PUBLIC LECTURE SERIES

Observing with Hubble: From Scientific Idea to Published Result (and Everything in Between!)

Featuring Guest Speaker:

Bill Blair

1
00:00:05,960 --> 00:00:03,050
out tonight's lithograph is the Hubble

2
00:00:08,480 --> 00:00:05,970
Space Telescope this is a picture from

3
00:00:10,070 --> 00:00:08,490
the last servicing mission it's actually

4
00:00:11,900 --> 00:00:10,080
one of the farewell pictures I look at

5
00:00:15,650 --> 00:00:11,910
this and I sort of get nostalgic because

6
00:00:18,410 --> 00:00:15,660
this is the last time humans visited

7
00:00:21,050 --> 00:00:18,420
Hubble okay this is one of the last

8
00:00:24,200 --> 00:00:21,060
photographs as they were leaving on the

9
00:00:27,529 --> 00:00:24,210
back is updated text newly updated for

10
00:00:29,210 --> 00:00:27,539
this year to include all of the new

11
00:00:31,189 --> 00:00:29,220
instruments and and mature an

12
00:00:33,380 --> 00:00:31,199
information about it the previous

13
00:00:35,299 --> 00:00:33,390

version we had of this lithograph had

14
00:00:38,920 --> 00:00:35,309
some old instruments on there that got

15
00:00:41,030 --> 00:00:38,930
actually got removed so we have new text

16
00:00:43,850 --> 00:00:41,040
with an old picture all right

17
00:00:46,090 --> 00:00:43,860
and please pick them up on your way out

18
00:00:48,830 --> 00:00:46,100
the reason we are doing that is because

19
00:00:50,540 --> 00:00:48,840
tonight we're talking about Hubble we're

20
00:00:52,670 --> 00:00:50,550
talking about observing with Hubble from

21
00:00:55,790 --> 00:00:52,680
scientific idea to published result and

22
00:00:57,560 --> 00:00:55,800
everything in between and bill says he's

23
00:01:03,080 --> 00:00:57,570
gonna do this in real time so we'll be

24
00:01:06,490 --> 00:01:03,090
here for about two and a half years up

25
00:01:08,960 --> 00:01:06,500
coming on December Mark kamionkowski

26
00:01:12,050 --> 00:01:08,970
from Johns Hopkins will be talking about

27
00:01:14,420 --> 00:01:12,060
black holes and other dark matters I

28
00:01:16,039 --> 00:01:14,430
don't know if that's his actual title

29
00:01:17,810 --> 00:01:16,049
because he said oh I'll give this talk

30
00:01:19,719 --> 00:01:17,820
and I said well what we call it this and

31
00:01:23,510 --> 00:01:19,729
he said okay sure

32
00:01:24,920 --> 00:01:23,520
he may change his title before then but

33
00:01:26,600 --> 00:01:24,930
because that's the title I gave it to

34
00:01:29,630 --> 00:01:26,610
him but he seemed to like it

35
00:01:31,999 --> 00:01:29,640
in January we are not doing the first

36
00:01:34,580 --> 00:01:32,009
Tuesday we are not doing the second

37
00:01:35,030 --> 00:01:34,590
Tuesday we're doing the third Tuesday

38
00:01:37,219 --> 00:01:35,040

okay

39
00:01:38,420 --> 00:01:37,229
the first Tuesday is January 1st New

40
00:01:41,240 --> 00:01:38,430
Year's Day we're not going to do that

41
00:01:43,190 --> 00:01:41,250
the second Tuesday is during the

42
00:01:45,469 --> 00:01:43,200
American Astronomical Society meeting

43
00:01:48,080 --> 00:01:45,479
the January meeting is the biggest

44
00:01:50,030 --> 00:01:48,090
double a s meeting a strata meeting of

45
00:01:52,880 --> 00:01:50,040
the year a lot of people will be in

46
00:01:54,950 --> 00:01:52,890
Seattle including myself for that

47
00:01:57,980 --> 00:01:54,960
meeting so we're going to push back to

48
00:01:59,450 --> 00:01:57,990
January 15th for initial exoplanet

49
00:02:01,450 --> 00:01:59,460
discoveries with two guests the

50
00:02:03,889 --> 00:02:01,460
transiting exoplanet survey satellite

51
00:02:05,749 --> 00:02:03,899
this is one you don't want to miss okay

52
00:02:08,570 --> 00:02:05,759
because this is a brand new satellite

53
00:02:10,550 --> 00:02:08,580
brand new results from it and guess what

54
00:02:12,170 --> 00:02:10,560
there's gonna be a lot of discussion of

55
00:02:13,250 --> 00:02:12,180
this at the double-a s so they'll he'll

56
00:02:15,800 --> 00:02:13,260
be a lot of new content

57
00:02:17,330 --> 00:02:15,810
that he can discuss during this talk

58
00:02:20,149 --> 00:02:17,340
that he couldn't discuss if we held it

59
00:02:22,009 --> 00:02:20,159
before the double AAS okay so Scott

60
00:02:25,580 --> 00:02:22,019
Fleming will discuss that in January and

61
00:02:28,630 --> 00:02:25,590
in February a mi Amoro Martin we'll be

62
00:02:31,479 --> 00:02:28,640
talking about your place in the Stars

63
00:02:34,399 --> 00:02:31,489

okay if you would like more information

64
00:02:36,589 --> 00:02:34,409
you can go to our website use your

65
00:02:38,509 --> 00:02:36,599
favorite search engine for Hubble public

66
00:02:40,819 --> 00:02:38,519
lecture series or space telescope public

67
00:02:42,949 --> 00:02:40,829
lectures you'll find this webpage where

68
00:02:45,410 --> 00:02:42,959
we have the upcoming lectures listed

69
00:02:47,990 --> 00:02:45,420
over here on the right we have links to

70
00:02:50,809 --> 00:02:48,000
our webcasting both on YouTube and the

71
00:02:54,140 --> 00:02:50,819
Space Telescope webcasting folks and you

72
00:02:58,640 --> 00:02:54,150
can see the archive back to 2014 on

73
00:03:01,819 --> 00:02:58,650
YouTube and back to 2005 in our

74
00:03:04,940 --> 00:03:01,829
wonderful webcasting sites you can also

75
00:03:08,210 --> 00:03:04,950
sign up for our email list and get a

76
00:03:09,860 --> 00:03:08,220
like to emails a month about what the

77
00:03:11,990 --> 00:03:09,870
upcoming lectures are going to be and

78
00:03:13,399 --> 00:03:12,000
when they are which will help remind you

79
00:03:14,899 --> 00:03:13,409
that it's gonna be the third Tuesday and

80
00:03:19,099 --> 00:03:14,909
not the first or second Tuesday in

81
00:03:20,839 --> 00:03:19,109
January so the announcements sign up to

82
00:03:23,420 --> 00:03:20,849
the website if you have questions

83
00:03:26,479 --> 00:03:23,430
there's email address public lecture at

84
00:03:28,250 --> 00:03:26,489
stsci edu you want to follow us on

85
00:03:30,949 --> 00:03:28,260
social media we've got Facebook and

86
00:03:33,140 --> 00:03:30,959
Twitter and YouTube and Instagram for

87
00:03:35,839 --> 00:03:33,150
Hubble for the Space Telescope Science

88
00:03:38,150 --> 00:03:35,849

Institute and for the Webb telescope as

89
00:03:41,300 --> 00:03:38,160
well I have a little bit that I do I

90
00:03:43,819 --> 00:03:41,310
don't do much unfortunately

91
00:03:45,770 --> 00:03:43,829
the clouds are out tonight and the

92
00:03:48,920 --> 00:03:45,780
Maryland Space Grant Observatory will

93
00:03:50,809 --> 00:03:48,930
not be operating they do have open

94
00:03:52,220 --> 00:03:50,819
houses on Friday evenings I'm not sure

95
00:03:54,800 --> 00:03:52,230
what the weather forecast is for this

96
00:03:57,530 --> 00:03:54,810
Friday I understand that they're doing a

97
00:03:59,659 --> 00:03:57,540
special event on the roof of Bloomberg

98
00:04:02,659 --> 00:03:59,669
this weekend something called celestial

99
00:04:06,610 --> 00:04:02,669
terrestrial and I couldn't find a web

100
00:04:09,409 --> 00:04:06,620
link for it but the folks who run the

101
00:04:10,969 --> 00:04:09,419
spacecraft server Tory told me that this

102
00:04:13,939 --> 00:04:10,979
weekend if you can find something about

103
00:04:17,020 --> 00:04:13,949
celestial terrestrial they're doing it

104
00:04:19,640 --> 00:04:17,030
on the go up on the roof of Bloomberg

105
00:04:21,199 --> 00:04:19,650
and it has some art component as well as

106
00:04:24,290 --> 00:04:21,209
the strong as science component to it

107
00:04:26,500 --> 00:04:24,300
and Zolt up there is looking at because

108
00:04:28,150 --> 00:04:26,510
he has a art

109
00:04:30,850 --> 00:04:28,160
called celestial terrestrial convergence

110
00:04:35,530 --> 00:04:30,860
that he has done and this is not Zola

111
00:04:38,080 --> 00:04:35,540
vase art convergence art show okay all

112
00:04:42,040 --> 00:04:38,090
right now our news from the universe for

113
00:04:43,960 --> 00:04:42,050

know what question ah the Bloomberg

114
00:04:46,180 --> 00:04:43,970
building is right across the street that

115
00:04:47,740 --> 00:04:46,190
big huge brick building that that an

116
00:04:49,570 --> 00:04:47,750
edifice that rises across the street

117
00:04:50,920 --> 00:04:49,580
from us okay that is where the physics

118
00:04:54,580 --> 00:04:50,930
and astronomy departments are housed

119
00:04:56,380 --> 00:04:54,590
okay now our news from the universe for

120
00:04:59,800 --> 00:04:56,390
November 2018

121
00:05:01,980 --> 00:04:59,810
our first story tonight are some mission

122
00:05:04,330 --> 00:05:01,990
updates if you've been paying attention

123
00:05:06,520 --> 00:05:04,340
there's been a lot to pay attention to

124
00:05:09,430 --> 00:05:06,530
over the last month or so okay first of

125
00:05:10,950 --> 00:05:09,440
all on October 5th our favorite

126
00:05:14,830 --> 00:05:10,960
Telescope the Hubble Space Telescope

127
00:05:16,450 --> 00:05:14,840
went into what we call safe mode because

128
00:05:17,320 --> 00:05:16,460
we had a failure of one of the

129
00:05:19,120 --> 00:05:17,330
gyroscopes

130
00:05:21,640 --> 00:05:19,130
now this gyroscope had been showing

131
00:05:23,140 --> 00:05:21,650
anomalies for about a year and we were

132
00:05:26,560 --> 00:05:23,150
sort of expecting it to fail

133
00:05:28,870 --> 00:05:26,570
at any time and it did fail on October

134
00:05:30,430 --> 00:05:28,880
1st October 5th and we have of course

135
00:05:32,950 --> 00:05:30,440
procedures built in place because we

136
00:05:36,220 --> 00:05:32,960
have six gyroscopes on Hubble and we

137
00:05:38,110 --> 00:05:36,230
need three to point it accurately when

138
00:05:42,250 --> 00:05:38,120

they fired up one of the reserve gyros

139
00:05:43,930 --> 00:05:42,260
it had a problem it's high spin rate was

140
00:05:46,930 --> 00:05:43,940
supposed to high as low spin rate was

141
00:05:48,760 --> 00:05:46,940
was not in observational with Ian's

142
00:05:51,940 --> 00:05:48,770
observational parameters so they did

143
00:05:55,690 --> 00:05:51,950
some testing and they couldn't solve it

144
00:05:57,910 --> 00:05:55,700
so they did more testing and it sort of

145
00:05:59,560 --> 00:05:57,920
went somewhere but not quite where they

146
00:06:02,140 --> 00:05:59,570
wanted it to is hell yeah they did even

147
00:06:05,370 --> 00:06:02,150
more extensive testing these guys are

148
00:06:09,490 --> 00:06:05,380
really really good they're very patient

149
00:06:11,680 --> 00:06:09,500
and after over three weeks of almost

150
00:06:13,270 --> 00:06:11,690
three weeks they were able to find a

151
00:06:16,900 --> 00:06:13,280
solution to the problem and get that

152
00:06:20,160 --> 00:06:16,910
reserved gyro back into observational

153
00:06:23,440 --> 00:06:20,170
status okay so that so that so the

154
00:06:25,000 --> 00:06:23,450
resulting of that gyro was high-quality

155
00:06:29,080 --> 00:06:25,010
enough that we could do Hubble observing

156
00:06:31,300 --> 00:06:29,090
so on October 26 we resumed observations

157
00:06:34,150 --> 00:06:31,310
okay so Hubble took a three week

158
00:06:35,500 --> 00:06:34,160
vacation from observing mode while of

159
00:06:37,570 --> 00:06:35,510
course the engineers here on the ground

160
00:06:39,839 --> 00:06:37,580
took anything but a three-week vacation

161
00:06:44,119 --> 00:06:39,849
getting it back in

162
00:06:47,790 --> 00:06:44,129
they do an amazing amount of work also

163
00:06:49,859 --> 00:06:47,800

the Kepler mission had a problem it had

164
00:06:52,350 --> 00:06:49,869
done its primary mission for four years

165
00:06:55,049 --> 00:06:52,360
which we're observing the Stars and

166
00:06:57,419 --> 00:06:55,059
looking for the light dips that indicate

167
00:06:58,859 --> 00:06:57,429
planets passing in front of them that's

168
00:07:01,199 --> 00:06:58,869
called the transit method of looking for

169
00:07:03,059 --> 00:07:01,209
extrasolar planets and then it had a

170
00:07:05,760 --> 00:07:03,069
reaction wheel problem this was a while

171
00:07:07,709 --> 00:07:05,770
ago and then we moved it to its

172
00:07:11,040 --> 00:07:07,719
secondary mission that can be - mission

173
00:07:13,409 --> 00:07:11,050
which it did observing as it could given

174
00:07:16,169 --> 00:07:13,419
the reaction wheel problem for another

175
00:07:19,139 --> 00:07:16,179
four years and then finally on October

176
00:07:22,019 --> 00:07:19,149
30th of this year the fuel was exhausted

177
00:07:23,969 --> 00:07:22,029
the Poynting fuel that the fuel that's

178
00:07:26,189 --> 00:07:23,979
necessary to point the telescope was

179
00:07:30,659 --> 00:07:26,199
finally exhausted which was again what

180
00:07:32,369 --> 00:07:30,669
was expected and so that the fuel the

181
00:07:34,829 --> 00:07:32,379
Kepler mission had to be brought to a

182
00:07:36,689 --> 00:07:34,839
close but it did do its full four years

183
00:07:38,249 --> 00:07:36,699
of its primary mission and it got

184
00:07:41,100 --> 00:07:38,259
another four years of its secondary

185
00:07:44,339 --> 00:07:41,110
mission was actually up for it almost

186
00:07:48,179 --> 00:07:44,349
nine years doing observations is that

187
00:07:51,059 --> 00:07:48,189
the end of Kepler no because Kepler

188
00:07:53,699 --> 00:07:51,069

created an incredible data set of light

189
00:07:55,319 --> 00:07:53,709
curves all of these stars and their

190
00:07:57,540 --> 00:07:55,329
brightnesses and their dips and their

191
00:07:59,939 --> 00:07:57,550
brightnesses that will be researched and

192
00:08:01,739 --> 00:07:59,949
research for quite some time to come and

193
00:08:03,540 --> 00:08:01,749
where are you going to go for that

194
00:08:06,329 --> 00:08:03,550
you're going to go to the Mikulski

195
00:08:08,009 --> 00:08:06,339
archive for Space Telescope's right here

196
00:08:10,889 --> 00:08:08,019
in this building also affectionately

197
00:08:12,929 --> 00:08:10,899
known as mast and one of the managers of

198
00:08:17,369 --> 00:08:12,939
it is sitting right up there who retired

199
00:08:19,679 --> 00:08:17,379
a month ago as well if I forget what

200
00:08:23,100 --> 00:08:19,689
your status was with Matt what your

201
00:08:25,169 --> 00:08:23,110
title was a mass archive size archive

202
00:08:28,649 --> 00:08:25,179
scientists sciences branch manager

203
00:08:31,949 --> 00:08:28,659
that's Karen all of a zoltán Karen both

204
00:08:34,709 --> 00:08:31,959
retired a while ago and so the mast

205
00:08:37,439 --> 00:08:34,719
archive here will continue to serve data

206
00:08:39,480 --> 00:08:37,449
for the Kepler mission and so it will

207
00:08:42,059 --> 00:08:39,490
actually have a lot more science results

208
00:08:43,679 --> 00:08:42,069
to come because one of the things that

209
00:08:45,449 --> 00:08:43,689
we're getting in the modern era is you

210
00:08:47,610 --> 00:08:45,459
get this incredible data that people

211
00:08:49,679 --> 00:08:47,620
search through the archives and make new

212
00:08:52,680 --> 00:08:49,689
discoveries for years and decades to

213
00:08:55,680 --> 00:08:52,690

come the third

214
00:08:58,170 --> 00:08:55,690
and update it concerns the dawn mission

215
00:09:00,030 --> 00:08:58,180
and if you remember the dawn mission was

216
00:09:03,680 --> 00:09:00,040
to study at the two largest asteroids

217
00:09:05,880 --> 00:09:03,690
Vesta and Ceres it was launched in 2007

218
00:09:08,220 --> 00:09:05,890
spent four years travelling the solar

219
00:09:11,640 --> 00:09:08,230
system to get to Vesta it stayed with

220
00:09:13,710 --> 00:09:11,650
Vesta for a year and then continued on

221
00:09:16,410 --> 00:09:13,720
traveling three years around the solar

222
00:09:19,110 --> 00:09:16,420
system to get to Ceres spent the last

223
00:09:22,920 --> 00:09:19,120
three years studying series in a or

224
00:09:26,730 --> 00:09:22,930
orbit a very close orbit amazing amazing

225
00:09:27,900 --> 00:09:26,740
data about series but a day after that

226
00:09:29,820 --> 00:09:27,910
the Kepler mission of Schewel was

227
00:09:31,920 --> 00:09:29,830
exhausted it was announced that the

228
00:09:33,780 --> 00:09:31,930
Dawn's mission fuel was also exhausted

229
00:09:36,210 --> 00:09:33,790
neither of these were any surprise okay

230
00:09:38,100 --> 00:09:36,220
we knew that that the hydrazine only

231
00:09:41,730 --> 00:09:38,110
last for so long for pointing the

232
00:09:45,600 --> 00:09:41,740
telescope but dawn celebrated 11 years

233
00:09:48,960 --> 00:09:45,610
and 4.3 billion miles around the solar

234
00:09:50,970 --> 00:09:48,970
system so the Kepler and Dawn missions

235
00:09:58,670 --> 00:09:50,980
are finished Hubble is back in operation

236
00:10:02,940 --> 00:10:00,930
Parker Solar Probe I have not mentioned

237
00:10:05,460 --> 00:10:02,950
the Parker Solar Probe you want me to

238
00:10:08,100 --> 00:10:05,470

mention it next month I will I will read

239
00:10:10,980 --> 00:10:08,110
up about the Parker Solar Probe it did

240
00:10:14,340 --> 00:10:10,990
make a very close pass to the Sun over

241
00:10:17,520 --> 00:10:14,350
the last month or so it's got to make

242
00:10:19,110 --> 00:10:17,530
lots of things and it's accommodating

243
00:10:21,060 --> 00:10:19,120
data they're not going to be announcing

244
00:10:22,920 --> 00:10:21,070
results from it I usually chime in when

245
00:10:25,260 --> 00:10:22,930
they're an else result results announced

246
00:10:26,820 --> 00:10:25,270
but just for you I'll take a look at the

247
00:10:29,340 --> 00:10:26,830
Parker Solar Probe for next month's news

248
00:10:31,980 --> 00:10:29,350
okay all right

249
00:10:36,120 --> 00:10:31,990
so for some science results tonight we

250
00:10:39,600 --> 00:10:36,130
have evidence of an EXO moon okay so we

251
00:10:41,550 --> 00:10:39,610
have seen lots of planets or evidence of

252
00:10:42,960 --> 00:10:41,560
lots of planets around other stars these

253
00:10:46,320 --> 00:10:42,970
are called extrasolar planets or

254
00:10:51,270 --> 00:10:46,330
exoplanets okay but we have never seen

255
00:10:53,550 --> 00:10:51,280
one with a moon and with the Kepler data

256
00:10:55,770 --> 00:10:53,560
than I mentioned just previously and

257
00:10:59,040 --> 00:10:55,780
some Hubble follow-up observations we

258
00:11:02,430 --> 00:10:59,050
now have evidence that there may be a

259
00:11:06,510 --> 00:11:02,440
moon around a star called a star called

260
00:11:10,380 --> 00:11:06,520
Kepler 16:25 and a planet called 16:20

261
00:11:13,230 --> 00:11:10,390
be all right so the way it works is that

262
00:11:15,870 --> 00:11:13,240
as I said Kepler records the light of

263
00:11:18,630 --> 00:11:15,880

the star and the dips in the light when

264
00:11:21,390 --> 00:11:18,640
a planet passes in front of it and with

265
00:11:23,220 --> 00:11:21,400
this massive Kepler database researchers

266
00:11:25,560 --> 00:11:23,230
up at Columbia University went searching

267
00:11:28,050 --> 00:11:25,570
to see if they could find evidence of

268
00:11:29,400 --> 00:11:28,060
moons right so you've got a planet

269
00:11:31,260 --> 00:11:29,410
passing in front if there's another moon

270
00:11:34,830 --> 00:11:31,270
there would be another dip and so they

271
00:11:36,840 --> 00:11:34,840
went through lots of these light curves

272
00:11:39,360 --> 00:11:36,850
looking for anomalies that might

273
00:11:41,540 --> 00:11:39,370
indicate a moon they found about 40 pop

274
00:11:43,470 --> 00:11:41,550
candidates but this is the best one and

275
00:11:46,410 --> 00:11:43,480
because this was the best one they were

276
00:11:48,450 --> 00:11:46,420
able to get Hubble follow-up time and so

277
00:11:50,900 --> 00:11:48,460
they used Hubble follow-up time to

278
00:11:54,210 --> 00:11:50,910
record the light curve really accurately

279
00:11:57,630 --> 00:11:54,220
and Hubble saw the planet passing across

280
00:12:00,770 --> 00:11:57,640
as you see in slide two and then the

281
00:12:04,680 --> 00:12:00,780
planet stops the planet comes out of

282
00:12:08,130 --> 00:12:04,690
transit and slide 3 and then in slide 4

283
00:12:11,160 --> 00:12:08,140
you can see a moon passing across which

284
00:12:13,920 --> 00:12:11,170
causes another smutch smaller dip in the

285
00:12:18,300 --> 00:12:13,930
light curve now unfortunately the Hubble

286
00:12:20,820 --> 00:12:18,310
observing window closed before the moon

287
00:12:23,430 --> 00:12:20,830
made its full pass across so they can't

288
00:12:25,230 --> 00:12:23,440

fully confirm it okay they would need

289
00:12:27,300 --> 00:12:25,240
actually to look many times over and

290
00:12:29,460 --> 00:12:27,310
over again so they're proposing a course

291
00:12:32,640 --> 00:12:29,470
to do follow-up observations but if

292
00:12:35,400 --> 00:12:32,650
confirmed this is the first detection of

293
00:12:38,400 --> 00:12:35,410
a moon around a planet around another

294
00:12:41,520 --> 00:12:38,410
star and that would be kind of cool not

295
00:12:47,310 --> 00:12:41,530
only is it interesting for that but also

296
00:12:49,980 --> 00:12:47,320
because it's not what color is that does

297
00:12:53,220 --> 00:12:49,990
that look like our moon this is not a

298
00:12:56,520 --> 00:12:53,230
moon like our moon this is not a moon

299
00:12:59,190 --> 00:12:56,530
like any moon in our solar system there

300
00:13:01,340 --> 00:12:59,200
are 200 moons in our solar system none

301
00:13:05,760 --> 00:13:01,350
of them are like this because this is

302
00:13:08,340 --> 00:13:05,770
actually more like Neptune okay the

303
00:13:10,440 --> 00:13:08,350
planet is several times larger than

304
00:13:14,310 --> 00:13:10,450
Jupiter like three to five Jupiter mass

305
00:13:17,550 --> 00:13:14,320
planet and the moon is like a Neptune

306
00:13:20,760 --> 00:13:17,560
mass planet all right

307
00:13:23,550 --> 00:13:20,770
and we do have one moon in the solar

308
00:13:26,250 --> 00:13:23,560
system that has an atmosphere Titan but

309
00:13:29,420 --> 00:13:26,260
we it's at its core it's more like a

310
00:13:34,050 --> 00:13:29,430
rocky planet okay an earth Venus Mars

311
00:13:37,920 --> 00:13:34,060
type planet right this is a planet like

312
00:13:40,410 --> 00:13:37,930
Neptune and Uranus but it's a moon

313
00:13:45,510 --> 00:13:40,420

around a planet that's larger than

314
00:13:48,829 --> 00:13:45,520
Jupiter yeah how do you form a Uranus

315
00:13:51,450 --> 00:13:48,839
type planet around a Jupiter type planet

316
00:13:53,070 --> 00:13:51,460
Uranus type moon around a Jupiter type I

317
00:13:57,720 --> 00:13:53,080
can't even say Uranus type moon because

318
00:14:00,480 --> 00:13:57,730
it just doesn't work in my brain it

319
00:14:02,460 --> 00:14:00,490
probably didn't form in situating to our

320
00:14:04,769 --> 00:14:02,470
current ideas but maybe we don't have

321
00:14:06,660 --> 00:14:04,779
the best ideas okay so this is

322
00:14:09,150 --> 00:14:06,670
intriguing not only because it could be

323
00:14:12,269 --> 00:14:09,160
the first moon discovered elsewhere and

324
00:14:15,810 --> 00:14:12,279
this hole is in the universe but also it

325
00:14:19,170 --> 00:14:15,820
might be the first giant moon discovered

326
00:14:21,269 --> 00:14:19,180
in this in the universe so stay tuned

327
00:14:26,070 --> 00:14:21,279
there might be some might be more coming

328
00:14:29,400 --> 00:14:26,080
up all right any chance it's a binary

329
00:14:31,950 --> 00:14:29,410
planet no the mass ratio between the

330
00:14:35,010 --> 00:14:31,960
planet and the moon is approximately the

331
00:14:37,320 --> 00:14:35,020
same as the mass ratio between Earth and

332
00:14:39,870 --> 00:14:37,330
our moon so it's it's it's it's

333
00:14:42,480 --> 00:14:39,880
relatively large actually I think it's

334
00:14:44,970 --> 00:14:42,490
larger than the mass ratio think it's

335
00:14:48,240 --> 00:14:44,980
only the moon is only a few percent the

336
00:14:49,260 --> 00:14:48,250
mass of the planet okay so that's that

337
00:14:53,070 --> 00:14:49,270
wouldn't that wouldn't qualify as a

338
00:14:56,100 --> 00:14:53,080

binary question thank you alright one

339
00:15:00,420 --> 00:14:56,110
last thing to note is Hubble is having

340
00:15:02,340 --> 00:15:00,430
its symphonic premiere this is a project

341
00:15:05,160 --> 00:15:02,350
I'm very happy to tell you about we've

342
00:15:07,530 --> 00:15:05,170
been working on it for 18 months on this

343
00:15:09,810 --> 00:15:07,540
Friday at the Kennedy Space Center in

344
00:15:12,240 --> 00:15:09,820
Florida we'll have a premiere of Deep

345
00:15:14,550 --> 00:15:12,250
Field the impossible magnitude of our

346
00:15:16,470 --> 00:15:14,560
universe this is a project we've been

347
00:15:19,199 --> 00:15:16,480
working with conductor and composer Eric

348
00:15:22,920 --> 00:15:19,209
Whitacre he composed a 23-minute

349
00:15:26,730 --> 00:15:22,930
symphony called Deep Field which was

350
00:15:29,130 --> 00:15:26,740
inspired by the Hubble Deep Field and we

351
00:15:31,460 --> 00:15:29,140
have been working with his company music

352
00:15:34,010 --> 00:15:31,470
productions limited as well as 59

353
00:15:36,440 --> 00:15:34,020
actions a company based out of London to

354
00:15:40,130 --> 00:15:36,450
create a film to go along with his

355
00:15:42,530 --> 00:15:40,140
symphony and it will premiere Friday

356
00:15:46,070 --> 00:15:42,540
November 16th down at Kennedy

357
00:15:52,610 --> 00:15:46,080
it will also be released on YouTube ok

358
00:15:56,030 --> 00:15:52,620
so everyone can see this it's a how to

359
00:15:58,880 --> 00:15:56,040
describe it so what it's a modern

360
00:16:02,000 --> 00:15:58,890
somewhat minimalist symphony with very

361
00:16:04,730 --> 00:16:02,010
stirring music and very quiet music and

362
00:16:08,660 --> 00:16:04,740
the progression of images starts with

363
00:16:14,120 --> 00:16:08,670

our very own Zolt lavas photography of

364
00:16:16,790 --> 00:16:14,130
the milky way in and what what National

365
00:16:19,190 --> 00:16:16,800
Park Capitol Reef eyes don't want to say

366
00:16:21,110 --> 00:16:19,200
Canyonlands for every battle reef he was

367
00:16:22,580 --> 00:16:21,120
a photographer he was out doing an

368
00:16:24,590 --> 00:16:22,590
artist-in-residence at Capitol Reef

369
00:16:27,260 --> 00:16:24,600
National Park and got an amazing shot of

370
00:16:29,630 --> 00:16:27,270
the Milky Way panning across the night

371
00:16:32,420 --> 00:16:29,640
sky that opens the film we go through

372
00:16:34,670 --> 00:16:32,430
planets and stars and nebulae and

373
00:16:38,300 --> 00:16:34,680
galaxies and out to the edge of the

374
00:16:41,840 --> 00:16:38,310
universe and the deep field in this with

375
00:16:44,300 --> 00:16:41,850
all to Eric Whitakers wonderful music so

376
00:16:45,680 --> 00:16:44,310
look for that if you want more

377
00:16:49,610 --> 00:16:45,690
information you can go to Deep Field

378
00:16:58,570 --> 00:16:49,620
film comm it says it will be released

379
00:17:04,430 --> 00:17:02,420
and I will probably take one of the

380
00:17:06,500 --> 00:17:04,440
public lecture series is next year and

381
00:17:08,240 --> 00:17:06,510
play this film for you and we'll do a

382
00:17:09,800 --> 00:17:08,250
discussion of how what we what we did

383
00:17:12,440 --> 00:17:09,810
the Space Telescope Science Institute

384
00:17:14,150 --> 00:17:12,450
was involved in 11 sequences in this

385
00:17:17,540 --> 00:17:14,160
film over half of the visuals are

386
00:17:20,000 --> 00:17:17,550
derived from our work so we're very very

387
00:17:23,990 --> 00:17:20,010
proud to show this off to the public all

388
00:17:35,460 --> 00:17:24,000

right and now our featured speaker let's

389
00:17:40,740 --> 00:17:38,530
our speaker tonight is dr. bill Blair

390
00:17:44,049 --> 00:17:40,750
he's across the street at Johns Hopkins

391
00:17:49,570 --> 00:17:44,059
but he's also here Space Telescope in a

392
00:17:51,340 --> 00:17:49,580
way he joined Hopkins in 1984 and has

393
00:17:53,200 --> 00:17:51,350
been there ever since working on the

394
00:17:55,140 --> 00:17:53,210
Hopkins ultraviolet telescope which

395
00:17:57,040 --> 00:17:55,150
twice flew on the space shuttle

396
00:17:59,680 --> 00:17:57,050
observing an ultraviolet which you can

397
00:18:01,419 --> 00:17:59,690
only do from space then he worked on an

398
00:18:02,740 --> 00:18:01,429
even more ambitious ultraviolet

399
00:18:06,610 --> 00:18:02,750
telescope the far ultraviolet

400
00:18:09,580 --> 00:18:06,620
spectrograph Explorer fuse and he

401
00:18:12,190 --> 00:18:09,590
parlayed the experience of running fuse

402
00:18:14,740 --> 00:18:12,200
to come over and work with us on the

403
00:18:17,049 --> 00:18:14,750
James Webb Space Telescope where you can

404
00:18:21,250 --> 00:18:17,059
see he is project scientist for use of

405
00:18:23,169 --> 00:18:21,260
support for JWST so he's going to use

406
00:18:26,020 --> 00:18:23,179
that amazing knowledge to tell us all

407
00:18:35,730 --> 00:18:26,030
about Hubble uh-huh ladies and gentlemen

408
00:18:40,690 --> 00:18:38,440
thanks Frank and thank you all for

409
00:18:43,960 --> 00:18:40,700
coming out tonight this is great to see

410
00:18:47,020 --> 00:18:43,970
such a good crowd so I am an astronomer

411
00:18:49,180 --> 00:18:47,030
I've used Hubble many times over the

412
00:18:51,070 --> 00:18:49,190
years and as many times as I would have

413
00:18:53,970 --> 00:18:51,080

liked to but I get lucky every once in a

414
00:18:56,110 --> 00:18:53,980
while and get a project and the

415
00:18:58,840 --> 00:18:56,120
functional side of my work though has

416
00:19:01,480 --> 00:18:58,850
always been in user support and user

417
00:19:03,430 --> 00:19:01,490
support is supporting astronomers to use

418
00:19:06,130 --> 00:19:03,440
the various facilities like the Hubble

419
00:19:08,590 --> 00:19:06,140
telescope or like the fuse or the Hut

420
00:19:10,570 --> 00:19:08,600
telescopes before that and so a lot of

421
00:19:14,080 --> 00:19:10,580
my professional activity has been

422
00:19:16,450 --> 00:19:14,090
involved in enabling science the systems

423
00:19:18,310 --> 00:19:16,460
and the software to help run these

424
00:19:22,390 --> 00:19:18,320
telescopes and get the data that

425
00:19:23,980 --> 00:19:22,400
astronomers need or desire so I'm going

426
00:19:25,900 --> 00:19:23,990
to put those two pieces together today i

427
00:19:29,050 --> 00:19:25,910
intent is to try to give you a little

428
00:19:31,990 --> 00:19:29,060
bit of a behind-the-scenes look at what

429
00:19:33,730 --> 00:19:32,000
it takes to get a project accepted for

430
00:19:36,130 --> 00:19:33,740
one of these telescopes to get it

431
00:19:38,980 --> 00:19:36,140
scheduled to get the data back and to do

432
00:19:43,330 --> 00:19:38,990
something reasonable with the data after

433
00:19:45,790 --> 00:19:43,340
it comes back and I think you'll get a

434
00:19:47,410 --> 00:19:45,800
perspective on why it takes an institute

435
00:19:49,870 --> 00:19:47,420
like this to actually run something like

436
00:19:54,940 --> 00:19:49,880
the Hubble Space Telescope because there

437
00:19:56,980 --> 00:19:54,950
is so much involved behind the scenes so

438
00:19:59,200 --> 00:19:56,990

I know that you all have seen many of

439
00:20:01,120 --> 00:19:59,210
these wonderful pictures that are

440
00:20:03,640 --> 00:20:01,130
released occasionally either in press

441
00:20:05,110 --> 00:20:03,650
releases or in photo releases from the

442
00:20:07,210 --> 00:20:05,120
Institute of course the Hubble heritage

443
00:20:10,900 --> 00:20:07,220
program for many years put one out every

444
00:20:14,350 --> 00:20:10,910
month this is just a partial screenshot

445
00:20:16,450 --> 00:20:14,360
of the Hubble heritage site and you see

446
00:20:18,850 --> 00:20:16,460
the many different kinds of pictures

447
00:20:22,210 --> 00:20:18,860
that are released but behind every one

448
00:20:26,190 --> 00:20:22,220
of these pictures is a story and the

449
00:20:28,360 --> 00:20:26,200
story usually has started with an idea a

450
00:20:30,220 --> 00:20:28,370
question it needs to be answered or an

451
00:20:33,400 --> 00:20:30,230
observation that can help answer a

452
00:20:35,320 --> 00:20:33,410
question a proposal written by an

453
00:20:38,260 --> 00:20:35,330
astronomer or more often a group of

454
00:20:41,920 --> 00:20:38,270
astronomers that wants to use get the

455
00:20:43,240 --> 00:20:41,930
data to do that project and then all the

456
00:20:46,150 --> 00:20:43,250
things that have to happen to actually

457
00:20:48,130 --> 00:20:46,160
schedule the telescope and to get the

458
00:20:49,450 --> 00:20:48,140
data to archive it

459
00:20:51,910 --> 00:20:49,460
then back to the astronomer for the

460
00:20:53,590 --> 00:20:51,920
analysis and understanding part and

461
00:20:56,410 --> 00:20:53,600
ultimately that a publication of a

462
00:20:58,330 --> 00:20:56,420
scientific result and sometimes fairly

463
00:21:00,280 --> 00:20:58,340

often there's a pretty picture that

464
00:21:03,430 --> 00:21:00,290
comes out of that as well that the oppo

465
00:21:07,000 --> 00:21:03,440
group here puts out as a photo release

466
00:21:08,860 --> 00:21:07,010
as you see here and so tonight this is

467
00:21:11,500 --> 00:21:08,870
going to be the story of one such

468
00:21:14,380 --> 00:21:11,510
picture this one of m83

469
00:21:15,820 --> 00:21:14,390
this wonderful galaxy that i'll be

470
00:21:18,310 --> 00:21:15,830
talking about off and on as we go

471
00:21:20,350 --> 00:21:18,320
through this process of what it takes to

472
00:21:23,640 --> 00:21:20,360
get science data from the Hubble

473
00:21:27,340 --> 00:21:23,650
telescope so there's the full heritage

474
00:21:29,980 --> 00:21:27,350
release you see this marvelous picture

475
00:21:31,090 --> 00:21:29,990
but there's a what's going on here in

476
00:21:33,670 --> 00:21:31,100
this galaxy is that there's a very

477
00:21:35,080 --> 00:21:33,680
bright burst of star formation happening

478
00:21:37,450 --> 00:21:35,090
in the very center of the galaxy the

479
00:21:39,970 --> 00:21:37,460
nucleus you see these very well formed

480
00:21:41,560 --> 00:21:39,980
spiral arms coming out you see this

481
00:21:44,170 --> 00:21:41,570
brown stuff around here which is

482
00:21:45,250 --> 00:21:44,180
interstellar dust dust bunnies I like to

483
00:21:47,290 --> 00:21:45,260
call it interstellar dust bunnies

484
00:21:50,140 --> 00:21:47,300
running around out there in that galaxy

485
00:21:52,360 --> 00:21:50,150
you see these big red glowing regions of

486
00:21:54,040 --> 00:21:52,370
hydrogen gas around the youngest stars

487
00:21:56,170 --> 00:21:54,050
that are forming that are exciting that

488
00:21:58,510 --> 00:21:56,180

gas to glow so you can see that there's

489
00:22:00,400 --> 00:21:58,520
a lot of star formation out here in the

490
00:22:02,710 --> 00:22:00,410
spiral arms but there's a tremendous

491
00:22:04,150 --> 00:22:02,720
burst of star formation going on here in

492
00:22:07,060 --> 00:22:04,160
the center and then this kind of

493
00:22:09,700 --> 00:22:07,070
yellowish red hazy light that you see

494
00:22:11,980 --> 00:22:09,710
there are older stars that are yellow or

495
00:22:14,590 --> 00:22:11,990
red or in color as opposed to the bright

496
00:22:17,710 --> 00:22:14,600
blue stars that have formed more

497
00:22:19,420 --> 00:22:17,720
recently well that's a beautiful picture

498
00:22:21,130 --> 00:22:19,430
it's a wonderful picture and what does

499
00:22:23,050 --> 00:22:21,140
it take that you and make a picture like

500
00:22:25,300 --> 00:22:23,060
that for a photo release well in this

501
00:22:28,300 --> 00:22:25,310
particular case it took two different

502
00:22:31,150 --> 00:22:28,310
programs of data one here the two yellow

503
00:22:33,700 --> 00:22:31,160
boxes were obtained first shortly after

504
00:22:37,120 --> 00:22:33,710
the Wide Field Camera 3 was installed in

505
00:22:38,920 --> 00:22:37,130
2009 and the results from those two

506
00:22:41,140 --> 00:22:38,930
fields were so astounding then I was

507
00:22:44,560 --> 00:22:41,150
able to come along the year or so later

508
00:22:46,570 --> 00:22:44,570
and and get a program to look at the red

509
00:22:48,430 --> 00:22:46,580
boxes here and a couple of other filters

510
00:22:52,000 --> 00:22:48,440
in the yellow boxes to complete this

511
00:22:53,220 --> 00:22:52,010
data set to observe m83 and I'll tell

512
00:22:56,200 --> 00:22:53,230
you a little bit about the science

513
00:22:57,100 --> 00:22:56,210

behind that as we go along tonight I

514
00:22:59,830 --> 00:22:57,110
just thought I would point out that

515
00:23:01,880 --> 00:22:59,840
basically this first program was 16 HST

516
00:23:06,440 --> 00:23:01,890
orbits my program

517
00:23:08,450 --> 00:23:06,450
was 36h HST Orbitz that's 56 total and

518
00:23:11,720 --> 00:23:08,460
at 14 and 1/2 orbits per day you're

519
00:23:13,220 --> 00:23:11,730
looking at basically four days of Hubble

520
00:23:15,890 --> 00:23:13,230
observing time just to make this one

521
00:23:19,280 --> 00:23:15,900
photo release picture that you see here

522
00:23:21,800 --> 00:23:19,290
tonight so here's a slightly different

523
00:23:23,690 --> 00:23:21,810
version of that same picture and you can

524
00:23:25,640 --> 00:23:23,700
see that basically the the photo release

525
00:23:27,110 --> 00:23:25,650
picture was the biggest rectangle you

526
00:23:28,910 --> 00:23:27,120
can cut out of this and not have this

527
00:23:30,380 --> 00:23:28,920
funny shape to it but we got one

528
00:23:34,340 --> 00:23:30,390
additional field out here to get an

529
00:23:36,140 --> 00:23:34,350
outer spiral arm in this galaxy and to

530
00:23:39,410 --> 00:23:36,150
put together this kind of a mosaic

531
00:23:42,530 --> 00:23:39,420
picture it took some special work by

532
00:23:44,480 --> 00:23:42,540
some of the staff here at STScI and of

533
00:23:47,300 --> 00:23:44,490
course result here who's here tonight

534
00:23:50,000 --> 00:23:47,310
great to see you sol was responsible for

535
00:23:51,710 --> 00:23:50,010
putting together this this photo release

536
00:23:53,540 --> 00:23:51,720
picture I thought I would just mention

537
00:23:55,640 --> 00:23:53,550
though that this picture includes the

538
00:23:57,380 --> 00:23:55,650

filters that you see here in blue which

539
00:24:00,650 --> 00:23:57,390
are all optical light pictures there's

540
00:24:02,450 --> 00:24:00,660
four different bands of starlight in

541
00:24:04,640 --> 00:24:02,460
this picture there were two more here

542
00:24:06,980 --> 00:24:04,650
this later yellow as the infrared camera

543
00:24:08,360 --> 00:24:06,990
bands and the H&K bands are not part of

544
00:24:10,250 --> 00:24:08,370
that picture but we're part of our data

545
00:24:12,160 --> 00:24:10,260
set and then in the emission lines

546
00:24:15,340 --> 00:24:12,170
you're seeing the h-alpha the red

547
00:24:18,440 --> 00:24:15,350
regions of a diffuse gas in that picture

548
00:24:19,910 --> 00:24:18,450
but we also took several other emission

549
00:24:21,980 --> 00:24:19,920
lines including one here that was in the

550
00:24:23,570 --> 00:24:21,990
infrared that I'll mentioned briefly as

551
00:24:25,430 --> 00:24:23,580
we go along as well of course Hubble

552
00:24:27,110 --> 00:24:25,440
mainly looks on the optical but it goes

553
00:24:29,390 --> 00:24:27,120
into the ultraviolet and into the

554
00:24:31,850 --> 00:24:29,400
near-infrared which is difficult to

555
00:24:33,590 --> 00:24:31,860
observe from the ground and these

556
00:24:35,840 --> 00:24:33,600
wonderful mosaics after we stitched all

557
00:24:40,370 --> 00:24:35,850
this together are actually available in

558
00:24:41,330 --> 00:24:40,380
the archive here at mast so why do we

559
00:24:43,010 --> 00:24:41,340
need to use Hubble to make an

560
00:24:44,600 --> 00:24:43,020
observation like that I mean we can take

561
00:24:45,890 --> 00:24:44,610
a picture of that whole galaxy with the

562
00:24:47,300 --> 00:24:45,900
ground-based telescope when you want a

563
00:24:49,130 --> 00:24:47,310

shot and not have to stitch all those

564
00:24:50,690 --> 00:24:49,140
fields together and whatnot and the

565
00:24:53,150 --> 00:24:50,700
reason is there before you there's

566
00:24:54,890 --> 00:24:53,160
nothing like having spatial resolution

567
00:24:56,540 --> 00:24:54,900
this is a ground-based

568
00:24:59,390 --> 00:24:56,550
picture of just a little piece of a

569
00:25:01,460 --> 00:24:59,400
spiral arm in m83 it's a ground-based

570
00:25:03,680 --> 00:25:01,470
data set that we took down in Chile at

571
00:25:06,500 --> 00:25:03,690
the Magellan telescope and this is an

572
00:25:08,390 --> 00:25:06,510
excellent ground-based data set the

573
00:25:10,160 --> 00:25:08,400
seeing here is about a half an arc

574
00:25:11,690 --> 00:25:10,170
second now some of you amateur

575
00:25:13,310 --> 00:25:11,700
astronomers are out there if you get

576
00:25:14,700 --> 00:25:13,320
below one arcsecond you're doing well

577
00:25:17,039 --> 00:25:14,710
oftentimes ground-based

578
00:25:18,570 --> 00:25:17,049
even not quite as good as one arcsecond

579
00:25:20,669 --> 00:25:18,580
this is half arcsecond for the whole

580
00:25:22,019 --> 00:25:20,679
galaxy and maybe three but when you look

581
00:25:24,090 --> 00:25:22,029
at a little piece of it that's what it

582
00:25:26,700 --> 00:25:24,100
looks like and here are the same filters

583
00:25:28,560 --> 00:25:26,710
now used in the Hubble data and if

584
00:25:30,060 --> 00:25:28,570
you're going to work on photometry of

585
00:25:32,190 --> 00:25:30,070
the stars measuring the brightness and

586
00:25:34,350 --> 00:25:32,200
the colors of stars I'd rather work on

587
00:25:36,870 --> 00:25:34,360
that data than on that data and that's

588
00:25:40,740 --> 00:25:36,880

the motivation for getting Hubble time

589
00:25:42,870 --> 00:25:40,750
is the spatial resolution well what does

590
00:25:44,760 --> 00:25:42,880
it actually take then to to get a

591
00:25:46,740 --> 00:25:44,770
proposal through the system here and

592
00:25:49,019 --> 00:25:46,750
have something happen well it starts

593
00:25:53,100 --> 00:25:49,029
down here with an idea or a question

594
00:25:54,990 --> 00:25:53,110
that needs to be answered after a lot of

595
00:25:56,070 --> 00:25:55,000
work which I'll mention in passing as we

596
00:25:59,130 --> 00:25:56,080
go along

597
00:26:01,649 --> 00:25:59,140
you submit a proposal the the proposal

598
00:26:03,269 --> 00:26:01,659
is peer reviewed and if you're lucky you

599
00:26:04,889 --> 00:26:03,279
get accepted and then you go into the

600
00:26:06,870 --> 00:26:04,899
planning and scheduling part of the

601
00:26:09,240 --> 00:26:06,880
process which takes several months of

602
00:26:11,399 --> 00:26:09,250
work here at the Institute as well as

603
00:26:14,070 --> 00:26:11,409
some more work by the astronomer to put

604
00:26:16,409 --> 00:26:14,080
together the detailed observing plan it

605
00:26:18,810 --> 00:26:16,419
gets turned into a sequence of commands

606
00:26:20,779 --> 00:26:18,820
that gets sent up to good old Hubble if

607
00:26:23,940 --> 00:26:20,789
you're lucky the data get captured

608
00:26:25,740 --> 00:26:23,950
appropriately downlinked and then

609
00:26:27,269 --> 00:26:25,750
processed and calibrated which is a job

610
00:26:30,029 --> 00:26:27,279
that is also done here at the Institute

611
00:26:31,830 --> 00:26:30,039
and archived and then finally the data

612
00:26:34,560 --> 00:26:31,840
comes back to the scientist for

613
00:26:37,320 --> 00:26:34,570

scientific analysis and publication so

614
00:26:38,610 --> 00:26:37,330
that's the the process there and I

615
00:26:40,950 --> 00:26:38,620
thought it might be fun to just look in

616
00:26:43,860 --> 00:26:40,960
a little bit more detail at this process

617
00:26:45,690 --> 00:26:43,870
because in the simplest form of this

618
00:26:48,299 --> 00:26:45,700
basically the astronomer is doing the

619
00:26:50,580 --> 00:26:48,309
work down below the line and STScI does

620
00:26:51,990 --> 00:26:50,590
the work above the line it's actually a

621
00:26:53,669 --> 00:26:52,000
little more complicated than that but to

622
00:26:56,070 --> 00:26:53,679
first order that's that's what's going

623
00:26:59,279 --> 00:26:56,080
on here so let's look at this first part

624
00:27:00,630 --> 00:26:59,289
of the process my idea or anybody in the

625
00:27:01,919 --> 00:27:00,640
community of course there's a lot of

626
00:27:04,260 --> 00:27:01,929
people writing proposals at the same

627
00:27:05,519 --> 00:27:04,270
time write proposals and submit them to

628
00:27:08,850 --> 00:27:05,529
the Institute and what's called the

629
00:27:10,440 --> 00:27:08,860
phase one proposal process this peer

630
00:27:12,659 --> 00:27:10,450
review so just to give you an idea each

631
00:27:14,010 --> 00:27:12,669
of these steps along the way is a big

632
00:27:14,580 --> 00:27:14,020
job and I'm skipping over a lot of

633
00:27:16,320 --> 00:27:14,590
details

634
00:27:20,430 --> 00:27:16,330
maybe I'll just pick out one here which

635
00:27:22,980 --> 00:27:20,440
is the peer review imagine getting 1,200

636
00:27:25,590 --> 00:27:22,990
proposals at the deadline for Hubble

637
00:27:27,500 --> 00:27:25,600
time and having arranged ahead of time

638
00:27:28,799 --> 00:27:27,510

for about a hundred and twenty

639
00:27:30,539 --> 00:27:28,809
scientists from

640
00:27:33,600 --> 00:27:30,549
around the country and around the world

641
00:27:35,580 --> 00:27:33,610
to come to Baltimore to participate in a

642
00:27:38,909 --> 00:27:35,590
review and a selection of these

643
00:27:41,759 --> 00:27:38,919
proposals that's a lot of work travel

644
00:27:43,860 --> 00:27:41,769
all the mechanics of ranging the rooms

645
00:27:45,409 --> 00:27:43,870
where these people meet the effort that

646
00:27:48,419 --> 00:27:45,419
they go to and the tracking of all the

647
00:27:50,700 --> 00:27:48,429
deliberations and so forth that one box

648
00:27:52,860 --> 00:27:50,710
there is a huge job and each one of

649
00:27:55,320 --> 00:27:52,870
these boxes is actually a pretty big job

650
00:27:57,180 --> 00:27:55,330
as we go along but if we're accepted

651
00:27:59,940 --> 00:27:57,190
okay you go into that planning and

652
00:28:02,310 --> 00:27:59,950
scheduling phase and here each of these

653
00:28:05,399 --> 00:28:02,320
boxes can take maybe approximately a

654
00:28:07,649 --> 00:28:05,409
month to happen well the astronomer gets

655
00:28:09,450 --> 00:28:07,659
of an accepted proposal it's about a

656
00:28:12,090 --> 00:28:09,460
month to turn in the detailed proposal

657
00:28:13,830 --> 00:28:12,100
and maybe write a budget there's a

658
00:28:16,109 --> 00:28:13,840
technical review process that happens

659
00:28:18,210 --> 00:28:16,119
here where that proposal is inspected by

660
00:28:21,389 --> 00:28:18,220
the experts here at the Institute to

661
00:28:23,820 --> 00:28:21,399
make sure that everything is up to snuff

662
00:28:26,070 --> 00:28:23,830
there there's the construction of a

663
00:28:27,570 --> 00:28:26,080

year-long plan that takes all the

664
00:28:29,310 --> 00:28:27,580
observations that have been accepted and

665
00:28:30,720 --> 00:28:29,320
tries to figure out the most efficient

666
00:28:31,889 --> 00:28:30,730
way to do the observations throughout

667
00:28:33,690 --> 00:28:31,899
the course of the year

668
00:28:35,669 --> 00:28:33,700
it's kind of a rough layout but

669
00:28:38,340 --> 00:28:35,679
basically what time of year for each

670
00:28:39,509 --> 00:28:38,350
observation so your observation might

671
00:28:40,799 --> 00:28:39,519
get done all at once or it might get

672
00:28:42,539 --> 00:28:40,809
spread up and broken up into pieces

673
00:28:45,210 --> 00:28:42,549
throughout the year depending on what

674
00:28:47,009 --> 00:28:45,220
you're asking for and then about one

675
00:28:48,480 --> 00:28:47,019
week at a time a piece of this

676
00:28:50,549 --> 00:28:48,490
long-range plan is pulled into a

677
00:28:53,489 --> 00:28:50,559
short-term scheduling process where

678
00:28:56,460 --> 00:28:53,499
about one week of observations is put

679
00:28:58,139 --> 00:28:56,470
together into a sequence are literally a

680
00:29:00,659 --> 00:28:58,149
second-by-second sequence of what Hubble

681
00:29:03,720 --> 00:29:00,669
has to do it gets turned into spacecraft

682
00:29:07,230 --> 00:29:03,730
language that Hubble can understand and

683
00:29:10,139 --> 00:29:07,240
is then up linked to the Hubble where

684
00:29:12,119 --> 00:29:10,149
Howell operates autonomously then to

685
00:29:13,680 --> 00:29:12,129
make the observations and if the target

686
00:29:16,139 --> 00:29:13,690
acquisitions work right and everything

687
00:29:18,239 --> 00:29:16,149
else works right yeah you get some data

688
00:29:20,190 --> 00:29:18,249

out of that process so that's it's a

689
00:29:22,649 --> 00:29:20,200
long time coming but that's the fun part

690
00:29:24,419 --> 00:29:22,659
when you get the data after the data are

691
00:29:27,029 --> 00:29:24,429
captured on Hubble they have to get down

692
00:29:29,730 --> 00:29:27,039
to the ground they have to be calibrated

693
00:29:31,289 --> 00:29:29,740
and processed into a form that the

694
00:29:33,119 --> 00:29:31,299
astronomer can actually use because

695
00:29:34,350 --> 00:29:33,129
there's a lot of engineering stuff in

696
00:29:36,210 --> 00:29:34,360
the background and whatnot thermal

697
00:29:38,639 --> 00:29:36,220
temperature gradients that have to be

698
00:29:40,169 --> 00:29:38,649
accounted for and distortions and images

699
00:29:41,660 --> 00:29:40,179
and so forth they get taken out as part

700
00:29:43,610 --> 00:29:41,670
of this process

701
00:29:45,500 --> 00:29:43,620
that's a huge huge process that involves

702
00:29:48,770 --> 00:29:45,510
hundreds of people here at the Institute

703
00:29:50,270 --> 00:29:48,780
to do and to keep the pipeline up to

704
00:29:52,280 --> 00:29:50,280
date where the calibration files and so

705
00:29:55,400 --> 00:29:52,290
forth and then the data gets archived

706
00:29:58,970 --> 00:29:55,410
and the astronomer comes to the archive

707
00:30:00,950 --> 00:29:58,980
to get their data and then the fun

708
00:30:03,320 --> 00:30:00,960
begins for the astronomer to actually do

709
00:30:07,850 --> 00:30:03,330
the science analysis and see what they

710
00:30:10,910 --> 00:30:07,860
can learn from the data okay so for the

711
00:30:12,620 --> 00:30:10,920
m83 project I wanted to just start with

712
00:30:16,700 --> 00:30:12,630
a kind of a big context picture here for

713
00:30:18,470 --> 00:30:16,710

a second because this is a big this is a

714
00:30:20,750 --> 00:30:18,480
big scientific project to observe

715
00:30:23,150 --> 00:30:20,760
stellar evolution star birth and star

716
00:30:25,070 --> 00:30:23,160
death in the local universe to determine

717
00:30:27,350 --> 00:30:25,080
how star formation is triggered how it

718
00:30:29,030 --> 00:30:27,360
happens how stars go through their

719
00:30:31,250 --> 00:30:29,040
lifetime the impact that they have on

720
00:30:33,770 --> 00:30:31,260
their host galaxies those are all very

721
00:30:35,660 --> 00:30:33,780
large-scale questions and it would take

722
00:30:37,850 --> 00:30:35,670
a very large Hubble program to really

723
00:30:40,130 --> 00:30:37,860
address that and so what happens is that

724
00:30:41,690 --> 00:30:40,140
people pick off a piece of that big

725
00:30:43,700 --> 00:30:41,700
picture and say here's a piece I can

726
00:30:45,890 --> 00:30:43,710
actually tackle in a reasonable size

727
00:30:48,400 --> 00:30:45,900
proposal and for me it was finding and

728
00:30:50,690 --> 00:30:48,410
studying the supernova remnants in m83

729
00:30:53,510 --> 00:30:50,700
we also want to tie that into the

730
00:30:55,280 --> 00:30:53,520
stellar component as well but but my

731
00:30:56,570 --> 00:30:55,290
particular interest in motivation for

732
00:30:58,790 --> 00:30:56,580
this was to look at the supernova

733
00:31:01,580 --> 00:30:58,800
remnants in this galaxy and it turns out

734
00:31:05,780 --> 00:31:01,590
the m83 is a particularly good spot to

735
00:31:07,190 --> 00:31:05,790
do this m83 is about 15 million light

736
00:31:08,420 --> 00:31:07,200
years away which sounds like a big

737
00:31:12,290 --> 00:31:08,430
number but it's actually relatively

738
00:31:13,880 --> 00:31:12,300

nearby big face on a spiral galaxy the

739
00:31:15,230 --> 00:31:13,890
starburst nucleus and lots of star

740
00:31:18,470 --> 00:31:15,240
formation going on even in the outer

741
00:31:20,240 --> 00:31:18,480
part of of the galaxy and the reason

742
00:31:22,700 --> 00:31:20,250
it's a good place to look for supernova

743
00:31:25,220 --> 00:31:22,710
remnants the things that are left over

744
00:31:26,780 --> 00:31:25,230
after the supernova the remnants of the

745
00:31:28,910 --> 00:31:26,790
supernova is because it's had a lot of

746
00:31:31,700 --> 00:31:28,920
supernovae it had at least six or

747
00:31:33,350 --> 00:31:31,710
possibly seven supernovae in the last

748
00:31:35,450 --> 00:31:33,360
hundred years and so it's basically

749
00:31:38,000 --> 00:31:35,460
popping them off with with great

750
00:31:41,210 --> 00:31:38,010
regularity and so there'll be of order

751
00:31:43,610 --> 00:31:41,220
then 60 or 70 young supernova remnants a

752
00:31:46,070 --> 00:31:43,620
less than a thousand years old and many

753
00:31:48,770 --> 00:31:46,080
hundreds then that would might be older

754
00:31:50,840 --> 00:31:48,780
still and still visible so it's a great

755
00:31:54,050 --> 00:31:50,850
place to to look for the supernova

756
00:31:55,220 --> 00:31:54,060
remnants that I want to find this galaxy

757
00:31:57,470 --> 00:31:55,230
is about a quarter of

758
00:31:59,060 --> 00:31:57,480
degree across if you know the full moon

759
00:32:00,650 --> 00:31:59,070
is about a half a degree across so if

760
00:32:02,380 --> 00:32:00,660
you could look up on the sky and see a

761
00:32:05,060 --> 00:32:02,390
maybe three like that you'd see a

762
00:32:06,650 --> 00:32:05,070
extended physical object up there in the

763
00:32:10,730 --> 00:32:06,660

sky it's a beautiful galaxy although it

764
00:32:12,980 --> 00:32:10,740
is in the southern sky okay so the idea

765
00:32:14,810 --> 00:32:12,990
in particular for me is to find the

766
00:32:16,580 --> 00:32:14,820
young supernovae in the population and

767
00:32:20,480 --> 00:32:16,590
I'll tell you why here as we go along a

768
00:32:22,220 --> 00:32:20,490
little bit but also you know to tie the

769
00:32:23,900 --> 00:32:22,230
supernova remnants that we find to the

770
00:32:25,880 --> 00:32:23,910
nearby stars and say can we actually

771
00:32:27,919 --> 00:32:25,890
determine something about the kind of

772
00:32:30,770 --> 00:32:27,929
star that exploded to create the

773
00:32:32,390 --> 00:32:30,780
supernova remnants that we see and then

774
00:32:34,370 --> 00:32:32,400
the big-picture stuff that how does the

775
00:32:37,190 --> 00:32:34,380
entire population of supernova remnants

776
00:32:38,780 --> 00:32:37,200
actually impact the host galaxy and to

777
00:32:41,090 --> 00:32:38,790
answer questions like that you actually

778
00:32:44,299 --> 00:32:41,100
want to combine let's say Hubble data

779
00:32:46,520 --> 00:32:44,309
with data from the x-ray satellite

780
00:32:48,110 --> 00:32:46,530
Chandra x-ray Observatory or maybe even

781
00:32:50,000 --> 00:32:48,120
the Spitzer Space Observatory for

782
00:32:53,960 --> 00:32:50,010
infrared data to put together the big

783
00:32:56,330 --> 00:32:53,970
the big picture there okay so here's a

784
00:32:58,640 --> 00:32:56,340
couple of well-known young supernova

785
00:33:01,070 --> 00:32:58,650
remnants in our galaxy the Crab Nebula

786
00:33:04,130 --> 00:33:01,080
course a very famous object almost a

787
00:33:06,799 --> 00:33:04,140
thousand years old and still expanding

788
00:33:08,510 --> 00:33:06,809

fairly rapidly and the Cassiopeia a

789
00:33:11,810 --> 00:33:08,520
supernova remnant which came from quite

790
00:33:14,720 --> 00:33:11,820
a massive star and this is a picture

791
00:33:16,669 --> 00:33:14,730
actually with Spitzer data in red the

792
00:33:18,169 --> 00:33:16,679
Hubble data is in yellow and the green

793
00:33:19,640 --> 00:33:18,179
and blue are two different energies of

794
00:33:21,770 --> 00:33:19,650
x-rays from the Challenger x-ray

795
00:33:23,570 --> 00:33:21,780
Observatory that that tells you right

796
00:33:25,340 --> 00:33:23,580
off the bat that supernova remnants he

797
00:33:27,620 --> 00:33:25,350
met across the entire electromagnetic

798
00:33:28,820 --> 00:33:27,630
spectrum and part that we see with

799
00:33:32,060 --> 00:33:28,830
Hubble is just the optical or

800
00:33:34,640 --> 00:33:32,070
near-infrared light typically but the

801
00:33:35,090 --> 00:33:34,650
Chandra data is also very interesting as

802
00:33:37,370 --> 00:33:35,100
well

803
00:33:39,590 --> 00:33:37,380
now these objects are nearby we see lots

804
00:33:41,510 --> 00:33:39,600
of structure in them and of course as we

805
00:33:43,600 --> 00:33:41,520
look way far away we don't see that kind

806
00:33:46,340 --> 00:33:43,610
of structure but this is just two

807
00:33:48,049 --> 00:33:46,350
objects and what's going on here they're

808
00:33:49,580 --> 00:33:48,059
very different this has got an active

809
00:33:52,280 --> 00:33:49,590
pulsar in here whipping around that's

810
00:33:56,120 --> 00:33:52,290
creating this this blue haze in here of

811
00:33:57,620 --> 00:33:56,130
a synchrotron radiation it's they're

812
00:33:59,270 --> 00:33:57,630
both expanding rapidly but this one is

813
00:34:01,130 --> 00:33:59,280

expanding at ten or twelve thousand

814
00:34:02,600 --> 00:34:01,140
kilometers per second this is 1,800

815
00:34:04,549 --> 00:34:02,610
kilometers per second this one is

816
00:34:07,340 --> 00:34:04,559
enriched in helium and nitrogen and

817
00:34:08,710 --> 00:34:07,350
carbon this one has oxygen sulphur argon

818
00:34:12,070 --> 00:34:08,720
all the heavy elements

819
00:34:13,570 --> 00:34:12,080
and is this typical we don't know we

820
00:34:15,220 --> 00:34:13,580
have two objects to look at and we have

821
00:34:17,169 --> 00:34:15,230
all these parameters that are changing

822
00:34:18,669 --> 00:34:17,179
and you'd really like to get a sample of

823
00:34:19,930 --> 00:34:18,679
yung reminisce that you could look at

824
00:34:22,300 --> 00:34:19,940
and try to understand some of the

825
00:34:23,740 --> 00:34:22,310
statistics of what's going on in young

826
00:34:25,599 --> 00:34:23,750
supernovae and then determine whether

827
00:34:27,520 --> 00:34:25,609
these are oddball objects or whether

828
00:34:29,290 --> 00:34:27,530
they are a kind of typical objects

829
00:34:32,980 --> 00:34:29,300
they're often taken to be typical and

830
00:34:35,500 --> 00:34:32,990
they're actually not so by going to a

831
00:34:37,330 --> 00:34:35,510
galaxy like m83 big face on galaxy if we

832
00:34:39,639 --> 00:34:37,340
could find 60 or 70 young remnants here

833
00:34:41,740 --> 00:34:39,649
that would be a big step forward and

834
00:34:44,710 --> 00:34:41,750
that was part of my motivation for this

835
00:34:46,540 --> 00:34:44,720
so I said that m83 has had six or seven

836
00:34:48,129 --> 00:34:46,550
historical supernovae here's their

837
00:34:51,790 --> 00:34:48,139
positions in the galaxy here

838
00:34:53,740 --> 00:34:51,800

I said six or seven because this one

839
00:34:55,510 --> 00:34:53,750
here in red is actually one that we

840
00:34:57,250 --> 00:34:55,520
found as part of the survey that I'll

841
00:35:00,940 --> 00:34:57,260
tell you about here the proposal that we

842
00:35:04,599 --> 00:35:00,950
wrote that turns out to be a supernova

843
00:35:05,650 --> 00:35:04,609
that nobody saw this is jumping ahead a

844
00:35:08,620 --> 00:35:05,660
little bit now because I'm showing you

845
00:35:10,870 --> 00:35:08,630
some results up here in this panel we've

846
00:35:13,210 --> 00:35:10,880
got two ground-based pictures here this

847
00:35:15,520 --> 00:35:13,220
is in emission lines and this is

848
00:35:18,220 --> 00:35:15,530
starlight and then here's the same

849
00:35:20,620 --> 00:35:18,230
filters than with Hubble emission lines

850
00:35:22,930 --> 00:35:20,630
and the Starlight of the same field of

851
00:35:24,940 --> 00:35:22,940
view this is one arcsecond we're looking

852
00:35:27,609 --> 00:35:24,950
at a tiny tiny piece of m83

853
00:35:29,500 --> 00:35:27,619
at this one little object here and it

854
00:35:32,770 --> 00:35:29,510
was quite intriguing because it is so

855
00:35:34,390 --> 00:35:32,780
small it's very small in size and yet

856
00:35:36,010 --> 00:35:34,400
when we took a spectrum of this object

857
00:35:37,839 --> 00:35:36,020
the squiggly line here is what we call a

858
00:35:40,089 --> 00:35:37,849
spectrum in astronomy and you see these

859
00:35:42,849 --> 00:35:40,099
big broad lines this is Doppler shifting

860
00:35:46,660 --> 00:35:42,859
of the emission lines in this picture

861
00:35:49,660 --> 00:35:46,670
and it says that it's expanding at 5,200

862
00:35:51,400 --> 00:35:49,670
kilometers per second this is a young

863
00:35:53,560 --> 00:35:51,410

object it's still flying out in the

864
00:35:55,960 --> 00:35:53,570
space and when you combine the expansion

865
00:35:58,000 --> 00:35:55,970
velocity and the upper limit on the size

866
00:35:59,770 --> 00:35:58,010
that comes from Hubble it tells us that

867
00:36:02,530 --> 00:35:59,780
it has to be less than a hundred years

868
00:36:05,079 --> 00:36:02,540
old and yet the supernova was not

869
00:36:07,329 --> 00:36:05,089
observed it was it could have just

870
00:36:09,880 --> 00:36:07,339
simply been that the supernova occurred

871
00:36:12,370 --> 00:36:09,890
when m83 was behind the Sun and by the

872
00:36:13,630 --> 00:36:12,380
time it came out nobody noticed it had

873
00:36:16,030 --> 00:36:13,640
faded quite a bit and it wasn't

874
00:36:17,859 --> 00:36:16,040
noticeable so it got missed so I say

875
00:36:19,599 --> 00:36:17,869
there's been seven supernovae even

876
00:36:21,040 --> 00:36:19,609
though one of them wasn't observed and

877
00:36:22,270 --> 00:36:21,050
that's actually resulted that came out

878
00:36:24,670 --> 00:36:22,280
on the project that I'm

879
00:36:26,050 --> 00:36:24,680
talking about here tonight so I think

880
00:36:28,240 --> 00:36:26,060
you can see the motivation here the

881
00:36:32,410 --> 00:36:28,250
spatial resolution that Hubble provides

882
00:36:34,090 --> 00:36:32,420
is just astounding and crucial for the

883
00:36:36,010 --> 00:36:34,100
kind of project that I want to do I want

884
00:36:37,450 --> 00:36:36,020
to measure the sizes of the supernova

885
00:36:39,340 --> 00:36:37,460
remnants that I find in m83

886
00:36:41,290 --> 00:36:39,350
to find the smallest ones which are the

887
00:36:42,940 --> 00:36:41,300
youngest ones and then understand their

888
00:36:44,830 --> 00:36:42,950

characteristics relative to the x-rays

889
00:36:45,850 --> 00:36:44,840
or to other other properties and of

890
00:36:49,960 --> 00:36:45,860
course I'm very interested in the other

891
00:36:51,520 --> 00:36:49,970
supernova remnants as well and so Hubble

892
00:36:54,130 --> 00:36:51,530
brings a lot to the table a spatial

893
00:36:55,780 --> 00:36:54,140
resolution of course and helps you out

894
00:36:57,430 --> 00:36:55,790
in complicated regions where at

895
00:36:59,440 --> 00:36:57,440
ground-based resolution stuff would be

896
00:37:01,390 --> 00:36:59,450
smeared out with an h2 region nearby a

897
00:37:02,950 --> 00:37:01,400
photo ionized region and it would make

898
00:37:04,720 --> 00:37:02,960
it hard to see the supernova remnant I

899
00:37:06,760 --> 00:37:04,730
can see it without where I couldn't see

900
00:37:08,830 --> 00:37:06,770
it from the ground and also the IR

901
00:37:11,740 --> 00:37:08,840
camera will come into play here in a

902
00:37:13,840 --> 00:37:11,750
moment because it lets us see through

903
00:37:15,490 --> 00:37:13,850
the dust and find supernova remnants

904
00:37:18,100 --> 00:37:15,500
that are hiding behind some of that

905
00:37:20,770 --> 00:37:18,110
brown dust that you saw in that that

906
00:37:22,240 --> 00:37:20,780
first picture so again I'm jumping ahead

907
00:37:23,740 --> 00:37:22,250
a little bit here because this is data

908
00:37:25,960 --> 00:37:23,750
from the survey that I'm talking about

909
00:37:27,700 --> 00:37:25,970
here above again these are ground-based

910
00:37:29,830 --> 00:37:27,710
pictures from the Magellan telescope

911
00:37:31,420 --> 00:37:29,840
here's the stars these are the emission

912
00:37:33,970 --> 00:37:31,430
lines and the things that show up kind

913
00:37:36,430 --> 00:37:33,980

of green yellow or white here are the

914
00:37:38,980 --> 00:37:36,440
things that were identified as supernova

915
00:37:40,450 --> 00:37:38,990
remnants so those four red circles and

916
00:37:42,640 --> 00:37:40,460
here in the Hubble emission line data

917
00:37:45,790 --> 00:37:42,650
you see the kind of greenish yellow

918
00:37:47,080 --> 00:37:45,800
shells here in three cases anyway kind

919
00:37:48,460 --> 00:37:47,090
of an oddball object here that's a

920
00:37:49,960 --> 00:37:48,470
little bit different shape but those

921
00:37:51,850 --> 00:37:49,970
four objects were supernova remnants

922
00:37:54,730 --> 00:37:51,860
that were identified from the ground but

923
00:37:57,100 --> 00:37:54,740
they were characterized by the Hubble

924
00:37:58,900 --> 00:37:57,110
data and allows us to see what's going

925
00:38:00,940 --> 00:37:58,910
on and you see I have a yellow circle

926
00:38:03,850 --> 00:38:00,950
here that doesn't seem to have anything

927
00:38:06,130 --> 00:38:03,860
defined in it and that's because if I

928
00:38:08,680 --> 00:38:06,140
now look at the infrared image from

929
00:38:10,630 --> 00:38:08,690
Hubble this is an iron - emission line

930
00:38:14,020 --> 00:38:10,640
image and again you see these four

931
00:38:16,450 --> 00:38:14,030
objects that we saw before but now you

932
00:38:18,730 --> 00:38:16,460
see there's also an object in the yellow

933
00:38:20,920 --> 00:38:18,740
circle that we didn't see and if you

934
00:38:22,690 --> 00:38:20,930
look at the Starlight you can see that

935
00:38:26,830 --> 00:38:22,700
that yellow circle is projected onto a

936
00:38:28,990 --> 00:38:26,840
dark band of dust that's a supernova

937
00:38:30,670 --> 00:38:29,000
remnant that is behind the dust so it

938
00:38:32,620 --> 00:38:30,680

didn't show up in the optical and we

939
00:38:34,750 --> 00:38:32,630
were able to find it with the iron two

940
00:38:35,350 --> 00:38:34,760
camera so that's another thing that that

941
00:38:38,980 --> 00:38:35,360
the Hubble

942
00:38:40,210 --> 00:38:38,990
a wide field camera it does for us okay

943
00:38:41,470 --> 00:38:40,220
so I got a step back now that I'm

944
00:38:42,790 --> 00:38:41,480
already showing you data but I haven't

945
00:38:44,320 --> 00:38:42,800
even gotten the proposal written yet

946
00:38:46,630 --> 00:38:44,330
right so we're going to go back and talk

947
00:38:48,010 --> 00:38:46,640
about the proposal and there's a lot of

948
00:38:49,810 --> 00:38:48,020
work that goes into this it typically

949
00:38:53,110 --> 00:38:49,820
takes about a month of effort not only

950
00:38:54,580 --> 00:38:53,120
on the person taking the lead on the

951
00:38:56,470 --> 00:38:54,590
proposal but the whole collaborative

952
00:38:58,540 --> 00:38:56,480
team if you put together a team of

953
00:39:01,090 --> 00:38:58,550
scientists we typically have several

954
00:39:02,500 --> 00:39:01,100
drafts of the science justification we

955
00:39:04,870 --> 00:39:02,510
have to decide all this technical stuff

956
00:39:07,390 --> 00:39:04,880
about which instrument which filters how

957
00:39:09,190 --> 00:39:07,400
much time is needed how does it layout

958
00:39:11,020 --> 00:39:09,200
into orbits because for Hubble I have to

959
00:39:14,500 --> 00:39:11,030
ask for a certain number of orbital

960
00:39:16,240 --> 00:39:14,510
viewing periods with Hubble and then we

961
00:39:19,360 --> 00:39:16,250
have to the important thing here is to

962
00:39:21,340 --> 00:39:19,370
write a clear science justification that

963
00:39:24,130 --> 00:39:21,350

tries to get the time through the peer

964
00:39:26,290 --> 00:39:24,140
review panel and obviously then the

965
00:39:28,540 --> 00:39:26,300
submit the proposal so just to give you

966
00:39:30,760 --> 00:39:28,550
a little flavor for this this is one of

967
00:39:33,430 --> 00:39:30,770
the Hubble exposure time calculators

968
00:39:35,860 --> 00:39:33,440
etc' we love acronyms and NASA right so

969
00:39:37,660 --> 00:39:35,870
here's the ETCs and you can see over

970
00:39:40,360 --> 00:39:37,670
here on the side that each instrument

971
00:39:43,930 --> 00:39:40,370
the ACS costs the stitch instrument all

972
00:39:45,550 --> 00:39:43,940
have multiple exposure time calculators

973
00:39:46,690 --> 00:39:45,560
for their different observing modes so

974
00:39:49,270 --> 00:39:46,700
when I've pulled up here is for the

975
00:39:52,480 --> 00:39:49,280
whiffs III and this is not this is just

976
00:39:54,520 --> 00:39:52,490
the first two two steps of a 15 step

977
00:39:56,260 --> 00:39:54,530
process that you have to set for every

978
00:39:57,910 --> 00:39:56,270
calculation of every object that you

979
00:39:59,530 --> 00:39:57,920
want to observe to show that you're

980
00:40:01,300 --> 00:39:59,540
getting the right amount of observing

981
00:40:03,460 --> 00:40:01,310
time to give you a good signal to noise

982
00:40:04,420 --> 00:40:03,470
ratio in your data and you can see the

983
00:40:07,270 --> 00:40:04,430
kind of things that you choose for

984
00:40:10,960 --> 00:40:07,280
imaging you choose a filter you set some

985
00:40:13,030 --> 00:40:10,970
detector parameters here you say do I

986
00:40:15,280 --> 00:40:13,040
want the exposure time needed to get to

987
00:40:18,310 --> 00:40:15,290
a certain signal-to-noise ratio or I can

988
00:40:19,660 --> 00:40:18,320

select for a thousand seconds or 900

989
00:40:21,520 --> 00:40:19,670
seconds what will the signal to noise

990
00:40:23,470 --> 00:40:21,530
ratio be you can do it either way and

991
00:40:25,150 --> 00:40:23,480
this goes down for about three or four

992
00:40:26,800 --> 00:40:25,160
more screens of information that you

993
00:40:29,380 --> 00:40:26,810
have to fill in for each calculation

994
00:40:31,330 --> 00:40:29,390
that you want to do with each observing

995
00:40:34,090 --> 00:40:31,340
mode or each filter so there's a lot of

996
00:40:36,520 --> 00:40:34,100
work just to do that part to scope out

997
00:40:38,230 --> 00:40:36,530
how much time you need then when you've

998
00:40:41,770 --> 00:40:38,240
got your x you put it into what's called

999
00:40:43,570 --> 00:40:41,780
the astronomers proposal tool and this

1000
00:40:44,800 --> 00:40:43,580
is just one piece of that where I've

1001
00:40:46,510 --> 00:40:44,810
already entered all the technical

1002
00:40:50,080 --> 00:40:46,520
information into the proposal and I've

1003
00:40:53,020 --> 00:40:50,090
asked apt to lay it out and two orbits

1004
00:40:54,880 --> 00:40:53,030
for me so that I can see how it fits and

1005
00:40:58,420 --> 00:40:54,890
whether it all works out and so these

1006
00:41:01,930 --> 00:40:58,430
blue speckled boxes are the observations

1007
00:41:04,780 --> 00:41:01,940
and so this whole thing is one orbit one

1008
00:41:06,340 --> 00:41:04,790
Hubble orbit and up to here is the

1009
00:41:07,900 --> 00:41:06,350
viewing part of the orbit where you can

1010
00:41:09,490 --> 00:41:07,910
see the target and then the earth gets

1011
00:41:11,620 --> 00:41:09,500
in the way the rest of the time out here

1012
00:41:13,240 --> 00:41:11,630
okay so here I've I've laid out my

1013
00:41:15,880 --> 00:41:13,250

observations into the orbital viewing

1014
00:41:18,130 --> 00:41:15,890
period I've got my data readouts they

1015
00:41:20,680 --> 00:41:18,140
all work out hidden behind other other

1016
00:41:22,450 --> 00:41:20,690
activities in this particular case I'm

1017
00:41:24,640 --> 00:41:22,460
actually taking some parallel data with

1018
00:41:27,340 --> 00:41:24,650
the other camera so down here are my

1019
00:41:31,390 --> 00:41:27,350
other observations laid out underneath

1020
00:41:35,380 --> 00:41:31,400
the primary observations and this is two

1021
00:41:37,510 --> 00:41:35,390
orbits out of 36 I had to lay out so

1022
00:41:39,100 --> 00:41:37,520
it's a big job just to write the

1023
00:41:41,770 --> 00:41:39,110
proposal is my point just to get the

1024
00:41:43,480 --> 00:41:41,780
proposal right and of course the

1025
00:41:45,070 --> 00:41:43,490
important part of this is really writing

1026
00:41:47,530 --> 00:41:45,080
the science justification that you hope

1027
00:41:51,970 --> 00:41:47,540
will convince the peer review that your

1028
00:41:55,180 --> 00:41:51,980
project is worth doing so it's a big job

1029
00:41:58,390 --> 00:41:55,190
okay but so there's a nasty little

1030
00:42:03,780 --> 00:41:58,400
secret behind the scenes here and that

1031
00:42:06,760 --> 00:42:03,790
is that each Hubble cycle is typically

1032
00:42:10,180 --> 00:42:06,770
oversubscribed by a factor of four to

1033
00:42:12,010 --> 00:42:10,190
six that is to say in these examples

1034
00:42:13,720 --> 00:42:12,020
here like let's take cycle 19 which is

1035
00:42:16,030 --> 00:42:13,730
where I got this proposal there were

1036
00:42:19,240 --> 00:42:16,040
over a thousand proposals submitted and

1037
00:42:23,770 --> 00:42:19,250
just 200 were accepted oversubscribed by

1038
00:42:25,510 --> 00:42:23,780

a factor of five so just writing a good

1039
00:42:27,250 --> 00:42:25,520
proposal is not good enough you have to

1040
00:42:29,590 --> 00:42:27,260
get lucky you have to write something

1041
00:42:31,390 --> 00:42:29,600
that the tach thinks is worthwhile above

1042
00:42:34,300 --> 00:42:31,400
other very good projects because in

1043
00:42:35,950 --> 00:42:34,310
every Hubble cycle good science gets

1044
00:42:40,050 --> 00:42:35,960
left on the table because there just

1045
00:42:42,850 --> 00:42:40,060
simply isn't enough observing time okay

1046
00:42:44,710 --> 00:42:42,860
so this is what really happens all right

1047
00:42:47,470 --> 00:42:44,720
here's my beautiful idea

1048
00:42:48,940 --> 00:42:47,480
I read my proposal I submitted and it

1049
00:42:51,460 --> 00:42:48,950
comes to the final selection then they

1050
00:42:53,920 --> 00:42:51,470
say no no how could they say that well

1051
00:42:56,290 --> 00:42:53,930
they did okay so you get feedback from

1052
00:42:58,960 --> 00:42:56,300
the tach you come back the next cycle

1053
00:43:00,059 --> 00:42:58,970
the next year okay and try again

1054
00:43:01,469 --> 00:43:00,069
sometimes you

1055
00:43:03,989 --> 00:43:01,479
that feedback and you revised your

1056
00:43:06,599 --> 00:43:03,999
proposal and you try again and you keep

1057
00:43:08,069 --> 00:43:06,609
going until you either give up or you

1058
00:43:12,630 --> 00:43:08,079
write a good-enough proposal and it gets

1059
00:43:16,410 --> 00:43:12,640
over the hump okay so here's where I

1060
00:43:18,180 --> 00:43:16,420
tried first cycle 15 back in 2006 I was

1061
00:43:19,380 --> 00:43:18,190
really focused on the young supernova

1062
00:43:22,680 --> 00:43:19,390
remnants that's where I started with

1063
00:43:25,529 --> 00:43:22,690

this process was not accepted so I tried

1064
00:43:26,699 --> 00:43:25,539
again the next year well I got some

1065
00:43:28,289 --> 00:43:26,709
collaborators that were interested in

1066
00:43:29,459 --> 00:43:28,299
the stellar populations and the stellar

1067
00:43:31,019 --> 00:43:29,469
part of the data set

1068
00:43:33,029 --> 00:43:31,029
not just the emission line part of the

1069
00:43:34,559 --> 00:43:33,039
data set okay we thought we put those

1070
00:43:37,109 --> 00:43:34,569
together and have a stronger proposal

1071
00:43:40,109 --> 00:43:37,119
which we did nope didn't get at that

1072
00:43:41,130 --> 00:43:40,119
time and next year we decided to try

1073
00:43:44,609 --> 00:43:41,140
something a little different because

1074
00:43:46,709 --> 00:43:44,619
since we did want Chandra time as well

1075
00:43:49,949 --> 00:43:46,719
and a lot of Chandra time this proposal

1076
00:43:52,949 --> 00:43:49,959
was for 700,000 seconds of Chandra time

1077
00:43:55,380 --> 00:43:52,959
to observe m83 and then we asked for the

1078
00:43:58,019 --> 00:43:55,390
Hubble time as part of the Chandra time

1079
00:44:00,120 --> 00:43:58,029
they have a joint allocation where you

1080
00:44:02,039 --> 00:44:00,130
could ask for both that way that was

1081
00:44:06,719 --> 00:44:02,049
close but no cigar they liked that a lot

1082
00:44:08,849 --> 00:44:06,729
but we didn't make it over the hub so we

1083
00:44:11,130 --> 00:44:08,859
came back the next year and tried again

1084
00:44:13,319 --> 00:44:11,140
and this time we decided to break him

1085
00:44:15,359 --> 00:44:13,329
apart again and go after the Chandra

1086
00:44:17,099 --> 00:44:15,369
time separately in the Chandra time it

1087
00:44:19,319 --> 00:44:17,109
wasn't just the supernova remnant it was

1088
00:44:21,299 --> 00:44:19,329

x-ray binaries it was the diffuse x-ray

1089
00:44:23,309 --> 00:44:21,309
gas there are a lot of different kinds

1090
00:44:25,949 --> 00:44:23,319
of science in that so we broke that off

1091
00:44:28,920 --> 00:44:25,959
and that time we actually got the

1092
00:44:30,479 --> 00:44:28,930
Chandra time but we didn't get the

1093
00:44:33,959 --> 00:44:30,489
Hubble time

1094
00:44:36,569 --> 00:44:33,969
now this time these were all a CS camera

1095
00:44:38,459 --> 00:44:36,579
and this was before the wif C 3 camera

1096
00:44:39,930 --> 00:44:38,469
was installed in the telescope but it

1097
00:44:41,910 --> 00:44:39,940
was the first year that they said you

1098
00:44:43,049 --> 00:44:41,920
could propose for it because after it

1099
00:44:45,599 --> 00:44:43,059
was installed that would be the

1100
00:44:48,900 --> 00:44:45,609
observing cycle so we tried to get with

1101
00:44:50,699 --> 00:44:48,910
C 3 we we did not get it but in the

1102
00:44:52,589 --> 00:44:50,709
meantime those two fields that I showed

1103
00:44:56,459 --> 00:44:52,599
you in the yellow boxes early on were

1104
00:44:58,439 --> 00:44:56,469
taken by the wif C 3 team and analyzing

1105
00:45:02,819 --> 00:44:58,449
those data helped us to convince them in

1106
00:45:06,989 --> 00:45:02,829
the next year to give us the time so we

1107
00:45:09,089 --> 00:45:06,999
got it in cycle 19 and we were delighted

1108
00:45:11,309 --> 00:45:09,099
to get that 36 orbits of prime time and

1109
00:45:14,010 --> 00:45:11,319
36 orbits in parallel with the ACS

1110
00:45:16,859 --> 00:45:14,020
camera that's a long haul

1111
00:45:20,190 --> 00:45:16,869
that's five years of effort just to get

1112
00:45:21,900 --> 00:45:20,200
the proposal accepted now you don't know

1113
00:45:23,100 --> 00:45:21,910

me I could have written crummy proposals

1114
00:45:25,680 --> 00:45:23,110
I'll tell you I didn't write a crummy

1115
00:45:27,300 --> 00:45:25,690
proposal but that's because of this over

1116
00:45:29,790 --> 00:45:27,310
subscription factor a lot of good things

1117
00:45:33,150 --> 00:45:29,800
get left on the table every time through

1118
00:45:39,270 --> 00:45:33,160
the process okay well I got an accepted

1119
00:45:41,460 --> 00:45:39,280
proposal now what happens well a lot

1120
00:45:43,290 --> 00:45:41,470
more work as it turns out so in this

1121
00:45:44,700 --> 00:45:43,300
chart this is kind of the process that

1122
00:45:46,470 --> 00:45:44,710
we've been talking about the peer review

1123
00:45:48,540 --> 00:45:46,480
the director accepts it and we've got an

1124
00:45:50,810 --> 00:45:48,550
accepted proposal and what happens well

1125
00:45:53,580 --> 00:45:50,820
we come back on we do not pass go and we

1126
00:45:55,410 --> 00:45:53,590
start all over again and what's called a

1127
00:45:58,710 --> 00:45:55,420
phase 2 process that's where I have to

1128
00:46:00,780 --> 00:45:58,720
write the actual details of the

1129
00:46:02,850 --> 00:46:00,790
observing plan into a file that is

1130
00:46:05,040 --> 00:46:02,860
submitted I have to do a grant if you

1131
00:46:06,990 --> 00:46:05,050
want to get money to support student or

1132
00:46:09,660 --> 00:46:07,000
whatever

1133
00:46:11,640 --> 00:46:09,670
once that's submitted then the people

1134
00:46:13,620 --> 00:46:11,650
here have to go through a process of

1135
00:46:16,230 --> 00:46:13,630
cleaning up that proposal and whatnot

1136
00:46:19,200 --> 00:46:16,240
which oftentimes involves iteration back

1137
00:46:20,910 --> 00:46:19,210
with the user to to clear things up we

1138
00:46:23,370 --> 00:46:20,920

build a long-range plan this full-year

1139
00:46:25,140 --> 00:46:23,380
plan where they check for GuideStar

1140
00:46:26,370 --> 00:46:25,150
availability other observing constraints

1141
00:46:28,710 --> 00:46:26,380
any constraints that I've put in the

1142
00:46:30,690 --> 00:46:28,720
proposal I'll go into figuring out when

1143
00:46:32,520 --> 00:46:30,700
in the year it can be observed we peel

1144
00:46:34,920 --> 00:46:32,530
off these one week at a time to do the

1145
00:46:37,410 --> 00:46:34,930
weekly schedules and we get the commands

1146
00:46:41,760 --> 00:46:37,420
ready to go up each of these boxes here

1147
00:46:43,890 --> 00:46:41,770
is 15 20 people working full-time to do

1148
00:46:45,650 --> 00:46:43,900
this right so it's a lot of effort to

1149
00:46:48,180 --> 00:46:45,660
make this happen

1150
00:46:50,460 --> 00:46:48,190
all right the commands go up to the

1151
00:46:54,240 --> 00:46:50,470
telescope and we take data and that's a

1152
00:46:56,010 --> 00:46:54,250
red-letter day but then we have to get

1153
00:46:57,720 --> 00:46:56,020
the data down to the ground and for

1154
00:46:59,310 --> 00:46:57,730
Hubble it actually comes through the

1155
00:47:02,520 --> 00:46:59,320
tracking and data relay satellite system

1156
00:47:04,950 --> 00:47:02,530
it comes down to White Sands ground

1157
00:47:06,630 --> 00:47:04,960
station in New Mexico it gets shipped to

1158
00:47:08,880 --> 00:47:06,640
Goddard Space Flight Center and it

1159
00:47:13,470 --> 00:47:08,890
finally makes its way to the Institute

1160
00:47:21,280 --> 00:47:18,270
now I won't go into detail but again

1161
00:47:23,920 --> 00:47:21,290
basically what's going on here is that

1162
00:47:25,510 --> 00:47:23,930
data processing and calibration step and

1163
00:47:28,120 --> 00:47:25,520

then the archiving and distribution

1164
00:47:30,190 --> 00:47:28,130
steps over here this involves many

1165
00:47:32,170 --> 00:47:30,200
databases there's engineering database

1166
00:47:34,120 --> 00:47:32,180
there's data the data processing

1167
00:47:37,120 --> 00:47:34,130
parameters that go into the science data

1168
00:47:39,030 --> 00:47:37,130
processing calibration and so forth then

1169
00:47:42,430 --> 00:47:39,040
the data gets put to the archive and it

1170
00:47:44,350 --> 00:47:42,440
gets obviously there's big databases

1171
00:47:46,810 --> 00:47:44,360
that they have to run the whole archival

1172
00:47:49,240 --> 00:47:46,820
process and stuff as well the part of

1173
00:47:51,100 --> 00:47:49,250
this process that the user sees that's

1174
00:47:53,020 --> 00:47:51,110
just right there it's like I get a

1175
00:47:55,420 --> 00:47:53,030
message that says data are available I

1176
00:47:57,460 --> 00:47:55,430
say okay give me the data stager it's

1177
00:47:59,320 --> 00:47:57,470
ready okay I download it I come as a

1178
00:48:06,150 --> 00:47:59,330
proposer by the way they actually

1179
00:48:07,750 --> 00:48:06,160
modeled this after me you see that but I

1180
00:48:09,610 --> 00:48:07,760
don't know you think of high-class

1181
00:48:11,550 --> 00:48:09,620
telescope we have a higher quality icon

1182
00:48:14,860 --> 00:48:11,560
than that but anyway that's what we got

1183
00:48:16,060 --> 00:48:14,870
anyway you see I finally got my data and

1184
00:48:19,750 --> 00:48:16,070
so I can do something with it

1185
00:48:22,720 --> 00:48:19,760
well maybe you can understand now why it

1186
00:48:24,700 --> 00:48:22,730
takes so many people to operate a Space

1187
00:48:26,800 --> 00:48:24,710
Telescope there are just so many things

1188
00:48:28,750 --> 00:48:26,810

behind the scenes that make this all

1189
00:48:32,740 --> 00:48:28,760
happen not only for the scientist in his

1190
00:48:36,280 --> 00:48:32,750
and his or her collaborators but for the

1191
00:48:38,320 --> 00:48:36,290
data processing and the whole system for

1192
00:48:39,760 --> 00:48:38,330
planning and scheduling as well this was

1193
00:48:41,680 --> 00:48:39,770
back after the last servicing mission

1194
00:48:42,910 --> 00:48:41,690
the astronauts came to visit and so some

1195
00:48:44,680 --> 00:48:42,920
of these are family members but there

1196
00:48:49,990 --> 00:48:44,690
are hundreds of people that work on

1197
00:48:52,420 --> 00:48:50,000
Hubble that make all that happen okay

1198
00:48:55,210 --> 00:48:52,430
well I've got data now what well the

1199
00:48:57,490 --> 00:48:55,220
data comes through as individual files

1200
00:49:00,040 --> 00:48:57,500
of each of the exposures that was done

1201
00:49:02,530 --> 00:49:00,050
and to stitch it together into the

1202
00:49:04,240 --> 00:49:02,540
datasets that I need to do my analysis

1203
00:49:06,250 --> 00:49:04,250
takes a lot of work we have to line

1204
00:49:09,730 --> 00:49:06,260
everything up on a coordinate system

1205
00:49:12,400 --> 00:49:09,740
it's called astrometry we have to build

1206
00:49:13,870 --> 00:49:12,410
these big mosaic images that you saw we

1207
00:49:15,390 --> 00:49:13,880
have to measure the stars and the star

1208
00:49:18,160 --> 00:49:15,400
clusters and all those different

1209
00:49:20,920 --> 00:49:18,170
continuum bands to get their colors and

1210
00:49:22,690 --> 00:49:20,930
their properties their sizes for my

1211
00:49:24,460 --> 00:49:22,700
emission line stuff for the supernova

1212
00:49:24,980 --> 00:49:24,470
remnant so I have to actually scale and

1213
00:49:27,950 --> 00:49:24,990

so

1214
00:49:30,140 --> 00:49:27,960
tract the residual starlight to get pure

1215
00:49:32,030 --> 00:49:30,150
emission line images to find the

1216
00:49:34,190 --> 00:49:32,040
supernova remnants and then finally I

1217
00:49:36,200 --> 00:49:34,200
can actually do what I really wanted to

1218
00:49:39,770 --> 00:49:36,210
do which is to search those data and

1219
00:49:40,850 --> 00:49:39,780
find the supernova remnants okay once I

1220
00:49:44,990 --> 00:49:40,860
found the super over and that's that I

1221
00:49:46,280 --> 00:49:45,000
have to actually try to get the relevant

1222
00:49:48,590 --> 00:49:46,290
information out of those as well

1223
00:49:50,150 --> 00:49:48,600
including the sizes of the objects the

1224
00:49:52,220 --> 00:49:50,160
fluxes and the different emission lines

1225
00:49:55,010 --> 00:49:52,230
and so forth so I could do the rest of

1226
00:49:56,420 --> 00:49:55,020
the analysis and then if you want to

1227
00:49:58,910 --> 00:49:56,430
compare to other things like Chandra

1228
00:50:01,190 --> 00:49:58,920
data and whatnot it happens after all

1229
00:50:03,200 --> 00:50:01,200
that other work so I wanted to give you

1230
00:50:04,460 --> 00:50:03,210
a little sense for what we found I can't

1231
00:50:06,080 --> 00:50:04,470
spend a lot of time on that I could

1232
00:50:08,390 --> 00:50:06,090
spend the whole talk on that but

1233
00:50:10,400 --> 00:50:08,400
basically we found a lot of supernova

1234
00:50:12,590 --> 00:50:10,410
remnants the green circles there on the

1235
00:50:14,300 --> 00:50:12,600
left hand side are the supernova

1236
00:50:16,190 --> 00:50:14,310
remnants that were found in combination

1237
00:50:18,109 --> 00:50:16,200
between Hubble and our ground-based

1238
00:50:20,450 --> 00:50:18,119

survey because you can see some of them

1239
00:50:22,100 --> 00:50:20,460
are outside the Hubble footprint there

1240
00:50:24,440 --> 00:50:22,110
but all the ones inside the yellow box

1241
00:50:26,540 --> 00:50:24,450
we were able to measure their sizes and

1242
00:50:28,700 --> 00:50:26,550
quantify their properties with the

1243
00:50:30,700 --> 00:50:28,710
Hubble dataset and over here I'm

1244
00:50:33,200 --> 00:50:30,710
actually showing you the Chandra x-ray

1245
00:50:35,930 --> 00:50:33,210
data on the same scale of course it

1246
00:50:38,240 --> 00:50:35,940
doesn't have the same resolution as a

1247
00:50:40,220 --> 00:50:38,250
ground-based or even as Hubble but it's

1248
00:50:41,930 --> 00:50:40,230
pretty good you see a lot of point

1249
00:50:44,000 --> 00:50:41,940
sources in here a lot of those are x-ray

1250
00:50:46,220 --> 00:50:44,010
binaries and m83 some of them are

1251
00:50:48,290 --> 00:50:46,230
background sources there are a little

1252
00:50:49,940 --> 00:50:48,300
red dots every once in a while many of

1253
00:50:51,830 --> 00:50:49,950
those are actually supernova remnants

1254
00:50:53,530 --> 00:50:51,840
that show up in the red part of the

1255
00:50:56,630 --> 00:50:53,540
x-ray band here that I'm showing

1256
00:50:59,840 --> 00:50:56,640
relatively low energy x-rays but also

1257
00:51:02,000 --> 00:50:59,850
look at the diffuse gas that just fills

1258
00:51:03,170 --> 00:51:02,010
the spiral arms and basically just kind

1259
00:51:04,700 --> 00:51:03,180
of follows where you have a lot of

1260
00:51:08,030 --> 00:51:04,710
supernova remnants you've got a lot of

1261
00:51:11,240 --> 00:51:08,040
diffuse x-ray emission as well we're

1262
00:51:13,220 --> 00:51:11,250
actually energizing the interstellar

1263
00:51:14,870 --> 00:51:13,230

medium of that galaxy by all the

1264
00:51:16,790 --> 00:51:14,880
supernovae that have happened over tens

1265
00:51:18,590 --> 00:51:16,800
of thousands of years and that whole

1266
00:51:20,240 --> 00:51:18,600
that's the but you wouldn't know this

1267
00:51:22,609 --> 00:51:20,250
what if I didn't tell you that is the

1268
00:51:25,730 --> 00:51:22,619
brightest diffuse x-ray emission in any

1269
00:51:30,330 --> 00:51:25,740
galaxy that we've ever observed and it's

1270
00:51:33,870 --> 00:51:32,460
okay so I just wanted to show a close-up

1271
00:51:36,240 --> 00:51:33,880
view of a few of these to give you an

1272
00:51:39,570 --> 00:51:36,250
idea of what the Hubbell resolution does

1273
00:51:41,310 --> 00:51:39,580
for us now this is uh the infrared band

1274
00:51:43,590 --> 00:51:41,320
I was telling you before here's the the

1275
00:51:45,780 --> 00:51:43,600
emission line data from Hubble here's

1276
00:51:48,600 --> 00:51:45,790
the starlight from Hubble and here's the

1277
00:51:50,280 --> 00:51:48,610
Chandra x-ray data over here typically

1278
00:51:52,680 --> 00:51:50,290
in the x-ray they show this red color

1279
00:51:54,780 --> 00:51:52,690
and this display those are relatively

1280
00:51:57,120 --> 00:51:54,790
low energy or soft x-rays we call them

1281
00:51:59,010 --> 00:51:57,130
but there's one object here this kind of

1282
00:52:00,750 --> 00:51:59,020
very young one has a very different

1283
00:52:02,280 --> 00:52:00,760
character to its x-ray emission compared

1284
00:52:04,200 --> 00:52:02,290
to the others and it turns out to be the

1285
00:52:05,460 --> 00:52:04,210
smallest of the three that I'm I'll show

1286
00:52:08,340 --> 00:52:05,470
you here it's the youngest one that

1287
00:52:10,380 --> 00:52:08,350
we're looking at here and but you also

1288
00:52:13,200 --> 00:52:10,390

see that it is kind of projected against

1289
00:52:15,060 --> 00:52:13,210
this band of dust and part of that

1290
00:52:17,100 --> 00:52:15,070
coloration change may just be because

1291
00:52:18,780 --> 00:52:17,110
it's behind the dust part of it maybe

1292
00:52:20,610 --> 00:52:18,790
there might be a young pulsar like a

1293
00:52:22,680 --> 00:52:20,620
Crab Nebula type of thing going on in

1294
00:52:26,340 --> 00:52:22,690
this very young object and it changes

1295
00:52:27,720 --> 00:52:26,350
the character of the x-ray emission this

1296
00:52:29,190 --> 00:52:27,730
one here is a middle-aged one that you

1297
00:52:32,010 --> 00:52:29,200
can see is actually resolved on it into

1298
00:52:33,690 --> 00:52:32,020
a little expanding shell this was in

1299
00:52:35,730 --> 00:52:33,700
between the other two that's a fairly

1300
00:52:38,100 --> 00:52:35,740
young one but you see it's projected

1301
00:52:39,480 --> 00:52:38,110
right against a cluster of stars and by

1302
00:52:40,710 --> 00:52:39,490
looking at the properties of those stars

1303
00:52:43,020 --> 00:52:40,720
we can say that the star that exploded

1304
00:52:46,350 --> 00:52:43,030
here was probably more than fifteen

1305
00:52:48,750 --> 00:52:46,360
solar masses before it exploded so

1306
00:52:50,640 --> 00:52:48,760
combining all these datasets in this way

1307
00:52:51,870 --> 00:52:50,650
you can start to piece together some of

1308
00:52:55,590 --> 00:52:51,880
those they answers to some of those

1309
00:52:59,400 --> 00:52:55,600
questions that I initially wanted to to

1310
00:53:02,520 --> 00:52:59,410
answer well we got to the publication we

1311
00:53:05,550 --> 00:53:02,530
actually did it that was in 2014 June it

1312
00:53:08,430 --> 00:53:05,560
was in 2006 when I first proposed for it

1313
00:53:11,130 --> 00:53:08,440

so that's yeah that's a long time to get

1314
00:53:12,690 --> 00:53:11,140
a science result out and what else did

1315
00:53:14,940 --> 00:53:12,700
we do with the data well we actually ran

1316
00:53:17,580 --> 00:53:14,950
an education and outreach program it's

1317
00:53:21,480 --> 00:53:17,590
called a citizen science project on the

1318
00:53:23,730 --> 00:53:21,490
star cluster population and m83 my

1319
00:53:26,010 --> 00:53:23,740
friend Redmond Whitmore at the Institute

1320
00:53:27,810 --> 00:53:26,020
here kind of headlined the preparation

1321
00:53:29,790 --> 00:53:27,820
of this or whatever and the idea was

1322
00:53:32,640 --> 00:53:29,800
that just by visually inspecting what

1323
00:53:34,470 --> 00:53:32,650
the clusters of stars look like you can

1324
00:53:38,430 --> 00:53:34,480
actually do a crude age-dating

1325
00:53:41,010 --> 00:53:38,440
of the cluster and by looking at 2600

1326
00:53:42,360 --> 00:53:41,020
clusters and having citizen scientists

1327
00:53:43,830 --> 00:53:42,370
people like yourself come online and

1328
00:53:45,390 --> 00:53:43,840
look at these images and

1329
00:53:47,840 --> 00:53:45,400
defy them according to this kind of a

1330
00:53:50,640 --> 00:53:47,850
scale we were able to amass a huge

1331
00:53:53,100 --> 00:53:50,650
classification an age distribution of

1332
00:53:55,020 --> 00:53:53,110
the star clusters in m83 without having

1333
00:53:58,230 --> 00:53:55,030
to look at all 2600 clusters ourselves

1334
00:53:59,970 --> 00:53:58,240
to make that determination but here you

1335
00:54:01,890 --> 00:53:59,980
can see very young clusters only 3

1336
00:54:04,830 --> 00:54:01,900
million years old are embedded in H

1337
00:54:06,390 --> 00:54:04,840
alpha emission from the the gas it

1338
00:54:07,770 --> 00:54:06,400

starts to blow it away so that's a

1339
00:54:09,570 --> 00:54:07,780
little bit older here it's in the

1340
00:54:11,760 --> 00:54:09,580
process of blowing it away so it's a

1341
00:54:13,740 --> 00:54:11,770
little older still now the gas is gone

1342
00:54:15,270 --> 00:54:13,750
but we still have lots of lots of blue

1343
00:54:16,920 --> 00:54:15,280
stars and you kind of resolve some of

1344
00:54:19,620 --> 00:54:16,930
the structures there and then as those

1345
00:54:22,800 --> 00:54:19,630
more massive stars go away you get just

1346
00:54:25,290 --> 00:54:22,810
a fuzzy ball that's extended more than a

1347
00:54:28,230 --> 00:54:25,300
point source and then the color becomes

1348
00:54:31,470 --> 00:54:28,240
render as it ages out to in this case is

1349
00:54:33,240 --> 00:54:31,480
out to 500 million years old so that was

1350
00:54:34,710 --> 00:54:33,250
just uh you know the other side of the

1351
00:54:37,970 --> 00:54:34,720
project not the supernova remnants were

1352
00:54:40,380 --> 00:54:37,980
involved in a lot of the cluster work

1353
00:54:42,840 --> 00:54:40,390
what we've gone to a lot of work to put

1354
00:54:44,490 --> 00:54:42,850
together these mosaics and so we

1355
00:54:46,080 --> 00:54:44,500
delivered them to the master archive is

1356
00:54:49,920 --> 00:54:46,090
what's called a high-level science

1357
00:54:51,840 --> 00:54:49,930
product and that was partly so that

1358
00:54:54,210 --> 00:54:51,850
other astronomers could come and use the

1359
00:54:55,680 --> 00:54:54,220
data as a starting point for their own

1360
00:54:57,930 --> 00:54:55,690
work without having to do all that

1361
00:54:59,610 --> 00:54:57,940
background work to make the mosaics in

1362
00:55:02,430 --> 00:54:59,620
the line of different fields and so

1363
00:55:06,210 --> 00:55:02,440

forth and so on and apparently this

1364
00:55:09,360 --> 00:55:06,220
worked because here is a list of the

1365
00:55:12,030 --> 00:55:09,370
articles that have used the data set

1366
00:55:14,940 --> 00:55:12,040
that I was that I got from my program

1367
00:55:17,250 --> 00:55:14,950
only a few of these are actually by me

1368
00:55:19,170 --> 00:55:17,260
or by one of my close collaborators most

1369
00:55:21,930 --> 00:55:19,180
of these are by other people that found

1370
00:55:24,000 --> 00:55:21,940
that data useful for their own science

1371
00:55:25,740 --> 00:55:24,010
projects so it was definitely a

1372
00:55:28,740 --> 00:55:25,750
worthwhile thing to do once we got the

1373
00:55:30,960 --> 00:55:28,750
data there's actually a whole nother set

1374
00:55:32,820 --> 00:55:30,970
of articles that were written on those

1375
00:55:34,500 --> 00:55:32,830
first two fields of data or on our

1376
00:55:36,390 --> 00:55:34,510
reprocessed versions of them and we

1377
00:55:38,700 --> 00:55:36,400
combined it with our more extensive

1378
00:55:41,280 --> 00:55:38,710
study and so these articles as well as

1379
00:55:43,170 --> 00:55:41,290
the other articles all came out of that

1380
00:55:44,970 --> 00:55:43,180
data set and quite frankly I have three

1381
00:55:47,640 --> 00:55:44,980
or four active projects that are still

1382
00:55:51,140 --> 00:55:47,650
going on with different collaborators on

1383
00:55:55,170 --> 00:55:51,150
various aspects of this data set so

1384
00:55:56,940 --> 00:55:55,180
that's quite a story behind behind one

1385
00:55:57,660 --> 00:55:56,950
of those pictures on the on the first

1386
00:56:00,059 --> 00:55:57,670
page of our

1387
00:56:02,910 --> 00:56:00,069
presentation here today I want to just

1388
00:56:04,980 --> 00:56:02,920

give you a little heads-up on one other

1389
00:56:07,559 --> 00:56:04,990
thing that we found that that was a

1390
00:56:10,230 --> 00:56:07,569
complete surprise and it combined our

1391
00:56:13,079 --> 00:56:10,240
x-ray data with the Hubble data in a

1392
00:56:14,069 --> 00:56:13,089
fascinating way Hubble had actually

1393
00:56:17,549 --> 00:56:14,079
looked at m83

1394
00:56:19,140 --> 00:56:17,559
back in the year 2000 I'm sorry Chandra

1395
00:56:21,390 --> 00:56:19,150
had looked at it in the x-rays here

1396
00:56:23,250 --> 00:56:21,400
that's the starburst nucleus here's the

1397
00:56:26,640 --> 00:56:23,260
one spiral I'm coming out and out here

1398
00:56:28,650 --> 00:56:26,650
in the middle is nothing but in 2010 in

1399
00:56:30,420 --> 00:56:28,660
2011 when we observe there is the

1400
00:56:32,130 --> 00:56:30,430
brightest point x-ray source except for

1401
00:56:33,750 --> 00:56:32,140
the the nucleus has got a bunch of stuff

1402
00:56:36,059 --> 00:56:33,760
in here but that's the brightest source

1403
00:56:38,880 --> 00:56:36,069
in the galaxy and yet there was nothing

1404
00:56:39,960 --> 00:56:38,890
there back in the year 2000 so we went

1405
00:56:43,230 --> 00:56:39,970
looked at the Hubble data that were

1406
00:56:45,240 --> 00:56:43,240
taken as part of the initial early

1407
00:56:47,789 --> 00:56:45,250
release science result and this is what

1408
00:56:49,260 --> 00:56:47,799
this has now assumed way into that just

1409
00:56:50,700 --> 00:56:49,270
a tiny in the center of that yellow box

1410
00:56:53,010 --> 00:56:50,710
now we're looking at the Hubble data

1411
00:56:54,660 --> 00:56:53,020
here's a few red stars nothing very

1412
00:56:56,280 --> 00:56:54,670
interesting going on and right in the

1413
00:56:58,500 --> 00:56:56,290

center here are those white tick marks

1414
00:57:01,079 --> 00:56:58,510
is where the position of the x-ray

1415
00:57:05,130 --> 00:57:01,089
source was supposed to be and so we said

1416
00:57:06,630 --> 00:57:05,140
well this was 2009 was 2010 what if it

1417
00:57:07,500 --> 00:57:06,640
just went off recently so why don't we

1418
00:57:09,630 --> 00:57:07,510
look at it again

1419
00:57:10,890 --> 00:57:09,640
so 2011 we went back with Hubble and

1420
00:57:14,490 --> 00:57:10,900
looked at it again and sure enough

1421
00:57:17,609 --> 00:57:14,500
there's a blue source right at the x-ray

1422
00:57:19,799 --> 00:57:17,619
position and that blue light is coming

1423
00:57:22,349 --> 00:57:19,809
from a binary star around the black hole

1424
00:57:23,970 --> 00:57:22,359
and material pulled off the star must

1425
00:57:26,010 --> 00:57:23,980
have just gotten close enough that it

1426
00:57:27,839 --> 00:57:26,020
started to pull material in and as it

1427
00:57:30,299 --> 00:57:27,849
swirls in it heats up and that UV and

1428
00:57:33,539 --> 00:57:30,309
optical blue light is what we're seeing

1429
00:57:35,309 --> 00:57:33,549
in the Hubble data complete surprise to

1430
00:57:38,670 --> 00:57:35,319
us this is very this is called an

1431
00:57:40,859 --> 00:57:38,680
ultraluminous x-ray source ulx because

1432
00:57:43,500 --> 00:57:40,869
of its brightness and the x-rays and

1433
00:57:45,240 --> 00:57:43,510
it's fascinating because we've seen

1434
00:57:47,190 --> 00:57:45,250
these things before in other galaxies

1435
00:57:49,319 --> 00:57:47,200
but we've never seen one before it got

1436
00:57:52,260 --> 00:57:49,329
bright and so people look at this and

1437
00:57:53,819 --> 00:57:52,270
they say ah it's a blue star because we

1438
00:57:55,530 --> 00:57:53,829

see blue light it's the blue star here

1439
00:57:57,690 --> 00:57:55,540
this that's that's sending material over

1440
00:57:59,760 --> 00:57:57,700
onto the black hole we say no there's no

1441
00:58:01,500 --> 00:57:59,770
blue source there it's only blue after

1442
00:58:04,710 --> 00:58:01,510
it starts to accrete the material we're

1443
00:58:07,710 --> 00:58:04,720
seeing the actual accretion disk here in

1444
00:58:08,640 --> 00:58:07,720
in the blue light that Hubble sees so

1445
00:58:10,230 --> 00:58:08,650
that was that was a neat little

1446
00:58:12,210 --> 00:58:10,240
sidelight

1447
00:58:14,850 --> 00:58:12,220
and of course we participated in the

1448
00:58:16,260 --> 00:58:14,860
hubble heritage release for this if you

1449
00:58:18,030 --> 00:58:16,270
actually go to the hubble heritage page

1450
00:58:20,190 --> 00:58:18,040
and go into some of the supplemental

1451
00:58:21,690 --> 00:58:20,200
information you can actually pull up a

1452
00:58:23,370 --> 00:58:21,700
version of this picture that allows you

1453
00:58:26,070 --> 00:58:23,380
to zoom into it and pan around

1454
00:58:27,690 --> 00:58:26,080
it's really quite spectacular a lot of

1455
00:58:29,370 --> 00:58:27,700
fun to do that and some other materials

1456
00:58:31,580 --> 00:58:29,380
that were put together for each of these

1457
00:58:36,210 --> 00:58:31,590
heritage releases it's a fabulous

1458
00:58:37,350 --> 00:58:36,220
resource out there so just to kind of

1459
00:58:39,500 --> 00:58:37,360
close things out

1460
00:58:43,859 --> 00:58:39,510
well we found lots of supernova remnants

1461
00:58:45,540 --> 00:58:43,869
we actually did not find many that look

1462
00:58:47,210 --> 00:58:45,550
like what we expected I didn't have time

1463
00:58:49,770 --> 00:58:47,220

to really talk about that tonight but

1464
00:58:51,570 --> 00:58:49,780
but we did I did show you how the

1465
00:58:54,359 --> 00:58:51,580
supernova remnants are actually

1466
00:58:55,710 --> 00:58:54,369
energizing the entire interstellar

1467
00:58:59,580 --> 00:58:55,720
medium and the spiral arms of this

1468
00:59:01,770 --> 00:58:59,590
galaxy in a big way we are looking at

1469
00:59:04,680 --> 00:59:01,780
the stars nearby to determine the masses

1470
00:59:06,000 --> 00:59:04,690
of of the precursor stars in many cases

1471
00:59:09,840 --> 00:59:06,010
many more cases than were available

1472
00:59:14,010 --> 00:59:09,850
before and interestingly enough when the

1473
00:59:15,060 --> 00:59:14,020
next supernova goes off at m83 we're

1474
00:59:18,180 --> 00:59:15,070
going to be able to look back at these

1475
00:59:19,800 --> 00:59:18,190
data and find the star before it blew up

1476
00:59:23,000 --> 00:59:19,810
and know what kind of star it was

1477
00:59:25,320 --> 00:59:23,010
directly by observing the precursor star

1478
00:59:26,790 --> 00:59:25,330
and of course I hope you've got an

1479
00:59:30,660 --> 00:59:26,800
indication that it really does take

1480
00:59:32,220 --> 00:59:30,670
tremendous dedication effort and the

1481
00:59:34,970 --> 00:59:32,230
talents of many people here at the

1482
00:59:39,510 --> 00:59:34,980
Institute to make results like this

1483
00:59:42,450 --> 00:59:39,520
possible now I'm proud dating myself by

1484
00:59:46,800 --> 00:59:42,460
showing this but every picture tells a

1485
00:59:49,500 --> 00:59:46,810
story donut and think of all the other

1486
00:59:50,290 --> 00:59:49,510
stories we could tell thanks for

1487
01:00:00,470 --> 00:59:50,300
listening

1488
01:00:08,069 --> 01:00:05,809

Eminiar how many hours do I work a week

1489
01:00:09,930 --> 01:00:08,079
depends on what you call work some of

1490
01:00:12,269 --> 01:00:09,940
the so fun you know I can't I can't

1491
01:00:14,849 --> 01:00:12,279
chalk it up to work it is a challenge

1492
01:00:17,430 --> 01:00:14,859
for me to do the research side of my job

1493
01:00:20,849 --> 01:00:17,440
because really I get very little support

1494
01:00:22,589 --> 01:00:20,859
money to do that side of my job I get

1495
01:00:24,839 --> 01:00:22,599
some support money to do the functional

1496
01:00:27,630 --> 01:00:24,849
role of trying to explain how you know

1497
01:00:30,329 --> 01:00:27,640
the astronomers are set up here in terms

1498
01:00:32,339 --> 01:00:30,339
of what they do in turn their functional

1499
01:00:36,059 --> 01:00:32,349
versus their scientific work yeah so a

1500
01:00:38,009 --> 01:00:36,069
lot of the science staff here are on 50

1501
01:00:39,870 --> 01:00:38,019
50 positions 50 percent their own

1502
01:00:41,910 --> 01:00:39,880
research time or whatever activities

1503
01:00:44,849 --> 01:00:41,920
they want to do at 50 percent support

1504
01:00:47,190 --> 01:00:44,859
work others are on an 80/20 eighty

1505
01:00:48,749 --> 01:00:47,200
percent functional xx percent support

1506
01:00:50,640 --> 01:00:48,759
although if they get grant money they

1507
01:00:53,009 --> 01:00:50,650
can buy more of their time back to work

1508
01:00:54,839 --> 01:00:53,019
on research so it's always a balance of

1509
01:00:56,880 --> 01:00:54,849
finding the functional versus the

1510
01:00:58,650 --> 01:00:56,890
science I'm in yet another category

1511
01:01:00,329 --> 01:00:58,660
since I'm actually a Hopkins person

1512
01:01:02,609 --> 01:01:00,339
that's working on a contract over here I

1513
01:01:06,450 --> 01:01:02,619

have to fulfill the contract obligations

1514
01:01:09,900 --> 01:01:06,460
so 85% of a 40-hour week I have to spend

1515
01:01:11,700 --> 01:01:09,910
on functional work 15 hours for research

1516
01:01:13,729 --> 01:01:11,710
is not very much and so what I end up

1517
01:01:17,460 --> 01:01:13,739
doing is doing research on my own time

1518
01:01:19,859 --> 01:01:17,470
and the hours do go above 40 pretty

1519
01:01:21,359 --> 01:01:19,869
regularly to actually do this but I mean

1520
01:01:23,519 --> 01:01:21,369
that's the fun part right that's the fun

1521
01:01:24,960 --> 01:01:23,529
and there's fun to enable these

1522
01:01:26,370 --> 01:01:24,970
telescopes to do stuff as well I don't

1523
01:01:28,529 --> 01:01:26,380
mean there's the functional part is not

1524
01:01:31,589 --> 01:01:28,539
fun but obviously I got into astronomy

1525
01:01:33,720 --> 01:01:31,599
because I love the science and the

1526
01:01:36,269 --> 01:01:33,730
things that I want to learn about the

1527
01:01:37,620 --> 01:01:36,279
universe and that oftentimes takes a

1528
01:01:41,400 --> 01:01:37,630
backseat but I try to work it in

1529
01:01:44,249 --> 01:01:41,410
wherever I can okay we have a microphone

1530
01:01:46,739 --> 01:01:44,259
for asking the questions so grant rule

1531
01:01:49,049 --> 01:01:46,749
as if this one can be tossed yeah you

1532
01:01:50,729 --> 01:01:49,059
can actually toss it but you have to

1533
01:01:54,210 --> 01:01:50,739
speak right into the speak right into

1534
01:01:56,489 --> 01:01:54,220
the black so for something like yours

1535
01:01:58,109 --> 01:01:56,499
you were looking at m83 you knew what

1536
01:02:00,089 --> 01:01:58,119
you were looking about how do you

1537
01:02:01,890 --> 01:02:00,099
calculate exposure time and that kind of

1538
01:02:03,390 --> 01:02:01,900

thing for something like the deep sky

1539
01:02:05,609 --> 01:02:03,400
photograph where they really weren't

1540
01:02:07,049 --> 01:02:05,619
sure what they're gonna get well that

1541
01:02:07,920 --> 01:02:07,059
one was easy they had to go as deep as

1542
01:02:09,109 --> 01:02:07,930
they could go I thought they just

1543
01:02:10,279 --> 01:02:09,119
cranked

1544
01:02:11,870 --> 01:02:10,289
you're looking for the faintest things

1545
01:02:14,210 --> 01:02:11,880
and so we said we'll just give all we

1546
01:02:16,190 --> 01:02:14,220
got and see what we can do now it's more

1547
01:02:18,650 --> 01:02:16,200
complicated than that you look at the

1548
01:02:21,019 --> 01:02:18,660
way that detectors are affected by noise

1549
01:02:22,640 --> 01:02:21,029
and whatnot and you have to scale your

1550
01:02:24,739 --> 01:02:22,650
exposure times properly to get the

1551
01:02:25,819 --> 01:02:24,749
highest sensitivity out of them and

1552
01:02:27,620 --> 01:02:25,829
whatnot there's work involved but

1553
01:02:30,529 --> 01:02:27,630
basically you just want to crank and

1554
01:02:31,970 --> 01:02:30,539
crank and crank and add you add the data

1555
01:02:34,099 --> 01:02:31,980
all together at the end to go as deep as

1556
01:02:36,109 --> 01:02:34,109
you can but for other things especially

1557
01:02:38,210 --> 01:02:36,119
if their optical where you have data

1558
01:02:40,370 --> 01:02:38,220
from a ground-based telescope you can

1559
01:02:42,499 --> 01:02:40,380
estimate the Flex levels and then you

1560
01:02:45,880 --> 01:02:42,509
scale the exposure times off of the Flex

1561
01:02:48,440 --> 01:02:45,890
levels that you expect to see behind you

1562
01:02:50,769 --> 01:02:48,450
um first of all thank you this was

1563
01:02:53,089 --> 01:02:50,779

absolutely exciting and beautifully done

1564
01:02:56,599 --> 01:02:53,099
what is the relationship of Barbara

1565
01:03:00,109 --> 01:02:56,609
Mikulski with the archives well Barbara

1566
01:03:01,880 --> 01:03:00,119
Mikulski has a longtime association with

1567
01:03:04,370 --> 01:03:01,890
the Institute and with NASA of course

1568
01:03:07,130 --> 01:03:04,380
she's been a tremendous booster of NASA

1569
01:03:09,470 --> 01:03:07,140
over the years and when she was still a

1570
01:03:11,420 --> 01:03:09,480
senator she for the servicing missions

1571
01:03:13,069 --> 01:03:11,430
and for all the way back to the Hubble

1572
01:03:14,569 --> 01:03:13,079
launch and the disaster with the Hubble

1573
01:03:17,029 --> 01:03:14,579
Mir problem and stuff back when we

1574
01:03:19,309 --> 01:03:17,039
launched Barbara was there through that

1575
01:03:21,829 --> 01:03:19,319
whole process she was supportive she was

1576
01:03:24,019 --> 01:03:21,839
firm with the problem that happened and

1577
01:03:25,430 --> 01:03:24,029
needing to fix it and whatnot but once

1578
01:03:26,390 --> 01:03:25,440
it was fixed she was one of our biggest

1579
01:03:30,309 --> 01:03:26,400
cheerleaders

1580
01:03:36,470 --> 01:03:30,319
she lives in Baltimore she comes to our

1581
01:03:38,390 --> 01:03:36,480
Halloween parties so we have a

1582
01:03:41,120 --> 01:03:38,400
relationship with Barbara and she she

1583
01:03:42,229 --> 01:03:41,130
she is at been a cheerleader for NASA

1584
01:03:44,720 --> 01:03:42,239
she's been a cheerleader for the

1585
01:03:48,400 --> 01:03:44,730
Institute for Hubble all these years and

1586
01:03:51,620 --> 01:03:48,410
as she was retiring from her public life

1587
01:03:53,989 --> 01:03:51,630
the archive here was named in her honor

1588
01:03:56,029 --> 01:03:53,999

it's great I used to be called the

1589
01:03:57,829 --> 01:03:56,039
multi-mission archive for Space

1590
01:03:59,599 --> 01:03:57,839
Telescope's mast and so we just changed

1591
01:04:07,690 --> 01:03:59,609
it to Mikulski right that's the

1592
01:04:10,700 --> 01:04:07,700
microphone back to that so you said that

1593
01:04:12,229 --> 01:04:10,710
the scientists have to come here to do

1594
01:04:16,039 --> 01:04:12,239
the science because the data is not

1595
01:04:17,989 --> 01:04:16,049
distributed no sorry the the scientists

1596
01:04:21,559 --> 01:04:17,999
come here for the peer-review process

1597
01:04:22,779 --> 01:04:21,569
they sit in rooms of about 10 people by

1598
01:04:24,789 --> 01:04:22,789
science top

1599
01:04:27,400 --> 01:04:24,799
and they take a batch of the proposals

1600
01:04:29,439 --> 01:04:27,410
that have been put in and the scientists

1601
01:04:31,749 --> 01:04:29,449
on the panel read those proposals they

1602
01:04:33,549 --> 01:04:31,759
grade them they rank them and then it's

1603
01:04:35,049 --> 01:04:33,559
the top section from each of those

1604
01:04:37,269 --> 01:04:35,059
panels and all the different science

1605
01:04:39,400 --> 01:04:37,279
categories that are accepted for the

1606
01:04:41,259 --> 01:04:39,410
next round of observing and though it's

1607
01:04:43,630 --> 01:04:41,269
the peer review of the proposals where

1608
01:04:45,130 --> 01:04:43,640
we bring people in the data go to the

1609
01:04:46,599 --> 01:04:45,140
archive and then anybody all over the

1610
01:04:48,159 --> 01:04:46,609
world could come and get the data out of

1611
01:04:50,169 --> 01:04:48,169
the archive as soon as it becomes public

1612
01:04:51,789 --> 01:04:50,179
okay because I guess that's where I was

1613
01:04:53,559 --> 01:04:51,799

getting confused because it said the

1614
01:04:56,559 --> 01:04:53,569
scientist has to get the data it's not

1615
01:04:58,120 --> 01:04:56,569
distributed but there is also access you

1616
01:05:00,159 --> 01:04:58,130
have to come to the archive and get your

1617
01:05:01,749 --> 01:05:00,169
data when it's ready they don't send you

1618
01:05:02,890 --> 01:05:01,759
a cd-rom or anything like that with the

1619
01:05:04,569 --> 01:05:02,900
data on it you have to just come

1620
01:05:06,549 --> 01:05:04,579
download it but everything is done with

1621
01:05:09,249 --> 01:05:06,559
the internet now there was a question

1622
01:05:11,589 --> 01:05:09,259
about the peer review and can you

1623
01:05:15,219 --> 01:05:11,599
explain how that the peer review is

1624
01:05:16,499 --> 01:05:15,229
blind now yeah so this was actually been

1625
01:05:21,969 --> 01:05:16,509
a big change this last cycle

1626
01:05:25,169 --> 01:05:21,979
pain-in-the-butt actually that there's

1627
01:05:30,059 --> 01:05:25,179
been a big motion in astronomy to try to

1628
01:05:32,439 --> 01:05:30,069
get a fairness into the proposal process

1629
01:05:34,419 --> 01:05:32,449
fairness in terms of gender in terms of

1630
01:05:36,279 --> 01:05:34,429
age distribution in terms of all these

1631
01:05:38,979 --> 01:05:36,289
things and when you see somebody's name

1632
01:05:40,749 --> 01:05:38,989
on a proposal and if it's an established

1633
01:05:42,099 --> 01:05:40,759
scientist as opposed to some postdoc

1634
01:05:44,109 --> 01:05:42,109
that you've never heard of or whatever

1635
01:05:46,089 --> 01:05:44,119
doesn't matter if that postdoc proposal

1636
01:05:48,669 --> 01:05:46,099
that reads grading is wonderful you

1637
01:05:50,829 --> 01:05:48,679
already have an implicit bias toward

1638
01:05:52,599 --> 01:05:50,839

somebody that's an established scientist

1639
01:05:56,859 --> 01:05:52,609
right or whatever the case may be so

1640
01:05:59,109 --> 01:05:56,869
this cycle they they they said you don't

1641
01:06:02,620 --> 01:05:59,119
even refer to your own work and your

1642
01:06:05,319 --> 01:06:02,630
proposal and say and I better at all

1643
01:06:06,880 --> 01:06:05,329
2014 did blah blah blah no you just you

1644
01:06:09,039 --> 01:06:06,890
take the eye part out of this you

1645
01:06:11,529 --> 01:06:09,049
basically make the whole referencing on

1646
01:06:13,209 --> 01:06:11,539
your proposal anonymous the names

1647
01:06:15,399 --> 01:06:13,219
although they're on the proposal when

1648
01:06:16,989 --> 01:06:15,409
it's submitted are not given to the peer

1649
01:06:18,880 --> 01:06:16,999
reviewers so the peer reviewers are

1650
01:06:20,469 --> 01:06:18,890
looking at a proposal with none of that

1651
01:06:23,769 --> 01:06:20,479
ancillary information that might

1652
01:06:25,539 --> 01:06:23,779
unintentionally bias their judgement

1653
01:06:27,669 --> 01:06:25,549
about the proposals and it really

1654
01:06:29,949 --> 01:06:27,679
focuses the panel on looking at the

1655
01:06:32,140 --> 01:06:29,959
science description that's provided and

1656
01:06:34,120 --> 01:06:32,150
and making their judgments for the best

1657
01:06:35,380 --> 01:06:34,130
science based on that I always impressed

1658
01:06:36,680 --> 01:06:35,390
that you know even after all these

1659
01:06:38,030 --> 01:06:36,690
cycles that we've done

1660
01:06:39,859 --> 01:06:38,040
and we've got incredible science

1661
01:06:42,200 --> 01:06:39,869
out-of-home are still working to improve

1662
01:06:44,240 --> 01:06:42,210
the process yeah which was a very

1663
01:06:46,280 --> 01:06:44,250

impressive and the web process will will

1664
01:06:47,900 --> 01:06:46,290
build off of the Hubble process without

1665
01:06:49,790 --> 01:06:47,910
all those years of experience now when

1666
01:06:51,309 --> 01:06:49,800
when web starts accepting proposals it's

1667
01:06:53,960 --> 01:06:51,319
going to learn from those experiences

1668
01:06:55,339 --> 01:06:53,970
okay question up there so I had a

1669
01:06:57,589 --> 01:06:55,349
question kind of about the process

1670
01:06:59,000 --> 01:06:57,599
thinking about those thousand proposals

1671
01:07:01,099 --> 01:06:59,010
they get kind of winnow down to two

1672
01:07:03,470 --> 01:07:01,109
hundred I wonder do you have a better

1673
01:07:05,780 --> 01:07:03,480
chance if you're kind of lucky and maybe

1674
01:07:08,059 --> 01:07:05,790
two or three proposals want to look at

1675
01:07:11,000 --> 01:07:08,069
the same thing I mean does that happen

1676
01:07:14,780 --> 01:07:11,010
where they could you know just to use

1677
01:07:17,420 --> 01:07:14,790
the time on Hubble more efficiently

1678
01:07:19,849 --> 01:07:17,430
maybe those proposals would be more

1679
01:07:22,400 --> 01:07:19,859
accepted than the ones that are more

1680
01:07:25,040 --> 01:07:22,410
disparate there's there are so many

1681
01:07:27,770 --> 01:07:25,050
variables in the process that that it

1682
01:07:28,910 --> 01:07:27,780
was probably one variable but there are

1683
01:07:30,650 --> 01:07:28,920
many many other things that come into

1684
01:07:32,690 --> 01:07:30,660
the process and it really comes down to

1685
01:07:34,700 --> 01:07:32,700
things like which panel does your

1686
01:07:36,680 --> 01:07:34,710
proposal go to and is there somebody

1687
01:07:38,420 --> 01:07:36,690
that happens to be on that panel that

1688
01:07:40,579 --> 01:07:38,430

kind of understands your science and

1689
01:07:42,770 --> 01:07:40,589
wanted to advocate for it in the panel

1690
01:07:46,099 --> 01:07:42,780
if they really like it so there are a

1691
01:07:48,079 --> 01:07:46,109
lot of intangibles as well as writing a

1692
01:07:49,849 --> 01:07:48,089
good proposal and supporting it as best

1693
01:07:50,750 --> 01:07:49,859
you can at the beginning so there but

1694
01:07:53,599 --> 01:07:50,760
there's a lot there's a lot of things

1695
01:07:55,760 --> 01:07:53,609
involved in the process yeah yeah I'm

1696
01:07:58,099 --> 01:07:55,770
just the very simple question though

1697
01:08:00,079 --> 01:07:58,109
with the recent gyroscope failure in

1698
01:08:03,620 --> 01:08:00,089
recovery were there any long-term

1699
01:08:06,349 --> 01:08:03,630
ramifications for the whole cycle well

1700
01:08:07,670 --> 01:08:06,359
since they recovered and night they are

1701
01:08:10,640 --> 01:08:07,680
still operating with their three gyro

1702
01:08:11,690 --> 01:08:10,650
mode there's very little impact I think

1703
01:08:13,550 --> 01:08:11,700
one of the reasons that the

1704
01:08:15,380 --> 01:08:13,560
announcements of this last cycle were a

1705
01:08:16,880 --> 01:08:15,390
little bit slow in coming out as they

1706
01:08:19,539 --> 01:08:16,890
kind of really wanted to understand

1707
01:08:21,499 --> 01:08:19,549
where they were with this gyro problem

1708
01:08:23,720 --> 01:08:21,509
gyroscopes are an interesting thing we

1709
01:08:25,999 --> 01:08:23,730
had gyro problems and reaction wheel

1710
01:08:28,309 --> 01:08:26,009
problems on the few satellite that I ran

1711
01:08:32,209 --> 01:08:28,319
over it Hopkins for many years as well

1712
01:08:34,280 --> 01:08:32,219
and it's amazing how with software and

1713
01:08:35,780 --> 01:08:34,290

other tricks these engineers figure out

1714
01:08:39,320 --> 01:08:35,790
things to do to keep these satellites

1715
01:08:42,559 --> 01:08:39,330
running for for Hubble the gyroscopes

1716
01:08:44,870 --> 01:08:42,569
are sensors they are sensing motion

1717
01:08:46,280 --> 01:08:44,880
relative motion and feeding that into

1718
01:08:47,780 --> 01:08:46,290
the Poynting system which is actually

1719
01:08:50,200 --> 01:08:47,790
done by what's called reaction wheels

1720
01:08:52,360 --> 01:08:50,210
momentum wheels that are spinning and

1721
01:08:54,610 --> 01:08:52,370
rate of speed to move the satellite

1722
01:08:57,099 --> 01:08:54,620
around her to hold it steady so it's

1723
01:08:58,360 --> 01:08:57,109
this it's a sensor problem and when you

1724
01:09:00,820 --> 01:08:58,370
have three gyros you're getting

1725
01:09:02,440 --> 01:09:00,830
information on all three axes from the

1726
01:09:04,840 --> 01:09:02,450
gyroscopes everything's happy the

1727
01:09:08,229 --> 01:09:04,850
control system is happy when you drop

1728
01:09:09,820 --> 01:09:08,239
below three gyros things change all of a

1729
01:09:11,200 --> 01:09:09,830
sudden you've got to find some

1730
01:09:14,050 --> 01:09:11,210
information from someplace else where

1731
01:09:16,959 --> 01:09:14,060
they substitute in star trackers for if

1732
01:09:19,180 --> 01:09:16,969
the pointing motion that their job is to

1733
01:09:20,530 --> 01:09:19,190
to sense the Stars not to hold the

1734
01:09:22,930 --> 01:09:20,540
satellite steady but they can change the

1735
01:09:24,940 --> 01:09:22,940
software to use star trackers to take

1736
01:09:27,010 --> 01:09:24,950
place of the gyros and they can actually

1737
01:09:29,920 --> 01:09:27,020
operate with one gyro and the star

1738
01:09:32,019 --> 01:09:29,930

trackers and and work almost as good

1739
01:09:34,059 --> 01:09:32,029
they just have certain limitations on

1740
01:09:36,550 --> 01:09:34,069
when they can point to various places

1741
01:09:37,930 --> 01:09:36,560
around the sky but they basically could

1742
01:09:38,800 --> 01:09:37,940
still see the entire sky it's just a

1743
01:09:40,809 --> 01:09:38,810
matter they have to be a little more

1744
01:09:43,180 --> 01:09:40,819
careful about when they go to a certain

1745
01:09:45,010 --> 01:09:43,190
part of the sky to observe with one gyro

1746
01:09:47,530 --> 01:09:45,020
mode so they're working with three gyros

1747
01:09:49,390 --> 01:09:47,540
now it's the last three out of six that

1748
01:09:51,190 --> 01:09:49,400
are working right now so when they lose

1749
01:09:52,420 --> 01:09:51,200
another one they they're not going to go

1750
01:09:55,150 --> 01:09:52,430
on two gyros they're going to drop to

1751
01:09:57,190 --> 01:09:55,160
one gyro use that one till it dies and

1752
01:10:00,250 --> 01:09:57,200
then use the last gyro until it dies and

1753
01:10:02,320 --> 01:10:00,260
extend the lifetime of Hubble as far as

1754
01:10:03,880 --> 01:10:02,330
they can so there will be some

1755
01:10:05,140 --> 01:10:03,890
restrictions to the pointing where it

1756
01:10:07,000 --> 01:10:05,150
gets down to the one general and

1757
01:10:08,890 --> 01:10:07,010
pertinent to your question was that the

1758
01:10:10,479 --> 01:10:08,900
three weeks of scheduling that they'd

1759
01:10:12,700 --> 01:10:10,489
already planned for those three weeks

1760
01:10:14,709 --> 01:10:12,710
will get folded into the later schedule

1761
01:10:19,090 --> 01:10:14,719
and okay the folks down the scheduling

1762
01:10:20,950 --> 01:10:19,100
branch they whenever there's a safe mode

1763
01:10:22,750 --> 01:10:20,960

they have to readjust and readjust and

1764
01:10:24,670 --> 01:10:22,760
they've been doing that for years I mean

1765
01:10:26,380 --> 01:10:24,680
it started off like it was 60 days they

1766
01:10:29,910 --> 01:10:26,390
uploaded commands in advance and now

1767
01:10:31,570 --> 01:10:29,920
it's down to a week in advance yeah so

1768
01:10:34,180 --> 01:10:31,580
amazing the amount of improvement

1769
01:10:36,959 --> 01:10:34,190
they've done in in the how long time

1770
01:10:46,959 --> 01:10:36,969
advance they need to schedule Hubble

1771
01:10:49,900 --> 01:10:46,969
other questions over there that's great

1772
01:10:51,930 --> 01:10:49,910
isn't it thank you short around this is

1773
01:10:54,399 --> 01:10:51,940
the coolest thing ever

1774
01:10:57,370 --> 01:10:54,409
so you mentioned that you had four days

1775
01:10:59,080 --> 01:10:57,380
of observation time for your m83

1776
01:11:01,089 --> 01:10:59,090
research which sounds like it's more

1777
01:11:03,189 --> 01:11:01,099
than maybe your average or a fair share

1778
01:11:07,589 --> 01:11:03,199
if you maybe can talk a little bit about

1779
01:11:10,239 --> 01:11:07,599
what is more of a typical so there's a

1780
01:11:13,060 --> 01:11:10,249
distribution of proposal sizes that go

1781
01:11:14,799 --> 01:11:13,070
from a single orbit or two up to

1782
01:11:16,540 --> 01:11:14,809
hundreds of orbits for the large and

1783
01:11:18,370 --> 01:11:16,550
very large projects that are a site

1784
01:11:19,899 --> 01:11:18,380
they're they're great in this sort of a

1785
01:11:22,479 --> 01:11:19,909
separate entity because they do take so

1786
01:11:25,930 --> 01:11:22,489
much resource they have to really be you

1787
01:11:28,270 --> 01:11:25,940
know whiz-bang science like deep field

1788
01:11:31,330 --> 01:11:28,280

or let those kind of things you know to

1789
01:11:33,339 --> 01:11:31,340
get the major or exoplanets get a lot of

1790
01:11:37,959 --> 01:11:33,349
time somehow I don't know why I well

1791
01:11:39,279 --> 01:11:37,969
anyway but but a you so I mean what's

1792
01:11:40,899 --> 01:11:39,289
typical I don't know there's a range

1793
01:11:44,020 --> 01:11:40,909
this this would have been classified as

1794
01:11:45,430 --> 01:11:44,030
a medium proposal and it is difficult to

1795
01:11:47,379 --> 01:11:45,440
get that kind of intermediate sized

1796
01:11:49,569 --> 01:11:47,389
proposal thirty fifty sixty orbits are

1797
01:11:55,270 --> 01:11:49,579
are difficult to get because there's a

1798
01:11:57,129 --> 01:11:55,280
sizable chunk of time but it's it's not

1799
01:11:59,729 --> 01:11:57,139
like the big program so it's it's in

1800
01:12:01,750 --> 01:11:59,739
between there someplace many of my

1801
01:12:03,279 --> 01:12:01,760
proposals in the past have been of order

1802
01:12:05,799 --> 01:12:03,289
five to ten orbits that's that's

1803
01:12:08,169 --> 01:12:05,809
probably a little more typical for for

1804
01:12:10,120 --> 01:12:08,179
many astronomers proposed again they

1805
01:12:13,000 --> 01:12:10,130
have a specific thing that they want to

1806
01:12:14,410 --> 01:12:13,010
do this if it didn't have if this galaxy

1807
01:12:16,600 --> 01:12:14,420
was smaller I didn't have as many fields

1808
01:12:17,620 --> 01:12:16,610
to cover the the main body of the galaxy

1809
01:12:19,029 --> 01:12:17,630
it wouldn't have been as many orbits

1810
01:12:21,160 --> 01:12:19,039
it's just there's which object do you

1811
01:12:23,819 --> 01:12:21,170
want to observe and how many times do

1812
01:12:26,649 --> 01:12:23,829
you need and that kind of thing yeah

1813
01:12:30,489 --> 01:12:26,659

thank you okay we had a question down

1814
01:12:40,629 --> 01:12:30,499
here must be allowed or I can I can I

1815
01:12:43,239 --> 01:12:40,639
could voice it first right there as we

1816
01:12:49,209 --> 01:12:43,249
once but I presume you already have a

1817
01:12:51,459 --> 01:12:49,219
long list requests so interestingly

1818
01:12:53,910 --> 01:12:51,469
enough the Webb telescope I'm sure you

1819
01:12:56,919 --> 01:12:53,920
heard on a previous month or you read

1820
01:12:58,660 --> 01:12:56,929
was its launch was delayed it was

1821
01:13:01,419 --> 01:12:58,670
supposed to be about now not that long

1822
01:13:03,379 --> 01:13:01,429
ago and it got pushed off and is now

1823
01:13:06,350 --> 01:13:03,389
sitting out an early

1824
01:13:09,740 --> 01:13:06,360
20:21 which is a long time in the future

1825
01:13:11,450 --> 01:13:09,750
but before that launch slip happened we

1826
01:13:14,180 --> 01:13:11,460
were actually in the first proposal

1827
01:13:15,649 --> 01:13:14,190
cycle for the James Webb telescope we

1828
01:13:18,040 --> 01:13:15,659
had not gotten to the submission point

1829
01:13:20,930 --> 01:13:18,050
yet we were 10 days out from submission

1830
01:13:25,189 --> 01:13:20,940
but people in the community were working

1831
01:13:28,129 --> 01:13:25,199
on proposals and they they announced the

1832
01:13:29,570 --> 01:13:28,139
launch the initial launch delay and such

1833
01:13:30,709 --> 01:13:29,580
time that they decided to just hold the

1834
01:13:33,709 --> 01:13:30,719
proposal cycle and not let those

1835
01:13:36,140 --> 01:13:33,719
proposals come in interestingly enough

1836
01:13:38,060 --> 01:13:36,150
what we did in response to that was we

1837
01:13:40,970 --> 01:13:38,070
immediately contacted the community and

1838
01:13:42,740 --> 01:13:40,980

got feedback on the tools that we had in

1839
01:13:45,470 --> 01:13:42,750
place to support them for that initial

1840
01:13:47,840 --> 01:13:45,480
cycle and we got lots of feedback for

1841
01:13:49,790 --> 01:13:47,850
making the system better when we

1842
01:13:52,129 --> 01:13:49,800
actually do this for the first time for

1843
01:13:53,510 --> 01:13:52,139
real which will be the proposal

1844
01:13:55,660 --> 01:13:53,520
opportunity right now is scheduled to

1845
01:13:58,580 --> 01:13:55,670
open up next December a year from now

1846
01:14:02,060 --> 01:13:58,590
the first call for proposals and the

1847
01:14:05,689 --> 01:14:02,070
proposals would be do then in spring or

1848
01:14:10,370 --> 01:14:05,699
summer of 2020 for the first time we

1849
01:14:13,040 --> 01:14:10,380
have a question from online let's see I

1850
01:14:16,669 --> 01:14:13,050
wonder if anyone has ever calculated the

1851
01:14:19,450 --> 01:14:16,679
person hours per HST exposure in other

1852
01:14:22,280 --> 01:14:19,460
words the hours of the STScI staff

1853
01:14:24,379 --> 01:14:22,290
divided by like for a full year divided

1854
01:14:26,240 --> 01:14:24,389
by the number of exposures in a year so

1855
01:14:28,669 --> 01:14:26,250
how many person hours go into one of

1856
01:14:30,410 --> 01:14:28,679
these observations the astronomer has to

1857
01:14:35,180 --> 01:14:30,420
put all those person hours but all the

1858
01:14:36,500 --> 01:14:35,190
people behind the scenes Wow I could say

1859
01:14:38,530 --> 01:14:36,510
it's a large enterprise that I cannot

1860
01:14:44,060 --> 01:14:38,540
even begin to fathom a number maybe a

1861
01:14:45,500 --> 01:14:44,070
google or something maybe I want

1862
01:14:46,700 --> 01:14:45,510
exposure of course some exposures are

1863
01:14:48,680 --> 01:14:46,710

long as some are short so I don't know

1864
01:14:50,240 --> 01:14:48,690
exactly what the criterion would be but

1865
01:14:52,790 --> 01:14:50,250
it's an interesting question try to got

1866
01:14:56,270 --> 01:14:52,800
about 500 people on average working here

1867
01:14:58,459 --> 01:14:56,280
and we do 3,000 orbits of observations

1868
01:15:00,080 --> 01:14:58,469
per year all right and we consider yeah

1869
01:15:02,870 --> 01:15:00,090
you can look exposure so something like

1870
01:15:11,650 --> 01:15:02,880
that yeah 500 years divided by 3000

1871
01:15:18,740 --> 01:15:14,960
my turn yeah there's an object that

1872
01:15:21,410 --> 01:15:18,750
orbits our Sun about once every 400

1873
01:15:23,540 --> 01:15:21,420
years I believe it's k2 recently

1874
01:15:29,080 --> 01:15:23,550
discovered what can you tell us about

1875
01:15:34,040 --> 01:15:32,330
Hey - is the kepler Cooper okay I

1876
01:15:42,830 --> 01:15:34,050
haven't heard of anything called k2 I

1877
01:15:45,500 --> 01:15:42,840
mean is this the planet 9 thing I heard

1878
01:15:47,420 --> 01:15:45,510
who the people may be over at the people

1879
01:15:49,610 --> 01:15:47,430
in Columbia but they're meeting and

1880
01:15:51,710 --> 01:15:49,620
they're talking about 400 years to go

1881
01:15:54,350 --> 01:15:51,720
wrong so there's something is big and it

1882
01:15:57,530 --> 01:15:54,360
goes around our Sun every 400 years

1883
01:15:59,330 --> 01:15:57,540
isn't the planet the the a large Kuiper

1884
01:16:01,190 --> 01:15:59,340
belt object that I discussed last month

1885
01:16:03,110 --> 01:16:01,200
during the movies it might be I mean

1886
01:16:05,570 --> 01:16:03,120
Pluto takes 230 years

1887
01:16:07,400 --> 01:16:05,580
139 years for though it's it's not that

1888
01:16:12,500 --> 01:16:07,410

much farther out than Pluto but water

1889
01:16:15,530 --> 01:16:12,510
uses way out there compared to the Oort

1890
01:16:17,360 --> 01:16:15,540
cloud and everything the object I

1891
01:16:19,310 --> 01:16:17,370
discussed last month was over 700 years

1892
01:16:24,470 --> 01:16:19,320
in its orbit it made you something with

1893
01:16:27,470 --> 01:16:24,480
our weather on earth no I don't think so

1894
01:16:30,230 --> 01:16:27,480
okay actually so there's a there's so

1895
01:16:33,410 --> 01:16:30,240
January 1st coming right up

1896
01:16:36,560 --> 01:16:33,420
the New Horizons mission the thing that

1897
01:16:38,450 --> 01:16:36,570
flew by Pluto isn't going to fly by

1898
01:16:40,580 --> 01:16:38,460
another object that's farther out on

1899
01:16:42,410 --> 01:16:40,590
January 1st coming right up and that

1900
01:16:45,470 --> 01:16:42,420
object has a Hubble connection right

1901
01:16:48,350 --> 01:16:45,480
because they found the thing to look at

1902
01:16:50,720 --> 01:16:48,360
by taking deep Hubble pictures in the

1903
01:16:52,160 --> 01:16:50,730
direction where New Horizons was headed

1904
01:16:53,240 --> 01:16:52,170
and is there anything out there for us

1905
01:16:55,460 --> 01:16:53,250
to look at they didn't know what they

1906
01:16:57,230 --> 01:16:55,470
were going to be able to go fly by and

1907
01:16:58,700 --> 01:16:57,240
they found two candidates this was the

1908
01:17:00,050 --> 01:16:58,710
better than the two candidates and it

1909
01:17:02,510 --> 01:17:00,060
was within the window where New Horizons

1910
01:17:04,550 --> 01:17:02,520
could adjust its its path to fly by this

1911
01:17:06,500 --> 01:17:04,560
thing and we have no idea it's just a

1912
01:17:08,240 --> 01:17:06,510
little Fleck of stuff out there and in

1913
01:17:10,100 --> 01:17:08,250

the Kuiper belt but we're gonna go see

1914
01:17:11,180 --> 01:17:10,110
another equip or belt objects I'm doing

1915
01:17:15,910 --> 01:17:11,190
nothing but it's been given the

1916
01:17:21,590 --> 01:17:18,950
it's actually catalog number mu 69 or

1917
01:17:24,960 --> 01:17:21,600
something like that but ultimate tool

1918
01:17:35,220 --> 01:17:24,970
all right do we have more question yep

1919
01:17:36,750 --> 01:17:35,230
good what was a Schmo drizzle I got rid

1920
01:17:38,490 --> 01:17:36,760
of most of the buzzwords but fewer I

1921
01:17:39,600 --> 01:17:38,500
grabbed slides from other talks and

1922
01:17:42,600 --> 01:17:39,610
stuff so I'm sorry about that

1923
01:17:44,430 --> 01:17:42,610
Astro drizzle is an incredible but

1924
01:17:46,890 --> 01:17:44,440
complicated piece of software that

1925
01:17:50,100 --> 01:17:46,900
allows you if you've taken your data in

1926
01:17:52,050 --> 01:17:50,110
the proper way to combine data sets in

1927
01:17:55,890 --> 01:17:52,060
such a way that you actually improve the

1928
01:17:58,680 --> 01:17:55,900
resolution above and beyond the initial

1929
01:18:00,660 --> 01:17:58,690
pixel size of the camera so imagine if

1930
01:18:03,120 --> 01:18:00,670
you have little square pixels of a CCD

1931
01:18:05,130 --> 01:18:03,130
array and you take a picture and then

1932
01:18:06,630 --> 01:18:05,140
you offset by a fraction of a pixel and

1933
01:18:09,120 --> 01:18:06,640
take another picture and a fraction of a

1934
01:18:10,740 --> 01:18:09,130
pixel and take another picture when you

1935
01:18:13,860 --> 01:18:10,750
stitch all those data together you can

1936
01:18:15,930 --> 01:18:13,870
actually with software create an image

1937
01:18:18,600 --> 01:18:15,940
that has better resolution than any of

1938
01:18:20,070 --> 01:18:18,610

the individual pictures astro drizzle

1939
01:18:21,780 --> 01:18:20,080
does that it's also the thing that does

1940
01:18:23,310 --> 01:18:21,790
a lot of the aligning of separate

1941
01:18:25,350 --> 01:18:23,320
exposures so you can add them together

1942
01:18:27,600 --> 01:18:25,360
and as you do that then you can get rid

1943
01:18:29,700 --> 01:18:27,610
of bad pixels and cosmic rays and things

1944
01:18:32,550 --> 01:18:29,710
that are not real data in your in your

1945
01:18:34,050 --> 01:18:32,560
data but Astro drizzle is an important

1946
01:18:38,970 --> 01:18:34,060
thing for getting the absolute highest

1947
01:18:42,300 --> 01:18:38,980
quality imaging out of Hubble all right

1948
01:18:44,580 --> 01:18:42,310
so that will be our event for this

1949
01:18:48,600 --> 01:18:44,590
evening there will not be any observing

1950
01:18:50,220 --> 01:18:48,610
tonight next month in December Mark

1951
01:18:52,770 --> 01:18:50,230
kamionkowski will be talk to you about

1952
01:18:55,230 --> 01:18:52,780
black holes and other dark matters