

1
00:00:00,000 --> 00:00:05,969
out tonight's lithograph is the Hubble

2
00:00:03,060 --> 00:00:08,490
Space Telescope this is a picture from

3
00:00:05,969 --> 00:00:10,080
the last servicing mission it's actually

4
00:00:08,490 --> 00:00:11,910
one of the farewell pictures I look at

5
00:00:10,080 --> 00:00:15,660
this and I sort of get nostalgic because

6
00:00:11,910 --> 00:00:18,420
this is the last time humans visited

7
00:00:15,660 --> 00:00:21,060
Hubble okay this is one of the last

8
00:00:18,420 --> 00:00:24,210
photographs as they were leaving on the

9
00:00:21,059 --> 00:00:27,538
back is updated text newly updated for

10
00:00:24,210 --> 00:00:29,219
this year to include all of the new

11
00:00:27,539 --> 00:00:31,199
instruments and and mature an

12
00:00:29,219 --> 00:00:33,390
information about it the previous

13
00:00:31,199 --> 00:00:35,309
version we had of this lithograph had

14
00:00:33,390 --> 00:00:38,929
some old instruments on there that got

15
00:00:35,308 --> 00:00:41,039
actually got removed so we have new text

16
00:00:38,929 --> 00:00:43,859
with an old picture all right

17
00:00:41,039 --> 00:00:46,100
and please pick them up on your way out

18
00:00:43,859 --> 00:00:48,840
the reason we are doing that is because

19
00:00:46,100 --> 00:00:50,550
tonight we're talking about Hubble we're

20
00:00:48,840 --> 00:00:52,680
talking about observing with Hubble from

21
00:00:50,549 --> 00:00:55,799
scientific idea to published result and

22
00:00:52,679 --> 00:00:57,570
everything in between and bill says he's

23
00:00:55,799 --> 00:01:03,089
gonna do this in real time so we'll be

24
00:00:57,570 --> 00:01:06,500
here for about two and a half years up

25
00:01:03,090 --> 00:01:08,969
coming on December Mark kamionkowski

26
00:01:06,500 --> 00:01:12,060
from Johns Hopkins will be talking about

27
00:01:08,969 --> 00:01:14,429
black holes and other dark matters I

28
00:01:12,060 --> 00:01:16,049
don't know if that's his actual title

29

00:01:14,430 --> 00:01:17,820
because he said oh I'll give this talk

30
00:01:16,049 --> 00:01:19,729
and I said well what we call it this and

31
00:01:17,819 --> 00:01:23,519
he said okay sure

32
00:01:19,728 --> 00:01:24,929
he may change his title before then but

33
00:01:23,519 --> 00:01:26,609
because that's the title I gave it to

34
00:01:24,930 --> 00:01:29,640
him but he seemed to like it

35
00:01:26,609 --> 00:01:32,009
in January we are not doing the first

36
00:01:29,640 --> 00:01:34,590
Tuesday we are not doing the second

37
00:01:32,009 --> 00:01:35,040
Tuesday we're doing the third Tuesday

38
00:01:34,590 --> 00:01:37,228
okay

39
00:01:35,040 --> 00:01:38,430
the first Tuesday is January 1st New

40
00:01:37,228 --> 00:01:41,250
Year's Day we're not going to do that

41
00:01:38,430 --> 00:01:43,200
the second Tuesday is during the

42
00:01:41,250 --> 00:01:45,478
American Astronomical Society meeting

43
00:01:43,200 --> 00:01:48,090

the January meeting is the biggest

44

00:01:45,478 --> 00:01:50,039

double a s meeting a strata meeting of

45

00:01:48,090 --> 00:01:52,890

the year a lot of people will be in

46

00:01:50,040 --> 00:01:54,960

Seattle including myself for that

47

00:01:52,890 --> 00:01:57,989

meeting so we're going to push back to

48

00:01:54,959 --> 00:01:59,459

January 15th for initial exoplanet

49

00:01:57,989 --> 00:02:01,459

discoveries with two guests the

50

00:01:59,459 --> 00:02:03,899

transiting exoplanet survey satellite

51

00:02:01,459 --> 00:02:05,759

this is one you don't want to miss okay

52

00:02:03,899 --> 00:02:08,580

because this is a brand new satellite

53

00:02:05,759 --> 00:02:10,560

brand new results from it and guess what

54

00:02:08,580 --> 00:02:12,180

there's gonna be a lot of discussion of

55

00:02:10,560 --> 00:02:13,259

this at the double-a s so they'll he'll

56

00:02:12,180 --> 00:02:15,810

be a lot of new content

57

00:02:13,259 --> 00:02:17,340

that he can discuss during this talk

58
00:02:15,810 --> 00:02:20,158
that he couldn't discuss if we held it

59
00:02:17,340 --> 00:02:22,019
before the double AAS okay so Scott

60
00:02:20,158 --> 00:02:25,590
Fleming will discuss that in January and

61
00:02:22,019 --> 00:02:28,640
in February a mi Amoro Martin we'll be

62
00:02:25,590 --> 00:02:31,489
talking about your place in the Stars

63
00:02:28,639 --> 00:02:34,408
okay if you would like more information

64
00:02:31,489 --> 00:02:36,599
you can go to our website use your

65
00:02:34,408 --> 00:02:38,519
favorite search engine for Hubble public

66
00:02:36,598 --> 00:02:40,828
lecture series or space telescope public

67
00:02:38,519 --> 00:02:42,959
lectures you'll find this webpage where

68
00:02:40,829 --> 00:02:45,420
we have the upcoming lectures listed

69
00:02:42,959 --> 00:02:48,000
over here on the right we have links to

70
00:02:45,419 --> 00:02:50,818
our webcasting both on YouTube and the

71
00:02:48,000 --> 00:02:54,150
Space Telescope webcasting folks and you

72
00:02:50,818 --> 00:02:58,649
can see the archive back to 2014 on

73
00:02:54,150 --> 00:03:01,829
YouTube and back to 2005 in our

74
00:02:58,650 --> 00:03:04,950
wonderful webcasting sites you can also

75
00:03:01,829 --> 00:03:08,219
sign up for our email list and get a

76
00:03:04,949 --> 00:03:09,869
like to emails a month about what the

77
00:03:08,219 --> 00:03:12,000
upcoming lectures are going to be and

78
00:03:09,870 --> 00:03:13,408
when they are which will help remind you

79
00:03:12,000 --> 00:03:14,908
that it's gonna be the third Tuesday and

80
00:03:13,408 --> 00:03:19,108
not the first or second Tuesday in

81
00:03:14,908 --> 00:03:20,848
January so the announcements sign up to

82
00:03:19,109 --> 00:03:23,430
the website if you have questions

83
00:03:20,848 --> 00:03:26,488
there's email address public lecture at

84
00:03:23,430 --> 00:03:28,260
stsci.edu you want to follow us on

85
00:03:26,489 --> 00:03:30,959
social media we've got Facebook and

86

00:03:28,259 --> 00:03:33,149
Twitter and YouTube and Instagram for

87
00:03:30,959 --> 00:03:35,848
Hubble for the Space Telescope Science

88
00:03:33,150 --> 00:03:38,159
Institute and for the Webb telescope as

89
00:03:35,848 --> 00:03:41,310
well I have a little bit that I do I

90
00:03:38,159 --> 00:03:43,829
don't do much unfortunately

91
00:03:41,310 --> 00:03:45,780
the clouds are out tonight and the

92
00:03:43,829 --> 00:03:48,930
Maryland Space Grant Observatory will

93
00:03:45,780 --> 00:03:50,818
not be operating they do have open

94
00:03:48,930 --> 00:03:52,230
houses on Friday evenings I'm not sure

95
00:03:50,818 --> 00:03:54,810
what the weather forecast is for this

96
00:03:52,229 --> 00:03:57,539
Friday I understand that they're doing a

97
00:03:54,810 --> 00:03:59,669
special event on the roof of Bloomberg

98
00:03:57,539 --> 00:04:02,668
this weekend something called celestial

99
00:03:59,669 --> 00:04:06,620
terrestrial and I couldn't find a web

100
00:04:02,669 --> 00:04:09,419

link for it but the folks who run the

101

00:04:06,620 --> 00:04:10,979

spacecraft server Tory told me that this

102

00:04:09,419 --> 00:04:13,949

weekend if you can find something about

103

00:04:10,979 --> 00:04:17,030

celestial terrestrial they're doing it

104

00:04:13,949 --> 00:04:19,650

on the go up on the roof of Bloomberg

105

00:04:17,029 --> 00:04:21,208

and it has some art component as well as

106

00:04:19,649 --> 00:04:24,299

the strong as science component to it

107

00:04:21,209 --> 00:04:26,509

and Zolt up there is looking at because

108

00:04:24,300 --> 00:04:28,160

he has a art

109

00:04:26,509 --> 00:04:30,860

called celestial terrestrial convergence

110

00:04:28,160 --> 00:04:35,540

that he has done and this is not Zola

111

00:04:30,860 --> 00:04:38,090

vase art convergence art show okay all

112

00:04:35,540 --> 00:04:42,050

right now our news from the universe for

113

00:04:38,089 --> 00:04:43,969

know what question ah the Bloomberg

114

00:04:42,050 --> 00:04:46,189

building is right across the street that

115
00:04:43,970 --> 00:04:47,750
big huge brick building that that an

116
00:04:46,189 --> 00:04:49,579
edifice that rises across the street

117
00:04:47,750 --> 00:04:50,930
from us okay that is where the physics

118
00:04:49,579 --> 00:04:54,589
and astronomy departments are housed

119
00:04:50,930 --> 00:04:56,389
okay now our news from the universe for

120
00:04:54,589 --> 00:04:59,810
November 2018

121
00:04:56,389 --> 00:05:01,990
our first story tonight are some mission

122
00:04:59,810 --> 00:05:04,339
updates if you've been paying attention

123
00:05:01,990 --> 00:05:06,530
there's been a lot to pay attention to

124
00:05:04,339 --> 00:05:09,439
over the last month or so okay first of

125
00:05:06,529 --> 00:05:10,959
all on October 5th our favorite

126
00:05:09,439 --> 00:05:14,839
Telescope the Hubble Space Telescope

127
00:05:10,959 --> 00:05:16,459
went into what we call safe mode because

128
00:05:14,839 --> 00:05:17,329
we had a failure of one of the

129
00:05:16,459 --> 00:05:19,129
gyroscopes

130
00:05:17,329 --> 00:05:21,649
now this gyroscope had been showing

131
00:05:19,129 --> 00:05:23,149
anomalies for about a year and we were

132
00:05:21,649 --> 00:05:26,569
sort of expecting it to fail

133
00:05:23,149 --> 00:05:28,879
at any time and it did fail on October

134
00:05:26,569 --> 00:05:30,439
1st October 5th and we have of course

135
00:05:28,879 --> 00:05:32,959
procedures built in place because we

136
00:05:30,439 --> 00:05:36,230
have six gyroscopes on Hubble and we

137
00:05:32,959 --> 00:05:38,120
need three to point it accurately when

138
00:05:36,230 --> 00:05:42,259
they fired up one of the reserve gyros

139
00:05:38,120 --> 00:05:43,939
it had a problem it's high spin rate was

140
00:05:42,259 --> 00:05:46,939
supposed to high as low spin rate was

141
00:05:43,939 --> 00:05:48,769
was not in observational with Ian's

142
00:05:46,939 --> 00:05:51,949
observational parameters so they did

143

00:05:48,769 --> 00:05:55,699
some testing and they couldn't solve it

144
00:05:51,949 --> 00:05:57,920
so they did more testing and it sort of

145
00:05:55,699 --> 00:05:59,569
went somewhere but not quite where they

146
00:05:57,920 --> 00:06:02,150
wanted it to is hell yeah they did even

147
00:05:59,569 --> 00:06:05,379
more extensive testing these guys are

148
00:06:02,149 --> 00:06:09,500
really really good they're very patient

149
00:06:05,379 --> 00:06:11,689
and after over three weeks of almost

150
00:06:09,500 --> 00:06:13,279
three weeks they were able to find a

151
00:06:11,689 --> 00:06:16,910
solution to the problem and get that

152
00:06:13,279 --> 00:06:20,169
reserved gyro back into observational

153
00:06:16,910 --> 00:06:23,450
status okay so that so that so the

154
00:06:20,170 --> 00:06:25,009
resulting of that gyro was high-quality

155
00:06:23,449 --> 00:06:29,089
enough that we could do Hubble observing

156
00:06:25,009 --> 00:06:31,310
so on October 26 we resumed observations

157
00:06:29,089 --> 00:06:34,159

okay so Hubble took a three week

158

00:06:31,310 --> 00:06:35,509

vacation from observing mode while of

159

00:06:34,160 --> 00:06:37,580

course the engineers here on the ground

160

00:06:35,509 --> 00:06:39,848

took anything but a three-week vacation

161

00:06:37,579 --> 00:06:44,128

getting it back in

162

00:06:39,848 --> 00:06:47,800

they do an amazing amount of work also

163

00:06:44,129 --> 00:06:49,869

the Kepler mission had a problem it had

164

00:06:47,800 --> 00:06:52,360

done its primary mission for four years

165

00:06:49,869 --> 00:06:55,059

which we're observing the Stars and

166

00:06:52,360 --> 00:06:57,429

looking for the light dips that indicate

167

00:06:55,059 --> 00:06:58,869

planets passing in front of them that's

168

00:06:57,428 --> 00:07:01,208

called the transit method of looking for

169

00:06:58,869 --> 00:07:03,069

extrasolar planets and then it had a

170

00:07:01,209 --> 00:07:05,769

reaction wheel problem this was a while

171

00:07:03,069 --> 00:07:07,718

ago and then we moved it to its

172
00:07:05,769 --> 00:07:11,049
secondary mission that can be - mission

173
00:07:07,718 --> 00:07:13,418
which it did observing as it could given

174
00:07:11,050 --> 00:07:16,179
the reaction wheel problem for another

175
00:07:13,418 --> 00:07:19,149
four years and then finally on October

176
00:07:16,178 --> 00:07:22,028
30th of this year the fuel was exhausted

177
00:07:19,149 --> 00:07:23,978
the Poynting fuel that the fuel that's

178
00:07:22,028 --> 00:07:26,199
necessary to point the telescope was

179
00:07:23,978 --> 00:07:30,668
finally exhausted which was again what

180
00:07:26,199 --> 00:07:32,379
was expected and so that the fuel the

181
00:07:30,668 --> 00:07:34,838
Kepler mission had to be brought to a

182
00:07:32,379 --> 00:07:36,699
close but it did do its full four years

183
00:07:34,838 --> 00:07:38,259
of its primary mission and it got

184
00:07:36,699 --> 00:07:41,110
another four years of its secondary

185
00:07:38,259 --> 00:07:44,348
mission was actually up for it almost

186
00:07:41,110 --> 00:07:48,189
nine years doing observations is that

187
00:07:44,348 --> 00:07:51,069
the end of Kepler no because Kepler

188
00:07:48,189 --> 00:07:53,709
created an incredible data set of light

189
00:07:51,069 --> 00:07:55,329
curves all of these stars and their

190
00:07:53,709 --> 00:07:57,550
brightnesses and their dips and their

191
00:07:55,329 --> 00:07:59,949
brightnesses that will be researched and

192
00:07:57,550 --> 00:08:01,749
research for quite some time to come and

193
00:07:59,949 --> 00:08:03,550
where are you going to go for that

194
00:08:01,749 --> 00:08:06,338
you're going to go to the Mikulski

195
00:08:03,550 --> 00:08:08,019
archive for Space Telescope's right here

196
00:08:06,338 --> 00:08:10,899
in this building also affectionately

197
00:08:08,019 --> 00:08:12,939
known as mast and one of the managers of

198
00:08:10,899 --> 00:08:17,379
it is sitting right up there who retired

199
00:08:12,939 --> 00:08:19,689
a month ago as well if I forget what

200

00:08:17,379 --> 00:08:23,110
your status was with Matt what your

201
00:08:19,689 --> 00:08:25,179
title was a mass archive size archive

202
00:08:23,110 --> 00:08:28,658
scientists sciences branch manager

203
00:08:25,178 --> 00:08:31,958
that's Karen all of a zoltán Karen both

204
00:08:28,658 --> 00:08:34,718
retired a while ago and so the mast

205
00:08:31,959 --> 00:08:37,448
archive here will continue to serve data

206
00:08:34,719 --> 00:08:39,490
for the Kepler mission and so it will

207
00:08:37,448 --> 00:08:42,068
actually have a lot more science results

208
00:08:39,490 --> 00:08:43,688
to come because one of the things that

209
00:08:42,068 --> 00:08:45,458
we're getting in the modern era is you

210
00:08:43,688 --> 00:08:47,620
get this incredible data that people

211
00:08:45,458 --> 00:08:49,688
search through the archives and make new

212
00:08:47,620 --> 00:08:52,690
discoveries for years and decades to

213
00:08:49,688 --> 00:08:55,689
come the third

214
00:08:52,690 --> 00:08:58,180

and update it concerns the dawn mission

215

00:08:55,690 --> 00:09:00,040

and if you remember the dawn mission was

216

00:08:58,179 --> 00:09:03,689

to study at the two largest asteroids

217

00:09:00,039 --> 00:09:05,889

Vesta and Ceres it was launched in 2007

218

00:09:03,690 --> 00:09:08,230

spent four years travelling the solar

219

00:09:05,889 --> 00:09:11,649

system to get to Vesta it stayed with

220

00:09:08,230 --> 00:09:13,720

Vesta for a year and then continued on

221

00:09:11,649 --> 00:09:16,419

traveling three years around the solar

222

00:09:13,720 --> 00:09:19,120

system to get to Ceres spent the last

223

00:09:16,419 --> 00:09:22,929

three years studying series in a or

224

00:09:19,120 --> 00:09:26,740

orbit a very close orbit amazing amazing

225

00:09:22,929 --> 00:09:27,909

data about series but a day after that

226

00:09:26,740 --> 00:09:29,830

the Kepler mission of Schewel was

227

00:09:27,909 --> 00:09:31,929

exhausted it was announced that the

228

00:09:29,830 --> 00:09:33,790

Dawn's mission fuel was also exhausted

229
00:09:31,929 --> 00:09:36,219
neither of these were any surprise okay

230
00:09:33,789 --> 00:09:38,110
we knew that that the hydrazine only

231
00:09:36,220 --> 00:09:41,740
last for so long for pointing the

232
00:09:38,110 --> 00:09:45,610
telescope but dawn celebrated 11 years

233
00:09:41,740 --> 00:09:48,970
and 4.3 billion miles around the solar

234
00:09:45,610 --> 00:09:50,980
system so the Kepler and Dawn missions

235
00:09:48,970 --> 00:09:57,120
are finished Hubble is back in operation

236
00:09:50,980 --> 00:09:57,120
and those are your mission updates yes

237
00:09:58,679 --> 00:10:02,949
Parker Solar Probe I have not mentioned

238
00:10:00,940 --> 00:10:05,470
the Parker Solar Probe you want me to

239
00:10:02,950 --> 00:10:08,110
mention it next month I will I will read

240
00:10:05,470 --> 00:10:10,990
up about the Parker Solar Probe it did

241
00:10:08,110 --> 00:10:14,350
make a very close pass to the Sun over

242
00:10:10,990 --> 00:10:17,529
the last month or so it's got to make

243
00:10:14,350 --> 00:10:19,120
lots of things and it's accommodating

244
00:10:17,529 --> 00:10:21,069
data they're not going to be announcing

245
00:10:19,120 --> 00:10:22,929
results from it I usually chime in when

246
00:10:21,070 --> 00:10:25,270
they're an else result results announced

247
00:10:22,929 --> 00:10:26,829
but just for you I'll take a look at the

248
00:10:25,269 --> 00:10:29,350
Parker Solar Probe for next month's news

249
00:10:26,830 --> 00:10:31,990
okay all right

250
00:10:29,350 --> 00:10:36,129
so for some science results tonight we

251
00:10:31,990 --> 00:10:39,610
have evidence of an EXO moon okay so we

252
00:10:36,129 --> 00:10:41,559
have seen lots of planets or evidence of

253
00:10:39,610 --> 00:10:42,970
lots of planets around other stars these

254
00:10:41,559 --> 00:10:46,329
are called extrasolar planets or

255
00:10:42,970 --> 00:10:51,279
exoplanets okay but we have never seen

256
00:10:46,330 --> 00:10:53,560
one with a moon and with the Kepler data

257

00:10:51,279 --> 00:10:55,779
than I mentioned just previously and

258
00:10:53,559 --> 00:10:59,049
some Hubble follow-up observations we

259
00:10:55,779 --> 00:11:02,439
now have evidence that there may be a

260
00:10:59,049 --> 00:11:06,519
moon around a star called a star called

261
00:11:02,440 --> 00:11:10,390
Kepler 16:25 and a planet called 16:20

262
00:11:06,519 --> 00:11:13,240
be all right so the way it works is that

263
00:11:10,389 --> 00:11:15,879
as I said Kepler records the light of

264
00:11:13,240 --> 00:11:18,639
the star and the dips in the light when

265
00:11:15,879 --> 00:11:21,399
a planet passes in front of it and with

266
00:11:18,639 --> 00:11:23,230
this massive Kepler database researchers

267
00:11:21,399 --> 00:11:25,569
up at Columbia University went searching

268
00:11:23,230 --> 00:11:28,060
to see if they could find evidence of

269
00:11:25,570 --> 00:11:29,410
moons right so you've got a planet

270
00:11:28,059 --> 00:11:31,269
passing in front if there's another moon

271
00:11:29,409 --> 00:11:34,839

there would be another dip and so they

272

00:11:31,269 --> 00:11:36,850

went through lots of these light curves

273

00:11:34,840 --> 00:11:39,370

looking for anomalies that might

274

00:11:36,850 --> 00:11:41,550

indicate a moon they found about 40 pop

275

00:11:39,370 --> 00:11:43,480

candidates but this is the best one and

276

00:11:41,549 --> 00:11:46,419

because this was the best one they were

277

00:11:43,480 --> 00:11:48,460

able to get Hubble follow-up time and so

278

00:11:46,419 --> 00:11:50,909

they used Hubble follow-up time to

279

00:11:48,460 --> 00:11:54,220

record the light curve really accurately

280

00:11:50,909 --> 00:11:57,639

and Hubble saw the planet passing across

281

00:11:54,220 --> 00:12:00,779

as you see in slide two and then the

282

00:11:57,639 --> 00:12:04,689

planet stops the planet comes out of

283

00:12:00,779 --> 00:12:08,139

transit and slide 3 and then in slide 4

284

00:12:04,690 --> 00:12:11,170

you can see a moon passing across which

285

00:12:08,139 --> 00:12:13,929

causes another smutch smaller dip in the

286
00:12:11,169 --> 00:12:18,309
light curve now unfortunately the Hubble

287
00:12:13,929 --> 00:12:20,829
observing window closed before the moon

288
00:12:18,309 --> 00:12:23,439
made its full pass across so they can't

289
00:12:20,830 --> 00:12:25,240
fully confirm it okay they would need

290
00:12:23,440 --> 00:12:27,310
actually to look many times over and

291
00:12:25,240 --> 00:12:29,470
over again so they're proposing a course

292
00:12:27,309 --> 00:12:32,649
to do follow-up observations but if

293
00:12:29,470 --> 00:12:35,410
confirmed this is the first detection of

294
00:12:32,649 --> 00:12:38,409
a moon around a planet around another

295
00:12:35,409 --> 00:12:41,529
star and that would be kind of cool not

296
00:12:38,409 --> 00:12:47,319
only is it interesting for that but also

297
00:12:41,529 --> 00:12:49,990
because it's not what color is that does

298
00:12:47,320 --> 00:12:53,230
that look like our moon this is not a

299
00:12:49,990 --> 00:12:56,529
moon like our moon this is not a moon

300
00:12:53,230 --> 00:12:59,200
like any moon in our solar system there

301
00:12:56,529 --> 00:13:01,350
are 200 moons in our solar system none

302
00:12:59,200 --> 00:13:05,770
of them are like this because this is

303
00:13:01,350 --> 00:13:08,350
actually more like Neptune okay the

304
00:13:05,769 --> 00:13:10,449
planet is several times larger than

305
00:13:08,350 --> 00:13:14,320
Jupiter like three to five Jupiter mass

306
00:13:10,450 --> 00:13:17,560
planet and the moon is like a Neptune

307
00:13:14,320 --> 00:13:20,770
mass planet all right

308
00:13:17,559 --> 00:13:23,559
and we do have one moon in the solar

309
00:13:20,769 --> 00:13:26,259
system that has an atmosphere Titan but

310
00:13:23,559 --> 00:13:29,429
we it's at its core it's more like a

311
00:13:26,259 --> 00:13:34,059
rocky planet okay an earth Venus Mars

312
00:13:29,429 --> 00:13:37,929
type planet right this is a planet like

313
00:13:34,059 --> 00:13:40,419
Neptune and Uranus but it's a moon

314

00:13:37,929 --> 00:13:45,519
around a planet that's larger than

315
00:13:40,419 --> 00:13:48,838
Jupiter yeah how do you form a Uranus

316
00:13:45,519 --> 00:13:51,460
type planet around a Jupiter type planet

317
00:13:48,839 --> 00:13:53,080
Uranus type moon around a Jupiter type I

318
00:13:51,460 --> 00:13:57,730
can't even say Uranus type moon because

319
00:13:53,080 --> 00:14:00,490
it just doesn't work in my brain it

320
00:13:57,730 --> 00:14:02,470
probably didn't form in situating to our

321
00:14:00,490 --> 00:14:04,778
current ideas but maybe we don't have

322
00:14:02,470 --> 00:14:06,670
the best ideas okay so this is

323
00:14:04,778 --> 00:14:09,159
intriguing not only because it could be

324
00:14:06,669 --> 00:14:12,278
the first moon discovered elsewhere and

325
00:14:09,159 --> 00:14:15,819
this hole is in the universe but also it

326
00:14:12,278 --> 00:14:19,179
might be the first giant moon discovered

327
00:14:15,820 --> 00:14:21,278
in this in the universe so stay tuned

328
00:14:19,179 --> 00:14:26,079

there might be some might be more coming

329

00:14:21,278 --> 00:14:29,409

up all right any chance it's a binary

330

00:14:26,080 --> 00:14:31,960

planet no the mass ratio between the

331

00:14:29,409 --> 00:14:35,019

planet and the moon is approximately the

332

00:14:31,960 --> 00:14:37,330

same as the mass ratio between Earth and

333

00:14:35,019 --> 00:14:39,879

our moon so it's it's it's it's

334

00:14:37,330 --> 00:14:42,490

relatively large actually I think it's

335

00:14:39,879 --> 00:14:44,980

larger than the mass ratio think it's

336

00:14:42,490 --> 00:14:48,250

only the moon is only a few percent the

337

00:14:44,980 --> 00:14:49,269

mass of the planet okay so that's that

338

00:14:48,250 --> 00:14:53,080

wouldn't that wouldn't qualify as a

339

00:14:49,269 --> 00:14:56,110

binary question thank you alright one

340

00:14:53,080 --> 00:15:00,430

last thing to note is Hubble is having

341

00:14:56,110 --> 00:15:02,350

its symphonic premiere this is a project

342

00:15:00,429 --> 00:15:05,169

I'm very happy to tell you about we've

343
00:15:02,350 --> 00:15:07,540
been working on it for 18 months on this

344
00:15:05,169 --> 00:15:09,819
Friday at the Kennedy Space Center in

345
00:15:07,539 --> 00:15:12,250
Florida we'll have a premiere of Deep

346
00:15:09,820 --> 00:15:14,560
Field the impossible magnitude of our

347
00:15:12,250 --> 00:15:16,480
universe this is a project we've been

348
00:15:14,559 --> 00:15:19,208
working with conductor and composer Eric

349
00:15:16,480 --> 00:15:22,930
Whitacre he composed a 23-minute

350
00:15:19,208 --> 00:15:26,739
symphony called Deep Field which was

351
00:15:22,929 --> 00:15:29,139
inspired by the Hubble Deep Field and we

352
00:15:26,740 --> 00:15:31,470
have been working with his company music

353
00:15:29,139 --> 00:15:34,019
productions limited as well as 59

354
00:15:31,470 --> 00:15:36,450
actions a company based out of London to

355
00:15:34,019 --> 00:15:40,139
create a film to go along with his

356
00:15:36,450 --> 00:15:42,540
symphony and it will premiere Friday

357
00:15:40,139 --> 00:15:46,080
November 16th down at Kennedy

358
00:15:42,539 --> 00:15:52,620
it will also be released on YouTube ok

359
00:15:46,080 --> 00:15:56,040
so everyone can see this it's a how to

360
00:15:52,620 --> 00:15:58,889
describe it so what it's a modern

361
00:15:56,039 --> 00:16:02,009
somewhat minimalist symphony with very

362
00:15:58,889 --> 00:16:04,740
stirring music and very quiet music and

363
00:16:02,009 --> 00:16:08,669
the progression of images starts with

364
00:16:04,740 --> 00:16:14,129
our very own Zolt lavas photography of

365
00:16:08,669 --> 00:16:16,799
the milky way in and what what National

366
00:16:14,129 --> 00:16:19,200
Park Capitol Reef eyes don't want to say

367
00:16:16,799 --> 00:16:21,120
Canyonlands for every battle reef he was

368
00:16:19,200 --> 00:16:22,590
a photographer he was out doing an

369
00:16:21,120 --> 00:16:24,600
artist-in-residence at Capitol Reef

370
00:16:22,590 --> 00:16:27,269
National Park and got an amazing shot of

371

00:16:24,600 --> 00:16:29,639
the Milky Way panning across the night

372
00:16:27,269 --> 00:16:32,429
sky that opens the film we go through

373
00:16:29,639 --> 00:16:34,679
planets and stars and nebulae and

374
00:16:32,429 --> 00:16:38,309
galaxies and out to the edge of the

375
00:16:34,679 --> 00:16:41,849
universe and the deep field in this with

376
00:16:38,309 --> 00:16:44,309
all to Eric Whitakers wonderful music so

377
00:16:41,850 --> 00:16:45,690
look for that if you want more

378
00:16:44,309 --> 00:16:49,619
information you can go to Deep Field

379
00:16:45,690 --> 00:16:55,100
film comm it says it will be released

380
00:16:49,620 --> 00:16:55,100
globally 7 a.m. Eastern Time on Friday

381
00:16:58,580 --> 00:17:04,440
and I will probably take one of the

382
00:17:02,429 --> 00:17:06,509
public lecture series is next year and

383
00:17:04,440 --> 00:17:08,250
play this film for you and we'll do a

384
00:17:06,509 --> 00:17:09,809
discussion of how what we what we did

385
00:17:08,250 --> 00:17:12,450

the Space Telescope Science Institute

386

00:17:09,809 --> 00:17:14,159

was involved in 11 sequences in this

387

00:17:12,450 --> 00:17:17,549

film over half of the visuals are

388

00:17:14,160 --> 00:17:20,009

derived from our work so we're very very

389

00:17:17,549 --> 00:17:24,000

proud to show this off to the public all

390

00:17:20,009 --> 00:17:26,960

right and now our featured speaker let's

391

00:17:24,000 --> 00:17:26,960

switch over to his slides

392

00:17:35,470 --> 00:17:40,750

our speaker tonight is dr. bill Blair

393

00:17:38,539 --> 00:17:44,058

he's across the street at Johns Hopkins

394

00:17:40,750 --> 00:17:49,579

but he's also here Space Telescope in a

395

00:17:44,058 --> 00:17:51,349

way he joined Hopkins in 1984 and has

396

00:17:49,579 --> 00:17:53,210

been there ever since working on the

397

00:17:51,349 --> 00:17:55,149

Hopkins ultraviolet telescope which

398

00:17:53,210 --> 00:17:57,049

twice flew on the space shuttle

399

00:17:55,150 --> 00:17:59,690

observing an ultraviolet which you can

400
00:17:57,049 --> 00:18:01,428
only do from space then he worked on an

401
00:17:59,690 --> 00:18:02,750
even more ambitious ultraviolet

402
00:18:01,429 --> 00:18:06,620
telescope the far ultraviolet

403
00:18:02,750 --> 00:18:09,589
spectrograph Explorer fuse and he

404
00:18:06,619 --> 00:18:12,199
parlayed the experience of running fuse

405
00:18:09,589 --> 00:18:14,750
to come over and work with us on the

406
00:18:12,200 --> 00:18:17,058
James Webb Space Telescope where you can

407
00:18:14,750 --> 00:18:21,259
see he is project scientist for use of

408
00:18:17,058 --> 00:18:23,178
support for JWST so he's going to use

409
00:18:21,259 --> 00:18:26,029
that amazing knowledge to tell us all

410
00:18:23,179 --> 00:18:29,470
about Hubble uh-huh ladies and gentlemen

411
00:18:26,029 --> 00:18:29,470
dr. bill Blair

412
00:18:35,740 --> 00:18:40,700
thanks Frank and thank you all for

413
00:18:38,450 --> 00:18:43,970
coming out tonight this is great to see

414
00:18:40,700 --> 00:18:47,029
such a good crowd so I am an astronomer

415
00:18:43,970 --> 00:18:49,190
I've used Hubble many times over the

416
00:18:47,029 --> 00:18:51,079
years and as many times as I would have

417
00:18:49,190 --> 00:18:53,980
liked to but I get lucky every once in a

418
00:18:51,079 --> 00:18:56,119
while and get a project and the

419
00:18:53,980 --> 00:18:58,849
functional side of my work though has

420
00:18:56,119 --> 00:19:01,489
always been in user support and user

421
00:18:58,849 --> 00:19:03,439
support is supporting astronomers to use

422
00:19:01,490 --> 00:19:06,140
the various facilities like the Hubble

423
00:19:03,440 --> 00:19:08,600
telescope or like the fuse or the Hut

424
00:19:06,140 --> 00:19:10,580
telescopes before that and so a lot of

425
00:19:08,599 --> 00:19:14,089
my professional activity has been

426
00:19:10,579 --> 00:19:16,460
involved in enabling science the systems

427
00:19:14,089 --> 00:19:18,319
and the software to help run these

428

00:19:16,460 --> 00:19:22,400
telescopes and get the data that

429
00:19:18,319 --> 00:19:23,990
astronomers need or desire so I'm going

430
00:19:22,400 --> 00:19:25,910
to put those two pieces together today i

431
00:19:23,990 --> 00:19:29,059
intent is to try to give you a little

432
00:19:25,910 --> 00:19:32,000
bit of a behind-the-scenes look at what

433
00:19:29,059 --> 00:19:33,740
it takes to get a project accepted for

434
00:19:32,000 --> 00:19:36,140
one of these telescopes to get it

435
00:19:33,740 --> 00:19:38,990
scheduled to get the data back and to do

436
00:19:36,140 --> 00:19:43,340
something reasonable with the data after

437
00:19:38,990 --> 00:19:45,799
it comes back and I think you'll get a

438
00:19:43,339 --> 00:19:47,419
perspective on why it takes an institute

439
00:19:45,799 --> 00:19:49,879
like this to actually run something like

440
00:19:47,420 --> 00:19:54,950
the Hubble Space Telescope because there

441
00:19:49,880 --> 00:19:56,990
is so much involved behind the scenes so

442
00:19:54,950 --> 00:19:59,210

I know that you all have seen many of

443

00:19:56,990 --> 00:20:01,130
these wonderful pictures that are

444

00:19:59,210 --> 00:20:03,650
released occasionally either in press

445

00:20:01,130 --> 00:20:05,120
releases or in photo releases from the

446

00:20:03,650 --> 00:20:07,220
Institute of course the Hubble heritage

447

00:20:05,119 --> 00:20:10,909
program for many years put one out every

448

00:20:07,220 --> 00:20:14,360
month this is just a partial screenshot

449

00:20:10,910 --> 00:20:16,460
of the Hubble heritage site and you see

450

00:20:14,359 --> 00:20:18,859
the many different kinds of pictures

451

00:20:16,460 --> 00:20:22,220
that are released but behind every one

452

00:20:18,859 --> 00:20:26,199
of these pictures is a story and the

453

00:20:22,220 --> 00:20:28,370
story usually has started with an idea a

454

00:20:26,200 --> 00:20:30,230
question it needs to be answered or an

455

00:20:28,369 --> 00:20:33,409
observation that can help answer a

456

00:20:30,230 --> 00:20:35,329
question a proposal written by an

457
00:20:33,410 --> 00:20:38,269
astronomer or more often a group of

458
00:20:35,329 --> 00:20:41,929
astronomers that wants to use get the

459
00:20:38,269 --> 00:20:43,250
data to do that project and then all the

460
00:20:41,930 --> 00:20:46,160
things that have to happen to actually

461
00:20:43,250 --> 00:20:48,140
schedule the telescope and to get the

462
00:20:46,160 --> 00:20:49,460
data to archive it

463
00:20:48,140 --> 00:20:51,920
then back to the astronomer for the

464
00:20:49,460 --> 00:20:53,600
analysis and understanding part and

465
00:20:51,920 --> 00:20:56,420
ultimately that a publication of a

466
00:20:53,599 --> 00:20:58,339
scientific result and sometimes fairly

467
00:20:56,420 --> 00:21:00,289
often there's a pretty picture that

468
00:20:58,339 --> 00:21:03,439
comes out of that as well that the oppo

469
00:21:00,289 --> 00:21:07,009
group here puts out as a photo release

470
00:21:03,440 --> 00:21:08,870
as you see here and so tonight this is

471
00:21:07,009 --> 00:21:11,509
going to be the story of one such

472
00:21:08,869 --> 00:21:14,389
picture this one of m83

473
00:21:11,509 --> 00:21:15,829
this wonderful galaxy that i'll be

474
00:21:14,390 --> 00:21:18,320
talking about off and on as we go

475
00:21:15,829 --> 00:21:20,359
through this process of what it takes to

476
00:21:18,319 --> 00:21:23,649
get science data from the Hubble

477
00:21:20,359 --> 00:21:27,349
telescope so there's the full heritage

478
00:21:23,650 --> 00:21:29,990
release you see this marvelous picture

479
00:21:27,349 --> 00:21:31,099
but there's a what's going on here in

480
00:21:29,990 --> 00:21:33,680
this galaxy is that there's a very

481
00:21:31,099 --> 00:21:35,089
bright burst of star formation happening

482
00:21:33,680 --> 00:21:37,460
in the very center of the galaxy the

483
00:21:35,089 --> 00:21:39,980
nucleus you see these very well formed

484
00:21:37,460 --> 00:21:41,569
spiral arms coming out you see this

485

00:21:39,980 --> 00:21:44,180
brown stuff around here which is

486
00:21:41,569 --> 00:21:45,259
interstellar dust dust bunnies I like to

487
00:21:44,180 --> 00:21:47,299
call it interstellar dust bunnies

488
00:21:45,259 --> 00:21:50,150
running around out there in that galaxy

489
00:21:47,299 --> 00:21:52,369
you see these big red glowing regions of

490
00:21:50,150 --> 00:21:54,050
hydrogen gas around the youngest stars

491
00:21:52,369 --> 00:21:56,179
that are forming that are exciting that

492
00:21:54,049 --> 00:21:58,519
gas to glow so you can see that there's

493
00:21:56,180 --> 00:22:00,410
a lot of star formation out here in the

494
00:21:58,519 --> 00:22:02,720
spiral arms but there's a tremendous

495
00:22:00,410 --> 00:22:04,160
burst of star formation going on here in

496
00:22:02,720 --> 00:22:07,069
the center and then this kind of

497
00:22:04,160 --> 00:22:09,710
yellowish red hazy light that you see

498
00:22:07,069 --> 00:22:11,990
there are older stars that are yellow or

499
00:22:09,710 --> 00:22:14,600

red or in color as opposed to the bright

500

00:22:11,990 --> 00:22:17,720

blue stars that have formed more

501

00:22:14,599 --> 00:22:19,429

recently well that's a beautiful picture

502

00:22:17,720 --> 00:22:21,140

it's a wonderful picture and what does

503

00:22:19,430 --> 00:22:23,060

it take that you and make a picture like

504

00:22:21,140 --> 00:22:25,310

that for a photo release well in this

505

00:22:23,059 --> 00:22:28,309

particular case it took two different

506

00:22:25,309 --> 00:22:31,159

programs of data one here the two yellow

507

00:22:28,309 --> 00:22:33,710

boxes were obtained first shortly after

508

00:22:31,160 --> 00:22:37,130

the Wide Field Camera 3 was installed in

509

00:22:33,710 --> 00:22:38,930

2009 and the results from those two

510

00:22:37,130 --> 00:22:41,150

fields were so astounding then I was

511

00:22:38,930 --> 00:22:44,570

able to come along the year or so later

512

00:22:41,150 --> 00:22:46,580

and and get a program to look at the red

513

00:22:44,569 --> 00:22:48,439

boxes here and a couple of other filters

514
00:22:46,579 --> 00:22:52,009
in the yellow boxes to complete this

515
00:22:48,440 --> 00:22:53,230
data set to observe m83 and I'll tell

516
00:22:52,009 --> 00:22:56,210
you a little bit about the science

517
00:22:53,230 --> 00:22:57,110
behind that as we go along tonight I

518
00:22:56,210 --> 00:22:59,840
just thought I would point out that

519
00:22:57,109 --> 00:23:01,889
basically this first program was 16 HST

520
00:22:59,839 --> 00:23:06,449
orbits my program

521
00:23:01,890 --> 00:23:08,460
was 36h HST Orbitz that's 56 total and

522
00:23:06,450 --> 00:23:11,730
at 14 and 1/2 orbits per day you're

523
00:23:08,460 --> 00:23:13,230
looking at basically four days of Hubble

524
00:23:11,730 --> 00:23:15,900
observing time just to make this one

525
00:23:13,230 --> 00:23:19,289
photo release picture that you see here

526
00:23:15,900 --> 00:23:21,810
tonight so here's a slightly different

527
00:23:19,289 --> 00:23:23,700
version of that same picture and you can

528
00:23:21,809 --> 00:23:25,649
see that basically the the photo release

529
00:23:23,700 --> 00:23:27,120
picture was the biggest rectangle you

530
00:23:25,650 --> 00:23:28,920
can cut out of this and not have this

531
00:23:27,119 --> 00:23:30,389
funny shape to it but we got one

532
00:23:28,920 --> 00:23:34,350
additional field out here to get an

533
00:23:30,390 --> 00:23:36,150
outer spiral arm in this galaxy and to

534
00:23:34,349 --> 00:23:39,419
put together this kind of a mosaic

535
00:23:36,150 --> 00:23:42,540
picture it took some special work by

536
00:23:39,420 --> 00:23:44,490
some of the staff here at STScI and of

537
00:23:42,539 --> 00:23:47,309
course result here who's here tonight

538
00:23:44,490 --> 00:23:50,009
great to see you sol was responsible for

539
00:23:47,309 --> 00:23:51,720
putting together this this photo release

540
00:23:50,009 --> 00:23:53,549
picture I thought I would just mention

541
00:23:51,720 --> 00:23:55,650
though that this picture includes the

542

00:23:53,549 --> 00:23:57,389
filters that you see here in blue which

543
00:23:55,650 --> 00:24:00,660
are all optical light pictures there's

544
00:23:57,390 --> 00:24:02,460
four different bands of starlight in

545
00:24:00,660 --> 00:24:04,650
this picture there were two more here

546
00:24:02,460 --> 00:24:06,990
this later yellow as the infrared camera

547
00:24:04,650 --> 00:24:08,370
bands and the H&K bands are not part of

548
00:24:06,990 --> 00:24:10,259
that picture but we're part of our data

549
00:24:08,369 --> 00:24:12,169
set and then in the emission lines

550
00:24:10,259 --> 00:24:15,349
you're seeing the h-alpha the red

551
00:24:12,170 --> 00:24:18,450
regions of a diffuse gas in that picture

552
00:24:15,349 --> 00:24:19,919
but we also took several other emission

553
00:24:18,450 --> 00:24:21,990
lines including one here that was in the

554
00:24:19,920 --> 00:24:23,580
infrared that I'll mentioned briefly as

555
00:24:21,990 --> 00:24:25,440
we go along as well of course Hubble

556
00:24:23,579 --> 00:24:27,119

mainly looks on the optical but it goes

557

00:24:25,440 --> 00:24:29,400
into the ultraviolet and into the

558

00:24:27,119 --> 00:24:31,859
near-infrared which is difficult to

559

00:24:29,400 --> 00:24:33,600
observe from the ground and these

560

00:24:31,859 --> 00:24:35,849
wonderful mosaics after we stitched all

561

00:24:33,599 --> 00:24:40,379
this together are actually available in

562

00:24:35,849 --> 00:24:41,339
the archive here at mast so why do we

563

00:24:40,380 --> 00:24:43,020
need to use Hubble to make an

564

00:24:41,339 --> 00:24:44,609
observation like that I mean we can take

565

00:24:43,019 --> 00:24:45,900
a picture of that whole galaxy with the

566

00:24:44,609 --> 00:24:47,309
ground-based telescope when you want a

567

00:24:45,900 --> 00:24:49,140
shot and not have to stitch all those

568

00:24:47,309 --> 00:24:50,700
fields together and whatnot and the

569

00:24:49,140 --> 00:24:53,160
reason is there before you there's

570

00:24:50,700 --> 00:24:54,900
nothing like having spatial resolution

571
00:24:53,160 --> 00:24:56,550
this is a ground-based

572
00:24:54,900 --> 00:24:59,400
picture of just a little piece of a

573
00:24:56,549 --> 00:25:01,470
spiral arm in m83 it's a ground-based

574
00:24:59,400 --> 00:25:03,690
data set that we took down in Chile at

575
00:25:01,470 --> 00:25:06,509
the Magellan telescope and this is an

576
00:25:03,690 --> 00:25:08,400
excellent ground-based data set the

577
00:25:06,509 --> 00:25:10,170
seeing here is about a half an arc

578
00:25:08,400 --> 00:25:11,700
second now some of you amateur

579
00:25:10,170 --> 00:25:13,320
astronomers are out there if you get

580
00:25:11,700 --> 00:25:14,710
below one arcsecond you're doing well

581
00:25:13,319 --> 00:25:17,048
oftentimes ground-based

582
00:25:14,710 --> 00:25:18,579
even not quite as good as one arcsecond

583
00:25:17,048 --> 00:25:20,679
this is half arcsecond for the whole

584
00:25:18,579 --> 00:25:22,028
galaxy and maybe three but when you look

585
00:25:20,679 --> 00:25:24,100
at a little piece of it that's what it

586
00:25:22,028 --> 00:25:26,710
looks like and here are the same filters

587
00:25:24,099 --> 00:25:28,569
now used in the Hubble data and if

588
00:25:26,710 --> 00:25:30,069
you're going to work on photometry of

589
00:25:28,569 --> 00:25:32,200
the stars measuring the brightness and

590
00:25:30,069 --> 00:25:34,359
the colors of stars I'd rather work on

591
00:25:32,200 --> 00:25:36,880
that data than on that data and that's

592
00:25:34,359 --> 00:25:40,750
the motivation for getting Hubble time

593
00:25:36,880 --> 00:25:42,880
is the spatial resolution well what does

594
00:25:40,750 --> 00:25:44,769
it actually take then to to get a

595
00:25:42,880 --> 00:25:46,750
proposal through the system here and

596
00:25:44,769 --> 00:25:49,028
have something happen well it starts

597
00:25:46,750 --> 00:25:53,109
down here with an idea or a question

598
00:25:49,028 --> 00:25:55,000
that needs to be answered after a lot of

599

00:25:53,109 --> 00:25:56,079
work which I'll mention in passing as we

600
00:25:55,000 --> 00:25:59,140
go along

601
00:25:56,079 --> 00:26:01,658
you submit a proposal the the proposal

602
00:25:59,140 --> 00:26:03,278
is peer reviewed and if you're lucky you

603
00:26:01,659 --> 00:26:04,899
get accepted and then you go into the

604
00:26:03,278 --> 00:26:06,880
planning and scheduling part of the

605
00:26:04,898 --> 00:26:09,250
process which takes several months of

606
00:26:06,880 --> 00:26:11,409
work here at the Institute as well as

607
00:26:09,250 --> 00:26:14,079
some more work by the astronomer to put

608
00:26:11,409 --> 00:26:16,419
together the detailed observing plan it

609
00:26:14,079 --> 00:26:18,819
gets turned into a sequence of commands

610
00:26:16,419 --> 00:26:20,788
that gets sent up to good old Hubble if

611
00:26:18,819 --> 00:26:23,950
you're lucky the data get captured

612
00:26:20,788 --> 00:26:25,750
appropriately downlinked and then

613
00:26:23,950 --> 00:26:27,278

processed and calibrated which is a job

614

00:26:25,750 --> 00:26:30,038

that is also done here at the Institute

615

00:26:27,278 --> 00:26:31,839

and archived and then finally the data

616

00:26:30,038 --> 00:26:34,569

comes back to the scientist for

617

00:26:31,839 --> 00:26:37,329

scientific analysis and publication so

618

00:26:34,569 --> 00:26:38,619

that's the the process there and I

619

00:26:37,329 --> 00:26:40,960

thought it might be fun to just look in

620

00:26:38,619 --> 00:26:43,869

a little bit more detail at this process

621

00:26:40,960 --> 00:26:45,700

because in the simplest form of this

622

00:26:43,869 --> 00:26:48,308

basically the astronomer is doing the

623

00:26:45,700 --> 00:26:50,590

work down below the line and STScI does

624

00:26:48,308 --> 00:26:52,000

the work above the line it's actually a

625

00:26:50,589 --> 00:26:53,678

little more complicated than that but to

626

00:26:52,000 --> 00:26:56,079

first order that's that's what's going

627

00:26:53,679 --> 00:26:59,288

on here so let's look at this first part

628
00:26:56,079 --> 00:27:00,639
of the process my idea or anybody in the

629
00:26:59,288 --> 00:27:01,929
community of course there's a lot of

630
00:27:00,640 --> 00:27:04,270
people writing proposals at the same

631
00:27:01,929 --> 00:27:05,528
time write proposals and submit them to

632
00:27:04,269 --> 00:27:08,859
the Institute and what's called the

633
00:27:05,528 --> 00:27:10,450
phase one proposal process this peer

634
00:27:08,859 --> 00:27:12,668
review so just to give you an idea each

635
00:27:10,450 --> 00:27:14,019
of these steps along the way is a big

636
00:27:12,669 --> 00:27:14,590
job and I'm skipping over a lot of

637
00:27:14,019 --> 00:27:16,329
details

638
00:27:14,589 --> 00:27:20,439
maybe I'll just pick out one here which

639
00:27:16,329 --> 00:27:22,990
is the peer review imagine getting 1,200

640
00:27:20,440 --> 00:27:25,600
proposals at the deadline for Hubble

641
00:27:22,990 --> 00:27:27,509
time and having arranged ahead of time

642
00:27:25,599 --> 00:27:28,808
for about a hundred and twenty

643
00:27:27,509 --> 00:27:30,548
scientists from

644
00:27:28,808 --> 00:27:33,609
around the country and around the world

645
00:27:30,548 --> 00:27:35,589
to come to Baltimore to participate in a

646
00:27:33,609 --> 00:27:38,918
review and a selection of these

647
00:27:35,589 --> 00:27:41,769
proposals that's a lot of work travel

648
00:27:38,919 --> 00:27:43,870
all the mechanics of ranging the rooms

649
00:27:41,769 --> 00:27:45,419
where these people meet the effort that

650
00:27:43,869 --> 00:27:48,428
they go to and the tracking of all the

651
00:27:45,419 --> 00:27:50,710
deliberations and so forth that one box

652
00:27:48,429 --> 00:27:52,870
there is a huge job and each one of

653
00:27:50,710 --> 00:27:55,329
these boxes is actually a pretty big job

654
00:27:52,869 --> 00:27:57,189
as we go along but if we're accepted

655
00:27:55,329 --> 00:27:59,949
okay you go into that planning and

656

00:27:57,190 --> 00:28:02,320
scheduling phase and here each of these

657
00:27:59,950 --> 00:28:05,409
boxes can take maybe approximately a

658
00:28:02,319 --> 00:28:07,658
month to happen well the astronomer gets

659
00:28:05,409 --> 00:28:09,460
of an accepted proposal it's about a

660
00:28:07,659 --> 00:28:12,100
month to turn in the detailed proposal

661
00:28:09,460 --> 00:28:13,840
and maybe write a budget there's a

662
00:28:12,099 --> 00:28:16,118
technical review process that happens

663
00:28:13,839 --> 00:28:18,220
here where that proposal is inspected by

664
00:28:16,118 --> 00:28:21,398
the experts here at the Institute to

665
00:28:18,220 --> 00:28:23,829
make sure that everything is up to snuff

666
00:28:21,398 --> 00:28:26,079
there there's the construction of a

667
00:28:23,829 --> 00:28:27,579
year-long plan that takes all the

668
00:28:26,079 --> 00:28:29,319
observations that have been accepted and

669
00:28:27,579 --> 00:28:30,730
tries to figure out the most efficient

670
00:28:29,319 --> 00:28:31,898

way to do the observations throughout

671

00:28:30,730 --> 00:28:33,700
the course of the year

672

00:28:31,898 --> 00:28:35,678
it's kind of a rough layout but

673

00:28:33,700 --> 00:28:38,350
basically what time of year for each

674

00:28:35,679 --> 00:28:39,519
observation so your observation might

675

00:28:38,349 --> 00:28:40,808
get done all at once or it might get

676

00:28:39,519 --> 00:28:42,548
spread up and broken up into pieces

677

00:28:40,808 --> 00:28:45,220
throughout the year depending on what

678

00:28:42,548 --> 00:28:47,019
you're asking for and then about one

679

00:28:45,220 --> 00:28:48,490
week at a time a piece of this

680

00:28:47,019 --> 00:28:50,558
long-range plan is pulled into a

681

00:28:48,490 --> 00:28:53,499
short-term scheduling process where

682

00:28:50,558 --> 00:28:56,470
about one week of observations is put

683

00:28:53,499 --> 00:28:58,149
together into a sequence are literally a

684

00:28:56,470 --> 00:29:00,669
second-by-second sequence of what Hubble

685
00:28:58,148 --> 00:29:03,729
has to do it gets turned into spacecraft

686
00:29:00,669 --> 00:29:07,240
language that Hubble can understand and

687
00:29:03,730 --> 00:29:10,149
is then up linked to the Hubble where

688
00:29:07,240 --> 00:29:12,128
Howell operates autonomously then to

689
00:29:10,148 --> 00:29:13,689
make the observations and if the target

690
00:29:12,128 --> 00:29:16,148
acquisitions work right and everything

691
00:29:13,690 --> 00:29:18,249
else works right yeah you get some data

692
00:29:16,148 --> 00:29:20,199
out of that process so that's it's a

693
00:29:18,249 --> 00:29:22,659
long time coming but that's the fun part

694
00:29:20,200 --> 00:29:24,429
when you get the data after the data are

695
00:29:22,659 --> 00:29:27,039
captured on Hubble they have to get down

696
00:29:24,429 --> 00:29:29,740
to the ground they have to be calibrated

697
00:29:27,038 --> 00:29:31,298
and processed into a form that the

698
00:29:29,740 --> 00:29:33,128
astronomer can actually use because

699
00:29:31,298 --> 00:29:34,359
there's a lot of engineering stuff in

700
00:29:33,128 --> 00:29:36,219
the background and whatnot thermal

701
00:29:34,359 --> 00:29:38,648
temperature gradients that have to be

702
00:29:36,220 --> 00:29:40,179
accounted for and distortions and images

703
00:29:38,648 --> 00:29:41,669
and so forth they get taken out as part

704
00:29:40,179 --> 00:29:43,620
of this process

705
00:29:41,670 --> 00:29:45,509
that's a huge huge process that involves

706
00:29:43,619 --> 00:29:48,779
hundreds of people here at the Institute

707
00:29:45,509 --> 00:29:50,279
to do and to keep the pipeline up to

708
00:29:48,779 --> 00:29:52,289
date where the calibration files and so

709
00:29:50,279 --> 00:29:55,410
forth and then the data gets archived

710
00:29:52,289 --> 00:29:58,980
and the astronomer comes to the archive

711
00:29:55,410 --> 00:30:00,960
to get their data and then the fun

712
00:29:58,980 --> 00:30:03,329
begins for the astronomer to actually do

713

00:30:00,960 --> 00:30:07,860
the science analysis and see what they

714
00:30:03,329 --> 00:30:10,919
can learn from the data okay so for the

715
00:30:07,859 --> 00:30:12,629
m83 project I wanted to just start with

716
00:30:10,920 --> 00:30:16,710
a kind of a big context picture here for

717
00:30:12,630 --> 00:30:18,480
a second because this is a big this is a

718
00:30:16,710 --> 00:30:20,759
big scientific project to observe

719
00:30:18,480 --> 00:30:23,160
stellar evolution star birth and star

720
00:30:20,759 --> 00:30:25,079
death in the local universe to determine

721
00:30:23,160 --> 00:30:27,360
how star formation is triggered how it

722
00:30:25,079 --> 00:30:29,039
happens how stars go through their

723
00:30:27,359 --> 00:30:31,259
lifetime the impact that they have on

724
00:30:29,039 --> 00:30:33,779
their host galaxies those are all very

725
00:30:31,259 --> 00:30:35,670
large-scale questions and it would take

726
00:30:33,779 --> 00:30:37,859
a very large Hubble program to really

727
00:30:35,670 --> 00:30:40,140

address that and so what happens is that

728

00:30:37,859 --> 00:30:41,699

people pick off a piece of that big

729

00:30:40,140 --> 00:30:43,710

picture and say here's a piece I can

730

00:30:41,700 --> 00:30:45,900

actually tackle in a reasonable size

731

00:30:43,710 --> 00:30:48,410

proposal and for me it was finding and

732

00:30:45,900 --> 00:30:50,700

studying the supernova remnants in m83

733

00:30:48,410 --> 00:30:53,519

we also want to tie that into the

734

00:30:50,700 --> 00:30:55,289

stellar component as well but but my

735

00:30:53,519 --> 00:30:56,579

particular interest in motivation for

736

00:30:55,289 --> 00:30:58,799

this was to look at the supernova

737

00:30:56,579 --> 00:31:01,589

remnants in this galaxy and it turns out

738

00:30:58,799 --> 00:31:05,789

the m83 is a particularly good spot to

739

00:31:01,589 --> 00:31:07,199

do this m83 is about 15 million light

740

00:31:05,789 --> 00:31:08,430

years away which sounds like a big

741

00:31:07,200 --> 00:31:12,299

number but it's actually relatively

742
00:31:08,430 --> 00:31:13,890
nearby big face on a spiral galaxy the

743
00:31:12,299 --> 00:31:15,240
starburst nucleus and lots of star

744
00:31:13,890 --> 00:31:18,480
formation going on even in the outer

745
00:31:15,240 --> 00:31:20,250
part of of the galaxy and the reason

746
00:31:18,480 --> 00:31:22,710
it's a good place to look for supernova

747
00:31:20,250 --> 00:31:25,230
remnants the things that are left over

748
00:31:22,710 --> 00:31:26,789
after the supernova the remnants of the

749
00:31:25,230 --> 00:31:28,920
supernova is because it's had a lot of

750
00:31:26,789 --> 00:31:31,710
supernovae it had at least six or

751
00:31:28,920 --> 00:31:33,360
possibly seven supernovae in the last

752
00:31:31,710 --> 00:31:35,460
hundred years and so it's basically

753
00:31:33,359 --> 00:31:38,009
popping them off with with great

754
00:31:35,460 --> 00:31:41,220
regularity and so there'll be of order

755
00:31:38,009 --> 00:31:43,619
then 60 or 70 young supernova remnants a

756
00:31:41,220 --> 00:31:46,079
less than a thousand years old and many

757
00:31:43,619 --> 00:31:48,779
hundreds then that would might be older

758
00:31:46,079 --> 00:31:50,849
still and still visible so it's a great

759
00:31:48,779 --> 00:31:54,059
place to to look for the supernova

760
00:31:50,849 --> 00:31:55,230
remnants that I want to find this galaxy

761
00:31:54,059 --> 00:31:57,480
is about a quarter of

762
00:31:55,230 --> 00:31:59,069
degree across if you know the full moon

763
00:31:57,480 --> 00:32:00,660
is about a half a degree across so if

764
00:31:59,069 --> 00:32:02,389
you could look up on the sky and see a

765
00:32:00,660 --> 00:32:05,070
maybe three like that you'd see a

766
00:32:02,390 --> 00:32:06,660
extended physical object up there in the

767
00:32:05,069 --> 00:32:10,740
sky it's a beautiful galaxy although it

768
00:32:06,660 --> 00:32:12,990
is in the southern sky okay so the idea

769
00:32:10,740 --> 00:32:14,819
in particular for me is to find the

770

00:32:12,990 --> 00:32:16,589
young supernovae in the population and

771
00:32:14,819 --> 00:32:20,490
I'll tell you why here as we go along a

772
00:32:16,589 --> 00:32:22,230
little bit but also you know to tie the

773
00:32:20,490 --> 00:32:23,910
supernova remnants that we find to the

774
00:32:22,230 --> 00:32:25,890
nearby stars and say can we actually

775
00:32:23,910 --> 00:32:27,929
determine something about the kind of

776
00:32:25,890 --> 00:32:30,780
star that exploded to create the

777
00:32:27,929 --> 00:32:32,400
supernova remnants that we see and then

778
00:32:30,779 --> 00:32:34,379
the big-picture stuff that how does the

779
00:32:32,400 --> 00:32:37,200
entire population of supernova remnants

780
00:32:34,380 --> 00:32:38,790
actually impact the host galaxy and to

781
00:32:37,200 --> 00:32:41,100
answer questions like that you actually

782
00:32:38,789 --> 00:32:44,308
want to combine let's say Hubble data

783
00:32:41,099 --> 00:32:46,529
with data from the x-ray satellite

784
00:32:44,308 --> 00:32:48,119

Chandra x-ray Observatory or maybe even

785

00:32:46,529 --> 00:32:50,009

the Spitzer Space Observatory for

786

00:32:48,119 --> 00:32:53,969

infrared data to put together the big

787

00:32:50,009 --> 00:32:56,339

the big picture there okay so here's a

788

00:32:53,970 --> 00:32:58,650

couple of well-known young supernova

789

00:32:56,339 --> 00:33:01,079

remnants in our galaxy the Crab Nebula

790

00:32:58,650 --> 00:33:04,140

course a very famous object almost a

791

00:33:01,079 --> 00:33:06,808

thousand years old and still expanding

792

00:33:04,140 --> 00:33:08,520

fairly rapidly and the Cassiopeia a

793

00:33:06,808 --> 00:33:11,819

supernova remnant which came from quite

794

00:33:08,519 --> 00:33:14,730

a massive star and this is a picture

795

00:33:11,819 --> 00:33:16,678

actually with Spitzer data in red the

796

00:33:14,730 --> 00:33:18,179

Hubble data is in yellow and the green

797

00:33:16,679 --> 00:33:19,650

and blue are two different energies of

798

00:33:18,179 --> 00:33:21,780

x-rays from the Challenger x-ray

799

00:33:19,650 --> 00:33:23,580

Observatory that that tells you right

800

00:33:21,779 --> 00:33:25,349

off the bat that supernova remnants he

801

00:33:23,579 --> 00:33:27,629

met across the entire electromagnetic

802

00:33:25,349 --> 00:33:28,829

spectrum and part that we see with

803

00:33:27,630 --> 00:33:32,070

Hubble is just the optical or

804

00:33:28,829 --> 00:33:34,649

near-infrared light typically but the

805

00:33:32,069 --> 00:33:35,099

Chandra data is also very interesting as

806

00:33:34,650 --> 00:33:37,380

well

807

00:33:35,099 --> 00:33:39,599

now these objects are nearby we see lots

808

00:33:37,380 --> 00:33:41,520

of structure in them and of course as we

809

00:33:39,599 --> 00:33:43,609

look way far away we don't see that kind

810

00:33:41,519 --> 00:33:46,349

of structure but this is just two

811

00:33:43,609 --> 00:33:48,058

objects and what's going on here they're

812

00:33:46,349 --> 00:33:49,589

very different this has got an active

813
00:33:48,058 --> 00:33:52,289
pulsar in here whipping around that's

814
00:33:49,589 --> 00:33:56,129
creating this this blue haze in here of

815
00:33:52,289 --> 00:33:57,629
a synchrotron radiation it's they're

816
00:33:56,130 --> 00:33:59,280
both expanding rapidly but this one is

817
00:33:57,630 --> 00:34:01,140
expanding at ten or twelve thousand

818
00:33:59,279 --> 00:34:02,609
kilometers per second this is 1,800

819
00:34:01,140 --> 00:34:04,559
kilometers per second this one is

820
00:34:02,609 --> 00:34:07,349
enriched in helium and nitrogen and

821
00:34:04,558 --> 00:34:08,719
carbon this one has oxygen sulphur argon

822
00:34:07,349 --> 00:34:12,079
all the heavy elements

823
00:34:08,719 --> 00:34:13,579
and is this typical we don't know we

824
00:34:12,079 --> 00:34:15,230
have two objects to look at and we have

825
00:34:13,579 --> 00:34:17,179
all these parameters that are changing

826
00:34:15,230 --> 00:34:18,679
and you'd really like to get a sample of

827

00:34:17,179 --> 00:34:19,940
yung reminisce that you could look at

828
00:34:18,679 --> 00:34:22,309
and try to understand some of the

829
00:34:19,940 --> 00:34:23,750
statistics of what's going on in young

830
00:34:22,309 --> 00:34:25,608
supernovae and then determine whether

831
00:34:23,750 --> 00:34:27,530
these are oddball objects or whether

832
00:34:25,608 --> 00:34:29,299
they are a kind of typical objects

833
00:34:27,530 --> 00:34:32,990
they're often taken to be typical and

834
00:34:29,300 --> 00:34:35,510
they're actually not so by going to a

835
00:34:32,989 --> 00:34:37,339
galaxy like m83 big face on galaxy if we

836
00:34:35,510 --> 00:34:39,649
could find 60 or 70 young remnants here

837
00:34:37,340 --> 00:34:41,750
that would be a big step forward and

838
00:34:39,648 --> 00:34:44,719
that was part of my motivation for this

839
00:34:41,750 --> 00:34:46,550
so I said that m83 has had six or seven

840
00:34:44,719 --> 00:34:48,138
historical supernovae here's their

841
00:34:46,550 --> 00:34:51,800

positions in the galaxy here

842

00:34:48,139 --> 00:34:53,750

I said six or seven because this one

843

00:34:51,800 --> 00:34:55,519

here in red is actually one that we

844

00:34:53,750 --> 00:34:57,260

found as part of the survey that I'll

845

00:34:55,519 --> 00:35:00,949

tell you about here the proposal that we

846

00:34:57,260 --> 00:35:04,609

wrote that turns out to be a supernova

847

00:35:00,949 --> 00:35:05,659

that nobody saw this is jumping ahead a

848

00:35:04,608 --> 00:35:08,630

little bit now because I'm showing you

849

00:35:05,659 --> 00:35:10,879

some results up here in this panel we've

850

00:35:08,630 --> 00:35:13,220

got two ground-based pictures here this

851

00:35:10,880 --> 00:35:15,530

is in emission lines and this is

852

00:35:13,219 --> 00:35:18,230

starlight and then here's the same

853

00:35:15,530 --> 00:35:20,630

filters than with Hubble emission lines

854

00:35:18,230 --> 00:35:22,940

and the Starlight of the same field of

855

00:35:20,630 --> 00:35:24,950

view this is one arcsecond we're looking

856
00:35:22,940 --> 00:35:27,619
at a tiny tiny piece of m83

857
00:35:24,949 --> 00:35:29,509
at this one little object here and it

858
00:35:27,619 --> 00:35:32,780
was quite intriguing because it is so

859
00:35:29,510 --> 00:35:34,400
small it's very small in size and yet

860
00:35:32,780 --> 00:35:36,019
when we took a spectrum of this object

861
00:35:34,400 --> 00:35:37,849
the squiggly line here is what we call a

862
00:35:36,019 --> 00:35:40,099
spectrum in astronomy and you see these

863
00:35:37,849 --> 00:35:42,859
big broad lines this is Doppler shifting

864
00:35:40,099 --> 00:35:46,670
of the emission lines in this picture

865
00:35:42,858 --> 00:35:49,670
and it says that it's expanding at 5,200

866
00:35:46,670 --> 00:35:51,409
kilometers per second this is a young

867
00:35:49,670 --> 00:35:53,570
object it's still flying out in the

868
00:35:51,409 --> 00:35:55,969
space and when you combine the expansion

869
00:35:53,570 --> 00:35:58,010
velocity and the upper limit on the size

870
00:35:55,969 --> 00:35:59,779
that comes from Hubble it tells us that

871
00:35:58,010 --> 00:36:02,540
it has to be less than a hundred years

872
00:35:59,780 --> 00:36:05,089
old and yet the supernova was not

873
00:36:02,539 --> 00:36:07,338
observed it was it could have just

874
00:36:05,088 --> 00:36:09,889
simply been that the supernova occurred

875
00:36:07,338 --> 00:36:12,380
when m83 was behind the Sun and by the

876
00:36:09,889 --> 00:36:13,639
time it came out nobody noticed it had

877
00:36:12,380 --> 00:36:16,039
faded quite a bit and it wasn't

878
00:36:13,639 --> 00:36:17,868
noticeable so it got missed so I say

879
00:36:16,039 --> 00:36:19,608
there's been seven supernovae even

880
00:36:17,869 --> 00:36:21,050
though one of them wasn't observed and

881
00:36:19,608 --> 00:36:22,279
that's actually resulted that came out

882
00:36:21,050 --> 00:36:24,680
on the project that I'm

883
00:36:22,280 --> 00:36:26,060
talking about here tonight so I think

884

00:36:24,679 --> 00:36:28,250
you can see the motivation here the

885
00:36:26,059 --> 00:36:32,420
spatial resolution that Hubble provides

886
00:36:28,250 --> 00:36:34,099
is just astounding and crucial for the

887
00:36:32,420 --> 00:36:36,019
kind of project that I want to do I want

888
00:36:34,099 --> 00:36:37,460
to measure the sizes of the supernova

889
00:36:36,019 --> 00:36:39,349
remnants that I find in m83

890
00:36:37,460 --> 00:36:41,300
to find the smallest ones which are the

891
00:36:39,349 --> 00:36:42,949
youngest ones and then understand their

892
00:36:41,300 --> 00:36:44,840
characteristics relative to the x-rays

893
00:36:42,949 --> 00:36:45,859
or to other other properties and of

894
00:36:44,840 --> 00:36:49,970
course I'm very interested in the other

895
00:36:45,860 --> 00:36:51,530
supernova remnants as well and so Hubble

896
00:36:49,969 --> 00:36:54,139
brings a lot to the table a spatial

897
00:36:51,530 --> 00:36:55,790
resolution of course and helps you out

898
00:36:54,139 --> 00:36:57,440

in complicated regions where at

899

00:36:55,789 --> 00:36:59,449

ground-based resolution stuff would be

900

00:36:57,440 --> 00:37:01,400

smeared out with an h2 region nearby a

901

00:36:59,449 --> 00:37:02,960

photo ionized region and it would make

902

00:37:01,400 --> 00:37:04,730

it hard to see the supernova remnant I

903

00:37:02,960 --> 00:37:06,769

can see it without where I couldn't see

904

00:37:04,730 --> 00:37:08,840

it from the ground and also the IR

905

00:37:06,769 --> 00:37:11,750

camera will come into play here in a

906

00:37:08,840 --> 00:37:13,850

moment because it lets us see through

907

00:37:11,750 --> 00:37:15,500

the dust and find supernova remnants

908

00:37:13,849 --> 00:37:18,110

that are hiding behind some of that

909

00:37:15,500 --> 00:37:20,780

brown dust that you saw in that that

910

00:37:18,110 --> 00:37:22,250

first picture so again I'm jumping ahead

911

00:37:20,780 --> 00:37:23,750

a little bit here because this is data

912

00:37:22,250 --> 00:37:25,969

from the survey that I'm talking about

913
00:37:23,750 --> 00:37:27,710
here above again these are ground-based

914
00:37:25,969 --> 00:37:29,839
pictures from the Magellan telescope

915
00:37:27,710 --> 00:37:31,429
here's the stars these are the emission

916
00:37:29,840 --> 00:37:33,980
lines and the things that show up kind

917
00:37:31,429 --> 00:37:36,440
of green yellow or white here are the

918
00:37:33,980 --> 00:37:38,990
things that were identified as supernova

919
00:37:36,440 --> 00:37:40,460
remnants so those four red circles and

920
00:37:38,989 --> 00:37:42,649
here in the Hubble emission line data

921
00:37:40,460 --> 00:37:45,800
you see the kind of greenish yellow

922
00:37:42,650 --> 00:37:47,090
shells here in three cases anyway kind

923
00:37:45,800 --> 00:37:48,470
of an oddball object here that's a

924
00:37:47,090 --> 00:37:49,970
little bit different shape but those

925
00:37:48,469 --> 00:37:51,859
four objects were supernova remnants

926
00:37:49,969 --> 00:37:54,739
that were identified from the ground but

927
00:37:51,860 --> 00:37:57,110
they were characterized by the Hubble

928
00:37:54,739 --> 00:37:58,909
data and allows us to see what's going

929
00:37:57,110 --> 00:38:00,950
on and you see I have a yellow circle

930
00:37:58,909 --> 00:38:03,859
here that doesn't seem to have anything

931
00:38:00,949 --> 00:38:06,139
defined in it and that's because if I

932
00:38:03,860 --> 00:38:08,690
now look at the infrared image from

933
00:38:06,139 --> 00:38:10,639
Hubble this is an iron - emission line

934
00:38:08,690 --> 00:38:14,030
image and again you see these four

935
00:38:10,639 --> 00:38:16,460
objects that we saw before but now you

936
00:38:14,030 --> 00:38:18,740
see there's also an object in the yellow

937
00:38:16,460 --> 00:38:20,929
circle that we didn't see and if you

938
00:38:18,739 --> 00:38:22,699
look at the Starlight you can see that

939
00:38:20,929 --> 00:38:26,839
that yellow circle is projected onto a

940
00:38:22,699 --> 00:38:29,000
dark band of dust that's a supernova

941

00:38:26,840 --> 00:38:30,680
remnant that is behind the dust so it

942
00:38:29,000 --> 00:38:32,630
didn't show up in the optical and we

943
00:38:30,679 --> 00:38:34,759
were able to find it with the iron two

944
00:38:32,630 --> 00:38:35,360
camera so that's another thing that that

945
00:38:34,760 --> 00:38:38,990
the Hubble

946
00:38:35,360 --> 00:38:40,220
a wide field camera it does for us okay

947
00:38:38,989 --> 00:38:41,479
so I got a step back now that I'm

948
00:38:40,219 --> 00:38:42,799
already showing you data but I haven't

949
00:38:41,480 --> 00:38:44,329
even gotten the proposal written yet

950
00:38:42,800 --> 00:38:46,640
right so we're going to go back and talk

951
00:38:44,329 --> 00:38:48,019
about the proposal and there's a lot of

952
00:38:46,639 --> 00:38:49,819
work that goes into this it typically

953
00:38:48,019 --> 00:38:53,119
takes about a month of effort not only

954
00:38:49,820 --> 00:38:54,590
on the person taking the lead on the

955
00:38:53,119 --> 00:38:56,480

proposal but the whole collaborative

956

00:38:54,590 --> 00:38:58,550

team if you put together a team of

957

00:38:56,480 --> 00:39:01,099

scientists we typically have several

958

00:38:58,550 --> 00:39:02,510

drafts of the science justification we

959

00:39:01,099 --> 00:39:04,880

have to decide all this technical stuff

960

00:39:02,510 --> 00:39:07,400

about which instrument which filters how

961

00:39:04,880 --> 00:39:09,200

much time is needed how does it layout

962

00:39:07,400 --> 00:39:11,030

into orbits because for Hubble I have to

963

00:39:09,199 --> 00:39:14,509

ask for a certain number of orbital

964

00:39:11,030 --> 00:39:16,250

viewing periods with Hubble and then we

965

00:39:14,510 --> 00:39:19,370

have to the important thing here is to

966

00:39:16,250 --> 00:39:21,349

write a clear science justification that

967

00:39:19,369 --> 00:39:24,139

tries to get the time through the peer

968

00:39:21,349 --> 00:39:26,299

review panel and obviously then the

969

00:39:24,139 --> 00:39:28,549

submit the proposal so just to give you

970
00:39:26,300 --> 00:39:30,769
a little flavor for this this is one of

971
00:39:28,550 --> 00:39:33,440
the Hubble exposure time calculators

972
00:39:30,769 --> 00:39:35,869
etc' we love acronyms and NASA right so

973
00:39:33,440 --> 00:39:37,670
here's the ETCs and you can see over

974
00:39:35,869 --> 00:39:40,369
here on the side that each instrument

975
00:39:37,670 --> 00:39:43,940
the ACS costs the stitch instrument all

976
00:39:40,369 --> 00:39:45,559
have multiple exposure time calculators

977
00:39:43,940 --> 00:39:46,700
for their different observing modes so

978
00:39:45,559 --> 00:39:49,279
when I've pulled up here is for the

979
00:39:46,699 --> 00:39:52,489
whiffs III and this is not this is just

980
00:39:49,280 --> 00:39:54,530
the first two two steps of a 15 step

981
00:39:52,489 --> 00:39:56,269
process that you have to set for every

982
00:39:54,530 --> 00:39:57,920
calculation of every object that you

983
00:39:56,269 --> 00:39:59,539
want to observe to show that you're

984
00:39:57,920 --> 00:40:01,309
getting the right amount of observing

985
00:39:59,539 --> 00:40:03,469
time to give you a good signal to noise

986
00:40:01,309 --> 00:40:04,429
ratio in your data and you can see the

987
00:40:03,469 --> 00:40:07,279
kind of things that you choose for

988
00:40:04,429 --> 00:40:10,969
imaging you choose a filter you set some

989
00:40:07,280 --> 00:40:13,040
detector parameters here you say do I

990
00:40:10,969 --> 00:40:15,289
want the exposure time needed to get to

991
00:40:13,039 --> 00:40:18,320
a certain signal-to-noise ratio or I can

992
00:40:15,289 --> 00:40:19,670
select for a thousand seconds or 900

993
00:40:18,320 --> 00:40:21,530
seconds what will the signal to noise

994
00:40:19,670 --> 00:40:23,480
ratio be you can do it either way and

995
00:40:21,530 --> 00:40:25,160
this goes down for about three or four

996
00:40:23,480 --> 00:40:26,809
more screens of information that you

997
00:40:25,159 --> 00:40:29,389
have to fill in for each calculation

998

00:40:26,809 --> 00:40:31,340
that you want to do with each observing

999
00:40:29,389 --> 00:40:34,099
mode or each filter so there's a lot of

1000
00:40:31,340 --> 00:40:36,530
work just to do that part to scope out

1001
00:40:34,099 --> 00:40:38,239
how much time you need then when you've

1002
00:40:36,530 --> 00:40:41,780
got your x you put it into what's called

1003
00:40:38,239 --> 00:40:43,579
the astronomers proposal tool and this

1004
00:40:41,780 --> 00:40:44,810
is just one piece of that where I've

1005
00:40:43,579 --> 00:40:46,519
already entered all the technical

1006
00:40:44,809 --> 00:40:50,090
information into the proposal and I've

1007
00:40:46,519 --> 00:40:53,030
asked apt to lay it out and two orbits

1008
00:40:50,090 --> 00:40:54,890
for me so that I can see how it fits and

1009
00:40:53,030 --> 00:40:58,430
whether it all works out and so these

1010
00:40:54,889 --> 00:41:01,940
blue speckled boxes are the observations

1011
00:40:58,429 --> 00:41:04,789
and so this whole thing is one orbit one

1012
00:41:01,940 --> 00:41:06,349

Hubble orbit and up to here is the

1013

00:41:04,789 --> 00:41:07,909

viewing part of the orbit where you can

1014

00:41:06,349 --> 00:41:09,500

see the target and then the earth gets

1015

00:41:07,909 --> 00:41:11,629

in the way the rest of the time out here

1016

00:41:09,500 --> 00:41:13,250

okay so here I've I've laid out my

1017

00:41:11,630 --> 00:41:15,890

observations into the orbital viewing

1018

00:41:13,250 --> 00:41:18,139

period I've got my data readouts they

1019

00:41:15,889 --> 00:41:20,690

all work out hidden behind other other

1020

00:41:18,139 --> 00:41:22,460

activities in this particular case I'm

1021

00:41:20,690 --> 00:41:24,650

actually taking some parallel data with

1022

00:41:22,460 --> 00:41:27,349

the other camera so down here are my

1023

00:41:24,650 --> 00:41:31,400

other observations laid out underneath

1024

00:41:27,349 --> 00:41:35,389

the primary observations and this is two

1025

00:41:31,400 --> 00:41:37,519

orbits out of 36 I had to lay out so

1026

00:41:35,389 --> 00:41:39,109

it's a big job just to write the

1027
00:41:37,519 --> 00:41:41,780
proposal is my point just to get the

1028
00:41:39,110 --> 00:41:43,490
proposal right and of course the

1029
00:41:41,780 --> 00:41:45,080
important part of this is really writing

1030
00:41:43,489 --> 00:41:47,539
the science justification that you hope

1031
00:41:45,079 --> 00:41:51,980
will convince the peer review that your

1032
00:41:47,539 --> 00:41:55,190
project is worth doing so it's a big job

1033
00:41:51,980 --> 00:41:58,400
okay but so there's a nasty little

1034
00:41:55,190 --> 00:42:03,789
secret behind the scenes here and that

1035
00:41:58,400 --> 00:42:06,769
is that each Hubble cycle is typically

1036
00:42:03,789 --> 00:42:10,190
oversubscribed by a factor of four to

1037
00:42:06,769 --> 00:42:12,019
six that is to say in these examples

1038
00:42:10,190 --> 00:42:13,730
here like let's take cycle 19 which is

1039
00:42:12,019 --> 00:42:16,039
where I got this proposal there were

1040
00:42:13,730 --> 00:42:19,250
over a thousand proposals submitted and

1041
00:42:16,039 --> 00:42:23,779
just 200 were accepted oversubscribed by

1042
00:42:19,250 --> 00:42:25,519
a factor of five so just writing a good

1043
00:42:23,780 --> 00:42:27,260
proposal is not good enough you have to

1044
00:42:25,519 --> 00:42:29,599
get lucky you have to write something

1045
00:42:27,260 --> 00:42:31,400
that the tach thinks is worthwhile above

1046
00:42:29,599 --> 00:42:34,309
other very good projects because in

1047
00:42:31,400 --> 00:42:35,960
every Hubble cycle good science gets

1048
00:42:34,309 --> 00:42:40,059
left on the table because there just

1049
00:42:35,960 --> 00:42:42,860
simply isn't enough observing time okay

1050
00:42:40,059 --> 00:42:44,719
so this is what really happens all right

1051
00:42:42,860 --> 00:42:47,480
here's my beautiful idea

1052
00:42:44,719 --> 00:42:48,949
I read my proposal I submitted and it

1053
00:42:47,480 --> 00:42:51,469
comes to the final selection then they

1054
00:42:48,949 --> 00:42:53,929
say no no how could they say that well

1055

00:42:51,469 --> 00:42:56,299
they did okay so you get feedback from

1056
00:42:53,929 --> 00:42:58,969
the tach you come back the next cycle

1057
00:42:56,300 --> 00:43:00,068
the next year okay and try again

1058
00:42:58,969 --> 00:43:01,478
sometimes you

1059
00:43:00,068 --> 00:43:03,998
that feedback and you revised your

1060
00:43:01,478 --> 00:43:06,608
proposal and you try again and you keep

1061
00:43:03,998 --> 00:43:08,078
going until you either give up or you

1062
00:43:06,608 --> 00:43:12,639
write a good-enough proposal and it gets

1063
00:43:08,079 --> 00:43:16,420
over the hump okay so here's where I

1064
00:43:12,639 --> 00:43:18,190
tried first cycle 15 back in 2006 I was

1065
00:43:16,420 --> 00:43:19,389
really focused on the young supernova

1066
00:43:18,190 --> 00:43:22,690
remnants that's where I started with

1067
00:43:19,389 --> 00:43:25,538
this process was not accepted so I tried

1068
00:43:22,690 --> 00:43:26,708
again the next year well I got some

1069
00:43:25,539 --> 00:43:28,299

collaborators that were interested in

1070

00:43:26,708 --> 00:43:29,469

the stellar populations and the stellar

1071

00:43:28,298 --> 00:43:31,028

part of the data set

1072

00:43:29,469 --> 00:43:33,039

not just the emission line part of the

1073

00:43:31,028 --> 00:43:34,568

data set okay we thought we put those

1074

00:43:33,039 --> 00:43:37,119

together and have a stronger proposal

1075

00:43:34,568 --> 00:43:40,119

which we did nope didn't get at that

1076

00:43:37,119 --> 00:43:41,140

time and next year we decided to try

1077

00:43:40,119 --> 00:43:44,619

something a little different because

1078

00:43:41,139 --> 00:43:46,719

since we did want Chandra time as well

1079

00:43:44,619 --> 00:43:49,959

and a lot of Chandra time this proposal

1080

00:43:46,719 --> 00:43:52,958

was for 700,000 seconds of Chandra time

1081

00:43:49,958 --> 00:43:55,389

to observe m83 and then we asked for the

1082

00:43:52,958 --> 00:43:58,028

Hubble time as part of the Chandra time

1083

00:43:55,389 --> 00:44:00,129

they have a joint allocation where you

1084
00:43:58,028 --> 00:44:02,048
could ask for both that way that was

1085
00:44:00,130 --> 00:44:06,729
close but no cigar they liked that a lot

1086
00:44:02,048 --> 00:44:08,858
but we didn't make it over the hub so we

1087
00:44:06,728 --> 00:44:11,139
came back the next year and tried again

1088
00:44:08,858 --> 00:44:13,328
and this time we decided to break him

1089
00:44:11,139 --> 00:44:15,368
apart again and go after the Chandra

1090
00:44:13,329 --> 00:44:17,109
time separately in the Chandra time it

1091
00:44:15,369 --> 00:44:19,329
wasn't just the supernova remnant it was

1092
00:44:17,108 --> 00:44:21,308
x-ray binaries it was the diffuse x-ray

1093
00:44:19,329 --> 00:44:23,318
gas there are a lot of different kinds

1094
00:44:21,309 --> 00:44:25,959
of science in that so we broke that off

1095
00:44:23,318 --> 00:44:28,929
and that time we actually got the

1096
00:44:25,958 --> 00:44:30,489
Chandra time but we didn't get the

1097
00:44:28,929 --> 00:44:33,969
Hubble time

1098
00:44:30,489 --> 00:44:36,579
now this time these were all a CS camera

1099
00:44:33,969 --> 00:44:38,469
and this was before the wif C 3 camera

1100
00:44:36,579 --> 00:44:39,940
was installed in the telescope but it

1101
00:44:38,469 --> 00:44:41,920
was the first year that they said you

1102
00:44:39,940 --> 00:44:43,059
could propose for it because after it

1103
00:44:41,920 --> 00:44:45,608
was installed that would be the

1104
00:44:43,059 --> 00:44:48,910
observing cycle so we tried to get with

1105
00:44:45,608 --> 00:44:50,708
C 3 we we did not get it but in the

1106
00:44:48,909 --> 00:44:52,598
meantime those two fields that I showed

1107
00:44:50,708 --> 00:44:56,469
you in the yellow boxes early on were

1108
00:44:52,599 --> 00:44:58,449
taken by the wif C 3 team and analyzing

1109
00:44:56,469 --> 00:45:02,829
those data helped us to convince them in

1110
00:44:58,449 --> 00:45:06,999
the next year to give us the time so we

1111
00:45:02,829 --> 00:45:09,099
got it in cycle 19 and we were delighted

1112

00:45:06,998 --> 00:45:11,318
to get that 36 orbits of prime time and

1113
00:45:09,099 --> 00:45:14,019
36 orbits in parallel with the ACS

1114
00:45:11,318 --> 00:45:16,869
camera that's a long haul

1115
00:45:14,019 --> 00:45:20,199
that's five years of effort just to get

1116
00:45:16,869 --> 00:45:21,910
the proposal accepted now you don't know

1117
00:45:20,199 --> 00:45:23,109
me I could have written crummy proposals

1118
00:45:21,909 --> 00:45:25,690
I'll tell you I didn't write a crummy

1119
00:45:23,110 --> 00:45:27,309
proposal but that's because of this over

1120
00:45:25,690 --> 00:45:29,800
subscription factor a lot of good things

1121
00:45:27,309 --> 00:45:33,159
get left on the table every time through

1122
00:45:29,800 --> 00:45:39,280
the process okay well I got an accepted

1123
00:45:33,159 --> 00:45:41,469
proposal now what happens well a lot

1124
00:45:39,280 --> 00:45:43,300
more work as it turns out so in this

1125
00:45:41,469 --> 00:45:44,709
chart this is kind of the process that

1126
00:45:43,300 --> 00:45:46,480

we've been talking about the peer review

1127

00:45:44,710 --> 00:45:48,550

the director accepts it and we've got an

1128

00:45:46,480 --> 00:45:50,820

accepted proposal and what happens well

1129

00:45:48,550 --> 00:45:53,590

we come back on we do not pass go and we

1130

00:45:50,820 --> 00:45:55,420

start all over again and what's called a

1131

00:45:53,590 --> 00:45:58,720

phase 2 process that's where I have to

1132

00:45:55,420 --> 00:46:00,789

write the actual details of the

1133

00:45:58,719 --> 00:46:02,859

observing plan into a file that is

1134

00:46:00,789 --> 00:46:05,050

submitted I have to do a grant if you

1135

00:46:02,860 --> 00:46:07,000

want to get money to support student or

1136

00:46:05,050 --> 00:46:09,670

whatever

1137

00:46:07,000 --> 00:46:11,650

once that's submitted then the people

1138

00:46:09,670 --> 00:46:13,630

here have to go through a process of

1139

00:46:11,650 --> 00:46:16,240

cleaning up that proposal and whatnot

1140

00:46:13,630 --> 00:46:19,210

which oftentimes involves iteration back

1141
00:46:16,239 --> 00:46:20,919
with the user to to clear things up we

1142
00:46:19,210 --> 00:46:23,380
build a long-range plan this full-year

1143
00:46:20,920 --> 00:46:25,150
plan where they check for GuideStar

1144
00:46:23,380 --> 00:46:26,380
availability other observing constraints

1145
00:46:25,150 --> 00:46:28,720
any constraints that I've put in the

1146
00:46:26,380 --> 00:46:30,700
proposal I'll go into figuring out when

1147
00:46:28,719 --> 00:46:32,529
in the year it can be observed we peel

1148
00:46:30,699 --> 00:46:34,929
off these one week at a time to do the

1149
00:46:32,530 --> 00:46:37,420
weekly schedules and we get the commands

1150
00:46:34,929 --> 00:46:41,769
ready to go up each of these boxes here

1151
00:46:37,420 --> 00:46:43,900
is 15 20 people working full-time to do

1152
00:46:41,769 --> 00:46:45,659
this right so it's a lot of effort to

1153
00:46:43,900 --> 00:46:48,190
make this happen

1154
00:46:45,659 --> 00:46:50,469
all right the commands go up to the

1155
00:46:48,190 --> 00:46:54,250
telescope and we take data and that's a

1156
00:46:50,469 --> 00:46:56,019
red-letter day but then we have to get

1157
00:46:54,250 --> 00:46:57,730
the data down to the ground and for

1158
00:46:56,019 --> 00:46:59,320
Hubble it actually comes through the

1159
00:46:57,730 --> 00:47:02,530
tracking and data relay satellite system

1160
00:46:59,320 --> 00:47:04,960
it comes down to White Sands ground

1161
00:47:02,530 --> 00:47:06,640
station in New Mexico it gets shipped to

1162
00:47:04,960 --> 00:47:08,889
Goddard Space Flight Center and it

1163
00:47:06,639 --> 00:47:12,690
finally makes its way to the Institute

1164
00:47:08,889 --> 00:47:12,690
where it enters into this process

1165
00:47:13,480 --> 00:47:21,289
now I won't go into detail but again

1166
00:47:18,280 --> 00:47:23,930
basically what's going on here is that

1167
00:47:21,289 --> 00:47:25,519
data processing and calibration step and

1168
00:47:23,929 --> 00:47:28,129
then the archiving and distribution

1169

00:47:25,519 --> 00:47:30,199
steps over here this involves many

1170
00:47:28,130 --> 00:47:32,180
databases there's engineering database

1171
00:47:30,199 --> 00:47:34,129
there's data the data processing

1172
00:47:32,179 --> 00:47:37,129
parameters that go into the science data

1173
00:47:34,130 --> 00:47:39,039
processing calibration and so forth then

1174
00:47:37,130 --> 00:47:42,440
the data gets put to the archive and it

1175
00:47:39,039 --> 00:47:44,360
gets obviously there's big databases

1176
00:47:42,440 --> 00:47:46,820
that they have to run the whole archival

1177
00:47:44,360 --> 00:47:49,250
process and stuff as well the part of

1178
00:47:46,820 --> 00:47:51,110
this process that the user sees that's

1179
00:47:49,250 --> 00:47:53,030
just right there it's like I get a

1180
00:47:51,110 --> 00:47:55,430
message that says data are available I

1181
00:47:53,030 --> 00:47:57,470
say okay give me the data stager it's

1182
00:47:55,429 --> 00:47:59,329
ready okay I download it I come as a

1183
00:47:57,469 --> 00:48:06,159

proposer by the way they actually

1184

00:47:59,329 --> 00:48:07,759

modeled this after me you see that but I

1185

00:48:06,159 --> 00:48:09,619

don't know you think of high-class

1186

00:48:07,760 --> 00:48:11,560

telescope we have a higher quality icon

1187

00:48:09,619 --> 00:48:14,869

than that but anyway that's what we got

1188

00:48:11,559 --> 00:48:16,070

anyway you see I finally got my data and

1189

00:48:14,869 --> 00:48:19,759

so I can do something with it

1190

00:48:16,070 --> 00:48:22,730

well maybe you can understand now why it

1191

00:48:19,760 --> 00:48:24,710

takes so many people to operate a Space

1192

00:48:22,730 --> 00:48:26,809

Telescope there are just so many things

1193

00:48:24,710 --> 00:48:28,760

behind the scenes that make this all

1194

00:48:26,809 --> 00:48:32,750

happen not only for the scientist in his

1195

00:48:28,760 --> 00:48:36,290

and his or her collaborators but for the

1196

00:48:32,750 --> 00:48:38,329

data processing and the whole system for

1197

00:48:36,289 --> 00:48:39,769

planning and scheduling as well this was

1198
00:48:38,329 --> 00:48:41,690
back after the last servicing mission

1199
00:48:39,769 --> 00:48:42,920
the astronauts came to visit and so some

1200
00:48:41,690 --> 00:48:44,690
of these are family members but there

1201
00:48:42,920 --> 00:48:50,000
are hundreds of people that work on

1202
00:48:44,690 --> 00:48:52,429
Hubble that make all that happen okay

1203
00:48:50,000 --> 00:48:55,219
well I've got data now what well the

1204
00:48:52,429 --> 00:48:57,500
data comes through as individual files

1205
00:48:55,219 --> 00:49:00,049
of each of the exposures that was done

1206
00:48:57,500 --> 00:49:02,539
and to stitch it together into the

1207
00:49:00,050 --> 00:49:04,250
datasets that I need to do my analysis

1208
00:49:02,539 --> 00:49:06,259
takes a lot of work we have to line

1209
00:49:04,250 --> 00:49:09,739
everything up on a coordinate system

1210
00:49:06,260 --> 00:49:12,410
it's called astrometry we have to build

1211
00:49:09,739 --> 00:49:13,879
these big mosaic images that you saw we

1212
00:49:12,409 --> 00:49:15,399
have to measure the stars and the star

1213
00:49:13,880 --> 00:49:18,170
clusters and all those different

1214
00:49:15,400 --> 00:49:20,930
continuum bands to get their colors and

1215
00:49:18,170 --> 00:49:22,700
their properties their sizes for my

1216
00:49:20,929 --> 00:49:24,469
emission line stuff for the supernova

1217
00:49:22,699 --> 00:49:24,989
remnant so I have to actually scale and

1218
00:49:24,469 --> 00:49:27,959
so

1219
00:49:24,989 --> 00:49:30,149
tract the residual starlight to get pure

1220
00:49:27,960 --> 00:49:32,039
emission line images to find the

1221
00:49:30,150 --> 00:49:34,200
supernova remnants and then finally I

1222
00:49:32,039 --> 00:49:36,210
can actually do what I really wanted to

1223
00:49:34,199 --> 00:49:39,779
do which is to search those data and

1224
00:49:36,210 --> 00:49:40,860
find the supernova remnants okay once I

1225
00:49:39,780 --> 00:49:45,000
found the super over and that's that I

1226

00:49:40,860 --> 00:49:46,289
have to actually try to get the relevant

1227
00:49:45,000 --> 00:49:48,599
information out of those as well

1228
00:49:46,289 --> 00:49:50,159
including the sizes of the objects the

1229
00:49:48,599 --> 00:49:52,230
fluxes and the different emission lines

1230
00:49:50,159 --> 00:49:55,019
and so forth so I could do the rest of

1231
00:49:52,230 --> 00:49:56,429
the analysis and then if you want to

1232
00:49:55,019 --> 00:49:58,920
compare to other things like Chandra

1233
00:49:56,429 --> 00:50:01,199
data and whatnot it happens after all

1234
00:49:58,920 --> 00:50:03,210
that other work so I wanted to give you

1235
00:50:01,199 --> 00:50:04,469
a little sense for what we found I can't

1236
00:50:03,210 --> 00:50:06,090
spend a lot of time on that I could

1237
00:50:04,469 --> 00:50:08,399
spend the whole talk on that but

1238
00:50:06,090 --> 00:50:10,410
basically we found a lot of supernova

1239
00:50:08,400 --> 00:50:12,599
remnants the green circles there on the

1240
00:50:10,409 --> 00:50:14,309

left hand side are the supernova

1241
00:50:12,599 --> 00:50:16,199
remnants that were found in combination

1242
00:50:14,309 --> 00:50:18,119
between Hubble and our ground-based

1243
00:50:16,199 --> 00:50:20,460
survey because you can see some of them

1244
00:50:18,119 --> 00:50:22,110
are outside the Hubble footprint there

1245
00:50:20,460 --> 00:50:24,449
but all the ones inside the yellow box

1246
00:50:22,110 --> 00:50:26,550
we were able to measure their sizes and

1247
00:50:24,449 --> 00:50:28,710
quantify their properties with the

1248
00:50:26,550 --> 00:50:30,710
Hubble dataset and over here I'm

1249
00:50:28,710 --> 00:50:33,210
actually showing you the Chandra x-ray

1250
00:50:30,710 --> 00:50:35,940
data on the same scale of course it

1251
00:50:33,210 --> 00:50:38,250
doesn't have the same resolution as a

1252
00:50:35,940 --> 00:50:40,230
ground-based or even as Hubble but it's

1253
00:50:38,250 --> 00:50:41,940
pretty good you see a lot of point

1254
00:50:40,230 --> 00:50:44,010
sources in here a lot of those are x-ray

1255
00:50:41,940 --> 00:50:46,230
binaries and m83 some of them are

1256
00:50:44,010 --> 00:50:48,300
background sources there are a little

1257
00:50:46,230 --> 00:50:49,949
red dots every once in a while many of

1258
00:50:48,300 --> 00:50:51,840
those are actually supernova remnants

1259
00:50:49,949 --> 00:50:53,539
that show up in the red part of the

1260
00:50:51,840 --> 00:50:56,640
x-ray band here that I'm showing

1261
00:50:53,539 --> 00:50:59,849
relatively low energy x-rays but also

1262
00:50:56,639 --> 00:51:02,009
look at the diffuse gas that just fills

1263
00:50:59,849 --> 00:51:03,179
the spiral arms and basically just kind

1264
00:51:02,010 --> 00:51:04,710
of follows where you have a lot of

1265
00:51:03,179 --> 00:51:08,039
supernova remnants you've got a lot of

1266
00:51:04,710 --> 00:51:11,250
diffuse x-ray emission as well we're

1267
00:51:08,039 --> 00:51:13,230
actually energizing the interstellar

1268
00:51:11,250 --> 00:51:14,880
medium of that galaxy by all the

1269
00:51:13,230 --> 00:51:16,800
supernovae that have happened over tens

1270
00:51:14,880 --> 00:51:18,599
of thousands of years and that whole

1271
00:51:16,800 --> 00:51:20,250
that's the but you wouldn't know this

1272
00:51:18,599 --> 00:51:22,618
what if I didn't tell you that is the

1273
00:51:20,250 --> 00:51:25,739
brightest diffuse x-ray emission in any

1274
00:51:22,619 --> 00:51:29,840
galaxy that we've ever observed and it's

1275
00:51:25,739 --> 00:51:29,839
because of all that supernova activity

1276
00:51:30,340 --> 00:51:33,880
okay so I just wanted to show a close-up

1277
00:51:32,469 --> 00:51:36,250
view of a few of these to give you an

1278
00:51:33,880 --> 00:51:39,579
idea of what the Hubble resolution does

1279
00:51:36,250 --> 00:51:41,320
for us now this is uh the infrared band

1280
00:51:39,579 --> 00:51:43,599
I was telling you before here's the the

1281
00:51:41,320 --> 00:51:45,789
emission line data from Hubble here's

1282
00:51:43,599 --> 00:51:48,610
the starlight from Hubble and here's the

1283

00:51:45,789 --> 00:51:50,289
Chandra x-ray data over here typically

1284
00:51:48,610 --> 00:51:52,690
in the x-ray they show this red color

1285
00:51:50,289 --> 00:51:54,789
and this display those are relatively

1286
00:51:52,690 --> 00:51:57,130
low energy or soft x-rays we call them

1287
00:51:54,789 --> 00:51:59,019
but there's one object here this kind of

1288
00:51:57,130 --> 00:52:00,760
very young one has a very different

1289
00:51:59,019 --> 00:52:02,289
character to its x-ray emission compared

1290
00:52:00,760 --> 00:52:04,210
to the others and it turns out to be the

1291
00:52:02,289 --> 00:52:05,469
smallest of the three that I'm I'll show

1292
00:52:04,210 --> 00:52:08,349
you here it's the youngest one that

1293
00:52:05,469 --> 00:52:10,389
we're looking at here and but you also

1294
00:52:08,349 --> 00:52:13,210
see that it is kind of projected against

1295
00:52:10,389 --> 00:52:15,069
this band of dust and part of that

1296
00:52:13,210 --> 00:52:17,110
coloration change may just be because

1297
00:52:15,070 --> 00:52:18,789

it's behind the dust part of it maybe

1298

00:52:17,110 --> 00:52:20,620

there might be a young pulsar like a

1299

00:52:18,789 --> 00:52:22,690

Crab Nebula type of thing going on in

1300

00:52:20,619 --> 00:52:26,349

this very young object and it changes

1301

00:52:22,690 --> 00:52:27,730

the character of the x-ray emission this

1302

00:52:26,349 --> 00:52:29,199

one here is a middle-aged one that you

1303

00:52:27,730 --> 00:52:32,019

can see is actually resolved on it into

1304

00:52:29,199 --> 00:52:33,699

a little expanding shell this was in

1305

00:52:32,019 --> 00:52:35,739

between the other two that's a fairly

1306

00:52:33,699 --> 00:52:38,109

young one but you see it's projected

1307

00:52:35,739 --> 00:52:39,489

right against a cluster of stars and by

1308

00:52:38,110 --> 00:52:40,720

looking at the properties of those stars

1309

00:52:39,489 --> 00:52:43,029

we can say that the star that exploded

1310

00:52:40,719 --> 00:52:46,359

here was probably more than fifteen

1311

00:52:43,030 --> 00:52:48,760

solar masses before it exploded so

1312
00:52:46,360 --> 00:52:50,650
combining all these datasets in this way

1313
00:52:48,760 --> 00:52:51,880
you can start to piece together some of

1314
00:52:50,650 --> 00:52:55,599
those they answers to some of those

1315
00:52:51,880 --> 00:52:59,410
questions that I initially wanted to to

1316
00:52:55,599 --> 00:53:02,529
answer well we got to the publication we

1317
00:52:59,409 --> 00:53:05,559
actually did it that was in 2014 June it

1318
00:53:02,530 --> 00:53:08,440
was in 2006 when I first proposed for it

1319
00:53:05,559 --> 00:53:11,139
so that's yeah that's a long time to get

1320
00:53:08,440 --> 00:53:12,700
a science result out and what else did

1321
00:53:11,139 --> 00:53:14,949
we do with the data well we actually ran

1322
00:53:12,699 --> 00:53:17,589
an education and outreach program it's

1323
00:53:14,949 --> 00:53:21,489
called a citizen science project on the

1324
00:53:17,590 --> 00:53:23,740
star cluster population and m83 my

1325
00:53:21,489 --> 00:53:26,019
friend Redmond Whitmore at the Institute

1326
00:53:23,739 --> 00:53:27,819
here kind of headlined the preparation

1327
00:53:26,019 --> 00:53:29,800
of this or whatever and the idea was

1328
00:53:27,820 --> 00:53:32,650
that just by visually inspecting what

1329
00:53:29,800 --> 00:53:34,480
the clusters of stars look like you can

1330
00:53:32,650 --> 00:53:38,440
actually do a crude age-dating

1331
00:53:34,480 --> 00:53:41,019
of the cluster and by looking at 2600

1332
00:53:38,440 --> 00:53:42,369
clusters and having citizen scientists

1333
00:53:41,019 --> 00:53:43,840
people like yourself come online and

1334
00:53:42,369 --> 00:53:45,400
look at these images and

1335
00:53:43,840 --> 00:53:47,850
defy them according to this kind of a

1336
00:53:45,400 --> 00:53:50,650
scale we were able to amass a huge

1337
00:53:47,849 --> 00:53:53,110
classification an age distribution of

1338
00:53:50,650 --> 00:53:55,030
the star clusters in m83 without having

1339
00:53:53,110 --> 00:53:58,240
to look at all 2600 clusters ourselves

1340

00:53:55,030 --> 00:53:59,980
to make that determination but here you

1341
00:53:58,239 --> 00:54:01,899
can see very young clusters only 3

1342
00:53:59,980 --> 00:54:04,840
million years old are embedded in H

1343
00:54:01,900 --> 00:54:06,400
alpha emission from the the gas it

1344
00:54:04,840 --> 00:54:07,780
starts to blow it away so that's a

1345
00:54:06,400 --> 00:54:09,579
little bit older here it's in the

1346
00:54:07,780 --> 00:54:11,769
process of blowing it away so it's a

1347
00:54:09,579 --> 00:54:13,750
little older still now the gas is gone

1348
00:54:11,769 --> 00:54:15,280
but we still have lots of lots of blue

1349
00:54:13,750 --> 00:54:16,929
stars and you kind of resolve some of

1350
00:54:15,280 --> 00:54:19,630
the structures there and then as those

1351
00:54:16,929 --> 00:54:22,809
more massive stars go away you get just

1352
00:54:19,630 --> 00:54:25,300
a fuzzy ball that's extended more than a

1353
00:54:22,809 --> 00:54:28,239
point source and then the color becomes

1354
00:54:25,300 --> 00:54:31,480

render as it ages out to in this case is

1355

00:54:28,239 --> 00:54:33,250

out to 500 million years old so that was

1356

00:54:31,480 --> 00:54:34,719

just uh you know the other side of the

1357

00:54:33,250 --> 00:54:37,980

project not the supernova remnants were

1358

00:54:34,719 --> 00:54:40,389

involved in a lot of the cluster work

1359

00:54:37,980 --> 00:54:42,849

what we've gone to a lot of work to put

1360

00:54:40,389 --> 00:54:44,500

together these mosaics and so we

1361

00:54:42,849 --> 00:54:46,089

delivered them to the master archive is

1362

00:54:44,500 --> 00:54:49,929

what's called a high-level science

1363

00:54:46,090 --> 00:54:51,850

product and that was partly so that

1364

00:54:49,929 --> 00:54:54,219

other astronomers could come and use the

1365

00:54:51,849 --> 00:54:55,690

data as a starting point for their own

1366

00:54:54,219 --> 00:54:57,939

work without having to do all that

1367

00:54:55,690 --> 00:54:59,619

background work to make the mosaics in

1368

00:54:57,940 --> 00:55:02,440

the line of different fields and so

1369
00:54:59,619 --> 00:55:06,219
forth and so on and apparently this

1370
00:55:02,440 --> 00:55:09,369
worked because here is a list of the

1371
00:55:06,219 --> 00:55:12,039
articles that have used the data set

1372
00:55:09,369 --> 00:55:14,949
that I was that I got from my program

1373
00:55:12,039 --> 00:55:17,259
only a few of these are actually by me

1374
00:55:14,949 --> 00:55:19,179
or by one of my close collaborators most

1375
00:55:17,260 --> 00:55:21,940
of these are by other people that found

1376
00:55:19,179 --> 00:55:24,009
that data useful for their own science

1377
00:55:21,940 --> 00:55:25,750
projects so it was definitely a

1378
00:55:24,010 --> 00:55:28,750
worthwhile thing to do once we got the

1379
00:55:25,750 --> 00:55:30,969
data there's actually a whole nother set

1380
00:55:28,750 --> 00:55:32,829
of articles that were written on those

1381
00:55:30,969 --> 00:55:34,509
first two fields of data or on our

1382
00:55:32,829 --> 00:55:36,400
reprocessed versions of them and we

1383
00:55:34,510 --> 00:55:38,710
combined it with our more extensive

1384
00:55:36,400 --> 00:55:41,289
study and so these articles as well as

1385
00:55:38,710 --> 00:55:43,179
the other articles all came out of that

1386
00:55:41,289 --> 00:55:44,980
data set and quite frankly I have three

1387
00:55:43,179 --> 00:55:47,649
or four active projects that are still

1388
00:55:44,980 --> 00:55:51,150
going on with different collaborators on

1389
00:55:47,650 --> 00:55:55,180
various aspects of this data set so

1390
00:55:51,150 --> 00:55:56,950
that's quite a story behind behind one

1391
00:55:55,179 --> 00:55:57,669
of those pictures on the on the first

1392
00:55:56,949 --> 00:56:00,068
page of our

1393
00:55:57,670 --> 00:56:02,920
presentation here today I want to just

1394
00:56:00,068 --> 00:56:04,989
give you a little heads-up on one other

1395
00:56:02,920 --> 00:56:07,568
thing that we found that that was a

1396
00:56:04,989 --> 00:56:10,239
complete surprise and it combined our

1397

00:56:07,568 --> 00:56:13,088
x-ray data with the Hubble data in a

1398
00:56:10,239 --> 00:56:14,078
fascinating way Hubble had actually

1399
00:56:13,088 --> 00:56:17,558
looked at m83

1400
00:56:14,079 --> 00:56:19,150
back in the year 2000 I'm sorry Chandra

1401
00:56:17,559 --> 00:56:21,400
had looked at it in the x-rays here

1402
00:56:19,150 --> 00:56:23,260
that's the starburst nucleus here's the

1403
00:56:21,400 --> 00:56:26,650
one spiral I'm coming out and out here

1404
00:56:23,260 --> 00:56:28,660
in the middle is nothing but in 2010 in

1405
00:56:26,650 --> 00:56:30,430
2011 when we observe there is the

1406
00:56:28,659 --> 00:56:32,139
brightest point x-ray source except for

1407
00:56:30,429 --> 00:56:33,759
the the nucleus has got a bunch of stuff

1408
00:56:32,139 --> 00:56:36,068
in here but that's the brightest source

1409
00:56:33,760 --> 00:56:38,890
in the galaxy and yet there was nothing

1410
00:56:36,068 --> 00:56:39,969
there back in the year 2000 so we went

1411
00:56:38,889 --> 00:56:43,239

looked at the Hubble data that were

1412

00:56:39,969 --> 00:56:45,250
taken as part of the initial early

1413

00:56:43,239 --> 00:56:47,798
release science result and this is what

1414

00:56:45,250 --> 00:56:49,269
this has now assumed way into that just

1415

00:56:47,798 --> 00:56:50,710
a tiny in the center of that yellow box

1416

00:56:49,269 --> 00:56:53,019
now we're looking at the Hubble data

1417

00:56:50,710 --> 00:56:54,670
here's a few red stars nothing very

1418

00:56:53,019 --> 00:56:56,289
interesting going on and right in the

1419

00:56:54,670 --> 00:56:58,510
center here are those white tick marks

1420

00:56:56,289 --> 00:57:01,088
is where the position of the x-ray

1421

00:56:58,510 --> 00:57:05,140
source was supposed to be and so we said

1422

00:57:01,088 --> 00:57:06,639
well this was 2009 was 2010 what if it

1423

00:57:05,139 --> 00:57:07,509
just went off recently so why don't we

1424

00:57:06,639 --> 00:57:09,639
look at it again

1425

00:57:07,510 --> 00:57:10,900
so 2011 we went back with Hubble and

1426
00:57:09,639 --> 00:57:14,500
looked at it again and sure enough

1427
00:57:10,900 --> 00:57:17,619
there's a blue source right at the x-ray

1428
00:57:14,500 --> 00:57:19,809
position and that blue light is coming

1429
00:57:17,619 --> 00:57:22,358
from a binary star around the black hole

1430
00:57:19,809 --> 00:57:23,980
and material pulled off the star must

1431
00:57:22,358 --> 00:57:26,019
have just gotten close enough that it

1432
00:57:23,980 --> 00:57:27,849
started to pull material in and as it

1433
00:57:26,019 --> 00:57:30,309
swirls in it heats up and that UV and

1434
00:57:27,849 --> 00:57:33,548
optical blue light is what we're seeing

1435
00:57:30,309 --> 00:57:35,319
in the Hubble data complete surprise to

1436
00:57:33,548 --> 00:57:38,679
us this is very this is called an

1437
00:57:35,318 --> 00:57:40,869
ultraluminous x-ray source ulx because

1438
00:57:38,679 --> 00:57:43,509
of its brightness and the x-rays and

1439
00:57:40,869 --> 00:57:45,250
it's fascinating because we've seen

1440
00:57:43,510 --> 00:57:47,200
these things before in other galaxies

1441
00:57:45,250 --> 00:57:49,329
but we've never seen one before it got

1442
00:57:47,199 --> 00:57:52,269
bright and so people look at this and

1443
00:57:49,329 --> 00:57:53,829
they say ah it's a blue star because we

1444
00:57:52,269 --> 00:57:55,539
see blue light it's the blue star here

1445
00:57:53,829 --> 00:57:57,700
this that's that's sending material over

1446
00:57:55,539 --> 00:57:59,769
onto the black hole we say no there's no

1447
00:57:57,699 --> 00:58:01,509
blue source there it's only blue after

1448
00:57:59,769 --> 00:58:04,719
it starts to accrete the material we're

1449
00:58:01,510 --> 00:58:07,720
seeing the actual accretion disk here in

1450
00:58:04,719 --> 00:58:08,649
in the blue light that Hubble sees so

1451
00:58:07,719 --> 00:58:10,239
that was that was a neat little

1452
00:58:08,650 --> 00:58:12,220
sidelight

1453
00:58:10,239 --> 00:58:14,859
and of course we participated in the

1454

00:58:12,219 --> 00:58:16,269
hubble heritage release for this if you

1455
00:58:14,860 --> 00:58:18,039
actually go to the hubble heritage page

1456
00:58:16,269 --> 00:58:20,199
and go into some of the supplemental

1457
00:58:18,039 --> 00:58:21,699
information you can actually pull up a

1458
00:58:20,199 --> 00:58:23,379
version of this picture that allows you

1459
00:58:21,699 --> 00:58:26,079
to zoom into it and pan around

1460
00:58:23,380 --> 00:58:27,700
it's really quite spectacular a lot of

1461
00:58:26,079 --> 00:58:29,380
fun to do that and some other materials

1462
00:58:27,699 --> 00:58:31,589
that were put together for each of these

1463
00:58:29,380 --> 00:58:36,220
heritage releases it's a fabulous

1464
00:58:31,590 --> 00:58:37,360
resource out there so just to kind of

1465
00:58:36,219 --> 00:58:39,509
close things out

1466
00:58:37,360 --> 00:58:43,869
well we found lots of supernova remnants

1467
00:58:39,510 --> 00:58:45,550
we actually did not find many that look

1468
00:58:43,869 --> 00:58:47,220

like what we expected I didn't have time

1469

00:58:45,550 --> 00:58:49,780

to really talk about that tonight but

1470

00:58:47,219 --> 00:58:51,579

but we did I did show you how the

1471

00:58:49,780 --> 00:58:54,369

supernova remnants are actually

1472

00:58:51,579 --> 00:58:55,719

energizing the entire interstellar

1473

00:58:54,369 --> 00:58:59,590

medium and the spiral arms of this

1474

00:58:55,719 --> 00:59:01,779

galaxy in a big way we are looking at

1475

00:58:59,590 --> 00:59:04,690

the stars nearby to determine the masses

1476

00:59:01,780 --> 00:59:06,010

of of the precursor stars in many cases

1477

00:59:04,690 --> 00:59:09,849

many more cases than were available

1478

00:59:06,010 --> 00:59:14,020

before and interestingly enough when the

1479

00:59:09,849 --> 00:59:15,069

next supernova goes off at m83 we're

1480

00:59:14,019 --> 00:59:18,190

going to be able to look back at these

1481

00:59:15,070 --> 00:59:19,809

data and find the star before it blew up

1482

00:59:18,190 --> 00:59:23,010

and know what kind of star it was

1483
00:59:19,809 --> 00:59:25,329
directly by observing the precursor star

1484
00:59:23,010 --> 00:59:26,800
and of course I hope you've got an

1485
00:59:25,329 --> 00:59:30,670
indication that it really does take

1486
00:59:26,800 --> 00:59:32,230
tremendous dedication effort and the

1487
00:59:30,670 --> 00:59:34,980
talents of many people here at the

1488
00:59:32,230 --> 00:59:39,519
Institute to make results like this

1489
00:59:34,980 --> 00:59:42,460
possible now I'm proud dating myself by

1490
00:59:39,519 --> 00:59:46,809
showing this but every picture tells a

1491
00:59:42,460 --> 00:59:49,510
story donut and think of all the other

1492
00:59:46,809 --> 00:59:50,299
stories we could tell thanks for

1493
00:59:49,510 --> 00:59:53,469
listening

1494
00:59:50,300 --> 00:59:53,469
[Applause]

1495
01:00:00,480 --> 01:00:08,079
Eminiar how many hours do I work a week

1496
01:00:05,818 --> 01:00:09,940
depends on what you call work some of

1497
01:00:08,079 --> 01:00:12,278
the so fun you know I can't I can't

1498
01:00:09,940 --> 01:00:14,858
chalk it up to work it is a challenge

1499
01:00:12,278 --> 01:00:17,440
for me to do the research side of my job

1500
01:00:14,858 --> 01:00:20,858
because really I get very little support

1501
01:00:17,440 --> 01:00:22,599
money to do that side of my job I get

1502
01:00:20,858 --> 01:00:24,848
some support money to do the functional

1503
01:00:22,599 --> 01:00:27,640
role of trying to explain how you know

1504
01:00:24,849 --> 01:00:30,338
the astronomers are set up here in terms

1505
01:00:27,639 --> 01:00:32,348
of what they do in turn their functional

1506
01:00:30,338 --> 01:00:36,068
versus their scientific work yeah so a

1507
01:00:32,349 --> 01:00:38,019
lot of the science staff here are on 50

1508
01:00:36,068 --> 01:00:39,880
50 positions 50 percent their own

1509
01:00:38,018 --> 01:00:41,919
research time or whatever activities

1510
01:00:39,880 --> 01:00:44,858
they want to do at 50 percent support

1511

01:00:41,920 --> 01:00:47,200
work others are on an 80/20 eighty

1512
01:00:44,858 --> 01:00:48,759
percent functional xx percent support

1513
01:00:47,199 --> 01:00:50,649
although if they get grant money they

1514
01:00:48,759 --> 01:00:53,019
can buy more of their time back to work

1515
01:00:50,650 --> 01:00:54,849
on research so it's always a balance of

1516
01:00:53,018 --> 01:00:56,889
finding the functional versus the

1517
01:00:54,849 --> 01:00:58,660
science I'm in yet another category

1518
01:00:56,889 --> 01:01:00,338
since I'm actually a Hopkins person

1519
01:00:58,659 --> 01:01:02,618
that's working on a contract over here I

1520
01:01:00,338 --> 01:01:06,460
have to fulfill the contract obligations

1521
01:01:02,619 --> 01:01:09,910
so 85% of a 40-hour week I have to spend

1522
01:01:06,460 --> 01:01:11,710
on functional work 15 hours for research

1523
01:01:09,909 --> 01:01:13,739
is not very much and so what I end up

1524
01:01:11,710 --> 01:01:17,470
doing is doing research on my own time

1525
01:01:13,739 --> 01:01:19,869

and the hours do go above 40 pretty

1526

01:01:17,469 --> 01:01:21,368
regularly to actually do this but I mean

1527

01:01:19,869 --> 01:01:23,528
that's the fun part right that's the fun

1528

01:01:21,369 --> 01:01:24,970
and there's fun to enable these

1529

01:01:23,528 --> 01:01:26,380
telescopes to do stuff as well I don't

1530

01:01:24,969 --> 01:01:28,538
mean there's the functional part is not

1531

01:01:26,380 --> 01:01:31,599
fun but obviously I got into astronomy

1532

01:01:28,539 --> 01:01:33,730
because I love the science and the

1533

01:01:31,599 --> 01:01:36,278
things that I want to learn about the

1534

01:01:33,730 --> 01:01:37,630
universe and that oftentimes takes a

1535

01:01:36,278 --> 01:01:41,409
backseat but I try to work it in

1536

01:01:37,630 --> 01:01:44,259
wherever I can okay we have a microphone

1537

01:01:41,409 --> 01:01:46,748
for asking the questions so grant rule

1538

01:01:44,259 --> 01:01:49,059
as if this one can be tossed yeah you

1539

01:01:46,748 --> 01:01:50,738
can actually toss it but you have to

1540
01:01:49,059 --> 01:01:54,220
speak right into the speak right into

1541
01:01:50,739 --> 01:01:56,499
the black so for something like yours

1542
01:01:54,219 --> 01:01:58,118
you were looking at m83 you knew what

1543
01:01:56,498 --> 01:02:00,098
you were looking about how do you

1544
01:01:58,119 --> 01:02:01,900
calculate exposure time and that kind of

1545
01:02:00,099 --> 01:02:03,400
thing for something like the deep sky

1546
01:02:01,900 --> 01:02:05,619
photograph where they really weren't

1547
01:02:03,400 --> 01:02:07,059
sure what they're gonna get well that

1548
01:02:05,619 --> 01:02:07,930
one was easy they had to go as deep as

1549
01:02:07,059 --> 01:02:09,119
they could go I thought they just

1550
01:02:07,929 --> 01:02:10,288
cranked

1551
01:02:09,119 --> 01:02:11,880
you're looking for the faintest things

1552
01:02:10,289 --> 01:02:14,220
and so we said we'll just give all we

1553
01:02:11,880 --> 01:02:16,200
got and see what we can do now it's more

1554
01:02:14,219 --> 01:02:18,659
complicated than that you look at the

1555
01:02:16,199 --> 01:02:21,028
way that detectors are affected by noise

1556
01:02:18,659 --> 01:02:22,649
and whatnot and you have to scale your

1557
01:02:21,028 --> 01:02:24,748
exposure times properly to get the

1558
01:02:22,650 --> 01:02:25,829
highest sensitivity out of them and

1559
01:02:24,748 --> 01:02:27,629
whatnot there's work involved but

1560
01:02:25,829 --> 01:02:30,539
basically you just want to crank and

1561
01:02:27,630 --> 01:02:31,980
crank and crank and add you add the data

1562
01:02:30,539 --> 01:02:34,109
all together at the end to go as deep as

1563
01:02:31,980 --> 01:02:36,119
you can but for other things especially

1564
01:02:34,108 --> 01:02:38,219
if their optical where you have data

1565
01:02:36,119 --> 01:02:40,380
from a ground-based telescope you can

1566
01:02:38,219 --> 01:02:42,509
estimate the Flex levels and then you

1567
01:02:40,380 --> 01:02:45,890
scale the exposure times off of the Flex

1568

01:02:42,509 --> 01:02:48,449
levels that you expect to see behind you

1569
01:02:45,889 --> 01:02:50,778
um first of all thank you this was

1570
01:02:48,449 --> 01:02:53,098
absolutely exciting and beautifully done

1571
01:02:50,778 --> 01:02:56,608
what is the relationship of Barbara

1572
01:02:53,099 --> 01:03:00,119
Mikulski with the archives well Barbara

1573
01:02:56,608 --> 01:03:01,889
Mikulski has a longtime association with

1574
01:03:00,119 --> 01:03:04,380
the Institute and with NASA of course

1575
01:03:01,889 --> 01:03:07,139
she's been a tremendous booster of NASA

1576
01:03:04,380 --> 01:03:09,480
over the years and when she was still a

1577
01:03:07,139 --> 01:03:11,429
senator she for the servicing missions

1578
01:03:09,480 --> 01:03:13,079
and for all the way back to the Hubble

1579
01:03:11,429 --> 01:03:14,578
launch and the disaster with the Hubble

1580
01:03:13,079 --> 01:03:17,039
Mir problem and stuff back when we

1581
01:03:14,579 --> 01:03:19,318
launched Barbara was there through that

1582
01:03:17,039 --> 01:03:21,839

whole process she was supportive she was

1583

01:03:19,318 --> 01:03:24,028

firm with the problem that happened and

1584

01:03:21,838 --> 01:03:25,440

needing to fix it and whatnot but once

1585

01:03:24,028 --> 01:03:26,400

it was fixed she was one of our biggest

1586

01:03:25,440 --> 01:03:30,318

cheerleaders

1587

01:03:26,400 --> 01:03:36,480

she lives in Baltimore she comes to our

1588

01:03:30,318 --> 01:03:38,400

Halloween parties so we have a

1589

01:03:36,480 --> 01:03:41,130

relationship with Barbara and she she

1590

01:03:38,400 --> 01:03:42,239

she is at been a cheerleader for NASA

1591

01:03:41,130 --> 01:03:44,730

she's been a cheerleader for the

1592

01:03:42,239 --> 01:03:48,409

Institute for Hubble all these years and

1593

01:03:44,730 --> 01:03:51,630

as she was retiring from her public life

1594

01:03:48,409 --> 01:03:53,998

the archive here was named in her honor

1595

01:03:51,630 --> 01:03:56,039

it's great I used to be called the

1596

01:03:53,998 --> 01:03:57,838

multi-mission archive for Space

1597
01:03:56,039 --> 01:03:59,609
Telescope's mast and so we just changed

1598
01:03:57,838 --> 01:04:07,699
it to Mikulski right that's the

1599
01:03:59,608 --> 01:04:10,710
microphone back to that so you said that

1600
01:04:07,699 --> 01:04:12,239
the scientists have to come here to do

1601
01:04:10,710 --> 01:04:16,048
the science because the data is not

1602
01:04:12,239 --> 01:04:17,999
distributed no sorry the the scientists

1603
01:04:16,048 --> 01:04:21,568
come here for the peer-review process

1604
01:04:17,998 --> 01:04:22,788
they sit in rooms of about 10 people by

1605
01:04:21,568 --> 01:04:24,798
science top

1606
01:04:22,789 --> 01:04:27,410
and they take a batch of the proposals

1607
01:04:24,798 --> 01:04:29,449
that have been put in and the scientists

1608
01:04:27,409 --> 01:04:31,759
on the panel read those proposals they

1609
01:04:29,449 --> 01:04:33,559
grade them they rank them and then it's

1610
01:04:31,759 --> 01:04:35,059
the top section from each of those

1611
01:04:33,559 --> 01:04:37,278
panels and all the different science

1612
01:04:35,059 --> 01:04:39,410
categories that are accepted for the

1613
01:04:37,278 --> 01:04:41,268
next round of observing and though it's

1614
01:04:39,409 --> 01:04:43,639
the peer review of the proposals where

1615
01:04:41,268 --> 01:04:45,139
we bring people in the data go to the

1616
01:04:43,639 --> 01:04:46,608
archive and then anybody all over the

1617
01:04:45,139 --> 01:04:48,168
world could come and get the data out of

1618
01:04:46,608 --> 01:04:50,179
the archive as soon as it becomes public

1619
01:04:48,168 --> 01:04:51,798
okay because I guess that's where I was

1620
01:04:50,179 --> 01:04:53,568
getting confused because it said the

1621
01:04:51,798 --> 01:04:56,568
scientist has to get the data it's not

1622
01:04:53,568 --> 01:04:58,130
distributed but there is also access you

1623
01:04:56,568 --> 01:05:00,168
have to come to the archive and get your

1624
01:04:58,130 --> 01:05:01,759
data when it's ready they don't send you

1625

01:05:00,168 --> 01:05:02,900
a cd-rom or anything like that with the

1626
01:05:01,759 --> 01:05:04,579
data on it you have to just come

1627
01:05:02,900 --> 01:05:06,559
download it but everything is done with

1628
01:05:04,579 --> 01:05:09,259
the internet now there was a question

1629
01:05:06,559 --> 01:05:11,599
about the peer review and can you

1630
01:05:09,259 --> 01:05:15,228
explain how that the peer review is

1631
01:05:11,599 --> 01:05:16,509
blind now yeah so this was actually been

1632
01:05:15,228 --> 01:05:21,978
a big change this last cycle

1633
01:05:16,509 --> 01:05:25,179
pain-in-the-butt actually that there's

1634
01:05:21,978 --> 01:05:30,068
been a big motion in astronomy to try to

1635
01:05:25,179 --> 01:05:32,449
get a fairness into the proposal process

1636
01:05:30,068 --> 01:05:34,429
fairness in terms of gender in terms of

1637
01:05:32,449 --> 01:05:36,289
age distribution in terms of all these

1638
01:05:34,429 --> 01:05:38,989
things and when you see somebody's name

1639
01:05:36,289 --> 01:05:40,759

on a proposal and if it's an established

1640

01:05:38,989 --> 01:05:42,108

scientist as opposed to some postdoc

1641

01:05:40,759 --> 01:05:44,119

that you've never heard of or whatever

1642

01:05:42,108 --> 01:05:46,098

doesn't matter if that postdoc proposal

1643

01:05:44,119 --> 01:05:48,679

that reads grading is wonderful you

1644

01:05:46,099 --> 01:05:50,838

already have an implicit bias toward

1645

01:05:48,679 --> 01:05:52,608

somebody that's an established scientist

1646

01:05:50,838 --> 01:05:56,869

right or whatever the case may be so

1647

01:05:52,608 --> 01:05:59,119

this cycle they they they said you don't

1648

01:05:56,869 --> 01:06:02,630

even refer to your own work and your

1649

01:05:59,119 --> 01:06:05,329

proposal and say and I better at all

1650

01:06:02,630 --> 01:06:06,890

2014 did blah blah blah no you just you

1651

01:06:05,329 --> 01:06:09,048

take the eye part out of this you

1652

01:06:06,889 --> 01:06:11,538

basically make the whole referencing on

1653

01:06:09,048 --> 01:06:13,219

your proposal anonymous the names

1654
01:06:11,539 --> 01:06:15,409
although they're on the proposal when

1655
01:06:13,219 --> 01:06:16,999
it's submitted are not given to the peer

1656
01:06:15,409 --> 01:06:18,890
reviewers so the peer reviewers are

1657
01:06:16,998 --> 01:06:20,478
looking at a proposal with none of that

1658
01:06:18,889 --> 01:06:23,778
ancillary information that might

1659
01:06:20,478 --> 01:06:25,548
unintentionally bias their judgement

1660
01:06:23,778 --> 01:06:27,679
about the proposals and it really

1661
01:06:25,548 --> 01:06:29,958
focuses the panel on looking at the

1662
01:06:27,679 --> 01:06:32,150
science description that's provided and

1663
01:06:29,958 --> 01:06:34,129
and making their judgments for the best

1664
01:06:32,150 --> 01:06:35,389
science based on that I always impressed

1665
01:06:34,130 --> 01:06:36,690
that you know even after all these

1666
01:06:35,389 --> 01:06:38,039
cycles that we've done

1667
01:06:36,690 --> 01:06:39,869
and we've got incredible science

1668
01:06:38,039 --> 01:06:42,210
out-of-home are still working to improve

1669
01:06:39,869 --> 01:06:44,250
the process yeah which was a very

1670
01:06:42,210 --> 01:06:46,289
impressive and the web process will will

1671
01:06:44,250 --> 01:06:47,909
build off of the Hubble process without

1672
01:06:46,289 --> 01:06:49,800
all those years of experience now when

1673
01:06:47,909 --> 01:06:51,318
when web starts accepting proposals it's

1674
01:06:49,800 --> 01:06:53,970
going to learn from those experiences

1675
01:06:51,318 --> 01:06:55,349
okay question up there so I had a

1676
01:06:53,969 --> 01:06:57,598
question kind of about the process

1677
01:06:55,349 --> 01:06:59,010
thinking about those thousand proposals

1678
01:06:57,599 --> 01:07:01,109
they get kind of winnow down to two

1679
01:06:59,010 --> 01:07:03,480
hundred I wonder do you have a better

1680
01:07:01,108 --> 01:07:05,789
chance if you're kind of lucky and maybe

1681
01:07:03,480 --> 01:07:08,068
two or three proposals want to look at

1682

01:07:05,789 --> 01:07:11,009
the same thing I mean does that happen

1683
01:07:08,068 --> 01:07:14,789
where they could you know just to use

1684
01:07:11,010 --> 01:07:17,430
the time on Hubble more efficiently

1685
01:07:14,789 --> 01:07:19,858
maybe those proposals would be more

1686
01:07:17,429 --> 01:07:22,409
accepted than the ones that are more

1687
01:07:19,858 --> 01:07:25,049
disparate there's there are so many

1688
01:07:22,409 --> 01:07:27,779
variables in the process that that it

1689
01:07:25,050 --> 01:07:28,920
was probably one variable but there are

1690
01:07:27,780 --> 01:07:30,660
many many other things that come into

1691
01:07:28,920 --> 01:07:32,700
the process and it really comes down to

1692
01:07:30,659 --> 01:07:34,710
things like which panel does your

1693
01:07:32,699 --> 01:07:36,689
proposal go to and is there somebody

1694
01:07:34,710 --> 01:07:38,429
that happens to be on that panel that

1695
01:07:36,690 --> 01:07:40,588
kind of understands your science and

1696
01:07:38,429 --> 01:07:42,779

wanted to advocate for it in the panel

1697

01:07:40,588 --> 01:07:46,108

if they really like it so there are a

1698

01:07:42,780 --> 01:07:48,089

lot of intangibles as well as writing a

1699

01:07:46,108 --> 01:07:49,858

good proposal and supporting it as best

1700

01:07:48,088 --> 01:07:50,759

you can at the beginning so there but

1701

01:07:49,858 --> 01:07:53,608

there's a lot there's a lot of things

1702

01:07:50,760 --> 01:07:55,770

involved in the process yeah yeah I'm

1703

01:07:53,608 --> 01:07:58,108

just the very simple question though

1704

01:07:55,769 --> 01:08:00,088

with the recent gyroscope failure in

1705

01:07:58,108 --> 01:08:03,630

recovery were there any long-term

1706

01:08:00,088 --> 01:08:06,358

ramifications for the whole cycle well

1707

01:08:03,630 --> 01:08:07,680

since they recovered and night they are

1708

01:08:06,358 --> 01:08:10,650

still operating with their three gyro

1709

01:08:07,679 --> 01:08:11,699

mode there's very little impact I think

1710

01:08:10,650 --> 01:08:13,559

one of the reasons that the

1711
01:08:11,699 --> 01:08:15,389
announcements of this last cycle were a

1712
01:08:13,559 --> 01:08:16,890
little bit slow in coming out as they

1713
01:08:15,389 --> 01:08:19,548
kind of really wanted to understand

1714
01:08:16,890 --> 01:08:21,509
where they were with this gyro problem

1715
01:08:19,548 --> 01:08:23,729
gyroscopes are an interesting thing we

1716
01:08:21,509 --> 01:08:26,009
had gyro problems and reaction wheel

1717
01:08:23,729 --> 01:08:28,318
problems on the few satellite that I ran

1718
01:08:26,009 --> 01:08:32,219
over it Hopkins for many years as well

1719
01:08:28,319 --> 01:08:34,289
and it's amazing how with software and

1720
01:08:32,219 --> 01:08:35,789
other tricks these engineers figure out

1721
01:08:34,289 --> 01:08:39,329
things to do to keep these satellites

1722
01:08:35,789 --> 01:08:42,569
running for for Hubble the gyroscopes

1723
01:08:39,329 --> 01:08:44,880
are sensors they are sensing motion

1724
01:08:42,569 --> 01:08:46,289
relative motion and feeding that into

1725
01:08:44,880 --> 01:08:47,789
the Poynting system which is actually

1726
01:08:46,289 --> 01:08:50,210
done by what's called reaction wheels

1727
01:08:47,789 --> 01:08:52,369
momentum wheels that are spinning and

1728
01:08:50,210 --> 01:08:54,619
rate of speed to move the satellite

1729
01:08:52,369 --> 01:08:57,108
around her to hold it steady so it's

1730
01:08:54,619 --> 01:08:58,369
this it's a sensor problem and when you

1731
01:08:57,109 --> 01:09:00,829
have three gyros you're getting

1732
01:08:58,369 --> 01:09:02,449
information on all three axes from the

1733
01:09:00,829 --> 01:09:04,850
gyroscopes everything's happy the

1734
01:09:02,449 --> 01:09:08,238
control system is happy when you drop

1735
01:09:04,850 --> 01:09:09,829
below three gyros things change all of a

1736
01:09:08,238 --> 01:09:11,209
sudden you've got to find some

1737
01:09:09,829 --> 01:09:14,059
information from someplace else where

1738
01:09:11,210 --> 01:09:16,969
they substitute in star trackers for if

1739

01:09:14,060 --> 01:09:19,190
the pointing motion that their job is to

1740
01:09:16,969 --> 01:09:20,539
to sense the Stars not to hold the

1741
01:09:19,189 --> 01:09:22,939
satellite steady but they can change the

1742
01:09:20,539 --> 01:09:24,949
software to use star trackers to take

1743
01:09:22,939 --> 01:09:27,019
place of the gyros and they can actually

1744
01:09:24,949 --> 01:09:29,929
operate with one gyro and the star

1745
01:09:27,020 --> 01:09:32,029
trackers and and work almost as good

1746
01:09:29,930 --> 01:09:34,069
they just have certain limitations on

1747
01:09:32,029 --> 01:09:36,560
when they can point to various places

1748
01:09:34,069 --> 01:09:37,940
around the sky but they basically could

1749
01:09:36,560 --> 01:09:38,810
still see the entire sky it's just a

1750
01:09:37,939 --> 01:09:40,818
matter they have to be a little more

1751
01:09:38,810 --> 01:09:43,190
careful about when they go to a certain

1752
01:09:40,819 --> 01:09:45,020
part of the sky to observe with one gyro

1753
01:09:43,189 --> 01:09:47,539

mode so they're working with three gyros

1754

01:09:45,020 --> 01:09:49,400

now it's the last three out of six that

1755

01:09:47,539 --> 01:09:51,199

are working right now so when they lose

1756

01:09:49,399 --> 01:09:52,429

another one they they're not going to go

1757

01:09:51,199 --> 01:09:55,159

on two gyros they're going to drop to

1758

01:09:52,430 --> 01:09:57,200

one gyro use that one till it dies and

1759

01:09:55,159 --> 01:10:00,260

then use the last gyro until it dies and

1760

01:09:57,199 --> 01:10:02,329

extend the lifetime of Hubble as far as

1761

01:10:00,260 --> 01:10:03,890

they can so there will be some

1762

01:10:02,329 --> 01:10:05,149

restrictions to the pointing where it

1763

01:10:03,890 --> 01:10:07,010

gets down to the one general and

1764

01:10:05,149 --> 01:10:08,899

pertinent to your question was that the

1765

01:10:07,010 --> 01:10:10,489

three weeks of scheduling that they'd

1766

01:10:08,899 --> 01:10:12,710

already planned for those three weeks

1767

01:10:10,488 --> 01:10:14,718

will get folded into the later schedule

1768
01:10:12,710 --> 01:10:19,100
and okay the folks down the scheduling

1769
01:10:14,719 --> 01:10:20,960
branch they whenever there's a safe mode

1770
01:10:19,100 --> 01:10:22,760
they have to readjust and readjust and

1771
01:10:20,960 --> 01:10:24,680
they've been doing that for years I mean

1772
01:10:22,760 --> 01:10:26,390
it started off like it was 60 days they

1773
01:10:24,680 --> 01:10:29,920
uploaded commands in advance and now

1774
01:10:26,390 --> 01:10:31,579
it's down to a week in advance yeah so

1775
01:10:29,920 --> 01:10:34,190
amazing the amount of improvement

1776
01:10:31,579 --> 01:10:36,969
they've done in in the how long time

1777
01:10:34,189 --> 01:10:46,969
advance they need to schedule Hubble

1778
01:10:36,969 --> 01:10:49,909
other questions over there that's great

1779
01:10:46,969 --> 01:10:51,939
isn't it thank you short around this is

1780
01:10:49,909 --> 01:10:54,408
the coolest thing ever

1781
01:10:51,939 --> 01:10:57,379
so you mentioned that you had four days

1782
01:10:54,408 --> 01:10:59,089
of observation time for your m83

1783
01:10:57,380 --> 01:11:01,099
research which sounds like it's more

1784
01:10:59,090 --> 01:11:03,199
than maybe your average or a fair share

1785
01:11:01,099 --> 01:11:07,599
if you maybe can talk a little bit about

1786
01:11:03,198 --> 01:11:10,248
what is more of a typical so there's a

1787
01:11:07,599 --> 01:11:13,069
distribution of proposal sizes that go

1788
01:11:10,248 --> 01:11:14,809
from a single orbit or two up to

1789
01:11:13,069 --> 01:11:16,549
hundreds of orbits for the large and

1790
01:11:14,809 --> 01:11:18,380
very large projects that are a site

1791
01:11:16,550 --> 01:11:19,909
they're they're great in this sort of a

1792
01:11:18,380 --> 01:11:22,489
separate entity because they do take so

1793
01:11:19,908 --> 01:11:25,939
much resource they have to really be you

1794
01:11:22,488 --> 01:11:28,279
know whiz-bang science like deep field

1795
01:11:25,939 --> 01:11:31,339
or let those kind of things you know to

1796

01:11:28,279 --> 01:11:33,349
get the major or exoplanets get a lot of

1797
01:11:31,340 --> 01:11:37,969
time somehow I don't know why I well

1798
01:11:33,349 --> 01:11:39,288
anyway but but a you so I mean what's

1799
01:11:37,969 --> 01:11:40,908
typical I don't know there's a range

1800
01:11:39,288 --> 01:11:44,029
this this would have been classified as

1801
01:11:40,908 --> 01:11:45,439
a medium proposal and it is difficult to

1802
01:11:44,029 --> 01:11:47,389
get that kind of intermediate sized

1803
01:11:45,439 --> 01:11:49,578
proposal thirty fifty sixty orbits are

1804
01:11:47,389 --> 01:11:55,279
are difficult to get because there's a

1805
01:11:49,578 --> 01:11:57,139
sizable chunk of time but it's it's not

1806
01:11:55,279 --> 01:11:59,738
like the big program so it's it's in

1807
01:11:57,139 --> 01:12:01,760
between there someplace many of my

1808
01:11:59,738 --> 01:12:03,288
proposals in the past have been of order

1809
01:12:01,760 --> 01:12:05,809
five to ten orbits that's that's

1810
01:12:03,288 --> 01:12:08,179

probably a little more typical for for

1811
01:12:05,809 --> 01:12:10,130
many astronomers proposed again they

1812
01:12:08,179 --> 01:12:13,010
have a specific thing that they want to

1813
01:12:10,130 --> 01:12:14,420
do this if it didn't have if this galaxy

1814
01:12:13,010 --> 01:12:16,610
was smaller I didn't have as many fields

1815
01:12:14,420 --> 01:12:17,630
to cover the the main body of the galaxy

1816
01:12:16,609 --> 01:12:19,038
it wouldn't have been as many orbits

1817
01:12:17,630 --> 01:12:21,170
it's just there's which object do you

1818
01:12:19,038 --> 01:12:23,828
want to observe and how many times do

1819
01:12:21,170 --> 01:12:26,658
you need and that kind of thing yeah

1820
01:12:23,828 --> 01:12:30,498
thank you okay we had a question down

1821
01:12:26,658 --> 01:12:40,638
here must be allowed or I can I can I

1822
01:12:30,498 --> 01:12:43,248
could voice it first right there as we

1823
01:12:40,639 --> 01:12:49,219
once but I presume you already have a

1824
01:12:43,248 --> 01:12:51,469
long list requests so interestingly

1825
01:12:49,219 --> 01:12:53,920
enough the Webb telescope I'm sure you

1826
01:12:51,469 --> 01:12:56,929
heard on a previous month or you read

1827
01:12:53,920 --> 01:12:58,670
was its launch was delayed it was

1828
01:12:56,929 --> 01:13:01,429
supposed to be about now not that long

1829
01:12:58,670 --> 01:13:03,389
ago and it got pushed off and is now

1830
01:13:01,429 --> 01:13:06,359
sitting out an early

1831
01:13:03,389 --> 01:13:09,750
20:21 which is a long time in the future

1832
01:13:06,359 --> 01:13:11,460
but before that launch slip happened we

1833
01:13:09,750 --> 01:13:14,189
were actually in the first proposal

1834
01:13:11,460 --> 01:13:15,658
cycle for the James Webb telescope we

1835
01:13:14,189 --> 01:13:18,049
had not gotten to the submission point

1836
01:13:15,658 --> 01:13:20,939
yet we were 10 days out from submission

1837
01:13:18,050 --> 01:13:25,199
but people in the community were working

1838
01:13:20,939 --> 01:13:28,138
on proposals and they they announced the

1839
01:13:25,198 --> 01:13:29,579
launch the initial launch delay and such

1840
01:13:28,139 --> 01:13:30,719
time that they decided to just hold the

1841
01:13:29,579 --> 01:13:33,719
proposal cycle and not let those

1842
01:13:30,719 --> 01:13:36,149
proposals come in interestingly enough

1843
01:13:33,719 --> 01:13:38,069
what we did in response to that was we

1844
01:13:36,149 --> 01:13:40,979
immediately contacted the community and

1845
01:13:38,069 --> 01:13:42,750
got feedback on the tools that we had in

1846
01:13:40,979 --> 01:13:45,479
place to support them for that initial

1847
01:13:42,750 --> 01:13:47,850
cycle and we got lots of feedback for

1848
01:13:45,479 --> 01:13:49,799
making the system better when we

1849
01:13:47,850 --> 01:13:52,139
actually do this for the first time for

1850
01:13:49,800 --> 01:13:53,520
real which will be the proposal

1851
01:13:52,139 --> 01:13:55,670
opportunity right now is scheduled to

1852
01:13:53,520 --> 01:13:58,590
open up next December a year from now

1853

01:13:55,670 --> 01:14:02,069
the first call for proposals and the

1854
01:13:58,590 --> 01:14:05,699
proposals would be do then in spring or

1855
01:14:02,069 --> 01:14:10,380
summer of 2020 for the first time we

1856
01:14:05,698 --> 01:14:13,049
have a question from online let's see I

1857
01:14:10,380 --> 01:14:16,679
wonder if anyone has ever calculated the

1858
01:14:13,050 --> 01:14:19,460
person hours per HST exposure in other

1859
01:14:16,679 --> 01:14:22,289
words the hours of the STScI staff

1860
01:14:19,460 --> 01:14:24,389
divided by like for a full year divided

1861
01:14:22,289 --> 01:14:26,250
by the number of exposures in a year so

1862
01:14:24,389 --> 01:14:28,679
how many person hours go into one of

1863
01:14:26,250 --> 01:14:30,420
these observations the astronomer has to

1864
01:14:28,679 --> 01:14:35,190
put all those person hours but all the

1865
01:14:30,420 --> 01:14:36,510
people behind the scenes Wow I could say

1866
01:14:35,189 --> 01:14:38,539
it's a large enterprise that I cannot

1867
01:14:36,510 --> 01:14:44,070

even begin to fathom a number maybe a

1868

01:14:38,539 --> 01:14:45,510

google or something maybe I want

1869

01:14:44,069 --> 01:14:46,710

exposure of course some exposures are

1870

01:14:45,510 --> 01:14:48,690

long as some are short so I don't know

1871

01:14:46,710 --> 01:14:50,250

exactly what the criterion would be but

1872

01:14:48,689 --> 01:14:52,799

it's an interesting question try to get

1873

01:14:50,250 --> 01:14:56,279

about 500 people on average working here

1874

01:14:52,800 --> 01:14:58,469

and we do 3,000 orbits of observations

1875

01:14:56,279 --> 01:15:00,090

per year all right and we consider yeah

1876

01:14:58,469 --> 01:15:02,880

you can look exposure so something like

1877

01:15:00,090 --> 01:15:07,969

that yeah 500 years divided by 3000

1878

01:15:02,880 --> 01:15:07,969

orbits okay

1879

01:15:11,659 --> 01:15:18,750

my turn yeah there's an object that

1880

01:15:14,970 --> 01:15:21,420

orbits our Sun about once every 400

1881

01:15:18,750 --> 01:15:23,550

years I believe it's k2 recently

1882
01:15:21,420 --> 01:15:25,609
discovered what can you tell us about

1883
01:15:23,550 --> 01:15:25,610
that

1884
01:15:29,090 --> 01:15:34,050
Hey - is the kepler Cooper okay I

1885
01:15:32,340 --> 01:15:42,840
haven't heard of anything called k2 I

1886
01:15:34,050 --> 01:15:45,510
mean is this the planet 9 thing I heard

1887
01:15:42,840 --> 01:15:47,430
who the people may be over at the people

1888
01:15:45,510 --> 01:15:49,619
in Columbia but they're meeting and

1889
01:15:47,430 --> 01:15:51,720
they're talking about 400 years to go

1890
01:15:49,619 --> 01:15:54,359
wrong so there's something is big and it

1891
01:15:51,720 --> 01:15:57,539
goes around our Sun every 400 years

1892
01:15:54,359 --> 01:15:59,339
isn't the planet the the a large Kuiper

1893
01:15:57,539 --> 01:16:01,199
belt object that I discussed last month

1894
01:15:59,340 --> 01:16:03,119
during the movies it might be I mean

1895
01:16:01,199 --> 01:16:05,579
Pluto takes 230 years

1896
01:16:03,119 --> 01:16:07,409
139 years for though it's it's not that

1897
01:16:05,579 --> 01:16:12,510
much farther out than Pluto but water

1898
01:16:07,409 --> 01:16:15,539
uses way out there compared to the Oort

1899
01:16:12,510 --> 01:16:17,369
cloud and everything the object I

1900
01:16:15,539 --> 01:16:19,319
discussed last month was over 700 years

1901
01:16:17,369 --> 01:16:24,479
in its orbit it made you something with

1902
01:16:19,319 --> 01:16:27,479
our weather on earth no I don't think so

1903
01:16:24,479 --> 01:16:30,239
okay actually so there's a there's so

1904
01:16:27,479 --> 01:16:33,419
January 1st coming right up

1905
01:16:30,239 --> 01:16:36,569
the New Horizons mission the thing that

1906
01:16:33,420 --> 01:16:38,460
flew by Pluto isn't going to fly by

1907
01:16:36,569 --> 01:16:40,590
another object that's farther out on

1908
01:16:38,460 --> 01:16:42,420
January 1st coming right up and that

1909
01:16:40,590 --> 01:16:45,480
object has a Hubble connection right

1910

01:16:42,420 --> 01:16:48,359
because they found the thing to look at

1911
01:16:45,479 --> 01:16:50,729
by taking deep Hubble pictures in the

1912
01:16:48,359 --> 01:16:52,170
direction where New Horizons was headed

1913
01:16:50,729 --> 01:16:53,250
and is there anything out there for us

1914
01:16:52,170 --> 01:16:55,470
to look at they didn't know what they

1915
01:16:53,250 --> 01:16:57,239
were going to be able to go fly by and

1916
01:16:55,470 --> 01:16:58,710
they found two candidates this was the

1917
01:16:57,239 --> 01:17:00,059
better than the two candidates and it

1918
01:16:58,710 --> 01:17:02,520
was within the window where New Horizons

1919
01:17:00,060 --> 01:17:04,560
could adjust its its path to fly by this

1920
01:17:02,520 --> 01:17:06,510
thing and we have no idea it's just a

1921
01:17:04,560 --> 01:17:08,250
little Fleck of stuff out there and in

1922
01:17:06,510 --> 01:17:10,110
the Kuiper belt but we're gonna go see

1923
01:17:08,250 --> 01:17:11,189
another equip or belt objects I'm doing

1924
01:17:10,109 --> 01:17:15,710

nothing but it's been given the

1925

01:17:11,189 --> 01:17:15,710

impressive nickname of ultima boules

1926

01:17:15,920 --> 01:17:21,600

it's actually catalog number mu 69 or

1927

01:17:18,960 --> 01:17:24,970

something like that but ultimate tool

1928

01:17:21,600 --> 01:17:35,230

all right do we have more question yep

1929

01:17:24,970 --> 01:17:36,760

good what was a Schmo drizzle I got rid

1930

01:17:35,229 --> 01:17:38,500

of most of the buzzwords but fewer I

1931

01:17:36,760 --> 01:17:39,610

grabbed slides from other talks and

1932

01:17:38,500 --> 01:17:42,609

stuff so I'm sorry about that

1933

01:17:39,609 --> 01:17:44,439

Astro drizzle is an incredible but

1934

01:17:42,609 --> 01:17:46,899

complicated piece of software that

1935

01:17:44,439 --> 01:17:50,109

allows you if you've taken your data in

1936

01:17:46,899 --> 01:17:52,059

the proper way to combine data sets in

1937

01:17:50,109 --> 01:17:55,899

such a way that you actually improve the

1938

01:17:52,060 --> 01:17:58,690

resolution above and beyond the initial

1939
01:17:55,899 --> 01:18:00,670
pixel size of the camera so imagine if

1940
01:17:58,689 --> 01:18:03,129
you have little square pixels of a CCD

1941
01:18:00,670 --> 01:18:05,140
array and you take a picture and then

1942
01:18:03,130 --> 01:18:06,640
you offset by a fraction of a pixel and

1943
01:18:05,140 --> 01:18:09,130
take another picture and a fraction of a

1944
01:18:06,640 --> 01:18:10,750
pixel and take another picture when you

1945
01:18:09,130 --> 01:18:13,869
stitch all those data together you can

1946
01:18:10,750 --> 01:18:15,939
actually with software create an image

1947
01:18:13,869 --> 01:18:18,609
that has better resolution than any of

1948
01:18:15,939 --> 01:18:20,079
the individual pictures astro drizzle

1949
01:18:18,609 --> 01:18:21,789
does that it's also the thing that does

1950
01:18:20,079 --> 01:18:23,319
a lot of the aligning of separate

1951
01:18:21,789 --> 01:18:25,359
exposures so you can add them together

1952
01:18:23,319 --> 01:18:27,609
and as you do that then you can get rid

1953
01:18:25,359 --> 01:18:29,710
of bad pixels and cosmic rays and things

1954
01:18:27,609 --> 01:18:32,559
that are not real data in your in your

1955
01:18:29,710 --> 01:18:34,060
data but Astro drizzle is an important

1956
01:18:32,560 --> 01:18:38,980
thing for getting the absolute highest

1957
01:18:34,060 --> 01:18:42,310
quality imaging out of Hubble all right

1958
01:18:38,979 --> 01:18:44,589
so that will be our event for this

1959
01:18:42,310 --> 01:18:48,610
evening there will not be any observing

1960
01:18:44,590 --> 01:18:50,230
tonight next month in December Mark

1961
01:18:48,609 --> 01:18:52,779
kamionkowski will be talk to you about

1962
01:18:50,229 --> 01:18:55,239
black holes and other dark matters

1963
01:18:52,779 --> 01:18:57,479
please join us and let's give Bill one

1964
01:18:55,239 --> 01:18:57,479
more

1965
01:19:14,579 --> 01:19:25,140
guys somebody else what