PUBLIC LECTURE SERIES

The Art & Science of Webb Imagery

Featuring Guest Speakers:

Alyssa Pagan & Joseph DePasquale

1
00:00:08,330 --> 00:00:04,910
welcome to the Space Telescope public

2
00:00:11,629 --> 00:00:08,340
lecture series tonight's talk the Art

3
00:00:14,390 --> 00:00:11,639
and Science of web imagery by Alyssa

4
00:00:16,730 --> 00:00:14,400
Elisa Pagan and Joseph Joseph de

5
00:00:18,950 --> 00:00:16,740
Pasquale

6
00:00:20,510 --> 00:00:18,960
I am your host Dr Frank Summers of the

7
00:00:23,150 --> 00:00:20,520
Office of Public Outreach at the Space

8
00:00:25,310 --> 00:00:23,160
Telescope Science Institute and I want

9
00:00:28,189 --> 00:00:25,320
to thank our wonderful tech team Thomas

10
00:00:30,710 --> 00:00:28,199
marufu and Grant Justice who bring you

11
00:00:32,510 --> 00:00:30,720
the this webcast every month

12
00:00:34,610 --> 00:00:32,520
I will also remind you that the Space

13
00:00:37,250 --> 00:00:34,620

Telescope public lecture series will

14
00:00:39,709 --> 00:00:37,260
continue to be online only throughout

15
00:00:43,630 --> 00:00:39,719
2023.

16
00:00:46,369 --> 00:00:43,640
our upcoming talks on February 7th

17
00:00:49,729 --> 00:00:46,379
supermassive black holes in the centers

18
00:00:51,889 --> 00:00:49,739
of galaxies by darshan kakad of the

19
00:00:55,850 --> 00:00:51,899
Space Telescope Science Institute

20
00:00:57,830 --> 00:00:55,860
in March a talk on active galaxies by

21
00:01:01,270 --> 00:00:57,840
Travis Fisher also of the Space

22
00:01:03,650 --> 00:01:01,280
Telescope Science Institute and in April

23
00:01:07,490 --> 00:01:03,660
understanding planetary habitability

24
00:01:10,250 --> 00:01:07,500
using exoplanet atmospheres seeing the

25
00:01:12,230 --> 00:01:10,260
atmospheres of planets to understand how

26
00:01:14,090 --> 00:01:12,240
are they possibly habitable that's

27
00:01:16,789 --> 00:01:14,100
Catherine Bennett also of the Space

28
00:01:19,310 --> 00:01:16,799
Telescope Science Institute and if you

29
00:01:23,469 --> 00:01:19,320
want information about those talks you

30
00:01:30,289 --> 00:01:26,870
www.stsci.edu public hyphen lectures

31
00:01:32,510 --> 00:01:30,299
there you will find this webpage on the

32
00:01:35,030 --> 00:01:32,520
lower left you can see the links to our

33
00:01:38,390 --> 00:01:35,040
webcast the current webcast that's going

34
00:01:41,149 --> 00:01:38,400
on now also the uh the archive our

35
00:01:43,670 --> 00:01:41,159
webcast both on YouTube and on the Space

36
00:01:46,130 --> 00:01:43,680
Telescope Science Institute pages

37
00:01:48,770 --> 00:01:46,140
on the lower right we have our email

38
00:01:52,069 --> 00:01:48,780

list and you can sign up for the monthly

39
00:01:54,289 --> 00:01:52,079
announcements of the uh of the lectures

40
00:01:57,050 --> 00:01:54,299
and when the lectures are fully posted

41
00:01:59,810 --> 00:01:57,060
on YouTube afterwards

42
00:02:02,330 --> 00:01:59,820
also on that web page are the lists of

43
00:02:04,609 --> 00:02:02,340
the upcoming lectures uh and if you

44
00:02:08,270 --> 00:02:04,619
click on one of those lectures you will

45
00:02:10,490 --> 00:02:08,280
find the uh description as well as the

46
00:02:13,610 --> 00:02:10,500
after it has been recorded links to the

47
00:02:15,250 --> 00:02:13,620
sdsci webcast as well as the webcast on

48
00:02:18,110 --> 00:02:15,260
YouTube

49
00:02:21,110 --> 00:02:18,120
uh for the email announcements as I said

50
00:02:23,290 --> 00:02:21,120
sign up on our website the alternative

51
00:02:26,449 --> 00:02:23,300
you can subscribe to our YouTube channel

52
00:02:28,250 --> 00:02:26,459
youtube.com Hubble Space Telescope all

53
00:02:30,530 --> 00:02:28,260
one word you'll get the new video

54
00:02:32,390 --> 00:02:30,540
notices as well as the reminders of Live

55
00:02:34,070 --> 00:02:32,400
Events such as this

56
00:02:35,930 --> 00:02:34,080
finally if you have comments or

57
00:02:40,750 --> 00:02:35,940
questions you can send them to the email

58
00:02:44,210 --> 00:02:40,760
address public lecture at stsci.edu

59
00:02:45,949 --> 00:02:44,220
our social media uh we do social media

60
00:02:47,930 --> 00:02:45,959
for the Hubble Space Telescope for the

61
00:02:50,750 --> 00:02:47,940
web Space Telescope and for the Space

62
00:02:53,509 --> 00:02:50,760
Telescope Science Institute uh we're on

63
00:02:58,309 --> 00:02:53,519

Facebook Twitter Youtube and Instagram

64
00:03:01,369 --> 00:02:58,319
at those uh at those handles uh I as

65
00:03:06,170 --> 00:03:01,379
your host um and do a tiny amount on uh

66
00:03:12,710 --> 00:03:08,570
and now the news from the universe for

67
00:03:14,270 --> 00:03:12,720
January 2023 I'm only going to do one

68
00:03:16,250 --> 00:03:14,280
story tonight because I know you want to

69
00:03:19,190 --> 00:03:16,260
hear all about those web images but it's

70
00:03:21,649 --> 00:03:19,200
an awfully fun story and the story title

71
00:03:23,570 --> 00:03:21,659
I gave it is peek-a-boo looks into the

72
00:03:25,729 --> 00:03:23,580
early universe

73
00:03:27,290 --> 00:03:25,739
so this is an image from the Hubble

74
00:03:29,930 --> 00:03:27,300
Space Telescope

75
00:03:33,729 --> 00:03:29,940
um and the image appears to feature this

76
00:03:35,470 --> 00:03:33,739
star TYC

77
00:03:38,089 --> 00:03:35,480
7215-199-1

78
00:03:40,190 --> 00:03:38,099
that's a very long name but it's

79
00:03:43,130 --> 00:03:40,200
actually just a catalog name from the

80
00:03:44,690 --> 00:03:43,140
Tico Star catalog which is a catalog of

81
00:03:46,850 --> 00:03:44,700
about two and a half million of the

82
00:03:50,210 --> 00:03:46,860
brightest stars in the sky

83
00:03:53,509 --> 00:03:50,220
but this image really isn't about the

84
00:03:56,570 --> 00:03:53,519
star it's really about this small Galaxy

85
00:03:59,990 --> 00:03:56,580
behind the star on this dwarf Galaxy

86
00:04:02,890 --> 00:04:00,000
also has a convoluted catalog name it's

87
00:04:08,770 --> 00:04:05,869
j1131-3-1 all right

88
00:04:12,050 --> 00:04:08,780

um and this is a Galaxy

89
00:04:15,949 --> 00:04:12,060
that has just sort of appeared uh over

90
00:04:18,289 --> 00:04:15,959
the last hundred years because that star

91
00:04:21,110 --> 00:04:18,299
is what we call a high proper motion

92
00:04:23,749 --> 00:04:21,120
star it's moving fast across relatively

93
00:04:25,129 --> 00:04:23,759
fast across the sky as the sun moves in

94
00:04:27,890 --> 00:04:25,139
the galaxy and this star moves in the

95
00:04:31,010 --> 00:04:27,900
Galaxy it shifts position across the sky

96
00:04:34,670 --> 00:04:31,020
and a hundred years ago it was directly

97
00:04:37,430 --> 00:04:34,680
in front of this small Galaxy so we

98
00:04:39,650 --> 00:04:37,440
would have had trouble watching it so

99
00:04:42,110 --> 00:04:39,660
since this galaxy has sort of appeared

100
00:04:45,370 --> 00:04:42,120
from behind this star uh people have

101
00:04:48,670 --> 00:04:45,380
gotten to calling it the peekaboo Galaxy

102
00:04:54,590 --> 00:04:48,680
peekaboo you're seeing a small Galaxy

103
00:04:56,990 --> 00:04:54,600
and this is a small small Galaxy okay

104
00:05:00,110 --> 00:04:57,000
um it you talk about men as they're

105
00:05:03,830 --> 00:05:00,120
being Giants among giants right uh this

106
00:05:05,990 --> 00:05:03,840
is really a dwarf among dwarfs okay its

107
00:05:08,749 --> 00:05:06,000
size is about one percent the size of

108
00:05:11,510 --> 00:05:08,759
the Milky Way galaxy so here is a

109
00:05:13,969 --> 00:05:11,520
comparison uh on the left is the tiny

110
00:05:17,150 --> 00:05:13,979
peekaboo dwarf Galaxy and on the right

111
00:05:19,370 --> 00:05:17,160
is a drawing of our Milky Way galaxy and

112
00:05:20,810 --> 00:05:19,380
honestly the peekaboo Galaxy is even

113
00:05:22,370 --> 00:05:20,820

smaller than this I just wanted to make

114
00:05:25,010 --> 00:05:22,380
it sure it was large enough you could

115
00:05:27,850 --> 00:05:25,020
see it on the slide it's really small

116
00:05:31,490 --> 00:05:27,860
it's only about 1200 light years across

117
00:05:35,110 --> 00:05:31,500
and so if it's one percent the size of

118
00:05:38,930 --> 00:05:35,120
the Milky Way in linear distance it's

119
00:05:41,330 --> 00:05:38,940
one millionth the size in volume so it

120
00:05:44,090 --> 00:05:41,340
contains at most one millionth the

121
00:05:46,310 --> 00:05:44,100
number of stars in the Milky Way galaxy

122
00:05:48,590 --> 00:05:46,320
so when you stare at it you can see oh

123
00:05:50,930 --> 00:05:48,600
you it looks kind of like a star cluster

124
00:05:53,450 --> 00:05:50,940
right it's a very small thing I mean the

125
00:05:55,550 --> 00:05:53,460
Milky Way probably has star clusters it

126
00:05:57,350 --> 00:05:55,560
does have star clusters bigger than this

127
00:06:00,409 --> 00:05:57,360
entire galaxy

128
00:06:01,610 --> 00:06:00,419
so being this dwarf among dwarfs what

129
00:06:04,430 --> 00:06:01,620
makes it special

130
00:06:06,770 --> 00:06:04,440
well Hubble can study the individual

131
00:06:08,810 --> 00:06:06,780
stars in this galaxy it's about 22

132
00:06:11,570 --> 00:06:08,820
million light years away and we can

133
00:06:14,510 --> 00:06:11,580
resolve individual stars and we can

134
00:06:17,749 --> 00:06:14,520
study them to figure out the abundances

135
00:06:19,670 --> 00:06:17,759
of elements inside this okay and that's

136
00:06:23,210 --> 00:06:19,680
what makes it special the elemental

137
00:06:25,790 --> 00:06:23,220
abundances now let me just remind you of

138
00:06:28,670 --> 00:06:25,800

here is the chemist periodic table of

139
00:06:30,830 --> 00:06:28,680
the elements okay and you see on the

140
00:06:32,689 --> 00:06:30,840
left you've got the alkali metals and on

141
00:06:34,010 --> 00:06:32,699
the right you've got the noble gases and

142
00:06:36,409 --> 00:06:34,020
you've got the halogens you've got the

143
00:06:38,930 --> 00:06:36,419
metals and the transition it's really

144
00:06:40,370 --> 00:06:38,940
really complicated okay I mean you know

145
00:06:41,809 --> 00:06:40,380
some people probably had nightmares

146
00:06:43,330 --> 00:06:41,819
about this from their high school

147
00:06:47,450 --> 00:06:43,340
chemistry class

148
00:06:50,689 --> 00:06:47,460
but we're astronomers we have a much

149
00:06:52,010 --> 00:06:50,699
simpler periodic table and it looks like

150
00:06:54,770 --> 00:06:52,020
this

151
00:06:57,110 --> 00:06:54,780
to astronomers there is hydrogen and

152
00:06:58,969 --> 00:06:57,120
helium which were created during Big

153
00:07:00,290 --> 00:06:58,979
Bang nucleus instances so those were

154
00:07:02,629 --> 00:07:00,300
created at the beginning of the universe

155
00:07:04,969 --> 00:07:02,639
and then there's everything else which

156
00:07:07,010 --> 00:07:04,979
we lump into this category called Metals

157
00:07:07,969 --> 00:07:07,020
all right and this is stuff that's made

158
00:07:15,050 --> 00:07:07,979
later

159
00:07:17,210 --> 00:07:15,060
the amount of metals in a star indicates

160
00:07:19,430 --> 00:07:17,220
how much the material that makes up that

161
00:07:21,830 --> 00:07:19,440
star has been processed because you

162
00:07:24,950 --> 00:07:21,840
create these Metals via you know star

163
00:07:27,830 --> 00:07:24,960

deaths the Stellar explosions

164
00:07:29,629 --> 00:07:27,840
um uh Supernova uh planetary nebula

165
00:07:31,790 --> 00:07:29,639
winds neutron star neutron star

166
00:07:34,430 --> 00:07:31,800
collisions all sorts of things that

167
00:07:37,189 --> 00:07:34,440
process the elements to create these

168
00:07:40,309 --> 00:07:37,199
heavier elements these Metals okay

169
00:07:44,930 --> 00:07:40,319
so this is what makes the peekaboo dwarf

170
00:07:48,170 --> 00:07:44,940
Galaxy special when Hubble examined the

171
00:07:51,110 --> 00:07:48,180
elements in it it found it had very very

172
00:07:55,010 --> 00:07:51,120
few Metals okay this is what they call

173
00:07:59,150 --> 00:07:55,020
an extreme metal poor Galaxy

174
00:08:01,969 --> 00:07:59,160
somehow after 13.8 billion years of the

175
00:08:05,150 --> 00:08:01,979
universe the material in this tiny

176
00:08:07,670 --> 00:08:05,160
galaxy has not been processed very much

177
00:08:09,589 --> 00:08:07,680
it's only had you know it's still a

178
00:08:11,749 --> 00:08:09,599
little bit of processing to create a

179
00:08:16,490 --> 00:08:11,759
tiny amount of metals

180
00:08:20,749 --> 00:08:16,500
so this galaxy has stars in it that

181
00:08:23,150 --> 00:08:20,759
resemble stars in the early galaxies in

182
00:08:25,129 --> 00:08:23,160
the early Universe you know just shortly

183
00:08:27,050 --> 00:08:25,139
after the big bang when there'd only

184
00:08:28,850 --> 00:08:27,060
been a little bit of Stellar processing

185
00:08:31,610 --> 00:08:28,860
to create metals

186
00:08:33,649 --> 00:08:31,620
so by studying this galaxy which we can

187
00:08:36,290 --> 00:08:33,659
see because it's nearby only 22 million

188
00:08:39,409 --> 00:08:36,300

light years away we can use it as a

189
00:08:43,730 --> 00:08:39,419
proxy for studying galaxies in the early

190
00:08:46,190 --> 00:08:43,740
universe so this peekaboo Galaxy not

191
00:08:49,730 --> 00:08:46,200
just gives us an insight into dwarf

192
00:08:51,949 --> 00:08:49,740
galaxies it also gives us a look into

193
00:08:55,570 --> 00:08:51,959
what galaxies were like in the early

194
00:09:01,370 --> 00:08:59,990
our featured speakers tonight are my

195
00:09:04,130 --> 00:09:01,380
colleagues

196
00:09:07,430 --> 00:09:04,140
um Alisa Pagan and Joseph de Pasquale

197
00:09:09,590 --> 00:09:07,440
and I'm so glad that they came on here

198
00:09:11,030 --> 00:09:09,600
to give this talk actually I had to

199
00:09:13,310 --> 00:09:11,040
bribe them because you know they've been

200
00:09:15,170 --> 00:09:13,320
doing so many talks these days and

201
00:09:18,009 --> 00:09:15,180
they're like oh another talk Frank no

202
00:09:22,910 --> 00:09:18,019
but that but I guilted them into it okay

203
00:09:26,449 --> 00:09:22,920
uh Alisa uh got uh came to us in October

204
00:09:28,670 --> 00:09:26,459
of 2019 uh and uh actually she joined

205
00:09:31,670 --> 00:09:28,680
just like four months before we all were

206
00:09:34,070 --> 00:09:31,680
sent home for the uh pandemic so a good

207
00:09:35,690 --> 00:09:34,080
amount of her early time she was working

208
00:09:36,949 --> 00:09:35,700
from home without actually the benefits

209
00:09:39,170 --> 00:09:36,959
of actually being in the office she's

210
00:09:42,110 --> 00:09:39,180
back in the office now though

211
00:09:44,810 --> 00:09:42,120
um and she got her dual degrees she got

212
00:09:47,329 --> 00:09:44,820
a degree from Towson University in art

213
00:09:49,070 --> 00:09:47,339

and design and then she went back for

214
00:09:51,650 --> 00:09:49,080
another bachelor's degree in astronomy

215
00:09:53,570 --> 00:09:51,660
at the University of Maryland so she's

216
00:09:55,850 --> 00:09:53,580
got the art degree and she's got the

217
00:09:58,670 --> 00:09:55,860
science degree oh perfect perfect for

218
00:10:00,530 --> 00:09:58,680
the job she's doing and then she worked

219
00:10:02,449 --> 00:10:00,540
at the University of Maryland as a TA

220
00:10:04,370 --> 00:10:02,459
for a little while while she says she

221
00:10:06,230 --> 00:10:04,380
repeatedly replied applied at Space

222
00:10:10,009 --> 00:10:06,240
Telescope until we finally accepted her

223
00:10:12,290 --> 00:10:10,019
and we were very lucky to have her uh

224
00:10:15,170 --> 00:10:12,300
Joe on the other hand uh grew up in

225
00:10:17,690 --> 00:10:15,180
Philadelphia he did his undergraduate

226
00:10:20,389 --> 00:10:17,700
degree at Villanova in astronomy and

227
00:10:22,009 --> 00:10:20,399
astrophysics with a minor in physics or

228
00:10:23,889 --> 00:10:22,019
was it a second degree in physics or a

229
00:10:28,910 --> 00:10:23,899
minor

230
00:10:30,230 --> 00:10:28,920
physics okay but you know like I got a

231
00:10:32,030 --> 00:10:30,240
minor in mathematics when I did my

232
00:10:34,070 --> 00:10:32,040
degree in physics and it was like I took

233
00:10:35,150 --> 00:10:34,080
one extra course to do it so you

234
00:10:36,650 --> 00:10:35,160
probably didn't have to take too much

235
00:10:40,550 --> 00:10:36,660
extra to get a minor in physics here

236
00:10:42,590 --> 00:10:40,560
exactly yep yeah uh and then Joe went up

237
00:10:45,769 --> 00:10:42,600
to the Harvard Smithsonian Center for

238
00:10:48,170 --> 00:10:45,779

astrophysics up in Boston and he spent

239
00:10:50,269 --> 00:10:48,180
eight years working as a data processor

240
00:10:51,590 --> 00:10:50,279
okay doing the actual work with all the

241
00:10:52,910 --> 00:10:51,600
data

242
00:10:55,430 --> 00:10:52,920
um for the scientists that were working

243
00:10:58,130 --> 00:10:55,440
there and then he switched to public

244
00:11:00,590 --> 00:10:58,140
Outreach and became an image processor

245
00:11:02,329 --> 00:11:00,600
for the Chandra x-ray Observatory and

246
00:11:05,210 --> 00:11:02,339
I'm assume other missions that they run

247
00:11:08,509 --> 00:11:05,220
out of there uh he did a fantastic so

248
00:11:10,970 --> 00:11:08,519
fantastic of a job up at Chandra uh that

249
00:11:14,569 --> 00:11:10,980
we stole them away uh and we pulled him

250
00:11:16,970 --> 00:11:14,579
here back in 2017. so he's been with us

251
00:11:20,210 --> 00:11:16,980
for like almost six years now all right

252
00:11:22,910 --> 00:11:20,220
and so this is our dynamic duo of image

253
00:11:24,769 --> 00:11:22,920
processing uh some of you if you were

254
00:11:27,710 --> 00:11:24,779
watching last week on the Today's Show

255
00:11:29,210 --> 00:11:27,720
saw them do appear on The Today Show

256
00:11:31,009 --> 00:11:29,220
they've been doing talks like this all

257
00:11:33,889 --> 00:11:31,019
over the place because the web images

258
00:11:35,389 --> 00:11:33,899
are so popular so I guess after the

259
00:11:38,269 --> 00:11:35,399
Today Show this is going to be trivial

260
00:11:41,090 --> 00:11:38,279
for you guys right all right we're gonna

261
00:11:43,490 --> 00:11:41,100
tag team it and uh Elisa's gonna start

262
00:11:45,410 --> 00:11:43,500
so every ladies and gentlemen Elisa

263
00:11:47,150 --> 00:11:45,420

pagan

264
00:11:48,949 --> 00:11:47,160
hey everyone thank you so much Frank for

265
00:11:53,380 --> 00:11:48,959
that introduction and thanks for joining

266
00:11:53,390 --> 00:12:03,710
[Music]

267
00:12:03,720 --> 00:12:06,769
all right

268
00:12:06,779 --> 00:12:12,769
and can everyone see that

269
00:12:17,329 --> 00:12:14,690
thank you we're not seeing your

270
00:12:27,470 --> 00:12:20,509
when it actually comes time to do it it

271
00:12:31,790 --> 00:12:28,790
I always do this thing where you know

272
00:12:33,949 --> 00:12:31,800
you actually have to click on it

273
00:12:37,790 --> 00:12:33,959
all right

274
00:12:41,630 --> 00:12:38,690
yeah

275
00:12:43,190 --> 00:12:41,640
we're still we're still seeing the zoom

276
00:12:47,329 --> 00:12:43,200
screen

277
00:12:48,769 --> 00:12:47,339
seeing that we're seeing the web browser

278
00:12:50,990 --> 00:12:48,779
screen

279
00:12:55,790 --> 00:12:51,000
Oh weird

280
00:13:02,530 --> 00:12:59,410
was working it was

281
00:13:05,750 --> 00:13:02,540
I know it was working

282
00:13:09,230 --> 00:13:05,760
we did it I was working 15 minutes ago

283
00:13:13,190 --> 00:13:11,329
there you go now it's working that's

284
00:13:15,650 --> 00:13:13,200
perfect I'm just trying to build up you

285
00:13:17,870 --> 00:13:15,660
know all right the anticipation the

286
00:13:20,210 --> 00:13:17,880
anticipation is killing us go for it

287
00:13:22,009 --> 00:13:20,220
anyways thanks everyone I am Elise

288
00:13:23,750 --> 00:13:22,019

begone as Frank mentioned and I work

289
00:13:26,150 --> 00:13:23,760
with Joe Diesel Pasquale and Lee

290
00:13:27,829 --> 00:13:26,160
processed the imagery for web uh so we

291
00:13:29,329 --> 00:13:27,839
take astronomical data from Webb and

292
00:13:31,430 --> 00:13:29,339
Hubble and other observatories and

293
00:13:34,430 --> 00:13:31,440
create color imagery and we do that to

294
00:13:36,530 --> 00:13:34,440
support our news releases our Outreach

295
00:13:38,269 --> 00:13:36,540
products and other educational resources

296
00:13:40,910 --> 00:13:38,279
so that's what we do but before I jump

297
00:13:43,190 --> 00:13:40,920
too far into the process of how we do

298
00:13:45,230 --> 00:13:43,200
this why do we even care about infrared

299
00:13:47,509 --> 00:13:45,240
light why do we study it and why do we

300
00:13:49,009 --> 00:13:47,519
need a Space Telescope like web to look

301
00:13:50,810 --> 00:13:49,019
at infrared light

302
00:13:52,970 --> 00:13:50,820
so you might be familiar with the

303
00:13:54,410 --> 00:13:52,980
electromagnetic spectrum of course we're

304
00:13:56,090 --> 00:13:54,420
all familiar with visible light and

305
00:13:57,530 --> 00:13:56,100
that's just a very specific part of the

306
00:13:59,690 --> 00:13:57,540
spectrum that we can see with our own

307
00:14:01,850 --> 00:13:59,700
eyes but as you can see it's a very very

308
00:14:03,530 --> 00:14:01,860
tiny part of the spectrum on the right

309
00:14:05,150 --> 00:14:03,540
we have the shorter wavelength so the

310
00:14:07,310 --> 00:14:05,160
higher energy wavelengths like the

311
00:14:09,710 --> 00:14:07,320
x-rays and the gamma rays and on the

312
00:14:12,110 --> 00:14:09,720
left we have the longer wavelength so

313
00:14:14,870 --> 00:14:12,120

the lower energy wavelengths the radio

314
00:14:17,870 --> 00:14:14,880
the microwaves and so if we just studied

315
00:14:19,490 --> 00:14:17,880
what we saw then we'd be missing all

316
00:14:21,350 --> 00:14:19,500
this stuff and understanding our

317
00:14:24,470 --> 00:14:21,360
universe and space

318
00:14:25,970 --> 00:14:24,480
and in particular uh infrared and of

319
00:14:29,329 --> 00:14:25,980
course it's not just about studying it

320
00:14:30,769 --> 00:14:29,339
but we actually use light to transfer

321
00:14:33,110 --> 00:14:30,779
information so if we didn't actually

322
00:14:35,389 --> 00:14:33,120
know about this then we wouldn't be able

323
00:14:37,310 --> 00:14:35,399
to sort of text our friends or turn on

324
00:14:39,170 --> 00:14:37,320
the TV or you know listen to the radio

325
00:14:40,790 --> 00:14:39,180
so it's very important and we'll focus

326
00:14:43,310 --> 00:14:40,800
on infrared which is really important

327
00:14:46,370 --> 00:14:43,320
for understanding astronomy objects in

328
00:14:49,009 --> 00:14:46,380
general and so what exactly is infrared

329
00:14:50,810 --> 00:14:49,019
light so we feel it as heat and so you

330
00:14:52,850 --> 00:14:50,820
can kind of think of it if you ever seen

331
00:14:54,889 --> 00:14:52,860
the movie Predator he has infrared

332
00:14:56,990 --> 00:14:54,899
vision so he's looking for the prey he's

333
00:14:59,509 --> 00:14:57,000
hunting them down he can see them like

334
00:15:01,370 --> 00:14:59,519
in a bush and so that's how it works and

335
00:15:03,710 --> 00:15:01,380
so on the left we have an image showing

336
00:15:05,150 --> 00:15:03,720
that we got a fellow here he's sticking

337
00:15:06,889 --> 00:15:05,160
his hand in this trash bag which is

338
00:15:09,590 --> 00:15:06,899

opaque to us invisible light we can't

339
00:15:12,050 --> 00:15:09,600
see the hand but we take an infrared

340
00:15:14,389 --> 00:15:12,060
camera all of a sudden we can see that

341
00:15:16,009 --> 00:15:14,399
Han is admitting the Heat and we can

342
00:15:18,530 --> 00:15:16,019
capture it and so the brighter regions

343
00:15:20,210 --> 00:15:18,540
that are that are hotter are showing up

344
00:15:22,310 --> 00:15:20,220
in sort of this white yellow and then

345
00:15:25,129 --> 00:15:22,320
the cooler regions are this blue wear

346
00:15:26,569 --> 00:15:25,139
purple color so and it works that

347
00:15:28,550 --> 00:15:26,579
mechanism works the same when we're

348
00:15:30,949 --> 00:15:28,560
looking at space because we can look

349
00:15:33,290 --> 00:15:30,959
using infrared light to see through dust

350
00:15:34,670 --> 00:15:33,300
and gas whether that's to see sort of

351
00:15:36,829 --> 00:15:34,680
the stars that are hidden within the

352
00:15:39,410 --> 00:15:36,839
dust or to see behind the dust to see

353
00:15:41,329 --> 00:15:39,420
sort of these young galaxies

354
00:15:43,670 --> 00:15:41,339
and look that goes into this part as

355
00:15:45,290 --> 00:15:43,680
well why infrared light is important is

356
00:15:47,509 --> 00:15:45,300
because it helps us to see farther into

357
00:15:49,850 --> 00:15:47,519
the past and this is because of

358
00:15:51,590 --> 00:15:49,860
something called cosmological redshift

359
00:15:54,650 --> 00:15:51,600
and all that means that space is

360
00:15:56,750 --> 00:15:54,660
expanding and as space expands light

361
00:15:59,150 --> 00:15:56,760
that's traveling through space Also

362
00:16:00,889 --> 00:15:59,160
extends or stretches so something's

363
00:16:02,569 --> 00:16:00,899

emitting far away from us invisible

364
00:16:04,150 --> 00:16:02,579
light by the time it gets to us the

365
00:16:06,710 --> 00:16:04,160
wavelength has been stretched so much

366
00:16:08,449 --> 00:16:06,720
redshifted so that we see it infrared

367
00:16:10,069 --> 00:16:08,459
light well we can see it but that's why

368
00:16:11,810 --> 00:16:10,079
we need these telescopes to be able to

369
00:16:13,790 --> 00:16:11,820
see it and that way we're seeing sort of

370
00:16:16,250 --> 00:16:13,800
the first galaxies and the first stars

371
00:16:18,470 --> 00:16:16,260
that it Formed so it's a very powerful

372
00:16:20,329 --> 00:16:18,480
tool and the reason why it needs to be

373
00:16:22,670 --> 00:16:20,339
in space of course is because the

374
00:16:24,889 --> 00:16:22,680
atmosphere primarily absorbs all this

375
00:16:26,629 --> 00:16:24,899
infrared light so we need it to be above

376
00:16:28,670 --> 00:16:26,639
the atmosphere so it doesn't interfere

377
00:16:30,829 --> 00:16:28,680
and also we need to be very cold because

378
00:16:33,350 --> 00:16:30,839
it is heat so we don't want sort of

379
00:16:34,970 --> 00:16:33,360
extra signal coming from the heat of the

380
00:16:36,650 --> 00:16:34,980
instruments which is why Webb has a sun

381
00:16:39,470 --> 00:16:36,660
shield and it's why it's located where

382
00:16:43,970 --> 00:16:41,569
and that's kind of to go full circle at

383
00:16:45,410 --> 00:16:43,980
the importance of being able to see in

384
00:16:47,329 --> 00:16:45,420
all these different wavelengths of light

385
00:16:49,009 --> 00:16:47,339
just like we have Hubble that seems a

386
00:16:50,569 --> 00:16:49,019
little bit in the visible well a lot of

387
00:16:52,850 --> 00:16:50,579
the visible a little bit in the infrared

388
00:16:55,069 --> 00:16:52,860

a little bit into the UV web sees

389
00:16:56,810 --> 00:16:55,079
farther into the infrared and that's the

390
00:16:58,310 --> 00:16:56,820
same reason why we have medical

391
00:16:59,930 --> 00:16:58,320
equipment too that sees in different

392
00:17:01,730 --> 00:16:59,940
wavelengths to tell us different things

393
00:17:04,490 --> 00:17:01,740
about our body for instance we use

394
00:17:06,530 --> 00:17:04,500
x-rays to see our bones versus like MRIs

395
00:17:08,689 --> 00:17:06,540
to see our soft tissues using radio

396
00:17:11,150 --> 00:17:08,699
wavelengths so it's all very important

397
00:17:13,250 --> 00:17:11,160
to our understanding

398
00:17:14,689 --> 00:17:13,260
another question that comes up often

399
00:17:18,829 --> 00:17:14,699
when people are looking at these images

400
00:17:21,230 --> 00:17:18,839
is are they real and then what goes

401
00:17:22,970 --> 00:17:21,240
along with this often is is this how it

402
00:17:24,949 --> 00:17:22,980
would look like if we could actually go

403
00:17:27,829 --> 00:17:24,959
there so the first question I can answer

404
00:17:29,210 --> 00:17:27,839
very easily and say it's 100 real in

405
00:17:30,590 --> 00:17:29,220
that it's real data it's real

406
00:17:32,690 --> 00:17:30,600
astronomical data that is being

407
00:17:34,669 --> 00:17:32,700
collected by these telescopes it's just

408
00:17:37,730 --> 00:17:34,679
light that we cannot see or measure with

409
00:17:40,310 --> 00:17:37,740
our own eyes so would it look like there

410
00:17:42,409 --> 00:17:40,320
if we could go there well not quite

411
00:17:44,150 --> 00:17:42,419
because again our eyes are not as

412
00:17:46,130 --> 00:17:44,160
sensitive as these telescopes and of

413
00:17:48,409 --> 00:17:46,140

course we cannot see an infrared but

414
00:17:49,789 --> 00:17:48,419
it's a huge tool and just because we

415
00:17:51,230 --> 00:17:49,799
wouldn't see it this way it doesn't mean

416
00:17:53,870 --> 00:17:51,240
the universe doesn't exist that way

417
00:17:55,789 --> 00:17:53,880
we're getting more information

418
00:17:57,890 --> 00:17:55,799
and so a nice way to also sort of

419
00:17:59,630 --> 00:17:57,900
explore this a little bit further is to

420
00:18:01,789 --> 00:17:59,640
look at a parallel into a different

421
00:18:04,850 --> 00:18:01,799
science field in this case microbiology

422
00:18:06,590 --> 00:18:04,860
and like astronomy microbiology use

423
00:18:08,270 --> 00:18:06,600
Advanced instruments in order to help

424
00:18:10,549 --> 00:18:08,280
our understanding to see things that we

425
00:18:13,310 --> 00:18:10,559
can't see with our own eyes in the case

426
00:18:14,810 --> 00:18:13,320
of microbiology we use microscopes and

427
00:18:17,450 --> 00:18:14,820
then of course for astronomy we use

428
00:18:19,010 --> 00:18:17,460
telescopes so on the left here we have

429
00:18:21,289 --> 00:18:19,020
this black and white image of the

430
00:18:23,390 --> 00:18:21,299
coronavirus this is how it appears

431
00:18:25,250 --> 00:18:23,400
through an electron microscope and so

432
00:18:27,830 --> 00:18:25,260
we're getting information here but it's

433
00:18:29,210 --> 00:18:27,840
not quite as interesting or evocative as

434
00:18:31,250 --> 00:18:29,220
sort of this image you see on the right

435
00:18:33,169 --> 00:18:31,260
this is actually a rendering that was

436
00:18:35,029 --> 00:18:33,179
produced by the CDC and we're actually

437
00:18:36,650 --> 00:18:35,039
seeing using the color to sort of

438
00:18:38,090 --> 00:18:36,660

separate these different structures the

439
00:18:39,470 --> 00:18:38,100
different proteins that are actually

440
00:18:41,690 --> 00:18:39,480
existing

441
00:18:43,669 --> 00:18:41,700
and this is very similar to how

442
00:18:45,590 --> 00:18:43,679
astronomy Works in which we are using

443
00:18:48,529 --> 00:18:45,600
Color to Showcase different structures

444
00:18:50,090 --> 00:18:48,539
as well but in the case of astronomy

445
00:18:51,470 --> 00:18:50,100
these structures and colors aren't

446
00:18:53,570 --> 00:18:51,480
arbitrary they actually have physical

447
00:18:56,330 --> 00:18:53,580
meaning and we'll get into what the

448
00:18:58,070 --> 00:18:56,340
wavelength mean and why we prescribe the

449
00:18:59,750 --> 00:18:58,080
colors that we do a little bit further

450
00:19:01,370 --> 00:18:59,760
on but as you can see when we're

451
00:19:03,230 --> 00:19:01,380
combining all these wavelengths together

452
00:19:04,190 --> 00:19:03,240
we're getting that full color image

453
00:19:06,230 --> 00:19:04,200
we're seeing all these different

454
00:19:08,270 --> 00:19:06,240
structures that are contrasted by the

455
00:19:09,890 --> 00:19:08,280
color which are saying different things

456
00:19:13,190 --> 00:19:09,900
that are actually physically happening

457
00:19:14,930 --> 00:19:13,200
in this particular image

458
00:19:17,090 --> 00:19:14,940
and then also why do we make color

459
00:19:19,310 --> 00:19:17,100
images in the first place like it's

460
00:19:21,289 --> 00:19:19,320
really fun and it's really nice to look

461
00:19:22,909 --> 00:19:21,299
at but of course I kind of mentioned it

462
00:19:24,890 --> 00:19:22,919
before is that it's really important to

463
00:19:27,289 --> 00:19:24,900

be able to see the data to visualize it

464
00:19:29,570 --> 00:19:27,299
so numbers are great for data analysis

465
00:19:32,690 --> 00:19:29,580
and science and research but just to get

466
00:19:34,250 --> 00:19:32,700
like a broad overview understanding Big

467
00:19:36,470 --> 00:19:34,260
Picture understanding it's helpful to

468
00:19:38,690 --> 00:19:36,480
see all the data sort of at once in a

469
00:19:40,430 --> 00:19:38,700
color image and then of course we want

470
00:19:43,190 --> 00:19:40,440
to illustrate the scientific discoveries

471
00:19:45,049 --> 00:19:43,200
and the concepts because scientists for

472
00:19:46,789 --> 00:19:45,059
everyone what we find out is something

473
00:19:48,890 --> 00:19:46,799
that we want to share and we want it to

474
00:19:50,870 --> 00:19:48,900
be digestible we don't we don't want

475
00:19:52,850 --> 00:19:50,880
scientific literacy to limit sort of

476
00:19:54,529 --> 00:19:52,860
what people get from these these

477
00:19:57,250 --> 00:19:54,539
discoveries we want to make it you know

478
00:19:59,750 --> 00:19:57,260
accessible and that sort of ties into

479
00:20:02,450 --> 00:19:59,760
engaging the public we want images that

480
00:20:04,370 --> 00:20:02,460
are compelling that Inspire that make

481
00:20:06,590 --> 00:20:04,380
you want to get interested or involved

482
00:20:08,150 --> 00:20:06,600
in astronomy and maybe Inspire next

483
00:20:10,490 --> 00:20:08,160
generation of Engineers or image

484
00:20:11,930 --> 00:20:10,500
processors or you know whatever and so

485
00:20:13,909 --> 00:20:11,940
those are the goals that we have in mind

486
00:20:15,770 --> 00:20:13,919
when we're processing these images and

487
00:20:20,090 --> 00:20:15,780
it affects sort of our decisions that we

488
00:20:24,830 --> 00:20:22,610

okay so now let's actually get to sort

489
00:20:27,110 --> 00:20:24,840
of a general idea of how we process web

490
00:20:29,930 --> 00:20:27,120
data and so the start is something we

491
00:20:31,909 --> 00:20:29,940
call Image stretching

492
00:20:33,770 --> 00:20:31,919
so it might come a surprise to you that

493
00:20:35,330 --> 00:20:33,780
these images don't start off in color

494
00:20:38,090 --> 00:20:35,340
they actually start off in black and

495
00:20:40,010 --> 00:20:38,100
white and so this is actually one image

496
00:20:41,570 --> 00:20:40,020
of the web Deep Field taken through one

497
00:20:44,330 --> 00:20:41,580
specific filter or one specific

498
00:20:46,070 --> 00:20:44,340
wavelength range of light the 2.7 micron

499
00:20:47,090 --> 00:20:46,080
filter but as you can see it looks very

500
00:20:49,549 --> 00:20:47,100
dark it doesn't look like there's

501
00:20:51,289 --> 00:20:49,559
anything there but there is it's just

502
00:20:54,289 --> 00:20:51,299
because these telescopes are so so

503
00:20:56,270 --> 00:20:54,299
sensitive that we have to actually scale

504
00:20:58,730 --> 00:20:56,280
the brightness values in order to show

505
00:21:00,650 --> 00:20:58,740
them or display them on our screens so

506
00:21:02,450 --> 00:21:00,660
you can see here there's all this data

507
00:21:04,370 --> 00:21:02,460
here but it's all kind of locked up in

508
00:21:06,350 --> 00:21:04,380
the black point so this is a histogram

509
00:21:08,870 --> 00:21:06,360
and this represents the brightness

510
00:21:10,850 --> 00:21:08,880
distribution or the values here or the

511
00:21:12,350 --> 00:21:10,860
pixel values distribution and you can

512
00:21:13,970 --> 00:21:12,360
see that they're all kind of pushed to

513
00:21:15,890 --> 00:21:13,980

the black end but we want to literally

514
00:21:17,990 --> 00:21:15,900
stretch this histogram out we want to

515
00:21:20,150 --> 00:21:18,000
just distribute it so that we can

516
00:21:21,529 --> 00:21:20,160
actually see the details that are hidden

517
00:21:23,750 --> 00:21:21,539
in the dark end

518
00:21:26,270 --> 00:21:23,760
so a nice way to kind of look at this is

519
00:21:29,690 --> 00:21:26,280
like a simpler example and we have this

520
00:21:32,149 --> 00:21:29,700
four value parent here we have dark gray

521
00:21:33,890 --> 00:21:32,159
we have black light gray and white and

522
00:21:36,409 --> 00:21:33,900
we have this distribution of these four

523
00:21:38,930 --> 00:21:36,419
pixel values here now what if we wanted

524
00:21:41,870 --> 00:21:38,940
to scale the brightness values of this

525
00:21:43,850 --> 00:21:41,880
image or stretch it so to speak so on

526
00:21:45,350 --> 00:21:43,860
the left here our first example we

527
00:21:48,169 --> 00:21:45,360
haven't done anything this is just

528
00:21:51,110 --> 00:21:48,179
linear one to one no transformation

529
00:21:53,630 --> 00:21:51,120
now on the middle part we have have

530
00:21:56,090 --> 00:21:53,640
scaled the brightness values but now you

531
00:21:59,330 --> 00:21:56,100
can see that in the and while we're

532
00:22:01,130 --> 00:21:59,340
trying to bring out this darker gray we

533
00:22:02,930 --> 00:22:01,140
end up completely losing the brightest

534
00:22:05,870 --> 00:22:02,940
values so we can't differentiate between

535
00:22:07,190 --> 00:22:05,880
these these pixels which is not not good

536
00:22:09,789 --> 00:22:07,200
because then we don't we're losing

537
00:22:13,789 --> 00:22:12,110
and so what we end up doing and this is

538
00:22:15,710 --> 00:22:13,799

the stretch that we want to do for

539
00:22:17,630 --> 00:22:15,720
astronomy is we want to do what we call

540
00:22:19,789 --> 00:22:17,640
a non-linear stretch and that just means

541
00:22:22,130 --> 00:22:19,799
performing a transformation that helps

542
00:22:23,870 --> 00:22:22,140
to emphasize these darker regions

543
00:22:26,210 --> 00:22:23,880
bringing out those details in sort of

544
00:22:28,909 --> 00:22:26,220
the parrot here but we're not losing

545
00:22:31,310 --> 00:22:28,919
those values on the brightest end

546
00:22:33,770 --> 00:22:31,320
and so we can see another example with

547
00:22:35,390 --> 00:22:33,780
this image of the web Deep Field and

548
00:22:36,710 --> 00:22:35,400
this is what we called the linear

549
00:22:38,930 --> 00:22:36,720
stretch this is something that we don't

550
00:22:40,669 --> 00:22:38,940
want to do because as you can see even

551
00:22:42,890 --> 00:22:40,679
though we're bringing out those faint

552
00:22:44,870 --> 00:22:42,900
structures in the background we're

553
00:22:46,850 --> 00:22:44,880
completely saturating these regions it's

554
00:22:48,350 --> 00:22:46,860
too bright we've lost information here

555
00:22:49,850 --> 00:22:48,360
and you can kind of see that here in

556
00:22:51,950 --> 00:22:49,860
this histogram because it's been cut off

557
00:22:55,190 --> 00:22:51,960
it's been clipped so that's information

558
00:22:58,130 --> 00:22:55,200
that we can't get back if we continue on

559
00:23:00,289 --> 00:22:58,140
so that's why it's so important to apply

560
00:23:01,789 --> 00:23:00,299
what we call a non-linear stretch so

561
00:23:03,289 --> 00:23:01,799
we're preserving the highlights we're

562
00:23:04,730 --> 00:23:03,299
bringing out these features you can kind

563
00:23:07,250 --> 00:23:04,740

of think of it as bringing out those

564
00:23:09,950 --> 00:23:07,260
mid-tones and we are stretching out this

565
00:23:12,890 --> 00:23:09,960
histogram across this range of values so

566
00:23:14,510 --> 00:23:12,900
we get a really nice contrast driven

567
00:23:17,090 --> 00:23:14,520
image

568
00:23:18,890 --> 00:23:17,100
so let's look at that with an example of

569
00:23:20,810 --> 00:23:18,900
the Karina nebula so for the Karina

570
00:23:23,630 --> 00:23:20,820
nebula we have six different filters

571
00:23:25,130 --> 00:23:23,640
here's or stiff six different specific

572
00:23:26,270 --> 00:23:25,140
wavelength ranges of light that we

573
00:23:29,330 --> 00:23:26,280
collected

574
00:23:31,010 --> 00:23:29,340
and here uh they are non-stretch so this

575
00:23:32,930 --> 00:23:31,020
is linear we haven't done anything this

576
00:23:34,310 --> 00:23:32,940
is straight from the telescope but for

577
00:23:35,630 --> 00:23:34,320
all the filters we have to do that

578
00:23:37,370 --> 00:23:35,640
stretching we have to scale the

579
00:23:39,169 --> 00:23:37,380
brightness values and so that's what we

580
00:23:40,909 --> 00:23:39,179
do here you can see like it comes to

581
00:23:43,250 --> 00:23:40,919
life all of a sudden you see all this

582
00:23:46,610 --> 00:23:43,260
detail and structure and information and

583
00:23:50,990 --> 00:23:48,590
okay and now we get to the second step

584
00:23:53,750 --> 00:23:51,000
after this which is the chromatic color

585
00:23:55,669 --> 00:23:53,760
or prescribed prescribing the color so I

586
00:23:57,710 --> 00:23:55,679
kind of mentioned this already that

587
00:23:59,630 --> 00:23:57,720
these images that we get start off in

588
00:24:02,029 --> 00:23:59,640

Black and White and The Way We prescribe

589
00:24:03,890 --> 00:24:02,039
color is we collect specific wavelengths

590
00:24:06,649 --> 00:24:03,900
of light through this through this

591
00:24:08,690 --> 00:24:06,659
filter we're filter wheel and so this is

592
00:24:10,430 --> 00:24:08,700
actually a video of the mid infrared

593
00:24:12,169 --> 00:24:10,440
instrument the Miri instrument which is

594
00:24:13,370 --> 00:24:12,179
collecting the light redirecting it

595
00:24:15,289 --> 00:24:13,380
through this filter wheel the filter

596
00:24:16,970 --> 00:24:15,299
wheel can move and then we can get

597
00:24:18,770 --> 00:24:16,980
different specific wavelength ranges of

598
00:24:21,529 --> 00:24:18,780
light and then it's redirected to the

599
00:24:24,409 --> 00:24:21,539
detector so our camera and then it gets

600
00:24:29,450 --> 00:24:25,669
now

601
00:24:32,149 --> 00:24:29,460
how do we prescribe color so we see

602
00:24:33,890 --> 00:24:32,159
visible light as the shorter wavelength

603
00:24:35,990 --> 00:24:33,900
being the Bluer color and the longer

604
00:24:37,730 --> 00:24:36,000
wavelengths being the redder color and

605
00:24:39,710 --> 00:24:37,740
so that's the relationship that exists

606
00:24:41,870 --> 00:24:39,720
with visible light so we extend that

607
00:24:43,909 --> 00:24:41,880
relationship into the infrared

608
00:24:46,310 --> 00:24:43,919
essentially so even though we can't see

609
00:24:48,890 --> 00:24:46,320
an infrared we can use that relationship

610
00:24:50,870 --> 00:24:48,900
and apply it to the infrared so in

611
00:24:52,490 --> 00:24:50,880
essence you're taking the infrared

612
00:24:54,830 --> 00:24:52,500
wavelengths and shifting it into a

613
00:24:56,690 --> 00:24:54,840

visible color space so now your shortest

614
00:24:59,390 --> 00:24:56,700
wavelength in infrared is your Bluer

615
00:25:02,990 --> 00:24:59,400
color and Etc so you can see that's what

616
00:25:05,630 --> 00:25:03,000
we do that's how we apply Color

617
00:25:08,090 --> 00:25:05,640
in chromatic order where our shortest

618
00:25:11,990 --> 00:25:08,100
wavelength filter here is prescribed

619
00:25:14,450 --> 00:25:12,000
blue and so on so cyan green orange red

620
00:25:16,490 --> 00:25:14,460
and then yellow which seems okay we got

621
00:25:18,350 --> 00:25:16,500
an outlier here because right this

622
00:25:20,210 --> 00:25:18,360
should come this should be red

623
00:25:22,130 --> 00:25:20,220
but the reason why we do this we're not

624
00:25:24,230 --> 00:25:22,140
actually breaking any conventions here

625
00:25:27,950 --> 00:25:24,240
this little guy on the right is actually

626
00:25:30,289 --> 00:25:27,960
very very hot hydrogen gas and it's a

627
00:25:32,810 --> 00:25:30,299
very specific filter range

628
00:25:33,890 --> 00:25:32,820
and it actually gets captured in another

629
00:25:35,350 --> 00:25:33,900
filter

630
00:25:38,390 --> 00:25:35,360
this

631
00:25:40,190 --> 00:25:38,400
2.12 micron filter and so if we switch

632
00:25:41,930 --> 00:25:40,200
it out we're not breaking any rules here

633
00:25:43,970 --> 00:25:41,940
and the reason why it's important to

634
00:25:45,529 --> 00:25:43,980
actually designate this yellow rather

635
00:25:47,210 --> 00:25:45,539
than Red is because it's a really

636
00:25:49,310 --> 00:25:47,220
important feature that's showing you

637
00:25:51,409 --> 00:25:49,320
where these really hot young stars are

638
00:25:53,390 --> 00:25:51,419

embedded in this dust and if we just

639
00:25:55,010 --> 00:25:53,400
prescribe it red we're losing all that

640
00:25:56,570 --> 00:25:55,020
information there and that's the whole

641
00:25:59,450 --> 00:25:56,580
point is we want to showcase the science

642
00:26:01,070 --> 00:25:59,460
and the astronomy and the you know all

643
00:26:04,490 --> 00:26:01,080
this really cool information while

644
00:26:08,870 --> 00:26:07,010
okay so after we have performed the

645
00:26:10,909 --> 00:26:08,880
stretching and we're prescribing colors

646
00:26:13,010 --> 00:26:10,919
we want to do one thing on each filter

647
00:26:15,230 --> 00:26:13,020
before we continue and that's dealing

648
00:26:17,149 --> 00:26:15,240
with stuff with like artifacts and

649
00:26:19,130 --> 00:26:17,159
artifacts are just intrinsic to the

650
00:26:20,990 --> 00:26:19,140
detector the telescope itself and the

651
00:26:22,190 --> 00:26:21,000
calibration and all of it so it's

652
00:26:24,590 --> 00:26:22,200
something that you wouldn't actually see

653
00:26:26,870 --> 00:26:24,600
if you were there so things like readout

654
00:26:29,149 --> 00:26:26,880
noise from the electronics or you have

655
00:26:31,669 --> 00:26:29,159
these sort of dark centers of stars

656
00:26:34,190 --> 00:26:31,679
those are introduced by the calibration

657
00:26:35,029 --> 00:26:34,200
pipeline so all this data gets cleaned

658
00:26:37,250 --> 00:26:35,039
up

659
00:26:39,409 --> 00:26:37,260
and because these stars are saturated

660
00:26:41,750 --> 00:26:39,419
they get replaced with null values

661
00:26:43,250 --> 00:26:41,760
because it's just a warning to the

662
00:26:45,110 --> 00:26:43,260
scientists that you can't perform any

663
00:26:47,630 --> 00:26:45,120

sort of photometry you can't perform any

664
00:26:49,789 --> 00:26:47,640
sort of analysis on this because it is

665
00:26:51,950 --> 00:26:49,799
no longer reliable so that's just sort

666
00:26:53,450 --> 00:26:51,960
of and that's why that is there and but

667
00:26:55,070 --> 00:26:53,460
we have to remove those because of

668
00:26:56,810 --> 00:26:55,080
course we're not looking at the sky and

669
00:26:58,850 --> 00:26:56,820
seeing these black in the center of

670
00:27:00,470 --> 00:26:58,860
stars and we also have these striations

671
00:27:02,330 --> 00:27:00,480
again which is from the electronic

672
00:27:04,070 --> 00:27:02,340
readout noise so we have to do things to

673
00:27:06,350 --> 00:27:04,080
remove this and we have a lot of

674
00:27:08,029 --> 00:27:06,360
algorithms um to do this but this is

675
00:27:09,649 --> 00:27:08,039
just two some of the things that we end

676
00:27:10,610 --> 00:27:09,659
up doing in sort of photo editing

677
00:27:12,890 --> 00:27:10,620
software

678
00:27:15,649 --> 00:27:12,900
is removing those bands and replacing

679
00:27:17,990 --> 00:27:15,659
that area of the dark cores with the

680
00:27:20,390 --> 00:27:18,000
nearest neighbor

681
00:27:22,190 --> 00:27:20,400
okay so this is our first initial color

682
00:27:24,049 --> 00:27:22,200
composite after we've done the

683
00:27:25,669 --> 00:27:24,059
stretching and prescribed all the colors

684
00:27:28,610 --> 00:27:25,679
this is what we initially get when we

685
00:27:32,090 --> 00:27:28,620
combine them added together and so this

686
00:27:34,669 --> 00:27:32,100
is there's no one point that it turns

687
00:27:36,350 --> 00:27:34,679
into a subjective from the objective

688
00:27:38,810 --> 00:27:36,360

we're always sort of weighing the art

689
00:27:40,310 --> 00:27:38,820
and science elements as we go along and

690
00:27:42,110 --> 00:27:40,320
thinking of the story we're trying to

691
00:27:42,890 --> 00:27:42,120
tell the science story we're trying to

692
00:27:44,750 --> 00:27:42,900
tell

693
00:27:47,570 --> 00:27:44,760
um this is sort of the first phase of

694
00:27:49,970 --> 00:27:47,580
that now that being said there still are

695
00:27:51,649 --> 00:27:49,980
artistic principles or aesthetic

696
00:27:53,990 --> 00:27:51,659
principles that we're thinking of all

697
00:27:56,149 --> 00:27:54,000
the time and that we're applying and

698
00:27:58,010 --> 00:27:56,159
things like Clarity color composition

699
00:28:00,169 --> 00:27:58,020
things again that helps tell the science

700
00:28:02,149 --> 00:28:00,179
story in fact there's decisions that

701
00:28:04,970 --> 00:28:02,159
we've already made that are aesthetic

702
00:28:07,370 --> 00:28:04,980
decisions uh things like I was talking

703
00:28:08,870 --> 00:28:07,380
about the artifacts that we removed but

704
00:28:11,090 --> 00:28:08,880
there's actually an artifact in here

705
00:28:14,029 --> 00:28:11,100
that remains and that's what we call the

706
00:28:16,370 --> 00:28:14,039
diffraction spikes so this eight Spike

707
00:28:18,049 --> 00:28:16,380
star we keep that in there and why do we

708
00:28:19,970 --> 00:28:18,059
do that well there's a little bit of a

709
00:28:22,610 --> 00:28:19,980
whimsicality there it's sort of like the

710
00:28:24,049 --> 00:28:22,620
twinkling star just sort of the what do

711
00:28:25,310 --> 00:28:24,059
you think of space so when you think of

712
00:28:27,049 --> 00:28:25,320
a space image you think of these

713
00:28:29,390 --> 00:28:27,059

twinkling stars and so that's sort of

714
00:28:32,149 --> 00:28:29,400
the convention there but also it acts as

715
00:28:33,830 --> 00:28:32,159
like a signature to web because the

716
00:28:36,769 --> 00:28:33,840
diffraction spikes come from the light

717
00:28:39,710 --> 00:28:36,779
interacting with the hexagonal mirror of

718
00:28:41,029 --> 00:28:39,720
web and also the two struts that are

719
00:28:43,250 --> 00:28:41,039
holding up the secondary mirror so

720
00:28:44,690 --> 00:28:43,260
that's why you get these spikes uh and

721
00:28:46,909 --> 00:28:44,700
so we keep them in there so you know

722
00:28:48,529 --> 00:28:46,919
like oh we're looking at web also it'd

723
00:28:50,690 --> 00:28:48,539
be really hard to remove them it would

724
00:28:53,090 --> 00:28:50,700
take a a long time we do have algorithms

725
00:28:55,549 --> 00:28:53,100
in place to sort of replace those areas

726
00:28:57,110 --> 00:28:55,559
um with samples of data uh but the

727
00:28:59,149 --> 00:28:57,120
better way to do that would actually be

728
00:29:01,669 --> 00:28:59,159
to rotate the telescope get another

729
00:29:03,230 --> 00:29:01,679
exposure of it and fill that data in

730
00:29:04,490 --> 00:29:03,240
over the diffraction spikes or where

731
00:29:06,950 --> 00:29:04,500
they overlap

732
00:29:08,690 --> 00:29:06,960
but that costs a lot of money and

733
00:29:10,789 --> 00:29:08,700
there's a lot of competition for web

734
00:29:13,789 --> 00:29:10,799
time so it's not the most feasible thing

735
00:29:18,230 --> 00:29:16,070
also a decision that we've already made

736
00:29:20,630 --> 00:29:18,240
that you might have not thought about

737
00:29:22,970 --> 00:29:20,640
you've probably seen this image Karina

738
00:29:25,610 --> 00:29:22,980

nebula and if you have it's been

739
00:29:27,649 --> 00:29:25,620
primarily in this orientation even

740
00:29:30,470 --> 00:29:27,659
though the Norfolk convention for

741
00:29:34,490 --> 00:29:30,480
astronomers is the orientation on the

742
00:29:36,769 --> 00:29:34,500
right now why is that so no there's no

743
00:29:38,330 --> 00:29:36,779
true north out so it could be really

744
00:29:40,430 --> 00:29:38,340
anything it's just a convention that

745
00:29:42,350 --> 00:29:40,440
astronomers use but it was a choice to

746
00:29:44,630 --> 00:29:42,360
change the orientation and that choice

747
00:29:46,430 --> 00:29:44,640
is important because the one on the

748
00:29:48,710 --> 00:29:46,440
right feels a little bit unbalanced

749
00:29:50,149 --> 00:29:48,720
unstable and also if we crop this down

750
00:29:52,250 --> 00:29:50,159
we're going to lose a lot of real estate

751
00:29:53,690 --> 00:29:52,260
and of course we want to showcase all

752
00:29:55,010 --> 00:29:53,700
the details and the data that we got

753
00:29:56,990 --> 00:29:55,020
because it took a lot of time to get it

754
00:29:58,490 --> 00:29:57,000
so we're thinking about that and we're

755
00:30:01,130 --> 00:29:58,500
also thinking about how does this

756
00:30:03,350 --> 00:30:01,140
provide context so this helps us feel

757
00:30:05,090 --> 00:30:03,360
like this is a landscape this feels more

758
00:30:07,669 --> 00:30:05,100
familiar something we might have seen

759
00:30:09,350 --> 00:30:07,679
something that we can draw a parallel to

760
00:30:11,930 --> 00:30:09,360
so in the case

761
00:30:14,210 --> 00:30:11,940
of this Karina nebula these mountainous

762
00:30:16,370 --> 00:30:14,220
Regions they're being eroded by these

763
00:30:18,289 --> 00:30:16,380

hot stars and that's similar to what we

764
00:30:19,850 --> 00:30:18,299
see you know on Earth where we're

765
00:30:21,710 --> 00:30:19,860
looking at mountain ranges that are

766
00:30:24,470 --> 00:30:21,720
being eroded by weathering or natural

767
00:30:26,330 --> 00:30:24,480
forces so that parallel helps with the

768
00:30:28,430 --> 00:30:26,340
story and the understanding of what's

769
00:30:30,409 --> 00:30:28,440
actually happening in this image besides

770
00:30:33,049 --> 00:30:30,419
just making it feel a little bit more

771
00:30:36,230 --> 00:30:33,059
stable like more appropriately weighted

772
00:30:38,149 --> 00:30:36,240
and helps your eye move across the the

773
00:30:40,370 --> 00:30:38,159
image

774
00:30:42,769 --> 00:30:40,380
okay so let's go back to our initial

775
00:30:44,389 --> 00:30:42,779
color composite this is where we're kind

776
00:30:45,889 --> 00:30:44,399
of looking at this more as a

777
00:30:47,389 --> 00:30:45,899
photographer would so we're thinking of

778
00:30:49,610 --> 00:30:47,399
sort of the white balancing we're

779
00:30:51,169 --> 00:30:49,620
thinking about color balancing so we use

780
00:30:53,510 --> 00:30:51,179
the center of the stars for our white

781
00:30:54,889 --> 00:30:53,520
references in this particular case and

782
00:30:56,409 --> 00:30:54,899
normally we would neutralize the

783
00:31:00,049 --> 00:30:56,419
background make sure that we have equal

784
00:31:02,810 --> 00:31:00,059
number of our red green and blue values

785
00:31:05,269 --> 00:31:02,820
because that background should be very

786
00:31:08,029 --> 00:31:05,279
very dark right or almost black

787
00:31:10,190 --> 00:31:08,039
but in the case of nebulae we don't

788
00:31:11,870 --> 00:31:10,200

really have a region to use this that

789
00:31:14,210 --> 00:31:11,880
reference because there actually is some

790
00:31:15,769 --> 00:31:14,220
dust so there is a little bit of or I

791
00:31:18,230 --> 00:31:15,779
should say there's some gas back here so

792
00:31:20,810 --> 00:31:18,240
that's not true true you know dark sky

793
00:31:22,730 --> 00:31:20,820
and so there is a little bit of by eye

794
00:31:24,769 --> 00:31:22,740
that we have to do but it is a very

795
00:31:27,769 --> 00:31:24,779
iterative process and it's one that we

796
00:31:29,630 --> 00:31:27,779
do with the scientists out as well so

797
00:31:31,430 --> 00:31:29,640
starting from this phase I actually end

798
00:31:33,169 --> 00:31:31,440
up shifting this image a little bit

799
00:31:35,090 --> 00:31:33,179
closer to the blue part of the spectrum

800
00:31:36,769 --> 00:31:35,100
now all the relationships between the

801
00:31:38,389 --> 00:31:36,779
colors are remain the same they're just

802
00:31:40,010 --> 00:31:38,399
slightly shifted to really bring out

803
00:31:42,110 --> 00:31:40,020
these two different processes at work

804
00:31:44,269 --> 00:31:42,120
here we have the mountain range on the

805
00:31:46,850 --> 00:31:44,279
bottom which is just a very dense dust

806
00:31:48,590 --> 00:31:46,860
and then on top we have the hot gas and

807
00:31:51,529 --> 00:31:48,600
sort of that complementary nature of

808
00:31:52,850 --> 00:31:51,539
that orangey dune-like scene with the

809
00:31:54,889 --> 00:31:52,860
sky seam feels a little bit more

810
00:31:56,269 --> 00:31:54,899
familiar and also helps with that

811
00:31:58,070 --> 00:31:56,279
contrast

812
00:32:00,230 --> 00:31:58,080
and of course I want to bring out these

813
00:32:02,450 --> 00:32:00,240

features even more because that's you

814
00:32:03,590 --> 00:32:02,460
know we got all this data and these

815
00:32:05,090 --> 00:32:03,600
different filters that are showing us

816
00:32:06,409 --> 00:32:05,100
different things we really want to bring

817
00:32:09,169 --> 00:32:06,419
out the contrast and the color

818
00:32:10,789 --> 00:32:09,179
separation here now this I went a little

819
00:32:12,409 --> 00:32:10,799
too far here so I have to take it back

820
00:32:14,450 --> 00:32:12,419
and that happens sometimes you work on

821
00:32:16,490 --> 00:32:14,460
an image for a while and then you just

822
00:32:18,110 --> 00:32:16,500
you get so you know wrapped up in the

823
00:32:19,250 --> 00:32:18,120
pixels and bringing out all that detail

824
00:32:21,409 --> 00:32:19,260
that you kind of have to take a step

825
00:32:23,090 --> 00:32:21,419
back and be like oh you know that

826
00:32:25,070 --> 00:32:23,100
doesn't seem natural anymore so you kind

827
00:32:26,750 --> 00:32:25,080
of have to take it back and at this

828
00:32:28,970 --> 00:32:26,760
stage again I'm working with the

829
00:32:31,250 --> 00:32:28,980
scientists and this region we have here

830
00:32:32,450 --> 00:32:31,260
is sort of this blue gas that's sort of

831
00:32:34,730 --> 00:32:32,460
coming through

832
00:32:37,010 --> 00:32:34,740
this mountainous region and it seems to

833
00:32:39,649 --> 00:32:37,020
be overshadowing obscuring it and this

834
00:32:41,389 --> 00:32:39,659
is very real this this exists but

835
00:32:43,250 --> 00:32:41,399
speaking with the scientists they felt

836
00:32:45,169 --> 00:32:43,260
like it took away from the 3D nature of

837
00:32:47,810 --> 00:32:45,179
the dust and the structure so we want to

838
00:32:50,330 --> 00:32:47,820

go back in there and really enforce that

839
00:32:52,190 --> 00:32:50,340
dust 3D landscape so that's what you can

840
00:32:53,570 --> 00:32:52,200
see here it goes a little fast but you

841
00:32:55,310 --> 00:32:53,580
can see that we get a little bit more of

842
00:32:57,769 --> 00:32:55,320
the structure back in here and we've

843
00:33:00,409 --> 00:32:57,779
tone things down a little bit

844
00:33:02,210 --> 00:33:00,419
and then in the end this is what we are

845
00:33:04,010 --> 00:33:02,220
left with the final image and there's a

846
00:33:05,570 --> 00:33:04,020
lot of ways to sort of approach an

847
00:33:07,310 --> 00:33:05,580
object and different objects will be

848
00:33:09,529 --> 00:33:07,320
processed differently and they'll also

849
00:33:10,730 --> 00:33:09,539
be processed by differently by different

850
00:33:12,649 --> 00:33:10,740
people

851
00:33:13,750 --> 00:33:12,659
um and so I'll let Joe get into that a

852
00:33:21,669 --> 00:33:13,760
little bit more

853
00:33:26,810 --> 00:33:24,950
thanks Elisa I'm going to pick up from

854
00:33:32,029 --> 00:33:26,820
here so let me um

855
00:33:37,730 --> 00:33:35,210
okay so I am going to continue talking

856
00:33:39,289 --> 00:33:37,740
about uh the Karina nebula image but

857
00:33:40,610 --> 00:33:39,299
before I do

858
00:33:42,409 --> 00:33:40,620
um I just noticed that Elisa was talking

859
00:33:44,570 --> 00:33:42,419
about the eight-pointed stars on web and

860
00:33:46,909 --> 00:33:44,580
I thought we could explore a little bit

861
00:33:48,169 --> 00:33:46,919
about why they appear that way it

862
00:33:50,750 --> 00:33:48,179
actually has to do with the optical

863
00:33:53,029 --> 00:33:50,760

system of the telescope

864
00:33:57,009 --> 00:33:53,039
um in a system like this every hard Edge

865
00:34:00,590 --> 00:33:57,019
imparts uh a diffraction pattern onto

866
00:34:02,810 --> 00:34:00,600
light sources right so a point source

867
00:34:05,450 --> 00:34:02,820
star is going to interact with the hard

868
00:34:07,310 --> 00:34:05,460
edges all along the mirrors so all 18

869
00:34:10,030 --> 00:34:07,320
hexagonal segments are going to

870
00:34:12,050 --> 00:34:10,040
contribute something to the final

871
00:34:13,730 --> 00:34:12,060
appearance of the star

872
00:34:16,250 --> 00:34:13,740
in addition to that we have these green

873
00:34:18,409 --> 00:34:16,260
lines representing uh the diffraction

874
00:34:20,389 --> 00:34:18,419
that's imparted by the support struts

875
00:34:22,190 --> 00:34:20,399
that hold up the secondary mirror and so

876
00:34:24,889 --> 00:34:22,200
when everything comes to focus at the

877
00:34:27,109 --> 00:34:24,899
detector you get this pattern which we

878
00:34:29,629 --> 00:34:27,119
see in every bright star that web

879
00:34:31,310 --> 00:34:29,639
observes so that is the the origin sort

880
00:34:33,109 --> 00:34:31,320
of you know generally quickly

881
00:34:34,550 --> 00:34:33,119
summarizing where that comes from that

882
00:34:36,470 --> 00:34:34,560
is the origin of the web's unique

883
00:34:37,669 --> 00:34:36,480
diffractions pattern

884
00:34:39,950 --> 00:34:37,679
foreign

885
00:34:42,589 --> 00:34:39,960
now jumping back into the Karina nebula

886
00:34:44,570 --> 00:34:42,599
what I'd like to do is talk about uh the

887
00:34:46,430 --> 00:34:44,580
Miri observations of this remember Elisa

888
00:34:48,889 --> 00:34:46,440

had discussed a little bit about the

889
00:34:50,750 --> 00:34:48,899
mid-infrared instrument we took Miri

890
00:34:53,089 --> 00:34:50,760
data of this same region it's a smaller

891
00:34:55,609 --> 00:34:53,099
field of view so it actually takes up

892
00:34:56,990 --> 00:34:55,619
this region here but the origin of the

893
00:34:58,790 --> 00:34:57,000
appearance of this image is actually an

894
00:35:00,349 --> 00:34:58,800
interesting story

895
00:35:02,870 --> 00:35:00,359
um

896
00:35:04,430 --> 00:35:02,880
we let's see

897
00:35:06,470 --> 00:35:04,440
yes so it's the mid inferred instrument

898
00:35:07,490 --> 00:35:06,480
and remember Elisa had showed this this

899
00:35:08,930 --> 00:35:07,500
movie

900
00:35:10,190 --> 00:35:08,940
um this is actually the final frame of

901
00:35:12,170 --> 00:35:10,200
that movie that just shows you there's

902
00:35:14,150 --> 00:35:12,180
you know the pick-off mirror and the

903
00:35:15,589 --> 00:35:14,160
detector at the bottom and the filter

904
00:35:16,970 --> 00:35:15,599
wheel which is where all the colors come

905
00:35:19,310 --> 00:35:16,980
from so this is just to sort of ground

906
00:35:20,690 --> 00:35:19,320
you in where what Miri is and where that

907
00:35:22,970 --> 00:35:20,700
data is coming from

908
00:35:25,069 --> 00:35:22,980
now Mary is observing in the longer

909
00:35:27,349 --> 00:35:25,079
infrared wavelengths and so if we were

910
00:35:29,690 --> 00:35:27,359
to combine the data together of near Cam

911
00:35:32,390 --> 00:35:29,700
and Mary according to the chromatic

912
00:35:33,710 --> 00:35:32,400
principles that Alisa has laid out uh

913
00:35:35,930 --> 00:35:33,720

you would expect to see something like

914
00:35:38,030 --> 00:35:35,940
this where the blues and the teals and

915
00:35:40,730 --> 00:35:38,040
maybe the greens would be confined to

916
00:35:42,410 --> 00:35:40,740
the near cam regime of the image and

917
00:35:44,089 --> 00:35:42,420
then as you move into longer wavelengths

918
00:35:46,670 --> 00:35:44,099
of the Miri we would have yellows

919
00:35:48,890 --> 00:35:46,680
oranges and reds uh it turns out if you

920
00:35:51,290 --> 00:35:48,900
apply that process to the data you get

921
00:35:54,710 --> 00:35:51,300
an image that looks more like this which

922
00:35:55,790 --> 00:35:54,720
when I first put this together uh I

923
00:35:58,190 --> 00:35:55,800
wondered how we were going to deal with

924
00:36:00,650 --> 00:35:58,200
this it's not a very aesthetically

925
00:36:03,770 --> 00:36:00,660
pleasing image the purple sky the green

926
00:36:06,170 --> 00:36:03,780
clouds uh it's interesting that it

927
00:36:08,210 --> 00:36:06,180
astrophysically speaking most of the

928
00:36:11,270 --> 00:36:08,220
stars in this image appear in the short

929
00:36:13,550 --> 00:36:11,280
in short wavelength infrared bands and

930
00:36:15,230 --> 00:36:13,560
so they don't appear in the mid infrared

931
00:36:17,270 --> 00:36:15,240
and so you end up getting a lot of blue

932
00:36:19,490 --> 00:36:17,280
stars that are just pure blue which

933
00:36:21,890 --> 00:36:19,500
looks very unnatural in the composite

934
00:36:23,510 --> 00:36:21,900
color image so the next step for me the

935
00:36:25,609 --> 00:36:23,520
next logical step was to say well okay

936
00:36:27,290 --> 00:36:25,619
this looks kind of strange what happens

937
00:36:28,670 --> 00:36:27,300
if we just make an image in the Miri

938
00:36:30,890 --> 00:36:28,680

wavelengths alone and what do we get

939
00:36:32,870 --> 00:36:30,900
from that

940
00:36:34,609 --> 00:36:32,880
so shifting this just to Miri and

941
00:36:37,190 --> 00:36:34,619
applying the chromatic ordering to the

942
00:36:38,150 --> 00:36:37,200
Miri wavelengths what do we see we see

943
00:36:42,650 --> 00:36:38,160
this

944
00:36:44,150 --> 00:36:42,660
interesting image it's very evocative

945
00:36:46,250 --> 00:36:44,160
it's very different from what we saw

946
00:36:49,490 --> 00:36:46,260
with near cam in fact it actually

947
00:36:51,650 --> 00:36:49,500
reminded me of Monet's ruined Cathedral

948
00:36:54,050 --> 00:36:51,660
series of paintings you know Monet went

949
00:36:56,690 --> 00:36:54,060
to this area of France and painted the

950
00:36:58,849 --> 00:36:56,700
ruined Cathedral over 30 times at

951
00:37:01,550 --> 00:36:58,859
different times of day trying to capture

952
00:37:04,370 --> 00:37:01,560
the essence of the atmosphere of the

953
00:37:06,170 --> 00:37:04,380
lighting of the atmosphere whether it

954
00:37:08,630 --> 00:37:06,180
was you know morning or evening or

955
00:37:11,030 --> 00:37:08,640
mid-afternoon you know the effects of

956
00:37:12,410 --> 00:37:11,040
the environment on the scene itself and

957
00:37:13,790 --> 00:37:12,420
you get you know 30 very different

958
00:37:14,810 --> 00:37:13,800
looking paintings even though it's the

959
00:37:17,270 --> 00:37:14,820
same object

960
00:37:18,890 --> 00:37:17,280
uh so that that if this image brought

961
00:37:20,630 --> 00:37:18,900
that to my mind as I was working on it

962
00:37:22,370 --> 00:37:20,640
and so then I thought well okay we have

963
00:37:23,690 --> 00:37:22,380

this beautiful image for Miri we also

964
00:37:25,430 --> 00:37:23,700
have this beautiful image from near cam

965
00:37:27,170 --> 00:37:25,440
is there a way that we can combine them

966
00:37:28,730 --> 00:37:27,180
together that emphasizes both the

967
00:37:30,829 --> 00:37:28,740
astronomy you know the astrophysics of

968
00:37:32,390 --> 00:37:30,839
what's happening but also emphasizes the

969
00:37:34,130 --> 00:37:32,400
beauty that each of these instruments

970
00:37:35,990 --> 00:37:34,140
provides in this scene

971
00:37:38,210 --> 00:37:36,000
and so we came up with this idea of

972
00:37:39,050 --> 00:37:38,220
interleaving the short wavelengths the

973
00:37:40,730 --> 00:37:39,060
middle wavelengths and the long

974
00:37:43,190 --> 00:37:40,740
wavelengths of each camera together

975
00:37:45,589 --> 00:37:43,200
right so now we have what we call near

976
00:37:48,109 --> 00:37:45,599
Mary cam where the short wavelengths of

977
00:37:50,450 --> 00:37:48,119
near Cam and Miri are assigned blue and

978
00:37:52,250 --> 00:37:50,460
then we go to green into red

979
00:37:53,690 --> 00:37:52,260
and that was how we came up with this

980
00:37:56,030 --> 00:37:53,700
this final version of the image here

981
00:37:57,650 --> 00:37:56,040
which you know aesthetically speaking we

982
00:37:59,210 --> 00:37:57,660
have stars with white cores in them

983
00:38:00,650 --> 00:37:59,220
which looks more natural

984
00:38:02,630 --> 00:38:00,660
um but astrophysically speaking it's

985
00:38:04,310 --> 00:38:02,640
still astrophysically relevant right the

986
00:38:06,710 --> 00:38:04,320
the young Stars the stars that are

987
00:38:08,810 --> 00:38:06,720
embedded in dust they still appear uh

988
00:38:11,690 --> 00:38:08,820

Dusty and red because they show up red

989
00:38:13,250 --> 00:38:11,700
in both near Cam and Miri and it

990
00:38:15,710 --> 00:38:13,260
actually gives us more information than

991
00:38:17,230 --> 00:38:15,720
either one of them alone near cam gives

992
00:38:19,130 --> 00:38:17,240
us all of the stars in the background

993
00:38:21,829 --> 00:38:19,140
Miri gives us

994
00:38:23,510 --> 00:38:21,839
a deeper um we penetrate deeper into

995
00:38:25,069 --> 00:38:23,520
these clouds to be able to see these

996
00:38:26,870 --> 00:38:25,079
young stars in the process of forming

997
00:38:28,370 --> 00:38:26,880
with their jets shooting out in

998
00:38:30,230 --> 00:38:28,380
different directions

999
00:38:32,390 --> 00:38:30,240
okay so that is the story of the near

1000
00:38:35,569 --> 00:38:32,400
Mary Cam and now I would like to shift

1001
00:38:37,370 --> 00:38:35,579
Focus to the tarantula nebula uh this is

1002
00:38:39,650 --> 00:38:37,380
one of my favorite images of the early

1003
00:38:41,450 --> 00:38:39,660
release observations this one was

1004
00:38:43,609 --> 00:38:41,460
actually the first image the First Data

1005
00:38:44,690 --> 00:38:43,619
to come down for the telescope

1006
00:38:46,609 --> 00:38:44,700
um

1007
00:38:48,250 --> 00:38:46,619
and of course this is that image and

1008
00:38:51,650 --> 00:38:48,260
when this was released it was actually

1009
00:38:53,329 --> 00:38:51,660
compared to like Old Masters uh

1010
00:38:55,490 --> 00:38:53,339
Renaissance Era paintings right like

1011
00:38:56,870 --> 00:38:55,500
Caravaggio so I did a little research

1012
00:38:59,150 --> 00:38:56,880
and I found a painting that I thought

1013
00:39:01,490 --> 00:38:59,160

kind of captures the the quality and the

1014
00:39:03,050 --> 00:39:01,500
essence of this and that is caravaggio's

1015
00:39:05,750 --> 00:39:03,060
painting of Judith beheading Hollow

1016
00:39:08,450 --> 00:39:05,760
furnies which is despite its Macabre

1017
00:39:10,310 --> 00:39:08,460
nature is actually the colors here and

1018
00:39:12,050 --> 00:39:10,320
the quality of the light really Echoes

1019
00:39:14,329 --> 00:39:12,060
what I what I think I see in the

1020
00:39:17,329 --> 00:39:14,339
tarantula nebula and just keep that

1021
00:39:19,250 --> 00:39:17,339
painting in mind it'll come back later

1022
00:39:20,569 --> 00:39:19,260
um I do want to go all the way back to

1023
00:39:22,069 --> 00:39:20,579
the source data though and talk a little

1024
00:39:22,970 --> 00:39:22,079
bit about where this came from and how

1025
00:39:24,589 --> 00:39:22,980
we

1026
00:39:25,490 --> 00:39:24,599
um planned this observation and put it

1027
00:39:28,430 --> 00:39:25,500
all together

1028
00:39:30,950 --> 00:39:28,440
so in both the cases of Karina and uh

1029
00:39:34,250 --> 00:39:30,960
tarantula these are mosaics made up of

1030
00:39:36,170 --> 00:39:34,260
many different images in in both cases I

1031
00:39:38,510 --> 00:39:36,180
believe it's six filters

1032
00:39:40,190 --> 00:39:38,520
so let's zoom in and look at the raw

1033
00:39:41,810 --> 00:39:40,200
data that we get from The Observatory

1034
00:39:44,210 --> 00:39:41,820
we're going to back out to the very

1035
00:39:46,430 --> 00:39:44,220
first frame okay this is when we take

1036
00:39:48,589 --> 00:39:46,440
observations with web it takes a series

1037
00:39:51,410 --> 00:39:48,599
of exposures and it adds that together

1038
00:39:53,690 --> 00:39:51,420

to get to the final image so this is the

1039
00:39:57,410 --> 00:39:53,700
first exposure it's a we call it a stage

1040
00:39:59,690 --> 00:39:57,420
zero image so it's uncalibrated and

1041
00:40:00,890 --> 00:39:59,700
um it's about 161 seconds of exposure

1042
00:40:02,210 --> 00:40:00,900
time so it's you know like two and a

1043
00:40:04,609 --> 00:40:02,220
half minutes roughly that the

1044
00:40:06,589 --> 00:40:04,619
observatory was just collecting photons

1045
00:40:08,390 --> 00:40:06,599
of infrared light and creating this

1046
00:40:10,970 --> 00:40:08,400
image and you can see here that there's

1047
00:40:13,010 --> 00:40:10,980
already some stars and they're saturated

1048
00:40:15,710 --> 00:40:13,020
and so this is actually the origins of

1049
00:40:17,569 --> 00:40:15,720
the black holes in the centers of stars

1050
00:40:18,710 --> 00:40:17,579
if you have a saturated region in the

1051
00:40:20,270 --> 00:40:18,720
very first exposure there's no way

1052
00:40:21,829 --> 00:40:20,280
you're going to be able to get valid

1053
00:40:24,050 --> 00:40:21,839
information from that so the pipeline

1054
00:40:27,170 --> 00:40:24,060
processing will assign null values or

1055
00:40:28,490 --> 00:40:27,180
zeros to those values those pixels and

1056
00:40:31,550 --> 00:40:28,500
so you end up getting these black holes

1057
00:40:33,829 --> 00:40:31,560
but watch as I step through uh for each

1058
00:40:37,310 --> 00:40:33,839
exposure you know one exposure on web is

1059
00:40:38,870 --> 00:40:37,320
actually eight individual of these 162nd

1060
00:40:40,609 --> 00:40:38,880
exposures and you can actually see the

1061
00:40:43,130 --> 00:40:40,619
image sort of come into view

1062
00:40:45,290 --> 00:40:43,140
with each additional exposure

1063
00:40:47,210 --> 00:40:45,300

as I step through it

1064
00:40:48,770 --> 00:40:47,220
now this next one is going to going to

1065
00:40:50,630 --> 00:40:48,780
be the next step in the calibration

1066
00:40:52,430 --> 00:40:50,640
processing and it's where you'll see the

1067
00:40:54,230 --> 00:40:52,440
black holes come into play

1068
00:40:56,270 --> 00:40:54,240
so now we've gone from the eight

1069
00:40:58,849 --> 00:40:56,280
individual exposures to one calibrated

1070
00:41:00,470 --> 00:40:58,859
image this is uh this is called a rate

1071
00:41:03,410 --> 00:41:00,480
image it's actually not calibrated yet

1072
00:41:05,390 --> 00:41:03,420
but this is the combining all of those

1073
00:41:07,910 --> 00:41:05,400
eight exposures together to get the the

1074
00:41:10,430 --> 00:41:07,920
depth and the detail in a single

1075
00:41:12,290 --> 00:41:10,440
exposure but you can see if I bounce

1076
00:41:14,510 --> 00:41:12,300
back and forth where you have those

1077
00:41:16,250 --> 00:41:14,520
bright regions now that was saturated

1078
00:41:18,589 --> 00:41:16,260
data that's

1079
00:41:19,370 --> 00:41:18,599
um invalid data so it's been assigned to

1080
00:41:21,589 --> 00:41:19,380
Black

1081
00:41:23,990 --> 00:41:21,599
now you fill in a lot of this through

1082
00:41:25,250 --> 00:41:24,000
using um Dithers which means you just

1083
00:41:26,990 --> 00:41:25,260
sort of move the scene around a little

1084
00:41:28,970 --> 00:41:27,000
bit and you take multiple exposures and

1085
00:41:30,230 --> 00:41:28,980
you build up an image that fills in all

1086
00:41:31,970 --> 00:41:30,240
of these holes

1087
00:41:34,550 --> 00:41:31,980
moving on to the next step of the

1088
00:41:36,050 --> 00:41:34,560

calibration pipeline we see this slight

1089
00:41:39,050 --> 00:41:36,060
change in the appearance of the image

1090
00:41:41,089 --> 00:41:39,060
this is just a distortion correction and

1091
00:41:43,670 --> 00:41:41,099
so what that means is that the detector

1092
00:41:44,990 --> 00:41:43,680
is maybe slightly angled and so the

1093
00:41:47,270 --> 00:41:45,000
light is coming in it's not coming in

1094
00:41:48,589 --> 00:41:47,280
exactly parallel to the detector and so

1095
00:41:50,990 --> 00:41:48,599
to account for that you have to apply

1096
00:41:53,630 --> 00:41:51,000
this Distortion correction to get uh the

1097
00:41:54,589 --> 00:41:53,640
proper um aspect ratio for the final

1098
00:41:57,109 --> 00:41:54,599
image

1099
00:41:59,630 --> 00:41:57,119
so this would be the stage 2 calibrated

1100
00:42:01,609 --> 00:41:59,640
image from our pipeline processing it

1101
00:42:03,770 --> 00:42:01,619
has been flat fielded so it's removed a

1102
00:42:05,630 --> 00:42:03,780
lot of the instrumental artifacts you

1103
00:42:06,589 --> 00:42:05,640
know if I go all the way back here you

1104
00:42:08,810 --> 00:42:06,599
can see there's actually a lot of

1105
00:42:10,550 --> 00:42:08,820
instrumental artifacts that are present

1106
00:42:12,770 --> 00:42:10,560
here that can be completely subtracted

1107
00:42:15,050 --> 00:42:12,780
out of the final image

1108
00:42:16,790 --> 00:42:15,060
foreign

1109
00:42:19,550 --> 00:42:16,800
and then we'll go back to the full field

1110
00:42:21,829 --> 00:42:19,560
so in this case the tarantula nebula

1111
00:42:23,390 --> 00:42:21,839
image is actually for each filter is a

1112
00:42:25,550 --> 00:42:23,400
combination of over 40 individual

1113
00:42:27,170 --> 00:42:25,560

exposures and there were six filters and

1114
00:42:30,349 --> 00:42:27,180
so we're talking about combining

1115
00:42:33,290 --> 00:42:30,359
together over 200 like 240 individual

1116
00:42:36,230 --> 00:42:33,300
images to make this final uh Mosaic

1117
00:42:38,569 --> 00:42:36,240
image and then this is just one filter I

1118
00:42:39,589 --> 00:42:38,579
think we're looking at like 3.3 microns

1119
00:42:41,270 --> 00:42:39,599
here

1120
00:42:42,589 --> 00:42:41,280
the final image is actually made up of

1121
00:42:44,510 --> 00:42:42,599
all six filters and that's where we get

1122
00:42:46,609 --> 00:42:44,520
the colors from of course so let's break

1123
00:42:48,530 --> 00:42:46,619
that down and take a look at that we're

1124
00:42:51,170 --> 00:42:48,540
only looking at four of the filters here

1125
00:42:53,930 --> 00:42:51,180
so the shortest wavelength is the 0.9

1126
00:42:56,030 --> 00:42:53,940
Micron the longest is 4.4

1127
00:42:58,370 --> 00:42:56,040
um we'll take the colors out we're sort

1128
00:43:01,010 --> 00:42:58,380
of working backwards from the way Elisa

1129
00:43:02,630 --> 00:43:01,020
had demonstrated this and in particular

1130
00:43:06,349 --> 00:43:02,640
I just want to draw your attention to

1131
00:43:08,510 --> 00:43:06,359
this f335m that is a narrower band

1132
00:43:10,010 --> 00:43:08,520
filter than uh the ones that have a w

1133
00:43:12,829 --> 00:43:10,020
next to there at the end of their name

1134
00:43:14,390 --> 00:43:12,839
the W stands for wide band m in this

1135
00:43:16,490 --> 00:43:14,400
case stands for medium band and then

1136
00:43:18,410 --> 00:43:16,500
you've seen n as well and it is for

1137
00:43:20,870 --> 00:43:18,420
narrow band and that just means a filter

1138
00:43:23,030 --> 00:43:20,880

that allows less light through and so

1139
00:43:25,430 --> 00:43:23,040
for the 335m we're talking about a

1140
00:43:28,490 --> 00:43:25,440
filter that allows light of a specific

1141
00:43:30,410 --> 00:43:28,500
frequency 3.35 microns and only a little

1142
00:43:32,450 --> 00:43:30,420
bit of that around that area gets

1143
00:43:34,430 --> 00:43:32,460
through to the detector

1144
00:43:36,170 --> 00:43:34,440
um to get a really clean image in just

1145
00:43:37,309 --> 00:43:36,180
that one specific wavelength you can

1146
00:43:39,230 --> 00:43:37,319
actually do something called Continuum

1147
00:43:43,190 --> 00:43:39,240
subtraction and so in this case we

1148
00:43:45,410 --> 00:43:43,200
subtract the 200w image from the 335 to

1149
00:43:47,089 --> 00:43:45,420
get the bottom image here which gives

1150
00:43:50,030 --> 00:43:47,099
you the light of

1151
00:43:52,910 --> 00:43:50,040
um a very specific kind of light uh this

1152
00:43:56,750 --> 00:43:52,920
in this case it's a warm dust polycyclic

1153
00:43:59,150 --> 00:43:56,760
aromatic hydrocarbons or pahs

1154
00:44:01,609 --> 00:43:59,160
now coming back to our in our painting

1155
00:44:04,190 --> 00:44:01,619
here we can we can sort of conceptualize

1156
00:44:05,990 --> 00:44:04,200
this this continuous attraction uh in an

1157
00:44:07,309 --> 00:44:06,000
interesting way I think let's take this

1158
00:44:08,870 --> 00:44:07,319
painting and break it down into its

1159
00:44:11,329 --> 00:44:08,880
color channels right red green and blue

1160
00:44:13,609 --> 00:44:11,339
that's how we perceive light as Elisa

1161
00:44:15,170 --> 00:44:13,619
alluded to earlier with the eyeball what

1162
00:44:17,690 --> 00:44:15,180
if we were to take just the red filter

1163
00:44:20,210 --> 00:44:17,700

of this image and look at that now

1164
00:44:22,550 --> 00:44:20,220
seeing the backgrounds the the tapestry

1165
00:44:24,170 --> 00:44:22,560
in the background is uh it shines

1166
00:44:27,109 --> 00:44:24,180
brightly in the red filter because it is

1167
00:44:28,609 --> 00:44:27,119
a red object skin tones are showing up

1168
00:44:30,349 --> 00:44:28,619
here so their you know skin is very

1169
00:44:33,410 --> 00:44:30,359
bright because it has a lot of red in it

1170
00:44:35,510 --> 00:44:33,420
so in the in a composite image there'd

1171
00:44:37,370 --> 00:44:35,520
be a lot of red but imagine if you

1172
00:44:39,650 --> 00:44:37,380
wanted to just be able to see the light

1173
00:44:42,109 --> 00:44:39,660
of blood right so you could continue and

1174
00:44:44,270 --> 00:44:42,119
subtract everything but the specific

1175
00:44:45,410 --> 00:44:44,280
wavelength of blood from the image

1176
00:44:47,990 --> 00:44:45,420
that's kind of what we're doing with

1177
00:44:50,089 --> 00:44:48,000
Continuum subtraction

1178
00:44:52,250 --> 00:44:50,099
so going back to our our color images

1179
00:44:53,630 --> 00:44:52,260
now if we combine all of these together

1180
00:44:56,210 --> 00:44:53,640
we get

1181
00:44:58,910 --> 00:44:56,220
this image has the final version

1182
00:45:00,710 --> 00:44:58,920
and this is of course not not the final

1183
00:45:02,690 --> 00:45:00,720
version this is the what I would

1184
00:45:04,370 --> 00:45:02,700
consider if you're a photographer this

1185
00:45:08,089 --> 00:45:04,380
would be like the raw file from a camera

1186
00:45:10,430 --> 00:45:08,099
and this needs to be color calibrated uh

1187
00:45:12,710 --> 00:45:10,440
white balance adjusted we do adjustments

1188
00:45:14,510 --> 00:45:12,720

to the tonality to the contrast to get

1189
00:45:15,829 --> 00:45:14,520
to the final version of the image and

1190
00:45:18,170 --> 00:45:15,839
you know rather than step through all of

1191
00:45:20,329 --> 00:45:18,180
that I will just allow it to fade from

1192
00:45:22,490 --> 00:45:20,339
one to the next

1193
00:45:24,349 --> 00:45:22,500
and then we get to the final version of

1194
00:45:26,390 --> 00:45:24,359
the image here after all of those steps

1195
00:45:28,609 --> 00:45:26,400
have been applied

1196
00:45:30,829 --> 00:45:28,619
shifting gears to the distant Universe

1197
00:45:32,870 --> 00:45:30,839
I'd like to talk a little bit about our

1198
00:45:34,069 --> 00:45:32,880
image of the Deep Field and how that was

1199
00:45:37,970 --> 00:45:34,079
put together

1200
00:45:41,150 --> 00:45:37,980
so s Max or Smacks 0723

1201
00:45:44,329 --> 00:45:41,160
this was Webb's first Deep Field image

1202
00:45:45,950 --> 00:45:44,339
we saw a Galaxy definitely at least one

1203
00:45:48,530 --> 00:45:45,960
Galaxy in here that's over 13 billion

1204
00:45:51,890 --> 00:45:48,540
light years away so this is a really

1205
00:45:53,450 --> 00:45:51,900
Monumental image a very impactful maybe

1206
00:45:54,950 --> 00:45:53,460
not as aesthetically pleasing as some of

1207
00:45:57,410 --> 00:45:54,960
the other images from the first releases

1208
00:45:59,990 --> 00:45:57,420
but definitely an impactful image

1209
00:46:01,910 --> 00:46:00,000
demonstrating Webb's capabilities to see

1210
00:46:03,710 --> 00:46:01,920
all the way into the early Universe to

1211
00:46:06,130 --> 00:46:03,720
those galaxies that form just a couple

1212
00:46:09,050 --> 00:46:06,140
hundred million years after the big bang

1213
00:46:11,809 --> 00:46:09,060

so this image was pulled together

1214
00:46:14,150 --> 00:46:11,819
through six different filters uh using

1215
00:46:16,550 --> 00:46:14,160
the near cam instrument so here's each

1216
00:46:17,750 --> 00:46:16,560
one of those individual filters shown in

1217
00:46:19,130 --> 00:46:17,760
black and white

1218
00:46:20,690 --> 00:46:19,140
as we see them it's already been

1219
00:46:23,270 --> 00:46:20,700
stretched you know according to the the

1220
00:46:25,309 --> 00:46:23,280
principles that uh Elisa described in

1221
00:46:26,770 --> 00:46:25,319
her part of the talk uh so we're looking

1222
00:46:30,650 --> 00:46:26,780
at that here

1223
00:46:31,670 --> 00:46:30,660
near cam is very uh very capable of

1224
00:46:33,109 --> 00:46:31,680
looking at the universe in many

1225
00:46:34,550 --> 00:46:33,119
different colors of infrared light so it

1226
00:46:36,589 --> 00:46:34,560
has a lot of filters and a lot of ways

1227
00:46:38,329 --> 00:46:36,599
to slice infrared light in the case of

1228
00:46:40,309 --> 00:46:38,339
the Deep Field image we used this

1229
00:46:41,690 --> 00:46:40,319
arrangement of filters these six filters

1230
00:46:43,910 --> 00:46:41,700
here so we have a really nice broad

1231
00:46:46,430 --> 00:46:43,920
range of infrared capabilities from near

1232
00:46:48,109 --> 00:46:46,440
cam here

1233
00:46:49,970 --> 00:46:48,119
um having six filters allows us to

1234
00:46:50,750 --> 00:46:49,980
combine the data in such a ways that we

1235
00:46:51,530 --> 00:46:50,760
can

1236
00:46:53,809 --> 00:46:51,540
um

1237
00:46:56,150 --> 00:46:53,819
we can assign the colors cleanly through

1238
00:46:58,309 --> 00:46:56,160

red green and blue channels using two

1239
00:47:00,770 --> 00:46:58,319
filters per Channel and it really is

1240
00:47:02,329 --> 00:47:00,780
just a linear combination right so the

1241
00:47:04,370 --> 00:47:02,339
blue channel is just the two shortest

1242
00:47:05,690 --> 00:47:04,380
wavelength filters added together and

1243
00:47:07,970 --> 00:47:05,700
divided by two so you get an equal

1244
00:47:09,230 --> 00:47:07,980
weighting of both of those filters you

1245
00:47:10,849 --> 00:47:09,240
know there are other ways that you could

1246
00:47:12,410 --> 00:47:10,859
slice and dice the data to create a

1247
00:47:15,109 --> 00:47:12,420
color image but to me this seems like

1248
00:47:17,450 --> 00:47:15,119
the most straightforward and clean

1249
00:47:19,010 --> 00:47:17,460
representation of the data

1250
00:47:21,589 --> 00:47:19,020
so the green channel is then the

1251
00:47:24,109 --> 00:47:21,599
definition is it's defined as the the

1252
00:47:25,970 --> 00:47:24,119
next two longer wavelengths uh combined

1253
00:47:29,089 --> 00:47:25,980
and divided by two that red is the

1254
00:47:32,450 --> 00:47:30,710
so when we do that we get this version

1255
00:47:34,790 --> 00:47:32,460
of the image here

1256
00:47:36,890 --> 00:47:34,800
and this is again this is like the

1257
00:47:38,990 --> 00:47:36,900
camera raw file this needs to be color

1258
00:47:41,510 --> 00:47:39,000
balanced adjusted uh white balance

1259
00:47:42,950 --> 00:47:41,520
adjusted and it's interesting when we're

1260
00:47:45,650 --> 00:47:42,960
working with a Deep Field image we have

1261
00:47:48,410 --> 00:47:45,660
the opportunity to apply white balancing

1262
00:47:50,270 --> 00:47:48,420
using the data itself

1263
00:47:51,950 --> 00:47:50,280

um you know as Elisa was saying with the

1264
00:47:54,550 --> 00:47:51,960
Karina image we use the stars and the

1265
00:47:57,010 --> 00:47:54,560
cores of stars as the white reference

1266
00:47:59,510 --> 00:47:57,020
for a deep Field image we can actually

1267
00:48:01,430 --> 00:47:59,520
utilize the fact that we have plenty of

1268
00:48:03,950 --> 00:48:01,440
galaxies in this image as our white

1269
00:48:06,710 --> 00:48:03,960
reference and so I have these two boxes

1270
00:48:08,630 --> 00:48:06,720
here the top long rectangular box that

1271
00:48:11,210 --> 00:48:08,640
defines the background region and so

1272
00:48:13,490 --> 00:48:11,220
that's a that should be a region that's

1273
00:48:15,290 --> 00:48:13,500
sort of relatively free of any

1274
00:48:18,109 --> 00:48:15,300
um any part of the image any kind of

1275
00:48:20,450 --> 00:48:18,119
Galaxy or Star we want that to be the

1276
00:48:22,190 --> 00:48:20,460
reference for a neutral background and

1277
00:48:25,370 --> 00:48:22,200
so we're trying to subtract off you know

1278
00:48:26,809 --> 00:48:25,380
any uh excess light in any one of the

1279
00:48:29,930 --> 00:48:26,819
filters so that we can get sort of a

1280
00:48:32,270 --> 00:48:29,940
neutral gray as our background value

1281
00:48:35,690 --> 00:48:32,280
uh the other box you see here on the

1282
00:48:37,490 --> 00:48:35,700
right that is a indicative of the type

1283
00:48:39,829 --> 00:48:37,500
of galaxy that we would use as a white

1284
00:48:42,589 --> 00:48:39,839
reference it's a face on spiral galaxy

1285
00:48:44,870 --> 00:48:42,599
and the reason that works so well as a

1286
00:48:46,790 --> 00:48:44,880
white reference is because spiral

1287
00:48:48,950 --> 00:48:46,800
galaxies contain all the populations of

1288
00:48:50,569 --> 00:48:48,960

stars from the youngest to oldest

1289
00:48:53,569 --> 00:48:50,579
representing all the possible colors of

1290
00:48:55,730 --> 00:48:53,579
stars so from Blues all the ways to Reds

1291
00:48:57,589 --> 00:48:55,740
so it works really well as a weight

1292
00:48:59,210 --> 00:48:57,599
reference to use the entirety of a

1293
00:49:00,829 --> 00:48:59,220
spiral galaxy as your weight reference

1294
00:49:02,630 --> 00:49:00,839
when you do that sort of everything else

1295
00:49:05,210 --> 00:49:02,640
kind of falls into place and the colors

1296
00:49:07,069 --> 00:49:05,220
appear more natural here so looking at

1297
00:49:09,050 --> 00:49:07,079
this now I can see the background

1298
00:49:10,670 --> 00:49:09,060
galaxies are taking on a much more red

1299
00:49:12,950 --> 00:49:10,680
appearance which is what we want to see

1300
00:49:14,930 --> 00:49:12,960
we know those distant galaxies should be

1301
00:49:17,230 --> 00:49:14,940
showing up in the red channels because

1302
00:49:19,670 --> 00:49:17,240
they are redshifted

1303
00:49:21,230 --> 00:49:19,680
the foreground Galaxy cluster has taken

1304
00:49:22,730 --> 00:49:21,240
on sort of a more white appearance as

1305
00:49:25,309 --> 00:49:22,740
opposed to the greenish shoes that we

1306
00:49:27,349 --> 00:49:25,319
saw previously and so the the color

1307
00:49:29,270 --> 00:49:27,359
balance here was a very important step

1308
00:49:31,190 --> 00:49:29,280
the other issue that we dealt with with

1309
00:49:33,829 --> 00:49:31,200
the Deep Field image in particular was

1310
00:49:37,970 --> 00:49:33,839
uh variations in the background

1311
00:49:40,609 --> 00:49:37,980
um through each filter and so you that

1312
00:49:42,890 --> 00:49:40,619
sort of manifests itself here as a blue

1313
00:49:44,750 --> 00:49:42,900

box in the bottom right and that blue

1314
00:49:46,370 --> 00:49:44,760
box is just there because again this is

1315
00:49:48,890 --> 00:49:46,380
like a mosaic so we're you know

1316
00:49:50,270 --> 00:49:48,900
combining multiple images together and

1317
00:49:51,710 --> 00:49:50,280
it just so happened that in some of

1318
00:49:53,569 --> 00:49:51,720
those images the background levels were

1319
00:49:55,250 --> 00:49:53,579
a little higher than others and so when

1320
00:49:57,710 --> 00:49:55,260
you've combined them all together you

1321
00:49:59,630 --> 00:49:57,720
get sort of an excess of blue in one

1322
00:50:02,089 --> 00:49:59,640
part of the image versus another and

1323
00:50:04,250 --> 00:50:02,099
that has to be subtracted out that can

1324
00:50:06,530 --> 00:50:04,260
be handled in pipeline processing before

1325
00:50:08,510 --> 00:50:06,540
we start working with the data but at

1326
00:50:10,609 --> 00:50:08,520
the time we were working with the Deep

1327
00:50:12,650 --> 00:50:10,619
Field data this was soon after launch

1328
00:50:15,230 --> 00:50:12,660
the calibration had not been completely

1329
00:50:17,569 --> 00:50:15,240
finished yet and so we were working with

1330
00:50:19,190 --> 00:50:17,579
data that had was based on ground-based

1331
00:50:20,809 --> 00:50:19,200
calibration and of course the

1332
00:50:22,190 --> 00:50:20,819
observatory was now had been launched it

1333
00:50:23,990 --> 00:50:22,200
was in space it was in a new environment

1334
00:50:25,309 --> 00:50:24,000
and we had to understand that

1335
00:50:27,050 --> 00:50:25,319
calibration a little better before we

1336
00:50:28,790 --> 00:50:27,060
could move forward

1337
00:50:30,109 --> 00:50:28,800
um but we we had to take these

1338
00:50:32,030 --> 00:50:30,119

observations and get them out there so

1339
00:50:34,130 --> 00:50:32,040
uh we sort of had to calibrate by hand

1340
00:50:36,170 --> 00:50:34,140
on the fly as we were going and in the

1341
00:50:37,730 --> 00:50:36,180
case of the Deep Field it was actually a

1342
00:50:39,170 --> 00:50:37,740
large amount of that was done sort of by

1343
00:50:41,630 --> 00:50:39,180
eye

1344
00:50:43,730 --> 00:50:41,640
um here I've isolated just the short

1345
00:50:45,829 --> 00:50:43,740
wavelengths channel so this is the

1346
00:50:49,670 --> 00:50:45,839
combination of the 0.9 and the 1.5

1347
00:50:52,730 --> 00:50:49,680
Micron data and I used uh what we call

1348
00:50:55,609 --> 00:50:52,740
Curves adjustments to balance those

1349
00:50:57,049 --> 00:50:55,619
pixel values in the boxes and try to get

1350
00:50:59,630 --> 00:50:57,059
a uniform background throughout the

1351
00:51:01,730 --> 00:50:59,640
image and so now this next slide should

1352
00:51:04,490 --> 00:51:01,740
be an animation that shows stepping

1353
00:51:06,349 --> 00:51:04,500
through each one of those curves

1354
00:51:08,569 --> 00:51:06,359
adjustments

1355
00:51:11,150 --> 00:51:08,579
and as they're moving you can see that

1356
00:51:13,190 --> 00:51:11,160
uh the overall background is sort of

1357
00:51:14,030 --> 00:51:13,200
unified we're getting a much cleaner

1358
00:51:16,130 --> 00:51:14,040
image

1359
00:51:18,230 --> 00:51:16,140
and

1360
00:51:19,329 --> 00:51:18,240
the background is is becoming much more

1361
00:51:22,569 --> 00:51:19,339
clear

1362
00:51:25,069 --> 00:51:22,579
in the end we have a really clean image

1363
00:51:27,049 --> 00:51:25,079

uh we have to be really careful though

1364
00:51:29,450 --> 00:51:27,059
because the foreground Galaxy cluster

1365
00:51:31,250 --> 00:51:29,460
here actually has the glow of very faint

1366
00:51:33,049 --> 00:51:31,260
stars that have been sort of flung all

1367
00:51:35,150 --> 00:51:33,059
out from around it

1368
00:51:37,430 --> 00:51:35,160
and that is a it's a very faint signal

1369
00:51:39,470 --> 00:51:37,440
and so it's easy it could easily be sort

1370
00:51:41,569 --> 00:51:39,480
of crushed in this process where you

1371
00:51:43,609 --> 00:51:41,579
know this ring of material here from

1372
00:51:45,589 --> 00:51:43,619
these stars and this this area down here

1373
00:51:46,790 --> 00:51:45,599
that could have easily been crushed so I

1374
00:51:48,349 --> 00:51:46,800
just had to keep that in mind as I was

1375
00:51:50,030 --> 00:51:48,359
adjusting the background levels for this

1376
00:51:52,430 --> 00:51:50,040
the final version of the image

1377
00:51:54,770 --> 00:51:52,440
so after applying this change we get to

1378
00:51:55,849 --> 00:51:54,780
this version of the image this is a

1379
00:51:57,890 --> 00:51:55,859
little bit more uniform in this

1380
00:51:59,750 --> 00:51:57,900
background and at this point there were

1381
00:52:02,030 --> 00:51:59,760
some artifacts that had to be dealt with

1382
00:52:04,730 --> 00:52:02,040
cleaned up to get to the final version

1383
00:52:05,690 --> 00:52:04,740
of the image which we see

1384
00:52:07,609 --> 00:52:05,700
here

1385
00:52:10,190 --> 00:52:07,619
and you know the final adjustments were

1386
00:52:11,990 --> 00:52:10,200
some some of the artifacts uh cleaning

1387
00:52:13,670 --> 00:52:12,000
up some artifacts and also getting that

1388
00:52:14,930 --> 00:52:13,680

background down you know so press down

1389
00:52:16,670 --> 00:52:14,940
just a little bit to give you sort of

1390
00:52:19,309 --> 00:52:16,680
that sense of the the deep space

1391
00:52:21,049 --> 00:52:19,319
background uh from which all of these

1392
00:52:23,750 --> 00:52:21,059
galaxies are sort of popping out

1393
00:52:25,370 --> 00:52:23,760
and um and then what I like to do with

1394
00:52:27,530 --> 00:52:25,380
this image is actually we can compare it

1395
00:52:30,049 --> 00:52:27,540
to some previous observations so we'll

1396
00:52:31,790 --> 00:52:30,059
zoom out a little bit here and we will

1397
00:52:34,010 --> 00:52:31,800
uh reference this against previous

1398
00:52:36,349 --> 00:52:34,020
Hubble observations

1399
00:52:37,910 --> 00:52:36,359
of the same region now this is slightly

1400
00:52:40,250 --> 00:52:37,920
unfair of a comparison because this was

1401
00:52:42,770 --> 00:52:40,260
only two hours of exposure versus web's

1402
00:52:45,290 --> 00:52:42,780
12 hours but still it gives you a sense

1403
00:52:47,270 --> 00:52:45,300
of the difference of what web and Hubble

1404
00:52:48,710 --> 00:52:47,280
have here in looking at this version of

1405
00:52:50,450 --> 00:52:48,720
the Universe

1406
00:52:52,309 --> 00:52:50,460
um being able to pull out some of those

1407
00:52:53,809 --> 00:52:52,319
really faint galaxies you know only web

1408
00:52:56,150 --> 00:52:53,819
can do that Hubble is not going to be

1409
00:52:58,250 --> 00:52:56,160
able to see the really really distant or

1410
00:52:59,690 --> 00:52:58,260
the really dusty galaxies things that

1411
00:53:01,309 --> 00:52:59,700
have been redshifted so far that they're

1412
00:53:03,829 --> 00:53:01,319
sort of outside the range of what Hubble

1413
00:53:07,609 --> 00:53:05,990

um this is the Hubble infrared image

1414
00:53:09,950 --> 00:53:07,619
remember Elisa mentioned earlier that

1415
00:53:11,390 --> 00:53:09,960
Hubble is capable of seeing infrared uh

1416
00:53:14,329 --> 00:53:11,400
it sees a little bit into the infrared

1417
00:53:17,329 --> 00:53:14,339
and so this is that view of this region

1418
00:53:19,430 --> 00:53:17,339
of space in infrared from Hubble

1419
00:53:21,890 --> 00:53:19,440
and then this is the view from uh the

1420
00:53:23,510 --> 00:53:21,900
previous uh Flagship infrared

1421
00:53:25,730 --> 00:53:23,520
Observatory the Spitzer Space Telescope

1422
00:53:28,069 --> 00:53:25,740
it had a much smaller mirror than than

1423
00:53:30,589 --> 00:53:28,079
webs and so it's resolution capabilities

1424
00:53:33,349 --> 00:53:30,599
were much more limited but it was able

1425
00:53:34,730 --> 00:53:33,359
to to detect you know the the signals of

1426
00:53:36,109 --> 00:53:34,740
these galaxies

1427
00:53:37,970 --> 00:53:36,119
um in infrared wavelengths similar to

1428
00:53:40,549 --> 00:53:37,980
what Webb can see but I really like

1429
00:53:42,230 --> 00:53:40,559
doing this uh slow fade from the Spitzer

1430
00:53:50,210 --> 00:53:42,240
to the web image you can see as the

1431
00:53:54,470 --> 00:53:52,970
so finally I thought I'd just like to

1432
00:53:57,470 --> 00:53:54,480
Ponder a little bit of the question of

1433
00:53:58,790 --> 00:53:57,480
why do we do this right why I mean Elisa

1434
00:54:00,530 --> 00:53:58,800
already talked a little bit about why do

1435
00:54:03,109 --> 00:54:00,540
we study infrared light why do we use

1436
00:54:04,790 --> 00:54:03,119
web why do we need web but also why do

1437
00:54:06,650 --> 00:54:04,800
we put all this effort into creating

1438
00:54:08,150 --> 00:54:06,660

these color images and what is the

1439
00:54:10,790 --> 00:54:08,160
significance of that

1440
00:54:13,609 --> 00:54:10,800
I think personally I think that

1441
00:54:15,470 --> 00:54:13,619
um these images they speak to an innate

1442
00:54:16,970 --> 00:54:15,480
curiosity within us to understand our

1443
00:54:19,370 --> 00:54:16,980
place in the universe

1444
00:54:21,530 --> 00:54:19,380
to understand where we come from and

1445
00:54:23,569 --> 00:54:21,540
what we're made of and where we're going

1446
00:54:25,670 --> 00:54:23,579
and it's really it's true when you think

1447
00:54:27,589 --> 00:54:25,680
of um you know as Frank was mentioning

1448
00:54:29,510 --> 00:54:27,599
earlier to bring this full circle he

1449
00:54:31,730 --> 00:54:29,520
mentioned the astronomers periodic table

1450
00:54:34,130 --> 00:54:31,740
uh where hydrogen helium and everything

1451
00:54:36,190 --> 00:54:34,140
else is Metals right and that comes from

1452
00:54:39,349 --> 00:54:36,200
the fact that in the Big Bang

1453
00:54:40,430 --> 00:54:39,359
the materials that were created are all

1454
00:54:41,990 --> 00:54:40,440
of the material of the universe was

1455
00:54:43,910 --> 00:54:42,000
created in the Big Bang but only

1456
00:54:46,190 --> 00:54:43,920
hydrogen and helium had enough time

1457
00:54:47,809 --> 00:54:46,200
after the big bang and the universe

1458
00:54:49,970 --> 00:54:47,819
cooled we only had enough time for

1459
00:54:51,650 --> 00:54:49,980
hydrogen and helium to form all of the

1460
00:54:53,809 --> 00:54:51,660
heavier elements had to form later on

1461
00:54:56,450 --> 00:54:53,819
millions of years later after the first

1462
00:54:57,770 --> 00:54:56,460
generations of stars formed and died and

1463
00:54:59,690 --> 00:54:57,780

exploded and populated their

1464
00:55:01,670 --> 00:54:59,700
environments with heavier elements and

1465
00:55:03,650 --> 00:55:01,680
so quite literally we are star stuff you

1466
00:55:05,569 --> 00:55:03,660
know to quote Carl Sagan we are made

1467
00:55:09,230 --> 00:55:05,579
from the materials that were generated

1468
00:55:10,309 --> 00:55:09,240
in those generations of stars and we are

1469
00:55:12,410 --> 00:55:10,319
the universe attempting to understand

1470
00:55:14,270 --> 00:55:12,420
itself and so

1471
00:55:15,890 --> 00:55:14,280
you know as opposed to being to give in

1472
00:55:17,450 --> 00:55:15,900
to despair when you look at an image

1473
00:55:19,010 --> 00:55:17,460
like this and you Ponder the enormity of

1474
00:55:21,410 --> 00:55:19,020
the universe there is a tendency I've

1475
00:55:22,970 --> 00:55:21,420
seen at least online uh to give into

1476
00:55:24,589 --> 00:55:22,980
Despair and to think like oh we're so

1477
00:55:27,230 --> 00:55:24,599
insignificant we have no place in this

1478
00:55:30,049 --> 00:55:27,240
universe we're so such a tiny Speck but

1479
00:55:32,569 --> 00:55:30,059
really these images they they give us a

1480
00:55:34,730 --> 00:55:32,579
window into our Origins we're looking at

1481
00:55:37,970 --> 00:55:34,740
the raw materials that make up solar

1482
00:55:40,490 --> 00:55:37,980
systems and planets and ultimately life

1483
00:55:44,030 --> 00:55:40,500
and so I feel a deep sense of connection

1484
00:55:45,170 --> 00:55:44,040
to other people through pondering the

1485
00:55:46,910 --> 00:55:45,180
universe through looking at these images

1486
00:55:48,410 --> 00:55:46,920
and I think that's an essential part of

1487
00:55:49,609 --> 00:55:48,420
what makes them important and why we do

1488
00:55:51,770 --> 00:55:49,619

this

1489
00:55:54,170 --> 00:55:51,780
um to take that even further physicist

1490
00:55:56,329 --> 00:55:54,180
Alan Lightman makes some really provides

1491
00:55:58,370 --> 00:55:56,339
some really good context to

1492
00:56:00,170 --> 00:55:58,380
why we're it why it's important to

1493
00:56:01,730 --> 00:56:00,180
observe the universe why how do we fit

1494
00:56:03,530 --> 00:56:01,740
into that right

1495
00:56:05,870 --> 00:56:03,540
um in two different ways one is if you

1496
00:56:08,030 --> 00:56:05,880
think about the human brain it's made up

1497
00:56:09,410 --> 00:56:08,040
of neurons and there are approximately

1498
00:56:11,210 --> 00:56:09,420
100

1499
00:56:13,490 --> 00:56:11,220
000 billion neurons per human brain

1500
00:56:15,349 --> 00:56:13,500
right and it just happens to be almost

1501
00:56:17,150 --> 00:56:15,359
the same amount of stars that make up a

1502
00:56:19,190 --> 00:56:17,160
Galaxy and so as you're walking around

1503
00:56:20,750 --> 00:56:19,200
and you see people in the street you can

1504
00:56:23,270 --> 00:56:20,760
think of them as each being their own

1505
00:56:25,790 --> 00:56:23,280
little Galaxy right you're you're a

1506
00:56:27,589 --> 00:56:25,800
Galaxy among galaxies in the world and

1507
00:56:30,589 --> 00:56:27,599
so that provides a certain perspective

1508
00:56:32,930 --> 00:56:30,599
right the other one is scale sizes if we

1509
00:56:35,809 --> 00:56:32,940
think about scale sizes and how do we

1510
00:56:37,490 --> 00:56:35,819
compare to the enormity of the universe

1511
00:56:38,870 --> 00:56:37,500
um well if you took the average human

1512
00:56:41,089 --> 00:56:38,880
and you were to divide them in half

1513
00:56:42,410 --> 00:56:41,099

multiple times how long would it take or

1514
00:56:44,569 --> 00:56:42,420
how many divisions would it take to get

1515
00:56:46,549 --> 00:56:44,579
to the size of an atom it turns out

1516
00:56:48,109 --> 00:56:46,559
that's about 33 divisions

1517
00:56:49,370 --> 00:56:48,119
and then going in the other direction if

1518
00:56:51,290 --> 00:56:49,380
you were to double the size of the

1519
00:56:53,329 --> 00:56:51,300
average human how long would it take or

1520
00:56:55,490 --> 00:56:53,339
how many doublings would it take to get

1521
00:56:58,130 --> 00:56:55,500
to the size of say a star and it happens

1522
00:57:00,109 --> 00:56:58,140
to be about 30. and so in terms of you

1523
00:57:04,010 --> 00:57:00,119
know thinking of things in in scale

1524
00:57:06,470 --> 00:57:04,020
sizes of doublings we exist in a scale

1525
00:57:07,849 --> 00:57:06,480
size that is roughly halfway between you

1526
00:57:09,950 --> 00:57:07,859
know the fundamental fundamental

1527
00:57:11,390 --> 00:57:09,960
particles that make up the universe and

1528
00:57:14,030 --> 00:57:11,400
stars the fundamental particles that

1529
00:57:16,130 --> 00:57:14,040
make up galaxies and so it really does

1530
00:57:17,870 --> 00:57:16,140
put it into perspective uh the

1531
00:57:20,030 --> 00:57:17,880
importance of understanding our place in

1532
00:57:21,710 --> 00:57:20,040
the universe and why we're here and

1533
00:57:24,109 --> 00:57:21,720
where we're going

1534
00:57:26,089 --> 00:57:24,119
and with that I will say thank you for

1535
00:57:28,609 --> 00:57:26,099
your time and we would love to answer

1536
00:57:32,390 --> 00:57:28,619
any questions you may have

1537
00:57:36,410 --> 00:57:32,400
all right thank you Joe and thank you

1538
00:57:39,770 --> 00:57:36,420

Elisa uh that's um we had a lot of great

1539
00:57:42,349 --> 00:57:39,780
uh comments online on the chat and

1540
00:57:44,390 --> 00:57:42,359
YouTube they uh they loved you uh

1541
00:57:46,250 --> 00:57:44,400
especially the um the professional

1542
00:57:48,109 --> 00:57:46,260
photographers out there that we're

1543
00:57:50,089 --> 00:57:48,119
learning all your secrets and they're

1544
00:57:52,849 --> 00:57:50,099
now I'm gonna make their images just as

1545
00:57:54,349 --> 00:57:52,859
cool as the web telescope images well

1546
00:57:57,890 --> 00:57:54,359
all right they have to have the source

1547
00:58:04,490 --> 00:58:01,609
um so I wanna I wanna start with a

1548
00:58:06,349 --> 00:58:04,500
question about Hubble versus web

1549
00:58:07,970 --> 00:58:06,359
um and Joe you did a good job of showing

1550
00:58:09,890 --> 00:58:07,980
that you know they they show different

1551
00:58:12,650 --> 00:58:09,900
things especially those those background

1552
00:58:15,470 --> 00:58:12,660
galaxies that uh web sees so much better

1553
00:58:17,990 --> 00:58:15,480
than Hubble uh but I wanted to know if

1554
00:58:19,970 --> 00:58:18,000
there are different image processing

1555
00:58:22,130 --> 00:58:19,980
techniques or a different mindset you

1556
00:58:23,930 --> 00:58:22,140
use because YouTube process Hubble one

1557
00:58:26,750 --> 00:58:23,940
day and then web the next day and

1558
00:58:28,309 --> 00:58:26,760
everything so um are there different you

1559
00:58:30,230 --> 00:58:28,319
know different techniques or thoughts

1560
00:58:32,569 --> 00:58:30,240
you use are really just this does the

1561
00:58:41,230 --> 00:58:32,579
same techniques apply to all of the

1562
00:58:45,770 --> 00:58:43,670
yeah no so I would say the overall

1563
00:58:47,870 --> 00:58:45,780

process process is like very similar

1564
00:58:49,970 --> 00:58:47,880
like I feel like the mindset is very

1565
00:58:51,710 --> 00:58:49,980
similar I think with web at least for

1566
00:58:53,270 --> 00:58:51,720
the early release images since the

1567
00:58:55,190 --> 00:58:53,280
reference files and the calibration

1568
00:58:56,930 --> 00:58:55,200
files it just took a while to get used

1569
00:58:58,430 --> 00:58:56,940
to dealing with that and those sort of

1570
00:59:00,770 --> 00:58:58,440
artifacts that that takes a little bit

1571
00:59:02,990 --> 00:59:00,780
more time to kind of get it set up while

1572
00:59:05,150 --> 00:59:03,000
with Hubble's pipeline it's so refined

1573
00:59:07,010 --> 00:59:05,160
after all these years that the data is

1574
00:59:09,230 --> 00:59:07,020
just so clean that you kind of can just

1575
00:59:11,089 --> 00:59:09,240
jump right into it so I think that with

1576
00:59:12,650 --> 00:59:11,099
web it's just the setup takes a little

1577
00:59:14,809 --> 00:59:12,660
bit longer and I would say that's like

1578
00:59:17,450 --> 00:59:14,819
the biggest difference and then like as

1579
00:59:19,910 --> 00:59:17,460
Joe said like you really want to bring

1580
00:59:21,710 --> 00:59:19,920
out the faintest things because like

1581
00:59:23,089 --> 00:59:21,720
you're that could be a Galaxy that no

1582
00:59:25,250 --> 00:59:23,099
one's ever seen before so you

1583
00:59:26,870 --> 00:59:25,260
concentrate on really and you do this

1584
00:59:28,609 --> 00:59:26,880
with all astronomy images but

1585
00:59:31,069 --> 00:59:28,619
particularly with web we're really

1586
00:59:33,530 --> 00:59:31,079
concentrating on sort of gaining the

1587
00:59:34,910 --> 00:59:33,540
best signal but like but suppressing the

1588
00:59:36,829 --> 00:59:34,920

noise but really bringing out those

1589
00:59:38,690 --> 00:59:36,839
faint details that you know are the

1590
00:59:41,690 --> 00:59:38,700
early universe so that's kind of what we

1591
00:59:43,430 --> 00:59:41,700
keep in mind I think

1592
00:59:45,170 --> 00:59:43,440
Joe do you have anything you want to add

1593
00:59:46,430 --> 00:59:45,180
to that yeah I was just going to say um

1594
00:59:48,289 --> 00:59:46,440
just you know building on what Elisa

1595
00:59:51,410 --> 00:59:48,299
said the process is remarkably similar

1596
00:59:53,870 --> 00:59:51,420
uh processing web data versus Hubble uh

1597
00:59:56,210 --> 00:59:53,880
we're using that same approach of

1598
00:59:57,410 --> 00:59:56,220
applying color chromatically

1599
00:59:59,569 --> 00:59:57,420
um it's just that with web we're working

1600
01:00:00,950 --> 00:59:59,579
in infrared but it's the same process

1601
01:00:04,010 --> 01:00:00,960
it's just you know applying color

1602
01:00:05,569 --> 01:00:04,020
according to wavelength and there are

1603
01:00:06,770 --> 01:00:05,579
subtle differences between the two of

1604
01:00:09,410 --> 01:00:06,780
course you know the the diffraction

1605
01:00:11,329 --> 01:00:09,420
patterns of stars in Hubble versus web

1606
01:00:12,650 --> 01:00:11,339
are very different and of course the

1607
01:00:14,569 --> 01:00:12,660
instrumental artifacts that we have to

1608
01:00:16,250 --> 01:00:14,579
deal with between the two observatories

1609
01:00:17,750 --> 01:00:16,260
are different and so we have to address

1610
01:00:21,109 --> 01:00:17,760
them differently but otherwise it is

1611
01:00:22,849 --> 01:00:21,119
very similar okay great all right so the

1612
01:00:25,309 --> 01:00:22,859
other question that I can't help but

1613
01:00:28,069 --> 01:00:25,319

asking uh being the astronomer on the

1614
01:00:31,010 --> 01:00:28,079
visualization team uh working so close

1615
01:00:33,530 --> 01:00:31,020
with you guys uh is that I truly

1616
01:00:36,289 --> 01:00:33,540
appreciate that you guys have astronomy

1617
01:00:38,690 --> 01:00:36,299
degrees in your background as well as

1618
01:00:40,910 --> 01:00:38,700
being these image processors and Elisa

1619
01:00:43,309 --> 01:00:40,920
you have your art and design degree as

1620
01:00:45,289 --> 01:00:43,319
well and you you mentioned a lot in your

1621
01:00:48,230 --> 01:00:45,299
discussion how you go back and forth

1622
01:00:49,609 --> 01:00:48,240
with the scientists okay so could you

1623
01:00:52,250 --> 01:00:49,619
just you know elaborate a little bit

1624
01:00:53,450 --> 01:00:52,260
more on this combination of Art and

1625
01:00:55,609 --> 01:00:53,460
Science

1626
01:00:57,470 --> 01:00:55,619
um and to me that's the sort of the The

1627
01:00:59,390 --> 01:00:57,480
crucial point that people don't don't

1628
01:01:01,670 --> 01:00:59,400
get that it's not just all science and

1629
01:01:04,309 --> 01:01:01,680
it's not just all art it really is that

1630
01:01:06,410 --> 01:01:04,319
collaboration so uh Joe you want to

1631
01:01:07,370 --> 01:01:06,420
start us off the hair on this one sure

1632
01:01:09,470 --> 01:01:07,380
yeah

1633
01:01:10,609 --> 01:01:09,480
um so again not to beat a dead horse

1634
01:01:12,950 --> 01:01:10,619
here but

1635
01:01:14,750 --> 01:01:12,960
chromatic ordering is so important and

1636
01:01:16,370 --> 01:01:14,760
it's scientifically driven you know the

1637
01:01:18,770 --> 01:01:16,380
reason why we apply Color the way we do

1638
01:01:20,510 --> 01:01:18,780

is because of the science and everything

1639
01:01:22,849 --> 01:01:20,520
that we do when we're processing these

1640
01:01:24,829 --> 01:01:22,859
images is with respect to the original

1641
01:01:26,390 --> 01:01:24,839
Source data you know we're not trying to

1642
01:01:27,470 --> 01:01:26,400
introduce things that weren't there and

1643
01:01:30,470 --> 01:01:27,480
we're not trying to take things away

1644
01:01:31,789 --> 01:01:30,480
that are there uh with the exception of

1645
01:01:34,130 --> 01:01:31,799
the instrumental artifacts things that

1646
01:01:35,630 --> 01:01:34,140
we know are imparted because of the

1647
01:01:36,890 --> 01:01:35,640
optical system of whatever telescope

1648
01:01:39,289 --> 01:01:36,900
we're working with

1649
01:01:41,870 --> 01:01:39,299
so it really it requires the knowledge

1650
01:01:42,650 --> 01:01:41,880
of the objects that you're looking at

1651
01:01:44,690 --> 01:01:42,660
um

1652
01:01:47,030 --> 01:01:44,700
to to have a good idea of what this

1653
01:01:48,650 --> 01:01:47,040
should generally look like right so as a

1654
01:01:50,630 --> 01:01:48,660
starting point when you pull that color

1655
01:01:52,190 --> 01:01:50,640
image together knowing it's kind of

1656
01:01:54,289 --> 01:01:52,200
generally what the final image should

1657
01:01:56,630 --> 01:01:54,299
look like it really helps and so having

1658
01:01:58,549 --> 01:01:56,640
that background in astronomy informs the

1659
01:01:59,809 --> 01:01:58,559
decisions we make as image processors to

1660
01:02:01,030 --> 01:01:59,819
get to that point

1661
01:02:03,230 --> 01:02:01,040
and uh

1662
01:02:05,630 --> 01:02:03,240
Alisa you mentioned things about knowing

1663
01:02:08,510 --> 01:02:05,640

the dot that this is dust and this is

1664
01:02:10,490 --> 01:02:08,520
you know the ionized ionizing gas or et

1665
01:02:11,750 --> 01:02:10,500
cetera in the stars and so how important

1666
01:02:13,130 --> 01:02:11,760
is it to have that astronomical

1667
01:02:15,829 --> 01:02:13,140
knowledge as you're doing the image

1668
01:02:17,569 --> 01:02:15,839
processing it definitely helps just to

1669
01:02:19,190 --> 01:02:17,579
have that sort of intuition because you

1670
01:02:21,230 --> 01:02:19,200
have a little bit of insight there while

1671
01:02:24,589 --> 01:02:21,240
you're processing the image and then you

1672
01:02:26,569 --> 01:02:24,599
know like it's a little bit uh easier

1673
01:02:28,670 --> 01:02:26,579
for Hubble imagery in the sense of like

1674
01:02:30,170 --> 01:02:28,680
those symbols that we've developed or

1675
01:02:32,990 --> 01:02:30,180
connections we've developed like with

1676
01:02:35,270 --> 01:02:33,000
galaxies like we know that those you

1677
01:02:36,890 --> 01:02:35,280
know really bright blue stars like we

1678
01:02:38,690 --> 01:02:36,900
have to that represents like these young

1679
01:02:40,849 --> 01:02:38,700
stars and that's why they're blue and

1680
01:02:42,349 --> 01:02:40,859
then of course if we're looking at sort

1681
01:02:44,510 --> 01:02:42,359
of the Dust they're kind of like this

1682
01:02:46,549 --> 01:02:44,520
ready Dusty areas and the spiral arms

1683
01:02:48,109 --> 01:02:46,559
are sort of the cooler dust and those

1684
01:02:49,910 --> 01:02:48,119
are sort of like things that you're

1685
01:02:51,890 --> 01:02:49,920
looking out for just little keys that

1686
01:02:54,109 --> 01:02:51,900
you you want to make sure is reinforcing

1687
01:02:55,910 --> 01:02:54,119
the story because if you start showing

1688
01:02:57,650 --> 01:02:55,920

things that don't reinforce the story it

1689
01:02:59,150 --> 01:02:57,660
gets confusing so you want to build off

1690
01:03:01,609 --> 01:02:59,160
of what we've already developed sort of

1691
01:03:03,289 --> 01:03:01,619
like these let's key this Legend that's

1692
01:03:05,569 --> 01:03:03,299
sort of been built in astronomy

1693
01:03:08,030 --> 01:03:05,579
conventions but again doing it in a way

1694
01:03:10,549 --> 01:03:08,040
that's interesting and exciting so but

1695
01:03:13,370 --> 01:03:10,559
yeah it's definitely it's a combination

1696
01:03:15,289 --> 01:03:13,380
yeah and you're going to develop a close

1697
01:03:17,630 --> 01:03:15,299
personal relationship with polycyclic

1698
01:03:24,130 --> 01:03:17,640
aromatic hydrocarbons over the next few

1699
01:03:29,990 --> 01:03:28,190
we love dust all right so uh Grant

1700
01:03:32,150 --> 01:03:30,000
Justice is going to join us here he's

1701
01:03:34,130 --> 01:03:32,160
been following the chat on YouTube and

1702
01:03:36,109 --> 01:03:34,140
picking out questions out of YouTube so

1703
01:03:40,190 --> 01:03:36,119
Grant wants you turn on your video and

1704
01:03:46,490 --> 01:03:41,990
oh

1705
01:03:48,230 --> 01:03:46,500
absolutely there we are okay so

1706
01:03:50,569 --> 01:03:48,240
um the first one there are two questions

1707
01:03:52,430 --> 01:03:50,579
that are very similar

1708
01:03:56,270 --> 01:03:52,440
um and I kind of want to highlight them

1709
01:03:58,430 --> 01:03:56,280
both so ask one of one and one of the

1710
01:04:01,730 --> 01:03:58,440
other yeah

1711
01:04:04,430 --> 01:04:01,740
they are very they're very similar so

1712
01:04:07,010 --> 01:04:04,440
um so why do processors use different

1713
01:04:10,609 --> 01:04:07,020

tones when processing images not the

1714
01:04:11,930 --> 01:04:10,619
graphical colors of the filters

1715
01:04:13,849 --> 01:04:11,940
um this person says when they use the

1716
01:04:15,530 --> 01:04:13,859
graphical tone specified in the graph of

1717
01:04:18,650 --> 01:04:15,540
the telescope filters they get different

1718
01:04:23,329 --> 01:04:22,549
okay so yeah yeah I'll jump in and I

1719
01:04:25,250 --> 01:04:23,339
think

1720
01:04:27,710 --> 01:04:25,260
with the

1721
01:04:31,010 --> 01:04:27,720
the question is referring to

1722
01:04:32,750 --> 01:04:31,020
uh you know the the actual color of the

1723
01:04:34,190 --> 01:04:32,760
filter right so and this would this

1724
01:04:36,410 --> 01:04:34,200
would be applicable to Hubble data

1725
01:04:37,789 --> 01:04:36,420
because Hubble is a visible telescope

1726
01:04:40,069 --> 01:04:37,799
um with web

1727
01:04:41,870 --> 01:04:40,079
it's infrared right so it's it's beyond

1728
01:04:44,030 --> 01:04:41,880
any color that we can see

1729
01:04:45,470 --> 01:04:44,040
um but certainly for for Hubble in

1730
01:04:48,770 --> 01:04:45,480
general if we're doing like a wide band

1731
01:04:50,690 --> 01:04:48,780
uh color image we might use red green

1732
01:04:52,609 --> 01:04:50,700
and blue filters and those would be

1733
01:04:54,829 --> 01:04:52,619
colored red green and blue it's when we

1734
01:04:56,270 --> 01:04:54,839
get into doing narrow bands or

1735
01:04:59,329 --> 01:04:56,280
combinations of narrow band with

1736
01:05:00,950 --> 01:04:59,339
Broadband where the choice of colors is

1737
01:05:02,990 --> 01:05:00,960
important and being able to have the

1738
01:05:05,510 --> 01:05:03,000

flexibility to slide those colors around

1739
01:05:08,270 --> 01:05:05,520
within the visible spectrum because you

1740
01:05:10,370 --> 01:05:08,280
may only have you know three filters

1741
01:05:11,630 --> 01:05:10,380
that are sort of centered around red and

1742
01:05:12,829 --> 01:05:11,640
so if you color them all red you're

1743
01:05:14,569 --> 01:05:12,839
going to get a very red image and it's

1744
01:05:16,069 --> 01:05:14,579
not going to look very good so if you

1745
01:05:18,530 --> 01:05:16,079
take the shortest wavelength and give it

1746
01:05:20,150 --> 01:05:18,540
blue and then green and red you'll get a

1747
01:05:21,410 --> 01:05:20,160
more aesthetically pleasing but also a

1748
01:05:22,670 --> 01:05:21,420
more and scientifically informative

1749
01:05:24,829 --> 01:05:22,680
image

1750
01:05:26,569 --> 01:05:24,839
yeah have you guys done many narrowband

1751
01:05:28,670 --> 01:05:26,579
filters from web

1752
01:05:32,390 --> 01:05:28,680
where you've had to do the the specific

1753
01:05:34,370 --> 01:05:32,400
color uh choices Alisa

1754
01:05:37,130 --> 01:05:34,380
um

1755
01:05:37,910 --> 01:05:37,140
quite like we didn't like I didn't keep

1756
01:05:40,309 --> 01:05:37,920
it

1757
01:05:43,490 --> 01:05:40,319
perfect in relationship to the Spectrum

1758
01:05:46,490 --> 01:05:43,500
I suppose and that there's like we like

1759
01:05:48,470 --> 01:05:46,500
maintain sort of the spacing exactly it

1760
01:05:51,049 --> 01:05:48,480
really is what Joe suggested even though

1761
01:05:53,089 --> 01:05:51,059
we're using the arrow band it's really a

1762
01:05:54,470 --> 01:05:53,099
way to get a color balance image which

1763
01:05:56,030 --> 01:05:54,480

is very difficult with neural band again

1764
01:05:59,150 --> 01:05:56,040
because we're not capturing the full

1765
01:06:01,370 --> 01:05:59,160
sort of covering the full spectrum and

1766
01:06:02,930 --> 01:06:01,380
also it's just about separating the

1767
01:06:04,849 --> 01:06:02,940
colors enough so we can actually

1768
01:06:07,430 --> 01:06:04,859
differentiate the different structures

1769
01:06:08,990 --> 01:06:07,440
and processes and like Joe mentioned if

1770
01:06:10,250 --> 01:06:09,000
you have two filters two narrow band

1771
01:06:13,190 --> 01:06:10,260
filters that are very close together

1772
01:06:15,170 --> 01:06:13,200
sort of on the longer wavelength and and

1773
01:06:17,150 --> 01:06:15,180
they're both red then you're losing

1774
01:06:18,650 --> 01:06:17,160
information rather than gaining

1775
01:06:20,750 --> 01:06:18,660
information so you want a little bit

1776
01:06:22,609 --> 01:06:20,760
more separation so maybe they're both on

1777
01:06:25,130 --> 01:06:22,619
the redder end but you make one orange

1778
01:06:27,109 --> 01:06:25,140
and one red so you can actually get the

1779
01:06:29,630 --> 01:06:27,119
information that those filters are

1780
01:06:31,190 --> 01:06:29,640
giving you right and I I will say as an

1781
01:06:32,809 --> 01:06:31,200
astronomer it's important when you look

1782
01:06:34,549 --> 01:06:32,819
at these color images to be able to

1783
01:06:36,170 --> 01:06:34,559
differentiate between the two filters

1784
01:06:38,510 --> 01:06:36,180
because that's what you're trying to do

1785
01:06:40,970 --> 01:06:38,520
to gain the Insight in terms of oh well

1786
01:06:42,589 --> 01:06:40,980
you know the um the Silicon filter is

1787
01:06:44,390 --> 01:06:42,599
seeing this and then the oxygen filter

1788
01:06:47,690 --> 01:06:44,400

seeing this and you you'll be able to

1789
01:06:49,730 --> 01:06:47,700
then guide your analysis of this yeah

1790
01:06:51,410 --> 01:06:49,740
this is directly related to the origins

1791
01:06:52,670 --> 01:06:51,420
of the Hubble palette you know any

1792
01:06:55,970 --> 01:06:52,680
astrophotographers out there will know

1793
01:06:58,250 --> 01:06:55,980
the Hubble palette it's because of this

1794
01:07:02,089 --> 01:06:58,260
so that actually leads us perfectly into

1795
01:07:04,549 --> 01:07:02,099
the next question uh which is from

1796
01:07:06,109 --> 01:07:04,559
Neil's I mean first off everyone loves

1797
01:07:08,270 --> 01:07:06,119
the images but you already knew that

1798
01:07:11,390 --> 01:07:08,280
that's why you're here

1799
01:07:13,690 --> 01:07:11,400
um what is it that it actually tells you

1800
01:07:17,210 --> 01:07:13,700
when you are looking at those images

1801
01:07:18,710 --> 01:07:17,220
like I I mean we're bringing it all the

1802
01:07:20,630 --> 01:07:18,720
way back I know you've already done a

1803
01:07:22,309 --> 01:07:20,640
talk on this I would have highly suggest

1804
01:07:24,349 --> 01:07:22,319
looking up Joe's other talk that he's

1805
01:07:26,390 --> 01:07:24,359
done with us by the way but bringing it

1806
01:07:28,430 --> 01:07:26,400
back as to like why we're doing this in

1807
01:07:30,289 --> 01:07:28,440
the first place

1808
01:07:32,150 --> 01:07:30,299
what is it that it shows you when you

1809
01:07:34,250 --> 01:07:32,160
when you've separate it out when you

1810
01:07:36,650 --> 01:07:34,260
combine it into this

1811
01:07:38,630 --> 01:07:36,660
so Grant are you asking um the RGB

1812
01:07:41,690 --> 01:07:38,640
images what what people get out of the

1813
01:07:43,370 --> 01:07:41,700

RGB images yeah the RGB images along

1814
01:07:45,770 --> 01:07:43,380
with a little bit of the spectroscopy

1815
01:07:49,490 --> 01:07:45,780
involved

1816
01:07:51,109 --> 01:07:49,500
so yeah this depends really on the

1817
01:07:52,549 --> 01:07:51,119
object that we're looking at right so

1818
01:07:53,809 --> 01:07:52,559
which gets a little bit confusing we

1819
01:07:56,270 --> 01:07:53,819
apply chromatic order so that

1820
01:07:58,309 --> 01:07:56,280
relationship Remains the Same but what

1821
01:08:00,589 --> 01:07:58,319
it's telling you is different so like

1822
01:08:02,930 --> 01:08:00,599
for instance with the Deep Field as Joe

1823
01:08:04,789 --> 01:08:02,940
mentioned the redder galaxies are

1824
01:08:07,190 --> 01:08:04,799
further away or they're more dusty but

1825
01:08:09,109 --> 01:08:07,200
in general the smaller redder galaxies

1826
01:08:11,690 --> 01:08:09,119
are further away and things that are

1827
01:08:13,430 --> 01:08:11,700
nearest to you like are more white more

1828
01:08:15,470 --> 01:08:13,440
blue more yellow and so you're actually

1829
01:08:17,390 --> 01:08:15,480
differentiating things the color is

1830
01:08:18,769 --> 01:08:17,400
actually showing you distances but if

1831
01:08:20,870 --> 01:08:18,779
you're looking at something closer to us

1832
01:08:22,490 --> 01:08:20,880
like the Karina nebula that's showing

1833
01:08:24,650 --> 01:08:22,500
you more of sort of the temperature of

1834
01:08:25,910 --> 01:08:24,660
these gases and their composition where

1835
01:08:28,070 --> 01:08:25,920
they're located so you're

1836
01:08:30,289 --> 01:08:28,080
differentiating things like if you have

1837
01:08:32,689 --> 01:08:30,299
if you're looking through the Dust

1838
01:08:34,669 --> 01:08:32,699

and you see like a really red star

1839
01:08:37,010 --> 01:08:34,679
that's like a really it's a cooler Star

1840
01:08:39,289 --> 01:08:37,020
because it's embedded within this dust

1841
01:08:41,150 --> 01:08:39,299
region so these cues are kind of

1842
01:08:43,070 --> 01:08:41,160
different depending on the image you're

1843
01:08:45,370 --> 01:08:43,080
looking at but again that chromatic

1844
01:08:49,070 --> 01:08:45,380
ordering is separating like temperature

1845
01:08:50,930 --> 01:08:49,080
processes or distances or even more if

1846
01:08:52,849 --> 01:08:50,940
you're looking at sort of Spectra and

1847
01:08:54,829 --> 01:08:52,859
Beyond

1848
01:08:57,590 --> 01:08:54,839
yeah it's giving you an insight into the

1849
01:08:59,689 --> 01:08:57,600
astrophysics that drives the appearance

1850
01:09:02,030 --> 01:08:59,699
of the image that you're looking at

1851
01:09:04,430 --> 01:09:02,040
so you know Grant behind you you have 30

1852
01:09:06,050 --> 01:09:04,440
doradis the tarantula nebula and you've

1853
01:09:07,789 --> 01:09:06,060
got you know on the left side of you or

1854
01:09:09,349 --> 01:09:07,799
at least the way I see it you've got an

1855
01:09:11,809 --> 01:09:09,359
American Image right and on the right

1856
01:09:13,970 --> 01:09:11,819
side you've got your cam and Miri so mid

1857
01:09:15,349 --> 01:09:13,980
infrared wavelengths of the same region

1858
01:09:16,550 --> 01:09:15,359
right so that's actually showing you

1859
01:09:18,650 --> 01:09:16,560
something really interesting you're

1860
01:09:21,829 --> 01:09:18,660
seeing the same like that cluster of

1861
01:09:22,870 --> 01:09:21,839
young Stars that's really bright on the

1862
01:09:25,370 --> 01:09:22,880
left sorry

1863
01:09:27,590 --> 01:09:25,380

uh which is now blocked by Grant's chair

1864
01:09:29,090 --> 01:09:27,600
uh that cluster of stars almost

1865
01:09:30,829 --> 01:09:29,100
completely disappears in the mid

1866
01:09:32,749 --> 01:09:30,839
infrared it's gone right those Stars

1867
01:09:34,550 --> 01:09:32,759
just like we saw with uh Karina the

1868
01:09:36,289 --> 01:09:34,560
Stars they show up in near Cam and then

1869
01:09:38,209 --> 01:09:36,299
they're gone in Miri in mid infrared

1870
01:09:39,590 --> 01:09:38,219
wavelengths there's there's astrophysics

1871
01:09:41,510 --> 01:09:39,600
there there's a reason for that and the

1872
01:09:43,849 --> 01:09:41,520
colors tell us something about that yeah

1873
01:09:45,769 --> 01:09:43,859
and let me just say that from an

1874
01:09:47,390 --> 01:09:45,779
astronomer's point of view these RGB

1875
01:09:48,590 --> 01:09:47,400
images are not the ones that you're

1876
01:09:51,829 --> 01:09:48,600
they're going to do the science with

1877
01:09:54,650 --> 01:09:51,839
okay but they can help guide the science

1878
01:09:56,689 --> 01:09:54,660
uh by pulling out features that

1879
01:09:58,490 --> 01:09:56,699
astronomer goes hey and then he goes

1880
01:10:00,590 --> 01:09:58,500
back to the black and white images and

1881
01:10:02,270 --> 01:10:00,600
processes those through his analysis

1882
01:10:04,310 --> 01:10:02,280
software to pull out the information

1883
01:10:06,890 --> 01:10:04,320
he's looking for so the science is

1884
01:10:08,290 --> 01:10:06,900
always done with the high dynamic range

1885
01:10:11,630 --> 01:10:08,300
black and white images

1886
01:10:13,189 --> 01:10:11,640
but it doesn't mean astronomers are

1887
01:10:15,790 --> 01:10:13,199
human you you give them a nice color

1888
01:10:18,530 --> 01:10:15,800

image they start to see more uh in it

1889
01:10:20,330 --> 01:10:18,540
and the the Joe's comment about how

1890
01:10:22,430 --> 01:10:20,340
stars appear in the near infrared but

1891
01:10:23,510 --> 01:10:22,440
don't appear in the mid-infrared was one

1892
01:10:25,250 --> 01:10:23,520
of the interesting things that we

1893
01:10:27,770 --> 01:10:25,260
thought about before we got those first

1894
01:10:29,630 --> 01:10:27,780
images right because we chatted about it

1895
01:10:30,729 --> 01:10:29,640
in our group discussions that like wait

1896
01:10:34,010 --> 01:10:30,739
a minute

1897
01:10:35,870 --> 01:10:34,020
we're just the Stars you know in Spitzer

1898
01:10:39,530 --> 01:10:35,880
only appeared in the blue channels right

1899
01:10:43,130 --> 01:10:39,540
and so it adds uh it adds a whole new

1900
01:10:45,830 --> 01:10:43,140
dimension to processing these images

1901
01:10:47,390 --> 01:10:45,840
absolutely I actually like this next

1902
01:10:50,450 --> 01:10:47,400
question

1903
01:10:53,810 --> 01:10:50,460
um have you seen any jwst images that

1904
01:10:56,470 --> 01:10:53,820
have been processed by someone else and

1905
01:10:59,990 --> 01:10:56,480
if so what did you think about them

1906
01:11:07,610 --> 01:11:00,000
I love this oh this is a booby trap

1907
01:11:11,930 --> 01:11:09,649
cool to see the response from people

1908
01:11:14,810 --> 01:11:11,940
about Webb the fact that it's showing

1909
01:11:16,370 --> 01:11:14,820
you that people can access the data like

1910
01:11:18,410 --> 01:11:16,380
anyone can access the data it can be a

1911
01:11:21,010 --> 01:11:18,420
little bit hard to navigate sort of this

1912
01:11:24,229 --> 01:11:21,020
archive but if you go to

1913
01:11:25,729 --> 01:11:24,239

mass.stsci.edu you can go grab all the

1914
01:11:27,830 --> 01:11:25,739
data that's been taken from Hubble and

1915
01:11:29,750 --> 01:11:27,840
web there might be a proprietary period

1916
01:11:31,430 --> 01:11:29,760
where you have to wait six months but

1917
01:11:33,890 --> 01:11:31,440
Max a year but most the data is already

1918
01:11:35,930 --> 01:11:33,900
available and it's nice to see what

1919
01:11:37,130 --> 01:11:35,940
people think of because again like I

1920
01:11:39,229 --> 01:11:37,140
mentioned before

1921
01:11:41,510 --> 01:11:39,239
not everyone's going to see the image

1922
01:11:43,189 --> 01:11:41,520
the same way and when we're processing

1923
01:11:46,130 --> 01:11:43,199
an image Joe and I are very much Guided

1924
01:11:47,930 --> 01:11:46,140
by the science Discovery so we're kind

1925
01:11:50,390 --> 01:11:47,940
of following the lead of the scientists

1926
01:11:52,010 --> 01:11:50,400
while someone else who is processing the

1927
01:11:53,450 --> 01:11:52,020
data might see something else that they

1928
01:11:55,669 --> 01:11:53,460
find interesting that they want to show

1929
01:11:57,350 --> 01:11:55,679
and so having that different lens and

1930
01:11:59,390 --> 01:11:57,360
the perspective is really cool and it's

1931
01:12:01,790 --> 01:11:59,400
fun to see we might be a little jealous

1932
01:12:03,229 --> 01:12:01,800
that you got to process it but that's

1933
01:12:05,930 --> 01:12:03,239
about it

1934
01:12:08,990 --> 01:12:05,940
yeah I I find it hugely inspiring to see

1935
01:12:10,729 --> 01:12:09,000
how inspired people are by Webb and you

1936
01:12:13,130 --> 01:12:10,739
know or does they have a desire to go in

1937
01:12:14,570 --> 01:12:13,140
and understand more fundamentally how it

1938
01:12:16,310 --> 01:12:14,580

works and get the data and work with

1939
01:12:18,050 --> 01:12:16,320
that data and make their own versions of

1940
01:12:20,450 --> 01:12:18,060
the images that's great and I wholly

1941
01:12:22,130 --> 01:12:20,460
encourage it and this is a seriously a

1942
01:12:24,470 --> 01:12:22,140
change from when you know we were doing

1943
01:12:27,070 --> 01:12:24,480
Hubble image only a decade or so ago

1944
01:12:29,870 --> 01:12:27,080
right people didn't go into Mast and

1945
01:12:32,149 --> 01:12:29,880
regularly process them and now everyone

1946
01:12:34,669 --> 01:12:32,159
got really excited about web and we got

1947
01:12:36,350 --> 01:12:34,679
a lot of Groundswell of people doing

1948
01:12:38,450 --> 01:12:36,360
this so this is you know this is really

1949
01:12:42,110 --> 01:12:38,460
really good for getting astronomy out

1950
01:12:43,729 --> 01:12:42,120
there yeah um and Joe that leads us to

1951
01:12:45,770 --> 01:12:43,739
would you say something about NASA's

1952
01:12:48,350 --> 01:12:45,780
astrophoto challenge I was just a

1953
01:12:50,750 --> 01:12:48,360
project you're involved in thank you yes

1954
01:12:52,550 --> 01:12:50,760
uh so if you are interested in working

1955
01:12:55,010 --> 01:12:52,560
with real data from NASA observatories

1956
01:12:57,350 --> 01:12:55,020
we've made it somewhat easier to get to

1957
01:12:59,870 --> 01:12:57,360
the data uh through a program called

1958
01:13:01,250 --> 01:12:59,880
NASA's astrophoto Challenge and what

1959
01:13:02,750 --> 01:13:01,260
that is if you Google Astra photo

1960
01:13:04,850 --> 01:13:02,760
challenge or NASA's astrophoto challenge

1961
01:13:07,189 --> 01:13:04,860
you have the opportunity to work with

1962
01:13:10,610 --> 01:13:07,199
real data from Hubble and Webb and

1963
01:13:11,750 --> 01:13:10,620

Spitzer and Chandra and something called

1964
01:13:13,910 --> 01:13:11,760
the micro Observatory which is

1965
01:13:15,770 --> 01:13:13,920
ground-based observatories and you can

1966
01:13:19,189 --> 01:13:15,780
take that data and make your own images

1967
01:13:21,709 --> 01:13:19,199
from the real data and submit them to be

1968
01:13:24,290 --> 01:13:21,719
you know analyzed or or viewed by

1969
01:13:25,729 --> 01:13:24,300
professional astronomers it's a great

1970
01:13:26,870 --> 01:13:25,739
program we've been running for years on

1971
01:13:29,689 --> 01:13:26,880
different objects the one that's

1972
01:13:31,610 --> 01:13:29,699
currently running is looking at the

1973
01:13:33,830 --> 01:13:31,620
pillars of creation image that was

1974
01:13:35,209 --> 01:13:33,840
recently released uh well for the web

1975
01:13:37,550 --> 01:13:35,219
image that was recently released but

1976
01:13:40,669 --> 01:13:37,560
there's data from Hubble web Spitzer and

1977
01:13:43,189 --> 01:13:40,679
Chandra I believe in that challenge yeah

1978
01:13:44,750 --> 01:13:43,199
and that challenge runs through February

1979
01:13:48,709 --> 01:13:44,760
28th if I remember correctly that's

1980
01:13:50,570 --> 01:13:48,719
right yeah okay so um get to it and you

1981
01:13:53,149 --> 01:13:50,580
can process somebody you can do your own

1982
01:13:54,709 --> 01:13:53,159
interpretation of some NASA data right

1983
01:13:57,890 --> 01:13:54,719
without without having to go through the

1984
01:14:01,970 --> 01:13:57,900
archive all right grant after that plug

1985
01:14:06,649 --> 01:14:03,770
uh Grant you're muted

1986
01:14:08,149 --> 01:14:06,659
or I couldn't hear you yeah yep that was

1987
01:14:09,610 --> 01:14:08,159
my bad Shameless plugs are always

1988
01:14:13,130 --> 01:14:09,620

welcome

1989
01:14:14,750 --> 01:14:13,140
all right so are the image are the

1990
01:14:17,209 --> 01:14:14,760
single image processes applied

1991
01:14:18,590 --> 01:14:17,219
differently when animation slash zooms

1992
01:14:20,209 --> 01:14:18,600
are created this is probably more for

1993
01:14:22,850 --> 01:14:20,219
Frank

1994
01:14:25,850 --> 01:14:22,860
well no it's not actually because uh

1995
01:14:28,010 --> 01:14:25,860
when we need a zoom into an image

1996
01:14:31,850 --> 01:14:28,020
um the visualization that that's more

1997
01:14:33,530 --> 01:14:31,860
the the 3D work but uh Lisa is our

1998
01:14:35,030 --> 01:14:33,540
Master of the zooms to get into these

1999
01:14:37,910 --> 01:14:35,040
images you want to talk a little bit

2000
01:14:39,229 --> 01:14:37,920
about that well I'm learning things yes

2001
01:14:40,850 --> 01:14:39,239
so I'm trying to remember the first part

2002
01:14:42,229 --> 01:14:40,860
of that question which I think was like

2003
01:14:45,110 --> 01:14:42,239
creating the animation like between

2004
01:14:46,610 --> 01:14:45,120
frames is that the question like like

2005
01:14:49,610 --> 01:14:46,620
I'm not sure if I understood the first

2006
01:14:51,830 --> 01:14:49,620
part um the question was are the single

2007
01:14:54,709 --> 01:14:51,840
image processes applied differently when

2008
01:14:59,630 --> 01:14:54,719
animations or zooms are created

2009
01:15:01,250 --> 01:14:59,640
ah yes so the overall process is the

2010
01:15:03,050 --> 01:15:01,260
same in the sense that we still want to

2011
01:15:04,490 --> 01:15:03,060
make like the best most compelling image

2012
01:15:06,770 --> 01:15:04,500
that we feel that we can make in

2013
01:15:08,810 --> 01:15:06,780

bringing out the details but we might

2014
01:15:10,850 --> 01:15:08,820
adjust it sort of in the end but usually

2015
01:15:12,890 --> 01:15:10,860
what what happens when we make a zoom

2016
01:15:15,350 --> 01:15:12,900
image so to speak like if we're doing an

2017
01:15:18,229 --> 01:15:15,360
image for a web and um

2018
01:15:20,090 --> 01:15:18,239
is we process the web image and then we

2019
01:15:22,010 --> 01:15:20,100
get sort of these intermediate images

2020
01:15:24,470 --> 01:15:22,020
like the ground-based telescopes we use

2021
01:15:27,590 --> 01:15:24,480
Fuji a lot and then we go into sort of a

2022
01:15:29,810 --> 01:15:27,600
more intermediate one in between web and

2023
01:15:32,030 --> 01:15:29,820
uh DSS for example and we usually

2024
01:15:33,950 --> 01:15:32,040
actually adjust those those wider

2025
01:15:35,750 --> 01:15:33,960
context Fields because it's easier to

2026
01:15:38,689 --> 01:15:35,760
adjust those and sort of go in and

2027
01:15:40,790 --> 01:15:38,699
adjust sort of these much smaller field

2028
01:15:42,830 --> 01:15:40,800
of views where like that sort of stretch

2029
01:15:44,149 --> 01:15:42,840
is very important to it and like that

2030
01:15:45,530 --> 01:15:44,159
was just like you worked very hard to

2031
01:15:46,970 --> 01:15:45,540
get that stretch to bring out that

2032
01:15:49,669 --> 01:15:46,980
detail so you don't want to kind of like

2033
01:15:52,189 --> 01:15:49,679
undo it so to speak so generally the

2034
01:15:53,930 --> 01:15:52,199
process is overall the same in order to

2035
01:15:55,669 --> 01:15:53,940
make sort of those seamless transitions

2036
01:15:58,729 --> 01:15:55,679
between one or the other in terms of

2037
01:16:00,649 --> 01:15:58,739
like color balance or tonality or

2038
01:16:03,950 --> 01:16:00,659

contrast so yeah I would say like the

2039
01:16:05,689 --> 01:16:03,960
other plates that we use to zoom in to

2040
01:16:08,810 --> 01:16:05,699
the final image or the ones that we

2041
01:16:11,149 --> 01:16:08,820
usually adjust hopefully that yeah and

2042
01:16:12,530 --> 01:16:11,159
Joe could you elaborate further on that

2043
01:16:14,930 --> 01:16:12,540
so like when we create the 3D

2044
01:16:16,729 --> 01:16:14,940
visualizations and we're flying into an

2045
01:16:18,590 --> 01:16:16,739
image right what sort of image

2046
01:16:20,689 --> 01:16:18,600
processing is required there

2047
01:16:22,850 --> 01:16:20,699
yeah so that those visualizations

2048
01:16:25,370 --> 01:16:22,860
they're based on the actual image that

2049
01:16:27,290 --> 01:16:25,380
we built from the data right so we take

2050
01:16:30,350 --> 01:16:27,300
an image say you know last year we did

2051
01:16:32,149 --> 01:16:30,360
uh Hickson compact group 40 HCG 40 for

2052
01:16:35,030 --> 01:16:32,159
Hubble's anniversary and then we did a

2053
01:16:37,130 --> 01:16:35,040
3D fly-through of that and the 3D fly

2054
01:16:39,410 --> 01:16:37,140
through is built from the press release

2055
01:16:40,729 --> 01:16:39,420
image we actually go in and the image

2056
01:16:42,770 --> 01:16:40,739
processing that takes place is to

2057
01:16:44,689 --> 01:16:42,780
actually extract the different parts of

2058
01:16:46,610 --> 01:16:44,699
the image so we'll pull the stars out

2059
01:16:48,470 --> 01:16:46,620
and then we'll pull the galaxies out and

2060
01:16:50,270 --> 01:16:48,480
make them separate layers so they're

2061
01:16:53,209 --> 01:16:50,280
coming directly from the image itself

2062
01:16:54,350 --> 01:16:53,219
and then they're placed in 3D space and

2063
01:16:55,669 --> 01:16:54,360

then the only thing that has to you have

2064
01:16:57,410 --> 01:16:55,679
to fill in the background right if you

2065
01:16:59,510 --> 01:16:57,420
pull the Galaxy out we don't know what's

2066
01:17:01,130 --> 01:16:59,520
behind the Galaxy so we sort of fill

2067
01:17:03,890 --> 01:17:01,140
that in with the sort of the average

2068
01:17:05,750 --> 01:17:03,900
background level of sky so then that

2069
01:17:07,310 --> 01:17:05,760
gives you this depth perception as

2070
01:17:09,470 --> 01:17:07,320
you're moving in towards it you see the

2071
01:17:11,149 --> 01:17:09,480
galaxy moving against the background

2072
01:17:12,410 --> 01:17:11,159
um that's that's how we go through that

2073
01:17:16,490 --> 01:17:12,420
process

2074
01:17:18,229 --> 01:17:16,500
complicated when it comes to nebulae

2075
01:17:20,450 --> 01:17:18,239
because you pull off the front layer of

2076
01:17:22,550 --> 01:17:20,460
the NBA what's behind it you got to fill

2077
01:17:24,649 --> 01:17:22,560
in that stuff and so like when we did

2078
01:17:27,890 --> 01:17:24,659
Cosmic Reef we had all sorts of fill in

2079
01:17:29,209 --> 01:17:27,900
and and such to work on those yeah but

2080
01:17:30,830 --> 01:17:29,219
the good thing about it is that we you

2081
01:17:33,350 --> 01:17:30,840
know working at Space Telescope we have

2082
01:17:34,910 --> 01:17:33,360
access to plenty of astronomers who you

2083
01:17:37,010 --> 01:17:34,920
know it's their life's work is to work

2084
01:17:38,570 --> 01:17:37,020
on these objects and so we consult with

2085
01:17:40,490 --> 01:17:38,580
them and make sure that the decisions

2086
01:17:41,570 --> 01:17:40,500
that we're making that the artistic

2087
01:17:43,910 --> 01:17:41,580
decisions we're making as image

2088
01:17:45,770 --> 01:17:43,920

processors or as visualizers make sense

2089
01:17:49,250 --> 01:17:45,780
and could be you know plausible

2090
01:17:52,490 --> 01:17:49,260
scientifically speaking yep all right

2091
01:17:56,030 --> 01:17:52,500
grant what else we got

2092
01:17:59,090 --> 01:17:56,040
um is stsci slash NASA making attempts

2093
01:18:00,830 --> 01:17:59,100
to process or present the data in some

2094
01:18:02,270 --> 01:18:00,840
way that can be seen by visually

2095
01:18:04,189 --> 01:18:02,280
impaired people

2096
01:18:05,870 --> 01:18:04,199
like are we doing accessibility for any

2097
01:18:08,209 --> 01:18:05,880
of these images other than the alt text

2098
01:18:09,770 --> 01:18:08,219
which we're already doing chat if you

2099
01:18:12,709 --> 01:18:09,780
haven't seen the alt text for the web

2100
01:18:15,290 --> 01:18:12,719
images go see it it's amazing

2101
01:18:17,090 --> 01:18:15,300
right I mean yes that that's obviously

2102
01:18:18,470 --> 01:18:17,100
the first answer is about yes now do

2103
01:18:20,450 --> 01:18:18,480
either you want to comment on the alt

2104
01:18:23,090 --> 01:18:20,460
text

2105
01:18:24,830 --> 01:18:23,100
um I think it's great our writers

2106
01:18:27,350 --> 01:18:24,840
our writers have done an excellent job

2107
01:18:29,510 --> 01:18:27,360
of taking alt text to a new level right

2108
01:18:31,970 --> 01:18:29,520
really describing everything you see in

2109
01:18:34,430 --> 01:18:31,980
these images in such Exquisite detail

2110
01:18:36,890 --> 01:18:34,440
because usually the alt text just says

2111
01:18:38,270 --> 01:18:36,900
image of Karina nebula right exactly and

2112
01:18:40,729 --> 01:18:38,280
they've taken it and they've turned it

2113
01:18:45,229 --> 01:18:40,739

into a visual description of the image

2114
01:18:47,870 --> 01:18:45,239
and so I mean the the thing I have in my

2115
01:18:49,850 --> 01:18:47,880
head about what alt text is is this

2116
01:18:51,890 --> 01:18:49,860
isn't it this is this is a pure visual

2117
01:18:53,390 --> 01:18:51,900
description

2118
01:18:55,729 --> 01:18:53,400
um now

2119
01:18:57,590 --> 01:18:55,739
um we have other projects that we work

2120
01:19:01,010 --> 01:18:57,600
with uh for

2121
01:19:03,169 --> 01:19:01,020
um uh through the 3D printing of um like

2122
01:19:05,090 --> 01:19:03,179
they did of Stefan's quintet right you

2123
01:19:06,770 --> 01:19:05,100
want to talk about that yes so we have

2124
01:19:10,010 --> 01:19:06,780
like sort of almost like a relief map

2125
01:19:12,169 --> 01:19:10,020
that's built up from the Miri image of

2126
01:19:14,209 --> 01:19:12,179
Stefan's quintet and what that is it's

2127
01:19:15,830 --> 01:19:14,219
like a table like a physical table where

2128
01:19:17,270 --> 01:19:15,840
you have the image sort of represented

2129
01:19:20,330 --> 01:19:17,280
on the table and then the brightness

2130
01:19:22,550 --> 01:19:20,340
levels of the image corresponds to uh

2131
01:19:24,950 --> 01:19:22,560
depth of bumpiness right so you can sort

2132
01:19:26,630 --> 01:19:24,960
of move your hand across the image and

2133
01:19:28,430 --> 01:19:26,640
feel where there may be a bright star

2134
01:19:29,570 --> 01:19:28,440
there's going to be like a big bump on

2135
01:19:31,910 --> 01:19:29,580
the table

2136
01:19:34,490 --> 01:19:31,920
um addition additionally to that there

2137
01:19:35,870 --> 01:19:34,500
are audio Snips that actually correspond

2138
01:19:37,189 --> 01:19:35,880

to different parts of the image so you

2139
01:19:38,390 --> 01:19:37,199
can you know move your hand across

2140
01:19:40,310 --> 01:19:38,400
something and then you'll you'll

2141
01:19:41,750 --> 01:19:40,320
interact with a button and that button

2142
01:19:43,790 --> 01:19:41,760
tells you something about that specific

2143
01:19:45,770 --> 01:19:43,800
part of the image so this is you know an

2144
01:19:48,050 --> 01:19:45,780
attempt to to reach out to a broader

2145
01:19:49,310 --> 01:19:48,060
audience and and engage people uh blind

2146
01:19:50,630 --> 01:19:49,320
and low vision people

2147
01:19:52,189 --> 01:19:50,640
right

2148
01:19:53,450 --> 01:19:52,199
um and I will just mention that in

2149
01:19:55,550 --> 01:19:53,460
addition to that

2150
01:19:57,350 --> 01:19:55,560
um uh a project that's based at Space

2151
01:19:59,810 --> 01:19:57,360
Telescope NASA's Universe of learning

2152
01:20:02,630 --> 01:19:59,820
has an accessible learning resources

2153
01:20:04,310 --> 01:20:02,640
project that's based out of uh up in

2154
01:20:06,649 --> 01:20:04,320
Boston that uh the center for

2155
01:20:09,229 --> 01:20:06,659
astrophysics where Joe used to be

2156
01:20:11,330 --> 01:20:09,239
um and they will do also do visual

2157
01:20:14,510 --> 01:20:11,340
descriptions they will also do 3D

2158
01:20:16,610 --> 01:20:14,520
printing things as well as sonification

2159
01:20:19,250 --> 01:20:16,620
um they'll like you know run run a line

2160
01:20:22,370 --> 01:20:19,260
across an image and have the uh the

2161
01:20:24,350 --> 01:20:22,380
pixels uh translated into sound so

2162
01:20:27,530 --> 01:20:24,360
there's a variety of those things

2163
01:20:28,430 --> 01:20:27,540

okay uh another question Grant and Elise

2164
01:20:31,430 --> 01:20:28,440
everything okay with your internet

2165
01:20:36,530 --> 01:20:33,729
um not sure

2166
01:20:38,990 --> 01:20:36,540
well maybe that's a good note for us to

2167
01:20:40,310 --> 01:20:39,000
end on then okay you got one more

2168
01:20:42,229 --> 01:20:40,320
question Greg or

2169
01:20:45,169 --> 01:20:42,239
no they've done a great job answering

2170
01:20:47,390 --> 01:20:45,179
all the chats okay let me just check uh

2171
01:20:48,590 --> 01:20:47,400
I think I've gotten through all of those

2172
01:20:51,229 --> 01:20:48,600
things

2173
01:20:55,970 --> 01:20:51,239
yeah um oh actually somebody asked uh

2174
01:21:00,229 --> 01:20:59,030
really just a unit thing um yeah at

2175
01:21:03,470 --> 01:21:00,239
least you wanted to explain what an

2176
01:21:05,930 --> 01:21:03,480
angstrom is thank you

2177
01:21:08,149 --> 01:21:05,940
uh it's just another way to describe a

2178
01:21:09,830 --> 01:21:08,159
wavelength so like nanometers is like 10

2179
01:21:11,810 --> 01:21:09,840
to the ninth we'll say or that's like

2180
01:21:14,990 --> 01:21:11,820
how I remember it in my brain and then

2181
01:21:18,169 --> 01:21:15,000
like um angstrom is 10 to the it's

2182
01:21:21,169 --> 01:21:18,179
negative 10. so it's just like a way to

2183
01:21:23,030 --> 01:21:21,179
a helpful way to use it for science I

2184
01:21:25,910 --> 01:21:23,040
honestly this is like back from my

2185
01:21:28,490 --> 01:21:25,920
astronomy days so I'm probably not

2186
01:21:30,590 --> 01:21:28,500
talking about it but I like for instance

2187
01:21:32,510 --> 01:21:30,600
like to describe a wavelengths for web

2188
01:21:34,610 --> 01:21:32,520

we use microns because it just makes the

2189
01:21:37,250 --> 01:21:34,620
most sense because that's just a the

2190
01:21:39,169 --> 01:21:37,260
easiest way to show that number but it

2191
01:21:41,209 --> 01:21:39,179
really just depends on the what

2192
01:21:42,649 --> 01:21:41,219
wavelength or what sort of part of the

2193
01:21:44,510 --> 01:21:42,659
electromagnetic spectrum you're working

2194
01:21:47,209 --> 01:21:44,520
on and what makes sense to you so yeah

2195
01:21:50,149 --> 01:21:47,219
just a it's just a different unit

2196
01:21:51,590 --> 01:21:50,159
um make sure you pay attention to those

2197
01:21:53,630 --> 01:21:51,600
yeah yeah

2198
01:21:55,430 --> 01:21:53,640
it's an astronomy specific unit yeah

2199
01:21:58,610 --> 01:21:55,440
it's an astronomy specific unit right

2200
01:22:00,470 --> 01:21:58,620
and um it's it's more more for x-ray

2201
01:22:02,050 --> 01:22:00,480
astronomy right Joe

2202
01:22:06,410 --> 01:22:02,060
angstroms

2203
01:22:07,910 --> 01:22:06,420
you're x-rays aren't you yeah yeah it's

2204
01:22:09,790 --> 01:22:07,920
true I mean I usually think of it in

2205
01:22:14,330 --> 01:22:09,800
electron volts but yeah

2206
01:22:16,250 --> 01:22:14,340
yeah another unit yeah uh specific to us

2207
01:22:17,750 --> 01:22:16,260
that astronomers use all the time yeah

2208
01:22:20,590 --> 01:22:17,760
so we do have we do have some

2209
01:22:24,350 --> 01:22:20,600
interesting uh

2210
01:22:27,229 --> 01:22:24,360
jargon in our field how about that yeah

2211
01:22:30,229 --> 01:22:27,239
all righty uh thank you so much Joe

2212
01:22:32,570 --> 01:22:30,239
thank you so much Alisa uh and thank you

2213
01:22:35,030 --> 01:22:32,580

of course Grant uh this has been a lot

2214
01:22:36,590 --> 01:22:35,040
of fun I'm sure we'll get uh you guys

2215
01:22:38,870 --> 01:22:36,600
will get a lot more requests to do these

2216
01:22:40,729 --> 01:22:38,880
talks because it's I was just so

2217
01:22:42,410 --> 01:22:40,739
interested in the web images

2218
01:22:44,570 --> 01:22:42,420
um and seeing how they are made just you

2219
01:22:46,610 --> 01:22:44,580
know turns on a light for so many people

2220
01:22:50,149 --> 01:22:46,620
all right next month

2221
01:22:53,209 --> 01:22:50,159
February 7th super massive black holes

2222
01:22:55,490 --> 01:22:53,219
in the center of galaxies please join us