

HUBBLE
25



HUBBLE

hangouts

Hubble Discovers Vibrant Star Formation in the
Heart of a Distant Galaxy Cluster

Thursday Sept 10, 2015 3pm EDT

1
00:00:09,580 --> 00:00:07,720
hello everybody and welcome to this

2
00:00:11,169 --> 00:00:09,590
week's Hubble hang out my name is Tony

3
00:00:13,690 --> 00:00:11,179
Darnell and I work at the Space

4
00:00:15,400 --> 00:00:13,700
Telescope Science Institute it makes me

5
00:00:17,080 --> 00:00:15,410
very happy to welcome you all back to

6
00:00:19,750 --> 00:00:17,090
our Hubble hangouts here because you

7
00:00:22,330 --> 00:00:19,760
guys have been feeling giving us all

8
00:00:23,980 --> 00:00:22,340
kinds of great feedback and just it's

9
00:00:25,359 --> 00:00:23,990
just been amazing that we were just

10
00:00:27,339 --> 00:00:25,369
talking before the Hangout this is we've

11
00:00:29,170 --> 00:00:27,349
been doing this for two years now so

12
00:00:30,279 --> 00:00:29,180
every week we try to bring you new

13
00:00:33,459 --> 00:00:30,289

science from the Hubble Space Telescope

14

00:00:35,740 --> 00:00:33,469

and we are here today with yet another

15

00:00:37,720 --> 00:00:35,750

example of that this week astronomers

16

00:00:40,170 --> 00:00:37,730

using both the Spitzer Space Telescope

17

00:00:43,180 --> 00:00:40,180

and the Hubble Space Telescope have I

18

00:00:45,040 --> 00:00:43,190

have been looking at your galaxy

19

00:00:47,740 --> 00:00:45,050

clusters and they have found something

20

00:00:49,090 --> 00:00:47,750

interesting in there that ordinarily

21

00:00:52,389 --> 00:00:49,100

they do not find I'm not going to give

22

00:00:55,389 --> 00:00:52,399

it away yet because the I have the

23

00:00:57,670 --> 00:00:55,399

astronomers tell you all about it so now

24

00:00:59,500 --> 00:00:57,680

this is ordinarily the time when I start

25

00:01:01,119 --> 00:00:59,510

giving out announcements and stuff but I

26

00:01:03,729 --> 00:01:01,129

don't have any so because I don't think

27

00:01:05,350 --> 00:01:03,739

anything yeah all that interesting was

28

00:01:08,320 --> 00:01:05,360

going on so i'm not going to pass it on

29

00:01:11,380 --> 00:01:08,330

to you guys but i would like to invite

30

00:01:13,120 --> 00:01:11,390

you guys to leave questions and comments

31

00:01:14,830 --> 00:01:13,130

throughout the throughout the hangout

32

00:01:15,850 --> 00:01:14,840

and we will read them throughout and i'm

33

00:01:17,200 --> 00:01:15,860

going to have scott tell you about that

34

00:01:20,800 --> 00:01:17,210

in just a minute but first i have to

35

00:01:23,950 --> 00:01:20,810

introduce my partners in crime dr. carol

36

00:01:25,990 --> 00:01:23,960

christian who joins the HST project

37

00:01:29,050 --> 00:01:26,000

outreach scientist hi Carol also don't

38

00:01:33,819 --> 00:01:29,060

know also joining me is almost a doctor

39

00:01:37,060 --> 00:01:33,829

dr. Scott Lewis no notice Scott Lewis

40

00:01:38,380 --> 00:01:37,070

from the from another cosmos calm and

41

00:01:40,030 --> 00:01:38,390

play great many other places around the

42

00:01:41,740 --> 00:01:40,040

internet he's driving the drive the

43

00:01:43,719 --> 00:01:41,750

internet force during these hangouts and

44

00:01:45,219 --> 00:01:43,729

why don't you tell everybody's got how

45

00:01:47,440 --> 00:01:45,229

they can interact with us yeah

46

00:01:49,240 --> 00:01:47,450

absolutely so the best and easiest way

47

00:01:51,130 --> 00:01:49,250

for you to interact with us is using the

48

00:01:52,539 --> 00:01:51,140

Q&A app so what we're live right now

49

00:01:54,340 --> 00:01:52,549

you'll see on the bottom left of your

50

00:01:56,440 --> 00:01:54,350

screen some yellow text saying that we

51
00:01:58,510 --> 00:01:56,450
are answering questions I've got it

52
00:02:00,880 --> 00:01:58,520
loaded up Tony's got it loaded up if you

53
00:02:03,010 --> 00:02:00,890
have any questions for us and our guests

54
00:02:06,010 --> 00:02:03,020
or even some comments about that you can

55
00:02:07,420 --> 00:02:06,020
ask that in there and you can even +1

56
00:02:09,100 --> 00:02:07,430
you can bump them up so if there's a

57
00:02:10,630 --> 00:02:09,110
question out there that that you like

58
00:02:12,490 --> 00:02:10,640
and you want to have answer you can go

59
00:02:14,380 --> 00:02:12,500
ahead and recommend that and we can

60
00:02:16,000 --> 00:02:14,390
select it when it's live and let

61
00:02:18,400 --> 00:02:16,010
people know that we are answering that

62
00:02:20,320 --> 00:02:18,410
question is going on you can also

63
00:02:22,300 --> 00:02:20,330

comment on youtube and also on google

64

00:02:24,309 --> 00:02:22,310

plus we have a facebook event for this

65

00:02:26,410 --> 00:02:24,319

as well and the other great way for

66

00:02:27,820 --> 00:02:26,420

interacting up with us is over on

67

00:02:29,860 --> 00:02:27,830

twitter so as you see my lower third

68

00:02:32,830 --> 00:02:29,870

here we have the hubble hang out hashtag

69

00:02:34,360 --> 00:02:32,840

so I've got Twitter up right now over in

70

00:02:36,940 --> 00:02:34,370

tweetdeck and we'll be answering

71

00:02:39,670 --> 00:02:36,950

questions and I'll be live tweeting as

72

00:02:42,790 --> 00:02:39,680

we're going on so just either at mention

73

00:02:44,949 --> 00:02:42,800

Hubble telescope or use the hashtag

74

00:02:47,050 --> 00:02:44,959

Hubble hang out and we will get your

75

00:02:50,080 --> 00:02:47,060

questions and reply to them during the

76
00:02:52,810 --> 00:02:50,090
show and would also i want to remind you

77
00:02:54,370 --> 00:02:52,820
guys that you know it happens about it

78
00:02:56,259 --> 00:02:54,380
starting to happen more often now people

79
00:02:58,240 --> 00:02:56,269
are telling me that they can't find the

80
00:03:00,699 --> 00:02:58,250
Hangout and the best way to find it is

81
00:03:03,190 --> 00:03:00,709
to subscribe to us on hubble site

82
00:03:04,690 --> 00:03:03,200
channel on youtube and that will alert

83
00:03:06,490 --> 00:03:04,700
you when the ones are coming out live

84
00:03:08,290 --> 00:03:06,500
but you guys should know by now every

85
00:03:10,780 --> 00:03:08,300
thursday at three o'clock eastern

86
00:03:12,729 --> 00:03:10,790
daylight time we are here doing Hubble

87
00:03:13,960 --> 00:03:12,739
hangouts and so you should always check

88
00:03:15,729 --> 00:03:13,970

out the channel there you could also

89

00:03:17,500 --> 00:03:15,739

follow us like Scout said on ADD Hubble

90

00:03:19,330 --> 00:03:17,510

telescopes those are the two easiest

91

00:03:21,220 --> 00:03:19,340

ways to find out about these hangouts

92

00:03:22,990 --> 00:03:21,230

and you know you want to find them

93

00:03:25,509 --> 00:03:23,000

because they're becoming world famous I

94

00:03:28,650 --> 00:03:25,519

was looking at the demographics the

95

00:03:31,000 --> 00:03:28,660

other day Hubble huggers huh blurs

96

00:03:33,699 --> 00:03:31,010

Hubble Alex whatever you want to call

97

00:03:35,830 --> 00:03:33,709

yourselves oh if you guys are all over

98

00:03:37,270 --> 00:03:35,840

the world watching these hangouts and I

99

00:03:38,830 --> 00:03:37,280

think I know why we were talking about

100

00:03:40,960 --> 00:03:38,840

this also before the Hangout you know

101
00:03:44,050 --> 00:03:40,970
why because where else in the entire

102
00:03:47,110 --> 00:03:44,060
internet are you going to learn what the

103
00:03:51,220 --> 00:03:47,120
mass of a blue giant star is in units of

104
00:03:54,039 --> 00:03:51,230
cow Wow trailer or the energy of a crazy

105
00:03:57,009 --> 00:03:54,049
idea of the energy of a quasar in units

106
00:03:58,660 --> 00:03:57,019
of ant push-ups these are the kinds of

107
00:04:01,720 --> 00:03:58,670
things folks we made us tautomers do in

108
00:04:03,009 --> 00:04:01,730
the past where i get it entire internet

109
00:04:06,750 --> 00:04:03,019
are you going to find something like

110
00:04:13,150 --> 00:04:06,760
that going our guests have just left yes

111
00:04:16,630 --> 00:04:13,160
we we make you guys earn your degrees

112
00:04:18,880 --> 00:04:16,640
right as I i yes it's great to everybody

113
00:04:20,560 --> 00:04:18,890

else and just I just want to comment I

114

00:04:23,860 --> 00:04:20,570

don't know why people can't find helpful

115

00:04:26,120 --> 00:04:23,870

hangouts it's called google I know I'm

116

00:04:30,310 --> 00:04:26,130

Hubble hang out

117

00:04:33,110 --> 00:04:30,320

like five links youtube to our website

118

00:04:34,400 --> 00:04:33,120

chopping so looks great by the still

119

00:04:36,980 --> 00:04:34,410

nevertheless people say they search for

120

00:04:41,690 --> 00:04:36,990

can't find it so I'm trying to help them

121

00:04:42,890 --> 00:04:41,700

in any way I can put your diet yeah you

122

00:04:45,110 --> 00:04:42,900

know what I'm going to do in the next

123

00:04:47,420 --> 00:04:45,120

and the next uh exoplanet hang out i'm

124

00:04:50,720 --> 00:04:47,430

going to ask the guest to tell me how

125

00:04:52,520 --> 00:04:50,730

many chewed up pieces of gum with it

126

00:04:53,900 --> 00:04:52,530

would fit in a Neptune size exoplanet

127

00:04:55,910 --> 00:04:53,910

that's what I want to know next so stay

128

00:04:59,770 --> 00:04:55,920

tuned folks will find all that out this

129

00:05:04,100 --> 00:04:59,780

week yeah that might be an estimate

130

00:05:05,660 --> 00:05:04,110

black people so this week we have a very

131

00:05:07,100 --> 00:05:05,670

interesting hang out in store for you

132

00:05:08,420 --> 00:05:07,110

and if I haven't scared away my guess

133

00:05:11,480 --> 00:05:08,430

although I feels like i have almost

134

00:05:12,590 --> 00:05:11,490

scared away one of them already I don't

135

00:05:14,780 --> 00:05:12,600

worry we're not going to make you do any

136

00:05:18,110 --> 00:05:14,790

weird calculations this week unless I

137

00:05:19,640 --> 00:05:18,120

will I'll making you on it okay I was

138

00:05:22,880 --> 00:05:19,650

gonna be nice but you know Scott's I've

139

00:05:25,220 --> 00:05:22,890

never known as well as I mentioned at

140

00:05:27,740 --> 00:05:25,230

the top of the hangout astronomers using

141

00:05:29,570 --> 00:05:27,750

both the Spitzer Space Telescope and

142

00:05:31,600 --> 00:05:29,580

Hubble and I guess the Canada France

143

00:05:35,990 --> 00:05:31,610

Hawaii telescope which is on the ground

144

00:05:37,580 --> 00:05:36,000

in Hawaii we're looking at this galaxy

145

00:05:39,290 --> 00:05:37,590

cluster and they found something they

146

00:05:41,630 --> 00:05:39,300

looked at something they found things

147

00:05:43,160 --> 00:05:41,640

that's surprising I'm gonna let you I'm

148

00:05:44,600 --> 00:05:43,170

gonna let them describe what that is but

149

00:05:47,660 --> 00:05:44,610

before i do i've got introduced and with

150

00:05:49,730 --> 00:05:47,670

me is dr. tracy web she is from mcgill

151
00:05:52,040 --> 00:05:49,740
university astronomer in montreal height

152
00:05:54,350 --> 00:05:52,050
weight tracy and welcome thank you very

153
00:05:55,670 --> 00:05:54,360
much also joining me as dr. allison

154
00:05:58,400 --> 00:05:55,680
noble she is from the university of

155
00:05:59,720 --> 00:05:58,410
toronto and adam buzzing from cambridge

156
00:06:02,660 --> 00:05:59,730
welcome to both of you guys it's good to

157
00:06:05,600 --> 00:06:02,670
have you on our hangout thank you hello

158
00:06:07,250 --> 00:06:05,610
okay so let's get started by the way we

159
00:06:11,890 --> 00:06:07,260
really appreciate them being here

160
00:06:14,930 --> 00:06:11,900
visiting us from Italy oh really

161
00:06:17,600 --> 00:06:14,940
conference and Italy oh you're you're in

162
00:06:19,760 --> 00:06:17,610
Italy right now yeah oh yes we had to

163
00:06:23,420 --> 00:06:19,770

clear a very business network yeah we

164

00:06:26,030 --> 00:06:23,430

could be having a glass of wine you

165

00:06:27,880 --> 00:06:26,040

don't know i knows he didn't stop you

166

00:06:30,020 --> 00:06:27,890

from having a glass of wine that's right

167

00:06:31,730 --> 00:06:30,030

in fact we're gonna probably come up

168

00:06:33,680 --> 00:06:31,740

with a word for a drinking game soon so

169

00:06:34,909 --> 00:06:33,690

you might want to you might want to stay

170

00:06:39,520 --> 00:06:34,919

it would not be a first time you've had

171

00:06:41,630 --> 00:06:39,530

a drinking game drinking espresso shots

172

00:06:47,480 --> 00:06:41,640

which is the last thing any of us need

173

00:06:49,250 --> 00:06:47,490

right now ok so today we put out on on

174

00:06:51,170 --> 00:06:49,260

Hubble side and as well as went out into

175

00:06:53,570 --> 00:06:51,180

the internets in general a press release

176
00:06:55,430 --> 00:06:53,580
that was announcing some of these

177
00:06:56,780 --> 00:06:55,440
findings some of these observations so

178
00:06:58,940 --> 00:06:56,790
Tracy I think I'd like to start with you

179
00:07:00,680 --> 00:06:58,950
but I also want to we always wait too

180
00:07:03,700 --> 00:07:00,690
long to put up images so Scott if you'd

181
00:07:06,110 --> 00:07:03,710
go ahead and put up this image this is a

182
00:07:07,490 --> 00:07:06,120
galaxy cluster and Tracy can you

183
00:07:11,270 --> 00:07:07,500
describe a little bit what we're looking

184
00:07:15,710 --> 00:07:11,280
at here yeah so what you're seeing is I

185
00:07:18,350 --> 00:07:15,720
guess a side-by-side image the obviously

186
00:07:20,480 --> 00:07:18,360
but i'll just make it clear that the

187
00:07:22,550 --> 00:07:20,490
image on the right hand side is a zoom

188
00:07:26,780 --> 00:07:22,560

in of the image on the left hand side

189

00:07:30,530 --> 00:07:26,790

and the image on the left hand side is a

190

00:07:32,770 --> 00:07:30,540

close-up of this galaxy cluster that

191

00:07:36,590 --> 00:07:32,780

myself and my collaborators discovered

192

00:07:38,360 --> 00:07:36,600

you can see a lot of the wall we can

193

00:07:40,330 --> 00:07:38,370

explain what a galaxy cluster is in a

194

00:07:43,640 --> 00:07:40,340

minute but it's essentially a

195

00:07:47,120 --> 00:07:43,650

conglomeration of many many galaxies

196

00:07:50,330 --> 00:07:47,130

held together in in space by their own

197

00:07:52,970 --> 00:07:50,340

pullet mutual gravity you can see we can

198

00:07:54,920 --> 00:07:52,980

see a lot of the clusters there the

199

00:07:59,330 --> 00:07:54,930

cluster member sorry shown as kind of

200

00:08:02,510 --> 00:07:59,340

red galaxies now but the thing that we

201
00:08:05,330 --> 00:08:02,520
were really surprised to see is that

202
00:08:08,810 --> 00:08:05,340
funny J shaped object that seems to run

203
00:08:10,820 --> 00:08:08,820
in between two of those kind of red

204
00:08:13,100 --> 00:08:10,830
galaxies which is highlighted on the

205
00:08:14,240 --> 00:08:13,110
right hand side ok I want to let's get

206
00:08:15,860 --> 00:08:14,250
to that in just a minute but let's go

207
00:08:17,150 --> 00:08:15,870
back to what let's just let's take a

208
00:08:18,470 --> 00:08:17,160
step back and you were already on the

209
00:08:20,930 --> 00:08:18,480
right track by describing what these

210
00:08:23,600 --> 00:08:20,940
galaxies clusters are what is the name

211
00:08:27,260 --> 00:08:23,610
of this thing and has a name that I'm

212
00:08:31,700 --> 00:08:27,270
afraid to say it is called sparks 10 49

213
00:08:35,240 --> 00:08:31,710

plus 56 ok and it's called that for what

214

00:08:39,620 --> 00:08:35,250

reason it's called that because it was

215

00:08:41,810 --> 00:08:39,630

discovered as part of a search or a

216

00:08:43,640 --> 00:08:41,820

survey for galaxy clusters which is

217

00:08:46,270 --> 00:08:43,650

called sparks and Adam can tell you a

218

00:08:49,550 --> 00:08:46,280

lot about sparks because that's his baby

219

00:08:50,280 --> 00:08:49,560

sparks stands for the Spitzer adaptation

220

00:08:53,519 --> 00:08:50,290

of the

221

00:08:56,280 --> 00:08:53,529

sequence cluster survey i love i love

222

00:09:02,069 --> 00:08:56,290

acronyms like that is acronym within the

223

00:09:06,120 --> 00:09:02,079

name be kids right acronyms all the way

224

00:09:07,499 --> 00:09:06,130

down recursive acronym so yes sparks is

225

00:09:11,189 --> 00:09:07,509

the name of the survey that it was found

226

00:09:15,300 --> 00:09:11,199

with him and then 10 49 plus 56 is just

227

00:09:17,730 --> 00:09:15,310

a short handle for its coordinates

228

00:09:18,930 --> 00:09:17,740

celestial coordinates in the sky you

229

00:09:20,309 --> 00:09:18,940

guys say it that way when you're in like

230

00:09:22,769 --> 00:09:20,319

meetings and stuff to go you know that i

231

00:09:25,199 --> 00:09:22,779

was looking at sparks 10 49 plus 56 and

232

00:09:26,730 --> 00:09:25,209

i saw so for the longest time they were

233

00:09:28,620 --> 00:09:26,740

just calling it Tracy's cluster which I

234

00:09:34,800 --> 00:09:28,630

really liked oh that's really good

235

00:09:36,600 --> 00:09:34,810

Tracy's cluster yeah but we probably

236

00:09:41,160 --> 00:09:36,610

designed after the show make sure you

237

00:09:42,329 --> 00:09:41,170

okay in short we call it 10 49 okay well

238

00:09:43,860 --> 00:09:42,339

Tracy's con we're going to call it

239

00:09:46,680 --> 00:09:43,870

Tracy's cluster on this hangout now so

240

00:09:50,579 --> 00:09:46,690

Tracy's cluster it has according to the

241

00:09:53,189 --> 00:09:50,589

president has 27 galaxies in it and it's

242

00:09:55,920 --> 00:09:53,199

pretty massive how many how many sons

243

00:09:59,519 --> 00:09:55,930

would that be well so first of all it

244

00:10:01,259 --> 00:09:59,529

we've only confirmed 27 oh there may be

245

00:10:03,389 --> 00:10:01,269

more than there's probably lots more

246

00:10:05,430 --> 00:10:03,399

because it's it takes a long time on a

247

00:10:08,250 --> 00:10:05,440

telescope even just to get one member

248

00:10:10,800 --> 00:10:08,260

confirmed so we've confirmed 27 but

249

00:10:14,519 --> 00:10:10,810

there's probably lots more probably I'm

250

00:10:18,180 --> 00:10:14,529

sure you know many hundreds but in terms

251
00:10:24,809 --> 00:10:18,190
of the overall mass of the cluster we

252
00:10:27,720 --> 00:10:24,819
estimate it to be a few so in scientific

253
00:10:35,220 --> 00:10:27,730
speak a few times 10 to the 14 solar

254
00:10:38,460 --> 00:10:35,230
masses report into the 14 so 10 to the 9

255
00:10:41,879 --> 00:10:38,470
is a billion and this is 10 to the 14

256
00:10:44,699 --> 00:10:41,889
sons okay that includes you know all of

257
00:10:46,829 --> 00:10:44,709
the galaxies all of the gas and all of

258
00:10:49,679 --> 00:10:46,839
the dark matter so we are into the

259
00:10:51,740 --> 00:10:49,689
trillions and it is and these things are

260
00:10:54,090 --> 00:10:51,750
pretty far away then right that's right

261
00:10:56,160 --> 00:10:54,100
roughly according about 10 billion light

262
00:10:57,809 --> 00:10:56,170
years and for those of you who want to

263
00:11:00,120 --> 00:10:57,819

see it in the sky you have to look in

264

00:11:01,730 --> 00:11:00,130

the constellation of Ursa Major so

265

00:11:03,550 --> 00:11:01,740

that's sort of what we're talking about

266

00:11:05,200 --> 00:11:03,560

so

267

00:11:06,670 --> 00:11:05,210

Adam let me ask you about the spark what

268

00:11:09,100 --> 00:11:06,680

is the spark survey then was that

269

00:11:11,790 --> 00:11:09,110

something that is looking at the this

270

00:11:14,230 --> 00:11:11,800

the word survey tends to imply an entire

271

00:11:17,260 --> 00:11:14,240

looking at big areas of the sky is that

272

00:11:20,050 --> 00:11:17,270

what it's doing yeah actually so sparks

273

00:11:22,720 --> 00:11:20,060

used a combination of data from the

274

00:11:25,269 --> 00:11:22,730

Spitzer telescope and the Canada France

275

00:11:27,490 --> 00:11:25,279

Hawaii telescope and basically the way

276

00:11:29,769 --> 00:11:27,500

that what we did is we took pictures of

277

00:11:31,990 --> 00:11:29,779

the sky over a fairly large area from

278

00:11:34,120 --> 00:11:32,000

both of those telescopes and the idea is

279

00:11:36,640 --> 00:11:34,130

that if you want to find very distant

280

00:11:39,790 --> 00:11:36,650

galaxies clusters the galaxy's that you

281

00:11:41,740 --> 00:11:39,800

find in them tend to be very red and so

282

00:11:43,720 --> 00:11:41,750

you look for things that are sort of

283

00:11:46,150 --> 00:11:43,730

very red when you take pictures between

284

00:11:48,519 --> 00:11:46,160

Canada France and Spitzer and if you can

285

00:11:50,860 --> 00:11:48,529

find those and they're all so bright and

286

00:11:53,140 --> 00:11:50,870

in big clumps those tend to be galaxy

287

00:11:54,670 --> 00:11:53,150

clusters that are very very far away so

288

00:11:56,500 --> 00:11:54,680

the point of sparks was to find these

289

00:11:58,060 --> 00:11:56,510

kind of things very distant galaxy

290

00:12:01,090 --> 00:11:58,070

clusters you know amongst the most

291

00:12:02,769 --> 00:12:01,100

distant that we can possibly find okay

292

00:12:03,670 --> 00:12:02,779

and I want to I'm Tracy I want to come

293

00:12:05,680 --> 00:12:03,680

back to you in a minute about this

294

00:12:08,140 --> 00:12:05,690

getting these things confirmed members

295

00:12:09,550 --> 00:12:08,150

of the galaxy note 4 duelists Carol let

296

00:12:11,020 --> 00:12:09,560

me get you I'd like to get you to tell

297

00:12:12,820 --> 00:12:11,030

you said before we started you know a

298

00:12:15,430 --> 00:12:12,830

lot about the Canada France Hawaii

299

00:12:16,210 --> 00:12:15,440

telescope and Spitzer so why don't you

300

00:12:19,780 --> 00:12:16,220

tell us a little bit about these

301
00:12:22,060 --> 00:12:19,790
instruments what I like so this spitzer

302
00:12:25,000 --> 00:12:22,070
is a space telescope which is one of the

303
00:12:28,060 --> 00:12:25,010
great observatories like Hubble Chandra

304
00:12:31,870 --> 00:12:28,070
is the x-ray great observatory spitzer

305
00:12:33,250 --> 00:12:31,880
is roughly the infrared Hubble is the UV

306
00:12:35,410 --> 00:12:33,260
optical although it has a little

307
00:12:37,690 --> 00:12:35,420
infrared and then there was a gamma-ray

308
00:12:40,510 --> 00:12:37,700
observatory and those were called the

309
00:12:44,020 --> 00:12:40,520
Great observatories and the three a

310
00:12:46,870 --> 00:12:44,030
Chandra Spitzer and Hubble are still in

311
00:12:50,110 --> 00:12:46,880
orbit and they are often used in concert

312
00:12:52,420 --> 00:12:50,120
to do multi-wavelength studies because

313
00:12:54,910 --> 00:12:52,430

you know an object might have x-rays

314

00:12:58,740 --> 00:12:54,920

might be visible in the infrared want to

315

00:13:03,300 --> 00:12:58,750

compare to Hubble and Spitzer is

316

00:13:05,500 --> 00:13:03,310

something like 33 34 inch diameter

317

00:13:07,600 --> 00:13:05,510

telescope it has a number of instruments

318

00:13:10,510 --> 00:13:07,610

on it and mostly looks in the infrared

319

00:13:14,400 --> 00:13:10,520

so it's really good for looking at some

320

00:13:17,500 --> 00:13:14,410

of our favorite things distant galaxies

321

00:13:19,120 --> 00:13:17,510

exoplanets and also the center

322

00:13:20,980 --> 00:13:19,130

our galaxy or in other parts of our

323

00:13:25,330 --> 00:13:20,990

galaxy because the infrared looks

324

00:13:27,550 --> 00:13:25,340

through the dust infrared also as Adam

325

00:13:29,620 --> 00:13:27,560

was just saying can help find things

326

00:13:32,050 --> 00:13:29,630

that are very far away because of the

327

00:13:35,080 --> 00:13:32,060

reddening and the expansion of the

328

00:13:39,250 --> 00:13:35,090

universe canada france is actually a

329

00:13:42,730 --> 00:13:39,260

ground-based telescope it was built by

330

00:13:45,550 --> 00:13:42,740

canada france and the university of

331

00:13:50,350 --> 00:13:45,560

hawaii it's on Mauna Kea in Hawaii I

332

00:13:53,140 --> 00:13:50,360

worked there for nine years and it's

333

00:13:56,620 --> 00:13:53,150

actually a magnificent telescope and it

334

00:13:58,330 --> 00:13:56,630

has lots of capability it has imaging

335

00:14:01,860 --> 00:13:58,340

capability because the site is really

336

00:14:04,300 --> 00:14:01,870

good not as good as as orbiting a

337

00:14:07,150 --> 00:14:04,310

satellite telescopes but in the minutes

338

00:14:08,590 --> 00:14:07,160

day it did some pretty darn good imaging

339

00:14:11,290 --> 00:14:08,600

and it's still really good imaging and

340

00:14:12,790 --> 00:14:11,300

it also does spectroscopy and so it's

341

00:14:15,760 --> 00:14:12,800

always helpful to have ground-based

342

00:14:17,650 --> 00:14:15,770

telescopes because you can get there

343

00:14:20,440 --> 00:14:17,660

they're useful because you can change

344

00:14:22,090 --> 00:14:20,450

instruments more quickly and if you

345

00:14:24,730 --> 00:14:22,100

build new ones you can put them on a

346

00:14:27,040 --> 00:14:24,740

ground-based telescope more quickly you

347

00:14:28,900 --> 00:14:27,050

can't put anyone and we're not servicing

348

00:14:32,110 --> 00:14:28,910

novel anymore and we never service bits

349

00:14:34,450 --> 00:14:32,120

or whenevers first service Chandra so

350

00:14:36,790 --> 00:14:34,460

Canada France has a really good suite of

351

00:14:37,900 --> 00:14:36,800

instruments for this kind of work a lot

352

00:14:39,970 --> 00:14:37,910

of people don't know this but while

353

00:14:41,620 --> 00:14:39,980

infrared astronomy is best done in space

354

00:14:44,020 --> 00:14:41,630

there are some places on the planet

355

00:14:45,670 --> 00:14:44,030

wherever that are very good for doing

356

00:14:47,590 --> 00:14:45,680

infrared astronomy the requirement being

357

00:14:48,730 --> 00:14:47,600

you need it to be very dry you need to

358

00:14:50,800 --> 00:14:48,740

have very little water vapor in the

359

00:14:52,360 --> 00:14:50,810

atmosphere so that the infrared can get

360

00:14:53,530 --> 00:14:52,370

through and in Hawaii happens to be one

361

00:14:55,870 --> 00:14:53,540

of those places even though you think of

362

00:14:58,240 --> 00:14:55,880

Hawaii is a humid tropical environment

363

00:15:00,460 --> 00:14:58,250

at 14,000 feet it's pretty dry up there

364

00:15:01,900 --> 00:15:00,470

and the same is true for the high high

365

00:15:04,450 --> 00:15:01,910

in the mountains of Chile which is what

366

00:15:07,480 --> 00:15:04,460

you see a lot of ground-based telescopes

367

00:15:09,760 --> 00:15:07,490

and back in the day we used to go up to

368

00:15:11,800 --> 00:15:09,770

the telescope open do the observations

369

00:15:14,020 --> 00:15:11,810

and I'll tell you there's nothing better

370

00:15:16,060 --> 00:15:14,030

than coming out of that you know four

371

00:15:20,800 --> 00:15:16,070

days of dusty environment going straight

372

00:15:24,430 --> 00:15:20,810

to the beach get the babes going the

373

00:15:28,360 --> 00:15:24,440

other way well that yeah that's amazing

374

00:15:29,800 --> 00:15:28,370

so but what do they do now you said back

375

00:15:31,360 --> 00:15:29,810

in the day they do that what are they

376

00:15:34,240 --> 00:15:31,370

still go up to the

377

00:15:39,040 --> 00:15:34,250

no largely the observations i'm not sure

378

00:15:40,720 --> 00:15:39,050

what Traci Ann carburetors did but our

379

00:15:42,340 --> 00:15:40,730

friend Gordon Squires was just out there

380

00:15:44,890 --> 00:15:42,350

two weeks ago observing and they

381

00:15:49,210 --> 00:15:44,900

observed from God's country kamuela

382

00:15:52,030 --> 00:15:49,220

Hawaii or Waimea you know from either

383

00:15:55,840 --> 00:15:52,040

cfh kak there's a bunch of observatories

384

00:15:58,720 --> 00:15:55,850

and they they often observe from a more

385

00:16:01,780 --> 00:15:58,730

habitable place where you can actually

386

00:16:04,630 --> 00:16:01,790

get food and like water stiffly get so

387

00:16:06,610 --> 00:16:04,640

don't get you know altitude sickness

388

00:16:08,860 --> 00:16:06,620

going up I was just there a little while

389

00:16:10,840 --> 00:16:08,870

ago too and the dubra tories for check

390

00:16:12,550 --> 00:16:10,850

out there are it's like out no man's

391

00:16:14,260 --> 00:16:12,560

land but it's still great you still have

392

00:16:16,150 --> 00:16:14,270

access everything as opposed to being in

393

00:16:19,180 --> 00:16:16,160

no-man's right there's a starbucks

394

00:16:22,720 --> 00:16:19,190

across the street from tech so well I

395

00:16:25,480 --> 00:16:22,730

need to go back then because I'll be

396

00:16:29,620 --> 00:16:25,490

awesome oh you'll get that even my soy

397

00:16:32,140 --> 00:16:29,630

latte now exactly for him alright we

398

00:16:36,190 --> 00:16:32,150

digress don't get that in space Spitzer

399

00:16:37,300 --> 00:16:36,200

okay so all right so uh Tracy I want to

400

00:16:39,430 --> 00:16:37,310

go back to something you were to you

401
00:16:41,650 --> 00:16:39,440
would send about these galaxies clusters

402
00:16:43,990 --> 00:16:41,660
and getting members of them confirmed

403
00:16:46,269 --> 00:16:44,000
you said that was kind of a big deal but

404
00:16:47,470 --> 00:16:46,279
that you know there were only 27 so far

405
00:16:50,140 --> 00:16:47,480
but you think there's hundreds I don't

406
00:16:52,199 --> 00:16:50,150
understand what I mean Adam was just

407
00:16:54,730 --> 00:16:52,209
telling us about the survey itself they

408
00:16:56,530 --> 00:16:54,740
presumably identify these clusters

409
00:16:59,380 --> 00:16:56,540
pretty quickly there's a big old chunk

410
00:17:01,390 --> 00:16:59,390
of them there and then but then you said

411
00:17:03,370 --> 00:17:01,400
that getting the individual galaxies

412
00:17:04,179 --> 00:17:03,380
confirmed is kind of a big deal we want

413
00:17:05,980 --> 00:17:04,189

to talk a little bit about what that

414

00:17:07,960 --> 00:17:05,990

what that's involved what's involved in

415

00:17:10,240 --> 00:17:07,970

that right so if we want to know what

416

00:17:13,000 --> 00:17:10,250

what Adam finds is essentially the

417

00:17:15,340 --> 00:17:13,010

location of one of these galaxies

418

00:17:18,579 --> 00:17:15,350

clusters he sees like a big over density

419

00:17:21,460 --> 00:17:18,589

of galaxies in his survey but we don't

420

00:17:23,829 --> 00:17:21,470

know right away which individual

421

00:17:26,620 --> 00:17:23,839

galaxies in that over density are

422

00:17:28,360 --> 00:17:26,630

actually part of the of the cluster

423

00:17:29,620 --> 00:17:28,370

because if you think about it what

424

00:17:31,630 --> 00:17:29,630

you're seeing when you look at the

425

00:17:33,220 --> 00:17:31,640

cluster is everything that's in front of

426
00:17:34,780 --> 00:17:33,230
the cluster and everything that's behind

427
00:17:37,450 --> 00:17:34,790
the cluster and everything that's in the

428
00:17:39,940 --> 00:17:37,460
cluster all projected onto one sort of

429
00:17:42,100 --> 00:17:39,950
two-dimensional image and so just by

430
00:17:43,930 --> 00:17:42,110
looking at it we can't necessarily we

431
00:17:44,770 --> 00:17:43,940
know that most of the galaxies that we

432
00:17:46,840 --> 00:17:44,780
see in that image

433
00:17:49,720 --> 00:17:46,850
probably cluster members but we know

434
00:17:53,050 --> 00:17:49,730
that there's also some contamination so

435
00:17:55,150 --> 00:17:53,060
the way we actually the way we confirm

436
00:17:57,610 --> 00:17:55,160
that a galaxy is within the cluster is

437
00:18:00,390 --> 00:17:57,620
by measuring the distance or the

438
00:18:04,540 --> 00:18:00,400

redshift to that particular galaxy and

439

00:18:06,790 --> 00:18:04,550

so we do that by gathering obtaining

440

00:18:09,220 --> 00:18:06,800

spectrum for the galaxy so we need a

441

00:18:12,580 --> 00:18:09,230

really really powerful telescope that

442

00:18:15,400 --> 00:18:12,590

can provide really detailed measurements

443

00:18:17,950 --> 00:18:15,410

of the emission or the absorption lines

444

00:18:19,150 --> 00:18:17,960

in the galaxy spectrum and for that we

445

00:18:21,760 --> 00:18:19,160

actually used another ground-based

446

00:18:25,330 --> 00:18:21,770

telescope which is the the Keck

447

00:18:28,000 --> 00:18:25,340

Observatory and so we have to go out and

448

00:18:30,670 --> 00:18:28,010

measure an individual distance to every

449

00:18:32,560 --> 00:18:30,680

single galaxy in that image that you see

450

00:18:34,270 --> 00:18:32,570

there and see which ones are at the

451
00:18:36,460 --> 00:18:34,280
distance of the cluster and which ones

452
00:18:38,560 --> 00:18:36,470
are either in the foreground or in the

453
00:18:40,630 --> 00:18:38,570
background and basically separated out

454
00:18:43,930 --> 00:18:40,640
into like a three-dimensional image and

455
00:18:46,570 --> 00:18:43,940
so each one of those observations takes

456
00:18:48,520 --> 00:18:46,580
a long time I see so that's what you

457
00:18:50,890 --> 00:18:48,530
meant ok so with redshift we've talked

458
00:18:53,920 --> 00:18:50,900
about that at least a hundred and fifty

459
00:18:56,500 --> 00:18:53,930
three times on these hangouts so there

460
00:18:59,230 --> 00:18:56,510
it's a number it's just a way in which

461
00:19:00,910 --> 00:18:59,240
we find out how far away these galaxies

462
00:19:03,690 --> 00:19:00,920
are the bigger the number the farther

463
00:19:06,220 --> 00:19:03,700

away they are the galaxies record of

464

00:19:08,140 --> 00:19:06,230

Hubble has been somewhere of about Z

465

00:19:12,280 --> 00:19:08,150

equals 11 something like that which is

466

00:19:14,980 --> 00:19:12,290

pretty darn far away but frontier fields

467

00:19:16,660 --> 00:19:14,990

is hoping to make that even break that

468

00:19:18,130 --> 00:19:16,670

record too so anyway that's just a

469

00:19:19,660 --> 00:19:18,140

number of how far away things are and

470

00:19:22,390 --> 00:19:19,670

it's a time consuming measurement now

471

00:19:28,240 --> 00:19:22,400

you guys said you used qik to get that

472

00:19:30,070 --> 00:19:28,250

done but so the Alice are yeah Allison

473

00:19:31,210 --> 00:19:30,080

let me let me try to get you into this

474

00:19:32,290 --> 00:19:31,220

conversation a little bit haven't heard

475

00:19:34,060 --> 00:19:32,300

from you yet why don't you describe for

476

00:19:35,950 --> 00:19:34,070

us a little bit about what your role is

477

00:19:38,050 --> 00:19:35,960

what your interest is in this and some

478

00:19:39,910 --> 00:19:38,060

of the things that that you that you've

479

00:19:43,330 --> 00:19:39,920

noticed about the about this galaxy

480

00:19:47,110 --> 00:19:43,340

cluster so you broke out for a second oh

481

00:19:48,580 --> 00:19:47,120

oh oh sorry i was out what i want to try

482

00:19:50,320 --> 00:19:48,590

and get you involved in the guy wanted

483

00:19:51,670 --> 00:19:50,330

to get a sense of what you were doing as

484

00:19:54,580 --> 00:19:51,680

part of this team with what your

485

00:19:57,580 --> 00:19:54,590

interest is and what about this galaxy

486

00:20:00,430 --> 00:19:57,590

cluster got you got you going

487

00:20:02,590 --> 00:20:00,440

right so we've only just started to talk

488

00:20:04,500 --> 00:20:02,600

about some of the wavelengths we've

489

00:20:07,440 --> 00:20:04,510

looked at this cluster but we've also

490

00:20:09,370 --> 00:20:07,450

looked at it at the far infrared

491

00:20:10,990 --> 00:20:09,380

infrared all the way through far

492

00:20:12,010 --> 00:20:11,000

infrared and submillimetre wavelengths

493

00:20:13,539 --> 00:20:12,020

as well and that's kind of where my

494

00:20:16,299 --> 00:20:13,549

world comes in is looking at some of

495

00:20:19,180 --> 00:20:16,309

these longer wavelengths emission from

496

00:20:23,500 --> 00:20:19,190

the cluster and the galaxies in the

497

00:20:26,500 --> 00:20:23,510

cluster so we so we we talked about

498

00:20:29,580 --> 00:20:26,510

Spitzer that we have MIPS 24 micron

499

00:20:32,529 --> 00:20:29,590

imaging but we also have another

500

00:20:36,760 --> 00:20:32,539

space-based telescope that we're using

501
00:20:40,720 --> 00:20:36,770
which is Herschel oh no longer that's a

502
00:20:44,139 --> 00:20:40,730
nice Oh scope or was yes was yes so it's

503
00:20:47,680 --> 00:20:44,149
no longer running but they there's a

504
00:20:49,779 --> 00:20:47,690
bunch of archival data from Herschel

505
00:20:53,440 --> 00:20:49,789
that you can download yourself and

506
00:20:55,659 --> 00:20:53,450
reduce the images so we use that the

507
00:20:58,870 --> 00:20:55,669
archival data to get three additional

508
00:21:01,750 --> 00:20:58,880
wave length measurements of one of the

509
00:21:03,010 --> 00:21:01,760
the galaxies in this this cluster that

510
00:21:05,710 --> 00:21:03,020
I'm sure trace is going to talk about a

511
00:21:08,830 --> 00:21:05,720
bit more so it's the brightest cluster

512
00:21:12,519 --> 00:21:08,840
galaxies which is kind of the main focus

513
00:21:16,570 --> 00:21:12,529

of this paper and then additionally we

514

00:21:19,419 --> 00:21:16,580

also got imaging from submillimeter

515

00:21:22,240 --> 00:21:19,429

telescope also on Mauna Kea called the

516

00:21:28,210 --> 00:21:22,250

JC mt you guys hauled up everybody's

517

00:21:33,580 --> 00:21:28,220

time these people live right right they

518

00:21:40,480 --> 00:21:33,590

go to conferences in in Italy I was like

519

00:21:42,250 --> 00:21:40,490

really forget sir we galaxy you still go

520

00:21:44,049 --> 00:21:42,260

up the mountain center JC mt which is

521

00:21:46,570 --> 00:21:44,059

kind of nice yeah little bit of

522

00:21:48,970 --> 00:21:46,580

starbucks but you you do get to see the

523

00:21:52,029 --> 00:21:48,980

mars-like landscape on the top of Mauna

524

00:21:54,850 --> 00:21:52,039

Kea and spend 14 our nights observing on

525

00:21:57,549 --> 00:21:54,860

JC Mt there it is Scott's got a picture

526
00:22:00,370 --> 00:21:57,559
of it there so yeah staring at us from

527
00:22:03,820 --> 00:22:00,380
the top of not at us but at sky at it

528
00:22:05,710 --> 00:22:03,830
from the top of Mauna Kea so okay well

529
00:22:08,340 --> 00:22:05,720
so you looked at Scott would you please

530
00:22:11,049 --> 00:22:08,350
put back up the the cluster image again

531
00:22:11,980 --> 00:22:11,059
so Hubble had something to do with

532
00:22:13,779 --> 00:22:11,990
us we're going to get to that in a

533
00:22:16,810 --> 00:22:13,789
minute but first you look at it with

534
00:22:19,180 --> 00:22:16,820
Spitzer as part of this survey went and

535
00:22:22,749 --> 00:22:19,190
use the c f h t to kind of go back and

536
00:22:24,310 --> 00:22:22,759
verify things and so Tracy go ahead you

537
00:22:26,649 --> 00:22:24,320
said the thing that interested you the

538
00:22:30,310 --> 00:22:26,659

most was this little squishy thing in

539

00:22:33,580 --> 00:22:30,320

between these bright blobs there I know

540

00:22:36,850 --> 00:22:33,590

this is extremely dense jargon i'm using

541

00:22:38,710 --> 00:22:36,860

here budget ok so but this squishy thing

542

00:22:40,509 --> 00:22:38,720

the squishy thing is what you wouldn't

543

00:22:42,639 --> 00:22:40,519

treat you what is that a galaxy being

544

00:22:45,100 --> 00:22:42,649

lens what is that well okay so let me

545

00:22:47,830 --> 00:22:45,110

back up to that is is seen only in the

546

00:22:49,330 --> 00:22:47,840

Hubble image so that was a when we

547

00:22:52,629 --> 00:22:49,340

actually knew that we had something

548

00:22:55,810 --> 00:22:52,639

really exciting before that from the

549

00:22:59,759 --> 00:22:55,820

Spitzer imaging that Allison was talking

550

00:23:03,220 --> 00:22:59,769

about which gives us it gives us

551
00:23:07,680 --> 00:23:03,230
measurements in the mid infrared so at

552
00:23:11,019 --> 00:23:07,690
24 microns and that's a wavelength that

553
00:23:13,149 --> 00:23:11,029
comes from dusk that's heated by very

554
00:23:14,529 --> 00:23:13,159
young stars and it's a really good if

555
00:23:17,470 --> 00:23:14,539
you want to know if there's star

556
00:23:19,720 --> 00:23:17,480
formation going on in a galaxy a really

557
00:23:22,629 --> 00:23:19,730
good way of determining that is to look

558
00:23:24,310 --> 00:23:22,639
at it at these 24 micron wavelengths

559
00:23:25,720 --> 00:23:24,320
because if there is star formation going

560
00:23:27,759 --> 00:23:25,730
on the whole thing will just glow

561
00:23:30,609 --> 00:23:27,769
because it's hot there's a lot of hot

562
00:23:32,950 --> 00:23:30,619
hot exactly exactly and and the star

563
00:23:34,509 --> 00:23:32,960

formation generally occurs behind these

564

00:23:38,710 --> 00:23:34,519

I'd like to think of them as big cocoons

565

00:23:41,560 --> 00:23:38,720

and the cocoons of dust and the dust

566

00:23:43,389 --> 00:23:41,570

absorbs the light from the baby stars

567

00:23:45,129 --> 00:23:43,399

and then radiates it away in the

568

00:23:52,200 --> 00:23:45,139

infrared just like you and I radiate the

569

00:23:57,879 --> 00:23:56,139

so okay so Spitzer looked at this first

570

00:23:59,259 --> 00:23:57,889

she saw a lot of heat going on there and

571

00:24:01,330 --> 00:23:59,269

that caught your attention and that

572

00:24:03,789 --> 00:24:01,340

caught our attention and so then we

573

00:24:07,239 --> 00:24:03,799

wrote a proposal to the Hubble Space

574

00:24:09,220 --> 00:24:07,249

Telescope which essentially wanted to

575

00:24:10,899 --> 00:24:09,230

see what was going on we wanted to know

576
00:24:14,109 --> 00:24:10,909
why there was so much star formation

577
00:24:15,909 --> 00:24:14,119
happening and when we took the image

578
00:24:17,889 --> 00:24:15,919
with a Hubble Space Telescope this is

579
00:24:19,269 --> 00:24:17,899
the image that we saw we saw I don't

580
00:24:23,560 --> 00:24:19,279
remember what you called it now but the

581
00:24:24,610 --> 00:24:23,570
the long blobby thing I'm calma squishy

582
00:24:26,799 --> 00:24:24,620
profession

583
00:24:30,190 --> 00:24:26,809
you're the astronomer so if it's blobby

584
00:24:32,080 --> 00:24:30,200
then it's both it's so if you look at it

585
00:24:33,730 --> 00:24:32,090
edit careful you have to kind of squint

586
00:24:36,700 --> 00:24:33,740
your eyes a little bit but it is a long

587
00:24:38,530 --> 00:24:36,710
tail which seems to be coming out of one

588
00:24:41,049 --> 00:24:38,540

of the very bright galaxies that you see

589

00:24:43,210 --> 00:24:41,059

there and there's sort of clumps all the

590

00:24:45,540 --> 00:24:43,220

way along that tail and then it finishes

591

00:24:48,640 --> 00:24:45,550

off in this kind of backwards J

592

00:24:50,380 --> 00:24:48,650

structure which also has lumps in it so

593

00:24:51,970 --> 00:24:50,390

there's both diffuse emission and the

594

00:24:53,799 --> 00:24:51,980

whole thing is very long and then along

595

00:24:56,290 --> 00:24:53,809

its length there's all of these clumps

596

00:24:59,560 --> 00:24:56,300

and we could only see that with the

597

00:25:01,410 --> 00:24:59,570

extremely high resolution of the Spitzer

598

00:25:03,880 --> 00:25:01,420

Space Telescope it was completely

599

00:25:06,610 --> 00:25:03,890

invisible in all of the other imaging

600

00:25:10,810 --> 00:25:06,620

that we had and so this was really

601
00:25:13,810 --> 00:25:10,820
exciting because this is the this is a

602
00:25:17,140 --> 00:25:13,820
sign that something very violent has

603
00:25:20,169 --> 00:25:17,150
been happening with this object it

604
00:25:23,290 --> 00:25:20,179
something in this object has essentially

605
00:25:25,960 --> 00:25:23,300
been ripped apart and it's been pulled

606
00:25:28,419 --> 00:25:25,970
apart along what we call this tidal tail

607
00:25:31,510 --> 00:25:28,429
and there's new stars which are probably

608
00:25:34,000 --> 00:25:31,520
being formed all along it because of

609
00:25:35,860 --> 00:25:34,010
this very violent process so which blob

610
00:25:37,900 --> 00:25:35,870
which red blob are you thinking this is

611
00:25:39,640 --> 00:25:37,910
a part of dude one in the upper right or

612
00:25:41,740 --> 00:25:39,650
the more one on the upper right so that

613
00:25:43,270 --> 00:25:41,750

so this was part of the really hard work

614

00:25:48,100 --> 00:25:43,280

the blob in the upper right which is

615

00:25:50,919 --> 00:25:48,110

circled Oh way to go Scott good cue I'm

616

00:25:54,490 --> 00:25:50,929

a professional Tony URI professional I'm

617

00:25:56,470 --> 00:25:54,500

amazed that's what we think is a what's

618

00:25:58,930 --> 00:25:56,480

called the brightest cluster galaxies

619

00:26:01,630 --> 00:25:58,940

which is as mentioned here the central

620

00:26:04,240 --> 00:26:01,640

cluster galaxies so it is a huge mass of

621

00:26:07,900 --> 00:26:04,250

galaxies which is sitting at the very

622

00:26:09,850 --> 00:26:07,910

center of this galaxy cluster and it's

623

00:26:11,919 --> 00:26:09,860

different than all other galaxies in the

624

00:26:14,320 --> 00:26:11,929

universe so most galaxy clusters have

625

00:26:17,560 --> 00:26:14,330

one of these hulking Giants sitting in

626
00:26:19,840 --> 00:26:17,570
their very centers and so we think that

627
00:26:23,080 --> 00:26:19,850
the tail is kind of emanating out from

628
00:26:24,940 --> 00:26:23,090
that object so if you trace it all the

629
00:26:27,370 --> 00:26:24,950
way back you can see it sort of curls

630
00:26:29,320 --> 00:26:27,380
its way back into that object just for

631
00:26:31,960 --> 00:26:29,330
interest the two there's two bright

632
00:26:34,060 --> 00:26:31,970
blobs to the lower left and those are

633
00:26:36,190 --> 00:26:34,070
actually they have nothing to do with

634
00:26:37,779 --> 00:26:36,200
the galaxy cluster we've confirmed using

635
00:26:41,710 --> 00:26:37,789
Keck that those are things that are

636
00:26:44,680 --> 00:26:41,720
actually seen from the foreground I'm

637
00:26:46,149 --> 00:26:44,690
Richard we got all the chips okay all

638
00:26:47,830 --> 00:26:46,159

right interesting answer again because

639

00:26:49,419 --> 00:26:47,840

it looks like at first glance of the

640

00:26:50,979 --> 00:26:49,429

line of sight that they are all really

641

00:26:52,359 --> 00:26:50,989

close together well that's what we

642

00:26:54,430 --> 00:26:52,369

thought originally and it was a lot of

643

00:26:56,560 --> 00:26:54,440

hard work to show that they weren't and

644

00:27:00,519 --> 00:26:56,570

they're just kind of there actually

645

00:27:01,599 --> 00:27:00,529

frustrating they're in our way yeah you

646

00:27:03,249 --> 00:27:01,609

think nature would be a little more

647

00:27:06,129 --> 00:27:03,259

accommodating with some of its some of

648

00:27:07,869 --> 00:27:06,139

the secrets well okay so now this was

649

00:27:09,899 --> 00:27:07,879

this was something you kind of didn't

650

00:27:11,799 --> 00:27:09,909

expect to find right that sort of the

651
00:27:13,139 --> 00:27:11,809
impression I get from reading the press

652
00:27:17,379 --> 00:27:13,149
release you guys weren't expecting this

653
00:27:18,940 --> 00:27:17,389
this isn't common that's right so to my

654
00:27:22,960 --> 00:27:18,950
knowledge this is only the second

655
00:27:25,450 --> 00:27:22,970
example of this kind of thing this kind

656
00:27:27,460 --> 00:27:25,460
of saying meaning this very violent

657
00:27:31,330 --> 00:27:27,470
ripped apart galaxy sitting at the

658
00:27:35,259 --> 00:27:31,340
center of a galaxy cluster that's this

659
00:27:37,749 --> 00:27:35,269
large usually when we look so I

660
00:27:39,009 --> 00:27:37,759
mentioned that every massive galaxy

661
00:27:43,479 --> 00:27:39,019
cluster has one of these hulking

662
00:27:45,339 --> 00:27:43,489
galaxies at its center and these are not

663
00:27:47,830 --> 00:27:45,349

only the most massive galaxies in the

664

00:27:50,649 --> 00:27:47,840

universe but some of the oldest and by

665

00:27:52,749 --> 00:27:50,659

old we mean they form their stars a long

666

00:27:55,089 --> 00:27:52,759

long time ago and they haven't formed

667

00:27:56,950 --> 00:27:55,099

any sense so like elliptical galaxies

668

00:27:59,259 --> 00:27:56,960

exactly they're the biggest elliptical

669

00:28:00,639 --> 00:27:59,269

galaxies in the universe now in these

670

00:28:01,869 --> 00:28:00,649

clusters let me just interrupt you real

671

00:28:03,339 --> 00:28:01,879

quick to make sure i'm a you said

672

00:28:04,839 --> 00:28:03,349

there's usually a hulking mass in the

673

00:28:07,659 --> 00:28:04,849

center of these co they gravitationally

674

00:28:09,129 --> 00:28:07,669

bound to it or is it is it just loosely

675

00:28:10,479 --> 00:28:09,139

are they loosely connected what's the

676
00:28:12,820 --> 00:28:10,489
connection there you mean the galaxies

677
00:28:15,070 --> 00:28:12,830
with the brightest cluster galaxies yes

678
00:28:16,479 --> 00:28:15,080
well the whole so the whole cluster is

679
00:28:18,489 --> 00:28:16,489
bound together by its dark matter

680
00:28:20,769 --> 00:28:18,499
essentially and the brightest cluster

681
00:28:23,499 --> 00:28:20,779
galaxies sits at the very center of that

682
00:28:26,009 --> 00:28:23,509
dark matter distribution okay so they're

683
00:28:28,239 --> 00:28:26,019
all bound together okay good thank you

684
00:28:32,379 --> 00:28:28,249
okay so this was something you didn't

685
00:28:36,279 --> 00:28:32,389
expect to see as violently well so as

686
00:28:38,589 --> 00:28:36,289
far back as we looked most almost all

687
00:28:41,229 --> 00:28:38,599
galaxy clusters have these massive

688
00:28:44,619 --> 00:28:41,239

galaxies galaxies in their Center and

689

00:28:47,830 --> 00:28:44,629

these massive galaxies look old so it's

690

00:28:49,720 --> 00:28:47,840

a real mystery in astrophysics one of

691

00:28:51,250 --> 00:28:49,730

our big questions is how and when did

692

00:28:53,220 --> 00:28:51,260

these things form because we

693

00:28:56,290 --> 00:28:53,230

figure we keep looking back in time

694

00:28:58,510 --> 00:28:56,300

deeper and deeper images we should at

695

00:29:00,820 --> 00:28:58,520

some point see these things forming and

696

00:29:03,640 --> 00:29:00,830

that is yet to happen and so this was

697

00:29:07,150 --> 00:29:03,650

one of the first images that actually

698

00:29:09,490 --> 00:29:07,160

caught one of these objects in phase

699

00:29:11,890 --> 00:29:09,500

that we think is a phase related to its

700

00:29:13,710 --> 00:29:11,900

formation and that is this violent phase

701
00:29:15,940 --> 00:29:13,720
of ripping apart one galaxy to

702
00:29:22,090 --> 00:29:15,950
cannibalize it and then forming new

703
00:29:23,740 --> 00:29:22,100
stars as it does that ok well the and I

704
00:29:25,360 --> 00:29:23,750
want to get to this topic or this

705
00:29:27,330 --> 00:29:25,370
concept i'm not quite sure how to make

706
00:29:29,650 --> 00:29:27,340
this out the segway but there was a

707
00:29:31,450 --> 00:29:29,660
there's this thing that we that was

708
00:29:32,890 --> 00:29:31,460
mentioned and we've had a we've had a

709
00:29:35,530 --> 00:29:32,900
hanging on this before about something

710
00:29:38,530 --> 00:29:35,540
called beads on a string and this is a

711
00:29:41,500 --> 00:29:38,540
characteristic of pockets of gas of

712
00:29:44,050 --> 00:29:41,510
where new stars are being born inside

713
00:29:46,330 --> 00:29:44,060

the cluster and this is this one of

714

00:29:49,660 --> 00:29:46,340

those things is that a bead on a string

715

00:29:52,630 --> 00:29:49,670

or so we face them we think that if you

716

00:29:55,750 --> 00:29:52,640

if you look ease if you look at just the

717

00:29:57,130 --> 00:29:55,760

bare bones hsd image without the Spitzer

718

00:29:58,890 --> 00:29:57,140

image overlaid you can see it a little

719

00:30:02,020 --> 00:29:58,900

bit better but if you look at the

720

00:30:04,030 --> 00:30:02,030

central they're really handy scott i

721

00:30:06,730 --> 00:30:04,040

don't think so i think we've only got

722

00:30:09,310 --> 00:30:06,740

there oh okay all right okay hmm i'm

723

00:30:11,710 --> 00:30:09,320

talking about really the raw data icic

724

00:30:14,740 --> 00:30:11,720

okay if you look in the center regions

725

00:30:16,780 --> 00:30:14,750

where the tail comes out from the

726

00:30:18,820 --> 00:30:16,790

central cluster galaxies you'll notice

727

00:30:22,240 --> 00:30:18,830

that along there there's the sort of

728

00:30:24,130 --> 00:30:22,250

equally spaced clumps all the way along

729

00:30:26,590 --> 00:30:24,140

before the whole thing kind of blows up

730

00:30:28,720 --> 00:30:26,600

oh yeah yeah they are and that's what we

731

00:30:31,330 --> 00:30:28,730

call beads on a string and it's the same

732

00:30:34,270 --> 00:30:31,340

kind of physics really as beads

733

00:30:38,800 --> 00:30:34,280

collecting on a string to these clumps

734

00:30:41,320 --> 00:30:38,810

of condensation a long day flying okay

735

00:30:43,870 --> 00:30:41,330

now because I'm a man child and I'm

736

00:30:46,450 --> 00:30:43,880

infantile this part made me laugh but uh

737

00:30:53,370 --> 00:30:46,460

this is what you're calling a wet merger

738

00:30:59,480 --> 00:30:53,380

is that correct yes yes oh my god Oh

739

00:31:04,280 --> 00:31:02,330

but there this is this is simply a state

740

00:31:07,130 --> 00:31:04,290

it is what you're describing when it's

741

00:31:09,440 --> 00:31:07,140

gas which i guess is somehow

742

00:31:13,130 --> 00:31:09,450

characterized as wet being involved in a

743

00:31:15,200 --> 00:31:13,140

na and star forming region like this

744

00:31:17,180 --> 00:31:15,210

right well that's right so what we're

745

00:31:19,310 --> 00:31:17,190

seeing so just to be clear what we're

746

00:31:21,799 --> 00:31:19,320

seeing with the HST image is not the gas

747

00:31:24,500 --> 00:31:21,809

but the stars but we know that there has

748

00:31:27,080 --> 00:31:24,510

to be gas there because there's so much

749

00:31:30,020 --> 00:31:27,090

star formation going on and the stars

750

00:31:31,460 --> 00:31:30,030

have to be forming out of gas so the

751
00:31:32,960 --> 00:31:31,470
between the infrared wavelengths which

752
00:31:34,520 --> 00:31:32,970
are generating the heat and the visible

753
00:31:36,680 --> 00:31:34,530
light which we see here and Hubble

754
00:31:39,200 --> 00:31:36,690
there's a lot of other physics going on

755
00:31:41,690 --> 00:31:39,210
a lot of other physics that's right okay

756
00:31:43,370 --> 00:31:41,700
which which we hope that's sort of one

757
00:31:46,820 --> 00:31:43,380
of the next things that will do is get a

758
00:31:48,560 --> 00:31:46,830
real picture of the actual gas okay so

759
00:31:51,080 --> 00:31:48,570
that when there's lots of gas involved

760
00:31:53,810 --> 00:31:51,090
that's a wet merger but the the dry ones

761
00:31:57,860 --> 00:31:53,820
are they they're just they still have

762
00:31:59,210 --> 00:31:57,870
gas because they are beating they are

763
00:32:02,450 --> 00:31:59,220

they just don't listen there's no stars

764

00:32:05,390 --> 00:32:02,460

because so what a dry merger is and and

765

00:32:08,330 --> 00:32:05,400

it's been known for a long time it's

766

00:32:10,640 --> 00:32:08,340

been known that brightest cluster

767

00:32:13,370 --> 00:32:10,650

galaxies can grow through what are

768

00:32:16,330 --> 00:32:13,380

called dry mergers and a dry merger is

769

00:32:19,280 --> 00:32:16,340

when two galaxies merge but they're old

770

00:32:21,470 --> 00:32:19,290

elliptical galaxies and neither one of

771

00:32:24,919 --> 00:32:21,480

them has very much gas to bring to the

772

00:32:28,310 --> 00:32:24,929

table essentially and so there's no fuel

773

00:32:32,000 --> 00:32:28,320

there for new star formation where is in

774

00:32:34,549 --> 00:32:32,010

a wet merger at least one of the

775

00:32:37,490 --> 00:32:34,559

galaxies is a galaxy more like our own

776

00:32:40,160 --> 00:32:37,500

Milky Way with a lot of gas and that gas

777

00:32:42,830 --> 00:32:40,170

is then compressed and funneled and

778

00:32:46,580 --> 00:32:42,840

channeled during the merger to form new

779

00:32:48,560 --> 00:32:46,590

stars so in a merge both are kinds of

780

00:32:50,690 --> 00:32:48,570

mergers where two galaxies collide

781

00:32:53,240 --> 00:32:50,700

together and eventually form one larger

782

00:32:56,120 --> 00:32:53,250

galaxy but in the dry merger the stars

783

00:32:57,790 --> 00:32:56,130

just kind of come together and in a wet

784

00:32:59,960 --> 00:32:57,800

merger there's new stars being formed

785

00:33:01,610 --> 00:32:59,970

okay so yeah the wet mergers that

786

00:33:04,330 --> 00:33:01,620

haven't been seen before at the Centers

787

00:33:06,500 --> 00:33:04,340

of clusters okay so yeah this is

788

00:33:08,000 --> 00:33:06,510

something that you expected to find as

789

00:33:10,100 --> 00:33:08,010

you say but haven't yet this is one of

790

00:33:13,010 --> 00:33:10,110

the first first times you've seen one of

791

00:33:15,230 --> 00:33:13,020

these there I guess

792

00:33:16,940 --> 00:33:15,240

so let me there's a there's a got a

793

00:33:18,620 --> 00:33:16,950

quick question in here that's been

794

00:33:20,390 --> 00:33:18,630

sitting for a while I want to ask this

795

00:33:23,210 --> 00:33:20,400

is about the galaxy cluster this is from

796

00:33:26,180 --> 00:33:23,220

John glasco on the Q&A app he's going is

797

00:33:28,100 --> 00:33:26,190

the pinwheel galaxy which is M 101 when

798

00:33:30,770 --> 00:33:28,110

and he even knows that it's six parts

799

00:33:32,690 --> 00:33:30,780

megaparsecs away good job John anywhere

800

00:33:34,490 --> 00:33:32,700

new is it is the pinwheel anywhere near

801
00:33:36,710 --> 00:33:34,500
this cluster or is this cluster much

802
00:33:39,830 --> 00:33:36,720
farther away now the pinwheel galaxy is

803
00:33:41,540 --> 00:33:39,840
one of the most detailed images of a

804
00:33:43,700 --> 00:33:41,550
spiral galaxy the Hubble's ever taken

805
00:33:48,040 --> 00:33:43,710
but where is it you do we know where it

806
00:33:51,920 --> 00:33:48,050
might be with relation to in 101 oh gosh

807
00:33:55,730 --> 00:33:51,930
do you mean on the sky or in distance

808
00:33:58,010 --> 00:33:55,740
well it's in Ursa Major I believe and so

809
00:33:59,660 --> 00:33:58,020
rough is it anywhere nearby other than

810
00:34:01,490 --> 00:33:59,670
just say it's in the same constellation

811
00:34:06,550 --> 00:34:01,500
or is it not really a part of the

812
00:34:09,500 --> 00:34:06,560
cluster no no no pinwheels a nearby

813
00:34:11,180 --> 00:34:09,510

relatively nearby galaxies okay so these

814

00:34:12,860 --> 00:34:11,190

are much further away than alright

815

00:34:19,940 --> 00:34:12,870

alright thank you John it was good

816

00:34:22,130 --> 00:34:19,950

question um so let's see the so are

817

00:34:23,690 --> 00:34:22,140

there other galaxy clusters as part of

818

00:34:25,190 --> 00:34:23,700

the survey that you're looking at are

819

00:34:28,880 --> 00:34:25,200

you going to continue looking more

820

00:34:30,530 --> 00:34:28,890

closely at this particular one too is

821

00:34:31,940 --> 00:34:30,540

there anything more that we can learn

822

00:34:34,130 --> 00:34:31,950

from this but with other would say

823

00:34:35,810 --> 00:34:34,140

wavelengths or or other observations

824

00:34:38,930 --> 00:34:35,820

that you might want to make yeah so

825

00:34:42,169 --> 00:34:38,940

we're we're what we're doing both we're

826

00:34:45,260 --> 00:34:42,179

actively trying to study this particular

827

00:34:47,480 --> 00:34:45,270

object in more detail so like I said one

828

00:34:50,870 --> 00:34:47,490

of the things we would like to do is get

829

00:34:52,610 --> 00:34:50,880

an image of the actual gas within this

830

00:34:54,830 --> 00:34:52,620

system and see where the gas is and what

831

00:34:59,270 --> 00:34:54,840

the gas is doing and so we have some

832

00:35:00,890 --> 00:34:59,280

proposals in to do that as well and we'd

833

00:35:02,810 --> 00:35:00,900

like to learn more about the cluster as

834

00:35:04,840 --> 00:35:02,820

a whole we'd like to confirm more

835

00:35:07,670 --> 00:35:04,850

members and get a very Bette erm Escher

836

00:35:10,010 --> 00:35:07,680

mass so we know exactly what we're

837

00:35:13,340 --> 00:35:10,020

dealing with but at the same time Adams

838

00:35:15,680 --> 00:35:13,350

survey has produced hundreds and

839

00:35:18,730 --> 00:35:15,690

hundreds of galaxy clusters at large

840

00:35:21,830 --> 00:35:18,740

distances from us and many of them show

841

00:35:25,920 --> 00:35:21,840

evidence that they might be similar

842

00:35:27,150 --> 00:35:25,930

systems to this and what in one way

843

00:35:28,950 --> 00:35:27,160

we could add them to comment on that a

844

00:35:30,150 --> 00:35:28,960

little bit when what so what uh what are

845

00:35:32,730 --> 00:35:30,160

some of these characteristics that

846

00:35:34,140 --> 00:35:32,740

you're noticing another are you looking

847

00:35:36,450 --> 00:35:34,150

primarily for bright spots in the

848

00:35:38,760 --> 00:35:36,460

infrared or what do you what are you

849

00:35:40,770 --> 00:35:38,770

looking at yeah well that's that's

850

00:35:44,490 --> 00:35:40,780

precisely it right we are looking for

851
00:35:46,200 --> 00:35:44,500
things that are really red overall so we

852
00:35:48,120 --> 00:35:46,210
did the thing with the Canada France you

853
00:35:50,430 --> 00:35:48,130
want them to be not very bright in the

854
00:35:53,220 --> 00:35:50,440
optical and then in combination to be

855
00:35:54,809 --> 00:35:53,230
very bright with Spitzer so big big

856
00:35:57,510 --> 00:35:54,819
lumps of galaxies that are bright and

857
00:35:59,910 --> 00:35:57,520
Spitzer and not very bright in in the

858
00:36:02,220 --> 00:35:59,920
optical and we have found as Tracy said

859
00:36:04,589 --> 00:36:02,230
a few hundred of them I think what she's

860
00:36:06,990 --> 00:36:04,599
referring to is you know Tracy is a very

861
00:36:09,240 --> 00:36:07,000
prolific scientist and she also wrote a

862
00:36:11,700 --> 00:36:09,250
paper in the last couple weeks where she

863
00:36:13,290 --> 00:36:11,710

looked at some of the other brightest

864

00:36:16,200 --> 00:36:13,300

cluster galaxies and some of the other

865

00:36:18,359 --> 00:36:16,210

clusters we found and what we're finding

866

00:36:22,790 --> 00:36:18,369

is that well this kind of thing that

867

00:36:25,470 --> 00:36:22,800

we're talking about today is very rare

868

00:36:27,480 --> 00:36:25,480

particularly nearby as we start looking

869

00:36:30,690 --> 00:36:27,490

at more and more of these very distant

870

00:36:32,460 --> 00:36:30,700

clusters it's still uncommon but it's

871

00:36:34,230 --> 00:36:32,470

not completely uncommon so there's

872

00:36:36,530 --> 00:36:34,240

there's some other clusters in our

873

00:36:38,760 --> 00:36:36,540

survey where the central galaxy has

874

00:36:42,140 --> 00:36:38,770

potentially very high star formation

875

00:36:44,160 --> 00:36:42,150

rates just like this one cool okay so

876

00:36:45,780 --> 00:36:44,170

Andrew planets got a good question i

877

00:36:47,549 --> 00:36:45,790

want to ask real quick and that is if

878

00:36:49,079 --> 00:36:47,559

these galaxy clusters contain

879

00:36:52,680 --> 00:36:49,089

supermassive black holes in their

880

00:36:54,359 --> 00:36:52,690

centers i could star formation be due to

881

00:36:57,299 --> 00:36:54,369

the constituents convincing from black

882

00:37:00,120 --> 00:36:57,309

hole high-energy jets forming gas fuel

883

00:37:02,220 --> 00:37:00,130

for new stars in the process is that at

884

00:37:04,170 --> 00:37:02,230

all possible so what are the you know

885

00:37:06,809 --> 00:37:04,180

our black holes playing any role in star

886

00:37:08,819 --> 00:37:06,819

formation either feeding it or called

887

00:37:11,640 --> 00:37:08,829

again causing it to condense in these

888

00:37:14,280 --> 00:37:11,650

galaxy clusters so that's a another

889

00:37:15,750 --> 00:37:14,290

really good question and I didn't

890

00:37:20,339 --> 00:37:15,760

mention this at all but we do know that

891

00:37:21,930 --> 00:37:20,349

there well we suspect strongly that

892

00:37:25,010 --> 00:37:21,940

there is a black hole at the center of

893

00:37:27,780 --> 00:37:25,020

this galaxy cluster and it's also

894

00:37:29,880 --> 00:37:27,790

contributing to the infrared emission

895

00:37:31,410 --> 00:37:29,890

that we've been mentioning the intense

896

00:37:34,920 --> 00:37:31,420

infrared emission that we see from it

897

00:37:36,539 --> 00:37:34,930

it's not dominating most of the energy

898

00:37:39,089 --> 00:37:36,549

that's being produced in the infrared is

899

00:37:42,180 --> 00:37:39,099

coming from star formation but there is

900

00:37:44,729 --> 00:37:42,190

black hole there whether or not the

901
00:37:48,079 --> 00:37:44,739
black hole is causing the star formation

902
00:37:51,359 --> 00:37:48,089
is an interesting idea because in fact

903
00:37:53,759 --> 00:37:51,369
black holes are usually invoked in these

904
00:37:56,609 --> 00:37:53,769
situations to do the opposite to

905
00:38:00,450 --> 00:37:56,619
actually stop the star formation so the

906
00:38:02,249 --> 00:38:00,460
feedback from so your listener mentioned

907
00:38:05,370 --> 00:38:02,259
these Jets that come out of the black

908
00:38:07,979 --> 00:38:05,380
hole the radiative and mechanical

909
00:38:09,749 --> 00:38:07,989
feedback that comes from the accretion

910
00:38:12,180 --> 00:38:09,759
disk and all the other activity that's

911
00:38:15,509 --> 00:38:12,190
going on around a black hole can

912
00:38:19,229 --> 00:38:15,519
actually disrupt the star formation and

913
00:38:20,670 --> 00:38:19,239

blow the gas out of you know keep it

914

00:38:23,609 --> 00:38:20,680

from condensing and forming new stars

915

00:38:26,009 --> 00:38:23,619

and so we think that if the black hole

916

00:38:28,319 --> 00:38:26,019

in this particular cluster is allowed to

917

00:38:30,210 --> 00:38:28,329

grow it might actually stop the star

918

00:38:32,370 --> 00:38:30,220

formation that we're seeing and that may

919

00:38:33,930 --> 00:38:32,380

be and that might be why these things

920

00:38:35,729 --> 00:38:33,940

are so hard to see period right i mean

921

00:38:37,289 --> 00:38:35,739

in most galaxy clusters it could be

922

00:38:39,029 --> 00:38:37,299

these black holes or disrupting a lot of

923

00:38:40,469 --> 00:38:39,039

the star for me it's a good question so

924

00:38:42,509 --> 00:38:40,479

one of the questions we were trying to

925

00:38:44,849 --> 00:38:42,519

get a tat in one of the papers was what

926
00:38:46,769 --> 00:38:44,859
was essentially the duty cycle how long

927
00:38:49,739 --> 00:38:46,779
does the star formation go on for before

928
00:38:52,170 --> 00:38:49,749
an AGN shuts it down and you can is not

929
00:38:54,569 --> 00:38:52,180
active life an active galactic nucleus a

930
00:38:56,819 --> 00:38:54,579
black hole and so the fact that these

931
00:38:59,039 --> 00:38:56,829
things appear to be quite rare may be

932
00:39:02,700 --> 00:38:59,049
telling us that the AGN that the black

933
00:39:04,259 --> 00:39:02,710
hole shuts it down very rapidly okay

934
00:39:06,989 --> 00:39:04,269
good question Andrew thanks as always

935
00:39:08,849 --> 00:39:06,999
and Cecil Morgan's asking what

936
00:39:11,269 --> 00:39:08,859
instrument this is from the Q&A app what

937
00:39:14,400 --> 00:39:11,279
instruments would be used to see the gas

938
00:39:16,289 --> 00:39:14,410

presumably the infrared showing you not

939

00:39:18,599 --> 00:39:16,299

the gas but the heat coming from the

940

00:39:20,609 --> 00:39:18,609

star formation and the hubble the

941

00:39:22,529 --> 00:39:20,619

infrared visible light are showing the

942

00:39:26,789 --> 00:39:22,539

stars what could you use to see the gas

943

00:39:30,450 --> 00:39:26,799

with so for that we're hoping again to

944

00:39:33,959 --> 00:39:30,460

use a spectroscopic instrument on the

945

00:39:37,339 --> 00:39:33,969

Keck telescope essentially what we need

946

00:39:41,370 --> 00:39:37,349

to do is get what's called a spectrum of

947

00:39:42,809 --> 00:39:41,380

the galaxy and that's the same and the

948

00:39:45,599 --> 00:39:42,819

region surrounding it that's the same

949

00:39:49,049 --> 00:39:45,609

kind of observation that we do to get a

950

00:39:52,049 --> 00:39:49,059

redshift and there we're looking for a

951
00:39:52,859 --> 00:39:52,059
mission that's coming from the gas so

952
00:39:56,420 --> 00:39:52,869
we're looking for the

953
00:39:58,890 --> 00:39:56,430
hydrogen lines and the oxygen lines

954
00:40:02,640 --> 00:39:58,900
basically using the same kind of physics

955
00:40:04,710 --> 00:40:02,650
that people use in neon lights to try

956
00:40:07,440 --> 00:40:04,720
and and see the gas in that way so it

957
00:40:10,710 --> 00:40:07,450
would be a ground-based optical and

958
00:40:12,420 --> 00:40:10,720
infrared spectrograph cool yeah that's

959
00:40:13,710 --> 00:40:12,430
important we've all don't know if you

960
00:40:16,339 --> 00:40:13,720
ever done that lab experiment where

961
00:40:20,190 --> 00:40:16,349
you've looked at a at a tube like a

962
00:40:21,749 --> 00:40:20,200
spectrum tube through a little pair of

963
00:40:24,089 --> 00:40:21,759

glasses and you can see the lines coming

964

00:40:26,609 --> 00:40:24,099

from it it's something very similar the

965

00:40:28,109 --> 00:40:26,619

bright lines that would black and the

966

00:40:29,400 --> 00:40:28,119

bright and dark absorption lines coming

967

00:40:30,779 --> 00:40:29,410

from a spectrum to tell you what

968

00:40:32,999 --> 00:40:30,789

elements are in that gas and whether

969

00:40:35,220 --> 00:40:33,009

there's gas present so good question

970

00:40:36,569 --> 00:40:35,230

Cecil ok I want to point out one little

971

00:40:40,259 --> 00:40:36,579

thing that I noticed when I was reading

972

00:40:42,269 --> 00:40:40,269

about it was a good comparison of the

973

00:40:43,910 --> 00:40:42,279

star formation rates apparently

974

00:40:47,579 --> 00:40:43,920

according to what you guys have found

975

00:40:50,849 --> 00:40:47,589

this is creating this little region is

976
00:40:53,630 --> 00:40:50,859
creating about 860 new stars a year and

977
00:40:55,950 --> 00:40:53,640
by comparison our Milky Way galaxy

978
00:40:57,960 --> 00:40:55,960
generally forms only about one or two

979
00:41:00,499 --> 00:40:57,970
stars a year so this is quite a bit this

980
00:41:05,339 --> 00:41:00,509
is a huge increase in star forming

981
00:41:06,989 --> 00:41:05,349
activity yeah that's right it's I mean I

982
00:41:08,549 --> 00:41:06,999
think maybe Allison can comment on this

983
00:41:10,769 --> 00:41:08,559
a little better than I can cuz she was

984
00:41:13,769 --> 00:41:10,779
the one who who made that measurement I

985
00:41:18,180 --> 00:41:13,779
love that idea go ahead Allison yeah

986
00:41:20,430 --> 00:41:18,190
well so um basically the way you can

987
00:41:23,279 --> 00:41:20,440
calculate this is by using all of the

988
00:41:25,109 --> 00:41:23,289

data that we've been talking about but

989

00:41:27,660 --> 00:41:25,119

particularly at the infrared and

990

00:41:30,299 --> 00:41:27,670

submillimetre wavelengths which as Carol

991

00:41:34,319 --> 00:41:30,309

mentioned earlier really is tracing the

992

00:41:37,710 --> 00:41:34,329

dust that's being heated by the stars so

993

00:41:39,960 --> 00:41:37,720

once you have a the UV radiation coming

994

00:41:41,460 --> 00:41:39,970

from a star it heats all this dust and

995

00:41:46,489 --> 00:41:41,470

every radiates and the infrared

996

00:41:48,269 --> 00:41:46,499

wavelengths so when you have multiple

997

00:41:50,609 --> 00:41:48,279

wavelengths from different telescopes

998

00:41:52,079 --> 00:41:50,619

all in the infrared and submillimetre

999

00:41:55,229 --> 00:41:52,089

wavelengths you can get a pretty good

1000

00:41:57,479 --> 00:41:55,239

estimate of the star formation right so

1001
00:42:00,269 --> 00:41:57,489
that's what we've done with herschel and

1002
00:42:02,249 --> 00:42:00,279
the JC mt and spitzer so those are the

1003
00:42:03,930 --> 00:42:02,259
primary instruments we use to measure

1004
00:42:06,480 --> 00:42:03,940
the star-formation rate and yes it's

1005
00:42:09,720 --> 00:42:06,490
forming about 860 sons

1006
00:42:11,190 --> 00:42:09,730
a year cool so pure like I have a

1007
00:42:12,750 --> 00:42:11,200
question for you Caroline and I don't

1008
00:42:15,510 --> 00:42:12,760
know this may be totally dumb but I'm

1009
00:42:17,820 --> 00:42:15,520
going to ask it anyway and the

1010
00:42:19,320 --> 00:42:17,830
ultraviolet which Hubble is got an

1011
00:42:21,090 --> 00:42:19,330
instrument on that lets us see in that

1012
00:42:23,640 --> 00:42:21,100
wavelength could you see anything in the

1013
00:42:26,430 --> 00:42:23,650

ultraviolet do you think uh in this

1014

00:42:29,310 --> 00:42:26,440

situation or no because it doesn't say

1015

00:42:31,290 --> 00:42:29,320

something about stars for me yes well I

1016

00:42:34,290 --> 00:42:31,300

mean they have an observation of it

1017

00:42:36,210 --> 00:42:34,300

which I don't have but sometimes it

1018

00:42:37,800 --> 00:42:36,220

depends it depends on how much dust is

1019

00:42:39,870 --> 00:42:37,810

in the system if they've got a lot of

1020

00:42:42,240 --> 00:42:39,880

dust in front of whatever the UV

1021

00:42:46,200 --> 00:42:42,250

radiation is then you're not really

1022

00:42:49,260 --> 00:42:46,210

really going to see it so um I haven't I

1023

00:42:52,830 --> 00:42:49,270

haven't seen the pure Hubble image but

1024

00:42:54,720 --> 00:42:52,840

it just depends um if if you don't have

1025

00:42:57,960 --> 00:42:54,730

a lot of dust in the system anymore you

1026
00:43:01,470 --> 00:42:57,970
could get a lot of UV radiation coming

1027
00:43:03,240 --> 00:43:01,480
out so it just depends on the

1028
00:43:05,070 --> 00:43:03,250
circumstance of the object you're trying

1029
00:43:06,840 --> 00:43:05,080
to look at have you thought about that

1030
00:43:09,120 --> 00:43:06,850
wavelength Tracy or is that probably not

1031
00:43:10,920 --> 00:43:09,130
going to work here well so in fact the

1032
00:43:13,500 --> 00:43:10,930
image that you're seeing with Hubble is

1033
00:43:15,870 --> 00:43:13,510
pretty close to the ultraviolet it's

1034
00:43:17,940 --> 00:43:15,880
it's taken in the infrared wavelengths

1035
00:43:19,650 --> 00:43:17,950
but because of the redshift because of

1036
00:43:22,230 --> 00:43:19,660
the great distance that this cluster is

1037
00:43:25,290 --> 00:43:22,240
from us what we're actually seeing is

1038
00:43:27,359 --> 00:43:25,300

light that was emitted in the UV oh good

1039

00:43:30,060 --> 00:43:27,369

point so these are actually the young

1040

00:43:33,330 --> 00:43:30,070

stars that we're probably seeing in this

1041

00:43:36,240 --> 00:43:33,340

this tale awesome ok well thank you for

1042

00:43:38,370 --> 00:43:36,250

that uh all right i think scott i'm

1043

00:43:39,840 --> 00:43:38,380

looking around and oh wait here's one

1044

00:43:41,700 --> 00:43:39,850

from andrew planet i'm gonna ask you in

1045

00:43:43,290 --> 00:43:41,710

a minute for twitter so let me get this

1046

00:43:45,030 --> 00:43:43,300

question from Andrew again he goes

1047

00:43:47,099 --> 00:43:45,040

thanks for the answer he's the one that

1048

00:43:48,780 --> 00:43:47,109

asked the black hole question what

1049

00:43:50,640 --> 00:43:48,790

eventually happens then to all the

1050

00:43:52,859 --> 00:43:50,650

material that makes up high energy Jets

1051
00:43:54,810 --> 00:43:52,869
so I think these Jets are assumed to be

1052
00:43:56,310 --> 00:43:54,820
producing if they're actively well if

1053
00:44:00,180 --> 00:43:56,320
they're active they're feeding on I'm

1054
00:44:02,609 --> 00:44:00,190
surrounding material so I do the first

1055
00:44:06,349 --> 00:44:02,619
of all are their Jets here and if so

1056
00:44:09,690 --> 00:44:06,359
what what happens to all that stuff so

1057
00:44:11,160 --> 00:44:09,700
I'm not an expert on black holes in the

1058
00:44:14,640 --> 00:44:11,170
Centers of galaxies clusters I don't

1059
00:44:16,410 --> 00:44:14,650
know if Adam feels any more comfortable

1060
00:44:18,870 --> 00:44:16,420
with that idea what about you Adam do

1061
00:44:20,370 --> 00:44:18,880
you feel like yeah hey at least I'm not

1062
00:44:29,249 --> 00:44:20,380
asking you to calculate something

1063
00:44:30,059 --> 00:44:29,259

on and in terms of I mean okay well why

1064

00:44:31,559 --> 00:44:30,069

don't you just say what you were

1065

00:44:32,880 --> 00:44:31,569

thinking and then we'll see if that

1066

00:44:35,519 --> 00:44:32,890

answers this question well I mean

1067

00:44:40,170 --> 00:44:35,529

certainly there's we don't we don't see

1068

00:44:42,120 --> 00:44:40,180

any Jets in this image yet but we

1069

00:44:44,519 --> 00:44:42,130

haven't really looked at the right

1070

00:44:46,019 --> 00:44:44,529

wavelengths so it is possible that there

1071

00:44:48,359 --> 00:44:46,029

might be some jets there and we have a

1072

00:44:51,630 --> 00:44:48,369

proposal into the Very Large Array which

1073

00:44:53,690 --> 00:44:51,640

is a radio telescope to see what kind of

1074

00:44:56,430 --> 00:44:53,700

radio emission is coming from this thing

1075

00:44:59,999 --> 00:44:56,440

we're hoping also to get some x-ray

1076
00:45:02,249 --> 00:45:00,009
observations possibly from Chandra to

1077
00:45:05,670 --> 00:45:02,259
see if there's any signs of black hole

1078
00:45:07,859 --> 00:45:05,680
activity as well so the as to what

1079
00:45:12,450 --> 00:45:07,869
happens to all the material that's blown

1080
00:45:14,160 --> 00:45:12,460
out from the Jets I think that's I mean

1081
00:45:16,519 --> 00:45:14,170
what happens is it goes out into the

1082
00:45:19,710 --> 00:45:16,529
what we call the intracluster medium

1083
00:45:21,450 --> 00:45:19,720
which is all of the gas and material in

1084
00:45:24,660 --> 00:45:21,460
between the galaxies within the galaxy

1085
00:45:26,309 --> 00:45:24,670
cluster in so we have when we have a

1086
00:45:28,230 --> 00:45:26,319
galaxy cluster if there's a whole bunch

1087
00:45:29,549 --> 00:45:28,240
of galaxies that you can see there's a

1088
00:45:31,410 --> 00:45:29,559

whole bunch of dark matter holding it

1089

00:45:35,370 --> 00:45:31,420

together and then there's also a lot of

1090

00:45:37,559 --> 00:45:35,380

hot gas and so the material that's being

1091

00:45:40,289 --> 00:45:37,569

blown out from the center of the galaxy

1092

00:45:43,380 --> 00:45:40,299

cluster will be formed will form part of

1093

00:45:46,620 --> 00:45:43,390

this inter-cluster medium but we I have

1094

00:45:48,599 --> 00:45:46,630

collaborators who study this a lot here

1095

00:45:50,910 --> 00:45:48,609

in Montreal and you know they can they

1096

00:45:53,999 --> 00:45:50,920

see all sorts of wonderful images in the

1097

00:45:56,579 --> 00:45:54,009

x-ray of huge holes and cavities being

1098

00:45:57,960 --> 00:45:56,589

blown out within the intracluster medium

1099

00:46:00,900 --> 00:45:57,970

that they think are being caused by

1100

00:46:04,380 --> 00:46:00,910

these Jets just basically clearing away

1101
00:46:07,049 --> 00:46:04,390
material so it's a very violent place

1102
00:46:10,109 --> 00:46:07,059
and how it all settles down i think is

1103
00:46:12,499 --> 00:46:10,119
it's an open question yeah that's a good

1104
00:46:14,789 --> 00:46:12,509
question than in a and highlights the

1105
00:46:16,589 --> 00:46:14,799
importance of all the wavelengths you

1106
00:46:19,370 --> 00:46:16,599
can get to bear on a on a particular

1107
00:46:21,630 --> 00:46:19,380
area this guy is always useful right

1108
00:46:22,859 --> 00:46:21,640
okay so Scott do you see anything on

1109
00:46:24,599 --> 00:46:22,869
twitter is there anything I should we

1110
00:46:26,099 --> 00:46:24,609
should we should mention on that it's a

1111
00:46:29,009 --> 00:46:26,109
question that we've touched on and we

1112
00:46:31,170 --> 00:46:29,019
kind of danced around but I'm really

1113
00:46:35,000 --> 00:46:31,180

sorry no dancing on these hangouts I

1114

00:46:37,650 --> 00:46:35,010

yes sir dancing you just don't know him

1115

00:46:40,319 --> 00:46:37,660

but I am so sorry if I mispronounced

1116

00:46:43,109 --> 00:46:40,329

your name but nowhere travell see she's

1117

00:46:44,609 --> 00:46:43,119

wondering how we're able to measure the

1118

00:46:47,579 --> 00:46:44,619

redshifts oh we've we've talked about

1119

00:46:49,020 --> 00:46:47,589

spectra but how were you able to this

1120

00:46:51,510 --> 00:46:49,030

was back before when we're talking about

1121

00:46:53,940 --> 00:46:51,520

how the two blobs the lower-left were

1122

00:46:56,579 --> 00:46:53,950

actually foreground objects and she was

1123

00:46:59,130 --> 00:46:56,589

wondering how you're able to find out

1124

00:47:00,960 --> 00:46:59,140

you know how your uvula measure the

1125

00:47:04,020 --> 00:47:00,970

redshift to find out that it is a

1126
00:47:08,760 --> 00:47:04,030
foreground object Adam do you want to

1127
00:47:09,809 --> 00:47:08,770
take this one yeah sure it's it's once

1128
00:47:12,030 --> 00:47:09,819
you get the data it's a fairly

1129
00:47:14,250 --> 00:47:12,040
straightforward thing to do or what

1130
00:47:16,640 --> 00:47:14,260
we're looking for is Tracy mentioned

1131
00:47:19,410 --> 00:47:16,650
before these emission lines that you see

1132
00:47:21,660 --> 00:47:19,420
come from gas and come from star or

1133
00:47:23,940 --> 00:47:21,670
absorption lines come from stars in the

1134
00:47:26,130 --> 00:47:23,950
galaxy and so when we get a spectrum we

1135
00:47:29,250 --> 00:47:26,140
see a series of absorption features and

1136
00:47:31,890 --> 00:47:29,260
a series of emission features and what

1137
00:47:34,170 --> 00:47:31,900
we do is we know what wavelength we

1138
00:47:36,870 --> 00:47:34,180

would see them that if they were here on

1139

00:47:38,370 --> 00:47:36,880

earth and of course because they're not

1140

00:47:40,170 --> 00:47:38,380

here on earth and they're very far away

1141

00:47:42,270 --> 00:47:40,180

and their redshift that and they're

1142

00:47:44,400 --> 00:47:42,280

moving away from us the wavelengths that

1143

00:47:47,280 --> 00:47:44,410

we see them out has been shifted into

1144

00:47:48,930 --> 00:47:47,290

the red and so we simply compare all

1145

00:47:51,089 --> 00:47:48,940

those wavelengths that we know you know

1146

00:47:52,530 --> 00:47:51,099

all those features that we know the

1147

00:47:54,089 --> 00:47:52,540

wavelengths that we measure to the ones

1148

00:47:57,120 --> 00:47:54,099

we know they should be and that

1149

00:47:59,730 --> 00:47:57,130

difference is the red shift and and from

1150

00:48:01,349 --> 00:47:59,740

the red shift based on knowing stuff

1151
00:48:04,770 --> 00:48:01,359
about the way the universe expands we

1152
00:48:06,480 --> 00:48:04,780
can tell how far away it is right in a

1153
00:48:09,210 --> 00:48:06,490
another interesting part about this

1154
00:48:11,220 --> 00:48:09,220
whole thing is the the the fact that the

1155
00:48:12,510 --> 00:48:11,230
wavelengths eat what Tracy was talking

1156
00:48:14,190 --> 00:48:12,520
about earlier the fact that these stars

1157
00:48:17,910 --> 00:48:14,200
were burning bright in one way playing

1158
00:48:19,740 --> 00:48:17,920
as the as the the universe expanded and

1159
00:48:21,450 --> 00:48:19,750
they and they got further away they are

1160
00:48:23,430 --> 00:48:21,460
they shifted the wavelength of the light

1161
00:48:25,349 --> 00:48:23,440
into the lower wavelengths of infrared

1162
00:48:28,049 --> 00:48:25,359
which i think is it's always kind of

1163
00:48:31,470 --> 00:48:28,059

blows my mind a little bit so and so

1164

00:48:33,599 --> 00:48:31,480

when you have the to demote Tracy very

1165

00:48:35,039 --> 00:48:33,609

early onset is a two-dimensional image

1166

00:48:37,410 --> 00:48:35,049

you have this two-dimensional image

1167

00:48:40,319 --> 00:48:37,420

which gives you like x and y to get the

1168

00:48:43,079 --> 00:48:40,329

Z then you look at these red shifts and

1169

00:48:44,800 --> 00:48:43,089

depending on how close the cluster is

1170

00:48:46,930 --> 00:48:44,810

sometimes you can get enough

1171

00:48:49,480 --> 00:48:46,940

solution not only to tell that all those

1172

00:48:52,120 --> 00:48:49,490

objects have the same red shift and some

1173

00:48:54,280 --> 00:48:52,130

another object is in front because it's

1174

00:48:56,170 --> 00:48:54,290

not as far away sometimes you can

1175

00:48:57,760 --> 00:48:56,180

actually tell the individual motions

1176
00:48:59,260 --> 00:48:57,770
within their so you know how far away

1177
00:49:02,440 --> 00:48:59,270
and then they have a little little

1178
00:49:04,390 --> 00:49:02,450
little bit emotions relative to like the

1179
00:49:06,970 --> 00:49:04,400
central this big massive central thing

1180
00:49:08,440 --> 00:49:06,980
so it just depends on how far away it is

1181
00:49:10,420 --> 00:49:08,450
how much light it puts out the

1182
00:49:13,300 --> 00:49:10,430
resolution spectrograph all those

1183
00:49:15,280 --> 00:49:13,310
combinations but certainly telling a

1184
00:49:19,780 --> 00:49:15,290
foreground object from the cluster

1185
00:49:21,850 --> 00:49:19,790
object is is fairly straightforward yeah

1186
00:49:24,130 --> 00:49:21,860
that's actually what we do we do see

1187
00:49:25,780 --> 00:49:24,140
those extra little Wiggles on top of it

1188
00:49:27,730 --> 00:49:25,790

and those extra little Wiggles are the

1189

00:49:29,680 --> 00:49:27,740

galaxies moving around inside the

1190

00:49:32,440 --> 00:49:29,690

cluster and for measuring that that's

1191

00:49:33,940 --> 00:49:32,450

actually how much out how much mass is

1192

00:49:36,010 --> 00:49:33,950

in the cluster and that's how we know

1193

00:49:41,970 --> 00:49:36,020

this is you know 100 trillion Suns

1194

00:49:46,270 --> 00:49:41,980

worthless in the center of this cluster

1195

00:49:49,330 --> 00:49:46,280

okay uh Adam synergy I see you there

1196

00:49:52,570 --> 00:49:49,340

you're in a longtime viewer he's on the

1197

00:49:54,130 --> 00:49:52,580

the Google+ event page he's uh he's

1198

00:49:57,070 --> 00:49:54,140

saying that he's having trouble watching

1199

00:49:58,810 --> 00:49:57,080

on mrs. synergies ipad today is that

1200

00:50:00,640 --> 00:49:58,820

your real name synergy that's really

1201
00:50:02,320 --> 00:50:00,650
cool the Q&A app doesn't want to play

1202
00:50:06,010 --> 00:50:02,330
nicely so you folks have a day off from

1203
00:50:08,500 --> 00:50:06,020
my crazy questions so you guys got a

1204
00:50:10,150 --> 00:50:08,510
reprieve at UH gentleman tell me can get

1205
00:50:14,710 --> 00:50:10,160
us on Twitter but I've not seen him on

1206
00:50:17,680 --> 00:50:14,720
Twitter yet synergy I was I want that

1207
00:50:19,090 --> 00:50:17,690
last name okay okay well its got

1208
00:50:22,150 --> 00:50:19,100
anything else am I missing anything we

1209
00:50:25,030 --> 00:50:22,160
did you get a no that's anything's been

1210
00:50:26,560 --> 00:50:25,040
already asked or answered in the Hangout

1211
00:50:28,890 --> 00:50:26,570
it's been really great sparse our

1212
00:50:31,270 --> 00:50:28,900
interaction on there let me check

1213
00:50:33,340 --> 00:50:31,280

YouTube real quick to make sure we have

1214

00:50:35,170 --> 00:50:33,350

a missing thing over there I keep

1215

00:50:36,720 --> 00:50:35,180

forgetting to do that are you kidding we

1216

00:50:40,240 --> 00:50:36,730

solved all the mysteries in the universe

1217

00:50:43,170 --> 00:50:40,250

unless you're not work yeah unless an

1218

00:50:46,870 --> 00:50:43,180

hour absolutely we should get a bonus a

1219

00:50:50,770 --> 00:50:46,880

question oh no we should get wine served

1220

00:50:56,410 --> 00:50:50,780

to us well we don't it yeah I knew I the

1221

00:50:56,410 --> 00:50:56,420

Italian contingent oh maybe already

1222

00:51:02,300 --> 00:50:58,880

I'll continue their they're getting

1223

00:51:03,950 --> 00:51:02,310

ready I'm sure if no mention well we

1224

00:51:05,330 --> 00:51:03,960

didn't do it we didn't get our word for

1225

00:51:07,070 --> 00:51:05,340

the drinking game me at this time around

1226

00:51:08,450 --> 00:51:07,080

either but maybe next week okay well

1227

00:51:11,990 --> 00:51:08,460

folks I guess we're going to we're going

1228

00:51:14,540 --> 00:51:12,000

to call it there a Tracy Tracy web and

1229

00:51:16,130 --> 00:51:14,550

allison and and adam i want to thank all

1230

00:51:18,920 --> 00:51:16,140

of you for joining us today and sharing

1231

00:51:20,780 --> 00:51:18,930

with us your research on on this galaxy

1232

00:51:22,670 --> 00:51:20,790

cluster and hopefully when you get more

1233

00:51:24,530 --> 00:51:22,680

wavelengths you'll come back and and

1234

00:51:26,450 --> 00:51:24,540

should show us what you found or give us

1235

00:51:28,250 --> 00:51:26,460

an update on what's happening whoa can

1236

00:51:30,290 --> 00:51:28,260

we get will you do that for us sure

1237

00:51:32,920 --> 00:51:30,300

awesome great thank you so much okay

1238

00:51:36,110 --> 00:51:32,930

guys I guess that's it on behalf of

1239

00:51:37,550 --> 00:51:36,120

Scott Lewis Carroll Christian I want to

1240

00:51:39,830 --> 00:51:37,560

thank you all for watching we will be

1241

00:51:42,620 --> 00:51:39,840

back next week same Hubble time same

1242

00:51:44,390 --> 00:51:42,630

Hubble channel and come up with a new

1243

00:51:45,680 --> 00:51:44,400

Hubble name oh wait Hubble holics that

1244

00:51:48,020 --> 00:51:45,690

was mine i came up with that one this

1245

00:51:50,660 --> 00:51:48,030

week so still unfilled little toddlers i

1246

00:51:53,240 --> 00:51:50,670

know i'm still and i'm still a hubble

1247

00:51:57,860 --> 00:51:53,250

hugger yeah i know that's right hubble

1248

00:52:02,090 --> 00:51:57,870

hubble oh yeah right hablando Scoob

1249

00:52:04,730 --> 00:52:02,100

Londos ok thanks I think the word was

1250

00:52:08,420 --> 00:52:04,740

actually squishy squish all was that

1251

00:52:16,570 --> 00:52:08,430

hurt well we didn't we didn't come Tony

1252

00:52:21,950 --> 00:52:20,480

alright we're done thanks to all of you