

1  
00:00:05,169 --> 00:00:09,589  
hello everybody and welcome to this

2  
00:00:07,730 --> 00:00:11,179  
week's Hubble hang out my name is Tony

3  
00:00:09,589 --> 00:00:13,699  
Darnell and I work at the Space

4  
00:00:11,179 --> 00:00:15,410  
Telescope Science Institute it makes me

5  
00:00:13,699 --> 00:00:17,089  
very happy to welcome you all back to

6  
00:00:15,410 --> 00:00:19,759  
our Hubble hangouts here because you

7  
00:00:17,089 --> 00:00:22,339  
guys have been feeling giving us all

8  
00:00:19,760 --> 00:00:23,990  
kinds of great feedback and just it's

9  
00:00:22,339 --> 00:00:25,368  
just been amazing that we were just

10  
00:00:23,989 --> 00:00:27,348  
talking before the Hangout this is we've

11  
00:00:25,368 --> 00:00:29,179  
been doing this for two years now so

12  
00:00:27,349 --> 00:00:30,289  
every week we try to bring you new

13  
00:00:29,179 --> 00:00:33,469  
science from the Hubble Space Telescope

14  
00:00:30,289 --> 00:00:35,750  
and we are here today with yet another

15  
00:00:33,469 --> 00:00:37,730  
example of that this week astronomers

16  
00:00:35,750 --> 00:00:40,179  
using both the Spitzer Space Telescope

17  
00:00:37,729 --> 00:00:43,189  
and the Hubble Space Telescope have I

18  
00:00:40,179 --> 00:00:45,049  
have been looking at your galaxy

19  
00:00:43,189 --> 00:00:47,750  
clusters and they have found something

20  
00:00:45,049 --> 00:00:49,099  
interesting in there that ordinarily

21  
00:00:47,750 --> 00:00:52,399  
they do not find I'm not going to give

22  
00:00:49,100 --> 00:00:55,399  
it away yet because the I have the

23  
00:00:52,399 --> 00:00:57,679  
astronomers tell you all about it so now

24  
00:00:55,399 --> 00:00:59,509  
this is ordinarily the time when I start

25  
00:00:57,679 --> 00:01:01,128  
giving out announcements and stuff but I

26  
00:00:59,509 --> 00:01:03,738  
don't have any so because I don't think

27  
00:01:01,128 --> 00:01:05,359  
anything yeah all that interesting was

28  
00:01:03,738 --> 00:01:08,329  
going on so i'm not going to pass it on

29

00:01:05,359 --> 00:01:11,390  
to you guys but i would like to invite

30  
00:01:08,329 --> 00:01:13,129  
you guys to leave questions and comments

31  
00:01:11,390 --> 00:01:14,840  
throughout the throughout the hangout

32  
00:01:13,129 --> 00:01:15,859  
and we will read them throughout and i'm

33  
00:01:14,840 --> 00:01:17,210  
going to have scott tell you about that

34  
00:01:15,859 --> 00:01:20,810  
in just a minute but first i have to

35  
00:01:17,209 --> 00:01:23,959  
introduce my partners in crime dr. carol

36  
00:01:20,810 --> 00:01:26,000  
christian who joins the HST project

37  
00:01:23,959 --> 00:01:29,059  
outreach scientist hi Carol also don't

38  
00:01:26,000 --> 00:01:33,828  
know also joining me is almost a doctor

39  
00:01:29,060 --> 00:01:37,070  
dr. Scott Lewis no notice Scott Lewis

40  
00:01:33,828 --> 00:01:38,389  
from the from another cosmos calm and

41  
00:01:37,069 --> 00:01:40,039  
play great many other places around the

42  
00:01:38,390 --> 00:01:41,750  
internet he's driving the drive the

43  
00:01:40,040 --> 00:01:43,729

internet force during these hangouts and

44

00:01:41,750 --> 00:01:45,228

why don't you tell everybody's got how

45

00:01:43,728 --> 00:01:47,450

they can interact with us yeah

46

00:01:45,228 --> 00:01:49,250

absolutely so the best and easiest way

47

00:01:47,450 --> 00:01:51,140

for you to interact with us is using the

48

00:01:49,250 --> 00:01:52,549

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

49

00:01:51,140 --> 00:01:54,349

you'll see on the bottom left of your

50

00:01:52,549 --> 00:01:56,450

screen some yellow text saying that we

51

00:01:54,349 --> 00:01:58,519

are answering questions I've got it

52

00:01:56,450 --> 00:02:00,890

loaded up Tony's got it loaded up if you

53

00:01:58,519 --> 00:02:03,019

have any questions for us and our guests

54

00:02:00,890 --> 00:02:06,019

or even some comments about that you can

55

00:02:03,019 --> 00:02:07,429

ask that in there and you can even +1

56

00:02:06,019 --> 00:02:09,109

you can bump them up so if there's a

57

00:02:07,430 --> 00:02:10,640

question out there that that you like

58  
00:02:09,110 --> 00:02:12,500  
and you want to have answer you can go

59  
00:02:10,639 --> 00:02:14,389  
ahead and recommend that and we can

60  
00:02:12,500 --> 00:02:16,009  
select it when it's live and let

61  
00:02:14,389 --> 00:02:18,409  
people know that we are answering that

62  
00:02:16,009 --> 00:02:20,329  
question is going on you can also

63  
00:02:18,409 --> 00:02:22,310  
comment on youtube and also on google

64  
00:02:20,330 --> 00:02:24,319  
plus we have a facebook event for this

65  
00:02:22,310 --> 00:02:26,420  
as well and the other great way for

66  
00:02:24,318 --> 00:02:27,829  
interacting up with us is over on

67  
00:02:26,419 --> 00:02:29,869  
twitter so as you see my lower third

68  
00:02:27,830 --> 00:02:32,840  
here we have the hubble hang out hashtag

69  
00:02:29,870 --> 00:02:34,370  
so I've got Twitter up right now over in

70  
00:02:32,840 --> 00:02:36,950  
tweetdeck and we'll be answering

71  
00:02:34,370 --> 00:02:39,680  
questions and i'll be live tweeting as

72  
00:02:36,949 --> 00:02:42,799  
we're going on so just either at mention

73  
00:02:39,680 --> 00:02:44,959  
Hubble telescope or use the hashtag

74  
00:02:42,800 --> 00:02:47,060  
Hubble hang out and we will get your

75  
00:02:44,959 --> 00:02:50,090  
questions and reply to them during the

76  
00:02:47,060 --> 00:02:52,819  
show and would also i want to remind you

77  
00:02:50,090 --> 00:02:54,379  
guys that you know it happens about it

78  
00:02:52,819 --> 00:02:56,269  
starting to happen more often now people

79  
00:02:54,379 --> 00:02:58,250  
are telling me that they can't find the

80  
00:02:56,269 --> 00:03:00,709  
Hangout and the best way to find it is

81  
00:02:58,250 --> 00:03:03,199  
to subscribe to us on hubble site

82  
00:03:00,709 --> 00:03:04,700  
channel on youtube and that will alert

83  
00:03:03,199 --> 00:03:06,500  
you when the ones are coming out live

84  
00:03:04,699 --> 00:03:08,299  
but you guys should know by now every

85  
00:03:06,500 --> 00:03:10,789  
thursday at three o'clock eastern

86

00:03:08,300 --> 00:03:12,739  
daylight time we are here doing Hubble

87  
00:03:10,789 --> 00:03:13,969  
hangouts and so you should always check

88  
00:03:12,739 --> 00:03:15,739  
out the channel there you could also

89  
00:03:13,969 --> 00:03:17,509  
follow us like Scout said on ADD Hubble

90  
00:03:15,739 --> 00:03:19,340  
telescopes those are the two easiest

91  
00:03:17,509 --> 00:03:21,229  
ways to find out about these hangouts

92  
00:03:19,340 --> 00:03:23,000  
and you know you want to find them

93  
00:03:21,229 --> 00:03:25,518  
because they're becoming world famous I

94  
00:03:23,000 --> 00:03:28,659  
was looking at the demographics the

95  
00:03:25,519 --> 00:03:31,009  
other day Hubble huggers huh blurs

96  
00:03:28,659 --> 00:03:33,709  
Hubble Alex whatever you want to call

97  
00:03:31,009 --> 00:03:35,840  
yourselves oh if you guys are all over

98  
00:03:33,709 --> 00:03:37,280  
the world watching these hangouts and I

99  
00:03:35,840 --> 00:03:38,840  
think I know why we were talking about

100  
00:03:37,280 --> 00:03:40,969

this also before the Hangout you know

101

00:03:38,840 --> 00:03:44,060

why because where else in the entire

102

00:03:40,969 --> 00:03:47,120

internet are you going to learn what the

103

00:03:44,060 --> 00:03:51,229

mass of a blue giant star is in units of

104

00:03:47,120 --> 00:03:54,049

cow Wow trailer or the energy of a crazy

105

00:03:51,229 --> 00:03:57,018

idea of the energy of a quasar in units

106

00:03:54,049 --> 00:03:58,670

of ant push-ups these are the kinds of

107

00:03:57,019 --> 00:04:01,730

things folks we made us tautomers do in

108

00:03:58,669 --> 00:04:03,018

the past where i get it entire internet

109

00:04:01,729 --> 00:04:06,759

are you going to find something like

110

00:04:03,019 --> 00:04:13,159

that going our guests have just left yes

111

00:04:06,759 --> 00:04:16,639

we we make you guys earn your degrees

112

00:04:13,159 --> 00:04:18,889

right as I i yes it's great to everybody

113

00:04:16,639 --> 00:04:20,569

else and just I just want to comment I

114

00:04:18,889 --> 00:04:23,870

don't know why people can't find helpful



115  
00:04:20,569 --> 00:04:26,129  
hangouts it's called google I know I'm

116  
00:04:23,870 --> 00:04:30,319  
Hubble hang out

117  
00:04:26,129 --> 00:04:33,120  
like five links youtube to our website

118  
00:04:30,319 --> 00:04:34,409  
chopping so looks great by the still

119  
00:04:33,120 --> 00:04:36,990  
nevertheless people say they search for

120  
00:04:34,410 --> 00:04:41,700  
can't find it so I'm trying to help them

121  
00:04:36,990 --> 00:04:42,900  
in any way I can put your diet yeah you

122  
00:04:41,699 --> 00:04:45,120  
know what I'm going to do in the next

123  
00:04:42,899 --> 00:04:47,429  
and the next uh exoplanet hang out i'm

124  
00:04:45,120 --> 00:04:50,730  
going to ask the guest to tell me how

125  
00:04:47,430 --> 00:04:52,530  
many chewed up pieces of gum with it

126  
00:04:50,730 --> 00:04:53,910  
would fit in a Neptune size exoplanet

127  
00:04:52,529 --> 00:04:55,919  
that's what I want to know next so stay

128  
00:04:53,910 --> 00:04:59,780  
tuned folks will find all that out this

129  
00:04:55,920 --> 00:05:04,110  
week yeah that might be an estimate

130  
00:04:59,779 --> 00:05:05,669  
black people so this week we have a very

131  
00:05:04,110 --> 00:05:07,110  
interesting hang out in store for you

132  
00:05:05,670 --> 00:05:08,430  
and if I haven't scared away my guess

133  
00:05:07,110 --> 00:05:11,490  
although I feels like i have almost

134  
00:05:08,430 --> 00:05:12,600  
scared away one of them already I don't

135  
00:05:11,490 --> 00:05:14,790  
worry we're not going to make you do any

136  
00:05:12,600 --> 00:05:18,120  
weird calculations this week unless I

137  
00:05:14,790 --> 00:05:19,650  
will I'll making you on it okay I was

138  
00:05:18,120 --> 00:05:22,889  
gonna be nice but you know Scott's I've

139  
00:05:19,649 --> 00:05:25,229  
never known as well as I mentioned at

140  
00:05:22,889 --> 00:05:27,750  
the top of the hangout astronomers using

141  
00:05:25,230 --> 00:05:29,580  
both the Spitzer Space Telescope and

142  
00:05:27,750 --> 00:05:31,610  
Hubble and I guess the Canada France

143

00:05:29,579 --> 00:05:36,000  
Hawaii telescope which is on the ground

144  
00:05:31,610 --> 00:05:37,590  
in Hawaii we're looking at this galaxy

145  
00:05:36,000 --> 00:05:39,300  
cluster and they found something they

146  
00:05:37,589 --> 00:05:41,639  
looked at something they found things

147  
00:05:39,300 --> 00:05:43,170  
that's surprising I'm gonna let you I'm

148  
00:05:41,639 --> 00:05:44,610  
gonna let them describe what that is but

149  
00:05:43,170 --> 00:05:47,670  
before i do i've got introduced and with

150  
00:05:44,610 --> 00:05:49,740  
me is dr. tracy web she is from mcgill

151  
00:05:47,670 --> 00:05:52,050  
university astronomer in montreal height

152  
00:05:49,740 --> 00:05:54,360  
weight tracy and welcome thank you very

153  
00:05:52,050 --> 00:05:55,680  
much also joining me as dr. allison

154  
00:05:54,360 --> 00:05:58,410  
noble she is from the university of

155  
00:05:55,680 --> 00:05:59,730  
toronto and adam buzzing from cambridge

156  
00:05:58,410 --> 00:06:02,670  
welcome to both of you guys it's good to

157  
00:05:59,730 --> 00:06:05,610

have you on our hangout thank you hello

158

00:06:02,670 --> 00:06:07,259

okay so let's get started by the way we

159

00:06:05,610 --> 00:06:11,900

really appreciate them being here

160

00:06:07,259 --> 00:06:14,939

visiting us from Italy oh really

161

00:06:11,899 --> 00:06:17,609

conference and Italy oh you're you're in

162

00:06:14,939 --> 00:06:19,769

Italy right now yeah oh yes we had to

163

00:06:17,610 --> 00:06:23,430

clear a very business network yeah we

164

00:06:19,769 --> 00:06:26,039

could be having a glass of wine you

165

00:06:23,430 --> 00:06:27,889

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

166

00:06:26,040 --> 00:06:30,030

from having a glass of wine that's right

167

00:06:27,889 --> 00:06:31,740

in fact we're gonna probably come up

168

00:06:30,029 --> 00:06:33,689

with a word for a drinking game soon so

169

00:06:31,740 --> 00:06:34,918

you might want to you might want to stay

170

00:06:33,689 --> 00:06:39,529

it would not be a first time you've had

171

00:06:34,918 --> 00:06:41,639

a drinking game drinking espresso shots

172  
00:06:39,529 --> 00:06:47,489  
which is the last thing any of us need

173  
00:06:41,639 --> 00:06:49,259  
right now ok so today we put out on on

174  
00:06:47,490 --> 00:06:51,180  
Hubble side and as well as went out into

175  
00:06:49,259 --> 00:06:53,579  
the internets in general a press release

176  
00:06:51,180 --> 00:06:55,439  
that was announcing some of these

177  
00:06:53,579 --> 00:06:56,789  
findings some of these observations so

178  
00:06:55,439 --> 00:06:58,949  
Tracy I think I'd like to start with you

179  
00:06:56,790 --> 00:07:00,689  
but I also want to we always wait too

180  
00:06:58,949 --> 00:07:03,709  
long to put up images so Scott if you'd

181  
00:07:00,689 --> 00:07:06,120  
go ahead and put up this image this is a

182  
00:07:03,709 --> 00:07:07,500  
galaxy cluster and Tracy can you

183  
00:07:06,120 --> 00:07:11,280  
describe a little bit what we're looking

184  
00:07:07,500 --> 00:07:15,720  
at here yeah so what you're seeing is I

185  
00:07:11,279 --> 00:07:18,359  
guess a side-by-side image the obviously

186  
00:07:15,720 --> 00:07:20,490  
but i'll just make it clear that the

187  
00:07:18,360 --> 00:07:22,560  
image on the right hand side is a zoom

188  
00:07:20,490 --> 00:07:26,790  
in of the image on the left hand side

189  
00:07:22,560 --> 00:07:30,540  
and the image on the left hand side is a

190  
00:07:26,790 --> 00:07:32,780  
close-up of this galaxy cluster that

191  
00:07:30,540 --> 00:07:36,600  
myself and my collaborators discovered

192  
00:07:32,779 --> 00:07:38,369  
you can see a lot of the wall we can

193  
00:07:36,600 --> 00:07:40,340  
explain what a galaxy cluster is in a

194  
00:07:38,370 --> 00:07:43,649  
minute but it's essentially a

195  
00:07:40,339 --> 00:07:47,129  
conglomeration of many many galaxies

196  
00:07:43,649 --> 00:07:50,339  
held together in in space by their own

197  
00:07:47,129 --> 00:07:52,980  
pullet mutual gravity you can see we can

198  
00:07:50,339 --> 00:07:54,929  
see a lot of the clusters there the

199  
00:07:52,980 --> 00:07:59,340  
cluster member sorry shown as kind of

200

00:07:54,930 --> 00:08:02,519  
red galaxies now but the thing that we

201  
00:07:59,339 --> 00:08:05,339  
were really surprised to see is that

202  
00:08:02,519 --> 00:08:08,819  
funny J shaped object that seems to run

203  
00:08:05,339 --> 00:08:10,829  
in between two of those kind of red

204  
00:08:08,819 --> 00:08:13,110  
galaxies which is highlighted on the

205  
00:08:10,829 --> 00:08:14,250  
right hand side ok I want to let's get

206  
00:08:13,110 --> 00:08:15,870  
to that in just a minute but let's go

207  
00:08:14,250 --> 00:08:17,160  
back to what let's just let's take a

208  
00:08:15,870 --> 00:08:18,480  
step back and you were already on the

209  
00:08:17,160 --> 00:08:20,939  
right track by describing what these

210  
00:08:18,480 --> 00:08:23,610  
galaxies clusters are what is the name

211  
00:08:20,939 --> 00:08:27,269  
of this thing and has a name that I'm

212  
00:08:23,610 --> 00:08:31,710  
afraid to say it is called sparks 10 49

213  
00:08:27,269 --> 00:08:35,250  
plus 56 ok and it's called that for what

214  
00:08:31,709 --> 00:08:39,629

reason it's called that because it was

215

00:08:35,250 --> 00:08:41,820  
discovered as part of a search or a

216

00:08:39,629 --> 00:08:43,649  
survey for galaxy clusters which is

217

00:08:41,820 --> 00:08:46,280  
called sparks and Adam can tell you a

218

00:08:43,649 --> 00:08:49,559  
lot about sparks because that's his baby

219

00:08:46,279 --> 00:08:50,289  
sparks stands for the Spitzer adaptation

220

00:08:49,559 --> 00:08:53,528  
of the

221

00:08:50,289 --> 00:08:56,289  
sequence cluster survey i love i love

222

00:08:53,528 --> 00:09:02,078  
acronyms like that is acronym within the

223

00:08:56,289 --> 00:09:06,129  
name be kids right acronyms all the way

224

00:09:02,078 --> 00:09:07,508  
down recursive acronym so yes sparks is

225

00:09:06,129 --> 00:09:11,198  
the name of the survey that it was found

226

00:09:07,509 --> 00:09:15,310  
with him and then 10 49 plus 56 is just

227

00:09:11,198 --> 00:09:17,740  
a short handle for its coordinates

228

00:09:15,309 --> 00:09:18,939  
celestial coordinates in the sky you



229  
00:09:17,740 --> 00:09:20,318  
guys say it that way when you're in like

230  
00:09:18,940 --> 00:09:22,779  
meetings and stuff to go you know that i

231  
00:09:20,318 --> 00:09:25,208  
was looking at sparks 10 49 plus 56 and

232  
00:09:22,778 --> 00:09:26,740  
i saw so for the longest time they were

233  
00:09:25,208 --> 00:09:28,629  
just calling it Tracy's cluster which I

234  
00:09:26,740 --> 00:09:34,810  
really liked oh that's really good

235  
00:09:28,629 --> 00:09:36,610  
Tracy's cluster yeah but we probably

236  
00:09:34,809 --> 00:09:41,169  
designed after the show make sure you

237  
00:09:36,610 --> 00:09:42,339  
okay in short we call it 10 49 okay well

238  
00:09:41,169 --> 00:09:43,870  
Tracy's con we're going to call it

239  
00:09:42,339 --> 00:09:46,690  
Tracy's cluster on this hangout now so

240  
00:09:43,870 --> 00:09:50,589  
Tracy's cluster it has according to the

241  
00:09:46,690 --> 00:09:53,199  
president has 27 galaxies in it and it's

242  
00:09:50,589 --> 00:09:55,930  
pretty massive how many how many sons

243  
00:09:53,198 --> 00:09:59,528  
would that be well so first of all it

244  
00:09:55,929 --> 00:10:01,269  
we've only confirmed 27 oh there may be

245  
00:09:59,528 --> 00:10:03,399  
more than there's probably lots more

246  
00:10:01,269 --> 00:10:05,440  
because it's it takes a long time on a

247  
00:10:03,399 --> 00:10:08,259  
telescope even just to get one member

248  
00:10:05,440 --> 00:10:10,810  
confirmed so we've confirmed 27 but

249  
00:10:08,259 --> 00:10:14,528  
there's probably lots more probably I'm

250  
00:10:10,809 --> 00:10:18,189  
sure you know many hundreds but in terms

251  
00:10:14,528 --> 00:10:24,818  
of the overall mass of the cluster we

252  
00:10:18,190 --> 00:10:27,730  
estimate it to be a few so in scientific

253  
00:10:24,818 --> 00:10:35,229  
speak a few times 10 to the 14 solar

254  
00:10:27,730 --> 00:10:38,470  
masses report into the 14 so 10 to the 9

255  
00:10:35,230 --> 00:10:41,889  
is a billion and this is 10 to the 14

256  
00:10:38,470 --> 00:10:44,709  
sons okay that includes you know all of

257

00:10:41,889 --> 00:10:46,839  
the galaxies all of the gas and all of

258  
00:10:44,708 --> 00:10:49,688  
the dark matter so we are into the

259  
00:10:46,839 --> 00:10:51,750  
trillions and it is and these things are

260  
00:10:49,688 --> 00:10:54,099  
pretty far away then right that's right

261  
00:10:51,750 --> 00:10:56,169  
roughly according about 10 billion light

262  
00:10:54,100 --> 00:10:57,819  
years and for those of you who want to

263  
00:10:56,169 --> 00:11:00,129  
see it in the sky you have to look in

264  
00:10:57,818 --> 00:11:01,740  
the constellation of Ursa Major so

265  
00:11:00,129 --> 00:11:03,559  
that's sort of what we're talking about

266  
00:11:01,740 --> 00:11:05,210  
so

267  
00:11:03,559 --> 00:11:06,679  
Adam let me ask you about the spark what

268  
00:11:05,210 --> 00:11:09,110  
is the spark survey then was that

269  
00:11:06,679 --> 00:11:11,799  
something that is looking at the this

270  
00:11:09,110 --> 00:11:14,240  
the word survey tends to imply an entire

271  
00:11:11,799 --> 00:11:17,269

looking at big areas of the sky is that

272

00:11:14,240 --> 00:11:20,060

what it's doing yeah actually so sparks

273

00:11:17,269 --> 00:11:22,730

used a combination of data from the

274

00:11:20,059 --> 00:11:25,278

Spitzer telescope and the Canada France

275

00:11:22,730 --> 00:11:27,500

Hawaii telescope and basically the way

276

00:11:25,278 --> 00:11:29,778

that what we did is we took pictures of

277

00:11:27,500 --> 00:11:32,000

the sky over a fairly large area from

278

00:11:29,778 --> 00:11:34,129

both of those telescopes and the idea is

279

00:11:32,000 --> 00:11:36,649

that if you want to find very distant

280

00:11:34,129 --> 00:11:39,799

galaxies clusters the galaxy's that you

281

00:11:36,649 --> 00:11:41,750

find in them tend to be very red and so

282

00:11:39,799 --> 00:11:43,729

you look for things that are sort of

283

00:11:41,750 --> 00:11:46,159

very red when you take pictures between

284

00:11:43,730 --> 00:11:48,528

Canada France and Spitzer and if you can

285

00:11:46,159 --> 00:11:50,870

find those and they're all so bright and

286  
00:11:48,528 --> 00:11:53,149  
in big clumps those tend to be galaxy

287  
00:11:50,870 --> 00:11:54,679  
clusters that are very very far away so

288  
00:11:53,149 --> 00:11:56,509  
the point of sparks was to find these

289  
00:11:54,679 --> 00:11:58,069  
kind of things very distant galaxy

290  
00:11:56,509 --> 00:12:01,100  
clusters you know amongst the most

291  
00:11:58,070 --> 00:12:02,778  
distant that we can possibly find okay

292  
00:12:01,100 --> 00:12:03,680  
and I want to I'm Tracy I want to come

293  
00:12:02,778 --> 00:12:05,689  
back to you in a minute about this

294  
00:12:03,679 --> 00:12:08,149  
getting these things confirmed members

295  
00:12:05,690 --> 00:12:09,560  
of the galaxy note 4 duelists Carol let

296  
00:12:08,149 --> 00:12:11,029  
me get you I'd like to get you to tell

297  
00:12:09,559 --> 00:12:12,829  
you said before we started you know a

298  
00:12:11,029 --> 00:12:15,439  
lot about the Canada France Hawaii

299  
00:12:12,830 --> 00:12:16,220  
telescope and Spitzer so why don't you

300  
00:12:15,440 --> 00:12:19,790  
tell us a little bit about these

301  
00:12:16,220 --> 00:12:22,070  
instruments what I like so this spitzer

302  
00:12:19,789 --> 00:12:25,009  
is a space telescope which is one of the

303  
00:12:22,070 --> 00:12:28,070  
great observatories like Hubble Chandra

304  
00:12:25,009 --> 00:12:31,879  
is the x-ray great observatory spitzer

305  
00:12:28,070 --> 00:12:33,260  
is roughly the infrared Hubble is the UV

306  
00:12:31,879 --> 00:12:35,419  
optical although it has a little

307  
00:12:33,259 --> 00:12:37,700  
infrared and then there was a gamma-ray

308  
00:12:35,419 --> 00:12:40,519  
observatory and those were called the

309  
00:12:37,700 --> 00:12:44,030  
Great observatories and the three a

310  
00:12:40,519 --> 00:12:46,879  
Chandra Spitzer and Hubble are still in

311  
00:12:44,029 --> 00:12:50,120  
orbit and they are often used in concert

312  
00:12:46,879 --> 00:12:52,429  
to do multi-wavelength studies because

313  
00:12:50,120 --> 00:12:54,919  
you know an object might have x-rays

314

00:12:52,429 --> 00:12:58,750  
might be visible in the infrared want to

315  
00:12:54,919 --> 00:13:03,309  
compare to Hubble and Spitzer is

316  
00:12:58,750 --> 00:13:05,509  
something like 33 34 inch diameter

317  
00:13:03,309 --> 00:13:07,609  
telescope it has a number of instruments

318  
00:13:05,509 --> 00:13:10,519  
on it and mostly looks in the infrared

319  
00:13:07,610 --> 00:13:14,409  
so it's really good for looking at some

320  
00:13:10,519 --> 00:13:17,509  
of our favorite things distant galaxies

321  
00:13:14,409 --> 00:13:19,129  
exoplanets and also the center

322  
00:13:17,509 --> 00:13:20,990  
our galaxy or in other parts of our

323  
00:13:19,129 --> 00:13:25,340  
galaxy because the infrared looks

324  
00:13:20,990 --> 00:13:27,560  
through the dust infrared also as Adam

325  
00:13:25,340 --> 00:13:29,629  
was just saying can help find things

326  
00:13:27,559 --> 00:13:32,059  
that are very far away because of the

327  
00:13:29,629 --> 00:13:35,090  
reddening and the expansion of the

328  
00:13:32,059 --> 00:13:39,259

universe canada france is actually a

329

00:13:35,090 --> 00:13:42,740

ground-based telescope it was built by

330

00:13:39,259 --> 00:13:45,559

canada france and the university of

331

00:13:42,740 --> 00:13:50,360

hawaii it's on Mauna Kea in Hawaii I

332

00:13:45,559 --> 00:13:53,149

worked there for nine years and it's

333

00:13:50,360 --> 00:13:56,629

actually a magnificent telescope and it

334

00:13:53,149 --> 00:13:58,340

has lots of capability it has imaging

335

00:13:56,629 --> 00:14:01,870

capability because the site is really

336

00:13:58,340 --> 00:14:04,310

good not as good as as orbiting a

337

00:14:01,870 --> 00:14:07,159

satellite telescopes but in the minutes

338

00:14:04,309 --> 00:14:08,599

day it did some pretty darn good imaging

339

00:14:07,159 --> 00:14:11,299

and it's still really good imaging and

340

00:14:08,600 --> 00:14:12,800

it also does spectroscopy and so it's

341

00:14:11,299 --> 00:14:15,769

always helpful to have ground-based

342

00:14:12,799 --> 00:14:17,659

telescopes because you can get there



343  
00:14:15,769 --> 00:14:20,449  
they're useful because you can change

344  
00:14:17,659 --> 00:14:22,100  
instruments more quickly and if you

345  
00:14:20,450 --> 00:14:24,740  
build new ones you can put them on a

346  
00:14:22,100 --> 00:14:27,050  
ground-based telescope more quickly you

347  
00:14:24,740 --> 00:14:28,909  
can't put anyone and we're not servicing

348  
00:14:27,049 --> 00:14:32,120  
novel anymore and we never service bits

349  
00:14:28,909 --> 00:14:34,459  
or whenevers first service Chandra so

350  
00:14:32,120 --> 00:14:36,799  
Canada France has a really good suite of

351  
00:14:34,460 --> 00:14:37,910  
instruments for this kind of work a lot

352  
00:14:36,799 --> 00:14:39,979  
of people don't know this but while

353  
00:14:37,909 --> 00:14:41,629  
infrared astronomy is best done in space

354  
00:14:39,980 --> 00:14:44,029  
there are some places on the planet

355  
00:14:41,629 --> 00:14:45,679  
wherever that are very good for doing

356  
00:14:44,029 --> 00:14:47,600  
infrared astronomy the requirement being

357  
00:14:45,679 --> 00:14:48,739  
you need it to be very dry you need to

358  
00:14:47,600 --> 00:14:50,810  
have very little water vapor in the

359  
00:14:48,740 --> 00:14:52,370  
atmosphere so that the infrared can get

360  
00:14:50,809 --> 00:14:53,539  
through and in Hawaii happens to be one

361  
00:14:52,370 --> 00:14:55,879  
of those places even though you think of

362  
00:14:53,539 --> 00:14:58,250  
Hawaii is a humid tropical environment

363  
00:14:55,879 --> 00:15:00,470  
at 14,000 feet it's pretty dry up there

364  
00:14:58,250 --> 00:15:01,909  
and the same is true for the high high

365  
00:15:00,470 --> 00:15:04,460  
in the mountains of Chile which is what

366  
00:15:01,909 --> 00:15:07,490  
you see a lot of ground-based telescopes

367  
00:15:04,460 --> 00:15:09,769  
and back in the day we used to go up to

368  
00:15:07,490 --> 00:15:11,810  
the telescope open do the observations

369  
00:15:09,769 --> 00:15:14,029  
and I'll tell you there's nothing better

370  
00:15:11,809 --> 00:15:16,069  
than coming out of that you know four

371

00:15:14,029 --> 00:15:20,809  
days of dusty environment going straight

372  
00:15:16,070 --> 00:15:24,440  
to the beach get the babes going the

373  
00:15:20,809 --> 00:15:28,369  
other way well that yeah that's amazing

374  
00:15:24,440 --> 00:15:29,810  
so but what do they do now you said back

375  
00:15:28,370 --> 00:15:31,370  
in the day they do that what are they

376  
00:15:29,809 --> 00:15:34,250  
still go up to the

377  
00:15:31,370 --> 00:15:39,049  
no largely the observations i'm not sure

378  
00:15:34,250 --> 00:15:40,730  
what Traci Ann carburetors did but our

379  
00:15:39,049 --> 00:15:42,349  
friend Gordon Squires was just out there

380  
00:15:40,730 --> 00:15:44,899  
two weeks ago observing and they

381  
00:15:42,350 --> 00:15:49,220  
observed from God's country kamuela

382  
00:15:44,899 --> 00:15:52,039  
Hawaii or Waimea you know from either

383  
00:15:49,220 --> 00:15:55,850  
cfh kak there's a bunch of observatories

384  
00:15:52,039 --> 00:15:58,730  
and they they often observe from a more

385  
00:15:55,850 --> 00:16:01,790

habitable place where you can actually

386

00:15:58,730 --> 00:16:04,639

get food and like water stiffly get so

387

00:16:01,789 --> 00:16:06,620

don't get you know altitude sickness

388

00:16:04,639 --> 00:16:08,870

going up I was just there a little while

389

00:16:06,620 --> 00:16:10,850

ago too and the dubra tories for check

390

00:16:08,870 --> 00:16:12,560

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

391

00:16:10,850 --> 00:16:14,269

land but it's still great you still have

392

00:16:12,559 --> 00:16:16,159

access everything as opposed to being in

393

00:16:14,269 --> 00:16:19,189

no-man's right there's a starbucks

394

00:16:16,159 --> 00:16:22,730

across the street from tech so well I

395

00:16:19,190 --> 00:16:25,490

need to go back then because I'll be

396

00:16:22,730 --> 00:16:29,629

awesome oh you'll get that even my soy

397

00:16:25,490 --> 00:16:32,149

latte now exactly for him alright we

398

00:16:29,629 --> 00:16:36,200

digress don't get that in space Spitzer

399

00:16:32,149 --> 00:16:37,309

okay so all right so uh Tracy I want to

400  
00:16:36,200 --> 00:16:39,440  
go back to something you were to you

401  
00:16:37,309 --> 00:16:41,659  
would send about these galaxies clusters

402  
00:16:39,440 --> 00:16:44,000  
and getting members of them confirmed

403  
00:16:41,659 --> 00:16:46,278  
you said that was kind of a big deal but

404  
00:16:44,000 --> 00:16:47,480  
that you know there were only 27 so far

405  
00:16:46,278 --> 00:16:50,149  
but you think there's hundreds I don't

406  
00:16:47,480 --> 00:16:52,209  
understand what I mean Adam was just

407  
00:16:50,149 --> 00:16:54,740  
telling us about the survey itself they

408  
00:16:52,208 --> 00:16:56,539  
presumably identify these clusters

409  
00:16:54,740 --> 00:16:59,389  
pretty quickly there's a big old chunk

410  
00:16:56,539 --> 00:17:01,399  
of them there and then but then you said

411  
00:16:59,389 --> 00:17:03,379  
that getting the individual galaxies

412  
00:17:01,399 --> 00:17:04,189  
confirmed is kind of a big deal we want

413  
00:17:03,379 --> 00:17:05,990  
to talk a little bit about what that

414  
00:17:04,189 --> 00:17:07,970  
what that's involved what's involved in

415  
00:17:05,990 --> 00:17:10,250  
that right so if we want to know what

416  
00:17:07,970 --> 00:17:13,009  
what Adam finds is essentially the

417  
00:17:10,250 --> 00:17:15,349  
location of one of these galaxies

418  
00:17:13,009 --> 00:17:18,588  
clusters he sees like a big over density

419  
00:17:15,349 --> 00:17:21,469  
of galaxies in his survey but we don't

420  
00:17:18,588 --> 00:17:23,838  
know right away which individual

421  
00:17:21,470 --> 00:17:26,630  
galaxies in that over density are

422  
00:17:23,838 --> 00:17:28,369  
actually part of the of the cluster

423  
00:17:26,630 --> 00:17:29,630  
because if you think about it what

424  
00:17:28,369 --> 00:17:31,639  
you're seeing when you look at the

425  
00:17:29,630 --> 00:17:33,230  
cluster is everything that's in front of

426  
00:17:31,640 --> 00:17:34,790  
the cluster and everything that's behind

427  
00:17:33,230 --> 00:17:37,460  
the cluster and everything that's in the

428

00:17:34,789 --> 00:17:39,950  
cluster all projected onto one sort of

429  
00:17:37,460 --> 00:17:42,110  
two-dimensional image and so just by

430  
00:17:39,950 --> 00:17:43,940  
looking at it we can't necessarily we

431  
00:17:42,109 --> 00:17:44,779  
know that most of the galaxies that we

432  
00:17:43,940 --> 00:17:46,850  
see in that image

433  
00:17:44,779 --> 00:17:49,730  
probably cluster members but we know

434  
00:17:46,849 --> 00:17:53,059  
that there's also some contamination so

435  
00:17:49,730 --> 00:17:55,160  
the way we actually the way we confirm

436  
00:17:53,059 --> 00:17:57,619  
that a galaxy is within the cluster is

437  
00:17:55,160 --> 00:18:00,400  
by measuring the distance or the

438  
00:17:57,619 --> 00:18:04,549  
redshift to that particular galaxy and

439  
00:18:00,400 --> 00:18:06,800  
so we do that by gathering obtaining

440  
00:18:04,549 --> 00:18:09,230  
spectrum for the galaxy so we need a

441  
00:18:06,799 --> 00:18:12,589  
really really powerful telescope that

442  
00:18:09,230 --> 00:18:15,410

can provide really detailed measurements

443

00:18:12,589 --> 00:18:17,959

of the emission or the absorption lines

444

00:18:15,410 --> 00:18:19,160

in the galaxy spectrum and for that we

445

00:18:17,960 --> 00:18:21,769

actually used another ground-based

446

00:18:19,160 --> 00:18:25,340

telescope which is the the Keck

447

00:18:21,769 --> 00:18:28,009

Observatory and so we have to go out and

448

00:18:25,339 --> 00:18:30,679

measure an individual distance to every

449

00:18:28,009 --> 00:18:32,569

single galaxy in that image that you see

450

00:18:30,680 --> 00:18:34,279

there and see which ones are at the

451

00:18:32,569 --> 00:18:36,470

distance of the cluster and which ones

452

00:18:34,279 --> 00:18:38,569

are either in the foreground or in the

453

00:18:36,470 --> 00:18:40,640

background and basically separated out

454

00:18:38,569 --> 00:18:43,939

into like a three-dimensional image and

455

00:18:40,640 --> 00:18:46,580

so each one of those observations takes

456

00:18:43,940 --> 00:18:48,529

a long time I see so that's what you



457  
00:18:46,579 --> 00:18:50,899  
meant ok so with redshift we've talked

458  
00:18:48,529 --> 00:18:53,930  
about that at least a hundred and fifty

459  
00:18:50,900 --> 00:18:56,509  
three times on these hangouts so there

460  
00:18:53,930 --> 00:18:59,240  
it's a number it's just a way in which

461  
00:18:56,509 --> 00:19:00,920  
we find out how far away these galaxies

462  
00:18:59,240 --> 00:19:03,700  
are the bigger the number the farther

463  
00:19:00,920 --> 00:19:06,230  
away they are the galaxies record of

464  
00:19:03,700 --> 00:19:08,150  
Hubble has been somewhere of about Z

465  
00:19:06,230 --> 00:19:12,289  
equals 11 something like that which is

466  
00:19:08,150 --> 00:19:14,990  
pretty darn far away but frontier fields

467  
00:19:12,289 --> 00:19:16,670  
is hoping to make that even break that

468  
00:19:14,990 --> 00:19:18,140  
record too so anyway that's just a

469  
00:19:16,670 --> 00:19:19,670  
number of how far away things are and

470  
00:19:18,140 --> 00:19:22,400  
it's a time consuming measurement now

471  
00:19:19,670 --> 00:19:28,250  
you guys said you used qik to get that

472  
00:19:22,400 --> 00:19:30,080  
done but so the Alice are yeah Allison

473  
00:19:28,250 --> 00:19:31,220  
let me let me try to get you into this

474  
00:19:30,079 --> 00:19:32,299  
conversation a little bit haven't heard

475  
00:19:31,220 --> 00:19:34,069  
from you yet why don't you describe for

476  
00:19:32,299 --> 00:19:35,960  
us a little bit about what your role is

477  
00:19:34,069 --> 00:19:38,059  
what your interest is in this and some

478  
00:19:35,960 --> 00:19:39,920  
of the things that that you that you've

479  
00:19:38,059 --> 00:19:43,339  
noticed about the about this galaxy

480  
00:19:39,920 --> 00:19:47,120  
cluster so you broke out for a second oh

481  
00:19:43,339 --> 00:19:48,589  
oh oh sorry i was out what i want to try

482  
00:19:47,119 --> 00:19:50,329  
and get you involved in the guy wanted

483  
00:19:48,589 --> 00:19:51,679  
to get a sense of what you were doing as

484  
00:19:50,329 --> 00:19:54,589  
part of this team with what your

485

00:19:51,680 --> 00:19:57,590  
interest is and what about this galaxy

486  
00:19:54,589 --> 00:20:00,439  
cluster got you got you going

487  
00:19:57,589 --> 00:20:02,599  
right so we've only just started to talk

488  
00:20:00,440 --> 00:20:04,509  
about some of the wavelengths we've

489  
00:20:02,599 --> 00:20:07,449  
looked at this cluster but we've also

490  
00:20:04,509 --> 00:20:09,379  
looked at it at the far infrared

491  
00:20:07,450 --> 00:20:11,000  
infrared all the way through far

492  
00:20:09,380 --> 00:20:12,020  
infrared and submillimetre wavelengths

493  
00:20:11,000 --> 00:20:13,548  
as well and that's kind of where my

494  
00:20:12,019 --> 00:20:16,308  
world comes in is looking at some of

495  
00:20:13,548 --> 00:20:19,190  
these longer wavelengths emission from

496  
00:20:16,308 --> 00:20:23,509  
the cluster and the galaxies in the

497  
00:20:19,190 --> 00:20:26,509  
cluster so we so we we talked about

498  
00:20:23,509 --> 00:20:29,589  
Spitzer that we have MIPS 24 micron

499  
00:20:26,509 --> 00:20:32,538

imaging but we also have another

500  
00:20:29,589 --> 00:20:36,769  
space-based telescope that we're using

501  
00:20:32,538 --> 00:20:40,730  
which is Herschel oh no longer that's a

502  
00:20:36,769 --> 00:20:44,148  
nice Oh scope or was yes was yes so it's

503  
00:20:40,730 --> 00:20:47,690  
no longer running but they there's a

504  
00:20:44,148 --> 00:20:49,788  
bunch of archival data from Herschel

505  
00:20:47,690 --> 00:20:53,450  
that you can download yourself and

506  
00:20:49,788 --> 00:20:55,669  
reduce the images so we use that the

507  
00:20:53,450 --> 00:20:58,880  
archival data to get three additional

508  
00:20:55,669 --> 00:21:01,759  
wave length measurements of one of the

509  
00:20:58,880 --> 00:21:03,020  
the galaxies in this this cluster that

510  
00:21:01,759 --> 00:21:05,720  
I'm sure trace is going to talk about a

511  
00:21:03,019 --> 00:21:08,839  
bit more so it's the brightest cluster

512  
00:21:05,720 --> 00:21:12,528  
galaxies which is kind of the main focus

513  
00:21:08,839 --> 00:21:16,579  
of this paper and then additionally we

514  
00:21:12,528 --> 00:21:19,429  
also got imaging from submillimeter

515  
00:21:16,579 --> 00:21:22,250  
telescope also on Mauna Kea called the

516  
00:21:19,429 --> 00:21:28,220  
JC mt you guys hauled up everybody's

517  
00:21:22,250 --> 00:21:33,589  
time these people live right right they

518  
00:21:28,220 --> 00:21:40,490  
go to conferences in in Italy I was like

519  
00:21:33,589 --> 00:21:42,259  
really forget sir we galaxy you still go

520  
00:21:40,490 --> 00:21:44,058  
up the mountain center JC mt which is

521  
00:21:42,259 --> 00:21:46,579  
kind of nice yeah little bit of

522  
00:21:44,058 --> 00:21:48,980  
starbucks but you you do get to see the

523  
00:21:46,579 --> 00:21:52,038  
mars-like landscape on the top of Mauna

524  
00:21:48,980 --> 00:21:54,860  
Kea and spend 14 our nights observing on

525  
00:21:52,038 --> 00:21:57,558  
JC Mt there it is Scott's got a picture

526  
00:21:54,859 --> 00:22:00,379  
of it there so yeah staring at us from

527  
00:21:57,558 --> 00:22:03,829  
the top of not at us but at sky at it

528  
00:22:00,380 --> 00:22:05,720  
from the top of Mauna Kea so okay well

529  
00:22:03,829 --> 00:22:08,349  
so you looked at Scott would you please

530  
00:22:05,720 --> 00:22:11,058  
put back up the the cluster image again

531  
00:22:08,349 --> 00:22:11,990  
so Hubble had something to do with

532  
00:22:11,058 --> 00:22:13,788  
us we're going to get to that in a

533  
00:22:11,990 --> 00:22:16,819  
minute but first you look at it with

534  
00:22:13,788 --> 00:22:19,190  
Spitzer as part of this survey went and

535  
00:22:16,819 --> 00:22:22,759  
use the c f h t to kind of go back and

536  
00:22:19,190 --> 00:22:24,320  
verify things and so Tracy go ahead you

537  
00:22:22,759 --> 00:22:26,659  
said the thing that interested you the

538  
00:22:24,319 --> 00:22:30,319  
most was this little squishy thing in

539  
00:22:26,659 --> 00:22:33,590  
between these bright blobs there I know

540  
00:22:30,319 --> 00:22:36,859  
this is extremely dense jargon i'm using

541  
00:22:33,589 --> 00:22:38,720  
here budget ok so but this squishy thing

542

00:22:36,859 --> 00:22:40,519  
the squishy thing is what you wouldn't

543  
00:22:38,720 --> 00:22:42,649  
treat you what is that a galaxy being

544  
00:22:40,519 --> 00:22:45,109  
lens what is that well okay so let me

545  
00:22:42,648 --> 00:22:47,839  
back up to that is is seen only in the

546  
00:22:45,109 --> 00:22:49,339  
Hubble image so that was a when we

547  
00:22:47,839 --> 00:22:52,638  
actually knew that we had something

548  
00:22:49,339 --> 00:22:55,819  
really exciting before that from the

549  
00:22:52,638 --> 00:22:59,769  
Spitzer imaging that Allison was talking

550  
00:22:55,819 --> 00:23:03,230  
about which gives us it gives us

551  
00:22:59,769 --> 00:23:07,690  
measurements in the mid infrared so at

552  
00:23:03,230 --> 00:23:11,028  
24 microns and that's a wavelength that

553  
00:23:07,690 --> 00:23:13,159  
comes from dusk that's heated by very

554  
00:23:11,028 --> 00:23:14,538  
young stars and it's a really good if

555  
00:23:13,159 --> 00:23:17,480  
you want to know if there's star

556  
00:23:14,538 --> 00:23:19,730

formation going on in a galaxy a really

557

00:23:17,480 --> 00:23:22,639

good way of determining that is to look

558

00:23:19,730 --> 00:23:24,319

at it at these 24 micron wavelengths

559

00:23:22,638 --> 00:23:25,729

because if there is star formation going

560

00:23:24,319 --> 00:23:27,769

on the whole thing will just glow

561

00:23:25,730 --> 00:23:30,618

because it's hot there's a lot of hot

562

00:23:27,769 --> 00:23:32,960

hot exactly exactly and and the star

563

00:23:30,618 --> 00:23:34,519

formation generally occurs behind these

564

00:23:32,960 --> 00:23:38,720

I'd like to think of them as big cocoons

565

00:23:34,519 --> 00:23:41,569

and the cocoons of dust and the dust

566

00:23:38,720 --> 00:23:43,399

absorbs the light from the baby stars

567

00:23:41,569 --> 00:23:45,138

and then radiates it away in the

568

00:23:43,398 --> 00:23:50,709

infrared just like you and I radiate the

569

00:23:45,138 --> 00:23:50,709

infrared and so we some more than others

570

00:23:52,210 --> 00:23:57,889

so okay so Spitzer looked at this first



571  
00:23:56,148 --> 00:23:59,268  
she saw a lot of heat going on there and

572  
00:23:57,888 --> 00:24:01,339  
that caught your attention and that

573  
00:23:59,269 --> 00:24:03,798  
caught our attention and so then we

574  
00:24:01,339 --> 00:24:07,249  
wrote a proposal to the Hubble Space

575  
00:24:03,798 --> 00:24:09,230  
Telescope which essentially wanted to

576  
00:24:07,249 --> 00:24:10,909  
see what was going on we wanted to know

577  
00:24:09,230 --> 00:24:14,118  
why there was so much star formation

578  
00:24:10,909 --> 00:24:15,919  
happening and when we took the image

579  
00:24:14,118 --> 00:24:17,898  
with a Hubble Space Telescope this is

580  
00:24:15,919 --> 00:24:19,278  
the image that we saw we saw I don't

581  
00:24:17,898 --> 00:24:23,569  
remember what you called it now but the

582  
00:24:19,278 --> 00:24:24,619  
the long blobby thing I'm calma squishy

583  
00:24:23,569 --> 00:24:26,808  
profession

584  
00:24:24,619 --> 00:24:30,199  
you're the astronomer so if it's blobby

585  
00:24:26,808 --> 00:24:32,089  
then it's both it's so if you look at it

586  
00:24:30,200 --> 00:24:33,740  
edit careful you have to kind of squint

587  
00:24:32,089 --> 00:24:36,709  
your eyes a little bit but it is a long

588  
00:24:33,740 --> 00:24:38,539  
tail which seems to be coming out of one

589  
00:24:36,710 --> 00:24:41,058  
of the very bright galaxies that you see

590  
00:24:38,539 --> 00:24:43,220  
there and there's sort of clumps all the

591  
00:24:41,058 --> 00:24:45,549  
way along that tail and then it finishes

592  
00:24:43,220 --> 00:24:48,650  
off in this kind of backwards J

593  
00:24:45,549 --> 00:24:50,389  
structure which also has lumps in it so

594  
00:24:48,650 --> 00:24:51,980  
there's both diffuse emission and the

595  
00:24:50,390 --> 00:24:53,809  
whole thing is very long and then along

596  
00:24:51,980 --> 00:24:56,299  
its length there's all of these clumps

597  
00:24:53,808 --> 00:24:59,569  
and we could only see that with the

598  
00:24:56,299 --> 00:25:01,419  
extremely high resolution of the Spitzer

599

00:24:59,569 --> 00:25:03,889  
Space Telescope it was completely

600  
00:25:01,420 --> 00:25:06,620  
invisible in all of the other imaging

601  
00:25:03,890 --> 00:25:10,820  
that we had and so this was really

602  
00:25:06,619 --> 00:25:13,819  
exciting because this is the this is a

603  
00:25:10,819 --> 00:25:17,149  
sign that something very violent has

604  
00:25:13,819 --> 00:25:20,178  
been happening with this object it

605  
00:25:17,150 --> 00:25:23,300  
something in this object has essentially

606  
00:25:20,179 --> 00:25:25,970  
been ripped apart and it's been pulled

607  
00:25:23,299 --> 00:25:28,428  
apart along what we call this tidal tail

608  
00:25:25,970 --> 00:25:31,519  
and there's new stars which are probably

609  
00:25:28,429 --> 00:25:34,009  
being formed all along it because of

610  
00:25:31,519 --> 00:25:35,869  
this very violent process so which blob

611  
00:25:34,009 --> 00:25:37,910  
which red blob are you thinking this is

612  
00:25:35,869 --> 00:25:39,649  
a part of dude one in the upper right or

613  
00:25:37,910 --> 00:25:41,750

the more one on the upper right so that

614

00:25:39,650 --> 00:25:43,280

so this was part of the really hard work

615

00:25:41,750 --> 00:25:48,109

the blob in the upper right which is

616

00:25:43,279 --> 00:25:50,928

circled Oh way to go Scott good cue I'm

617

00:25:48,109 --> 00:25:54,500

a professional Tony URI professional I'm

618

00:25:50,929 --> 00:25:56,480

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

619

00:25:54,500 --> 00:25:58,940

called the brightest cluster galaxies

620

00:25:56,480 --> 00:26:01,640

which is as mentioned here the central

621

00:25:58,940 --> 00:26:04,250

cluster galaxies so it is a huge mass of

622

00:26:01,640 --> 00:26:07,910

galaxies which is sitting at the very

623

00:26:04,250 --> 00:26:09,859

center of this galaxy cluster and it's

624

00:26:07,910 --> 00:26:11,929

different than all other galaxies in the

625

00:26:09,859 --> 00:26:14,329

universe so most galaxy clusters have

626

00:26:11,929 --> 00:26:17,570

one of these hulking Giants sitting in

627

00:26:14,329 --> 00:26:19,849

their very centers and so we think that

628  
00:26:17,569 --> 00:26:23,089  
the tail is kind of emanating out from

629  
00:26:19,849 --> 00:26:24,949  
that object so if you trace it all the

630  
00:26:23,089 --> 00:26:27,379  
way back you can see it sort of curls

631  
00:26:24,950 --> 00:26:29,330  
its way back into that object just for

632  
00:26:27,380 --> 00:26:31,970  
interest the two there's two bright

633  
00:26:29,329 --> 00:26:34,069  
blobs to the lower left and those are

634  
00:26:31,970 --> 00:26:36,200  
actually they have nothing to do with

635  
00:26:34,069 --> 00:26:37,788  
the galaxy cluster we've confirmed using

636  
00:26:36,200 --> 00:26:41,720  
Keck that those are things that are

637  
00:26:37,788 --> 00:26:44,690  
actually seen from the foreground I'm

638  
00:26:41,720 --> 00:26:46,159  
Richard we got all the chips okay all

639  
00:26:44,690 --> 00:26:47,840  
right interesting answer again because

640  
00:26:46,159 --> 00:26:49,429  
it looks like at first glance of the

641  
00:26:47,839 --> 00:26:50,988  
line of sight that they are all really

642  
00:26:49,429 --> 00:26:52,369  
close together well that's what we

643  
00:26:50,989 --> 00:26:54,440  
thought originally and it was a lot of

644  
00:26:52,368 --> 00:26:56,569  
hard work to show that they weren't and

645  
00:26:54,440 --> 00:27:00,528  
they're just kind of there actually

646  
00:26:56,569 --> 00:27:01,608  
frustrating they're in our way yeah you

647  
00:27:00,528 --> 00:27:03,259  
think nature would be a little more

648  
00:27:01,608 --> 00:27:06,138  
accommodating with some of its some of

649  
00:27:03,259 --> 00:27:07,878  
the secrets well okay so now this was

650  
00:27:06,138 --> 00:27:09,908  
this was something you kind of didn't

651  
00:27:07,878 --> 00:27:11,808  
expect to find right that sort of the

652  
00:27:09,909 --> 00:27:13,149  
impression I get from reading the press

653  
00:27:11,808 --> 00:27:17,388  
release you guys weren't expecting this

654  
00:27:13,148 --> 00:27:18,949  
this isn't common that's right so to my

655  
00:27:17,388 --> 00:27:22,969  
knowledge this is only the second

656

00:27:18,950 --> 00:27:25,460  
example of this kind of thing this kind

657  
00:27:22,970 --> 00:27:27,470  
of saying meaning this very violent

658  
00:27:25,460 --> 00:27:31,340  
ripped apart galaxy sitting at the

659  
00:27:27,470 --> 00:27:35,269  
center of a galaxy cluster that's this

660  
00:27:31,339 --> 00:27:37,759  
large usually when we look so I

661  
00:27:35,269 --> 00:27:39,019  
mentioned that every massive galaxy

662  
00:27:37,759 --> 00:27:43,489  
cluster has one of these hulking

663  
00:27:39,019 --> 00:27:45,348  
galaxies at its center and these are not

664  
00:27:43,489 --> 00:27:47,840  
only the most massive galaxies in the

665  
00:27:45,348 --> 00:27:50,658  
universe but some of the oldest and by

666  
00:27:47,839 --> 00:27:52,759  
old we mean they form their stars a long

667  
00:27:50,659 --> 00:27:55,099  
long time ago and they haven't formed

668  
00:27:52,759 --> 00:27:56,960  
any sense so like elliptical galaxies

669  
00:27:55,098 --> 00:27:59,269  
exactly they're the biggest elliptical

670  
00:27:56,960 --> 00:28:00,649

galaxies in the universe now in these

671

00:27:59,269 --> 00:28:01,878

clusters let me just interrupt you real

672

00:28:00,648 --> 00:28:03,348

quick to make sure i'm a you said

673

00:28:01,878 --> 00:28:04,848

there's usually a hulking mass in the

674

00:28:03,348 --> 00:28:07,668

center of these co thay gravitationally

675

00:28:04,848 --> 00:28:09,138

bound to it or is it is it just loosely

676

00:28:07,669 --> 00:28:10,489

are they loosely connected what's the

677

00:28:09,138 --> 00:28:12,829

connection there you mean the galaxies

678

00:28:10,489 --> 00:28:15,079

with the brightest cluster galaxies yes

679

00:28:12,829 --> 00:28:16,489

well the whole so the whole cluster is

680

00:28:15,079 --> 00:28:18,499

bound together by its dark matter

681

00:28:16,489 --> 00:28:20,778

essentially and the brightest cluster

682

00:28:18,499 --> 00:28:23,509

galaxies sits at the very center of that

683

00:28:20,778 --> 00:28:26,019

dark matter distribution okay so they're

684

00:28:23,509 --> 00:28:28,249

all bound together okay good thank you



685  
00:28:26,019 --> 00:28:32,388  
okay so this was something you didn't

686  
00:28:28,249 --> 00:28:36,288  
expect to see as violently well so as

687  
00:28:32,388 --> 00:28:38,598  
far back as we looked most almost all

688  
00:28:36,288 --> 00:28:41,239  
galaxy clusters have these massive

689  
00:28:38,598 --> 00:28:44,628  
galaxies galaxies in their Center and

690  
00:28:41,239 --> 00:28:47,840  
these massive galaxies look old so it's

691  
00:28:44,628 --> 00:28:49,730  
a real mystery in astrophysics one of

692  
00:28:47,839 --> 00:28:51,259  
our big questions is how and when did

693  
00:28:49,730 --> 00:28:53,230  
these things form because we

694  
00:28:51,259 --> 00:28:56,299  
figure we keep looking back in time

695  
00:28:53,230 --> 00:28:58,519  
deeper and deeper images we should at

696  
00:28:56,299 --> 00:29:00,829  
some point see these things forming and

697  
00:28:58,519 --> 00:29:03,650  
that is yet to happen and so this was

698  
00:29:00,829 --> 00:29:07,159  
one of the first images that actually

699  
00:29:03,650 --> 00:29:09,500  
caught one of these objects in phase

700  
00:29:07,160 --> 00:29:11,900  
that we think is a phase related to its

701  
00:29:09,500 --> 00:29:13,720  
formation and that is this violent phase

702  
00:29:11,900 --> 00:29:15,950  
of ripping apart one galaxy to

703  
00:29:13,720 --> 00:29:22,100  
cannibalize it and then forming new

704  
00:29:15,950 --> 00:29:23,750  
stars as it does that ok well the and I

705  
00:29:22,099 --> 00:29:25,369  
want to get to this topic or this

706  
00:29:23,750 --> 00:29:27,339  
concept i'm not quite sure how to make

707  
00:29:25,369 --> 00:29:29,659  
this out the segway but there was a

708  
00:29:27,339 --> 00:29:31,459  
there's this thing that we that was

709  
00:29:29,660 --> 00:29:32,900  
mentioned and we've had a we've had a

710  
00:29:31,460 --> 00:29:35,539  
hanging on this before about something

711  
00:29:32,900 --> 00:29:38,540  
called beads on a string and this is a

712  
00:29:35,539 --> 00:29:41,509  
characteristic of pockets of gas of

713

00:29:38,539 --> 00:29:44,059  
where new stars are being born inside

714  
00:29:41,509 --> 00:29:46,339  
the cluster and this is this one of

715  
00:29:44,059 --> 00:29:49,669  
those things is that a bead on a string

716  
00:29:46,339 --> 00:29:52,639  
or so we face them we think that if you

717  
00:29:49,670 --> 00:29:55,759  
if you look ease if you look at just the

718  
00:29:52,640 --> 00:29:57,140  
bare bones hsd image without the Spitzer

719  
00:29:55,759 --> 00:29:58,900  
image overlaid you can see it a little

720  
00:29:57,140 --> 00:30:02,030  
bit better but if you look at the

721  
00:29:58,900 --> 00:30:04,040  
central they're really handy scott i

722  
00:30:02,029 --> 00:30:06,740  
don't think so i think we've only got

723  
00:30:04,039 --> 00:30:09,319  
there oh okay all right okay hmm i'm

724  
00:30:06,740 --> 00:30:11,720  
talking about really the raw data icic

725  
00:30:09,319 --> 00:30:14,750  
okay if you look in the center regions

726  
00:30:11,720 --> 00:30:16,789  
where the tail comes out from the

727  
00:30:14,750 --> 00:30:18,829

central cluster galaxies you'll notice

728

00:30:16,789 --> 00:30:22,250

that along there there's the sort of

729

00:30:18,829 --> 00:30:24,139

equally spaced clumps all the way along

730

00:30:22,250 --> 00:30:26,599

before the whole thing kind of blows up

731

00:30:24,140 --> 00:30:28,730

oh yeah yeah they are and that's what we

732

00:30:26,599 --> 00:30:31,339

call beads on a string and it's the same

733

00:30:28,730 --> 00:30:34,279

kind of physics really as beads

734

00:30:31,339 --> 00:30:38,809

collecting on a string to these clumps

735

00:30:34,279 --> 00:30:41,329

of condensation a long day flying okay

736

00:30:38,809 --> 00:30:43,879

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

737

00:30:41,329 --> 00:30:46,460

infantile this part made me laugh but uh

738

00:30:43,880 --> 00:30:53,380

this is what you're calling a wet merger

739

00:30:46,460 --> 00:30:58,509

is that correct yes yes oh my god Oh

740

00:30:53,380 --> 00:30:58,510

better can we you Tim

741

00:30:59,490 --> 00:31:04,289

but there this is this is simply a state

742  
00:31:02,339 --> 00:31:07,139  
it is what you're describing when it's

743  
00:31:04,289 --> 00:31:09,450  
gas which i guess is somehow

744  
00:31:07,140 --> 00:31:13,140  
characterized as wet being involved in a

745  
00:31:09,450 --> 00:31:15,210  
na and star forming region like this

746  
00:31:13,140 --> 00:31:17,190  
right well that's right so what we're

747  
00:31:15,210 --> 00:31:19,319  
seeing so just to be clear what we're

748  
00:31:17,190 --> 00:31:21,808  
seeing with the HST image is not the gas

749  
00:31:19,319 --> 00:31:24,509  
but the stars but we know that there has

750  
00:31:21,808 --> 00:31:27,089  
to be gas there because there's so much

751  
00:31:24,509 --> 00:31:30,029  
star formation going on and the stars

752  
00:31:27,089 --> 00:31:31,470  
have to be forming out of gas so the

753  
00:31:30,029 --> 00:31:32,970  
between the infrared wavelengths which

754  
00:31:31,470 --> 00:31:34,529  
are generating the heat and the visible

755  
00:31:32,970 --> 00:31:36,690  
light which we see here and Hubble

756  
00:31:34,529 --> 00:31:39,210  
there's a lot of other physics going on

757  
00:31:36,690 --> 00:31:41,700  
a lot of other physics that's right okay

758  
00:31:39,210 --> 00:31:43,380  
which which we hope that's sort of one

759  
00:31:41,700 --> 00:31:46,830  
of the next things that will do is get a

760  
00:31:43,380 --> 00:31:48,570  
real picture of the actual gas okay so

761  
00:31:46,829 --> 00:31:51,089  
that when there's lots of gas involved

762  
00:31:48,569 --> 00:31:53,819  
that's a wet merger but the the dry ones

763  
00:31:51,089 --> 00:31:57,869  
are they they're just they still have

764  
00:31:53,819 --> 00:31:59,220  
gas because they are beating they are

765  
00:31:57,869 --> 00:32:02,459  
they just don't listen there's no stars

766  
00:31:59,220 --> 00:32:05,400  
because so what a dry merger is and and

767  
00:32:02,460 --> 00:32:08,340  
it's been known for a long time it's

768  
00:32:05,400 --> 00:32:10,650  
been known that brightest cluster

769  
00:32:08,339 --> 00:32:13,379  
galaxies can grow through what are

770

00:32:10,650 --> 00:32:16,340  
called dry mergers and a dry merger is

771  
00:32:13,380 --> 00:32:19,290  
when two galaxies merge but they're old

772  
00:32:16,339 --> 00:32:21,480  
elliptical galaxies and neither one of

773  
00:32:19,289 --> 00:32:24,928  
them has very much gas to bring to the

774  
00:32:21,480 --> 00:32:28,319  
table essentially and so there's no fuel

775  
00:32:24,929 --> 00:32:32,009  
there for new star formation where is in

776  
00:32:28,319 --> 00:32:34,558  
a wet merger at least one of the

777  
00:32:32,009 --> 00:32:37,500  
galaxies is a galaxy more like our own

778  
00:32:34,558 --> 00:32:40,170  
Milky Way with a lot of gas and that gas

779  
00:32:37,500 --> 00:32:42,839  
is then compressed and funneled and

780  
00:32:40,170 --> 00:32:46,590  
channeled during the merger to form new

781  
00:32:42,839 --> 00:32:48,569  
stars so in a merge both are kinds of

782  
00:32:46,589 --> 00:32:50,699  
mergers where two galaxies collide

783  
00:32:48,569 --> 00:32:53,250  
together and eventually form one larger

784  
00:32:50,700 --> 00:32:56,130

galaxy but in the dry merger the stars

785

00:32:53,250 --> 00:32:57,799

just kind of come together and in a wet

786

00:32:56,130 --> 00:32:59,970

merger there's new stars being formed

787

00:32:57,799 --> 00:33:01,619

okay so yeah the wet mergers that

788

00:32:59,970 --> 00:33:04,339

haven't been seen before at the Centers

789

00:33:01,619 --> 00:33:06,509

of clusters okay so yeah this is

790

00:33:04,339 --> 00:33:08,009

something that you expected to find as

791

00:33:06,509 --> 00:33:10,109

you say but haven't yet this is one of

792

00:33:08,009 --> 00:33:13,019

the first first times you've seen one of

793

00:33:10,109 --> 00:33:15,240

these there I guess

794

00:33:13,019 --> 00:33:16,950

so let me there's a there's a got a

795

00:33:15,240 --> 00:33:18,630

quick question in here that's been

796

00:33:16,950 --> 00:33:20,400

sitting for a while I want to ask this

797

00:33:18,630 --> 00:33:23,220

is about the galaxy cluster this is from

798

00:33:20,400 --> 00:33:26,190

John Glasco on the Q&A app he's going is



799

00:33:23,220 --> 00:33:28,110

the pinwheel galaxy which is M 101 when

800

00:33:26,190 --> 00:33:30,779

and he even knows that it's six parts

801

00:33:28,109 --> 00:33:32,699

megaparsecs away good job John anywhere

802

00:33:30,779 --> 00:33:34,500

new is it is the pinwheel anywhere near

803

00:33:32,700 --> 00:33:36,720

this cluster or is this cluster much

804

00:33:34,500 --> 00:33:39,839

farther away now the pinwheel galaxy is

805

00:33:36,720 --> 00:33:41,549

one of the most detailed images of a

806

00:33:39,839 --> 00:33:43,709

spiral galaxy the Hubble's ever taken

807

00:33:41,549 --> 00:33:48,049

but where is it you do we know where it

808

00:33:43,710 --> 00:33:51,930

might be with relation to in 101 oh gosh

809

00:33:48,049 --> 00:33:55,740

do you mean on the sky or in distance

810

00:33:51,930 --> 00:33:58,019

well it's in Ursa Major I believe and so

811

00:33:55,740 --> 00:33:59,670

rough is it anywhere nearby other than

812

00:33:58,019 --> 00:34:01,500

just say it's in the same constellation

813  
00:33:59,670 --> 00:34:06,560  
or is it not really a part of the

814  
00:34:01,500 --> 00:34:09,510  
cluster no no no pinwheels a nearby

815  
00:34:06,559 --> 00:34:11,190  
relatively nearby galaxies okay so these

816  
00:34:09,510 --> 00:34:12,870  
are much further away than alright

817  
00:34:11,190 --> 00:34:19,950  
alright thank you John it was good

818  
00:34:12,869 --> 00:34:22,139  
question um so let's see the so are

819  
00:34:19,949 --> 00:34:23,699  
there other galaxy clusters as part of

820  
00:34:22,139 --> 00:34:25,199  
the survey that you're looking at are

821  
00:34:23,699 --> 00:34:28,889  
you going to continue looking more

822  
00:34:25,199 --> 00:34:30,539  
closely at this particular one too is

823  
00:34:28,889 --> 00:34:31,949  
there anything more that we can learn

824  
00:34:30,539 --> 00:34:34,139  
from this but with other would say

825  
00:34:31,949 --> 00:34:35,819  
wavelengths or or other observations

826  
00:34:34,139 --> 00:34:38,940  
that you might want to make yeah so

827

00:34:35,820 --> 00:34:42,179  
we're we're what we're doing both we're

828  
00:34:38,940 --> 00:34:45,269  
actively trying to study this particular

829  
00:34:42,179 --> 00:34:47,490  
object in more detail so like I said one

830  
00:34:45,269 --> 00:34:50,880  
of the things we would like to do is get

831  
00:34:47,489 --> 00:34:52,619  
an image of the actual gas within this

832  
00:34:50,880 --> 00:34:54,840  
system and see where the gas is and what

833  
00:34:52,619 --> 00:34:59,279  
the gas is doing and so we have some

834  
00:34:54,840 --> 00:35:00,900  
proposals in to do that as well and we'd

835  
00:34:59,280 --> 00:35:02,820  
like to learn more about the cluster as

836  
00:35:00,900 --> 00:35:04,849  
a whole we'd like to confirm more

837  
00:35:02,820 --> 00:35:07,680  
members and get a very Bette erm Escher

838  
00:35:04,849 --> 00:35:10,019  
mass so we know exactly what we're

839  
00:35:07,679 --> 00:35:13,349  
dealing with but at the same time Adams

840  
00:35:10,019 --> 00:35:15,690  
survey has produced hundreds and

841  
00:35:13,349 --> 00:35:18,739

hundreds of galaxy clusters at large

842

00:35:15,690 --> 00:35:21,840

distances from us and many of them show

843

00:35:18,739 --> 00:35:25,929

evidence that they might be similar

844

00:35:21,840 --> 00:35:27,160

systems to this and what in one way

845

00:35:25,929 --> 00:35:28,960

we could add them to comment on that a

846

00:35:27,159 --> 00:35:30,159

little bit when what so what uh what are

847

00:35:28,960 --> 00:35:32,740

some of these characteristics that

848

00:35:30,159 --> 00:35:34,149

you're noticing another are you looking

849

00:35:32,739 --> 00:35:36,459

primarily for bright spots in the

850

00:35:34,150 --> 00:35:38,769

infrared or what do you what are you

851

00:35:36,460 --> 00:35:40,780

looking at yeah well that's that's

852

00:35:38,769 --> 00:35:44,500

precisely it right we are looking for

853

00:35:40,780 --> 00:35:46,210

things that are really red overall so we

854

00:35:44,500 --> 00:35:48,130

did the thing with the Canada France you

855

00:35:46,210 --> 00:35:50,440

want them to be not very bright in the

856  
00:35:48,130 --> 00:35:53,230  
optical and then in combination to be

857  
00:35:50,440 --> 00:35:54,818  
very bright with Spitzer so big big

858  
00:35:53,230 --> 00:35:57,519  
lumps of galaxies that are bright and

859  
00:35:54,818 --> 00:35:59,920  
Spitzer and not very bright in in the

860  
00:35:57,519 --> 00:36:02,230  
optical and we have found as Tracy said

861  
00:35:59,920 --> 00:36:04,599  
a few hundred of them I think what she's

862  
00:36:02,230 --> 00:36:07,000  
referring to is you know Tracy is a very

863  
00:36:04,599 --> 00:36:09,250  
prolific scientist and she also wrote a

864  
00:36:07,000 --> 00:36:11,710  
paper in the last couple weeks where she

865  
00:36:09,250 --> 00:36:13,300  
looked at some of the other brightest

866  
00:36:11,710 --> 00:36:16,210  
cluster galaxies and some of the other

867  
00:36:13,300 --> 00:36:18,369  
clusters we found and what we're finding

868  
00:36:16,210 --> 00:36:22,800  
is that well this kind of thing that

869  
00:36:18,369 --> 00:36:25,480  
we're talking about today is very rare

870  
00:36:22,800 --> 00:36:27,490  
particularly nearby as we start looking

871  
00:36:25,480 --> 00:36:30,699  
at more and more of these very distant

872  
00:36:27,489 --> 00:36:32,469  
clusters it's still uncommon but it's

873  
00:36:30,699 --> 00:36:34,239  
not completely uncommon so there's

874  
00:36:32,469 --> 00:36:36,539  
there's some other clusters in our

875  
00:36:34,239 --> 00:36:38,769  
survey where the central galaxy has

876  
00:36:36,539 --> 00:36:42,150  
potentially very high star formation

877  
00:36:38,769 --> 00:36:44,170  
rates just like this one cool okay so

878  
00:36:42,150 --> 00:36:45,789  
Andrew planets got a good question i

879  
00:36:44,170 --> 00:36:47,559  
want to ask real quick and that is if

880  
00:36:45,789 --> 00:36:49,088  
these galaxy clusters contain

881  
00:36:47,559 --> 00:36:52,690  
supermassive black holes in their

882  
00:36:49,088 --> 00:36:54,369  
centers i could star formation be due to

883  
00:36:52,690 --> 00:36:57,309  
the constituents convincing from black

884

00:36:54,369 --> 00:37:00,130  
hole high-energy jets forming gas fuel

885  
00:36:57,309 --> 00:37:02,230  
for new stars in the process is that at

886  
00:37:00,130 --> 00:37:04,180  
all possible so what are the you know

887  
00:37:02,230 --> 00:37:06,818  
our black holes playing any role in star

888  
00:37:04,179 --> 00:37:08,828  
formation either feeding it or called

889  
00:37:06,818 --> 00:37:11,650  
again causing it to condense in these

890  
00:37:08,829 --> 00:37:14,289  
galaxy clusters so that's a another

891  
00:37:11,650 --> 00:37:15,760  
really good question and I didn't

892  
00:37:14,289 --> 00:37:20,349  
mention this at all but we do know that

893  
00:37:15,760 --> 00:37:21,940  
there well we suspect strongly that

894  
00:37:20,349 --> 00:37:25,019  
there is a black hole at the center of

895  
00:37:21,940 --> 00:37:27,789  
this galaxy cluster and it's also

896  
00:37:25,019 --> 00:37:29,889  
contributing to the infrared emission

897  
00:37:27,789 --> 00:37:31,420  
that we've been mentioning the intense

898  
00:37:29,889 --> 00:37:34,929

infrared emission that we see from it

899

00:37:31,420 --> 00:37:36,548

it's not dominating most of the energy

900

00:37:34,929 --> 00:37:39,098

that's being produced in the infrared is

901

00:37:36,548 --> 00:37:42,190

coming from star formation but there is

902

00:37:39,099 --> 00:37:44,739

black hole there whether or not the

903

00:37:42,190 --> 00:37:48,088

black hole is causing the star formation

904

00:37:44,739 --> 00:37:51,369

is an interesting idea because in fact

905

00:37:48,088 --> 00:37:53,768

black holes are usually invoked in these

906

00:37:51,369 --> 00:37:56,619

situations to do the opposite to

907

00:37:53,768 --> 00:38:00,459

actually stop the star formation so the

908

00:37:56,619 --> 00:38:02,259

feedback from so your listener mentioned

909

00:38:00,460 --> 00:38:05,380

these Jets that come out of the black

910

00:38:02,259 --> 00:38:07,989

hole the radiative and mechanical

911

00:38:05,380 --> 00:38:09,759

feedback that comes from the accretion

912

00:38:07,989 --> 00:38:12,190

disk and all the other activity that's



913  
00:38:09,759 --> 00:38:15,519  
going on around a black hole can

914  
00:38:12,190 --> 00:38:19,239  
actually disrupt the star formation and

915  
00:38:15,518 --> 00:38:20,679  
blow the gas out of you know keep it

916  
00:38:19,239 --> 00:38:23,619  
from condensing and forming new stars

917  
00:38:20,679 --> 00:38:26,018  
and so we think that if the black hole

918  
00:38:23,619 --> 00:38:28,329  
in this particular cluster is allowed to

919  
00:38:26,018 --> 00:38:30,219  
grow it might actually stop the star

920  
00:38:28,329 --> 00:38:32,380  
formation that we're seeing and that may

921  
00:38:30,219 --> 00:38:33,939  
be and that might be why these things

922  
00:38:32,380 --> 00:38:35,739  
are so hard to see period right i mean

923  
00:38:33,940 --> 00:38:37,298  
in most galaxy clusters it could be

924  
00:38:35,739 --> 00:38:39,039  
these black holes or disrupting a lot of

925  
00:38:37,298 --> 00:38:40,478  
the star for me it's a good question so

926  
00:38:39,039 --> 00:38:42,519  
one of the questions we were trying to

927  
00:38:40,478 --> 00:38:44,858  
get a tat in one of the papers was what

928  
00:38:42,518 --> 00:38:46,778  
was essentially the duty cycle how long

929  
00:38:44,858 --> 00:38:49,748  
does the star formation go on for before

930  
00:38:46,778 --> 00:38:52,179  
an AGN shuts it down and you can is not

931  
00:38:49,748 --> 00:38:54,578  
active life an active galactic nucleus a

932  
00:38:52,179 --> 00:38:56,828  
black hole and so the fact that these

933  
00:38:54,579 --> 00:38:59,048  
things appear to be quite rare may be

934  
00:38:56,829 --> 00:39:02,710  
telling us that the AGN that the black

935  
00:38:59,048 --> 00:39:04,268  
hole shuts it down very rapidly okay

936  
00:39:02,710 --> 00:39:06,999  
good question Andrew thanks as always

937  
00:39:04,268 --> 00:39:08,858  
and Cecil Morgan's asking what

938  
00:39:06,998 --> 00:39:11,278  
instrument this is from the Q&A app what

939  
00:39:08,858 --> 00:39:14,409  
instruments would be used to see the gas

940  
00:39:11,278 --> 00:39:16,298  
presumably the infrared showing you not

941

00:39:14,409 --> 00:39:18,608  
the gas but the heat coming from the

942  
00:39:16,298 --> 00:39:20,619  
star formation and the hubble the

943  
00:39:18,608 --> 00:39:22,538  
infrared visible light are showing the

944  
00:39:20,619 --> 00:39:26,798  
stars what could you use to see the gas

945  
00:39:22,539 --> 00:39:30,460  
with so for that we're hoping again to

946  
00:39:26,798 --> 00:39:33,969  
use a spectroscopic instrument on the

947  
00:39:30,460 --> 00:39:37,349  
Keck telescope essentially what we need

948  
00:39:33,969 --> 00:39:41,380  
to do is get what's called a spectrum of

949  
00:39:37,349 --> 00:39:42,818  
the galaxy and that's the same and the

950  
00:39:41,380 --> 00:39:45,608  
region surrounding it that's the same

951  
00:39:42,818 --> 00:39:49,058  
kind of observation that we do to get a

952  
00:39:45,608 --> 00:39:52,058  
redshift and there we're looking for a

953  
00:39:49,059 --> 00:39:52,869  
mission that's coming from the gas so

954  
00:39:52,059 --> 00:39:56,430  
we're looking for the

955  
00:39:52,869 --> 00:39:58,900

hydrogen lines and the oxygen lines

956

00:39:56,429 --> 00:40:02,649

basically using the same kind of physics

957

00:39:58,900 --> 00:40:04,720

that people use in neon lights to try

958

00:40:02,650 --> 00:40:07,450

and and see the gas in that way so it

959

00:40:04,719 --> 00:40:10,719

would be a ground-based optical and

960

00:40:07,449 --> 00:40:12,429

infrared spectrograph cool yeah that's

961

00:40:10,719 --> 00:40:13,719

important we've all don't know if you

962

00:40:12,429 --> 00:40:16,348

ever done that lab experiment where

963

00:40:13,719 --> 00:40:20,199

you've looked at a at a tube like a

964

00:40:16,349 --> 00:40:21,759

spectrum tube through a little pair of

965

00:40:20,199 --> 00:40:24,098

glasses and you can see the lines coming

966

00:40:21,759 --> 00:40:26,619

from it it's something very similar the

967

00:40:24,099 --> 00:40:28,119

bright lines that would black and the

968

00:40:26,619 --> 00:40:29,410

bright and dark absorption lines coming

969

00:40:28,119 --> 00:40:30,789

from a spectrum to tell you what

970  
00:40:29,409 --> 00:40:33,009  
elements are in that gas and whether

971  
00:40:30,789 --> 00:40:35,230  
there's gas present so good question

972  
00:40:33,009 --> 00:40:36,579  
Cecil ok I want to point out one little

973  
00:40:35,230 --> 00:40:40,269  
thing that I noticed when I was reading

974  
00:40:36,579 --> 00:40:42,278  
about it was a good comparison of the

975  
00:40:40,268 --> 00:40:43,919  
star formation rates apparently

976  
00:40:42,278 --> 00:40:47,588  
according to what you guys have found

977  
00:40:43,920 --> 00:40:50,858  
this is creating this little region is

978  
00:40:47,588 --> 00:40:53,639  
creating about 860 new stars a year and

979  
00:40:50,858 --> 00:40:55,960  
by comparison our Milky Way galaxy

980  
00:40:53,639 --> 00:40:57,969  
generally forms only about one or two

981  
00:40:55,960 --> 00:41:00,509  
stars a year so this is quite a bit this

982  
00:40:57,969 --> 00:41:05,348  
is a huge increase in star forming

983  
00:41:00,509 --> 00:41:06,998  
activity yeah that's right it's I mean I

984

00:41:05,349 --> 00:41:08,559

think maybe Allison can comment on this

985

00:41:06,998 --> 00:41:10,778

a little better than I can cuz she was

986

00:41:08,559 --> 00:41:13,778

the one who who made that measurement I

987

00:41:10,778 --> 00:41:18,190

love that idea go ahead Allison yeah

988

00:41:13,778 --> 00:41:20,440

well so um basically the way you can

989

00:41:18,190 --> 00:41:23,289

calculate this is by using all of the

990

00:41:20,440 --> 00:41:25,119

data that we've been talking about but

991

00:41:23,289 --> 00:41:27,670

particularly at the infrared and

992

00:41:25,119 --> 00:41:30,309

submillimetre wavelengths which as Carol

993

00:41:27,670 --> 00:41:34,329

mentioned earlier really is tracing the

994

00:41:30,309 --> 00:41:37,720

dust that's being heated by the stars so

995

00:41:34,329 --> 00:41:39,970

once you have a the UV radiation coming

996

00:41:37,719 --> 00:41:41,469

from a star it heats all this dust and

997

00:41:39,969 --> 00:41:46,498

every radiates and the infrared

998

00:41:41,469 --> 00:41:48,278  
wavelengths so when you have multiple

999  
00:41:46,498 --> 00:41:50,618  
wavelengths from different telescopes

1000  
00:41:48,278 --> 00:41:52,088  
all in the infrared and submillimetre

1001  
00:41:50,619 --> 00:41:55,239  
wavelengths you can get a pretty good

1002  
00:41:52,088 --> 00:41:57,489  
estimate of the star formation right so

1003  
00:41:55,239 --> 00:42:00,278  
that's what we've done with herchel and

1004  
00:41:57,489 --> 00:42:02,259  
the JC mt and spitzer so those are the

1005  
00:42:00,278 --> 00:42:03,940  
primary instruments we use to measure

1006  
00:42:02,259 --> 00:42:06,490  
the star-formation rate and yes it's

1007  
00:42:03,940 --> 00:42:09,730  
forming about 860 stars

1008  
00:42:06,489 --> 00:42:11,199  
a year cool so pure like I have a

1009  
00:42:09,730 --> 00:42:12,760  
question for you Caroline and I don't

1010  
00:42:11,199 --> 00:42:15,519  
know this may be totally dumb but I'm

1011  
00:42:12,760 --> 00:42:17,830  
going to ask it anyway and the

1012  
00:42:15,519 --> 00:42:19,329

ultraviolet which Hubble is got an

1013

00:42:17,829 --> 00:42:21,099

instrument on that lets us see in that

1014

00:42:19,329 --> 00:42:23,650

wavelength could you see anything in the

1015

00:42:21,099 --> 00:42:26,440

ultraviolet do you think uh in this

1016

00:42:23,650 --> 00:42:29,320

situation or no because it doesn't say

1017

00:42:26,440 --> 00:42:31,300

something about stars for me yes well I

1018

00:42:29,320 --> 00:42:34,300

mean they have an observation of it

1019

00:42:31,300 --> 00:42:36,220

which I don't have but sometimes it

1020

00:42:34,300 --> 00:42:37,810

depends it depends on how much dust is

1021

00:42:36,219 --> 00:42:39,879

in the system if they've got a lot of

1022

00:42:37,809 --> 00:42:42,250

dust in front of whatever the UV

1023

00:42:39,880 --> 00:42:46,210

radiation is then you're not really

1024

00:42:42,250 --> 00:42:49,269

really going to see it so um I haven't I

1025

00:42:46,210 --> 00:42:52,840

haven't seen the pure Hubble image but

1026

00:42:49,269 --> 00:42:54,730

it just depends um if if you don't have



1027  
00:42:52,840 --> 00:42:57,970  
a lot of dust in the system anymore you

1028  
00:42:54,730 --> 00:43:01,480  
could get a lot of UV radiation coming

1029  
00:42:57,969 --> 00:43:03,250  
out so it just depends on the

1030  
00:43:01,480 --> 00:43:05,079  
circumstance of the object you're trying

1031  
00:43:03,250 --> 00:43:06,849  
to look at have you thought about that

1032  
00:43:05,079 --> 00:43:09,130  
wavelength Tracy or is that probably not

1033  
00:43:06,849 --> 00:43:10,929  
going to work here well so in fact the

1034  
00:43:09,130 --> 00:43:13,510  
image that you're seeing with Hubble is

1035  
00:43:10,929 --> 00:43:15,879  
pretty close to the ultraviolet it's

1036  
00:43:13,510 --> 00:43:17,950  
it's taken in the infrared wavelengths

1037  
00:43:15,880 --> 00:43:19,660  
but because of the redshift because of

1038  
00:43:17,949 --> 00:43:22,239  
the great distance that this cluster is

1039  
00:43:19,659 --> 00:43:25,299  
from us what we're actually seeing is

1040  
00:43:22,239 --> 00:43:27,368  
light that was emitted in the UV oh good

1041  
00:43:25,300 --> 00:43:30,070  
point so these are actually the young

1042  
00:43:27,369 --> 00:43:33,340  
stars that we're probably seeing in this

1043  
00:43:30,070 --> 00:43:36,250  
this tale awesome ok well thank you for

1044  
00:43:33,340 --> 00:43:38,380  
that uh all right i think scott i'm

1045  
00:43:36,250 --> 00:43:39,849  
looking around and oh wait here's one

1046  
00:43:38,380 --> 00:43:41,710  
from andrew planet i'm gonna ask you in

1047  
00:43:39,849 --> 00:43:43,299  
a minute for twitter so let me get this

1048  
00:43:41,710 --> 00:43:45,039  
question from Andrew again he goes

1049  
00:43:43,300 --> 00:43:47,109  
thanks for the answer he's the one that

1050  
00:43:45,039 --> 00:43:48,789  
asked the black hole question what

1051  
00:43:47,108 --> 00:43:50,650  
eventually happens then to all the

1052  
00:43:48,789 --> 00:43:52,869  
material that makes up high energy Jets

1053  
00:43:50,650 --> 00:43:54,820  
so I think these Jets are assumed to be

1054  
00:43:52,869 --> 00:43:56,320  
producing if they're actively well if

1055

00:43:54,820 --> 00:44:00,190  
they're active they're feeding on I'm

1056  
00:43:56,320 --> 00:44:02,619  
surrounding material so I do the first

1057  
00:44:00,190 --> 00:44:06,358  
of all are their Jets here and if so

1058  
00:44:02,619 --> 00:44:09,700  
what what happens to all that stuff so

1059  
00:44:06,358 --> 00:44:11,170  
I'm not an expert on black holes in the

1060  
00:44:09,699 --> 00:44:14,649  
Centers of galaxies clusters I don't

1061  
00:44:11,170 --> 00:44:16,420  
know if Adam feels any more comfortable

1062  
00:44:14,650 --> 00:44:18,880  
with that idea what about you Adam do

1063  
00:44:16,420 --> 00:44:20,380  
you feel like yeah hey at least I'm not

1064  
00:44:18,880 --> 00:44:29,259  
asking you to calculate something

1065  
00:44:20,380 --> 00:44:30,068  
on and in terms of I mean okay well why

1066  
00:44:29,259 --> 00:44:31,568  
don't you just say what you were

1067  
00:44:30,068 --> 00:44:32,889  
thinking and then we'll see if that

1068  
00:44:31,568 --> 00:44:35,528  
answers this question well I mean

1069  
00:44:32,889 --> 00:44:40,179

certainly there's we don't we don't see

1070

00:44:35,528 --> 00:44:42,130  
any Jets in this image yet but we

1071

00:44:40,179 --> 00:44:44,528  
haven't really looked at the right

1072

00:44:42,130 --> 00:44:46,028  
wavelengths so it is possible that there

1073

00:44:44,528 --> 00:44:48,369  
might be some jets there and we have a

1074

00:44:46,028 --> 00:44:51,639  
proposal into the Very Large Array which

1075

00:44:48,369 --> 00:44:53,700  
is a radio telescope to see what kind of

1076

00:44:51,639 --> 00:44:56,440  
radio emission is coming from this thing

1077

00:44:53,699 --> 00:45:00,009  
we're hoping also to get some x-ray

1078

00:44:56,440 --> 00:45:02,259  
observations possibly from Chandra to

1079

00:45:00,009 --> 00:45:05,679  
see if there's any signs of black hole

1080

00:45:02,259 --> 00:45:07,869  
activity as well so the as to what

1081

00:45:05,679 --> 00:45:12,460  
happens to all the material that's blown

1082

00:45:07,869 --> 00:45:14,170  
out from the Jets I think that's I mean

1083

00:45:12,460 --> 00:45:16,528  
what happens is it goes out into the

1084  
00:45:14,170 --> 00:45:19,720  
what we call the intracluster medium

1085  
00:45:16,528 --> 00:45:21,460  
which is all of the gas and material in

1086  
00:45:19,719 --> 00:45:24,669  
between the galaxies within the galaxy

1087  
00:45:21,460 --> 00:45:26,318  
cluster in so we have when we have a

1088  
00:45:24,670 --> 00:45:28,240  
galaxy cluster if there's a whole bunch

1089  
00:45:26,318 --> 00:45:29,558  
of galaxies that you can see there's a

1090  
00:45:28,239 --> 00:45:31,419  
whole bunch of dark matter holding it

1091  
00:45:29,559 --> 00:45:35,380  
together and then there's also a lot of

1092  
00:45:31,420 --> 00:45:37,568  
hot gas and so the material that's being

1093  
00:45:35,380 --> 00:45:40,298  
blown out from the center of the galaxy

1094  
00:45:37,568 --> 00:45:43,389  
cluster will be formed will form part of

1095  
00:45:40,298 --> 00:45:46,630  
this inter-cluster medium but we I have

1096  
00:45:43,389 --> 00:45:48,608  
collaborators who study this a lot here

1097  
00:45:46,630 --> 00:45:50,920  
in Montreal and you know they can they

1098  
00:45:48,608 --> 00:45:54,009  
see all sorts of wonderful images in the

1099  
00:45:50,920 --> 00:45:56,588  
x-ray of huge holes and cavities being

1100  
00:45:54,009 --> 00:45:57,969  
blown out within the intracluster medium

1101  
00:45:56,588 --> 00:46:00,909  
that they think are being caused by

1102  
00:45:57,969 --> 00:46:04,389  
these Jets just basically clearing away

1103  
00:46:00,909 --> 00:46:07,058  
material so it's a very violent place

1104  
00:46:04,389 --> 00:46:10,118  
and how it all settles down i think is

1105  
00:46:07,059 --> 00:46:12,509  
it's an open question yeah that's a good

1106  
00:46:10,119 --> 00:46:14,798  
question than in a and highlights the

1107  
00:46:12,509 --> 00:46:16,599  
importance of all the wavelengths you

1108  
00:46:14,798 --> 00:46:19,380  
can get to bear on a on a particular

1109  
00:46:16,599 --> 00:46:21,640  
area this guy is always useful right

1110  
00:46:19,380 --> 00:46:22,869  
okay so Scott do you see anything on

1111  
00:46:21,639 --> 00:46:24,608  
twitter is there anything I should we

1112

00:46:22,869 --> 00:46:26,108  
should we should mention on that it's a

1113  
00:46:24,608 --> 00:46:29,018  
question that we've touched on and we

1114  
00:46:26,108 --> 00:46:31,179  
kind of danced around but I'm really

1115  
00:46:29,018 --> 00:46:35,009  
sorry no dancing on these hangouts I

1116  
00:46:31,179 --> 00:46:37,659  
yes sir dancing you just don't know him

1117  
00:46:35,010 --> 00:46:40,329  
but I am so sorry if I mispronounced

1118  
00:46:37,659 --> 00:46:43,118  
your name but nowhere travell see she's

1119  
00:46:40,329 --> 00:46:44,619  
wondering how we're able to measure the

1120  
00:46:43,119 --> 00:46:47,588  
redshifts oh we've we've talked about

1121  
00:46:44,619 --> 00:46:49,030  
spectra but how were you able to this

1122  
00:46:47,588 --> 00:46:51,519  
was back before when we're talking about

1123  
00:46:49,030 --> 00:46:53,950  
how the two blobs the lower-left were

1124  
00:46:51,519 --> 00:46:56,588  
actually foreground objects and she was

1125  
00:46:53,949 --> 00:46:59,139  
wondering how you're able to find out

1126  
00:46:56,588 --> 00:47:00,969

you know how your uvula measure the

1127

00:46:59,139 --> 00:47:04,029  
redshift to find out that it is a

1128

00:47:00,969 --> 00:47:08,769  
foreground object Adam do you want to

1129

00:47:04,030 --> 00:47:09,819  
take this one yeah sure it's it's once

1130

00:47:08,769 --> 00:47:12,039  
you get the data it's a fairly

1131

00:47:09,818 --> 00:47:14,259  
straightforward thing to do or what

1132

00:47:12,039 --> 00:47:16,650  
we're looking for is Tracy mentioned

1133

00:47:14,260 --> 00:47:19,420  
before these emission lines that you see

1134

00:47:16,650 --> 00:47:21,670  
come from gas and come from star or

1135

00:47:19,420 --> 00:47:23,950  
absorption lines come from stars in the

1136

00:47:21,670 --> 00:47:26,139  
galaxy and so when we get a spectrum we

1137

00:47:23,949 --> 00:47:29,259  
see a series of absorption features and

1138

00:47:26,139 --> 00:47:31,900  
a series of emission features and what

1139

00:47:29,260 --> 00:47:34,180  
we do is we know what wavelength we

1140

00:47:31,900 --> 00:47:36,880  
would see them that if they were here on



1141  
00:47:34,179 --> 00:47:38,379  
earth and of course because they're not

1142  
00:47:36,880 --> 00:47:40,180  
here on earth and they're very far away

1143  
00:47:38,380 --> 00:47:42,280  
and their redshift that and they're

1144  
00:47:40,179 --> 00:47:44,409  
moving away from us the wavelengths that

1145  
00:47:42,280 --> 00:47:47,290  
we see them out has been shifted into

1146  
00:47:44,409 --> 00:47:48,940  
the red and so we simply compare all

1147  
00:47:47,289 --> 00:47:51,099  
those wavelengths that we know you know

1148  
00:47:48,940 --> 00:47:52,539  
all those features that we know the

1149  
00:47:51,099 --> 00:47:54,099  
wavelengths that we measure to the ones

1150  
00:47:52,539 --> 00:47:57,130  
we know they should be and that

1151  
00:47:54,099 --> 00:47:59,740  
difference is the red shift and and from

1152  
00:47:57,130 --> 00:48:01,358  
the red shift based on knowing stuff

1153  
00:47:59,739 --> 00:48:04,779  
about the way the universe expands we

1154  
00:48:01,358 --> 00:48:06,489  
can tell how far away it is right in a

1155  
00:48:04,780 --> 00:48:09,220  
another interesting part about this

1156  
00:48:06,489 --> 00:48:11,229  
whole thing is the the the fact that the

1157  
00:48:09,219 --> 00:48:12,519  
wavelengths eat what Tracy was talking

1158  
00:48:11,230 --> 00:48:14,199  
about earlier the fact that these stars

1159  
00:48:12,519 --> 00:48:17,920  
were burning bright in one way playing

1160  
00:48:14,199 --> 00:48:19,750  
as the as the the universe expanded and

1161  
00:48:17,920 --> 00:48:21,460  
they and they got further away they are

1162  
00:48:19,750 --> 00:48:23,440  
they shifted the wavelength of the light

1163  
00:48:21,460 --> 00:48:25,358  
into the lower wavelengths of infrared

1164  
00:48:23,440 --> 00:48:28,059  
which i think is it's always kind of

1165  
00:48:25,358 --> 00:48:31,480  
blows my mind a little bit so and so

1166  
00:48:28,059 --> 00:48:33,609  
when you have the to demote Tracy very

1167  
00:48:31,480 --> 00:48:35,048  
early onset is a two-dimensional image

1168  
00:48:33,608 --> 00:48:37,420  
you have this two-dimensional image

1169

00:48:35,048 --> 00:48:40,329  
which gives you like x and y to get the

1170  
00:48:37,420 --> 00:48:43,088  
Z then you look at these red shifts and

1171  
00:48:40,329 --> 00:48:44,810  
depending on how close the cluster is

1172  
00:48:43,088 --> 00:48:46,940  
sometimes you can get enough

1173  
00:48:44,809 --> 00:48:49,489  
solution not only to tell that all those

1174  
00:48:46,940 --> 00:48:52,130  
objects have the same red shift and some

1175  
00:48:49,489 --> 00:48:54,289  
another object is in front because it's

1176  
00:48:52,130 --> 00:48:56,180  
not as far away sometimes you can

1177  
00:48:54,289 --> 00:48:57,769  
actually tell the individual motions

1178  
00:48:56,179 --> 00:48:59,269  
within their so you know how far away

1179  
00:48:57,769 --> 00:49:02,449  
and then they have a little little

1180  
00:48:59,269 --> 00:49:04,400  
little bit emotions relative to like the

1181  
00:49:02,449 --> 00:49:06,980  
central this big massive central thing

1182  
00:49:04,400 --> 00:49:08,450  
so it just depends on how far away it is

1183  
00:49:06,980 --> 00:49:10,429

how much light it puts out the

1184

00:49:08,449 --> 00:49:13,309

resolution spectrograph all those

1185

00:49:10,429 --> 00:49:15,289

combinations but certainly telling a

1186

00:49:13,309 --> 00:49:19,789

foreground object from the cluster

1187

00:49:15,289 --> 00:49:21,860

object is is fairly straightforward yeah

1188

00:49:19,789 --> 00:49:24,139

that's actually what we do we do see

1189

00:49:21,860 --> 00:49:25,789

those extra little Wiggles on top of it

1190

00:49:24,139 --> 00:49:27,739

and those extra little Wiggles are the

1191

00:49:25,789 --> 00:49:29,690

galaxies moving around inside the

1192

00:49:27,739 --> 00:49:32,449

cluster and for measuring that that's

1193

00:49:29,690 --> 00:49:33,950

actually how much out how much mass is

1194

00:49:32,449 --> 00:49:36,019

in the cluster and that's how we know

1195

00:49:33,949 --> 00:49:41,980

this is you know 100 trillion Suns

1196

00:49:36,019 --> 00:49:46,280

worthless in the center of this cluster

1197

00:49:41,980 --> 00:49:49,340

okay uh Adam synergy I see you there

1198  
00:49:46,280 --> 00:49:52,580  
you're in a longtime viewer he's on the

1199  
00:49:49,340 --> 00:49:54,140  
the Google+ event page he's uh he's

1200  
00:49:52,579 --> 00:49:57,079  
saying that he's having trouble watching

1201  
00:49:54,139 --> 00:49:58,819  
on mrs. synergies ipad today is that

1202  
00:49:57,079 --> 00:50:00,650  
your real name synergy that's really

1203  
00:49:58,820 --> 00:50:02,330  
cool the Q&A app doesn't want to play

1204  
00:50:00,650 --> 00:50:06,019  
nicely so you folks have a day off from

1205  
00:50:02,329 --> 00:50:08,509  
my crazy questions so you guys got a

1206  
00:50:06,019 --> 00:50:10,159  
reprieve at UH gentleman tell me can get

1207  
00:50:08,510 --> 00:50:14,720  
us on Twitter but I've not seen him on

1208  
00:50:10,159 --> 00:50:17,690  
Twitter yet synergy I was I want that

1209  
00:50:14,719 --> 00:50:19,099  
last name okay okay well its got

1210  
00:50:17,690 --> 00:50:22,159  
anything else am I missing anything we

1211  
00:50:19,099 --> 00:50:25,039  
did you get a no that's anything's been

1212  
00:50:22,159 --> 00:50:26,569  
already asked or answered in the Hangout

1213  
00:50:25,039 --> 00:50:28,900  
it's been really great sparse our

1214  
00:50:26,570 --> 00:50:31,280  
interaction on there let me check

1215  
00:50:28,900 --> 00:50:33,349  
YouTube real quick to make sure we have

1216  
00:50:31,280 --> 00:50:35,180  
a missing thing over there I keep

1217  
00:50:33,349 --> 00:50:36,730  
forgetting to do that are you kidding we

1218  
00:50:35,179 --> 00:50:40,250  
solved all the mysteries in the universe

1219  
00:50:36,730 --> 00:50:43,179  
unless you're not work yeah unless an

1220  
00:50:40,250 --> 00:50:46,880  
hour absolutely we should get a bonus a

1221  
00:50:43,179 --> 00:50:50,779  
question oh no we should get wine served

1222  
00:50:46,880 --> 00:50:56,410  
to us well we don't it yeah I knew I the

1223  
00:50:50,780 --> 00:50:56,410  
Italian contingent oh maybe already

1224  
00:50:56,420 --> 00:51:02,309  
I'll continue their they're getting

1225  
00:50:58,889 --> 00:51:03,960  
ready I'm sure if no mention well we

1226

00:51:02,309 --> 00:51:05,340  
didn't do it we didn't get our word for

1227  
00:51:03,960 --> 00:51:07,079  
the drinking game me at this time around

1228  
00:51:05,340 --> 00:51:08,460  
either but maybe next week okay well

1229  
00:51:07,079 --> 00:51:12,000  
folks I guess we're going to we're going

1230  
00:51:08,460 --> 00:51:14,550  
to call it there a Tracy Tracy web and

1231  
00:51:12,000 --> 00:51:16,139  
allison and and adam i want to thank all

1232  
00:51:14,550 --> 00:51:18,930  
of you for joining us today and sharing

1233  
00:51:16,139 --> 00:51:20,789  
with us your research on on this galaxy

1234  
00:51:18,929 --> 00:51:22,679  
cluster and hopefully when you get more

1235  
00:51:20,789 --> 00:51:24,539  
wavelengths you'll come back and and

1236  
00:51:22,679 --> 00:51:26,460  
should show us what you found or give us

1237  
00:51:24,539 --> 00:51:28,259  
an update on what's happening whoa can

1238  
00:51:26,460 --> 00:51:30,300  
we get will you do that for us sure

1239  
00:51:28,260 --> 00:51:32,930  
awesome great thank you so much okay

1240  
00:51:30,300 --> 00:51:36,120

guys I guess that's it on behalf of

1241  
00:51:32,929 --> 00:51:37,559  
Scott Lewis Carroll Christian I want to

1242  
00:51:36,119 --> 00:51:39,839  
thank you all for watching we will be

1243  
00:51:37,559 --> 00:51:42,630  
back next week same Hubble time same

1244  
00:51:39,840 --> 00:51:44,400  
Hubble channel and come up with a new

1245  
00:51:42,630 --> 00:51:45,690  
Hubble name oh wait Hubble holics that

1246  
00:51:44,400 --> 00:51:48,030  
was mine i came up with that one this

1247  
00:51:45,690 --> 00:51:50,670  
week so still unfilled little toddlers i

1248  
00:51:48,030 --> 00:51:53,250  
know i'm still and i'm still a hubble

1249  
00:51:50,670 --> 00:51:57,869  
hugger yeah i know that's right hubble

1250  
00:51:53,250 --> 00:52:02,099  
hubble oh yeah right hablando Scoob

1251  
00:51:57,869 --> 00:52:04,739  
Londos ok thanks I think the word was

1252  
00:52:02,099 --> 00:52:08,429  
actually squishy squish all was that

1253  
00:52:04,739 --> 00:52:12,889  
hurt well we didn't we didn't come Tony

1254  
00:52:08,429 --> 00:52:12,889  
you can be my squishy Hubble hugger oh



1255

00:52:16,579 --> 00:52:21,960

alright we're done thanks to all of you

1256

00:52:20,489 --> 00:52:26,209

for watching we'll see you guys next

1257

00:52:21,960 --> 00:52:26,210

week and as always keep looking up