
HUBBLE
SPACE TELESCOPE
30

1
00:00:05,630 --> 00:00:02,960
hello and welcome to the Hubble Space

2
00:00:08,450 --> 00:00:05,640
Telescope's 30th anniversary image

3
00:00:11,930 --> 00:00:08,460
unveiling webcast we're so glad you

4
00:00:13,820 --> 00:00:11,940
could join us for this special event I'm

5
00:00:15,499 --> 00:00:13,830
dr. Frank summers of the office of

6
00:00:17,900 --> 00:00:15,509
public outreach at the Space Telescope

7
00:00:20,060 --> 00:00:17,910
Science Institute and joining me later

8
00:00:22,189 --> 00:00:20,070
in the program will be dr. Ellen asabi

9
00:00:25,490 --> 00:00:22,199
also of the Space Telescope Science

10
00:00:28,750 --> 00:00:25,500
Institute now you may think this program

11
00:00:33,110 --> 00:00:28,760
has been thirty years in the making but

12
00:00:36,920 --> 00:00:33,120
actually Hubble as an idea goes back

13
00:00:39,790 --> 00:00:36,930

much further it goes back to the 1940s

14
00:00:42,410 --> 00:00:39,800
when Lyman Spitzer wrote a seminal paper

15
00:00:46,760 --> 00:00:42,420
imagining the benefits of a telescope

16
00:00:49,840 --> 00:00:46,770
located in space that was a full decade

17
00:00:54,500 --> 00:00:49,850
before Sputnik started the Space Age and

18
00:00:57,470 --> 00:00:54,510
went before NASA was created in the

19
00:00:59,720 --> 00:00:57,480
1960s the idea of a Space Telescope

20
00:01:02,560 --> 00:00:59,730
became a recommendation from the

21
00:01:06,200 --> 00:01:02,570
National Academy of Sciences and in the

22
00:01:08,539 --> 00:01:06,210
1970s that vision was finally funded by

23
00:01:13,190 --> 00:01:08,549
Congress and the European Space Agency

24
00:01:16,070 --> 00:01:13,200
in the mid 90s 1985 Hubble had been

25
00:01:22,880 --> 00:01:16,080
constructed and it was launched on this

26
00:01:24,560 --> 00:01:22,890
day 30 years ago in 1990 so for 30 years

27
00:01:29,120 --> 00:01:24,570
we have had the Hubble Space Telescope

28
00:01:31,850 --> 00:01:29,130
in orbit and people sort of ask what

29
00:01:36,020 --> 00:01:31,860
wait a minute why Hubble what makes it

30
00:01:38,480 --> 00:01:36,030
so special well the first thing is that

31
00:01:42,490 --> 00:01:38,490
hull has the three things that every

32
00:01:47,630 --> 00:01:42,500
real estate agent wants it has location

33
00:01:51,109 --> 00:01:47,640
location and location after all space is

34
00:01:54,649 --> 00:01:51,119
its middle name and by being located in

35
00:01:56,749 --> 00:01:54,659
space it gets the clearest view of any

36
00:01:58,520 --> 00:01:56,759
telescope I mean you look at this image

37
00:02:00,830 --> 00:01:58,530
and you can see that the clouds are

38
00:02:03,770 --> 00:02:00,840

beneath Hubble and that's the point

39
00:02:05,840 --> 00:02:03,780
the clouds are underneath Hubble Hubble

40
00:02:07,459 --> 00:02:05,850
is up above it the ground-based

41
00:02:10,369 --> 00:02:07,469
telescopes have to look through that

42
00:02:13,309 --> 00:02:10,379
atmosphere and they do not get as clear

43
00:02:13,670 --> 00:02:13,319
an image as Hubble but Hubble being out

44
00:02:16,390 --> 00:02:13,680
in two

45
00:02:19,580 --> 00:02:16,400
space is not that far out into space

46
00:02:22,729 --> 00:02:19,590
here in this diagram you can see this is

47
00:02:26,089 --> 00:02:22,739
the size of Earth is about 6,400

48
00:02:28,789 --> 00:02:26,099
kilometers in radius Earth's atmosphere

49
00:02:31,270 --> 00:02:28,799
is a very thin layer around that that's

50
00:02:34,490 --> 00:02:31,280
only 100 kilometers above the surface

51
00:02:37,280 --> 00:02:34,500
Hubble gets up above that atmosphere but

52
00:02:39,500 --> 00:02:37,290
not that far above it's only 600

53
00:02:41,780 --> 00:02:39,510
kilometers above the surface so Hubble

54
00:02:44,089 --> 00:02:41,790
goes far enough to get above the

55
00:02:48,319 --> 00:02:44,099
atmosphere but doesn't go really really

56
00:02:51,530 --> 00:02:48,329
far out into space this is an orbit that

57
00:02:53,240 --> 00:02:51,540
we call low Earth orbit and that

58
00:02:56,000 --> 00:02:53,250
provides another advantage to Hubble

59
00:02:59,179 --> 00:02:56,010
because that is an orbit that can be

60
00:03:02,270 --> 00:02:59,189
reached by astronauts Hubble was

61
00:03:04,940 --> 00:03:02,280
launched aboard the space shuttle 30

62
00:03:07,970 --> 00:03:04,950
years ago and it has been visited by

63
00:03:11,179 --> 00:03:07,980

astronauts five times for servicing

64
00:03:14,270 --> 00:03:11,189
missions the astronauts took the space

65
00:03:16,699 --> 00:03:14,280
shuttle up they caught up to Hubble they

66
00:03:19,699 --> 00:03:16,709
grappled it and pulled it into the cargo

67
00:03:22,670 --> 00:03:19,709
bay and then they've performed servicing

68
00:03:26,869 --> 00:03:22,680
on it they swapped out old instruments

69
00:03:28,670 --> 00:03:26,879
they put in new technology they changed

70
00:03:30,770 --> 00:03:28,680
the gyroscopes they changed the

71
00:03:33,379 --> 00:03:30,780
batteries they put in new thermal

72
00:03:36,229 --> 00:03:33,389
insulation as NASA likes to say they

73
00:03:38,809 --> 00:03:36,239
were able to repair refresh and renew

74
00:03:41,659 --> 00:03:38,819
the Hubble Space Telescope and that has

75
00:03:44,149 --> 00:03:41,669
been a major factor in being able to

76
00:03:48,589 --> 00:03:44,159
provide productive science for three

77
00:03:51,050 --> 00:03:48,599
decades another thing that helps Hubble

78
00:03:54,439 --> 00:03:51,060
lasts for so long is the incredible

79
00:03:56,719 --> 00:03:54,449
ground support it gets now this is the

80
00:03:59,659 --> 00:03:56,729
Space Telescope Science Institute this

81
00:04:03,140 --> 00:03:59,669
is where I work and there are people

82
00:04:04,569 --> 00:04:03,150
here that provide amazing support for

83
00:04:07,780 --> 00:04:04,579
the astronomers who want to do

84
00:04:10,009 --> 00:04:07,790
observations on Hubble they organize the

85
00:04:12,140 --> 00:04:10,019
allocation committee's that decide who

86
00:04:14,719 --> 00:04:12,150
gets time on Hubble they help the

87
00:04:17,390 --> 00:04:14,729
observers plan all their observations

88
00:04:19,670 --> 00:04:17,400

they provide the software and they

89
00:04:22,580 --> 00:04:19,680
provide the scheduling and they provide

90
00:04:26,190 --> 00:04:22,590
everything the astronomers need to

91
00:04:30,390 --> 00:04:26,200
maximize the science output of Hubble it

92
00:04:32,280 --> 00:04:30,400
it's actually a a a the way you think

93
00:04:34,800 --> 00:04:32,290
astronomy should always have been done

94
00:04:36,510 --> 00:04:34,810
but in 1990 when Hubble was launched

95
00:04:39,360 --> 00:04:36,520
this was actually a relatively new idea

96
00:04:42,420 --> 00:04:39,370
to have an entire it's dedicated to it

97
00:04:45,480 --> 00:04:42,430
and now it is the model of how these

98
00:04:47,550 --> 00:04:45,490
major observatories are supported also

99
00:04:49,880 --> 00:04:47,560
located at the Space Telescope Science

100
00:04:53,700 --> 00:04:49,890
Institute is the Barbara a Mikulski

101
00:04:56,640 --> 00:04:53,710
archive for space telescopes and every

102
00:04:59,700 --> 00:04:56,650
observation done with Hubble ends up in

103
00:05:03,150 --> 00:04:59,710
this archive we like to call it mast and

104
00:05:06,920 --> 00:05:03,160
any astronomer anywhere in the world can

105
00:05:11,490 --> 00:05:06,930
log in to mast and access Hubble data

106
00:05:14,070 --> 00:05:11,500
now this acts as a huge imperative for

107
00:05:17,550 --> 00:05:14,080
astronomers to publish the science that

108
00:05:19,350 --> 00:05:17,560
they do on Hubble because when you've

109
00:05:21,300 --> 00:05:19,360
worked really really hard to get your

110
00:05:24,690 --> 00:05:21,310
observations and you finally get your

111
00:05:28,050 --> 00:05:24,700
day down from Hubble you've got one year

112
00:05:31,260 --> 00:05:28,060
only one year before that data becomes

113
00:05:34,050 --> 00:05:31,270

public and masked so if you don't write

114
00:05:36,840 --> 00:05:34,060
your science papers then your fiercest

115
00:05:39,690 --> 00:05:36,850
competitor can go into massed and get

116
00:05:43,530 --> 00:05:39,700
your data and scoop you on your science

117
00:05:46,350 --> 00:05:43,540
so astronomers have a huge impetus to

118
00:05:48,900 --> 00:05:46,360
make sure that they not only get their

119
00:05:51,360 --> 00:05:48,910
get their data but do they write the

120
00:05:53,730 --> 00:05:51,370
papers and the science with it another

121
00:05:56,760 --> 00:05:53,740
great thing about mast is mass isn't

122
00:05:58,740 --> 00:05:56,770
just for the Hubble Space Telescope it

123
00:06:01,740 --> 00:05:58,750
has grown to support many different

124
00:06:03,740 --> 00:06:01,750
space missions that's why it's plural

125
00:06:07,620 --> 00:06:03,750
the archive for space telescopes and

126
00:06:10,530 --> 00:06:07,630
that is another reason why Hubble is so

127
00:06:14,070 --> 00:06:10,540
effective because Hubble is part of a

128
00:06:17,430 --> 00:06:14,080
team and this team is not the Avengers

129
00:06:18,990 --> 00:06:17,440
it's the NASA Great observatories it

130
00:06:21,360 --> 00:06:19,000
includes the Hubble Space Telescope that

131
00:06:24,330 --> 00:06:21,370
looks in visible light the Compton

132
00:06:26,220 --> 00:06:24,340
gamma-ray Observatory the Spitzer Space

133
00:06:30,300 --> 00:06:26,230
Telescope that looks an infrared light

134
00:06:33,920 --> 00:06:30,310
and the Chandra x-ray Observatory these

135
00:06:36,690 --> 00:06:33,930
four telescopes are all extremely

136
00:06:39,540 --> 00:06:36,700
powerful observatories that look in

137
00:06:42,330 --> 00:06:39,550
different wavelengths of light and to

138
00:06:45,060 --> 00:06:42,340

gather they get a more complete view of

139
00:06:47,520 --> 00:06:45,070
astronomical objects then could be done

140
00:06:50,850 --> 00:06:47,530
by any telescope alone let me give you

141
00:06:54,120 --> 00:06:50,860
an example so this is the spiral galaxy

142
00:06:55,620 --> 00:06:54,130
Messier 101 and on the left you see the

143
00:06:58,020 --> 00:06:55,630
infrared image from Spitzer

144
00:07:00,570 --> 00:06:58,030
in the center you see the visible light

145
00:07:03,480 --> 00:07:00,580
image from Hubble and on the right you

146
00:07:04,980 --> 00:07:03,490
see the x-ray image from Chandra now

147
00:07:06,960 --> 00:07:04,990
we're used to what we see in visible

148
00:07:09,570 --> 00:07:06,970
light all the stars in that beautiful

149
00:07:12,210 --> 00:07:09,580
spiral pattern of the galaxy but in the

150
00:07:14,130 --> 00:07:12,220
infrared image we see the glowing dust

151
00:07:16,410 --> 00:07:14,140
clouds of gas and dust clouds that

152
00:07:18,870 --> 00:07:16,420
underlie that beautiful spiral structure

153
00:07:20,970 --> 00:07:18,880
and in the x-ray image we see the

154
00:07:23,190 --> 00:07:20,980
high-energy mission from things like

155
00:07:26,580 --> 00:07:23,200
black holes within the galaxy and

156
00:07:28,770 --> 00:07:26,590
together we get a more a composite view

157
00:07:31,430 --> 00:07:28,780
of all the physical processes going on

158
00:07:34,680 --> 00:07:31,440
at many different energies and a more

159
00:07:37,590 --> 00:07:34,690
deeper understanding of the objects in

160
00:07:39,660 --> 00:07:37,600
question now the Compton gamma-ray

161
00:07:43,020 --> 00:07:39,670
Observatory was retired many years ago

162
00:07:45,270 --> 00:07:43,030
and earlier this year we retired the

163
00:07:47,100 --> 00:07:45,280

Spitzer Space Telescope so right now

164
00:07:51,720 --> 00:07:47,110
it's only Hubble and Chandra that are

165
00:07:55,050 --> 00:07:51,730
working however next year in 2021 a new

166
00:07:58,470 --> 00:07:55,060
team member will come in this is the

167
00:08:01,530 --> 00:07:58,480
James Webb Space Telescope JWST or

168
00:08:03,270 --> 00:08:01,540
Webb's we like to call it is a telescope

169
00:08:06,780 --> 00:08:03,280
that will observe mainly in the infrared

170
00:08:09,210 --> 00:08:06,790
like spitzer but its mirror will be so

171
00:08:11,900 --> 00:08:09,220
much larger that it will have the

172
00:08:14,370 --> 00:08:11,910
incredibly high resolution like Hubble

173
00:08:17,670 --> 00:08:14,380
it's kind of like combining the best of

174
00:08:20,400 --> 00:08:17,680
both of those telescopes and JWST will

175
00:08:22,380 --> 00:08:20,410
be able to look at planets forming

176
00:08:24,810 --> 00:08:22,390
around other stars and they'll be able

177
00:08:27,690 --> 00:08:24,820
to look at very distant galaxies that

178
00:08:30,600 --> 00:08:27,700
Hubble can't see it's gonna be extremely

179
00:08:32,760 --> 00:08:30,610
exciting to have Webb become joined the

180
00:08:35,780 --> 00:08:32,770
team of the Great observatories and that

181
00:08:39,600 --> 00:08:35,790
will happen in 2021

182
00:08:41,520 --> 00:08:39,610
but today is Hubble's anniversary so

183
00:08:44,400 --> 00:08:41,530
let's focus just a little bit on

184
00:08:47,250 --> 00:08:44,410
Hubble's discoveries and they only let

185
00:08:48,750 --> 00:08:47,260
me do five of these okay I if I went

186
00:08:51,020 --> 00:08:48,760
through all of Hubble's discoveries I

187
00:08:52,820 --> 00:08:51,030
guess we'd be here for about 30 hours

188
00:08:55,400 --> 00:08:52,830

but we're going to go

189
00:08:57,980 --> 00:08:55,410
were just a few of Hubble's discoveries

190
00:09:01,310 --> 00:08:57,990
now let's take a look at planets and

191
00:09:02,900 --> 00:09:01,320
this is Jupiter and one of my favorite

192
00:09:04,160 --> 00:09:02,910
things in the universe is Jupiter's

193
00:09:06,020 --> 00:09:04,170
Great Red Spot

194
00:09:08,150 --> 00:09:06,030
I mean I'd fallen in love with this ever

195
00:09:12,320 --> 00:09:08,160
since forager took that close-up picture

196
00:09:14,780 --> 00:09:12,330
on in the 1970s however that brings up a

197
00:09:16,670 --> 00:09:14,790
question I mean what can Hubble do I

198
00:09:19,760 --> 00:09:16,680
mean Hubble has the clearest view from

199
00:09:22,280 --> 00:09:19,770
Earth but we've sent the Galileo Voyager

200
00:09:23,780 --> 00:09:22,290
and Galileo and now Juno is there at

201
00:09:27,470 --> 00:09:23,790
Jupiter and they get really close-up

202
00:09:29,840 --> 00:09:27,480
images what can Hubble do well Hubble's

203
00:09:33,800 --> 00:09:29,850
been up for 30 years so it can use the

204
00:09:36,740 --> 00:09:33,810
power of time what you see here now is

205
00:09:43,370 --> 00:09:36,750
how the Great Red Spot has changed from

206
00:09:45,230 --> 00:09:43,380
1995 to 2009 to 2014 and you'll notice

207
00:09:48,380 --> 00:09:45,240
that the Great Red Spot has been

208
00:09:51,380 --> 00:09:48,390
shrinking it's now some 30 percent

209
00:09:54,470 --> 00:09:51,390
smaller than it was when Hubble went up

210
00:09:58,460 --> 00:09:54,480
and I gotta say astronomers are not

211
00:09:59,870 --> 00:09:58,470
exactly sure why but Hubble and using

212
00:10:02,150 --> 00:09:59,880
the power of time and being able to

213
00:10:05,260 --> 00:10:02,160

consistent observations over the decades

214
00:10:08,540 --> 00:10:05,270
can help us answer such questions

215
00:10:10,310 --> 00:10:08,550
Hubble also looks at stars and my

216
00:10:12,620 --> 00:10:10,320
favorite star clusters to look at are

217
00:10:15,890 --> 00:10:12,630
these globular clusters I mean these are

218
00:10:18,500 --> 00:10:15,900
dense glomer ations of tens of thousands

219
00:10:20,810 --> 00:10:18,510
to millions of stars all or being around

220
00:10:22,660 --> 00:10:20,820
one another I mean it's an amazing

221
00:10:25,520 --> 00:10:22,670
dynamical laboratory when you've got

222
00:10:27,740 --> 00:10:25,530
10,000 objects all orbiting around each

223
00:10:29,690 --> 00:10:27,750
other and this is the kind of things

224
00:10:32,690 --> 00:10:29,700
that people really love to study to

225
00:10:35,810 --> 00:10:32,700
understand the behavior in in these

226
00:10:38,720 --> 00:10:35,820
complex gravitational fields so Hubble

227
00:10:41,240 --> 00:10:38,730
can look deep inside these globular

228
00:10:44,090 --> 00:10:41,250
clusters and can actually track the

229
00:10:46,610 --> 00:10:44,100
motions of stars it takes a picture at

230
00:10:48,710 --> 00:10:46,620
one year and then a few years later it

231
00:10:50,930 --> 00:10:48,720
can actually measure the motions with

232
00:10:53,900 --> 00:10:50,940
its resolution and we can begin to

233
00:10:58,190 --> 00:10:53,910
understand these amazing dynamical

234
00:11:00,470 --> 00:10:58,200
laboratories of globular clusters Hubble

235
00:11:02,870 --> 00:11:00,480
looks at nebula it's probably the most

236
00:11:04,940 --> 00:11:02,880
de famous thing that Hubble looks at and

237
00:11:05,720 --> 00:11:04,950
this is perhaps one of its most famous

238
00:11:07,789 --> 00:11:05,730

nebulae

239
00:11:10,429 --> 00:11:07,799
we're the so-called pillars of creation

240
00:11:14,329 --> 00:11:10,439
in the Eagle Nebula also known as

241
00:11:16,759 --> 00:11:14,339
Messier 16 and this was so popular that

242
00:11:20,989 --> 00:11:16,769
we went back with a new instrument and

243
00:11:24,530 --> 00:11:20,999
viewed it in 2015 and you can see these

244
00:11:27,590 --> 00:11:24,540
pillars are act are not dense

245
00:11:31,150 --> 00:11:27,600
collaborations a material they're

246
00:11:34,579 --> 00:11:31,160
actually being ablated away by the

247
00:11:36,859 --> 00:11:34,589
high-energy radiation from stars that

248
00:11:39,470 --> 00:11:36,869
are off screen above and that's why they

249
00:11:41,539 --> 00:11:39,480
have these bright tops and in the bright

250
00:11:44,150 --> 00:11:41,549
tops that's where they're dense regions

251
00:11:46,460 --> 00:11:44,160
are and that's where stars are for

252
00:11:50,689 --> 00:11:46,470
mation so these tops of these pillars

253
00:11:53,799 --> 00:11:50,699
are where stars are forming and to see

254
00:11:57,889 --> 00:11:53,809
that Hubble in 2015 also looked in

255
00:12:00,739 --> 00:11:57,899
infrared and in the near infrared Hubble

256
00:12:03,710 --> 00:12:00,749
can see that that leftmost pillar is not

257
00:12:07,189 --> 00:12:03,720
solid it's actually just the shadow of

258
00:12:10,460 --> 00:12:07,199
that dense region created by the

259
00:12:13,519 --> 00:12:10,470
streaming of the radiation from the

260
00:12:15,079 --> 00:12:13,529
stars so the infrared is an example of

261
00:12:17,749 --> 00:12:15,089
what James Webb will be able to produce

262
00:12:20,900 --> 00:12:17,759
can select a seat through some of this

263
00:12:25,460 --> 00:12:20,910

gas and see more detail in these nebulae

264
00:12:27,379 --> 00:12:25,470
on the scale of galaxies well again I

265
00:12:30,009 --> 00:12:27,389
chose my favorite thought Whirlpool

266
00:12:32,809 --> 00:12:30,019
Galaxy is just absolutely gorgeous

267
00:12:35,659 --> 00:12:32,819
spiral structure it's a grand design

268
00:12:38,150 --> 00:12:35,669
spiral and Hubble sees amazing detail

269
00:12:41,329 --> 00:12:38,160
along the spiral arms of all those pink

270
00:12:43,369 --> 00:12:41,339
star forming regions but I gotta say we

271
00:12:45,559 --> 00:12:43,379
also learn a tremendous amount from

272
00:12:47,749 --> 00:12:45,569
galaxies that don't have this beautiful

273
00:12:50,509 --> 00:12:47,759
structure galaxies whose structure has

274
00:12:52,220 --> 00:12:50,519
actually been distorted and on the left

275
00:12:54,739 --> 00:12:52,230
you see a ground-based image of two

276
00:12:56,509 --> 00:12:54,749
galaxies called the antennae and they

277
00:12:59,329 --> 00:12:56,519
have gravitationally interacted and

278
00:13:01,639 --> 00:12:59,339
stretched themselves out to form these

279
00:13:03,919 --> 00:13:01,649
big long tidal tails that give it its

280
00:13:06,979 --> 00:13:03,929
nickname but on the right you see

281
00:13:09,590 --> 00:13:06,989
Hubble's close-up view of the collegian

282
00:13:12,470 --> 00:13:09,600
where the galaxies are colliding and the

283
00:13:15,369 --> 00:13:12,480
gas clouds collapse and you produce this

284
00:13:17,800 --> 00:13:15,379
tremendous burst of star formation

285
00:13:20,470 --> 00:13:17,810
astronomers have discovered soup

286
00:13:23,110 --> 00:13:20,480
star clusters with tens of thousands of

287
00:13:27,190 --> 00:13:23,120
really really bright stars in these

288
00:13:29,590 --> 00:13:27,200

galaxies collisions going to the largest

289
00:13:32,530 --> 00:13:29,600
scales well we've got to talk about

290
00:13:34,930 --> 00:13:32,540
Hubble's deep field observations these

291
00:13:37,510 --> 00:13:34,940
started in 1995 with the original Deep

292
00:13:39,640 --> 00:13:37,520
Field and I'm showing here the

293
00:13:42,880 --> 00:13:39,650
observation of the Hubble Ultra Deep

294
00:13:46,150 --> 00:13:42,890
Field where we can find thousands of

295
00:13:48,640 --> 00:13:46,160
galaxies in a single Hubble image by

296
00:13:51,250 --> 00:13:48,650
looking for very very very long times

297
00:13:54,519 --> 00:13:51,260
this image is cumulative exposure of

298
00:13:56,890 --> 00:13:54,529
about 11 days of observing time and we

299
00:13:59,170 --> 00:13:56,900
see galaxies all the way that are very

300
00:14:02,350 --> 00:13:59,180
faint but they're also stretched out

301
00:14:05,410 --> 00:14:02,360
across space and now the really cool

302
00:14:08,860 --> 00:14:05,420
thing about this is that looking out

303
00:14:12,670 --> 00:14:08,870
into space is also looking back into

304
00:14:15,579 --> 00:14:12,680
time because if a galaxy is 10 billion

305
00:14:19,150 --> 00:14:15,589
light-years away its light takes 10

306
00:14:23,170 --> 00:14:19,160
billion years to travel to us so we see

307
00:14:28,000 --> 00:14:23,180
that galaxy as it was 10 billion years

308
00:14:30,670 --> 00:14:28,010
ago we can look out into space back into

309
00:14:34,240 --> 00:14:30,680
time and trace the development of

310
00:14:36,030 --> 00:14:34,250
galaxies each of these ovals represents

311
00:14:38,860 --> 00:14:36,040
galaxies at a different distance and

312
00:14:40,960 --> 00:14:38,870
therefore at a different time in the

313
00:14:44,380 --> 00:14:40,970

universe and you can see how their color

314
00:14:50,980 --> 00:14:44,390
their size and their morphology changes

315
00:14:53,410 --> 00:14:50,990
as the universe grows up so Hubble has

316
00:14:55,930 --> 00:14:53,420
had an a tremendous number of

317
00:14:59,829 --> 00:14:55,940
observations a tremendous number of

318
00:15:01,600 --> 00:14:59,839
discoveries over its 30 years this

319
00:15:04,660 --> 00:15:01,610
produces a problem for those of us in

320
00:15:08,199 --> 00:15:04,670
the office of public outreach basically

321
00:15:10,960 --> 00:15:08,209
how are we gonna top that what are we

322
00:15:13,860 --> 00:15:10,970
gonna do for Hubble's 30th anniversary

323
00:15:17,740 --> 00:15:13,870
image that's gonna compete with all that

324
00:15:20,380 --> 00:15:17,750
now it's quite a project but I think

325
00:15:23,910 --> 00:15:20,390
that they have really outdone themselves

326
00:15:26,230 --> 00:15:23,920
this time so let me start out by

327
00:15:28,930 --> 00:15:26,240
orienting you where on the sky this

328
00:15:31,540 --> 00:15:28,940
object is on the right you can see the

329
00:15:33,759 --> 00:15:31,550
constellation of Orion

330
00:15:37,630 --> 00:15:33,769
and we're not going there and across the

331
00:15:39,970 --> 00:15:37,640
top you can see the the the plane of our

332
00:15:41,040 --> 00:15:39,980
galaxy the Milky Way we're not going

333
00:15:45,070 --> 00:15:41,050
there either

334
00:15:48,340 --> 00:15:45,080
instead we're going to a satellite

335
00:15:50,710 --> 00:15:48,350
galaxy called the Large Magellanic Cloud

336
00:15:52,750 --> 00:15:50,720
this is a galaxy that orbits around the

337
00:15:54,730 --> 00:15:52,760
Milky Way and one of its most

338
00:15:58,540 --> 00:15:54,740

distinctive features is this bright blue

339
00:16:00,699 --> 00:15:58,550
region called the tarantula nebula we're

340
00:16:02,740 --> 00:16:00,709
not going there either we're going to

341
00:16:05,949 --> 00:16:02,750
this swath of star forming regions up

342
00:16:08,050 --> 00:16:05,959
above it and we're zooming in to two

343
00:16:12,639 --> 00:16:08,060
nebula one called

344
00:16:20,440 --> 00:16:12,649
NGC 2014 that's in red and one called

345
00:16:23,500 --> 00:16:20,450
NGC 2020 that is in blue so here is the

346
00:16:24,180 --> 00:16:23,510
region of the whoops that's not supposed

347
00:16:29,110 --> 00:16:24,190
to happen

348
00:16:33,759 --> 00:16:29,120
there we go here is the region of NGC

349
00:16:36,880 --> 00:16:33,769
2014 and NGC 2020 that Hubble looked at

350
00:16:41,010 --> 00:16:36,890
this is the ground-based Survey

351
00:16:48,060 --> 00:16:41,020
telescope view and this you ready for it

352
00:16:56,110 --> 00:16:53,069
isn't that amazing is it that just so

353
00:16:59,079 --> 00:16:56,120
beautiful I mean get your booze and your

354
00:17:01,930 --> 00:16:59,089
oz out there this is an amazing image

355
00:17:02,740 --> 00:17:01,940
and you guys aren't even seeing the half

356
00:17:04,929 --> 00:17:02,750
of it okay

357
00:17:09,189 --> 00:17:04,939
let me go to the full scale image

358
00:17:12,730 --> 00:17:09,199
alright and this image is 200 million

359
00:17:16,720 --> 00:17:12,740
pixels of Hubble goodness all right it's

360
00:17:20,620 --> 00:17:16,730
just it's just somebody was on the

361
00:17:23,939 --> 00:17:20,630
internet going a ykm and I was like what

362
00:17:27,159 --> 00:17:23,949
the heck's that and it's like are you

363
00:17:29,020 --> 00:17:27,169

okay so there has been fantastic

364
00:17:32,080 --> 00:17:29,030
responses to this today on the internet

365
00:17:34,360 --> 00:17:32,090
and our initial response was that it

366
00:17:36,130 --> 00:17:34,370
sort of looked like it was underwater

367
00:17:37,720 --> 00:17:36,140
because you can see on the right side

368
00:17:41,260 --> 00:17:37,730
this sort of thing that resembles coral

369
00:17:42,400 --> 00:17:41,270
reef and the blue thing down there that

370
00:17:44,799 --> 00:17:42,410
could be sort of like a jellyfish

371
00:17:45,500 --> 00:17:44,809
dancing around on the coral reef and so

372
00:17:48,620 --> 00:17:45,510
we

373
00:17:51,070 --> 00:17:48,630
named it the cosmic reef and that you

374
00:17:54,200 --> 00:17:51,080
knows it might represent an underwater

375
00:17:56,510 --> 00:17:54,210
underwater scene in the universe of

376
00:17:58,820 --> 00:17:56,520
course it's not an underwater scene in

377
00:18:01,610 --> 00:17:58,830
the universe and here to tell us what it

378
00:18:04,640 --> 00:18:01,620
really is is dr. Ellen asabi

379
00:18:07,100 --> 00:18:04,650
I don't know please take over thank you

380
00:18:10,070 --> 00:18:07,110
that would be a great way to celebrate

381
00:18:13,730 --> 00:18:10,080
30 years of Hubble operation what you're

382
00:18:15,950 --> 00:18:13,740
seeing here is a huge cloud of gas and

383
00:18:20,840 --> 00:18:15,960
dust that are surrounding the Stefani

384
00:18:24,710 --> 00:18:20,850
region and JC 2014 this image is huge

385
00:18:28,160 --> 00:18:24,720
the cloud of gas is about 400

386
00:18:30,800 --> 00:18:28,170
light-years in diameter almost 20 26

387
00:18:33,830 --> 00:18:30,810
million times the distance of the earth

388
00:18:37,070 --> 00:18:33,840

to the Sun and in this region we have

389
00:18:39,380 --> 00:18:37,080
hundreds of stars 10 to 20 times more

390
00:18:41,810 --> 00:18:39,390
massive than our Sun that has releasing

391
00:18:46,550 --> 00:18:41,820
a huge amount of energy in the forms of

392
00:18:48,530 --> 00:18:46,560
light and heat this star shine as bright

393
00:18:50,810 --> 00:18:48,540
blue spot in the image and most of them

394
00:18:55,310 --> 00:18:50,820
are actually hidden to our eyes by this

395
00:18:59,240 --> 00:18:55,320
thick wall of gas and gas that you can

396
00:19:01,190 --> 00:18:59,250
see in the science shades look at how

397
00:19:04,010 --> 00:19:01,200
spectacular is the Hubble image there

398
00:19:06,740 --> 00:19:04,020
are all these layers and ripples these

399
00:19:09,290 --> 00:19:06,750
are all created by the radiation of the

400
00:19:12,620 --> 00:19:09,300
Sun that is blowing the way the gas that

401
00:19:15,320 --> 00:19:12,630
they used before to form all these

402
00:19:20,630 --> 00:19:15,330
cavities are really created by the power

403
00:19:23,150 --> 00:19:20,640
of the stars and you can look in the

404
00:19:25,280 --> 00:19:23,160
detail at this large bubble inside of

405
00:19:27,830 --> 00:19:25,290
the image here you can see that around

406
00:19:30,230 --> 00:19:27,840
some of the stars there are a ring of

407
00:19:32,960 --> 00:19:30,240
dots this is just a smaller scale of

408
00:19:34,490 --> 00:19:32,970
what you saw in the lower corner before

409
00:19:36,350 --> 00:19:34,500
these are the stars that are just

410
00:19:40,640 --> 00:19:36,360
getting rid of all the material they

411
00:19:42,980 --> 00:19:40,650
were using to form before and this image

412
00:19:45,380 --> 00:19:42,990
is incredibly powerful in showing how

413
00:19:47,780 --> 00:19:45,390

harsh the first few million years in the

414
00:19:50,750 --> 00:19:47,790
life of a star can be so in the lower

415
00:19:53,600 --> 00:19:50,760
left corner you have NGC 2020 this is a

416
00:19:56,420 --> 00:19:53,610
star that at birth was 50 times more

417
00:19:58,310 --> 00:19:56,430
massive than our Sun and it formed with

418
00:20:01,040 --> 00:19:58,320
the other stars in the center of the big

419
00:20:03,800 --> 00:20:01,050
cloud of gas but at a certain point it

420
00:20:06,320 --> 00:20:03,810
went through a very strong collision and

421
00:20:10,100 --> 00:20:06,330
so it was kicked out of the moduli of

422
00:20:13,640 --> 00:20:10,110
the of NGC 2014 I had 240 light-years

423
00:20:15,820 --> 00:20:13,650
away and now it is zooming through the

424
00:20:19,690 --> 00:20:15,830
Magellanic Clouds at a speed between

425
00:20:23,630 --> 00:20:19,700
27,000 and 46,000 miles per hour

426
00:20:28,010 --> 00:20:23,640
now NGC 2020 is approaching it's there

427
00:20:31,130 --> 00:20:28,020
and it does this through a sequence of

428
00:20:33,680 --> 00:20:31,140
pulses that are expelling the outer

429
00:20:37,340 --> 00:20:33,690
layer so what you see in the blue ring

430
00:20:39,110 --> 00:20:37,350
around the stars are the external layers

431
00:20:42,320 --> 00:20:39,120
the surface of the stars that have been

432
00:20:44,570 --> 00:20:42,330
ejected about 1/2 million years ago and

433
00:20:47,420 --> 00:20:44,580
then the star had the second pulses

434
00:20:49,730 --> 00:20:47,430
about 250,000 years ago and it will

435
00:20:53,150 --> 00:20:49,740
continue doing this until it will

436
00:20:55,700 --> 00:20:53,160
explode as a supernova but if some of

437
00:20:59,540 --> 00:20:55,710
these stars are are already dying in NGC

438
00:20:59,990 --> 00:20:59,550

2014 many are emerging only now from the

439
00:21:02,210 --> 00:21:00,000
crebbil

440
00:21:04,730 --> 00:21:02,220
and you can see them at the top of this

441
00:21:07,160 --> 00:21:04,740
huge pillar of dust and gas in the

442
00:21:09,560 --> 00:21:07,170
center of the image these are similar to

443
00:21:12,850 --> 00:21:09,570
the pillar of creation that Frank was

444
00:21:15,470 --> 00:21:12,860
talking about before and then if you go

445
00:21:17,960 --> 00:21:15,480
outside the cloud you can see that there

446
00:21:19,180 --> 00:21:17,970
are several right red and orange

447
00:21:22,460 --> 00:21:19,190
Global's

448
00:21:25,400 --> 00:21:22,470
these are stellar nursery we're stuck

449
00:21:27,770 --> 00:21:25,410
nurseries where stars more massive than

450
00:21:29,480 --> 00:21:27,780
our Sun 10 20 maybe even 30 times more

451
00:21:31,360 --> 00:21:29,490
massive than our Sun I'm forming around

452
00:21:34,250 --> 00:21:31,370
now and they

453
00:21:35,780 --> 00:21:34,260
injecting energy in the environment and

454
00:21:38,960 --> 00:21:35,790
so they are puffing up the stellar

455
00:21:41,060 --> 00:21:38,970
nursery and it starts to shine and in

456
00:21:43,820 --> 00:21:41,070
about half a million years we will be

457
00:21:46,640 --> 00:21:43,830
able to finally see them so go to the

458
00:21:49,310 --> 00:21:46,650
hub website of order website and see

459
00:21:56,690 --> 00:21:49,320
with your eyes out spectacular is the

460
00:22:04,160 --> 00:22:00,850
it says I'm muta grant and I commuted

461
00:22:05,120 --> 00:22:04,170
okay you can hear me now thank you that

462
00:22:07,190 --> 00:22:05,130
was fantastic

463
00:22:08,960 --> 00:22:07,200

Ilona and I have a whole bunch of

464
00:22:11,180 --> 00:22:08,970
questions for you and I'm sure our

465
00:22:13,430 --> 00:22:11,190
audience does too so if you have

466
00:22:15,620 --> 00:22:13,440
questions for Elinor or for me please

467
00:22:17,710 --> 00:22:15,630
type them into the chat and we will get

468
00:22:21,410 --> 00:22:17,720
to them at the end of the presentation

469
00:22:23,810 --> 00:22:21,420
now let's do the Big Finish let's take

470
00:22:25,370 --> 00:22:23,820
this in to a whole new dimension let's

471
00:22:27,620 --> 00:22:25,380
actually take it into the third

472
00:22:30,710 --> 00:22:27,630
dimension and to do that we're actually

473
00:22:32,930 --> 00:22:30,720
gonna flip the image upside down simply

474
00:22:34,700 --> 00:22:32,940
because alright to be honest with you

475
00:22:36,410 --> 00:22:34,710
the camera path through the

476
00:22:38,299 --> 00:22:36,420
three-dimensional visualization works

477
00:22:40,180 --> 00:22:38,309
better from this orientation you'll see

478
00:22:44,060 --> 00:22:40,190
you'll see it's a fantastic camera path

479
00:22:47,210 --> 00:22:44,070
so what our team did at Space Telescope

480
00:22:49,400 --> 00:22:47,220
is we took this image and we analyzed it

481
00:22:52,400 --> 00:22:49,410
with Ella's help into the

482
00:22:54,440 --> 00:22:52,410
three-dimensional structure of NGC 2014

483
00:22:57,590 --> 00:22:54,450
and the three-dimensional structure of

484
00:23:00,770 --> 00:22:57,600
20/20 and we separated out into layers

485
00:23:03,680 --> 00:23:00,780
in 3d modeling software and then fly you

486
00:23:05,450 --> 00:23:03,690
through it now I can't really describe

487
00:23:08,090 --> 00:23:05,460
this with all my hand waving and

488
00:23:10,760 --> 00:23:08,100

everything but I can show it to you so

489
00:23:12,560 --> 00:23:10,770
here is what we call our model build

490
00:23:14,750 --> 00:23:12,570
sequence and we're gonna start with

491
00:23:17,750 --> 00:23:14,760
those star forming regions very back and

492
00:23:20,870 --> 00:23:17,760
then start building up the layers of NGC

493
00:23:23,120 --> 00:23:20,880
2040 and you can see there are a lot of

494
00:23:26,000 --> 00:23:23,130
layers a variant of this reflect this

495
00:23:28,669 --> 00:23:26,010
very complex structure in the center of

496
00:23:30,200 --> 00:23:28,679
this star forming region then we start

497
00:23:32,450 --> 00:23:30,210
building the right side where you've got

498
00:23:34,870 --> 00:23:32,460
these tendrils of gas flowing and then

499
00:23:37,640 --> 00:23:34,880
the left side where you've got that

500
00:23:41,570 --> 00:23:37,650
bubble and coral reef like structure and

501
00:23:43,940 --> 00:23:41,580
we fill out the full 2014 then we add in

502
00:23:46,070 --> 00:23:43,950
NGC 2020 and the

503
00:23:49,100 --> 00:23:46,080
hours of the cluster and finally the

504
00:23:50,330 --> 00:23:49,110
stars across the whole image and so now

505
00:23:52,279 --> 00:23:50,340
you're seeing what you're seeing

506
00:23:56,509 --> 00:23:52,289
looks like the Hubble image but it's

507
00:23:58,960 --> 00:23:56,519
actually a 3d model and now let's take

508
00:24:17,720 --> 00:23:58,970
you on a flight through that model

509
00:24:32,000 --> 00:24:23,600
[Music]

510
00:24:59,870 --> 00:24:32,010
[Laughter]

511
00:25:03,600 --> 00:24:59,880
[Music]

512
00:25:06,690 --> 00:25:03,610
what did I tell you is that fantastic or

513
00:25:09,510 --> 00:25:06,700

what I mean and I love this ending

514
00:25:13,320 --> 00:25:09,520
position because here you really get to

515
00:25:14,790 --> 00:25:13,330
see the structure of NGC 2020 that Wolf

516
00:25:18,540 --> 00:25:14,800
Ray a star in the center has been

517
00:25:20,250 --> 00:25:18,550
ejecting material out into space and you

518
00:25:22,980 --> 00:25:20,260
can see that it's actually injecting it

519
00:25:25,080 --> 00:25:22,990
along a double lobe structure if we go

520
00:25:28,470 --> 00:25:25,090
back to the Hubble image you're looking

521
00:25:31,560 --> 00:25:28,480
down the axis of that emission and it

522
00:25:34,170 --> 00:25:31,570
looks relatively circular instead we get

523
00:25:36,930 --> 00:25:34,180
to show you in the 3d visualization the

524
00:25:38,940 --> 00:25:36,940
correct double lobe structure and give

525
00:25:42,930 --> 00:25:38,950
you a proper mental model to imagine

526
00:25:45,870 --> 00:25:42,940
this now if you would like to get access

527
00:25:48,600 --> 00:25:45,880
to all these images and visualizations

528
00:25:51,030 --> 00:25:48,610
and much much more for Hubble's 30th

529
00:25:55,620 --> 00:25:51,040
anniversary go to our website

530
00:25:58,680 --> 00:25:55,630
Hubble site dot o-r-g okay so I'm gonna

531
00:26:01,530 --> 00:25:58,690
leave you with one final thing this I

532
00:26:03,990 --> 00:26:01,540
gotta say is my favorite picture of

533
00:26:07,260 --> 00:26:04,000
Hubble it was taken by the space shuttle

534
00:26:10,230 --> 00:26:07,270
astronauts after they put Hubble back

535
00:26:14,250 --> 00:26:10,240
out into space ready to do more science

536
00:26:16,350 --> 00:26:14,260
and there it is it's it's hopeful Hubble

537
00:26:19,410 --> 00:26:16,360
looking out into the universe and you

538
00:26:21,900 --> 00:26:19,420

imagine what is it looking at what

539
00:26:24,570 --> 00:26:21,910
amazing images are gonna get what

540
00:26:28,770 --> 00:26:24,580
amazing discovery is it going to make

541
00:26:32,250 --> 00:26:28,780
and this is how I like to view the

542
00:26:35,190 --> 00:26:32,260
universe the joy and wonder of science

543
00:26:37,070 --> 00:26:35,200
discovery that we get to do here at the

544
00:26:41,310 --> 00:26:37,080
Space Telescope Science Institute and

545
00:26:43,350 --> 00:26:41,320
Hubble is our vehicle and it is

546
00:26:45,990 --> 00:26:43,360
something that we've grown very fond of

547
00:26:48,960 --> 00:26:46,000
over the last three decades it has

548
00:26:51,450 --> 00:26:48,970
produced amazing images and wonderful

549
00:26:53,940 --> 00:26:51,460
science discoveries and I hope you hold

550
00:26:56,670 --> 00:26:53,950
it as dear in your hearts as we do in

551
00:26:59,350 --> 00:26:56,680
ours thank you for your attention here

552
00:27:05,950 --> 00:27:02,560
now I'm going to bring in our behind the

553
00:27:07,840 --> 00:27:05,960
scenes person grant justice and he's

554
00:27:10,150 --> 00:27:07,850
been monitoring the chat to see if you

555
00:27:13,090 --> 00:27:10,160
have any questions grant do we have any

556
00:27:15,520 --> 00:27:13,100
questions for our speakers here we do

557
00:27:17,560 --> 00:27:15,530
absolutely hello everyone thank you for

558
00:27:20,320 --> 00:27:17,570
joining us for this and I do want to

559
00:27:21,760 --> 00:27:20,330
take just a moment to say that this is a

560
00:27:23,440 --> 00:27:21,770
celebration of Hubble and the

561
00:27:25,450 --> 00:27:23,450
achievements of everyone but it's

562
00:27:27,370 --> 00:27:25,460
important to remember that without the

563
00:27:29,710 --> 00:27:27,380

audience without the people who are here

564
00:27:31,450 --> 00:27:29,720
watching and interested in us then we

565
00:27:33,880 --> 00:27:31,460
wouldn't be able to do anything we would

566
00:27:35,470 --> 00:27:33,890
we currently do so it's important to

567
00:27:37,120 --> 00:27:35,480
remind yourselves that everyone is a

568
00:27:40,630 --> 00:27:37,130
part of this and we thank you for your

569
00:27:43,270 --> 00:27:40,640
support for all of us so yes we have had

570
00:27:46,720 --> 00:27:43,280
a few questions in the audience and the

571
00:27:50,380 --> 00:27:46,730
first one that I picked out I think

572
00:27:54,960 --> 00:27:50,390
you'll like this one is why is NGC 2020

573
00:27:59,580 --> 00:27:54,970
so blue ellen:oh that's definitely yours

574
00:28:07,180 --> 00:28:03,190
it's a work for a oxygen-rich star it's

575
00:28:09,549 --> 00:28:07,190
a star that as I said before ejected

576
00:28:12,460 --> 00:28:09,559
master of his atmosphere and when it

577
00:28:15,970 --> 00:28:12,470
because is expelled it starts to emit

578
00:28:17,650 --> 00:28:15,980
light in the in the various components

579
00:28:19,270 --> 00:28:17,660
chemical components that you can find in

580
00:28:21,490 --> 00:28:19,280
atmosphere of the star so this start is

581
00:28:24,940 --> 00:28:21,500
particularly rich in oxygen and it has

582
00:28:27,190 --> 00:28:24,950
very strong light it's very strong

583
00:28:30,090 --> 00:28:27,200
emission line and one of these emission

584
00:28:34,840 --> 00:28:30,100
line the oxygen sticks very high energy

585
00:28:39,250 --> 00:28:34,850
line it's folding by coincidence within

586
00:28:40,930 --> 00:28:39,260
the within the space that you can see in

587
00:28:45,220 --> 00:28:40,940
the filter that we chose for the blue

588
00:28:46,930 --> 00:28:45,230

light in this image Frank would you put

589
00:28:48,820 --> 00:28:46,940
back up the image so that we can look at

590
00:28:52,450 --> 00:28:48,830
it while we're discussing it sounds good

591
00:28:55,169 --> 00:28:52,460
let's go there this is the inverted

592
00:28:59,200 --> 00:28:55,179
version but it's still the same pixels

593
00:29:02,169 --> 00:28:59,210
okay continually now I'm sorry right so

594
00:29:06,430 --> 00:29:02,179
basically one trick that we we do to

595
00:29:08,710 --> 00:29:06,440
understand where the values the chemical

596
00:29:11,140 --> 00:29:08,720
element or the various component of a

597
00:29:13,090 --> 00:29:11,150
very during space are we tend to slide

598
00:29:15,549 --> 00:29:13,100
there to slice the light

599
00:29:18,760 --> 00:29:15,559
come from these images using filters

600
00:29:20,740 --> 00:29:18,770
that they only letting a little fraction

601
00:29:22,360 --> 00:29:20,750
of the light coming through seeing as to

602
00:29:23,320 --> 00:29:22,370
what happened when you put sunglasses

603
00:29:26,020 --> 00:29:23,330
and all of the time

604
00:29:27,850 --> 00:29:26,030
all of the sudden the world changed

605
00:29:29,529 --> 00:29:27,860
colors you are blessing only a small

606
00:29:31,659 --> 00:29:29,539
fraction of light coming through your

607
00:29:35,440 --> 00:29:31,669
your eyes and this is what we do with

608
00:29:37,870 --> 00:29:35,450
Hubble we let only oxygen coming out and

609
00:29:40,330 --> 00:29:37,880
we see where oxygen in and then he's and

610
00:29:42,370 --> 00:29:40,340
then we use another filter that lets

611
00:29:44,830 --> 00:29:42,380
only hydrogen coming through and that is

612
00:29:48,820 --> 00:29:44,840
why we can see the beautiful red cloud

613
00:29:50,820 --> 00:29:48,830

around the star forming region okay

614
00:29:55,960 --> 00:29:50,830
thank you grant we have another question

615
00:29:58,180 --> 00:29:55,970
we do we absolutely do so the next one

616
00:29:59,470 --> 00:29:58,190
is one of my favorites this came

617
00:30:00,789 --> 00:29:59,480
directly from the comment because we

618
00:30:03,789 --> 00:30:00,799
talk about this all the time

619
00:30:08,649 --> 00:30:03,799
well Hubble work with James Webb and

620
00:30:10,510 --> 00:30:08,659
what is the future for Hubble I think

621
00:30:13,180 --> 00:30:10,520
did we see this question this one's a

622
00:30:15,340 --> 00:30:13,190
perfect question I so yes as I talked

623
00:30:19,990 --> 00:30:15,350
about Hubble is part of a team of great

624
00:30:23,140 --> 00:30:20,000
observatories and we absolutely want

625
00:30:25,390 --> 00:30:23,150
Hubble and Webb to be observing the same

626
00:30:28,539 --> 00:30:25,400
objects at the same time to get these

627
00:30:31,779 --> 00:30:28,549
different views to learn more science

628
00:30:34,740 --> 00:30:31,789
that is one of our one of the crucial

629
00:30:36,970 --> 00:30:34,750
things that will happen because

630
00:30:38,710 --> 00:30:36,980
extending the wavelength region over

631
00:30:41,799 --> 00:30:38,720
which you look at something really does

632
00:30:43,840 --> 00:30:41,809
give you a lot more information and so

633
00:30:46,149 --> 00:30:43,850
the future for Hubble is actually a

634
00:30:48,370 --> 00:30:46,159
little unknown Hubble is operating

635
00:30:49,870 --> 00:30:48,380
really well and that's kind of

636
00:30:52,690 --> 00:30:49,880
surprising because the last servicing

637
00:30:54,880 --> 00:30:52,700
mission was back in 2009 and the space

638
00:30:56,799 --> 00:30:54,890

shuttle program is not no longer

639
00:30:57,850 --> 00:30:56,809
operating so we can't go back up and

640
00:31:01,690 --> 00:30:57,860
service it anymore

641
00:31:04,419 --> 00:31:01,700
so but the folks at Space Telescope have

642
00:31:06,909 --> 00:31:04,429
30 years of experience of operating this

643
00:31:08,620 --> 00:31:06,919
telescope and they have learned all its

644
00:31:11,200 --> 00:31:08,630
quirks and behaviors and they know how

645
00:31:13,899 --> 00:31:11,210
to repair things just by software fixes

646
00:31:16,330 --> 00:31:13,909
so the hair doing a fantastic job of

647
00:31:18,159 --> 00:31:16,340
keeping it in tip-top shape now

648
00:31:21,460 --> 00:31:18,169
eventually the gyroscopes will fail

649
00:31:23,110 --> 00:31:21,470
eventually the batteries may run out I

650
00:31:26,590 --> 00:31:23,120
think the gyroscopes are the most likely

651
00:31:28,630 --> 00:31:26,600
thing but right now the future is

652
00:31:30,970 --> 00:31:28,640
looking good and we're hoping for

653
00:31:32,260 --> 00:31:30,980
another five years who knows maybe we

654
00:31:35,560 --> 00:31:32,270
can speculate that we'll get another 10

655
00:31:37,630 --> 00:31:35,570
years out of bobble so it's it's got a

656
00:31:43,330 --> 00:31:37,640
bright it still has a bright future even

657
00:31:46,539 --> 00:31:43,340
after 30 years alright and the next one

658
00:31:49,090 --> 00:31:46,549
that I have is how many stars are in

659
00:32:02,830 --> 00:31:49,100
this nebula your take give or take of

660
00:32:05,140 --> 00:32:02,840
course much smaller than our Sun and let

661
00:32:07,899 --> 00:32:05,150
me just add to that because we are

662
00:32:10,330 --> 00:32:07,909
looking at an object that is in a

663
00:32:11,980 --> 00:32:10,340

different galaxy and as we look at that

664
00:32:14,590 --> 00:32:11,990
we have to look out through our own

665
00:32:16,750 --> 00:32:14,600
galaxy to that other galaxy and usually

666
00:32:18,310 --> 00:32:16,760
in a lot of Hubble images we have a lot

667
00:32:20,470 --> 00:32:18,320
of foreground stars that are in our own

668
00:32:21,970 --> 00:32:20,480
galaxy and that are extremely bright and

669
00:32:24,490 --> 00:32:21,980
actually can get in the way of looking

670
00:32:27,490 --> 00:32:24,500
at distant things but this is at what we

671
00:32:28,990 --> 00:32:27,500
call a high Galactic latitude so one of

672
00:32:31,690 --> 00:32:29,000
the cool things about this image is that

673
00:32:34,659 --> 00:32:31,700
there aren't too many of the Milky Way

674
00:32:36,279 --> 00:32:34,669
stars in the way getting in the way of

675
00:32:38,590 --> 00:32:36,289
what we're seeing almost all the stars

676
00:32:40,630 --> 00:32:38,600
that we see in this image are inside the

677
00:32:42,820 --> 00:32:40,640
Large Magellanic Cloud and that was a

678
00:32:45,070 --> 00:32:42,830
cool feature that Ellen and I discussed

679
00:32:49,390 --> 00:32:45,080
Oh months ago when we first started

680
00:32:51,010 --> 00:32:49,400
looking at this object it was great all

681
00:32:51,909 --> 00:32:51,020
right and I think I'll have one more

682
00:32:54,700 --> 00:32:51,919
question

683
00:32:57,909 --> 00:32:54,710
goodness about our time we've done our

684
00:32:59,500 --> 00:32:57,919
half-hour yeah so obviously this is a

685
00:33:01,270 --> 00:32:59,510
beautiful image and I've seen a couple

686
00:33:02,289 --> 00:33:01,280
things come through the comments and

687
00:33:04,419 --> 00:33:02,299
whatnot

688
00:33:07,450 --> 00:33:04,429

there is a huge chucks position between

689
00:33:10,450 --> 00:33:07,460
the coloring of this image how does

690
00:33:15,039 --> 00:33:10,460
Hubble detect that color and what does

691
00:33:18,010 --> 00:33:15,049
it mean so Hubble when you look at the

692
00:33:21,640 --> 00:33:18,020
Hubble image it black and white so what

693
00:33:24,130 --> 00:33:21,650
we do to be able to understand where the

694
00:33:26,470 --> 00:33:24,140
various colors are is to use filters as

695
00:33:31,180 --> 00:33:26,480
I said before and to slice the light in

696
00:33:33,340 --> 00:33:31,190
pieces and then we use incredible

697
00:33:35,860 --> 00:33:33,350
artists here at Space Telescope to allow

698
00:33:38,289 --> 00:33:35,870
us to tune the advances of the images

699
00:33:40,390 --> 00:33:38,299
but the colors in this image are quite

700
00:33:44,350 --> 00:33:40,400
close to how

701
00:33:46,720 --> 00:33:44,360
image looking real life yeah let me

702
00:33:48,730 --> 00:33:46,730
emphasize that the every photon that

703
00:33:53,290 --> 00:33:48,740
you're seeing here is real it came from

704
00:33:55,540 --> 00:33:53,300
Hubble and to get the Stars they had to

705
00:33:57,100 --> 00:33:55,550
use some broadband filters in addition

706
00:33:59,980 --> 00:33:57,110
to the narrow band filters that Ellen I

707
00:34:02,500 --> 00:33:59,990
talked about and to get that sorry and

708
00:34:05,230 --> 00:34:02,510
the color balancing is what the artists

709
00:34:06,850 --> 00:34:05,240
really do because you have what four

710
00:34:09,850 --> 00:34:06,860
different four or five different filters

711
00:34:11,620 --> 00:34:09,860
on this image and to bring out the

712
00:34:13,810 --> 00:34:11,630
colors that the astronomers know is

713
00:34:15,760 --> 00:34:13,820

there from these five separate

714
00:34:17,530 --> 00:34:15,770
black-and-white images each taken in

715
00:34:20,260 --> 00:34:17,540
different filters and you apply the

716
00:34:22,149 --> 00:34:20,270
color to each filter according to what

717
00:34:23,980 --> 00:34:22,159
rather you know I read to the red filter

718
00:34:27,220 --> 00:34:23,990
or apply blue to the blue filter and so

719
00:34:29,530 --> 00:34:27,230
on but they did an awful lot of work on

720
00:34:31,810 --> 00:34:29,540
this with a you know two hundred million

721
00:34:36,399 --> 00:34:31,820
pixel image that said thanks that takes

722
00:34:39,399 --> 00:34:36,409
a lot of time all right that's all we

723
00:34:42,190 --> 00:34:39,409
have time for speaking of time thank you

724
00:34:44,649 --> 00:34:42,200
so much for joining us we are incredibly

725
00:34:48,280 --> 00:34:44,659
proud to be able to present this 30th

726
00:34:51,130 --> 00:34:48,290
anniversary image to you please like and

727
00:34:54,120 --> 00:34:51,140
subscribe to our youtube channel go to

728
00:34:56,950 --> 00:34:54,130
hubble site o RG download the images

729
00:34:59,920 --> 00:34:56,960
download the visualizations watch the

730
00:35:03,340 --> 00:34:59,930
videos on youtube and just enjoy and

731
00:35:06,190 --> 00:35:03,350
keep on exploring your universe thank