PUBLIC LECTURE SERIES

An Astrovizicist's Guide to the Film "Deep Field: The Impossible Magnitude of Our Universe"

Featuring Guest Speaker :

Frank Summers

1
00:00:06,289 --> 00:00:03,320
field if you didn't get one grab one on

2
00:00:08,870 --> 00:00:06,299
the way out we have a picture of the the

3
00:00:10,879 --> 00:00:08,880
ultra-deep field on the front and a

4
00:00:13,759 --> 00:00:10,889
description on the back telling you

5
00:00:15,829 --> 00:00:13,769
about it and our online audience can

6
00:00:19,519 --> 00:00:15,839
find it at the amazing space tour

7
00:00:21,320 --> 00:00:19,529
website its lithograph number 36 some of

8
00:00:23,650 --> 00:00:21,330
our resources there so it's actually one

9
00:00:27,140 --> 00:00:23,660
of our earlier ones that we produced

10
00:00:30,470 --> 00:00:27,150
tonight we have an astrophysicist guide

11
00:00:33,350 --> 00:00:30,480
to the film deep field the impossible

12
00:00:37,100 --> 00:00:33,360
magnitude of our universe by Frank

13
00:00:39,049 --> 00:00:37,110

summers from space telescope so I am NOT

14
00:00:44,030 --> 00:00:39,059
just your host tonight I'm also your

15
00:00:50,180 --> 00:00:44,040
speaker you guys are needy you guys are

16
00:00:52,760 --> 00:00:50,190
an easy audience April we had a change

17
00:00:55,310 --> 00:00:52,770
of plans for April I had two speakers

18
00:00:57,889 --> 00:00:55,320
who were possible available for the

19
00:01:00,950 --> 00:00:57,899
early April talk both of them had to

20
00:01:04,729 --> 00:01:00,960
cancel on me but we have a symposium

21
00:01:07,370 --> 00:01:04,739
here on April 23rd on the week of April

22
00:01:10,340 --> 00:01:07,380
23rd and they wanted to bring a special

23
00:01:12,890 --> 00:01:10,350
guest speaker from the symposium to do a

24
00:01:15,560 --> 00:01:12,900
public lecture and so I said great I'll

25
00:01:19,160 --> 00:01:15,570
just move the April date until April

26
00:01:21,440 --> 00:01:19,170
23rd okay so I think the normal date

27
00:01:23,480 --> 00:01:21,450
would be like April 2nd yeah we're gonna

28
00:01:26,120 --> 00:01:23,490
be three weeks late next month I'm sorry

29
00:01:28,399 --> 00:01:26,130
we're gonna do April 23rd a special date

30
00:01:31,249 --> 00:01:28,409
but I promise you a special guest

31
00:01:33,800 --> 00:01:31,259
speaker this speaker is so special that

32
00:01:37,460 --> 00:01:33,810
they haven't even told me who it is

33
00:01:38,810 --> 00:01:37,470
okay they've been I've been in

34
00:01:40,190 --> 00:01:38,820
communication with him this month and

35
00:01:41,539 --> 00:01:40,200
they said oh yeah we got it we got it

36
00:01:43,100 --> 00:01:41,549
we're good

37
00:01:45,679 --> 00:01:43,110
but we haven't confirmed so we're not

38
00:01:47,630 --> 00:01:45,689

going to tell you yet okay as soon as I

39
00:01:51,609 --> 00:01:47,640
know you'll know it'll be up on the

40
00:01:52,899 --> 00:01:51,619
website in May we have the fiery fate of

41
00:01:55,219 --> 00:01:52,909
exoplanets

42
00:01:58,310 --> 00:01:55,229
sounds like planets that wander too

43
00:02:01,190 --> 00:01:58,320
close to their star by Joleen Karlberg

44
00:02:04,069 --> 00:02:01,200
and in June the question that everyone

45
00:02:08,029 --> 00:02:04,079
has been asking can pulsar recycling

46
00:02:09,410 --> 00:02:08,039
produce a gamma-ray excess yeah I'll

47
00:02:11,460 --> 00:02:09,420
figure out what that means before next

48
00:02:13,990 --> 00:02:11,470
month okay

49
00:02:15,550 --> 00:02:14,000
this is a new astronomer in the office

50
00:02:18,160 --> 00:02:15,560
of public outreach he arrived about a

51
00:02:21,270 --> 00:02:18,170
year ago Christopher Britt and I finally

52
00:02:24,400 --> 00:02:21,280
have wrangled him into doing our talk

53
00:02:26,020 --> 00:02:24,410
for the other talks upcoming we can go

54
00:02:28,090 --> 00:02:26,030
find our website go to your favorite

55
00:02:30,160 --> 00:02:28,100
search engine type in Hubble public

56
00:02:32,650 --> 00:02:30,170
talks and you should find this webpage

57
00:02:35,950 --> 00:02:32,660
with our upcoming lectures over here on

58
00:02:39,370 --> 00:02:35,960
the right links to our webcasting both

59
00:02:41,020 --> 00:02:39,380
alive and the archives okay we go back

60
00:02:44,590 --> 00:02:41,030
to 2014

61
00:02:47,100 --> 00:02:44,600
I guess that's five years now Wow five

62
00:02:51,670 --> 00:02:47,110
years of Space Telescope webcast of

63
00:02:54,670 --> 00:02:51,680

YouTube webcasting and back to 2005 so

64
00:02:57,700 --> 00:02:54,680
that's of Wow that's about 14 years of

65
00:03:00,280 --> 00:02:57,710
Space Telescope webcasting if you'd like

66
00:03:03,610 --> 00:03:00,290
to get on our email list you can also do

67
00:03:05,530 --> 00:03:03,620
there our email are basically just the

68
00:03:07,900 --> 00:03:05,540
announcements of the lectures and when

69
00:03:09,100 --> 00:03:07,910
the webcasts are posted on YouTube we

70
00:03:10,750 --> 00:03:09,110
let you know about it

71
00:03:12,760 --> 00:03:10,760
if you don't like signing up on our

72
00:03:14,410 --> 00:03:12,770
website you can write your email address

73
00:03:16,150 --> 00:03:14,420
down on a piece of paper hand it to me

74
00:03:18,400 --> 00:03:16,160
after the lecture and I'll make sure you

75
00:03:20,260 --> 00:03:18,410
get on there if you have comments or

76
00:03:25,420 --> 00:03:20,270
questions you can send them to our email

77
00:03:28,060 --> 00:03:25,430
public lecture at STScI edu and finally

78
00:03:29,710 --> 00:03:28,070
if you are on social media if you want

79
00:03:32,410 --> 00:03:29,720
to follow the Hubble Space Telescope the

80
00:03:33,990 --> 00:03:32,420
Webb Space Telescope or the Space

81
00:03:36,790 --> 00:03:34,000
Telescope Science Institute we have

82
00:03:40,720 --> 00:03:36,800
Facebook Twitter YouTube and Instagram

83
00:03:42,910 --> 00:03:40,730
for you to follow I myself do a little

84
00:03:46,320 --> 00:03:42,920
bit of Facebook and Twitter if you're

85
00:03:48,790 --> 00:03:46,330
interested in my latest thoughts

86
00:03:52,870 --> 00:03:48,800
oftentimes after this we have the

87
00:03:54,760 --> 00:03:52,880
observatory was the was it cloudy clouds

88
00:03:56,380 --> 00:03:54,770

are moving in okay I did not receive a

89
00:03:59,230 --> 00:03:56,390
notification from the Maryland space

90
00:04:01,030 --> 00:03:59,240
based grant folks so I put a question

91
00:04:04,390 --> 00:04:01,040
mark here I was assuming it probably was

92
00:04:07,900 --> 00:04:04,400
a no all right anybody from Maryland

93
00:04:09,490 --> 00:04:07,910
Space Grant here No okay I'll ask remind

94
00:04:11,350 --> 00:04:09,500
me to ask again at the end just in case

95
00:04:13,780 --> 00:04:11,360
because you know not often we get a

96
00:04:15,520 --> 00:04:13,790
chance to go across but you do get

97
00:04:18,190 --> 00:04:15,530
chances on Friday evenings when they're

98
00:04:21,340 --> 00:04:18,200
open houses if you go to MD dot Space

99
00:04:23,600 --> 00:04:21,350
Grant o RG you can they have you can

100
00:04:25,999 --> 00:04:23,610
find this webpage over here

101
00:04:27,740 --> 00:04:26,009
on Fridays by 5 or 6 p.m. they will

102
00:04:30,260 --> 00:04:27,750
announced whether or not they're going

103
00:04:34,399 --> 00:04:30,270
to open the observatory Friday evenings

104
00:04:36,230 --> 00:04:34,409
for observing ok all right we are not

105
00:04:38,270 --> 00:04:36,240
going to have the news from the universe

106
00:04:40,999 --> 00:04:38,280
that I usually do since I am your

107
00:04:43,249 --> 00:04:41,009
speaker tonight I didn't have time to

108
00:04:48,100 --> 00:04:43,259
prepare the news of universe so I will

109
00:04:51,200 --> 00:04:48,110
now introduce our speaker our speaker

110
00:04:52,820 --> 00:04:51,210
our speaker is Frank summers of the

111
00:04:55,399 --> 00:04:52,830
office of public outreach here at Space

112
00:04:59,959 --> 00:04:55,409
Telescope Science Institute he's been

113
00:05:03,469 --> 00:04:59,969

here since 2001 working on all aspects

114
00:05:05,240 --> 00:05:03,479
of Hubble Space Telescope public

115
00:05:07,459 --> 00:05:05,250
outreach whether it's websites or

116
00:05:10,399 --> 00:05:07,469
educational materials or the news

117
00:05:13,249 --> 00:05:10,409
releases or his specialty which is

118
00:05:16,249 --> 00:05:13,259
scientific visualizations and because

119
00:05:18,350 --> 00:05:16,259
he's an astronomer who makes movies who

120
00:05:22,309 --> 00:05:18,360
does visualizations he likes to call

121
00:05:24,519 --> 00:05:22,319
himself an astrophysicist he also thinks

122
00:05:27,110 --> 00:05:24,529
it sounds kind of cool

123
00:05:30,529 --> 00:05:27,120
it's just a play on astrophysicist who

124
00:05:32,269 --> 00:05:30,539
does visualizations let's see I usually

125
00:05:34,730 --> 00:05:32,279
tell you something special about myself

126
00:05:37,519 --> 00:05:34,740
when I give the talks I didn't prepare

127
00:05:40,459 --> 00:05:37,529
anything special before I was here at

128
00:05:42,050 --> 00:05:40,469
the Space Telescope I was at the

129
00:05:44,930 --> 00:05:42,060
American Museum of Natural History in

130
00:05:46,730 --> 00:05:44,940
New York where Neil Tyson Steve Souter

131
00:05:50,540 --> 00:05:46,740
and I built the Rose Center for Earth

132
00:05:52,909 --> 00:05:50,550
and space that opened in 2000 and before

133
00:05:56,209 --> 00:05:52,919
that I did postdocs at Columbia and

134
00:05:59,329 --> 00:05:56,219
Princeton and my PhD came from you Cal

135
00:06:11,670 --> 00:05:59,339
Berkeley so ladies and gentlemen while I

136
00:06:20,850 --> 00:06:19,620
mr. Frank summers all right can we get

137
00:06:23,480 --> 00:06:20,860
the lights down a little in the audience

138
00:06:28,740 --> 00:06:27,870

all right it is really fun to be here

139
00:06:30,870 --> 00:06:28,750
tonight okay

140
00:06:35,990 --> 00:06:30,880
being able to show you this project that

141
00:06:38,909 --> 00:06:36,000
we worked on for about 18 months just a

142
00:06:41,999 --> 00:06:38,919
there sometimes you get to work on

143
00:06:45,270 --> 00:06:42,009
really special projects and this is one

144
00:06:47,879 --> 00:06:45,280
of them it's gonna give you my guide to

145
00:06:51,390 --> 00:06:47,889
deep field the impossible magnitude of

146
00:06:54,150 --> 00:06:51,400
universe this film that is based on a

147
00:06:55,590 --> 00:06:54,160
symphony called Deep Field by the

148
00:06:58,980 --> 00:06:55,600
composer Eric Whitacre

149
00:07:04,230 --> 00:06:58,990
and the first question that people often

150
00:07:08,480 --> 00:07:04,240
have is why would a Hubble image be

151
00:07:10,260 --> 00:07:08,490
deserving of a 24-minute symphony huh

152
00:07:13,080 --> 00:07:10,270
what's going on here

153
00:07:14,939 --> 00:07:13,090
so let's start with the Deep Field and

154
00:07:17,879 --> 00:07:14,949
to explain the Deep Field we're gonna

155
00:07:20,430 --> 00:07:17,889
start here this is the constellation of

156
00:07:23,520 --> 00:07:20,440
Ursa Major most of you know it as the

157
00:07:25,050 --> 00:07:23,530
Big Dipper okay we're going to zoom in

158
00:07:28,110 --> 00:07:25,060
all right so we're gonna zoom into this

159
00:07:29,430 --> 00:07:28,120
region go in a little closer all right

160
00:07:32,430 --> 00:07:29,440
and then we're gonna zoom into this

161
00:07:34,620 --> 00:07:32,440
region and go a little closer and then

162
00:07:36,980 --> 00:07:34,630
we're gonna zoom into this region and go

163
00:07:41,189 --> 00:07:36,990

a little closer and we'll go soom

164
00:07:44,610 --> 00:07:41,199
further get a little closer at one more

165
00:07:49,050 --> 00:07:44,620
time going in down to this field of view

166
00:07:52,680 --> 00:07:49,060
ah isn't that amazing yeah we're talking

167
00:07:54,960 --> 00:07:52,690
about this rectangle right there what

168
00:07:58,950 --> 00:07:54,970
can you guys see there I can see like

169
00:08:01,469 --> 00:07:58,960
two fuzzy nothing's there it's in this

170
00:08:05,010 --> 00:08:01,479
ground-based survey there's nothing

171
00:08:08,540 --> 00:08:05,020
there basically right okay so what would

172
00:08:12,629 --> 00:08:08,550
you say if prominent astronomers

173
00:08:17,010 --> 00:08:12,639
proposed to stare at this empty region

174
00:08:20,339 --> 00:08:17,020
and use eleven days of Hubble observing

175
00:08:24,120 --> 00:08:20,349
a total of a hundred and forty hours of

176
00:08:27,580 --> 00:08:24,130
observing looking at nothing what would

177
00:08:35,089 --> 00:08:32,329
it sounds like a crazy idea okay and you

178
00:08:37,010 --> 00:08:35,099
know what a few astronomers at the time

179
00:08:39,950 --> 00:08:37,020
would have agreed with you all right

180
00:08:42,019 --> 00:08:39,960
so the idea behind this was to use the

181
00:08:43,430 --> 00:08:42,029
incredible resolution of Hubble and the

182
00:08:46,250 --> 00:08:43,440
fact that it's up above Earth's

183
00:08:48,829 --> 00:08:46,260
atmosphere and has this clear view to

184
00:08:51,050 --> 00:08:48,839
see as far out into the universe as we

185
00:08:54,530 --> 00:08:51,060
could see alright we want to see

186
00:08:55,970 --> 00:08:54,540
galaxies at their most distant but the

187
00:08:58,519 --> 00:08:55,980
folks who said this was a crazy idea

188
00:08:59,990 --> 00:08:58,529

said well wait a bit wait galaxies as

189
00:09:02,110 --> 00:09:00,000
they get further and further away are

190
00:09:05,720 --> 00:09:02,120
gonna get smaller and smaller and

191
00:09:08,810 --> 00:09:05,730
fainter and fainter and eventually you

192
00:09:11,510 --> 00:09:08,820
won't be able to see them and you could

193
00:09:14,000 --> 00:09:11,520
end up wasting a tremendous amount of

194
00:09:16,130 --> 00:09:14,010
Hubble time and Hubble time is really

195
00:09:19,310 --> 00:09:16,140
valuable here to spend six days

196
00:09:22,670 --> 00:09:19,320
integrative integration time on a blank

197
00:09:24,230 --> 00:09:22,680
field but the director of the Space

198
00:09:28,700 --> 00:09:24,240
Telescope Science Institute at the time

199
00:09:31,130 --> 00:09:28,710
Bob Williams was convinced that if we

200
00:09:33,860 --> 00:09:31,140
saw something it would be fantastic and

201
00:09:35,630 --> 00:09:33,870
if we didn't see something it would

202
00:09:37,910 --> 00:09:35,640
still be really good because it would

203
00:09:40,400 --> 00:09:37,920
show us the limitations of astronomy

204
00:09:42,440 --> 00:09:40,410
so as the director and using his

205
00:09:44,990 --> 00:09:42,450
director's discretionary time he

206
00:09:52,040 --> 00:09:45,000
approved the original Hubble Deep Field

207
00:09:57,370 --> 00:09:52,050
project the results were astounding in

208
00:10:00,550 --> 00:09:57,380
this small tiny field they found over

209
00:10:04,310 --> 00:10:00,560
3,000 galaxies stretching out to

210
00:10:07,790 --> 00:10:04,320
distances beyond where galaxies had ever

211
00:10:10,640 --> 00:10:07,800
been seen this was the original Hubble

212
00:10:14,269 --> 00:10:10,650
Deep Field done in 1996 and it was so

213
00:10:17,240 --> 00:10:14,279

successful it changed cosmology that we

214
00:10:19,430 --> 00:10:17,250
not only have this but we had follow-on

215
00:10:22,579 --> 00:10:19,440
projects on the right you see the Hubble

216
00:10:25,250 --> 00:10:22,589
ultra-deep field that was taken in 2003

217
00:10:27,590 --> 00:10:25,260
and released in 2004 it covered a

218
00:10:30,620 --> 00:10:27,600
slightly larger field with a new camera

219
00:10:33,410 --> 00:10:30,630
on Hubble went even deeper than the

220
00:10:37,680 --> 00:10:33,420
original one and found about 10,000

221
00:10:40,830 --> 00:10:37,690
galaxies and a very tiny region of sky

222
00:10:42,480 --> 00:10:40,840
how small well I sort of did the zoom

223
00:10:44,550 --> 00:10:42,490
but you sort of get lost on the scale of

224
00:10:47,400 --> 00:10:44,560
it let's compare the size of the Hubble

225
00:10:50,910 --> 00:10:47,410
ultra-deep field to the size of the full

226
00:10:54,090 --> 00:10:50,920
moon okay it's really about the size of

227
00:10:57,120 --> 00:10:54,100
oh one of these moiré over here on the

228
00:10:58,710 --> 00:10:57,130
moon now I know some of you probably

229
00:11:02,070 --> 00:10:58,720
think that the full moon is actually

230
00:11:04,290 --> 00:11:02,080
really really large and I have no idea

231
00:11:07,770 --> 00:11:04,300
where you could possibly have gotten

232
00:11:10,740 --> 00:11:07,780
such a silly idea but if you take a real

233
00:11:12,330 --> 00:11:10,750
view of the full moon and you look at it

234
00:11:15,380 --> 00:11:12,340
you can see that the full moon is only

235
00:11:18,090 --> 00:11:15,390
half a degree across on the sky and

236
00:11:21,750 --> 00:11:18,100
Hubble ultra-deep field being about you

237
00:11:27,350 --> 00:11:21,760
know one third or one tenth of size of

238
00:11:30,930 --> 00:11:27,360

it there are over 12 million patches

239
00:11:31,770 --> 00:11:30,940
entire night sky the size of the Hubble

240
00:11:34,860 --> 00:11:31,780
ultra-deep field

241
00:11:40,410 --> 00:11:34,870
it is 112 millionth of the entire night

242
00:11:42,480 --> 00:11:40,420
sky but in it we see galaxies across the

243
00:11:44,580 --> 00:11:42,490
universe and here are some details from

244
00:11:46,920 --> 00:11:44,590
the Hubble Ultra Deep Field we can see

245
00:11:48,510 --> 00:11:46,930
big galaxies that are nearby like here

246
00:11:50,730 --> 00:11:48,520
in the upper right we can see

247
00:11:53,100 --> 00:11:50,740
medium-sized galaxies we can the smaller

248
00:11:55,350 --> 00:11:53,110
and smaller galaxies we can see flotsam

249
00:11:57,330 --> 00:11:55,360
and jetsam galaxies and so this is a

250
00:11:59,280 --> 00:11:57,340
core sample through the universe

251
00:12:02,250 --> 00:11:59,290
stretching out billions of light-years

252
00:12:05,580 --> 00:12:02,260
through the universe studying galaxies

253
00:12:06,180 --> 00:12:05,590
and if you want to study galaxies in the

254
00:12:10,080 --> 00:12:06,190
universe

255
00:12:13,110 --> 00:12:10,090
this is your rosetta stone this is how

256
00:12:16,860 --> 00:12:13,120
we transformed our understanding of

257
00:12:19,380 --> 00:12:16,870
galaxies in the universe so that's the

258
00:12:22,020 --> 00:12:19,390
story of why the Hubble Deep Field is so

259
00:12:24,870 --> 00:12:22,030
important and it caught the attention of

260
00:12:28,170 --> 00:12:24,880
this man composer and conductor Eric

261
00:12:32,040 --> 00:12:28,180
Whitacre and he decided that he was

262
00:12:35,820 --> 00:12:32,050
going to write a symphony expressing

263
00:12:40,080 --> 00:12:35,830

some of this all and you know immensity

264
00:12:42,840 --> 00:12:40,090
of the of the deep field now I can't

265
00:12:44,340 --> 00:12:42,850
explain his reasoning as well as he can

266
00:12:46,860 --> 00:12:44,350
I've heard him present this several

267
00:12:50,760 --> 00:12:46,870
times but he gave me this slide here

268
00:12:51,510 --> 00:12:50,770
that is one of his drawings of how he

269
00:12:53,850 --> 00:12:51,520
sort of died

270
00:12:56,100 --> 00:12:53,860
out his ideas for the Deep Field

271
00:12:58,980 --> 00:12:56,110
Symphony and you can see that it has

272
00:13:02,280 --> 00:12:58,990
this opening up starting small and

273
00:13:04,650 --> 00:13:02,290
rising up and making it big and he talks

274
00:13:07,680 --> 00:13:04,660
about it being muddy and out of focus in

275
00:13:09,750 --> 00:13:07,690
the beginning which is to him to sort of

276
00:13:11,730 --> 00:13:09,760
reflect the fact that the Hubble Space

277
00:13:14,130 --> 00:13:11,740
Telescope was as you remember

278
00:13:15,900 --> 00:13:14,140
out-of-focus to begin until after

279
00:13:18,000 --> 00:13:15,910
servicing mission one when it was

280
00:13:20,760 --> 00:13:18,010
repaired and we had brought it into

281
00:13:22,920 --> 00:13:20,770
focus so one of his themes in his music

282
00:13:24,480 --> 00:13:22,930
is gonna be take things that the music

283
00:13:27,780 --> 00:13:24,490
is gonna be slightly out of focus and

284
00:13:30,690 --> 00:13:27,790
then come into focus it's gonna grow and

285
00:13:32,490 --> 00:13:30,700
and you know progress forward and pull

286
00:13:36,890 --> 00:13:32,500
back progress forward and pull back

287
00:13:39,570 --> 00:13:36,900
until it reaches this triumphant chord

288
00:13:43,590 --> 00:13:39,580

at the presentation of the Ultra Deep

289
00:13:45,090 --> 00:13:43,600
Field and you'll I'll explain some of

290
00:13:46,680 --> 00:13:45,100
the other things things about it as I'm

291
00:13:49,350 --> 00:13:46,690
going through here but he really has

292
00:13:51,690 --> 00:13:49,360
this full complete idea of all these

293
00:13:54,000 --> 00:13:51,700
themes that he wants to do and certain

294
00:13:57,090 --> 00:13:54,010
notes and presentations and this this

295
00:13:59,940 --> 00:13:57,100
golden brick idea of the the repeating

296
00:14:02,400 --> 00:13:59,950
themes that he works through in order to

297
00:14:05,430 --> 00:14:02,410
try and express some of the majesty that

298
00:14:09,200 --> 00:14:05,440
you are presented with in this field so

299
00:14:11,640 --> 00:14:09,210
he wrote this 24 minutes Symphony and he

300
00:14:14,450 --> 00:14:11,650
conducted it and it's had its world

301
00:14:17,940 --> 00:14:14,460
premiere in Minneapolis Minnesota and

302
00:14:22,370 --> 00:14:17,950
attending that performance was Bob

303
00:14:24,510 --> 00:14:22,380
Williams the stsci director who had

304
00:14:27,870 --> 00:14:24,520
allowed the deep field to happen to

305
00:14:30,840 --> 00:14:27,880
begin with and Bob amongst others I'm

306
00:14:33,570 --> 00:14:30,850
going to understand met Eric afterwards

307
00:14:36,360 --> 00:14:33,580
and said you must combine this Symphony

308
00:14:39,960 --> 00:14:36,370
with the Hubble visuals to make an

309
00:14:43,560 --> 00:14:39,970
incredible fusion of science and music

310
00:14:45,330 --> 00:14:43,570
together so that's what Eric did I

311
00:14:48,050 --> 00:14:45,340
actually think Eric probably wanted to

312
00:14:50,820 --> 00:14:48,060
do this already he assembled a team

313
00:14:52,800 --> 00:14:50,830

first starting with 59 productions a

314
00:14:57,300 --> 00:14:52,810
london-based production company that

315
00:14:59,360 --> 00:14:57,310
does unbelievable presentations this is

316
00:15:02,550 --> 00:14:59,370
from their website where they put video

317
00:15:05,400 --> 00:15:02,560
onto the Sydney Opera House the entire

318
00:15:07,259 --> 00:15:05,410
Sydney Opera House covered in

319
00:15:09,869 --> 00:15:07,269
video projections right they put

320
00:15:13,259 --> 00:15:09,879
projections on castles and on 747

321
00:15:16,350 --> 00:15:13,269
airplanes they do amazing work in

322
00:15:18,090 --> 00:15:16,360
combining art and technology and then of

323
00:15:20,759 --> 00:15:18,100
course he also came here to the Space

324
00:15:22,379 --> 00:15:20,769
Telescope Science Institute because we

325
00:15:26,610 --> 00:15:22,389
are the ones who have the Hubble images

326
00:15:28,530 --> 00:15:26,620
and we have the the visual of scientific

327
00:15:32,689 --> 00:15:28,540
visualizations of those Hubble images

328
00:15:38,519 --> 00:15:36,509
so we just met with Eric we showed him a

329
00:15:40,199 --> 00:15:38,529
variety of our work and we started to

330
00:15:42,990 --> 00:15:40,209
talk through what we could do because

331
00:15:45,269 --> 00:15:43,000
look you can't show that Ultra Deep

332
00:15:47,819 --> 00:15:45,279
Field for 24 minutes okay this this

333
00:15:50,519 --> 00:15:47,829
movie can't be just about what image

334
00:15:52,949 --> 00:15:50,529
okay what it really needs to be about is

335
00:15:55,559 --> 00:15:52,959
that journey to understand that image

336
00:15:57,660 --> 00:15:55,569
that progression from what we see here

337
00:16:01,530 --> 00:15:57,670
on earth out through the solar system

338
00:16:03,929 --> 00:16:01,540

and stars and nebulae and galaxies until

339
00:16:05,879 --> 00:16:03,939
you can get out to the farthest edge of

340
00:16:08,240 --> 00:16:05,889
the universe and so we developed in

341
00:16:10,740 --> 00:16:08,250
collaboration with 59 productions and

342
00:16:12,960 --> 00:16:10,750
music production is limited this story

343
00:16:15,629 --> 00:16:12,970
line of various ideas and everything and

344
00:16:19,230 --> 00:16:15,639
it was all taking the music first and

345
00:16:22,889 --> 00:16:19,240
then trying to craft visuals that would

346
00:16:24,360 --> 00:16:22,899
do justice to this music I will say here

347
00:16:27,230 --> 00:16:24,370
at the Space Telescope Science Institute

348
00:16:29,189 --> 00:16:27,240
we contributed 11 sequences to this film

349
00:16:31,470 --> 00:16:29,199
seven of which we it had already

350
00:16:34,650 --> 00:16:31,480
produced and four of which were brand

351
00:16:37,439 --> 00:16:34,660
new this is our team that worked on the

352
00:16:38,720 --> 00:16:37,449
four new ones - one person that you'll

353
00:16:43,439 --> 00:16:38,730
see in just a minute

354
00:16:45,840 --> 00:16:43,449
this is myself Joe Danny and Greg we're

355
00:16:48,509 --> 00:16:45,850
down at NASA Kennedy Space Center last

356
00:16:51,870 --> 00:16:48,519
fall for the grand or the world premiere

357
00:16:55,710 --> 00:16:51,880
of this film so we don't have a huge

358
00:16:58,650 --> 00:16:55,720
staff ok this is not like your latest

359
00:17:00,509 --> 00:16:58,660
Avengers blockbuster CGI fest where

360
00:17:03,059 --> 00:17:00,519
there's five hundred people working on

361
00:17:07,470 --> 00:17:03,069
the computer graphics okay we got five

362
00:17:10,100 --> 00:17:07,480
here guys okay but that's part of what

363
00:17:13,770 --> 00:17:10,110

made it such a special project for us

364
00:17:16,829 --> 00:17:13,780
because it was audacious and ambitious

365
00:17:18,569 --> 00:17:16,839
so let me talk you through a variety of

366
00:17:19,649 --> 00:17:18,579
the sequences of

367
00:17:21,090 --> 00:17:19,659
the deep field matter fact I'm gonna

368
00:17:24,360 --> 00:17:21,100
talk you through all of the astronomy

369
00:17:26,850 --> 00:17:24,370
sequences because when people sit down

370
00:17:30,870 --> 00:17:26,860
and watch it I'm always getting people

371
00:17:32,519 --> 00:17:30,880
with suing mere Oh what's this

372
00:17:34,320 --> 00:17:32,529
and I don't want you doing that during

373
00:17:35,820 --> 00:17:34,330
the film okay I want you to know what

374
00:17:37,950 --> 00:17:35,830
you're looking at so I'm gonna tell you

375
00:17:39,210 --> 00:17:37,960
all of the sign all of the astronomy

376
00:17:42,779 --> 00:17:39,220
sequences that you're gonna look at all

377
00:17:46,680 --> 00:17:42,789
right so the film begins with a view of

378
00:17:51,990 --> 00:17:46,690
the night sky and actually it starts out

379
00:17:53,700 --> 00:17:52,000
of focus and slowly can we get it can

380
00:17:56,070 --> 00:17:53,710
you guys see this well I'm not sure that

381
00:17:58,529 --> 00:17:56,080
this light is too bright

382
00:18:00,629 --> 00:17:58,539
I need the light off the screen as much

383
00:18:02,580 --> 00:18:00,639
as possible nobody needs to see me by

384
00:18:05,629 --> 00:18:02,590
the way okay we they need to see the

385
00:18:07,860 --> 00:18:05,639
screen though so take some lights down

386
00:18:09,600 --> 00:18:07,870
astronomy has it has a major problem

387
00:18:13,560 --> 00:18:09,610
because we do a lot of black in our

388
00:18:16,889 --> 00:18:13,570

night skies I think it's probably this

389
00:18:23,759 --> 00:18:16,899
one that that's coming the panel one

390
00:18:25,230 --> 00:18:23,769
that's I need on me all right

391
00:18:27,659 --> 00:18:25,240
well I guess you guess you can see it up

392
00:18:28,230 --> 00:18:27,669
on that screen okay there we go thank

393
00:18:30,450 --> 00:18:28,240
you

394
00:18:33,500 --> 00:18:30,460
whatever that did that worked all right

395
00:18:36,779 --> 00:18:33,510
and slowly it starts coming into focus

396
00:18:37,279 --> 00:18:36,789
until you can see the stars of the night

397
00:18:39,840 --> 00:18:37,289
sky

398
00:18:42,570 --> 00:18:39,850
now that was what fifty-nine productions

399
00:18:45,149 --> 00:18:42,580
wanted to do to mirror the ideas in

400
00:18:48,960 --> 00:18:45,159
Eric's music of the music slowly coming

401
00:18:52,379 --> 00:18:48,970
into focus Hubble the flaw coming into

402
00:18:55,950 --> 00:18:52,389
focus and the major transitions in the

403
00:19:00,210 --> 00:18:55,960
film include that change out of OD focus

404
00:19:03,960 --> 00:19:00,220
too focused and then this sequence leads

405
00:19:06,419 --> 00:19:03,970
on into showing you the milky way that

406
00:19:08,399 --> 00:19:06,429
goes across the night sky and one of the

407
00:19:10,710 --> 00:19:08,409
other really great things that I love

408
00:19:12,330 --> 00:19:10,720
that they did was that as the music

409
00:19:14,519 --> 00:19:12,340
slowly built it starts off with these

410
00:19:17,299 --> 00:19:14,529
hanging notes that are thin and just

411
00:19:20,639 --> 00:19:17,309
free and as this music builds and builds

412
00:19:24,149 --> 00:19:20,649
they build the exposure okay so you

413
00:19:26,549 --> 00:19:24,159

start off seeing just the stars but they

414
00:19:31,019 --> 00:19:26,559
increase the exposure so that you can

415
00:19:32,370 --> 00:19:31,029
see the full milky milky way as as the

416
00:19:35,700 --> 00:19:32,380
as music builds and it's

417
00:19:39,390 --> 00:19:35,710
just increases along with it this

418
00:19:42,450 --> 00:19:39,400
sequence here was shot by our own very

419
00:19:45,270 --> 00:19:42,460
very own astronomical image processors

420
00:19:47,340 --> 00:19:45,280
Olave he has been our master image

421
00:19:51,090 --> 00:19:47,350
processor on Hubble images for many

422
00:19:54,330 --> 00:19:51,100
years and retired last fall just before

423
00:19:56,640 --> 00:19:54,340
this film was released and not only

424
00:20:01,080 --> 00:19:56,650
dealing with astronomical images he is a

425
00:20:02,970 --> 00:20:01,090
avid Astro photographer himself such

426
00:20:05,670 --> 00:20:02,980
that he was given an artist-in-residence

427
00:20:09,150 --> 00:20:05,680
at Capitol Reef National Park last

428
00:20:11,430 --> 00:20:09,160
summer and while he was there he spent

429
00:20:14,970 --> 00:20:11,440
several nights tracking getting these

430
00:20:18,330 --> 00:20:14,980
time-lapse of imagery of the Milky Way

431
00:20:22,650 --> 00:20:18,340
this is old in his national park

432
00:20:25,410 --> 00:20:22,660
official volunteer outfit they told him

433
00:20:27,120 --> 00:20:25,420
he did he got to keep the shirt but not

434
00:20:31,410 --> 00:20:27,130
the Hat or vice versa I can't remember

435
00:20:33,990 --> 00:20:31,420
which all right

436
00:20:36,090 --> 00:20:34,000
also this shot over here on the right is

437
00:20:38,820 --> 00:20:36,100
from Capitol Reef and it shows a very

438
00:20:40,440 --> 00:20:38,830

important thing that right there now

439
00:20:43,800 --> 00:20:40,450
many of you might look at that and go oh

440
00:20:45,450 --> 00:20:43,810
that's a meteor trail no it's not it's

441
00:20:47,790 --> 00:20:45,460
an airplane okay

442
00:20:49,590 --> 00:20:47,800
Capitol Reef National Park is out in the

443
00:20:50,640 --> 00:20:49,600
middle of nowhere but it's not so far

444
00:20:54,660 --> 00:20:50,650
out in the middle of nowhere that

445
00:20:58,500 --> 00:20:54,670
airplanes don't fly through so in zoltes

446
00:21:01,350 --> 00:20:58,510
time-lapse over 70 airplanes flew

447
00:21:04,650 --> 00:21:01,360
through his time-lapse there was an

448
00:21:08,220 --> 00:21:04,660
intern at 59 productions who spent his

449
00:21:11,610 --> 00:21:08,230
entire work on the project removing

450
00:21:14,610 --> 00:21:11,620
those airplanes from the Milky Way from

451
00:21:17,280 --> 00:21:14,620
thing so the fact that there are no

452
00:21:19,760 --> 00:21:17,290
airplanes in the Milky Way sequence you

453
00:21:22,170 --> 00:21:19,770
can thank that intern at 59 productions

454
00:21:25,470 --> 00:21:22,180
the other cool thing about the milky way

455
00:21:27,240 --> 00:21:25,480
shot is the D focus at the end of it and

456
00:21:28,830 --> 00:21:27,250
they D focus out you can start to see

457
00:21:31,080 --> 00:21:28,840
there's this funky little pattern here

458
00:21:35,460 --> 00:21:31,090
that they use for the D focus it's not

459
00:21:38,460 --> 00:21:35,470
just a circular blur this is in fact the

460
00:21:42,270 --> 00:21:38,470
point spread function of Hubble before

461
00:21:46,259 --> 00:21:42,280
the flaw was fixed so this is actually a

462
00:21:50,849 --> 00:21:46,269
typical would take of a point

463
00:21:52,259 --> 00:21:50,859

in 1990 before the the flaw was fixed

464
00:21:54,180 --> 00:21:52,269
after the services servicing mission one

465
00:21:55,619 --> 00:21:54,190
so that's like just a cute little thing

466
00:21:57,599 --> 00:21:55,629
that they threw in in one of the

467
00:21:59,820 --> 00:21:57,609
defocusing things to throw in the point

468
00:22:02,519 --> 00:21:59,830
spread function from Hubble all right

469
00:22:03,389 --> 00:22:02,529
the next set of sequences is the solar

470
00:22:05,129 --> 00:22:03,399
system

471
00:22:07,320 --> 00:22:05,139
we here at Space Telescope did not work

472
00:22:10,919 --> 00:22:07,330
on them because these are all NASA

473
00:22:13,249 --> 00:22:10,929
missions that go through it begins with

474
00:22:14,430 --> 00:22:13,259
the moon from Lunar Reconnaissance

475
00:22:18,419 --> 00:22:14,440
Orbiter

476
00:22:20,299 --> 00:22:18,429
these are wonderful wonderful pans and I

477
00:22:22,349 --> 00:22:20,309
will say that while that was it AMNH

478
00:22:25,919 --> 00:22:22,359
people would come to me and say wait a

479
00:22:28,919 --> 00:22:25,929
minute we went to the moon and also we

480
00:22:31,079 --> 00:22:28,929
took we're black-and-white cameras and

481
00:22:35,069 --> 00:22:31,089
then of course you show them all right

482
00:22:37,859 --> 00:22:35,079
well yeah we went to the moon but these

483
00:22:38,909 --> 00:22:37,869
are color photographs of a black and

484
00:22:42,509 --> 00:22:38,919
white world

485
00:22:44,219 --> 00:22:42,519
all right so yes the moon is just black

486
00:22:46,109 --> 00:22:44,229
and white but that's the way the moon

487
00:22:48,419 --> 00:22:46,119
really is not because we're not

488
00:22:51,389 --> 00:22:48,429

colorizing these things if you want

489
00:22:54,299 --> 00:22:51,399
color you get in the next sequence from

490
00:22:56,899 --> 00:22:54,309
Mars a whole sequence of images from

491
00:22:59,310 --> 00:22:56,909
Viking and from Mars Global Surveyor

492
00:23:03,810 --> 00:22:59,320
incredible details of the surface of

493
00:23:06,839 --> 00:23:03,820
Mars the Jupiter sequence comes from the

494
00:23:09,749 --> 00:23:06,849
mission Juno and Juno I don't know if

495
00:23:11,879 --> 00:23:09,759
you know is a mission that's designed to

496
00:23:14,459 --> 00:23:11,889
study the magnetosphere and the

497
00:23:19,379 --> 00:23:14,469
atmosphere and the interior of Jupiter

498
00:23:22,289 --> 00:23:19,389
it really isn't a imager it doesn't take

499
00:23:25,379 --> 00:23:22,299
pictures none of the science data from

500
00:23:28,169 --> 00:23:25,389
the Juno mission are pictures what we

501
00:23:31,999 --> 00:23:28,179
see from Juno is actually a instrument

502
00:23:35,149 --> 00:23:32,009
called Juno cam which is essentially a

503
00:23:37,859 --> 00:23:35,159
webcam added to the scientific mission

504
00:23:39,180 --> 00:23:37,869
they recognize that we're going to get

505
00:23:41,399 --> 00:23:39,190
this incredible data about the

506
00:23:44,279 --> 00:23:41,409
magnetosphere of jupiter but the public

507
00:23:48,060 --> 00:23:44,289
loves our images so they put a space

508
00:23:50,729 --> 00:23:48,070
hardened web cam type apparatus on it

509
00:23:52,829 --> 00:23:50,739
and when judo makes these gorgeous flow

510
00:23:55,440 --> 00:23:52,839
these flybys they get these gorgeous

511
00:23:58,560 --> 00:23:55,450
images of the cloud tops of Jupiter and

512
00:24:00,180 --> 00:23:58,570
really has been produced much more

513
00:24:02,670 --> 00:24:00,190

amazing images than I ever

514
00:24:04,620 --> 00:24:02,680
would be possible with the level of

515
00:24:07,190 --> 00:24:04,630
camera that they put on it and you'll

516
00:24:10,280 --> 00:24:07,200
see tonight that they're just amazing

517
00:24:13,500 --> 00:24:10,290
finally the last platter that glass

518
00:24:15,480 --> 00:24:13,510
planet visited is Saturn and you might

519
00:24:18,540 --> 00:24:15,490
look at this and say well why did they

520
00:24:20,580 --> 00:24:18,550
put in a still shot of Saturn it's not a

521
00:24:23,520 --> 00:24:20,590
still shot you must watch for these

522
00:24:25,470 --> 00:24:23,530
objects right there those are the moons

523
00:24:27,840 --> 00:24:25,480
of Saturn and you will see them move

524
00:24:30,390 --> 00:24:27,850
through it Saturn itself doesn't change

525
00:24:32,820 --> 00:24:30,400
much in the shot in the film but there

526
00:24:34,550 --> 00:24:32,830
are five moons four here there's a fifth

527
00:24:37,410 --> 00:24:34,560
one that enters at the top of the screen

528
00:24:41,040 --> 00:24:37,420
that will be part of it okay and that's

529
00:24:43,740 --> 00:24:41,050
the movement that covers the planets the

530
00:24:47,280 --> 00:24:43,750
next movement in the film covers these

531
00:24:50,100 --> 00:24:47,290
stars and nebulae so the symphony you

532
00:24:51,810 --> 00:24:50,110
know changes a bit and introduced brings

533
00:24:55,440 --> 00:24:51,820
in our nearest star which is of course

534
00:24:56,670 --> 00:24:55,450
our Sun this is the Sun in ultraviolet

535
00:25:00,660 --> 00:24:56,680
light from the Solar Dynamics

536
00:25:03,870 --> 00:25:00,670
Observatory and when you he see that and

537
00:25:06,300 --> 00:25:03,880
hear the chord that comes with it you

538
00:25:08,760 --> 00:25:06,310

will start to hear the priests aging of

539
00:25:11,670 --> 00:25:08,770
the Magnificent chord that will happen

540
00:25:15,660 --> 00:25:11,680
with the deep field and this one comes

541
00:25:17,550 --> 00:25:15,670
in and it's slightly out of focus when I

542
00:25:20,520 --> 00:25:17,560
first heard it I was like what's he

543
00:25:22,680 --> 00:25:20,530
doing here I didn't really I like this

544
00:25:25,710 --> 00:25:22,690
is is this out of key or what it's

545
00:25:28,350 --> 00:25:25,720
intentionally slightly out of focus so

546
00:25:31,260 --> 00:25:28,360
that the music clarifies over the course

547
00:25:34,410 --> 00:25:31,270
of its development all right and so this

548
00:25:36,300 --> 00:25:34,420
is a really nice a nice way of

549
00:25:39,660 --> 00:25:36,310
appreciating what he's going to come up

550
00:25:42,180 --> 00:25:39,670
with we pull out of the Sun and then we

551
00:25:44,070 --> 00:25:42,190
start to fly through a star filled with

552
00:25:46,530 --> 00:25:44,080
the Milky Way in the background so

553
00:25:48,450 --> 00:25:46,540
escape out of our solar system starts

554
00:25:51,450 --> 00:25:48,460
flying through a star field and this

555
00:25:54,390 --> 00:25:51,460
shot here was based on a shot that I did

556
00:25:57,060 --> 00:25:54,400
for a documentary filmmaker flying

557
00:25:58,590 --> 00:25:57,070
towards the Orion constellation and I

558
00:26:00,110 --> 00:25:58,600
just want to mention one thing about it

559
00:26:03,960 --> 00:26:00,120
because it's going to come up in

560
00:26:05,730 --> 00:26:03,970
different pattern later that the Milky

561
00:26:08,220 --> 00:26:05,740
Way is so big that when you're flying

562
00:26:10,200 --> 00:26:08,230
through the local stars the Milky Way

563
00:26:12,960 --> 00:26:10,210

doesn't change that much so we use a

564
00:26:14,040 --> 00:26:12,970
standard technique where we have a star

565
00:26:17,850 --> 00:26:14,050
field

566
00:26:20,730 --> 00:26:17,860
we fly through it and the stars are all

567
00:26:21,960 --> 00:26:20,740
flying past you but the background is

568
00:26:25,710 --> 00:26:21,970
just a Milky Way

569
00:26:27,930 --> 00:26:25,720
that's a static 2d image okay so we have

570
00:26:30,240 --> 00:26:27,940
this foreground background thing to make

571
00:26:32,040 --> 00:26:30,250
our computation easier because trying to

572
00:26:34,590 --> 00:26:32,050
build out a full Milky Way that could be

573
00:26:37,080 --> 00:26:34,600
a difficult project right yeah you'll

574
00:26:38,460 --> 00:26:37,090
see in just a minute so this foreground

575
00:26:41,130 --> 00:26:38,470
background I just want you to keep that

576
00:26:43,830 --> 00:26:41,140
in mind for later we fly through the

577
00:26:47,160 --> 00:26:43,840
stars and we come up upon the star

578
00:26:51,030 --> 00:26:47,170
forming region sharpless 2 - 106 which

579
00:26:56,400 --> 00:26:54,060
of a sequence of four massive star

580
00:26:58,290 --> 00:26:56,410
sequences all right in the center of

581
00:27:00,990 --> 00:26:58,300
this this is a star forming region we've

582
00:27:04,560 --> 00:27:01,000
just formed a very massive star at the

583
00:27:07,350 --> 00:27:04,570
core of this nebula and the winds from

584
00:27:10,410 --> 00:27:07,360
this star and the ultraviolet radiation

585
00:27:12,870 --> 00:27:10,420
from this star have carved this nebula

586
00:27:15,240 --> 00:27:12,880
there's a probably a disc of material

587
00:27:17,400 --> 00:27:15,250
around this star here in the center

588
00:27:19,950 --> 00:27:17,410

which constrains things in that

589
00:27:22,350 --> 00:27:19,960
direction and allows the winds to blow

590
00:27:25,590 --> 00:27:22,360
out in opposite directions creating this

591
00:27:27,240 --> 00:27:25,600
hourglass shape to it and we knew enough

592
00:27:29,010 --> 00:27:27,250
about the 3d structure of this that we

593
00:27:32,430 --> 00:27:29,020
could build the model and we actually

594
00:27:34,890 --> 00:27:32,440
fly down onto it 59 production then

595
00:27:37,530 --> 00:27:34,900
takes us flying through it transfers

596
00:27:40,669 --> 00:27:37,540
over to the next nebula which is the

597
00:27:41,850 --> 00:27:40,679
bubble nebula a visualization we did in

598
00:27:44,430 --> 00:27:41,860
2016

599
00:27:49,470 --> 00:27:44,440
another massive star in the core of it

600
00:27:51,660 --> 00:27:49,480
and it has had ejection of a wind and

601
00:27:53,549 --> 00:27:51,670
that wind has got this bubble that is

602
00:27:55,950 --> 00:27:53,559
being blown in the center of this nebula

603
00:27:58,320 --> 00:27:55,960
and you may look at this bubble and say

604
00:28:02,520 --> 00:27:58,330
hey wait a minute how come the star is

605
00:28:03,510 --> 00:28:02,530
off-center that is actually correct that

606
00:28:06,570 --> 00:28:03,520
it is off-center

607
00:28:09,630 --> 00:28:06,580
because the nebula is on the left and

608
00:28:12,360 --> 00:28:09,640
the nebula has a pressure from it that

609
00:28:14,880 --> 00:28:12,370
resists the flow of the bubble the wind

610
00:28:17,520 --> 00:28:14,890
that's pushing making this bubble on the

611
00:28:20,640 --> 00:28:17,530
right the nebula is not there and it is

612
00:28:23,460 --> 00:28:20,650
able to expand more freely and expand so

613
00:28:25,980 --> 00:28:23,470

that this star actually is off-center

614
00:28:27,539 --> 00:28:25,990
within this gorgeous glowing bubble of

615
00:28:31,950 --> 00:28:27,549
the nebula

616
00:28:34,980 --> 00:28:31,960
next nebula is the Lagoon Nebula this

617
00:28:37,950 --> 00:28:34,990
was a visualization we did in 2018 and

618
00:28:40,560 --> 00:28:37,960
again you see a massive star here this

619
00:28:43,590 --> 00:28:40,570
one is actually hidden behind a lot of

620
00:28:46,889 --> 00:28:43,600
dark gas but it's a radiation is causing

621
00:28:50,100 --> 00:28:46,899
all of the the cool colors within the

622
00:28:52,500 --> 00:28:50,110
nebula this visualization also then

623
00:28:54,539 --> 00:28:52,510
rises up through the rest of the Lagoon

624
00:28:57,659 --> 00:28:54,549
Nebula and shows you some gorgeous

625
00:28:59,820 --> 00:28:57,669
ionization fronts there red ridges along

626
00:29:02,549 --> 00:28:59,830
the edge of the dark gas where the

627
00:29:05,730 --> 00:29:02,559
ionizing radiation hits the gas and

628
00:29:07,260 --> 00:29:05,740
causes the gas to to ionize gorgeous

629
00:29:10,049 --> 00:29:07,270
little ionization fronts look for them

630
00:29:13,560 --> 00:29:10,059
in that sequence and the last of our

631
00:29:15,600 --> 00:29:13,570
massive star sequences is a massive star

632
00:29:19,260 --> 00:29:15,610
cluster a cluster of massive stars

633
00:29:21,990 --> 00:29:19,270
called westerlyn - and Westerlund - has

634
00:29:24,630 --> 00:29:22,000
more the largest collections of massive

635
00:29:27,870 --> 00:29:24,640
stars in a cluster within a nebula

636
00:29:29,820 --> 00:29:27,880
that's called gum 29 and I'm going to

637
00:29:31,610 --> 00:29:29,830
tell you a bit about this one so you can

638
00:29:33,570 --> 00:29:31,620

get understanding of how we visualize

639
00:29:36,720 --> 00:29:33,580
sequences like this all of these

640
00:29:39,930 --> 00:29:36,730
sequences are visualized using a similar

641
00:29:42,389 --> 00:29:39,940
technique so here is the Westerlund -

642
00:29:45,149 --> 00:29:42,399
image that do we used for the

643
00:29:47,789 --> 00:29:45,159
visualization the central region is the

644
00:29:49,470 --> 00:29:47,799
Hubble image and the outer regions come

645
00:29:52,889 --> 00:29:49,480
from a European Southern Observatory

646
00:29:54,450 --> 00:29:52,899
larger image of gum 29 and the first

647
00:29:57,269 --> 00:29:54,460
thing we're gonna do to visualize this

648
00:30:00,539 --> 00:29:57,279
is we're gonna get rid of all those

649
00:30:04,860 --> 00:30:00,549
stars I love being able to do that with

650
00:30:07,830 --> 00:30:04,870
one click that as you might guess is a

651
00:30:10,279 --> 00:30:07,840
tremendous amount of work by our image

652
00:30:13,080 --> 00:30:10,289
processors they do some fantastic work

653
00:30:15,930 --> 00:30:13,090
but we got to get those stars back okay

654
00:30:17,250 --> 00:30:15,940
and we're not going to go in and cut out

655
00:30:19,529 --> 00:30:17,260
images of every single one of those

656
00:30:21,899 --> 00:30:19,539
stars and and paste them back into our

657
00:30:24,870 --> 00:30:21,909
3d model instead we're gonna use

658
00:30:27,539 --> 00:30:24,880
something that I like to call PSF stars

659
00:30:30,080 --> 00:30:27,549
or synthetic stars all right so we can

660
00:30:32,669 --> 00:30:30,090
go through with our astronomical image

661
00:30:34,440 --> 00:30:32,679
astronomical software and identify all

662
00:30:36,740 --> 00:30:34,450
the stars in the images and we've got

663
00:30:39,629 --> 00:30:36,750

them in several different filters okay

664
00:30:40,980 --> 00:30:39,639
the five five five is in the middle of

665
00:30:44,280 --> 00:30:40,990
the visible this is

666
00:30:46,919 --> 00:30:44,290
the red and this is in the infrared okay

667
00:30:49,980 --> 00:30:46,929
and so here's an image of all the stars

668
00:30:52,560 --> 00:30:49,990
in the Hubble image that are that there

669
00:30:55,500 --> 00:30:52,570
and their colors so we can measure the

670
00:30:57,390 --> 00:30:55,510
brightness --is and colors of every star

671
00:31:01,470 --> 00:30:57,400
in the image and put them into a catalog

672
00:31:05,160 --> 00:31:01,480
okay we also know a lot about the point

673
00:31:08,610 --> 00:31:05,170
spread function of a star we know how it

674
00:31:11,160 --> 00:31:08,620
goes from a very small dot to a larger

675
00:31:13,860 --> 00:31:11,170
and larger and larger and how the light

676
00:31:16,169 --> 00:31:13,870
spreads out across the Hubble detector

677
00:31:18,210 --> 00:31:16,179
so if we know the brightness of the star

678
00:31:21,660 --> 00:31:18,220
we can predict an we can predict

679
00:31:23,549 --> 00:31:21,670
accurately what it will look like on the

680
00:31:26,669 --> 00:31:23,559
Hubble image alright so using this

681
00:31:29,040 --> 00:31:26,679
catalog together we can create the

682
00:31:31,590 --> 00:31:29,050
colors of the stars and we can create

683
00:31:33,810 --> 00:31:31,600
the look of those stars synthetically

684
00:31:36,210 --> 00:31:33,820
without having to reap go back through

685
00:31:38,760 --> 00:31:36,220
an photoshop and cut things out we can

686
00:31:40,440 --> 00:31:38,770
do it scientifically all right the other

687
00:31:42,720 --> 00:31:40,450
thing we need to do is actually separate

688
00:31:46,049 --> 00:31:42,730

out which stars are in the foreground

689
00:31:48,090 --> 00:31:46,059
and which stars are in the cluster and

690
00:31:49,200 --> 00:31:48,100
we do this with a scientific measurement

691
00:31:52,590 --> 00:31:49,210
which we call the color magnitude

692
00:31:54,750 --> 00:31:52,600
diagram a CMD and it's basically a color

693
00:31:57,390 --> 00:31:54,760
color diagram and you can see the ones

694
00:31:59,669 --> 00:31:57,400
highlighted in red here are the ones

695
00:32:01,470 --> 00:31:59,679
that scientists we were working with

696
00:32:03,720 --> 00:32:01,480
identified as these are the ones that

697
00:32:06,390 --> 00:32:03,730
are in the cluster and this big long

698
00:32:08,610 --> 00:32:06,400
white swath of Owens these are the ones

699
00:32:11,340 --> 00:32:08,620
in the foreground and so we're able to

700
00:32:13,250 --> 00:32:11,350
map out and we subtract out the cluster

701
00:32:16,260 --> 00:32:13,260
stars you can see there's a little

702
00:32:19,290 --> 00:32:16,270
residual but overall pretty good and

703
00:32:20,669 --> 00:32:19,300
that takes care of the Hubble stars the

704
00:32:23,640 --> 00:32:20,679
other thing we can do is we can go to

705
00:32:25,410 --> 00:32:23,650
the 2mass catalog and pull in the stars

706
00:32:28,340 --> 00:32:25,420
in the rest of the field all of these

707
00:32:31,020 --> 00:32:28,350
white stars here use the 2mass catalog

708
00:32:33,270 --> 00:32:31,030
match them to the Hubble band passes and

709
00:32:36,180 --> 00:32:33,280
reproduce stars in the external part of

710
00:32:41,790 --> 00:32:36,190
the field so we can recreate all the

711
00:32:45,630 --> 00:32:41,800
stars and statistically distribute them

712
00:32:47,940 --> 00:32:45,640
around the nebula for for the thing so

713
00:32:51,840 --> 00:32:47,950

now we've got to get back to the nebula

714
00:32:54,549 --> 00:32:51,850
itself and this nebula is done with what

715
00:32:57,190 --> 00:32:54,559
process that we call sculpted decoupage

716
00:32:59,139 --> 00:32:57,200
alright illustrate that I'm going to

717
00:33:00,190 --> 00:32:59,149
take this image the great wave of Ken

718
00:33:03,669 --> 00:33:00,200
Agha

719
00:33:05,560 --> 00:33:03,679
and if you cut it up we make multiple

720
00:33:07,119 --> 00:33:05,570
versions of it and you cut it up into

721
00:33:10,029 --> 00:33:07,129
its various pieces and you put little

722
00:33:13,119 --> 00:33:10,039
spacers between them you create what is

723
00:33:16,509 --> 00:33:13,129
called a decoupage box and it gives you

724
00:33:20,230 --> 00:33:16,519
a 3d look and feel by having multiple

725
00:33:23,289 --> 00:33:20,240
flat layers so we do the same sort of

726
00:33:26,019 --> 00:33:23,299
thing but we do it digitally in a 3d

727
00:33:28,090 --> 00:33:26,029
modeling program and we also instead of

728
00:33:30,580 --> 00:33:28,100
using flat layers we sculpt the various

729
00:33:35,710 --> 00:33:30,590
layers to give them texture and feel so

730
00:33:37,810 --> 00:33:35,720
in our digital program we have this type

731
00:33:40,330 --> 00:33:37,820
of configuration all right so the camera

732
00:33:43,509 --> 00:33:40,340
is up here looking down at the nebula

733
00:33:45,460 --> 00:33:43,519
year and what's highlighted white here

734
00:33:48,519 --> 00:33:45,470
are these are the background layers of

735
00:33:50,560 --> 00:33:48,529
the nebula then we have the pieces that

736
00:33:53,560 --> 00:33:50,570
are inside the nebula the pillars and

737
00:33:55,629 --> 00:33:53,570
all of the structures inside the nebula

738
00:33:58,149 --> 00:33:55,639

then we have the layers that are at the

739
00:34:00,159 --> 00:33:58,159
front side of the nebula the the dark

740
00:34:03,129 --> 00:34:00,169
gas and such that and the gas that's

741
00:34:06,430 --> 00:34:03,139
being irradiated by the stars as well as

742
00:34:07,960 --> 00:34:06,440
there is this small little fluffy stuff

743
00:34:09,879 --> 00:34:07,970
in front of it which we call the veil of

744
00:34:11,950 --> 00:34:09,889
the nebula it's sort of gas that's been

745
00:34:14,740 --> 00:34:11,960
blown out of the nebula in the direction

746
00:34:16,839 --> 00:34:14,750
toward where we are looking plus we've

747
00:34:20,079 --> 00:34:16,849
got in this model the cluster stars down

748
00:34:22,030 --> 00:34:20,089
here Hubble stars here

749
00:34:24,639 --> 00:34:22,040
statistically distributed in front of

750
00:34:27,190 --> 00:34:24,649
the nebula and then the two mass stars

751
00:34:31,109 --> 00:34:27,200
the ESO stars statistically distributed

752
00:34:33,309 --> 00:34:31,119
around those and this is how we create

753
00:34:36,280 --> 00:34:33,319
well I guess I call this the Christmas

754
00:34:40,240 --> 00:34:36,290
tree of our model we've got about 25

755
00:34:42,909 --> 00:34:40,250
layers of the nebula and about 25,000

756
00:34:46,089 --> 00:34:42,919
individual stars floating in 3d that

757
00:34:48,790 --> 00:34:46,099
we're gonna pass the camera through but

758
00:34:51,010 --> 00:34:48,800
that visually this is the build sequence

759
00:34:53,980 --> 00:34:51,020
starting from the back to the front so

760
00:34:56,649 --> 00:34:53,990
the background behind the nebula pulling

761
00:35:00,120 --> 00:34:56,659
in the cluster stars all the pieces are

762
00:35:02,200 --> 00:35:00,130
inside the nebula many of these the

763
00:35:04,539 --> 00:35:02,210

pillars that are pointing toward the

764
00:35:06,339 --> 00:35:04,549
cluster at the center so we get to the

765
00:35:07,549 --> 00:35:06,349
front part of the nebula and then the

766
00:35:10,910 --> 00:35:07,559
veil

767
00:35:13,699 --> 00:35:10,920
bring in the Hubble Stars and the stars

768
00:35:16,670 --> 00:35:13,709
this is the full 3d model as you watch

769
00:35:21,370 --> 00:35:16,680
it that we then fly through to build for

770
00:35:24,380 --> 00:35:21,380
it so this same sort of sequence of

771
00:35:26,269 --> 00:35:24,390
sculpted decoupage procedure is what we

772
00:35:28,039 --> 00:35:26,279
use for all of these nebula sequences

773
00:35:29,599 --> 00:35:28,049
and we'll actually also use it for one

774
00:35:33,339 --> 00:35:29,609
of the galaxy sequences I'll show you in

775
00:35:37,009 --> 00:35:33,349
just a minute all right back to the film

776
00:35:40,039 --> 00:35:37,019
the nebula the nebula movement ends and

777
00:35:42,559 --> 00:35:40,049
we go into the galaxy movement and the

778
00:35:45,890 --> 00:35:42,569
galaxy movement begins with probably the

779
00:35:49,579 --> 00:35:45,900
toughest shot in the entire film

780
00:35:52,429 --> 00:35:49,589
this was the galaxy Traverse sequence in

781
00:35:54,829 --> 00:35:52,439
which we had to fly through a Milky Way

782
00:35:56,660 --> 00:35:54,839
galaxy we flew out of our solar system

783
00:35:58,579 --> 00:35:56,670
and through the stars of the galaxy now

784
00:36:02,660 --> 00:35:58,589
we want to escape the galaxy and go out

785
00:36:04,849 --> 00:36:02,670
and explore other galaxies and I gotta

786
00:36:07,789 --> 00:36:04,859
say I probably spent 4 to 6 weeks

787
00:36:10,189 --> 00:36:07,799
working on this sequence so I'm gonna

788
00:36:13,969 --> 00:36:10,199

tell you about it cuz it was a quite a

789
00:36:15,890 --> 00:36:13,979
lot of work it began at the Astro VA's

790
00:36:17,989 --> 00:36:15,900
conference that was held in Pasadena

791
00:36:19,759 --> 00:36:17,999
last summer where the astronomy

792
00:36:22,519 --> 00:36:19,769
visualization experts got together and

793
00:36:26,059 --> 00:36:22,529
chatted about things and somebody showed

794
00:36:28,789 --> 00:36:26,069
this image this is gas and dust in a

795
00:36:31,729 --> 00:36:28,799
spiral galaxy but it's not an

796
00:36:35,660 --> 00:36:31,739
observation this is a computer

797
00:36:37,699 --> 00:36:35,670
simulation that looks so realistic ok

798
00:36:40,279 --> 00:36:37,709
this is the fire simulations that

799
00:36:42,650 --> 00:36:40,289
feedback and realistic environment by

800
00:36:45,229 --> 00:36:42,660
Hummels Hopkins and Wetzel and Cameron

801
00:36:47,900 --> 00:36:45,239
Hummels who presented it I said oh I

802
00:36:49,880 --> 00:36:47,910
gotta get this data this is so cool I

803
00:36:52,939 --> 00:36:49,890
can use that the visualizations of this

804
00:36:55,130 --> 00:36:52,949
could be fantastic so if they had this

805
00:36:57,679 --> 00:36:55,140
one as a Milky Way analog with 150

806
00:36:59,390 --> 00:36:57,689
million points and all the details of

807
00:37:01,279 --> 00:36:59,400
the star formation going on there I said

808
00:37:03,289 --> 00:37:01,289
great let's take a look at this and I

809
00:37:06,380 --> 00:37:03,299
played with it and I got to visualizing

810
00:37:09,859 --> 00:37:06,390
it and I said fantastic look at this

811
00:37:11,959 --> 00:37:09,869
this just feels like a galaxy look at

812
00:37:16,339 --> 00:37:11,969
all the dust and all the stuff it's just

813
00:37:18,169 --> 00:37:16,349

oh wow all I got to do you know I got I

814
00:37:20,290 --> 00:37:18,179
got a I got to do is just fly through

815
00:37:22,900 --> 00:37:20,300
this and I said to myself hey

816
00:37:24,670 --> 00:37:22,910
Sunset Boulevard we're ready for your

817
00:37:26,250 --> 00:37:24,680
cult our close-up okay

818
00:37:30,510 --> 00:37:26,260
I always thinking this is gonna be the

819
00:37:33,820 --> 00:37:30,520
simplest sequence at all and then I

820
00:37:35,740 --> 00:37:33,830
tried it and it looks okay here and as

821
00:37:40,450 --> 00:37:35,750
you get closer it starts to break down

822
00:37:44,020 --> 00:37:40,460
and as you get inside it it's blue it

823
00:37:45,670 --> 00:37:44,030
looked and I could adjust the parameters

824
00:37:47,890 --> 00:37:45,680
and play with it and I could get okay I

825
00:37:49,420 --> 00:37:47,900
can get the foreground star stuff here

826
00:37:52,540 --> 00:37:49,430
but look at that background stuff it's

827
00:37:54,520 --> 00:37:52,550
just all muddy and disgusting and I was

828
00:37:56,590 --> 00:37:54,530
going back and forth and back and forth

829
00:37:59,020 --> 00:37:56,600
because I wasn't getting what I needed

830
00:38:00,640 --> 00:37:59,030
which is this this is an image of our

831
00:38:02,980 --> 00:38:00,650
Milky Way okay

832
00:38:05,560 --> 00:38:02,990
and you can see this beautiful structure

833
00:38:07,960 --> 00:38:05,570
of the dark gas and all the light the

834
00:38:10,210 --> 00:38:07,970
the the the brightness of the halo in

835
00:38:12,640 --> 00:38:10,220
behind it and stuff like I couldn't get

836
00:38:16,720 --> 00:38:12,650
it until I smacked myself in the head

837
00:38:22,090 --> 00:38:16,730
you go on dude you can't see that dark

838
00:38:23,830 --> 00:38:22,100

stuff unless you got backlight right you

839
00:38:27,010 --> 00:38:23,840
really need to make sure you get the

840
00:38:29,200 --> 00:38:27,020
full backlight in behind your dark gas

841
00:38:31,810 --> 00:38:29,210
otherwise the dark gas is just you know

842
00:38:33,310 --> 00:38:31,820
it doesn't add to your picture so

843
00:38:35,710 --> 00:38:33,320
remember that foreground background

844
00:38:38,800 --> 00:38:35,720
stuff I had to go back to that

845
00:38:39,940 --> 00:38:38,810
foreground background and reinterpret it

846
00:38:42,940 --> 00:38:39,950
in two new ways

847
00:38:44,680 --> 00:38:42,950
so my multi-layered starv is had to have

848
00:38:46,750 --> 00:38:44,690
the foreground okay which was the same

849
00:38:48,430 --> 00:38:46,760
as I did for the star thing this is the

850
00:38:50,290 --> 00:38:48,440
Hipparcos catalog of the other

851
00:38:52,990 --> 00:38:50,300
foreground stars these are the bright

852
00:38:55,420 --> 00:38:53,000
stars that are in the near ground and

853
00:38:57,190 --> 00:38:55,430
for that you know I basically I only

854
00:38:59,200 --> 00:38:57,200
generated those stars along the camera

855
00:39:00,850 --> 00:38:59,210
path because there's like a hundred

856
00:39:01,840 --> 00:39:00,860
billion stars in the Milky Way I'm not

857
00:39:02,470 --> 00:39:01,850
going to generate a hundred billion

858
00:39:04,180 --> 00:39:02,480
stars

859
00:39:06,520 --> 00:39:04,190
I only generate the ones that I need

860
00:39:09,430 --> 00:39:06,530
that are along the camera path so I get

861
00:39:11,620 --> 00:39:09,440
you know tens of millions instead then I

862
00:39:13,210 --> 00:39:11,630
created in the mid ground which was that

863
00:39:15,160 --> 00:39:13,220

standard point cloud viz that I just

864
00:39:16,900 --> 00:39:15,170
showed you and that all worked but I

865
00:39:19,330 --> 00:39:16,910
recognized that when doing the

866
00:39:21,910 --> 00:39:19,340
mid-ground there's a lot of stars that

867
00:39:23,980 --> 00:39:21,920
were too faint and too small that you

868
00:39:26,110 --> 00:39:23,990
just ignored because they weren't they

869
00:39:28,210 --> 00:39:26,120
weren't bright enough to be seen but

870
00:39:30,910 --> 00:39:28,220
that light was getting lost in the

871
00:39:33,049 --> 00:39:30,920
procedure and so I collected all that

872
00:39:36,349 --> 00:39:33,059
light that was

873
00:39:39,979 --> 00:39:36,359
individually too faint to see but adding

874
00:39:41,899 --> 00:39:39,989
it together provided this 3d background

875
00:39:44,120 --> 00:39:41,909
so instead of having a 2d background for

876
00:39:46,159 --> 00:39:44,130
my galaxy I added in a full

877
00:39:49,219 --> 00:39:46,169
three-dimensional background that could

878
00:39:51,890 --> 00:39:49,229
then illuminate those dark dust clouds

879
00:39:54,649 --> 00:39:51,900
all right and then I was able to produce

880
00:39:56,359 --> 00:39:54,659
a test image like this I said yes I'm

881
00:39:59,179 --> 00:39:56,369
starting to get some dark dust clouds I

882
00:40:00,979 --> 00:39:59,189
can deal with this this is great and

883
00:40:04,189 --> 00:40:00,989
then we worked for several a couple more

884
00:40:06,559 --> 00:40:04,199
weeks and got to hear of the procedure

885
00:40:09,649 --> 00:40:06,569
for this is this is a shot from the film

886
00:40:12,439 --> 00:40:09,659
and one of the cool things about it was

887
00:40:14,449 --> 00:40:12,449
that in the simulations they had all the

888
00:40:16,699 --> 00:40:14,459

information on the star formation so

889
00:40:18,949 --> 00:40:16,709
these red clouds here and these blue

890
00:40:22,279 --> 00:40:18,959
clouds here these are emission and

891
00:40:25,159 --> 00:40:22,289
reflection nebulae that are tied to

892
00:40:27,409 --> 00:40:25,169
where stars have recently formed in the

893
00:40:28,999 --> 00:40:27,419
simulation because I got the information

894
00:40:31,219 --> 00:40:29,009
about when stars have formed in the

895
00:40:33,459 --> 00:40:31,229
simulation and the gas around the room

896
00:40:36,799 --> 00:40:33,469
newly forming stars will be illuminated

897
00:40:38,870 --> 00:40:36,809
up and will glow red or will if it's a

898
00:40:41,659 --> 00:40:38,880
little older will actually reflect the

899
00:40:44,719 --> 00:40:41,669
light of the newborn stars and glow blue

900
00:40:46,640 --> 00:40:44,729
and I know that no one will ever notice

901
00:40:49,189 --> 00:40:46,650
that that these are actually the correct

902
00:40:51,709 --> 00:40:49,199
star forming places in the galaxy but I

903
00:40:53,599 --> 00:40:51,719
know and it's really geeky cool to be

904
00:40:56,149 --> 00:40:53,609
able to say that yes these are the right

905
00:40:57,349 --> 00:40:56,159
places for those h2 regions and h1

906
00:41:00,439 --> 00:40:57,359
regions in the galaxy

907
00:41:03,049 --> 00:41:00,449
alright so we fly out of our galaxy in

908
00:41:05,239 --> 00:41:03,059
this sequence and we come upon one of

909
00:41:08,959 --> 00:41:05,249
Hubble's most famous galaxy observations

910
00:41:11,149 --> 00:41:08,969
the Whirlpool Galaxy ok and this is the

911
00:41:12,349 --> 00:41:11,159
Hubble visualization of it and I'll go

912
00:41:13,969 --> 00:41:12,359
through this just relatively quickly

913
00:41:16,759 --> 00:41:13,979

because this was another major project

914
00:41:19,099 --> 00:41:16,769
here so this is Hubble's observation of

915
00:41:21,979 --> 00:41:19,109
the whirlpool and we didn't want to deal

916
00:41:25,819 --> 00:41:21,989
with the satellite galaxies so goodbye

917
00:41:27,319 --> 00:41:25,829
we erased it for this and then we had to

918
00:41:29,419 --> 00:41:27,329
separate this into its various

919
00:41:31,489 --> 00:41:29,429
components and you can see you've got

920
00:41:34,729 --> 00:41:31,499
these old stars here that are sort of

921
00:41:37,189 --> 00:41:34,739
yellowish the young stars here which are

922
00:41:38,659 --> 00:41:37,199
sort of bluish and greenish and then

923
00:41:41,359 --> 00:41:38,669
you've got these red star forming

924
00:41:43,549 --> 00:41:41,369
regions here and we first tried doing

925
00:41:45,020 --> 00:41:43,559
the standard RGB separation red green

926
00:41:47,870 --> 00:41:45,030
blue separation

927
00:41:50,960 --> 00:41:47,880
and it really didn't work and then I hit

928
00:41:53,300 --> 00:41:50,970
my head oh we've got sort of cyan and

929
00:41:56,810 --> 00:41:53,310
sort of magenta and yellow we're gonna

930
00:41:58,850 --> 00:41:56,820
do the CMYK separation color separation

931
00:41:59,330 --> 00:41:58,860
you've never heard of it don't worry

932
00:42:01,490 --> 00:41:59,340
about it

933
00:42:05,120 --> 00:42:01,500
it's a standard color separation using

934
00:42:08,360 --> 00:42:05,130
cyan magenta and yellow and black and

935
00:42:10,370 --> 00:42:08,370
these were the three the cyan magenta

936
00:42:13,250 --> 00:42:10,380
and yellow separations of the image

937
00:42:15,200 --> 00:42:13,260
which we could then transform into the

938
00:42:17,900 --> 00:42:15,210

young stars from the blue from the cyan

939
00:42:20,690 --> 00:42:17,910
the emission nebula from the magenta and

940
00:42:23,390 --> 00:42:20,700
these are pink on the old stars that are

941
00:42:24,740 --> 00:42:23,400
yellowish and whitish and so now we have

942
00:42:27,230 --> 00:42:24,750
two-dimensional images that sort of

943
00:42:30,290 --> 00:42:27,240
separate out the various components of

944
00:42:34,310 --> 00:42:30,300
that galaxy we also could use the black

945
00:42:36,830 --> 00:42:34,320
to do the dust lanes in the galaxy and

946
00:42:38,240 --> 00:42:36,840
Hubble's dust lanes are fine but really

947
00:42:40,550 --> 00:42:38,250
if you want to look at dust you want to

948
00:42:43,430 --> 00:42:40,560
go really into the infrared so we also

949
00:42:46,520 --> 00:42:43,440
use the spitzer image here to get the

950
00:42:49,430 --> 00:42:46,530
dust lanes for the the Whirlpool Galaxy

951
00:42:51,430 --> 00:42:49,440
alright combining these we had to use

952
00:42:55,130 --> 00:42:51,440
what we call point cloud visualizations

953
00:42:57,140 --> 00:42:55,140
taking those images and creating point

954
00:42:58,370 --> 00:42:57,150
clouds above and below those images so

955
00:43:00,530 --> 00:42:58,380
these are you know two-dimensional

956
00:43:01,940 --> 00:43:00,540
images so you make them 3d and give them

957
00:43:03,110 --> 00:43:01,950
the right density structure in the

958
00:43:04,820 --> 00:43:03,120
printer and the presentation and

959
00:43:07,610 --> 00:43:04,830
everything and we ended up creating

960
00:43:09,140 --> 00:43:07,620
about a hundred million point clouds and

961
00:43:13,160 --> 00:43:09,150
we have custom software called

962
00:43:16,040 --> 00:43:13,170
pointillism to to handle it and these

963
00:43:18,020 --> 00:43:16,050

sequences were a little heavy on the hit

964
00:43:20,780 --> 00:43:18,030
my maximum which is about three CPU

965
00:43:23,240 --> 00:43:20,790
hours per frame that's not frames per

966
00:43:26,150 --> 00:43:23,250
second it's hours per frame three hours

967
00:43:29,510 --> 00:43:26,160
to render one frame of this sequence at

968
00:43:31,400 --> 00:43:29,520
4k that's usually my maximum I well I

969
00:43:32,870 --> 00:43:31,410
don't like to go beyond that fortunately

970
00:43:35,660 --> 00:43:32,880
a hundred million point clouds was it

971
00:43:38,060 --> 00:43:35,670
was doable in that for this project okay

972
00:43:40,400 --> 00:43:38,070
we rendered all of them separately so we

973
00:43:42,920 --> 00:43:40,410
have the old stars here we have the

974
00:43:45,710 --> 00:43:42,930
young stars here we have the emission

975
00:43:48,980 --> 00:43:45,720
nebula here along with the cluster stars

976
00:43:52,250 --> 00:43:48,990
inside those things and boom together

977
00:43:54,080 --> 00:43:52,260
they form the Whirlpool Galaxy now I'm

978
00:43:56,180 --> 00:43:54,090
going to digress for one little second

979
00:43:58,670 --> 00:43:56,190
here okay because we went further than

980
00:44:00,200 --> 00:43:58,680
this with the universe of learning

981
00:44:02,060 --> 00:44:00,210
we have our educational project here

982
00:44:04,460 --> 00:44:02,070
called the universe of learning and

983
00:44:06,320 --> 00:44:04,470
Hubble isn't the only one that has

984
00:44:08,780 --> 00:44:06,330
observed the Whirlpool Galaxy as I've

985
00:44:10,670 --> 00:44:08,790
already used the Spitzer image and the

986
00:44:13,400 --> 00:44:10,680
Chandra x-ray Observatory observed it as

987
00:44:16,280 --> 00:44:13,410
well so we went further and we took the

988
00:44:19,820 --> 00:44:16,290

Spitzer data and the Chandra data and we

989
00:44:22,820 --> 00:44:19,830
made 3d models for them as well so we've

990
00:44:25,760 --> 00:44:22,830
got the two wavelengths of infrared and

991
00:44:27,740 --> 00:44:25,770
two energies for the x-ray combining

992
00:44:32,090 --> 00:44:27,750
them we can cross compare between

993
00:44:34,280 --> 00:44:32,100
infrared visible and x-ray in a short

994
00:44:36,860 --> 00:44:34,290
little film that we called shedding new

995
00:44:40,850 --> 00:44:36,870
light on the Whirlpool Galaxy giving you

996
00:44:43,220 --> 00:44:40,860
a visual representation of the value of

997
00:44:44,990 --> 00:44:43,230
all these NASA observatories and the

998
00:44:47,480 --> 00:44:45,000
strength of doing multi-wavelength

999
00:44:49,310 --> 00:44:47,490
astronomy this is an example of one of

1000
00:44:51,200 --> 00:44:49,320
the sort of educational the learning

1001
00:44:53,060 --> 00:44:51,210
projects that we can do with NASA's

1002
00:44:55,330 --> 00:44:53,070
universe of learning based on some of

1003
00:44:58,040 --> 00:44:55,340
these visualization projects all right

1004
00:45:00,500 --> 00:44:58,050
back to the film all right

1005
00:45:02,480 --> 00:45:00,510
the galaxies sequence continues with a

1006
00:45:05,780 --> 00:45:02,490
new visualization we did a Stephan's

1007
00:45:07,250 --> 00:45:05,790
quintet of galaxies and this over here

1008
00:45:09,080 --> 00:45:07,260
on the right hand side those five

1009
00:45:11,990 --> 00:45:09,090
galaxies are what's usually called the

1010
00:45:14,510 --> 00:45:12,000
quintet although they are actually just

1011
00:45:17,300 --> 00:45:14,520
a quartet because this blue galaxy here

1012
00:45:20,060 --> 00:45:17,310
is a foreground galaxy that happens to

1013
00:45:22,220 --> 00:45:20,070

be projected along the line of sight but

1014
00:45:25,070 --> 00:45:22,230
while working on this project I also

1015
00:45:27,140 --> 00:45:25,080
learned that this galaxy over here is on

1016
00:45:31,040 --> 00:45:27,150
the left is that the same distance as

1017
00:45:33,650 --> 00:45:31,050
the main grouping so this quintet that's

1018
00:45:35,180 --> 00:45:33,660
actually a quartet is really a sextet

1019
00:45:37,910 --> 00:45:35,190
that's really actually really is a

1020
00:45:40,610 --> 00:45:37,920
quintet all right so the point of all

1021
00:45:43,550 --> 00:45:40,620
this is that galaxies can be found in

1022
00:45:45,290 --> 00:45:43,560
these groups together we fly through the

1023
00:45:48,550 --> 00:45:45,300
quintet of galaxies in the movie and

1024
00:45:51,080 --> 00:45:48,560
take us into the candles galaxies survey

1025
00:45:54,410 --> 00:45:51,090
one of the largest visualizations we've

1026
00:45:58,460 --> 00:45:54,420
ever done thirty-five thousand galaxies

1027
00:46:01,730 --> 00:45:58,470
stretched out across across space we did

1028
00:46:04,700 --> 00:46:01,740
this in 2017 and we fly through this as

1029
00:46:07,250 --> 00:46:04,710
a preparation for seeing the Hubble

1030
00:46:09,770 --> 00:46:07,260
Ultra Deep Field and we hit the climax

1031
00:46:11,150 --> 00:46:09,780
of the film and you get that resplendent

1032
00:46:15,200 --> 00:46:11,160
chord

1033
00:46:16,520 --> 00:46:15,210
Eric has been building up to and when

1034
00:46:18,950 --> 00:46:16,530
you're flying through the Hubble

1035
00:46:21,200 --> 00:46:18,960
ultra-deep field we want to tell you a

1036
00:46:24,380 --> 00:46:21,210
story and it's a story I think you all

1037
00:46:29,540 --> 00:46:24,390
are familiar with the story is a long

1038
00:46:32,990 --> 00:46:29,550

time ago in a galaxy far far away now

1039
00:46:35,900 --> 00:46:33,000
this is one of the things that George

1040
00:46:39,590 --> 00:46:35,910
Lucas accidentally got right in Star

1041
00:46:40,190 --> 00:46:39,600
Wars because galaxies that are far far

1042
00:46:43,910 --> 00:46:40,200
away

1043
00:46:47,000 --> 00:46:43,920
are galaxies that are seen a long time

1044
00:46:48,830 --> 00:46:47,010
ago the light from a galaxy can take

1045
00:46:52,820 --> 00:46:48,840
billions of years to cross the

1046
00:46:55,430 --> 00:46:52,830
intervening space before we see it so if

1047
00:46:58,970 --> 00:46:55,440
the light from the galaxy left it 5

1048
00:47:03,110 --> 00:46:58,980
billion years ago we're seeing that

1049
00:47:05,060 --> 00:47:03,120
galaxy as it was 5 billion years ago all

1050
00:47:07,370 --> 00:47:05,070
right a galaxy that's 10 million light

1051
00:47:10,760 --> 00:47:07,380
years away we're seeing as it was 10

1052
00:47:15,050 --> 00:47:10,770
billion years ago if we look at galaxies

1053
00:47:18,080 --> 00:47:15,060
nearby and further away and further away

1054
00:47:20,780 --> 00:47:18,090
their morphology changes because

1055
00:47:24,590 --> 00:47:20,790
galaxies develop over these billion year

1056
00:47:28,190 --> 00:47:24,600
timescales we can see the development of

1057
00:47:31,550 --> 00:47:28,200
galaxies we look out into space we look

1058
00:47:34,220 --> 00:47:31,560
back into time and we can see how

1059
00:47:37,040 --> 00:47:34,230
galaxies have developed over the history

1060
00:47:39,920 --> 00:47:37,050
of the universe and that's one of the

1061
00:47:43,940 --> 00:47:39,930
most powerful things that we find in

1062
00:47:45,500 --> 00:47:43,950
this Hubble ultra-deep field so to do do

1063
00:47:47,690 --> 00:47:45,510

this we actually have to have the

1064
00:47:50,000 --> 00:47:47,700
individual galaxies so we take this

1065
00:47:52,070 --> 00:47:50,010
Hubble ultra-deep field and effectively

1066
00:47:54,740 --> 00:47:52,080
we just cut little postage stamps around

1067
00:47:56,570 --> 00:47:54,750
every single one of these galaxies now

1068
00:47:58,700 --> 00:47:56,580
we're not going to do this by hand okay

1069
00:48:00,740 --> 00:47:58,710
you're just somebody would go crazy

1070
00:48:03,230 --> 00:48:00,750
we actually have scientific software

1071
00:48:04,790 --> 00:48:03,240
that does all this and we pull out those

1072
00:48:08,630 --> 00:48:04,800
little postage stamps and we bring it

1073
00:48:09,890 --> 00:48:08,640
into our 3d software now this dense

1074
00:48:11,720 --> 00:48:09,900
region in here that's the Hubble

1075
00:48:14,060 --> 00:48:11,730
ultra-deep field within the much larger

1076
00:48:16,610 --> 00:48:14,070
great observatories origins deep survey

1077
00:48:20,240 --> 00:48:16,620
or the goods field in our 3d and these

1078
00:48:22,370 --> 00:48:20,250
are just the the rectangles representing

1079
00:48:24,010 --> 00:48:22,380
the galaxies images and if we look at it

1080
00:48:25,630 --> 00:48:24,020
from the side

1081
00:48:28,089 --> 00:48:25,640
the cameras over here we're looking down

1082
00:48:31,300 --> 00:48:28,099
through it and you can see this this big

1083
00:48:33,910 --> 00:48:31,310
long pyramid of galaxies stretching out

1084
00:48:35,589 --> 00:48:33,920
across the universe and I wanted to show

1085
00:48:38,800 --> 00:48:35,599
you this because I wanted to admit to

1086
00:48:41,740 --> 00:48:38,810
you that we cheated here okay I like to

1087
00:48:43,510 --> 00:48:41,750
tell you when we when we cheat this

1088
00:48:47,170 --> 00:48:43,520

pyramid should be about five hundred

1089
00:48:49,390 --> 00:48:47,180
times longer than it is okay

1090
00:48:51,760 --> 00:48:49,400
the universe is a really really really

1091
00:48:55,630 --> 00:48:51,770
big place this is a very long and thin

1092
00:48:57,579 --> 00:48:55,640
pyramid but if I did it correct

1093
00:48:59,410 --> 00:48:57,589
scientifically correctly instead of

1094
00:49:02,020 --> 00:48:59,420
flying through in a minute it would take

1095
00:49:03,520 --> 00:49:02,030
about eight hours to fly through it and

1096
00:49:04,990 --> 00:49:03,530
I don't think you guys would want to sit

1097
00:49:07,150 --> 00:49:05,000
around and wait eight hours to fly

1098
00:49:08,710 --> 00:49:07,160
through the altitude field so we

1099
00:49:10,300 --> 00:49:08,720
scrunched it up so that we could fly

1100
00:49:13,599 --> 00:49:10,310
through it in a reasonable amount of

1101
00:49:15,700 --> 00:49:13,609
time plus there's one other cheat that

1102
00:49:16,150 --> 00:49:15,710
we did but it has a really good reason

1103
00:49:18,040 --> 00:49:16,160
for it

1104
00:49:21,310 --> 00:49:18,050
because when you look at the most

1105
00:49:23,349 --> 00:49:21,320
distant objects in the Deep Field they

1106
00:49:25,870 --> 00:49:23,359
are the galaxies that are the farthest

1107
00:49:28,329 --> 00:49:25,880
away seen at the earliest times of the

1108
00:49:31,720 --> 00:49:28,339
universe and the earliest development

1109
00:49:34,240 --> 00:49:31,730
and they are these red dots okay

1110
00:49:35,740 --> 00:49:34,250
they are the galaxies who are redshifted

1111
00:49:37,570 --> 00:49:35,750
the most so their light is all the way

1112
00:49:39,400 --> 00:49:37,580
into the infrared and they're just

1113
00:49:41,230 --> 00:49:39,410

beginning to develop there could be even

1114
00:49:44,620 --> 00:49:41,240
called proto galaxies so they're just

1115
00:49:47,170 --> 00:49:44,630
blobs all right these are the most

1116
00:49:48,640 --> 00:49:47,180
important galaxies that we find in the

1117
00:49:52,030 --> 00:49:48,650
Ultra Deep Field because they show us

1118
00:49:54,520 --> 00:49:52,040
the earliest stages that we can find in

1119
00:49:58,240 --> 00:49:54,530
the Hubble Ultra Deep Field of galaxies

1120
00:50:01,060 --> 00:49:58,250
and I wanted a red dot galaxy to be the

1121
00:50:02,890 --> 00:50:01,070
last thing that you see so in this front

1122
00:50:05,859 --> 00:50:02,900
of this shot as we exit the Deep Field

1123
00:50:08,200 --> 00:50:05,869
this galaxy right here doesn't belong

1124
00:50:11,470 --> 00:50:08,210
there it's actually in the Ultra Deep

1125
00:50:12,880 --> 00:50:11,480
Field okay but I had the guys at 59

1126
00:50:15,370 --> 00:50:12,890
productions take it from where it was

1127
00:50:17,560 --> 00:50:15,380
and push it into our field so that we

1128
00:50:20,079 --> 00:50:17,570
could fly past and this would be the

1129
00:50:21,520 --> 00:50:20,089
last galaxy you see okay so I cheated

1130
00:50:24,099 --> 00:50:21,530
but there's a scientific reason behind

1131
00:50:26,650 --> 00:50:24,109
that cheat so that a red dot galaxy

1132
00:50:28,329 --> 00:50:26,660
would be the last thing you see alright

1133
00:50:30,460 --> 00:50:28,339
so we've taken you through the whole

1134
00:50:32,079 --> 00:50:30,470
universe right and we're sitting out the

1135
00:50:34,240 --> 00:50:32,089
edge of the inner edge of yours and

1136
00:50:37,030 --> 00:50:34,250
we're just gonna leave you there no no

1137
00:50:37,720 --> 00:50:37,040
no now we bring in Eric's pet project

1138
00:50:40,270 --> 00:50:37,730

the virtual

1139
00:50:42,580 --> 00:50:40,280
choir all right and so after we get

1140
00:50:45,970 --> 00:50:42,590
through the whole universe and suddenly

1141
00:50:47,740 --> 00:50:45,980
these swirls start appearing and they're

1142
00:50:50,230 --> 00:50:47,750
really cool this is a cool graphic

1143
00:50:52,450 --> 00:50:50,240
effect I honestly you know when I first

1144
00:50:54,190 --> 00:50:52,460
saw these they reminded me of the the

1145
00:50:57,790 --> 00:50:54,200
trails left in old particle physics

1146
00:51:01,300 --> 00:50:57,800
experiments but they're not they are

1147
00:51:05,290 --> 00:51:01,310
actually eric whitacre conducting the

1148
00:51:08,440 --> 00:51:05,300
universe when he conducted the orchestra

1149
00:51:10,900 --> 00:51:08,450
to record this symphony a second time

1150
00:51:15,430 --> 00:51:10,910
they put Eric in a motion capture suit

1151
00:51:18,250 --> 00:51:15,440
they recorded his motions and Eric is a

1152
00:51:20,170 --> 00:51:18,260
performer okay he is a performer okay

1153
00:51:22,000 --> 00:51:20,180
and I think you can sort of like see can

1154
00:51:24,910 --> 00:51:22,010
you imagine his baton here in his arms

1155
00:51:27,280 --> 00:51:24,920
wailing and swishing these were

1156
00:51:29,830 --> 00:51:27,290
generated from the motion capture of

1157
00:51:31,540 --> 00:51:29,840
Eric conducting the symphony let's get

1158
00:51:33,670 --> 00:51:31,550
that kind of cool thing that you'd never

1159
00:51:37,330 --> 00:51:33,680
know unless you came to this talk okay

1160
00:51:40,270 --> 00:51:37,340
and then this segues into the virtual

1161
00:51:43,240 --> 00:51:40,280
choir okay and all of these P all of

1162
00:51:45,820 --> 00:51:43,250
these singers floating through space now

1163
00:51:49,450 --> 00:51:45,830

Eric started the virtual choir after

1164
00:51:51,880 --> 00:51:49,460
this woman named Britten posted a video

1165
00:51:54,160 --> 00:51:51,890
on youtube of her seeing one of Eric's

1166
00:51:55,330 --> 00:51:54,170
song as a dedication to him and of

1167
00:51:59,500 --> 00:51:55,340
course he was flattered and everything

1168
00:52:02,170 --> 00:51:59,510
but he said wait a minute if I got a

1169
00:52:05,050 --> 00:52:02,180
bunch of people to record themselves

1170
00:52:06,940 --> 00:52:05,060
singing I could sort of put them

1171
00:52:09,010 --> 00:52:06,950
together into this virtual choir of

1172
00:52:11,859 --> 00:52:09,020
people who never met each other but

1173
00:52:14,380 --> 00:52:11,869
we're all singing in unison so he

1174
00:52:18,340 --> 00:52:14,390
uploaded a video of him conducting one

1175
00:52:21,460 --> 00:52:18,350
of his pieces looks a room quay and the

1176
00:52:23,230 --> 00:52:21,470
singers sat in their living rooms or

1177
00:52:26,020 --> 00:52:23,240
dining rooms or bedrooms or whatever and

1178
00:52:28,660 --> 00:52:26,030
recorded themselves singing to his

1179
00:52:32,200 --> 00:52:28,670
conduction and then submitted his videos

1180
00:52:33,730 --> 00:52:32,210
and his team put it together for his

1181
00:52:36,660 --> 00:52:33,740
virtual choir here's Eric doing the

1182
00:52:39,730 --> 00:52:36,670
conducting and hear all the people

1183
00:52:43,960 --> 00:52:39,740
singing their various parts from her

1184
00:52:47,080 --> 00:52:43,970
from you know totally distant places all

1185
00:52:48,640 --> 00:52:47,090
right he such a success the choral

1186
00:52:51,609 --> 00:52:48,650
people absolutely loved it he did it

1187
00:52:53,859 --> 00:52:51,619
again with a whole bunch more people

1188
00:52:55,959 --> 00:52:53,869

separate across all various countries

1189
00:52:58,059 --> 00:52:55,969
and did it again with thousands of

1190
00:53:00,910 --> 00:52:58,069
people and then upped it so that we had

1191
00:53:02,079 --> 00:53:00,920
a 3d they had a 3d eric conducting all

1192
00:53:05,289 --> 00:53:02,089
these people okay

1193
00:53:08,620 --> 00:53:05,299
so deep field was to be the fifth Arkin

1194
00:53:12,279 --> 00:53:08,630
incarnation of his virtual choir and he

1195
00:53:16,930 --> 00:53:12,289
got more than 8,000 singers around the

1196
00:53:19,359 --> 00:53:16,940
globe to submit so you will see 8,000

1197
00:53:22,289 --> 00:53:19,369
singers in this film and this is a

1198
00:53:24,609 --> 00:53:22,299
reason why the credits take six minutes

1199
00:53:27,880 --> 00:53:24,619
every single one of these virtual choir

1200
00:53:30,459 --> 00:53:27,890
singers is in the credits okay but

1201
00:53:32,739 --> 00:53:30,469
because they were working with us and I

1202
00:53:35,529 --> 00:53:32,749
gotta give music productions a huge and

1203
00:53:38,289 --> 00:53:35,539
they wanted to include science and

1204
00:53:40,059 --> 00:53:38,299
technology in it so not only did you

1205
00:53:42,459 --> 00:53:40,069
upload your video you also had a chance

1206
00:53:45,219 --> 00:53:42,469
to earn these badges on their on their

1207
00:53:46,359 --> 00:53:45,229
website there were 18 badges anybody

1208
00:53:48,219 --> 00:53:46,369
recognize this pattern

1209
00:53:51,039 --> 00:53:48,229
yeah the James Webb Space Telescope

1210
00:53:54,219 --> 00:53:51,049
pattern of hexagons each one of these is

1211
00:53:56,499 --> 00:53:54,229
a separate badge involving science

1212
00:53:59,499 --> 00:53:56,509
technology engineering art and design

1213
00:54:01,269 --> 00:53:59,509

and math so called steam education for

1214
00:54:04,660 --> 00:54:01,279
example one of them was the Hubble

1215
00:54:06,670 --> 00:54:04,670
ultra-deep field sauna fied where if you

1216
00:54:08,499 --> 00:54:06,680
ran your cursor over these things the

1217
00:54:10,599 --> 00:54:08,509
redshift of the galaxies gave you a note

1218
00:54:13,089 --> 00:54:10,609
that was really low if it was far away

1219
00:54:15,609 --> 00:54:13,099
or very high if it was nearby you had a

1220
00:54:17,380 --> 00:54:15,619
sonification all sorts of amazing things

1221
00:54:19,509 --> 00:54:17,390
and I just was like this

1222
00:54:21,700 --> 00:54:19,519
these are partners you want to work with

1223
00:54:23,019 --> 00:54:21,710
okay these are the kind of people you

1224
00:54:25,959 --> 00:54:23,029
really want to work with because they

1225
00:54:27,910 --> 00:54:25,969
don't just do want to do it halfway they

1226
00:54:31,599 --> 00:54:27,920
really go all the way to combining

1227
00:54:33,400 --> 00:54:31,609
science and art together alright so now

1228
00:54:36,489 --> 00:54:33,410
we begin the word turn home the final

1229
00:54:39,339 --> 00:54:36,499
sequence of a film all right and they

1230
00:54:42,519 --> 00:54:39,349
came out through the Hubble Space

1231
00:54:44,499 --> 00:54:42,529
Telescope sitting over earth and I gotta

1232
00:54:47,229 --> 00:54:44,509
be honest with you Greg bacon and I when

1233
00:54:50,440 --> 00:54:47,239
we saw this sequence said this is kind

1234
00:54:52,509 --> 00:54:50,450
of trite so many documentaries have the

1235
00:54:55,390 --> 00:54:52,519
camera moving through the Hubble mirror

1236
00:54:59,979 --> 00:54:55,400
to see things and like alright okay I

1237
00:55:03,549 --> 00:54:59,989
guess but we changed our minds

1238
00:55:05,160 --> 00:55:03,559

because by coming out with Hubble here

1239
00:55:07,589 --> 00:55:05,170
by bringing the camera out

1240
00:55:10,950 --> 00:55:07,599
home with Hubble it puts you in that

1241
00:55:13,079 --> 00:55:10,960
low-earth orbit from which you can then

1242
00:55:15,780 --> 00:55:13,089
go into a sequence of space shuttle

1243
00:55:18,359 --> 00:55:15,790
shots of the earth and so the next

1244
00:55:20,819 --> 00:55:18,369
sequences are these gorgeous space

1245
00:55:22,109 --> 00:55:20,829
shuttle shots here's one it took me a

1246
00:55:24,450 --> 00:55:22,119
while to figure out these things this is

1247
00:55:26,309 --> 00:55:24,460
Baja Peninsula here and the Gulf of

1248
00:55:29,099 --> 00:55:26,319
California California is over here

1249
00:55:31,589 --> 00:55:29,109
Arizona's here all right you get the

1250
00:55:33,660 --> 00:55:31,599
shot of Switzerland down and down bottom

1251
00:55:37,710 --> 00:55:33,670
the Alps running across the center and

1252
00:55:40,349 --> 00:55:37,720
Italy up here and then the amazing shot

1253
00:55:42,870 --> 00:55:40,359
of the Nile River Delta all right these

1254
00:55:45,870 --> 00:55:42,880
wonderful shots from space bring you

1255
00:55:49,260 --> 00:55:45,880
back home show you the beauty of our

1256
00:55:53,549 --> 00:55:49,270
planet and then they bring back the

1257
00:55:56,789 --> 00:55:53,559
virtual choir and they fill the screen

1258
00:55:59,520 --> 00:55:56,799
they cover the earth with this virtual

1259
00:56:01,410 --> 00:55:59,530
choir this is a global choir they're

1260
00:56:03,510 --> 00:56:01,420
getting that point across to you that

1261
00:56:06,049 --> 00:56:03,520
this is a truly global choir and you saw

1262
00:56:09,599 --> 00:56:06,059
from the math that it really is and

1263
00:56:13,410 --> 00:56:09,609

finally the last sequence simply our

1264
00:56:15,150 --> 00:56:13,420
earth hanging there in space and Erik

1265
00:56:17,940 --> 00:56:15,160
says that he really wanted to bring

1266
00:56:22,410 --> 00:56:17,950
across that Carl Sagan point of view the

1267
00:56:26,270 --> 00:56:22,420
idea that looking at our planet from

1268
00:56:30,089 --> 00:56:26,280
outside seeing it there hanging in space

1269
00:56:33,510 --> 00:56:30,099
changes your perspective and through

1270
00:56:36,720 --> 00:56:33,520
this you really can with this film you

1271
00:56:41,339 --> 00:56:36,730
truly can connect those dots from that

1272
00:56:45,150 --> 00:56:41,349
tiny red dot galaxy how did the edge of

1273
00:56:49,980 --> 00:56:45,160
our observable universe across the 13

1274
00:56:54,780 --> 00:56:49,990
billion light years of space to our pale

1275
00:56:58,620 --> 00:56:54,790
blue dot then we call home that expanse

1276
00:57:02,360 --> 00:56:58,630
that expression that truly is the

1277
00:57:04,830 --> 00:57:02,370
impossible magnitude of our universe

1278
00:57:13,609 --> 00:57:04,840
thank you for your attention

1279
00:57:22,950 --> 00:57:17,749
okay we are going to end the webcast now

1280
00:57:24,690 --> 00:57:22,960
so for the folks who are online you can

1281
00:57:28,230 --> 00:57:24,700
watch the film it is already available

1282
00:57:31,140 --> 00:57:28,240
at Deep Field film.com alright and

1283
00:57:34,140 --> 00:57:31,150
please for the best experience you know

1284
00:57:37,890 --> 00:57:34,150
watch it on a big screen in a dark room

1285
00:57:39,299 --> 00:57:37,900
with really good sound I suppose you

1286
00:57:42,720 --> 00:57:39,309
could probably watch it on your phone

1287
00:57:44,339 --> 00:57:42,730
I mean I'll shed a tear but it's better

1288
00:57:47,519 --> 00:57:44,349

than not watching it at all okay so

1289
00:57:51,180 --> 00:57:47,529
please if you can watch it nice and big

1290
00:57:54,210 --> 00:57:51,190
alright and thank you all for for

1291
00:57:57,390 --> 00:57:54,220
joining us online I hope you've enjoyed

1292
00:57:58,259 --> 00:57:57,400
this expression of this film as much as

1293
00:58:00,390 --> 00:57:58,269
us

1294
00:58:02,279 --> 00:58:00,400
we here at Space Telescope and in

1295
00:58:04,769 --> 00:58:02,289
collaboration with 59 productions and

1296
00:58:06,450 --> 00:58:04,779
with music productions we had a great

1297
00:58:07,230 --> 00:58:06,460
time presenting it and we really hope