

1
00:00:00,000 --> 00:00:04,200
I checked the weather report here in

2
00:00:01,530 --> 00:00:05,960
Baltimore if there's snow tonight it's

3
00:00:04,200 --> 00:00:08,339
not going to happen till it's supposedly

4
00:00:05,960 --> 00:00:10,980
not gonna happen till after 11 o'clock

5
00:00:08,339 --> 00:00:12,599
so we finish at 9:30 you should have

6
00:00:10,980 --> 00:00:22,910
plenty of time to get home unless you

7
00:00:12,599 --> 00:00:22,910
drove two hours to get here all right

8
00:01:35,868 --> 00:01:40,509
oh my gosh that's great

9
00:02:18,620 --> 00:02:31,730
all right Kelvin we're ready

10
00:02:22,400 --> 00:02:33,379
you've got the thumbs up okay good

11
00:02:31,729 --> 00:02:35,840
evening ladies and gentlemen and welcome

12
00:02:33,378 --> 00:02:38,268
to the Space Telescope public lecture

13
00:02:35,840 --> 00:02:41,000
series I'm your host dr. Frank summers

14
00:02:38,269 --> 00:02:46,700
of the office of public outreach and

15
00:02:41,000 --> 00:02:48,530
when you came in there are lithographs

16
00:02:46,699 --> 00:02:51,048
on the table here our lithograph tonight

17
00:02:48,530 --> 00:02:53,239
is the Eagle Nebula m16 these are the

18
00:02:51,049 --> 00:02:56,390
pillars of creation in the Eagle Nebula

19
00:02:53,239 --> 00:02:57,920
scene in both visible light and infrared

20
00:02:56,389 --> 00:03:00,619
light and this will have special

21
00:02:57,919 --> 00:03:06,108
significance for our talk about infrared

22
00:03:00,620 --> 00:03:08,719
telescopes tonight our talk is it's not

23
00:03:06,109 --> 00:03:11,930
working all right so let's go here our

24
00:03:08,719 --> 00:03:15,229
talk is web in three acts the telescope

25
00:03:11,930 --> 00:03:17,180
the science the legacy we have three

26
00:03:15,229 --> 00:03:20,509
speakers to take care of those three

27
00:03:17,180 --> 00:03:23,060
parts and I'll introduce them later but

28
00:03:20,509 --> 00:03:26,120
we're gonna get a good look at the James

29

00:03:23,060 --> 00:03:28,459
Webb Space Telescope tonight next month

30
00:03:26,120 --> 00:03:31,489
we have the wildest weather in the

31
00:03:28,459 --> 00:03:33,289
universe by Hannah wake furred and in

32
00:03:31,489 --> 00:03:36,200
that she's not talking about just in our

33
00:03:33,289 --> 00:03:39,560
solar system but also in other planetary

34
00:03:36,199 --> 00:03:41,628
systems the new planetary systems that

35
00:03:39,560 --> 00:03:45,590
we have found and the weather that we

36
00:03:41,628 --> 00:03:47,899
would do Sanh those planets on March we

37
00:03:45,590 --> 00:03:49,909
have Mia boville coming back again she's

38
00:03:47,900 --> 00:03:52,069
given some wonderful talks the last

39
00:03:49,909 --> 00:03:54,680
couple of years and she decided she was

40
00:03:52,068 --> 00:03:56,509
going to have some fun with her title so

41
00:03:54,680 --> 00:03:59,540
it's called mapping the United

42
00:03:56,509 --> 00:04:02,929
Federation of Planets an astronomers

43
00:03:59,539 --> 00:04:05,539

Guide to the galaxy so she will be using

44

00:04:02,930 --> 00:04:08,870

lots and lots of Star Trek references

45

00:04:05,539 --> 00:04:11,179

okay but she will also be putting them

46

00:04:08,870 --> 00:04:13,430

in context of our actual scientific

47

00:04:11,180 --> 00:04:16,209

knowledge of the galaxy so if you were

48

00:04:13,430 --> 00:04:21,348

on a combination of a fact and fiction

49

00:04:16,209 --> 00:04:23,538

come to us see in march in april susanna

50

00:04:21,348 --> 00:04:25,699

datastore is going to talk and she's did

51

00:04:23,538 --> 00:04:26,839

not give me an actual topic she just

52

00:04:25,699 --> 00:04:28,218

said i'll talk about something about

53

00:04:26,839 --> 00:04:31,429

cosmology because everybody loves

54

00:04:28,218 --> 00:04:31,969

cosmology so in the next month or so I

55

00:04:31,430 --> 00:04:34,160

will

56

00:04:31,970 --> 00:04:36,650

get an actual title out of her but you

57

00:04:34,160 --> 00:04:37,820

guys do love Kamal cosmology right yeah

58
00:04:36,649 --> 00:04:41,329
so you're gonna come no matter what

59
00:04:37,819 --> 00:04:45,019
all right great if you would like to

60
00:04:41,329 --> 00:04:46,879
keep up with what's going on you can go

61
00:04:45,019 --> 00:04:48,469
to our website if you just sort of put

62
00:04:46,879 --> 00:04:50,449
in your favorite search engine

63
00:04:48,470 --> 00:04:52,580
Hubble public talks you'll find this

64
00:04:50,449 --> 00:04:54,680
webpage and you can see we've got a list

65
00:04:52,579 --> 00:04:58,490
of the upcoming lectures we've got links

66
00:04:54,680 --> 00:05:01,730
to the webcasting which are live when we

67
00:04:58,490 --> 00:05:04,879
are doing it live now as well as links

68
00:05:01,730 --> 00:05:07,400
to the past lectures we've been on

69
00:05:04,879 --> 00:05:10,810
YouTube since spring of 2014 and we have

70
00:05:07,399 --> 00:05:14,629
been on the stsci webcasting site since

71
00:05:10,810 --> 00:05:17,420
2005 so we're approaching 13 years of

72
00:05:14,629 --> 00:05:19,699
astronomy lectures on our webcasting

73
00:05:17,420 --> 00:05:21,230
site that's one of the reasons I ask you

74
00:05:19,699 --> 00:05:22,939
all to get a hand to our webcasting

75
00:05:21,230 --> 00:05:25,250
folks at the beginning because they do

76
00:05:22,939 --> 00:05:28,670
such an amazing job in archiving these

77
00:05:25,250 --> 00:05:31,879
wonderful talks you can also sign up for

78
00:05:28,670 --> 00:05:36,560
our email list that will send you

79
00:05:31,879 --> 00:05:38,389
reminders of the talks every month this

80
00:05:36,560 --> 00:05:41,269
is the email one which is sort of

81
00:05:38,389 --> 00:05:45,019
redundant now that we have the sign up

82
00:05:41,269 --> 00:05:46,549
on our webpage you can also however send

83
00:05:45,019 --> 00:05:52,099
us comments and questions to public

84
00:05:46,550 --> 00:05:55,040
lecture at STScI dot edu social media we

85
00:05:52,100 --> 00:05:56,930
have Facebook we have not one but two

86

00:05:55,040 --> 00:05:59,720
Twitter accounts we have YouTube we have

87
00:05:56,930 --> 00:06:02,509
Instagram we actually ought to get the J

88
00:05:59,720 --> 00:06:05,270
toasty ones up on here now that we're

89
00:06:02,509 --> 00:06:06,439
getting closer to Jos T launch so yeah

90
00:06:05,269 --> 00:06:08,599
all right

91
00:06:06,439 --> 00:06:12,769
my apologies it'll be fixed for next

92
00:06:08,600 --> 00:06:14,510
month okay using space telescope around

93
00:06:12,769 --> 00:06:16,759
all right here right now I also

94
00:06:14,509 --> 00:06:18,918
occasionally have post on a blog in

95
00:06:16,759 --> 00:06:22,129
Facebook Google+ and Twitter and you can

96
00:06:18,918 --> 00:06:23,930
get those if you like these across the

97
00:06:22,129 --> 00:06:26,209
street we have the Maryland Space Grant

98
00:06:23,930 --> 00:06:27,740
consortium Observatory

99
00:06:26,209 --> 00:06:30,109
the Maryland Space Grant Observatory

100
00:06:27,740 --> 00:06:32,240

will not be open tonight if you looked

101

00:06:30,110 --> 00:06:35,960

up you didn't see many stars if any on

102

00:06:32,240 --> 00:06:37,490

your way in it's cloudy actually the

103

00:06:35,959 --> 00:06:39,349

fact that it's cold is really good

104

00:06:37,490 --> 00:06:41,269

because when it's cold the air is still

105

00:06:39,350 --> 00:06:42,740

and be a really good night okay some of

106

00:06:41,269 --> 00:06:45,349

the best nights observing or when you're

107

00:06:42,740 --> 00:06:47,750

totally freezing your butt off okay

108

00:06:45,350 --> 00:06:50,900

unfortunately clouds are never help

109

00:06:47,750 --> 00:06:52,879

whether it's cold or warm so they will

110

00:06:50,899 --> 00:06:54,949

not they do have open houses on Friday

111

00:06:52,879 --> 00:06:58,790

evenings if you go to MDI space grant o

112

00:06:54,949 --> 00:07:00,529

RG they have this page here where you

113

00:06:58,790 --> 00:07:02,780

can find the observatory status they

114

00:07:00,529 --> 00:07:04,819

will post it by like 6:00 or 6:30 on

115
00:07:02,779 --> 00:07:07,729
every Friday as to whether they're

116
00:07:04,819 --> 00:07:10,040
opening up on those Fridays ok so come

117
00:07:07,730 --> 00:07:11,569
back to and visit us in future lecture

118
00:07:10,040 --> 00:07:13,490
series and maybe we'll be open but

119
00:07:11,569 --> 00:07:17,629
certainly you can try every Friday on

120
00:07:13,490 --> 00:07:22,910
that and now the news from the universe

121
00:07:17,629 --> 00:07:24,860
for January 2018 our first story is a

122
00:07:22,910 --> 00:07:29,960
month old

123
00:07:24,860 --> 00:07:31,250
it is our Yuletide stars so every year

124
00:07:29,959 --> 00:07:33,529
we have to put out something for

125
00:07:31,250 --> 00:07:35,180
holidays right and they go through a

126
00:07:33,529 --> 00:07:37,039
selection process and they come up with

127
00:07:35,180 --> 00:07:41,209
something and this year they came up

128
00:07:37,040 --> 00:07:43,520
with the globular cluster Messier 79 and

129
00:07:41,209 --> 00:07:45,529
this was brought up in our news meeting

130
00:07:43,519 --> 00:07:50,299
and they said ok what can we do with

131
00:07:45,529 --> 00:07:51,679
this to make this holiday and we were

132
00:07:50,300 --> 00:07:53,509
batting around ideas and I came up with

133
00:07:51,680 --> 00:07:55,970
something I said well you know we could

134
00:07:53,509 --> 00:07:57,170
do this thing that we did and I'm not

135
00:07:55,970 --> 00:08:00,380
going to tell you the idea because it'll

136
00:07:57,170 --> 00:08:03,080
show up in just a second and I said you

137
00:08:00,379 --> 00:08:05,329
know that might be work and they held me

138
00:08:03,079 --> 00:08:06,949
to it so I can't with this idea in the

139
00:08:05,329 --> 00:08:09,769
middle of a meeting just off the top of

140
00:08:06,949 --> 00:08:13,670
my head and they made me follow through

141
00:08:09,769 --> 00:08:15,919
it so the team and I got together and we

142
00:08:13,670 --> 00:08:18,350
put together a little visualization of

143

00:08:15,920 --> 00:08:28,640
this globular star cluster with a

144
00:08:18,350 --> 00:08:30,590
surprise holiday theme at the end so

145
00:08:28,639 --> 00:08:32,479
this is one of our normal zooms in on

146
00:08:30,589 --> 00:08:36,978
the night sky to show you where Messier

147
00:08:32,479 --> 00:08:38,750
79 is and it really is deeply hidden

148
00:08:36,979 --> 00:08:41,479
there we start to see the cluster this

149
00:08:38,750 --> 00:08:43,219
is a ground-based version of it but as

150
00:08:41,479 --> 00:08:45,560
we zoom in you find out that Hubble

151
00:08:43,219 --> 00:08:47,570
doesn't see that wide field version it

152
00:08:45,559 --> 00:08:51,259
doesn't even see this version it sees

153
00:08:47,570 --> 00:08:54,020
the very central region of this globular

154
00:08:51,259 --> 00:08:57,740
star cluster and to give you a feel of a

155
00:08:54,019 --> 00:08:59,069
3d we created this 3d visualization it

156
00:08:57,740 --> 00:09:01,590
has the same similar

157
00:08:59,070 --> 00:09:04,800

statistical properties as this m79

158

00:09:01,590 --> 00:09:12,420

globular star cluster and then as we

159

00:09:04,799 --> 00:09:22,289

pull out our idea of a stellar snow

160

00:09:12,419 --> 00:09:25,679

globe is revealed so this will teach me

161

00:09:22,289 --> 00:09:29,699

to speak up during meetings we also

162

00:09:25,679 --> 00:09:32,519

created this version which is just the

163

00:09:29,700 --> 00:09:34,410

snow globe spinning and it actually is

164

00:09:32,519 --> 00:09:35,669

on a loop so you could play this put

165

00:09:34,409 --> 00:09:37,469

this in the background of your holiday

166

00:09:35,669 --> 00:09:40,469

party next year and you could have that

167

00:09:37,470 --> 00:09:44,930

snow globe spinning infinitely with the

168

00:09:40,470 --> 00:09:44,930

holiday season greeting on it as well

169

00:09:47,419 --> 00:09:54,959

our second story tonight finding defects

170

00:09:51,179 --> 00:09:56,279

in the star formation Factory yes there

171

00:09:54,960 --> 00:10:00,269

are people who have to find those

172
00:09:56,279 --> 00:10:01,949
defects all right so this is the star

173
00:10:00,269 --> 00:10:05,159
formation Factory I'm talking about it's

174
00:10:01,950 --> 00:10:07,890
called the Orion Nebula and this is a

175
00:10:05,159 --> 00:10:10,679
star forming region and there are

176
00:10:07,889 --> 00:10:13,740
several thousand stars about four

177
00:10:10,679 --> 00:10:15,809
thousand stars that have just formed and

178
00:10:13,740 --> 00:10:17,730
when we say just swarmed on astronomical

179
00:10:15,809 --> 00:10:19,289
timescales that's two million years ago

180
00:10:17,730 --> 00:10:21,210
okay so they're stars in the Orion

181
00:10:19,289 --> 00:10:25,459
Nebula that are two million years old

182
00:10:21,210 --> 00:10:28,290
but not all things that collapse are

183
00:10:25,460 --> 00:10:30,230
massive enough to form stars okay so if

184
00:10:28,289 --> 00:10:32,399
you're this is a star formation Factory

185
00:10:30,230 --> 00:10:35,670
sometimes you get some defects that are

186
00:10:32,399 --> 00:10:37,919
too small to form stars okay and it's

187
00:10:35,669 --> 00:10:39,389
important for us as astronomers to try

188
00:10:37,919 --> 00:10:41,459
and understand when you've got a

189
00:10:39,389 --> 00:10:43,710
collapsing nebula you've got a gas cloud

190
00:10:41,460 --> 00:10:45,330
that's collapsing to form objects what

191
00:10:43,710 --> 00:10:47,430
percentage of that material goes into

192
00:10:45,330 --> 00:10:48,870
stars what percentage of the material

193
00:10:47,429 --> 00:10:50,250
goes into planets we really want to know

194
00:10:48,870 --> 00:10:52,230
that too and we're searching that in

195
00:10:50,250 --> 00:10:53,610
other ways but what percentage of it

196
00:10:52,230 --> 00:10:56,399
goes into something that's bigger than a

197
00:10:53,610 --> 00:10:59,210
planet but smaller than a star and

198
00:10:56,399 --> 00:11:02,879
that's what we call brown dwarfs okay

199
00:10:59,210 --> 00:11:05,490
brown dwarfs are range from basically 15

200

00:11:02,879 --> 00:11:08,100
times Jupiter's mass to about 70 times

201
00:11:05,490 --> 00:11:09,960
Jupiter's mass okay something that's you

202
00:11:08,100 --> 00:11:12,200
know and that's when you get what we

203
00:11:09,960 --> 00:11:14,420
call deuterium fusion

204
00:11:12,200 --> 00:11:16,009
now the main-sequence stars are powered

205
00:11:14,419 --> 00:11:18,379
by hydrogen fusion the fusion of

206
00:11:16,009 --> 00:11:20,809
hydrogen into helium is what powers the

207
00:11:18,379 --> 00:11:23,289
Sun and other main-sequence stars but

208
00:11:20,809 --> 00:11:26,778
deuterium which is called heavy hydrogen

209
00:11:23,289 --> 00:11:29,870
that is not as a long-term sustained

210
00:11:26,778 --> 00:11:31,909
fusion it will flare up it will last for

211
00:11:29,870 --> 00:11:34,278
a while and then it will fade away so

212
00:11:31,909 --> 00:11:37,009
these brown dwarfs are extremely faint

213
00:11:34,278 --> 00:11:40,639
and compared to stars they're extremely

214
00:11:37,009 --> 00:11:43,159

cool they're so cool that water

215

00:11:40,639 --> 00:11:46,669

molecules will form in their atmosphere

216

00:11:43,159 --> 00:11:49,549

and you can actually detect them by

217

00:11:46,669 --> 00:11:52,309

looking for water molecules and where do

218

00:11:49,549 --> 00:11:57,078

the water molecules show up in the

219

00:11:52,309 --> 00:11:59,559

infrared so this is just a single filter

220

00:11:57,078 --> 00:12:03,189

from Hubble in the near-infrared and

221

00:11:59,559 --> 00:12:07,129

those circles are around certain

222

00:12:03,190 --> 00:12:09,380

detections of these brown dwarfs now

223

00:12:07,129 --> 00:12:15,078

what they did is they look in the water

224

00:12:09,379 --> 00:12:18,439

vapor line to find 1,200 really red

225

00:12:15,078 --> 00:12:20,750

candidates ok candidates that could have

226

00:12:18,440 --> 00:12:23,089

brown dwarfs and what they're really

227

00:12:20,750 --> 00:12:26,208

looking for was finding those faint red

228

00:12:23,089 --> 00:12:28,790

stars that had brown dwarf companions

229
00:12:26,208 --> 00:12:33,588
around them okay because you often get

230
00:12:28,789 --> 00:12:36,620
companions and they found 17 brown dwarf

231
00:12:33,589 --> 00:12:40,490
companions around these red dwarf stars

232
00:12:36,620 --> 00:12:42,500
as well as three planetary-mass

233
00:12:40,490 --> 00:12:45,649
companions three that were below the

234
00:12:42,500 --> 00:12:46,940
level of the brown dwarf masts and into

235
00:12:45,649 --> 00:12:48,799
the planetary mass now those are only

236
00:12:46,940 --> 00:12:51,949
candidates okay they can't confirm those

237
00:12:48,799 --> 00:12:54,289
in fact all 17 are candidates but in

238
00:12:51,948 --> 00:12:56,509
talking with one of the researchers he

239
00:12:54,289 --> 00:12:59,208
said there's like a 95% confidence level

240
00:12:56,509 --> 00:13:00,708
in all 17 of them that they are actual

241
00:12:59,208 --> 00:13:02,719
brown dwarfs it's the planetary ones

242
00:13:00,708 --> 00:13:05,299
that are really small that they can't be

243
00:13:02,720 --> 00:13:06,560
totally sure about so these are their

244
00:13:05,299 --> 00:13:09,169
locations and if you want to see what

245
00:13:06,559 --> 00:13:13,359
they look like this is the highly

246
00:13:09,169 --> 00:13:15,799
processed images yeah really difficult

247
00:13:13,360 --> 00:13:18,379
my laser pointer isn't working sorry

248
00:13:15,799 --> 00:13:20,240
about that but what you see on the in

249
00:13:18,379 --> 00:13:23,028
each of those images on the left is the

250
00:13:20,240 --> 00:13:25,360
star and on the right is the small

251
00:13:23,028 --> 00:13:27,370
pixels of the brow

252
00:13:25,360 --> 00:13:29,230
or companion all right and so you can

253
00:13:27,370 --> 00:13:31,570
see the star itself is only about five

254
00:13:29,230 --> 00:13:33,759
or six pixels across and the brown dwarf

255
00:13:31,570 --> 00:13:36,190
companion is only one or two pixels

256
00:13:33,759 --> 00:13:38,019
across and the detector and those are

257

00:13:36,190 --> 00:13:40,720
still actually unresolved they're really

258
00:13:38,019 --> 00:13:43,450
smaller than an individual pixel at that

259
00:13:40,720 --> 00:13:47,440
scale so you're really having to work

260
00:13:43,450 --> 00:13:50,470
deep into the data to be able to pull

261
00:13:47,440 --> 00:13:52,750
this out but hey that's what science is

262
00:13:50,470 --> 00:13:54,550
at the cutting edge we don't get

263
00:13:52,750 --> 00:13:56,350
gorgeous pictures we just get these

264
00:13:54,549 --> 00:13:58,689
little tiny little pixel things and

265
00:13:56,350 --> 00:14:02,680
being able to pull out these brown dwarf

266
00:13:58,690 --> 00:14:05,529
companions now needless to say this will

267
00:14:02,679 --> 00:14:07,479
change immeasurably when we have the

268
00:14:05,528 --> 00:14:10,169
james webb space telescope that has

269
00:14:07,480 --> 00:14:12,250
hubble resolution but in the infrared

270
00:14:10,169 --> 00:14:14,528
wavelengths and can see these much more

271
00:14:12,250 --> 00:14:17,259

clearly and i would tell you all about

272

00:14:14,528 --> 00:14:19,028

that but that's the job of our speakers

273

00:14:17,259 --> 00:14:21,278

here tonight so i'll leave it to them to

274

00:14:19,028 --> 00:14:24,100

discuss how the James Webb will take

275

00:14:21,278 --> 00:14:26,769

this and take it to the next level and

276

00:14:24,100 --> 00:14:32,560

really get good census of the brown

277

00:14:26,769 --> 00:14:34,659

dwarfs in the Orion Nebula alright so

278

00:14:32,559 --> 00:14:39,278

now I move on to our featured speakers

279

00:14:34,659 --> 00:14:42,189

tonight they are Bonnie Meinke and Klaus

280

00:14:39,278 --> 00:14:44,439

pontoppidan from the J toasty mission

281

00:14:42,190 --> 00:14:47,290

office as well as Alexander Lockwood

282

00:14:44,440 --> 00:14:49,390

from the Office of public outreach and I

283

00:14:47,289 --> 00:14:51,129

didn't memorize their titles so Bonnie

284

00:14:49,389 --> 00:14:54,399

gave me a title that they are just

285

00:14:51,129 --> 00:14:56,169

absolutely amazing people doing amazing

286
00:14:54,399 --> 00:14:58,208
work here at the Space Telescope Science

287
00:14:56,169 --> 00:15:00,610
Institute so ladies and gentlemen an

288
00:14:58,208 --> 00:15:01,949
amazing team to discuss the James Webb

289
00:15:00,610 --> 00:15:10,570
Space Telescope gimme a hand

290
00:15:01,950 --> 00:15:10,570
[Applause]

291
00:15:22,809 --> 00:15:31,099
is does his work yeah

292
00:15:25,250 --> 00:15:35,750
ah good all right so so my name is Klaus

293
00:15:31,100 --> 00:15:37,100
pontoppidan my official title is deputy

294
00:15:35,750 --> 00:15:38,570
project scientist for the James Webb

295
00:15:37,100 --> 00:15:43,759
Space Telescope here at the Institute

296
00:15:38,570 --> 00:15:46,160
bonnie has the same title and alex is C

297
00:15:43,759 --> 00:15:49,639
is the communications lead polygraph

298
00:15:46,159 --> 00:15:50,809
outreach arm for database T so what we

299
00:15:49,639 --> 00:15:53,710
gonna do with this talk is we're gonna

300
00:15:50,809 --> 00:15:56,149
tag-team it and we gave it three titles

301
00:15:53,710 --> 00:15:57,200
the telescope designs in the legacy and

302
00:15:56,149 --> 00:15:59,149
I'm gonna do the telescope and then

303
00:15:57,200 --> 00:16:01,310
after that I'm gonna give it over to to

304
00:15:59,149 --> 00:16:05,269
Bonnie to talk about science and then

305
00:16:01,309 --> 00:16:08,779
Alex to to talk about the legacy alright

306
00:16:05,269 --> 00:16:11,840
so just to introduce this arm you may

307
00:16:08,779 --> 00:16:13,279
have seen these before I'm not sure what

308
00:16:11,840 --> 00:16:16,610
do we do at the Institute here that's

309
00:16:13,279 --> 00:16:19,309
how how is it related to to the web well

310
00:16:16,610 --> 00:16:21,649
I mean Institute hasn't existed for four

311
00:16:19,309 --> 00:16:23,809
decades now supporting the operations of

312
00:16:21,649 --> 00:16:27,919
the Hubble Space Telescope as you as you

313
00:16:23,809 --> 00:16:30,649
all know very well we're operated by an

314

00:16:27,919 --> 00:16:32,120
organization called the association of

315
00:16:30,649 --> 00:16:34,850
universities for research in astronomy

316
00:16:32,120 --> 00:16:37,039
or aura for short and we're basically a

317
00:16:34,850 --> 00:16:40,070
NASA contract and NASA contracts us to

318
00:16:37,039 --> 00:16:44,089
to run the science part of of its

319
00:16:40,070 --> 00:16:45,980
astronomical space missions and as is

320
00:16:44,090 --> 00:16:48,560
true for Hubble has been true it's true

321
00:16:45,980 --> 00:16:50,480
for the wide field Infrared Survey

322
00:16:48,559 --> 00:16:53,899
telescope and it's true for the James

323
00:16:50,480 --> 00:16:56,810
Webb Space Telescope as well and so

324
00:16:53,899 --> 00:17:00,199
another way to look at it in terms of

325
00:16:56,809 --> 00:17:04,039
roles here is that you need to do many

326
00:17:00,200 --> 00:17:06,680
things to make an astronomy mission I do

327
00:17:04,039 --> 00:17:08,299
have to have our oversight of the

328
00:17:06,680 --> 00:17:11,720

mission and the policy and if somebody

329

00:17:08,299 --> 00:17:13,490

has to drive it from the get-go so NASA

330

00:17:11,720 --> 00:17:15,559

is doing that and the James Webb Space

331

00:17:13,490 --> 00:17:17,000

Telescope is a partnership with European

332

00:17:15,559 --> 00:17:19,609

Space Agency and the Canadian

333

00:17:17,000 --> 00:17:21,799

base agency and so they provide the the

334

00:17:19,609 --> 00:17:23,539

oversight in the policy of cooking new

335

00:17:21,799 --> 00:17:25,119

technology you know gonna have a Space

336

00:17:23,539 --> 00:17:28,639

Telescope unless you have some hardware

337

00:17:25,119 --> 00:17:30,859

and so so that is built in case of James

338

00:17:28,640 --> 00:17:34,370

Webb by Goddard Space Flight Center just

339

00:17:30,859 --> 00:17:36,019

just south of here as well as partners

340

00:17:34,369 --> 00:17:38,599

from the industry Northrop Grumman is

341

00:17:36,019 --> 00:17:40,700

the prime contractor for James Webb I

342

00:17:38,599 --> 00:17:42,889

know also other partners like Ball

343
00:17:40,700 --> 00:17:45,259
Aerospace but then of course you need

344
00:17:42,890 --> 00:17:47,150
science right without without science

345
00:17:45,259 --> 00:17:51,829
you know all your habits is a piece of

346
00:17:47,150 --> 00:17:54,410
machinery and so the Institute here is

347
00:17:51,829 --> 00:17:56,230
responsible for for operating the

348
00:17:54,410 --> 00:17:59,240
telescope for scientists

349
00:17:56,230 --> 00:18:01,849
we are the interface between the

350
00:17:59,240 --> 00:18:04,430
observatory and the international

351
00:18:01,849 --> 00:18:06,529
astronomical community and the same as

352
00:18:04,430 --> 00:18:07,970
as for the Hubble Space Telescope so

353
00:18:06,529 --> 00:18:11,809
anything that has to do with science is

354
00:18:07,970 --> 00:18:16,309
is centered at the at the Institute all

355
00:18:11,809 --> 00:18:17,869
right so the telescope well so we have

356
00:18:16,309 --> 00:18:20,029
the Hubble Space Telescope you all all

357
00:18:17,869 --> 00:18:23,359
know that very well and we we love that

358
00:18:20,029 --> 00:18:24,769
very much you all familiar with the with

359
00:18:23,359 --> 00:18:27,169
the beautiful data and the beautiful

360
00:18:24,769 --> 00:18:28,730
images that Hubble has returned so these

361
00:18:27,170 --> 00:18:31,340
are all these are all Hubble images

362
00:18:28,730 --> 00:18:34,849
taken in the indivisible wavelengths

363
00:18:31,339 --> 00:18:38,779
range in the optical visible with with

364
00:18:34,849 --> 00:18:41,209
our eyes and has been operating for many

365
00:18:38,779 --> 00:18:42,410
years now you know this isn't this

366
00:18:41,210 --> 00:18:45,440
awesome you know what more do you need

367
00:18:42,410 --> 00:18:47,120
than this you know how do you do some

368
00:18:45,440 --> 00:18:50,509
how do you do the next big thing what

369
00:18:47,119 --> 00:18:51,649
what what is that going to be well so so

370
00:18:50,509 --> 00:18:53,000
so one of the some of the things that

371

00:18:51,650 --> 00:18:54,680
that Hubble has been doing and really

372
00:18:53,000 --> 00:18:58,809
showing us that these deep fields of

373
00:18:54,680 --> 00:19:01,160
galaxies high-redshift galaxies to

374
00:18:58,809 --> 00:19:03,289
enormous distances in the universe and

375
00:19:01,160 --> 00:19:04,940
it looks back in time of course ah to

376
00:19:03,289 --> 00:19:10,279
the not quite the beginning of the

377
00:19:04,940 --> 00:19:13,009
universe but but but but close and and

378
00:19:10,279 --> 00:19:17,240
and deep exposures with with Hubble has

379
00:19:13,009 --> 00:19:19,789
you know has has revealed faint galaxies

380
00:19:17,240 --> 00:19:24,170
at at the edge of where of detection

381
00:19:19,789 --> 00:19:26,240
here this is related to the to the

382
00:19:24,170 --> 00:19:30,200
original concept of the James Webb Space

383
00:19:26,240 --> 00:19:30,890
Telescope as it was conceived already

384
00:19:30,200 --> 00:19:38,660
back in the mid

385
00:19:30,890 --> 00:19:40,910

90s it was realized that if you want to

386

00:19:38,660 --> 00:19:43,519

go really to the weight to the back to

387

00:19:40,910 --> 00:19:45,290

the beginning of the universe you have

388

00:19:43,519 --> 00:19:45,920

to take into account cosmological

389

00:19:45,289 --> 00:19:47,930

redshift

390

00:19:45,920 --> 00:19:51,470

all right so essentially what happens is

391

00:19:47,930 --> 00:19:53,029

where the galaxy emits light and I said

392

00:19:51,470 --> 00:19:56,480

light travel through the universe to

393

00:19:53,029 --> 00:19:57,920

light stretches and becomes redder and

394

00:19:56,480 --> 00:20:01,220

by the time it reaches to us and can be

395

00:19:57,920 --> 00:20:02,900

quite red and if the galaxy is old

396

00:20:01,220 --> 00:20:04,279

enough if the light was emitted long

397

00:20:02,900 --> 00:20:07,070

enough to go that means if the galaxy is

398

00:20:04,279 --> 00:20:09,319

far enough away that that red shift that

399

00:20:07,069 --> 00:20:11,509

cosmological redshift is large enough to

400
00:20:09,319 --> 00:20:13,579
shift that light out of the wavelength

401
00:20:11,509 --> 00:20:16,849
range if James Webb right it becomes to

402
00:20:13,579 --> 00:20:19,099
read it becomes infrared and basically

403
00:20:16,849 --> 00:20:20,750
the galaxy disappears from U of Hubble

404
00:20:19,099 --> 00:20:22,879
and you won't need no longer see it and

405
00:20:20,750 --> 00:20:26,119
in order to see that galaxy

406
00:20:22,880 --> 00:20:27,940
you'd need sensitive Space Telescope

407
00:20:26,119 --> 00:20:31,309
that operates at longer wavelengths than

408
00:20:27,940 --> 00:20:33,650
Hubble indi in the infrared and that was

409
00:20:31,309 --> 00:20:35,929
the original impetus for James Webb it

410
00:20:33,650 --> 00:20:38,090
was to be able to see the first galaxies

411
00:20:35,930 --> 00:20:40,009
first light in the universe by going to

412
00:20:38,089 --> 00:20:43,659
the infrared to see the most red shifted

413
00:20:40,009 --> 00:20:43,660
galaxies now

414
00:20:43,819 --> 00:20:48,500
of course today this is decades to go

415
00:20:46,750 --> 00:20:49,789
other people have looked at this

416
00:20:48,500 --> 00:20:51,589
telescope and you're like well you know

417
00:20:49,789 --> 00:20:53,539
you have this big infrared telescope and

418
00:20:51,589 --> 00:20:56,480
you could do this awesome science when

419
00:20:53,539 --> 00:20:57,950
this was first started there was no such

420
00:20:56,480 --> 00:20:59,720
thing as exoplanets and now we have

421
00:20:57,950 --> 00:21:01,100
thousands of exoplanets and so a lot of

422
00:20:59,720 --> 00:21:03,259
work has been going into the James Webb

423
00:21:01,099 --> 00:21:05,419
to make sure that it can can also get

424
00:21:03,259 --> 00:21:07,009
great data in in the area of exoplanets

425
00:21:05,420 --> 00:21:10,100
and this goes on and on for many many

426
00:21:07,009 --> 00:21:12,349
different science areas all right so

427
00:21:10,099 --> 00:21:14,119
what let me say a few more things about

428

00:21:12,349 --> 00:21:16,339
the infrared here so here we have our

429
00:21:14,119 --> 00:21:19,819
just visible rainbow just to give you

430
00:21:16,339 --> 00:21:22,339
some context from from blue to red

431
00:21:19,819 --> 00:21:25,039
high-energy low-energy short wavelength

432
00:21:22,339 --> 00:21:26,929
long wavelength of course this is only a

433
00:21:25,039 --> 00:21:29,990
very very small part of the of the

434
00:21:26,930 --> 00:21:31,490
electromagnetic spectrum to the to the

435
00:21:29,990 --> 00:21:34,240
high-energy side you have ultraviolet

436
00:21:31,490 --> 00:21:36,230
radiation x-rays gamma rays these all

437
00:21:34,240 --> 00:21:38,089
wavelengths that are very unhealthy to

438
00:21:36,230 --> 00:21:39,980
humans so you don't want to expose

439
00:21:38,089 --> 00:21:43,519
yourself too much to those because they

440
00:21:39,980 --> 00:21:44,460
break chemical bonds and can give you

441
00:21:43,519 --> 00:21:46,259
all sorts of

442
00:21:44,460 --> 00:21:47,759

nasty effects going to the other way

443

00:21:46,259 --> 00:21:49,410

it's low energy you get infrared

444

00:21:47,759 --> 00:21:50,670

microwave you can heat your food but

445

00:21:49,410 --> 00:21:55,560

it's not going to break your molecules

446

00:21:50,670 --> 00:21:57,509

apart so it's a lot safer point here is

447

00:21:55,559 --> 00:22:00,179

that the visible is only a tiny tiny

448

00:21:57,509 --> 00:22:02,430

fraction of the of the introspect of the

449

00:22:00,180 --> 00:22:04,500

electromagnetic spectrum and so James

450

00:22:02,430 --> 00:22:06,570

Webb is going to give us a lot of the

451

00:22:04,500 --> 00:22:08,099

infrared or access to that so here's how

452

00:22:06,569 --> 00:22:10,919

here's an indication of that you have

453

00:22:08,099 --> 00:22:12,809

the range of Hubble goes out a little

454

00:22:10,920 --> 00:22:15,360

bit into the near-infrared around to

455

00:22:12,809 --> 00:22:18,000

about 1.8 micron or something like that

456

00:22:15,359 --> 00:22:19,919

and then it stops data bisti is going to

457
00:22:18,000 --> 00:22:23,210
be a little bit into the visible

458
00:22:19,920 --> 00:22:25,560
actually goes down to about yellow light

459
00:22:23,210 --> 00:22:27,390
and it's going to go way into the

460
00:22:25,559 --> 00:22:28,799
infrared beyond the near-infrared what

461
00:22:27,390 --> 00:22:31,050
we call the mid infrared or the thermal

462
00:22:28,799 --> 00:22:37,289
infrared out to twenty-eight micron and

463
00:22:31,049 --> 00:22:39,389
a little bit so in terms of of grasp

464
00:22:37,289 --> 00:22:41,220
there's actually a wider grasp in terms

465
00:22:39,390 --> 00:22:42,509
of wavelength of data vis T than and for

466
00:22:41,220 --> 00:22:46,410
Hubble so there's a lot of things in

467
00:22:42,509 --> 00:22:48,359
there all right so so people got back in

468
00:22:46,410 --> 00:22:51,930
the mid 90s got together and thought

469
00:22:48,359 --> 00:22:53,219
okay so how do we do this and there's a

470
00:22:51,930 --> 00:22:54,600
number of challenges with making an

471
00:22:53,220 --> 00:22:56,460
infrared Space Telescope and it's not

472
00:22:54,599 --> 00:22:57,750
gonna end up not gonna look like like

473
00:22:56,460 --> 00:22:59,819
hubble so this is an early sketch

474
00:22:57,750 --> 00:23:03,960
actually you know essentially on a piece

475
00:22:59,819 --> 00:23:05,639
of napkin considering what such a Space

476
00:23:03,960 --> 00:23:07,110
Telescope might look like well for one

477
00:23:05,640 --> 00:23:10,830
thing is you need you know there had to

478
00:23:07,109 --> 00:23:13,649
be a large mirror in it and so you can

479
00:23:10,829 --> 00:23:15,779
see this here you can see a deployable

480
00:23:13,650 --> 00:23:17,190
mirror this here that doesn't even have

481
00:23:15,779 --> 00:23:19,680
a filled aperture that's actually gaps

482
00:23:17,190 --> 00:23:20,850
in between and the idea here is that you

483
00:23:19,680 --> 00:23:23,279
have something that was folded up and

484
00:23:20,849 --> 00:23:25,469
falls out once you're in orbit so you

485

00:23:23,279 --> 00:23:26,670
can fit into a rocket so that's one

486
00:23:25,470 --> 00:23:27,930
thing to note about another thing to

487
00:23:26,670 --> 00:23:29,820
know about is there's no baffle all

488
00:23:27,930 --> 00:23:31,980
right so so Hubble is enclosed into a

489
00:23:29,819 --> 00:23:33,659
tube in order to make this deployment

490
00:23:31,980 --> 00:23:36,900
here you couldn't have have a tube

491
00:23:33,660 --> 00:23:38,490
around it so there's no baffle and the

492
00:23:36,900 --> 00:23:41,400
final thing to note is this big thing

493
00:23:38,490 --> 00:23:43,589
that it sits on and that's a that's a

494
00:23:41,400 --> 00:23:45,150
Sun shield and the reason you need a Sun

495
00:23:43,589 --> 00:23:47,279
shield they said to have an infertility

496
00:23:45,150 --> 00:23:49,350
up that is sensitive that can see faint

497
00:23:47,279 --> 00:23:51,000
things needed to be super cold

498
00:23:49,349 --> 00:23:52,829
I really really called Hubble it's kind

499
00:23:51,000 --> 00:23:54,390

of room temperature this has to be much

500

00:23:52,829 --> 00:23:56,549

much much colder and we'll go into that

501

00:23:54,390 --> 00:23:58,080

a little bit more detail so in order to

502

00:23:56,549 --> 00:24:00,119

keep this cold you

503

00:23:58,079 --> 00:24:01,349

have soul sunlight shining directly on

504

00:24:00,119 --> 00:24:04,319

it so you have to have this big

505

00:24:01,349 --> 00:24:06,839

insulating shield to protect it from the

506

00:24:04,319 --> 00:24:08,428

Sun it also means that that you know

507

00:24:06,839 --> 00:24:10,949

there are some limitations and where you

508

00:24:08,429 --> 00:24:14,070

can point because you can't turn this R

509

00:24:10,950 --> 00:24:15,690

to face the Sun I mean if if the if the

510

00:24:14,069 --> 00:24:18,000

telescope itself would ever see the Sun

511

00:24:15,690 --> 00:24:21,720

it would heat up and and ruin your your

512

00:24:18,000 --> 00:24:23,398

day alright so what we have now today is

513

00:24:21,720 --> 00:24:26,038

is something that looks more like that

514
00:24:23,398 --> 00:24:27,658
comes from the napkin ends up it subs

515
00:24:26,038 --> 00:24:30,569
like this here and so you have to go far

516
00:24:27,659 --> 00:24:33,028
away from from the both the earth and

517
00:24:30,569 --> 00:24:35,398
the moon because the earth is is like a

518
00:24:33,028 --> 00:24:37,288
big heat lamp as well and so it goes a

519
00:24:35,398 --> 00:24:40,199
million miles away from the earth down

520
00:24:37,288 --> 00:24:41,278
to a point in space called L2 which is

521
00:24:40,200 --> 00:24:42,659
point of balance between the

522
00:24:41,278 --> 00:24:46,288
gravitational field of the Sun and the

523
00:24:42,659 --> 00:24:49,019
earth but I find it fascinating that

524
00:24:46,288 --> 00:24:51,359
from that all drawing and what it looks

525
00:24:49,019 --> 00:24:53,220
like today I mean you can kind of

526
00:24:51,359 --> 00:24:54,778
recognize it has the elements it has no

527
00:24:53,220 --> 00:25:01,038
baffle it has a deployable mirror and

528
00:24:54,778 --> 00:25:03,269
has a big Sun shield alright alright so

529
00:25:01,038 --> 00:25:05,190
let me talk a little bit more about so

530
00:25:03,269 --> 00:25:06,569
the the general application of infrared

531
00:25:05,190 --> 00:25:09,028
as well and so Frank talked a little bit

532
00:25:06,569 --> 00:25:10,950
about that just just earlier like one

533
00:25:09,028 --> 00:25:12,690
thing is you can you can see very faint

534
00:25:10,950 --> 00:25:13,519
galaxies but you can do so much more

535
00:25:12,690 --> 00:25:16,710
than that

536
00:25:13,519 --> 00:25:20,038
so hey here's an example here you can

537
00:25:16,710 --> 00:25:21,600
look at at the formation of stars and

538
00:25:20,038 --> 00:25:23,879
planets for example here so here if you

539
00:25:21,599 --> 00:25:25,500
got on a dark night on a dark place

540
00:25:23,880 --> 00:25:27,090
that's much darker than Baltimore or

541
00:25:25,500 --> 00:25:28,470
most places on the East Coast but if

542

00:25:27,089 --> 00:25:30,388
you're lucky you can you'll have access

543
00:25:28,470 --> 00:25:33,750
to a to a dark place like this you can

544
00:25:30,388 --> 00:25:36,869
see the Milky Way yes up here is you see

545
00:25:33,750 --> 00:25:38,159
you there that's a laser yeah up here

546
00:25:36,869 --> 00:25:40,739
you have close the center of the Milky

547
00:25:38,159 --> 00:25:42,510
Way and you also see that the Milky Way

548
00:25:40,740 --> 00:25:43,859
is you know there's a bright still a

549
00:25:42,509 --> 00:25:47,278
background field but there's and there's

550
00:25:43,859 --> 00:25:50,189
lots of dark clouds in those dark clouds

551
00:25:47,278 --> 00:25:53,220
of course are consist of gas and dust

552
00:25:50,190 --> 00:25:54,659
and this is where stars form so you can

553
00:25:53,220 --> 00:25:55,950
zoom into one of the places let me let

554
00:25:54,659 --> 00:25:58,679
me go back here so you can see here this

555
00:25:55,950 --> 00:26:02,639
go to a better image here assuming that

556
00:25:58,679 --> 00:26:06,059

that region here low resolution Frank

557

00:26:02,638 --> 00:26:07,439

does you can enhance this this is a one

558

00:26:06,058 --> 00:26:10,230

of the nearest star forming regions it's

559

00:26:07,440 --> 00:26:11,390

about four times near three or four

560

00:26:10,230 --> 00:26:13,548

times nearer than or

561

00:26:11,390 --> 00:26:16,549

and Frank showed this it's called a few

562

00:26:13,548 --> 00:26:19,450

cos this is an area that forms stars

563

00:26:16,548 --> 00:26:21,740

much like our Sun so low-mass stars and

564

00:26:19,450 --> 00:26:24,080

but it's really dominating and you can

565

00:26:21,740 --> 00:26:25,490

see these streamers here of dust that's

566

00:26:24,079 --> 00:26:28,669

what you see and again these are visible

567

00:26:25,490 --> 00:26:30,200

visible images you can make a bigger

568

00:26:28,670 --> 00:26:31,730

telescope you can make a deeper

569

00:26:30,200 --> 00:26:32,750

integration here and you see more more

570

00:26:31,730 --> 00:26:35,120

structure here again it's the same

571
00:26:32,750 --> 00:26:37,970
region it's just a longer integration

572
00:26:35,119 --> 00:26:40,669
time with a bigger telescope can zoom in

573
00:26:37,970 --> 00:26:43,100
on that yeah and you see more of this

574
00:26:40,670 --> 00:26:45,590
this dark cloud he don't he can also

575
00:26:43,099 --> 00:26:47,029
enhance that so again we have dark cloud

576
00:26:45,589 --> 00:26:48,859
here so I wants you to focus in this

577
00:26:47,029 --> 00:26:49,639
area here very dark but not much is

578
00:26:48,859 --> 00:26:54,918
going on there

579
00:26:49,640 --> 00:26:58,100
zoom in again here Wow enhance okay this

580
00:26:54,919 --> 00:27:00,380
is very dark again this is a low mass

581
00:26:58,099 --> 00:27:02,808
star forming region once you go to the

582
00:27:00,380 --> 00:27:04,820
to the infrared let's go a little bit

583
00:27:02,808 --> 00:27:08,298
into the infrared to start with that but

584
00:27:04,819 --> 00:27:09,649
also note that you see the dark cloudy

585
00:27:08,298 --> 00:27:11,179
and you see around it there's there's

586
00:27:09,650 --> 00:27:12,980
some light here this is actually light

587
00:27:11,179 --> 00:27:15,259
that's scattered off of dust grains from

588
00:27:12,980 --> 00:27:16,339
stars in the surrounding area so you see

589
00:27:15,259 --> 00:27:18,619
a little bit of light there when you go

590
00:27:16,339 --> 00:27:20,720
into the near-infrared just you know to

591
00:27:18,619 --> 00:27:22,879
micro 2 micrometers or so it looks like

592
00:27:20,720 --> 00:27:26,179
this so all the scattered light fades

593
00:27:22,880 --> 00:27:28,820
away and you start to see these these

594
00:27:26,179 --> 00:27:31,460
red things inside the cloud these are

595
00:27:28,819 --> 00:27:34,069
forming young stars that were there were

596
00:27:31,460 --> 00:27:35,870
hidden before and you see look and you

597
00:27:34,069 --> 00:27:38,659
see a lot of these these more widely

598
00:27:35,869 --> 00:27:40,668
stars he's a background stars so stars

599

00:27:38,660 --> 00:27:41,960
located behind the cloud but there's

600
00:27:40,669 --> 00:27:43,610
more to it than that so this is just to

601
00:27:41,960 --> 00:27:46,400
my friend so so the Hubble can sort of

602
00:27:43,609 --> 00:27:48,859
almost which this kind of infrared James

603
00:27:46,400 --> 00:27:51,290
Webb can do more all right so if you

604
00:27:48,859 --> 00:27:54,019
continue a journey into the mid infrared

605
00:27:51,289 --> 00:27:56,839
into the thermal infrared this area

606
00:27:54,019 --> 00:27:59,750
looks like this and what you see now is

607
00:27:56,839 --> 00:28:02,209
that dust itself starts to shine so in a

608
00:27:59,750 --> 00:28:04,730
near infrared you see through dust in

609
00:28:02,210 --> 00:28:07,160
the mid infrared dust itself lights up

610
00:28:04,730 --> 00:28:09,798
so here you see this bright areas here

611
00:28:07,160 --> 00:28:12,320
these are actually tiny dust grains that

612
00:28:09,798 --> 00:28:15,369
are made of it's kind of like a smog

613
00:28:12,319 --> 00:28:18,589

it's made of complex organic chemistry

614

00:28:15,369 --> 00:28:21,349

those light up brightly you also see

615

00:28:18,589 --> 00:28:23,389

these red stars now you know these

616

00:28:21,349 --> 00:28:24,658

scattered in among these these blue

617

00:28:23,390 --> 00:28:26,278

stars the

618

00:28:24,659 --> 00:28:27,989

nustar's you just regular starter in

619

00:28:26,278 --> 00:28:29,398

infrared and emit infrared this will be

620

00:28:27,989 --> 00:28:31,590

blue these are background stars just

621

00:28:29,398 --> 00:28:32,668

boring old stars with nothing under

622

00:28:31,589 --> 00:28:35,069

although of course many of them will

623

00:28:32,669 --> 00:28:37,379

have planets but the red ones here those

624

00:28:35,069 --> 00:28:38,788

are stars that have protoplanetary discs

625

00:28:37,378 --> 00:28:41,638

around them so they're surrounded by

626

00:28:38,788 --> 00:28:43,169

discs of gas and dust that are circling

627

00:28:41,638 --> 00:28:45,178

around them and those discs actively

628
00:28:43,169 --> 00:28:47,159
forming planets so when you go to the

629
00:28:45,179 --> 00:28:49,590
midden for this it's it's very easy to

630
00:28:47,159 --> 00:28:51,149
pick out the objects that are right now

631
00:28:49,589 --> 00:28:56,668
currently forming planets it's the red

632
00:28:51,148 --> 00:28:59,638
ones and and so and this is an example

633
00:28:56,669 --> 00:29:04,649
of what you gain from going to longer

634
00:28:59,638 --> 00:29:07,348
wavelengths and and Hubble beyond the

635
00:29:04,648 --> 00:29:10,348
original galaxy formation case and so

636
00:29:07,348 --> 00:29:13,108
why is it that that that you see dust in

637
00:29:10,348 --> 00:29:15,689
and mid-infrared wavelengths well what

638
00:29:13,108 --> 00:29:18,898
you can do is is you can look at this

639
00:29:15,690 --> 00:29:20,970
relation here between temperature and

640
00:29:18,898 --> 00:29:23,728
wavelengths so anything that has a

641
00:29:20,970 --> 00:29:25,798
temperature emits light if it's if it's

642
00:29:23,729 --> 00:29:29,669
hot enough you know you can get white

643
00:29:25,798 --> 00:29:31,950
hot iron for example that emits light on

644
00:29:29,669 --> 00:29:34,169
its own because it's hot enough and

645
00:29:31,950 --> 00:29:35,788
stars emit light because they're hot in

646
00:29:34,169 --> 00:29:37,889
offices so starts a thousands of degrees

647
00:29:35,788 --> 00:29:39,658
on their surface and so we can see them

648
00:29:37,888 --> 00:29:41,638
you look at the Sun it emits lights on

649
00:29:39,659 --> 00:29:43,080
its own the earth it we're standing on

650
00:29:41,638 --> 00:29:44,969
it's also emitting light but we can see

651
00:29:43,079 --> 00:29:47,038
it because it emits light in the

652
00:29:44,970 --> 00:29:48,329
infrared because it's cooler and so this

653
00:29:47,038 --> 00:29:50,878
is just to give an indication of

654
00:29:48,329 --> 00:29:53,428
relation between the temperature of an

655
00:29:50,878 --> 00:29:55,138
object you know different planets and in

656

00:29:53,429 --> 00:29:58,080
the solar system and what wavelengths

657
00:29:55,138 --> 00:29:59,939
their peak emission comes out at so you

658
00:29:58,079 --> 00:30:01,288
have stars here through the visible once

659
00:29:59,940 --> 00:30:04,200
you go out into the infrared you have

660
00:30:01,288 --> 00:30:05,759
Venus comes here that peaks at 4-4

661
00:30:04,200 --> 00:30:08,729
micron or something like that

662
00:30:05,759 --> 00:30:10,558
earth itself itself emission peaks at

663
00:30:08,729 --> 00:30:12,690
around 10 micrometers and then if you

664
00:30:10,558 --> 00:30:14,339
garden the outer solar system you end up

665
00:30:12,690 --> 00:30:16,139
in in beyond the mid infrared what's

666
00:30:14,339 --> 00:30:18,209
called the far infrared so something

667
00:30:16,138 --> 00:30:22,108
like Pluto emits most of it light slide

668
00:30:18,210 --> 00:30:23,970
at you know 70 80 micro meters beyond

669
00:30:22,108 --> 00:30:26,728
what j-dub is T can do but you can see

670
00:30:23,970 --> 00:30:29,729

that that that the data was T range here

671

00:30:26,729 --> 00:30:31,019

the web range is is perfect if you're

672

00:30:29,729 --> 00:30:34,649

interested in looking at things that

673

00:30:31,019 --> 00:30:35,970

have room temperature and of course you

674

00:30:34,648 --> 00:30:37,459

are right because we're interested in

675

00:30:35,970 --> 00:30:39,589

looking at planets with room temp

676

00:30:37,460 --> 00:30:44,120

for example we're interested in look in

677

00:30:39,589 --> 00:30:46,788

understanding dust and material in in

678

00:30:44,119 --> 00:30:48,979

planet-forming regions that that is much

679

00:30:46,788 --> 00:30:51,079

like you know what we're surrounded yeah

680

00:30:48,980 --> 00:30:52,190

in in this room so if you're not so

681

00:30:51,079 --> 00:30:53,569

lesson is if you want to look at cool

682

00:30:52,190 --> 00:30:55,220

cool things you want to go to the middle

683

00:30:53,569 --> 00:30:58,668

into there to the infrared and

684

00:30:55,220 --> 00:31:01,370

particularly the median fret alright so

685
00:30:58,669 --> 00:31:02,750
in terms of size for that so again you

686
00:31:01,369 --> 00:31:07,449
want to be cold you want to be big this

687
00:31:02,750 --> 00:31:12,019
is James Webb compared to to Hubble

688
00:31:07,450 --> 00:31:15,080
they're actually about in in a sense the

689
00:31:12,019 --> 00:31:17,028
data base T is not that that much much

690
00:31:15,079 --> 00:31:19,210
bigger that's actually in terms of mass

691
00:31:17,028 --> 00:31:21,798
not a much different and and then Hubble

692
00:31:19,210 --> 00:31:25,669
but because it has this this sort of

693
00:31:21,798 --> 00:31:27,889
modern design with no baffle dominated

694
00:31:25,669 --> 00:31:31,460
by Sun shield which is really very thin

695
00:31:27,890 --> 00:31:33,200
layers of insulating material you can

696
00:31:31,460 --> 00:31:38,210
get a much bigger telescope for the same

697
00:31:33,200 --> 00:31:41,360
for the same kind of of mass here is

698
00:31:38,210 --> 00:31:44,028
here is the design related to keeping a

699
00:31:41,359 --> 00:31:47,719
telescope cool so you'll have this side

700
00:31:44,028 --> 00:31:49,640
here which is always facing the Sun it's

701
00:31:47,720 --> 00:31:53,600
a warm side and so that contains the

702
00:31:49,640 --> 00:31:55,250
spacecraft communications computer all

703
00:31:53,599 --> 00:31:56,500
those things it's actually quite hot

704
00:31:55,250 --> 00:31:59,630
about a hundred eighty five degrees

705
00:31:56,500 --> 00:32:01,640
Fahrenheit and then as a cold side here

706
00:31:59,630 --> 00:32:05,000
with all the with the science payload is

707
00:32:01,640 --> 00:32:06,559
because has all the optics light comes

708
00:32:05,000 --> 00:32:10,038
in here bounces off the primary because

709
00:32:06,558 --> 00:32:11,869
the secondary goes into this package

710
00:32:10,038 --> 00:32:13,609
here which is the the instrument package

711
00:32:11,869 --> 00:32:16,129
so all the science instrument cameras

712
00:32:13,609 --> 00:32:19,278
and things like that sits it behind the

713

00:32:16,130 --> 00:32:22,309
the primary mirror here and is also on

714
00:32:19,278 --> 00:32:24,710
the cold side about minus 400 degrees

715
00:32:22,308 --> 00:32:26,418
Fahrenheit so you can imagine the

716
00:32:24,710 --> 00:32:28,069
temperature gradient across here is

717
00:32:26,419 --> 00:32:29,390
enormous through these five layers of

718
00:32:28,069 --> 00:32:31,009
Sun shield it's it's quite an

719
00:32:29,390 --> 00:32:37,270
engineering feat to to make that

720
00:32:31,009 --> 00:32:40,609
possible so what do you get from having

721
00:32:37,269 --> 00:32:43,700
a large telescope that is cold in the

722
00:32:40,609 --> 00:32:46,099
infrared well we can compare what in a

723
00:32:43,700 --> 00:32:48,740
million Fred what Webb can do compared

724
00:32:46,099 --> 00:32:49,969
to what has been possible in the past

725
00:32:48,740 --> 00:32:51,019
for example with the Spitzer Space

726
00:32:49,970 --> 00:32:53,180
Telescope

727
00:32:51,019 --> 00:32:55,700

we may have heard about which is NASA's

728

00:32:53,180 --> 00:32:59,299

last infrared telescope which was an 85

729

00:32:55,700 --> 00:33:03,590

centimeter mirror right so just over

730

00:32:59,299 --> 00:33:05,629

over a couple of feet so if you look at

731

00:33:03,589 --> 00:33:08,269

the science case where you're looking at

732

00:33:05,630 --> 00:33:09,830

star formation the star forming region I

733

00:33:08,269 --> 00:33:11,420

showed you and many others and Orion

734

00:33:09,829 --> 00:33:13,519

itself is all contained within this

735

00:33:11,420 --> 00:33:14,900

little circle here and in our galaxy

736

00:33:13,519 --> 00:33:19,400

it's quite far it's about eight

737

00:33:14,900 --> 00:33:22,310

kiloparsecs to the to the center once

738

00:33:19,400 --> 00:33:24,440

you go you go to web and you apply that

739

00:33:22,309 --> 00:33:27,710

to the same kind of science looking at

740

00:33:24,440 --> 00:33:29,809

young stars how far away in the galaxy

741

00:33:27,710 --> 00:33:31,490

can you can you do the same kind of

742
00:33:29,809 --> 00:33:34,159
science at Spitzer could do in the in

743
00:33:31,490 --> 00:33:38,630
the solar neighborhood well it expands

744
00:33:34,160 --> 00:33:40,660
our horizon like this and we web will

745
00:33:38,630 --> 00:33:43,460
allow us to do the same kind of science

746
00:33:40,660 --> 00:33:45,590
but across the galaxy two completely

747
00:33:43,460 --> 00:33:46,940
different regions we can we can look at

748
00:33:45,589 --> 00:33:49,039
star and planet information near the

749
00:33:46,940 --> 00:33:51,920
galactic center we can look go to the

750
00:33:49,039 --> 00:33:54,079
other side look for our you know what

751
00:33:51,920 --> 00:33:56,570
happens if you're you're out in areas

752
00:33:54,079 --> 00:33:58,539
where you don't have as much dust where

753
00:33:56,569 --> 00:34:01,250
less was formed with it's more quiet and

754
00:33:58,539 --> 00:34:05,170
we can really understand

755
00:34:01,250 --> 00:34:08,898
planets and stars in in a galactic

756
00:34:05,170 --> 00:34:10,909
context and a galactic sense all right

757
00:34:08,898 --> 00:34:13,668
compared to people this is how big it is

758
00:34:10,909 --> 00:34:15,829
so this is a model was at Goddard at

759
00:34:13,668 --> 00:34:18,529
this point here and see some of the

760
00:34:15,829 --> 00:34:20,719
people who've been working on it so it's

761
00:34:18,530 --> 00:34:24,019
about tennis court size once it's fully

762
00:34:20,719 --> 00:34:26,959
deployed of course you can't fit that

763
00:34:24,019 --> 00:34:29,719
into a rocket so so Webb will be

764
00:34:26,960 --> 00:34:32,630
launched by the European Space Agency in

765
00:34:29,719 --> 00:34:34,339
an area in five from Kourou in in South

766
00:34:32,630 --> 00:34:36,800
America and so here's an example of that

767
00:34:34,340 --> 00:34:39,019
and you can look inside the Ariane 5

768
00:34:36,800 --> 00:34:41,240
fairing here and you can see how Webb

769
00:34:39,019 --> 00:34:43,579
will be all folded up the sides will

770

00:34:41,239 --> 00:34:46,189
have come back from the from the primary

771
00:34:43,579 --> 00:34:48,230
mirror in orbit they get folded out and

772
00:34:46,190 --> 00:34:52,190
the Sun shield is also folded up into

773
00:34:48,230 --> 00:34:53,659
two pallets and sit along the the mirror

774
00:34:52,190 --> 00:34:55,490
so it's again it's a quite an

775
00:34:53,659 --> 00:34:57,920
engineering feat to make this all fit

776
00:34:55,489 --> 00:35:02,119
together so it can fit inside and in an

777
00:34:57,920 --> 00:35:04,550
area in five there's a lot of progress

778
00:35:02,119 --> 00:35:08,929
has been made on the telescope

779
00:35:04,550 --> 00:35:10,970
so here is here's a recent image from

780
00:35:08,929 --> 00:35:14,329
this is from Goddard when it was still

781
00:35:10,969 --> 00:35:16,789
there fully deployed science payload you

782
00:35:14,329 --> 00:35:19,159
can see the golden mirror here covered

783
00:35:16,789 --> 00:35:21,679
in gold for the best reflectivity in the

784
00:35:19,159 --> 00:35:23,719

in the infrared so I was covered in gold

785

00:35:21,679 --> 00:35:27,289

because he's a secondary up here also

786

00:35:23,719 --> 00:35:29,989

also covered in gold this is the the

787

00:35:27,289 --> 00:35:31,610

instrument module as you can see sea

788

00:35:29,989 --> 00:35:33,469

instruments that are bolted onto the

789

00:35:31,610 --> 00:35:35,390

sides here so it has four instruments in

790

00:35:33,469 --> 00:35:38,000

here I'll show you an overview of those

791

00:35:35,389 --> 00:35:40,819

a bit later here you can see the

792

00:35:38,000 --> 00:35:47,989

instrument package put in place behind

793

00:35:40,820 --> 00:35:50,570

the the primary mirror and after it was

794

00:35:47,989 --> 00:35:53,479

all completed the science payload at at

795

00:35:50,570 --> 00:35:56,950

Goddard was transported to Johnson Space

796

00:35:53,480 --> 00:36:00,849

Center in in Texas where underwent

797

00:35:56,949 --> 00:36:06,259

extensive tests with the inside this big

798

00:36:00,849 --> 00:36:07,880

vacuum cryogenic vacuum chamber had to

799
00:36:06,260 --> 00:36:12,650
be very big this was originally built

800
00:36:07,880 --> 00:36:14,119
for for testing Apollo and so so the

801
00:36:12,650 --> 00:36:16,070
whole the whole science payload was

802
00:36:14,119 --> 00:36:17,000
tested all together in there and that

803
00:36:16,070 --> 00:36:19,160
test has just been successfully

804
00:36:17,000 --> 00:36:23,210
completed and it's out of that that

805
00:36:19,159 --> 00:36:25,399
chamber again and here you have the the

806
00:36:23,210 --> 00:36:28,039
sunshield they'll be as a spacecraft

807
00:36:25,400 --> 00:36:29,539
pass underneath here with all that

808
00:36:28,039 --> 00:36:32,960
basically these are the two pieces at

809
00:36:29,539 --> 00:36:35,230
the left of the observatory so the

810
00:36:32,960 --> 00:36:37,309
science payload he'll be shipped to

811
00:36:35,230 --> 00:36:39,440
Northrop Grumman in California

812
00:36:37,309 --> 00:36:40,849
where the Sun shield is and will be made

813
00:36:39,440 --> 00:36:42,650
it two together and it'll be a number of

814
00:36:40,849 --> 00:36:43,608
tests all together with a spacecraft all

815
00:36:42,650 --> 00:36:45,670
together and for the first time you'll

816
00:36:43,608 --> 00:36:48,108
be able to see the whole thing together

817
00:36:45,670 --> 00:36:49,220
instead of looking at at artist's

818
00:36:48,108 --> 00:36:50,690
impressions and that's the best

819
00:36:49,219 --> 00:36:52,879
essentially last step that integration

820
00:36:50,690 --> 00:36:54,619
and testing then it'll be packed up and

821
00:36:52,880 --> 00:36:58,460
shipped to to South America for launch

822
00:36:54,619 --> 00:37:03,559
which is slated for the second quarter

823
00:36:58,460 --> 00:37:04,880
right now of 2019 at the end of you know

824
00:37:03,559 --> 00:37:06,529
you might want to stick around to the

825
00:37:04,880 --> 00:37:10,280
end of this presentation because there's

826
00:37:06,530 --> 00:37:13,060
we have a very very very cool little

827

00:37:10,280 --> 00:37:18,290
video that shows the Assembly of this so

828
00:37:13,059 --> 00:37:21,849
it looks nice alright so

829
00:37:18,289 --> 00:37:21,849
there's a number of science instruments

830
00:37:22,179 --> 00:37:27,769
in the Observatory name before called

831
00:37:25,250 --> 00:37:29,000
near speck near kam Mirian nearest point

832
00:37:27,769 --> 00:37:31,610
of this year is that this is what it's

833
00:37:29,000 --> 00:37:33,889
called a focal plane so essentially when

834
00:37:31,610 --> 00:37:36,019
you're pointed on the sky each

835
00:37:33,889 --> 00:37:37,809
instrument points at some place in the

836
00:37:36,019 --> 00:37:40,250
sky the same time but not the same place

837
00:37:37,809 --> 00:37:42,590
so here near kam that's a near infrared

838
00:37:40,250 --> 00:37:44,599
camera that will point at this part of

839
00:37:42,590 --> 00:37:48,140
the sky Miri which is emit infrared

840
00:37:44,599 --> 00:37:49,789
instrument pointer to sky the same time

841
00:37:48,139 --> 00:37:51,650

but a slightly different different spot

842

00:37:49,789 --> 00:37:53,420

so it's actually possible to operate

843

00:37:51,650 --> 00:37:55,039

more than one instrument at the same

844

00:37:53,420 --> 00:37:56,869

time and can take pictures with both

845

00:37:55,039 --> 00:37:57,860

near cam and with Miri at the same time

846

00:37:56,869 --> 00:38:00,019

they're just looking at slightly

847

00:37:57,860 --> 00:38:03,349

different spots in the sky and if you're

848

00:38:00,019 --> 00:38:06,170

smart you might say if you're mapping a

849

00:38:03,349 --> 00:38:07,730

larger region and by stepping the

850

00:38:06,170 --> 00:38:09,320

telescope you know maybe over here and

851

00:38:07,730 --> 00:38:10,730

taking another image stepping it over

852

00:38:09,320 --> 00:38:12,650

here taking another image stepping it

853

00:38:10,730 --> 00:38:15,170

over here take another image and so on

854

00:38:12,650 --> 00:38:17,360

you might have an overlap region where

855

00:38:15,170 --> 00:38:19,220

where both instruments are taking are

856
00:38:17,360 --> 00:38:20,840
taking data I want you to collect

857
00:38:19,219 --> 00:38:23,359
everything and so they are observing

858
00:38:20,840 --> 00:38:28,280
strategies that do that new speck is

859
00:38:23,360 --> 00:38:30,140
just spectroscopy in an infrared and the

860
00:38:28,280 --> 00:38:33,769
new is here that's that's the instrument

861
00:38:30,139 --> 00:38:35,659
that'll be or a lot of that instrument

862
00:38:33,769 --> 00:38:38,210
will be used to to take spectra of

863
00:38:35,659 --> 00:38:39,259
transiting exoplanets and and Barney is

864
00:38:38,210 --> 00:38:43,699
going to talk a little bit more about

865
00:38:39,260 --> 00:38:45,890
that later an important part of Webb

866
00:38:43,699 --> 00:38:48,109
compared to Hubble is that it's not just

867
00:38:45,889 --> 00:38:50,179
imaging there's coarsest and imaging

868
00:38:48,110 --> 00:38:52,400
modes you know all the wavelengths but

869
00:38:50,179 --> 00:38:54,679
it has lots and lots of four instruments

870
00:38:52,400 --> 00:38:55,579
that do spectroscopy and like why do you

871
00:38:54,679 --> 00:38:58,609
do spectroscopy

872
00:38:55,579 --> 00:39:01,460
well imaging typically will tell you

873
00:38:58,610 --> 00:39:03,920
where things are but spectroscopy will

874
00:39:01,460 --> 00:39:06,320
tell you what they're made of so if

875
00:39:03,920 --> 00:39:10,039
you're interested in say looking at

876
00:39:06,320 --> 00:39:12,710
what's the composition of planet-forming

877
00:39:10,039 --> 00:39:14,360
disks or a young star or galaxy you take

878
00:39:12,710 --> 00:39:15,740
a spectrum of it and it'll really reveal

879
00:39:14,360 --> 00:39:18,170
what's what what's there in particular

880
00:39:15,739 --> 00:39:19,609
like for example is I said interested in

881
00:39:18,170 --> 00:39:22,010
if there's water there you'd need a

882
00:39:19,610 --> 00:39:24,140
spectrum typically to tell you that

883
00:39:22,010 --> 00:39:28,010
and also will tell you properties of

884

00:39:24,139 --> 00:39:29,029
that example how hot it is and so we

885
00:39:28,010 --> 00:39:32,750
expect to be lots and lots of

886
00:39:29,030 --> 00:39:36,710
spectroscopy done with with Webb alright

887
00:39:32,750 --> 00:39:39,050
so at the end of the telescope part I'll

888
00:39:36,710 --> 00:39:57,380
hand it on to Barney talk about the

889
00:39:39,050 --> 00:40:01,240
science okay hi really okay so yes I'm

890
00:39:57,380 --> 00:40:01,240
going to talk about the science day and

891
00:40:02,710 --> 00:40:10,280
there's you know the class was talking

892
00:40:06,380 --> 00:40:13,130
about how great of a history Webb

893
00:40:10,280 --> 00:40:16,519
telescope has had in coming to what it

894
00:40:13,130 --> 00:40:21,130
is today and it came up do you know the

895
00:40:16,519 --> 00:40:24,889
original cases for the science wise were

896
00:40:21,130 --> 00:40:26,690
we're very far away from home you know

897
00:40:24,889 --> 00:40:30,019
there there are these these early early

898
00:40:26,690 --> 00:40:31,700

galaxies and then as the cases all

899

00:40:30,019 --> 00:40:35,300

develop the science cases developed

900

00:40:31,699 --> 00:40:36,469

there really settled on four big topics

901

00:40:35,300 --> 00:40:39,620

so I'm going to take you guys through

902

00:40:36,469 --> 00:40:43,609

these four big topics one of them still

903

00:40:39,619 --> 00:40:45,920

remain remains the first light in the

904

00:40:43,610 --> 00:40:48,890

universe so some of those first galaxies

905

00:40:45,920 --> 00:40:52,220

to form in the universe how did that

906

00:40:48,889 --> 00:40:55,670

happen how do those galaxies then grow

907

00:40:52,219 --> 00:40:58,250

over cosmic time some of that work is

908

00:40:55,670 --> 00:41:01,670

motivated again by by Hubble and other

909

00:40:58,250 --> 00:41:05,690

telescopes looking at all these

910

00:41:01,670 --> 00:41:08,119

different epochs of galaxies then we

911

00:41:05,690 --> 00:41:10,760

come to how do stars and planets form

912

00:41:08,119 --> 00:41:13,130

we're getting closer to home and smaller

913
00:41:10,760 --> 00:41:14,540
and smaller show you tell you guys a

914
00:41:13,130 --> 00:41:17,110
little bit more about that and finally

915
00:41:14,539 --> 00:41:20,949
what our planetary atmospheres made of

916
00:41:17,110 --> 00:41:24,230
so over the course of all the science of

917
00:41:20,949 --> 00:41:26,149
and the science case made for Webb as it

918
00:41:24,230 --> 00:41:29,269
was being developed we discovered

919
00:41:26,150 --> 00:41:31,280
exoplanets and we started looking at

920
00:41:29,269 --> 00:41:33,050
them and we'd be developed techniques

921
00:41:31,280 --> 00:41:38,030
for actually being able to probe their

922
00:41:33,050 --> 00:41:40,970
atmospheres so this is a these four big

923
00:41:38,030 --> 00:41:44,990
themes may seem obvious to us right now

924
00:41:40,969 --> 00:41:47,149
but it's been such a long

925
00:41:44,989 --> 00:41:49,549
with a lot of people involved that that

926
00:41:47,150 --> 00:41:51,019
these weren't necessarily what we

927
00:41:49,550 --> 00:41:53,600
thought we'd be able to get out of this

928
00:41:51,019 --> 00:41:57,829
telescope when it first started I'll

929
00:41:53,599 --> 00:42:00,880
also add that like Hubble I'm sure even

930
00:41:57,829 --> 00:42:04,929
more things will come out of Webb so

931
00:42:00,880 --> 00:42:07,490
back to these these are these first

932
00:42:04,929 --> 00:42:11,199
first light and the epoch of

933
00:42:07,489 --> 00:42:14,089
reionization so this is a graphic of

934
00:42:11,199 --> 00:42:16,669
cosmic time basically so we start all

935
00:42:14,090 --> 00:42:20,120
the way over here with the Big Bang

936
00:42:16,670 --> 00:42:22,220
okay who's heard of the Big Bang pants

937
00:42:20,119 --> 00:42:23,809
okay good you got I see a lot of regular

938
00:42:22,219 --> 00:42:26,269
faces out there too so okay I figured if

939
00:42:23,809 --> 00:42:29,299
you guys need okay so everything's the

940
00:42:26,269 --> 00:42:32,840
universe starts basically okay

941

00:42:29,300 --> 00:42:34,789
then there's it's just a big soupy mess

942
00:42:32,840 --> 00:42:38,329
basically that's that's the technical

943
00:42:34,789 --> 00:42:40,340
term for it a soupy mess and you go

944
00:42:38,329 --> 00:42:44,860
through what's what's called radiation

945
00:42:40,340 --> 00:42:48,950
era and the dark ages and then we

946
00:42:44,860 --> 00:42:52,700
photons come flooding out and we call it

947
00:42:48,949 --> 00:42:54,919
the epoch of rihanna's ation so from

948
00:42:52,699 --> 00:42:57,500
that we start being able to so that from

949
00:42:54,920 --> 00:42:59,840
this epoch of reorganisation particles

950
00:42:57,500 --> 00:43:04,010
start coming together we start getting

951
00:42:59,840 --> 00:43:07,010
little little protons and neutrons and

952
00:43:04,010 --> 00:43:09,440
those you know those those early that

953
00:43:07,010 --> 00:43:13,000
that early stuff the the hydrogen and

954
00:43:09,440 --> 00:43:15,650
the helium starts forming some stars and

955
00:43:13,000 --> 00:43:19,489

eventually all that stuff comes together

956

00:43:15,650 --> 00:43:23,119

and forms those first galaxies okay and

957

00:43:19,489 --> 00:43:24,949

then from there we have you know a whole

958

00:43:23,119 --> 00:43:28,069

bunch of stuff happens and then we have

959

00:43:24,949 --> 00:43:31,039

the beautiful jewel box gem box that we

960

00:43:28,070 --> 00:43:32,450

now have of galaxies in things we've

961

00:43:31,039 --> 00:43:34,190

seen that are part of popular culture

962

00:43:32,449 --> 00:43:36,230

like the Hubble Deep fields

963

00:43:34,190 --> 00:43:39,769

so you're regulars I'm sure you have the

964

00:43:36,230 --> 00:43:43,159

lithograph of that so give you guys a

965

00:43:39,769 --> 00:43:47,900

kind of an interesting view of what I

966

00:43:43,159 --> 00:43:54,379

just talked about but with beautiful

967

00:43:47,900 --> 00:43:55,940

animation you see stuff starting to all

968

00:43:54,380 --> 00:43:57,570

these little stars these first stars

969

00:43:55,940 --> 00:44:00,269

starting to come

970
00:43:57,570 --> 00:44:07,680
together eventually we get we get lots

971
00:44:00,269 --> 00:44:12,289
of galaxies forming we get this kind of

972
00:44:07,679 --> 00:44:15,059
thing happening and this is what we're

973
00:44:12,289 --> 00:44:18,170
looking for we're looking for these

974
00:44:15,059 --> 00:44:20,849
first stars and galaxies to form

975
00:44:18,170 --> 00:44:24,079
eventually start populating the entire

976
00:44:20,849 --> 00:44:26,849
universe gravitationally interact and

977
00:44:24,079 --> 00:44:29,190
hopefully hopefully we can see the light

978
00:44:26,849 --> 00:44:32,579
from those okay and this will give us a

979
00:44:29,190 --> 00:44:34,829
bit a greater appreciation and better

980
00:44:32,579 --> 00:44:37,549
understanding of what's going on out

981
00:44:34,829 --> 00:44:40,650
there how are all of these galaxies

982
00:44:37,550 --> 00:44:43,500
forming how are they evolving what do

983
00:44:40,650 --> 00:44:46,320
they look like as they're evolving so

984
00:44:43,500 --> 00:44:48,719
white right now with Hubble we've been

985
00:44:46,320 --> 00:44:51,660
able to look back with things like the

986
00:44:48,719 --> 00:44:54,119
Hubble Ultra Deep Field back even

987
00:44:51,659 --> 00:44:56,909
further with special projects like the

988
00:44:54,119 --> 00:45:00,389
frontier fields which used gravitational

989
00:44:56,909 --> 00:45:04,019
lensing to be able to probe even farther

990
00:45:00,389 --> 00:45:06,420
back toward more distant galaxies but

991
00:45:04,019 --> 00:45:08,880
really all we've seen or maybe you know

992
00:45:06,420 --> 00:45:12,329
if you compare it to a human life span

993
00:45:08,880 --> 00:45:14,670
something like a toddler okay what we

994
00:45:12,329 --> 00:45:16,860
may be maybe an infant but maybe like

995
00:45:14,670 --> 00:45:18,990
eight nine months old what we want to

996
00:45:16,860 --> 00:45:22,530
see are those baby baby pictures those

997
00:45:18,989 --> 00:45:26,219
infants that newborn and we want to see

998

00:45:22,530 --> 00:45:29,400
that that chubby squishy little face and

999
00:45:26,219 --> 00:45:31,709
see what exactly the full lifespan of

1000
00:45:29,400 --> 00:45:34,740
galaxies has been in our universe so

1001
00:45:31,710 --> 00:45:37,470
that's really important to us and you

1002
00:45:34,739 --> 00:45:39,000
see just that get to get to this you

1003
00:45:37,469 --> 00:45:42,389
know up a point today where we can look

1004
00:45:39,000 --> 00:45:45,630
out through any soda straw out into the

1005
00:45:42,389 --> 00:45:50,099
universe and see a jewel box of galaxies

1006
00:45:45,630 --> 00:45:52,079
of all different types so and to be able

1007
00:45:50,099 --> 00:45:54,809
to look at those galaxies that are

1008
00:45:52,079 --> 00:45:58,049
closer in and more modern or

1009
00:45:54,809 --> 00:46:00,420
contemporary and see what is going on

1010
00:45:58,050 --> 00:46:02,100
inside of those galaxies so this this

1011
00:46:00,420 --> 00:46:06,570
comes back to that second science theme

1012
00:46:02,099 --> 00:46:10,799

of of the the galaxy evolution and what

1013

00:46:06,570 --> 00:46:11,550

galaxies are looking like today so you

1014

00:46:10,800 --> 00:46:13,650

see this

1015

00:46:11,550 --> 00:46:17,039

perfectly divided down the middle this

1016

00:46:13,650 --> 00:46:20,610

is the infrared side and this is the

1017

00:46:17,039 --> 00:46:23,300

visible side so you may have seen this

1018

00:46:20,610 --> 00:46:25,680

side of the whole thing the visible side

1019

00:46:23,300 --> 00:46:28,650

because I believe we also have beautiful

1020

00:46:25,679 --> 00:46:30,119

Hubble images of this in the lithographs

1021

00:46:28,650 --> 00:46:32,670

that you may have received at public

1022

00:46:30,119 --> 00:46:35,339

lecture series you can see these bright

1023

00:46:32,670 --> 00:46:37,639

spots of star formation in here you

1024

00:46:35,340 --> 00:46:40,740

could also see these dark dust lanes

1025

00:46:37,639 --> 00:46:44,849

here that's all the dark parts here are

1026

00:46:40,739 --> 00:46:46,919

those dust lanes where the visible light

1027
00:46:44,849 --> 00:46:50,159
of what's going on in this galaxy can't

1028
00:46:46,920 --> 00:46:55,409
get through to our eyes or to Hubble's

1029
00:46:50,159 --> 00:46:58,739
eyes it can't pass through that dust but

1030
00:46:55,409 --> 00:47:00,899
when we look in the infrared all that

1031
00:46:58,739 --> 00:47:02,309
dust is glowing so we can see what's

1032
00:47:00,900 --> 00:47:05,610
going on with that dust so you see that

1033
00:47:02,309 --> 00:47:07,710
these dark lanes here suddenly become

1034
00:47:05,610 --> 00:47:09,539
the brightest thing and what we're

1035
00:47:07,710 --> 00:47:13,740
looking at in the infrared so that's

1036
00:47:09,539 --> 00:47:15,480
what we're hoping for with with Webb is

1037
00:47:13,739 --> 00:47:17,729
we're going to study these sorts of

1038
00:47:15,480 --> 00:47:20,699
things we're going to look at these dust

1039
00:47:17,730 --> 00:47:22,440
lanes in nearby galaxies and look for

1040
00:47:20,699 --> 00:47:25,259
what's happening there and how they're

1041
00:47:22,440 --> 00:47:31,909
glowing and trace map out all that that

1042
00:47:25,260 --> 00:47:35,820
dust and learn some more about it okay

1043
00:47:31,909 --> 00:47:40,170
third topic that I mentioned earlier was

1044
00:47:35,820 --> 00:47:42,980
the formation of stars and planets and I

1045
00:47:40,170 --> 00:47:47,130
think this is one that really strikes

1046
00:47:42,980 --> 00:47:49,139
people's imaginations because we're

1047
00:47:47,130 --> 00:47:52,500
living it every day you know you're

1048
00:47:49,139 --> 00:47:55,529
you're in you're living on a planet in a

1049
00:47:52,500 --> 00:47:57,840
solar system that has a star and so

1050
00:47:55,530 --> 00:48:00,780
every day you can look up at the sky and

1051
00:47:57,840 --> 00:48:05,400
think well how did that get there how

1052
00:48:00,780 --> 00:48:07,260
are we here and on a very everyday level

1053
00:48:05,400 --> 00:48:10,559
it's there so what we're looking at here

1054
00:48:07,260 --> 00:48:13,080
is something that Webb will be able to

1055

00:48:10,559 --> 00:48:16,710
look at which would be an early a

1056
00:48:13,079 --> 00:48:19,650
newborn star a forming star and with a

1057
00:48:16,710 --> 00:48:24,409
forming star you get this big disk of

1058
00:48:19,650 --> 00:48:28,990
gas and dust around it you get jets

1059
00:48:24,409 --> 00:48:33,190
I mean out of it of of really really hot

1060
00:48:28,989 --> 00:48:38,959
gas particles things like that then

1061
00:48:33,190 --> 00:48:41,599
inside you have the new star for me so

1062
00:48:38,960 --> 00:48:43,250
I'm gonna take this you know there we go

1063
00:48:41,599 --> 00:48:45,110
oh it's on repeat I didn't realize you

1064
00:48:43,250 --> 00:48:48,019
did that thank you

1065
00:48:45,110 --> 00:48:51,079
so we have this slider here that takes

1066
00:48:48,019 --> 00:48:55,099
you from the visible to the infrared of

1067
00:48:51,079 --> 00:48:56,539
this image and you can see those Jets I

1068
00:48:55,099 --> 00:48:59,829
was talking about when you look at it

1069
00:48:56,539 --> 00:49:02,900

and the visible all we see is that new

1070

00:48:59,829 --> 00:49:05,779

forming star right there the rest of it

1071

00:49:02,900 --> 00:49:07,460

is all dark dark dust because we can't

1072

00:49:05,780 --> 00:49:11,269

see light visible light coming through

1073

00:49:07,460 --> 00:49:14,659

it but in the infrared right here you

1074

00:49:11,269 --> 00:49:17,659

get to see those Jets become visible and

1075

00:49:14,659 --> 00:49:24,559

so we can learn more about how these

1076

00:49:17,659 --> 00:49:26,629

stars are forming and how what what

1077

00:49:24,559 --> 00:49:28,130

processes are happening and how they're

1078

00:49:26,630 --> 00:49:32,360

affecting the environment around those

1079

00:49:28,130 --> 00:49:36,039

stars one of the other things we can

1080

00:49:32,360 --> 00:49:40,760

look at as as Klaus mentioned earlier is

1081

00:49:36,039 --> 00:49:42,469

a spectra so doing spectroscopy I'm sure

1082

00:49:40,760 --> 00:49:44,180

many of you regular public lecture

1083

00:49:42,469 --> 00:49:48,619

series goers have heard about

1084
00:49:44,179 --> 00:49:50,569
spectroscopy a lot looking at what stuff

1085
00:49:48,619 --> 00:49:54,109
is made of what's really going on in

1086
00:49:50,570 --> 00:49:56,059
there so you get a taste of of a couple

1087
00:49:54,110 --> 00:50:00,079
of things here with web new ways to

1088
00:49:56,059 --> 00:50:03,289
probe these discs of material forming

1089
00:50:00,079 --> 00:50:06,019
around these stars so the new stars have

1090
00:50:03,289 --> 00:50:09,349
big protoplanetary discs okay you can

1091
00:50:06,019 --> 00:50:14,269
see them up here do I have a thing right

1092
00:50:09,349 --> 00:50:16,909
there yeah with the the star around it

1093
00:50:14,269 --> 00:50:19,250
with a big disc you know kind of like a

1094
00:50:16,909 --> 00:50:21,409
plate a frisbee something like that

1095
00:50:19,250 --> 00:50:25,429
around it and what we can do is we can

1096
00:50:21,409 --> 00:50:28,039
start to probe what is going on in those

1097
00:50:25,429 --> 00:50:31,219
discs and by probing what's in those

1098
00:50:28,039 --> 00:50:34,429
discs we can find in torino with

1099
00:50:31,219 --> 00:50:37,259
wavelength of light you see these the

1100
00:50:34,429 --> 00:50:40,169
spikes are telling us what's there

1101
00:50:37,260 --> 00:50:43,080
you see a couple interesting places

1102
00:50:40,170 --> 00:50:45,030
labeled here with with different types

1103
00:50:43,079 --> 00:50:48,029
of molecules so you see carbon dioxide

1104
00:50:45,030 --> 00:50:49,940
there something that maybe maybe you

1105
00:50:48,030 --> 00:50:51,630
don't want some major season in there

1106
00:50:49,940 --> 00:50:55,079
you wouldn't want it in your house

1107
00:50:51,630 --> 00:50:56,400
anyway so then we have so that's that's

1108
00:50:55,079 --> 00:50:57,480
an interesting way to probe it and see

1109
00:50:56,400 --> 00:50:59,820
what's going on there cuz seeing what

1110
00:50:57,480 --> 00:51:04,110
stuff is made of tells us part of how

1111
00:50:59,820 --> 00:51:06,390
it's made and and maybe how things

1112

00:51:04,110 --> 00:51:08,820
evolve because you can start out with

1113
00:51:06,389 --> 00:51:10,289
discs you know different stuffs gonna

1114
00:51:08,820 --> 00:51:11,640
form in different places in the discs

1115
00:51:10,289 --> 00:51:15,059
because you get further away from the

1116
00:51:11,639 --> 00:51:17,609
star discs is gonna get cooler and so

1117
00:51:15,059 --> 00:51:21,690
maybe you get you get more Isis stuff

1118
00:51:17,610 --> 00:51:25,200
that can can live as ice farther farther

1119
00:51:21,690 --> 00:51:26,700
out at cooler temperatures and they may

1120
00:51:25,199 --> 00:51:29,789
be that means a different type of planet

1121
00:51:26,699 --> 00:51:32,309
could form maybe that means the liquid

1122
00:51:29,789 --> 00:51:34,949
water or frozen water could hang out for

1123
00:51:32,309 --> 00:51:37,679
longer so all those things are building

1124
00:51:34,949 --> 00:51:41,279
this this model of what what we expect

1125
00:51:37,679 --> 00:51:46,309
in a solar system as it forms one of the

1126
00:51:41,280 --> 00:51:51,300

other things we can do is I don't know

1127

00:51:46,309 --> 00:51:53,610

oops sorry is Klaus mentioned this a

1128

00:51:51,300 --> 00:51:58,160

little bit too he had an image of it was

1129

00:51:53,610 --> 00:52:00,930

a coronagraph so that's that's basically

1130

00:51:58,159 --> 00:52:04,500

blocking out the light of the star to

1131

00:52:00,929 --> 00:52:07,139

see what's happening around it I think I

1132

00:52:04,500 --> 00:52:10,079

have another image of that coming up as

1133

00:52:07,139 --> 00:52:11,549

I talk about planetary atmospheres so

1134

00:52:10,079 --> 00:52:13,710

that's that force one planetary

1135

00:52:11,550 --> 00:52:15,960

atmospheres and this is one of the ones

1136

00:52:13,710 --> 00:52:19,559

that's you know it's a it's a field

1137

00:52:15,960 --> 00:52:21,300

that's really gotten big in the last

1138

00:52:19,559 --> 00:52:24,480

decade probably in the last five years

1139

00:52:21,300 --> 00:52:26,430

even as we explore these worlds and

1140

00:52:24,480 --> 00:52:30,570

we've gone from being able to just see

1141
00:52:26,429 --> 00:52:32,250
hot Jupiters to being able to see what

1142
00:52:30,570 --> 00:52:35,430
is going to be happening in atmospheres

1143
00:52:32,250 --> 00:52:37,500
of terrestrial type planets around other

1144
00:52:35,429 --> 00:52:39,719
stars and that's that's really the

1145
00:52:37,500 --> 00:52:44,730
promise of web so who here heard about

1146
00:52:39,719 --> 00:52:46,859
the Trappist system okay so this this

1147
00:52:44,730 --> 00:52:50,159
this came out about a year ago now it's

1148
00:52:46,860 --> 00:52:53,640
a star with seven plane

1149
00:52:50,159 --> 00:52:55,949
surround it many of them are around

1150
00:52:53,639 --> 00:52:59,670
maybe a little bit bigger than Earth

1151
00:52:55,949 --> 00:53:00,960
size they're all in what would be are

1152
00:52:59,670 --> 00:53:02,730
some of them are in what would be

1153
00:53:00,960 --> 00:53:06,240
considered the habitable zone of that

1154
00:53:02,730 --> 00:53:09,210
star so able to have liquid water on

1155
00:53:06,239 --> 00:53:11,279
them one of the big cool things that web

1156
00:53:09,210 --> 00:53:14,130
can do is when we find systems like that

1157
00:53:11,280 --> 00:53:15,690
to go and probe those atmospheres and

1158
00:53:14,130 --> 00:53:17,340
I'll show you a little bit about how

1159
00:53:15,690 --> 00:53:22,139
that how we do that you can do this with

1160
00:53:17,340 --> 00:53:25,110
with Jupiter's too so what we have here

1161
00:53:22,139 --> 00:53:26,609
is the same this is the same system okay

1162
00:53:25,110 --> 00:53:29,010
just two ways of looking at it one of

1163
00:53:26,610 --> 00:53:30,450
them is what you'd look what we'd see if

1164
00:53:29,010 --> 00:53:33,600
you were in the system you'd see this a

1165
00:53:30,449 --> 00:53:38,730
planet coming around or beating around

1166
00:53:33,599 --> 00:53:41,279
its star going to the backside okay but

1167
00:53:38,730 --> 00:53:42,750
down here is what we'd see if we just

1168
00:53:41,280 --> 00:53:50,280
looked at the light coming from that

1169

00:53:42,750 --> 00:53:51,900
system we would see the as this it do

1170
00:53:50,280 --> 00:53:54,120
you see where it dips there that's where

1171
00:53:51,900 --> 00:53:56,039
the planet went in front of the star and

1172
00:53:54,119 --> 00:53:59,190
blocked out the light of the of the star

1173
00:53:56,039 --> 00:54:00,929
but then when it goes behind the star

1174
00:53:59,190 --> 00:54:03,240
you see there's another little dip

1175
00:54:00,929 --> 00:54:06,029
that's because this planet is shining in

1176
00:54:03,239 --> 00:54:09,629
its own light so wait when it goes

1177
00:54:06,030 --> 00:54:12,000
behind the star we're losing some of the

1178
00:54:09,630 --> 00:54:15,660
light of the whole system because the

1179
00:54:12,000 --> 00:54:16,590
star is locking out to the planet and in

1180
00:54:15,659 --> 00:54:20,369
doing this

1181
00:54:16,590 --> 00:54:25,110
we're in doing this what we're really

1182
00:54:20,369 --> 00:54:26,460
doing is being able to probe what's the

1183
00:54:25,110 --> 00:54:29,220

first of all there's a planet there

1184

00:54:26,460 --> 00:54:31,470

second of all what's what is in that

1185

00:54:29,219 --> 00:54:34,099

plan that's atmosphere as it as it goes

1186

00:54:31,469 --> 00:54:40,799

in and out because we can also do this

1187

00:54:34,099 --> 00:54:42,809

spectroscopically okay next we have I

1188

00:54:40,800 --> 00:54:44,780

mentioned this earlier choreography so

1189

00:54:42,809 --> 00:54:49,739

one of the cool things the web can do is

1190

00:54:44,780 --> 00:54:52,950

to look at directly image planets around

1191

00:54:49,739 --> 00:54:56,129

other stars not just look at the dip

1192

00:54:52,949 --> 00:54:59,579

look for the dip in light so to give you

1193

00:54:56,130 --> 00:55:03,088

a comparison point this is what earth

1194

00:54:59,579 --> 00:55:07,228

looks like compared to the Sun so it's

1195

00:55:03,088 --> 00:55:08,849

a teeny tiny and if you know you can

1196

00:55:07,228 --> 00:55:10,528

imagine if it was if it was out here it

1197

00:55:08,849 --> 00:55:12,869

would it would be very very dim it's

1198
00:55:10,528 --> 00:55:15,478
like you know a little Firefly next to a

1199
00:55:12,869 --> 00:55:18,479
bright street lamp very difficult to see

1200
00:55:15,478 --> 00:55:20,189
unless you hold up your hand and block

1201
00:55:18,478 --> 00:55:21,929
out that street lamp and then all of a

1202
00:55:20,190 --> 00:55:24,749
sudden you can see oh there's like five

1203
00:55:21,929 --> 00:55:28,199
fireflies right there so that's kind of

1204
00:55:24,748 --> 00:55:30,778
what's what's going on here we can find

1205
00:55:28,199 --> 00:55:32,548
exoplanets you see where they are here

1206
00:55:30,778 --> 00:55:34,469
but you can't see them right so hold up

1207
00:55:32,548 --> 00:55:38,219
your hand block out the light of that

1208
00:55:34,469 --> 00:55:43,950
star and all of a sudden they are

1209
00:55:38,219 --> 00:55:46,229
revealed we get these these exoplanets

1210
00:55:43,949 --> 00:55:49,649
here which which we've seen this is a

1211
00:55:46,228 --> 00:55:52,348
from the Keck telescope but which also

1212
00:55:49,650 --> 00:55:53,729
has a coronagraph but when will will

1213
00:55:52,349 --> 00:55:55,890
have a coronagraph and be able to do

1214
00:55:53,728 --> 00:55:57,568
this type of measurement too so we're

1215
00:55:55,889 --> 00:55:59,308
we're hitting it from all angles with

1216
00:55:57,568 --> 00:56:01,588
web we're really gonna it's going to be

1217
00:55:59,309 --> 00:56:04,890
a workhorse for characterizing

1218
00:56:01,588 --> 00:56:06,989
exoplanets so far many of the space

1219
00:56:04,889 --> 00:56:08,308
telescopes we've had and even even some

1220
00:56:06,989 --> 00:56:11,579
ground-based ones are all about

1221
00:56:08,309 --> 00:56:14,190
detecting exoplanets we're there we know

1222
00:56:11,579 --> 00:56:18,839
exoplanets exist there's a lot of them

1223
00:56:14,190 --> 00:56:21,900
they're very exciting we we now know

1224
00:56:18,838 --> 00:56:26,420
that on average in our galaxy every

1225
00:56:21,900 --> 00:56:29,838
every star has one planet that's

1226

00:56:26,420 --> 00:56:32,548
incredibly exciting that's amazing but

1227
00:56:29,838 --> 00:56:34,528
we've also seen that there's a lot of

1228
00:56:32,548 --> 00:56:37,048
types of planets that could be out there

1229
00:56:34,528 --> 00:56:39,150
and Webb's job will be to characterize

1230
00:56:37,048 --> 00:56:41,130
those and figure out exactly what's

1231
00:56:39,150 --> 00:56:44,338
going on with these different systems

1232
00:56:41,130 --> 00:56:47,640
and to bring it back home ultimately

1233
00:56:44,338 --> 00:56:50,578
help us figure out is our system weird

1234
00:56:47,639 --> 00:56:52,588
are we typical what's going on with

1235
00:56:50,579 --> 00:56:55,140
earth what's going on with our solar

1236
00:56:52,588 --> 00:56:58,440
system okay

1237
00:56:55,139 --> 00:57:00,239
I mentioned characterizing awesome and

1238
00:56:58,440 --> 00:57:02,009
are we weird one of the things that

1239
00:57:00,239 --> 00:57:06,150
probably leads us to think we're kind of

1240
00:57:02,009 --> 00:57:12,478

weird some people call it special is we

1241
00:57:06,150 --> 00:57:16,329
have life on Earth and while Webb is not

1242
00:57:12,478 --> 00:57:19,179
a life finder its mission is not to

1243
00:57:16,329 --> 00:57:23,139
find alien life anywhere one of the

1244
00:57:19,179 --> 00:57:26,429
things it can do with spectroscopy is to

1245
00:57:23,139 --> 00:57:30,849
study these atmospheres and look for

1246
00:57:26,429 --> 00:57:32,829
various molecules that are abundant in

1247
00:57:30,849 --> 00:57:34,539
those atmospheres and this tells us

1248
00:57:32,829 --> 00:57:38,860
about what's going on there so for

1249
00:57:34,539 --> 00:57:40,269
example if it finds carbon dioxide that

1250
00:57:38,860 --> 00:57:42,519
could mean that you know things are

1251
00:57:40,269 --> 00:57:44,679
breathing the way that we breathe or it

1252
00:57:42,519 --> 00:57:50,259
could mean that there is volcanic

1253
00:57:44,679 --> 00:57:53,579
activity on on that planet if there's

1254
00:57:50,260 --> 00:57:56,050
methane there could be some sort of

1255
00:57:53,579 --> 00:57:57,549
natural geologic process causing that

1256
00:57:56,050 --> 00:58:00,460
methane but there could also be the

1257
00:57:57,550 --> 00:58:05,019
presence of anaerobic bacteria which Oh

1258
00:58:00,460 --> 00:58:07,389
exciting and of course water vapor might

1259
00:58:05,019 --> 00:58:09,280
indicate some sort of liquid water on

1260
00:58:07,389 --> 00:58:12,099
the surface which then would indicate

1261
00:58:09,280 --> 00:58:13,780
habitability of course none of these

1262
00:58:12,099 --> 00:58:15,670
things guarantee that there's life on

1263
00:58:13,780 --> 00:58:18,400
these place on these planets but it's

1264
00:58:15,670 --> 00:58:20,079
all about building the case right we're

1265
00:58:18,400 --> 00:58:21,820
still in a fact-finding mission that's

1266
00:58:20,079 --> 00:58:23,949
what science is so we're trying to just

1267
00:58:21,820 --> 00:58:29,160
find find what we can put the pieces

1268
00:58:23,949 --> 00:58:32,230
together pieces of the puzzle okay and

1269
00:58:29,159 --> 00:58:33,609
with that as we're putting the pieces of

1270
00:58:32,230 --> 00:58:37,650
the puzzle together I'll turn it over to

1271
00:58:33,610 --> 00:58:37,650
Alex so she can talk about the legacy

1272
00:58:52,719 --> 00:59:00,949
okay okay so the final piece of the

1273
00:58:56,210 --> 00:59:03,710
puzzle web s class explained was built

1274
00:59:00,949 --> 00:59:05,118
on Hubble's legacy and as bonnie has

1275
00:59:03,710 --> 00:59:06,858
told you about the science of the

1276
00:59:05,119 --> 00:59:08,750
mission it's going to be incredible and

1277
00:59:06,858 --> 00:59:12,259
really leave its own legacy and just

1278
00:59:08,750 --> 00:59:13,730
like Hubble found galaxies in this area

1279
00:59:12,260 --> 00:59:16,220
of the sky that looked like nothing and

1280
00:59:13,730 --> 00:59:18,440
just like Hubble found exoplanet

1281
00:59:16,219 --> 00:59:21,980
atmospheres Webb will find things that

1282
00:59:18,440 --> 00:59:24,139
we can't even anticipate and this is

1283

00:59:21,980 --> 00:59:25,280
really mind-boggling but how do we get

1284
00:59:24,139 --> 00:59:28,129
there

1285
00:59:25,280 --> 00:59:29,329
so as Klaus mentioned this has been more

1286
00:59:28,130 --> 00:59:34,010
than 20 years in the making

1287
00:59:29,329 --> 00:59:36,109
so before here today and it's launching

1288
00:59:34,010 --> 00:59:38,839
in about a year and a half that is only

1289
00:59:36,108 --> 00:59:40,578
you know 10% less than 10% of the

1290
00:59:38,838 --> 00:59:43,250
timeline that people have been working

1291
00:59:40,579 --> 00:59:45,400
on this mission here's a few of the

1292
00:59:43,250 --> 00:59:48,800
highlights of that timeline pulled out

1293
00:59:45,400 --> 00:59:51,380
that image that beautiful napkin drawing

1294
00:59:48,800 --> 00:59:54,170
that Klaus showed you before is right

1295
00:59:51,380 --> 00:59:56,630
around here in 95 so again over 20 years

1296
00:59:54,170 --> 01:00:01,519
ago people who are born in 97 are now

1297
00:59:56,630 --> 01:00:03,710

allowed to buy alcohol oh my god so this

1298

01:00:01,519 --> 01:00:04,969

is really we're all really feeling this

1299

01:00:03,710 --> 01:00:10,220

I remember when I was an undergraduate

1300

01:00:04,969 --> 01:00:13,969

and web was gonna launch in 2013 so now

1301

01:00:10,219 --> 01:00:15,559

it's gonna launch in 2019 and so here in

1302

01:00:13,969 --> 01:00:17,149

2002 it actually got named the James

1303

01:00:15,559 --> 01:00:18,920

Webb Space Telescope before that it was

1304

01:00:17,150 --> 01:00:22,039

approved as the next generation space

1305

01:00:18,920 --> 01:00:23,930

telescope and since then we've been

1306

01:00:22,039 --> 01:00:25,579

doing construction we have the

1307

01:00:23,929 --> 01:00:28,730

complicated instruments we have that

1308

01:00:25,579 --> 01:00:31,910

giant folding primary mirror we have a

1309

01:00:28,730 --> 01:00:34,099

Sun shield that is you know layers with

1310

01:00:31,909 --> 01:00:38,059

thickness and smaller than a plastic bag

1311

01:00:34,099 --> 01:00:42,079

and all of these things have been built

1312
01:00:38,059 --> 01:00:43,279
tested tested again tested again the Sun

1313
01:00:42,079 --> 01:00:46,010
shield I heard was folded and unfolded

1314
01:00:43,280 --> 01:00:48,380
five times to make sure that you know

1315
01:00:46,010 --> 01:00:50,089
despite being very very thin so that it

1316
01:00:48,380 --> 01:00:53,329
was less weight it's still very strong

1317
01:00:50,088 --> 01:00:56,719
and can be unfolded in space safely and

1318
01:00:53,329 --> 01:00:58,099
as of only a few days ago there was a

1319
01:00:56,719 --> 01:01:00,949
press release out of Johnson Space

1320
01:00:58,099 --> 01:01:02,539
Flight Center that said that testing on

1321
01:01:00,949 --> 01:01:04,068
the optical telescope instrument which

1322
01:01:02,539 --> 01:01:05,000
is our beautiful primary mirror you see

1323
01:01:04,068 --> 01:01:07,159
and

1324
01:01:05,000 --> 01:01:08,440
instrument module so all the instruments

1325
01:01:07,159 --> 01:01:11,029
on the back of the primary mirror

1326
01:01:08,440 --> 01:01:15,170
everything's good to go it is now being

1327
01:01:11,030 --> 01:01:16,369
shipped to California so this is the

1328
01:01:15,170 --> 01:01:17,750
time line of people who have been

1329
01:01:16,369 --> 01:01:20,869
working for over 20 years on this

1330
01:01:17,750 --> 01:01:23,119
telescope well why the real mission here

1331
01:01:20,869 --> 01:01:24,619
despite all of this engineering feats is

1332
01:01:23,119 --> 01:01:26,000
the science that's coming out of it and

1333
01:01:24,619 --> 01:01:27,289
they're from people who've been thinking

1334
01:01:26,000 --> 01:01:30,519
about the science for more than twenty

1335
01:01:27,289 --> 01:01:33,409
years the science portion the science

1336
01:01:30,519 --> 01:01:35,030
observations that will be taken over the

1337
01:01:33,409 --> 01:01:36,829
course of Webb's lifetime fall into

1338
01:01:35,030 --> 01:01:38,540
three different categories the first

1339
01:01:36,829 --> 01:01:41,750
category is called guaranteed time

1340

01:01:38,539 --> 01:01:43,789
observations I'll explain what each of

1341
01:01:41,750 --> 01:01:45,980
these mean in just a second

1342
01:01:43,789 --> 01:01:48,380
the second category and this is so here

1343
01:01:45,980 --> 01:01:49,940
into time observations these have begun

1344
01:01:48,380 --> 01:01:50,930
people these are people who've been

1345
01:01:49,940 --> 01:01:53,630
working on the mission since the

1346
01:01:50,929 --> 01:01:54,618
beginning they get this time then

1347
01:01:53,630 --> 01:01:57,440
there's early really science

1348
01:01:54,619 --> 01:01:59,780
observations which the call for that and

1349
01:01:57,440 --> 01:02:01,940
the release of those observations was

1350
01:01:59,780 --> 01:02:02,930
just made in November or the release of

1351
01:02:01,940 --> 01:02:04,400
the observations the call was made

1352
01:02:02,929 --> 01:02:05,509
earlier but the release of what those

1353
01:02:04,400 --> 01:02:07,039
targets are just made in November

1354
01:02:05,510 --> 01:02:08,869

everything's available online if you'd

1355

01:02:07,039 --> 01:02:11,059

like to know what the telescope will be

1356

01:02:08,869 --> 01:02:12,530

looking at as and all of these will be

1357

01:02:11,059 --> 01:02:15,559

taken in the very beginning of the

1358

01:02:12,530 --> 01:02:17,359

telescopes mission lifetime and made

1359

01:02:15,559 --> 01:02:18,619

available to the community so that

1360

01:02:17,358 --> 01:02:21,348

people can know what the telescope can

1361

01:02:18,619 --> 01:02:22,849

do immediately and then finally what we

1362

01:02:21,349 --> 01:02:24,890

have what we call geo or general

1363

01:02:22,849 --> 01:02:26,359

observation time general observers time

1364

01:02:24,889 --> 01:02:28,759

and this is open to anyone in the entire

1365

01:02:26,358 --> 01:02:29,929

world it's not just space telescopes not

1366

01:02:28,760 --> 01:02:32,540

just the u.s. it's not just people

1367

01:02:29,929 --> 01:02:34,338

affiliated with NASA or ISA or CSA any

1368

01:02:32,539 --> 01:02:35,900

of the space agencies it's anyone anyone

1369
01:02:34,338 --> 01:02:38,659
in the world can propose for time on

1370
01:02:35,900 --> 01:02:41,869
this but Space Telescope and that is the

1371
01:02:38,659 --> 01:02:44,838
same for Hubble although all of these

1372
01:02:41,869 --> 01:02:46,338
things are vetted so you can try but you

1373
01:02:44,838 --> 01:02:47,299
might want to might not want to spend

1374
01:02:46,338 --> 01:02:48,858
your time because there's a lot of

1375
01:02:47,300 --> 01:02:51,830
really qualified scientists who are

1376
01:02:48,858 --> 01:02:54,440
gonna be going after this time and and

1377
01:02:51,829 --> 01:02:56,869
do some great science with it so as I

1378
01:02:54,440 --> 01:02:58,940
mentioned here we are today will launch

1379
01:02:56,869 --> 01:03:00,470
about six months later we'll actually

1380
01:02:58,940 --> 01:03:02,000
start to get data out because it takes a

1381
01:03:00,469 --> 01:03:02,449
while to get out a million miles into

1382
01:03:02,000 --> 01:03:04,130
space

1383
01:03:02,449 --> 01:03:05,779
it takes a while to open up this big

1384
01:03:04,130 --> 01:03:07,789
beautiful telescope it takes a while to

1385
01:03:05,780 --> 01:03:09,170
cool down the instruments because they

1386
01:03:07,789 --> 01:03:10,639
started here on earth and they get out

1387
01:03:09,170 --> 01:03:15,829
from space in there some of them are

1388
01:03:10,639 --> 01:03:16,879
operating at seven degrees so all that

1389
01:03:15,829 --> 01:03:17,909
takes a while it's going to be many

1390
01:03:16,880 --> 01:03:19,108
months between

1391
01:03:17,909 --> 01:03:20,848
launch the telescope and when it's ready

1392
01:03:19,108 --> 01:03:22,769
to give a science but when it does that

1393
01:03:20,849 --> 01:03:23,910
it's going to give us these three

1394
01:03:22,769 --> 01:03:26,130
different types of science and I

1395
01:03:23,909 --> 01:03:28,469
apologize if the colors aren't super

1396
01:03:26,130 --> 01:03:30,510
clear here but this is green purple and

1397

01:03:28,469 --> 01:03:31,618
pink and again the green observation is

1398
01:03:30,510 --> 01:03:33,180
the early-release science will be the

1399
01:03:31,619 --> 01:03:34,730
first observations taken that I'll be

1400
01:03:33,179 --> 01:03:37,230
taking in the first few months and

1401
01:03:34,730 --> 01:03:38,880
immediately made available and this is

1402
01:03:37,230 --> 01:03:41,068
kind of a unique thing but it's really

1403
01:03:38,880 --> 01:03:43,500
great it means people law scientists put

1404
01:03:41,068 --> 01:03:44,670
a lot of work to take observations then

1405
01:03:43,500 --> 01:03:47,280
then are immediately available to

1406
01:03:44,670 --> 01:03:49,559
everyone to look at and say what can

1407
01:03:47,280 --> 01:03:51,869
Webb do how can I do it what's its

1408
01:03:49,559 --> 01:03:54,089
capabilities how do we use it best going

1409
01:03:51,869 --> 01:03:55,680
forward and then you have these

1410
01:03:54,088 --> 01:03:57,480
guaranteed time observations that all be

1411
01:03:55,679 --> 01:03:58,858

taken in the first few years and then

1412

01:03:57,480 --> 01:04:01,079

the general observer time the time

1413

01:03:58,858 --> 01:04:02,699

that's open to the entire world over the

1414

01:04:01,079 --> 01:04:05,130

entire astronomical community is really

1415

01:04:02,699 --> 01:04:06,298

who will be using it goes on for the

1416

01:04:05,130 --> 01:04:08,880

lifetime of the mission which is

1417

01:04:06,298 --> 01:04:13,469

guaranteed five years hopefully up to

1418

01:04:08,880 --> 01:04:15,329

ten years so about those programs a

1419

01:04:13,469 --> 01:04:16,769

little more again there's people who've

1420

01:04:15,329 --> 01:04:19,170

been working on this for over twenty

1421

01:04:16,769 --> 01:04:20,730

years and they get some time

1422

01:04:19,170 --> 01:04:22,139

automatically on the telescope because

1423

01:04:20,730 --> 01:04:23,608

they put and they put in the grace work

1424

01:04:22,139 --> 01:04:24,659

they put in the legwork so those are

1425

01:04:23,608 --> 01:04:28,108

called guaranteed to have observations

1426
01:04:24,659 --> 01:04:30,088
and that's going to be a chunk of the

1427
01:04:28,108 --> 01:04:32,009
first couple of years of observations a

1428
01:04:30,088 --> 01:04:33,690
very small portion was a very

1429
01:04:32,010 --> 01:04:36,690
competitive selection for what we call

1430
01:04:33,690 --> 01:04:38,429
early release science and these people

1431
01:04:36,690 --> 01:04:40,079
get to look at objects in the sky that

1432
01:04:38,429 --> 01:04:42,598
they want to look at but they don't get

1433
01:04:40,079 --> 01:04:44,250
to keep the data which is which is we

1434
01:04:42,599 --> 01:04:45,930
call proprietary you normally you get to

1435
01:04:44,250 --> 01:04:47,400
keep the data just for you to work on

1436
01:04:45,929 --> 01:04:49,348
for a little bit these people said no

1437
01:04:47,400 --> 01:04:51,599
I'm gonna propose I'm gonna find things

1438
01:04:49,349 --> 01:04:52,289
out in the sky and I'm gonna share it

1439
01:04:51,599 --> 01:04:54,720
with everyone

1440
01:04:52,289 --> 01:04:56,910
immediately so that everyone knows what

1441
01:04:54,719 --> 01:04:58,379
the telescope can do and so you're gonna

1442
01:04:56,909 --> 01:05:02,179
see a lot of stuff coming out of these

1443
01:04:58,380 --> 01:05:06,480
you know is sort of soon after telescope

1444
01:05:02,179 --> 01:05:08,578
launches and and comes comes alive and

1445
01:05:06,480 --> 01:05:11,159
then finally we have the general

1446
01:05:08,579 --> 01:05:13,200
observer pool now the topics are all the

1447
01:05:11,159 --> 01:05:15,420
topics the body covered you know from

1448
01:05:13,199 --> 01:05:18,868
solar system exoplanets protoplanetary

1449
01:05:15,420 --> 01:05:23,159
discs assembly of galaxies first light

1450
01:05:18,869 --> 01:05:26,700
the first galaxies you know lensing

1451
01:05:23,159 --> 01:05:27,750
gravitational lensing of objects things

1452
01:05:26,699 --> 01:05:30,989
in our solar system

1453
01:05:27,750 --> 01:05:31,278
asteroids direct imaging of exoplanets

1454

01:05:30,989 --> 01:05:33,528
with

1455
01:05:31,278 --> 01:05:35,659
pornography transmissions are trust me

1456
01:05:33,528 --> 01:05:37,130
of exoplanets all of that is covered in

1457
01:05:35,659 --> 01:05:39,469
all three it's going to be covered in

1458
01:05:37,130 --> 01:05:41,028
all three of these programs so well we

1459
01:05:39,469 --> 01:05:42,079
do just there is a distinction and a

1460
01:05:41,028 --> 01:05:44,989
reason that we have all of these

1461
01:05:42,079 --> 01:05:46,609
different things really you're gonna see

1462
01:05:44,989 --> 01:05:48,318
all of this great science coming out and

1463
01:05:46,608 --> 01:05:50,179
it's gonna cover the gamut and you're

1464
01:05:48,318 --> 01:05:51,858
not really gonna know but this is really

1465
01:05:50,179 --> 01:05:53,778
this is really there's a lot of people

1466
01:05:51,858 --> 01:05:55,338
have been working really hard on this on

1467
01:05:53,778 --> 01:06:00,829
behalf of the community on behalf of

1468
01:05:55,338 --> 01:06:02,719

this giant space telescope so from from

1469

01:06:00,829 --> 01:06:04,429

this and looking at the science well

1470

01:06:02,719 --> 01:06:06,829

where are we now we're here today and

1471

01:06:04,429 --> 01:06:10,969

let's give you a little bit just what to

1472

01:06:06,829 --> 01:06:13,400

look forward to in the next two years so

1473

01:06:10,969 --> 01:06:16,699

right now we are here while we were here

1474

01:06:13,400 --> 01:06:18,380

we were just past here Paul out in 2017

1475

01:06:16,699 --> 01:06:20,509

we finished our instrument a mirror

1476

01:06:18,380 --> 01:06:21,709

testing at Johnson Space Center that

1477

01:06:20,509 --> 01:06:24,858

went really well this is a beautiful

1478

01:06:21,708 --> 01:06:26,688

picture that was actually shared and

1479

01:06:24,858 --> 01:06:28,929

believe it was the Atlantic magazine

1480

01:06:26,688 --> 01:06:32,058

there's a few people who shared this as

1481

01:06:28,929 --> 01:06:33,709

one of the hopeful images of the year

1482

01:06:32,059 --> 01:06:35,150

like they put together thirty-five

1483
01:06:33,708 --> 01:06:37,338
hopeful images and this was one of them

1484
01:06:35,150 --> 01:06:40,189
because this is what our society can do

1485
01:06:37,338 --> 01:06:43,880
and where it's going really tackling

1486
01:06:40,188 --> 01:06:47,688
these these feats so this is this was

1487
01:06:43,880 --> 01:06:49,669
after it came out of chamber a next it's

1488
01:06:47,688 --> 01:06:52,219
going to Northrop Grumman space park out

1489
01:06:49,668 --> 01:06:54,348
in Redondo Beach California Northrop

1490
01:06:52,219 --> 01:06:56,599
Grumman will take this giant Sun shield

1491
01:06:54,349 --> 01:06:58,369
put it with the telescope element AB

1492
01:06:56,599 --> 01:07:00,679
this what we call the spacecraft bust

1493
01:06:58,369 --> 01:07:01,999
put everything together and if you

1494
01:07:00,679 --> 01:07:05,630
happen to be out and on to beach

1495
01:07:01,998 --> 01:07:06,078
sometime early summer late summer early

1496
01:07:05,630 --> 01:07:08,179
fall

1497
01:07:06,079 --> 01:07:09,999
you can go maybe see this thing all

1498
01:07:08,179 --> 01:07:15,650
fully assembled and it'll allow you

1499
01:07:09,998 --> 01:07:20,139
because it's very amazing next fall next

1500
01:07:15,650 --> 01:07:22,579
phone something next fall next fall Oh

1501
01:07:20,139 --> 01:07:24,558
next fall will they complete the

1502
01:07:22,579 --> 01:07:26,209
integration of spacecraft and the

1503
01:07:24,559 --> 01:07:27,349
instruments and the optical telescope

1504
01:07:26,208 --> 01:07:29,598
and the Sun shield this giant thing

1505
01:07:27,349 --> 01:07:33,019
they'll pack it up and they will send it

1506
01:07:29,599 --> 01:07:35,949
on its way to French Guiana that is

1507
01:07:33,018 --> 01:07:39,618
launching this giant rocket the Ariane 5

1508
01:07:35,949 --> 01:07:43,668
next spring between what would you say

1509
01:07:39,619 --> 01:07:44,690
spring and then it will be operated out

1510
01:07:43,668 --> 01:07:46,788
of this building

1511

01:07:44,690 --> 01:07:50,329
the mission operations Control Center is

1512
01:07:46,789 --> 01:07:52,130
just up there and that is what it looks

1513
01:07:50,329 --> 01:07:54,410
like you probably can't go up there but

1514
01:07:52,130 --> 01:07:56,170
it is that's what it looks like so you

1515
01:07:54,409 --> 01:07:58,399
know missing much now you've seen it

1516
01:07:56,170 --> 01:08:02,960
it's a bunch of computers because that's

1517
01:07:58,400 --> 01:08:05,059
what we do nowadays so after it gets

1518
01:08:02,960 --> 01:08:08,599
launched from here it'll go out into

1519
01:08:05,059 --> 01:08:11,900
space it'll take about 24 to 29 days to

1520
01:08:08,599 --> 01:08:13,460
get out to what I think one of you

1521
01:08:11,900 --> 01:08:13,940
referred to as LTV it cost referred to

1522
01:08:13,460 --> 01:08:15,949
as I2

1523
01:08:13,940 --> 01:08:17,448
this lagrangian point it's basically

1524
01:08:15,949 --> 01:08:18,948
just a place where it can hang out and

1525
01:08:17,448 --> 01:08:19,488

we don't have to keep pumping it and to

1526

01:08:18,948 --> 01:08:22,159
be there

1527

01:08:19,488 --> 01:08:24,829
it'll just happily drift in space and

1528

01:08:22,159 --> 01:08:27,289
follow along with the earth at this I2

1529

01:08:24,829 --> 01:08:29,778
point in the meantime the Sun shield

1530

01:08:27,289 --> 01:08:31,338
opens up the telescope opens up if you

1531

01:08:29,779 --> 01:08:32,359
haven't seen the deployment we think

1532

01:08:31,338 --> 01:08:33,710
some of you have seen it so we're not

1533

01:08:32,359 --> 01:08:34,969
sure we're not showing that deployment

1534

01:08:33,710 --> 01:08:37,310
sequence today but if you haven't seen

1535

01:08:34,969 --> 01:08:37,789
it every time I watch it it blows my

1536

01:08:37,310 --> 01:08:39,589
mind

1537

01:08:37,789 --> 01:08:41,179
you are unfolding something the size of

1538

01:08:39,588 --> 01:08:44,179
a tennis court outlet space by itself

1539

01:08:41,179 --> 01:08:46,429
it's really mind-boggling and it takes

1540
01:08:44,179 --> 01:08:48,079
days to do that and we're checking all

1541
01:08:46,429 --> 01:08:49,310
the instruments it'll take a month to

1542
01:08:48,079 --> 01:08:51,229
get out here but then it'll take another

1543
01:08:49,310 --> 01:08:52,400
five months to cool down check

1544
01:08:51,229 --> 01:08:54,229
everything out all of those newer

1545
01:08:52,399 --> 01:08:56,088
segments have to be aligned there's also

1546
01:08:54,229 --> 01:08:59,928
a really cool animation online of all of

1547
01:08:56,088 --> 01:09:00,979
this mirror segments going to make sure

1548
01:08:59,929 --> 01:09:03,259
that they're all looking at the same

1549
01:09:00,979 --> 01:09:04,639
thing at the same time that was Hubble's

1550
01:09:03,259 --> 01:09:06,679
problem is that it wasn't properly

1551
01:09:04,640 --> 01:09:07,670
polished so we took care of that by

1552
01:09:06,679 --> 01:09:09,949
having lots of different mirrors that we

1553
01:09:07,670 --> 01:09:13,359
can move around but you got a you gotta

1554
01:09:09,948 --> 01:09:13,358
fix them so they move around right so

1555
01:09:13,750 --> 01:09:20,659
and then and then we find ourselves post

1556
01:09:18,380 --> 01:09:22,100
post what we call launch and

1557
01:09:20,659 --> 01:09:25,579
commissioning where we check out the

1558
01:09:22,100 --> 01:09:28,338
telescope about 170 180 days after

1559
01:09:25,579 --> 01:09:30,170
launch we are at the most important part

1560
01:09:28,338 --> 01:09:34,009
which is where we get all of that good

1561
01:09:30,170 --> 01:09:36,949
science and this will be the legacy of

1562
01:09:34,009 --> 01:09:39,048
web just like Hubble has has had a

1563
01:09:36,948 --> 01:09:41,778
legacy and continues on and we look

1564
01:09:39,048 --> 01:09:43,838
forward to the next generation of space

1565
01:09:41,779 --> 01:09:45,739
telescopes after web but in the meantime

1566
01:09:43,838 --> 01:09:47,719
we're going to show you a really cool

1567
01:09:45,738 --> 01:09:52,218
video of all of this getting put

1568

01:09:47,719 --> 01:09:54,619
together and this is this is footage

1569
01:09:52,219 --> 01:09:58,130
from I think from Ball Aerospace from

1570
01:09:54,619 --> 01:10:01,579
Goddard Space Flight Center from Houston

1571
01:09:58,130 --> 01:10:03,800
and also from northrup-grumman so this

1572
01:10:01,579 --> 01:10:06,079
is a really poor lapse that all of us

1573
01:10:03,800 --> 01:10:09,349
find really awesome so we figured you

1574
01:10:06,079 --> 01:10:20,809
would to it runs like two or three

1575
01:10:09,349 --> 01:10:22,279
minutes so I guess we should talk

1576
01:10:20,810 --> 01:10:23,599
through it just a little bit okay we can

1577
01:10:22,279 --> 01:10:27,559
just tell you what's going on so that's

1578
01:10:23,599 --> 01:10:30,170
the the spacecraft element so so what is

1579
01:10:27,560 --> 01:10:32,090
gonna thrust out into space now I'm not

1580
01:10:30,170 --> 01:10:36,230
an engineer but we're gonna go through

1581
01:10:32,090 --> 01:10:37,940
this so this is in probably Northrop

1582
01:10:36,229 --> 01:10:40,848

Grumman is cleanroom because they did

1583

01:10:37,939 --> 01:10:42,079

the spacecraft so then they're gonna

1584

01:10:40,849 --> 01:10:43,789

shove it in a box for a little bit and

1585

01:10:42,079 --> 01:10:48,889

do some testing on it and that comes

1586

01:10:43,789 --> 01:10:53,238

back out and you could just see how many

1587

01:10:48,889 --> 01:10:56,840

people are working on this thing so now

1588

01:10:53,238 --> 01:10:58,609

as you can see there's a they're

1589

01:10:56,840 --> 01:11:00,319

starting to attach the pallets that have

1590

01:10:58,609 --> 01:11:01,939

the sun shield on them again this is all

1591

01:11:00,319 --> 01:11:03,859

at Northrop Grumman and so there's these

1592

01:11:01,939 --> 01:11:05,658

giant things again think of this the

1593

01:11:03,859 --> 01:11:08,000

size of a tennis court this whole thing

1594

01:11:05,658 --> 01:11:10,969

and so they're laying down and there's

1595

01:11:08,000 --> 01:11:13,329

this special material that very very

1596

01:11:10,969 --> 01:11:15,800

very thin but very durable and

1597
01:11:13,329 --> 01:11:17,599
reflective to get rid of all of that

1598
01:11:15,800 --> 01:11:19,070
heat from the Sun from the earth from

1599
01:11:17,599 --> 01:11:20,630
the moon that we don't want because we

1600
01:11:19,069 --> 01:11:23,448
only want heat from objects out in the

1601
01:11:20,630 --> 01:11:26,630
space so this is the frame of the sun

1602
01:11:23,448 --> 01:11:29,928
shield it's a nice cool kite because i

1603
01:11:26,630 --> 01:11:31,190
don't put a giant kite in space and then

1604
01:11:29,929 --> 01:11:36,279
you can see they're adding the layers of

1605
01:11:31,189 --> 01:11:39,049
the sun shield and spreading them out

1606
01:11:36,279 --> 01:11:41,859
really really thin really slow this is a

1607
01:11:39,050 --> 01:11:41,860
time-lapse so

1608
01:11:54,868 --> 01:11:59,399
and they can see they're lifting up all

1609
01:11:57,029 --> 01:12:01,829
the layers layers do have spacers in

1610
01:11:59,399 --> 01:12:03,559
between so they shouldn't catch on each

1611
01:12:01,829 --> 01:12:07,229
other as the whole thing is deploying

1612
01:12:03,560 --> 01:12:08,849
all of this has been thought of multiple

1613
01:12:07,229 --> 01:12:11,459
times in multiple ways and tested

1614
01:12:08,849 --> 01:12:12,900
multiple times as you can see now

1615
01:12:11,460 --> 01:12:17,279
they're folding up the palettes of the

1616
01:12:12,899 --> 01:12:19,138
sunshield for the for the the the way

1617
01:12:17,279 --> 01:12:23,368
that it's gonna be packed for when it

1618
01:12:19,139 --> 01:12:25,170
goes into space they're the the actual

1619
01:12:23,368 --> 01:12:27,719
mirror will be in the center here with

1620
01:12:25,170 --> 01:12:30,539
the instrument module but right now

1621
01:12:27,719 --> 01:12:33,510
they're just testing the Sun field and

1622
01:12:30,539 --> 01:12:37,948
everything in a faker that's the

1623
01:12:33,510 --> 01:12:42,199
official term for it so this just

1624
01:12:37,948 --> 01:12:42,198
simulates the weight of the spacecraft

1625

01:13:07,479 --> 01:13:25,329
this is not gonna work in space on its

1626
01:13:10,539 --> 01:13:28,720
own oh you wish so now they're showing

1627
01:13:25,329 --> 01:13:29,289
how the center part to deploy the

1628
01:13:28,720 --> 01:13:30,970
sunshield

1629
01:13:29,289 --> 01:13:32,319
everything's folded up it's fold it's

1630
01:13:30,970 --> 01:13:34,449
folded up in these pallets and then

1631
01:13:32,319 --> 01:13:36,909
stacked up so they have to unfold the

1632
01:13:34,449 --> 01:13:39,460
pallets pull out into the kite shape and

1633
01:13:36,909 --> 01:13:40,720
then pull up the center part and all of

1634
01:13:39,460 --> 01:13:42,340
the layers so that there's these five

1635
01:13:40,720 --> 01:13:44,640
layers and that they sit separate from

1636
01:13:42,340 --> 01:13:47,409
each other so that they don't conduct

1637
01:13:44,640 --> 01:13:49,390
but instead just each one of them

1638
01:13:47,409 --> 01:13:51,220
provides a blocking and then here

1639
01:13:49,390 --> 01:13:52,869

they're tightening the sun shield to

1640

01:13:51,220 --> 01:13:55,000
make sure that it'll stay in that

1641

01:13:52,869 --> 01:13:57,579
configuration and it doesn't break and

1642

01:13:55,000 --> 01:13:59,289
it doesn't and you and actually you can

1643

01:13:57,579 --> 01:14:00,609
see you can see some well you could see

1644

01:13:59,289 --> 01:14:01,930
some of the structure on the Sun shield

1645

01:14:00,609 --> 01:14:05,589
there you could see that it wasn't a

1646

01:14:01,930 --> 01:14:07,300
flat piece there was some like so what

1647

01:14:05,590 --> 01:14:09,310
looked like crosshairs or some some

1648

01:14:07,300 --> 01:14:10,930
plaid stuff those are called RIP stops

1649

01:14:09,310 --> 01:14:12,489
and it's actually designed so that if

1650

01:14:10,930 --> 01:14:14,800
there was like a tiny micro meteorite

1651

01:14:12,488 --> 01:14:16,329
that flew through it it would just break

1652

01:14:14,800 --> 01:14:21,190
one small part of it it wouldn't rip the

1653

01:14:16,329 --> 01:14:25,949
whole thing so it's I mean the thoughts

1654
01:14:21,189 --> 01:14:25,949
and things I think

1655
01:14:28,890 --> 01:14:47,750
[Applause]

1656
01:14:35,159 --> 01:14:51,859
I know if we can handle this audience

1657
01:14:47,750 --> 01:14:51,859
he's always the question moderate

1658
01:14:53,989 --> 01:15:06,090
questions right there so they're the

1659
01:15:04,590 --> 01:15:07,590
question I have to repeat the question

1660
01:15:06,090 --> 01:15:12,960
for the webcam that's my main purpose

1661
01:15:07,590 --> 01:15:16,170
here so so what is the launch site is it

1662
01:15:12,960 --> 01:15:20,000
Peru or is it yeah it's it's Guiana it's

1663
01:15:16,170 --> 01:15:21,840
kuru is is the area in French Guiana

1664
01:15:20,000 --> 01:15:23,819
that yeah sorry

1665
01:15:21,840 --> 01:15:27,829
so it sounds like Peru sometimes this is

1666
01:15:23,819 --> 01:15:50,099
kuru it's a European spaceport cool yeah

1667
01:15:27,829 --> 01:15:51,449
okay all the way in the back okay okay

1668
01:15:50,100 --> 01:15:55,039
well she finds it let's take another

1669
01:15:51,449 --> 01:15:55,039
question there was a question down front

1670
01:15:56,390 --> 01:16:03,840
what is the probability that a star has

1671
01:15:59,250 --> 01:16:09,899
a planet around it in our galaxy we it's

1672
01:16:03,840 --> 01:16:16,079
it's it's it's on average one planet per

1673
01:16:09,899 --> 01:16:20,279
star at least one right so you're gonna

1674
01:16:16,079 --> 01:16:21,720
say yeah I I'm I've never heard it said

1675
01:16:20,279 --> 01:16:30,300
is what's the probability a star has a

1676
01:16:21,720 --> 01:16:33,030
planet but so yeah basically everything

1677
01:16:30,300 --> 01:16:36,510
has a star everything has a planet so at

1678
01:16:33,029 --> 01:16:38,460
least one okay so it for everything you

1679
01:16:36,510 --> 01:16:40,409
see up in the night sky you're looking

1680
01:16:38,460 --> 01:16:42,239
at planet as well as the star all right

1681
01:16:40,409 --> 01:16:43,970
have you got the slide okay is this is

1682

01:16:42,239 --> 01:16:46,670
this the one you were talking about

1683
01:16:43,970 --> 01:17:10,940
first form equipped like the one with

1684
01:16:46,670 --> 01:17:12,890
the zoomit that one okay how about you

1685
01:17:10,939 --> 01:17:27,979
ask your question and we'll find the

1686
01:17:12,890 --> 01:17:29,930
right thing so so what is that that

1687
01:17:27,979 --> 01:17:35,209
interesting thing in the upper left it's

1688
01:17:29,930 --> 01:17:38,750
a good question that that is is almost

1689
01:17:35,210 --> 01:17:40,369
certainly a reflection of the optical

1690
01:17:38,750 --> 01:17:42,079
element of the telescope so you can

1691
01:17:40,369 --> 01:17:47,899
actually you can see the primary mirror

1692
01:17:42,079 --> 01:17:49,609
and and some of the the rods that the

1693
01:17:47,899 --> 01:17:51,829
secondary mirror is hanging on so if you

1694
01:17:49,609 --> 01:17:53,329
have something very bright and you feel

1695
01:17:51,829 --> 01:17:56,380
it's just a camera reflection it's the

1696
01:17:53,329 --> 01:17:58,309

same if you if you take a picture of

1697

01:17:56,380 --> 01:18:02,989

something bright like the Sun with a

1698

01:17:58,310 --> 01:18:04,400

regular reflex camera you sometimes you

1699

01:18:02,989 --> 01:18:07,069

get out you get a reflection somewhere

1700

01:18:04,399 --> 01:18:14,049

the system and you'll get a little image

1701

01:18:07,069 --> 01:18:14,049

of your of your aperture okay over there

1702

01:18:14,619 --> 01:18:22,519

so what's the rate of the data transfer

1703

01:18:16,909 --> 01:18:25,630

from 1/2 to earth what how fast is the

1704

01:18:22,520 --> 01:18:25,630

interplanetary Internet

1705

01:18:26,909 --> 01:18:38,279

if I can remember the exact number the

1706

01:18:34,149 --> 01:18:41,259

the data recorder is is a few tens of

1707

01:18:38,279 --> 01:18:44,529

gigabytes and it gets domed once a day

1708

01:18:41,260 --> 01:18:50,829

or so so the data rate is pretty fast

1709

01:18:44,529 --> 01:19:00,250

but it's not super fast all right

1710

01:18:50,829 --> 01:19:02,649

question down here alright so what

1711
01:19:00,250 --> 01:19:04,869
percentage your efficiency do you get

1712
01:19:02,649 --> 01:19:07,750
for observing versus say calibrations

1713
01:19:04,869 --> 01:19:10,960
and other testing and such Wow some some

1714
01:19:07,750 --> 01:19:13,000
good questions here so that really it

1715
01:19:10,960 --> 01:19:17,890
really depends on what what you're

1716
01:19:13,000 --> 01:19:21,010
observing right so on on the for example

1717
01:19:17,890 --> 01:19:22,630
in the science cases of of looking for

1718
01:19:21,010 --> 01:19:24,070
faint galaxies at the edge of the

1719
01:19:22,630 --> 01:19:25,539
universe where you're gonna park a

1720
01:19:24,069 --> 01:19:28,599
telescope in a space and just make

1721
01:19:25,539 --> 01:19:33,550
really long integrations efficiency is

1722
01:19:28,600 --> 01:19:34,930
about 70% of course they'll be it's a

1723
01:19:33,550 --> 01:19:36,400
very sensitive telescopes there'll be

1724
01:19:34,930 --> 01:19:37,780
lots of science done with much brighter

1725
01:19:36,399 --> 01:19:40,559
targets where you don't spend as much

1726
01:19:37,779 --> 01:19:43,949
time and then it'll be worse than that

1727
01:19:40,560 --> 01:19:47,170
okay so we got a question from online

1728
01:19:43,949 --> 01:19:49,840
what is going is the coolant going to be

1729
01:19:47,170 --> 01:19:52,180
a significance constraint on JT or C

1730
01:19:49,840 --> 01:19:53,440
observing and since I know the answer

1731
01:19:52,180 --> 01:19:55,480
the question I'll ask the follow-up

1732
01:19:53,439 --> 01:19:57,009
question if it's not the coolant what

1733
01:19:55,479 --> 01:20:00,909
might be the constraint on the lifetime

1734
01:19:57,010 --> 01:20:02,500
of the telescope right so there's no

1735
01:20:00,909 --> 01:20:06,189
there's no coolant that's a consumable

1736
01:20:02,500 --> 01:20:09,609
at the telescope there's a there's a

1737
01:20:06,189 --> 01:20:10,960
there's one cooler for for Miri that's

1738
01:20:09,609 --> 01:20:12,189
an active cooler but it's a closed cycle

1739

01:20:10,960 --> 01:20:16,390
cooler so it works like a refrigerator

1740
01:20:12,189 --> 01:20:18,069
it's a pump that compresses I guess and

1741
01:20:16,390 --> 01:20:19,690
so there's nothing lost so that's not a

1742
01:20:18,069 --> 01:20:24,009
consumable consume main consumable is

1743
01:20:19,689 --> 01:20:25,829
propellant so the I2 orbit is not a

1744
01:20:24,010 --> 01:20:27,940
stable orbit so you have to use

1745
01:20:25,829 --> 01:20:33,789
essentially rocket fuels to keep it in

1746
01:20:27,939 --> 01:20:36,429
place you also have to use fuel to well

1747
01:20:33,789 --> 01:20:39,189
so so basically the because you have

1748
01:20:36,430 --> 01:20:39,789
that big Sun shield it actually gets

1749
01:20:39,189 --> 01:20:41,679
pushed

1750
01:20:39,789 --> 01:20:45,789
by the solar wind and so the particles

1751
01:20:41,680 --> 01:20:47,079
from the Sun and so that if you didn't

1752
01:20:45,789 --> 01:20:48,760
do anything with the telescope it would

1753
01:20:47,079 --> 01:20:51,609

actually start to rotate and eventually

1754

01:20:48,760 --> 01:20:53,170

tumble and so you don't want that so you

1755

01:20:51,609 --> 01:20:55,049

have a reaction wheel on it that spins

1756

01:20:53,170 --> 01:20:57,550

up to counteract that rotation

1757

01:20:55,050 --> 01:20:59,289

eventually that reaches its limit and

1758

01:20:57,550 --> 01:21:02,020

you have to make a burn to spin that

1759

01:20:59,289 --> 01:21:05,470

wheel down again and so that also uses

1760

01:21:02,020 --> 01:21:08,620

propellant so so the ultimate consumer

1761

01:21:05,470 --> 01:21:10,420

Bowl is rocket fuel so the question you

1762

01:21:08,619 --> 01:21:12,909

know with that is that is then that they

1763

01:21:10,420 --> 01:21:15,880

ask is so what what do we expect is a

1764

01:21:12,909 --> 01:21:18,819

lifetime for jato st how many years how

1765

01:21:15,880 --> 01:21:21,039

many decades how about that we were

1766

01:21:18,819 --> 01:21:23,289

issued counted in decades the

1767

01:21:21,039 --> 01:21:24,699

requirement is five years ah but it's

1768
01:21:23,289 --> 01:21:26,939
not gonna be launched with less

1769
01:21:24,699 --> 01:21:30,220
propellant than for at least 10 years

1770
01:21:26,939 --> 01:21:32,799
and so that means that it can live for

1771
01:21:30,220 --> 01:21:34,750
10 years even maybe a bit more but it's

1772
01:21:32,800 --> 01:21:36,310
possible that something you know parts

1773
01:21:34,750 --> 01:21:38,010
of some instruments might break between

1774
01:21:36,310 --> 01:21:41,500
the 5 and the 10 year mark

1775
01:21:38,010 --> 01:21:45,239
hopefully not okay in the middle of the

1776
01:21:41,500 --> 01:21:45,239
audience here in the black sweater there

1777
01:21:49,560 --> 01:21:55,539
so what is the resolution of James Webb

1778
01:21:51,850 --> 01:21:59,289
compared to Hubble alright so so you can

1779
01:21:55,539 --> 01:21:59,769
you can you can calculate that fairly

1780
01:21:59,289 --> 01:22:04,390
easily

1781
01:21:59,770 --> 01:22:06,580
um so the Hubble has a two point for me

1782
01:22:04,390 --> 01:22:08,829
to telescope and data beastly has a six

1783
01:22:06,579 --> 01:22:11,739
and a half metre telescope and so the

1784
01:22:08,829 --> 01:22:13,720
rally the resolution scales linearly

1785
01:22:11,739 --> 01:22:19,260
with that it also scales with wavelength

1786
01:22:13,720 --> 01:22:22,420
so let's say you the mirror of Webb is

1787
01:22:19,260 --> 01:22:24,640
about two and a half times the size of

1788
01:22:22,420 --> 01:22:25,869
Hubble and so the same wavelength the

1789
01:22:24,640 --> 01:22:27,100
resolution will be two-and-a-half times

1790
01:22:25,869 --> 01:22:29,609
better but you're not at the same

1791
01:22:27,100 --> 01:22:32,950
wavelength unit about you know two to

1792
01:22:29,609 --> 01:22:35,109
five to ten times longer wavelength and

1793
01:22:32,949 --> 01:22:36,729
so then you scale scale back down again

1794
01:22:35,109 --> 01:22:38,409
so this is the that's a complicated

1795
01:22:36,729 --> 01:22:46,629
answer the the simple answer is it'll be

1796

01:22:38,409 --> 01:22:49,079
about the same resolution this would

1797
01:22:46,630 --> 01:22:52,029
they look the same then

1798
01:22:49,079 --> 01:22:53,559
it would have the same similar sharpness

1799
01:22:52,029 --> 01:22:55,988
but it will look quite different because

1800
01:22:53,559 --> 01:22:59,288
you'd be looking at and say dust instead

1801
01:22:55,988 --> 01:23:00,818
of stars but but as he said at the same

1802
01:22:59,288 --> 01:23:03,368
wavelength it'll be two knife times

1803
01:23:00,819 --> 01:23:04,839
sharper okay it a couple times sharper

1804
01:23:03,368 --> 01:23:06,158
it's just if you're looking at the

1805
01:23:04,838 --> 01:23:07,269
longer wavelengths it'll be about the

1806
01:23:06,158 --> 01:23:15,549
same okay

1807
01:23:07,269 --> 01:23:16,989
so in front here right yeah this

1808
01:23:15,550 --> 01:23:18,878
question came up on the chat as well

1809
01:23:16,988 --> 01:23:20,888
they're worried that web would be

1810
01:23:18,878 --> 01:23:24,099

restricted because it has to point away

1811

01:23:20,889 --> 01:23:25,208

from the Sun in what it can observe yeah

1812

01:23:24,099 --> 01:23:27,458

they said that's an excellent question

1813

01:23:25,208 --> 01:23:32,010

as well aw it's a bit a bit of geometry

1814

01:23:27,458 --> 01:23:34,988

there so it orbits web orbits the Sun

1815

01:23:32,010 --> 01:23:36,309

along with the earth and so the answer

1816

01:23:34,988 --> 01:23:39,279

is actually that it can observe every

1817

01:23:36,309 --> 01:23:41,769

place in the sky but because the Sun

1818

01:23:39,279 --> 01:23:43,868

shield will point to the earth the

1819

01:23:41,769 --> 01:23:47,019

telescope will point you know either up

1820

01:23:43,868 --> 01:23:48,639

or down all the way around like a circle

1821

01:23:47,019 --> 01:23:50,199

like that so you imagine you'll have a

1822

01:23:48,639 --> 01:23:52,538

circle on the sky that looks like that

1823

01:23:50,198 --> 01:23:55,029

over the course of a year that circle

1824

01:23:52,538 --> 01:23:57,309

will move all the way around and scan

1825
01:23:55,029 --> 01:23:59,918
the entire sky so if you have an object

1826
01:23:57,309 --> 01:24:00,998
that is very close to the clip let's say

1827
01:23:59,918 --> 01:24:02,349
the Sun and the earth if you have a

1828
01:24:00,998 --> 01:24:05,228
target it's very close to the ecliptic

1829
01:24:02,349 --> 01:24:06,668
pole you can observe it all the time if

1830
01:24:05,229 --> 01:24:08,469
you have a target that it's pointed

1831
01:24:06,668 --> 01:24:24,788
directly away from the Sun earth plane

1832
01:24:08,469 --> 01:24:26,319
you can observe it twice a year so if

1833
01:24:24,788 --> 01:24:27,818
you want to do a really long observing

1834
01:24:26,319 --> 01:24:30,760
time do you have other special points in

1835
01:24:27,819 --> 01:24:31,869
the sky you have to be pointed at yes it

1836
01:24:30,760 --> 01:24:35,019
has to be has to be a very long

1837
01:24:31,868 --> 01:24:38,018
observing time so so any any given point

1838
01:24:35,019 --> 01:24:41,679
will have a couple of weeks of potential

1839
01:24:38,019 --> 01:24:44,109
time and if you really want a cool way

1840
01:24:41,679 --> 01:24:46,479
to visualize this stay tuned to those

1841
01:24:44,109 --> 01:24:48,939
social media accounts that Frank shared

1842
01:24:46,479 --> 01:24:50,050
earlier in about a month maybe a month

1843
01:24:48,939 --> 01:24:51,849
and a half they'll be a really cool

1844
01:24:50,050 --> 01:24:53,889
animation to show you exactly what web

1845
01:24:51,849 --> 01:24:59,279
can see in the sky and explain that

1846
01:24:53,889 --> 01:24:59,279
circle rotating that Kosh just mentioned

1847
01:25:00,050 --> 01:25:10,909
okay other questions over there so how

1848
01:25:08,869 --> 01:25:15,949
long will Hubble operate and will Jade

1849
01:25:10,909 --> 01:25:20,750
OST and Hubble overlap I'll take this

1850
01:25:15,949 --> 01:25:24,199
okay so Hubble is doing really well

1851
01:25:20,750 --> 01:25:26,060
April is Hubble's 28th birthday and so

1852
01:25:24,199 --> 01:25:28,539
we are expecting good things it's in

1853

01:25:26,060 --> 01:25:31,789
good health it looks good

1854
01:25:28,539 --> 01:25:35,359
so yes we anticipate that Hubble and

1855
01:25:31,789 --> 01:25:36,710
Webb will observe simultaneously and one

1856
01:25:35,359 --> 01:25:38,149
of the cool things you can do with this

1857
01:25:36,710 --> 01:25:40,670
I'm putting in a plug for my own thing

1858
01:25:38,149 --> 01:25:41,389
here is because they're about a million

1859
01:25:40,670 --> 01:25:45,350
miles apart

1860
01:25:41,390 --> 01:25:48,320
think about your two eyes and what what

1861
01:25:45,350 --> 01:25:52,490
does having two eyes by you yeah

1862
01:25:48,319 --> 01:25:55,009
depth perception so one of the cool

1863
01:25:52,489 --> 01:25:57,229
things we might be able to do with Webb

1864
01:25:55,010 --> 01:26:01,340
and Hubble at the same time is look at

1865
01:25:57,229 --> 01:26:03,109
objects and be able to get some some

1866
01:26:01,340 --> 01:26:04,880
depth perception there especially things

1867
01:26:03,109 --> 01:26:06,799

close to us so solar system objects

1868

01:26:04,880 --> 01:26:09,199

things like that I'm a planetary person

1869

01:26:06,800 --> 01:26:11,000

so I'm really into this idea okay that's

1870

01:26:09,199 --> 01:26:14,029

that's why I kick Klaus out of the way I

1871

01:26:11,000 --> 01:26:15,739

want to answer that one but my

1872

01:26:14,029 --> 01:26:16,759

understanding is it won't be good much

1873

01:26:15,739 --> 01:26:19,460

beyond Jupiter

1874

01:26:16,760 --> 01:26:22,340

maybe asteroid belt would be a yeah yeah

1875

01:26:19,460 --> 01:26:24,920

yeah we have cool things like the active

1876

01:26:22,340 --> 01:26:27,409

asteroids that are shooting out Jets and

1877

01:26:24,920 --> 01:26:29,239

you know some you know three-dimensional

1878

01:26:27,409 --> 01:26:32,500

information on that you can just some

1879

01:26:29,239 --> 01:26:34,699

great stereo views of rocks

1880

01:26:32,500 --> 01:26:38,050

it'll be like going to Mars again

1881

01:26:34,699 --> 01:26:40,880

[Laughter]

1882
01:26:38,050 --> 01:26:48,020
alright sorry we're just having fun

1883
01:26:40,880 --> 01:26:50,539
question here another question that came

1884
01:26:48,020 --> 01:26:52,790
up in our chat online are there research

1885
01:26:50,539 --> 01:26:55,489
proposals that have been submitted

1886
01:26:52,789 --> 01:26:59,090
and/or approved we know what Webb is

1887
01:26:55,489 --> 01:27:00,949
gonna look at first we know some of the

1888
01:26:59,090 --> 01:27:02,900
things that Webb will look at first so

1889
01:27:00,949 --> 01:27:04,550
these are what Alex was talking about so

1890
01:27:02,899 --> 01:27:09,319
I'm gonna let her keep answering that

1891
01:27:04,550 --> 01:27:13,340
question okay I will just pull up the

1892
01:27:09,319 --> 01:27:15,229
slides because you know I do extra work

1893
01:27:13,340 --> 01:27:18,559
the answer is yes we have these

1894
01:27:15,229 --> 01:27:21,019
proposals and so two of the three types

1895
01:27:18,559 --> 01:27:22,579
that I mentioned this is fun

1896
01:27:21,020 --> 01:27:26,599
two of the three types that I mentioned

1897
01:27:22,578 --> 01:27:28,698
the programs and the ers programs the

1898
01:27:26,599 --> 01:27:30,380
guaranteed time observations which is

1899
01:27:28,698 --> 01:27:32,000
that time that we give to those people

1900
01:27:30,380 --> 01:27:35,000
who've worked on this for five ten

1901
01:27:32,000 --> 01:27:37,460
twenty years this purple graph here of

1902
01:27:35,000 --> 01:27:39,948
people working they get time they get a

1903
01:27:37,460 --> 01:27:44,719
couple of thousand hours in the first

1904
01:27:39,948 --> 01:27:46,788
couple of years and then this directors

1905
01:27:44,719 --> 01:27:47,868
discretionary early release science was

1906
01:27:46,788 --> 01:27:50,840
picked by the director of the Space

1907
01:27:47,868 --> 01:27:52,429
Telescope Institute as science cases to

1908
01:27:50,840 --> 01:27:54,260
demonstrate the capabilities of the

1909
01:27:52,429 --> 01:27:56,538
telescope and will be released

1910

01:27:54,260 --> 01:27:58,520
immediately and taken in the first

1911
01:27:56,538 --> 01:28:00,469
couple of months after launch these

1912
01:27:58,520 --> 01:28:02,900
programs are already decided they're

1913
01:28:00,469 --> 01:28:07,730
available online there's 13 programs

1914
01:28:02,899 --> 01:28:09,348
under the ers and there's well if you

1915
01:28:07,729 --> 01:28:12,500
break them down into programs a couple

1916
01:28:09,349 --> 01:28:15,889
of dozen programs for GTOs under a few

1917
01:28:12,500 --> 01:28:17,090
key people the the key people who were

1918
01:28:15,889 --> 01:28:19,250
part of the program from the beginning

1919
01:28:17,090 --> 01:28:20,900
they got time and they said this is what

1920
01:28:19,250 --> 01:28:23,988
I want to spend my time on you can

1921
01:28:20,899 --> 01:28:25,969
review all of this it's online if you

1922
01:28:23,988 --> 01:28:27,859
want that link come after it so we can

1923
01:28:25,969 --> 01:28:30,050
get it to you it's long but all of this

1924
01:28:27,859 --> 01:28:34,819

information is available online if you

1925

01:28:30,050 --> 01:28:36,559

just google JWST early release science

1926

01:28:34,819 --> 01:28:39,529

you'll get an article that explains all

1927

01:28:36,559 --> 01:28:42,500

of the things and again this covers

1928

01:28:39,529 --> 01:28:43,819

solar system objects all of the for

1929

01:28:42,500 --> 01:28:46,819

science themes that Bonnie talked about

1930

01:28:43,819 --> 01:28:49,250

and we do know these already these will

1931

01:28:46,819 --> 01:28:52,549

be decided in the summer and you'll hear

1932

01:28:49,250 --> 01:28:55,118

about them probably July for the first

1933

01:28:52,550 --> 01:28:58,010

round of general observer observations

1934

01:28:55,118 --> 01:28:59,089

from then on these are already decided

1935

01:28:58,010 --> 01:29:02,239

and they'll be taken at the beginning

1936

01:28:59,090 --> 01:29:05,630

from then on we'll have several calls

1937

01:29:02,238 --> 01:29:07,488

for people to submit ideas and as we get

1938

01:29:05,630 --> 01:29:09,739

back data from web and find out what it

1939
01:29:07,488 --> 01:29:11,658
can do that'll spark ideas for new

1940
01:29:09,738 --> 01:29:13,399
proposals and so for the lifetime of the

1941
01:29:11,658 --> 01:29:14,779
mission we'll keep asking the

1942
01:29:13,399 --> 01:29:16,250
astronomical community for what they

1943
01:29:14,779 --> 01:29:18,078
want to do with the telescope and it

1944
01:29:16,250 --> 01:29:19,250
will keep getting answers but thus far

1945
01:29:18,078 --> 01:29:21,439
the programs that have already been

1946
01:29:19,250 --> 01:29:24,408
approved fall into these two buckets and

1947
01:29:21,439 --> 01:29:26,629
you can find them online ok we have time

1948
01:29:24,408 --> 01:29:29,629
for one last question if anybody has it

1949
01:29:26,630 --> 01:29:31,219
going once help take it and go what's

1950
01:29:29,630 --> 01:29:51,619
the last question make it good make it

1951
01:29:31,219 --> 01:29:54,350
good cuz it's the last one okay so

1952
01:29:51,619 --> 01:29:56,979
alright so obviously there's tons are

1953
01:29:54,350 --> 01:29:59,360
really cool science we can do with web

1954
01:29:56,979 --> 01:30:02,388
what's the plans for the telescopes

1955
01:29:59,359 --> 01:30:05,000
beyond web that will replace Hubble and

1956
01:30:02,389 --> 01:30:12,819
Webb in the 2030s who wants to answer

1957
01:30:05,000 --> 01:30:16,300
that question well okay so so there's

1958
01:30:12,819 --> 01:30:18,619
yeah I don't I don't hurt myself here so

1959
01:30:16,300 --> 01:30:21,320
there there's there's the wide-field

1960
01:30:18,619 --> 01:30:23,238
infrared telescope which is under

1961
01:30:21,319 --> 01:30:27,198
construction at the moment which is a

1962
01:30:23,238 --> 01:30:30,589
near infrared telescope that has Hubble

1963
01:30:27,198 --> 01:30:33,349
sized but it has a hundred times the

1964
01:30:30,590 --> 01:30:34,969
field of view so make Hubble like

1965
01:30:33,350 --> 01:30:36,440
pictures but it'll be a hundred times

1966
01:30:34,969 --> 01:30:37,969
bigger

1967

01:30:36,439 --> 01:30:39,109
just watch the survey telescope so

1968
01:30:37,969 --> 01:30:41,689
that's approved and that's under

1969
01:30:39,109 --> 01:30:45,139
construction beyond that for the 2030s

1970
01:30:41,689 --> 01:30:48,198
there's a process ongoing that happens

1971
01:30:45,139 --> 01:30:50,239
every decade in the United States it's

1972
01:30:48,198 --> 01:30:54,289
called a decadal survey and that

1973
01:30:50,238 --> 01:31:00,488
consists of the community historical

1974
01:30:54,289 --> 01:31:00,488
community getting together and yeah

1975
01:31:04,448 --> 01:31:10,759
right so the community gets together and

1976
01:31:08,000 --> 01:31:13,340
they they think about what they might

1977
01:31:10,760 --> 01:31:16,010
want to do for the following decade in

1978
01:31:13,340 --> 01:31:18,829
this case for the 2030s today so so so

1979
01:31:16,010 --> 01:31:21,320
datums T was the selection for \$2000

1980
01:31:18,829 --> 01:31:23,600
stores the selection for 2010 we need a

1981
01:31:21,319 --> 01:31:25,399

selection for the 2020s one other so

1982

01:31:23,600 --> 01:31:27,860

there's four concepts for new flagship

1983

01:31:25,399 --> 01:31:30,888

telescopes and one of them is an

1984

01:31:27,859 --> 01:31:33,738

infrared telescope ah that goes beyond

1985

01:31:30,889 --> 01:31:37,239

in wavelength even WOD TMT does it

1986

01:31:33,738 --> 01:31:40,459

covers from five micron to 660 micron

1987

01:31:37,238 --> 01:31:42,579

but it'll be between a sow

1988

01:31:40,460 --> 01:31:45,109

10,000 times more sensitive than

1989

01:31:42,579 --> 01:31:46,309

anything has been done before so that's

1990

01:31:45,109 --> 01:31:48,170

that's new frontier it's called the

1991

01:31:46,310 --> 01:31:49,670

origin space telescope and you can

1992

01:31:48,170 --> 01:31:51,289

google that and look it up that's one of

1993

01:31:49,670 --> 01:31:53,300

the one of the concepts now the other

1994

01:31:51,289 --> 01:31:55,810

concepts as well there's a there's also

1995

01:31:53,300 --> 01:31:59,420

a concept it's called leVoir which is

1996
01:31:55,810 --> 01:32:02,539
the next optical telescope which is a 15

1997
01:31:59,420 --> 01:32:05,029
meter telescope that's going to follow

1998
01:32:02,539 --> 01:32:07,519
up on Hubble so that's going to be some

1999
01:32:05,029 --> 01:32:09,229
tough decisions to make for the

2000
01:32:07,520 --> 01:32:11,630
astronomical community of what is the

2001
01:32:09,229 --> 01:32:12,979
best the best way to spend money going

2002
01:32:11,630 --> 01:32:16,430
forward for the 2030s will be

2003
01:32:12,979 --> 01:32:18,139
interesting okay so that's all we have

2004
01:32:16,430 --> 01:32:19,400
time for tonight if you have more

2005
01:32:18,140 --> 01:32:21,710
questions or things you can come down

2006
01:32:19,399 --> 01:32:24,079
the speaker's will be here next month

2007
01:32:21,710 --> 01:32:27,680
February 6 which is only just a couple

2008
01:32:24,079 --> 01:32:29,238
of weeks away the wildest weather in the

2009
01:32:27,680 --> 01:32:33,130
universe let's give all three our

2010

01:32:29,238 --> 01:32:33,129

speakers I great big and good night

2011

01:32:39,300 --> 01:33:09,500

a solid nobody