PUBLIC LECTURE SERIES

The Webb Space Telescope: Launching a Legacy

Featuring Guest Speaker: Alexandra Lockwood

1
00:00:06,710 --> 00:00:04,550
welcome to the space telescope public

2
00:00:09,030 --> 00:00:06,720
lecture series tonight

3
00:00:13,190 --> 00:00:09,040
the webb space telescope launching a

4
00:00:15,350 --> 00:00:13,200
legacy with dr alexandra lockwood

5
00:00:18,230 --> 00:00:15,360
i'm your host dr frank summers of the

6
00:00:20,150 --> 00:00:18,240
office of public outreach here at stsci

7
00:00:22,870 --> 00:00:20,160
and i would like to thank our wonderful

8
00:00:23,910 --> 00:00:22,880
tech team thomas marufu and grant

9
00:00:25,830 --> 00:00:23,920
justice

10
00:00:28,310 --> 00:00:25,840
i also note that this public lecture

11
00:00:31,669 --> 00:00:28,320
series will continue to be online only

12
00:00:35,270 --> 00:00:31,679
until further notice

13
00:00:36,790 --> 00:00:35,280

our upcoming talks on january 4th of

14
00:00:39,350 --> 00:00:36,800
2022

15
00:00:42,150 --> 00:00:39,360
we will talk about the vibrant life in

16
00:00:44,869 --> 00:00:42,160
cities of galaxies this is the

17
00:00:46,869 --> 00:00:44,879
big clusters of galaxies where you know

18
00:00:50,709 --> 00:00:46,879
like in the big cities this is where the

19
00:00:52,069 --> 00:00:50,719
action happens uh maria montesquiles of

20
00:00:53,029 --> 00:00:52,079
space telescope will present that

21
00:00:54,950 --> 00:00:53,039
lecture

22
00:00:57,670 --> 00:00:54,960
on february 1st

23
00:01:00,549 --> 00:00:57,680
from the front lines of the exoplanet

24
00:01:02,150 --> 00:01:00,559
revolution and this is uh

25
00:01:04,869 --> 00:01:02,160
really been a developing story over the

26
00:01:07,350 --> 00:01:04,879
last 25 years that we discovered planets

27
00:01:08,870 --> 00:01:07,360
around other stars and our peter roy

28
00:01:10,230 --> 00:01:08,880
also of the space telescope science

29
00:01:11,510 --> 00:01:10,240
institute will be presenting that

30
00:01:13,429 --> 00:01:11,520
lecture

31
00:01:16,390 --> 00:01:13,439
on march 1st

32
00:01:18,710 --> 00:01:16,400
a talk with a very long title a hubble

33
00:01:21,590 --> 00:01:18,720
from space an integral field

34
00:01:24,870 --> 00:01:21,600
spectroscopy from the ground seeing both

35
00:01:27,350 --> 00:01:24,880
the forests and the trees and this will

36
00:01:28,550 --> 00:01:27,360
be our first lecture from someone from

37
00:01:31,390 --> 00:01:28,560
ireland

38
00:01:33,670 --> 00:01:31,400

mark sauzi of arma observatory and

39
00:01:35,910 --> 00:01:33,680
planetarium yes we are

40
00:01:37,350 --> 00:01:35,920
branching abroad for uh some of our

41
00:01:38,630 --> 00:01:37,360
talks this year

42
00:01:41,190 --> 00:01:38,640
if you would like to keep up with all

43
00:01:46,149 --> 00:01:41,200
the talks you can go to our website at

44
00:01:50,550 --> 00:01:48,950
public hyphen lectures that's the

45
00:01:53,109 --> 00:01:50,560
shortcut that will get you to this

46
00:01:56,389 --> 00:01:53,119
webpage and you'll see on the left side

47
00:01:59,590 --> 00:01:56,399
the webcasts of our past lectures both

48
00:02:01,429 --> 00:01:59,600
on our youtube playlist and in our sdsci

49
00:02:03,109 --> 00:02:01,439
webcast archive

50
00:02:05,190 --> 00:02:03,119
and on the right you see the button

51
00:02:06,950 --> 00:02:05,200
where you can enter your email address

52
00:02:09,669 --> 00:02:06,960
to subscribe to our mailing list and

53
00:02:13,110 --> 00:02:09,679
you'll get basically two or three emails

54
00:02:15,430 --> 00:02:13,120
per month telling you about our lectures

55
00:02:17,910 --> 00:02:15,440
also on the web pages you will see the

56
00:02:19,990 --> 00:02:17,920
list of the upcoming lectures with the

57
00:02:22,390 --> 00:02:20,000
titles and the

58
00:02:24,710 --> 00:02:22,400
speaker and the abstract if you click on

59
00:02:26,869 --> 00:02:24,720
the read more button you will find out

60
00:02:28,710 --> 00:02:26,879
all the information about it including

61
00:02:30,790 --> 00:02:28,720
the description and after it has been

62
00:02:34,070 --> 00:02:30,800
broadcast you will sign links to the

63
00:02:37,030 --> 00:02:34,080

sdsci webcast as well as the youtube

64
00:02:39,430 --> 00:02:37,040
webcast

65
00:02:41,910 --> 00:02:39,440
reminders as i said you can sign up on

66
00:02:44,550 --> 00:02:41,920
our website or another way to get

67
00:02:45,630 --> 00:02:44,560
reminders is to subscribe to our youtube

68
00:02:49,030 --> 00:02:45,640
channel

69
00:02:50,710 --> 00:02:49,040
youtube.com slash hubble space telescope

70
00:02:53,430 --> 00:02:50,720
all one word

71
00:02:55,350 --> 00:02:53,440
you will get notices for our new videos

72
00:02:56,630 --> 00:02:55,360
as well as reminders of these live

73
00:02:58,390 --> 00:02:56,640
events

74
00:03:00,149 --> 00:02:58,400
finally if you have comments or

75
00:03:04,160 --> 00:03:00,159
questions you can send them to the email

76
00:03:05,750 --> 00:03:04,170
address public lecture at stsci.org

77
00:03:07,430 --> 00:03:05,760
[Music]

78
00:03:09,990 --> 00:03:07,440
for those of you who want to follow us

79
00:03:11,990 --> 00:03:10,000
on social media we have social media

80
00:03:14,470 --> 00:03:12,000
accounts for the hubble space telescope

81
00:03:16,949 --> 00:03:14,480
for the web space telescope and for the

82
00:03:18,390 --> 00:03:16,959
space telescope science institute on

83
00:03:20,710 --> 00:03:18,400
facebook twitter

84
00:03:23,430 --> 00:03:20,720
youtube and instagram

85
00:03:25,910 --> 00:03:23,440
i myself do a very very tiny bit of

86
00:03:29,270 --> 00:03:25,920
social media and i'm on both facebook

87
00:03:34,470 --> 00:03:31,190
and now our news from the universe for

88
00:03:37,750 --> 00:03:34,480

89
00:03:40,630 --> 00:03:37,760
our first story tonight a supernova

90
00:03:42,630 --> 00:03:40,640
caught in the act

91
00:03:44,149 --> 00:03:42,640
now many of you may recognize this

92
00:03:45,430 --> 00:03:44,159
constellation this is the constellation

93
00:03:48,229 --> 00:03:45,440
of orion

94
00:03:51,670 --> 00:03:48,239
and orion's shoulder is caused the star

95
00:03:53,589 --> 00:03:51,680
betelgeuse and betelgeuse is a red

96
00:03:56,309 --> 00:03:53,599
supergiant star

97
00:03:58,830 --> 00:03:56,319
that will end its life in a supernova

98
00:04:02,309 --> 00:03:58,840
explosion the star will blow itself

99
00:04:04,309 --> 00:04:02,319
apart but the question is when

100
00:04:05,429 --> 00:04:04,319
and we don't know when we can really

101
00:04:08,070 --> 00:04:05,439
just say

102
00:04:09,910 --> 00:04:08,080
sometime in the next few million years

103
00:04:12,070 --> 00:04:09,920
maybe four or five million years

104
00:04:13,589 --> 00:04:12,080
betelgeuse is going to explode

105
00:04:16,150 --> 00:04:13,599
and that's something somewhat

106
00:04:19,110 --> 00:04:16,160
unsatisfactory that we don't know when

107
00:04:22,069 --> 00:04:19,120
so when we comes to supernova such as

108
00:04:23,749 --> 00:04:22,079
this supernova 1987a

109
00:04:24,550 --> 00:04:23,759
we're sort of just playing a waiting

110
00:04:28,150 --> 00:04:24,560
game

111
00:04:30,070 --> 00:04:28,160
so we have this we saw supernova 1987a

112
00:04:32,790 --> 00:04:30,080
go off and that gave us this picture on

113
00:04:33,749 --> 00:04:32,800

the right that's the after picture

114
00:04:35,510 --> 00:04:33,759
but

115
00:04:37,350 --> 00:04:35,520
then we went back and searched to find

116
00:04:39,030 --> 00:04:37,360
the before picture okay because we

117
00:04:40,310 --> 00:04:39,040
didn't know it was going off we can't

118
00:04:42,230 --> 00:04:40,320
sit there and wait for it because we

119
00:04:43,990 --> 00:04:42,240
didn't know when it's going off so

120
00:04:46,870 --> 00:04:44,000
usually when we do follow-up

121
00:04:49,510 --> 00:04:46,880
observations to a supernova we only get

122
00:04:52,469 --> 00:04:49,520
it you know a day or two or a week or

123
00:04:54,230 --> 00:04:52,479
maybe even more after the supernova has

124
00:04:56,870 --> 00:04:54,240
start has gone off

125
00:04:59,510 --> 00:04:56,880
so that doesn't give us any idea of what

126
00:05:01,029 --> 00:04:59,520
happens before the supernova goes off we

127
00:05:02,469 --> 00:05:01,039
can go back and look into archival

128
00:05:05,029 --> 00:05:02,479
footage sometimes and sometimes we get

129
00:05:07,430 --> 00:05:05,039
lucky to find it but we'd really like to

130
00:05:08,950 --> 00:05:07,440
have real-time coverage of a supernova

131
00:05:11,510 --> 00:05:08,960
going off

132
00:05:14,150 --> 00:05:11,520
which leads us to this hub new hubble

133
00:05:16,310 --> 00:05:14,160
observation of the two galaxies known as

134
00:05:19,590 --> 00:05:16,320
ngc 4567

135
00:05:21,830 --> 00:05:19,600
and ngc four five six eight uh these are

136
00:05:23,510 --> 00:05:21,840
some times called the butterfly galaxies

137
00:05:25,029 --> 00:05:23,520
because if you squint your eyes and look

138
00:05:26,070 --> 00:05:25,039

at it you can sort of see a butterfly

139
00:05:29,189 --> 00:05:26,080
right

140
00:05:31,350 --> 00:05:29,199
well in the front galaxy

141
00:05:34,790 --> 00:05:31,360
we saw a supernova

142
00:05:36,790 --> 00:05:34,800
supernova 2020 fqv

143
00:05:38,710 --> 00:05:36,800
and this supernova

144
00:05:40,790 --> 00:05:38,720
was special because it's the one that

145
00:05:42,950 --> 00:05:40,800
was caught in the act

146
00:05:44,150 --> 00:05:42,960
these galaxies and the star that went

147
00:05:46,390 --> 00:05:44,160
supernova

148
00:05:48,390 --> 00:05:46,400
are in the field of view that's

149
00:05:51,110 --> 00:05:48,400
currently being monitored by the

150
00:05:53,749 --> 00:05:51,120
transiting exoplanet survey satellite

151
00:05:55,749 --> 00:05:53,759
tess and tess is designed to look at

152
00:05:57,350 --> 00:05:55,759
extrasolar planets and it's seeing

153
00:05:59,590 --> 00:05:57,360
extrasolar planets as they pass in front

154
00:06:02,710 --> 00:05:59,600
of their stars so it observes the same

155
00:06:05,270 --> 00:06:02,720
field over and over and over okay over

156
00:06:07,430 --> 00:06:05,280
the course of of a couple years it's

157
00:06:10,230 --> 00:06:07,440
going to cover the entire sky

158
00:06:11,830 --> 00:06:10,240
but during the supernova it was also

159
00:06:15,189 --> 00:06:11,840
being monitored

160
00:06:17,430 --> 00:06:15,199
so when this supernova went off and this

161
00:06:19,830 --> 00:06:17,440
is a scientific graph and you see this

162
00:06:21,590 --> 00:06:19,840
orange arrow that i added there that's

163
00:06:23,590 --> 00:06:21,600

when the supernova went off

164
00:06:26,230 --> 00:06:23,600
all those blue dots

165
00:06:27,590 --> 00:06:26,240
those are test observations of that

166
00:06:30,309 --> 00:06:27,600
supernova

167
00:06:33,510 --> 00:06:30,319
because you they got observations every

168
00:06:35,670 --> 00:06:33,520
30 minutes as the supernova went off now

169
00:06:37,749 --> 00:06:35,680
this is just totally happenstance just

170
00:06:41,110 --> 00:06:37,759
happened to be looking in that area but

171
00:06:42,550 --> 00:06:41,120
we got it we got to catch the supernova

172
00:06:45,510 --> 00:06:42,560
in the act

173
00:06:47,270 --> 00:06:45,520
also we're able to see it as it's on its

174
00:06:48,950 --> 00:06:47,280
rise which is extremely that's the

175
00:06:51,430 --> 00:06:48,960
really important part

176
00:06:53,749 --> 00:06:51,440
and identify other telescopes

177
00:06:55,670 --> 00:06:53,759
including hubble to go out and take a

178
00:06:57,589 --> 00:06:55,680
look at it and hubble has a program

179
00:06:59,909 --> 00:06:57,599
that's called targets of opportunity

180
00:07:00,790 --> 00:06:59,919
when something special happens that can

181
00:07:02,390 --> 00:07:00,800
you know

182
00:07:05,110 --> 00:07:02,400
it's time sensitive

183
00:07:07,430 --> 00:07:05,120
we hubble can actually be switched into

184
00:07:09,350 --> 00:07:07,440
observing that that object and hubble

185
00:07:11,189 --> 00:07:09,360
was able to get early critical

186
00:07:14,550 --> 00:07:11,199
observations of it

187
00:07:16,390 --> 00:07:14,560
in order to see that rise of the light

188
00:07:18,629 --> 00:07:16,400

and the the beginning and the

189
00:07:20,950 --> 00:07:18,639
development of the supernova

190
00:07:23,029 --> 00:07:20,960
now what's really important about hubble

191
00:07:25,510 --> 00:07:23,039
is that hubble has the fine resolution

192
00:07:27,270 --> 00:07:25,520
to see the details around the star uh

193
00:07:29,350 --> 00:07:27,280
hubble has much finer resolution than

194
00:07:31,670 --> 00:07:29,360
tess would have or other ground-based

195
00:07:33,589 --> 00:07:31,680
telescopes would have so hubble can see

196
00:07:34,469 --> 00:07:33,599
the details around the stars that others

197
00:07:37,110 --> 00:07:34,479
can't

198
00:07:40,469 --> 00:07:37,120
and with this complete suite of

199
00:07:43,270 --> 00:07:40,479
observations following the rise of this

200
00:07:46,070 --> 00:07:43,280
of the supernova we can finally get an

201
00:07:48,150 --> 00:07:46,080
idea of what's going on

202
00:07:49,670 --> 00:07:48,160
to follow supernova

203
00:07:52,550 --> 00:07:49,680
furthermore

204
00:07:54,550 --> 00:07:52,560
these clues may help us predict which

205
00:07:55,909 --> 00:07:54,560
stars are likely to go supernova in the

206
00:07:57,909 --> 00:07:55,919
near future

207
00:08:00,390 --> 00:07:57,919
now we can't say that with just one of

208
00:08:02,070 --> 00:08:00,400
these observations that week supernova

209
00:08:03,909 --> 00:08:02,080
observations we'll have to get dozens

210
00:08:05,430 --> 00:08:03,919
and dozens of them in order to be able

211
00:08:06,550 --> 00:08:05,440
to really say all right here are the

212
00:08:09,430 --> 00:08:06,560
characteristic

213
00:08:10,390 --> 00:08:09,440

clues but this is another major step

214
00:08:12,469 --> 00:08:10,400
forward

215
00:08:15,749 --> 00:08:12,479
in being able to understand the lives of

216
00:08:19,670 --> 00:08:15,759
massive stars and how they end in these

217
00:08:24,150 --> 00:08:21,589
second story i have for you tonight is

218
00:08:27,110 --> 00:08:24,160
hubble's annual tour of the outer solar

219
00:08:30,230 --> 00:08:27,120
system and so each year from hubble

220
00:08:33,190 --> 00:08:30,240
you'll get a suite of pictures like this

221
00:08:36,389 --> 00:08:33,200
these are the outer planets uh jupiter

222
00:08:39,829 --> 00:08:36,399
saturn uranus and neptune here and

223
00:08:42,070 --> 00:08:39,839
they're gorgeous as always right now but

224
00:08:43,029 --> 00:08:42,080
hubble gets to look at them every single

225
00:08:45,110 --> 00:08:43,039
year

226
00:08:47,590 --> 00:08:45,120
and this is part of a very special

227
00:08:50,470 --> 00:08:47,600
program that runs on hubble it's called

228
00:08:52,389 --> 00:08:50,480
opal the outer planets atmospheres

229
00:08:53,990 --> 00:08:52,399
legacy program

230
00:08:55,670 --> 00:08:54,000
and uh if you can look on the left you

231
00:08:57,509 --> 00:08:55,680
can see a lot of the

232
00:08:59,110 --> 00:08:57,519
papers that have come out of it but

233
00:09:01,590 --> 00:08:59,120
what's interesting is on the right

234
00:09:03,670 --> 00:09:01,600
starting in 2014

235
00:09:05,190 --> 00:09:03,680
there had been observations of all four

236
00:09:07,750 --> 00:09:05,200
of these planets

237
00:09:09,990 --> 00:09:07,760
uh in order to um

238
00:09:12,949 --> 00:09:10,000

keep track of them year after year i

239
00:09:14,790 --> 00:09:12,959
mean hubble doesn't do what uh say the

240
00:09:16,389 --> 00:09:14,800
juno mission is doing right now juno is

241
00:09:18,710 --> 00:09:16,399
there and it's orbiting up close and

242
00:09:20,630 --> 00:09:18,720
personal or the cassini mission it was

243
00:09:22,470 --> 00:09:20,640
at saturn it's up close and personal and

244
00:09:25,030 --> 00:09:22,480
sees all the details

245
00:09:27,590 --> 00:09:25,040
but hubble being a long-term mission

246
00:09:29,990 --> 00:09:27,600
it's been up for 30 years can monitor

247
00:09:32,630 --> 00:09:30,000
these planets year after year after year

248
00:09:34,870 --> 00:09:32,640
and get the best view from earth in

249
00:09:37,590 --> 00:09:34,880
order to see all the details

250
00:09:39,590 --> 00:09:37,600
as much detail as we can and watch them

251
00:09:41,350 --> 00:09:39,600
over time and so

252
00:09:44,070 --> 00:09:41,360
this is what we get and

253
00:09:45,750 --> 00:09:44,080
what happens is that this is a 3d view

254
00:09:46,870 --> 00:09:45,760
of the solar system with earth in the

255
00:09:47,670 --> 00:09:46,880
foreground

256
00:09:49,590 --> 00:09:47,680
and

257
00:09:51,829 --> 00:09:49,600
earth spins around the sun much much

258
00:09:54,870 --> 00:09:51,839
faster it takes one year for earth uh it

259
00:09:57,350 --> 00:09:54,880
takes a five ten years i think for for

260
00:09:59,910 --> 00:09:57,360
for jupiter 30 years for saturn and so

261
00:10:03,190 --> 00:09:59,920
on so hubble orbits quickly

262
00:10:05,350 --> 00:10:03,200
and whenever the sun earth and the

263
00:10:07,509 --> 00:10:05,360

outer planets line up it can take a it

264
00:10:09,750 --> 00:10:07,519
can get a good picture of it right and

265
00:10:11,430 --> 00:10:09,760
so basically once a little over a year

266
00:10:14,230 --> 00:10:11,440
for every every of these one of these

267
00:10:16,790 --> 00:10:14,240
outer planets hubble can take a really

268
00:10:21,030 --> 00:10:16,800
good observation and stacking those up

269
00:10:22,870 --> 00:10:21,040
over the years gives us a fantastic

270
00:10:24,150 --> 00:10:22,880
database from which to study the outer

271
00:10:25,509 --> 00:10:24,160
planets and it's particularly their

272
00:10:27,750 --> 00:10:25,519
atmospheres

273
00:10:28,790 --> 00:10:27,760
it also allows us to do cool things like

274
00:10:30,949 --> 00:10:28,800
this

275
00:10:33,430 --> 00:10:30,959
such as make rotations of each of these

276
00:10:35,750 --> 00:10:33,440
planets because each planet is observed

277
00:10:38,870 --> 00:10:35,760
over the course of two rotations

278
00:10:41,269 --> 00:10:38,880
and yes saturn and uranus are actually

279
00:10:43,350 --> 00:10:41,279
uh rotating in this image and we can

280
00:10:45,269 --> 00:10:43,360
compare for example how long the length

281
00:10:47,910 --> 00:10:45,279
of a day on the different planets where

282
00:10:51,269 --> 00:10:47,920
jupiter and saturn are about 10 hours

283
00:10:53,110 --> 00:10:51,279
while uranus and neptune are about 16 or

284
00:10:55,670 --> 00:10:53,120
17 hours

285
00:10:57,030 --> 00:10:55,680
and so this is a what we call a legacy

286
00:10:58,790 --> 00:10:57,040
program it's one of these things that

287
00:11:00,870 --> 00:10:58,800
hubble only can do

288
00:11:07,030 --> 00:11:00,880

that we will be continuing to do every

289
00:11:13,430 --> 00:11:10,630
so our talk tonight is a very special

290
00:11:15,509 --> 00:11:13,440
talk we're really excited about this

291
00:11:16,949 --> 00:11:15,519
the web space telescope launching a

292
00:11:19,829 --> 00:11:16,959
legacy

293
00:11:21,509 --> 00:11:19,839
and our speaker for you tonight is uh dr

294
00:11:25,350 --> 00:11:21,519
alex lockwood

295
00:11:27,190 --> 00:11:25,360
and she is the project scientist for web

296
00:11:29,030 --> 00:11:27,200
outreach here at the space telescope

297
00:11:31,269 --> 00:11:29,040
science institute she's been with us for

298
00:11:33,910 --> 00:11:31,279
about four and a half years

299
00:11:36,389 --> 00:11:33,920
she did her bachelor's degree in physics

300
00:11:40,310 --> 00:11:36,399
and astronomy at the university of

301
00:11:42,389 --> 00:11:40,320
maryland uh followed up with her phd um

302
00:11:44,790 --> 00:11:42,399
act from tech

303
00:11:46,790 --> 00:11:44,800
she then took an interesting diversion

304
00:11:49,990 --> 00:11:46,800
uh going off to the middle east working

305
00:11:51,829 --> 00:11:50,000
for university uh in doing a news

306
00:11:53,110 --> 00:11:51,839
publication for the university in the

307
00:11:54,829 --> 00:11:53,120
middle east

308
00:11:57,750 --> 00:11:54,839
she came back worked with

309
00:11:59,670 --> 00:11:57,760
nao noao and nasa

310
00:12:01,590 --> 00:11:59,680
for a little bit and then finally we

311
00:12:03,590 --> 00:12:01,600
nabbed her brought her here to the space

312
00:12:05,110 --> 00:12:03,600
telescope science institute

313
00:12:06,790 --> 00:12:05,120

where she is you know

314
00:12:09,269 --> 00:12:06,800
kind of responsible for

315
00:12:11,269 --> 00:12:09,279
so many things related to web space

316
00:12:13,350 --> 00:12:11,279
telescope outreach

317
00:12:14,949 --> 00:12:13,360
uh and i always ask my speakers for

318
00:12:16,230 --> 00:12:14,959
something interesting about what they're

319
00:12:17,110 --> 00:12:16,240
doing

320
00:12:24,470 --> 00:12:17,120
she

321
00:12:27,430 --> 00:12:24,480
reaching 500 miles of running this year

322
00:12:30,150 --> 00:12:27,440
so that is an excellent uh achievement

323
00:12:32,870 --> 00:12:30,160
alex um i you we've had you running

324
00:12:35,509 --> 00:12:32,880
around like crazy uh getting ready for

325
00:12:38,550 --> 00:12:35,519
web and we're all so excited it's gonna

326
00:12:42,069 --> 00:12:38,560
launch this month right uh so ladies and

327
00:12:45,590 --> 00:12:42,079
gentlemen dr alex lockwood

328
00:12:46,870 --> 00:12:45,600
thank you so much frank um

329
00:12:53,829 --> 00:12:46,880
let me

330
00:12:59,110 --> 00:12:55,990
all right i

331
00:13:03,030 --> 00:12:59,120
hope that's coming through

332
00:13:05,509 --> 00:13:03,040
i'll see yes looking good okay wonderful

333
00:13:07,030 --> 00:13:05,519
all right um well i

334
00:13:09,670 --> 00:13:07,040
you've just heard about some amazing

335
00:13:11,269 --> 00:13:09,680
discoveries from hubble which uh 30 plus

336
00:13:13,350 --> 00:13:11,279
years and going strong

337
00:13:15,750 --> 00:13:13,360
um and um

338
00:13:17,670 --> 00:13:15,760

i i'm sure you all are as much of a fan

339
00:13:18,710 --> 00:13:17,680
of hubble as i am and

340
00:13:21,430 --> 00:13:18,720
um

341
00:13:23,670 --> 00:13:21,440
and set to be uh the biggest fans of the

342
00:13:25,829 --> 00:13:23,680
next great observatory uh the james webb

343
00:13:26,949 --> 00:13:25,839
space telescope which is why we're here

344
00:13:27,990 --> 00:13:26,959
tonight

345
00:13:30,470 --> 00:13:28,000
um

346
00:13:33,590 --> 00:13:30,480
as you may be aware web is launching

347
00:13:34,470 --> 00:13:33,600
later this month and so i'd like to talk

348
00:13:36,069 --> 00:13:34,480
about

349
00:13:38,550 --> 00:13:36,079
um

350
00:13:41,430 --> 00:13:38,560
the the history of web you know why how

351
00:13:43,509 --> 00:13:41,440
it came to be why why it's so important

352
00:13:45,670 --> 00:13:43,519
um and part of that is the fact that it

353
00:13:48,069 --> 00:13:45,680
will study infrared light

354
00:13:50,150 --> 00:13:48,079
as opposed to hubble's mainly visible

355
00:13:52,629 --> 00:13:50,160
spectrum including some ultraviolet and

356
00:13:54,550 --> 00:13:52,639
some some near infrared

357
00:13:55,990 --> 00:13:54,560
and then we'll talk about the science

358
00:13:58,150 --> 00:13:56,000
with web

359
00:14:02,389 --> 00:13:58,160
four main science themes which really

360
00:14:04,069 --> 00:14:02,399
span the breadth of astronomy

361
00:14:06,150 --> 00:14:04,079
and then talk more about the telescope

362
00:14:07,189 --> 00:14:06,160
and what we can look to look forward to

363
00:14:12,389 --> 00:14:07,199

in the next

364
00:14:16,470 --> 00:14:15,750
how web came to be

365
00:14:18,790 --> 00:14:16,480
you

366
00:14:22,550 --> 00:14:18,800
might be familiar with a few of these

367
00:14:23,910 --> 00:14:22,560
telescopes um i i hope at least everyone

368
00:14:26,870 --> 00:14:23,920
watching this knows what the hubble

369
00:14:28,629 --> 00:14:26,880
space telescope is uh no no introduction

370
00:14:31,030 --> 00:14:28,639
needed there

371
00:14:33,189 --> 00:14:31,040
but the hubble is just one of several

372
00:14:36,150 --> 00:14:33,199
great observatories that we have had

373
00:14:37,269 --> 00:14:36,160
that the us has put into space um to

374
00:14:37,990 --> 00:14:37,279
study

375
00:14:43,910 --> 00:14:38,000
the

376
00:14:45,750 --> 00:14:43,920
observatory which is still going uh

377
00:14:47,509 --> 00:14:45,760
collecting x-rays from all across the

378
00:14:49,750 --> 00:14:47,519
universe um and this fits a space

379
00:14:51,590 --> 00:14:49,760
telescope that um

380
00:14:53,350 --> 00:14:51,600
operated at many wavelengths for several

381
00:14:56,310 --> 00:14:53,360
years then went into what we call a warm

382
00:14:58,150 --> 00:14:56,320
mission when it's cryogenics

383
00:15:01,269 --> 00:14:58,160
ran out and was officially

384
00:15:02,389 --> 00:15:01,279
decommissioned uh last year

385
00:15:05,189 --> 00:15:02,399
um

386
00:15:07,509 --> 00:15:05,199
all of these have made incredible leaps

387
00:15:10,829 --> 00:15:07,519
in our understanding of the universe

388
00:15:13,030 --> 00:15:10,839

and um james webb is is the next to do

389
00:15:13,990 --> 00:15:13,040
this um

390
00:15:16,310 --> 00:15:14,000
another thing that all of these

391
00:15:17,829 --> 00:15:16,320
observatories have in common is that

392
00:15:19,750 --> 00:15:17,839
they were not limited to the science

393
00:15:22,310 --> 00:15:19,760
they could do they were really meant as

394
00:15:26,069 --> 00:15:22,320
all-purpose observatories

395
00:15:28,870 --> 00:15:26,079
um examples you can see here um the crab

396
00:15:32,150 --> 00:15:28,880
nebula this is an x-rays you can see

397
00:15:34,389 --> 00:15:32,160
um shocks from um

398
00:15:38,870 --> 00:15:34,399
star the center star

399
00:15:42,150 --> 00:15:38,880
um same thing in zeta or yuki or yukai

400
00:15:44,550 --> 00:15:42,160
uh you here in infrared wavelengths from

401
00:15:47,509 --> 00:15:44,560
spitzer uh you're actually looking

402
00:15:49,269 --> 00:15:47,519
through um the gas and dust to to see

403
00:15:50,870 --> 00:15:49,279
the shock wave that's caused by by the

404
00:15:52,310 --> 00:15:50,880
central star and you can see that very

405
00:15:53,110 --> 00:15:52,320
beautiful here

406
00:15:55,030 --> 00:15:53,120
um

407
00:15:57,749 --> 00:15:55,040
the ring nebula a beautiful planetary

408
00:15:58,629 --> 00:15:57,759
nebula captured by hubble

409
00:16:01,110 --> 00:15:58,639
um

410
00:16:02,870 --> 00:16:01,120
and then here you can see an actual

411
00:16:05,749 --> 00:16:02,880
composite picture from all of these

412
00:16:08,629 --> 00:16:05,759
observatories of the antenna galaxies uh

413
00:16:10,470 --> 00:16:08,639

some interacting galaxies and you can

414
00:16:12,710 --> 00:16:10,480
just see the depth in this picture and

415
00:16:14,790 --> 00:16:12,720
what you get when you combine multiple

416
00:16:18,389 --> 00:16:14,800
wavelengths and you have

417
00:16:20,150 --> 00:16:18,399
gas and dust and stars all

418
00:16:21,910 --> 00:16:20,160
filling up the frame and telling you a

419
00:16:27,030 --> 00:16:21,920
different story about how all this

420
00:16:30,310 --> 00:16:28,069
and

421
00:16:31,910 --> 00:16:30,320
so this is an example of the different

422
00:16:33,990 --> 00:16:31,920
types of objects that all of our great

423
00:16:37,990 --> 00:16:34,000
observatories can

424
00:16:43,269 --> 00:16:40,230
but one of the

425
00:16:43,279 --> 00:16:46,870
most poignant

426
00:16:51,990 --> 00:16:49,030
reasonings behind james webb

427
00:16:53,670 --> 00:16:52,000
is this image right here and uh its

428
00:16:55,910 --> 00:16:53,680
predecessor the hubble deep field so

429
00:16:56,870 --> 00:16:55,920
this is the hubble ultra deep field

430
00:16:59,030 --> 00:16:56,880
um

431
00:17:03,110 --> 00:16:59,040
taken several years ago now

432
00:17:05,909 --> 00:17:03,120
um by staring at a patch of the sky

433
00:17:07,669 --> 00:17:05,919
where we saw nothing where

434
00:17:09,990 --> 00:17:07,679
we saw nothing with our eyes we saw

435
00:17:12,390 --> 00:17:10,000
nothing with our telescopes

436
00:17:14,710 --> 00:17:12,400
as far as you could tell

437
00:17:17,429 --> 00:17:14,720
it was a small patch of dark sky that

438
00:17:20,230 --> 00:17:17,439

had absolutely nothing there and for

439
00:17:22,230 --> 00:17:20,240
context this patch of sky was only about

440
00:17:24,150 --> 00:17:22,240
as big as your thumb on the sky if you

441
00:17:26,789 --> 00:17:24,160
held up your thumb

442
00:17:30,390 --> 00:17:26,799
and put it up in space

443
00:17:33,029 --> 00:17:30,400
by staring for several days with hubble

444
00:17:34,789 --> 00:17:33,039
we found thousands of galaxies

445
00:17:38,070 --> 00:17:34,799
in what appeared to be

446
00:17:38,950 --> 00:17:38,080
the emptiness of space

447
00:17:40,870 --> 00:17:38,960
we

448
00:17:42,150 --> 00:17:40,880
have learned from hubble

449
00:17:43,510 --> 00:17:42,160
that

450
00:17:46,870 --> 00:17:43,520
there are

451
00:17:49,590 --> 00:17:46,880
billions and billions of galaxies

452
00:17:50,390 --> 00:17:49,600
out throughout the universe and

453
00:17:52,390 --> 00:17:50,400
it's

454
00:17:54,470 --> 00:17:52,400
you can generally say anywhere you put

455
00:17:55,990 --> 00:17:54,480
up your thumb on the sky you're gonna be

456
00:17:59,110 --> 00:17:56,000
blocking out more than a thousand

457
00:18:00,630 --> 00:17:59,120
galaxies which is incredible

458
00:18:02,150 --> 00:18:00,640
but one of the really interesting things

459
00:18:03,669 --> 00:18:02,160
about this picture

460
00:18:06,470 --> 00:18:03,679
is that you see different types of

461
00:18:09,350 --> 00:18:06,480
galaxies you see red ones you see blue

462
00:18:11,029 --> 00:18:09,360
ones and more white and yellow ones you

463
00:18:13,590 --> 00:18:11,039

see a few stars but most of these are

464
00:18:16,150 --> 00:18:13,600
galaxies um but they're all different

465
00:18:19,590 --> 00:18:16,160
shapes and sizes as well

466
00:18:21,669 --> 00:18:19,600
and the diversity of galaxies um

467
00:18:24,549 --> 00:18:21,679
including the earliest ones

468
00:18:26,789 --> 00:18:24,559
and finding the earliest ones is a huge

469
00:18:28,470 --> 00:18:26,799
um

470
00:18:31,190 --> 00:18:28,480
scientific goal for james webb and we'll

471
00:18:34,710 --> 00:18:31,200
talk about that more

472
00:18:36,070 --> 00:18:34,720
james webb was designed to capture faint

473
00:18:37,430 --> 00:18:36,080
infrared light

474
00:18:40,150 --> 00:18:37,440
um

475
00:18:42,789 --> 00:18:40,160
you can see it as a follow-on to spitzer

476
00:18:43,669 --> 00:18:42,799
but it will have hubble's resolution

477
00:18:45,669 --> 00:18:43,679
and

478
00:18:47,909 --> 00:18:45,679
a wavelength range that is between

479
00:18:50,150 --> 00:18:47,919
hubble and spitzer but

480
00:18:51,909 --> 00:18:50,160
it's giving us a view into the infrared

481
00:18:56,310 --> 00:18:51,919
universe that we no longer have now that

482
00:19:02,390 --> 00:18:58,710
there have been several designs over the

483
00:19:03,270 --> 00:19:02,400
years for this telescope um but it was

484
00:19:05,510 --> 00:19:03,280
really

485
00:19:06,390 --> 00:19:05,520
um this this is one of the early designs

486
00:19:07,909 --> 00:19:06,400
and and

487
00:19:09,430 --> 00:19:07,919
if you know what web looks like today it

488
00:19:10,630 --> 00:19:09,440

was on the original slide it doesn't

489
00:19:12,950 --> 00:19:10,640
actually look too much different from

490
00:19:14,950 --> 00:19:12,960
this and and that's because it was

491
00:19:17,190 --> 00:19:14,960
realized that to capture that faint

492
00:19:18,310 --> 00:19:17,200
infrared light we needed a very big

493
00:19:20,230 --> 00:19:18,320
telescope

494
00:19:22,070 --> 00:19:20,240
a very big mirror i should say much

495
00:19:23,430 --> 00:19:22,080
bigger than hubble

496
00:19:26,710 --> 00:19:23,440
and

497
00:19:29,350 --> 00:19:26,720
maybe we couldn't enshroud that mirror

498
00:19:32,470 --> 00:19:29,360
in a tube like we did for hubble and

499
00:19:34,549 --> 00:19:32,480
spitzer and many of you know the mini

500
00:19:37,990 --> 00:19:34,559
your backyard telescope has a tube

501
00:19:39,669 --> 00:19:38,000
that's a typical design um

502
00:19:41,830 --> 00:19:39,679
our mirror is just going to be too big

503
00:19:45,190 --> 00:19:41,840
for that to send into space

504
00:19:47,190 --> 00:19:45,200
and so this here it's gold but but in

505
00:19:50,390 --> 00:19:47,200
real life it is it is a beautiful silver

506
00:19:53,190 --> 00:19:50,400
color a giant sun shield to block

507
00:19:55,430 --> 00:19:53,200
the the thermal radiation the heat the

508
00:19:57,909 --> 00:19:55,440
infrared light um

509
00:20:01,110 --> 00:19:57,919
from nearby sources like the earth and

510
00:20:04,470 --> 00:20:01,120
the sun to protect this giant mirror um

511
00:20:09,590 --> 00:20:04,480
and enable it to measure distant faint

512
00:20:14,470 --> 00:20:11,750
infrared light may not be something that

513
00:20:17,029 --> 00:20:14,480

you are completely familiar with um you

514
00:20:19,750 --> 00:20:17,039
can see a rainbow here on the side um

515
00:20:20,549 --> 00:20:19,760
shows you that the the extent of visible

516
00:20:25,029 --> 00:20:20,559
light

517
00:20:26,390 --> 00:20:25,039
is is different

518
00:20:28,630 --> 00:20:26,400
um

519
00:20:30,470 --> 00:20:28,640
but very very helpful for understanding

520
00:20:31,909 --> 00:20:30,480
things for example

521
00:20:34,390 --> 00:20:31,919
here's two things you may be familiar

522
00:20:36,230 --> 00:20:34,400
with invisible light

523
00:20:38,710 --> 00:20:36,240
we can take an image of them in infrared

524
00:20:41,750 --> 00:20:38,720
light and get a lot more information

525
00:20:44,070 --> 00:20:41,760
the crocodile doesn't glow as bright

526
00:20:45,750 --> 00:20:44,080
crocodile lives in the water it's a

527
00:20:47,350 --> 00:20:45,760
cold-blooded animal

528
00:20:49,190 --> 00:20:47,360
versus if you look at the meerkats you

529
00:20:52,149 --> 00:20:49,200
can actually see how warm they are

530
00:20:54,870 --> 00:20:52,159
including their bright eye sockets

531
00:20:55,909 --> 00:20:54,880
and and their warm bellies

532
00:20:57,669 --> 00:20:55,919
and

533
00:21:01,270 --> 00:20:57,679
so

534
00:21:03,350 --> 00:21:01,280
infrared light as we know it is heat

535
00:21:04,870 --> 00:21:03,360
but it has so many other

536
00:21:08,149 --> 00:21:04,880
capabilities when we're studying

537
00:21:13,029 --> 00:21:09,990
as i mentioned the jameson space

538
00:21:14,789 --> 00:21:13,039

telescope is tuned so that its

539
00:21:17,430 --> 00:21:14,799
wavelengths capture

540
00:21:19,190 --> 00:21:17,440
it's it's it's detectors capture

541
00:21:20,390 --> 00:21:19,200
near-infrared and mid-infrared

542
00:21:22,950 --> 00:21:20,400
wavelengths

543
00:21:24,310 --> 00:21:22,960
um there is a little bit of overlap with

544
00:21:26,310 --> 00:21:24,320
the wavelengths that the hubble space

545
00:21:28,630 --> 00:21:26,320
telescope um

546
00:21:31,029 --> 00:21:28,640
can and has been able to do currently

547
00:21:32,950 --> 00:21:31,039
hubble can go out to about 1.6 microns

548
00:21:34,230 --> 00:21:32,960
it has had the ability to go out a

549
00:21:36,310 --> 00:21:34,240
little bit further in the past from

550
00:21:37,190 --> 00:21:36,320
previous instrumentation

551
00:21:40,470 --> 00:21:37,200
um

552
00:21:42,870 --> 00:21:40,480
and spitzer was a mid and far infrared

553
00:21:44,870 --> 00:21:42,880
instrument uh james webb space telescope

554
00:21:46,390 --> 00:21:44,880
goes from just at the end of the red

555
00:21:49,270 --> 00:21:46,400
side of the spectrum about 600

556
00:21:52,390 --> 00:21:49,280
nanometers all the way out to 28 microns

557
00:21:54,950 --> 00:21:52,400
which is in the mid infrared um and

558
00:21:56,870 --> 00:21:54,960
capabilities that are afforded to us in

559
00:21:59,830 --> 00:21:56,880
understanding the universe at these

560
00:22:04,070 --> 00:21:59,840
wavelengths are incredible

561
00:22:08,710 --> 00:22:06,549
the first of web science themes is the

562
00:22:11,590 --> 00:22:08,720
early universe

563
00:22:13,669 --> 00:22:11,600

uh this other than the big bang which

564
00:22:15,350 --> 00:22:13,679
maybe you've heard of this might not be

565
00:22:17,430 --> 00:22:15,360
the most familiar topic to most people

566
00:22:18,870 --> 00:22:17,440
and in full disclosure this is not my

567
00:22:19,990 --> 00:22:18,880
area of research

568
00:22:21,350 --> 00:22:20,000
but

569
00:22:22,310 --> 00:22:21,360
to give you a little overview of what

570
00:22:23,990 --> 00:22:22,320
happened at the beginning of the

571
00:22:26,549 --> 00:22:24,000
universe

572
00:22:29,669 --> 00:22:26,559
we had the big bang

573
00:22:31,350 --> 00:22:29,679
matter or plasma started spreading out

574
00:22:32,310 --> 00:22:31,360
cooled enough

575
00:22:35,110 --> 00:22:32,320
so that

576
00:22:38,149 --> 00:22:35,120
atoms could start forming

577
00:22:41,110 --> 00:22:38,159
pulled more stars began forming heating

578
00:22:43,669 --> 00:22:41,120
the gas around them and the stars began

579
00:22:46,390 --> 00:22:43,679
to assemble into galaxies however there

580
00:22:47,990 --> 00:22:46,400
was still this kind of giant

581
00:22:50,789 --> 00:22:48,000
at this point it was no longer a plasma

582
00:22:54,870 --> 00:22:50,799
but it was kind of a big fog of lots and

583
00:22:56,710 --> 00:22:54,880
lots of of of neutral hydrogen atoms

584
00:22:58,710 --> 00:22:56,720
and so as stars formed they had some

585
00:23:00,310 --> 00:22:58,720
light that that sort of ate into this

586
00:23:01,350 --> 00:23:00,320
fog and this illustration here is

587
00:23:04,070 --> 00:23:01,360
showing you

588
00:23:05,669 --> 00:23:04,080

how as galaxies formed their light

589
00:23:09,350 --> 00:23:05,679
created enough radiation to kind of

590
00:23:11,669 --> 00:23:09,360
carve out bubbles in a fog

591
00:23:14,549 --> 00:23:11,679
and eventually the fog was cleared by

592
00:23:18,310 --> 00:23:14,559
enough radiation from these galaxies

593
00:23:21,590 --> 00:23:19,909
but

594
00:23:23,590 --> 00:23:21,600
there is a time in the beginning of the

595
00:23:25,190 --> 00:23:23,600
universe where these early galaxies were

596
00:23:27,350 --> 00:23:25,200
really shrouded in fog and we have to

597
00:23:29,350 --> 00:23:27,360
see through that fog to be able to even

598
00:23:31,830 --> 00:23:29,360
find the galaxies

599
00:23:34,310 --> 00:23:31,840
um and this era of clearing out we call

600
00:23:38,950 --> 00:23:34,320
the epic of realization that is one of

601
00:23:43,350 --> 00:23:42,070
so to see these very first galaxies we

602
00:23:45,430 --> 00:23:43,360
need to

603
00:23:47,110 --> 00:23:45,440
not only be able to see them

604
00:23:48,950 --> 00:23:47,120
with the right kinds of light but also

605
00:23:50,470 --> 00:23:48,960
to be able to see through this fog so

606
00:23:52,070 --> 00:23:50,480
what does that look like

607
00:23:54,310 --> 00:23:52,080
i shared this picture earlier i'm coming

608
00:23:56,950 --> 00:23:54,320
back to it not only because it is one of

609
00:23:58,549 --> 00:23:56,960
my favorite images ever uh just the the

610
00:23:59,909 --> 00:23:58,559
sheer magnitude of what it tells us

611
00:24:01,750 --> 00:23:59,919
about the universe

612
00:24:03,669 --> 00:24:01,760
but also because it really demonstrates

613
00:24:05,669 --> 00:24:03,679

what webs

614
00:24:08,390 --> 00:24:05,679
first scientific goal was and that was

615
00:24:10,470 --> 00:24:08,400
to find the earliest galaxies

616
00:24:12,870 --> 00:24:10,480
as i mentioned in this picture you have

617
00:24:14,070 --> 00:24:12,880
galaxies of all shapes and sizes and

618
00:24:16,149 --> 00:24:14,080
colors

619
00:24:19,430 --> 00:24:16,159
and you'll notice a few of them

620
00:24:21,990 --> 00:24:19,440
are very very small and red

621
00:24:24,630 --> 00:24:22,000
these are some of the earliest galaxies

622
00:24:27,110 --> 00:24:24,640
in the universe

623
00:24:29,990 --> 00:24:27,120
why are they red

624
00:24:32,070 --> 00:24:30,000
if you imagine a typical galaxy today

625
00:24:34,070 --> 00:24:32,080
that we might image with hubble

626
00:24:35,350 --> 00:24:34,080
cartwheel galaxy any of several galaxies

627
00:24:37,110 --> 00:24:35,360
usually they're much more colorful and

628
00:24:38,310 --> 00:24:37,120
they have a lot of blue light

629
00:24:39,750 --> 00:24:38,320
um

630
00:24:41,269 --> 00:24:39,760
that we can see from bright stars in

631
00:24:42,789 --> 00:24:41,279
those galaxies

632
00:24:45,430 --> 00:24:42,799
however

633
00:24:46,789 --> 00:24:45,440
as light gets stretched

634
00:24:49,029 --> 00:24:46,799
over time

635
00:24:50,789 --> 00:24:49,039
so for example light that was emitted

636
00:24:52,789 --> 00:24:50,799
from a galaxy that's

637
00:24:55,350 --> 00:24:52,799
here as shown in blue

638
00:24:57,110 --> 00:24:55,360

if that light was emitted in blue as the

639
00:24:59,190 --> 00:24:57,120
universe has stretched

640
00:25:01,029 --> 00:24:59,200
over time the expansion of the universe

641
00:25:02,549 --> 00:25:01,039
that light those wavelengths of light

642
00:25:04,870 --> 00:25:02,559
from those early objects have also

643
00:25:06,310 --> 00:25:04,880
stretched into redder and redder

644
00:25:07,669 --> 00:25:06,320
wavelengths

645
00:25:10,149 --> 00:25:07,679
and

646
00:25:11,029 --> 00:25:10,159
we can actually take pullouts

647
00:25:13,269 --> 00:25:11,039
from

648
00:25:14,390 --> 00:25:13,279
the hubble deep field

649
00:25:15,350 --> 00:25:14,400
to see

650
00:25:17,590 --> 00:25:15,360
how

651
00:25:19,350 --> 00:25:17,600
not only the morphology but also the

652
00:25:22,470 --> 00:25:19,360
color of these galaxies changes over

653
00:25:23,990 --> 00:25:22,480
time so on the left here you have a much

654
00:25:26,390 --> 00:25:24,000
newer

655
00:25:27,350 --> 00:25:26,400
younger galaxy that's close closer by to

656
00:25:29,029 --> 00:25:27,360
us

657
00:25:30,070 --> 00:25:29,039
and then all the way to the right you

658
00:25:32,870 --> 00:25:30,080
have

659
00:25:35,909 --> 00:25:32,880
just a red speck and this is

660
00:25:39,190 --> 00:25:35,919
the limit in both sensitivity and color

661
00:25:43,430 --> 00:25:40,870
and you can see that that you can kind

662
00:25:45,110 --> 00:25:43,440
of make a evolution you can kind of

663
00:25:47,510 --> 00:25:45,120

understand what an evolution of a galaxy

664
00:25:48,549 --> 00:25:47,520
would look like over time and this is

665
00:25:51,430 --> 00:25:48,559
due to

666
00:25:52,870 --> 00:25:51,440
um the the changes in in star formation

667
00:25:53,750 --> 00:25:52,880
the changes in

668
00:25:54,549 --> 00:25:53,760
um

669
00:26:01,269 --> 00:25:54,559
in

670
00:26:03,830 --> 00:26:01,279
mass of black hole and dark matter

671
00:26:05,590 --> 00:26:03,840
um so we're trying to understand not

672
00:26:07,909 --> 00:26:05,600
only what this evolution of galaxies

673
00:26:10,789 --> 00:26:07,919
look like but really getting at those

674
00:26:13,110 --> 00:26:10,799
earliest galaxies which as you can see

675
00:26:14,149 --> 00:26:13,120
in this picture are red

676
00:26:17,029 --> 00:26:14,159
and

677
00:26:19,669 --> 00:26:17,039
earlier than that they're even redder

678
00:26:22,789 --> 00:26:19,679
than red which is infrared

679
00:26:24,549 --> 00:26:22,799
so we do know the oldest galaxy or the

680
00:26:25,830 --> 00:26:24,559
old yes the oldest galaxy that hubble

681
00:26:27,510 --> 00:26:25,840
has discovered

682
00:26:28,870 --> 00:26:27,520
which was very recently

683
00:26:30,870 --> 00:26:28,880
um

684
00:26:32,789 --> 00:26:30,880
and it is about four to five hundred

685
00:26:35,110 --> 00:26:32,799
million years old so four to five

686
00:26:37,350 --> 00:26:35,120
hundred million years after the big bang

687
00:26:39,909 --> 00:26:37,360
it is the small red blob and this is

688
00:26:41,909 --> 00:26:39,919

pushing the limit of webs of hubble

689
00:26:44,789 --> 00:26:41,919
sensitivity

690
00:26:47,029 --> 00:26:44,799
james webb is going to see older

691
00:26:49,750 --> 00:26:47,039
more distant

692
00:26:50,870 --> 00:26:49,760
more red galaxies using infrared

693
00:26:53,029 --> 00:26:50,880
wavelengths

694
00:26:55,990 --> 00:26:53,039
the only way that we can see earlier

695
00:26:56,789 --> 00:26:56,000
galaxies is using infrared wavelengths

696
00:26:59,510 --> 00:26:56,799
so

697
00:27:00,950 --> 00:26:59,520
first and foremost james webb is big

698
00:27:03,669 --> 00:27:00,960
enough

699
00:27:05,750 --> 00:27:03,679
and is an infrared telescope

700
00:27:09,350 --> 00:27:05,760
so that it can discover the first

701
00:27:14,789 --> 00:27:11,510
in addition to that there are so many

702
00:27:17,269 --> 00:27:14,799
other scientific capabilities of web

703
00:27:19,830 --> 00:27:17,279
black holes as far as we know exist in

704
00:27:21,350 --> 00:27:19,840
the center of most galaxies and affect

705
00:27:22,870 --> 00:27:21,360
the dynamics of that galaxy and the

706
00:27:24,310 --> 00:27:22,880
evolution of galaxies as i was

707
00:27:26,470 --> 00:27:24,320
discussing

708
00:27:28,549 --> 00:27:26,480
in our own milky way we will peer

709
00:27:30,389 --> 00:27:28,559
through the dust

710
00:27:32,070 --> 00:27:30,399
to see towards the center of the milky

711
00:27:33,909 --> 00:27:32,080
way and see what kind of dynamics are

712
00:27:35,990 --> 00:27:33,919
happening between all of the in-falling

713
00:27:39,269 --> 00:27:36,000

matter and the black hole

714
00:27:41,669 --> 00:27:39,279
we will look at distant galaxies with

715
00:27:42,549 --> 00:27:41,679
with active black holes that are

716
00:27:45,110 --> 00:27:42,559
creating

717
00:27:46,549 --> 00:27:45,120
material and understand how those black

718
00:27:48,870 --> 00:27:46,559
holes

719
00:27:51,029 --> 00:27:48,880
have evolved with their galaxies over

720
00:27:52,789 --> 00:27:51,039
time and how that those black holes

721
00:27:54,950 --> 00:27:52,799
affect the evolution of the galaxy which

722
00:27:56,789 --> 00:27:54,960
we know are tied to it and the more

723
00:27:58,870 --> 00:27:56,799
objects that we can study

724
00:28:01,110 --> 00:27:58,880
um and especially at infrared

725
00:28:04,470 --> 00:28:01,120
wavelengths where you can really

726
00:28:06,630 --> 00:28:04,480
see both the dust and

727
00:28:10,070 --> 00:28:06,640
through the dust

728
00:28:13,909 --> 00:28:11,830
here are two images from hubble that you

729
00:28:17,750 --> 00:28:13,919
may be familiar with one is invisible

730
00:28:19,110 --> 00:28:17,760
light and one is in infrared light

731
00:28:20,870 --> 00:28:19,120
these are both star-forming regions

732
00:28:22,549 --> 00:28:20,880
which is another huge capability of

733
00:28:24,710 --> 00:28:22,559
james webb to be able to study these

734
00:28:25,750 --> 00:28:24,720
regions and say

735
00:28:27,750 --> 00:28:25,760
oh

736
00:28:29,350 --> 00:28:27,760
we understand that there are stars

737
00:28:32,230 --> 00:28:29,360
forming and they make these beautiful

738
00:28:34,310 --> 00:28:32,240

images invisible wavelengths with hubble

739
00:28:36,630 --> 00:28:34,320
however

740
00:28:38,149 --> 00:28:36,640
it's not so much for an astronomer we're

741
00:28:40,710 --> 00:28:38,159
much more interested in what's inside

742
00:28:42,470 --> 00:28:40,720
the dust than what does it look like

743
00:28:44,470 --> 00:28:42,480
at near-infrared wavelengths as you can

744
00:28:46,230 --> 00:28:44,480
see on the image on the right here

745
00:28:49,029 --> 00:28:46,240
can see through

746
00:28:50,950 --> 00:28:49,039
these pillars of gas and dust inside

747
00:28:54,149 --> 00:28:50,960
which planets

748
00:28:56,149 --> 00:28:54,159
stars and planets are forming

749
00:28:58,149 --> 00:28:56,159
hubble has given us

750
00:28:59,909 --> 00:28:58,159
just the beginning of the capability to

751
00:29:01,990 --> 00:28:59,919
study inside these regions with near

752
00:29:05,029 --> 00:29:02,000
infrared light

753
00:29:07,190 --> 00:29:05,039
web will expand upon this capability

754
00:29:09,990 --> 00:29:07,200
web has the same sensitivity the same

755
00:29:10,950 --> 00:29:10,000
resolution has the same resolution as

756
00:29:13,510 --> 00:29:10,960
hubble

757
00:29:15,269 --> 00:29:13,520
at near infrared wavelengths so the

758
00:29:17,190 --> 00:29:15,279
crispness that you see in this visible

759
00:29:19,350 --> 00:29:17,200
light image we don't quite get with

760
00:29:21,190 --> 00:29:19,360
hubble for near infrared

761
00:29:23,350 --> 00:29:21,200
webb will get it with near infrared and

762
00:29:26,070 --> 00:29:23,360
we will be able to peer into these

763
00:29:27,990 --> 00:29:26,080

places where stars are forming and a lot

764
00:29:30,470 --> 00:29:28,000
of times stars are dying and really we

765
00:29:32,230 --> 00:29:30,480
see the entire stellar life cycle within

766
00:29:34,630 --> 00:29:32,240
these planetary nebulas and oftentimes

767
00:29:37,990 --> 00:29:34,640
the star dying will create a shock wave

768
00:29:40,630 --> 00:29:38,000
and and and cause other dust to collapse

769
00:29:42,870 --> 00:29:40,640
and make a star being formed so these

770
00:29:45,669 --> 00:29:42,880
are really really dynamic places

771
00:29:48,470 --> 00:29:45,679
and webb has the ability with its near

772
00:29:50,950 --> 00:29:48,480
and mid infrared capabilities

773
00:29:52,710 --> 00:29:50,960
to both look through the dust and also

774
00:29:55,430 --> 00:29:52,720
study the dust so this is another

775
00:29:57,590 --> 00:29:55,440
example of a star-forming region um very

776
00:29:59,909 --> 00:29:57,600
very iconic image on the left here the

777
00:30:02,230 --> 00:29:59,919
eagle nebula from hubble

778
00:30:03,830 --> 00:30:02,240
and there's a lot to learn from this

779
00:30:06,630 --> 00:30:03,840
picture and the structure of these

780
00:30:08,230 --> 00:30:06,640
things from with visible wavelengths but

781
00:30:10,070 --> 00:30:08,240
when we get into the near infrared you

782
00:30:12,310 --> 00:30:10,080
can start seeing through the dust seeing

783
00:30:14,710 --> 00:30:12,320
the stars starting to study

784
00:30:16,710 --> 00:30:14,720
those young stars and those planetary

785
00:30:17,909 --> 00:30:16,720
environments

786
00:30:20,549 --> 00:30:17,919
and then on the right here is a

787
00:30:22,789 --> 00:30:20,559
mid-infrared picture you can see that

788
00:30:25,430 --> 00:30:22,799

the sensitivity or the resolution excuse

789
00:30:26,549 --> 00:30:25,440
me is just not very good

790
00:30:28,870 --> 00:30:26,559
and

791
00:30:32,710 --> 00:30:28,880
web will blow this out of the water

792
00:30:34,149 --> 00:30:32,720
and these pillars of gas in mid and

793
00:30:35,269 --> 00:30:34,159
pillars of dust in mid infrared

794
00:30:37,110 --> 00:30:35,279
wavelengths

795
00:30:38,950 --> 00:30:37,120
will be so bright

796
00:30:40,470 --> 00:30:38,960
we'll be able to study them their

797
00:30:41,909 --> 00:30:40,480
structure their temperature their

798
00:30:44,950 --> 00:30:41,919
composition

799
00:30:46,710 --> 00:30:44,960
what is there we will finally be able to

800
00:30:47,990 --> 00:30:46,720
really get into these star-forming

801
00:30:52,549 --> 00:30:48,000
regions

802
00:30:54,710 --> 00:30:52,559
and figure out what molecules are there

803
00:30:56,389 --> 00:30:54,720
which not only informs the whole process

804
00:30:58,630 --> 00:30:56,399
of stellar

805
00:31:00,149 --> 00:30:58,640
birth and stellar evolution as i said a

806
00:31:01,590 --> 00:31:00,159
lot of places where stars are born they

807
00:31:04,149 --> 00:31:01,600
are also dying

808
00:31:05,509 --> 00:31:04,159
and stellar death as we've seen with

809
00:31:08,149 --> 00:31:05,519
those beautiful images of the ring

810
00:31:10,950 --> 00:31:08,159
nebula and and and

811
00:31:13,269 --> 00:31:10,960
um all sorts of of hubble images that

812
00:31:17,590 --> 00:31:13,279
show those beautiful planetary nebula

813
00:31:19,430 --> 00:31:17,600

and and um supernova from when stars die

814
00:31:20,870 --> 00:31:19,440
those beautiful colors from hubble are

815
00:31:22,389 --> 00:31:20,880
all because there's there's different

816
00:31:24,470 --> 00:31:22,399
molecules there

817
00:31:27,190 --> 00:31:24,480
and hubble shows us the hot gas that's

818
00:31:29,590 --> 00:31:27,200
being expanded but web will show us the

819
00:31:31,190 --> 00:31:29,600
dust which is an equally important part

820
00:31:33,509 --> 00:31:31,200
of this whole process about of the

821
00:31:35,669 --> 00:31:33,519
chemistry and of the composition so if

822
00:31:37,509 --> 00:31:35,679
we want to understand what is in these

823
00:31:38,950 --> 00:31:37,519
star forming regions not just look at

824
00:31:40,710 --> 00:31:38,960
the beautiful pictures but really

825
00:31:43,269 --> 00:31:40,720
understand them

826
00:31:46,549 --> 00:31:43,279
we need to go to near and mid infrared

827
00:31:50,789 --> 00:31:48,310
while we're studying molecules there's a

828
00:31:52,789 --> 00:31:50,799
lot of things closer to our backyard

829
00:31:54,549 --> 00:31:52,799
that have very interesting molecules and

830
00:31:56,310 --> 00:31:54,559
structure

831
00:31:58,630 --> 00:31:56,320
so

832
00:32:00,630 --> 00:31:58,640
webb will be able to look at our outer

833
00:32:03,190 --> 00:32:00,640
solar system so anything beyond its own

834
00:32:04,549 --> 00:32:03,200
orbit from mars on out through the

835
00:32:07,029 --> 00:32:04,559
kuiper belt

836
00:32:09,110 --> 00:32:07,039
um and be able to

837
00:32:11,990 --> 00:32:09,120
use infrared wavelengths to study really

838
00:32:16,230 --> 00:32:12,000

interesting molecules in the planets and

839
00:32:17,669 --> 00:32:16,240
moons and rings in our own solar system

840
00:32:20,070 --> 00:32:17,679
um it will

841
00:32:22,950 --> 00:32:20,080
also be able to kind of be a global

842
00:32:23,990 --> 00:32:22,960
pathfinder for

843
00:32:25,990 --> 00:32:24,000
planets

844
00:32:29,509 --> 00:32:26,000
with missions like the new mission to

845
00:32:30,789 --> 00:32:29,519
europa titan

846
00:32:32,789 --> 00:32:30,799
mars

847
00:32:34,310 --> 00:32:32,799
we'll be able to get a global view of

848
00:32:36,630 --> 00:32:34,320
these with webb

849
00:32:38,549 --> 00:32:36,640
and then missions to those planets will

850
00:32:43,669 --> 00:32:38,559
give us much more more detailed and

851
00:32:47,909 --> 00:32:45,430
another beautiful thing about infrared

852
00:32:52,389 --> 00:32:47,919
wavelengths is that not only

853
00:32:53,990 --> 00:32:52,399
does it highlight and find molecules but

854
00:32:56,789 --> 00:32:54,000
infrared wavelengths as we spoke about

855
00:32:59,350 --> 00:32:56,799
earlier is actually heat

856
00:33:01,750 --> 00:32:59,360
so you saw a picture of the meerkat in

857
00:33:03,590 --> 00:33:01,760
infrared wavelengths being very bright

858
00:33:05,590 --> 00:33:03,600
turns out you and i are also very bright

859
00:33:07,430 --> 00:33:05,600
infrared wavelengths we have heat we

860
00:33:09,190 --> 00:33:07,440
have body heat

861
00:33:11,269 --> 00:33:09,200
and our temperature

862
00:33:13,029 --> 00:33:11,279
is actually about the same temperature

863
00:33:14,470 --> 00:33:13,039

as a forming

864
00:33:15,909 --> 00:33:14,480
star

865
00:33:17,430 --> 00:33:15,919
we're a little bit cooler sorry a

866
00:33:19,750 --> 00:33:17,440
forming planet excuse me we're a little

867
00:33:20,950 --> 00:33:19,760
bit cooler than forming planets

868
00:33:22,070 --> 00:33:20,960
um

869
00:33:24,549 --> 00:33:22,080
but

870
00:33:26,789 --> 00:33:24,559
their wavelengths their their radiation

871
00:33:29,190 --> 00:33:26,799
emits the most strongly at infrared

872
00:33:31,990 --> 00:33:29,200
wavelengths

873
00:33:34,470 --> 00:33:32,000
here is an infrared uh video which is

874
00:33:38,789 --> 00:33:34,480
actually several images taken over about

875
00:33:41,990 --> 00:33:38,799
a couple of years of the system hr879

876
00:33:43,830 --> 00:33:42,000
and this was taken using direct imaging

877
00:33:46,549 --> 00:33:43,840
so the black circle at the center of

878
00:33:48,950 --> 00:33:46,559
this image is covering the central star

879
00:33:50,950 --> 00:33:48,960
so that its light does not obscure the

880
00:33:53,350 --> 00:33:50,960
much fainter light of the planets around

881
00:33:56,310 --> 00:33:53,360
it this is one technique that we use to

882
00:33:57,669 --> 00:33:56,320
discover exoplanets um and you can see

883
00:33:59,430 --> 00:33:57,679
that there's four planets that have been

884
00:34:00,310 --> 00:33:59,440
discovered using this technique in that

885
00:34:02,789 --> 00:34:00,320
system

886
00:34:05,669 --> 00:34:02,799
but this was done using infrared light

887
00:34:08,550 --> 00:34:05,679
because that is where the bright the

888
00:34:10,950 --> 00:34:08,560

light from the planet is the brightest

889
00:34:13,430 --> 00:34:10,960
especially relative to

890
00:34:15,669 --> 00:34:13,440
the brightness of the central star which

891
00:34:16,869 --> 00:34:15,679
should be blocked out

892
00:34:18,950 --> 00:34:16,879
webb has

893
00:34:21,030 --> 00:34:18,960
coronagraphs at both mid infrared and

894
00:34:23,589 --> 00:34:21,040
near-infrared wavelengths and will

895
00:34:25,909 --> 00:34:23,599
employ this technique to look at

896
00:34:28,629 --> 00:34:25,919
existing star systems

897
00:34:32,230 --> 00:34:28,639
to help us understand those those

898
00:34:38,629 --> 00:34:35,750
and last but not least um another place

899
00:34:41,829 --> 00:34:38,639
that we have very uh a huge interest in

900
00:34:44,950 --> 00:34:41,839
molecular chemistry uh out in space is

901
00:34:47,430 --> 00:34:44,960
in exoplanets um we there's more than

902
00:34:49,909 --> 00:34:47,440
four thousand candidates out there

903
00:34:51,909 --> 00:34:49,919
and webb has i believe it's something

904
00:34:53,430 --> 00:34:51,919
like

905
00:34:56,149 --> 00:34:53,440
i couldn't give you a number web has

906
00:34:57,910 --> 00:34:56,159
many exoplanets on its roster to study

907
00:34:59,190 --> 00:34:57,920
the first year of science

908
00:34:59,990 --> 00:34:59,200
um

909
00:35:02,630 --> 00:35:00,000
but

910
00:35:05,990 --> 00:35:02,640
the amazing thing about webb

911
00:35:07,829 --> 00:35:06,000
is that it gives us access to

912
00:35:09,670 --> 00:35:07,839
study molecules that are very

913
00:35:12,550 --> 00:35:09,680

interesting to us

914
00:35:15,990 --> 00:35:12,560
um especially as they relate to the

915
00:35:17,349 --> 00:35:16,000
possibility of habitability and life as

916
00:35:19,670 --> 00:35:17,359
we know it

917
00:35:22,870 --> 00:35:19,680
which would include water and carbon

918
00:35:25,510 --> 00:35:22,880
dioxide and methane and ozone

919
00:35:27,270 --> 00:35:25,520
um this right here is a sample spectrum

920
00:35:29,510 --> 00:35:27,280
of the earth

921
00:35:31,270 --> 00:35:29,520
and you can see all of these molecules

922
00:35:33,190 --> 00:35:31,280
are in abundance in our own atmosphere

923
00:35:35,589 --> 00:35:33,200
so we're very interested in finding them

924
00:35:37,190 --> 00:35:35,599
in other planets atmospheres

925
00:35:39,589 --> 00:35:37,200
however

926
00:35:40,950 --> 00:35:39,599
we don't have any capabilities like this

927
00:35:44,310 --> 00:35:40,960
currently

928
00:35:45,910 --> 00:35:44,320
our space capabilities are limited um as

929
00:35:47,990 --> 00:35:45,920
i said just out to one and a half

930
00:35:51,109 --> 00:35:48,000
microns with hubble

931
00:35:53,030 --> 00:35:51,119
spitzer did some great work with a very

932
00:35:54,069 --> 00:35:53,040
limited capacity in the end of its

933
00:35:56,109 --> 00:35:54,079
lifetime

934
00:35:59,829 --> 00:35:56,119
to study um

935
00:36:00,630 --> 00:35:59,839
a few molecules that reside

936
00:36:01,990 --> 00:36:00,640
um

937
00:36:05,109 --> 00:36:02,000
just uh

938
00:36:06,710 --> 00:36:05,119

at three 3.6 and four and a half microns

939
00:36:09,910 --> 00:36:06,720
um

940
00:36:11,670 --> 00:36:09,920
and unfortunately

941
00:36:13,589 --> 00:36:11,680
most of this wavelength range is

942
00:36:15,990 --> 00:36:13,599
obscured from the ground so we can't

943
00:36:18,069 --> 00:36:16,000
study these molecules from the ground

944
00:36:19,829 --> 00:36:18,079
we can only study these molecules with

945
00:36:22,550 --> 00:36:19,839
an infrared telescope that we sent into

946
00:36:24,230 --> 00:36:22,560
space and that is james webb

947
00:36:26,550 --> 00:36:24,240
so we are hoping to make some of the

948
00:36:27,750 --> 00:36:26,560
first detections of

949
00:36:29,109 --> 00:36:27,760
methane

950
00:36:30,470 --> 00:36:29,119
ozone

951
00:36:33,430 --> 00:36:30,480
um

952
00:36:35,510 --> 00:36:33,440
on atmospheric atmospheres of exoplanets

953
00:36:39,589 --> 00:36:35,520
as well as as much more robust

954
00:36:41,990 --> 00:36:39,599
detections of water and carbon dioxide

955
00:36:43,349 --> 00:36:42,000
and and other molecules that we we have

956
00:36:48,069 --> 00:36:43,359
detected

957
00:36:52,950 --> 00:36:50,390
so i hope i excited you about all of the

958
00:36:54,950 --> 00:36:52,960
different possibilities near far

959
00:36:56,790 --> 00:36:54,960
large very small

960
00:36:59,510 --> 00:36:56,800
and that webb is going to do but how is

961
00:37:02,630 --> 00:36:59,520
it going to do that um

962
00:37:05,190 --> 00:37:02,640
it is going to do that thanks to

963
00:37:06,870 --> 00:37:05,200

millions of men hours and hundreds of

964
00:37:09,829 --> 00:37:06,880
engineers

965
00:37:11,990 --> 00:37:09,839
and scientists who have enabled this

966
00:37:13,030 --> 00:37:12,000
observatory

967
00:37:14,069 --> 00:37:13,040
web has

968
00:37:15,990 --> 00:37:14,079
really

969
00:37:17,349 --> 00:37:16,000
two you know two things that have never

970
00:37:19,190 --> 00:37:17,359
been done before and it's the two

971
00:37:19,990 --> 00:37:19,200
biggest pieces of the telescope

972
00:37:22,550 --> 00:37:20,000
one

973
00:37:24,870 --> 00:37:22,560
is a six and a half meter primary mirror

974
00:37:26,550 --> 00:37:24,880
it is segmented uh we've done a

975
00:37:28,470 --> 00:37:26,560
segmented mirror before but never in

976
00:37:29,990 --> 00:37:28,480
space like this

977
00:37:31,990 --> 00:37:30,000
um

978
00:37:33,270 --> 00:37:32,000
and we've never sent anything this big

979
00:37:35,349 --> 00:37:33,280
into space

980
00:37:38,069 --> 00:37:35,359
as we discussed before

981
00:37:40,230 --> 00:37:38,079
we have to protect that mirror from all

982
00:37:42,870 --> 00:37:40,240
of the ambient radiation

983
00:37:45,430 --> 00:37:42,880
uh in this case especially the sun and

984
00:37:47,349 --> 00:37:45,440
the earth because the sun is hot and we

985
00:37:49,430 --> 00:37:47,359
are measuring heat

986
00:37:52,230 --> 00:37:49,440
the earth and the moon are actually also

987
00:37:53,990 --> 00:37:52,240
quite warm at infrared wavelengths or

988
00:37:55,030 --> 00:37:54,000

quite bright i should say

989
00:37:56,630 --> 00:37:55,040
um

990
00:37:59,030 --> 00:37:56,640
and so

991
00:38:01,270 --> 00:37:59,040
rather than trying to build a giant tube

992
00:38:02,710 --> 00:38:01,280
to house this thing which would probably

993
00:38:05,109 --> 00:38:02,720
be way too heavy to even launch into

994
00:38:08,310 --> 00:38:05,119
space

995
00:38:09,990 --> 00:38:08,320
a giant sun shield was imagined

996
00:38:12,470 --> 00:38:10,000
as you can see on the bottom right here

997
00:38:14,710 --> 00:38:12,480
is an image of that giant sun shield

998
00:38:17,270 --> 00:38:14,720
in its tensioning tests at northrop

999
00:38:18,950 --> 00:38:17,280
grumman out in california this was last

1000
00:38:21,109 --> 00:38:18,960
year

1001
00:38:22,550 --> 00:38:21,119
there are five layers to the sun shield

1002
00:38:24,790 --> 00:38:22,560
and between those five layers they

1003
00:38:26,390 --> 00:38:24,800
create about a 400 degree temperature

1004
00:38:27,510 --> 00:38:26,400
difference

1005
00:38:29,510 --> 00:38:27,520
so that

1006
00:38:30,790 --> 00:38:29,520
what was hot

1007
00:38:33,829 --> 00:38:30,800
on

1008
00:38:35,829 --> 00:38:33,839
from the earth is now less than 50

1009
00:38:36,950 --> 00:38:35,839
kelvin

1010
00:38:38,150 --> 00:38:36,960
um

1011
00:38:39,670 --> 00:38:38,160
for those of you who aren't familiar

1012
00:38:40,829 --> 00:38:39,680
with that that's

1013
00:38:44,710 --> 00:38:40,839

about

1014
00:38:48,710 --> 00:38:44,720
220 degrees below ups below uh zero

1015
00:38:52,069 --> 00:38:51,030
webb's mirror had to be big it had to be

1016
00:38:54,069 --> 00:38:52,079
big

1017
00:38:56,230 --> 00:38:54,079
to capture the light the faint light

1018
00:38:58,390 --> 00:38:56,240
from those earliest galaxies

1019
00:39:00,710 --> 00:38:58,400
and it had to be big to give us the same

1020
00:39:02,470 --> 00:39:00,720
resolution as hubble

1021
00:39:04,230 --> 00:39:02,480
we love our beautiful images from hubble

1022
00:39:05,589 --> 00:39:04,240
and they tell us so much detail about

1023
00:39:06,950 --> 00:39:05,599
these objects

1024
00:39:08,550 --> 00:39:06,960
but

1025
00:39:10,790 --> 00:39:08,560
when you go to longer wavelengths like

1026
00:39:12,710 --> 00:39:10,800
we are at infrared

1027
00:39:14,870 --> 00:39:12,720
you have to go to a bigger telescope to

1028
00:39:16,790 --> 00:39:14,880
match those longer wavelengths

1029
00:39:18,950 --> 00:39:16,800
and so to see those beautiful crystal

1030
00:39:21,589 --> 00:39:18,960
clear images and get the detail that we

1031
00:39:24,790 --> 00:39:21,599
want about these astronomical objects

1032
00:39:26,710 --> 00:39:24,800
webb's mirrors had to be very big

1033
00:39:29,589 --> 00:39:26,720
and to catch all of that very distant

1034
00:39:30,470 --> 00:39:29,599
fade light from those earliest galaxies

1035
00:39:33,430 --> 00:39:30,480
um

1036
00:39:39,270 --> 00:39:33,440
by area web is about six and a half

1037
00:39:45,030 --> 00:39:42,470
webb has four scientific instruments

1038
00:39:46,550 --> 00:39:45,040

they are listed here the near infrared

1039
00:39:49,030 --> 00:39:46,560
spectrograph

1040
00:39:50,630 --> 00:39:49,040
on the left is near spec the near

1041
00:39:52,390 --> 00:39:50,640
infrared camera

1042
00:39:53,910 --> 00:39:52,400
shown in the middle here

1043
00:39:56,310 --> 00:39:53,920
is near cam

1044
00:39:59,030 --> 00:39:56,320
on the bottom is the near infrared

1045
00:40:02,390 --> 00:39:59,040
imager and the spectrograph nearest

1046
00:40:03,990 --> 00:40:02,400
and uh the mid infrared instrument miri

1047
00:40:06,230 --> 00:40:04,000
uh near spec

1048
00:40:08,790 --> 00:40:06,240
uh is a european contribution from the

1049
00:40:10,550 --> 00:40:08,800
european space agency nearest is a

1050
00:40:11,750 --> 00:40:10,560
contribution from the canadian space

1051
00:40:14,950 --> 00:40:11,760
agency

1052
00:40:18,550 --> 00:40:14,960
and miri is an instrument that was um

1053
00:40:20,550 --> 00:40:18,560
jointly led by the us and by europe

1054
00:40:22,710 --> 00:40:20,560
and near ken is is european it is an

1055
00:40:24,150 --> 00:40:22,720
american instrument

1056
00:40:25,670 --> 00:40:24,160
shown here are the fields of view of

1057
00:40:27,910 --> 00:40:25,680
each of those instruments so you can see

1058
00:40:30,950 --> 00:40:27,920
near camp at the center allows us to

1059
00:40:33,030 --> 00:40:30,960
focus the the telescope um and ensure

1060
00:40:35,349 --> 00:40:33,040
that we are pointing correctly

1061
00:40:38,710 --> 00:40:35,359
um at objects in the sky

1062
00:40:40,470 --> 00:40:38,720
and then the rest of these um

1063
00:40:42,630 --> 00:40:40,480

instruments have their own fields of

1064
00:40:43,670 --> 00:40:42,640
view and can take beautiful pictures of

1065
00:40:46,390 --> 00:40:43,680
the sky

1066
00:40:48,870 --> 00:40:46,400
just um for your awareness

1067
00:40:50,630 --> 00:40:48,880
the field of view here um for for any

1068
00:40:53,510 --> 00:40:50,640
one of these instruments really is about

1069
00:40:55,270 --> 00:40:53,520
the same as as as that for hubble

1070
00:40:57,349 --> 00:40:55,280
so just like with hubble we are looking

1071
00:40:59,030 --> 00:40:57,359
at individual

1072
00:41:01,990 --> 00:40:59,040
objects on the sky we point to them

1073
00:41:04,710 --> 00:41:02,000
directly and study one object at a time

1074
00:41:07,109 --> 00:41:04,720
for the most part

1075
00:41:08,470 --> 00:41:07,119
um as you might suspect from the names

1076
00:41:10,790 --> 00:41:08,480
three of these instruments are in the

1077
00:41:12,710 --> 00:41:10,800
near infrared spectrum and one of them

1078
00:41:14,390 --> 00:41:12,720
is in the mid-infrared

1079
00:41:16,470 --> 00:41:14,400
um

1080
00:41:17,990 --> 00:41:16,480
they you can see the words imager and

1081
00:41:19,829 --> 00:41:18,000
spectrograph

1082
00:41:21,589 --> 00:41:19,839
you may be familiar with imaging as

1083
00:41:23,589 --> 00:41:21,599
we've seen beautiful images from hubble

1084
00:41:25,589 --> 00:41:23,599
for years and years and years now

1085
00:41:27,750 --> 00:41:25,599
um but one of the

1086
00:41:29,670 --> 00:41:27,760
really powerful

1087
00:41:31,829 --> 00:41:29,680
things about james webb

1088
00:41:33,510 --> 00:41:31,839

is its spectroscopic capabilities and as

1089
00:41:34,470 --> 00:41:33,520
you can see here

1090
00:41:36,550 --> 00:41:34,480
um

1091
00:41:38,309 --> 00:41:36,560
you can actually see it in the near cam

1092
00:41:39,910 --> 00:41:38,319
image instrument as well but every

1093
00:41:42,870 --> 00:41:39,920
single one of these instruments has the

1094
00:41:45,109 --> 00:41:42,880
ability to do spectroscopy

1095
00:41:48,150 --> 00:41:45,119
spectroscopy is

1096
00:41:49,510 --> 00:41:48,160
taking light from a distant source as

1097
00:41:51,349 --> 00:41:49,520
you can see here you can take an image

1098
00:41:53,910 --> 00:41:51,359
of a star and it's beautiful but it

1099
00:41:55,829 --> 00:41:53,920
doesn't tell you as much information as

1100
00:41:57,430 --> 00:41:55,839
a spectrum what we do is we take light

1101
00:41:59,670 --> 00:41:57,440
from a source

1102
00:42:00,710 --> 00:41:59,680
we pass it through a prism

1103
00:42:05,829 --> 00:42:00,720
and

1104
00:42:07,190 --> 00:42:05,839
colors that appear or colors that don't

1105
00:42:08,870 --> 00:42:07,200
appear as you can see here on your

1106
00:42:11,030 --> 00:42:08,880
screen there's some black lines within

1107
00:42:12,309 --> 00:42:11,040
this rainbow

1108
00:42:15,030 --> 00:42:12,319
those black lines are actually

1109
00:42:17,670 --> 00:42:15,040
indicative of what molecules are there

1110
00:42:20,710 --> 00:42:17,680
so we said that we can study molecules

1111
00:42:23,190 --> 00:42:20,720
in star forming regions in nearby

1112
00:42:25,589 --> 00:42:23,200
planets in exoplanets

1113
00:42:27,829 --> 00:42:25,599

in galaxies we can study

1114
00:42:29,190 --> 00:42:27,839
the molecules the elements the chemical

1115
00:42:31,589 --> 00:42:29,200
makeup

1116
00:42:33,349 --> 00:42:31,599
of all of these different

1117
00:42:34,950 --> 00:42:33,359
objects out in space

1118
00:42:37,670 --> 00:42:34,960
large and small

1119
00:42:38,630 --> 00:42:37,680
using spectroscopy

1120
00:42:39,829 --> 00:42:38,640
these

1121
00:42:40,630 --> 00:42:39,839
spectra

1122
00:42:41,990 --> 00:42:40,640
are

1123
00:42:44,870 --> 00:42:42,000
fingerprints

1124
00:42:46,790 --> 00:42:44,880
and so no two chemicals no two molecules

1125
00:42:47,589 --> 00:42:46,800
no two elements are going to look the

1126
00:42:49,990 --> 00:42:47,599
same

1127
00:42:51,270 --> 00:42:50,000
and from doing tests on earth here we

1128
00:42:54,550 --> 00:42:51,280
know what they're supposed to look like

1129
00:42:57,829 --> 00:42:54,560
and so if we see a pattern in the light

1130
00:42:59,349 --> 00:42:57,839
we can tell what chemicals are are in an

1131
00:43:00,309 --> 00:42:59,359
object

1132
00:43:02,470 --> 00:43:00,319
um

1133
00:43:04,150 --> 00:43:02,480
i can't stress enough how important

1134
00:43:05,270 --> 00:43:04,160
spectroscopy is

1135
00:43:07,510 --> 00:43:05,280
even though

1136
00:43:09,750 --> 00:43:07,520
these lines in a rainbow may not be as

1137
00:43:12,230 --> 00:43:09,760
beautiful as the images that hubble has

1138
00:43:17,030 --> 00:43:12,240

been producing and james webb will also

1139
00:43:21,109 --> 00:43:19,109
webb is going to be orbiting about a

1140
00:43:22,630 --> 00:43:21,119
million miles away from the earth it

1141
00:43:24,630 --> 00:43:22,640
will orbit

1142
00:43:27,030 --> 00:43:24,640
the sun along with the earth so it'll

1143
00:43:29,270 --> 00:43:27,040
always be the line

1144
00:43:30,710 --> 00:43:29,280
um with with the earth and the sun as

1145
00:43:33,270 --> 00:43:30,720
you can see here

1146
00:43:35,750 --> 00:43:33,280
um so that that giant sun shield which

1147
00:43:38,309 --> 00:43:35,760
is as big as the tennis court

1148
00:43:40,230 --> 00:43:38,319
um so that that giant sun shield can

1149
00:43:43,510 --> 00:43:40,240
block out the light from the sun and the

1150
00:43:45,510 --> 00:43:43,520
moon and the earth all at the same time

1151
00:43:47,510 --> 00:43:45,520
that means that web will go around the

1152
00:43:50,950 --> 00:43:47,520
sun once a year

1153
00:43:55,990 --> 00:43:53,670
it also means that the communications

1154
00:43:57,829 --> 00:43:56,000
antenna that are on the bottom

1155
00:43:59,589 --> 00:43:57,839
of that sunshield are always pointed

1156
00:44:02,230 --> 00:43:59,599
towards the earth so we always can be in

1157
00:44:03,910 --> 00:44:02,240
communication with our satellite both

1158
00:44:06,710 --> 00:44:03,920
sending up commands and also receiving

1159
00:44:10,150 --> 00:44:08,630
in addition to the primary mirror and

1160
00:44:11,910 --> 00:44:10,160
the sun shield

1161
00:44:14,390 --> 00:44:11,920
um the other main components of the

1162
00:44:16,950 --> 00:44:14,400
observatory are a secondary mirror

1163
00:44:20,069 --> 00:44:16,960

a fold-out structure here that focuses

1164
00:44:22,870 --> 00:44:20,079
the light from the primary mirror into

1165
00:44:25,829 --> 00:44:22,880
um the center of the primary mirror you

1166
00:44:27,829 --> 00:44:25,839
can see a little black box um behind

1167
00:44:30,230 --> 00:44:27,839
there is another mirror and all of the

1168
00:44:32,950 --> 00:44:30,240
instrumentation the secondary mirror

1169
00:44:34,790 --> 00:44:32,960
focuses um light from the big primary

1170
00:44:38,309 --> 00:44:34,800
mirror

1171
00:44:40,790 --> 00:44:38,319
uh as well as a solar array that gives

1172
00:44:42,710 --> 00:44:40,800
us the minimal power that we need uh to

1173
00:44:45,670 --> 00:44:42,720
operate our instrumentation

1174
00:44:48,230 --> 00:44:45,680
um and and other spacecraft components

1175
00:44:50,150 --> 00:44:48,240
uh steering and control star trackers um

1176
00:44:52,069 --> 00:44:50,160
and the communications antenna as i

1177
00:44:54,630 --> 00:44:52,079
mentioned um and the scientific

1178
00:44:59,109 --> 00:44:54,640
instruments are behind that primary

1179
00:45:02,710 --> 00:45:01,030
um i mentioned that two of the

1180
00:45:05,270 --> 00:45:02,720
instruments or three of the instruments

1181
00:45:09,349 --> 00:45:05,280
excuse me mirror spec miri and nearest

1182
00:45:11,510 --> 00:45:09,359
our international contributions um as is

1183
00:45:13,589 --> 00:45:11,520
the um

1184
00:45:16,790 --> 00:45:13,599
the rocket that we are launching on

1185
00:45:18,790 --> 00:45:16,800
later this month um the rn5 is also a

1186
00:45:20,150 --> 00:45:18,800
contribution from aryan spas in

1187
00:45:21,190 --> 00:45:20,160
collaboration with the european space

1188
00:45:23,670 --> 00:45:21,200

agency

1189
00:45:26,230 --> 00:45:23,680
um and the fine guidance centers that

1190
00:45:28,470 --> 00:45:26,240
help us uh stay stay pointed and and

1191
00:45:32,710 --> 00:45:28,480
finally tuned to the sky uh is the

1192
00:45:34,790 --> 00:45:32,720
canadian our canadian contribution so um

1193
00:45:36,950 --> 00:45:34,800
there are 14 i believe countries that

1194
00:45:39,829 --> 00:45:36,960
are contributed to web uh you can see

1195
00:45:42,150 --> 00:45:39,839
dots here across the u.s and europe that

1196
00:45:44,230 --> 00:45:42,160
show um all of the different country

1197
00:45:46,550 --> 00:45:44,240
contributing partners

1198
00:45:48,550 --> 00:45:46,560
between academia industry

1199
00:45:50,069 --> 00:45:48,560
and government agencies

1200
00:45:51,589 --> 00:45:50,079
um and

1201
00:45:54,150 --> 00:45:51,599
it um

1202
00:45:57,349 --> 00:45:54,160
in addition to all of the countries that

1203
00:45:59,589 --> 00:45:57,359
have contributed to making web to

1204
00:46:03,030 --> 00:45:59,599
creating web and physically developing

1205
00:46:04,630 --> 00:46:03,040
it there are over 40 countries who are

1206
00:46:06,710 --> 00:46:04,640
set to use

1207
00:46:07,750 --> 00:46:06,720
data from web from web's first year of

1208
00:46:09,349 --> 00:46:07,760
data

1209
00:46:11,589 --> 00:46:09,359
so

1210
00:46:13,589 --> 00:46:11,599
we have over a dozen

1211
00:46:17,190 --> 00:46:13,599
countries that were involved from the

1212
00:46:18,309 --> 00:46:17,200
onset to build the thing and now over 40

1213
00:46:20,870 --> 00:46:18,319

countries

1214
00:46:23,030 --> 00:46:20,880
are already signed up to use the data

1215
00:46:25,510 --> 00:46:23,040
from this observatory and i imagine that

1216
00:46:27,430 --> 00:46:25,520
that will only continue to grow

1217
00:46:29,589 --> 00:46:27,440
as it has with hubble

1218
00:46:31,829 --> 00:46:29,599
and really this could not have been done

1219
00:46:34,309 --> 00:46:31,839
without the international contributions

1220
00:46:39,109 --> 00:46:34,319
um so it goes to show what we can do

1221
00:46:45,190 --> 00:46:43,750
web will be commanded um and and steered

1222
00:46:46,870 --> 00:46:45,200
and um

1223
00:46:49,190 --> 00:46:46,880
from from the space telescope science

1224
00:46:51,750 --> 00:46:49,200
institute where frank and and thomas and

1225
00:46:52,870 --> 00:46:51,760
grant and i work in baltimore maryland

1226
00:46:53,670 --> 00:46:52,880
um

1227
00:46:59,030 --> 00:46:53,680
we

1228
00:47:00,950 --> 00:46:59,040
every

1229
00:47:03,349 --> 00:47:00,960
approximately once a week

1230
00:47:05,750 --> 00:47:03,359
and download data twice a day from the

1231
00:47:08,309 --> 00:47:05,760
observatory

1232
00:47:10,470 --> 00:47:08,319
we use deep space network to make our

1233
00:47:12,790 --> 00:47:10,480
connections to the observatory as the

1234
00:47:14,790 --> 00:47:12,800
earth rotates so we always have a

1235
00:47:18,710 --> 00:47:14,800
contact with

1236
00:47:22,790 --> 00:47:21,190
and then we're looking forward we are so

1237
00:47:25,589 --> 00:47:22,800
close

1238
00:47:27,349 --> 00:47:25,599

webb is currently in peru french guiana

1239
00:47:29,030 --> 00:47:27,359
doing its final testing you may have

1240
00:47:31,750 --> 00:47:29,040
seen recent posts

1241
00:47:32,870 --> 00:47:31,760
about the fueling operations just being

1242
00:47:34,790 --> 00:47:32,880
completed

1243
00:47:36,870 --> 00:47:34,800
they are doing final tests wrapping it

1244
00:47:38,710 --> 00:47:36,880
up and in the next

1245
00:47:40,790 --> 00:47:38,720
probably next week they will start

1246
00:47:43,430 --> 00:47:40,800
putting the observatory onto the rocket

1247
00:47:45,349 --> 00:47:43,440
for final preparations um which is so

1248
00:47:47,109 --> 00:47:45,359
exciting you know i've worked on the

1249
00:47:49,670 --> 00:47:47,119
mission for four and a half years but

1250
00:47:51,030 --> 00:47:49,680
there are others who've worked on it for

1251
00:47:53,030 --> 00:47:51,040
decades

1252
00:47:54,549 --> 00:47:53,040
and i'm sure many of you have been many

1253
00:47:56,150 --> 00:47:54,559
years in the waiting for this

1254
00:48:00,470 --> 00:47:56,160
observatory and the science it's going

1255
00:48:05,990 --> 00:48:03,430
our launch is planned for december 22nd

1256
00:48:07,829 --> 00:48:06,000
uh and there are several you know when

1257
00:48:10,549 --> 00:48:07,839
we launch there's a series of things

1258
00:48:12,150 --> 00:48:10,559
that happens in the first half an hour

1259
00:48:14,230 --> 00:48:12,160
um where

1260
00:48:16,230 --> 00:48:14,240
in that first half an hour aryan spas

1261
00:48:18,150 --> 00:48:16,240
sends its orion 5 rocket

1262
00:48:21,030 --> 00:48:18,160
we go into space

1263
00:48:23,270 --> 00:48:21,040

we jettison our boosters we open up

1264
00:48:25,349 --> 00:48:23,280
we do these amazing maneuvers in space

1265
00:48:27,589 --> 00:48:25,359
to make sure that we are staying

1266
00:48:29,829 --> 00:48:27,599
appropriately shielded from the sun

1267
00:48:31,589 --> 00:48:29,839
before we deploy our sunshield

1268
00:48:32,549 --> 00:48:31,599
and then about a half an hour after we

1269
00:48:34,950 --> 00:48:32,559
launch

1270
00:48:37,270 --> 00:48:34,960
we have a radar we have we have deployed

1271
00:48:39,510 --> 00:48:37,280
our solar array

1272
00:48:40,630 --> 00:48:39,520
we start to deploy our communications

1273
00:48:42,230 --> 00:48:40,640
antennas

1274
00:48:46,230 --> 00:48:42,240
and

1275
00:48:47,270 --> 00:48:46,240
we are operating the mission in full

1276
00:48:50,230 --> 00:48:47,280
from there

1277
00:48:52,230 --> 00:48:50,240
it's about a two-week process to unfold

1278
00:48:53,430 --> 00:48:52,240
this giant thing in space

1279
00:48:56,470 --> 00:48:53,440
um

1280
00:48:58,390 --> 00:48:56,480
when i say giant i mean webb is taller

1281
00:49:00,829 --> 00:48:58,400
than a house and

1282
00:49:04,630 --> 00:49:00,839
longer than a

1283
00:49:06,549 --> 00:49:04,640
uh as long as a tennis court it is huge

1284
00:49:07,510 --> 00:49:06,559
we've never done this before

1285
00:49:09,270 --> 00:49:07,520
and

1286
00:49:10,710 --> 00:49:09,280
there are a series of deployments over

1287
00:49:12,390 --> 00:49:10,720
about two weeks

1288
00:49:15,270 --> 00:49:12,400

that have to happen

1289
00:49:17,030 --> 00:49:15,280
in order to make uh this a success

1290
00:49:19,750 --> 00:49:17,040
and then webb continues this journey out

1291
00:49:22,710 --> 00:49:19,760
to its final orbit at around

1292
00:49:24,549 --> 00:49:22,720
around the l2 the second lagrange point

1293
00:49:26,230 --> 00:49:24,559
um which takes

1294
00:49:29,030 --> 00:49:26,240
another another two weeks to get out to

1295
00:49:31,750 --> 00:49:29,040
that final point

1296
00:49:33,430 --> 00:49:31,760
this process of deployments is um

1297
00:49:34,309 --> 00:49:33,440
illustrated here

1298
00:49:36,870 --> 00:49:34,319
um

1299
00:49:43,430 --> 00:49:36,880
the

1300
00:49:45,670 --> 00:49:43,440
and all five layers tension

1301
00:49:47,990 --> 00:49:45,680
secondary mirror comes out and both of

1302
00:49:49,349 --> 00:49:48,000
the primary wings come out

1303
00:49:51,990 --> 00:49:49,359
now this graphic is beautiful and

1304
00:49:53,349 --> 00:49:52,000
describes what's happening but i am much

1305
00:49:55,910 --> 00:49:53,359
more compelled

1306
00:49:57,430 --> 00:49:55,920
by the animation of this

1307
00:50:01,430 --> 00:49:57,440
deployments

1308
00:50:03,910 --> 00:50:01,440
and it is it is exciting and harrowing

1309
00:50:06,309 --> 00:50:03,920
um and i honestly can't believe that we

1310
00:50:08,309 --> 00:50:06,319
have figured out how to do this um which

1311
00:50:10,710 --> 00:50:08,319
enables our amazing science

1312
00:50:12,870 --> 00:50:10,720
so here we see the sunshield

1313
00:50:14,549 --> 00:50:12,880

the full array deploy around a half an

1314
00:50:15,349 --> 00:50:14,559
hour after launch

1315
00:50:17,190 --> 00:50:15,359
then

1316
00:50:18,710 --> 00:50:17,200
uh we make sure the observatory is

1317
00:50:19,990 --> 00:50:18,720
positioned correctly with respect to the

1318
00:50:22,950 --> 00:50:20,000
earth

1319
00:50:25,349 --> 00:50:22,960
gets another boost out into on its on to

1320
00:50:28,069 --> 00:50:25,359
its orbital trajectory

1321
00:50:30,230 --> 00:50:28,079
communications antenna has just deployed

1322
00:50:32,549 --> 00:50:30,240
we are now releasing the forward and the

1323
00:50:34,390 --> 00:50:32,559
aft sunshield pallets

1324
00:50:37,349 --> 00:50:34,400
you can see here we're at about day

1325
00:50:39,670 --> 00:50:37,359
three day four this whole the whole

1326
00:50:42,309 --> 00:50:39,680
primary mirror and instruments

1327
00:50:45,270 --> 00:50:42,319
unfold we've just released the momentum

1328
00:50:46,069 --> 00:50:45,280
flap in the back now we are releasing

1329
00:50:52,790 --> 00:50:46,079
the

1330
00:50:55,510 --> 00:50:52,800
launch

1331
00:50:57,990 --> 00:50:55,520
and now what we call the mid booms the

1332
00:51:00,230 --> 00:50:58,000
two side components are stretching out

1333
00:51:02,309 --> 00:51:00,240
to stretch um

1334
00:51:05,270 --> 00:51:02,319
all five layers of the

1335
00:51:07,670 --> 00:51:05,280
uh telescope and now we're actually um

1336
00:51:09,750 --> 00:51:07,680
at about day seven or eight here when

1337
00:51:11,510 --> 00:51:09,760
the sun shield is deployed

1338
00:51:12,950 --> 00:51:11,520

next the secondary mirror structure

1339
00:51:15,750 --> 00:51:12,960
comes out

1340
00:51:17,589 --> 00:51:15,760
the back radiator um

1341
00:51:20,150 --> 00:51:17,599
is released to cool down the instruments

1342
00:51:22,950 --> 00:51:20,160
in the back and the primary mirror wings

1343
00:51:24,950 --> 00:51:22,960
both deploy as i mentioned this process

1344
00:51:26,549 --> 00:51:24,960
takes about two weeks and then it takes

1345
00:51:29,670 --> 00:51:26,559
another two weeks

1346
00:51:31,670 --> 00:51:29,680
to get out to our final orbital location

1347
00:51:33,510 --> 00:51:31,680
and at day 29

1348
00:51:35,430 --> 00:51:33,520
we have um

1349
00:51:37,750 --> 00:51:35,440
gone where no man has gone before and

1350
00:51:39,270 --> 00:51:37,760
and done an amazing technical feat

1351
00:51:42,069 --> 00:51:39,280
um

1352
00:51:43,030 --> 00:51:42,079
which is still only the beginning

1353
00:51:45,589 --> 00:51:43,040
um

1354
00:51:47,910 --> 00:51:45,599
after these beautiful deployments

1355
00:51:51,349 --> 00:51:47,920
and arrival at our at our uh orbital

1356
00:51:53,670 --> 00:51:51,359
location at the second lagrange point l2

1357
00:51:55,990 --> 00:51:53,680
there's a several month process

1358
00:51:58,309 --> 00:51:56,000
to ready the telescope

1359
00:52:01,190 --> 00:51:58,319
this involves cooling the telescope at

1360
00:52:03,270 --> 00:52:01,200
first the telescope is passively cooled

1361
00:52:04,390 --> 00:52:03,280
um so that the entire observatory all of

1362
00:52:06,870 --> 00:52:04,400
the optics

1363
00:52:09,510 --> 00:52:06,880

are below 50 kelvin

1364
00:52:11,670 --> 00:52:09,520
there is also an active cryo cooler on

1365
00:52:15,109 --> 00:52:11,680
the mid infrared instrument so that it

1366
00:52:17,670 --> 00:52:15,119
gets down to just over seven degrees

1367
00:52:19,589 --> 00:52:17,680
above absolute zero

1368
00:52:20,549 --> 00:52:19,599
this process takes approximately three

1369
00:52:22,549 --> 00:52:20,559
months

1370
00:52:24,630 --> 00:52:22,559
and starts at launch the cooling process

1371
00:52:27,109 --> 00:52:24,640
and takes approximately three months

1372
00:52:29,030 --> 00:52:27,119
takes another month after that to make

1373
00:52:32,549 --> 00:52:29,040
sure that all of those beautiful 18

1374
00:52:33,990 --> 00:52:32,559
segments on the mirror are aligned

1375
00:52:37,510 --> 00:52:34,000
um

1376
00:52:39,270 --> 00:52:37,520
and another two months to check out all

1377
00:52:41,190 --> 00:52:39,280
of those different instruments and the

1378
00:52:43,510 --> 00:52:41,200
imaging and spectroscopy modes and the

1379
00:52:45,349 --> 00:52:43,520
choreography modes and the integral

1380
00:52:46,950 --> 00:52:45,359
field spectroscopy modes that we didn't

1381
00:52:49,750 --> 00:52:46,960
talk about but

1382
00:52:51,190 --> 00:52:49,760
will be discussed at a future public

1383
00:52:53,270 --> 00:52:51,200
lecture series

1384
00:52:54,549 --> 00:52:53,280
um and provide a lot of scientific

1385
00:52:56,950 --> 00:52:54,559
capabilities

1386
00:53:00,069 --> 00:52:56,960
um and so we do anticipate the first

1387
00:53:02,309 --> 00:53:00,079
images in spectra to arrive next summer

1388
00:53:04,790 --> 00:53:02,319

which may seem like a long wait but

1389
00:53:06,790 --> 00:53:04,800
we've waited this long and i can promise

1390
00:53:08,069 --> 00:53:06,800
you it's worth the wait i can promise

1391
00:53:08,950 --> 00:53:08,079
you

1392
00:53:10,950 --> 00:53:08,960
um

1393
00:53:13,589 --> 00:53:10,960
and and then the science will start

1394
00:53:17,270 --> 00:53:14,950
so again

1395
00:53:20,630 --> 00:53:17,280
just to really get you as excited as i

1396
00:53:24,150 --> 00:53:20,640
am about all of the amazing science from

1397
00:53:25,270 --> 00:53:24,160
nearby planets to far away planets

1398
00:53:28,309 --> 00:53:25,280
to

1399
00:53:32,630 --> 00:53:28,319
galaxies near and far including the

1400
00:53:34,470 --> 00:53:32,640
farthest ones we could ever detect

1401
00:53:37,349 --> 00:53:34,480
webb's going to do it all

1402
00:53:39,910 --> 00:53:37,359
and i'm so excited to be on this journey

1403
00:53:42,470 --> 00:53:39,920
and i hope you all will follow along

1404
00:53:43,910 --> 00:53:42,480
i'm happy to answer any questions and

1405
00:53:47,270 --> 00:53:43,920
there are a lot of opportunities on

1406
00:53:50,230 --> 00:53:47,280
social media and online to follow what

1407
00:53:52,630 --> 00:53:50,240
web is doing um every step of the way

1408
00:53:54,790 --> 00:53:52,640
lots of websites there's a blog

1409
00:53:55,589 --> 00:53:54,800
lots of social media interaction you can

1410
00:53:57,990 --> 00:53:55,599
use

1411
00:54:00,630 --> 00:53:58,000
you can follow the accounts at nasa web

1412
00:54:03,349 --> 00:54:00,640
or use the hashtag unfold the universe

1413
00:54:05,910 --> 00:54:03,359

to focus in specifically on what's new

1414
00:54:10,230 --> 00:54:05,920
happening with with web's launch and

1415
00:54:15,270 --> 00:54:11,670
all right

1416
00:54:18,710 --> 00:54:15,280
thank you alex that is fantastic

1417
00:54:20,950 --> 00:54:18,720
ah we are so excited about this

1418
00:54:23,030 --> 00:54:20,960
upcoming journey with the uh

1419
00:54:25,190 --> 00:54:23,040
of adventure and science with the webb

1420
00:54:27,030 --> 00:54:25,200
space telescope

1421
00:54:29,190 --> 00:54:27,040
i got to say we got a ton of people

1422
00:54:32,710 --> 00:54:29,200
online they're asking a ton of questions

1423
00:54:35,829 --> 00:54:32,720
which we will not have enough time for

1424
00:54:38,230 --> 00:54:35,839
but it really made me laugh that one of

1425
00:54:41,270 --> 00:54:38,240
the first questions and i know you can't

1426
00:54:42,789 --> 00:54:41,280
answer this but is what are the targets

1427
00:54:45,670 --> 00:54:42,799
that you're going to look like look at

1428
00:54:47,829 --> 00:54:45,680
during the early observations i.e the

1429
00:54:49,109 --> 00:54:47,839
early release observations somebody out

1430
00:54:52,789 --> 00:54:49,119
there wants to know what those are going

1431
00:54:57,270 --> 00:54:53,670
i

1432
00:54:59,030 --> 00:54:57,280
people

1433
00:55:02,150 --> 00:54:59,040
that actually do know what those are

1434
00:55:07,750 --> 00:55:05,670
and it is a highly prized secret um

1435
00:55:09,670 --> 00:55:07,760
however you know what

1436
00:55:12,470 --> 00:55:09,680
we

1437
00:55:13,349 --> 00:55:12,480
so

1438
00:55:15,030 --> 00:55:13,359

um

1439
00:55:16,549 --> 00:55:15,040
you know take your best guesses and you

1440
00:55:18,829 --> 00:55:16,559
probably get one right

1441
00:55:21,109 --> 00:55:18,839
uh at least in terms of what types of

1442
00:55:23,670 --> 00:55:21,119
objects okay and then i will say the

1443
00:55:25,109 --> 00:55:23,680
most asked question was when are we

1444
00:55:27,670 --> 00:55:25,119
going to see the first images when is

1445
00:55:28,390 --> 00:55:27,680
the public going to see these images

1446
00:55:30,549 --> 00:55:28,400
so

1447
00:55:32,069 --> 00:55:30,559
what is what is the current schedule

1448
00:55:32,829 --> 00:55:32,079
the current schedule

1449
00:55:35,670 --> 00:55:32,839
is

1450
00:55:38,309 --> 00:55:35,680
july july okay

1451
00:55:41,270 --> 00:55:38,319
july 2022 because as you showed it takes

1452
00:55:43,750 --> 00:55:41,280
just a half 30 days just to get to out

1453
00:55:45,430 --> 00:55:43,760
there and then it inserts into the orbit

1454
00:55:46,950 --> 00:55:45,440
and then of course it has to cool i

1455
00:55:49,109 --> 00:55:46,960
think that's one thing most people don't

1456
00:55:50,870 --> 00:55:49,119
understand is that the telescope itself

1457
00:55:53,670 --> 00:55:50,880
has to cool especially an infrared

1458
00:55:59,109 --> 00:55:53,680
telescope you want to elaborate on that

1459
00:56:03,349 --> 00:56:01,589
for some reason body odor just came to

1460
00:56:05,349 --> 00:56:03,359
mind as like you can't smell your own

1461
00:56:07,430 --> 00:56:05,359
body odor but um

1462
00:56:09,190 --> 00:56:07,440
it it's you know

1463
00:56:11,030 --> 00:56:09,200

you what you

1464
00:56:13,430 --> 00:56:11,040
if you're measuring heat you don't want

1465
00:56:15,190 --> 00:56:13,440
to be giving off your own heat um

1466
00:56:16,789 --> 00:56:15,200
exactly so not only do we have the sun

1467
00:56:18,470 --> 00:56:16,799
shield to block the heat from the earth

1468
00:56:19,910 --> 00:56:18,480
and the

1469
00:56:21,589 --> 00:56:19,920
sun but

1470
00:56:23,510 --> 00:56:21,599
all of this instrumentation the entire

1471
00:56:26,390 --> 00:56:23,520
observatory came from the earth it's at

1472
00:56:29,349 --> 00:56:26,400
ambient room temperature and that is 300

1473
00:56:31,109 --> 00:56:29,359
degrees too hot for anything and so get

1474
00:56:33,829 --> 00:56:31,119
out into the vacuum of space

1475
00:56:35,750 --> 00:56:33,839
we passively cool and so the entire

1476
00:56:36,950 --> 00:56:35,760
observatory will cool with time but it

1477
00:56:40,230 --> 00:56:36,960
takes time

1478
00:56:42,870 --> 00:56:40,240
and then it takes even more time um to

1479
00:56:45,510 --> 00:56:42,880
to manage the proper temperature

1480
00:56:48,069 --> 00:56:45,520
of the mid infrared instrument um the

1481
00:56:49,670 --> 00:56:48,079
longer wavelengths you go to the colder

1482
00:56:52,150 --> 00:56:49,680
it has to be

1483
00:56:54,069 --> 00:56:52,160
so near infrared instrumentation we

1484
00:56:55,829 --> 00:56:54,079
could just be out in space and do it but

1485
00:56:57,270 --> 00:56:55,839
for mid infrared instruments you have to

1486
00:56:58,630 --> 00:56:57,280
actually be colder than you would get

1487
00:57:01,030 --> 00:56:58,640
too naturally

1488
00:57:03,510 --> 00:57:01,040

which is also why spitzer had

1489
00:57:05,990 --> 00:57:03,520
a shortened lifetime of its longer

1490
00:57:07,270 --> 00:57:06,000
wavelengths but it went into its warm

1491
00:57:09,670 --> 00:57:07,280
mission

1492
00:57:11,670 --> 00:57:09,680
where when the cryogenics ran out on

1493
00:57:13,510 --> 00:57:11,680
spitzer it could still do infrared rate

1494
00:57:15,190 --> 00:57:13,520
lengths exactly

1495
00:57:17,030 --> 00:57:15,200
okay i mean because we're getting down

1496
00:57:19,270 --> 00:57:17,040
to tens of degrees kelvin right they're

1497
00:57:21,030 --> 00:57:19,280
going to start out at 2 270 degrees

1498
00:57:22,710 --> 00:57:21,040
kelvin and they got to get down to tens

1499
00:57:24,630 --> 00:57:22,720
of degrees kelvin so

1500
00:57:25,510 --> 00:57:24,640
that's going to take a few uh a few

1501
00:57:28,710 --> 00:57:25,520
months

1502
00:57:30,390 --> 00:57:28,720
yeah yes all right great um grant

1503
00:57:33,030 --> 00:57:30,400
justice has been monitoring the chat

1504
00:57:35,030 --> 00:57:33,040
along with me uh and so grant would you

1505
00:57:36,390 --> 00:57:35,040
like to join us and uh

1506
00:57:38,309 --> 00:57:36,400
ask up a couple questions that you

1507
00:57:39,829 --> 00:57:38,319
selected from the chat

1508
00:57:42,870 --> 00:57:39,839
absolutely

1509
00:57:44,950 --> 00:57:42,880
all right so um first off alex thank you

1510
00:57:46,789 --> 00:57:44,960
for the talk and i'll begin with this

1511
00:57:48,470 --> 00:57:46,799
question so we can head it off because

1512
00:57:49,670 --> 00:57:48,480
it keeps popping up again and again in

1513
00:57:51,670 --> 00:57:49,680

the chat

1514
00:57:54,630 --> 00:57:51,680
would you explain a little more about

1515
00:57:57,430 --> 00:57:54,640
the lagrange point how it's going to

1516
00:58:00,230 --> 00:57:57,440
stay there why it was chosen

1517
00:58:02,789 --> 00:58:00,240
and how it does it's i would say

1518
00:58:03,910 --> 00:58:02,799
relative position keeping

1519
00:58:06,069 --> 00:58:03,920
absolutely

1520
00:58:08,069 --> 00:58:06,079
um so

1521
00:58:10,069 --> 00:58:08,079
for any system of two bodies which in

1522
00:58:11,750 --> 00:58:10,079
this case the two bodies in question are

1523
00:58:12,789 --> 00:58:11,760
the earth and the sun

1524
00:58:15,510 --> 00:58:12,799
um

1525
00:58:17,910 --> 00:58:15,520
there are only a few places so when you

1526
00:58:19,670 --> 00:58:17,920
have two bodies orbiting each other we

1527
00:58:21,270 --> 00:58:19,680
know from kepler's laws and from

1528
00:58:23,430 --> 00:58:21,280
everything we've seen in space that they

1529
00:58:25,270 --> 00:58:23,440
they orbit nicely in nice little circle

1530
00:58:26,870 --> 00:58:25,280
lips dance

1531
00:58:28,789 --> 00:58:26,880
you throw a third body in there and

1532
00:58:30,390 --> 00:58:28,799
everything goes haywire

1533
00:58:31,510 --> 00:58:30,400
and this is a very classical physics

1534
00:58:32,950 --> 00:58:31,520
problem we call it the three body

1535
00:58:35,510 --> 00:58:32,960
problem you tell any you ask any

1536
00:58:38,630 --> 00:58:35,520
physicist and they'll literally chuckle

1537
00:58:41,430 --> 00:58:38,640
um so for wet but for any two body

1538
00:58:43,589 --> 00:58:41,440

system there are a few places that are

1539
00:58:44,549 --> 00:58:43,599
relatively stable

1540
00:58:46,230 --> 00:58:44,559
um

1541
00:58:47,430 --> 00:58:46,240
and these are called the lagrange points

1542
00:58:50,870 --> 00:58:47,440
named after

1543
00:58:52,260 --> 00:58:50,880
an old jean

1544
00:58:54,309 --> 00:58:52,270
i just love saying that name

1545
00:58:56,390 --> 00:58:54,319
[Laughter]

1546
00:58:58,789 --> 00:58:56,400
thank you frank i i was i was at a loss

1547
00:59:00,309 --> 00:58:58,799
except for the last name um

1548
00:59:04,710 --> 00:59:00,319
so there are there are five of these

1549
00:59:07,670 --> 00:59:04,720
points um and they uh fall um

1550
00:59:09,910 --> 00:59:07,680
both in line with the two objects the

1551
00:59:13,030 --> 00:59:09,920
two more massive objects so they fall

1552
00:59:14,870 --> 00:59:13,040
along that line and then they fall ahead

1553
00:59:17,030 --> 00:59:14,880
of and behind

1554
00:59:19,270 --> 00:59:17,040
one of the orbits so you may have heard

1555
00:59:21,430 --> 00:59:19,280
of the trojan asteroids the trojan

1556
00:59:22,549 --> 00:59:21,440
asteroids sit at the third and fourth i

1557
00:59:24,069 --> 00:59:22,559
think it's the third and fourth where's

1558
00:59:27,910 --> 00:59:24,079
the fourth the fourth and fifth lagrange

1559
00:59:29,190 --> 00:59:27,920
points um 60 degrees ahead of and behind

1560
00:59:30,309 --> 00:59:29,200
jupiter

1561
00:59:33,990 --> 00:59:30,319
in its

1562
00:59:36,870 --> 00:59:34,000
um

1563
00:59:39,349 --> 00:59:36,880

and then there are three three points

1564
00:59:41,750 --> 00:59:39,359
where something can be semi-stable

1565
00:59:43,510 --> 00:59:41,760
with respect to the sun and the earth

1566
00:59:46,069 --> 00:59:43,520
along that line one of them is the

1567
00:59:46,950 --> 00:59:46,079
second lagrange point it is on the other

1568
00:59:48,950 --> 00:59:46,960
side

1569
00:59:51,190 --> 00:59:48,960
of the earth from the sun

1570
00:59:53,030 --> 00:59:51,200
uh and for us it's about a million miles

1571
00:59:55,990 --> 00:59:53,040
away there's been other observatories

1572
00:59:58,549 --> 00:59:56,000
that we've sent out there um to also

1573
01:00:00,630 --> 00:59:58,559
reside in what we call deep space this

1574
01:00:02,870 --> 01:00:00,640
is not a low earth orbit like hubble

1575
01:00:05,589 --> 01:00:02,880
this is much much much farther out

1576
01:00:08,150 --> 01:00:05,599
um but because of that it can get cooler

1577
01:00:10,710 --> 01:00:08,160
and can be in the same position relative

1578
01:00:12,390 --> 01:00:10,720
to the sun and the earth at all times

1579
01:00:16,470 --> 01:00:12,400
for webb

1580
01:00:18,789 --> 01:00:16,480
um well for for any uh any observatory

1581
01:00:21,349 --> 01:00:18,799
this is not a completely stable orbit in

1582
01:00:22,870 --> 01:00:21,359
that over time it will lose will

1583
01:00:24,630 --> 01:00:22,880
fall out of that

1584
01:00:26,950 --> 01:00:24,640
local gravity well

1585
01:00:28,870 --> 01:00:26,960
um and therefore

1586
01:00:31,030 --> 01:00:28,880
webb does two things first of all it

1587
01:00:33,270 --> 01:00:31,040
orbit it actually finds itself being

1588
01:00:34,470 --> 01:00:33,280

more stable orbiting around this

1589
01:00:37,109 --> 01:00:34,480
location

1590
01:00:39,990 --> 01:00:37,119
so web goes in a circle that's actually

1591
01:00:43,829 --> 01:00:40,000
perpendicular to the orbit that it's

1592
01:00:46,390 --> 01:00:43,839
it goes around the sun with the earth um

1593
01:00:48,309 --> 01:00:46,400
and it requires a little bit of momentum

1594
01:00:50,630 --> 01:00:48,319
a little bit of propellant every three

1595
01:00:53,190 --> 01:00:50,640
weeks we do what we call station keeping

1596
01:00:55,750 --> 01:00:53,200
where we fire our boosters and make sure

1597
01:00:57,589 --> 01:00:55,760
that we're staying in that orbit um it

1598
01:00:58,950 --> 01:00:57,599
requires very little propellant and it

1599
01:01:00,390 --> 01:00:58,960
means that we have very little

1600
01:01:02,470 --> 01:01:00,400
propellant on board for a very long

1601
01:01:06,309 --> 01:01:02,480
mission lifetime um but it is still

1602
01:01:08,549 --> 01:01:06,319
required um to to combat all of the

1603
01:01:09,990 --> 01:01:08,559
other gravitational forces

1604
01:01:12,390 --> 01:01:10,000
yeah and one of the things that i

1605
01:01:15,910 --> 01:01:12,400
remember about it is that the diameter

1606
01:01:17,829 --> 01:01:15,920
of this a halo orbit around l2 uh is

1607
01:01:19,510 --> 01:01:17,839
about half a million miles isn't it it's

1608
01:01:22,549 --> 01:01:19,520
400 to 500

1609
01:01:24,309 --> 01:01:22,559
um thousand miles so uh it's a million

1610
01:01:27,270 --> 01:01:24,319
miles away but it's got like almost a

1611
01:01:28,789 --> 01:01:27,280
million mile diameter halo orbit so uh

1612
01:01:30,710 --> 01:01:28,799
it's you know it's it's quite a big

1613
01:01:32,470 --> 01:01:30,720

orbit around l2 it's quite a big orbit

1614
01:01:33,990 --> 01:01:32,480
but but it it

1615
01:01:36,829 --> 01:01:34,000
you can see animations of it looks like

1616
01:01:39,349 --> 01:01:36,839
a beautiful dance throughout the

1617
01:01:42,710 --> 01:01:39,359
class it's actually you know dancing up

1618
01:01:44,150 --> 01:01:42,720
and down uh across the ecliptic plane

1619
01:01:46,309 --> 01:01:44,160
and sorry

1620
01:01:48,309 --> 01:01:46,319
yep that leads us to two other things

1621
01:01:49,910 --> 01:01:48,319
which were meant in the jet as well is

1622
01:01:51,990 --> 01:01:49,920
unlike hubble which was in low earth

1623
01:01:53,829 --> 01:01:52,000
orbit this is not going to be

1624
01:01:56,230 --> 01:01:53,839
serviceable in

1625
01:01:57,589 --> 01:01:56,240
really any respect because of its

1626
01:02:00,470 --> 01:01:57,599
location

1627
01:02:02,549 --> 01:02:00,480
um and if i'm not if i'm not mistaken in

1628
01:02:04,309 --> 01:02:02,559
this the only real consumable on the

1629
01:02:07,670 --> 01:02:04,319
station then would be the precision

1630
01:02:09,750 --> 01:02:07,680
station keeping like thrusters because

1631
01:02:12,230 --> 01:02:09,760
deep space cools the back the front is

1632
01:02:14,069 --> 01:02:12,240
facing where it needs to go so that's

1633
01:02:15,829 --> 01:02:14,079
really the only consumable as far as i

1634
01:02:19,190 --> 01:02:15,839
know

1635
01:02:21,349 --> 01:02:19,200
yes yes there is there is um i forget

1636
01:02:24,470 --> 01:02:21,359
what it is but there is the cryo cooler

1637
01:02:27,349 --> 01:02:24,480
that's that separately um cools miri but

1638
01:02:29,029 --> 01:02:27,359

it is a closed system and so there's no

1639
01:02:31,349 --> 01:02:29,039
plan for that to run out and the

1640
01:02:34,069 --> 01:02:31,359
propellant is the one consumable

1641
01:02:36,870 --> 01:02:34,079
um and we have plenty of propellant on

1642
01:02:39,670 --> 01:02:36,880
board um the first 24 hours of the

1643
01:02:41,750 --> 01:02:39,680
mission will be critical um in getting

1644
01:02:43,029 --> 01:02:41,760
us on the right trajectory to our final

1645
01:02:45,349 --> 01:02:43,039
destination

1646
01:02:46,710 --> 01:02:45,359
to ensure that um

1647
01:02:49,029 --> 01:02:46,720
you know our

1648
01:02:52,069 --> 01:02:49,039
our lifetime that is

1649
01:02:55,589 --> 01:02:52,079
that is distinguished by propellants um

1650
01:02:57,270 --> 01:02:55,599
is much longer than the lifetime of of

1651
01:02:59,029 --> 01:02:57,280
the anticipated the anticipated lifetime

1652
01:03:00,470 --> 01:02:59,039
of the mission which at this point is

1653
01:03:01,349 --> 01:03:00,480
five to ten years

1654
01:03:03,589 --> 01:03:01,359
um

1655
01:03:05,589 --> 01:03:03,599
and yes it is it is in deep space it is

1656
01:03:06,870 --> 01:03:05,599
not serviceable as far as we know um

1657
01:03:08,950 --> 01:03:06,880
doesn't mean something couldn't change

1658
01:03:11,990 --> 01:03:08,960
in the next 10 years with our technology

1659
01:03:14,150 --> 01:03:12,000
and commercial space flight um but

1660
01:03:16,470 --> 01:03:14,160
we currently have no plans to service uh

1661
01:03:17,990 --> 01:03:16,480
the mission um

1662
01:03:19,670 --> 01:03:18,000
which is why you've done extensive

1663
01:03:22,789 --> 01:03:19,680

testing on the ground to get things

1664
01:03:23,990 --> 01:03:22,799
right and we have

1665
01:03:25,349 --> 01:03:24,000
all right so i had there was a really

1666
01:03:28,069 --> 01:03:25,359
cool there are two really cool questions

1667
01:03:30,069 --> 01:03:28,079
i wanted to ask um the first one is uh

1668
01:03:32,309 --> 01:03:30,079
they're watching your ultra deep field

1669
01:03:34,230 --> 01:03:32,319
discussion and going all right well just

1670
01:03:35,670 --> 01:03:34,240
how high a redshift is what i've

1671
01:03:38,390 --> 01:03:35,680
expected to see

1672
01:03:40,390 --> 01:03:38,400
i mean what numbers are we looking at

1673
01:03:42,549 --> 01:03:40,400
here hubble goes out to

1674
01:03:44,150 --> 01:03:42,559
i mean in extreme circumstances when you

1675
01:03:46,390 --> 01:03:44,160
get gravitational lensing it can get out

1676
01:03:48,630 --> 01:03:46,400
beyond 10. but hubble generally only

1677
01:03:50,950 --> 01:03:48,640
goes between seven and maybe out to 10

1678
01:03:53,349 --> 01:03:50,960
without with its optics where where are

1679
01:03:55,510 --> 01:03:53,359
we going to get with with web

1680
01:03:58,789 --> 01:03:55,520
so

1681
01:04:01,190 --> 01:03:58,799
i am not a cosmologist um

1682
01:04:04,309 --> 01:04:01,200
so so the the redshift conversion is not

1683
01:04:05,910 --> 01:04:04,319
on the top of my head um but

1684
01:04:07,990 --> 01:04:05,920
yes farther than

1685
01:04:09,750 --> 01:04:08,000
farther than 11 which is as far as we've

1686
01:04:13,349 --> 01:04:09,760
seen with gravitational lensing with

1687
01:04:15,910 --> 01:04:13,359
with um uh hubble um and

1688
01:04:17,750 --> 01:04:15,920

the like the the

1689
01:04:19,349 --> 01:04:17,760
i'm not sure what redshift this matches

1690
01:04:20,950 --> 01:04:19,359
to i think it's about 20 but i'm not

1691
01:04:23,510 --> 01:04:20,960
sure um

1692
01:04:26,309 --> 01:04:23,520
webb expects to see

1693
01:04:27,430 --> 01:04:26,319
out to about 200 million years after the

1694
01:04:30,549 --> 01:04:27,440
big bang

1695
01:04:32,950 --> 01:04:30,559
so kabul currently is at 4-500

1696
01:04:34,950 --> 01:04:32,960
web is expected to go to 200

1697
01:04:37,349 --> 01:04:34,960
um million years after the big bang that

1698
01:04:39,029 --> 01:04:37,359
may not seem like a lot but

1699
01:04:40,630 --> 01:04:39,039
i have a one-year-old and i can tell you

1700
01:04:42,630 --> 01:04:40,640
the difference between

1701
01:04:45,270 --> 01:04:42,640
six months and one year and one and a

1702
01:04:47,349 --> 01:04:45,280
half years in a child's lifetime is

1703
01:04:49,190 --> 01:04:47,359
extremely different and it is the same

1704
01:04:50,950 --> 01:04:49,200
for galaxies and so

1705
01:04:53,349 --> 01:04:50,960
you know that that the very early piece

1706
01:04:55,029 --> 01:04:53,359
that webb is going to find it

1707
01:04:57,589 --> 01:04:55,039
it it's going to give us incredible

1708
01:05:00,470 --> 01:04:57,599
insight into how these things form

1709
01:05:02,069 --> 01:05:00,480
right yeah you know a redshift 10 galaxy

1710
01:05:04,950 --> 01:05:02,079
and going to a rich of 20 galaxy you

1711
01:05:07,990 --> 01:05:04,960
know is is very large in redshift which

1712
01:05:10,309 --> 01:05:08,000
makes it extreme technical feat uh but

1713
01:05:11,670 --> 01:05:10,319

it's not as it's not it's not it doesn't

1714
01:05:13,109 --> 01:05:11,680
sound as impressive when you put it in

1715
01:05:14,789 --> 01:05:13,119
hundreds of millions of years after the

1716
01:05:16,950 --> 01:05:14,799
big bang but

1717
01:05:19,670 --> 01:05:16,960
it's really really difficult to get that

1718
01:05:20,789 --> 01:05:19,680
extra extra pushback

1719
01:05:22,309 --> 01:05:20,799
in time

1720
01:05:24,470 --> 01:05:22,319
it's very much like the little missing

1721
01:05:27,510 --> 01:05:24,480
piece that we've had thus far

1722
01:05:29,349 --> 01:05:27,520
that people haven't been able to see so

1723
01:05:32,630 --> 01:05:29,359
all right grant do you have a question

1724
01:05:35,349 --> 01:05:32,640
yeah your list yeah absolutely um so

1725
01:05:37,029 --> 01:05:35,359
future plans for jwst this is someone

1726
01:05:39,589 --> 01:05:37,039
asking along the same lines of hubble

1727
01:05:41,109 --> 01:05:39,599
like is there a sister station plan like

1728
01:05:43,349 --> 01:05:41,119
obviously we know the answer to this but

1729
01:05:46,630 --> 01:05:43,359
we want to talk about this um future

1730
01:05:48,390 --> 01:05:46,640
projects or any uh

1731
01:05:49,910 --> 01:05:48,400
other observatories that it will be

1732
01:05:52,710 --> 01:05:49,920
interacting with kind of like hubble and

1733
01:05:53,670 --> 01:05:52,720
jwst and supposed to be but didn't

1734
01:05:55,270 --> 01:05:53,680
happen

1735
01:05:57,270 --> 01:05:55,280
and related to that there was a question

1736
01:05:59,750 --> 01:05:57,280
early on about um the fact that

1737
01:06:02,390 --> 01:05:59,760
spitzer's now retired yes uh do we lose

1738
01:06:03,510 --> 01:06:02,400

any science because spitzer and jwst

1739
01:06:07,910 --> 01:06:03,520
aren't going to be able to observe

1740
01:06:11,510 --> 01:06:10,630
jdwt is giving us a lot of opportunity

1741
01:06:13,270 --> 01:06:11,520
it is

1742
01:06:15,910 --> 01:06:13,280
is taking over a lot of the load that

1743
01:06:18,150 --> 01:06:15,920
that spitzer had um it doesn't go out as

1744
01:06:20,390 --> 01:06:18,160
far into wavelength coverage but for

1745
01:06:21,190 --> 01:06:20,400
those of you who have been following

1746
01:06:23,190 --> 01:06:21,200
the

1747
01:06:24,870 --> 01:06:23,200
recent decadal survey actually

1748
01:06:26,230 --> 01:06:24,880
prioritizes

1749
01:06:34,870 --> 01:06:26,240
a

1750
01:06:37,829 --> 01:06:34,880
uh

1751
01:06:41,430 --> 01:06:37,839
near term is relative um

1752
01:06:43,430 --> 01:06:41,440
webb absolutely will be uh working with

1753
01:06:45,430 --> 01:06:43,440
other observatories so

1754
01:06:47,910 --> 01:06:45,440
um the great observatories hubble and

1755
01:06:50,150 --> 01:06:47,920
chandra are obvious um

1756
01:06:51,990 --> 01:06:50,160
plug-ins and and and we've we've

1757
01:06:54,630 --> 01:06:52,000
discussed a lot at our institution about

1758
01:06:57,349 --> 01:06:54,640
how how those are going to work together

1759
01:06:58,870 --> 01:06:57,359
um the roman uh nascar roman space

1760
01:07:01,029 --> 01:06:58,880
telescope is coming online in a few

1761
01:07:03,109 --> 01:07:01,039
years it is more of a survey telescope

1762
01:07:04,549 --> 01:07:03,119
but whatever it finds webb will be

1763
01:07:07,109 --> 01:07:04,559

perfectly

1764
01:07:09,190 --> 01:07:07,119
lined up to follow up on same thing with

1765
01:07:10,230 --> 01:07:09,200
any of the large survey telescopes the

1766
01:07:12,230 --> 01:07:10,240
reuben

1767
01:07:13,430 --> 01:07:12,240
that are currently being developed on

1768
01:07:15,349 --> 01:07:13,440
the ground

1769
01:07:17,430 --> 01:07:15,359
anything that's a survey-based telescope

1770
01:07:19,589 --> 01:07:17,440
james webb will be able to

1771
01:07:21,829 --> 01:07:19,599
be the precision eyes to focus in and

1772
01:07:23,829 --> 01:07:21,839
get more detail about a given object

1773
01:07:26,309 --> 01:07:23,839
um similarly

1774
01:07:29,190 --> 01:07:26,319
all the planetary missions webb can do

1775
01:07:31,910 --> 01:07:29,200
kind of you know scouting for them um on

1776
01:07:34,710 --> 01:07:31,920
a global scale um and

1777
01:07:37,750 --> 01:07:34,720
exoplanets we still have

1778
01:07:40,470 --> 01:07:37,760
thousands of exoplanet candidates um

1779
01:07:41,510 --> 01:07:40,480
and test keeps discovering them in in

1780
01:07:44,870 --> 01:07:41,520
the data

1781
01:07:46,630 --> 01:07:44,880
and web is the tool to follow up those

1782
01:07:49,029 --> 01:07:46,640
observations so there's so many

1783
01:07:51,270 --> 01:07:49,039
compatibilities with other missions um

1784
01:07:52,470 --> 01:07:51,280
and i'm sure i'm missing some

1785
01:07:54,150 --> 01:07:52,480
um

1786
01:07:56,390 --> 01:07:54,160
and uh

1787
01:07:58,309 --> 01:07:56,400
as i said we have no plans to fix it

1788
01:07:59,750 --> 01:07:58,319

um

1789
01:08:01,349 --> 01:07:59,760
should we need to but we have we have no

1790
01:08:03,670 --> 01:08:01,359
plans for to to

1791
01:08:06,230 --> 01:08:03,680
you know for for a sister

1792
01:08:07,670 --> 01:08:06,240
observatory or anything but um

1793
01:08:11,589 --> 01:08:07,680
again if you're following the decadal

1794
01:08:15,029 --> 01:08:11,599
survey uh a a similarly sized

1795
01:08:18,789 --> 01:08:15,039
uh telescope was proposed for um the

1796
01:08:20,149 --> 01:08:18,799
next uh great observatory and so i i am

1797
01:08:21,829 --> 01:08:20,159
sure there will be a lot of lessons

1798
01:08:26,229 --> 01:08:21,839
learned if not direct technology

1799
01:08:29,030 --> 01:08:26,239
adaptation um from web so um it's

1800
01:08:32,309 --> 01:08:29,040
it will have a long legacy um even if

1801
01:08:33,749 --> 01:08:32,319
it's the actual telescope lifetime is is

1802
01:08:36,229 --> 01:08:33,759
is the five to ten years that's

1803
01:08:37,990 --> 01:08:36,239
currently um

1804
01:08:40,390 --> 01:08:38,000
anticipated and and these space

1805
01:08:41,749 --> 01:08:40,400
telescopes are so such useful for

1806
01:08:43,510 --> 01:08:41,759
getting the high precision high

1807
01:08:45,749 --> 01:08:43,520
resolution observations

1808
01:08:47,990 --> 01:08:45,759
whereas you know the telescope and the

1809
01:08:49,829 --> 01:08:48,000
planned extremely large telescopes etc

1810
01:08:51,110 --> 01:08:49,839
are these giant light buckets that you

1811
01:08:53,829 --> 01:08:51,120
don't have the resolution from the

1812
01:08:56,550 --> 01:08:53,839
ground but can get so much so much faint

1813
01:08:59,510 --> 01:08:56,560

here and such so it really is you know

1814
01:09:01,829 --> 01:08:59,520
as the decadal survey lays out it is a

1815
01:09:03,910 --> 01:09:01,839
structured um

1816
01:09:05,829 --> 01:09:03,920
a set of telescopes to get different

1817
01:09:07,269 --> 01:09:05,839
advantages of each telescope and we're

1818
01:09:09,269 --> 01:09:07,279
really you know laying out what are the

1819
01:09:11,430 --> 01:09:09,279
best telescopes to get the advantages of

1820
01:09:13,110 --> 01:09:11,440
each uh of each style

1821
01:09:14,870 --> 01:09:13,120
pulling out like different right the

1822
01:09:16,870 --> 01:09:14,880
spectrum so

1823
01:09:18,470 --> 01:09:16,880
in terms of the spec and and and and

1824
01:09:19,349 --> 01:09:18,480
that's the other thing the audience

1825
01:09:22,229 --> 01:09:19,359
should appreciate is that

1826
01:09:23,990 --> 01:09:22,239
multi-wavelength astronomy is the way we

1827
01:09:26,950 --> 01:09:24,000
do astronomy these days

1828
01:09:29,030 --> 01:09:26,960
having x-ray and infrared and visible

1829
01:09:31,749 --> 01:09:29,040
really is required to get all the

1830
01:09:33,510 --> 01:09:31,759
information we need these days

1831
01:09:36,149 --> 01:09:33,520
so i had one other question that i

1832
01:09:38,630 --> 01:09:36,159
thought was really cool

1833
01:09:42,709 --> 01:09:38,640
or intriguing oh

1834
01:09:44,309 --> 01:09:42,719
what about the spikes on jwst they were

1835
01:09:46,229 --> 01:09:44,319
looking at the mirror going well you

1836
01:09:48,390 --> 01:09:46,239
know hubble has these cross spikes that

1837
01:09:51,030 --> 01:09:48,400
it produces is webb gonna have like

1838
01:09:53,110 --> 01:09:51,040

these y spikes or something what's gonna

1839
01:09:56,390 --> 01:09:53,120
happen with this psf and the spikes on

1840
01:09:57,669 --> 01:09:56,400
uh indicating a a james webb observatory

1841
01:10:00,229 --> 01:09:57,679
image

1842
01:10:02,550 --> 01:10:00,239
yeah yeah um that's actually

1843
01:10:04,470 --> 01:10:02,560
it's very cool um i've seen some

1844
01:10:06,870 --> 01:10:04,480
simulated data so far

1845
01:10:08,709 --> 01:10:06,880
um and uh because of the hexagonal

1846
01:10:11,510 --> 01:10:08,719
mirrors of web because it's not uh

1847
01:10:13,669 --> 01:10:11,520
perfectly circular um the

1848
01:10:17,030 --> 01:10:13,679
diffraction spikes that you get for

1849
01:10:18,870 --> 01:10:17,040
example looking at a star um you you see

1850
01:10:22,310 --> 01:10:18,880
you see this this cross hairs with

1851
01:10:24,310 --> 01:10:22,320
hubble um you'll actually see more of a

1852
01:10:27,350 --> 01:10:24,320
looks like kind of a snowflake pattern

1853
01:10:29,350 --> 01:10:27,360
um it is a um

1854
01:10:32,550 --> 01:10:29,360
a six uh

1855
01:10:35,430 --> 01:10:32,560
six it's the same thing but six

1856
01:10:37,430 --> 01:10:35,440
three three crosses instead um

1857
01:10:38,390 --> 01:10:37,440
and uh and

1858
01:10:40,790 --> 01:10:38,400
uh

1859
01:10:42,830 --> 01:10:40,800
yeah it's gonna be it's gonna make web

1860
01:10:45,110 --> 01:10:42,840
images very distinctive from hubble

1861
01:10:46,870 --> 01:10:45,120
images um

1862
01:10:48,790 --> 01:10:46,880
cool because i mean everyone's just sort

1863
01:10:50,550 --> 01:10:48,800

of gotten used to the cross spikes from

1864
01:10:53,669 --> 01:10:50,560
hubble now we have to get used to the

1865
01:10:55,030 --> 01:10:53,679
snowflake spikes uh from james webb

1866
01:10:57,030 --> 01:10:55,040
oh cool

1867
01:10:59,750 --> 01:10:57,040
all right like my my sweat my christmas

1868
01:11:02,630 --> 01:10:59,760
sweater here

1869
01:11:03,669 --> 01:11:02,640
such a holiday uh observatory in so many

1870
01:11:06,470 --> 01:11:03,679
ways

1871
01:11:07,270 --> 01:11:06,480
it'll be snow snowflakes all year long

1872
01:11:09,830 --> 01:11:07,280
all right

1873
01:11:11,830 --> 01:11:09,840
what you got if i might yeah last one

1874
01:11:14,229 --> 01:11:11,840
and this is just the audience really

1875
01:11:16,550 --> 01:11:14,239
enjoyed this so alex if you would plug

1876
01:11:20,310 --> 01:11:16,560
your socials and whatnot at the end

1877
01:11:23,189 --> 01:11:20,320
for the the crew out there

1878
01:11:24,390 --> 01:11:23,199
sure sure i'm i'm not much on social but

1879
01:11:29,030 --> 01:11:24,400
um i'm

1880
01:11:31,830 --> 01:11:30,950
and then yeah where were you did you

1881
01:11:32,950 --> 01:11:31,840
have another did you have another

1882
01:11:36,630 --> 01:11:32,960
question

1883
01:11:38,709 --> 01:11:36,640
okay yeah yeah absolutely we started

1884
01:11:41,590 --> 01:11:38,719
late so i'm we have time for another

1885
01:11:43,030 --> 01:11:41,600
question okay also i'll just say um on

1886
01:11:46,470 --> 01:11:43,040
twitter and again i'm not very much on

1887
01:11:49,510 --> 01:11:46,480
twitter i'm asked ask astro alex i think

1888
01:11:51,910 --> 01:11:49,520

that instruction as well so um great

1889
01:11:54,709 --> 01:11:51,920
handle

1890
01:11:57,110 --> 01:11:54,719
all right um so uh last question then um

1891
01:11:59,910 --> 01:11:57,120
we've spoken a couple times about

1892
01:12:01,669 --> 01:11:59,920
the way that we can reach out to see

1893
01:12:02,870 --> 01:12:01,679
this light like frank mentioned kind of

1894
01:12:05,590 --> 01:12:02,880
these giant

1895
01:12:07,350 --> 01:12:05,600
light gathering observatories and those

1896
01:12:10,229 --> 01:12:07,360
sorts of things what would you actually

1897
01:12:11,830 --> 01:12:10,239
need in terms of an observatory or in

1898
01:12:13,990 --> 01:12:11,840
terms of

1899
01:12:15,669 --> 01:12:14,000
spectroscopy to be able to really see as

1900
01:12:22,229 --> 01:12:15,679
far back as we really want to see like

1901
01:12:22,239 --> 01:12:28,229
so

1902
01:12:31,910 --> 01:12:30,149
to be honest i just don't really think

1903
01:12:33,830 --> 01:12:31,920
it's possible there's kind of a few

1904
01:12:35,270 --> 01:12:33,840
discrete points that we get stopped

1905
01:12:36,630 --> 01:12:35,280
along the way

1906
01:12:39,110 --> 01:12:36,640
um

1907
01:12:41,510 --> 01:12:39,120
one is uh what we call the epic of

1908
01:12:45,430 --> 01:12:41,520
reionization that's when the hot plasma

1909
01:12:48,390 --> 01:12:45,440
after the big bang cooled enough to form

1910
01:12:51,189 --> 01:12:48,400
atoms and in doing so

1911
01:12:53,189 --> 01:12:51,199
released photons um for the first moment

1912
01:12:56,630 --> 01:12:53,199
of let there be light

1913
01:12:58,790 --> 01:12:56,640

um and that that original uh release of

1914
01:13:00,550 --> 01:12:58,800
photons um

1915
01:13:02,870 --> 01:13:00,560
is known as the cosmic microwave

1916
01:13:07,350 --> 01:13:02,880
background that light has been stretched

1917
01:13:09,910 --> 01:13:07,360
so far from 300 000 400 000 years

1918
01:13:11,430 --> 01:13:09,920
100 000 instead of million after the big

1919
01:13:14,630 --> 01:13:11,440
bang that's been stretched so far it's

1920
01:13:16,149 --> 01:13:14,640
in microwave wavelengths and satellites

1921
01:13:18,149 --> 01:13:16,159
like kobe

1922
01:13:20,070 --> 01:13:18,159
and the planck satellite have measured

1923
01:13:21,910 --> 01:13:20,080
that and that tells us about

1924
01:13:23,830 --> 01:13:21,920
you know fluctuations in that plasma

1925
01:13:26,070 --> 01:13:23,840
from the beginning of the universe um

1926
01:13:28,149 --> 01:13:26,080
but that's kind of one marked period and

1927
01:13:30,790 --> 01:13:28,159
then after that you do hit this

1928
01:13:32,470 --> 01:13:30,800
this neutral hydrogen that's a giant fog

1929
01:13:34,870 --> 01:13:32,480
um and the only thing that is strong

1930
01:13:38,390 --> 01:13:34,880
enough to break through that um and and

1931
01:13:41,110 --> 01:13:38,400
and and re-ionize it as we say um were

1932
01:13:42,870 --> 01:13:41,120
were these very first galaxies populated

1933
01:13:43,910 --> 01:13:42,880
with very hot stars

1934
01:13:49,669 --> 01:13:43,920
um

1935
01:13:52,470 --> 01:13:49,679
there is a

1936
01:13:55,189 --> 01:13:52,480
tiny chance a theoretical chance that

1937
01:13:57,030 --> 01:13:55,199
webb could actually detect for stars

1938
01:13:59,350 --> 01:13:57,040

um you know some of these individual

1939
01:14:01,350 --> 01:13:59,360
bright stars but much more likely that

1940
01:14:03,669 --> 01:14:01,360
it will detect galaxies that are you

1941
01:14:05,110 --> 01:14:03,679
know that are clusters of these stars

1942
01:14:06,790 --> 01:14:05,120
um

1943
01:14:10,070 --> 01:14:06,800
and and so

1944
01:14:14,310 --> 01:14:12,149
you know every

1945
01:14:16,550 --> 01:14:14,320
the farther back you want to go you have

1946
01:14:18,310 --> 01:14:16,560
to get bigger to get

1947
01:14:19,830 --> 01:14:18,320
the because the light is fainter because

1948
01:14:21,270 --> 01:14:19,840
the objects are both smaller and more

1949
01:14:22,709 --> 01:14:21,280
distant and you have to get more

1950
01:14:23,750 --> 01:14:22,719
infrared

1951
01:14:25,350 --> 01:14:23,760
um

1952
01:14:28,070 --> 01:14:25,360
web is kind of the limit of where we've

1953
01:14:29,910 --> 01:14:28,080
imagined that um because then you also

1954
01:14:30,709 --> 01:14:29,920
have the neutral hydrogen uh to deal

1955
01:14:32,790 --> 01:14:30,719
with

1956
01:14:34,709 --> 01:14:32,800
um

1957
01:14:36,229 --> 01:14:34,719
frank may have that just

1958
01:14:38,149 --> 01:14:36,239
no i'm agreeing with you i'm sitting

1959
01:14:40,310 --> 01:14:38,159
here nodding my head at you because

1960
01:14:42,390 --> 01:14:40,320
we won't if there if we need to go

1961
01:14:43,669 --> 01:14:42,400
further we need a bigger mirror or

1962
01:14:45,110 --> 01:14:43,679
we need to go further into the

1963
01:14:46,870 --> 01:14:45,120

mid-infrared

1964
01:14:49,669 --> 01:14:46,880
we won't know until lab gets out there

1965
01:14:51,910 --> 01:14:49,679
and does its observations right i mean

1966
01:14:53,350 --> 01:14:51,920
when we did the hubble deep field there

1967
01:14:56,870 --> 01:14:53,360
were a lot of astronomers who said

1968
01:14:58,870 --> 01:14:56,880
you're wasting so much hubble time right

1969
01:15:00,790 --> 01:14:58,880
we didn't know and then we found out oh

1970
01:15:01,990 --> 01:15:00,800
you know what we can see this and that

1971
01:15:03,350 --> 01:15:02,000
led to oh well

1972
01:15:05,430 --> 01:15:03,360
now we'll now we need to go to the

1973
01:15:07,030 --> 01:15:05,440
infrared and we'll see even further and

1974
01:15:08,790 --> 01:15:07,040
then we'll find out with with web

1975
01:15:11,430 --> 01:15:08,800
whether or not we need to go even

1976
01:15:13,350 --> 01:15:11,440
further than that um every good

1977
01:15:14,790 --> 01:15:13,360
discovery comes brings with it new

1978
01:15:16,390 --> 01:15:14,800
questions right

1979
01:15:18,310 --> 01:15:16,400
yeah and how you know hubble's found a

1980
01:15:20,229 --> 01:15:18,320
few of these early galaxies well we'll

1981
01:15:22,470 --> 01:15:20,239
find more what will help us understand

1982
01:15:24,229 --> 01:15:22,480
how many of them there are how big they

1983
01:15:26,630 --> 01:15:24,239
are you know what is what is

1984
01:15:28,390 --> 01:15:26,640
realistically feasible um because you

1985
01:15:31,189 --> 01:15:28,400
know galaxy is much brighter than a star

1986
01:15:33,030 --> 01:15:31,199
so you have to get to a certain point

1987
01:15:35,270 --> 01:15:33,040
to register on even an even larger

1988
01:15:36,630 --> 01:15:35,280

telescope and so um

1989
01:15:37,910 --> 01:15:36,640
yeah

1990
01:15:40,390 --> 01:15:37,920
i'm so looking forward to this because

1991
01:15:42,229 --> 01:15:40,400
things that are exceptional you know

1992
01:15:43,590 --> 01:15:42,239
really you know pushing to the very edge

1993
01:15:44,950 --> 01:15:43,600
of what hubble can do

1994
01:15:47,030 --> 01:15:44,960
well we'll be able to do them as a

1995
01:15:48,310 --> 01:15:47,040
matter of course and so they'll be you

1996
01:15:50,070 --> 01:15:48,320
know they won't be ordinary they'll

1997
01:15:53,990 --> 01:15:50,080
still be exceptional but there'll be a

1998
01:15:57,030 --> 01:15:54,000
whole lot more of them right yes yes

1999
01:15:59,270 --> 01:15:57,040
all right so that is a fantastic look

2000
01:16:00,630 --> 01:15:59,280
forward um at what this telescope is

2001
01:16:04,229 --> 01:16:00,640
going to do let's remind everybody all

2002
01:16:06,550 --> 01:16:04,239
right launch december 22nd 7 20 a.m

2003
01:16:08,709 --> 01:16:06,560
eastern time according to what i've what

2004
01:16:10,630 --> 01:16:08,719
i've read and i will we will always say

2005
01:16:12,630 --> 01:16:10,640
that launches are subject to delays

2006
01:16:14,229 --> 01:16:12,640
weather other problems whatever okay

2007
01:16:16,390 --> 01:16:14,239
recognize that you know launches

2008
01:16:19,270 --> 01:16:16,400
sometimes go perfectly right on schedule

2009
01:16:21,750 --> 01:16:19,280
and sometimes they they slept right

2010
01:16:22,790 --> 01:16:21,760
um it will take six months to get out

2011
01:16:24,390 --> 01:16:22,800
and

2012
01:16:26,149 --> 01:16:24,400
get through commissioning we'll do

2013
01:16:29,350 --> 01:16:26,159

observations and

2014
01:16:30,310 --> 01:16:29,360
first images probably july 2022. i got

2015
01:16:31,669 --> 01:16:30,320
all that right

2016
01:16:35,270 --> 01:16:31,679
absolutely

2017
01:16:37,110 --> 01:16:35,280
all right well thank you so much alex um

2018
01:16:39,750 --> 01:16:37,120
i know that this audience is really

2019
01:16:41,750 --> 01:16:39,760
looking forward to the results and just

2020
01:16:42,630 --> 01:16:41,760
as almost as much as we are

2021
01:16:46,229 --> 01:16:42,640
um

2022
01:16:48,470 --> 01:16:46,239
next month january 4th the vibrant life

2023
01:16:51,350 --> 01:16:48,480
in cities of the galaxies by

2024
01:16:54,229 --> 01:16:51,360
maria montesquiles um we will look

2025
01:16:56,709 --> 01:16:54,239
forward to seeing you then until then

2026
01:16:58,709 --> 01:16:56,719
cross your fingers and watch that launch

2027
01:16:59,990 --> 01:16:58,719
and uh uh