

1
00:00:02,178 --> 00:00:07,709
hi I'm dr. Frank summers of the Space

2
00:00:05,250 --> 00:00:10,830
Telescope Science Institute and welcome

3
00:00:07,710 --> 00:00:13,199
to the Hubble national teachin first

4
00:00:10,830 --> 00:00:15,240
we've got a very special guest NASA

5
00:00:13,199 --> 00:00:18,108
Administrator Charles Bolden who wants

6
00:00:15,240 --> 00:00:20,789
to give you his own personal welcome

7
00:00:18,109 --> 00:00:23,010
thank you to all the educators students

8
00:00:20,789 --> 00:00:25,380
scientists and engineers participating

9
00:00:23,010 --> 00:00:27,660
in today's Hubble teach-in when we

10
00:00:25,379 --> 00:00:30,358
launch this magnificent telescope 25

11
00:00:27,660 --> 00:00:32,700
years ago today we knew it would be

12
00:00:30,359 --> 00:00:34,710
special but we really had no idea the

13
00:00:32,700 --> 00:00:36,270
degree to which it would transform our

14
00:00:34,710 --> 00:00:39,750
understanding of the universe and

15
00:00:36,270 --> 00:00:42,210
rewrite textbooks today the Hubble Space

16
00:00:39,750 --> 00:00:44,789
Telescope continues to provide more data

17
00:00:42,210 --> 00:00:47,759
each year than there is in the entire

18
00:00:44,789 --> 00:00:49,530
library of congress it's confirmed the

19
00:00:47,759 --> 00:00:51,750
presence of black holes in the Centers

20
00:00:49,530 --> 00:00:53,850
of the galaxies it made the first

21
00:00:51,750 --> 00:00:55,320
observations of the chemical makeup of

22
00:00:53,850 --> 00:00:57,840
the atmosphere of a planet orbiting

23
00:00:55,320 --> 00:01:00,390
another star it helped scientists

24
00:00:57,840 --> 00:01:03,510
determine that the cosmos is 13.7

25
00:01:00,390 --> 00:01:06,239
billion years old it provided the first

26
00:01:03,509 --> 00:01:08,429
high-resolution maps of the structures

27
00:01:06,239 --> 00:01:11,728
of planet-forming discs around stars

28
00:01:08,430 --> 00:01:15,240
like our Sun and those are just a few of

29

00:01:11,728 --> 00:01:16,978
Hubble's greatest hits it was my great

30
00:01:15,239 --> 00:01:19,560
pleasure to be a part of the crew that

31
00:01:16,978 --> 00:01:22,019
brought Hubble to space many astronauts

32
00:01:19,560 --> 00:01:23,879
cents have helped repair it and keep it

33
00:01:22,019 --> 00:01:26,609
running and many talented and dedicated

34
00:01:23,879 --> 00:01:28,739
folks on the ground have continued to

35
00:01:26,609 --> 00:01:31,349
monitor and manage this magnificent

36
00:01:28,739 --> 00:01:34,019
one-of-a-kind telescope there are nearly

37
00:01:31,349 --> 00:01:36,209
endless possibilities for learning from

38
00:01:34,019 --> 00:01:39,118
the wonderful data and images that

39
00:01:36,209 --> 00:01:41,578
Hubble continues to send us I applaud

40
00:01:39,118 --> 00:01:43,200
the teachin for helping to inspire the

41
00:01:41,578 --> 00:01:46,228
next generation of scientists and

42
00:01:43,200 --> 00:01:48,920
engineers who may someday work on their

43
00:01:46,228 --> 00:01:51,359

own great observatory and once again

44

00:01:48,920 --> 00:01:54,030

transform humanity's understanding of

45

00:01:51,359 --> 00:01:56,430

our place in the universe I hope you

46

00:01:54,030 --> 00:01:58,409

learn a lot today I also hope your

47

00:01:56,430 --> 00:02:00,630

journey with Hubble the James Webb Space

48

00:01:58,409 --> 00:02:03,780

Telescope that launches in just a few

49

00:02:00,629 --> 00:02:06,149

years and all of NASA's missions will

50

00:02:03,780 --> 00:02:10,699

continue to inspire you and help you

51

00:02:06,149 --> 00:02:10,699

make your own great leaps of discovery

52

00:02:15,409 --> 00:02:20,870

it's a public outreach here at stsci in

53

00:02:18,919 --> 00:02:23,089

particular I want to give you a welcome

54

00:02:20,870 --> 00:02:25,189

from Bonnie aizen hammer our education

55

00:02:23,090 --> 00:02:27,860

program manager she's the one on the

56

00:02:25,189 --> 00:02:30,319

right in this image Bonnie and I work

57

00:02:27,860 --> 00:02:32,960

very close together we believe in the

58
00:02:30,319 --> 00:02:35,209
scientist educator partnership which is

59
00:02:32,960 --> 00:02:37,879
what makes our education program so

60
00:02:35,210 --> 00:02:39,500
special we also have a lot of other

61
00:02:37,879 --> 00:02:41,960
folks here at the Space Telescope

62
00:02:39,500 --> 00:02:44,210
Science Institute this is one of our

63
00:02:41,960 --> 00:02:46,400
group photographs we've taken when the

64
00:02:44,210 --> 00:02:48,370
astronauts come to visit you can see

65
00:02:46,400 --> 00:02:50,960
that there are a lot of folks here and

66
00:02:48,370 --> 00:02:53,330
it includes the people that you might

67
00:02:50,960 --> 00:02:56,120
normally expect the astronomers the

68
00:02:53,330 --> 00:02:57,440
engineers the computer programmers it

69
00:02:56,120 --> 00:02:59,599
also includes the people that you would

70
00:02:57,439 --> 00:03:02,599
you need to run a business those who

71
00:02:59,599 --> 00:03:04,759
work in finance personnel maintenance

72
00:03:02,599 --> 00:03:08,269
but it also includes some people you

73
00:03:04,759 --> 00:03:11,239
might not expect like writers artists

74
00:03:08,270 --> 00:03:13,250
and teachers these are the people that

75
00:03:11,240 --> 00:03:16,370
helped us get Hubble's discoveries out

76
00:03:13,250 --> 00:03:19,639
to the public and out into our education

77
00:03:16,370 --> 00:03:22,879
and I think it for us it teaches a

78
00:03:19,639 --> 00:03:26,000
lesson that you don't have to be a PhD

79
00:03:22,879 --> 00:03:29,150
astrophysics geek to work on Hubble we

80
00:03:26,000 --> 00:03:31,610
have about 500 people here who all are

81
00:03:29,150 --> 00:03:34,219
very proud to a good part of the Hubble

82
00:03:31,610 --> 00:03:38,150
program so no matter what you do in your

83
00:03:34,219 --> 00:03:40,189
career you can be an artist and still be

84
00:03:38,150 --> 00:03:43,849
involved in science I'm an astronomer

85
00:03:40,189 --> 00:03:46,039
but I've worked on three IMAX films so

86

00:03:43,849 --> 00:03:47,959
really you don't need to limit yourself

87
00:03:46,039 --> 00:03:50,049
in your career and we embody that here

88
00:03:47,959 --> 00:03:53,959
at the Space Telescope Science Institute

89
00:03:50,050 --> 00:03:56,390
so let's talk about how Hubble is a

90
00:03:53,959 --> 00:04:00,170
Space Telescope spaces its middle name

91
00:03:56,389 --> 00:04:03,949
and here is an image of Earth and it's

92
00:04:00,169 --> 00:04:06,829
not that far out into space here is a

93
00:04:03,949 --> 00:04:10,069
diagram showing you the size of Hubble's

94
00:04:06,830 --> 00:04:12,400
orbit relative to the size of Earth how

95
00:04:10,069 --> 00:04:16,120
about is what we call low Earth orbit

96
00:04:12,400 --> 00:04:18,548
it's just up above Earth's atmosphere

97
00:04:16,120 --> 00:04:21,199
here's an image that illustrates that

98
00:04:18,548 --> 00:04:23,209
Hubble is just above Earth's atmosphere

99
00:04:21,199 --> 00:04:25,879
and if you look you can see that fuzzy

100
00:04:23,209 --> 00:04:27,359

edge to Earth's atmosphere that is

101

00:04:25,879 --> 00:04:30,060

Hubble's main

102

00:04:27,360 --> 00:04:33,030

advantage by getting up above Earth's

103

00:04:30,060 --> 00:04:36,538

atmosphere Hubble gets the clearest view

104

00:04:33,029 --> 00:04:38,309

of any visible light telescope now when

105

00:04:36,538 --> 00:04:40,649

we were young we all learned about

106

00:04:38,310 --> 00:04:43,348

twinkle twinkle little star well that

107

00:04:40,649 --> 00:04:45,598

twinkle is caused by Earth's atmosphere

108

00:04:43,348 --> 00:04:48,240

so it is the process of getting above

109

00:04:45,598 --> 00:04:53,009

Earth's atmosphere that gives Hubble

110

00:04:48,240 --> 00:04:54,598

it's amazing you'd now you don't need to

111

00:04:53,009 --> 00:04:56,788

read all this slide this is just some

112

00:04:54,598 --> 00:04:59,699

facts about Hubble but you might want to

113

00:04:56,788 --> 00:05:01,829

know its size its length is about 43

114

00:04:59,699 --> 00:05:04,528

feet and that's the size of a large

115
00:05:01,829 --> 00:05:06,300
school bus I like to sort of joke that

116
00:05:04,528 --> 00:05:08,339
if ms frizzle and the Magic School Bus

117
00:05:06,300 --> 00:05:10,978
would not to visit Hubble it'd be about

118
00:05:08,339 --> 00:05:12,718
the same size of course those of you

119
00:05:10,978 --> 00:05:14,218
who've read the books recognize that ms

120
00:05:12,718 --> 00:05:15,718
frizzle drives a shorter school bus

121
00:05:14,218 --> 00:05:17,519
she'd have to drag one of the big long

122
00:05:15,718 --> 00:05:20,278
school buses and then it would be about

123
00:05:17,519 --> 00:05:22,459
the same size as Howell the other thing

124
00:05:20,278 --> 00:05:25,348
to note is that Hubble is moving at

125
00:05:22,459 --> 00:05:28,288
17,000 about 17,000 miles an hour and

126
00:05:25,348 --> 00:05:31,259
makes one orbit about an an hour and a

127
00:05:28,288 --> 00:05:33,778
half so while we're doing this teaching

128
00:05:31,259 --> 00:05:35,218
for about an hour Hubble will travel

129
00:05:33,778 --> 00:05:40,288
around two thirds of the way around

130
00:05:35,218 --> 00:05:44,959
Earth the hubble space telescope was

131
00:05:40,288 --> 00:05:46,860
launched in 1990 25 years ago today and

132
00:05:44,959 --> 00:05:50,278
do you know what NASA Administrator

133
00:05:46,860 --> 00:05:53,699
Charles Bolden was doing then he was on

134
00:05:50,278 --> 00:05:57,000
the astronaut team that put Hubble into

135
00:05:53,699 --> 00:06:00,259
orbit and here is a marvelous photograph

136
00:05:57,000 --> 00:06:04,860
of home being set into orbit from the

137
00:06:00,259 --> 00:06:07,080
Bay of the space shuttle now 25 years

138
00:06:04,860 --> 00:06:08,968
ago is a really long time matter of fact

139
00:06:07,079 --> 00:06:11,218
for all the kids that are in elementary

140
00:06:08,968 --> 00:06:14,968
school and middle school and high school

141
00:06:11,218 --> 00:06:17,098
and even college 25 years is longer than

142
00:06:14,968 --> 00:06:19,918
they've been alive Hubble was launched

143

00:06:17,098 --> 00:06:23,038
before you were born you've never known

144
00:06:19,918 --> 00:06:25,438
a world without Hubble so let's try and

145
00:06:23,038 --> 00:06:28,560
do Oh an idea of what it was like way

146
00:06:25,439 --> 00:06:30,689
back in nineteen ninety so this is an

147
00:06:28,560 --> 00:06:34,439
image of a computer that's very much

148
00:06:30,689 --> 00:06:37,349
like the one I had in 1994 the adults

149
00:06:34,439 --> 00:06:39,750
it's like a 386 with a cd-rom drive and

150
00:06:37,348 --> 00:06:42,959
a three-and-a-half inch floppy disk

151
00:06:39,750 --> 00:06:45,480
now I have a computer that's thousand

152
00:06:42,959 --> 00:06:52,019
times faster and has a thousand times

153
00:06:45,480 --> 00:06:55,890
more memory and it fits in my pocket my

154
00:06:52,019 --> 00:06:58,229
cell phone that i carry today is times

155
00:06:55,889 --> 00:07:01,620
better in every way then the computer i

156
00:06:58,230 --> 00:07:03,750
had in 1990 and it's probably a million

157
00:07:01,620 --> 00:07:06,509

times more useful because of all the

158

00:07:03,750 --> 00:07:08,790

software that's written for it now

159

00:07:06,509 --> 00:07:11,370

because of that because it was so long

160

00:07:08,790 --> 00:07:13,280

ago in technical technology time people

161

00:07:11,370 --> 00:07:16,769

may think that Hubble is old technology

162

00:07:13,279 --> 00:07:18,689

well how do we keep it current the

163

00:07:16,769 --> 00:07:20,849

astronauts who put Hubble until it not

164

00:07:18,689 --> 00:07:23,730

only put Hubble into orbit they also

165

00:07:20,850 --> 00:07:25,740

went up and had five servicing missions

166

00:07:23,730 --> 00:07:27,660

to help here are pictures of the

167

00:07:25,740 --> 00:07:29,939

astronauts and some pictures of them

168

00:07:27,660 --> 00:07:32,430

servicing Kabul and during those five

169

00:07:29,939 --> 00:07:34,860

servicing missions like that old

170

00:07:32,430 --> 00:07:37,590

computer which I was able to upgrade the

171

00:07:34,860 --> 00:07:40,139

processor and upgrade the RAM and go

172
00:07:37,589 --> 00:07:42,418
from a cd-rom drive to a dvd-rom drive

173
00:07:40,139 --> 00:07:44,610
we've been able to do that with Hubble

174
00:07:42,418 --> 00:07:46,949
we've been able to take out the old

175
00:07:44,610 --> 00:07:49,800
instruments put in new instruments

176
00:07:46,949 --> 00:07:52,829
upgrade it repair it and as NASA likes

177
00:07:49,800 --> 00:07:55,918
to say repair refresh and renew Hubble

178
00:07:52,829 --> 00:07:59,310
with each visit so Hubble isn't old

179
00:07:55,918 --> 00:08:01,829
technology how well as is 25 years old

180
00:07:59,310 --> 00:08:03,780
since it was launched but it is filled

181
00:08:01,829 --> 00:08:06,300
with a lot of brand new technology and

182
00:08:03,779 --> 00:08:09,089
I'll show you the roles of that now it

183
00:08:06,300 --> 00:08:11,759
was really great that Hubble was able to

184
00:08:09,089 --> 00:08:13,469
be serviced because and you don't

185
00:08:11,759 --> 00:08:15,449
remember this again this had probably

186
00:08:13,470 --> 00:08:17,580
happened before you were born but when

187
00:08:15,449 --> 00:08:20,279
Hubble was originally launched it had a

188
00:08:17,579 --> 00:08:22,529
flaw in the mirror the mirror was ground

189
00:08:20,279 --> 00:08:26,579
to a very exact shape but it was just

190
00:08:22,529 --> 00:08:28,459
slightly out of focus so on the left you

191
00:08:26,579 --> 00:08:32,309
see the image of the center of a galaxy

192
00:08:28,459 --> 00:08:35,338
before the repair in 1993 servicing

193
00:08:32,309 --> 00:08:37,348
mission 11 went up and repaired the flaw

194
00:08:35,339 --> 00:08:39,570
on Hubble's mirror it fit on well it's

195
00:08:37,349 --> 00:08:42,120
could put on my glasses on Hubble so

196
00:08:39,570 --> 00:08:44,700
that it could correct the wave front so

197
00:08:42,120 --> 00:08:46,889
that Hubble could see clearly on the

198
00:08:44,700 --> 00:08:49,140
right you see the result after the

199
00:08:46,889 --> 00:08:52,500
repair and you can see the clarity with

200

00:08:49,139 --> 00:08:53,328
which Hubble sees the universe now

201
00:08:52,500 --> 00:08:54,769
that's not

202
00:08:53,328 --> 00:08:57,618
say that before the repair Hubble was

203
00:08:54,769 --> 00:08:59,298
useless how will still had better

204
00:08:57,619 --> 00:09:01,459
resolution than any ground-based

205
00:08:59,298 --> 00:09:04,009
telescope before the repair and could

206
00:09:01,458 --> 00:09:07,068
still do science that could not be done

207
00:09:04,009 --> 00:09:09,230
from the ground however it was after the

208
00:09:07,068 --> 00:09:10,818
repair missions that Hubble was finally

209
00:09:09,230 --> 00:09:13,188
able to achieve its design

210
00:09:10,818 --> 00:09:16,519
specifications and do all the great

211
00:09:13,188 --> 00:09:18,169
science that we intended it for so let's

212
00:09:16,519 --> 00:09:19,999
talk about some of that science and will

213
00:09:18,169 --> 00:09:23,269
begin in our solar system with the

214
00:09:19,999 --> 00:09:26,058

planet Jupiter this is Jupiter the

215

00:09:23,269 --> 00:09:28,459

largest of the planets and it has a

216

00:09:26,058 --> 00:09:30,558

wonderful feature called the Great Red

217

00:09:28,458 --> 00:09:33,618

Spot you can see it down there just

218

00:09:30,558 --> 00:09:35,539

below the equator and i zoom in on it

219

00:09:33,619 --> 00:09:37,040

well this is an assume and this is a

220

00:09:35,539 --> 00:09:38,808

picture from the Voyager mission that

221

00:09:37,039 --> 00:09:40,669

went past it it's one of my favorite

222

00:09:38,808 --> 00:09:42,588

pictures in astronomy there so many of

223

00:09:40,669 --> 00:09:45,198

those but you can see the Great Red Spot

224

00:09:42,589 --> 00:09:47,679

and you can also see those white ovals

225

00:09:45,198 --> 00:09:51,678

those large white ovals these are all

226

00:09:47,678 --> 00:09:54,169

storms in Jupiter's atmosphere jupiter

227

00:09:51,678 --> 00:09:56,298

has a lot of storms and those white

228

00:09:54,169 --> 00:09:58,639

ovals are storms like our giant

229
00:09:56,298 --> 00:10:01,188
hurricanes and the Great Red Spot is the

230
00:09:58,639 --> 00:10:04,818
granddaddy of them all it's the largest

231
00:10:01,188 --> 00:10:07,759
of the storms on Jupiter how large is it

232
00:10:04,818 --> 00:10:13,068
well here is a comparison of the Great

233
00:10:07,759 --> 00:10:16,389
Red Spot to our entire planet on Jupiter

234
00:10:13,068 --> 00:10:21,558
they have a storm larger than our entire

235
00:10:16,389 --> 00:10:25,489
planet that's big and not only is it big

236
00:10:21,558 --> 00:10:29,058
but it's also long lasting Hubble has

237
00:10:25,489 --> 00:10:31,929
been up for 25 years and has studied the

238
00:10:29,058 --> 00:10:35,298
Great Red Spot for the entire 25 years

239
00:10:31,928 --> 00:10:37,818
but the Great Red Spot has been around

240
00:10:35,298 --> 00:10:40,789
for as long as we know we have

241
00:10:37,818 --> 00:10:43,368
observations from 200 years ago showing

242
00:10:40,789 --> 00:10:46,458
the Great Red Spot and we may even have

243
00:10:43,369 --> 00:10:49,668
observations from 350 years ago showing

244
00:10:46,458 --> 00:10:54,229
the red spot so it's a giant storm at

245
00:10:49,668 --> 00:10:56,838
last for centuries now during Hubble's

246
00:10:54,230 --> 00:11:00,470
time watching it Hubble has actually

247
00:10:56,839 --> 00:11:03,009
seen the Great Red Spot shrink you can

248
00:11:00,470 --> 00:11:06,168
see in the top image the Great Red Spot

249
00:11:03,009 --> 00:11:06,990
1995 was significantly larger than it is

250
00:11:06,168 --> 00:11:10,949
in the bottom

251
00:11:06,990 --> 00:11:13,200
image the Great Red Spot in 2014 we've

252
00:11:10,950 --> 00:11:15,209
actually seen the grid rate that red

253
00:11:13,200 --> 00:11:19,140
spots to shrink over the time Hubble has

254
00:11:15,208 --> 00:11:22,409
been up why well I got to be honest with

255
00:11:19,139 --> 00:11:24,269
you we're not exactly sure it's a topic

256
00:11:22,409 --> 00:11:26,669
of current research trying to find out

257

00:11:24,269 --> 00:11:29,059
why the Great Red Spot is very slowly

258
00:11:26,669 --> 00:11:33,449
shrinking over these past few decades

259
00:11:29,059 --> 00:11:36,389
but there's more for red spots because

260
00:11:33,450 --> 00:11:38,550
in 1997 three of those white ovals that

261
00:11:36,389 --> 00:11:41,759
I mentioned earlier started to merge

262
00:11:38,549 --> 00:11:46,949
together and in 1998 two of them merged

263
00:11:41,759 --> 00:11:48,629
and in 2003 all words together to form

264
00:11:46,950 --> 00:11:52,620
an oval that well I guess it's called

265
00:11:48,629 --> 00:11:55,458
oval VA and that was the largest storm

266
00:11:52,620 --> 00:12:01,980
outside of the Great Red Spot on Jupiter

267
00:11:55,458 --> 00:12:05,009
but in 2006 that ol turned red and for

268
00:12:01,980 --> 00:12:09,360
the first time ever we saw the formation

269
00:12:05,009 --> 00:12:11,220
of a red spot now again it's called oval

270
00:12:09,360 --> 00:12:15,028
ba but we gave it the colloquial name

271
00:12:11,220 --> 00:12:17,370

red spot junior and red spot junior has

272

00:12:15,028 --> 00:12:19,139

also proven to be a long-lived storm and

273

00:12:17,370 --> 00:12:25,679

it is still there in Jupiter's

274

00:12:19,139 --> 00:12:28,980

atmosphere plus in 2008 we saw the

275

00:12:25,679 --> 00:12:31,528

appearance of a third red spot so you've

276

00:12:28,980 --> 00:12:34,259

got the great red spot on the right red

277

00:12:31,528 --> 00:12:36,419

spot Junior down lower left and in the

278

00:12:34,259 --> 00:12:39,659

middle on the left we have what we hope

279

00:12:36,419 --> 00:12:41,189

we have called baby red spot but you can

280

00:12:39,659 --> 00:12:43,799

see that red spot Junior is at a

281

00:12:41,190 --> 00:12:45,959

different latitude from the Great Red

282

00:12:43,799 --> 00:12:48,859

Spot it is passed by the Great Red Spot

283

00:12:45,958 --> 00:12:51,599

several times and everything's fine

284

00:12:48,860 --> 00:12:54,149

unfortunately the baby red spot was at

285

00:12:51,600 --> 00:12:57,600

the same latitude and so we watched over

286
00:12:54,149 --> 00:13:00,240
the summer of 2008 as it approached and

287
00:12:57,600 --> 00:13:04,110
then got caught into the vortices of the

288
00:13:00,240 --> 00:13:06,120
Great Red Spot and dissipated away so

289
00:13:04,110 --> 00:13:08,430
with Hubble we've been able to study the

290
00:13:06,120 --> 00:13:10,980
Great Red Spot over decades we've seen

291
00:13:08,429 --> 00:13:12,958
the formation of red spot jr. and we've

292
00:13:10,980 --> 00:13:15,810
seen the dissolution of the baby red

293
00:13:12,958 --> 00:13:17,939
spot now next time you think that the

294
00:13:15,809 --> 00:13:19,229
door weather is really horrible just

295
00:13:17,940 --> 00:13:20,610
remember the storms here on earth

296
00:13:19,230 --> 00:13:24,539
they're nothing

297
00:13:20,610 --> 00:13:27,360
compared to what we have on Jupiter so

298
00:13:24,539 --> 00:13:29,909
let's move on the go up a scale to stars

299
00:13:27,360 --> 00:13:31,879
and what we show here is the

300
00:13:29,909 --> 00:13:35,009
constellation of Orion and the

301
00:13:31,879 --> 00:13:37,528
upper-left star is the star called fatal

302
00:13:35,009 --> 00:13:39,929
juice now what you need to remember

303
00:13:37,528 --> 00:13:43,078
about stars is that they're really

304
00:13:39,929 --> 00:13:46,349
really far away so when we look at a

305
00:13:43,078 --> 00:13:49,528
star it's just a point of light the size

306
00:13:46,350 --> 00:13:52,230
of a star compared to its distance is so

307
00:13:49,528 --> 00:13:56,480
great that even with the best telescopes

308
00:13:52,230 --> 00:13:59,909
stars or desk points of light except

309
00:13:56,480 --> 00:14:03,600
Hubble with its exquisite resolution was

310
00:13:59,909 --> 00:14:05,549
able to resolve the star Betelgeuse it

311
00:14:03,600 --> 00:14:07,889
was able to measure several pixels

312
00:14:05,549 --> 00:14:10,679
across the face of bailed it's the first

313
00:14:07,889 --> 00:14:13,860
time an optical telescope had been able

314

00:14:10,679 --> 00:14:16,739
to resolve a star now you might say wow

315
00:14:13,860 --> 00:14:19,889
Hubble is just so amazing well it's also

316
00:14:16,740 --> 00:14:23,129
that baitul juice is so amazing because

317
00:14:19,889 --> 00:14:26,309
baitul juice is a red supergiant star

318
00:14:23,129 --> 00:14:29,399
and you can see by the scale bars but

319
00:14:26,309 --> 00:14:31,859
beneath it that baitul juice is not only

320
00:14:29,399 --> 00:14:35,129
larger than Earth's orbit it's larger

321
00:14:31,860 --> 00:14:36,539
than Jupiter's orbit around the Sun so

322
00:14:35,129 --> 00:14:41,370
if baitul juice were in the place of our

323
00:14:36,539 --> 00:14:44,698
Sun Mercury Venus Earth Mars and Jupiter

324
00:14:41,370 --> 00:14:49,049
would all be orbiting inside of baitul

325
00:14:44,698 --> 00:14:51,299
juice another great use of Hubble four

326
00:14:49,049 --> 00:14:53,879
stars has been to look at star clusters

327
00:14:51,299 --> 00:14:56,789
and this is this globular cluster

328
00:14:53,879 --> 00:14:59,519

Messier 80 and these are these really

329

00:14:56,789 --> 00:15:01,799

dense stellar systems stars that formed

330

00:14:59,519 --> 00:15:04,169

all together and are orbiting around one

331

00:15:01,799 --> 00:15:07,409

another and Hubble's exquisite

332

00:15:04,169 --> 00:15:08,969

resolution is especially good in looking

333

00:15:07,409 --> 00:15:11,448

toward the course of these globular

334

00:15:08,970 --> 00:15:14,879

clusters and being able to resolve the

335

00:15:11,448 --> 00:15:17,549

individual stars and see the details of

336

00:15:14,879 --> 00:15:21,539

their characteristics and their motions

337

00:15:17,549 --> 00:15:23,909

within these globular clusters also

338

00:15:21,539 --> 00:15:26,698

Hubble being above Earth's atmosphere

339

00:15:23,909 --> 00:15:29,360

can look in the ultraviolet at the

340

00:15:26,698 --> 00:15:33,079

visible and a little bit of the infrared

341

00:15:29,360 --> 00:15:36,230

so this image here with it's bright red

342

00:15:33,080 --> 00:15:38,930

bright blue colors is actually showing

343
00:15:36,230 --> 00:15:42,379
you a multi-wavelength view of the

344
00:15:38,929 --> 00:15:45,019
interior of a globular cluster the blue

345
00:15:42,379 --> 00:15:48,100
in this image is ultraviolet light and

346
00:15:45,019 --> 00:15:50,629
the red in this image is infrared light

347
00:15:48,100 --> 00:15:52,670
this shows that Hubble has been able to

348
00:15:50,629 --> 00:15:55,759
look a multi-wavelength from ultraviolet

349
00:15:52,669 --> 00:15:58,610
to visible to infrared inside this

350
00:15:55,759 --> 00:16:02,330
globular cluster it also allows Hubble

351
00:15:58,610 --> 00:16:04,909
to capture the very rare objects within

352
00:16:02,330 --> 00:16:07,490
the globular cluster for example stars

353
00:16:04,909 --> 00:16:09,169
and collided together and merged these

354
00:16:07,490 --> 00:16:11,870
stellar collisions that occur only

355
00:16:09,169 --> 00:16:13,879
inside globular clusters create blue

356
00:16:11,870 --> 00:16:16,549
stars that radiate in the ultraviolet or

357
00:16:13,879 --> 00:16:17,840
the old stars like baitul juice the ones

358
00:16:16,549 --> 00:16:20,209
that are becoming red giants and

359
00:16:17,840 --> 00:16:23,480
supergiant's they will radiate a lot in

360
00:16:20,210 --> 00:16:25,610
the infrared and show up in the red so

361
00:16:23,480 --> 00:16:28,639
Hubble has been very very valuable in

362
00:16:25,610 --> 00:16:31,550
the study of these dense stellar systems

363
00:16:28,639 --> 00:16:35,600
and see how stars move and act in their

364
00:16:31,549 --> 00:16:39,109
characteristics inside star clusters now

365
00:16:35,600 --> 00:16:42,350
star clusters are also very associated

366
00:16:39,110 --> 00:16:45,830
with nebula matter of fact stars form in

367
00:16:42,350 --> 00:16:47,779
clusters inside nebula and this image

368
00:16:45,830 --> 00:16:50,360
here is one that we released yesterday

369
00:16:47,779 --> 00:16:52,610
for Hubble's 25th anniversary

370
00:16:50,360 --> 00:16:56,570
re-released an image of the star cluster

371

00:16:52,610 --> 00:16:58,850
Westerlund to inside the nebula gum 29

372
00:16:56,570 --> 00:17:00,350
and this is an image you may have seen

373
00:16:58,850 --> 00:17:02,060
on the internet in the last 24 hours

374
00:17:00,350 --> 00:17:04,910
because it's gotten quite a lot of

375
00:17:02,059 --> 00:17:06,948
attention we also made a

376
00:17:04,910 --> 00:17:09,140
three-dimensional visualization of this

377
00:17:06,949 --> 00:17:11,690
where we get to fly in to take a look at

378
00:17:09,140 --> 00:17:14,089
that star cluster now I can't show you

379
00:17:11,690 --> 00:17:15,769
the movies on this hangout but I can

380
00:17:14,088 --> 00:17:19,039
give you a few frames of it to give the

381
00:17:15,769 --> 00:17:23,299
ax feeling of it so the camera flies

382
00:17:19,039 --> 00:17:25,639
into the the nebula gum 29 and as we

383
00:17:23,299 --> 00:17:29,299
zoom in the stars come past the camera

384
00:17:25,640 --> 00:17:31,580
and the camera descends onto the edge of

385
00:17:29,299 --> 00:17:34,730

the nebula the nebula gum 29 onto the

386

00:17:31,579 --> 00:17:37,399

lower rim of it then it starts to pass

387

00:17:34,730 --> 00:17:39,470

by a little valves of gas that's on the

388

00:17:37,400 --> 00:17:42,320

near edge of it and starts to penetrate

389

00:17:39,470 --> 00:17:44,420

into the heart of the nebula we five

390

00:17:42,319 --> 00:17:45,349

past all those pillars these pillars

391

00:17:44,420 --> 00:17:47,360

would get a dark

392

00:17:45,349 --> 00:17:48,918

acid us that are pointed toward the

393

00:17:47,359 --> 00:17:51,678

cluster because they're actually being

394

00:17:48,919 --> 00:17:54,169

shaped by the cluster the winds and

395

00:17:51,679 --> 00:17:56,900

radiation are shaping them and finally

396

00:17:54,169 --> 00:17:59,530

we zoom in to see the details the

397

00:17:56,900 --> 00:18:04,370

thousands of stars inside the cluster

398

00:17:59,529 --> 00:18:07,609

Westerlund to this is a wonderful way to

399

00:18:04,369 --> 00:18:09,529

experience it and it is our way of

400
00:18:07,609 --> 00:18:11,808
reminding you that these two-dimensional

401
00:18:09,529 --> 00:18:13,639
images from Hubble are really

402
00:18:11,808 --> 00:18:17,599
representations of a three-dimensional

403
00:18:13,640 --> 00:18:20,059
universe now this is a great segue into

404
00:18:17,599 --> 00:18:22,399
talking about nebula and a particular

405
00:18:20,058 --> 00:18:24,288
star cluster star formation of street as

406
00:18:22,400 --> 00:18:27,650
we a particular star formation region

407
00:18:24,288 --> 00:18:30,710
called the Orion Nebula the Orion Nebula

408
00:18:27,650 --> 00:18:33,230
is one of the nearest large star forming

409
00:18:30,710 --> 00:18:35,779
regions it has all sorts of activity

410
00:18:33,230 --> 00:18:38,870
going on in it and this image from 2006

411
00:18:35,779 --> 00:18:41,750
is incredibly detailed but actually I'm

412
00:18:38,869 --> 00:18:45,678
going to go back to an image from 1995

413
00:18:41,750 --> 00:18:48,169
which takes the center of the Orion

414
00:18:45,679 --> 00:18:51,110
Nebula and brings that out in sharp

415
00:18:48,169 --> 00:18:53,900
relief in the center there are four

416
00:18:51,109 --> 00:18:56,298
large stars called the trapezium and it

417
00:18:53,900 --> 00:18:58,610
is these stars that have the strong

418
00:18:56,298 --> 00:19:01,970
stellar winds and the intense

419
00:18:58,609 --> 00:19:04,668
ultraviolet emission that caused the gas

420
00:19:01,970 --> 00:19:08,089
around it to glow and also shape the

421
00:19:04,669 --> 00:19:10,880
objects around it for example on the

422
00:19:08,089 --> 00:19:13,639
right in this image is a star called I

423
00:19:10,880 --> 00:19:16,039
Orion's and the winds from these hot

424
00:19:13,640 --> 00:19:18,980
stars in the center are sweeping past

425
00:19:16,038 --> 00:19:21,769
I Orion's and you can see a bow shock

426
00:19:18,980 --> 00:19:23,960
in on its near side a bow shock like

427
00:19:21,769 --> 00:19:25,970
a boat going across a calm motion

428

00:19:23,960 --> 00:19:28,370
creates a bow shock in front of it it's

429
00:19:25,970 --> 00:19:31,038
the same thing here but now it's the

430
00:19:28,369 --> 00:19:35,149
winds from these stars sweeping past the

431
00:19:31,038 --> 00:19:38,029
gas around II orianna's the upper left I

432
00:19:35,150 --> 00:19:40,400
show you a star that's forming much

433
00:19:38,029 --> 00:19:43,099
nearer to the central cluster and

434
00:19:40,400 --> 00:19:45,409
instead of just creating a nice soft bow

435
00:19:43,099 --> 00:19:50,149
shock that bow shock has wrapped around

436
00:19:45,409 --> 00:19:53,419
to form a windsock type type shape we

437
00:19:50,150 --> 00:19:55,519
call these tadpoles or actually

438
00:19:53,419 --> 00:19:57,910
astronomers given the name Pro pleads

439
00:19:55,519 --> 00:19:59,920
for protoplanetary discs

440
00:19:57,910 --> 00:20:02,860
what's happened is the wind is so strong

441
00:19:59,920 --> 00:20:06,820
it is wrapped the gas around it and you

442
00:20:02,859 --> 00:20:09,309

get that win sought type shape finally

443

00:20:06,819 --> 00:20:12,339

down bottom you can see an image of a

444

00:20:09,309 --> 00:20:17,529

newborn star and you can see a black

445

00:20:12,339 --> 00:20:21,250

area around it that black area is a disk

446

00:20:17,529 --> 00:20:25,990

of material and inside that disk of

447

00:20:21,250 --> 00:20:30,940

material planets will be forming in the

448

00:20:25,990 --> 00:20:34,450

Orion Nebula we have now seen solar

449

00:20:30,940 --> 00:20:37,150

systems in formation that star is born

450

00:20:34,450 --> 00:20:39,610

and as that stars form you form a disk

451

00:20:37,150 --> 00:20:43,000

of material around it and in that disk

452

00:20:39,609 --> 00:20:47,109

you get planets we can see planetary

453

00:20:43,000 --> 00:20:49,809

systems in formation in Iranian an Orion

454

00:20:47,109 --> 00:20:53,199

is very special to me because the IMAX

455

00:20:49,809 --> 00:20:55,629

film hubble 3d we did a full fledged 3d

456

00:20:53,200 --> 00:20:59,400

visualization of Orion and I want to let

457
00:20:55,630 --> 00:21:01,690
you know that the imax company has

458
00:20:59,400 --> 00:21:03,940
re-released imax hubble 3d in

459
00:21:01,690 --> 00:21:06,250
celebration of Hubble's 25th anniversary

460
00:21:03,940 --> 00:21:08,230
so if you're looking for a way to get

461
00:21:06,250 --> 00:21:09,640
more Hubble this weekend go out and

462
00:21:08,230 --> 00:21:11,680
check and see if your outlook imax

463
00:21:09,640 --> 00:21:16,180
theatre is playing imax hubble this

464
00:21:11,680 --> 00:21:19,450
weekend let's the move on up to galaxies

465
00:21:16,180 --> 00:21:21,580
and again i have so many favorite images

466
00:21:19,450 --> 00:21:24,400
in astronomy this is definitely one of

467
00:21:21,579 --> 00:21:26,649
them the Whirlpool Galaxy it's the

468
00:21:24,400 --> 00:21:29,200
classic spiral galaxy you can see those

469
00:21:26,650 --> 00:21:32,290
beautiful pinwheel shape of those spiral

470
00:21:29,200 --> 00:21:34,809
arms now to get a sense of scale for

471
00:21:32,289 --> 00:21:38,740
this galaxy do you see all those pink

472
00:21:34,809 --> 00:21:41,769
dots along the spiral arms those pink

473
00:21:38,740 --> 00:21:45,160
regions are star forming regions like

474
00:21:41,769 --> 00:21:46,779
the Orion Nebula every single one that

475
00:21:45,160 --> 00:21:49,690
affect Orion would probably be a pretty

476
00:21:46,779 --> 00:21:52,000
small one of those pink dots all of

477
00:21:49,690 --> 00:21:54,519
those pink dots are places where

478
00:21:52,000 --> 00:21:56,650
thousands of stars are being born and

479
00:21:54,519 --> 00:21:59,559
that gives you a scale that you know

480
00:21:56,650 --> 00:22:03,460
there are hundreds of billions of stars

481
00:21:59,559 --> 00:22:07,089
in this galaxy now spiral galaxies can

482
00:22:03,460 --> 00:22:09,160
also look like this one here because

483
00:22:07,089 --> 00:22:11,839
spiral galaxies are actually pancake

484
00:22:09,160 --> 00:22:14,269
shape you see the spiral arms

485

00:22:11,839 --> 00:22:16,399
you look at the pancake face on but when

486
00:22:14,269 --> 00:22:20,210
you look at it edge on you see that dark

487
00:22:16,400 --> 00:22:23,630
disk of material other galaxies shapes

488
00:22:20,210 --> 00:22:26,240
include a barred spiral shape in which

489
00:22:23,630 --> 00:22:28,730
you've got a very long bar as well as

490
00:22:26,240 --> 00:22:32,480
the spiral arms the spiral arms come off

491
00:22:28,730 --> 00:22:34,130
of the long bar in the center if you

492
00:22:32,480 --> 00:22:36,798
just take that central region which is

493
00:22:34,130 --> 00:22:40,039
sort of you know fluffy shaped you get a

494
00:22:36,798 --> 00:22:42,679
an elliptical galaxy which is spread out

495
00:22:40,038 --> 00:22:43,640
across a filling filling volume you

496
00:22:42,679 --> 00:22:45,200
could call it sort of call it a

497
00:22:43,640 --> 00:22:46,850
football-shaped galaxy because there

498
00:22:45,200 --> 00:22:49,569
never actually circular they're always

499
00:22:46,849 --> 00:22:54,769

sort of an oblong football like shape

500

00:22:49,569 --> 00:22:56,898

then if you combine the two if you take

501

00:22:54,769 --> 00:22:58,220

that elliptical galaxy and center and

502

00:22:56,898 --> 00:23:00,739

you have that spiral the disk of the

503

00:22:58,220 --> 00:23:04,250

spiral you get a shape called a

504

00:23:00,740 --> 00:23:06,319

lenticular galaxy all right this is some

505

00:23:04,250 --> 00:23:07,398

rare o galaxy you might be able to squit

506

00:23:06,319 --> 00:23:09,500

and be able to see the outline of

507

00:23:07,398 --> 00:23:13,369

sombrero but you can see it has that

508

00:23:09,500 --> 00:23:15,679

great big bulge as well as that disc so

509

00:23:13,369 --> 00:23:17,329

these are the basic shapes of galaxies

510

00:23:15,679 --> 00:23:18,830

and I'm don't want to claim that Hubble

511

00:23:17,329 --> 00:23:20,298

discover them they were discovered

512

00:23:18,829 --> 00:23:22,519

actually by they were actually

513

00:23:20,298 --> 00:23:25,069

classified by Edwin Hubble the namesake

514
00:23:22,519 --> 00:23:27,230
of the telescope what Hubble has looked

515
00:23:25,069 --> 00:23:29,599
at are the different types of galaxies

516
00:23:27,230 --> 00:23:32,298
that go beyond this so here are two

517
00:23:29,599 --> 00:23:35,058
galaxies there to spiral galaxies that

518
00:23:32,298 --> 00:23:36,829
are appear to be interacting but they're

519
00:23:35,058 --> 00:23:40,460
not they're just passing by each other

520
00:23:36,829 --> 00:23:43,009
one is overlapping however if they did

521
00:23:40,460 --> 00:23:45,620
interact you might get galaxies that

522
00:23:43,009 --> 00:23:47,599
look like this these two galaxies are

523
00:23:45,619 --> 00:23:49,250
called the mice and you can see the

524
00:23:47,599 --> 00:23:52,490
center of the galaxies there and then

525
00:23:49,250 --> 00:23:54,230
these long tidal tails these tidal tails

526
00:23:52,490 --> 00:23:56,419
have been stretched off by the

527
00:23:54,230 --> 00:23:59,360
gravitational interaction between these

528
00:23:56,419 --> 00:24:01,490
galaxies and Hubble has studied these

529
00:23:59,359 --> 00:24:03,889
galaxies interact galaxy interactions

530
00:24:01,490 --> 00:24:05,929
and in particular on the left you see a

531
00:24:03,890 --> 00:24:08,330
ground-based image of a pair of galaxies

532
00:24:05,929 --> 00:24:09,769
called the antenna again for those long

533
00:24:08,329 --> 00:24:11,898
tidal tails looking like antennas

534
00:24:09,769 --> 00:24:13,879
sticking away from the center and in the

535
00:24:11,898 --> 00:24:17,658
Hubble image on the right you can see

536
00:24:13,880 --> 00:24:21,230
all those bright blue regions these are

537
00:24:17,659 --> 00:24:24,710
observed an ultraviolet to find out the

538
00:24:21,230 --> 00:24:25,490
details of what's going on in the galaxy

539
00:24:24,710 --> 00:24:27,920
interaction

540
00:24:25,490 --> 00:24:31,759
and we found that there were immense

541
00:24:27,920 --> 00:24:34,220
numbers of stars formed during these

542

00:24:31,759 --> 00:24:36,740
galaxies interactions they form these

543
00:24:34,220 --> 00:24:39,049
giant star clusters bigger than we

544
00:24:36,740 --> 00:24:41,000
imagined before so big that the

545
00:24:39,049 --> 00:24:44,389
astronomer called them super star

546
00:24:41,000 --> 00:24:46,339
clusters so there are a lot of these

547
00:24:44,390 --> 00:24:48,650
galaxies interactions and Hubble has

548
00:24:46,339 --> 00:24:51,409
studied a lot of them this is our

549
00:24:48,650 --> 00:24:55,400
largest press release ever when we had

550
00:24:51,410 --> 00:24:57,170
59 images of galaxies interactions and

551
00:24:55,400 --> 00:24:59,120
we can study galaxies that are coming

552
00:24:57,170 --> 00:25:01,250
together as they smash through each

553
00:24:59,119 --> 00:25:05,000
other they develop their tail tails and

554
00:25:01,250 --> 00:25:07,400
come back and merge together but Hubble

555
00:25:05,000 --> 00:25:10,279
had a really special press release

556
00:25:07,400 --> 00:25:14,120

concerning our own Milky Way galaxy in

557

00:25:10,279 --> 00:25:16,160

the top left you can see an image of our

558

00:25:14,119 --> 00:25:19,549

Milky Way galaxy as it looks today and

559

00:25:16,160 --> 00:25:22,070

it is a spiral galaxy but we're inside

560

00:25:19,549 --> 00:25:26,480

the spiral so we see that edge-on view

561

00:25:22,069 --> 00:25:28,759

because we're inside that pancake and in

562

00:25:26,480 --> 00:25:31,069

the background you see a very small

563

00:25:28,759 --> 00:25:34,789

little galaxy that's the nearest large

564

00:25:31,069 --> 00:25:37,039

galaxy called Andromeda and Andromeda

565

00:25:34,789 --> 00:25:40,879

has been shown to be coming towards us

566

00:25:37,039 --> 00:25:44,359

so in the top right we have done a

567

00:25:40,880 --> 00:25:46,030

simulation of it and you can see a drama

568

00:25:44,359 --> 00:25:48,199

that is heading towards us and the

569

00:25:46,029 --> 00:25:52,639

bottom left you can see Andromeda

570

00:25:48,200 --> 00:25:55,670

getting even bigger however Hubble was

571
00:25:52,640 --> 00:25:58,550
able to measure the sideways motion of

572
00:25:55,670 --> 00:26:00,529
Andromeda to characterize the future

573
00:25:58,549 --> 00:26:03,289
collision between the Milky Way and

574
00:26:00,529 --> 00:26:05,029
Andromeda and what Hubble it was able to

575
00:26:03,289 --> 00:26:08,690
determine that no other telescope was

576
00:26:05,029 --> 00:26:11,808
able to do was that we are headed for a

577
00:26:08,690 --> 00:26:14,690
tour head-on collision the Milky Way and

578
00:26:11,808 --> 00:26:17,839
Andromeda will collide in about 4

579
00:26:14,690 --> 00:26:20,808
billion years and that collision is

580
00:26:17,839 --> 00:26:23,209
shown in the lower right then we took it

581
00:26:20,808 --> 00:26:25,490
further we followed it with a simulation

582
00:26:23,210 --> 00:26:27,890
to try and see how it would develop and

583
00:26:25,490 --> 00:26:29,960
you can see in the upper left lots of

584
00:26:27,890 --> 00:26:32,090
star formation happening during the

585
00:26:29,960 --> 00:26:35,150
collision in the upper right you can see

586
00:26:32,089 --> 00:26:37,308
the tidal tails stretching out and in

587
00:26:35,150 --> 00:26:37,700
the lower left you see the galaxies

588
00:26:37,308 --> 00:26:40,460
coming

589
00:26:37,700 --> 00:26:42,889
back together and finally the lower

590
00:26:40,460 --> 00:26:45,500
right you see that about six billion

591
00:26:42,888 --> 00:26:48,859
years from now the Milky Way and

592
00:26:45,500 --> 00:26:53,869
Andromeda will actually merge together

593
00:26:48,859 --> 00:26:56,359
to become one galaxy that is in our

594
00:26:53,869 --> 00:26:58,250
future however you don't really need to

595
00:26:56,359 --> 00:27:00,408
worry about it your kids won't see it

596
00:26:58,250 --> 00:27:01,700
your grandkids won't see it you're a

597
00:27:00,409 --> 00:27:04,070
great great great great great great

598
00:27:01,700 --> 00:27:06,169
great grandkids won't see it because

599

00:27:04,069 --> 00:27:08,869
it's all going to happen about 4 billion

600
00:27:06,169 --> 00:27:11,509
years in the future but I can say that I

601
00:27:08,869 --> 00:27:13,308
is an astronomer man I'd really love to

602
00:27:11,509 --> 00:27:16,879
see that night sky during the collision

603
00:27:13,308 --> 00:27:19,308
that'll be a sight to see alright so

604
00:27:16,880 --> 00:27:21,528
let's step up one more scale let's go up

605
00:27:19,308 --> 00:27:24,200
to the scale of the entire universe with

606
00:27:21,528 --> 00:27:25,669
its image the Hubble Ultra Deep Field or

607
00:27:24,200 --> 00:27:28,610
i'm just going to for short i'm going to

608
00:27:25,669 --> 00:27:31,309
call it the HUD f now the Hubble Ultra

609
00:27:28,609 --> 00:27:33,349
Deep Field is the longest visible light

610
00:27:31,308 --> 00:27:37,069
exposure ever taken of the universe it

611
00:27:33,349 --> 00:27:39,250
sees more galaxies and fainter galaxies

612
00:27:37,069 --> 00:27:42,200
and thus galaxies at greater distances

613
00:27:39,250 --> 00:27:45,349

than any other visible light exposure

614

00:27:42,200 --> 00:27:47,720

ever taken let me zoom in on some of the

615

00:27:45,349 --> 00:27:49,308

details so here are some of the details

616

00:27:47,720 --> 00:27:51,798

so we can see we've got some big

617

00:27:49,308 --> 00:27:54,829

galaxies we got some medium galaxies we

618

00:27:51,798 --> 00:27:56,720

got some small galaxies now I don't have

619

00:27:54,829 --> 00:28:00,048

to know exactly where these galaxies

620

00:27:56,720 --> 00:28:01,490

exist but I can tell that the bigger

621

00:28:00,048 --> 00:28:03,888

galaxies well they're probably going to

622

00:28:01,490 --> 00:28:04,849

be more nearby the medium-sized galaxies

623

00:28:03,888 --> 00:28:07,369

they're gonna be able bit further away

624

00:28:04,849 --> 00:28:09,469

and then small galaxies well they're

625

00:28:07,369 --> 00:28:12,648

going to be even more just so we're

626

00:28:09,470 --> 00:28:15,620

looking at galaxies stretched across the

627

00:28:12,648 --> 00:28:18,558

universe one of the questions you might

628
00:28:15,619 --> 00:28:22,158
have however is well just how many

629
00:28:18,558 --> 00:28:25,250
galaxies are there and this is where we

630
00:28:22,159 --> 00:28:28,100
bring up our nationwide galaxy count so

631
00:28:25,250 --> 00:28:31,009
in preparation for this teaching we said

632
00:28:28,099 --> 00:28:33,648
what can we do and involve the students

633
00:28:31,009 --> 00:28:35,869
in a science project during our national

634
00:28:33,648 --> 00:28:38,148
teachin so if you came to our teaching

635
00:28:35,869 --> 00:28:39,918
page a couple weeks ago we were able to

636
00:28:38,148 --> 00:28:41,989
participate in the nationwide galaxy cow

637
00:28:39,919 --> 00:28:44,538
and what we did is we took that Hubble

638
00:28:41,990 --> 00:28:47,298
Ultra Deep Field and we split it up into

639
00:28:44,538 --> 00:28:50,789
these small cutouts and we asked people

640
00:28:47,298 --> 00:28:52,950
to go ahead and count galaxies in

641
00:28:50,789 --> 00:28:56,849
cut outs and submit your numbers to us

642
00:28:52,950 --> 00:29:00,090
and you did we got a good number of

643
00:28:56,849 --> 00:29:02,399
responses and we get a lot of variety in

644
00:29:00,089 --> 00:29:04,379
our responses so this is the galaxy

645
00:29:02,400 --> 00:29:07,380
count distribution and you can see it

646
00:29:04,380 --> 00:29:09,600
goes from zero to 125 on the graph the

647
00:29:07,380 --> 00:29:12,930
lowest we got was around five and the

648
00:29:09,599 --> 00:29:15,539
highest we got was little over 120 so

649
00:29:12,930 --> 00:29:17,880
the same peep the same cut out being

650
00:29:15,539 --> 00:29:20,670
counted by different people comes up

651
00:29:17,880 --> 00:29:22,830
with a variety of answers now you might

652
00:29:20,670 --> 00:29:25,769
say oh well they got it right and they

653
00:29:22,829 --> 00:29:30,210
got it wrong I would say that you all

654
00:29:25,769 --> 00:29:32,250
got it right simply because we didn't

655
00:29:30,210 --> 00:29:35,549
tell you exactly what counted as a

656

00:29:32,250 --> 00:29:36,930
galaxy we let that in vague in the

657
00:29:35,549 --> 00:29:39,659
instructions and matter fact we put it

658
00:29:36,930 --> 00:29:41,580
up to you to say you should look at it

659
00:29:39,660 --> 00:29:43,800
and you should try to determine what is

660
00:29:41,579 --> 00:29:46,439
a galaxy a matter of fact we wanted you

661
00:29:43,799 --> 00:29:49,259
to work in teams because this is very

662
00:29:46,440 --> 00:29:51,000
important idea of science that science

663
00:29:49,259 --> 00:29:52,920
isn't just coming up with the right

664
00:29:51,000 --> 00:29:55,440
answer the right answer is not as

665
00:29:52,920 --> 00:29:58,170
important as the process of getting

666
00:29:55,440 --> 00:30:00,299
there and so by working in a team and

667
00:29:58,170 --> 00:30:02,490
discussing with your team well this is

668
00:30:00,299 --> 00:30:04,649
what I think a galaxy should count as or

669
00:30:02,490 --> 00:30:07,799
no no this is what I think a galaxy

670
00:30:04,650 --> 00:30:10,500

should count as that is really the best

671

00:30:07,799 --> 00:30:13,109

process of science it's that discussion

672

00:30:10,500 --> 00:30:15,180

in figuring out what you're after that's

673

00:30:13,109 --> 00:30:18,750

really where the science scientific

674

00:30:15,180 --> 00:30:21,600

insight takes place of course everyone

675

00:30:18,750 --> 00:30:23,670

does want the answer alright so let me

676

00:30:21,599 --> 00:30:26,490

give you the answer not for me as the

677

00:30:23,670 --> 00:30:29,330

astronomer but from you the folks who

678

00:30:26,490 --> 00:30:33,000

did the counting so here is your answer

679

00:30:29,329 --> 00:30:35,309

so in the HUD f galaxy counts the

680

00:30:33,000 --> 00:30:39,930

average across all of the cutouts that

681

00:30:35,309 --> 00:30:42,210

people counted was 54.4 galaxies so all

682

00:30:39,930 --> 00:30:46,500

these galaxies of all the cutouts you

683

00:30:42,210 --> 00:30:48,210

know the average number was 54 so first

684

00:30:46,500 --> 00:30:52,470

thing we want to do is estimate how many

685
00:30:48,210 --> 00:30:54,809
galaxies are in the entire HUD f but how

686
00:30:52,470 --> 00:30:58,039
are we going to do that what I need to

687
00:30:54,809 --> 00:31:03,059
tell you is that each of those cutouts

688
00:30:58,039 --> 00:31:04,440
was one percent of the HUD f we divided

689
00:31:03,059 --> 00:31:07,319
the HUD f up into

690
00:31:04,440 --> 00:31:09,390
by 10 by 10 grid and asks you to count

691
00:31:07,319 --> 00:31:14,009
the cutouts which were just one of those

692
00:31:09,390 --> 00:31:16,110
grid points so if we are going to make a

693
00:31:14,009 --> 00:31:19,170
estimate of the number of galaxies in

694
00:31:16,109 --> 00:31:23,339
the HUD f based on our average we simply

695
00:31:19,170 --> 00:31:26,570
multiply by a 100 and our estimate for

696
00:31:23,339 --> 00:31:31,559
the number of galaxies in the HUD f is

697
00:31:26,569 --> 00:31:35,539
5440 really good estimate now let's take

698
00:31:31,559 --> 00:31:37,859
it one step further if the HUD f is a

699
00:31:35,539 --> 00:31:41,879
representative sample of the entire

700
00:31:37,859 --> 00:31:45,269
night sky how much how many galaxies are

701
00:31:41,880 --> 00:31:47,280
there in the whole night sky again you

702
00:31:45,269 --> 00:31:49,529
need to know what percentage the HUD f

703
00:31:47,279 --> 00:31:53,430
is of the whole night sky to get that

704
00:31:49,529 --> 00:31:55,379
answer let me show you here is the

705
00:31:53,430 --> 00:31:58,080
apparent side here is the full moon and

706
00:31:55,380 --> 00:32:02,070
the full moon on our night sky appears

707
00:31:58,079 --> 00:32:05,039
up half a degree across the hu yep by

708
00:32:02,069 --> 00:32:08,700
comparison is only about one-tenth of

709
00:32:05,039 --> 00:32:11,190
that size ok so the heb f is small

710
00:32:08,700 --> 00:32:14,220
compared to the full moon as it appears

711
00:32:11,190 --> 00:32:17,400
from Earth the full moon although you

712
00:32:14,220 --> 00:32:19,319
might think it's awfully large well if

713

00:32:17,400 --> 00:32:22,200
you take a proper perspective view of it

714
00:32:19,319 --> 00:32:24,329
it's actually pretty small because it's

715
00:32:22,200 --> 00:32:26,759
only half a degree across and you

716
00:32:24,329 --> 00:32:28,799
remember there are 360 degrees in a

717
00:32:26,759 --> 00:32:33,119
circle so half a degree in the night sky

718
00:32:28,799 --> 00:32:36,809
isn't all that big so we're talking one

719
00:32:33,119 --> 00:32:39,809
factor in 720 in a circle and then one

720
00:32:36,809 --> 00:32:44,279
factor in 10 from that the answer is

721
00:32:39,809 --> 00:32:46,679
that there are 12 valve million seven

722
00:32:44,279 --> 00:32:49,559
hundred and forty-six thousand seven

723
00:32:46,680 --> 00:32:53,450
hundred and eighty four patches the same

724
00:32:49,559 --> 00:32:58,289
sizes HUD F across the entire night sky

725
00:32:53,450 --> 00:33:03,000
the HUD F only represents 112 million of

726
00:32:58,289 --> 00:33:07,559
the entire night sky so let's go back to

727
00:33:03,000 --> 00:33:10,500

our calculation if we have 5440 galaxies

728

00:33:07,559 --> 00:33:13,859

in the HUD f and we multiply that by

729

00:33:10,500 --> 00:33:16,440

twelve point seven million your estimate

730

00:33:13,859 --> 00:33:17,279

of the entire number of galaxies in the

731

00:33:16,440 --> 00:33:22,100

entire you

732

00:33:17,279 --> 00:33:24,930

verse is 69 billion that's kind of cool

733

00:33:22,099 --> 00:33:27,449

just doing accounting exercise in your

734

00:33:24,930 --> 00:33:31,410

classroom you can estimate the number of

735

00:33:27,450 --> 00:33:34,230

galaxies in the entire universe when

736

00:33:31,410 --> 00:33:36,600

astronomers do it we don't ask school

737

00:33:34,230 --> 00:33:38,069

kids to count our galaxies for us we

738

00:33:36,599 --> 00:33:40,439

don't even ask our graduate students to

739

00:33:38,069 --> 00:33:42,059

do that we ask our computers to do it

740

00:33:40,440 --> 00:33:44,460

and so we have very sophisticated

741

00:33:42,059 --> 00:33:46,649

computer programs to identify the

742
00:33:44,460 --> 00:33:49,200
galaxies and images like this and count

743
00:33:46,650 --> 00:33:51,269
all of them for us and so we can count

744
00:33:49,200 --> 00:33:54,990
all the galaxies in the HUD f and the

745
00:33:51,269 --> 00:33:56,700
number we get is about 10,000 now you

746
00:33:54,990 --> 00:33:58,829
should expect that you're counting will

747
00:33:56,700 --> 00:34:01,319
of course be lower simply because you

748
00:33:58,829 --> 00:34:04,019
don't can't see the very fine and faint

749
00:34:01,319 --> 00:34:06,419
pixels that a computer can see but you

750
00:34:04,019 --> 00:34:09,840
did really well and so if you take that

751
00:34:06,420 --> 00:34:12,030
10,000 number in the HUD f you can see

752
00:34:09,840 --> 00:34:15,059
that astronomers estimate that they're

753
00:34:12,030 --> 00:34:18,990
more than 100 billion galaxies in the

754
00:34:15,059 --> 00:34:22,079
entire universe now if that were all the

755
00:34:18,989 --> 00:34:24,689
HUD f was was about it still be a really

756
00:34:22,079 --> 00:34:27,539
great image but there is another story I

757
00:34:24,690 --> 00:34:29,550
want to tell you about it and here to

758
00:34:27,539 --> 00:34:31,559
illustrate that story are some of the

759
00:34:29,550 --> 00:34:34,260
most distant objects in the Hubble Ultra

760
00:34:31,559 --> 00:34:36,809
Deep Field and you can see they're not

761
00:34:34,260 --> 00:34:40,980
very exciting and galaxies there faint

762
00:34:36,809 --> 00:34:43,739
red dots small red things out of the

763
00:34:40,980 --> 00:34:46,769
furthest reaches of the universe now let

764
00:34:43,739 --> 00:34:48,898
me tell you why are they red well they

765
00:34:46,769 --> 00:34:51,179
are red because the universe is

766
00:34:48,898 --> 00:34:54,059
expanding and the light that travels

767
00:34:51,179 --> 00:34:56,880
across the expanding universe becomes

768
00:34:54,059 --> 00:34:59,880
stretched along with it recall this

769
00:34:56,880 --> 00:35:01,980
cosmological redshift because if you

770

00:34:59,880 --> 00:35:04,860
take short wavelengths and stretch them

771
00:35:01,980 --> 00:35:07,530
to longer wavelengths for visible light

772
00:35:04,860 --> 00:35:09,660
the blue is the shorter wavelengths the

773
00:35:07,530 --> 00:35:12,180
red is the longer wavelengths so the

774
00:35:09,659 --> 00:35:15,149
wavelengths stretched or the red end of

775
00:35:12,179 --> 00:35:16,710
the spectrum that's what cosmological

776
00:35:15,150 --> 00:35:20,480
redshift is and that's why these

777
00:35:16,710 --> 00:35:24,240
galaxies appear red they appear small

778
00:35:20,480 --> 00:35:27,829
because well this is a different story a

779
00:35:24,239 --> 00:35:30,569
long time ago in a galaxy far far away

780
00:35:27,829 --> 00:35:33,360
now you may recognize that

781
00:35:30,570 --> 00:35:36,870
the opening of Star Wars Episode four

782
00:35:33,360 --> 00:35:40,829
and it's actually one thing that George

783
00:35:36,869 --> 00:35:43,710
Lucas got right because when you are

784
00:35:40,829 --> 00:35:47,029

looking at a galaxy far far away you

785

00:35:43,710 --> 00:35:49,139

have to be looking at it a long time ago

786

00:35:47,030 --> 00:35:50,790

remember i talked about light traveling

787

00:35:49,139 --> 00:35:53,699

across space doesn't happen

788

00:35:50,789 --> 00:35:56,190

instantaneously light takes time to

789

00:35:53,699 --> 00:36:00,179

cross space and for these most distant

790

00:35:56,190 --> 00:36:02,610

galaxies it takes billions of years so

791

00:36:00,179 --> 00:36:06,149

we're seeing these galaxies not as they

792

00:36:02,610 --> 00:36:09,630

are today but as they were billions of

793

00:36:06,150 --> 00:36:13,139

years ago here's a diagram to illustrate

794

00:36:09,630 --> 00:36:14,910

that the bottom left you can see some

795

00:36:13,139 --> 00:36:17,339

galaxies out to about three billion

796

00:36:14,909 --> 00:36:20,069

light-years away so we're seeing them as

797

00:36:17,340 --> 00:36:22,350

they were out to 3 billion years ago and

798

00:36:20,070 --> 00:36:24,440

you can see those galaxies have the

799
00:36:22,349 --> 00:36:27,269
normal spiral shapes that we expect in

800
00:36:24,440 --> 00:36:29,099
the center circle we see galaxies from

801
00:36:27,269 --> 00:36:33,059
three to seven billion light-years away

802
00:36:29,099 --> 00:36:35,849
so three to seven billion years ago and

803
00:36:33,059 --> 00:36:37,949
they also have spiral shapes but they're

804
00:36:35,849 --> 00:36:40,110
not fully developed you know if the

805
00:36:37,949 --> 00:36:41,309
bottom ones are adult galaxies these

806
00:36:40,110 --> 00:36:44,190
middle ones maybe we'll call them

807
00:36:41,309 --> 00:36:46,380
teenager galaxies and in the top right

808
00:36:44,190 --> 00:36:49,139
you can see the galaxies that are red

809
00:36:46,380 --> 00:36:50,610
and they're small and they really don't

810
00:36:49,139 --> 00:36:53,670
have much spiral structure at all

811
00:36:50,610 --> 00:36:56,370
they're still developing these would be

812
00:36:53,670 --> 00:37:00,480
the kid galaxies as we look out into

813
00:36:56,369 --> 00:37:03,389
space we look back into time and we can

814
00:37:00,480 --> 00:37:06,269
see the development of galaxies over

815
00:37:03,389 --> 00:37:09,089
time and that is what makes the Hubble

816
00:37:06,269 --> 00:37:11,460
Ultra Deep Field so special that not

817
00:37:09,090 --> 00:37:14,220
only do we see so many galaxies stretch

818
00:37:11,460 --> 00:37:17,190
across space but also stretched across

819
00:37:14,219 --> 00:37:20,279
time and we can see the history of the

820
00:37:17,190 --> 00:37:24,840
universe by looking deep with the Hubble

821
00:37:20,280 --> 00:37:28,610
Space Telescope so we have shown you

822
00:37:24,840 --> 00:37:31,260
planets and stars and nebulae and

823
00:37:28,610 --> 00:37:33,269
galaxies and we've taken you to the edge

824
00:37:31,260 --> 00:37:35,970
of the universe Hubble as a

825
00:37:33,269 --> 00:37:38,940
general-purpose Observatory is able to

826
00:37:35,969 --> 00:37:42,839
study the complete sweep of the universe

827

00:37:38,940 --> 00:37:44,450
and its really are privileged to be able

828
00:37:42,840 --> 00:37:46,490
to bring this to you

829
00:37:44,449 --> 00:37:49,159
now I know that you have some questions

830
00:37:46,489 --> 00:37:51,199
and we asked you in advance to submit

831
00:37:49,159 --> 00:37:53,118
your questions we got a whole bunch of

832
00:37:51,199 --> 00:37:56,449
questions we chose to that we would

833
00:37:53,119 --> 00:37:59,088
answer live during the teach it so the

834
00:37:56,449 --> 00:38:02,389
first question what makes the pictures

835
00:37:59,088 --> 00:38:04,519
from Hubble so colorful because hulls

836
00:38:02,389 --> 00:38:07,549
images are just wonderfully compelling

837
00:38:04,519 --> 00:38:10,338
I'm actually going to tell you a secret

838
00:38:07,550 --> 00:38:12,650
it's not really a secret but Hubble

839
00:38:10,338 --> 00:38:16,009
takes images that are always black and

840
00:38:12,650 --> 00:38:19,400
white every image Hubble takes is black

841
00:38:16,010 --> 00:38:22,010

and white but what Hubble does is it

842

00:38:19,400 --> 00:38:23,930

takes images through filters and so the

843

00:38:22,010 --> 00:38:25,760

image on the left is goes through a red

844

00:38:23,929 --> 00:38:27,739

filter the image in the center goes

845

00:38:25,760 --> 00:38:29,660

through a green filter and the image on

846

00:38:27,739 --> 00:38:32,299

the right goes through a blue filter and

847

00:38:29,659 --> 00:38:34,670

when they come down to us at Space

848

00:38:32,300 --> 00:38:37,550

Telescope they are black and white and

849

00:38:34,670 --> 00:38:40,250

we can add color to them so that we get

850

00:38:37,550 --> 00:38:42,109

red and green and blue to represent the

851

00:38:40,250 --> 00:38:44,750

colors that they've got and then we

852

00:38:42,108 --> 00:38:49,000

combine them together we get a full

853

00:38:44,750 --> 00:38:51,800

color image up in this case a galaxy and

854

00:38:49,000 --> 00:38:53,900

in this galaxy we have used these

855

00:38:51,800 --> 00:38:56,539

broadband red green and blue filters

856
00:38:53,900 --> 00:38:58,369
just like the codes in your eye you've

857
00:38:56,539 --> 00:39:01,608
got red green and blue cones in your eye

858
00:38:58,369 --> 00:39:03,530
and so we call this sort of natural

859
00:39:01,608 --> 00:39:06,318
color because it's kind of like what

860
00:39:03,530 --> 00:39:08,480
you're I would see if you had an eyeball

861
00:39:06,318 --> 00:39:12,500
as big as the hubble space telescope's

862
00:39:08,480 --> 00:39:14,719
mirror the area are however most of

863
00:39:12,500 --> 00:39:17,300
Hubble observations are not they taken

864
00:39:14,719 --> 00:39:19,730
in these broadband filters for example

865
00:39:17,300 --> 00:39:23,089
this image of a nebula was taken in the

866
00:39:19,730 --> 00:39:26,150
light of nitrogen emission of hydrogen

867
00:39:23,088 --> 00:39:28,460
emission and oxygen emission these are

868
00:39:26,150 --> 00:39:30,108
three specific elements that that

869
00:39:28,460 --> 00:39:32,150
radiated specific wavelengths and

870

00:39:30,108 --> 00:39:35,299

Hubble's able to filter out just that

871

00:39:32,150 --> 00:39:36,920

light which is important to science now

872

00:39:35,300 --> 00:39:40,670

the night both the nitrogen and the

873

00:39:36,920 --> 00:39:43,159

hydrogen outlines are in the red part of

874

00:39:40,670 --> 00:39:45,619

the spectrum and the oxygen is in more

875

00:39:43,159 --> 00:39:48,828

in the cyan portion of the spectrum and

876

00:39:45,619 --> 00:39:50,650

we combine them together we would get an

877

00:39:48,829 --> 00:39:53,630

image like you see in the lower left

878

00:39:50,650 --> 00:39:55,130

however in that image it's very hard to

879

00:39:53,630 --> 00:39:56,338

tell what is the nitrogen and what is

880

00:39:55,130 --> 00:39:58,229

the hydrogen they're all sort of

881

00:39:56,338 --> 00:40:00,808

mixed together so it's more

882

00:39:58,228 --> 00:40:03,598

scientifically useful and I will say

883

00:40:00,809 --> 00:40:06,469

more beautiful if instead we've used

884

00:40:03,599 --> 00:40:09,809
nitrogen is red hydrogen is green and

885
00:40:06,469 --> 00:40:12,349
oxygen is blue combine those together

886
00:40:09,809 --> 00:40:15,630
and you hit the image in the lower right

887
00:40:12,349 --> 00:40:18,269
which has a little bit more more beauty

888
00:40:15,630 --> 00:40:20,670
to it but it's also much more useful in

889
00:40:18,268 --> 00:40:23,848
being able to separate out the colors

890
00:40:20,670 --> 00:40:26,099
from the different emission of the

891
00:40:23,849 --> 00:40:28,650
different atoms and that is what's

892
00:40:26,099 --> 00:40:30,479
useful scientifically we call this

893
00:40:28,650 --> 00:40:32,489
representative color because we are

894
00:40:30,478 --> 00:40:35,308
representing each filter with a

895
00:40:32,489 --> 00:40:37,199
different color it's also what we do

896
00:40:35,309 --> 00:40:40,469
when we take images in the infrared and

897
00:40:37,199 --> 00:40:42,239
the ultraviolet because what color is

898
00:40:40,469 --> 00:40:44,519

the ultraviolet what color is the

899

00:40:42,239 --> 00:40:49,228

infrared we need to take visible light

900

00:40:44,518 --> 00:40:51,838

colors to represent those the point is

901

00:40:49,228 --> 00:40:56,129

that all of the all of the images you

902

00:40:51,838 --> 00:40:58,170

see from Hubble the data is real but the

903

00:40:56,130 --> 00:40:59,910

colors of course sometimes have to

904

00:40:58,170 --> 00:41:03,119

represent other things that you can't

905

00:40:59,909 --> 00:41:05,219

see the second question we're going to

906

00:41:03,119 --> 00:41:08,999

answer today is what is the future of

907

00:41:05,219 --> 00:41:11,489

Hubble and space astronomy well the

908

00:41:08,998 --> 00:41:14,218

future of Hubble is actually very bright

909

00:41:11,489 --> 00:41:15,838

you might think oh it's 25 years it's

910

00:41:14,219 --> 00:41:17,969

getting toward the end of its life you

911

00:41:15,838 --> 00:41:21,449

know this is a retrospective no actually

912

00:41:17,969 --> 00:41:23,999

Hubble is doing really great we've been

913
00:41:21,449 --> 00:41:26,368
really happy with the way the

914
00:41:23,998 --> 00:41:29,159
observatory has functioned since the

915
00:41:26,369 --> 00:41:30,778
last service commission in 2009 the

916
00:41:29,159 --> 00:41:32,998
folks here at Space Telescope have

917
00:41:30,778 --> 00:41:34,889
learned how to operate the batteries and

918
00:41:32,998 --> 00:41:37,018
the gyroscopes and preserve do the

919
00:41:34,889 --> 00:41:39,298
observing in such ways that we are

920
00:41:37,018 --> 00:41:42,088
preserving and prolonging the life of

921
00:41:39,298 --> 00:41:45,028
the telescope the hubble is in many ways

922
00:41:42,088 --> 00:41:47,219
still at the peak of its powers and we

923
00:41:45,028 --> 00:41:49,199
expect it to last at least another five

924
00:41:47,219 --> 00:41:51,329
years and we're crossing our fingers and

925
00:41:49,199 --> 00:41:54,058
hoping that hubble will last another 10

926
00:41:51,329 --> 00:41:56,930
years yeah we might be able to get 35

927
00:41:54,059 --> 00:42:00,989
years out of this amazing telescope

928
00:41:56,929 --> 00:42:03,629
going beyond Hubble we have a new great

929
00:42:00,989 --> 00:42:07,048
Grubbs ereri from NASA called the James

930
00:42:03,630 --> 00:42:09,210
Webb Space Telescope now the James Webb

931
00:42:07,048 --> 00:42:11,460
Space Telescope is the following

932
00:42:09,210 --> 00:42:13,889
hubble but it's a little different from

933
00:42:11,460 --> 00:42:16,019
how you can see it's got this giant

934
00:42:13,889 --> 00:42:18,089
mirror with this great big sunshade and

935
00:42:16,019 --> 00:42:20,849
that's because it is an infrared

936
00:42:18,090 --> 00:42:24,809
Observatory it will be observing an

937
00:42:20,849 --> 00:42:27,179
infrared light why the infrared well

938
00:42:24,809 --> 00:42:29,880
remember I talked about all those dust

939
00:42:27,179 --> 00:42:32,639
disks in Orion and you want to look into

940
00:42:29,880 --> 00:42:34,320
that as dark dust as well it's hard to

941

00:42:32,639 --> 00:42:37,829
see you can't see them using visible

942
00:42:34,320 --> 00:42:40,140
light but infrared light with its longer

943
00:42:37,829 --> 00:42:41,960
wavelengths as well as the radiation

944
00:42:40,139 --> 00:42:45,029
from the dusk occurs in the infrared

945
00:42:41,960 --> 00:42:47,849
allows the james webb space telescope to

946
00:42:45,030 --> 00:42:50,880
look inside those dust disks and study

947
00:42:47,849 --> 00:42:52,769
star formation and planet formation with

948
00:42:50,880 --> 00:42:56,970
greater detail than Hubble could ever

949
00:42:52,769 --> 00:43:00,539
possibly do also when we look out at

950
00:42:56,969 --> 00:43:03,000
those distant galaxies the light that is

951
00:43:00,539 --> 00:43:04,920
stretched by cosmological redshift can

952
00:43:03,000 --> 00:43:07,289
be stretched past the visible light

953
00:43:04,920 --> 00:43:10,950
spectrum can be stretched into the

954
00:43:07,289 --> 00:43:13,619
infrared and deep into the infrared the

955
00:43:10,949 --> 00:43:15,719

HUD f runs out of galaxies after a while

956

00:43:13,619 --> 00:43:19,349

not because the galaxies aren't there

957

00:43:15,719 --> 00:43:21,269

but because Hubble can't see them the

958

00:43:19,349 --> 00:43:23,519

weight light from those galaxies has

959

00:43:21,269 --> 00:43:25,469

been stretched to the infrared and we

960

00:43:23,519 --> 00:43:27,809

need the James Webb Space Telescope in

961

00:43:25,469 --> 00:43:30,959

order to see these most distance and the

962

00:43:27,809 --> 00:43:32,610

earliest galaxies in the universe so the

963

00:43:30,960 --> 00:43:34,650

James Webb Space Telescope is doing

964

00:43:32,610 --> 00:43:37,800

infrared observations it will have the

965

00:43:34,650 --> 00:43:40,380

resolution of Hubble in the infrared and

966

00:43:37,800 --> 00:43:43,740

be able to do science that the Hubble

967

00:43:40,380 --> 00:43:45,720

Space Telescope was not able to do now

968

00:43:43,739 --> 00:43:49,589

the James Webb Space Telescope doesn't

969

00:43:45,719 --> 00:43:50,969

launch until 2018 however that doesn't

970
00:43:49,590 --> 00:43:53,670
mean you can't get involved with the

971
00:43:50,969 --> 00:43:56,399
James Webb Space Telescope now and here

972
00:43:53,670 --> 00:43:59,070
to tell us about a project that you can

973
00:43:56,400 --> 00:44:04,940
do in your classroom is Jessica Kenny

974
00:43:59,070 --> 00:44:08,130
Space Telescope Science Institute hello

975
00:44:04,940 --> 00:44:09,630
welcome to our hangout again I we I am

976
00:44:08,130 --> 00:44:11,250
Jessica Kimmy and I will be telling you

977
00:44:09,630 --> 00:44:14,570
about the James Webb stem innovation

978
00:44:11,250 --> 00:44:17,639
project here at Space Telescope this

979
00:44:14,570 --> 00:44:20,500
project was based upon the success of

980
00:44:17,639 --> 00:44:22,989
the 2009 Hubble early release

981
00:44:20,500 --> 00:44:25,360
student pilot program is an

982
00:44:22,989 --> 00:44:27,279
interdisciplinary project where students

983
00:44:25,360 --> 00:44:30,550
are able to create and demonstrate their

984
00:44:27,280 --> 00:44:32,980
own ideas about the telescope this

985
00:44:30,550 --> 00:44:35,950
project is implemented in 50 different

986
00:44:32,980 --> 00:44:38,559
states within the US so this covers

987
00:44:35,949 --> 00:44:40,539
summer disciplines we have a music art

988
00:44:38,559 --> 00:44:41,829
in writing we have a few examples of

989
00:44:40,539 --> 00:44:44,469
some projects that students have

990
00:44:41,829 --> 00:44:47,590
completed we have students who have

991
00:44:44,469 --> 00:44:50,799
completed this project by creating songs

992
00:44:47,590 --> 00:44:53,289
through music we have students who have

993
00:44:50,800 --> 00:44:54,970
done a mural at their school that they

994
00:44:53,289 --> 00:44:56,650
devoted their summer time to create this

995
00:44:54,969 --> 00:44:58,209
mural with their parents with their

996
00:44:56,650 --> 00:45:01,480
teachers and with others in the

997
00:44:58,210 --> 00:45:03,760
community we also have social studies

998

00:45:01,480 --> 00:45:05,889
students working with this project it

999
00:45:03,760 --> 00:45:08,500
with world culture they've studied how

1000
00:45:05,889 --> 00:45:10,449
James Webb will impact the world and in

1001
00:45:08,500 --> 00:45:13,929
other countries that have involved in

1002
00:45:10,449 --> 00:45:16,149
creating the telescope and we've had

1003
00:45:13,929 --> 00:45:20,109
elementary school students who created

1004
00:45:16,150 --> 00:45:22,059
this awesome J diversity mirror segments

1005
00:45:20,110 --> 00:45:25,630
they recognize these patterns very

1006
00:45:22,059 --> 00:45:27,159
similar to beehive patterns and we have

1007
00:45:25,630 --> 00:45:28,869
a few comments from teachers is the

1008
00:45:27,159 --> 00:45:31,059
first grade teacher who felt like the

1009
00:45:28,869 --> 00:45:33,009
students really were gaining

1010
00:45:31,059 --> 00:45:35,469
thought-provoking questions related to

1011
00:45:33,010 --> 00:45:38,740
the project they develop skills in

1012
00:45:35,469 --> 00:45:41,319

high-level comprehension from learning

1013

00:45:38,739 --> 00:45:43,209

about the James Webb Space Telescope we

1014

00:45:41,320 --> 00:45:46,269

have a high school teacher who would

1015

00:45:43,210 --> 00:45:48,519

allow their students to get real-world

1016

00:45:46,269 --> 00:45:51,429

connections to the soap telescopes and

1017

00:45:48,519 --> 00:45:54,039

they did 3d models they did songwriting

1018

00:45:51,429 --> 00:45:56,859

computer drawings related to James Webb

1019

00:45:54,039 --> 00:45:58,449

and here's just some inspiration from

1020

00:45:56,860 --> 00:46:00,370

students who participated in this

1021

00:45:58,449 --> 00:46:04,109

project that they're really interested

1022

00:46:00,369 --> 00:46:07,210

in there hoping that they could go and

1023

00:46:04,110 --> 00:46:10,660

take this opportunity to go in the

1024

00:46:07,210 --> 00:46:11,800

future in their careers so how do you

1025

00:46:10,659 --> 00:46:13,420

want to get involved how do you

1026

00:46:11,800 --> 00:46:15,360

participate with us to partner with us

1027
00:46:13,420 --> 00:46:17,980
we were able to give you resources

1028
00:46:15,360 --> 00:46:20,559
information from Jay diversity

1029
00:46:17,980 --> 00:46:23,139
scientists and if you complete this

1030
00:46:20,559 --> 00:46:25,599
project you will receive a high quality

1031
00:46:23,139 --> 00:46:28,569
museum quality prep for your classroom

1032
00:46:25,599 --> 00:46:31,420
and our contact information is John

1033
00:46:28,570 --> 00:46:33,180
maple we will see it's a jay maple at

1034
00:46:31,420 --> 00:46:36,750
stsci edu

1035
00:46:33,179 --> 00:46:37,919
and here is an image of the museum

1036
00:46:36,750 --> 00:46:40,250
quality poster that you will receive

1037
00:46:37,920 --> 00:46:42,990
upon completion of this project

1038
00:46:40,250 --> 00:46:44,429
fantastic and it's great that we're able

1039
00:46:42,989 --> 00:46:47,368
to get the james webb space telescope

1040
00:46:44,429 --> 00:46:51,750
into classrooms four years five years

1041
00:46:47,369 --> 00:46:55,619
before its launch so Hubble has been up

1042
00:46:51,750 --> 00:46:58,260
for 25 years and we are so excited that

1043
00:46:55,619 --> 00:47:00,630
you chose to share with us but it's not

1044
00:46:58,260 --> 00:47:02,550
over there's a lot more there's a lot

1045
00:47:00,630 --> 00:47:04,079
more to come from Hubble and we hope

1046
00:47:02,550 --> 00:47:06,210
there's a lot more interaction that you

1047
00:47:04,079 --> 00:47:09,300
can have with us here at Space Telescope

1048
00:47:06,210 --> 00:47:11,670
Science Institute we run the what we

1049
00:47:09,300 --> 00:47:13,680
call the amazing space education program

1050
00:47:11,670 --> 00:47:15,329
and if you want to see all the

1051
00:47:13,679 --> 00:47:16,739
activities and you want to keep up

1052
00:47:15,329 --> 00:47:22,700
perhaps with the future events we're

1053
00:47:16,739 --> 00:47:27,838
going to do come to our website www

1054
00:47:22,699 --> 00:47:29,279
amazing hyphen space STScI dot edu now I

1055

00:47:27,838 --> 00:47:31,078
have to tell you I think that website is

1056
00:47:29,280 --> 00:47:33,869
going to undergo an upgrade over the

1057
00:47:31,079 --> 00:47:36,839
summer but by sep tember we will be able

1058
00:47:33,869 --> 00:47:38,880
to will be a new website and we'll

1059
00:47:36,838 --> 00:47:41,699
schedule some new events to do with

1060
00:47:38,880 --> 00:47:44,039
teachers across the country if you have

1061
00:47:41,699 --> 00:47:45,629
questions or comments I know we didn't

1062
00:47:44,039 --> 00:47:47,279
answer all the questions we got too many

1063
00:47:45,630 --> 00:47:50,369
to answer I tried to answer as many of

1064
00:47:47,280 --> 00:47:52,530
my talk but you can still send us

1065
00:47:50,369 --> 00:47:57,170
questions or comments about this too

1066
00:47:52,530 --> 00:48:00,900
amazing hyphen space at stsci edu

1067
00:47:57,170 --> 00:48:02,369
finally I know that you we always go

1068
00:48:00,900 --> 00:48:04,019
through these things much too quickly

1069
00:48:02,369 --> 00:48:05,430

and you might have missed something all

1070

00:48:04,019 --> 00:48:07,369

right well the recording will be

1071

00:48:05,429 --> 00:48:11,098

available on YouTube very shortly after

1072

00:48:07,369 --> 00:48:13,559

afterwards and also we will then put it

1073

00:48:11,099 --> 00:48:15,599

up on teachertube early next week i

1074

00:48:13,559 --> 00:48:18,269

believe by tuesday of next week we'll

1075

00:48:15,599 --> 00:48:21,240

have it up on teacher tube and guess

1076

00:48:18,269 --> 00:48:24,139

what our username is there it is amazing

1077

00:48:21,239 --> 00:48:27,598

space but this time without the hyphen

1078

00:48:24,139 --> 00:48:29,578

so on behalf of Bonnie Eisen hammer the

1079

00:48:27,599 --> 00:48:32,099

office of public outreach the Space

1080

00:48:29,579 --> 00:48:35,309

Telescope Science Institute and all of

1081

00:48:32,099 --> 00:48:36,690

the folks at NASA work on Hubble thank

1082

00:48:35,309 --> 00:48:39,480

you for celebrating Hubble's 25th

1083

00:48:36,690 --> 00:48:42,858

anniversary with us and keep exploring

1084

00:48:39,480 --> 00:48:42,858

your universe