

1
00:00:02,750 --> 00:00:07,649
hello everyone and welcome to this

2
00:00:05,580 --> 00:00:09,719
week's Hubbell hangout my name is Tony

3
00:00:07,649 --> 00:00:11,250
Darnell and we've got another great

4
00:00:09,718 --> 00:00:13,048
hangout planned for you this week

5
00:00:11,250 --> 00:00:15,990
astronomers using the Hubble Space

6
00:00:13,048 --> 00:00:17,698
Telescope have been looking at the Large

7
00:00:15,990 --> 00:00:20,429
Magellanic Cloud and in particular the

8
00:00:17,699 --> 00:00:23,310
tarantula nebula and they have found a

9
00:00:20,429 --> 00:00:25,109
great many wonderfully large luminous

10
00:00:23,309 --> 00:00:28,439
stars that they're gonna be telling us

11
00:00:25,109 --> 00:00:30,868
about and this I don't know this one's

12
00:00:28,439 --> 00:00:32,730
this one's great we all love big things

13
00:00:30,868 --> 00:00:34,259
right well we talked about the largest

14
00:00:32,729 --> 00:00:36,689
galaxies the most massive galaxies the

15
00:00:34,259 --> 00:00:37,890
most biggest the biggest plan of the

16
00:00:36,689 --> 00:00:40,169
largest planet the most massive planet

17
00:00:37,890 --> 00:00:42,808
well here if you've ever been wondering

18
00:00:40,170 --> 00:00:44,399
about the most massive star in known in

19
00:00:42,808 --> 00:00:45,449
the universe then you're gonna want to

20
00:00:44,399 --> 00:00:47,250
stick around because we're going to talk

21
00:00:45,450 --> 00:00:49,160
a lot about that it's in these

22
00:00:47,250 --> 00:00:52,259
observations and so we're gonna

23
00:00:49,159 --> 00:00:54,569
introduce you to the most one of the

24
00:00:52,259 --> 00:00:56,128
most no it is the most massive star in

25
00:00:54,570 --> 00:00:57,899
the universe's the current record holder

26
00:00:56,128 --> 00:01:00,570
so we're gonna talk about that this week

27
00:00:57,899 --> 00:01:03,179
and a bunch of other things but before I

28
00:01:00,570 --> 00:01:04,769
introduce my guest let me oh and I

29

00:01:03,179 --> 00:01:06,150
should point out that dr. Carol

30
00:01:04,769 --> 00:01:09,090
Christian could not join us this week

31
00:01:06,150 --> 00:01:10,890
she is in gay Paree we're at a

32
00:01:09,090 --> 00:01:14,130
conference and of course as with all

33
00:01:10,890 --> 00:01:16,680
conferences Internet bandwidth is an

34
00:01:14,129 --> 00:01:18,478
issue so she is unable to join us this

35
00:01:16,680 --> 00:01:20,490
week but she'll be back next week to

36
00:01:18,478 --> 00:01:22,200
tell us hopefully what she did in Paris

37
00:01:20,489 --> 00:01:25,798
because it's an interesting place to

38
00:01:22,200 --> 00:01:28,590
visit so will with no more ado no

39
00:01:25,799 --> 00:01:31,710
further ado I'd like to introduce my

40
00:01:28,590 --> 00:01:32,520
colleague Scott Lewis hi Scott how you

41
00:01:31,709 --> 00:01:33,929
doing Tony

42
00:01:32,519 --> 00:01:37,379
good to see you again I'm glad you're

43
00:01:33,930 --> 00:01:39,390

back I just why I was here in spirit

44

00:01:37,379 --> 00:01:42,629

please you just sit there and wait until

45

00:01:39,390 --> 00:01:45,210

you I actually live in the Internet I

46

00:01:42,629 --> 00:01:46,859

just oh you know I've actually no longer

47

00:01:45,209 --> 00:01:49,379

of a physical body I just live in the

48

00:01:46,859 --> 00:01:52,319

internet it saves on rent quite a bit I

49

00:01:49,379 --> 00:01:54,179

suppose so I did so do you so you just

50

00:01:52,319 --> 00:01:55,828

sit there until from Hubble hanging out

51

00:01:54,180 --> 00:01:57,270

to Hubble hang out then I just say here

52

00:01:55,828 --> 00:02:00,149

I tweet every once in a while watch a

53

00:01:57,269 --> 00:02:01,920

lot of Netflix do you lot a Netflix on

54

00:02:00,149 --> 00:02:03,269

the internet yeah that's what I'm

55

00:02:01,920 --> 00:02:04,859

hearing it takes up a lot of space on

56

00:02:03,269 --> 00:02:06,569

the Internet these days well welcome

57

00:02:04,859 --> 00:02:08,250

back and it's good that you'll be the

58
00:02:06,569 --> 00:02:10,109
one you'll be the one that will be

59
00:02:08,250 --> 00:02:12,689
driving the internet for us which brings

60
00:02:10,110 --> 00:02:13,430
me to your questions and comments this

61
00:02:12,689 --> 00:02:15,438
is an inner

62
00:02:13,430 --> 00:02:18,590
- medium folks this is a hangout not

63
00:02:15,438 --> 00:02:20,120
only do Scott and I hang out and talk

64
00:02:18,590 --> 00:02:22,069
about science but we also do it with

65
00:02:20,120 --> 00:02:23,180
astronomers and astrophysicists all over

66
00:02:22,068 --> 00:02:26,449
the world who use the Hubble Space

67
00:02:23,180 --> 00:02:28,670
Telescope now is your chance if you want

68
00:02:26,449 --> 00:02:30,378
to ask them questions and can't leave

69
00:02:28,669 --> 00:02:32,119
comments and we hope you will do that

70
00:02:30,378 --> 00:02:34,340
and Scott's gonna tell you the best way

71
00:02:32,120 --> 00:02:36,019
to do it well that's guys absolutely so

72
00:02:34,340 --> 00:02:37,819
the the best and easiest way for us

73
00:02:36,019 --> 00:02:39,530
while we're live is actually I'm already

74
00:02:37,818 --> 00:02:41,658
seeing a bunch of other people in here

75
00:02:39,530 --> 00:02:43,579
we are using the YouTube live chat since

76
00:02:41,658 --> 00:02:44,959
this is a YouTube live event so there's

77
00:02:43,579 --> 00:02:47,389
a bunch of people so hello everyone

78
00:02:44,959 --> 00:02:51,949
and yes I am being snarky Astro girl won

79
00:02:47,389 --> 00:02:55,879
USA oh yes hello esfir girl so yes

80
00:02:51,949 --> 00:02:57,289
please continue to comment I put links

81
00:02:55,878 --> 00:02:59,568
into the press releases into the

82
00:02:57,289 --> 00:03:01,908
different files that we'll be sharing

83
00:02:59,568 --> 00:03:03,289
drink today so if you have any questions

84
00:03:01,908 --> 00:03:04,818
or comments on those or anything that

85
00:03:03,289 --> 00:03:07,729
we're discussing please let us know

86

00:03:04,818 --> 00:03:09,500
they're in live chat and as Tony said as

87
00:03:07,729 --> 00:03:11,780
well we are over on Twitter so I'm live

88
00:03:09,500 --> 00:03:13,878
tweeting this event using the hashtag

89
00:03:11,780 --> 00:03:15,650
Hubbell hangout and so if you're

90
00:03:13,878 --> 00:03:17,418
watching this after the fact you can

91
00:03:15,650 --> 00:03:19,840
leave comments on YouTube or continue

92
00:03:17,419 --> 00:03:22,669
the conversation on Twitter and we will

93
00:03:19,840 --> 00:03:24,919
be continuing that on I'll be tweeting

94
00:03:22,669 --> 00:03:28,400
as both myself and as Hubble telescope

95
00:03:24,919 --> 00:03:30,290
and we'll be really trying to focus on

96
00:03:28,400 --> 00:03:32,569
your questions and comments and and give

97
00:03:30,289 --> 00:03:35,810
you more insight into these supermassive

98
00:03:32,568 --> 00:03:38,089
stars in the trench of nebulae awesome

99
00:03:35,810 --> 00:03:39,289
okay so as I said at the top of this

100
00:03:38,090 --> 00:03:41,598

hangout we've got a really great one

101

00:03:39,289 --> 00:03:43,370

planned for you an international team of

102

00:03:41,598 --> 00:03:45,108

astronomers using the ultraviolet

103

00:03:43,370 --> 00:03:47,959

capabilities of NASA's Hubble Space

104

00:03:45,109 --> 00:03:51,319

Telescope has identified nine monster

105

00:03:47,959 --> 00:03:54,439

stars with masses over 100 times the

106

00:03:51,318 --> 00:03:56,289

mass of the Sun 100 times the mass of

107

00:03:54,439 --> 00:03:59,329

the Sun and the star cluster known as

108

00:03:56,289 --> 00:04:02,269

r136 this makes for the largest sample

109

00:03:59,329 --> 00:04:03,889

of very massive stars identified to date

110

00:04:02,269 --> 00:04:06,019

and so three of the members of that

111

00:04:03,889 --> 00:04:08,510

international team are with us now I

112

00:04:06,019 --> 00:04:11,120

have dr. Fabian Schneider he is from the

113

00:04:08,509 --> 00:04:12,978

University of Oxford as and he's an

114

00:04:11,120 --> 00:04:15,379

astrophysicist they're also joining me

115
00:04:12,979 --> 00:04:17,900
is Professor Paul Crowther he's from the

116
00:04:15,378 --> 00:04:19,759
University of Sheffield and Selma

117
00:04:17,899 --> 00:04:21,468
Dominique from the University of

118
00:04:19,759 --> 00:04:23,718
Amsterdam she's and astrophysicists

119
00:04:21,468 --> 00:04:26,409
there welcome folks but good to have you

120
00:04:23,718 --> 00:04:29,418
on our hangout I think

121
00:04:26,410 --> 00:04:32,030
okay so let's get to this so let's see I

122
00:04:29,418 --> 00:04:34,519
think I'll start with with you Fabian

123
00:04:32,029 --> 00:04:37,519
let's see the give us an ID why don't

124
00:04:34,519 --> 00:04:41,839
you start with what the observations

125
00:04:37,519 --> 00:04:45,978
were what was your purpose and looking

126
00:04:41,839 --> 00:04:48,649
at this particular star cluster well as

127
00:04:45,978 --> 00:04:49,969
you know it's far away it's a star

128
00:04:48,649 --> 00:04:52,459
cluster in the Large Magellanic Clouds

129
00:04:49,970 --> 00:04:56,030
it's let's talk about that the Large

130
00:04:52,459 --> 00:04:58,399
Magellanic Cloud is what it's enabling

131
00:04:56,029 --> 00:05:02,179
dwarf galaxies next to our Milky Way one

132
00:04:58,399 --> 00:05:03,948
of our next closest companion so to say

133
00:05:02,180 --> 00:05:06,408
so it's sort of one of those satellite

134
00:05:03,949 --> 00:05:08,598
galaxies around lutely exactly oh yeah

135
00:05:06,408 --> 00:05:10,759
but within that there's a huge star

136
00:05:08,598 --> 00:05:12,319
forming region a gigantic one probably

137
00:05:10,759 --> 00:05:14,620
the largest in the local universe at

138
00:05:12,319 --> 00:05:18,110
least largest that we can really

139
00:05:14,620 --> 00:05:19,879
dissolve into individual stars and in

140
00:05:18,110 --> 00:05:22,069
that huge star forming region which by

141
00:05:19,879 --> 00:05:24,978
the way was supposed to be a single star

142
00:05:22,069 --> 00:05:27,229
in the past hence the name \$30 right so

143

00:05:24,978 --> 00:05:29,718
dourados had just a consolation in the

144
00:05:27,228 --> 00:05:32,149
south and it was a circuit thirties

145
00:05:29,718 --> 00:05:33,889
brightest in there and in that region

146
00:05:32,149 --> 00:05:37,579
you have a huge star forming crowd and

147
00:05:33,889 --> 00:05:39,110
in there another huge star cluster so

148
00:05:37,579 --> 00:05:41,418
it's really far away and the cluster

149
00:05:39,110 --> 00:05:43,759
itself is tiny so if you want to be

150
00:05:41,418 --> 00:05:46,129
solve it you're gonna go and look for

151
00:05:43,759 --> 00:05:48,620
Hubble observations or alternative

152
00:05:46,129 --> 00:05:51,110
alternatively if you have some adaptive

153
00:05:48,620 --> 00:05:53,680
optics observations from the VLT for

154
00:05:51,110 --> 00:05:55,729
example and with those you can then

155
00:05:53,680 --> 00:05:57,978
individually resolve all these massive

156
00:05:55,728 --> 00:05:59,508
beasts in there and only with these

157
00:05:57,978 --> 00:06:03,379

techniques you can see individual stars

158

00:05:59,509 --> 00:06:06,199

and see and weigh them so what Scott has

159

00:06:03,379 --> 00:06:08,060

up here is what exactly is this the star

160

00:06:06,199 --> 00:06:10,759

cluster itself down on the lower part of

161

00:06:08,060 --> 00:06:14,269

it absolutely exactly so if you look

162

00:06:10,759 --> 00:06:16,069

into that picture maybe for a moment you

163

00:06:14,269 --> 00:06:18,649

can see that all these blue dots that's

164

00:06:16,069 --> 00:06:21,620

the main star cluster we are thinking of

165

00:06:18,649 --> 00:06:23,839

and we're looking at and again this just

166

00:06:21,620 --> 00:06:25,848

this snapshot of the region is in

167

00:06:23,839 --> 00:06:28,038

principle quite huge it's not that small

168

00:06:25,848 --> 00:06:29,810

and we've been only looking into the

169

00:06:28,038 --> 00:06:31,459

very heart of this cluster so if you see

170

00:06:29,810 --> 00:06:34,579

this over dense region this over dense

171

00:06:31,459 --> 00:06:36,649

blue region somewhat in the mid well in

172
00:06:34,579 --> 00:06:38,620
the lower middle that's exactly where

173
00:06:36,649 --> 00:06:40,120
we've been pointing Hubble at

174
00:06:38,620 --> 00:06:43,870
and then we've been looking into the UV

175
00:06:40,120 --> 00:06:46,899
in at least that paper now and we have

176
00:06:43,870 --> 00:06:48,459
more more data coming up soon and trying

177
00:06:46,899 --> 00:06:50,379
to figure out which objects are there

178
00:06:48,459 --> 00:06:52,839
and in fact what they are I mean no one

179
00:06:50,379 --> 00:06:55,779
knew that before at least partly

180
00:06:52,839 --> 00:06:58,359
so you said before before the era of

181
00:06:55,779 --> 00:07:01,029
large telescope space telescopes this

182
00:06:58,360 --> 00:07:03,520
was really so small and unresolved that

183
00:07:01,029 --> 00:07:05,349
people thought it was just one star for

184
00:07:03,519 --> 00:07:07,060
the longest times I right it's

185
00:07:05,350 --> 00:07:09,040
absolutely right and there's another fun

186
00:07:07,060 --> 00:07:10,689
story about that one okay the past

187
00:07:09,040 --> 00:07:12,580
people have been thinking well this is

188
00:07:10,689 --> 00:07:14,469
one star but it's not every what we know

189
00:07:12,579 --> 00:07:17,019
now it's issue a whole star cluster and

190
00:07:14,470 --> 00:07:21,039
then people try to assign one single

191
00:07:17,019 --> 00:07:23,079
mass to this app and star in in in the

192
00:07:21,038 --> 00:07:25,719
region and they came up with the mass of

193
00:07:23,079 --> 00:07:29,409
several times thousands of yeah or that

194
00:07:25,720 --> 00:07:31,180
of a son for a son so it was huge in the

195
00:07:29,410 --> 00:07:33,639
past but then people were able to evolve

196
00:07:31,180 --> 00:07:35,918
it with interferometry and now we're

197
00:07:33,639 --> 00:07:37,840
able to look into it with Hubble and see

198
00:07:35,918 --> 00:07:39,698
its many many many objects but still

199
00:07:37,839 --> 00:07:41,469
it's a thing for fun part of the whole

200

00:07:39,699 --> 00:07:44,650
story you still have the most massive

201
00:07:41,470 --> 00:07:46,300
beast sitting in that cluster no well

202
00:07:44,649 --> 00:07:52,779
that's let's get to that also this is a

203
00:07:46,300 --> 00:07:54,610
this is the Paul this is the as as

204
00:07:52,779 --> 00:07:57,098
Fabien was pointing out the largest

205
00:07:54,610 --> 00:07:58,810
galaxy or the this has some pretty large

206
00:07:57,098 --> 00:08:01,060
stars and can you give us some idea of

207
00:07:58,810 --> 00:08:04,329
the kinds of stars that are in the star

208
00:08:01,060 --> 00:08:06,699
cluster so it's a very rich star cluster

209
00:08:04,329 --> 00:08:08,529
it's probably got at least 50,000 or

210
00:08:06,699 --> 00:08:10,719
maybe a hundred thousand stars in there

211
00:08:08,529 --> 00:08:12,909
but the things that we the thing is that

212
00:08:10,720 --> 00:08:15,070
we can see in that image it does blue

213
00:08:12,910 --> 00:08:17,020
glowing white points of light and that

214
00:08:15,069 --> 00:08:18,879

in that kind of concentrated core of

215

00:08:17,019 --> 00:08:20,728

that cluster the cluster itself is only

216

00:08:18,879 --> 00:08:23,889

a few light-years across

217

00:08:20,728 --> 00:08:27,430

but it's already got you know maybe

218

00:08:23,889 --> 00:08:29,079

50,000 or 100,000 stars within it it's a

219

00:08:27,430 --> 00:08:30,939

bit like an iceberg you know the things

220

00:08:29,079 --> 00:08:32,168

we see just the tip of the iceberg the

221

00:08:30,939 --> 00:08:34,719

things we should dominating the light

222

00:08:32,168 --> 00:08:37,269

it's the most massive stars which give

223

00:08:34,719 --> 00:08:39,459

off the most radiation and this is like

224

00:08:37,269 --> 00:08:42,338

this is a Hubble wide field three

225

00:08:39,458 --> 00:08:45,699

composite image of this central region

226

00:08:42,339 --> 00:08:48,670

of the 32 Ardis region within the Large

227

00:08:45,700 --> 00:08:50,320

Magellanic Cloud so it's a the way I

228

00:08:48,669 --> 00:08:51,699

like to kind of picture it is it the

229
00:08:50,320 --> 00:08:54,220
whole magic

230
00:08:51,700 --> 00:08:57,160
the whole tarantula nebula on the sky

231
00:08:54,220 --> 00:08:59,200
spans about the same angular extent of

232
00:08:57,159 --> 00:09:01,360
the Orion Nebula in our own Milky Way

233
00:08:59,200 --> 00:09:03,520
it's a hunt it's a hundred times further

234
00:09:01,360 --> 00:09:07,120
away so it's actually a hundred times

235
00:09:03,519 --> 00:09:08,500
bigger than the Orion Nebula so there's

236
00:09:07,120 --> 00:09:09,580
probably a couple hundred thousand stars

237
00:09:08,500 --> 00:09:11,620
in the entire nebula

238
00:09:09,580 --> 00:09:15,180
and maybe fifty thousand within that

239
00:09:11,620 --> 00:09:17,830
central few parsec a few light-years

240
00:09:15,179 --> 00:09:21,219
within within our 1:36 itself and our

241
00:09:17,830 --> 00:09:22,540
3:6 was once thought to be a star and

242
00:09:21,220 --> 00:09:26,920
then it was resolved into three

243
00:09:22,539 --> 00:09:28,899
components a B and C and and then later

244
00:09:26,919 --> 00:09:30,939
on it was in broken-down the component a

245
00:09:28,899 --> 00:09:32,500
which is the cluster itself has been

246
00:09:30,940 --> 00:09:34,750
broken down initially into an eight

247
00:09:32,500 --> 00:09:37,360
components and in fact we now know of

248
00:09:34,750 --> 00:09:40,720
many many stars in there and these the

249
00:09:37,360 --> 00:09:42,190
most massive stars the ones which which

250
00:09:40,720 --> 00:09:44,019
we were basically observing in

251
00:09:42,190 --> 00:09:47,950
ultraviolet we looked at we found

252
00:09:44,019 --> 00:09:50,740
several dozen stars with masses of at

253
00:09:47,950 --> 00:09:53,170
least 50 times the mass of the Sun so

254
00:09:50,740 --> 00:09:57,039
these are the kind of very very luminous

255
00:09:53,169 --> 00:09:58,750
may be each of them emitting maybe a

256
00:09:57,039 --> 00:10:00,429
hundred thousand five hundred thousand

257

00:09:58,750 --> 00:10:02,590
or sometimes a million times more than

258
00:10:00,429 --> 00:10:04,779
the Sun these are extremely hot and very

259
00:10:02,590 --> 00:10:06,910
blue stars and that's why they look kind

260
00:10:04,779 --> 00:10:08,559
of bluey white in that picture okay I

261
00:10:06,909 --> 00:10:11,230
want to get more in depth into the stars

262
00:10:08,559 --> 00:10:13,000
themselves in just a minute but someone

263
00:10:11,230 --> 00:10:15,850
can you help me get some idea of the

264
00:10:13,000 --> 00:10:17,350
topology what this image shows a lot

265
00:10:15,850 --> 00:10:19,210
more than just the star cluster is the

266
00:10:17,350 --> 00:10:22,720
entire thing that we're looking at here

267
00:10:19,210 --> 00:10:25,180
the Scott has up is all of this star

268
00:10:22,720 --> 00:10:27,160
forming region the the gas and the the

269
00:10:25,179 --> 00:10:29,859
other of the dust and everything else

270
00:10:27,159 --> 00:10:31,750
all around it what help me understand

271
00:10:29,860 --> 00:10:34,149

this topology here I know what the

272

00:10:31,750 --> 00:10:36,399

cluster is like see that but it is also

273

00:10:34,149 --> 00:10:38,439

these blue stars you know just a little

274

00:10:36,399 --> 00:10:41,110

bit higher up are they part of the same

275

00:10:38,440 --> 00:10:44,080

cluster and then what role do these if

276

00:10:41,110 --> 00:10:45,909

any of these clouds play so these clouds

277

00:10:44,080 --> 00:10:48,520

are where we think stars are being

278

00:10:45,909 --> 00:10:51,219

formed so before this cluster that was

279

00:10:48,519 --> 00:10:52,870

was here there were only clouds it would

280

00:10:51,220 --> 00:10:55,240

be a little hard to see them now we see

281

00:10:52,870 --> 00:10:56,769

them because they're heated up by the by

282

00:10:55,240 --> 00:10:59,560

the stars around them they shape them

283

00:10:56,769 --> 00:11:03,100

you cannot see it too well but the stars

284

00:10:59,559 --> 00:11:04,809

they shine with such strong radiation

285

00:11:03,100 --> 00:11:05,170

that they actually shape it into the

286
00:11:04,809 --> 00:11:07,838
form

287
00:11:05,169 --> 00:11:10,059
fingers and filaments so on the top for

288
00:11:07,839 --> 00:11:13,480
example you see some of the structures

289
00:11:10,059 --> 00:11:15,159
in these clouds it looks like smoke but

290
00:11:13,480 --> 00:11:18,820
it's actually there's new stars being

291
00:11:15,159 --> 00:11:20,559
formed in that region and so as soon as

292
00:11:18,820 --> 00:11:24,220
the stars become so hot that they can

293
00:11:20,559 --> 00:11:25,869
blow off these gas clouds nearby that's

294
00:11:24,220 --> 00:11:28,269
the part where we start to see them so

295
00:11:25,870 --> 00:11:29,828
the blue stars in the very middle you

296
00:11:28,269 --> 00:11:32,350
see they have cleared out most of the

297
00:11:29,828 --> 00:11:33,578
area around them they might be part of

298
00:11:32,350 --> 00:11:35,199
the star cluster and you see outer

299
00:11:33,578 --> 00:11:37,269
layers they may be part of the

300
00:11:35,198 --> 00:11:39,370
surroundings it's a little hard to tell

301
00:11:37,269 --> 00:11:41,679
we know that the star cluster is also

302
00:11:39,370 --> 00:11:44,230
shooting out stars into the environment

303
00:11:41,679 --> 00:11:46,750
so stars do not stay in the same place

304
00:11:44,230 --> 00:11:49,720
when they live their lives so so this is

305
00:11:46,750 --> 00:11:52,750
really active if we could magically

306
00:11:49,720 --> 00:11:56,290
somehow put a camera let's say off to 90

307
00:11:52,750 --> 00:11:59,198
degrees of this nebula would we see kind

308
00:11:56,289 --> 00:12:00,909
of a cave or a blown-out region where

309
00:11:59,198 --> 00:12:02,500
this is kind of a bowl because remember

310
00:12:00,909 --> 00:12:03,879
when we did those we've seen those fly

311
00:12:02,500 --> 00:12:05,110
throughs at least the ones that Frank

312
00:12:03,879 --> 00:12:08,019
summers have made with the Hubble stuff

313
00:12:05,110 --> 00:12:10,480
on the m42 the Orion Nebula we've seen

314

00:12:08,019 --> 00:12:12,639
these sort of blown out bowl of the

315
00:12:10,480 --> 00:12:13,778
Orion Nebula where the stars have formed

316
00:12:12,639 --> 00:12:16,958
employment where we see something like

317
00:12:13,778 --> 00:12:20,948
that maybe here's a one big twisties I

318
00:12:16,958 --> 00:12:22,479
would say okay well compared to the

319
00:12:20,948 --> 00:12:24,189
Orion Nebula and I know that Paul you

320
00:12:22,480 --> 00:12:25,629
alluded to this and and I think I might

321
00:12:24,190 --> 00:12:27,820
have gotten distracted when you said the

322
00:12:25,629 --> 00:12:30,549
difference but how does this region and

323
00:12:27,820 --> 00:12:33,010
this nebula compare with the Orion

324
00:12:30,549 --> 00:12:35,439
Nebula you said it's much much larger is

325
00:12:33,009 --> 00:12:37,269
that right yeah the whole region is

326
00:12:35,440 --> 00:12:38,920
around a hundred times bigger it's it's

327
00:12:37,269 --> 00:12:40,899
about the same angular size bigger okay

328
00:12:38,919 --> 00:12:42,969

yeah hundred times bigger this is

329

00:12:40,899 --> 00:12:46,750

probably a central part of the tarantula

330

00:12:42,970 --> 00:12:48,850

so it's a central half or so or third of

331

00:12:46,750 --> 00:12:51,250

the whole tarantula nebula so it's about

332

00:12:48,850 --> 00:12:53,709

overall 20 was around the 100 times

333

00:12:51,250 --> 00:12:57,129

bigger with a hundred times more stars

334

00:12:53,708 --> 00:12:59,289

than your eye nebula and it's also about

335

00:12:57,129 --> 00:13:01,419

a thousand times brighter the Kista star

336

00:12:59,289 --> 00:13:03,159

as a minute some of the stars are much

337

00:13:01,419 --> 00:13:04,509

hotter than those in your mind negative

338

00:13:03,159 --> 00:13:06,639

so if you put them two at the same

339

00:13:04,509 --> 00:13:09,039

distance you know it would be a thousand

340

00:13:06,639 --> 00:13:10,778

times brighter and it would be a hundred

341

00:13:09,039 --> 00:13:12,549

times larger on the sky if we put a

342

00:13:10,778 --> 00:13:15,039

distance of the Orion Nebula which was

343
00:13:12,549 --> 00:13:17,269
only you know five hundred parsec away

344
00:13:15,039 --> 00:13:20,179
one and a half thousand light-years

345
00:13:17,269 --> 00:13:21,980
much much richer staffing region but

346
00:13:20,179 --> 00:13:23,899
it's I'll guess it's comparisons more

347
00:13:21,980 --> 00:13:26,389
with the Orion molecular cloud from

348
00:13:23,899 --> 00:13:29,059
which the stars are form that's a much

349
00:13:26,389 --> 00:13:31,539
larger region around the nebula that we

350
00:13:29,059 --> 00:13:34,069
can that the famous nebula there's much

351
00:13:31,539 --> 00:13:35,329
extending well past the constellation

352
00:13:34,070 --> 00:13:36,710
boundaries itself now the reason we're

353
00:13:35,330 --> 00:13:38,900
talking about this folks is that the

354
00:13:36,710 --> 00:13:40,970
Orion Nebula is a star forming region

355
00:13:38,899 --> 00:13:42,409
within our own galaxy and so there's a

356
00:13:40,970 --> 00:13:44,570
lot of stars going on there

357
00:13:42,409 --> 00:13:46,819
all of our BR being born there but as

358
00:13:44,570 --> 00:13:48,590
polish's pointing out the kinds of stars

359
00:13:46,820 --> 00:13:50,510
and just a magnitude of the whole thing

360
00:13:48,590 --> 00:13:52,879
it's much much greater in the large

361
00:13:50,509 --> 00:13:55,759
magellanic cloud so you said earlier

362
00:13:52,879 --> 00:13:57,799
that there was different components to

363
00:13:55,759 --> 00:13:59,539
this it was a and a B component was that

364
00:13:57,799 --> 00:14:01,639
just because telescopes got better at

365
00:13:59,539 --> 00:14:05,750
resolving this area and we could see it

366
00:14:01,639 --> 00:14:09,110
more for what it was or yes around about

367
00:14:05,750 --> 00:14:11,389
60 years ago that it was first

368
00:14:09,110 --> 00:14:14,200
identified as a a bright star within

369
00:14:11,389 --> 00:14:17,090
that within the Large Magellanic Cloud

370
00:14:14,200 --> 00:14:19,129
with one three six and then it was in

371

00:14:17,090 --> 00:14:21,050
the 80s where it was then resolved into

372
00:14:19,129 --> 00:14:23,179
three components a B C and then

373
00:14:21,049 --> 00:14:26,449
component a it turned out to be the

374
00:14:23,179 --> 00:14:29,209
cluster was then in the mid eighties we

375
00:14:26,450 --> 00:14:31,190
thought into a number of components but

376
00:14:29,210 --> 00:14:32,690
really if you could see if you could

377
00:14:31,190 --> 00:14:34,880
resolve all the stars you would find

378
00:14:32,690 --> 00:14:36,920
many many tens of thousands of

379
00:14:34,879 --> 00:14:38,480
components in there it's just the right

380
00:14:36,919 --> 00:14:42,110
ones and ones that shine the brightest

381
00:14:38,480 --> 00:14:44,539
they're easy easy to see okay well so

382
00:14:42,110 --> 00:14:47,060
astro girl one USA hello welcome back

383
00:14:44,539 --> 00:14:48,259
I'm glad to see you're back again I was

384
00:14:47,059 --> 00:14:50,929
asking a relevant question what we're

385
00:14:48,259 --> 00:14:53,360

talking about how bright is it now I

386

00:14:50,929 --> 00:14:55,489

assume by that she saw my the magnitude

387

00:14:53,360 --> 00:14:57,350

let's pretend that it's just the one

388

00:14:55,490 --> 00:14:59,750

star thirty-two Radice or whatever and

389

00:14:57,350 --> 00:15:02,029

what would be the brightness of this

390

00:14:59,750 --> 00:15:03,740

thing and maybe is a beam is there

391

00:15:02,029 --> 00:15:06,980

something you can answer for us yeah

392

00:15:03,740 --> 00:15:09,560

sure so individually if you if it

393

00:15:06,980 --> 00:15:11,330

speaking of one of the most brightest

394

00:15:09,559 --> 00:15:13,939

most massive objects in there it can

395

00:15:11,330 --> 00:15:15,530

easily be millions or the luminosity of

396

00:15:13,940 --> 00:15:18,620

this object can be 1 million times that

397

00:15:15,529 --> 00:15:20,419

of our Sun and even above that so it's

398

00:15:18,620 --> 00:15:23,450

one individual object and now you can

399

00:15:20,419 --> 00:15:26,479

count well we have plenty of them say 50

400
00:15:23,450 --> 00:15:29,780
all of that at all of magnitude so the

401
00:15:26,480 --> 00:15:30,500
whole cluster itself can go up to 12 10

402
00:15:29,779 --> 00:15:34,730
to the 7

403
00:15:30,500 --> 00:15:38,149
solar luminosities so it's really you

404
00:15:34,730 --> 00:15:39,470
seven zeroes behind it and it's you know

405
00:15:38,149 --> 00:15:42,829
city you get can get from the cluster

406
00:15:39,470 --> 00:15:44,840
itself yeah okay so the way I and also

407
00:15:42,830 --> 00:15:46,370
interpret this is if I'm an old amateur

408
00:15:44,840 --> 00:15:52,759
astronomer and let me just get rid of

409
00:15:46,370 --> 00:15:56,360
that I'm an amateur astronomer and okay

410
00:15:52,759 --> 00:15:58,789
yeah and if I wanted to look at this

411
00:15:56,360 --> 00:15:59,870
through a telescope from my backyard

412
00:15:58,789 --> 00:16:11,000
could I

413
00:15:59,870 --> 00:16:13,220
or is it to dim the look all day and

414
00:16:11,000 --> 00:16:15,500
night long Tony but unless I can see

415
00:16:13,220 --> 00:16:20,300
through the earth I'm so glad you're

416
00:16:15,500 --> 00:16:22,370
here Scott right so if I were it like

417
00:16:20,299 --> 00:16:24,709
let's say I'm in Chile but I'm not up in

418
00:16:22,370 --> 00:16:26,600
the Andes and I want to look at this

419
00:16:24,710 --> 00:16:28,670
could I yeah what I'd be able to see in

420
00:16:26,600 --> 00:16:30,620
an amateur scope oh you would even see

421
00:16:28,669 --> 00:16:32,329
it with a bear I yeah that's the source

422
00:16:30,620 --> 00:16:33,560
that bright good that's that's sort of

423
00:16:32,330 --> 00:16:36,920
where I was going with that thank you

424
00:16:33,559 --> 00:16:38,419
Scott for making me uh well didn't come

425
00:16:36,919 --> 00:16:40,459
in the whole thing I'm just I'm just

426
00:16:38,419 --> 00:16:41,949
saying yeah I know I let you let that go

427
00:16:40,460 --> 00:16:45,379
so I should be counting my blessed

428

00:16:41,950 --> 00:16:48,980
okay so let's not really lesser in this

429
00:16:45,379 --> 00:16:54,730
group I got a comment here from Paul

430
00:16:48,980 --> 00:16:57,470
from astronomy in Jake Ombuds

431
00:16:54,730 --> 00:16:59,870
themselves in the galaxy cluster or in

432
00:16:57,470 --> 00:17:01,370
the star cluster and as we've you've

433
00:16:59,870 --> 00:17:03,529
already pointed out they're extremely

434
00:17:01,370 --> 00:17:05,660
bright they're they're much much larger

435
00:17:03,529 --> 00:17:07,789
or much more massive than the Sun in

436
00:17:05,660 --> 00:17:12,470
just about every single way they're all

437
00:17:07,789 --> 00:17:14,180
very blue which means give us an idea

438
00:17:12,470 --> 00:17:16,670
about first of all I want to know why

439
00:17:14,180 --> 00:17:18,170
they're blue and I know then that you're

440
00:17:16,670 --> 00:17:20,150
gonna tell me why the Hubble Space

441
00:17:18,170 --> 00:17:22,220
Telescope was able to get such clear

442
00:17:20,150 --> 00:17:24,290

pictures of this and maybe can you give

443

00:17:22,220 --> 00:17:26,529

us a sort of a quick quick rundown on

444

00:17:24,289 --> 00:17:29,329

why these stars are blue and and

445

00:17:26,529 --> 00:17:32,690

basically the the classification of

446

00:17:29,329 --> 00:17:35,000

stars that are in this mmm so I think

447

00:17:32,690 --> 00:17:37,519

the easiest way to explain that is by

448

00:17:35,000 --> 00:17:39,200

looking at a normal flame so if you if

449

00:17:37,519 --> 00:17:41,089

you look at a flame where this hottest

450

00:17:39,200 --> 00:17:42,590

it looks as if it was balloon right and

451

00:17:41,089 --> 00:17:44,399

then the flame gets maybe a bit cooler

452

00:17:42,589 --> 00:17:45,720

to the outside and it's getting

453

00:17:44,400 --> 00:17:48,330

I gather and together and maybe orange

454

00:17:45,720 --> 00:17:50,519

maybe some yellow inside and the star is

455

00:17:48,329 --> 00:17:52,379

nothing but like a flame in principle

456

00:17:50,519 --> 00:17:54,450

it's a blackbody as we would call it and

457
00:17:52,380 --> 00:17:57,120
so it's temperature on the surface tells

458
00:17:54,450 --> 00:17:58,500
what colored will have and these objects

459
00:17:57,119 --> 00:18:00,359
are very massive meaning they're

460
00:17:58,500 --> 00:18:03,660
extremely hot so on the surfaces we

461
00:18:00,359 --> 00:18:07,139
speak of say 50 thousand Kelvin or 50

462
00:18:03,660 --> 00:18:08,519
thousand degrees Celsius and that's its

463
00:18:07,140 --> 00:18:09,090
temperature and if you convert it into

464
00:18:08,519 --> 00:18:11,670
colors

465
00:18:09,089 --> 00:18:13,829
it is blue or in fact these objects

466
00:18:11,670 --> 00:18:15,480
would peak in the ultraviolet which we

467
00:18:13,829 --> 00:18:17,909
fortunately can't see and which you

468
00:18:15,480 --> 00:18:24,839
wouldn't see on earth our atmosphere is

469
00:18:17,910 --> 00:18:26,580
luckily and healthy right yep and so for

470
00:18:24,839 --> 00:18:28,230
us they look blue but if you really look

471
00:18:26,579 --> 00:18:30,029
at where they have their maximum in

472
00:18:28,230 --> 00:18:32,640
radiation it's somewhere over elephant

473
00:18:30,029 --> 00:18:34,579
now as carol has pointed out and if she

474
00:18:32,640 --> 00:18:36,960
were here I'm sure would do so again

475
00:18:34,579 --> 00:18:39,149
really Space Telescope's I think it was

476
00:18:36,960 --> 00:18:42,680
you Paul that pointed out that the ELT

477
00:18:39,150 --> 00:18:45,720
the extremely large telescope run by ESO

478
00:18:42,680 --> 00:18:47,460
the European Southern Observatory would

479
00:18:45,720 --> 00:18:49,410
be able to resolve the stars but not

480
00:18:47,460 --> 00:18:51,900
necessary I wouldn't be able to see this

481
00:18:49,410 --> 00:18:55,620
in the UV because it's a ground-based

482
00:18:51,900 --> 00:18:58,350
telescope so Hubble is one is the only

483
00:18:55,619 --> 00:19:00,299
game in town I'm told by Carol that if

484
00:18:58,349 --> 00:19:02,609
you want to get UV observations you have

485

00:19:00,299 --> 00:19:05,129
to go to Hubble and describe for me a

486
00:19:02,609 --> 00:19:07,429
little bit of Fabien how with what

487
00:19:05,130 --> 00:19:09,990
instrument you got these observations

488
00:19:07,430 --> 00:19:12,269
all right I'll try to explain that I

489
00:19:09,990 --> 00:19:14,220
guess Paul is the expert is all fair ok

490
00:19:12,269 --> 00:19:15,690
well then let me it's no problem I can

491
00:19:14,220 --> 00:19:17,640
you can start and you can kick in yeah

492
00:19:15,690 --> 00:19:20,160
you have to do this I'm asking home

493
00:19:17,640 --> 00:19:21,660
person you guys say now give that one a

494
00:19:20,160 --> 00:19:23,910
call

495
00:19:21,660 --> 00:19:27,170
well the instrument itself is quotes dis

496
00:19:23,910 --> 00:19:30,090
which is when Hubble it's in there in

497
00:19:27,170 --> 00:19:31,560
interferometer and so a spectrograph and

498
00:19:30,089 --> 00:19:34,349
what you do with that is you just have

499
00:19:31,559 --> 00:19:36,359

slits on the sky and in each slit you

500

00:19:34,349 --> 00:19:38,519

take a spectrograph of all the objects

501

00:19:36,359 --> 00:19:40,259

so we oriented all those slits on to the

502

00:19:38,519 --> 00:19:43,049

sky such that in each slit we would have

503

00:19:40,259 --> 00:19:46,349

a couple of stars and then took Hubble

504

00:19:43,049 --> 00:19:48,269

to get all their spectra and that's yeah

505

00:19:46,349 --> 00:19:49,740

what we can get from that and then of

506

00:19:48,269 --> 00:19:51,629

course with a spectrograph or with the

507

00:19:49,740 --> 00:19:53,490

spectrum of the star you have a lot of

508

00:19:51,630 --> 00:19:56,250

information available in particular from

509

00:19:53,490 --> 00:19:58,289

the UV range it's telling a lot of about

510

00:19:56,250 --> 00:19:59,880

the details of the objects

511

00:19:58,289 --> 00:20:02,009

for example what kind of winds they have

512

00:19:59,880 --> 00:20:04,830

how fast the wind is escaping from the

513

00:20:02,009 --> 00:20:07,379

surfaces and so on and so forth okay so

514
00:20:04,829 --> 00:20:09,990
the so by the way still stands for the

515
00:20:07,380 --> 00:20:12,540
Space Telescope imaging spectrograph and

516
00:20:09,990 --> 00:20:14,250
it takes images and spectra at the same

517
00:20:12,539 --> 00:20:16,440
time and of course the Hubble has

518
00:20:14,250 --> 00:20:18,569
ultraviolet filters onboard that lets

519
00:20:16,440 --> 00:20:21,180
you see in these wavelengths so a Selma

520
00:20:18,569 --> 00:20:23,789
I know so we've talked about the colors

521
00:20:21,180 --> 00:20:25,380
of these stars and Polly's told us about

522
00:20:23,789 --> 00:20:27,899
how large they are things like that I

523
00:20:25,380 --> 00:20:30,000
want to know and I I want to know first

524
00:20:27,900 --> 00:20:34,040
of all how how do they get this big it

525
00:20:30,000 --> 00:20:37,380
what's so special about this about this

526
00:20:34,039 --> 00:20:39,779
cluster that makes such enormous stars I

527
00:20:37,380 --> 00:20:42,330
mean is there anything how they get this

528
00:20:39,779 --> 00:20:44,279
way oh you're asking the right question

529
00:20:42,329 --> 00:20:48,059
this is the question this is the big

530
00:20:44,279 --> 00:20:49,500
question for big box yeah it's the

531
00:20:48,059 --> 00:20:51,419
question we don't know the answer to and

532
00:20:49,500 --> 00:20:53,369
that's why we're so well excited to find

533
00:20:51,420 --> 00:20:55,050
them it's a it's frightening for for a

534
00:20:53,369 --> 00:20:57,149
theorist we don't know how such massive

535
00:20:55,049 --> 00:20:59,430
stars form because when you're forming

536
00:20:57,150 --> 00:21:01,320
them they are already so hot that they

537
00:20:59,430 --> 00:21:03,390
they already start to radiate before you

538
00:21:01,319 --> 00:21:06,419
before they have grown so massive and so

539
00:21:03,390 --> 00:21:08,670
all theoretical models that are trying

540
00:21:06,420 --> 00:21:11,910
to explain how you can make such massive

541
00:21:08,670 --> 00:21:13,590
stars they're failing so it's extremely

542

00:21:11,910 --> 00:21:16,680
interesting problem if you're in a

543
00:21:13,589 --> 00:21:18,509
theoretical astrophysicist Paul Crowther

544
00:21:16,680 --> 00:21:20,130
takes the observations there there we

545
00:21:18,509 --> 00:21:21,509
better try to understand when you see em

546
00:21:20,130 --> 00:21:22,800
you know they're there but so you're

547
00:21:21,509 --> 00:21:26,160
saying we've also you know on astronomy

548
00:21:22,799 --> 00:21:27,720
101 we've learned if you take if you go

549
00:21:26,160 --> 00:21:31,050
to university and you take your first

550
00:21:27,720 --> 00:21:34,500
class in stellar evolution you will take

551
00:21:31,049 --> 00:21:36,240
a very easy calculation and you will

552
00:21:34,500 --> 00:21:38,160
calculate yourself that is impossible to

553
00:21:36,240 --> 00:21:41,519
make any star above about 100 solar

554
00:21:38,160 --> 00:21:43,320
masses and then cool Crowther comes

555
00:21:41,519 --> 00:21:44,940
along and tells us well I have all these

556
00:21:43,319 --> 00:21:46,349

stars that are hundred fifty two hundred

557

00:21:44,940 --> 00:21:49,080

and Amy tells us they're born with

558

00:21:46,349 --> 00:21:51,750

around 300 so it's it's it's really

559

00:21:49,079 --> 00:21:53,759

turning a lot of our field around they

560

00:21:51,750 --> 00:21:56,009

don't get that way later they're born at

561

00:21:53,759 --> 00:21:58,079

this eyes okay so it turns out that that

562

00:21:56,009 --> 00:21:59,430

that simple exercise we do in the first

563

00:21:58,079 --> 00:22:01,230

year when you come to the University was

564

00:21:59,430 --> 00:22:02,490

a little bit simplified and so if you

565

00:22:01,230 --> 00:22:04,289

think about the details it's not

566

00:22:02,490 --> 00:22:07,170

impossible that there would be stars

567

00:22:04,289 --> 00:22:09,389

existing that are so massive but still

568

00:22:07,170 --> 00:22:11,909

we have no idea how so much gas can

569

00:22:09,390 --> 00:22:13,499

actually collect and make such a star

570

00:22:11,909 --> 00:22:15,869

and so we're trying to think of creative

571
00:22:13,499 --> 00:22:17,608
ways to find them and so one of the

572
00:22:15,868 --> 00:22:19,828
things you see we apparently find them

573
00:22:17,608 --> 00:22:23,128
only in very dense cluster like this and

574
00:22:19,828 --> 00:22:25,528
so one of the ideas that also Fabian and

575
00:22:23,128 --> 00:22:27,509
we have worked on is maybe these stars

576
00:22:25,528 --> 00:22:29,669
are not formed as normal stars but you

577
00:22:27,509 --> 00:22:31,828
can make them when you smash more than

578
00:22:29,669 --> 00:22:34,739
one star into each other so you make

579
00:22:31,828 --> 00:22:36,778
stars that are also massive but not

580
00:22:34,739 --> 00:22:39,209
crazy massive and you maybe make them in

581
00:22:36,778 --> 00:22:41,038
pairs and these pairs later come

582
00:22:39,209 --> 00:22:45,659
together we have an animation that shows

583
00:22:41,038 --> 00:22:48,989
some of this stuff so here we go okay so

584
00:22:45,659 --> 00:22:52,409
described here what what we're seeing so

585
00:22:48,989 --> 00:22:54,989
this is an animation of a star we found

586
00:22:52,409 --> 00:22:57,059
somewhere else in the region and this is

587
00:22:54,989 --> 00:22:58,889
what we call a contact binary is a kind

588
00:22:57,058 --> 00:23:00,739
of a peanut-shaped binary it's two stars

589
00:22:58,888 --> 00:23:03,358
that are actually touching each other

590
00:23:00,739 --> 00:23:06,088
in the kissing yes that's the press

591
00:23:03,358 --> 00:23:08,999
release we had a a few months ago

592
00:23:06,088 --> 00:23:10,918
actually it's not in this cluster but

593
00:23:08,999 --> 00:23:11,368
these two stars are 30 and 30 solar

594
00:23:10,919 --> 00:23:14,099
masses

595
00:23:11,368 --> 00:23:16,648
and we we think they will come together

596
00:23:14,098 --> 00:23:18,868
and make a 60 solar mass star but from

597
00:23:16,648 --> 00:23:21,508
60 is still a long way to make a 200

598
00:23:18,868 --> 00:23:23,009
solar mass star but this might be one of

599

00:23:21,509 --> 00:23:24,659
the ways we can make at least some of

600
00:23:23,009 --> 00:23:26,088
them but it's still a big puzzle it's

601
00:23:24,659 --> 00:23:28,019
not it's not

602
00:23:26,088 --> 00:23:30,778
astronomers are not agreeing that this

603
00:23:28,019 --> 00:23:32,578
is the only way to do it so Lester you

604
00:23:30,778 --> 00:23:34,648
might even merge these ones and and

605
00:23:32,578 --> 00:23:38,278
throw a third star in that passes by too

606
00:23:34,648 --> 00:23:40,408
close and they will eat up be is a real

607
00:23:38,278 --> 00:23:41,519
mess because if you take two of these

608
00:23:40,409 --> 00:23:43,949
things and they have over time

609
00:23:41,519 --> 00:23:46,440
eventually coalesce you've got two star

610
00:23:43,949 --> 00:23:49,199
cores you've got two stellar atmospheres

611
00:23:46,440 --> 00:23:53,009
all coming together to make one large

612
00:23:49,199 --> 00:23:54,599
star I just wow that just I don't even

613
00:23:53,009 --> 00:23:58,919

know what that would you know that would

614

00:23:54,598 --> 00:24:00,628

be a mess what sort of time scales are

615

00:23:58,919 --> 00:24:03,389

we talking about if this were what's

616

00:24:00,628 --> 00:24:05,728

happening how long do you think that

617

00:24:03,388 --> 00:24:07,618

would take so the whole cluster is still

618

00:24:05,729 --> 00:24:09,690

super young in astronomical terms

619

00:24:07,618 --> 00:24:12,328

meaning it's about 1 million years old

620

00:24:09,690 --> 00:24:13,949

that that is extremely young for a for a

621

00:24:12,328 --> 00:24:15,959

star cluster we don't have a many

622

00:24:13,949 --> 00:24:17,788

regions that are that young and so if

623

00:24:15,959 --> 00:24:20,759

stars pass too close if they're getting

624

00:24:17,788 --> 00:24:23,338

this close it will maybe take 10,000

625

00:24:20,759 --> 00:24:25,440

years or so or less if they if they're

626

00:24:23,338 --> 00:24:25,798

deeper in contact it can just take a few

627

00:24:25,440 --> 00:24:27,869

days

628
00:24:25,798 --> 00:24:30,239
to really do the last bit of the merger

629
00:24:27,868 --> 00:24:32,579
okay so this can happen on relatively

630
00:24:30,239 --> 00:24:33,989
short timescales so they get so let's

631
00:24:32,579 --> 00:24:36,509
get to a couple of these questions then

632
00:24:33,989 --> 00:24:37,710
that a word that I'm saying let's get to

633
00:24:36,509 --> 00:24:41,339
the other one that they're from Paul

634
00:24:37,710 --> 00:24:46,230
from astronomy and Jay comm what colors

635
00:24:41,339 --> 00:24:48,720
can stars start their lives as so you as

636
00:24:46,230 --> 00:24:50,639
I understand that you guys are saying

637
00:24:48,720 --> 00:24:53,720
that these stars in particular in this

638
00:24:50,638 --> 00:24:56,308
cluster in r134 these are starting as

639
00:24:53,720 --> 00:24:59,329
incredibly hot and therefore blue star

640
00:24:56,308 --> 00:25:03,058
that's what Fabien was telling us right

641
00:24:59,329 --> 00:25:05,398
yes so say that was probably a phase

642
00:25:03,058 --> 00:25:07,349
where the star started out more in the

643
00:25:05,398 --> 00:25:09,508
cooler Kazim but then very quickly

644
00:25:07,349 --> 00:25:11,548
equated all its mass and it immediately

645
00:25:09,509 --> 00:25:13,798
turns into something blue and short

646
00:25:11,548 --> 00:25:17,069
again on a time scale of stars of course

647
00:25:13,798 --> 00:25:18,599
so if you really think of so what it's

648
00:25:17,069 --> 00:25:21,778
probably the problem of how to define

649
00:25:18,599 --> 00:25:23,878
when a star gets into existence so when

650
00:25:21,778 --> 00:25:26,069
does the life of a star starts we would

651
00:25:23,878 --> 00:25:27,839
typically say well whenever in in the

652
00:25:26,069 --> 00:25:30,089
core and the interior you start to fuse

653
00:25:27,839 --> 00:25:32,579
hydrogen and at that point these stars

654
00:25:30,089 --> 00:25:33,868
are all extremely blue extremely hot but

655
00:25:32,579 --> 00:25:36,388
before that they had an accretion

656

00:25:33,868 --> 00:25:38,819
history and they're probably looking

657
00:25:36,388 --> 00:25:42,479
kind of reddish but we've never seen

658
00:25:38,819 --> 00:25:44,579
such an object forming yet so right so

659
00:25:42,480 --> 00:25:47,429
yeah I keep coming back to this we've

660
00:25:44,579 --> 00:25:49,230
seen the debates that we as someone was

661
00:25:47,429 --> 00:25:52,080
pointing out in astronomy 101 we counted

662
00:25:49,230 --> 00:25:53,999
it a simplified calculation to do this

663
00:25:52,079 --> 00:25:55,678
accretion model of this gas cloud coming

664
00:25:53,999 --> 00:25:57,419
together and forming whatever stars and

665
00:25:55,679 --> 00:25:59,340
I guess you could assume that you know

666
00:25:57,419 --> 00:26:01,139
red dwarf stars would not have started

667
00:25:59,339 --> 00:26:02,548
with this much material probably in a

668
00:26:01,138 --> 00:26:04,738
very remote region of the galaxy or

669
00:26:02,548 --> 00:26:07,079
whatever it is I don't and then the

670
00:26:04,739 --> 00:26:09,350

these stars obviously being break

671

00:26:07,079 --> 00:26:12,868

crowded and very dense and having a rich

672

00:26:09,349 --> 00:26:15,118

set of cross raw materials can create

673

00:26:12,868 --> 00:26:18,028

these very hot large and blue stars but

674

00:26:15,118 --> 00:26:20,069

even that by itself doesn't doesn't

675

00:26:18,028 --> 00:26:23,128

explain why they get so big and so this

676

00:26:20,069 --> 00:26:25,378

one sort of accretion our emerging model

677

00:26:23,128 --> 00:26:27,089

comes in there was another animation

678

00:26:25,378 --> 00:26:29,459

that I saw before the hangout started

679

00:26:27,089 --> 00:26:32,158

though is that relevant here to Selma

680

00:26:29,460 --> 00:26:33,720

with the there was an I don't recall

681

00:26:32,159 --> 00:26:35,909

what it what it said but there was

682

00:26:33,720 --> 00:26:38,999

another animation that you should we

683

00:26:35,909 --> 00:26:39,750

show I think Paul is proposing to show

684

00:26:38,999 --> 00:26:42,630

their compares

685
00:26:39,750 --> 00:26:44,269
between the Sun and Red Dwarf sir oh all

686
00:26:42,630 --> 00:26:47,490
right sure sure

687
00:26:44,269 --> 00:26:49,079
give me mama okay good okay all right I

688
00:26:47,490 --> 00:26:50,400
didn't know I can be please say

689
00:26:49,079 --> 00:26:52,619
something about this so just before

690
00:26:50,400 --> 00:26:55,590
these stars come in contact this is two

691
00:26:52,619 --> 00:26:59,219
two binary stars that are very close you

692
00:26:55,589 --> 00:27:01,230
see they're just system yeah so we think

693
00:26:59,220 --> 00:27:03,120
that most massive stars have companions

694
00:27:01,230 --> 00:27:05,940
like that it's very rarely we find them

695
00:27:03,119 --> 00:27:09,329
alone and so most normal massive stars

696
00:27:05,940 --> 00:27:11,279
are like this and they turn around each

697
00:27:09,329 --> 00:27:13,139
other like a planet around the Sun and

698
00:27:11,279 --> 00:27:15,769
then they start to interact which is

699
00:27:13,140 --> 00:27:18,750
what you just saw you saw one star

700
00:27:15,769 --> 00:27:21,629
throwing material to the other star some

701
00:27:18,750 --> 00:27:23,009
people call this a vampire system so

702
00:27:21,630 --> 00:27:25,260
this is something we think is a very

703
00:27:23,009 --> 00:27:27,960
common in massive stars the interesting

704
00:27:25,259 --> 00:27:29,670
thing is that these stars four hundred

705
00:27:27,960 --> 00:27:31,860
two hundred solar masses as far as we

706
00:27:29,670 --> 00:27:34,769
know now we don't see any companion

707
00:27:31,859 --> 00:27:36,929
which is actually very strange for a

708
00:27:34,769 --> 00:27:38,250
massive star for normal massive stars

709
00:27:36,930 --> 00:27:41,100
all have companions and these most

710
00:27:38,250 --> 00:27:43,470
massive stars so as far as we know today

711
00:27:41,099 --> 00:27:44,609
they don't have companions that kind of

712
00:27:43,470 --> 00:27:45,720
makes sense right I mean if they've

713

00:27:44,609 --> 00:27:47,639
already perished

714
00:27:45,720 --> 00:27:49,289
they've already might they might have

715
00:27:47,640 --> 00:27:50,610
already eaten their companion so one of

716
00:27:49,289 --> 00:27:52,440
the questions here is are they blue

717
00:27:50,609 --> 00:27:54,629
stragglers and yes that's exactly what

718
00:27:52,440 --> 00:27:57,210
we mean if if a star eats its companion

719
00:27:54,630 --> 00:27:59,850
you get a blue star that appears to be

720
00:27:57,210 --> 00:28:00,900
young it struggles behind the other star

721
00:27:59,849 --> 00:28:02,789
it struggles in time

722
00:28:00,900 --> 00:28:04,170
it looks younger than the other star so

723
00:28:02,789 --> 00:28:05,759
yes it's exactly what we call a blue

724
00:28:04,170 --> 00:28:08,550
straggler great that was from Richard

725
00:28:05,759 --> 00:28:09,900
Craig good question okay okay good so I

726
00:28:08,549 --> 00:28:16,399
want to get to their deaths in a minute

727
00:28:09,900 --> 00:28:16,400

- but the so okay so here's what morbid

728

00:28:16,970 --> 00:28:24,900

Wow look at that so we have not just

729

00:28:21,299 --> 00:28:26,099

impression okay kind of different sizes

730

00:28:24,900 --> 00:28:29,640

of these different styles and the colors

731

00:28:26,099 --> 00:28:31,439

so so most stars in the universe in a

732

00:28:29,640 --> 00:28:34,200

Milky Way and other galaxies are these

733

00:28:31,440 --> 00:28:35,880

red dwarf stars which are not much

734

00:28:34,200 --> 00:28:38,580

bigger than Jupiter and kind of live

735

00:28:35,880 --> 00:28:40,770

forever you know they kind of keep going

736

00:28:38,579 --> 00:28:42,359

on like they're they may faint and so

737

00:28:40,769 --> 00:28:44,609

they like getting through their hydrogen

738

00:28:42,359 --> 00:28:46,740

fuel very quickly and they just keep on

739

00:28:44,609 --> 00:28:48,269

trucking forever you know and then we

740

00:28:46,740 --> 00:28:51,440

have the next size up that's going to

741

00:28:48,269 --> 00:28:54,839

some sort of savage

742
00:28:51,440 --> 00:28:58,558
which are still pretty common in in

743
00:28:54,839 --> 00:29:00,538
galaxies somewhat bigger you know so 10

744
00:28:58,558 --> 00:29:02,460
times bigger than Jupiter hundred times

745
00:29:00,538 --> 00:29:05,729
bigger than the earth these things have

746
00:29:02,460 --> 00:29:08,278
got lifetimes of 10 billion years of

747
00:29:05,729 --> 00:29:09,690
10,000 million years or so and then most

748
00:29:08,278 --> 00:29:11,940
when we think about massive stars in

749
00:29:09,690 --> 00:29:13,859
general it's that kind of kind of bleed

750
00:29:11,940 --> 00:29:15,330
warf so instead it's a dwarf there it's

751
00:29:13,858 --> 00:29:17,728
not a supergiant star but it's only a

752
00:29:15,329 --> 00:29:20,009
few times bigger than the Sun and may

753
00:29:17,729 --> 00:29:22,979
have a mass of 10 times the mass of the

754
00:29:20,009 --> 00:29:26,009
Sun these are pretty pretty rare and

755
00:29:22,979 --> 00:29:27,450
these things exist in um in in the RAI

756
00:29:26,009 --> 00:29:29,548
nebula for example the few of these

757
00:29:27,450 --> 00:29:31,499
things are in there but still pretty

758
00:29:29,548 --> 00:29:33,839
rare and these had lifetimes of many

759
00:29:31,499 --> 00:29:35,489
tens of millions of years and the kind

760
00:29:33,839 --> 00:29:37,858
of most massive stars are ones which are

761
00:29:35,489 --> 00:29:40,619
in that central cluster in the tarantula

762
00:29:37,858 --> 00:29:44,489
in our 36-hour things a bit like that

763
00:29:40,618 --> 00:29:46,470
but that darker blue cartoon showing

764
00:29:44,489 --> 00:29:48,960
showing what we think is right now the

765
00:29:46,470 --> 00:29:51,419
most massive star known and see if these

766
00:29:48,960 --> 00:29:54,629
are these are maybe 20 times bigger than

767
00:29:51,419 --> 00:29:55,830
the Sun but incredibly luminous and

768
00:29:54,628 --> 00:29:57,269
incredibly short-lived

769
00:29:55,829 --> 00:30:01,019
you know the lifetimes to be stars are

770

00:29:57,269 --> 00:30:03,149
only a few million years and so we have

771
00:30:01,019 --> 00:30:04,798
to look in the youngest artists have a

772
00:30:03,148 --> 00:30:06,988
chance of seeing them you know if a

773
00:30:04,798 --> 00:30:08,489
cluster is only a few million years old

774
00:30:06,989 --> 00:30:09,979
it would be too late these guys are

775
00:30:08,489 --> 00:30:12,028
already gone

776
00:30:09,979 --> 00:30:13,769
amazing look I'm sorry look how large

777
00:30:12,028 --> 00:30:16,019
that it was to you and it's because it's

778
00:30:13,769 --> 00:30:17,308
because they they're so they're shining

779
00:30:16,019 --> 00:30:19,919
so brightly you know they're they're

780
00:30:17,308 --> 00:30:21,868
using up their fuel so quickly which is

781
00:30:19,919 --> 00:30:24,210
why they are such short lifetimes you

782
00:30:21,868 --> 00:30:26,368
know so they you know they're they have

783
00:30:24,210 --> 00:30:28,829
a fuel supply of a hundred times the Sun

784
00:30:26,368 --> 00:30:31,978

in terms of its hydrogen but because

785

00:30:28,829 --> 00:30:35,189

they're shining up - it's a cases now

786

00:30:31,979 --> 00:30:37,649

a36 a one we think shines together ten

787

00:30:35,190 --> 00:30:39,028

million times brighter than the Sun you

788

00:30:37,648 --> 00:30:40,558

know it's going through its fuel so

789

00:30:39,028 --> 00:30:44,909

quickly they live fast and die greedy

790

00:30:40,558 --> 00:30:50,638

young okay and there is another graphic

791

00:30:44,909 --> 00:30:51,749

that we had on the as a pie chart I

792

00:30:50,638 --> 00:30:53,069

guess once you go ahead and put that up

793

00:30:51,749 --> 00:30:56,999

Scott and then I'll have

794

00:30:53,069 --> 00:31:00,259

Fabian watch it why don't you describe

795

00:30:56,999 --> 00:31:02,569

or whose is this whose whose

796

00:31:00,259 --> 00:31:06,048

graphic is this yours Paul or whoever

797

00:31:02,569 --> 00:31:07,879

wants to talk about it I'm just I've

798

00:31:06,048 --> 00:31:11,898

made a gun I made it by tired but I let

799
00:31:07,880 --> 00:31:16,340
far beyond the explain explain so much

800
00:31:11,898 --> 00:31:19,819
pie talk to us so the pie chart looks

801
00:31:16,339 --> 00:31:23,000
like a cake someone's getting hungry no

802
00:31:19,819 --> 00:31:25,819
I don't know that would be any help I'm

803
00:31:23,000 --> 00:31:28,398
a little hungry over here hungry oh oh

804
00:31:25,819 --> 00:31:31,939
you can try it Neal afterwards I don't

805
00:31:28,398 --> 00:31:33,319
know well so what was found

806
00:31:31,940 --> 00:31:35,720
what some of it was is what this was

807
00:31:33,319 --> 00:31:37,250
describing is so most of the stars have

808
00:31:35,720 --> 00:31:38,839
you see in the universe massive stars

809
00:31:37,250 --> 00:31:43,190
they all have a companion so they don't

810
00:31:38,839 --> 00:31:45,949
live alone and it turns out that maybe

811
00:31:43,190 --> 00:31:49,278
1/3 of them or 29% as it is written down

812
00:31:45,950 --> 00:31:51,380
in this pie chart now only sort of live

813
00:31:49,278 --> 00:31:54,079
their life without ever seeing their

814
00:31:51,380 --> 00:31:56,450
companion really here to close or doing

815
00:31:54,079 --> 00:31:58,369
anything with it and all the other stars

816
00:31:56,450 --> 00:31:59,808
the other 2/3 they are doing something

817
00:31:58,369 --> 00:32:02,509
with their companions and you've seen

818
00:31:59,808 --> 00:32:04,819
our two animations already for example

819
00:32:02,509 --> 00:32:07,220
if you look in the into the into the

820
00:32:04,819 --> 00:32:09,019
animation we had just before that was

821
00:32:07,220 --> 00:32:10,940
his mass transfer in binary so there was

822
00:32:09,019 --> 00:32:13,929
just this vampire star sucking of

823
00:32:10,940 --> 00:32:16,220
material from from its companion and

824
00:32:13,929 --> 00:32:17,509
these are these stars that we have in

825
00:32:16,220 --> 00:32:21,110
this pie chart on the top right and

826
00:32:17,509 --> 00:32:23,058
bottom right so you see this mass being

827

00:32:21,109 --> 00:32:25,129
transferred and while you transfer mass

828
00:32:23,058 --> 00:32:26,569
or form um object to the other that

829
00:32:25,130 --> 00:32:28,549
means also you are stripping off its

830
00:32:26,569 --> 00:32:30,710
envelope so you revealing all the deep

831
00:32:28,548 --> 00:32:32,839
insights that have been burnt to helium

832
00:32:30,710 --> 00:32:35,840
into other elements and that can then

833
00:32:32,839 --> 00:32:38,418
explode in various ways and then this

834
00:32:35,839 --> 00:32:40,220
mass accretions stream will then as it

835
00:32:38,419 --> 00:32:41,659
was also shown in the animation spin up

836
00:32:40,220 --> 00:32:43,190
the companion because you're not only

837
00:32:41,659 --> 00:32:46,100
transferring mass but also angular

838
00:32:43,190 --> 00:32:48,558
momentum so it's like this ice skater

839
00:32:46,099 --> 00:32:51,859
that it's getting kind of mass now and

840
00:32:48,558 --> 00:32:53,329
then it spins up and that's what these

841
00:32:51,859 --> 00:32:55,129

stars - and then we've seen the other

842

00:32:53,329 --> 00:32:57,048

animation where the two stars get into

843

00:32:55,130 --> 00:32:59,570

contact or the kissing binaries that's a

844

00:32:57,048 --> 00:33:02,089

lower left region of this diagram and

845

00:32:59,569 --> 00:33:05,028

we'll think that roughly well maybe 1/4

846

00:33:02,089 --> 00:33:07,849

of all the stars that are born in Essos

847

00:33:05,028 --> 00:33:09,648

stars as hot messes stars that 1/4 maybe

848

00:33:07,849 --> 00:33:12,539

is merging with their companion and

849

00:33:09,648 --> 00:33:14,399

that's also what we think what could

850

00:33:12,539 --> 00:33:19,230

happened to maybe one or two of these

851

00:33:14,400 --> 00:33:21,570

beasts in our 156 ok well that's that

852

00:33:19,230 --> 00:33:23,069

that leads me now to another question

853

00:33:21,569 --> 00:33:25,409

that this is coming from John Willis on

854

00:33:23,069 --> 00:33:27,929

YouTube he's going he's asking about the

855

00:33:25,410 --> 00:33:30,630

metallicity of the stars and the gas

856
00:33:27,930 --> 00:33:33,360
clouds and if they're you know are they

857
00:33:30,630 --> 00:33:34,770
low or are they high so I probably get

858
00:33:33,359 --> 00:33:36,359
you in on this can you describe to us

859
00:33:34,769 --> 00:33:39,539
what it what it is first of all tell us

860
00:33:36,359 --> 00:33:41,219
what metallicity means and then maybe

861
00:33:39,539 --> 00:33:42,750
talking what are what are the

862
00:33:41,220 --> 00:33:47,250
metallicity of these stars do we know

863
00:33:42,750 --> 00:33:49,319
sure so so astronomers talk about metals

864
00:33:47,250 --> 00:33:51,630
metals what I'm is very different from

865
00:33:49,319 --> 00:33:55,500
what chemists might talk about different

866
00:33:51,630 --> 00:33:58,440
I learned anything which isn't hydrogen

867
00:33:55,500 --> 00:34:03,539
or helium is a metal so it's oxygen

868
00:33:58,440 --> 00:34:08,070
carbon iron nitrogen these elements and

869
00:34:03,539 --> 00:34:10,380
so in in this in our sole neighborhood

870
00:34:08,070 --> 00:34:13,200
the servants composition is mostly

871
00:34:10,380 --> 00:34:17,190
hydrogen helium with one one bit percent

872
00:34:13,199 --> 00:34:20,449
metals it's the same in the Orion Nebula

873
00:34:17,190 --> 00:34:23,159
where those stars are forming only a few

874
00:34:20,449 --> 00:34:26,460
thousand one thousand light years away

875
00:34:23,159 --> 00:34:29,699
in the in the LMC the present-day metal

876
00:34:26,460 --> 00:34:33,240
content is about half that of the solar

877
00:34:29,699 --> 00:34:36,928
neighborhood so it sits below the metal

878
00:34:33,239 --> 00:34:40,319
content of our local parts of Milky Way

879
00:34:36,929 --> 00:34:43,429
but it slowly a factor of two are there

880
00:34:40,320 --> 00:34:46,140
are places where the metal content is a

881
00:34:43,429 --> 00:34:48,179
hundred times lower you know very

882
00:34:46,139 --> 00:34:50,339
extreme places other places where it's a

883
00:34:48,179 --> 00:34:54,059
factor of a few higher but really it's

884

00:34:50,340 --> 00:34:56,070
it's fairly similar to our own part of

885
00:34:54,059 --> 00:34:57,929
the Milky Way a little bit about only a

886
00:34:56,070 --> 00:34:59,910
little bit ok good well where I want to

887
00:34:57,929 --> 00:35:02,579
go with this now is I want we've all

888
00:34:59,909 --> 00:35:04,139
heard about Jay the James Webb Space

889
00:35:02,579 --> 00:35:06,449
Telescope and the fact that it's going

890
00:35:04,139 --> 00:35:08,549
to be looking at the first galaxies and

891
00:35:06,449 --> 00:35:09,960
also the first stars and one of the

892
00:35:08,550 --> 00:35:11,789
things about the very first stars in the

893
00:35:09,960 --> 00:35:13,260
universe is that they are known for

894
00:35:11,789 --> 00:35:15,210
having their very low metallicity

895
00:35:13,260 --> 00:35:16,710
primarily hydrogen and helium and in the

896
00:35:15,210 --> 00:35:19,500
early universe was all they had to work

897
00:35:16,710 --> 00:35:21,539
with and so those stars are they when I

898
00:35:19,500 --> 00:35:24,090

hear you guys talk about the stars in

899

00:35:21,539 --> 00:35:25,029

this cluster it reminds me a lot about

900

00:35:24,090 --> 00:35:26,620

what I've learned

901

00:35:25,030 --> 00:35:28,000

heard about the James Webb Space

902

00:35:26,619 --> 00:35:30,369

Telescope was going to show us for the

903

00:35:28,000 --> 00:35:32,590

first stars and Paul you're just saying

904

00:35:30,369 --> 00:35:35,230

that they are about a factor of two

905

00:35:32,590 --> 00:35:37,000

lowering metallicity from our own but it

906

00:35:35,230 --> 00:35:38,860

sounds to me like there's some pretty

907

00:35:37,000 --> 00:35:42,219

big differences so what can you compare

908

00:35:38,860 --> 00:35:46,090

these stars was with what the very first

909

00:35:42,219 --> 00:35:47,589

stars would be like sure so I mean the

910

00:35:46,090 --> 00:35:49,329

kind of things which Hubble can do right

911

00:35:47,590 --> 00:35:51,880

now we're looking at the these these

912

00:35:49,329 --> 00:35:53,829

very early protocol X's what we call

913
00:35:51,880 --> 00:35:58,660
high redshift where shift of five or so

914
00:35:53,829 --> 00:36:01,929
I can do right now 10h of 10 these are

915
00:35:58,659 --> 00:36:03,639
these are things which I would say the

916
00:36:01,929 --> 00:36:05,259
kind of star formation because there's

917
00:36:03,639 --> 00:36:06,400
an awful lot of gas the star formation

918
00:36:05,260 --> 00:36:09,460
that's going on in those high-redshift

919
00:36:06,400 --> 00:36:11,170
galaxies is to me very similar to

920
00:36:09,460 --> 00:36:14,590
actually what's going on within the kind

921
00:36:11,170 --> 00:36:16,990
of tarantula you know tarantulas a very

922
00:36:14,590 --> 00:36:20,980
violent style forming place compared to

923
00:36:16,989 --> 00:36:23,679
our own very quiet lone star formation

924
00:36:20,980 --> 00:36:25,269
going on in our Milky Way so to me the

925
00:36:23,679 --> 00:36:27,849
tarantula is a good kind of template

926
00:36:25,269 --> 00:36:30,190
really for for typical star formation

927

00:36:27,849 --> 00:36:31,809
going on in these hybrid galaxies but if

928

00:36:30,190 --> 00:36:33,250
you want to go to the first galaxies of

929

00:36:31,809 --> 00:36:34,960
course they're the ones where there's no

930

00:36:33,250 --> 00:36:36,730
metals so you're looking at stars

931

00:36:34,960 --> 00:36:39,400
forming out of purely hydrogen and

932

00:36:36,730 --> 00:36:43,269
helium and we think that those stars are

933

00:36:39,400 --> 00:36:46,660
much more compact than those we see in a

934

00:36:43,269 --> 00:36:48,429
tarantula in our own Milky Way and and

935

00:36:46,659 --> 00:36:50,859
also therefore much more compact much

936

00:36:48,429 --> 00:36:53,500
hotter and we think probably also much

937

00:36:50,860 --> 00:36:55,090
higher mass on average you know that

938

00:36:53,500 --> 00:36:57,070
that image I showed you which showed the

939

00:36:55,090 --> 00:37:01,990
kind of typical Styles being a red dwarf

940

00:36:57,070 --> 00:37:03,400
you know a tenth of a solar mass and we

941

00:37:01,989 --> 00:37:05,469
think that probably the typical stars

942
00:37:03,400 --> 00:37:07,030
forming the first stars forming that

943
00:37:05,469 --> 00:37:11,019
James whoever should be able to kind of

944
00:37:07,030 --> 00:37:15,790
hopefully get get get to are probably

945
00:37:11,019 --> 00:37:20,380
typically the kind of blue more massive

946
00:37:15,789 --> 00:37:22,000
than the Sun so so quite the the messes

947
00:37:20,380 --> 00:37:24,579
we don't quite know what a typical mass

948
00:37:22,000 --> 00:37:26,860
of these first generations of stars are

949
00:37:24,579 --> 00:37:28,449
like well I heard it was more or less

950
00:37:26,860 --> 00:37:30,670
like what we're talking about here 100

951
00:37:28,449 --> 00:37:32,439
200 times yeah that the original

952
00:37:30,670 --> 00:37:34,210
simulation seemed to say typical stars

953
00:37:32,440 --> 00:37:36,940
where maybe a hundred times the mass of

954
00:37:34,210 --> 00:37:38,309
the Sun but the more modern simulations

955
00:37:36,940 --> 00:37:41,670

seem to say may have some way

956

00:37:38,309 --> 00:37:44,849

maybe what water 10 maybe but certainly

957

00:37:41,670 --> 00:37:46,559

those 10 Solomon stars would be much

958

00:37:44,849 --> 00:37:49,318

more compact and therefore emitting a

959

00:37:46,559 --> 00:37:50,999

lot of their energy in the ultraviolet a

960

00:37:49,318 --> 00:37:53,248

bit like these these guys in the

961

00:37:50,998 --> 00:37:54,808

tarantula and of course that light gets

962

00:37:53,248 --> 00:37:57,298

redshifted you know looking at a

963

00:37:54,809 --> 00:38:00,059

redshift 20 galaxies as they shifted out

964

00:37:57,298 --> 00:38:04,048

into the near infrared where where James

965

00:38:00,059 --> 00:38:06,298

Webb will really really explain its

966

00:38:04,048 --> 00:38:08,009

large angular size and collecting area

967

00:38:06,298 --> 00:38:10,288

yeah and I guess that's where the

968

00:38:08,009 --> 00:38:11,938

comparison kind of start because the the

969

00:38:10,289 --> 00:38:13,589

reason James Webb is going to be an

970
00:38:11,938 --> 00:38:15,118
infrared telescope is like you say a lot

971
00:38:13,588 --> 00:38:17,308
of these things that were very bright in

972
00:38:15,119 --> 00:38:19,709
the ultraviolet have red shifted into

973
00:38:17,309 --> 00:38:22,469
the infrared it's not going to be much

974
00:38:19,708 --> 00:38:24,899
help is it for looking at this

975
00:38:22,469 --> 00:38:26,309
particular cluster one if you wouldn't

976
00:38:24,900 --> 00:38:27,719
let's say they launched change web and

977
00:38:26,309 --> 00:38:30,028
one of them somebody comes up with a

978
00:38:27,719 --> 00:38:33,088
proposal I want to look at are 134 with

979
00:38:30,028 --> 00:38:34,829
this I'm what are they gonna see much

980
00:38:33,088 --> 00:38:38,338
are they because this is primarily a UV

981
00:38:34,829 --> 00:38:40,109
target well the most luminous stars are

982
00:38:38,338 --> 00:38:42,239
UV bright but they're still pretty

983
00:38:40,108 --> 00:38:44,188
bright in the infrared we've observed

984

00:38:42,239 --> 00:38:46,769

this cluster with their own eyes

985

00:38:44,188 --> 00:38:48,868

telescope in the infrared and it's got a

986

00:38:46,768 --> 00:38:53,428

similar resorbing similar angular

987

00:38:48,869 --> 00:38:55,079

resolving power to Hubble and so you can

988

00:38:53,429 --> 00:38:57,329

observe these things in the infrared but

989

00:38:55,079 --> 00:38:59,548

of course most of energy is Fabien

990

00:38:57,329 --> 00:39:02,548

mentioned earlier is being pumped out in

991

00:38:59,548 --> 00:39:04,409

the ultraviolet and so Yuri ideally hot

992

00:39:02,548 --> 00:39:05,849

always perfect in terms of looking at

993

00:39:04,409 --> 00:39:09,088

these styles where they're brightest in

994

00:39:05,849 --> 00:39:10,499

the ultraviolet part of the spectrum and

995

00:39:09,088 --> 00:39:12,298

it's only those guys which then when you

996

00:39:10,498 --> 00:39:14,578

look at those in hi Reggie can access

997

00:39:12,298 --> 00:39:16,018

that light gets red shifted out towards

998

00:39:14,579 --> 00:39:18,660
infrared wavelengths which James Webb

999
00:39:16,018 --> 00:39:20,308
will be able to exploit I keep saying

1000
00:39:18,659 --> 00:39:20,818
134 I don't know why I do you know why I

1001
00:39:20,309 --> 00:39:22,798
do that

1002
00:39:20,818 --> 00:39:25,349
you know what are 136 reminds me of it

1003
00:39:22,798 --> 00:39:29,099
reminds me of a refrigerant are 134

1004
00:39:25,349 --> 00:39:32,189
which I put in my air conditioner that's

1005
00:39:29,099 --> 00:39:37,410
really like 130 or so my apologies for

1006
00:39:32,188 --> 00:39:38,938
doing that I see are at 130 oh it's a

1007
00:39:37,409 --> 00:39:41,489
little warmer than that just a little

1008
00:39:38,938 --> 00:39:43,259
bit yeah I get that it's yeah so anyway

1009
00:39:41,489 --> 00:39:45,688
that's why I keep doing that I my

1010
00:39:43,259 --> 00:39:47,309
apologies for it for mispronouncing it

1011
00:39:45,688 --> 00:39:49,649
so let's go to the next stage so we know

1012
00:39:47,309 --> 00:39:52,170

these are these are being born in a very

1013

00:39:49,650 --> 00:39:54,088

rich area in the Large Magellanic Cloud

1014

00:39:52,170 --> 00:39:55,970

and nebula we know they're very large we

1015

00:39:54,088 --> 00:39:59,599

don't know quite how they got that big

1016

00:39:55,969 --> 00:40:03,118

but they are that big to 100 250 times

1017

00:39:59,599 --> 00:40:04,920

more massive than our Sun and Jeffrey

1018

00:40:03,119 --> 00:40:08,130

knee is asking is it impossible for a

1019

00:40:04,920 --> 00:40:10,500

star to gather 100 plus solar masses as

1020

00:40:08,130 --> 00:40:12,690

it travels through the nebula and I

1021

00:40:10,500 --> 00:40:15,449

think the answer to that is no cuz

1022

00:40:12,690 --> 00:40:17,700

they're there plenty of men right I mean

1023

00:40:15,449 --> 00:40:20,338

how would you answer that salma yeah

1024

00:40:17,699 --> 00:40:22,019

just gathering it by flying through a

1025

00:40:20,338 --> 00:40:25,588

cloud it's not helping this stars

1026

00:40:22,019 --> 00:40:28,159

shining and so actually it would blow

1027
00:40:25,588 --> 00:40:30,989
off material of the cloud it's shaping

1028
00:40:28,159 --> 00:40:33,269
holes it's making these what I could

1029
00:40:30,989 --> 00:40:35,189
cover Swiss cheese bubbles in these

1030
00:40:33,269 --> 00:40:37,530
clouds so no it cannot accrete it by

1031
00:40:35,190 --> 00:40:41,280
just moving through the crowd so it has

1032
00:40:37,530 --> 00:40:43,740
to get it either at formation or like

1033
00:40:41,280 --> 00:40:45,720
usually when it's reform when it's very

1034
00:40:43,739 --> 00:40:47,429
young when it's not really shining that

1035
00:40:45,719 --> 00:40:48,779
brightly and it's not that hot yet that

1036
00:40:47,429 --> 00:40:51,358
would be the moment when it can maybe

1037
00:40:48,780 --> 00:40:52,950
accrete and it would help over probably

1038
00:40:51,358 --> 00:40:54,808
when it's sitting in a dense center of

1039
00:40:52,949 --> 00:40:56,159
that star cluster and the gravity of all

1040
00:40:54,809 --> 00:40:59,430
these stars together maybe that's

1041
00:40:56,159 --> 00:41:03,690
helping in parts to to attract all these

1042
00:40:59,429 --> 00:41:05,489
gas clouds to fall into the gravity or

1043
00:41:03,690 --> 00:41:07,500
attracted by the gravity of these

1044
00:41:05,489 --> 00:41:08,838
combined stars well I have to ask this

1045
00:41:07,500 --> 00:41:10,619
because we're very enamored with

1046
00:41:08,838 --> 00:41:14,460
exoplanets these days what are the

1047
00:41:10,619 --> 00:41:16,740
planet prospects inside so the James

1048
00:41:14,460 --> 00:41:18,690
Webb is not maybe not I mean we would

1049
00:41:16,739 --> 00:41:23,219
love or UV telescope to be the next

1050
00:41:18,690 --> 00:41:24,780
telescope is gonna do great things for

1051
00:41:23,219 --> 00:41:26,489
for massive stars when they're slightly

1052
00:41:24,780 --> 00:41:29,010
younger and and something else you could

1053
00:41:26,489 --> 00:41:31,289
do if you would look in the infrared

1054
00:41:29,010 --> 00:41:33,210
these stars you would these stars it's

1055

00:41:31,289 --> 00:41:35,009
annoying they're so bright because it's

1056
00:41:33,210 --> 00:41:37,470
very hard to study what are the low mass

1057
00:41:35,010 --> 00:41:39,150
stars right next to it doing so if you

1058
00:41:37,469 --> 00:41:40,949
look in the infrared it would be a

1059
00:41:39,150 --> 00:41:44,460
really nice way to sort of put sun

1060
00:41:40,949 --> 00:41:45,779
shades sunglasses on to make the blue

1061
00:41:44,460 --> 00:41:47,490
stars a little bit dimmer so you can

1062
00:41:45,780 --> 00:41:49,710
actually see the low mass stars next to

1063
00:41:47,489 --> 00:41:52,108
it so I saw there was one question of

1064
00:41:49,710 --> 00:41:54,539
could such a massive star have a planet

1065
00:41:52,108 --> 00:41:56,909
that is unlikely because you need time

1066
00:41:54,539 --> 00:41:59,789
to form a planet and it's not helping if

1067
00:41:56,909 --> 00:42:01,618
the star shining so bright but these

1068
00:41:59,789 --> 00:42:04,068
stars may have tiny tiny little

1069
00:42:01,619 --> 00:42:06,030

companion stars that is kind of planets

1070

00:42:04,068 --> 00:42:08,880
and so it would help to

1071

00:42:06,030 --> 00:42:11,670
looking redder wavelengths to us to look

1072

00:42:08,880 --> 00:42:13,590
for these Lomas companions but I can't

1073

00:42:11,670 --> 00:42:16,289
imagine the environment in that star

1074

00:42:13,590 --> 00:42:18,750
cluster being all that habitable for any

1075

00:42:16,289 --> 00:42:21,539
planet so my feet in there but that's

1076

00:42:18,750 --> 00:42:24,119
just a guess that I would have so okay

1077

00:42:21,539 --> 00:42:25,529
well so we we don't there it's possible

1078

00:42:24,119 --> 00:42:27,059
that there are planets in there there's

1079

00:42:25,530 --> 00:42:28,920
also pot there's certainly lower mass

1080

00:42:27,059 --> 00:42:30,690
stars going on and shining in there as

1081

00:42:28,920 --> 00:42:32,070
well and as someone points out it'd be

1082

00:42:30,690 --> 00:42:34,800
great if we could maybe turn it down a

1083

00:42:32,070 --> 00:42:38,100
notch or two to take a look but it's not

1084
00:42:34,800 --> 00:42:40,320
that's not something we can be right I

1085
00:42:38,099 --> 00:42:42,029
mean as we're seeing here this is the

1086
00:42:40,320 --> 00:42:43,019
same area looking through VLT as we're

1087
00:42:42,030 --> 00:42:45,000
talking about for the Very Large

1088
00:42:43,019 --> 00:42:47,579
Telescope so as we're seeing in that

1089
00:42:45,000 --> 00:42:49,079
class they're just very blown out I'm

1090
00:42:47,579 --> 00:42:51,779
not able to resolve as well as we were

1091
00:42:49,079 --> 00:42:53,489
able to with with Hubble in the UV so

1092
00:42:51,780 --> 00:42:55,470
the cluster is that little dot right in

1093
00:42:53,489 --> 00:42:57,779
the center there is that bright that

1094
00:42:55,469 --> 00:42:59,279
bright dot in the center right so it's a

1095
00:42:57,780 --> 00:43:01,110
little you know a little different what

1096
00:42:59,280 --> 00:43:03,840
we're able to see with the most recent

1097
00:43:01,110 --> 00:43:05,940
one but I saying it is pretty bright in

1098
00:43:03,840 --> 00:43:09,539
infrared but we're not able to resolve

1099
00:43:05,940 --> 00:43:12,210
that stuff in the UV okay all right Tony

1100
00:43:09,539 --> 00:43:13,769
yeah about planets came up and so just

1101
00:43:12,210 --> 00:43:16,949
to give you a sense just to give you the

1102
00:43:13,769 --> 00:43:19,559
people a sense about what if you were a

1103
00:43:16,949 --> 00:43:21,480
planet hypothetical planet orbiting one

1104
00:43:19,559 --> 00:43:26,489
of these guys if you put you know if you

1105
00:43:21,480 --> 00:43:28,320
put the earth the same distance as from

1106
00:43:26,489 --> 00:43:30,779
one three six a one on one is other very

1107
00:43:28,320 --> 00:43:31,980
massive stars as it's from the Sun it

1108
00:43:30,780 --> 00:43:33,750
would it would not if it was to be

1109
00:43:31,980 --> 00:43:36,630
remain bound it would orbit in about

1110
00:43:33,750 --> 00:43:41,429
three weeks sorry yeah would be three

1111
00:43:36,630 --> 00:43:48,329
weeks on gonna make Tony even older than

1112

00:43:41,429 --> 00:43:50,159
he is now yes but the ocean is not to

1113
00:43:48,329 --> 00:43:51,929
boil away we'd have to put the earth

1114
00:43:50,159 --> 00:43:55,259
about a thousand over a thousand times

1115
00:43:51,929 --> 00:43:56,849
further away than the earth is for it

1116
00:43:55,260 --> 00:43:59,160
because there's huge radiation coming

1117
00:43:56,849 --> 00:44:00,150
from the star okay I don't want to go

1118
00:43:59,159 --> 00:44:02,969
off on rent here

1119
00:44:00,150 --> 00:44:04,289
but with with the exoplanets that we've

1120
00:44:02,969 --> 00:44:06,929
been learning about they all seem to

1121
00:44:04,289 --> 00:44:10,139
have these ridiculously short years

1122
00:44:06,929 --> 00:44:12,599
eighteen days two weeks three weeks four

1123
00:44:10,139 --> 00:44:14,519
mean that's just that's just crazy and I

1124
00:44:12,599 --> 00:44:16,349
mean you're right I don't even want to

1125
00:44:14,519 --> 00:44:19,559
think about how old I would be on a

1126
00:44:16,349 --> 00:44:21,449

planet with a year of only

1127

00:44:19,559 --> 00:44:23,189

eighteen days so you could just have all

1128

00:44:21,449 --> 00:44:25,680

that but anyway the calculation to make

1129

00:44:23,188 --> 00:44:27,078

any mess that's not let's just move

1130

00:44:25,679 --> 00:44:31,318

right along

1131

00:44:27,079 --> 00:44:36,619

okay so Fabian I want I want to talk

1132

00:44:31,318 --> 00:44:45,538

about how these stars are gonna die what

1133

00:44:36,619 --> 00:44:47,130

excellent question so we've got these

1134

00:44:45,539 --> 00:44:49,489

stars I don't they're bright they're hot

1135

00:44:47,130 --> 00:44:52,650

they're young they're huge they're

1136

00:44:49,489 --> 00:44:55,650

they're they're running out of fuel very

1137

00:44:52,650 --> 00:44:57,329

quickly the masses imply a lot of really

1138

00:44:55,650 --> 00:44:58,949

cool things when they run out start to

1139

00:44:57,329 --> 00:45:00,059

run out of fuel museum their lives so

1140

00:44:58,949 --> 00:45:02,909

what do you guys think will happen

1141
00:45:00,059 --> 00:45:05,278
exactly so the really interesting bit of

1142
00:45:02,909 --> 00:45:07,649
the Toronto net nebula is that it is at

1143
00:45:05,278 --> 00:45:09,748
a lower metallicity and the lower

1144
00:45:07,650 --> 00:45:13,229
melissa metallicity usually allows for

1145
00:45:09,748 --> 00:45:15,808
really crazy explosions of stars so say

1146
00:45:13,228 --> 00:45:17,129
in our own Milky Way backyard I guess

1147
00:45:15,809 --> 00:45:19,259
what we would have in the end of the

1148
00:45:17,130 --> 00:45:20,969
stellar life is that it's core collapses

1149
00:45:19,259 --> 00:45:23,309
so it's a classical core collapse

1150
00:45:20,969 --> 00:45:24,989
supernova as we would call it so what's

1151
00:45:23,309 --> 00:45:27,390
happening there is the star it's just

1152
00:45:24,989 --> 00:45:29,278
fusing all its fuel so it start our the

1153
00:45:27,389 --> 00:45:31,139
hydrogen convert it into helium and then

1154
00:45:29,278 --> 00:45:33,059
takes the helium further converts it

1155
00:45:31,139 --> 00:45:35,458
into carbon and oxygen and it goes on

1156
00:45:33,059 --> 00:45:36,869
and on and on until you hit a silicon

1157
00:45:35,458 --> 00:45:39,688
burning and the silicon burning is

1158
00:45:36,869 --> 00:45:42,660
converting everything into iron now with

1159
00:45:39,688 --> 00:45:46,469
I and you have a problem from I infusion

1160
00:45:42,659 --> 00:45:49,768
you cannot get any energy out over this

1161
00:45:46,469 --> 00:45:53,639
star is suddenly robbed of its energy

1162
00:45:49,768 --> 00:45:54,838
source and so it has to collapse and and

1163
00:45:53,639 --> 00:45:57,868
this is what we then call a core

1164
00:45:54,838 --> 00:46:00,420
collapse supernova it's a classical way

1165
00:45:57,869 --> 00:46:03,479
of a star to die and at low metallicity

1166
00:46:00,420 --> 00:46:06,088
z-- you have a well one more fancy way

1167
00:46:03,478 --> 00:46:08,038
to die if you like well in fact I would

1168
00:46:06,088 --> 00:46:10,498
say to two further ways that you can die

1169

00:46:08,039 --> 00:46:11,819
and the one is probably the path that we

1170
00:46:10,498 --> 00:46:13,978
would call a long-duration gamma-ray

1171
00:46:11,818 --> 00:46:15,808
burst I will come to that in a second

1172
00:46:13,978 --> 00:46:17,578
and the other one which is also

1173
00:46:15,809 --> 00:46:20,189
extremely fancy as a pair instability

1174
00:46:17,579 --> 00:46:23,339
supernova so let me first discuss his

1175
00:46:20,188 --> 00:46:25,108
parents ability a supernova so what is

1176
00:46:23,338 --> 00:46:27,659
happening here is the star is still

1177
00:46:25,108 --> 00:46:29,400
burning it's its fuel so it's at having

1178
00:46:27,659 --> 00:46:31,139
maybe a lot of helium in its core

1179
00:46:29,400 --> 00:46:33,510
so we're speaking of a core mass now

1180
00:46:31,139 --> 00:46:35,879
that is above say 60 times

1181
00:46:33,510 --> 00:46:37,619
or son just the core of a star so

1182
00:46:35,880 --> 00:46:41,099
there's still an envelope sitting on top

1183
00:46:37,619 --> 00:46:43,108

and once you're hitting them this helium

1184

00:46:41,099 --> 00:46:46,980

burning and later on into the carbon and

1185

00:46:43,108 --> 00:46:50,009

oxygen burning the interior of the star

1186

00:46:46,980 --> 00:46:53,250

is so hot that all its photons or some

1187

00:46:50,010 --> 00:46:56,400

of its photons can produce 12 and

1188

00:46:53,250 --> 00:46:58,590

positron pairs this pair creation and

1189

00:46:56,400 --> 00:47:00,269

you need to know now that this interior

1190

00:46:58,590 --> 00:47:03,390

of such stars is balanced by the

1191

00:47:00,269 --> 00:47:05,219

radiation so they are variation power

1192

00:47:03,389 --> 00:47:07,469

balance to the radiation pressure from

1193

00:47:05,219 --> 00:47:10,559

all the photons in the inside is keeping

1194

00:47:07,469 --> 00:47:12,118

up or battling gravity if you like but

1195

00:47:10,559 --> 00:47:13,440

now you're taking away these photons

1196

00:47:12,119 --> 00:47:15,210

because you're producing a bit of

1197

00:47:13,440 --> 00:47:16,320

electrons and positrons and suddenly

1198
00:47:15,210 --> 00:47:19,260
what's going to happen is that they

1199
00:47:16,320 --> 00:47:22,019
start contracts extremely fast it

1200
00:47:19,260 --> 00:47:23,670
contracts its heat heating up and so

1201
00:47:22,019 --> 00:47:26,460
you're hitting a regime where you have

1202
00:47:23,670 --> 00:47:28,289
an explosive nuclear burning and what it

1203
00:47:26,460 --> 00:47:30,389
really means is that these objects

1204
00:47:28,289 --> 00:47:33,358
everything in it in the inside are going

1205
00:47:30,389 --> 00:47:35,879
to be burned into iron elements and this

1206
00:47:33,358 --> 00:47:37,469
energy release is usually then enough to

1207
00:47:35,880 --> 00:47:40,440
unbind the whole star and you can have

1208
00:47:37,469 --> 00:47:42,299
an extraordinary bright explosion in

1209
00:47:40,440 --> 00:47:45,869
particular you can produce maybe up to

1210
00:47:42,300 --> 00:47:48,359
10 solar masses of nickel and maybe you

1211
00:47:45,869 --> 00:47:50,400
know nickel is a radioactive element so

1212
00:47:48,358 --> 00:47:52,108
it's going to decay and this decay of

1213
00:47:50,400 --> 00:47:54,240
all this tensile amounts of nickel for

1214
00:47:52,108 --> 00:47:55,949
example that is powering a light curve

1215
00:47:54,239 --> 00:47:57,559
and a supernova that is extremely bright

1216
00:47:55,949 --> 00:48:00,750
and that's why we call them

1217
00:47:57,559 --> 00:48:03,150
superluminous supernova yeah give me a

1218
00:48:00,750 --> 00:48:07,349
fancy name but it's one way of for these

1219
00:48:03,150 --> 00:48:09,358
guys to die and so I just want to point

1220
00:48:07,349 --> 00:48:11,190
out also these parent stability

1221
00:48:09,358 --> 00:48:12,960
supernova that you're talking about is

1222
00:48:11,190 --> 00:48:14,579
also what's going to happen to the very

1223
00:48:12,960 --> 00:48:17,039
first stars I mean that's also what

1224
00:48:14,579 --> 00:48:19,650
they're about so again there's a lot of

1225
00:48:17,039 --> 00:48:21,059
parallels between this research and the

1226

00:48:19,650 --> 00:48:23,010
early universe and it all has to do with

1227
00:48:21,059 --> 00:48:25,679
the level of metallicity and stars

1228
00:48:23,010 --> 00:48:27,119
correct exactly I should adhere that at

1229
00:48:25,679 --> 00:48:29,339
the metallicity of the Large Magellanic

1230
00:48:27,119 --> 00:48:31,590
Cloud we do not think that these stars

1231
00:48:29,340 --> 00:48:33,300
are ending up as a pain so pretty superb

1232
00:48:31,590 --> 00:48:34,559
yeah okay go so probably what's going to

1233
00:48:33,300 --> 00:48:36,150
happen is that their stellar winds

1234
00:48:34,559 --> 00:48:38,039
they're too strong so this star is

1235
00:48:36,150 --> 00:48:40,800
losing all its mass so we will never

1236
00:48:38,039 --> 00:48:43,469
have a core mass of helium above this 60

1237
00:48:40,800 --> 00:48:45,840
or 65 solar masses so it cannot go this

1238
00:48:43,469 --> 00:48:46,889
path but if you just go maybe I don't

1239
00:48:45,840 --> 00:48:49,769
know a factor to

1240
00:48:46,889 --> 00:48:53,460

three lower mid Lissa T and it's already

1241
00:48:49,768 --> 00:48:55,318
the regime where you can do it well the

1242
00:48:53,460 --> 00:48:58,460
other one the long location gamma-ray

1243
00:48:55,318 --> 00:49:02,068
bursts it's also really fun thing and

1244
00:48:58,460 --> 00:49:06,809
let that sound fun Fabian because I'll

1245
00:49:02,068 --> 00:49:12,329
tell you in a second why surfing on this

1246
00:49:06,809 --> 00:49:15,690
thing long-duration gamma-ray bursts do

1247
00:49:12,329 --> 00:49:17,849
not sound fun but go ahead go back a

1248
00:49:15,690 --> 00:49:20,278
couple of models out there and in terms

1249
00:49:17,849 --> 00:49:22,318
of what it can can happen but what

1250
00:49:20,278 --> 00:49:25,139
observations suggest nowadays is that

1251
00:49:22,318 --> 00:49:26,940
there is a correlation between massive

1252
00:49:25,139 --> 00:49:29,429
stars exploding and slow innovation

1253
00:49:26,940 --> 00:49:31,769
gamma-ray bursts and one favor or one

1254
00:49:29,429 --> 00:49:34,169
popular model is the so-called collapse

1255
00:49:31,768 --> 00:49:37,588
a model and the interior of the star

1256
00:49:34,170 --> 00:49:39,028
gave to a collapse are exactly so we

1257
00:49:37,588 --> 00:49:41,548
have to think of now the interior of the

1258
00:49:39,028 --> 00:49:45,420
star rapidly rotating so it's really a

1259
00:49:41,548 --> 00:49:47,429
and a ball of gas that is rotating

1260
00:49:45,420 --> 00:49:49,409
extremely quickly and now it's going to

1261
00:49:47,429 --> 00:49:51,389
collapse in the usual way as a coral of

1262
00:49:49,409 --> 00:49:53,429
supernova would do so is speaking maybe

1263
00:49:51,389 --> 00:49:56,699
of kind of intermediate masters in in

1264
00:49:53,429 --> 00:49:58,919
general here and if the star was

1265
00:49:56,699 --> 00:50:00,419
internally rotating quick enough then

1266
00:49:58,920 --> 00:50:02,700
you can form an accretion disk around

1267
00:50:00,420 --> 00:50:05,548
this collapsing core so you're producing

1268
00:50:02,699 --> 00:50:07,288
a black hole in the star and while we're

1269
00:50:05,548 --> 00:50:09,690
producing this black hole the outside

1270
00:50:07,289 --> 00:50:11,910
exterior part of the star the envelope

1271
00:50:09,690 --> 00:50:13,019
they still have noticed that and you

1272
00:50:11,909 --> 00:50:15,088
form a black hole or with an accretion

1273
00:50:13,018 --> 00:50:16,919
disk and form a sufficient is you can

1274
00:50:15,088 --> 00:50:18,630
launch a jet and this jet can then

1275
00:50:16,920 --> 00:50:19,349
explore the whole star I think that's

1276
00:50:18,630 --> 00:50:22,500
pretty cool

1277
00:50:19,349 --> 00:50:24,509
that is very cool sounds a little bit

1278
00:50:22,500 --> 00:50:26,489
wildly coyote too because the black hole

1279
00:50:24,509 --> 00:50:27,990
arms but the rest of star doesn't notice

1280
00:50:26,489 --> 00:50:29,338
yet it's kind of like when the koala

1281
00:50:27,989 --> 00:50:31,558
coyote gets out and walks out on the

1282
00:50:29,338 --> 00:50:33,058
over though the cliff and doesn't notice

1283

00:50:31,559 --> 00:50:36,869
and then when he does known as he falls

1284
00:50:33,059 --> 00:50:38,730
so it sounds like that a lot okay it's

1285
00:50:36,869 --> 00:50:40,710
really cool okay well alright so we've

1286
00:50:38,730 --> 00:50:43,108
got core-collapse supernova we've got

1287
00:50:40,710 --> 00:50:46,949
pair-instability supernova long-duration

1288
00:50:43,108 --> 00:50:48,538
gamma-ray burst and we've already seen

1289
00:50:46,949 --> 00:50:51,858
that these things are rotating that we

1290
00:50:48,539 --> 00:50:55,019
have lots of binary components to it

1291
00:50:51,858 --> 00:50:56,880
what about what about binary black holes

1292
00:50:55,018 --> 00:50:58,108
would those get forms and Selma maybe

1293
00:50:56,880 --> 00:51:02,210
you could give us some comments on that

1294
00:50:58,108 --> 00:51:02,210
yeah that seems like something topical

1295
00:51:04,090 --> 00:51:09,740
yeah so a couple of weeks ago of course

1296
00:51:07,010 --> 00:51:13,460
entire astronomy and physics was on its

1297
00:51:09,739 --> 00:51:16,519

head for the news of LIGO had found two

1298

00:51:13,460 --> 00:51:19,130

massive black holes massive 30 times as

1299

00:51:16,519 --> 00:51:20,719

massive at the Sun so we also he didn't

1300

00:51:19,130 --> 00:51:22,640

know that those are forming we had never

1301

00:51:20,719 --> 00:51:24,109

seen a 30 solar mass black hole we had

1302

00:51:22,639 --> 00:51:27,829

never seen a single black hole

1303

00:51:24,110 --> 00:51:29,870

we only know like boring black holes and

1304

00:51:27,829 --> 00:51:32,210

so we were extremely surprised they were

1305

00:51:29,869 --> 00:51:34,489

so massive and so it's two ideas how you

1306

00:51:32,210 --> 00:51:36,829

can make them and one involves a dense

1307

00:51:34,489 --> 00:51:39,799

star cluster something like r136

1308

00:51:36,829 --> 00:51:42,019

and the other idea involves a binary

1309

00:51:39,800 --> 00:51:44,539

system that has a special way of keeping

1310

00:51:42,019 --> 00:51:47,030

the stars together when they die and

1311

00:51:44,539 --> 00:51:49,009

make two black holes some some different

1312
00:51:47,030 --> 00:51:50,930
flavors do this and so now we're looking

1313
00:51:49,010 --> 00:51:55,100
at the star cluster we could do both

1314
00:51:50,929 --> 00:51:56,179
things in this one region right and so

1315
00:51:55,099 --> 00:51:57,529
it's very nice that the metallicity

1316
00:51:56,179 --> 00:51:59,089
talks a little bit about it that the

1317
00:51:57,530 --> 00:52:01,850
Middle East is a little bit lower so we

1318
00:51:59,090 --> 00:52:04,670
think that that helps for these stars to

1319
00:52:01,849 --> 00:52:06,409
not blow off to of too much mass and so

1320
00:52:04,670 --> 00:52:08,930
they actually can stay very massive and

1321
00:52:06,409 --> 00:52:10,759
maybe make pretty massive black holes so

1322
00:52:08,929 --> 00:52:12,379
maybe it was a cluster like this cluster

1323
00:52:10,760 --> 00:52:15,410
that made the two black holes that we

1324
00:52:12,380 --> 00:52:18,530
recently saw I mean I should say he

1325
00:52:15,409 --> 00:52:20,779
heard coalescing right it's the chirp I

1326
00:52:18,530 --> 00:52:25,910
don't know if you have seen the sound

1327
00:52:20,780 --> 00:52:29,769
movies they whoop yeah anyway so uh so

1328
00:52:25,909 --> 00:52:32,029
studies like this pole Crowder and his

1329
00:52:29,769 --> 00:52:34,070
expose dock and our all the

1330
00:52:32,030 --> 00:52:35,780
collaborators we're further examining

1331
00:52:34,070 --> 00:52:37,160
all the other stars in the star clusters

1332
00:52:35,780 --> 00:52:38,690
are we trying to understand better how

1333
00:52:37,159 --> 00:52:40,429
these stars live their life and

1334
00:52:38,690 --> 00:52:42,500
eventually as Fabien explained how they

1335
00:52:40,429 --> 00:52:43,940
die and what kind of black holes they

1336
00:52:42,500 --> 00:52:45,559
make and it's one of the big questions

1337
00:52:43,940 --> 00:52:47,720
we're trying to address here and Hubble

1338
00:52:45,559 --> 00:52:49,699
is has been amazing there to help out I

1339
00:52:47,719 --> 00:52:51,409
know it's it's it's just astonishing to

1340

00:52:49,699 --> 00:52:52,879
think about the idea that now we've got

1341
00:52:51,409 --> 00:52:55,789
the ability to detect gravitational

1342
00:52:52,880 --> 00:52:57,980
waves maybe this would be a sounds to me

1343
00:52:55,789 --> 00:52:59,779
like a pretty good target this this this

1344
00:52:57,980 --> 00:53:02,329
neighboring galaxies to take a look and

1345
00:52:59,780 --> 00:53:05,240
see what might come out of that most of

1346
00:53:02,329 --> 00:53:07,639
the stars are they still there in this

1347
00:53:05,239 --> 00:53:09,739
coming by that I mean have many is there

1348
00:53:07,639 --> 00:53:12,170
a way to know how many have died or

1349
00:53:09,739 --> 00:53:13,789
where we are in this whole evolution of

1350
00:53:12,170 --> 00:53:14,809
the star forming region so these stars

1351
00:53:13,789 --> 00:53:18,139
are still too young

1352
00:53:14,809 --> 00:53:20,150
we may be possibly one has made a black

1353
00:53:18,139 --> 00:53:21,739
hole already but we don't think so

1354
00:53:20,150 --> 00:53:23,750

it is this particularly since probably

1355

00:53:21,739 --> 00:53:24,949

too young and then as soon as you make

1356

00:53:23,750 --> 00:53:27,110

the black hole you still have to wait

1357

00:53:24,949 --> 00:53:29,960

for an extremely long time for the two

1358

00:53:27,110 --> 00:53:31,309

black holes to come together so they are

1359

00:53:29,960 --> 00:53:33,110

if you would have two black holes in a

1360

00:53:31,309 --> 00:53:34,909

binary it takes a long long time for

1361

00:53:33,110 --> 00:53:36,800

gravitational waves to slowly move them

1362

00:53:34,909 --> 00:53:39,019

together it would take Giga years and

1363

00:53:36,800 --> 00:53:40,910

then the last moment the gravitational

1364

00:53:39,019 --> 00:53:43,099

waves become very strong and that's when

1365

00:53:40,909 --> 00:53:46,309

we can listen teresting at the very end

1366

00:53:43,099 --> 00:53:49,069

I guess for this one we're not gonna we

1367

00:53:46,309 --> 00:53:50,719

got not gonna hear binary black hole

1368

00:53:49,070 --> 00:53:52,490

merger from this particular cluster but

1369
00:53:50,719 --> 00:53:54,259
we might hear from something from a

1370
00:53:52,489 --> 00:53:56,569
cluster that is like this one but that

1371
00:53:54,260 --> 00:54:02,450
is a bit further out in the universe and

1372
00:53:56,570 --> 00:54:04,840
it had time to wait so okay so here he

1373
00:54:02,449 --> 00:54:07,639
is a question from Karnak crux from

1374
00:54:04,840 --> 00:54:09,890
YouTube I wonder if James Webb will have

1375
00:54:07,639 --> 00:54:12,529
enough resolution to resolve the

1376
00:54:09,889 --> 00:54:15,710
population three first light stars and

1377
00:54:12,530 --> 00:54:17,300
the answer to that is yes it will and

1378
00:54:15,710 --> 00:54:20,990
I've talked to Massimo Steve Elia about

1379
00:54:17,300 --> 00:54:23,120
this a lot he's the JWST mission head at

1380
00:54:20,989 --> 00:54:25,039
the at the Institute and he was

1381
00:54:23,119 --> 00:54:26,239
explaining a lot about these stars and

1382
00:54:25,039 --> 00:54:29,090
what they're hoping to learn from James

1383
00:54:26,239 --> 00:54:30,859
Webb so the answer to that is yes and

1384
00:54:29,090 --> 00:54:33,470
they will hopefully teach us a lot about

1385
00:54:30,860 --> 00:54:35,960
stars like these but obviously a lot

1386
00:54:33,469 --> 00:54:37,459
less lower in metal content and probably

1387
00:54:35,960 --> 00:54:38,590
a lot smaller from the sounds of what

1388
00:54:37,460 --> 00:54:42,530
I'm hearing today

1389
00:54:38,590 --> 00:54:44,600
Barbara Kyle Cova is asking do you think

1390
00:54:42,530 --> 00:54:47,180
that if the vampire star consumes

1391
00:54:44,599 --> 00:54:50,329
another Stars mass does it get bigger

1392
00:54:47,179 --> 00:54:53,239
and if so when it confused astronomers

1393
00:54:50,329 --> 00:54:56,269
because when calculating its age because

1394
00:54:53,239 --> 00:54:58,099
it depends also on its size wants to

1395
00:54:56,269 --> 00:55:00,650
take that one yeah exactly

1396
00:54:58,099 --> 00:55:03,289
so yeah together with fabric we have

1397

00:55:00,650 --> 00:55:05,240
been writing papers on this so these

1398
00:55:03,289 --> 00:55:07,639
blue stragglers if they eat mass from

1399
00:55:05,239 --> 00:55:10,009
the other star we really like vampire

1400
00:55:07,639 --> 00:55:12,289
stars they kind of get new fuel from the

1401
00:55:10,010 --> 00:55:14,690
other star and that rejuvenates them it

1402
00:55:12,289 --> 00:55:16,670
makes them younger right and so if we

1403
00:55:14,690 --> 00:55:19,700
see these stars we would think they're

1404
00:55:16,670 --> 00:55:21,230
younger than they really are and so now

1405
00:55:19,699 --> 00:55:23,210
this whole clusters were young so it's a

1406
00:55:21,230 --> 00:55:25,789
bit hard to tell but these most massive

1407
00:55:23,210 --> 00:55:28,130
stars they're they're incredibly blue

1408
00:55:25,789 --> 00:55:30,259
and if they

1409
00:55:28,130 --> 00:55:32,630
be bit over we you would expect them to

1410
00:55:30,260 --> 00:55:34,190
be a little rather it's hard to tell for

1411
00:55:32,630 --> 00:55:35,539

this cluster but for clusters like this

1412
00:55:34,190 --> 00:55:37,099
we've seen that the most massive stars

1413
00:55:35,539 --> 00:55:39,230
are definitely younger than the other

1414
00:55:37,099 --> 00:55:40,699
stars and so if you would match the age

1415
00:55:39,230 --> 00:55:42,380
of that star cluster from the most

1416
00:55:40,699 --> 00:55:43,250
massive stars you act yeah you are

1417
00:55:42,380 --> 00:55:44,960
confused you

1418
00:55:43,250 --> 00:55:48,289
you think it's younger than it release

1419
00:55:44,960 --> 00:55:50,030
it's like there's a way to beat it it's

1420
00:55:48,289 --> 00:55:51,650
a facelift for the cluster yeah there's

1421
00:55:50,030 --> 00:55:55,010
many ways for you to pretend you're

1422
00:55:51,650 --> 00:55:58,970
younger but you know just for men and

1423
00:55:55,010 --> 00:56:01,220
your goatee might help - oh no I okay so

1424
00:55:58,969 --> 00:56:01,839
you look sophisticated in the House of

1425
00:56:01,219 --> 00:56:04,969
Lords

1426
00:56:01,840 --> 00:56:09,559
thank you okay well let's go - so while

1427
00:56:04,969 --> 00:56:11,869
I've got you here Scott what about

1428
00:56:09,559 --> 00:56:15,590
Twitter at all are we getting any other

1429
00:56:11,869 --> 00:56:17,569
Tweety files from the Tweety pies but we

1430
00:56:15,590 --> 00:56:19,760
are having lots of activity on on

1431
00:56:17,570 --> 00:56:21,860
Twitter especially as people just really

1432
00:56:19,760 --> 00:56:26,180
loving the the graphics that you guys

1433
00:56:21,860 --> 00:56:28,070
created from ESO the the images that

1434
00:56:26,179 --> 00:56:31,879
we've released from Hubble and the pie

1435
00:56:28,070 --> 00:56:34,700
chart was lovely as well yes ah yes so

1436
00:56:31,880 --> 00:56:36,470
that pie charts awesome and as well as

1437
00:56:34,699 --> 00:56:38,419
what I really loved and I'm seeing a lot

1438
00:56:36,469 --> 00:56:40,459
of conversation about is from the

1439
00:56:38,420 --> 00:56:42,680
comparison between the red dwarf the

1440
00:56:40,460 --> 00:56:45,829
yellow dwarf like our son a blue dwarf

1441
00:56:42,679 --> 00:56:48,559
and then just how much those are dwarfed

1442
00:56:45,829 --> 00:56:49,639
by our 136 oh that's like Paul calls

1443
00:56:48,559 --> 00:56:51,259
everything at dwarf I don't remember

1444
00:56:49,639 --> 00:56:53,119
calling I don't remember hearing a

1445
00:56:51,260 --> 00:56:54,860
yellow dwarf or a blue dwarf until I saw

1446
00:56:53,119 --> 00:56:58,579
that things because everything is dwarf

1447
00:56:54,860 --> 00:57:00,769
to that when that's what you're used to

1448
00:56:58,579 --> 00:57:02,840
working with I guess so alright you know

1449
00:57:00,769 --> 00:57:07,219
it is everything's tiny you know it's

1450
00:57:02,840 --> 00:57:09,289
all perspective okay well so what's so

1451
00:57:07,219 --> 00:57:10,939
what's next for you guys so you've got

1452
00:57:09,289 --> 00:57:11,840
these observations in are you going to

1453
00:57:10,940 --> 00:57:14,210
be follow doing some follow-up

1454

00:57:11,840 --> 00:57:16,010
observations with this cluster are you

1455
00:57:14,210 --> 00:57:17,690
looking at other clusters and I'll have

1456
00:57:16,010 --> 00:57:19,400
maybe maybe Fabian you can give us some

1457
00:57:17,690 --> 00:57:21,920
idea what's what's next for you guys I

1458
00:57:19,400 --> 00:57:25,519
would probably like to pass a credit

1459
00:57:21,920 --> 00:57:27,230
report because he's still sitting about

1460
00:57:25,519 --> 00:57:29,539
this particular cluster and even even

1461
00:57:27,230 --> 00:57:33,710
more so good so once you tell us what's

1462
00:57:29,539 --> 00:57:35,449
next for yes published the study of your

1463
00:57:33,710 --> 00:57:36,710
father Neil G violet and we're now

1464
00:57:35,449 --> 00:57:38,359
working through some optical

1465
00:57:36,710 --> 00:57:41,150
observations we've taken with Hubble

1466
00:57:38,360 --> 00:57:41,450
face and looking at the looking looking

1467
00:57:41,150 --> 00:57:43,849
for

1468
00:57:41,449 --> 00:57:46,279

is amongst the stars in the cluster

1469

00:57:43,849 --> 00:57:48,050

we're looking for how fast the stars are

1470

00:57:46,280 --> 00:57:50,210

rotating now give us a clue as to

1471

00:57:48,050 --> 00:57:55,640

whether they they've been spun up it's

1472

00:57:50,210 --> 00:57:57,199

really spam pyre mass exchange and

1473

00:57:55,639 --> 00:57:59,900

actually with with summer we're also

1474

00:57:57,199 --> 00:58:02,509

looking at with huh ball in ships this

1475

00:57:59,900 --> 00:58:04,070

has a exquisite angular resolution to be

1476

00:58:02,510 --> 00:58:05,780

able to resolve these stars we should

1477

00:58:04,070 --> 00:58:07,220

look very close together but there's

1478

00:58:05,780 --> 00:58:10,070

actually other instrument on Hubble

1479

00:58:07,219 --> 00:58:13,219

called fgs and that can actually go a

1480

00:58:10,070 --> 00:58:15,500

factor of factor of 10 better in angular

1481

00:58:13,219 --> 00:58:17,559

resolution so with Selma and my postdoc

1482

00:58:15,500 --> 00:58:20,809

we're looking at trying to look for

1483
00:58:17,559 --> 00:58:23,328
faint companions it's a much closer

1484
00:58:20,809 --> 00:58:26,690
separation than we can do with the kind

1485
00:58:23,329 --> 00:58:29,660
of conventional imaging approach so the

1486
00:58:26,690 --> 00:58:32,960
supercar loop the thing is there isn't

1487
00:58:29,659 --> 00:58:34,719
anything quite as impressive or more

1488
00:58:32,960 --> 00:58:37,369
impressive than our 36

1489
00:58:34,719 --> 00:58:39,949
within our galaxies this nothing is

1490
00:58:37,369 --> 00:58:42,588
impressive in Andromeda or in the

1491
00:58:39,949 --> 00:58:45,529
triangular member 3 and so you've got to

1492
00:58:42,588 --> 00:58:47,179
go quite a lot further away to find more

1493
00:58:45,530 --> 00:58:50,000
impressive star clusters than this one

1494
00:58:47,179 --> 00:58:52,578
and so really I think that the next for

1495
00:58:50,000 --> 00:58:54,260
the next in a while is to really get the

1496
00:58:52,579 --> 00:58:58,220
most out of this cluster to look for

1497
00:58:54,260 --> 00:59:00,200
look for binaries look for to figure

1498
00:58:58,219 --> 00:59:03,108
this as much as we can it's really great

1499
00:59:00,199 --> 00:59:04,879
it's such an amazing stellar nursery is

1500
00:59:03,108 --> 00:59:07,519
so close by for you to be able to study

1501
00:59:04,880 --> 00:59:08,750
that's really good so cool all right

1502
00:59:07,519 --> 00:59:10,489
well we'll look forward to hearing more

1503
00:59:08,750 --> 00:59:14,088
from you guys in your press releases and

1504
00:59:10,489 --> 00:59:17,088
your paper so thank you guys for joining

1505
00:59:14,088 --> 00:59:18,828
us so on behalf of Paul Crowther baby

1506
00:59:17,088 --> 00:59:20,150
and Schneider and so I'm gonna mink I

1507
00:59:18,829 --> 00:59:21,859
want to thank you and thank my guests

1508
00:59:20,150 --> 00:59:24,769
for showing up taking time out of their

1509
00:59:21,858 --> 00:59:26,690
day to explain there's awesome science

1510
00:59:24,769 --> 00:59:29,059
and the going on in the Large Magellanic

1511

00:59:26,690 --> 00:59:32,300
Cloud with the youngest or some of the

1512
00:59:29,059 --> 00:59:34,789
most massive stars in the known universe

1513
00:59:32,300 --> 00:59:36,530
writing next door right over there next

1514
00:59:34,789 --> 00:59:38,960
to Scotts house so that's where I don't

1515
00:59:36,530 --> 00:59:42,380
from my house if you know it's kind of a

1516
00:59:38,960 --> 00:59:45,139
big deal out here yeah I do want to

1517
00:59:42,380 --> 00:59:46,519
learn a lot more questions out there I'm

1518
00:59:45,139 --> 00:59:48,318
sorry we have many and we'll answer them

1519
00:59:46,519 --> 00:59:50,420
but there Ben this is just a fascinating

1520
00:59:48,318 --> 00:59:52,610
topic so well we'll try to do is try to

1521
00:59:50,420 --> 00:59:54,619
hit some of those on Twitter later on

1522
00:59:52,610 --> 00:59:57,440
or in the comments later on YouTube and

1523
00:59:54,619 --> 00:59:59,210
Facebook alright that's it and on behalf

1524
00:59:57,440 --> 01:00:00,409
of Karol Christian I will and Scott

1525
00:59:59,210 --> 01:00:02,179

Lewis I want to thank you all for

1526

01:00:00,409 --> 01:00:04,759

watching we'll be back next week same

1527

01:00:02,179 --> 01:00:06,859

time Thursday 3:00 p.m. Eastern I don't

1528

01:00:04,760 --> 01:00:09,710

know what the topic is because Carol

1529

01:00:06,860 --> 01:00:12,470

does that and so she'll tell us what you

1530

01:00:09,710 --> 01:00:13,940

drink what we talking about but we will

1531

01:00:12,469 --> 01:00:15,379

be back so hope you guys can tune in if

1532

01:00:13,940 --> 01:00:16,460

you have not subscribed to Hubble site

1533

01:00:15,380 --> 01:00:18,079

channel please do that

1534

01:00:16,460 --> 01:00:20,119

by clicking on the little subscribe

1535

01:00:18,079 --> 01:00:23,360

button on the channel page also follow

1536

01:00:20,119 --> 01:00:26,659

us on twitter at hubble telescope and as

1537

01:00:23,360 --> 01:00:29,559

always keep looking keep looking up

1538

01:00:26,659 --> 01:00:29,559

alright