 00:54:01,278
and math so called steam education for

1220
00:53:59,509 --> 00:54:04,670
example one of them was the Hubble

1221
00:54:01,278 --> 00:54:06,679
ultra-deep field sauna field where if you

1222
00:54:04,670 --> 00:54:08,509
ran your cursor over these things the

1223
00:54:06,679 --> 00:54:10,608
redshift of the galaxies gave you a note

1224
00:54:08,509 --> 00:54:13,099
that was really low if it was far away

1225
00:54:10,608 --> 00:54:15,619
or very high if it was nearby you had a

1226

00:54:13,099 --> 00:54:17,390
sonification all sorts of amazing things

1227
00:54:15,619 --> 00:54:19,519
and I just was like this

1228
00:54:17,389 --> 00:54:21,710
these are partners you want to work with

1229
00:54:19,518 --> 00:54:23,028
okay these are the kind of people you

1230
00:54:21,710 --> 00:54:25,969
really want to work with because they

1231
00:54:23,028 --> 00:54:27,920
don't just do want to do it halfway they

1232
00:54:25,969 --> 00:54:31,608
really go all the way to combining

1233
00:54:27,920 --> 00:54:33,409
science and art together alright so now

1234
00:54:31,608 --> 00:54:36,498
we begin the word turn home the final

1235
00:54:33,409 --> 00:54:39,348
sequence of a film all right and they

1236
00:54:36,498 --> 00:54:42,528
came out through the Hubble Space

1237
00:54:39,349 --> 00:54:44,509
Telescope sitting over earth and I gotta

1238
00:54:42,528 --> 00:54:47,239
be honest with you Greg bacon and I when

1239
00:54:44,509 --> 00:54:50,449
we saw this sequence said this is kind

1240
00:54:47,239 --> 00:54:52,519

of trite so many documentaries have the

1241
00:54:50,449 --> 00:54:55,399
camera moving through the Hubble mirror

1242
00:54:52,518 --> 00:54:59,988
to see things and like alright okay I

1243
00:54:55,400 --> 00:55:03,559
guess but we changed our minds

1244
00:54:59,989 --> 00:55:05,170
because by coming out with Hubble here

1245
00:55:03,559 --> 00:55:07,599
by bringing the camera out

1246
00:55:05,170 --> 00:55:10,960
home with Hubble it puts you in that

1247
00:55:07,599 --> 00:55:13,088
low-earth orbit from which you can then

1248
00:55:10,960 --> 00:55:15,789
go into a sequence of space shuttle

1249
00:55:13,088 --> 00:55:18,369
shots of the earth and so the next

1250
00:55:15,789 --> 00:55:20,829
sequences are these gorgeous space

1251
00:55:18,369 --> 00:55:22,119
shuttle shots here's one it took me a

1252
00:55:20,829 --> 00:55:24,460
while to figure out these things this is

1253
00:55:22,119 --> 00:55:26,318
Baja Peninsula here and the Gulf of

1254
00:55:24,460 --> 00:55:29,108
California California is over here

1255
00:55:26,318 --> 00:55:31,599
Arizona's here all right you get the

1256
00:55:29,108 --> 00:55:33,670
shot of Switzerland down and down bottom

1257
00:55:31,599 --> 00:55:37,720
the Alps running across the center and

1258
00:55:33,670 --> 00:55:40,358
Italy up here and then the amazing shot

1259
00:55:37,719 --> 00:55:42,879
of the Nile River Delta all right these

1260
00:55:40,358 --> 00:55:45,880
wonderful shots from space bring you

1261
00:55:42,880 --> 00:55:49,269
back home show you the beauty of our

1262
00:55:45,880 --> 00:55:53,559
planet and then they bring back the

1263
00:55:49,269 --> 00:55:56,798
virtual choir and they fill the screen

1264
00:55:53,559 --> 00:55:59,530
they cover the earth with this virtual

1265
00:55:56,798 --> 00:56:01,420
choir this is a global choir they're

1266
00:55:59,530 --> 00:56:03,519
getting that point across to you that

1267
00:56:01,420 --> 00:56:06,059
this is a truly global choir and you saw

1268
00:56:03,519 --> 00:56:09,608
from the math that it really is and

1269
00:56:06,059 --> 00:56:13,420
finally the last sequence simply our

1270
00:56:09,608 --> 00:56:15,159
earth hanging there in space and Erik

1271
00:56:13,420 --> 00:56:17,950
says that he really wanted to bring

1272
00:56:15,159 --> 00:56:22,420
across that Carl Sagan point of view the

1273
00:56:17,949 --> 00:56:26,279
idea that looking at our planet from

1274
00:56:22,420 --> 00:56:30,099
outside seeing it there hanging in space

1275
00:56:26,280 --> 00:56:33,519
changes your perspective and through

1276
00:56:30,099 --> 00:56:36,730
this you really can with this film you

1277
00:56:33,519 --> 00:56:41,349
truly can connect those dots from that

1278
00:56:36,730 --> 00:56:45,159
tiny red dot galaxy how did the edge of

1279
00:56:41,349 --> 00:56:49,990
our observable universe across the 13

1280
00:56:45,159 --> 00:56:54,789
billion light years of space to our pale

1281
00:56:49,989 --> 00:56:58,629
blue dot then we call home that expanse

1282
00:56:54,789 --> 00:57:02,369
that expression that truly is the

1283

00:56:58,630 --> 00:57:04,840
impossible magnitude of our universe

1284
00:57:02,369 --> 00:57:11,279
thank you for your attention

1285
00:57:04,840 --> 00:57:11,280
[Applause]

1286
00:57:13,619 --> 00:57:22,960
okay we are going to end the webcast now

1287
00:57:17,759 --> 00:57:24,699
so for the folks who are online you can

1288
00:57:22,960 --> 00:57:28,240
watch the film it is already available

1289
00:57:24,699 --> 00:57:31,149
at Deep Field film.com alright and

1290
00:57:28,239 --> 00:57:34,149
please for the best experience you know

1291
00:57:31,150 --> 00:57:37,900
watch it on a big screen in a dark room

1292
00:57:34,150 --> 00:57:39,309
with really good sound I suppose you

1293
00:57:37,900 --> 00:57:42,730
could probably watch it on your phone

1294
00:57:39,309 --> 00:57:44,349
I mean I'll shed a tear but it's better

1295
00:57:42,730 --> 00:57:47,528
than not watching it at all okay so

1296
00:57:44,349 --> 00:57:51,190
please if you can watch it nice and big

1297
00:57:47,528 --> 00:57:54,219

alright and thank you all for for

1298

00:57:51,190 --> 00:57:57,400

joining us online I hope you've enjoyed

1299

00:57:54,219 --> 00:57:58,268

this expression of this film as much as

1300

00:57:57,400 --> 00:58:00,400

us

1301

00:57:58,268 --> 00:58:02,288

we here at Space Telescope and in

1302

00:58:00,400 --> 00:58:04,778

collaboration with 59 productions and

1303

00:58:02,289 --> 00:58:06,460

with music productions we had a great

1304

00:58:04,778 --> 00:58:07,239

time presenting it and we really hope

1305

00:58:06,460 --> 00:58:13,920

you enjoy it

1306

00:58:07,239 --> 00:58:13,919

good night okay all right