
HUBBLE
hangouts
Frontier Fields: Pushing the Limits of the Hubble Space Telescope
Survey Progress Update!

1
00:00:05,900 --> 00:00:03,649
hello everybody and welcome to our

2
00:00:08,379 --> 00:00:05,910
latest Hubble hangout this is a place

3
00:00:10,580 --> 00:00:08,389
where you can be on the bleeding edge of

4
00:00:12,860 --> 00:00:10,590
science it's being done with the Hubble

5
00:00:13,999 --> 00:00:12,870
Space Telescope my name is Tony Darnell

6
00:00:16,970 --> 00:00:14,009
and I work at Space Telescope Science

7
00:00:18,710 --> 00:00:16,980
Institute with me to facilitate our

8
00:00:20,240 --> 00:00:18,720
discussion today is my colleague dr.

9
00:00:23,720 --> 00:00:20,250
Carol Christian from the Space Telescope

10
00:00:26,599 --> 00:00:23,730
Science Institute and Scott Lewis from

11
00:00:28,759 --> 00:00:26,609
space fan news and no the cosmos comm so

12
00:00:32,030 --> 00:00:28,769
these guys are going to help be discuss

13
00:00:34,160 --> 00:00:32,040

a very exciting topic today which is the

14
00:00:37,100 --> 00:00:34,170
frontier field survey we're gonna get an

15
00:00:39,740 --> 00:00:37,110
update on one of the largest programs

16
00:00:41,869 --> 00:00:39,750
ever to use the Hubble Space Telescope

17
00:00:43,790 --> 00:00:41,879
very ambitious project we've done

18
00:00:47,000 --> 00:00:43,800
hangouts on this before and I will make

19
00:00:48,529 --> 00:00:47,010
sure that we give you guys a good update

20
00:00:49,670 --> 00:00:48,539
as well as a sort a little bit of

21
00:00:51,560 --> 00:00:49,680
background on some of the things we've

22
00:00:54,229 --> 00:00:51,570
done if you've not heard of it before

23
00:00:55,729 --> 00:00:54,239
so before I guess or with the

24
00:00:59,209 --> 00:00:55,739
introductions let me say that we are

25
00:01:02,209 --> 00:00:59,219
monitoring the Q&A app on on YouTube and

26
00:01:04,280 --> 00:01:02,219
G+ as well as the G+ event event page

27
00:01:06,289 --> 00:01:04,290
from which this is being broadcast and

28
00:01:09,800 --> 00:01:06,299
I'm also looking at Twitter with the

29
00:01:12,469 --> 00:01:09,810
hashtag Hubble hangout so plz interact

30
00:01:14,539 --> 00:01:12,479
with us ask us questions comments this

31
00:01:16,460 --> 00:01:14,549
is the time to do it because very

32
00:01:18,890 --> 00:01:16,470
nowhere else will you get this much

33
00:01:21,070 --> 00:01:18,900
up-to-date access to people working

34
00:01:24,170 --> 00:01:21,080
directly with the Hubble Space Telescope

35
00:01:25,640 --> 00:01:24,180
so let's go ahead and get started let me

36
00:01:26,899 --> 00:01:25,650
let me introduce the team members we

37
00:01:29,690 --> 00:01:26,909
have here with us today starting with

38
00:01:31,249 --> 00:01:29,700

dr. Jennifer lot she's the principal

39
00:01:34,910 --> 00:01:31,259
investigator of the frontier fields

40
00:01:36,499 --> 00:01:34,920
survey and she will be giving us some

41
00:01:37,130 --> 00:01:36,509
updates as well as telling us how things

42
00:01:39,200 --> 00:01:37,140
were going

43
00:01:40,700 --> 00:01:39,210
also with us dr. dan Koh you remember

44
00:01:42,230 --> 00:01:40,710
him he's been in several hangouts with

45
00:01:45,289 --> 00:01:42,240
us he's also an astronomer at Space

46
00:01:47,359 --> 00:01:45,299
Telescope Science Institute and he is

47
00:01:49,460 --> 00:01:47,369
going to also give us good insight into

48
00:01:58,670 --> 00:01:49,470
what's going on and for the first time I

49
00:02:00,170 --> 00:01:58,680
have dr. Lewis I'm losing it blue bolt

50
00:02:04,069 --> 00:02:00,180
bulger right that's your last name

51
00:02:06,020 --> 00:02:04,079
Stroller sorry lou Strowger you didn't

52
00:02:07,670 --> 00:02:06,030
have it up and I drew a blank it's also

53
00:02:09,109 --> 00:02:07,680
for the first time and I'm we're gonna

54
00:02:11,390 --> 00:02:09,119
learn about his role on the project as

55
00:02:13,460 --> 00:02:11,400
well as some of his research interests

56
00:02:16,970 --> 00:02:13,470
as well dr. ray Lucas also

57
00:02:20,510 --> 00:02:16,980
a astronomer at the Institute working on

58
00:02:23,780 --> 00:02:20,520
the team dr. Norman Grogan also with us

59
00:02:27,440 --> 00:02:23,790
for the first time so we got three

60
00:02:30,770 --> 00:02:27,450
newbies and I just saw Anton Kokomo join

61
00:02:34,280 --> 00:02:30,780
hello Anton welcome good to see you

62
00:02:34,940 --> 00:02:34,290
again and so let's go ahead and get

63
00:02:36,800 --> 00:02:34,950

started

64
00:02:37,790 --> 00:02:36,810
we as I said will be monitoring all

65
00:02:39,590 --> 00:02:37,800
those different channels for the

66
00:02:41,240 --> 00:02:39,600
questions and comments but let's start

67
00:02:44,830 --> 00:02:41,250
with you Jim why don't you give us a

68
00:02:47,120 --> 00:02:44,840
very brief introduction into the

69
00:02:48,830 --> 00:02:47,130
frontier fields initiative that's what

70
00:02:50,840 --> 00:02:48,840
what the survey is trying to accomplish

71
00:02:52,760 --> 00:02:50,850
and I also want to mention before you

72
00:02:56,480 --> 00:02:52,770
get started that I have put a link in

73
00:02:58,640 --> 00:02:56,490
the description box of the event page on

74
00:03:01,520 --> 00:02:58,650
Google+ to our first hangout so you

75
00:03:03,470 --> 00:03:01,530
could go back watch a lot of what we've

76
00:03:05,900 --> 00:03:03,480
rd back the one we had in October where

77
00:03:07,280 --> 00:03:05,910
we over and and gave a background an

78
00:03:09,470 --> 00:03:07,290
overview of the whole survey when it

79
00:03:12,200 --> 00:03:09,480
just got started so Jennifer want to

80
00:03:15,430 --> 00:03:12,210
give us a brief overview okay sure I'll

81
00:03:21,110 --> 00:03:15,440
try to bring everybody up to speed so

82
00:03:25,430 --> 00:03:21,120
we're now about I don't know six months

83
00:03:28,160 --> 00:03:25,440
into observing this new program called

84
00:03:31,190 --> 00:03:28,170
the frontier fields and the aim of this

85
00:03:35,150 --> 00:03:31,200
program basically is to peer deeper into

86
00:03:37,070 --> 00:03:35,160
the universe than we ever have before so

87
00:03:39,350 --> 00:03:37,080
I think probably many of your listeners

88
00:03:42,560 --> 00:03:39,360

have heard of the Hubble Ultra Deep

89
00:03:45,170 --> 00:03:42,570
Field a new version of that actually

90
00:03:47,630 --> 00:03:45,180
came out quite recently last week was

91
00:03:49,460 --> 00:03:47,640
made made the press there was an

92
00:03:52,580 --> 00:03:49,470
ultraviolet addition to the Ultra Deep

93
00:03:54,740 --> 00:03:52,590
Field so what the frontier fields is

94
00:03:56,840 --> 00:03:54,750
aiming to do is actually to try to peer

95
00:04:00,380 --> 00:03:56,850
deeper into the universe than the Ultra

96
00:04:04,160 --> 00:04:00,390
Deep Field and we're going to do that by

97
00:04:08,210 --> 00:04:04,170
using a trick from Einstein's theory of

98
00:04:11,930 --> 00:04:08,220
general relativity by using very massive

99
00:04:15,650 --> 00:04:11,940
clusters of galaxies as telescopes so

100
00:04:17,780 --> 00:04:15,660
these objects can bend light and space

101
00:04:21,140 --> 00:04:17,790
and act like a telescope and magnify

102
00:04:24,380 --> 00:04:21,150
galaxies behind those clusters and so by

103
00:04:26,600 --> 00:04:24,390
peering very deeply at a very massive

104
00:04:27,260 --> 00:04:26,610
cluster of galaxies we should be able to

105
00:04:29,379 --> 00:04:27,270
see deeper

106
00:04:31,909 --> 00:04:29,389
to the universe than we would otherwise

107
00:04:35,180 --> 00:04:31,919
so the frontier fields is aiming to

108
00:04:38,450 --> 00:04:35,190
observe six of these strong lensing

109
00:04:41,119 --> 00:04:38,460
clusters or also getting parallel blank

110
00:04:43,309 --> 00:04:41,129
fields near to the cluster and we are

111
00:04:44,930 --> 00:04:43,319
almost done with our first cluster

112
00:04:47,210 --> 00:04:44,940
that's going to happen at the end of

113
00:04:49,689 --> 00:04:47,220

this month so we've had a few pretty

114
00:04:53,089 --> 00:04:49,699
images out there but we're really just

115
00:04:55,879 --> 00:04:53,099
as I said getting under way with this

116
00:04:58,369 --> 00:04:55,889
long-term project I have to say it's one

117
00:05:01,159 --> 00:04:58,379
of the most innovative ideas I've heard

118
00:05:02,990 --> 00:05:01,169
in a while using gravitational lensing

119
00:05:05,029 --> 00:05:03,000
to make the Hubble Space Telescope more

120
00:05:06,890 --> 00:05:05,039
powerful than it would otherwise be it's

121
00:05:08,930 --> 00:05:06,900
like adding a pair of that kind of like

122
00:05:10,939 --> 00:05:08,940
adding a Barlow lens to the Hubble right

123
00:05:13,460 --> 00:05:10,949
you can see just a little a little bit

124
00:05:16,040 --> 00:05:13,470
further back and into into this so you

125
00:05:17,749 --> 00:05:16,050
said you're almost done with the first

126
00:05:21,080 --> 00:05:17,759
field I thought we're we were done with

127
00:05:24,920 --> 00:05:21,090
with that one well what we're doing is

128
00:05:28,369 --> 00:05:24,930
for every cluster we're going to it back

129
00:05:30,499 --> 00:05:28,379
to it twice so Hubble has a number of

130
00:05:33,559 --> 00:05:30,509
cameras on it and we're going to we're

131
00:05:35,570 --> 00:05:33,569
turning on two cameras at once one is

132
00:05:38,480 --> 00:05:35,580
the infrared camera the Wide Field

133
00:05:40,399 --> 00:05:38,490
Camera 3 and the other is our trusty

134
00:05:43,879 --> 00:05:40,409
optical camera the advanced camera for

135
00:05:46,339 --> 00:05:43,889
surveys and while one camera is centered

136
00:05:50,420 --> 00:05:46,349
on the cluster the other camera will be

137
00:05:53,300 --> 00:05:50,430
on on a parallel field holding Hubble at

138
00:05:55,490 --> 00:05:53,310

a fixed angle as we collect a lot of

139
00:05:57,439 --> 00:05:55,500
data with those two cameras and then we

140
00:06:00,740 --> 00:05:57,449
have to come back and we have to let

141
00:06:02,209 --> 00:06:00,750
Hubble rotate around and so about six

142
00:06:05,719 --> 00:06:02,219
months later we come back to a field

143
00:06:09,110 --> 00:06:05,729
switching the cameras so now we're back

144
00:06:12,230 --> 00:06:09,120
to a bell 27:44 and we're swap the

145
00:06:15,379 --> 00:06:12,240
cameras so now we have the advanced

146
00:06:18,320 --> 00:06:15,389
camera for surveys on the cluster the

147
00:06:20,570 --> 00:06:18,330
intrud cameras on the parallel field we

148
00:06:22,550 --> 00:06:20,580
got data yesterday we're gonna get data

149
00:06:24,649 --> 00:06:22,560
tomorrow we're getting data all through

150
00:06:28,790 --> 00:06:24,659
the end of this month and then we'll be

151
00:06:30,800 --> 00:06:28,800
done with a bell 27:44 so Carol I don't

152
00:06:32,330 --> 00:06:30,810
want to ask you real quick do you can

153
00:06:40,170 --> 00:06:32,340
you've been associated with Hubble

154
00:07:10,680 --> 00:07:07,749
am I wrong what once I introduced

155
00:07:14,020 --> 00:07:10,690
Frank's hangout with M of the month so

156
00:07:17,740 --> 00:07:14,030
it's so I tend to do that so anyway okay

157
00:07:19,330 --> 00:07:17,750
so can you remember I've I've always

158
00:07:22,420 --> 00:07:19,340
described the frontier fields as being

159
00:07:25,390 --> 00:07:22,430
one of the most ambitious individual

160
00:07:26,860 --> 00:07:25,400
efforts that have been done by those by

161
00:07:28,029 --> 00:07:26,870
the Hubble Space Telescope would you

162
00:07:29,469 --> 00:07:28,039
agree with that statement or is there

163
00:07:33,640 --> 00:07:29,479

something been has there been anything

164
00:07:36,550 --> 00:07:33,650
that's used this much Hubble time well I

165
00:07:38,559 --> 00:07:36,560
think what I would comment on is that

166
00:07:41,589 --> 00:07:38,569
Hubble has gone through a number of

167
00:07:44,439 --> 00:07:41,599
stages and in the early days everybody

168
00:07:46,659 --> 00:07:44,449
was scrambling and so the the way the

169
00:07:49,510 --> 00:07:46,669
time was allocated was to individual

170
00:07:51,520 --> 00:07:49,520
teams there were some what were called

171
00:07:54,760 --> 00:07:51,530
guaranteed time observers and they got

172
00:07:56,560 --> 00:07:54,770
larger chunks of time but in general

173
00:07:58,600 --> 00:07:56,570
we're trying to get everybody in the

174
00:08:00,879 --> 00:07:58,610
Astronomy community to get a piece of

175
00:08:03,700 --> 00:08:00,889
the action and that we had award-winning

176
00:08:05,980 --> 00:08:03,710
proposals then and then with the Hubble

177
00:08:08,110 --> 00:08:05,990
Deep Field that kind of changed things

178
00:08:09,730 --> 00:08:08,120
that changed the game a little bit there

179
00:08:11,890 --> 00:08:09,740
was more cooperation with other

180
00:08:14,320 --> 00:08:11,900
observatories the idea of doing these

181
00:08:16,510 --> 00:08:14,330
deep fields and immediately offering all

182
00:08:19,629 --> 00:08:16,520
the data to the community to do research

183
00:08:21,339 --> 00:08:19,639
on that's that's one of the things is

184
00:08:23,050 --> 00:08:21,349
that the team that you see here is

185
00:08:25,510 --> 00:08:23,060
working very hard and they have their

186
00:08:27,909 --> 00:08:25,520
own science research goals but they are

187
00:08:29,529 --> 00:08:27,919
as soon as this data is fully processed

188
00:08:31,360 --> 00:08:29,539

and they're confident the data has

189
00:08:34,449 --> 00:08:31,370
integrity it's offered to the entire

190
00:08:36,850 --> 00:08:34,459
science community to do research on so

191
00:08:39,670 --> 00:08:36,860
that see change took place over the last

192
00:08:42,850 --> 00:08:39,680
ten years of doing these and so we're I

193
00:08:46,569 --> 00:08:42,860
would say that we've been trying to do

194
00:08:48,699 --> 00:08:46,579
on behalf it's kind of an observatory on

195
00:08:51,519 --> 00:08:48,709
behalf of the community so that

196
00:08:53,920 --> 00:08:51,529
everybody in the community can

197
00:08:56,259 --> 00:08:53,930
fit from the observations but we still

198
00:08:58,389 --> 00:08:56,269
have the normal time allocation process

199
00:09:00,579 --> 00:08:58,399
going on in parallel so people are still

200
00:09:02,800 --> 00:09:00,589
from individual teams applying for their

201
00:09:04,660 --> 00:09:02,810
own data and then we also have these

202
00:09:06,249 --> 00:09:04,670
things called Treasury programs which

203
00:09:08,499 --> 00:09:06,259
has a significant amount of data

204
00:09:10,780 --> 00:09:08,509
associated with them but this is sort of

205
00:09:13,900 --> 00:09:10,790
interesting because frontier fields is

206
00:09:16,030 --> 00:09:13,910
on behalf of the community conducted by

207
00:09:18,009 --> 00:09:16,040
the observatory so I think that's a

208
00:09:20,530 --> 00:09:18,019
little bit so we have now lots of

209
00:09:22,480 --> 00:09:20,540
flavors of kinds of programs done by

210
00:09:24,819 --> 00:09:22,490
Hubble Space Telescope and the fact that

211
00:09:28,170 --> 00:09:24,829
this looks so far back in time and gives

212
00:09:31,629 --> 00:09:28,180
us a little glimpse of what JWST may see

213
00:09:33,790 --> 00:09:31,639

after it's launched in 2018 is really

214
00:09:35,650 --> 00:09:33,800
exciting right and we're gonna get to

215
00:09:37,780 --> 00:09:35,660
the schedule here in just a little bit

216
00:09:38,980 --> 00:09:37,790
about where we are and the observing

217
00:09:41,470 --> 00:09:38,990
program but it sounds like what you're

218
00:09:43,030 --> 00:09:41,480
saying is the nature of the way Hubble

219
00:09:45,160 --> 00:09:43,040
is being used now is there starting to

220
00:09:47,829 --> 00:09:45,170
change and it got it started with the

221
00:09:49,540 --> 00:09:47,839
holder of the Hubble Deep Field and and

222
00:09:52,210 --> 00:09:49,550
also we're realistic we know this

223
00:09:54,610 --> 00:09:52,220
telescope won't last forever what we

224
00:09:56,290 --> 00:09:54,620
pretend like it would oh but we know it

225
00:09:57,939 --> 00:09:56,300
won't and so we're really in the phase

226
00:10:02,319 --> 00:09:57,949
of thinking about what is it that we

227
00:10:06,249 --> 00:10:02,329
have to do with HST you know before 2020

228
00:10:08,079 --> 00:10:06,259
or 2022 when it may not be operating in

229
00:10:10,210 --> 00:10:08,089
an optimal fashion we've got a beautiful

230
00:10:13,480 --> 00:10:10,220
observatory right now let's use it to

231
00:10:16,600 --> 00:10:13,490
its best advantage awesome ok well Dan

232
00:10:19,240 --> 00:10:16,610
so what as Dan Koh I want to ask you

233
00:10:21,490 --> 00:10:19,250
briefly about something that you know

234
00:10:23,220 --> 00:10:21,500
Jennifer alluded to when she was

235
00:10:26,170 --> 00:10:23,230
describing you know how the

236
00:10:28,689 --> 00:10:26,180
gravitational lensing what it will do a

237
00:10:31,569 --> 00:10:28,699
lot of that gravitational lensing when

238
00:10:33,280 --> 00:10:31,579

we look at the galaxy clusters that you

239
00:10:36,309 --> 00:10:33,290
guys have selected which I want to talk

240
00:10:38,019 --> 00:10:36,319
about too in just a minute but the when

241
00:10:40,090 --> 00:10:38,029
you look at those galaxy clusters the

242
00:10:43,569 --> 00:10:40,100
lensing that's happening there a lot of

243
00:10:46,990 --> 00:10:43,579
it is being affected by the dark matter

244
00:10:48,009 --> 00:10:47,000
that is up and around these galaxies

245
00:10:49,329 --> 00:10:48,019
right and I asked you this because

246
00:10:50,470 --> 00:10:49,339
you're my Dark Matter guy whenever I

247
00:10:53,379 --> 00:10:50,480
have a dark amount of question I always

248
00:10:54,970 --> 00:10:53,389
come to you first so I so do a little

249
00:10:56,470 --> 00:10:54,980
bit what how does it how does dark what

250
00:10:58,809 --> 00:10:56,480
does the role Dark Matter plays in some

251
00:11:01,030 --> 00:10:58,819
of this lensing that you're observing so

252
00:11:03,040 --> 00:11:01,040
dark matter is most of the stuff in the

253
00:11:05,199 --> 00:11:03,050
universe and in these galaxies clusters

254
00:11:07,329 --> 00:11:05,209
there's probably a hundred times as much

255
00:11:09,249 --> 00:11:07,339
dark matter is there is of the stuff

256
00:11:12,220 --> 00:11:09,259
that we can see the galaxies themselves

257
00:11:14,199 --> 00:11:12,230
the stars that have burned brightly so

258
00:11:16,239 --> 00:11:14,209
there's there's there's so much mass

259
00:11:18,429 --> 00:11:16,249
there and we can measure how much mass

260
00:11:20,739 --> 00:11:18,439
is there by this gravitational lensing

261
00:11:22,829 --> 00:11:20,749
effect and so I brought my handy

262
00:11:25,030 --> 00:11:22,839
gravitational lens here this is a

263
00:11:26,590 --> 00:11:25,040

plastic lens and I've shown this on

264
00:11:28,210 --> 00:11:26,600
these these hangouts before you bet you

265
00:11:30,309 --> 00:11:28,220
may have seen it before but basically

266
00:11:32,859 --> 00:11:30,319
it's it's ground to have a shape that's

267
00:11:35,590 --> 00:11:32,869
that's similar to exactly similar to a

268
00:11:38,769 --> 00:11:35,600
black hole okay before you start we star

269
00:11:41,079 --> 00:11:38,779
Scott would you put up one of the fields

270
00:11:42,819 --> 00:11:41,089
one of the fields that it doesn't matter

271
00:11:44,919 --> 00:11:42,829
which one one of the frontier fields

272
00:11:48,220 --> 00:11:44,929
with a per image because you let's take

273
00:11:49,809 --> 00:11:48,230
a look at that that what the the Hubble

274
00:11:51,220 --> 00:11:49,819
is actually taking a picture of him then

275
00:11:55,629 --> 00:11:51,230
we'll go to Dan's demo to kind of give

276
00:11:58,179 --> 00:11:55,639
it a little bit of more of knowledge

277
00:12:00,160 --> 00:11:58,189
there okay so your so you see one of the

278
00:12:03,939 --> 00:12:00,170
fields on the right is the galaxy

279
00:12:06,040 --> 00:12:03,949
cluster that is you can see all of these

280
00:12:09,160 --> 00:12:06,050
kind of elongated shapes that are kind

281
00:12:11,289 --> 00:12:09,170
of in the center of this galaxy some of

282
00:12:14,919 --> 00:12:11,299
the some of these galaxies are actually

283
00:12:17,019 --> 00:12:14,929
a little bit distorted this one's not

284
00:12:18,639 --> 00:12:17,029
there's not have the most biggest

285
00:12:20,319 --> 00:12:18,649
examples of what I'm talking about but

286
00:12:22,419 --> 00:12:20,329
you kind of get a sense of some of these

287
00:12:24,189 --> 00:12:22,429
galaxies are squished some of them are a

288
00:12:29,199 --> 00:12:24,199

little bit stretched out and that's due

289
00:12:30,249 --> 00:12:29,209
to the changing or the bending of the

290
00:12:33,309 --> 00:12:30,259
light as it goes through the

291
00:12:36,400 --> 00:12:33,319
gravitational wells of the of the of the

292
00:12:38,859 --> 00:12:36,410
galaxy cluster so with this in mind Dan

293
00:12:41,679 --> 00:12:38,869
go ahead alright so we have light coming

294
00:12:44,949 --> 00:12:41,689
from a distant galaxy right a cluster

295
00:12:47,259 --> 00:12:44,959
okay I'll let you take it yeah so so

296
00:12:51,100 --> 00:12:47,269
this is this is the most distant galaxy

297
00:12:52,749 --> 00:12:51,110
we know yet so this was found in a

298
00:12:54,999 --> 00:12:52,759
previous program it's exactly

299
00:12:57,280 --> 00:12:55,009
gravitationally lends itself and it's

300
00:12:59,199 --> 00:12:57,290
still pretty small but I have it here on

301
00:13:01,090 --> 00:12:59,209
my phone and and when what happens is

302
00:13:02,949 --> 00:13:01,100
when you pass a gravitational lens in

303
00:13:05,350 --> 00:13:02,959
front of a distant galaxy it gets

304
00:13:06,639 --> 00:13:05,360
magnified here let me bring up myself a

305
00:13:09,340 --> 00:13:06,649
bit bigger ik and I can see what I'm

306
00:13:10,749 --> 00:13:09,350
doing here so bring this this lens in

307
00:13:12,759 --> 00:13:10,759
front of it and it magnifies that

308
00:13:15,009 --> 00:13:12,769
distant galaxy so it makes it bigger we

309
00:13:16,840 --> 00:13:15,019
can see it better it also makes makes

310
00:13:19,040 --> 00:13:16,850
different arcs that you see in these

311
00:13:22,250 --> 00:13:19,050
images and it even makes multiple image

312
00:13:24,830 --> 00:13:22,260
and we see all of these same effects in

313
00:13:28,280 --> 00:13:24,840

these in these actual Hubble images and

314
00:13:30,890 --> 00:13:28,290
this is how we we see that the distant

315
00:13:32,690 --> 00:13:30,900
galaxies better but we can also map out

316
00:13:34,160 --> 00:13:32,700
the dark matter that's in this galaxy

317
00:13:36,110 --> 00:13:34,170
cluster so most of the mass that's in

318
00:13:37,430 --> 00:13:36,120
this galaxy cluster is stuff that we

319
00:13:39,830 --> 00:13:37,440
don't know what it is yet it's dark

320
00:13:42,080 --> 00:13:39,840
matter we can't see it but by measuring

321
00:13:44,810 --> 00:13:42,090
these deflections of the light we can

322
00:13:46,880 --> 00:13:44,820
tell how much mass is there to bet in

323
00:13:48,800 --> 00:13:46,890
space and time and in that amount to

324
00:13:51,740 --> 00:13:48,810
deflect the light around it and to tell

325
00:13:53,510 --> 00:13:51,750
us how powerful that lens it's so so put

326
00:13:57,020 --> 00:13:53,520
that back up just a so the analogy here

327
00:13:58,550 --> 00:13:57,030
is look at the pink and the yellow parts

328
00:13:59,570 --> 00:13:58,560
of the light on Dan's phone there that's

329
00:14:01,220 --> 00:13:59,580
the net that's the light don't worry

330
00:14:03,770 --> 00:14:01,230
about the reflections on the wineglasses

331
00:14:07,190 --> 00:14:03,780
right and but that's what's being in the

332
00:14:09,050 --> 00:14:07,200
the wineglass bottom is the analogy of

333
00:14:11,390 --> 00:14:09,060
what I see

334
00:14:13,190 --> 00:14:11,400
cluster lensing and that's the actual

335
00:14:15,230 --> 00:14:13,200
lens now I want to get to the lens

336
00:14:16,940 --> 00:14:15,240
models that are being used to figure

337
00:14:19,010 --> 00:14:16,950
this out later and we'll go back to this

338
00:14:20,540 --> 00:14:19,020

wine glass in just a second but that's

339
00:14:22,730 --> 00:14:20,550
what you want to pay attention to and

340
00:14:25,520 --> 00:14:22,740
that to me is one of the most easiest

341
00:14:27,380 --> 00:14:25,530
ways to see what the heck is going on in

342
00:14:28,490 --> 00:14:27,390
in gravitational lensing so thank you

343
00:14:31,490 --> 00:14:28,500
very much Dan now you didn't ask my

344
00:14:34,070 --> 00:14:31,500
question though how is dark matter

345
00:14:37,370 --> 00:14:34,080
playing the dominant role yes wincing

346
00:14:39,170 --> 00:14:37,380
absolutely under times more Dark Matter

347
00:14:41,000 --> 00:14:39,180
than that stuff that we can see and if

348
00:14:42,740 --> 00:14:41,010
it wasn't for the dark matter that these

349
00:14:45,170 --> 00:14:42,750
magnification effects would be much

350
00:14:46,880 --> 00:14:45,180
weaker and these these cosmic telescopes

351
00:14:50,150 --> 00:14:46,890
wouldn't magnify the distant galaxies

352
00:14:53,060 --> 00:14:50,160
nearly as much okay okay so that's a

353
00:14:55,250 --> 00:14:53,070
brief intro into what frontier fields is

354
00:14:57,770 --> 00:14:55,260
doing and why they're - and when done

355
00:15:00,140 --> 00:14:57,780
and how they're doing in and what the

356
00:15:02,090 --> 00:15:00,150
what they're looking at we didn't really

357
00:15:03,470 --> 00:15:02,100
talk about the parallel fields right now

358
00:15:05,600 --> 00:15:03,480
but maybe we'll get we'll get a chance

359
00:15:07,390 --> 00:15:05,610
to do that but one of the questions the

360
00:15:10,330 --> 00:15:07,400
frontier fields is trying to answer is

361
00:15:12,470 --> 00:15:10,340
is the Hubble ultra-deep field

362
00:15:14,810 --> 00:15:12,480
ubiquitous I mean if we look in other

363
00:15:16,340 --> 00:15:14,820

areas of the sky what will we see will

364
00:15:18,260 --> 00:15:16,350
we see nothing or will we see more

365
00:15:19,970 --> 00:15:18,270
galaxies like we did in the Ultra Deep

366
00:15:21,500 --> 00:15:19,980
Field than if we did what will they look

367
00:15:23,180 --> 00:15:21,510
like will they be distributed more or

368
00:15:24,770 --> 00:15:23,190
less the same so these are really

369
00:15:27,220 --> 00:15:24,780
important questions that ultimately go

370
00:15:29,660 --> 00:15:27,230
into our place in the universe and so

371
00:15:32,260 --> 00:15:29,670
that by looking at all that these just

372
00:15:33,639 --> 00:15:32,270
six different areas of the sky

373
00:15:36,340 --> 00:15:33,649
they're hoping to help answer that

374
00:15:39,040 --> 00:15:36,350
question now I want to ask I'm not sure

375
00:15:43,750 --> 00:15:39,050
to who maybe Jennifer why did you pick

376
00:15:47,940 --> 00:15:43,760
the six clusters you did oh well that

377
00:15:51,280 --> 00:15:47,950
was a very difficult task actually so

378
00:15:53,829 --> 00:15:51,290
this idea was originally conceived by a

379
00:15:56,350 --> 00:15:53,839
science working group and that working

380
00:15:58,810 --> 00:15:56,360
group you know pulled a bunch of experts

381
00:16:00,639 --> 00:15:58,820
and pulled together a list of like 20 or

382
00:16:03,670 --> 00:16:00,649
30 clusters that they thought might be

383
00:16:06,790 --> 00:16:03,680
good candidates that would be very

384
00:16:09,550 --> 00:16:06,800
strong lenders and then they gave us a

385
00:16:14,170 --> 00:16:09,560
long list of criteria one of which being

386
00:16:16,780 --> 00:16:14,180
you know you had to be able to you know

387
00:16:19,480 --> 00:16:16,790
have a high probability of finding very

388
00:16:22,960 --> 00:16:19,490

distant galaxies that would be very

389
00:16:25,570 --> 00:16:22,970
strongly lensed the galaxy cluster had

390
00:16:27,820 --> 00:16:25,580
to fit within our cut our camera right

391
00:16:29,949 --> 00:16:27,830
so it could be too far away it couldn't

392
00:16:31,540 --> 00:16:29,959
be too close it had to sort of be there

393
00:16:35,199 --> 00:16:31,550
just the right distance to fit within

394
00:16:38,769 --> 00:16:35,209
within the camera and it also needed to

395
00:16:41,800 --> 00:16:38,779
be in a really dark piece of sky right

396
00:16:44,170 --> 00:16:41,810
so that actually posed kind of a problem

397
00:16:49,060 --> 00:16:44,180
by not sort of out of the plane of the

398
00:16:51,250 --> 00:16:49,070
galaxy so we live in a galaxy and if

399
00:16:54,250 --> 00:16:51,260
you've ever seen the Milky Way you're

400
00:16:56,769 --> 00:16:54,260
seeing you know a lot of stars and

401
00:16:58,810 --> 00:16:56,779
actually a lot of dust that's associated

402
00:17:00,940 --> 00:16:58,820
with our galaxy and that makes are

403
00:17:03,490 --> 00:17:00,950
really really hard to see distant faint

404
00:17:06,610 --> 00:17:03,500
galaxies that are not you know part of

405
00:17:10,210 --> 00:17:06,620
our Milky not part of the Milky Way and

406
00:17:12,189 --> 00:17:10,220
so we wanted to avoid all of that junk

407
00:17:15,040 --> 00:17:12,199
that's in our galaxy when we were

408
00:17:17,140 --> 00:17:15,050
looking at distant distant clusters so

409
00:17:20,230 --> 00:17:17,150
we had to throw out a bunch of clusters

410
00:17:23,110 --> 00:17:20,240
because of that we also had to throw out

411
00:17:25,030 --> 00:17:23,120
clusters that were too close to the

412
00:17:26,770 --> 00:17:25,040
plane of our solar system because

413
00:17:30,310 --> 00:17:26,780

they're scattered light so diet coal

414
00:17:33,460 --> 00:17:30,320
it-- that would also make it difficult

415
00:17:35,440 --> 00:17:33,470
to see really really faint objects and

416
00:17:38,860 --> 00:17:35,450
then we had some other criteria we

417
00:17:41,940 --> 00:17:38,870
wanted it these clusters to be easily

418
00:17:45,159 --> 00:17:41,950
followed up by facilities on the ground

419
00:17:47,979 --> 00:17:45,169
so in particular there

420
00:17:51,249 --> 00:17:47,989
a telescope or actually a whole set of

421
00:17:51,669 --> 00:17:51,259
telescopes in the deserts of Chile

422
00:17:55,690 --> 00:17:51,679
called

423
00:17:58,060 --> 00:17:55,700
Alma which is a millimeter telescope and

424
00:18:02,109 --> 00:17:58,070
we thought that that telescope would be

425
00:18:04,479 --> 00:18:02,119
really good and powerful and perhaps be

426
00:18:07,570 --> 00:18:04,489
able to follow up any very faint distant

427
00:18:08,799 --> 00:18:07,580
galaxies that we found with Hubble and

428
00:18:11,229 --> 00:18:08,809
then of course the other great

429
00:18:14,919 --> 00:18:11,239
telescopes on the ground are in Hawaii

430
00:18:16,450 --> 00:18:14,929
on Mauna Kea and we wanted it to be

431
00:18:18,489 --> 00:18:16,460
observable from Mauna Kea

432
00:18:20,799 --> 00:18:18,499
so when you add all those you know

433
00:18:24,789 --> 00:18:20,809
selection criteria you actually end up

434
00:18:27,070 --> 00:18:24,799
with a very small list of good places in

435
00:18:28,779 --> 00:18:27,080
the sky and a small list of clusters

436
00:18:31,599 --> 00:18:28,789
well I'll say I mean it must be hard

437
00:18:33,700 --> 00:18:31,609
enough just to find somebody who can get

438
00:18:35,739 --> 00:18:33,710

the alignment right I mean that alone

439
00:18:37,269 --> 00:18:35,749
you know Swit seem to be a real real big

440
00:18:39,249 --> 00:18:37,279
filter in terms of what you can observe

441
00:18:40,269 --> 00:18:39,259
but I guess the ground Observatory part

442
00:18:41,830 --> 00:18:40,279
of it also makes it even more

443
00:18:47,289 --> 00:18:41,840
restrictive because you've got to do it

444
00:18:50,830 --> 00:18:47,299
where they can see - I want I jump in

445
00:18:52,479 --> 00:18:50,840
and just add this is Norman Norman also

446
00:18:54,879 --> 00:18:52,489
helped a lot with this process by all

447
00:18:56,739 --> 00:18:54,889
means go ahead that even even once we

448
00:18:58,810 --> 00:18:56,749
had the most desirable candidates

449
00:19:01,570 --> 00:18:58,820
selected we ran into trouble that this

450
00:19:04,599 --> 00:19:01,580
is such a large program that certain

451
00:19:06,279 --> 00:19:04,609
targets could not be observed in tandem

452
00:19:09,519 --> 00:19:06,289
just because Hubble did not have enough

453
00:19:11,999 --> 00:19:09,529
time of the day to point at those

454
00:19:14,320 --> 00:19:12,009
targets simultaneously so even beyond

455
00:19:16,479 --> 00:19:14,330
scientific desirability we had an issue

456
00:19:18,099 --> 00:19:16,489
with schedule ability and we had

457
00:19:20,649 --> 00:19:18,109
something of a jigsaw puzzle to solve

458
00:19:23,349 --> 00:19:20,659
where each season is it where we were

459
00:19:27,129 --> 00:19:23,359
doing a target and couldn't overlap as

460
00:19:30,759 --> 00:19:27,139
we can only do so much at one time cool

461
00:19:32,950 --> 00:19:30,769
so okay so I want to get to a little bit

462
00:19:33,909 --> 00:19:32,960
of where we are now so and then I want

463
00:19:36,369 --> 00:19:33,919

to get to some of the some of the

464
00:19:38,859 --> 00:19:36,379
science that Ray and Lois Lee or lured

465
00:19:40,899 --> 00:19:38,869
are involved in but Jennifer can you

466
00:19:42,879 --> 00:19:40,909
give us a quick update where are we now

467
00:19:47,379 --> 00:19:42,889
where's the I mean the project started

468
00:19:50,320 --> 00:19:47,389
back in October yes observing in October

469
00:19:53,200 --> 00:19:50,330
so as I said we're aiming to do six

470
00:19:56,499 --> 00:19:53,210
clusters we want to do two clusters a

471
00:19:58,510 --> 00:19:56,509
year and we have to go and look at each

472
00:20:01,900 --> 00:19:58,520
cluster every

473
00:20:03,820 --> 00:20:01,910
twice so come back after six months so

474
00:20:06,669 --> 00:20:03,830
we started in October with the first

475
00:20:14,160 --> 00:20:06,679
observations of a bell 2740 so I think

476
00:20:25,799 --> 00:20:17,980
the schedule yeah I like this Norman can

477
00:20:29,320 --> 00:20:25,809
you zoom in enhance so we went to a bell

478
00:20:31,720 --> 00:20:29,330
27:44 got some data then we switched

479
00:20:34,000 --> 00:20:31,730
over to the second cluster max oh four

480
00:20:38,169 --> 00:20:34,010
one six got some data and now we're back

481
00:20:39,820 --> 00:20:38,179
at a Bell 27:44 and as I said I think

482
00:20:42,669 --> 00:20:39,830
we'll be done by the end of the month

483
00:20:44,320 --> 00:20:42,679
with that our very first you know field

484
00:20:47,410 --> 00:20:44,330
for which we've collected all the data

485
00:20:49,660 --> 00:20:47,420
with both cameras on both the parallel

486
00:20:58,600 --> 00:20:49,670
and cluster fields this isn't quite oh I

487
00:21:00,520 --> 00:20:58,610
saw that going well this one has overlap

488
00:21:01,419 --> 00:21:00,530

with Spitzer observations so that's

489
00:21:03,370 --> 00:21:01,429
right

490
00:21:07,510 --> 00:21:03,380
that you're also using the Spitzer Space

491
00:21:09,549 --> 00:21:07,520
Telescope to gather observations to that

492
00:21:10,930 --> 00:21:09,559
is not on this schedule which is what

493
00:21:16,810 --> 00:21:10,940
Scott is showing which is from our

494
00:21:18,840 --> 00:21:16,820
webpage which is the Green is what has

495
00:21:22,960 --> 00:21:18,850
why you explained it to us

496
00:21:25,780 --> 00:21:22,970
maybe norm can explain this Norman well

497
00:21:30,240 --> 00:21:25,790
so I think this is a bit of that a

498
00:21:32,799 --> 00:21:30,250
jigsaw puzzle I was describing which is

499
00:21:35,020 --> 00:21:32,809
block block my face but we come back

500
00:21:40,510 --> 00:21:35,030
twice with every target so so where you

501
00:21:42,460 --> 00:21:40,520
see when you figure on the calendar

502
00:21:44,080 --> 00:21:42,470
we're learning that target and all the

503
00:21:46,120 --> 00:21:44,090
target names are over here on the side

504
00:21:47,560 --> 00:21:46,130
at some point I'll dredge up the actual

505
00:21:50,320 --> 00:21:47,570
electronic version hopefully by the end

506
00:21:54,220 --> 00:21:50,330
of the call no this is way more fun and

507
00:21:56,650 --> 00:21:54,230
so there's a blanket between the colored

508
00:21:59,350 --> 00:21:56,660
bands where and and there were you know

509
00:22:02,710 --> 00:21:59,360
all analyzing data doing Google Hangouts

510
00:22:05,169 --> 00:22:02,720
that sort of thing but you can see for

511
00:22:07,840 --> 00:22:05,179
most of the next or the current year in

512
00:22:09,909 --> 00:22:07,850
the next two years we plan to be doing

513
00:22:11,510 --> 00:22:09,919

these observations so we're going to be

514
00:22:14,420 --> 00:22:11,520
quite busy

515
00:22:16,300 --> 00:22:14,430
and as I mentioned earlier we needed to

516
00:22:19,600 --> 00:22:16,310
pick targets that in some sense were

517
00:22:22,280 --> 00:22:19,610
spring fall targets paired off with

518
00:22:24,530 --> 00:22:22,290
winter summer targets so that we don't

519
00:22:27,530 --> 00:22:24,540
have much overlap of Hubbell trying to

520
00:22:29,170 --> 00:22:27,540
do any two different fields at once

521
00:22:31,490 --> 00:22:29,180
because that would just be too many

522
00:22:34,730 --> 00:22:31,500
orbits of Hubbell to try to get done in

523
00:22:36,680 --> 00:22:34,740
that amount of time so on the far right

524
00:22:39,530 --> 00:22:36,690
or the far left I should say are the is

525
00:22:41,960 --> 00:22:39,540
the individual I'll put Scott's up here

526
00:22:46,340 --> 00:22:41,970
so you can put your to rest

527
00:22:48,440 --> 00:22:46,350
so the on the far far left is the galaxy

528
00:22:49,940 --> 00:22:48,450
cluster and and then throughout other

529
00:22:53,120 --> 00:22:49,950
dates for when everything is going to

530
00:22:55,850 --> 00:22:53,130
get observed it's right now a bell 27:44

531
00:23:00,260 --> 00:22:55,860
has been your starting your second pass

532
00:23:03,380 --> 00:23:00,270
on that one and what's the other one

533
00:23:04,910 --> 00:23:03,390
max oh four sixteen is that how I say

534
00:23:09,410 --> 00:23:04,920
that Jo four sixteen is that how you

535
00:23:10,640 --> 00:23:09,420
guys Branson oh that one is complete is

536
00:23:13,340 --> 00:23:10,650
that right is that what your blog said

537
00:23:14,990 --> 00:23:13,350
first oh no we're coming back to it in

538
00:23:17,720 --> 00:23:15,000

August oh you come back to us right

539
00:23:19,070 --> 00:23:17,730
that's right okay so the blog the blog

540
00:23:20,810 --> 00:23:19,080
post that I read said that you were

541
00:23:22,100 --> 00:23:20,820
finished with the first the first part

542
00:23:24,350 --> 00:23:22,110
of it that's right

543
00:23:26,270 --> 00:23:24,360
advanced camera for surveys for the main

544
00:23:29,270 --> 00:23:26,280
field and the wide field camera for the

545
00:23:32,810 --> 00:23:29,280
the parallel fields and and looking at

546
00:23:35,480 --> 00:23:32,820
this schedule okay remember that all the

547
00:23:37,790 --> 00:23:35,490
other observations have been that Hubble

548
00:23:41,420 --> 00:23:37,800
is doing has to fit in a schedule like

549
00:23:43,190 --> 00:23:41,430
this so imagine every one of the

550
00:23:45,590 --> 00:23:43,200
observations that is being done by all

551
00:23:47,510 --> 00:23:45,600
the community fold it into a calendar

552
00:23:50,420 --> 00:23:47,520
like this and that's what scheduling is

553
00:23:51,380 --> 00:23:50,430
like yeah clearly find us all the Hubble

554
00:23:55,400 --> 00:23:51,390
time which you know would have been

555
00:24:01,850 --> 00:23:55,410
lovely but Fields gets the highest

556
00:24:03,920 --> 00:24:01,860
priority obvious we've tried to make our

557
00:24:05,480 --> 00:24:03,930
program friendly to other observing

558
00:24:07,430 --> 00:24:05,490
that's going on that's that's why these

559
00:24:10,280 --> 00:24:07,440
bands of color here as wide as they are

560
00:24:12,080 --> 00:24:10,290
we try to allow for other people to get

561
00:24:14,030 --> 00:24:12,090
their work done without impinging on the

562
00:24:17,990 --> 00:24:14,040
schedule too severely we've had a few

563
00:24:20,240 --> 00:24:18,000

interesting schedule issues so anything

564
00:24:23,330 --> 00:24:20,250
you care to share just uh just work they

565
00:24:24,370 --> 00:24:23,340
just worked out okay um well I could I

566
00:24:27,039 --> 00:24:24,380
can explain

567
00:24:30,850 --> 00:24:27,049
issue that we came up with that actually

568
00:24:36,220 --> 00:24:30,860
the the people ray and Anton actually

569
00:24:39,190 --> 00:24:36,230
helped us solve quite quickly so during

570
00:24:41,409 --> 00:24:39,200
our last observing epoch which was max

571
00:24:44,200 --> 00:24:41,419
oh four one six

572
00:24:47,080 --> 00:24:44,210
we had infrared observations of the

573
00:24:49,000 --> 00:24:47,090
parallel field and there's a unique

574
00:24:51,669 --> 00:24:49,010
characteristic for infrared cameras and

575
00:24:54,279 --> 00:24:51,679
that sometimes if you go and observe

576
00:24:56,649 --> 00:24:54,289
something extremely bright it takes a

577
00:24:59,080 --> 00:24:56,659
while it can leave kind of a light and

578
00:25:01,870 --> 00:24:59,090
echo in the camera something that we

579
00:25:06,730 --> 00:25:01,880
call persistence and we ended up

580
00:25:09,340 --> 00:25:06,740
catching persistence in one of our a set

581
00:25:11,350 --> 00:25:09,350
of our observations for the frontier

582
00:25:13,600 --> 00:25:11,360
fields and it turns out actually that

583
00:25:15,760 --> 00:25:13,610
was coming from a planet or from an

584
00:25:18,279 --> 00:25:15,770
exoplanet observation that happened

585
00:25:20,470 --> 00:25:18,289
about ten hours before before our

586
00:25:22,539 --> 00:25:20,480
observations okay wait wait wait so you

587
00:25:24,730 --> 00:25:22,549
have to explain this to me a persistence

588
00:25:27,039 --> 00:25:24,740

means you were getting up observations

589
00:25:29,110 --> 00:25:27,049
from a previous you were still getting

590
00:25:30,130 --> 00:25:29,120
that's right signals from a previous

591
00:25:33,190 --> 00:25:30,140
Hubble observation

592
00:25:36,130 --> 00:25:33,200
yeah so that that that was looking at an

593
00:25:38,169 --> 00:25:36,140
incredibly bright star and spreading the

594
00:25:40,570 --> 00:25:38,179
light out of That star over most of the

595
00:25:43,810 --> 00:25:40,580
infrared camera and they were looking

596
00:25:46,870 --> 00:25:43,820
for very faint variations in the

597
00:25:49,240 --> 00:25:46,880
brightness of That star due to a planet

598
00:25:50,710 --> 00:25:49,250
going around that star you like sure

599
00:25:52,539 --> 00:25:50,720
yeah so they were kind of doing the

600
00:25:54,310 --> 00:25:52,549
exact opposite of what we're doing right

601
00:25:56,289 --> 00:25:54,320
we're looking for very tiny little faint

602
00:25:58,840 --> 00:25:56,299
dots and they're looking at really

603
00:26:00,669 --> 00:25:58,850
really bright stars you can annoy Hubble

604
00:26:02,620 --> 00:26:00,679
you keep doing this right right so they

605
00:26:05,500 --> 00:26:02,630
were getting their observations shortly

606
00:26:08,620 --> 00:26:05,510
before ours and there was a signal left

607
00:26:11,230 --> 00:26:08,630
over and in the camera but because we

608
00:26:13,990 --> 00:26:11,240
have a crack team our team is looking at

609
00:26:16,390 --> 00:26:14,000
the data as soon as it comes off the

610
00:26:19,539 --> 00:26:16,400
camera like like you know within within

611
00:26:21,340 --> 00:26:19,549
hours array and an amped honor are

612
00:26:22,870 --> 00:26:21,350
working on that and Ray is one of the

613
00:26:25,840 --> 00:26:22,880

people that does our data quality

614
00:26:29,230 --> 00:26:25,850
inspections and caught it quite quickly

615
00:26:30,730 --> 00:26:29,240
and you know this is a problem for us

616
00:26:33,789 --> 00:26:30,740
but it's not just a problem for us it's

617
00:26:35,830 --> 00:26:33,799
a problem for other Hubble users who

618
00:26:38,259 --> 00:26:35,840
have observations after these and so

619
00:26:40,299 --> 00:26:38,269
because of that we were able to

620
00:26:42,820 --> 00:26:40,309
to change the schedule and change the

621
00:26:44,949 --> 00:26:42,830
way that those observations are now

622
00:26:46,359 --> 00:26:44,959
planned oh good well I want to get to

623
00:26:48,849 --> 00:26:46,369
some of the surprises you guys have run

624
00:26:50,259 --> 00:26:48,859
across so far but would you so ray you

625
00:26:54,519 --> 00:26:50,269
want comment on that what was that like

626
00:26:55,749 --> 00:26:54,529
give the you know this while you're at

627
00:26:57,159 --> 00:26:55,759
it won't you go and explain to us what

628
00:26:59,099 --> 00:26:57,169
your what you're doing on the project is

629
00:27:02,680 --> 00:26:59,109
about one of the roles that you have

630
00:27:05,820 --> 00:27:02,690
well in deference to Carol and other

631
00:27:18,009 --> 00:27:05,830
folks I may be the oldest on here

632
00:27:20,099 --> 00:27:18,019
forever I actually got into this deep

633
00:27:29,079 --> 00:27:20,109
fields business

634
00:27:33,219 --> 00:27:29,089
in the early 90s when I was working with

635
00:27:36,219 --> 00:27:33,229
Alan Dressler's programs to observe

636
00:27:37,690 --> 00:27:36,229
medium distance galaxies clusters these

637
00:27:40,299 --> 00:27:37,700
weren't particularly known for having

638
00:27:43,149 --> 00:27:40,309

lenses and arcs and and that sort of

639
00:27:47,560 --> 00:27:43,159
thing as any prominent part of them but

640
00:27:49,629 --> 00:27:47,570
I worked on that with him as his

641
00:27:54,159 --> 00:27:49,639
Institute contact here in a number of

642
00:27:57,879 --> 00:27:54,169
ways and then leading that helped

643
00:28:02,079 --> 00:27:57,889
inspire the original Hubble Deep Field

644
00:28:05,019 --> 00:28:02,089
and so I was asked to help with some of

645
00:28:07,060 --> 00:28:05,029
that started out in a very informal way

646
00:28:09,459 --> 00:28:07,070
we were all just sort of deciding or

647
00:28:11,529 --> 00:28:09,469
talking about what could we do and

648
00:28:14,019 --> 00:28:11,539
various other things happened it grew

649
00:28:17,529 --> 00:28:14,029
into the project that we all know it

650
00:28:21,849 --> 00:28:17,539
turned into but I was part of that and

651
00:28:24,219 --> 00:28:21,859
then the Hubble Deep Field south that

652
00:28:25,629 --> 00:28:24,229
you were gonna get those get any real

653
00:28:28,930 --> 00:28:25,639
native back then wasn't it but wasn't

654
00:28:31,719 --> 00:28:28,940
that kind of a risky it was viewed that

655
00:28:34,449 --> 00:28:31,729
way by people a lot back then there were

656
00:28:37,869 --> 00:28:34,459
a lot of guff but there were a number of

657
00:28:40,989 --> 00:28:37,879
people actually who you know for better

658
00:28:43,029 --> 00:28:40,999
or worse from their own perspective were

659
00:28:46,569 --> 00:28:43,039
asked if they might be interested in

660
00:28:47,979 --> 00:28:46,579
helping do we do this or that and you

661
00:28:50,139 --> 00:28:47,989
know there were a number of people who

662
00:28:50,450 --> 00:28:50,149
for their own reasons and you know they

663
00:28:53,000 --> 00:28:50,460

had

664
00:28:55,490 --> 00:28:53,010
priorities but they you know felt you

665
00:28:57,650 --> 00:28:55,500
know I really might sink a lot of my

666
00:28:59,120 --> 00:28:57,660
time into this when I've got other

667
00:29:02,000 --> 00:28:59,130
things that I need to do with my career

668
00:29:04,760 --> 00:29:02,010
that I know are more certain and you

669
00:29:08,450 --> 00:29:04,770
know they didn't do it and you know it's

670
00:29:10,100 --> 00:29:08,460
I I I don't think people judge me my

671
00:29:11,930 --> 00:29:10,110
career right now then well but I don't

672
00:29:14,360 --> 00:29:11,940
think those people should be faulted for

673
00:29:16,820 --> 00:29:14,370
it really because you know they no one

674
00:29:19,070 --> 00:29:16,830
ever knows for sure how things will turn

675
00:29:20,750 --> 00:29:19,080
out and you know they had definite

676
00:29:23,030 --> 00:29:20,760
things that they wanted to work on that

677
00:29:26,240 --> 00:29:23,040
they could clearly see they had plenty

678
00:29:32,000 --> 00:29:26,250
to do with so I think it's sort of a

679
00:29:34,850 --> 00:29:32,010
combination of okay I can I can see some

680
00:29:37,220 --> 00:29:34,860
time or interest enough in myself to

681
00:29:38,870 --> 00:29:37,230
want to try this and enough of a sense

682
00:29:41,360 --> 00:29:38,880
of you know being part of something

683
00:29:45,170 --> 00:29:41,370
that's risky but could turn out to be

684
00:29:46,700 --> 00:29:45,180
historic and you know you you just do it

685
00:29:50,030 --> 00:29:46,710
and that's a decision that everyone has

686
00:29:53,960 --> 00:29:50,040
to make for themselves as I said I got

687
00:29:56,210 --> 00:29:53,970
involved in it because I was being asked

688
00:29:58,760 --> 00:29:56,220

you know can we do this kind of thing

689
00:30:04,640 --> 00:29:58,770
even is it feasible with the telescope

690
00:30:06,850 --> 00:30:04,650
and that role sort of propagated into

691
00:30:10,250 --> 00:30:06,860
several other programs that we worked on

692
00:30:11,780 --> 00:30:10,260
as I said after the original Hubble Deep

693
00:30:14,360 --> 00:30:11,790
Field I worked on the Hubble Deep Field

694
00:30:21,860 --> 00:30:14,370
south and then the Hubble Ultra Deep

695
00:30:23,840 --> 00:30:21,870
Field and and for some very large geo

696
00:30:25,460 --> 00:30:23,850
programs guest observer or general

697
00:30:31,030 --> 00:30:25,470
observer programs that go through the

698
00:30:34,460 --> 00:30:31,040
peer review unlike these programs do I

699
00:30:37,010 --> 00:30:34,470
you know I was in the role of one called

700
00:30:39,680 --> 00:30:37,020
Goods at first of trying to figure out

701
00:30:41,600 --> 00:30:39,690
if we could do it at all and then

702
00:30:44,330 --> 00:30:41,610
thankfully Norman came along and ever

703
00:30:46,610 --> 00:30:44,340
since has been taking over that kind of

704
00:30:48,700 --> 00:30:46,620
stuff in great detail and I'm very

705
00:30:51,440 --> 00:30:48,710
grateful for Norman

706
00:30:54,710 --> 00:30:51,450
because he's very good at it and it's

707
00:30:56,690 --> 00:30:54,720
very hard work it involves a lot of

708
00:31:01,100 --> 00:30:56,700
iteration back and forth finding all

709
00:31:04,420 --> 00:31:01,110
kinds of problems as he mentioned you

710
00:31:07,820 --> 00:31:04,430
know things like target visibility times

711
00:31:09,890 --> 00:31:07,830
guidestar lack of guide stars all of

712
00:31:11,750 --> 00:31:09,900
these operational issues like that that

713
00:31:14,920 --> 00:31:11,760

have to be factored in to actually make

714
00:31:17,420 --> 00:31:14,930
the observations and as far as my own

715
00:31:23,390 --> 00:31:17,430
part in this I mean I originally got

716
00:31:26,390 --> 00:31:23,400
involved in this at the early level or

717
00:31:28,670 --> 00:31:26,400
early time sort of talking about things

718
00:31:31,190 --> 00:31:28,680
like general advice historical

719
00:31:33,110 --> 00:31:31,200
precedents things that we've done with

720
00:31:40,430 --> 00:31:33,120
the original Hubble Deep Field and the

721
00:31:43,010 --> 00:31:40,440
other early observations more as more is

722
00:31:44,990 --> 00:31:43,020
just sort of oh yes I remember we did

723
00:31:47,060 --> 00:31:45,000
this back then this was a good idea or

724
00:31:51,200 --> 00:31:47,070
that maybe that didn't turn out so well

725
00:31:53,480 --> 00:31:51,210
or that kind of thing so I was just a

726
00:31:57,020 --> 00:31:53,490
little bit of institutional memory in

727
00:32:02,960 --> 00:31:57,030
that sense talking about program designs

728
00:32:04,580 --> 00:32:02,970
development testing policies believe it

729
00:32:07,430 --> 00:32:04,590
or not there are policies for us

730
00:32:10,190 --> 00:32:07,440
involved with this here if you actually

731
00:32:12,890 --> 00:32:10,200
have your fingers in the data you know

732
00:32:19,870 --> 00:32:12,900
in the pixels in any way you can't

733
00:32:23,480 --> 00:32:19,880
really be immediately engaged in science

734
00:32:26,540 --> 00:32:23,490
right away that's because of you know

735
00:32:29,090 --> 00:32:26,550
you don't want to let's have the

736
00:32:32,450 --> 00:32:29,100
situation where people in the Institute

737
00:32:36,070 --> 00:32:32,460
have an earlier advantage over there but

738
00:32:39,020 --> 00:32:36,080

that's I mean in this case we've got the

739
00:32:40,730 --> 00:32:39,030
data are available to everybody all the

740
00:32:49,850 --> 00:32:40,740
time it's like your frontier fields

741
00:32:55,550 --> 00:32:49,860
later available to everyone no ray your

742
00:32:56,930 --> 00:32:55,560
audio is all right well that's let's see

743
00:32:58,910 --> 00:32:56,940
let's hope it works itself out a little

744
00:33:01,580 --> 00:32:58,920
bit so let me know yeah let's go a

745
00:33:03,620 --> 00:33:01,590
little bit to the let's go a little bit

746
00:33:05,990 --> 00:33:03,630
to the to where we are now the fields

747
00:33:08,930 --> 00:33:06,000
that we have now we have two fields so

748
00:33:10,850 --> 00:33:08,940
far that we've imaged ooh I'd like to

749
00:33:11,780 --> 00:33:10,860
get you in on this discussion so why

750
00:33:13,010 --> 00:33:11,790
don't you tell us a little bit about

751
00:33:15,260 --> 00:33:13,020
what you're doing on the project but

752
00:33:15,960 --> 00:33:15,270
what can you tell us about where we're

753
00:33:17,520 --> 00:33:15,970
at now

754
00:33:20,820 --> 00:33:17,530
on with with the frontier field

755
00:33:23,340 --> 00:33:20,830
observations so I think Jen gave a

756
00:33:25,670 --> 00:33:23,350
little bit of a progress report on the

757
00:33:30,300 --> 00:33:25,680
the field the frontier fields progress

758
00:33:32,750 --> 00:33:30,310
I'm a part of a sort of a a piggyback or

759
00:33:35,430 --> 00:33:32,760
a satellite project to look for

760
00:33:37,710 --> 00:33:35,440
supernovae in these fields and try to

761
00:33:42,420 --> 00:33:37,720
analyze them to tell us something about

762
00:33:48,030 --> 00:33:42,430
you know the environments of the early

763
00:33:50,010 --> 00:33:48,040

universe our project has as looked at

764
00:33:52,440 --> 00:33:50,020
each one of each frame of the frontier

765
00:33:54,330 --> 00:33:52,450
fields as they come in and difference

766
00:33:56,790 --> 00:33:54,340
those frames to look for these you know

767
00:33:59,550 --> 00:33:56,800
various to subtracted one from the other

768
00:34:01,800 --> 00:33:59,560
and what's left behind is stuff that's

769
00:34:03,270 --> 00:34:01,810
different something is changing okay

770
00:34:04,740 --> 00:34:03,280
anything that goes bump in the night

771
00:34:09,840 --> 00:34:04,750
anything that changes in brightness we

772
00:34:12,090 --> 00:34:09,850
pick up and our plan is to analyze each

773
00:34:14,850 --> 00:34:12,100
one look for potential supernovae

774
00:34:15,780 --> 00:34:14,860
identify those supernovae and see if we

775
00:34:18,750 --> 00:34:15,790
can't learn something about their

776
00:34:21,660 --> 00:34:18,760
universe from them yet yes we've been

777
00:34:25,500 --> 00:34:21,670
very successful we've found 13 so far 13

778
00:34:26,850 --> 00:34:25,510
supernovae yeah yeah it's a it's a

779
00:34:29,910 --> 00:34:26,860
little bit larger than we expected but

780
00:34:32,130 --> 00:34:29,920
that's a to come are you expecting I

781
00:34:33,810 --> 00:34:32,140
don't remember it these things are

782
00:34:35,550 --> 00:34:33,820
actually pretty broad if you think of

783
00:34:38,310 --> 00:34:35,560
like you'd be happy if you caught two or

784
00:34:39,780 --> 00:34:38,320
three right yeah well it's not but it's

785
00:34:41,370 --> 00:34:39,790
it's something like on the order of a

786
00:34:45,540 --> 00:34:41,380
handful and now we're you know we're

787
00:34:47,610 --> 00:34:45,550
doing quite quite well and it depends

788
00:34:50,250 --> 00:34:47,620

also on what type of supernovae you're

789
00:34:53,340 --> 00:34:50,260
looking for whether or not it's related

790
00:34:55,470 --> 00:34:53,350
to very massive stars or the more

791
00:34:57,780 --> 00:34:55,480
coveted you know type 1a supernovae

792
00:35:01,560 --> 00:34:57,790
which we used to determine the distances

793
00:35:04,830 --> 00:35:01,570
to galaxies precisely and measure dark

794
00:35:06,570 --> 00:35:04,840
energy from so this project is a little

795
00:35:08,700 --> 00:35:06,580
different from our usual dark energy

796
00:35:10,410 --> 00:35:08,710
mission where we're looking more to

797
00:35:11,820 --> 00:35:10,420
understand the supernovae in the

798
00:35:16,020 --> 00:35:11,830
environments themselves so we've been

799
00:35:19,920 --> 00:35:16,030
trying we have a dark energy mission no

800
00:35:23,190 --> 00:35:19,930
uh so a with these deep fields that have

801
00:35:25,859 --> 00:35:23,200
been going on for 15 plus years

802
00:35:29,160 --> 00:35:25,869
Lee since goods let's say ten years

803
00:35:33,540 --> 00:35:29,170
we've had a component or we've built in

804
00:35:35,339 --> 00:35:33,550
a component to those two the the way in

805
00:35:37,560 --> 00:35:35,349
which those fields were accumulated to

806
00:35:41,760 --> 00:35:37,570
allow us to search for distant

807
00:35:46,319 --> 00:35:41,770
supernovae within them the mission then

808
00:35:49,620 --> 00:35:46,329
was to try and find as many type 1a

809
00:35:51,210 --> 00:35:49,630
supernovae as we could and determine if

810
00:35:54,450 --> 00:35:51,220
the universe was indeed not only

811
00:35:57,180 --> 00:35:54,460
accelerating at relatively recent epochs

812
00:36:01,230 --> 00:35:57,190
in the past but also decelerating at

813
00:36:03,109 --> 00:36:01,240

even further epochs or even really that

814
00:36:06,150 --> 00:36:03,119
deceleration aren't you guys you brought

815
00:36:15,540 --> 00:36:06,160
we found it we were very happy we found

816
00:36:20,849 --> 00:36:15,550
it it's a big fat medallion for four for

817
00:36:23,700 --> 00:36:20,859
that and I didn't wear it today but but

818
00:36:27,210 --> 00:36:23,710
yeah no it's we were very happy we found

819
00:36:31,710 --> 00:36:27,220
it and so since then the mission has

820
00:36:34,490 --> 00:36:31,720
been changing evolving to further

821
00:36:37,349 --> 00:36:34,500
refining the measure of dark energy

822
00:36:40,230 --> 00:36:37,359
which we still do to this day but also

823
00:36:43,020 --> 00:36:40,240
taking on other projects weird the great

824
00:36:45,599 --> 00:36:43,030
thing about these fields is the lensing

825
00:36:46,890 --> 00:36:45,609
and the lensing allows us to probe even

826
00:36:49,470 --> 00:36:46,900
earlier in the universe and we have

827
00:36:51,000 --> 00:36:49,480
before and we can do some really

828
00:36:54,630 --> 00:36:51,010
interesting things like that like say

829
00:36:57,660 --> 00:36:54,640
what the rate of occurrence of events

830
00:37:01,770 --> 00:36:57,670
are like in the very early universe we

831
00:37:04,170 --> 00:37:01,780
could say you know if we can see similar

832
00:37:07,230 --> 00:37:04,180
the most the earliest supernovae from

833
00:37:09,809 --> 00:37:07,240
the you know prime primordial superstars

834
00:37:11,670 --> 00:37:09,819
excuse me the first stars if we could

835
00:37:12,839 --> 00:37:11,680
see supernovae from the first stars that

836
00:37:15,450 --> 00:37:12,849
might be very important and very

837
00:37:17,280 --> 00:37:15,460
interesting so the Lansing's the lensing

838
00:37:19,230 --> 00:37:17,290

allows us to see this through the

839
00:37:21,690 --> 00:37:19,240
magnification that we get but blue

840
00:37:24,450 --> 00:37:21,700
aren't there the supernovae especially

841
00:37:26,700 --> 00:37:24,460
the type 1a is also really useful for

842
00:37:30,270 --> 00:37:26,710
testing how well we understand the

843
00:37:32,040 --> 00:37:30,280
lensing yeah because you know what the

844
00:37:34,890 --> 00:37:32,050
distance is you know how bright that

845
00:37:36,870 --> 00:37:34,900
supernova is supposed to be and so you

846
00:37:40,020 --> 00:37:36,880
can see if your prediction

847
00:37:42,360 --> 00:37:40,030
of the magnification due to the cluster

848
00:37:45,960 --> 00:37:42,370
is right or not that's right so we can

849
00:37:48,480 --> 00:37:45,970
actually turn the the test around and we

850
00:37:50,790 --> 00:37:48,490
could use the precise the precision of

851
00:37:53,670 --> 00:37:50,800
the supernovae to tell us something

852
00:37:57,090 --> 00:37:53,680
about the accuracy of the magnification

853
00:37:59,730 --> 00:37:57,100
maps and in fact we have a really new

854
00:38:02,250 --> 00:37:59,740
candidate which we just found in the

855
00:38:06,030 --> 00:38:02,260
last few weeks that is indeed a very

856
00:38:09,540 --> 00:38:06,040
precise type 1a supernova it's in a

857
00:38:13,230 --> 00:38:09,550
really unique environment but it's more

858
00:38:15,870 --> 00:38:13,240
or less unobscured doesn't have

859
00:38:18,150 --> 00:38:15,880
extinction to it and it's a very ideal

860
00:38:20,460 --> 00:38:18,160
object for measuring distances in

861
00:38:23,160 --> 00:38:20,470
measuring precisely luminosities and we

862
00:38:28,020 --> 00:38:23,170
can use that to test the lens model at

863
00:38:29,790 --> 00:38:28,030

that in this is in a a bell 27:44 okay

864
00:38:32,160 --> 00:38:29,800
so I didn't see that let me see if I can

865
00:38:34,620 --> 00:38:32,170
rephrase this in a way that might be a

866
00:38:35,790 --> 00:38:34,630
little more understandable to some

867
00:38:37,200 --> 00:38:35,800
people because I want to make sure this

868
00:38:40,170 --> 00:38:37,210
is an important point you're making so

869
00:38:42,330 --> 00:38:40,180
type 1a supernovae are are a supernova

870
00:38:44,580 --> 00:38:42,340
that we they're very special kind we

871
00:38:45,900 --> 00:38:44,590
then they we know they're special

872
00:38:47,610 --> 00:38:45,910
because we know their intrinsic

873
00:38:49,620 --> 00:38:47,620
brightness we know how bright they

874
00:38:50,790 --> 00:38:49,630
really are as if they would be right

875
00:38:51,840 --> 00:38:50,800
next to us we don't want them to be

876
00:38:54,300 --> 00:38:51,850
right next to us but if they were

877
00:38:56,160 --> 00:38:54,310
knowing how bright something is

878
00:38:58,410 --> 00:38:56,170
intrinsically and then measuring its

879
00:38:59,970 --> 00:38:58,420
brightness from wherever it is we get

880
00:39:01,650 --> 00:38:59,980
some sense of how far away it is that's

881
00:39:03,480 --> 00:39:01,660
why there's such good yard sticks but

882
00:39:06,000 --> 00:39:03,490
what lewis saying is they also can use

883
00:39:08,220 --> 00:39:06,010
those to tell them something about the

884
00:39:11,010 --> 00:39:08,230
way in which the lens that that light is

885
00:39:12,870 --> 00:39:11,020
traveling through is being modelled and

886
00:39:15,810 --> 00:39:12,880
how well they're doing at it am i right

887
00:39:18,960 --> 00:39:15,820
so sorry i don't know are doing a good

888
00:39:20,580 --> 00:39:18,970

job with your model then you would see a

889
00:39:21,990 --> 00:39:20,590
brightness that you observe with the

890
00:39:23,520 --> 00:39:22,000
frontier fields if you're doing a bad

891
00:39:24,450 --> 00:39:23,530
job with your model then frontier fields

892
00:39:27,450 --> 00:39:24,460
are going to show you something

893
00:39:29,400 --> 00:39:27,460
different because you're wrong your

894
00:39:31,920 --> 00:39:29,410
model isn't acting right on the on the

895
00:39:33,330 --> 00:39:31,930
and and now that we're on the subject of

896
00:39:36,000 --> 00:39:33,340
models we should probably bring that up

897
00:39:39,150 --> 00:39:36,010
now models are these things that you

898
00:39:41,250 --> 00:39:39,160
invent mathematically that explain what

899
00:39:42,810 --> 00:39:41,260
is happening to the light as it travels

900
00:39:44,070 --> 00:39:42,820
through the galaxy cluster in other

901
00:39:47,160 --> 00:39:44,080
words you get these squished out

902
00:39:49,920 --> 00:39:47,170
galaxies are all weird and snaky looking

903
00:39:53,160 --> 00:39:49,930
and in weird shapes it's being

904
00:39:55,530 --> 00:39:53,170
done - by the actual gravitational lens

905
00:39:58,109 --> 00:39:55,540
you're trying to mathematically describe

906
00:40:01,319 --> 00:39:58,119
that you've got some right who wants to

907
00:40:03,270 --> 00:40:01,329
talk about the models Dan yeah yeah okay

908
00:40:04,950 --> 00:40:03,280
Dan you wanna talk about the models yeah

909
00:40:06,690 --> 00:40:04,960
we I'm gonna get you in on this in just

910
00:40:08,250 --> 00:40:06,700
a minute don't worry I know I gotta get

911
00:40:10,200 --> 00:40:08,260
you in on cuz I will talk about data

912
00:40:11,730 --> 00:40:10,210
there's all this dark matter in the

913
00:40:13,530 --> 00:40:11,740

cluster like we talked about but we

914
00:40:15,270 --> 00:40:13,540
don't know exactly where it is and and

915
00:40:17,309 --> 00:40:15,280
just like you said Tony we we observe

916
00:40:19,650 --> 00:40:17,319
this lensing and and based on the

917
00:40:22,980 --> 00:40:19,660
lensing we we can map it out in some

918
00:40:26,069 --> 00:40:22,990
detail but but not perfectly and so we

919
00:40:29,040 --> 00:40:26,079
actually had five different teams from

920
00:40:30,990 --> 00:40:29,050
the community all submit their models so

921
00:40:33,900 --> 00:40:31,000
that everybody could could use them so

922
00:40:35,609 --> 00:40:33,910
these are all public favorite models and

923
00:40:38,220 --> 00:40:35,619
they all said use mine use mine right

924
00:40:40,020 --> 00:40:38,230
they all have different ways of modeling

925
00:40:41,370 --> 00:40:40,030
and describing exactly how the dark

926
00:40:43,140 --> 00:40:41,380
matter is distributed and you know

927
00:40:45,480 --> 00:40:43,150
there's it's constrained to some degree

928
00:40:46,980 --> 00:40:45,490
by the lensing but not exactly and so

929
00:40:48,720 --> 00:40:46,990
they all submitted these models and and

930
00:40:50,430 --> 00:40:48,730
these are teams that had you know kind

931
00:40:52,380 --> 00:40:50,440
of had friendly competition before and

932
00:40:53,940 --> 00:40:52,390
they'd be you know propose their models

933
00:40:55,920 --> 00:40:53,950
and they tried to one-up each other and

934
00:40:57,630 --> 00:40:55,930
you know and in this case they all work

935
00:41:00,270 --> 00:40:57,640
together so we brought them all together

936
00:41:02,700 --> 00:41:00,280
they did you know they shared all the

937
00:41:05,490 --> 00:41:02,710
best available lensing data that they

938
00:41:06,839 --> 00:41:05,500

had and they you know they then they

939
00:41:08,250 --> 00:41:06,849
went off and they worked separately and

940
00:41:09,870 --> 00:41:08,260
they made these models they you know but

941
00:41:11,789 --> 00:41:09,880
they kind of cooperated and and so now

942
00:41:15,180 --> 00:41:11,799
this is all available and so for any

943
00:41:17,819 --> 00:41:15,190
galaxy that you see being lens by one of

944
00:41:21,660 --> 00:41:17,829
these frontier fields clusters or any

945
00:41:24,089 --> 00:41:21,670
supernova you can you can go to a

946
00:41:25,680 --> 00:41:24,099
webpage and you can you can figure out

947
00:41:26,880 --> 00:41:25,690
what are the different magnification

948
00:41:29,220 --> 00:41:26,890
estimates from all these different

949
00:41:31,650 --> 00:41:29,230
models how much do the models say that

950
00:41:32,789 --> 00:41:31,660
this galaxy is being magnified and it'll

951
00:41:35,490 --> 00:41:32,799
give you this this whole range of

952
00:41:37,020 --> 00:41:35,500
predictions that then you can in the

953
00:41:39,329 --> 00:41:37,030
case of a supernova you can then predict

954
00:41:42,120 --> 00:41:39,339
you can then compare against what you

955
00:41:44,730 --> 00:41:42,130
actually know the magnification is so

956
00:41:48,109 --> 00:41:44,740
here Scott's got one up he went to the

957
00:41:50,789 --> 00:41:48,119
mast and pulled this up yeah that's

958
00:41:55,319 --> 00:41:50,799
right so so what we're looking at here

959
00:41:57,599 --> 00:41:55,329
is actually so the a magnification of a

960
00:41:59,670 --> 00:41:57,609
distant galaxy also depends on how far

961
00:42:00,890 --> 00:41:59,680
away that galaxy is so what we're

962
00:42:02,819 --> 00:42:00,900
looking at here is we're looking at

963
00:42:03,490 --> 00:42:02,829

magnifications for three different

964
00:42:05,480 --> 00:42:03,500
distance

965
00:42:06,680 --> 00:42:05,490
and if that's what you're seeing in a

966
00:42:08,990 --> 00:42:06,690
different color so it's a little bit

967
00:42:11,180 --> 00:42:09,000
confusing but basically a weight so this

968
00:42:13,160 --> 00:42:11,190
is this is the mathematical model right

969
00:42:15,620 --> 00:42:13,170
right the colors are different

970
00:42:17,930 --> 00:42:15,630
magnifications blue is maybe different

971
00:42:19,640 --> 00:42:17,940
magnifications in red right well so blue

972
00:42:21,800 --> 00:42:19,650
is for a galaxy that's a certain

973
00:42:24,140 --> 00:42:21,810
distance away and in green is for a

974
00:42:27,140 --> 00:42:24,150
galaxy that's more distant and then red

975
00:42:28,820 --> 00:42:27,150
is for some of the most distant galaxies

976
00:42:30,740 --> 00:42:28,830
we used we've we've yet discovered red

977
00:42:32,840 --> 00:42:30,750
is for those galaxies so if that's what

978
00:42:34,340 --> 00:42:32,850
you're interested in most like me you

979
00:42:36,140 --> 00:42:34,350
would be looking at the at the red and

980
00:42:38,450 --> 00:42:36,150
this image here and so what you're

981
00:42:40,040 --> 00:42:38,460
looking at here those words it's bright

982
00:42:43,880 --> 00:42:40,050
red is where the magnification is

983
00:42:45,890 --> 00:42:43,890
highest how many's models doing how done

984
00:42:55,460 --> 00:42:45,900
are they there I'd say they're doing

985
00:42:57,620 --> 00:42:55,470
well so so I would say they're not so

986
00:42:59,930 --> 00:42:57,630
our our first supernova that we had a

987
00:43:01,670 --> 00:42:59,940
chance to do this with is what I

988
00:43:03,110 --> 00:43:01,680

mentioned last week so we're still

989
00:43:05,960 --> 00:43:03,120
looking at the data but the plenary

990
00:43:08,810 --> 00:43:05,970
results are kind of interesting we've we

991
00:43:12,650 --> 00:43:08,820
think the lens models predict something

992
00:43:14,390 --> 00:43:12,660
like a factor of 10 magnification so the

993
00:43:17,270 --> 00:43:14,400
object should be ten times brighter than

994
00:43:20,960 --> 00:43:17,280
you would expect for it for its distance

995
00:43:23,000 --> 00:43:20,970
or its epic what we observe is something

996
00:43:25,370 --> 00:43:23,010
more like just a 30% increase in

997
00:43:27,920 --> 00:43:25,380
brightness so maybe this is a hole in

998
00:43:29,150 --> 00:43:27,930
the lens model or maybe it's saying that

999
00:43:31,010 --> 00:43:29,160
there's a problem with the lens model

1000
00:43:32,540 --> 00:43:31,020
yeah that is interesting and I mean

1001
00:43:33,680 --> 00:43:32,550
because didn't you all just have a press

1002
00:43:50,110 --> 00:43:33,690
release saying that this worked really

1003
00:43:54,380 --> 00:43:52,310
sorry last time it seemed to work well

1004
00:43:56,420 --> 00:43:54,390
and you know there are there are a range

1005
00:43:58,010 --> 00:43:56,430
of predictions so I mean that they all

1006
00:44:01,610 --> 00:43:58,020
well anyway well you know we'll have

1007
00:44:03,080 --> 00:44:01,620
time to so we've got we've got some

1008
00:44:04,370 --> 00:44:03,090
we've got a lot of comments and stuff at

1009
00:44:06,080 --> 00:44:04,380
Anton let me get you in on this

1010
00:44:07,340 --> 00:44:06,090
discussion welcome by the way it's good

1011
00:44:10,100 --> 00:44:07,350
to see you again I haven't seen you

1012
00:44:12,260 --> 00:44:10,110
since AS thank you Tony well we've been

1013
00:44:14,210 --> 00:44:12,270

kind of busy yeah I guess so the cider

1014
00:44:17,690 --> 00:44:14,220
coming in and so we've been doing all

1015
00:44:19,549 --> 00:44:17,700
this new combination of data

1016
00:44:21,470 --> 00:44:19,559
thank you for having me on so you're

1017
00:44:23,210 --> 00:44:21,480
doing the you're doing the pipelining

1018
00:44:26,180 --> 00:44:23,220
calibrations and things like that has

1019
00:44:28,160 --> 00:44:26,190
there been any any any surprises any

1020
00:44:30,950 --> 00:44:28,170
things that that you have come across

1021
00:44:32,569 --> 00:44:30,960
that you didn't expect yeah sure so let

1022
00:44:34,010 --> 00:44:32,579
me answer so you've asked a few times

1023
00:44:35,450 --> 00:44:34,020
what's the status of our current

1024
00:44:38,180 --> 00:44:35,460
observing I can give a quick update on

1025
00:44:41,299 --> 00:44:38,190
that maybe add a few more details to

1026
00:44:44,540 --> 00:44:41,309
what Jen was saying below yes so we've

1027
00:44:47,809 --> 00:44:44,550
now basically finished almost finished

1028
00:44:49,339 --> 00:44:47,819
our first cluster we are about let's say

1029
00:44:50,839 --> 00:44:49,349
two-thirds or three-quarters of the way

1030
00:44:53,750 --> 00:44:50,849
through our second epoch we have these

1031
00:44:55,760 --> 00:44:53,760
two e box on the clusters and when we're

1032
00:44:57,920 --> 00:44:55,770
done that means we have complete

1033
00:45:00,680 --> 00:44:57,930
coverage in both cameras on the cluster

1034
00:45:02,059 --> 00:45:00,690
and also on this parallel field so what

1035
00:45:04,549 --> 00:45:02,069
we're doing is we're basically looking

1036
00:45:06,260 --> 00:45:04,559
at the data as it comes in so I've got

1037
00:45:08,380 --> 00:45:06,270
this team of folks helping me I've got a

1038
00:45:11,870 --> 00:45:08,390

I've got about a half dozen other people

1039
00:45:13,790 --> 00:45:11,880
all looking at images as I come in and I

1040
00:45:15,710 --> 00:45:13,800
can actually share with you what we do

1041
00:45:18,230 --> 00:45:15,720
is basically we look live almost at the

1042
00:45:20,690 --> 00:45:18,240
exposures sort of after within a couple

1043
00:45:22,250 --> 00:45:20,700
of hours after Hubble takes it the

1044
00:45:23,870 --> 00:45:22,260
images come down and we can look at them

1045
00:45:25,970 --> 00:45:23,880
and we can inspect them very quickly and

1046
00:45:27,680 --> 00:45:25,980
have a really quick turnaround so I can

1047
00:45:29,180 --> 00:45:27,690
in fact share with you all if I can

1048
00:45:31,849 --> 00:45:29,190
figure out how to do the screen sharing

1049
00:45:33,829 --> 00:45:31,859
yeah all right yeah it's the latest data

1050
00:45:36,079 --> 00:45:33,839
that came in last night let me see this

1051
00:45:38,240 --> 00:45:36,089
it's a green arrow that arrow and the

1052
00:45:39,620 --> 00:45:38,250
green screen there and you see that yeah

1053
00:45:41,299 --> 00:45:39,630
it comes up and then there's a button

1054
00:45:43,190 --> 00:45:41,309
that says Start screen share but it's

1055
00:45:55,069 --> 00:45:43,200
grey for me I can't click it so I don't

1056
00:45:57,890 --> 00:45:55,079
know Oh cute okay I've seen that so I'm

1057
00:46:00,440 --> 00:45:57,900
gonna screen share this window and this

1058
00:46:04,430 --> 00:46:00,450
is the most recent observations that

1059
00:46:06,620 --> 00:46:04,440
came in nice oh wow bring that up so

1060
00:46:09,470 --> 00:46:06,630
that came in over night kind of

1061
00:46:11,960 --> 00:46:09,480
yesterday evening and Hubble just took

1062
00:46:15,500 --> 00:46:11,970
that basically not even a day ago kind

1063
00:46:17,390 --> 00:46:15,510

of within 12 hours ago maybe and this is

1064
00:46:21,589 --> 00:46:17,400
the images pretty much as we see them

1065
00:46:24,200 --> 00:46:21,599
coming in from the telescope or they are

1066
00:46:26,750 --> 00:46:24,210
the same filter they all the same filter

1067
00:46:29,480 --> 00:46:26,760
are so these are different exposures so

1068
00:46:30,470 --> 00:46:29,490
each each orbit basically we take four

1069
00:46:33,109 --> 00:46:30,480
exposures in the

1070
00:46:34,640 --> 00:46:33,119
given filter and the difference between

1071
00:46:37,070 --> 00:46:34,650
the ones on the left and ones on the

1072
00:46:39,349 --> 00:46:37,080
right in this case we apply a special

1073
00:46:41,510 --> 00:46:39,359
background scar subtraction these are

1074
00:46:43,900 --> 00:46:41,520
really quality checks ideally they

1075
00:46:46,190 --> 00:46:43,910
should look the same and luckily they do

1076
00:46:47,359 --> 00:46:46,200
look different than any way then there's

1077
00:46:48,910 --> 00:46:47,369
been too something wrong with it well

1078
00:46:50,450 --> 00:46:48,920
what about what about Lou and his

1079
00:46:51,320 --> 00:46:50,460
subtractions what would you be

1080
00:46:53,900 --> 00:46:51,330
subtracting Lou

1081
00:46:56,660 --> 00:46:53,910
you'd be doing another another O'War bit

1082
00:46:58,640 --> 00:46:56,670
later or what that's correct so we would

1083
00:47:00,800 --> 00:46:58,650
be looking at let's say the very first

1084
00:47:04,450 --> 00:47:00,810
visit relative to this in this visit

1085
00:47:07,400 --> 00:47:04,460
okay yeah and so what Lou would be doing

1086
00:47:09,890 --> 00:47:07,410
would be when you subtract these images

1087
00:47:11,660 --> 00:47:09,900
you'd see very little difference it'd be

1088
00:47:13,490 --> 00:47:11,670

maybe a few specks that are different

1089
00:47:17,240 --> 00:47:13,500
and some of them would be bad big sores

1090
00:47:18,859 --> 00:47:17,250
or things are change in the detector in

1091
00:47:21,380 --> 00:47:18,869
just a very small fraction of those

1092
00:47:24,109 --> 00:47:21,390
would actually be the supernovae this is

1093
00:47:26,330 --> 00:47:24,119
exactly the kind of thing that we can

1094
00:47:28,460 --> 00:47:26,340
sort of look at when we do these checks

1095
00:47:34,480 --> 00:47:28,470
I'm how to turn off the screen show this

1096
00:47:39,650 --> 00:47:37,099
interject a comment I think antenna is

1097
00:47:41,380 --> 00:47:39,660
kind of underselling calibration yeah I

1098
00:47:44,480 --> 00:47:41,390
think so too

1099
00:47:47,599 --> 00:47:44,490
and I've watched Anton as you know

1100
00:47:51,020 --> 00:47:47,609
outreach observer with the rest of the

1101
00:47:53,630 --> 00:47:51,030
team poring over these observations and

1102
00:47:55,310 --> 00:47:53,640
picking over every little nuance and so

1103
00:47:56,990 --> 00:47:55,320
calibration pipeline maybe you can talk

1104
00:47:59,960 --> 00:47:57,000
a little bit about what a calibration

1105
00:48:04,310 --> 00:47:59,970
pipeline is because it's not like taking

1106
00:48:06,650 --> 00:48:04,320
a cell phone picture yeah let's say a

1107
00:48:08,420 --> 00:48:06,660
few words about it these pictures you

1108
00:48:10,130 --> 00:48:08,430
see they've actually been through

1109
00:48:12,620 --> 00:48:10,140
calibration already so they look a

1110
00:48:14,510 --> 00:48:12,630
little bit prettier than the actual raw

1111
00:48:16,310 --> 00:48:14,520
images we get from the telescope which

1112
00:48:20,690 --> 00:48:16,320
look real nasty by the way folks they do

1113
00:48:22,370 --> 00:48:20,700

not they look pretty ugly because the

1114
00:48:24,830 --> 00:48:22,380
detectors are not perfect and so you get

1115
00:48:26,560 --> 00:48:24,840
all kinds of junk on them in fact you

1116
00:48:29,000 --> 00:48:26,570
can see yourself if you take a picture

1117
00:48:31,670 --> 00:48:29,010
some cell phones will do this on some

1118
00:48:32,960 --> 00:48:31,680
cameras to take like a long exposure at

1119
00:48:36,680 --> 00:48:32,970
night if you're taking a picture of

1120
00:48:38,599 --> 00:48:36,690
somebody in the evening yeah take maybe

1121
00:48:40,580 --> 00:48:38,609
a few seconds for the shadow to open and

1122
00:48:42,859 --> 00:48:40,590
close and when you look at their picture

1123
00:48:43,609 --> 00:48:42,869
you'll see the little bright spots all

1124
00:48:46,309 --> 00:48:43,619
over the image

1125
00:48:47,690 --> 00:48:46,319
and we deal with much the same thing we

1126
00:48:49,729 --> 00:48:47,700
deal with these little random bright

1127
00:48:51,680 --> 00:48:49,739
spots that mean different exposures and

1128
00:48:53,569 --> 00:48:51,690
so that's one aspect of the calibration

1129
00:48:55,519 --> 00:48:53,579
is making sure that the things in the

1130
00:48:57,680 --> 00:48:55,529
detector are actually removed before we

1131
00:48:59,539 --> 00:48:57,690
can make a clean image so yes if we

1132
00:49:01,549 --> 00:48:59,549
spend our time checking these images and

1133
00:49:03,829 --> 00:49:01,559
also running all the software pipelines

1134
00:49:05,329 --> 00:49:03,839
to clean them up and so what you see in

1135
00:49:08,180 --> 00:49:05,339
the end when we make these pretty color

1136
00:49:09,799 --> 00:49:08,190
pictures it's basically a version of

1137
00:49:11,569 --> 00:49:09,809
that for each different filter each

1138
00:49:13,099 --> 00:49:11,579

different color are you have to first

1139
00:49:14,930 --> 00:49:13,109
clean them up and stack them and make

1140
00:49:17,029 --> 00:49:14,940
them deeper and once you've done that

1141
00:49:19,009 --> 00:49:17,039
that takes a few weeks to do then we can

1142
00:49:21,410 --> 00:49:19,019
serve them out and let the rest of the

1143
00:49:34,729 --> 00:49:21,420
community use them but yeah that's what

1144
00:49:37,160 --> 00:49:34,739
keeps us busy and the cage of these go

1145
00:49:39,079 --> 00:49:37,170
across the field with Hubble and so we

1146
00:49:41,930 --> 00:49:39,089
see these bright streaks on the images

1147
00:49:44,209 --> 00:49:41,940
sometimes and folks like ray do a heroic

1148
00:49:45,559 --> 00:49:44,219
job of identifying these images and

1149
00:49:47,809 --> 00:49:45,569
actually masking them out because

1150
00:49:50,329 --> 00:49:47,819
otherwise the whole image would be criss

1151
00:49:52,999 --> 00:49:50,339
crossed by other satellites and you

1152
00:49:54,769 --> 00:49:53,009
wouldn't have to see like it's really

1153
00:49:57,289 --> 00:49:54,779
crowded up there now it's not like the

1154
00:49:59,630 --> 00:49:57,299
old days everybody's up there now yeah I

1155
00:50:01,190 --> 00:49:59,640
worry about that real estate and the l2

1156
00:50:04,609 --> 00:50:01,200
pointers are gonna get crowded too it

1157
00:50:05,959 --> 00:50:04,619
looks like it as well so ray I guess I

1158
00:50:08,299 --> 00:50:05,969
think you're back now I wanted to get

1159
00:50:10,099 --> 00:50:08,309
you just a few more thoughts I I want to

1160
00:50:11,390 --> 00:50:10,109
get to a lot of comments and stuff that

1161
00:50:12,499 --> 00:50:11,400
we have to but you didn't get you have

1162
00:50:14,450 --> 00:50:12,509
to finish your thought and I just wanted

1163
00:50:17,269 --> 00:50:14,460

to know if you had anything else you

1164
00:50:19,459 --> 00:50:17,279
would like to add well you were talking

1165
00:50:22,700 --> 00:50:19,469
about maybe in several different areas

1166
00:50:24,829 --> 00:50:22,710
you were talking about models and I

1167
00:50:28,729 --> 00:50:24,839
think one of the most fascinating things

1168
00:50:30,650 --> 00:50:28,739
to me and it's something that people try

1169
00:50:33,950 --> 00:50:30,660
to model but it depends on the accuracy

1170
00:50:36,979 --> 00:50:33,960
of what is known there and how how good

1171
00:50:40,400 --> 00:50:36,989
a quality it is people will sometimes

1172
00:50:42,950 --> 00:50:40,410
try to look at distant galaxies that are

1173
00:50:46,749 --> 00:50:42,960
lensed by the foreground clusters and

1174
00:50:52,819 --> 00:50:46,759
they'll try to essentially D project

1175
00:50:57,019 --> 00:50:52,829
those galaxies as observed into what

1176
00:50:59,319 --> 00:50:57,029
they really have in the way of shape

1177
00:51:01,909 --> 00:50:59,329
and I think that's a fascinating process

1178
00:51:04,039 --> 00:51:01,919
always I guess I'd obviously it depends

1179
00:51:05,120 --> 00:51:04,049
on how good your model is yes and

1180
00:51:08,719 --> 00:51:05,130
there's always a lot of room for

1181
00:51:12,140 --> 00:51:08,729
skepticism I imagine Lu's not gonna be

1182
00:51:13,939 --> 00:51:12,150
impressed probably but I do think it's

1183
00:51:15,769 --> 00:51:13,949
one of the most fascinating things about

1184
00:51:17,949 --> 00:51:15,779
this I've always been interested in

1185
00:51:20,419 --> 00:51:17,959
galaxies biologies in a lot of the

1186
00:51:23,870 --> 00:51:20,429
survey projects that I've been part of

1187
00:51:26,179 --> 00:51:23,880
and and so I think this is this is a

1188
00:51:29,989 --> 00:51:26,189

really fascinating aspect of it not only

1189
00:51:34,759 --> 00:51:29,999
the bringing and divisibility of the

1190
00:51:37,249 --> 00:51:34,769
most distant objects but also trying to

1191
00:51:40,309 --> 00:51:37,259
see where possible you know the the

1192
00:51:43,130 --> 00:51:40,319
structure of some more distant galaxies

1193
00:51:47,199 --> 00:51:43,140
of course the main point here I think is

1194
00:51:50,509 --> 00:51:47,209
is really finding those sort of you know

1195
00:51:54,409 --> 00:51:50,519
earliest galaxies if we can but but this

1196
00:51:56,479 --> 00:51:54,419
is just sort of a an interesting not

1197
00:51:58,880 --> 00:51:56,489
quite diversion but it's it's a separate

1198
00:52:01,399 --> 00:51:58,890
topic but fascinating

1199
00:52:03,380 --> 00:52:01,409
I don't know Scott can bring up the

1200
00:52:07,279 --> 00:52:03,390
image that I sent him earlier there's a

1201
00:52:09,709 --> 00:52:07,289
really good example of an object that's

1202
00:52:12,049 --> 00:52:09,719
that's not the most distant thing in the

1203
00:52:15,349 --> 00:52:12,059
universe but is extremely highly

1204
00:52:18,769 --> 00:52:15,359
magnified by our cluster max oh four one

1205
00:52:20,899 --> 00:52:18,779
six and actually there's just beautiful

1206
00:52:22,729 --> 00:52:20,909
things all over that image can we have

1207
00:52:29,449 --> 00:52:22,739
it up now yeah if you zoom in towards

1208
00:52:31,459 --> 00:52:29,459
the center let me even more yeah that's

1209
00:52:36,890 --> 00:52:31,469
right it's that kind of blue fuzzy thing

1210
00:52:39,949 --> 00:52:36,900
yeah look at all of them Wow yeah so so

1211
00:52:41,569 --> 00:52:39,959
the the reddish orangish galaxies are

1212
00:52:44,299 --> 00:52:41,579
the cluster galaxies those are the

1213
00:52:46,759 --> 00:52:44,309

things that are doing interesting and

1214
00:52:49,279 --> 00:52:46,769
the things that are those blue are key

1215
00:52:51,499 --> 00:52:49,289
things are the background galaxies which

1216
00:52:54,049 --> 00:52:51,509
are not you know those are probably not

1217
00:52:56,509 --> 00:52:54,059
the most distant things but but they're

1218
00:52:58,849 --> 00:52:56,519
really you know highly magnified and

1219
00:53:01,099 --> 00:52:58,859
then if you look you know close to that

1220
00:53:03,969 --> 00:53:01,109
bright central galaxy there's something

1221
00:53:07,759 --> 00:53:03,979
that's kind of fuzzy and blue and red

1222
00:53:10,260 --> 00:53:07,769
and that is a galaxy that's magnified by

1223
00:53:12,630 --> 00:53:10,270
like a factor of 20

1224
00:53:15,390 --> 00:53:12,640
so we're just seeing that object isn't

1225
00:53:17,820 --> 00:53:15,400
up Jupiter yeah it's not it's a it's a

1226
00:53:20,580 --> 00:53:17,830
galaxy that's just been magnified much

1227
00:53:21,900 --> 00:53:20,590
much much more than you could you know

1228
00:53:24,210 --> 00:53:21,910
it's at a much higher spatial resolution

1229
00:53:27,510 --> 00:53:24,220
than anything that Hubble would normally

1230
00:53:31,290 --> 00:53:27,520
see that's just a beautiful image this

1231
00:53:34,740 --> 00:53:31,300
is a great example of what also with the

1232
00:53:36,990 --> 00:53:34,750
wineglass demonstration and again also

1233
00:53:38,730 --> 00:53:37,000
there's the distortion aspect even

1234
00:53:42,060 --> 00:53:38,740
though something's highly magnified it

1235
00:53:43,650 --> 00:53:42,070
may be distorted quite a bit and that's

1236
00:53:46,920 --> 00:53:43,660
part of what I was talking about by D

1237
00:53:48,960 --> 00:53:46,930
projection of you know trying to apply

1238
00:53:51,150 --> 00:53:48,970

the distortion correction if you will

1239
00:53:53,580 --> 00:53:51,160
for the gravitational distortion

1240
00:53:55,320 --> 00:53:53,590
correction there there are also other

1241
00:53:57,240 --> 00:53:55,330
distortion corrections and the images

1242
00:54:00,060 --> 00:53:57,250
but that that we have to do but that's a

1243
00:54:06,360 --> 00:54:00,070
different matter so what's that bright I

1244
00:54:09,330 --> 00:54:06,370
am the red and blue points are stars the

1245
00:54:09,750 --> 00:54:09,340
little ring of green dots yeah look at

1246
00:54:14,760 --> 00:54:09,760
that

1247
00:54:17,220 --> 00:54:14,770
it's being imaged not only by the

1248
00:54:21,150 --> 00:54:17,230
cluster but by that red those smaller

1249
00:54:23,460 --> 00:54:21,160
red galaxies there you can scroll all

1250
00:54:26,670 --> 00:54:23,470
over this image and see examples like

1251
00:54:28,410 --> 00:54:26,680
that actually if you go the other way

1252
00:54:30,840 --> 00:54:28,420
towards the bottom there's some cool

1253
00:54:34,590 --> 00:54:30,850
things of is this available for people

1254
00:54:36,270 --> 00:54:34,600
or is this something that it's not but

1255
00:54:39,720 --> 00:54:36,280
we can make it of it we should put it on

1256
00:54:41,510 --> 00:54:39,730
our blog yeah so actually yeah right in

1257
00:54:44,700 --> 00:54:41,520
the corner there I don't know if you see

1258
00:54:48,420 --> 00:54:44,710
there's a there's a galaxy that's lensed

1259
00:54:51,000 --> 00:54:48,430
and it's being warped by that edge on

1260
00:54:52,920 --> 00:54:51,010
red galaxy there I mean it's just you

1261
00:54:56,940 --> 00:54:52,930
know I can look at how this is got a lot

1262
00:54:58,260 --> 00:54:56,950
look at all of them there's a lot so you

1263
00:55:00,420 --> 00:54:58,270

got to use do you have to use different

1264
00:55:02,930 --> 00:55:00,430
models for different galaxies or how do

1265
00:55:05,670 --> 00:55:02,940
you how do you do is it are the models

1266
00:55:08,280 --> 00:55:05,680
working only for certain clusters I mean

1267
00:55:10,230 --> 00:55:08,290
how do you apply the models maybe that's

1268
00:55:12,450 --> 00:55:10,240
a really hard question yeah I don't know

1269
00:55:13,620 --> 00:55:12,460
Dan can answer that one well the one

1270
00:55:15,930 --> 00:55:13,630
thing I wanted to point out I mean each

1271
00:55:18,150 --> 00:55:15,940
one of these lens galaxies that you see

1272
00:55:19,560 --> 00:55:18,160
there is another piece to them it's

1273
00:55:21,540 --> 00:55:19,570
another piece of the puzzle of where the

1274
00:55:23,760 --> 00:55:21,550
dark matter is and we see so many more

1275
00:55:27,330 --> 00:55:23,770
of these in these really deep images

1276
00:55:29,040 --> 00:55:27,340
we did before so the models of the

1277
00:55:29,840 --> 00:55:29,050
magnifications are just getting better

1278
00:55:32,730 --> 00:55:29,850
and better

1279
00:55:34,109 --> 00:55:32,740
did you say what cluster this was this

1280
00:55:39,090 --> 00:55:34,119
is Mac so for 16

1281
00:55:41,100 --> 00:55:39,100
very deep optical image of this so

1282
00:55:42,840 --> 00:55:41,110
actually any very distant galaxies are

1283
00:55:44,220 --> 00:55:42,850
not even visible because they're only

1284
00:55:45,480 --> 00:55:44,230
apparent in the infrared

1285
00:55:46,890 --> 00:55:45,490
that's right they'd show up in the

1286
00:55:50,550 --> 00:55:46,900
infrared okay I'll be getting the

1287
00:55:53,070 --> 00:55:50,560
infrared data in sort of August okay

1288
00:55:54,870 --> 00:55:53,080

great well guys we're gonna we're gonna

1289
00:55:57,330 --> 00:55:54,880
keep having more frontier fields

1290
00:55:59,670 --> 00:55:57,340
hangouts but I really want to get to

1291
00:56:02,550 --> 00:55:59,680
some some questions but before too much

1292
00:56:03,990 --> 00:56:02,560
time passes and and going along with the

1293
00:56:05,820 --> 00:56:04,000
different galaxies at different

1294
00:56:07,740 --> 00:56:05,830
distances kind of thing I have something

1295
00:56:10,380 --> 00:56:07,750
here from Adam synergy who says I think

1296
00:56:13,290 --> 00:56:10,390
the deepest image is so far have

1297
00:56:18,090 --> 00:56:13,300
revealed galaxies at around Z equals 7.8

1298
00:56:20,100 --> 00:56:18,100
so how deep can HST go now briefly say

1299
00:56:24,840 --> 00:56:20,110
us in as few words as possible what Z

1300
00:56:31,170 --> 00:56:24,850
means and then maybe I don't know mother

1301
00:56:33,240 --> 00:56:31,180
who's that - was Z is called is redshift

1302
00:56:35,460 --> 00:56:33,250
we talk about it as below and it's just

1303
00:56:36,990 --> 00:56:35,470
a number it's it's a number and in what

1304
00:56:39,780 --> 00:56:37,000
it describes is how much the universe

1305
00:56:42,690 --> 00:56:39,790
has stretched over the 13 billion year

1306
00:56:45,090 --> 00:56:42,700
history of our universe so if it's if

1307
00:56:48,210 --> 00:56:45,100
it's a Z of of 1 that means the universe

1308
00:56:49,980 --> 00:56:48,220
was half its size back then if the Z of

1309
00:56:51,450 --> 00:56:49,990
2 it means the universe was a third of

1310
00:56:53,609 --> 00:56:51,460
its size back can we see it and it's

1311
00:56:55,260 --> 00:56:53,619
been stretched by that factor and as the

1312
00:56:57,060 --> 00:56:55,270
universe has stretched have stretched

1313
00:56:59,010 --> 00:56:57,070

the light along with it and to redder

1314
00:57:01,650 --> 00:56:59,020
and redder wavelengths and if it's far

1315
00:57:02,849 --> 00:57:01,660
enough away you see the galaxies all the

1316
00:57:04,590 --> 00:57:02,859
way in the infrared and that's why we

1317
00:57:06,720 --> 00:57:04,600
need to look in the infrared to see the

1318
00:57:08,849 --> 00:57:06,730
most distant galaxies so the question

1319
00:57:13,109 --> 00:57:08,859
was that we we see galaxies out to

1320
00:57:15,960 --> 00:57:13,119
redshift of of 7.8 I think so there's

1321
00:57:18,540 --> 00:57:15,970
there's confirmed galaxies or you've

1322
00:57:20,099 --> 00:57:18,550
obtained a spectra and so you can tell

1323
00:57:23,490 --> 00:57:20,109
that the galaxy is definitely out too

1324
00:57:24,180 --> 00:57:23,500
much of 7.5 or 7.6 those have been

1325
00:57:26,310 --> 00:57:24,190
confirmed

1326
00:57:28,320 --> 00:57:26,320
then further out you have what are

1327
00:57:30,420 --> 00:57:28,330
candidates all the way up to the

1328
00:57:32,040 --> 00:57:30,430
redshift 11 and that was the one that I

1329
00:57:33,780 --> 00:57:32,050
was I was showing on my on my phone

1330
00:57:35,760 --> 00:57:33,790
earlier that's right damn we had a

1331
00:57:37,650 --> 00:57:35,770
hangout about that a while right

1332
00:57:41,190 --> 00:57:37,660
okay so Craig land

1333
00:57:45,329 --> 00:57:41,200
is saying poor doctor lots relegated to

1334
00:58:11,720 --> 00:57:45,339
the stsci dungeon venue how long does

1335
00:58:18,059 --> 00:58:16,020
okay so so here's one from Nava Vermeer

1336
00:58:22,829 --> 00:58:18,069
who goes is it possible that the first

1337
00:58:25,410 --> 00:58:22,839
AG ends black holes also suck in Dark

1338
00:58:27,000 --> 00:58:25,420

Matter that's a good question and we're

1339
00:58:29,400 --> 00:58:27,010
the seeds for the supermassive black

1340
00:58:34,170 --> 00:58:29,410
holes we observe today question well

1341
00:58:37,260 --> 00:58:34,180
that's a good one for Anton or Norman it

1342
00:58:40,740 --> 00:58:37,270
turns out black holes actually are dark

1343
00:58:43,230 --> 00:58:40,750
matter you know in a way one candidate

1344
00:58:46,559 --> 00:58:43,240
for dark matter at one point was lots of

1345
00:58:48,720 --> 00:58:46,569
small mini or micro black holes because

1346
00:58:50,430 --> 00:58:48,730
they dark you don't see them and they

1347
00:58:52,980 --> 00:58:50,440
can basically just act as gravitational

1348
00:58:55,200 --> 00:58:52,990
lenses I think that's now been largely

1349
00:58:57,660 --> 00:58:55,210
ruled out black holes are obviously not

1350
00:59:00,029 --> 00:58:57,670
a candidate for the Dark Matter we see

1351
00:59:03,140 --> 00:59:00,039
around galaxies it's more likely to be

1352
00:59:06,480 --> 00:59:03,150
very small particles but the black holes

1353
00:59:09,990 --> 00:59:06,490
certainly can still suck in anything

1354
00:59:13,890 --> 00:59:10,000
that that feels gravity and that has

1355
00:59:15,750 --> 00:59:13,900
math I think the main thing about the

1356
00:59:18,299 --> 00:59:15,760
black holes is even if they were to suck

1357
00:59:20,190 --> 00:59:18,309
in dark matter or we wouldn't actually

1358
00:59:23,670 --> 00:59:20,200
see it dark matter tends not to interact

1359
00:59:25,529 --> 00:59:23,680
with other with normal matter and so the

1360
00:59:28,529 --> 00:59:25,539
way we see black holes is when they suck

1361
00:59:32,069 --> 00:59:28,539
in normal gas like hydrogen and helium

1362
00:59:33,480 --> 00:59:32,079
and so forth that gas heats up and heats

1363
00:59:35,279 --> 00:59:33,490

up a lot actually heats up to about a

1364
00:59:37,529 --> 00:59:35,289
million degrees as it's being sucked in

1365
00:59:39,529 --> 00:59:37,539
by the black mold and so when there's

1366
00:59:41,880 --> 00:59:39,539
gas heats up it gives off a lot of

1367
00:59:44,190 --> 00:59:41,890
high-energy radiation gives off things

1368
00:59:46,470 --> 00:59:44,200
like x-rays and ultraviolet and so forth

1369
00:59:47,970 --> 00:59:46,480
just before it ever gets into the black

1370
00:59:49,920 --> 00:59:47,980
hole it forms a sort of a disk around

1371
00:59:51,240 --> 00:59:49,930
the black hole and gives off all this

1372
00:59:52,800 --> 00:59:51,250
x-rays and

1373
00:59:54,210 --> 00:59:52,810
what we see that's actually why we can

1374
00:59:56,280 --> 00:59:54,220
see black holes that we don't actually

1375
00:59:57,870 --> 00:59:56,290
see the black holes what we see is the

1376
00:59:59,760 --> 00:59:57,880
gas that's around them that's lighting

1377
01:00:02,580 --> 00:59:59,770
up and it's giving off all these x-rays

1378
01:00:04,470 --> 01:00:02,590
and it's an interesting question

1379
01:00:07,620 --> 01:00:04,480
these frontier fields classes are not

1380
01:00:09,660 --> 01:00:07,630
actually I would say the best place to

1381
01:00:12,390 --> 01:00:09,670
see early black holes because they tend

1382
01:00:14,400 --> 01:00:12,400
to be so rare and the frontier fields is

1383
01:00:16,890 --> 01:00:14,410
like a very narrow pencil beam looking

1384
01:00:18,810 --> 01:00:16,900
back into the early universe narrow or

1385
01:00:21,990 --> 01:00:18,820
even than the ultra deep field and the

1386
01:00:23,940 --> 01:00:22,000
other big surveys so if there are early

1387
01:00:25,350 --> 01:00:23,950
black holes but if we're very lucky we

1388
01:00:27,960 --> 01:00:25,360

might see them with the frontier field

1389
01:00:29,250 --> 01:00:27,970
but our better chance is to look at some

1390
01:00:31,890 --> 01:00:29,260
of the other big surveys we've been

1391
01:00:34,830 --> 01:00:31,900
doing like the cosmos survey and goods

1392
01:00:37,980 --> 01:00:34,840
and our candles because they spread out

1393
01:00:40,170 --> 01:00:37,990
more and so we tend to we tend to need a

1394
01:00:41,850 --> 01:00:40,180
big survey to find even just a few and

1395
01:00:43,830 --> 01:00:41,860
if Anton can I just can I just stop you

1396
01:00:46,410 --> 01:00:43,840
brief interruption here Jennifer

1397
01:00:47,760 --> 01:00:46,420
Jen Jen has to go she's got other

1398
01:00:50,880 --> 01:00:47,770
commitments I just wanted to break in

1399
01:00:56,730 --> 01:00:50,890
real fast as a janitor for being here

1400
01:01:02,610 --> 01:00:56,740
and your legacy she has to do so you may

1401
01:01:04,200 --> 01:01:02,620
thank you for attending and we're back

1402
01:01:06,330 --> 01:01:04,210
we're gonna be back for more updates on

1403
01:01:08,700 --> 01:01:06,340
this okay right you'll join us again

1404
01:01:10,350 --> 01:01:08,710
great yep sounds good

1405
01:01:14,130 --> 01:01:10,360
all right thank you Thank You Jan bye

1406
01:01:21,420 --> 01:01:14,140
bye okay Anton I'm sorry I'm done I have

1407
01:01:22,770 --> 01:01:21,430
to go alright so I guess yeah I guess so

1408
01:01:24,240 --> 01:01:22,780
I guess we are at the end of our time

1409
01:01:26,490 --> 01:01:24,250
when we should we should just probably

1410
01:01:28,140 --> 01:01:26,500
cut it here I'm afraid you have one

1411
01:01:32,010 --> 01:01:28,150
question that I really wanted answered

1412
01:01:34,110 --> 01:01:32,020
okay from YouTube and I cannot pronounce

1413
01:01:38,430 --> 01:01:34,120

his name so I'm just gonna share this up

1414
01:01:41,580 --> 01:01:38,440
on the window here there we go

1415
01:01:43,080 --> 01:01:41,590
is it purposes frontier fields is to

1416
01:01:45,210 --> 01:01:43,090
check whether the galaxies are

1417
01:01:48,270 --> 01:01:45,220
distributed and the ultra-deep field

1418
01:01:49,890 --> 01:01:48,280
around the sky is it better to just do

1419
01:01:53,160 --> 01:01:49,900
another ultra deep field at different

1420
01:01:56,660 --> 01:01:53,170
locations instead of deep fields around

1421
01:01:59,040 --> 01:01:56,670
new clusters or having it close to these

1422
01:02:01,860 --> 01:01:59,050
gravitational lens areas is that going

1423
01:02:05,470 --> 01:02:01,870
to affect the the deep fields that we

1424
01:02:09,950 --> 01:02:08,240
nobody we're doing both so we're doing

1425
01:02:12,140 --> 01:02:09,960
more of the deep fields and we're also

1426
01:02:13,910 --> 01:02:12,150
doing the lensing alongside of it so

1427
01:02:15,350 --> 01:02:13,920
we're observing even because right even

1428
01:02:17,120 --> 01:02:15,360
talked much about the parallel field

1429
01:02:22,310 --> 01:02:17,130
we're doing as well with these but

1430
01:02:23,990 --> 01:02:22,320
that's it is a tooth in there's a quick

1431
01:02:25,850 --> 01:02:24,000
answer to it that the parallel fields

1432
01:02:28,220 --> 01:02:25,860
are far enough away from the main

1433
01:02:30,770 --> 01:02:28,230
cluster that basically they are like

1434
01:02:32,630 --> 01:02:30,780
another ultra deep field there's a bit

1435
01:02:35,120 --> 01:02:32,640
of weak lensing so from the cluster but

1436
01:02:36,800 --> 01:02:35,130
not very much and so each parallel field

1437
01:02:39,380 --> 01:02:36,810
is basically like ultra deep field so

1438
01:02:41,060 --> 01:02:39,390

yes so we're basically getting six more

1439
01:02:42,620 --> 01:02:41,070
ultra deep field they're not quite as

1440
01:02:44,900 --> 01:02:42,630
deep as the original but they within

1441
01:02:46,430 --> 01:02:44,910
half a magnitude you know and in

1442
01:02:47,810 --> 01:02:46,440
addition we're getting this cluster so

1443
01:02:51,440 --> 01:02:47,820
we're getting a two-for-one basically

1444
01:02:53,900 --> 01:02:51,450
yeah official dynamo parlance what he's

1445
01:02:56,240 --> 01:02:53,910
talking about is cosmic variance and you

1446
01:02:57,590 --> 01:02:56,250
know that's exactly what we're doing by

1447
01:02:59,450 --> 01:02:57,600
getting all these different parallel

1448
01:03:02,300 --> 01:02:59,460
fields around different places in the

1449
01:03:05,330 --> 01:03:02,310
sky you know see how they're all normal

1450
01:03:06,890 --> 01:03:05,340
each one is compared to the rest that's

1451
01:03:16,790 --> 01:03:06,900
right only view your elephant through a

1452
01:03:19,300 --> 01:03:16,800
straw you kind of want to so what

1453
01:03:22,040 --> 01:03:19,310
they're talking about is imagine in the

1454
01:03:24,410 --> 01:03:22,050
field of view of the Hubble are two

1455
01:03:25,280 --> 01:03:24,420
cameras each looking in the same well

1456
01:03:27,740 --> 01:03:25,290
they're each looking in slightly

1457
01:03:28,970 --> 01:03:27,750
different areas of the image plane and

1458
01:03:32,240 --> 01:03:28,980
they're able to image at the exact same

1459
01:03:34,190 --> 01:03:32,250
time not only the cluster but the area

1460
01:03:35,390 --> 01:03:34,200
just adjacent to it in another camera

1461
01:03:37,940 --> 01:03:35,400
and as Jen was saying at the beginning

1462
01:03:41,030 --> 01:03:37,950
they come back to it and they rotate and

1463
01:03:42,230 --> 01:03:41,040

they use different cameras each time to

1464
01:03:45,320 --> 01:03:42,240
look at those things so that's what

1465
01:03:47,390 --> 01:03:45,330
that's the wavelength coverage yeah and

1466
01:03:49,700 --> 01:03:47,400
it's you think it's using the Hubble I

1467
01:03:51,680 --> 01:03:49,710
think in a pretty efficient way so guys

1468
01:03:55,250 --> 01:03:51,690
also as always it's great to talk

1469
01:03:57,440 --> 01:03:55,260
frontier fields Ultra Deep fields far

1470
01:03:58,850 --> 01:03:57,450
away things Dark Matter thank you so

1471
01:04:00,310 --> 01:03:58,860
much for joining us and giving us an

1472
01:04:04,040 --> 01:04:00,320
update you guys are doing great work

1473
01:04:06,020 --> 01:04:04,050
we're gonna look to get another oh well

1474
01:04:07,760 --> 01:04:06,030
can somebody come in just real fat Anton

1475
01:04:09,320 --> 01:04:07,770
I know you got to go so feel free if

1476
01:04:11,420 --> 01:04:09,330
you've got to go just you know go ahead

1477
01:04:14,900 --> 01:04:11,430
I just want to take a couple more

1478
01:04:16,760 --> 01:04:14,910
minutes and ask you know is there this

1479
01:04:18,080 --> 01:04:16,770
was scheduled for three years this

1480
01:04:22,220 --> 01:04:18,090
survey is it look like you

1481
01:04:24,620 --> 01:04:22,230
going to take that third year or not a

1482
01:04:27,530 --> 01:04:24,630
good question we've got a decision point

1483
01:04:29,750 --> 01:04:27,540
later this year actually about November

1484
01:04:31,370 --> 01:04:29,760
or so as to whether or not to do the

1485
01:04:33,790 --> 01:04:31,380
final two clusters we're certainly

1486
01:04:36,290 --> 01:04:33,800
committed to doing the first form and

1487
01:04:39,320 --> 01:04:36,300
why wouldn't lighter on this year yeah

1488
01:04:41,780 --> 01:04:39,330

why wouldn't we if Hubble keeps going if

1489
01:04:43,850 --> 01:04:41,790
the community supports it if it's

1490
01:04:46,010 --> 01:04:43,860
interesting science it coming out then

1491
01:04:47,810 --> 01:04:46,020
sure it's it's actually it provides a

1492
01:04:50,360 --> 01:04:47,820
good motivation to do the last two I

1493
01:04:52,970 --> 01:04:50,370
think basically want to have to see

1494
01:04:55,220 --> 01:04:52,980
people like Lou find supernovae or see

1495
01:04:58,520 --> 01:04:55,230
people like Dan find audit of galaxies

1496
01:05:00,350 --> 01:04:58,530
they keep doing that good stuff then

1497
01:05:02,510 --> 01:05:00,360
that provides a good incentive for us to

1498
01:05:03,680 --> 01:05:02,520
do the final two clusters and same for

1499
01:05:05,030 --> 01:05:03,690
the rest of the community - we're

1500
01:05:08,390 --> 01:05:05,040
throwing this wide open for the whole

1501
01:05:10,400 --> 01:05:08,400
community to to go and find things with

1502
01:05:12,710 --> 01:05:10,410
actually one thing it wasn't mentioned

1503
01:05:14,920 --> 01:05:12,720
we've got about almost what well over a

1504
01:05:17,060 --> 01:05:14,930
dozen almost approaching 20 different

1505
01:05:18,500 --> 01:05:17,070
scientific papers from different teams

1506
01:05:20,390 --> 01:05:18,510
in the community already that have been

1507
01:05:21,590 --> 01:05:20,400
submitted but are using the frontier

1508
01:05:22,910 --> 01:05:21,600
fuels to do different kinds of

1509
01:05:27,350 --> 01:05:22,920
discoveries so we're throwing it out

1510
01:05:29,690 --> 01:05:27,360
there is actually using using these data

1511
01:05:31,010 --> 01:05:29,700
so yeah I think if the community keeps

1512
01:05:33,350 --> 01:05:31,020
using it and keeps finding interesting

1513
01:05:36,050 --> 01:05:33,360

signs that would be a very strong case

1514
01:05:37,670 --> 01:05:36,060
for us to do the fun or two clusters yes

1515
01:05:39,110 --> 01:05:37,680
yeah so whilst I see you're being so

1516
01:05:40,820 --> 01:05:39,120
polite if you still got the community

1517
01:05:42,380 --> 01:05:40,830
support and everybody is you're still

1518
01:05:44,360 --> 01:05:42,390
getting good results everybody's you

1519
01:05:47,540 --> 01:05:44,370
know still thinks you should still be

1520
01:05:49,700 --> 01:05:47,550
doing it then you will I think it's not

1521
01:05:52,520 --> 01:05:49,710
just being polite I mean we really have

1522
01:05:54,770 --> 01:05:52,530
to you know undergo the assessment of

1523
01:05:58,420 --> 01:05:54,780
the community you have to prove that

1524
01:06:02,930 --> 01:06:00,590
want to comment that we've been talking

1525
01:06:05,180 --> 01:06:02,940
about the time allocation process which

1526
01:06:07,660 --> 01:06:05,190
is going on right now and each proposal

1527
01:06:10,430 --> 01:06:07,670
has maybe ten people that look at it

1528
01:06:13,550 --> 01:06:10,440
that's right your fields team has the

1529
01:06:16,220 --> 01:06:13,560
entire community looking at them right

1530
01:06:18,800 --> 01:06:16,230
so it's not just opinions and let me

1531
01:06:20,390 --> 01:06:18,810
tell you astronomers I know me if you

1532
01:06:22,700 --> 01:06:20,400
have ten astronomers in the room you

1533
01:06:24,560 --> 01:06:22,710
have a hundred ideas so you know

1534
01:06:28,970 --> 01:06:24,570
thousands of astronomers all looking at

1535
01:06:30,770 --> 01:06:28,980
the thousands of opinions of whether

1536
01:06:35,849 --> 01:06:30,780
this is worthwhile and so you try to get

1537
01:06:42,010 --> 01:06:39,220
it's a good thing because community is

1538
01:06:43,569 --> 01:06:42,020

behind the project which means that they

1539
01:06:45,819 --> 01:06:43,579
understand they have a vested interest

1540
01:06:47,829 --> 01:06:45,829
in it so there's there's a good flip

1541
01:06:50,109 --> 01:06:47,839
side it's right one thing that I would

1542
01:06:52,420 --> 01:06:50,119
add is that at least at the onset of the

1543
01:06:54,130 --> 01:06:52,430
project we were hoping that citizen

1544
01:06:55,480 --> 01:06:54,140
science might be an aspect of this and

1545
01:06:57,640 --> 01:06:55,490
we haven't really been exploiting that

1546
01:06:59,020 --> 01:06:57,650
too much but when we say community we're

1547
01:07:01,120 --> 01:06:59,030
thinking of not just astronomers from

1548
01:07:03,310 --> 01:07:01,130
the of the public as well helping out

1549
01:07:05,650 --> 01:07:03,320
with the effort we will that's in that's

1550
01:07:08,020 --> 01:07:05,660
in progress as you as you complete the

1551
01:07:08,920 --> 01:07:08,030
observations on the first - yeah he

1552
01:07:10,420 --> 01:07:08,930
brings up a good point

1553
01:07:11,890 --> 01:07:10,430
all of these data are available on the

1554
01:07:14,349 --> 01:07:11,900
archive you could just log in and get

1555
01:07:17,470 --> 01:07:14,359
them yourselves and and Carol and I will

1556
01:07:19,630 --> 01:07:17,480
be talking a lot more about the time

1557
01:07:20,980 --> 01:07:19,640
allocation process of Hubble and not

1558
01:07:24,550 --> 01:07:20,990
next week's hangout but the one after

1559
01:07:27,460 --> 01:07:24,560
and the or no maybe it's two Hangouts

1560
01:07:30,160 --> 01:07:27,470
from now and then there's the the issue

1561
01:07:32,859 --> 01:07:30,170
of other collaborators for frontier

1562
01:07:35,260 --> 01:07:32,869
fields Carol I want to organize another

1563
01:07:36,640 --> 01:07:35,270

hangout to discuss with them some of the

1564
01:07:39,040 --> 01:07:36,650
ways in which they're using frontier

1565
01:07:41,890 --> 01:07:39,050
fields data so that's all coming down

1566
01:07:44,200 --> 01:07:41,900
the pipeline so stay tuned guys thank

1567
01:07:46,089 --> 01:07:44,210
you all for joining us and Ray it was

1568
01:07:48,190 --> 01:07:46,099
great to have you thank you Norman

1569
01:07:50,200 --> 01:07:48,200
Anton as always it's great to have you

1570
01:07:51,910 --> 01:07:50,210
and Dan your rock star thank you I

1571
01:07:53,950 --> 01:07:51,920
thought of dark matter questions for you

1572
01:07:55,900 --> 01:07:53,960
at some point we should get another

1573
01:07:57,400 --> 01:07:55,910
hangout with you because I want about

1574
01:07:58,809 --> 01:07:57,410
some other things I've learned and we'll

1575
01:08:00,819 --> 01:07:58,819
talk more about the results coming out

1576
01:08:02,770 --> 01:08:00,829
of this program it's exactly absolutely

1577
01:08:04,440 --> 01:08:02,780
we got a lot more hangouts got a lot

1578
01:08:07,660 --> 01:08:04,450
more to learn from frontier fields so

1579
01:08:09,339 --> 01:08:07,670
and Carol Scott thank you as always for

1580
01:08:10,680 --> 01:08:09,349
for helping me and for doing this with

1581
01:08:13,240 --> 01:08:10,690
me it's so much fun to have you here

1582
01:08:15,730 --> 01:08:13,250
absolutely I wanted to add also the

1583
01:08:18,370 --> 01:08:15,740
Thayer life there are a lot of other

1584
01:08:20,470 --> 01:08:18,380
people also involved and then the

1585
01:08:22,450 --> 01:08:20,480
relatively few numbers that you've seen

1586
01:08:24,340 --> 01:08:22,460
here there are a lot of people doing

1587
01:08:25,959 --> 01:08:24,350
this as well that's right there's a

1588
01:08:27,340 --> 01:08:25,969

collaboration and we're gonna we're

1589
01:08:28,840 --> 01:08:27,350
gonna keep trying but we're gonna keep

1590
01:08:30,430 --> 01:08:28,850
coming back and giving you more of a

1591
01:08:32,559 --> 01:08:30,440
sense of different aspects of this

1592
01:08:34,180 --> 01:08:32,569
program as well so this is our third

1593
01:08:35,709 --> 01:08:34,190
frontier fields hangout we certainly

1594
01:08:38,170 --> 01:08:35,719
won't be our last so you'll learn a lot

1595
01:08:39,760 --> 01:08:38,180
more about the different parts of it so

1596
01:08:41,800 --> 01:08:39,770
guys I hope you like this hub we'll hang

1597
01:08:44,620 --> 01:08:41,810
out the next one we're having next week

1598
01:08:45,490 --> 01:08:44,630
speaking of ultra-deep fields they've

1599
01:08:47,620 --> 01:08:45,500
added to it

1600
01:08:50,950 --> 01:08:47,630
they've added another wavelength to the

1601
01:08:52,630 --> 01:08:50,960
ultra-deep field of the UV ultraviolet

1602
01:08:55,180 --> 01:08:52,640
so we're going to talk with the people

1603
01:08:57,670 --> 01:08:55,190
who made that image and discuss more

1604
01:08:59,380 --> 01:08:57,680
things very very far away and when you

1605
01:09:04,269 --> 01:08:59,390
stare at nothing what do you see with

1606
01:09:04,900 --> 01:09:04,279
the Hubble answer is quite a bit all

1607
01:09:06,820 --> 01:09:04,910
right folks

1608
01:09:08,260 --> 01:09:06,830
on behalf of Christian and Scott loads I