PUBLIC LECTURE SERIES

Webb's First Look: Images and Spectra from NASA's Newest Great Observatory

Featuring Guest Speaker:
Alexandra Lockwood

1
00:00:05,990 --> 00:00:04,470
welcome to the space telescope public

2
00:00:07,030 --> 00:00:06,000
lecture series

3
00:00:10,310 --> 00:00:07,040
tonight

4
00:00:13,509 --> 00:00:10,320
webb's first look images in spectra from

5
00:00:15,190 --> 00:00:13,519
nasa's newest great observatory with dr

6
00:00:18,150 --> 00:00:15,200
alexander lockwood of the space

7
00:00:20,630 --> 00:00:18,160
telescope science institute

8
00:00:22,310 --> 00:00:20,640
i'm your host i'm dr frank summers of

9
00:00:25,189 --> 00:00:22,320
the office of public outreach here at

10
00:00:28,310 --> 00:00:25,199
the space telescope science institute

11
00:00:31,429 --> 00:00:28,320
and i always thank our amazing tech team

12
00:00:33,910 --> 00:00:31,439
thomas marufu and grant justice who

13
00:00:35,750 --> 00:00:33,920

record this session and get it out to

14
00:00:37,510 --> 00:00:35,760
you on youtube

15
00:00:39,030 --> 00:00:37,520
i will note that even though the

16
00:00:40,310 --> 00:00:39,040
pandemic has

17
00:00:42,310 --> 00:00:40,320
died down

18
00:00:44,950 --> 00:00:42,320
the space telescope public like sheries

19
00:00:47,910 --> 00:00:44,960
will continue to be online only until

20
00:00:51,510 --> 00:00:49,910
our upcoming lectures

21
00:00:53,750 --> 00:00:51,520
in september

22
00:00:57,110 --> 00:00:53,760
first light unveiling the properties of

23
00:01:00,709 --> 00:00:57,120
galaxies at cosmic dawn from guido

24
00:01:03,270 --> 00:01:00,719
roberts bersani at ucla that sounds

25
00:01:05,189 --> 00:01:03,280
really cool looking out into space and

26
00:01:07,670 --> 00:01:05,199
back into time

27
00:01:11,429 --> 00:01:07,680
on october we have a very special talk

28
00:01:14,469 --> 00:01:11,439
for you the universe of dante alighieri

29
00:01:17,030 --> 00:01:14,479
by a descendant of dante ella gary named

30
00:01:18,950 --> 00:01:17,040
spirello de sorego allegari this is

31
00:01:22,070 --> 00:01:18,960
going to be really cool looking at the

32
00:01:25,109 --> 00:01:22,080
way astronomy and the universe is

33
00:01:28,310 --> 00:01:25,119
put into dante's works

34
00:01:31,350 --> 00:01:28,320
and november we have black holes how do

35
00:01:33,749 --> 00:01:31,360
we see that's what gives off no light

36
00:01:36,710 --> 00:01:33,759
from stephanie lamassa also here at

37
00:01:39,590 --> 00:01:36,720
space telescope science institute

38
00:01:45,749 --> 00:01:39,600

to find information about these lectures

39
00:01:51,749 --> 00:01:49,030
public hyphen lectures and on there on

40
00:01:53,990 --> 00:01:51,759
the left side of the page as you see

41
00:01:56,149 --> 00:01:54,000
we have our youtube playlist and our

42
00:01:57,429 --> 00:01:56,159
webcast archives

43
00:01:59,910 --> 00:01:57,439
that are

44
00:02:03,030 --> 00:01:59,920
from those stsci

45
00:02:05,749 --> 00:02:03,040
and on the right you see our easy easy

46
00:02:07,990 --> 00:02:05,759
method for subscribing to our email list

47
00:02:11,190 --> 00:02:08,000
just enter your email address and push

48
00:02:15,430 --> 00:02:13,750
also on our web pages we have lists of

49
00:02:17,030 --> 00:02:15,440
the upcoming lectures

50
00:02:19,589 --> 00:02:17,040
and if you click on one of those

51
00:02:22,070 --> 00:02:19,599
lectures that read more it will give you

52
00:02:24,869 --> 00:02:22,080
the information about the speaker and

53
00:02:27,589 --> 00:02:24,879
the uh abstract of the talk as well as

54
00:02:31,589 --> 00:02:27,599
after it's been recorded links to the

55
00:02:34,150 --> 00:02:31,599
stsci webcast as well as the posting on

56
00:02:39,509 --> 00:02:37,030
about our email is i as i showed you you

57
00:02:41,750 --> 00:02:39,519
can sign up at our website uh you can

58
00:02:45,270 --> 00:02:41,760
also you just subscribe to our youtube

59
00:02:47,589 --> 00:02:45,280
channel uh youtube.com hubble space

60
00:02:49,750 --> 00:02:47,599
telescope and you will get new video

61
00:02:51,190 --> 00:02:49,760
notices and reminders of live events

62
00:02:52,869 --> 00:02:51,200
such as this

63
00:02:54,790 --> 00:02:52,879

finally if you have comments or

64
00:02:56,949 --> 00:02:54,800
questions you can send them to the email

65
00:03:01,270 --> 00:02:56,959
address public lecture

66
00:03:07,430 --> 00:03:03,350
our social media channels include

67
00:03:08,710 --> 00:03:07,440
facebook twitter youtube and instagram

68
00:03:10,869 --> 00:03:08,720
we have

69
00:03:13,350 --> 00:03:10,879
channels for the hubble space telescope

70
00:03:16,309 --> 00:03:13,360
for the web space telescope and for the

71
00:03:19,430 --> 00:03:16,319
space telescope science institute

72
00:03:21,350 --> 00:03:19,440
i myself do a tiny bit of social media

73
00:03:25,509 --> 00:03:21,360
you can find me on facebook and twitter

74
00:03:29,830 --> 00:03:27,509
and now our news from the universe for

75
00:03:31,910 --> 00:03:29,840
august 2022

76
00:03:33,830 --> 00:03:31,920
now i know you all are excited to get to

77
00:03:35,990 --> 00:03:33,840
the web imagers so i'm only going to do

78
00:03:37,030 --> 00:03:36,000
one story but it's a really cool little

79
00:03:43,350 --> 00:03:37,040
story

80
00:03:46,390 --> 00:03:43,360
where's waldo black hole edition

81
00:03:49,270 --> 00:03:46,400
so some of you may remember a lot of you

82
00:03:51,030 --> 00:03:49,280
may remember the where's waldo books in

83
00:03:53,910 --> 00:03:51,040
which you're given a

84
00:03:56,869 --> 00:03:53,920
really complex picture like this and

85
00:03:59,350 --> 00:03:56,879
your job is to find this waldo character

86
00:04:02,470 --> 00:03:59,360
in his red and white uh striped sweater

87
00:04:04,869 --> 00:04:02,480
and hat in there uh and you know it's

88
00:04:07,110 --> 00:04:04,879

kind of fun it's a hunting pet hunt and

89
00:04:08,390 --> 00:04:07,120
search for one character amongst many

90
00:04:11,030 --> 00:04:08,400
and you'll have you have to notice all

91
00:04:12,630 --> 00:04:11,040
the details and touch up by the way i

92
00:04:14,550 --> 00:04:12,640
know some of you are trying to squint at

93
00:04:16,310 --> 00:04:14,560
your screen right now

94
00:04:17,590 --> 00:04:16,320
this is where waldo is in this picture

95
00:04:18,469 --> 00:04:17,600
okay

96
00:04:21,270 --> 00:04:18,479
now

97
00:04:23,990 --> 00:04:21,280
in the astronomical version of it

98
00:04:26,469 --> 00:04:24,000
we are looking in an image like this a

99
00:04:28,150 --> 00:04:26,479
star field this is actually a star field

100
00:04:30,710 --> 00:04:28,160
toward the galactic center toward the

101
00:04:32,150 --> 00:04:30,720
center of our galaxy tons and tons and

102
00:04:34,950 --> 00:04:32,160
tons of stars

103
00:04:36,070 --> 00:04:34,960
and in this image we're not looking for

104
00:04:39,110 --> 00:04:36,080
waldo

105
00:04:40,790 --> 00:04:39,120
we're looking for a black hole

106
00:04:43,189 --> 00:04:40,800
now there are

107
00:04:46,390 --> 00:04:43,199
black holes that are free-floating

108
00:04:48,230 --> 00:04:46,400
across our galaxy and what happens is

109
00:04:50,070 --> 00:04:48,240
that when you form a black hole by a

110
00:04:52,230 --> 00:04:50,080
supernova explosion

111
00:04:54,550 --> 00:04:52,240
that explosion doesn't have to be

112
00:04:57,270 --> 00:04:54,560
symmetrical it can be asymmetrical and

113
00:04:58,950 --> 00:04:57,280

give that black hole a kick and give it

114
00:05:03,029 --> 00:04:58,960
a significant

115
00:05:04,310 --> 00:05:03,039
motion across the galaxy so there are we

116
00:05:06,469 --> 00:05:04,320
we understand

117
00:05:08,150 --> 00:05:06,479
lots of black holes just floating out

118
00:05:10,390 --> 00:05:08,160
amongst the stars

119
00:05:13,270 --> 00:05:10,400
and so now we're going to play a where's

120
00:05:16,230 --> 00:05:13,280
waldo to try and find that black hole in

121
00:05:18,790 --> 00:05:16,240
this image because it's there

122
00:05:20,870 --> 00:05:18,800
and remember of course that black holes

123
00:05:22,070 --> 00:05:20,880
emit no light

124
00:05:24,629 --> 00:05:22,080
so

125
00:05:26,390 --> 00:05:24,639
how are we going to find a black hole

126
00:05:28,310 --> 00:05:26,400
well if you've been paying attention to

127
00:05:29,830 --> 00:05:28,320
the news over the past couple of years

128
00:05:31,990 --> 00:05:29,840
you know that we've actually taken a

129
00:05:33,590 --> 00:05:32,000
couple pictures of black holes using

130
00:05:37,029 --> 00:05:33,600
something called the event horizon

131
00:05:39,430 --> 00:05:37,039
telescope and this is the image of the

132
00:05:42,390 --> 00:05:39,440
supermassive black hole in the galaxy

133
00:05:43,189 --> 00:05:42,400
messier 87 m87

134
00:05:44,790 --> 00:05:43,199
now

135
00:05:47,510 --> 00:05:44,800
this was taken with the event horizon

136
00:05:50,310 --> 00:05:47,520
telescope which is a combination of many

137
00:05:53,430 --> 00:05:50,320
radio telescopes across earth

138
00:05:55,909 --> 00:05:53,440

and this black hole is as it's described

139
00:05:58,309 --> 00:05:55,919
here supermassive about a billion times

140
00:06:00,309 --> 00:05:58,319
the mass of the sun

141
00:06:02,710 --> 00:06:00,319
the black hole we're looking for is not

142
00:06:05,430 --> 00:06:02,720
supermassive and we're using hubble

143
00:06:07,350 --> 00:06:05,440
which is not a radio telescope so we

144
00:06:08,629 --> 00:06:07,360
can't use this method to find the black

145
00:06:10,390 --> 00:06:08,639
hole

146
00:06:12,710 --> 00:06:10,400
another method that we use to find black

147
00:06:16,150 --> 00:06:12,720
holes is when they are in a binary

148
00:06:18,469 --> 00:06:16,160
system and the material from ones from

149
00:06:20,950 --> 00:06:18,479
the companion star flows off of the

150
00:06:23,189 --> 00:06:20,960
companion star into like a disc around

151
00:06:25,670 --> 00:06:23,199
the black hole and that material gets

152
00:06:27,670 --> 00:06:25,680
speeded up to relativistic speeds emits

153
00:06:28,629 --> 00:06:27,680
huge amounts of energy sometimes there's

154
00:06:31,270 --> 00:06:28,639
jets

155
00:06:33,350 --> 00:06:31,280
and we can see them in x-rays

156
00:06:34,550 --> 00:06:33,360
alright and so these are called x-ray

157
00:06:35,990 --> 00:06:34,560
binaries

158
00:06:38,150 --> 00:06:36,000
now again

159
00:06:40,469 --> 00:06:38,160
this black hole we're looking for

160
00:06:41,430 --> 00:06:40,479
isn't in a binary system

161
00:06:43,670 --> 00:06:41,440
and

162
00:06:45,590 --> 00:06:43,680
we're not using an x-ray telescope so we

163
00:06:47,270 --> 00:06:45,600

can't use this method

164
00:06:50,230 --> 00:06:47,280
the method that we're going to use to

165
00:06:52,629 --> 00:06:50,240
find it is a method called gravitational

166
00:06:55,110 --> 00:06:52,639
microlensing all right

167
00:06:56,469 --> 00:06:55,120
and so this is where the gravity of the

168
00:06:59,270 --> 00:06:56,479
black hole

169
00:07:01,589 --> 00:06:59,280
shows its existence so in panel one on

170
00:07:03,670 --> 00:07:01,599
the left here we have this black hole

171
00:07:04,550 --> 00:07:03,680
that's going to pass between a distant

172
00:07:07,189 --> 00:07:04,560
star

173
00:07:09,189 --> 00:07:07,199
and earth it's not passing through so

174
00:07:10,950 --> 00:07:09,199
the image of the star is its normal

175
00:07:13,830 --> 00:07:10,960
image okay

176
00:07:15,029 --> 00:07:13,840
but as a black hole passes directly

177
00:07:18,150 --> 00:07:15,039
through

178
00:07:19,909 --> 00:07:18,160
the the light from the star gets warped

179
00:07:22,309 --> 00:07:19,919
around the black hole the black hole is

180
00:07:24,950 --> 00:07:22,319
a big enough distortion in space time it

181
00:07:28,230 --> 00:07:24,960
actually warps the light around it and

182
00:07:31,270 --> 00:07:28,240
causes the image of the star to brighten

183
00:07:33,670 --> 00:07:31,280
it focuses extra light rays onto us and

184
00:07:34,790 --> 00:07:33,680
so the the the the

185
00:07:43,589 --> 00:07:34,800
the

186
00:07:46,469 --> 00:07:43,599
star goes back to being normal

187
00:07:47,909 --> 00:07:46,479
so there is this sequence of brightening

188
00:07:50,550 --> 00:07:47,919

and fading

189
00:07:52,550 --> 00:07:50,560
that is characteristic to microlensing

190
00:07:54,790 --> 00:07:52,560
and of course stars variable vary they

191
00:07:56,550 --> 00:07:54,800
go up and down a lot on for other many

192
00:07:58,710 --> 00:07:56,560
other reasons so you got to watch it a

193
00:08:01,110 --> 00:07:58,720
long time to make sure that it does this

194
00:08:03,510 --> 00:08:01,120
pattern and it doesn't repeat it and and

195
00:08:04,950 --> 00:08:03,520
such and we've been doing micro lensing

196
00:08:07,110 --> 00:08:04,960
for many years

197
00:08:10,070 --> 00:08:07,120
and we've seen tens of thousands

198
00:08:12,309 --> 00:08:10,080
somebody said 30 000 events like this

199
00:08:13,510 --> 00:08:12,319
where we've seen microlensing

200
00:08:16,550 --> 00:08:13,520
but

201
00:08:18,230 --> 00:08:16,560
we have never seen one that was a black

202
00:08:19,749 --> 00:08:18,240
hole microlensing

203
00:08:22,390 --> 00:08:19,759
we saw that when things that are other

204
00:08:25,029 --> 00:08:22,400
stars passing through which also create

205
00:08:26,950 --> 00:08:25,039
this can create this microlensing effect

206
00:08:29,350 --> 00:08:26,960
and we know that there are stars because

207
00:08:32,310 --> 00:08:29,360
as it passes through the color of the

208
00:08:34,310 --> 00:08:32,320
background star changes a bit it's added

209
00:08:35,589 --> 00:08:34,320
in the star color of the star in the

210
00:08:38,070 --> 00:08:35,599
foreground

211
00:08:41,589 --> 00:08:38,080
black hole emits no light so there would

212
00:08:42,469 --> 00:08:41,599
be no color change and so we did find

213
00:08:44,470 --> 00:08:42,479

one

214
00:08:49,470 --> 00:08:44,480
in that field that i showed you before

215
00:08:53,750 --> 00:08:52,030
ogle-11-462 or

216
00:08:56,630 --> 00:08:53,760
og-11462

217
00:08:58,230 --> 00:08:56,640
and it's this thing right in here

218
00:08:59,829 --> 00:08:58,240
and let me blow this up so you can see

219
00:09:01,590 --> 00:08:59,839
what's going on here

220
00:09:03,990 --> 00:09:01,600
so what we have here is a lot of

221
00:09:05,750 --> 00:09:04,000
ground-based telescopes doing

222
00:09:08,230 --> 00:09:05,760
doing a lot of searching and when they

223
00:09:10,230 --> 00:09:08,240
find an interesting event then it

224
00:09:12,389 --> 00:09:10,240
triggers hubble to go into action so

225
00:09:15,430 --> 00:09:12,399
hubble in its very first image that we

226
00:09:17,750 --> 00:09:15,440
have here in august of 2011

227
00:09:19,910 --> 00:09:17,760
is actually the the the star here that's

228
00:09:22,630 --> 00:09:19,920
pointed to by the arrow is very bright

229
00:09:25,509 --> 00:09:22,640
this is in its amplified state

230
00:09:29,350 --> 00:09:25,519
um and then you can see in october uh

231
00:09:31,110 --> 00:09:29,360
2011 and september 2012 it has decreased

232
00:09:32,550 --> 00:09:31,120
so we catch sort of the second half of

233
00:09:34,710 --> 00:09:32,560
the light curve the ground based

234
00:09:36,710 --> 00:09:34,720
telescopes catch the first half the

235
00:09:38,949 --> 00:09:36,720
hubble catches the second half and

236
00:09:42,710 --> 00:09:38,959
hubble's continued to watch it for six

237
00:09:44,630 --> 00:09:42,720
years going all the way to august 2017.

238
00:09:46,230 --> 00:09:44,640

and you need to do that in order to

239
00:09:48,630 --> 00:09:46,240
really make sure the light curve is the

240
00:09:51,430 --> 00:09:48,640
way it is and then also that hubble can

241
00:09:53,829 --> 00:09:51,440
verify that this is a black hole lensing

242
00:09:56,070 --> 00:09:53,839
candidate because there is no color

243
00:09:58,070 --> 00:09:56,080
added to the light of the background

244
00:10:01,269 --> 00:09:58,080
star you need to get to when you can see

245
00:10:03,590 --> 00:10:01,279
the background star in its normal state

246
00:10:05,670 --> 00:10:03,600
so the thing that hubble can really do

247
00:10:09,509 --> 00:10:05,680
that no other telescope can do

248
00:10:12,230 --> 00:10:09,519
is measure the precise location of that

249
00:10:13,990 --> 00:10:12,240
star all right and as the black hole

250
00:10:16,630 --> 00:10:14,000
passes in front of it it actually

251
00:10:19,190 --> 00:10:16,640
jitters the star just a tiny bit

252
00:10:20,870 --> 00:10:19,200
right and so that motion of the star

253
00:10:23,829 --> 00:10:20,880
that jittering of the star back and

254
00:10:25,350 --> 00:10:23,839
forth as the black hole passes across is

255
00:10:27,190 --> 00:10:25,360
something that hubble can measure and

256
00:10:29,030 --> 00:10:27,200
when you measure that

257
00:10:31,350 --> 00:10:29,040
you not only can tell hey this is a

258
00:10:33,829 --> 00:10:31,360
black hole event but you can also

259
00:10:36,150 --> 00:10:33,839
measure the black hole parameters and

260
00:10:38,870 --> 00:10:36,160
the group that did this came up with the

261
00:10:41,670 --> 00:10:38,880
the black hole was about seven times the

262
00:10:45,430 --> 00:10:41,680
mass of the sun seven solar masses um

263
00:10:47,509 --> 00:10:45,440

and that it's over 5000 light years away

264
00:10:49,350 --> 00:10:47,519
all right so we're watching

265
00:10:51,910 --> 00:10:49,360
and we're seeing this floating black

266
00:10:54,949 --> 00:10:51,920
hole going across the galaxy

267
00:10:57,030 --> 00:10:54,959
making a random background star brighten

268
00:10:59,269 --> 00:10:57,040
and we'll be able to detect these

269
00:11:01,430 --> 00:10:59,279
free-floating black holes traveling

270
00:11:04,790 --> 00:11:01,440
throughout our galaxy

271
00:11:06,949 --> 00:11:04,800
so you know during the pandemic

272
00:11:09,190 --> 00:11:06,959
where's waldo kind of got a lot more

273
00:11:12,069 --> 00:11:09,200
easier because if they have to social

274
00:11:14,710 --> 00:11:12,079
distance it's pretty easy to find waldo

275
00:11:17,110 --> 00:11:14,720
but it's not so easy for astronomers

276
00:11:19,030 --> 00:11:17,120
even if they were socially distant

277
00:11:20,870 --> 00:11:19,040
because remember astronomers were

278
00:11:25,350 --> 00:11:20,880
playing where's waldo

279
00:11:27,670 --> 00:11:26,630
all right

280
00:11:30,710 --> 00:11:27,680
our

281
00:11:33,910 --> 00:11:30,720
this speaker tonight um is alexandra

282
00:11:35,990 --> 00:11:33,920
lockwood uh from the um

283
00:11:37,430 --> 00:11:36,000
space telescope science institute are

284
00:11:40,069 --> 00:11:37,440
actually she was from the space

285
00:11:43,509 --> 00:11:40,079
telescope science institute but she has

286
00:11:46,310 --> 00:11:43,519
now left us uh she obviously did such a

287
00:11:49,190 --> 00:11:46,320
great job for us that she was stolen by

288
00:11:51,269 --> 00:11:49,200

nasa headquarters she's now working uh

289
00:11:53,910 --> 00:11:51,279
at the actually she told me her first

290
00:11:57,110 --> 00:11:53,920
day today uh down at the science mission

291
00:11:59,670 --> 00:11:57,120
directorate in at nasa hq where she has

292
00:12:01,750 --> 00:11:59,680
the title of strategic content

293
00:12:03,910 --> 00:12:01,760
integrator um and you can ask her what

294
00:12:05,670 --> 00:12:03,920
that means at the end of the talk i'm

295
00:12:08,069 --> 00:12:05,680
not sure she knows just yet she's going

296
00:12:10,629 --> 00:12:08,079
to define her own job

297
00:12:11,509 --> 00:12:10,639
but before she left us

298
00:12:13,750 --> 00:12:11,519
she

299
00:12:15,590 --> 00:12:13,760
was the project scientist for the webb

300
00:12:17,910 --> 00:12:15,600
space telescope outreach here at the

301
00:12:20,069 --> 00:12:17,920
space telescope science institute

302
00:12:21,590 --> 00:12:20,079
she got her bachelor's degree in physics

303
00:12:22,949 --> 00:12:21,600
and astronomy from the university of

304
00:12:25,910 --> 00:12:22,959
maryland

305
00:12:27,670 --> 00:12:25,920
and the masters and phd from cal tech in

306
00:12:29,509 --> 00:12:27,680
planetary sciences

307
00:12:31,910 --> 00:12:29,519
where her research focused on

308
00:12:35,030 --> 00:12:31,920
understanding planetary systems and

309
00:12:38,150 --> 00:12:35,040
characterizing exoplanets

310
00:12:40,389 --> 00:12:38,160
she also before coming to us she worked

311
00:12:41,269 --> 00:12:40,399
on the joint polar satellite system

312
00:12:43,030 --> 00:12:41,279
mission

313
00:12:47,509 --> 00:12:43,040

at the king abdullah university of

314
00:12:49,829 --> 00:12:47,519
science and technology in saudi arabia

315
00:12:51,030 --> 00:12:49,839
she tells us that outside of work she

316
00:12:54,069 --> 00:12:51,040
loves running

317
00:12:56,230 --> 00:12:54,079
yoga and laughing with her kids yes

318
00:12:58,790 --> 00:12:56,240
instead also in doing all this she's

319
00:13:00,629 --> 00:12:58,800
also raising a family so uh doing a

320
00:13:05,110 --> 00:13:00,639
wonderful job at everything ladies and

321
00:13:12,949 --> 00:13:09,269
wow what an introduction thank you frank

322
00:13:15,350 --> 00:13:12,959
uh yes yes i do have two very young kids

323
00:13:18,069 --> 00:13:15,360
at home so i apologize if you hear

324
00:13:18,949 --> 00:13:18,079
screams i promise they're safe

325
00:13:25,670 --> 00:13:18,959
um

326
00:13:28,150 --> 00:13:25,680
very very incredible pleasure to have

327
00:13:31,030 --> 00:13:28,160
worked on web for the past five years

328
00:13:33,990 --> 00:13:31,040
um and uh to really help help the

329
00:13:35,910 --> 00:13:34,000
mission get to where we are today which

330
00:13:38,389 --> 00:13:35,920
i'm sure you all recognize the image

331
00:13:40,949 --> 00:13:38,399
behind me and uh today we'll talk a

332
00:13:43,750 --> 00:13:40,959
little bit more about the the path that

333
00:13:46,230 --> 00:13:43,760
led us here um

334
00:13:47,590 --> 00:13:46,240
and uh and and and where we're going

335
00:13:56,710 --> 00:13:47,600
from here

336
00:14:01,110 --> 00:13:58,150
and

337
00:14:04,550 --> 00:14:01,120
hopefully you are seeing

338
00:14:05,509 --> 00:14:04,560

the right view

339
00:14:11,750 --> 00:14:05,519
um

340
00:14:14,310 --> 00:14:11,760
and i've spent the past five years

341
00:14:16,230 --> 00:14:14,320
working on the web mission um

342
00:14:17,750 --> 00:14:16,240
uh leading its communications and

343
00:14:19,350 --> 00:14:17,760
outreach efforts

344
00:14:21,030 --> 00:14:19,360
um

345
00:14:23,829 --> 00:14:21,040
and so

346
00:14:27,110 --> 00:14:23,839
here we are exactly one

347
00:14:29,430 --> 00:14:27,120
almost exactly one month after uh

348
00:14:33,030 --> 00:14:29,440
we saw the first images from web

349
00:14:34,550 --> 00:14:33,040
and um i am elated to say that it was

350
00:14:36,230 --> 00:14:34,560
worth the wait it was everything we

351
00:14:39,829 --> 00:14:36,240
hoped it would be

352
00:14:42,550 --> 00:14:39,839
um but how did we get here so

353
00:14:45,189 --> 00:14:42,560
uh we'll talk a little bit about

354
00:14:47,670 --> 00:14:45,199
what has happened um in the past six

355
00:14:50,550 --> 00:14:47,680
months since um i actually

356
00:14:52,710 --> 00:14:50,560
gave a talk on web to this same audience

357
00:14:53,910 --> 00:14:52,720
i mean you can see that that talk

358
00:14:55,910 --> 00:14:53,920
um

359
00:14:57,750 --> 00:14:55,920
in the archives if you'd like

360
00:14:59,269 --> 00:14:57,760
um where we talked more about the

361
00:15:01,189 --> 00:14:59,279
previous steps of the mission but let's

362
00:15:04,550 --> 00:15:01,199
talk about what has happened in the past

363
00:15:06,389 --> 00:15:04,560

six months to get us from our launch to

364
00:15:08,550 --> 00:15:06,399
where we are today

365
00:15:10,949 --> 00:15:08,560
um we'll go back and talk about some of

366
00:15:12,470 --> 00:15:10,959
the motivations for the telescope which

367
00:15:14,629 --> 00:15:12,480
includes studying you know the

368
00:15:15,910 --> 00:15:14,639
motivations for studying infrared light

369
00:15:18,790 --> 00:15:15,920
um

370
00:15:21,509 --> 00:15:18,800
what web was anticipated to do and then

371
00:15:22,790 --> 00:15:21,519
we'll look at the very first results

372
00:15:27,110 --> 00:15:22,800
that

373
00:15:30,710 --> 00:15:27,120
is capable of doing what it was designed

374
00:15:33,990 --> 00:15:32,470
so um

375
00:15:36,629 --> 00:15:34,000
i don't know what you all were doing on

376
00:15:40,230 --> 00:15:36,639
christmas morning but uh this was a very

377
00:15:43,509 --> 00:15:40,240
uh exciting christmas for for me um as

378
00:15:46,629 --> 00:15:43,519
we watched the telescope launch on an

379
00:15:47,670 --> 00:15:46,639
rn5 at 7 20 in the morning on christmas

380
00:15:48,629 --> 00:15:47,680
morning

381
00:15:53,350 --> 00:15:48,639
it was

382
00:15:54,790 --> 00:15:53,360
with a 10 billion dollar payload

383
00:15:57,509 --> 00:15:54,800
needless to say we were holding our

384
00:15:59,110 --> 00:15:57,519
breath but it went off seamlessly so

385
00:16:01,590 --> 00:15:59,120
much so that

386
00:16:03,670 --> 00:16:01,600
um a few weeks ago they reported that

387
00:16:04,949 --> 00:16:03,680
officially that there is over 20 years

388
00:16:07,350 --> 00:16:04,959

of a lifetime

389
00:16:09,030 --> 00:16:07,360
um and that that number was very much

390
00:16:12,230 --> 00:16:09,040
dependent on

391
00:16:15,509 --> 00:16:12,240
the um precision of the trajectory uh

392
00:16:17,910 --> 00:16:15,519
both during the launch and in subsequent

393
00:16:19,749 --> 00:16:17,920
maneuvers that the telescope made to get

394
00:16:21,829 --> 00:16:19,759
into its orbit

395
00:16:25,509 --> 00:16:21,839
but the oreon5 rocket provided by the

396
00:16:27,509 --> 00:16:25,519
european space agency that took webb off

397
00:16:29,670 --> 00:16:27,519
performed beautifully

398
00:16:30,870 --> 00:16:29,680
it was a momentous occasion

399
00:16:34,389 --> 00:16:30,880
um

400
00:16:37,910 --> 00:16:34,399
and uh i i think even more iconic was

401
00:16:39,829 --> 00:16:37,920
this beautiful image that was taken as

402
00:16:41,749 --> 00:16:39,839
the spacecraft separated from the

403
00:16:42,629 --> 00:16:41,759
fairing you can see the limb of the

404
00:16:44,150 --> 00:16:42,639
earth

405
00:16:46,710 --> 00:16:44,160
and this was

406
00:16:48,870 --> 00:16:46,720
mere seconds before the solar erase

407
00:16:51,430 --> 00:16:48,880
successfully deployed very quickly and

408
00:16:53,030 --> 00:16:51,440
efficiently uh and we've had you know

409
00:16:53,910 --> 00:16:53,040
successful power

410
00:16:55,509 --> 00:16:53,920
um

411
00:16:57,910 --> 00:16:55,519
ever since

412
00:17:00,069 --> 00:16:57,920
uh this was 27 minutes into flight and

413
00:17:01,189 --> 00:17:00,079

at that moment when the spacecraft

414
00:17:04,470 --> 00:17:01,199
separated

415
00:17:05,429 --> 00:17:04,480
the uh operations of the telescope moved

416
00:17:06,150 --> 00:17:05,439
from

417
00:17:08,949 --> 00:17:06,160
the

418
00:17:10,789 --> 00:17:08,959
launch service provider aryan spas to

419
00:17:13,110 --> 00:17:10,799
the space telescope science institute

420
00:17:14,789 --> 00:17:13,120
where the mission operations center is

421
00:17:16,870 --> 00:17:14,799
so that was a big moment

422
00:17:20,230 --> 00:17:16,880
and um the space telescope science

423
00:17:22,069 --> 00:17:20,240
institute has been operating web ever

424
00:17:24,549 --> 00:17:22,079
since both in mission and in science

425
00:17:25,669 --> 00:17:24,559
operations

426
00:17:27,990 --> 00:17:25,679
um

427
00:17:29,350 --> 00:17:28,000
shortly thereafter this beautiful launch

428
00:17:34,150 --> 00:17:29,360
came a

429
00:17:35,669 --> 00:17:34,160
very harrowing few weeks of unfolding

430
00:17:38,070 --> 00:17:35,679
in order to

431
00:17:40,390 --> 00:17:38,080
get this behemoth of an observatory and

432
00:17:43,270 --> 00:17:40,400
we'll talk about why it has to be such a

433
00:17:45,270 --> 00:17:43,280
behemoth into space even on the largest

434
00:17:47,909 --> 00:17:45,280
rocket available internationally which

435
00:17:50,150 --> 00:17:47,919
was the ren5 at the time

436
00:17:52,150 --> 00:17:50,160
we had to fold it up and that meant we

437
00:17:54,230 --> 00:17:52,160
had to unfold it in space

438
00:17:56,470 --> 00:17:54,240

um with both the option of doing it

439
00:17:57,590 --> 00:17:56,480
manually and doing it automatically um

440
00:18:00,789 --> 00:17:57,600
but from

441
00:18:03,029 --> 00:18:00,799
hundreds of thousands of miles away um

442
00:18:04,230 --> 00:18:03,039
and

443
00:18:06,470 --> 00:18:04,240
this

444
00:18:08,070 --> 00:18:06,480
so many pieces of these what we call

445
00:18:10,310 --> 00:18:08,080
deployment sequence

446
00:18:12,710 --> 00:18:10,320
had never been done before yes we've put

447
00:18:16,549 --> 00:18:12,720
a telescope in space and and satellites

448
00:18:18,150 --> 00:18:16,559
in space yes we've had communication and

449
00:18:20,390 --> 00:18:18,160
communication antenna

450
00:18:22,789 --> 00:18:20,400
and solar arrays deployed before

451
00:18:26,310 --> 00:18:22,799
successfully many times but everything

452
00:18:27,270 --> 00:18:26,320
else almost was a first time

453
00:18:28,630 --> 00:18:27,280
and

454
00:18:30,150 --> 00:18:28,640
within the first

455
00:18:32,150 --> 00:18:30,160
two and a half weeks

456
00:18:34,070 --> 00:18:32,160
after webb was launched it was

457
00:18:36,310 --> 00:18:34,080
beautifully deployed in space following

458
00:18:37,510 --> 00:18:36,320
this sequence where the sun shield

459
00:18:39,669 --> 00:18:37,520
opened

460
00:18:41,350 --> 00:18:39,679
making sure to always protect the mirror

461
00:18:42,950 --> 00:18:41,360
from the heat of the sun the earth and

462
00:18:45,270 --> 00:18:42,960
the moon

463
00:18:47,270 --> 00:18:45,280

the sun shield fully tensioned

464
00:18:49,029 --> 00:18:47,280
the secondary mirror which is a huge

465
00:18:50,549 --> 00:18:49,039
single point of failure

466
00:18:52,150 --> 00:18:50,559
deployed

467
00:18:54,070 --> 00:18:52,160
to its position

468
00:18:59,430 --> 00:18:54,080
and the full expanse of the primary

469
00:19:04,070 --> 00:19:01,830
i'll tell you that this is literally the

470
00:19:06,710 --> 00:19:04,080
size of a house

471
00:19:09,110 --> 00:19:06,720
on a tennis court

472
00:19:10,789 --> 00:19:09,120
and we

473
00:19:13,750 --> 00:19:10,799
unfolded it

474
00:19:15,110 --> 00:19:13,760
from hundreds of thousands of miles away

475
00:19:17,029 --> 00:19:15,120
um

476
00:19:19,510 --> 00:19:17,039
to say it is a feat of engineering is an

477
00:19:22,870 --> 00:19:19,520
understatement

478
00:19:24,549 --> 00:19:22,880
this telescope is motivated by its giant

479
00:19:27,590 --> 00:19:24,559
mirror

480
00:19:28,390 --> 00:19:27,600
and the science requirements therein

481
00:19:30,230 --> 00:19:28,400
or

482
00:19:32,630 --> 00:19:30,240
i would say the science desires the

483
00:19:33,510 --> 00:19:32,640
science requirements um

484
00:19:36,150 --> 00:19:33,520
but

485
00:19:38,150 --> 00:19:36,160
in order to protect this giant

486
00:19:39,430 --> 00:19:38,160
mirror this giant hexagonal gold mirror

487
00:19:42,950 --> 00:19:39,440
from the sun

488
00:19:44,470 --> 00:19:42,960

there is a 70-foot sun shield made of

489
00:19:46,950 --> 00:19:44,480
hair thin

490
00:19:48,070 --> 00:19:46,960
layers of material that was uniquely

491
00:19:50,870 --> 00:19:48,080
designed

492
00:19:52,789 --> 00:19:50,880
to create 600 degrees of temperature

493
00:19:55,909 --> 00:19:52,799
differential between the two sides of

494
00:19:56,870 --> 00:19:55,919
the telescope but also be extremely lit

495
00:19:58,230 --> 00:19:56,880
thin

496
00:20:01,830 --> 00:19:58,240
lightweight

497
00:20:06,149 --> 00:20:03,510
all of this

498
00:20:08,230 --> 00:20:06,159
there's so many new technologies here

499
00:20:09,110 --> 00:20:08,240
created to enable web

500
00:20:11,350 --> 00:20:09,120
and

501
00:20:13,350 --> 00:20:11,360
not only did they work but they have

502
00:20:16,310 --> 00:20:13,360
subsequently been used in a lot of other

503
00:20:18,149 --> 00:20:16,320
applications including not you know not

504
00:20:20,070 --> 00:20:18,159
just other astronomy applications which

505
00:20:21,909 --> 00:20:20,080
which the infrared detectors were

506
00:20:24,470 --> 00:20:21,919
elevated um

507
00:20:26,310 --> 00:20:24,480
upgraded and have been used subsequently

508
00:20:29,270 --> 00:20:26,320
but also things like

509
00:20:34,549 --> 00:20:31,510
procedures and

510
00:20:36,630 --> 00:20:34,559
mammograms so

511
00:20:38,310 --> 00:20:36,640
you know it this this engineering these

512
00:20:40,630 --> 00:20:38,320
engineering feats that have accomplished

513
00:20:42,789 --> 00:20:40,640

just amazing science have also gone on

514
00:20:45,029 --> 00:20:42,799
and infiltrated other

515
00:20:49,669 --> 00:20:45,039
places in our society um as

516
00:20:53,590 --> 00:20:51,669
none of this would be possible

517
00:20:55,430 --> 00:20:53,600
if it weren't for an international

518
00:20:58,549 --> 00:20:55,440
collaboration

519
00:21:01,750 --> 00:20:58,559
nasa has recognized that

520
00:21:04,870 --> 00:21:01,760
it takes a village and specifically

521
00:21:06,630 --> 00:21:04,880
the ren5 rocket was the only rocket at

522
00:21:08,230 --> 00:21:06,640
the time that had a fairing size large

523
00:21:09,990 --> 00:21:08,240
enough to hold webb

524
00:21:11,350 --> 00:21:10,000
and so the european space agency

525
00:21:12,870 --> 00:21:11,360
contributed

526
00:21:15,909 --> 00:21:12,880
the rocket

527
00:21:17,029 --> 00:21:15,919
um arianespas the launch provider as

528
00:21:18,549 --> 00:21:17,039
well as

529
00:21:20,549 --> 00:21:18,559
one and a half of the scientific

530
00:21:23,190 --> 00:21:20,559
instruments uh the mid-infrared

531
00:21:25,590 --> 00:21:23,200
instrument and the near-spec instrument

532
00:21:28,310 --> 00:21:25,600
the canadian space agency provided the

533
00:21:32,149 --> 00:21:28,320
function the guiding functionality

534
00:21:34,549 --> 00:21:32,159
uh the uh fine guidance sensor

535
00:21:37,190 --> 00:21:34,559
and the nearest instrument which those

536
00:21:40,710 --> 00:21:37,200
two pieces are packaged together

537
00:21:42,710 --> 00:21:40,720
um so this is a collaboration from

538
00:21:44,549 --> 00:21:42,720

nasa the european space agency and the

539
00:21:46,710 --> 00:21:44,559
canadian space agency

540
00:21:48,149 --> 00:21:46,720
including 14 countries that helps to

541
00:21:49,270 --> 00:21:48,159
build and develop

542
00:21:50,549 --> 00:21:49,280
this

543
00:21:52,630 --> 00:21:50,559
telescope

544
00:21:54,630 --> 00:21:52,640
and now that we have

545
00:21:57,110 --> 00:21:54,640
uh scheduled the first year of science

546
00:21:59,350 --> 00:21:57,120
on the telescope this is actually a map

547
00:22:01,750 --> 00:21:59,360
showing countries that have been

548
00:22:03,029 --> 00:22:01,760
successfully awarded science time in the

549
00:22:06,070 --> 00:22:03,039
first year of

550
00:22:07,590 --> 00:22:06,080
observations so you can see that um well

551
00:22:09,190 --> 00:22:07,600
i don't know if you can tell immediately

552
00:22:11,110 --> 00:22:09,200
off this map but there's over 40

553
00:22:13,270 --> 00:22:11,120
countries um

554
00:22:15,430 --> 00:22:13,280
from which scientists will be using web

555
00:22:17,110 --> 00:22:15,440
data just in the first year and that

556
00:22:19,110 --> 00:22:17,120
doesn't count all of the

557
00:22:21,190 --> 00:22:19,120
that's only given proposals there will

558
00:22:24,070 --> 00:22:21,200
be many other people who take the data

559
00:22:29,270 --> 00:22:24,080
as it's available online and use it to

560
00:22:33,750 --> 00:22:31,270
to talk a little bit more about the the

561
00:22:36,230 --> 00:22:33,760
parts of the observatory um

562
00:22:39,350 --> 00:22:36,240
the the main part as i mentioned is the

563
00:22:42,870 --> 00:22:39,360

giant mirror and protected by a five

564
00:22:45,110 --> 00:22:42,880
layer sunshield made of super thin

565
00:22:46,789 --> 00:22:45,120
and and very uh thermally insulated

566
00:22:49,270 --> 00:22:46,799
kapton material

567
00:22:51,110 --> 00:22:49,280
the science instruments are on the back

568
00:22:53,590 --> 00:22:51,120
side of the

569
00:22:56,470 --> 00:22:53,600
telescope of the of the mirrors

570
00:22:58,789 --> 00:22:56,480
and a secondary mirror helps collect and

571
00:23:00,950 --> 00:22:58,799
focus the light from the primary mirror

572
00:23:02,870 --> 00:23:00,960
sends it back behind the primary mirror

573
00:23:04,070 --> 00:23:02,880
to the secondary to the science

574
00:23:06,070 --> 00:23:04,080
instruments

575
00:23:08,710 --> 00:23:06,080
um on the sun-facing side of the

576
00:23:10,710 --> 00:23:08,720
observatory you have the solar panels

577
00:23:12,390 --> 00:23:10,720
communication antenna which

578
00:23:16,230 --> 00:23:12,400
in addition to being solar facing is

579
00:23:17,990 --> 00:23:16,240
also earth-facing at all times um and

580
00:23:20,230 --> 00:23:18,000
that's how we get our communications um

581
00:23:22,549 --> 00:23:20,240
both uploading and downloading

582
00:23:25,350 --> 00:23:22,559
um and as well as steering and control

583
00:23:27,750 --> 00:23:25,360
and star trackers

584
00:23:31,110 --> 00:23:27,760
the key to web really is its giant

585
00:23:32,630 --> 00:23:31,120
mirror it is over six times the area of

586
00:23:33,080 --> 00:23:32,640
hubble's mirror

587
00:23:34,230 --> 00:23:33,090
um

588
00:23:37,270 --> 00:23:34,240

[Music]

589
00:23:38,789 --> 00:23:37,280
this is primarily due to the fact that

590
00:23:40,950 --> 00:23:38,799
we are working at infrared wavelengths

591
00:23:43,750 --> 00:23:40,960
which we'll talk a little bit more about

592
00:23:45,990 --> 00:23:43,760
and in order to get the same clarity of

593
00:23:48,549 --> 00:23:46,000
images which as you can see from my

594
00:23:50,470 --> 00:23:48,559
background and if you've seen the images

595
00:23:52,549 --> 00:23:50,480
we do have the same clarity these images

596
00:23:54,470 --> 00:23:52,559
are absolutely stunning

597
00:23:56,549 --> 00:23:54,480
but for longer wavelengths you need a

598
00:23:58,390 --> 00:23:56,559
larger mirror to get that same beautiful

599
00:23:59,990 --> 00:23:58,400
clarity

600
00:24:02,230 --> 00:24:00,000
additionally

601
00:24:04,230 --> 00:24:02,240
if we want to see very faint things even

602
00:24:05,830 --> 00:24:04,240
with the use of gravitational lensing as

603
00:24:09,269 --> 00:24:05,840
franken mentioned

604
00:24:11,990 --> 00:24:09,279
we need a bigger photon collector

605
00:24:14,630 --> 00:24:12,000
a bigger bucket to collect our light and

606
00:24:16,549 --> 00:24:14,640
so we needed a bigger mirror

607
00:24:18,549 --> 00:24:16,559
such a bigger mirror though

608
00:24:21,669 --> 00:24:18,559
necessitated all of these technological

609
00:24:23,990 --> 00:24:21,679
advancements and incredible technology

610
00:24:27,350 --> 00:24:24,000
and development and engineering to get

611
00:24:29,510 --> 00:24:27,360
it into space as we've discussed

612
00:24:31,510 --> 00:24:29,520
also webmer is gold

613
00:24:33,430 --> 00:24:31,520

it's only about a golf sized golf ball

614
00:24:35,269 --> 00:24:33,440
size worth of gold

615
00:24:37,430 --> 00:24:35,279
only only about a ma the mass of a golf

616
00:24:39,750 --> 00:24:37,440
ball size of a golf ball spread over

617
00:24:41,750 --> 00:24:39,760
these 18 mirrors this this this 20 foot

618
00:24:44,070 --> 00:24:41,760
diameter mirror

619
00:24:45,590 --> 00:24:44,080
very thin layer but that's because gold

620
00:24:47,190 --> 00:24:45,600
is the most reflective at infrared

621
00:24:49,110 --> 00:24:47,200
wavelengths

622
00:24:50,870 --> 00:24:49,120
hubble is a silver mirror

623
00:24:52,950 --> 00:24:50,880
the mirror in your bathroom is probably

624
00:24:54,549 --> 00:24:52,960
also a silver mirror that's because

625
00:24:56,149 --> 00:24:54,559
that's the most one of the most

626
00:24:58,149 --> 00:24:56,159
reflective surfaces at visible

627
00:25:00,310 --> 00:24:58,159
wavelengths that our eyes see

628
00:25:03,190 --> 00:25:00,320
so web is gold because it's an infrared

629
00:25:08,310 --> 00:25:05,110
there are four science instruments on

630
00:25:11,350 --> 00:25:08,320
the back of the telescope uh near spec

631
00:25:13,909 --> 00:25:11,360
near cam nearest and miri

632
00:25:15,990 --> 00:25:13,919
the ones that start with nir are for

633
00:25:18,630 --> 00:25:16,000
near infrared

634
00:25:21,110 --> 00:25:18,640
and the one that starts with mir is a

635
00:25:24,710 --> 00:25:21,120
mid infrared instrument

636
00:25:26,710 --> 00:25:24,720
they all have unique specialties um but

637
00:25:28,390 --> 00:25:26,720
they are they are all

638
00:25:30,630 --> 00:25:28,400

kind of

639
00:25:31,510 --> 00:25:30,640
multifunctional instruments so each one

640
00:25:33,830 --> 00:25:31,520
of them

641
00:25:35,750 --> 00:25:33,840
has an imaging and a spectroscopic

642
00:25:38,789 --> 00:25:35,760
capability

643
00:25:41,590 --> 00:25:38,799
all very powerful and offering unique

644
00:25:46,789 --> 00:25:41,600
specialties for the variety of science

645
00:25:52,149 --> 00:25:48,070
and

646
00:25:55,110 --> 00:25:52,159
science to happen

647
00:25:57,269 --> 00:25:55,120
is happening a million miles away webb

648
00:25:58,789 --> 00:25:57,279
was put into an orbit much much much

649
00:26:00,549 --> 00:25:58,799
different from hubble's

650
00:26:04,549 --> 00:26:00,559
uh hubble's in near earth

651
00:26:05,750 --> 00:26:04,559
near earth orbit a low earth orbit

652
00:26:07,430 --> 00:26:05,760
which

653
00:26:09,110 --> 00:26:07,440
provides its own opportunities and

654
00:26:11,350 --> 00:26:09,120
challenges

655
00:26:12,950 --> 00:26:11,360
but web was specifically put at a

656
00:26:16,070 --> 00:26:12,960
location we call the second lagrange

657
00:26:19,269 --> 00:26:16,080
point it is semi-stable gravitational

658
00:26:20,070 --> 00:26:19,279
uh location orbital location

659
00:26:23,990 --> 00:26:20,080
that

660
00:26:25,430 --> 00:26:24,000
simultaneously allows the telescope to

661
00:26:27,750 --> 00:26:25,440
always

662
00:26:30,070 --> 00:26:27,760
face away from the sun the earth and the

663
00:26:32,789 --> 00:26:30,080

moon which are three sources of infrared

664
00:26:35,669 --> 00:26:32,799
heat that could confuse it

665
00:26:36,870 --> 00:26:35,679
and also simultaneously always face the

666
00:26:38,710 --> 00:26:36,880
earth

667
00:26:41,909 --> 00:26:38,720
on the sun-facing side so that we always

668
00:26:43,510 --> 00:26:41,919
have communications

669
00:26:46,230 --> 00:26:43,520
additionally as i mentioned it is a

670
00:26:48,310 --> 00:26:46,240
semi-stable orbital location

671
00:26:50,950 --> 00:26:48,320
so it doesn't require a lot of fuel to

672
00:26:53,430 --> 00:26:50,960
stay there and as i mentioned earlier

673
00:26:55,990 --> 00:26:53,440
thanks to the excellent introductory

674
00:26:57,990 --> 00:26:56,000
given to us by the ren5 rocket

675
00:26:59,669 --> 00:26:58,000
and the engineers and the maneuvers that

676
00:27:01,830 --> 00:26:59,679
they did

677
00:27:03,110 --> 00:27:01,840
in in the subsequent weeks after webb's

678
00:27:06,149 --> 00:27:03,120
launch

679
00:27:10,310 --> 00:27:06,159
we have enough fuel to maintain an orbit

680
00:27:14,470 --> 00:27:12,390
and given that orbital location and

681
00:27:16,789 --> 00:27:14,480
always being able to talk to earth we

682
00:27:19,750 --> 00:27:16,799
take advantage of the deep space network

683
00:27:23,350 --> 00:27:19,760
with locations in goldstone california

684
00:27:26,310 --> 00:27:23,360
madrid spain and canberra australia

685
00:27:29,190 --> 00:27:26,320
to have daily communications both

686
00:27:31,590 --> 00:27:29,200
sending commands and downloading data

687
00:27:33,430 --> 00:27:31,600
to the telescope

688
00:27:34,710 --> 00:27:33,440

every day of the year

689
00:27:37,350 --> 00:27:34,720
and we

690
00:27:38,710 --> 00:27:37,360
technically at any given time have the

691
00:27:42,549 --> 00:27:38,720
opportunity to communicate with the

692
00:27:45,590 --> 00:27:43,990
and as i mentioned

693
00:27:47,430 --> 00:27:45,600
the telescope

694
00:27:49,190 --> 00:27:47,440
mission operations center web's mission

695
00:27:51,590 --> 00:27:49,200
operations center is located in

696
00:27:55,269 --> 00:27:51,600
baltimore maryland which doesn't often

697
00:27:56,549 --> 00:27:55,279
get the best rep but um shirley is a

698
00:27:58,630 --> 00:27:56,559
very

699
00:27:59,909 --> 00:27:58,640
influential city in that it operates

700
00:28:01,510 --> 00:27:59,919
both the hubble and the web space

701
00:28:03,350 --> 00:28:01,520
telescopes

702
00:28:06,070 --> 00:28:03,360
and the mission operations for the

703
00:28:07,750 --> 00:28:06,080
telescope uh is located in baltimore

704
00:28:10,149 --> 00:28:07,760
this is an image of the mission

705
00:28:12,789 --> 00:28:10,159
operations center on the right hand side

706
00:28:13,669 --> 00:28:12,799
with a very cool web uh

707
00:28:15,750 --> 00:28:13,679
uh

708
00:28:18,630 --> 00:28:15,760
astronomy mask is the mission operations

709
00:28:20,470 --> 00:28:18,640
manager carl starr who led us through

710
00:28:23,269 --> 00:28:20,480
this very intense six months

711
00:28:25,269 --> 00:28:23,279
commissioning period

712
00:28:26,549 --> 00:28:25,279
um

713
00:28:28,870 --> 00:28:26,559

all of it went

714
00:28:30,710 --> 00:28:28,880
swimmingly and we are here where we are

715
00:28:32,310 --> 00:28:30,720
today so let's talk more about the

716
00:28:34,389 --> 00:28:32,320
science

717
00:28:36,710 --> 00:28:34,399
um

718
00:28:39,590 --> 00:28:36,720
web is a giant infrared telescope and

719
00:28:41,669 --> 00:28:39,600
one could ask why do infrared instead of

720
00:28:43,750 --> 00:28:41,679
for example visible what we can

721
00:28:45,430 --> 00:28:43,760
appreciate with our eyes what hubble has

722
00:28:48,549 --> 00:28:45,440
shown us is a beautiful view of the

723
00:28:52,789 --> 00:28:50,630
well

724
00:28:56,549 --> 00:28:52,799
infrared is

725
00:28:59,110 --> 00:28:56,559
very complementary to visible

726
00:29:01,110 --> 00:28:59,120
for example you can see here

727
00:29:03,830 --> 00:29:01,120
views of two different kinds of animals

728
00:29:05,750 --> 00:29:03,840
meerkats and crocodiles on the left are

729
00:29:07,750 --> 00:29:05,760
visible images and on the right are

730
00:29:10,470 --> 00:29:07,760
infrared images

731
00:29:12,710 --> 00:29:10,480
very complementary but quite different

732
00:29:14,549 --> 00:29:12,720
the features that you can see what

733
00:29:16,630 --> 00:29:14,559
stands out

734
00:29:17,830 --> 00:29:16,640
and these images really

735
00:29:19,590 --> 00:29:17,840
show you

736
00:29:21,830 --> 00:29:19,600
the sort of number one feature of

737
00:29:24,870 --> 00:29:21,840
infrared light

738
00:29:26,470 --> 00:29:24,880

to us which is that it's heat

739
00:29:27,430 --> 00:29:26,480
the meerkats which are warm blooded

740
00:29:29,830 --> 00:29:27,440
animals

741
00:29:32,470 --> 00:29:29,840
glow bright and infrared light you can

742
00:29:33,990 --> 00:29:32,480
see their eye sockets you can see their

743
00:29:36,630 --> 00:29:34,000
warm bellies

744
00:29:38,149 --> 00:29:36,640
very bright in infrared light and the

745
00:29:40,789 --> 00:29:38,159
cold-blooded

746
00:29:42,470 --> 00:29:40,799
freshwater crocodile

747
00:29:45,669 --> 00:29:42,480
is quite dull

748
00:29:47,750 --> 00:29:45,679
so first and foremost

749
00:29:49,110 --> 00:29:47,760
infrared light is heat

750
00:29:50,710 --> 00:29:49,120
and

751
00:29:54,230 --> 00:29:50,720
whether it's the sun

752
00:29:56,789 --> 00:29:54,240
or stars or planets or even interstellar

753
00:30:03,430 --> 00:29:58,070
all of these things give off heat

754
00:30:08,710 --> 00:30:06,230
infrared light is longer wavelengths

755
00:30:10,149 --> 00:30:08,720
than visible light which also makes it a

756
00:30:11,350 --> 00:30:10,159
very crucial thing which we'll talk

757
00:30:13,269 --> 00:30:11,360
about

758
00:30:17,110 --> 00:30:13,279
um and

759
00:30:19,909 --> 00:30:17,120
webb was specifically chosen to study

760
00:30:22,630 --> 00:30:19,919
near and mid infrared wavelengths

761
00:30:25,590 --> 00:30:22,640
um we talked about the four instruments

762
00:30:26,950 --> 00:30:25,600
three of them start with nir for near

763
00:30:28,710 --> 00:30:26,960

and one of them is a mid-infrared

764
00:30:30,870 --> 00:30:28,720
instrument

765
00:30:32,389 --> 00:30:30,880
um but it was specifically chosen to

766
00:30:35,190 --> 00:30:32,399
study those wavelengths for the

767
00:30:36,789 --> 00:30:35,200
capabilities the astronomical insight

768
00:30:39,669 --> 00:30:36,799
that they provide

769
00:30:41,510 --> 00:30:39,679
and it happens to also overlap with a

770
00:30:42,789 --> 00:30:41,520
little bit with what the hubble space

771
00:30:44,389 --> 00:30:42,799
telescope

772
00:30:46,870 --> 00:30:44,399
has in terms of capabilities and what

773
00:30:48,630 --> 00:30:46,880
the spitzer space telescope had in terms

774
00:30:51,029 --> 00:30:48,640
of capabilities

775
00:30:53,029 --> 00:30:51,039
and so this both validates

776
00:30:55,029 --> 00:30:53,039
the results that web will get you know

777
00:30:56,710 --> 00:30:55,039
it's it's a good cross check but it also

778
00:30:59,669 --> 00:30:56,720
means that we can expand

779
00:31:01,750 --> 00:30:59,679
upon the findings of hubble and spitzer

780
00:31:03,590 --> 00:31:01,760
um spitzer is no longer operational but

781
00:31:06,230 --> 00:31:03,600
it did incredible things to pave the way

782
00:31:08,070 --> 00:31:06,240
for webb especially in exoplanets

783
00:31:10,230 --> 00:31:08,080
and

784
00:31:15,430 --> 00:31:10,240
hubble is still operational but doesn't

785
00:31:20,630 --> 00:31:17,269
as much as it used to

786
00:31:23,430 --> 00:31:20,640
and is very complementary to web in that

787
00:31:24,549 --> 00:31:23,440
web has better clarity at near-infrared

788
00:31:25,509 --> 00:31:24,559

wavelengths

789
00:31:28,310 --> 00:31:25,519
and

790
00:31:29,509 --> 00:31:28,320
can just provide more

791
00:31:31,350 --> 00:31:29,519
details

792
00:31:35,430 --> 00:31:31,360
further further along the spectrum

793
00:31:38,789 --> 00:31:37,110
so with infrared wavelengths talking

794
00:31:41,430 --> 00:31:38,799
about the near and mid infrared

795
00:31:42,950 --> 00:31:41,440
wavelengths

796
00:31:44,789 --> 00:31:42,960
there

797
00:31:46,549 --> 00:31:44,799
they are both

798
00:31:51,190 --> 00:31:46,559
complementary to visible wavelengths but

799
00:31:55,750 --> 00:31:53,509
shown here you can see

800
00:31:59,269 --> 00:31:55,760
a visible light image

801
00:32:00,470 --> 00:31:59,279
where you have hot clouds of gas

802
00:32:03,669 --> 00:32:00,480
coming through

803
00:32:06,870 --> 00:32:03,679
emanating invisible light very beautiful

804
00:32:07,750 --> 00:32:06,880
but you can also see these dark veins of

805
00:32:08,710 --> 00:32:07,760
dust

806
00:32:14,470 --> 00:32:08,720
that

807
00:32:16,230 --> 00:32:14,480
block a lot of the gas and the light

808
00:32:18,950 --> 00:32:16,240
at near infrared wavelengths you can

809
00:32:23,909 --> 00:32:18,960
start to see through that dust

810
00:32:26,149 --> 00:32:23,919
it is literally like seeing through fog

811
00:32:27,990 --> 00:32:26,159
and when you see through

812
00:32:32,230 --> 00:32:28,000
dust

813
00:32:34,310 --> 00:32:32,240

stars

814
00:32:36,149 --> 00:32:34,320
so near infrared wavelengths allow us to

815
00:32:38,389 --> 00:32:36,159
peer through dust

816
00:32:41,110 --> 00:32:38,399
start to see things we haven't seen and

817
00:32:42,870 --> 00:32:41,120
a lot of times those are stars and young

818
00:32:45,269 --> 00:32:42,880
stars that are forming within those

819
00:32:47,509 --> 00:32:45,279
clouds of dust

820
00:32:49,830 --> 00:32:47,519
now mid infrared wavelengths

821
00:32:51,669 --> 00:32:49,840
are quite different as you can see and

822
00:32:52,870 --> 00:32:51,679
that's where you're actually studying

823
00:32:54,870 --> 00:32:52,880
the dust

824
00:32:56,470 --> 00:32:54,880
so visible wavelengths you're studying a

825
00:32:58,549 --> 00:32:56,480
lot of

826
00:33:01,509 --> 00:32:58,559
hot gas

827
00:33:03,990 --> 00:33:01,519
and you see the dust but it's it's you

828
00:33:05,590 --> 00:33:04,000
know it's it's blocking your knowledge

829
00:33:07,350 --> 00:33:05,600
at near infrared wavelengths we start to

830
00:33:09,110 --> 00:33:07,360
see through the dust and what's behind

831
00:33:12,149 --> 00:33:09,120
there to get a picture and then at

832
00:33:14,470 --> 00:33:12,159
mid-infrared wavelengths the dust itself

833
00:33:16,630 --> 00:33:14,480
the warmth of the dust

834
00:33:18,070 --> 00:33:16,640
actually starts to shine brightly and we

835
00:33:20,149 --> 00:33:18,080
can understand things like the

836
00:33:22,950 --> 00:33:20,159
temperature and physical structure and

837
00:33:24,710 --> 00:33:22,960
composition of the dust itself

838
00:33:26,149 --> 00:33:24,720

so all of this is quite complimentary

839
00:33:27,909 --> 00:33:26,159
when you're talking about an environment

840
00:33:29,509 --> 00:33:27,919
that has dust and gas

841
00:33:30,389 --> 00:33:29,519
and you want to study the dust and the

842
00:33:32,630 --> 00:33:30,399
gas

843
00:33:35,830 --> 00:33:32,640
and where they are and

844
00:33:38,470 --> 00:33:35,840
you know co-spatially located

845
00:33:40,310 --> 00:33:38,480
so webb does it all

846
00:33:42,389 --> 00:33:40,320
um and

847
00:33:45,190 --> 00:33:42,399
additionally maybe more importantly but

848
00:33:48,549 --> 00:33:45,200
i i wouldn't uh order the importance of

849
00:33:50,630 --> 00:33:48,559
the science that web can do

850
00:33:52,310 --> 00:33:50,640
is looking at

851
00:33:55,669 --> 00:33:52,320
the ancient universe the beginning of

852
00:33:58,230 --> 00:33:55,679
the universe webb's first

853
00:34:01,750 --> 00:34:00,549
motivation was to study the earliest

854
00:34:04,389 --> 00:34:01,760
galaxies

855
00:34:07,269 --> 00:34:04,399
and this is possible because the

856
00:34:09,669 --> 00:34:07,279
earliest galaxies very very very far

857
00:34:13,430 --> 00:34:12,069
their light has been traveling for so

858
00:34:15,829 --> 00:34:13,440
long

859
00:34:18,550 --> 00:34:15,839
that as the universe expands

860
00:34:19,510 --> 00:34:18,560
the wavelength of light has expanded

861
00:34:21,990 --> 00:34:19,520
and as we were looking at the

862
00:34:24,629 --> 00:34:22,000
electromagnetic spectrum earlier

863
00:34:26,950 --> 00:34:24,639

red light or even blue light from

864
00:34:29,109 --> 00:34:26,960
distant galaxies

865
00:34:31,190 --> 00:34:29,119
as the universe has expanded

866
00:34:33,190 --> 00:34:31,200
the light itself has expanded and it's

867
00:34:34,869 --> 00:34:33,200
expanded all the way to infrared

868
00:34:36,629 --> 00:34:34,879
wavelengths

869
00:34:40,470 --> 00:34:36,639
so webb

870
00:34:42,389 --> 00:34:40,480
is uniquely positioned to study light

871
00:34:43,909 --> 00:34:42,399
that has traveled from the beginning of

872
00:34:47,109 --> 00:34:43,919
the universe

873
00:34:49,669 --> 00:34:47,119
across the distance and time

874
00:34:52,069 --> 00:34:49,679
of the expansion of the universe

875
00:34:55,190 --> 00:34:52,079
webb is the only observatory that can

876
00:34:57,670 --> 00:34:55,200
see these objects because their light is

877
00:35:01,190 --> 00:34:57,680
at infrared wavelengths

878
00:35:02,870 --> 00:35:01,200
and being so far away being so distant

879
00:35:04,870 --> 00:35:02,880
they're very faint

880
00:35:06,470 --> 00:35:04,880
it's another reason web is so big is

881
00:35:09,910 --> 00:35:06,480
because that big

882
00:35:12,150 --> 00:35:09,920
light collecting bucket of a mirror

883
00:35:17,349 --> 00:35:12,160
is the only thing that's able to capture

884
00:35:23,270 --> 00:35:18,870
so that's another benefit of infrared

885
00:35:26,230 --> 00:35:24,790
the other

886
00:35:28,390 --> 00:35:26,240
very cool piece about infrared

887
00:35:30,870 --> 00:35:28,400
wavelengths is that

888
00:35:33,349 --> 00:35:30,880

it just happens to tune in on some

889
00:35:35,589 --> 00:35:33,359
really interesting and incredible

890
00:35:37,030 --> 00:35:35,599
molecular information

891
00:35:39,990 --> 00:35:37,040
so we'll talk a little bit more about

892
00:35:40,950 --> 00:35:40,000
that but just an example right here

893
00:35:43,270 --> 00:35:40,960
is

894
00:35:46,470 --> 00:35:43,280
uh atomic

895
00:35:51,589 --> 00:35:49,829
detections of oxygen hydrogen

896
00:35:53,589 --> 00:35:51,599
nitrogen and sulfur

897
00:35:54,710 --> 00:35:53,599
um

898
00:35:58,069 --> 00:35:54,720
that

899
00:35:59,670 --> 00:35:58,079
we get at infrared wavelengths and some

900
00:36:01,990 --> 00:35:59,680
that are

901
00:36:03,670 --> 00:36:02,000
redshifted

902
00:36:05,829 --> 00:36:03,680
into infrared wavelengths that were

903
00:36:10,630 --> 00:36:05,839
previously invisible wavelengths which

904
00:36:16,150 --> 00:36:13,349
so

905
00:36:17,349 --> 00:36:16,160
let's talk about

906
00:36:18,790 --> 00:36:17,359
what webb

907
00:36:21,990 --> 00:36:18,800
has been

908
00:36:24,630 --> 00:36:23,589
as i mentioned

909
00:36:26,790 --> 00:36:24,640
webb

910
00:36:29,270 --> 00:36:26,800
is uniquely tuned to see the first

911
00:36:32,390 --> 00:36:29,280
galaxies in the universe

912
00:36:35,670 --> 00:36:32,400
this is an image of one of the candles

913
00:36:36,550 --> 00:36:35,680

fields of one of the the

914
00:36:40,630 --> 00:36:36,560
hubble

915
00:36:43,589 --> 00:36:42,230
this image

916
00:36:45,589 --> 00:36:43,599
up until

917
00:36:52,069 --> 00:36:45,599
a week ago

918
00:37:07,190 --> 00:36:53,430
i

919
00:37:11,910 --> 00:37:07,200
galaxy

920
00:37:14,950 --> 00:37:12,950
but

921
00:37:16,950 --> 00:37:14,960
this is a galaxy that was detected by

922
00:37:18,790 --> 00:37:16,960
hubble from about 400 million years

923
00:37:23,910 --> 00:37:18,800
after the big bang

924
00:37:27,589 --> 00:37:26,230
in order to see galaxies that are

925
00:37:29,430 --> 00:37:27,599
earlier

926
00:37:31,829 --> 00:37:29,440
we have to find things that are smaller

927
00:37:34,550 --> 00:37:31,839
fainter and redder

928
00:37:37,829 --> 00:37:34,560
and as i mentioned

929
00:37:39,670 --> 00:37:37,839
webb is a giant telescope

930
00:37:42,150 --> 00:37:39,680
specifically

931
00:37:43,030 --> 00:37:42,160
designed large enough to capture enough

932
00:37:45,589 --> 00:37:43,040
light

933
00:37:48,829 --> 00:37:45,599
from galaxies that are fainter than this

934
00:37:53,829 --> 00:37:51,750
and it is

935
00:37:56,630 --> 00:37:53,839
designed to catch capture things that

936
00:37:59,430 --> 00:37:56,640
are redder than this faint red splotch

937
00:38:00,790 --> 00:37:59,440
which are infrared

938
00:38:01,990 --> 00:38:00,800

webb's

939
00:38:05,990 --> 00:38:02,000
first

940
00:38:08,790 --> 00:38:06,000
inception goal was to find

941
00:38:12,950 --> 00:38:08,800
the first galaxies in the universe

942
00:38:19,670 --> 00:38:15,349
the first galaxies are a critical piece

943
00:38:21,589 --> 00:38:19,680
in the entire galactic evolution story

944
00:38:24,870 --> 00:38:21,599
which is something that we

945
00:38:26,710 --> 00:38:24,880
have barely been able to piece together

946
00:38:30,630 --> 00:38:26,720
from deep fields

947
00:38:33,589 --> 00:38:30,640
um shown here is a series i believe

948
00:38:34,550 --> 00:38:33,599
actually frank summers put this together

949
00:38:36,950 --> 00:38:34,560
um

950
00:38:38,470 --> 00:38:36,960
from an animation of the of the

951
00:38:39,430 --> 00:38:38,480
ultra deep field

952
00:38:40,390 --> 00:38:39,440
um

953
00:38:43,349 --> 00:38:40,400
but

954
00:38:45,270 --> 00:38:43,359
this is a sample of what we believe

955
00:38:47,349 --> 00:38:45,280
galaxy evolution could look like

956
00:38:49,510 --> 00:38:47,359
galaxies got more structured they got

957
00:38:51,109 --> 00:38:49,520
larger they got bluer

958
00:38:52,069 --> 00:38:51,119
over time

959
00:38:54,230 --> 00:38:52,079
but

960
00:38:57,349 --> 00:38:54,240
that process wasn't isn't a straight

961
00:38:58,630 --> 00:38:57,359
line there are a lot of mergers

962
00:39:01,270 --> 00:38:58,640
collisions

963
00:39:03,349 --> 00:39:01,280

changes in galaxy's structure

964
00:39:05,270 --> 00:39:03,359
as this evolution has happened

965
00:39:08,310 --> 00:39:05,280
and we really have only scratched the

966
00:39:10,150 --> 00:39:08,320
surface of of understanding how these

967
00:39:12,710 --> 00:39:10,160
happen

968
00:39:14,710 --> 00:39:12,720
um and not just that but what does it

969
00:39:16,790 --> 00:39:14,720
mean for the star formation within for

970
00:39:19,109 --> 00:39:16,800
the black holes within

971
00:39:20,710 --> 00:39:19,119
um and and

972
00:39:22,790 --> 00:39:20,720
for the overall

973
00:39:26,230 --> 00:39:22,800
composition and and

974
00:39:29,670 --> 00:39:26,240
final state of these galaxies

975
00:39:34,870 --> 00:39:31,990
by being able to study

976
00:39:36,710 --> 00:39:34,880
galaxy fields very efficiently

977
00:39:39,589 --> 00:39:36,720
deep fields of galaxies

978
00:39:41,910 --> 00:39:39,599
webb is able to get images of nearby

979
00:39:45,750 --> 00:39:41,920
galaxies distant galaxies young galaxies

980
00:39:47,430 --> 00:39:45,760
old galaxies all in one shot and give us

981
00:39:50,069 --> 00:39:47,440
huge surveys

982
00:39:52,550 --> 00:39:50,079
of galaxies at different galactic

983
00:39:55,190 --> 00:39:52,560
evolutions to help us

984
00:39:57,109 --> 00:39:55,200
fully put together this picture

985
00:40:00,550 --> 00:39:57,119
of what does galactic evolution look

986
00:40:03,030 --> 00:40:00,560
like and really fill in that early piece

987
00:40:04,550 --> 00:40:03,040
of what at the first galaxies look like

988
00:40:06,790 --> 00:40:04,560

um because other than faint red

989
00:40:10,470 --> 00:40:06,800
splotches we didn't have a lot of idea

990
00:40:14,710 --> 00:40:13,589
um of personal interest to me is that we

991
00:40:17,589 --> 00:40:14,720
can study

992
00:40:18,790 --> 00:40:17,599
star and planet formation

993
00:40:20,309 --> 00:40:18,800
um

994
00:40:21,750 --> 00:40:20,319
going back to the

995
00:40:23,990 --> 00:40:21,760
uh

996
00:40:26,230 --> 00:40:24,000
capabilities of near-infrared light to

997
00:40:28,069 --> 00:40:26,240
look through dust

998
00:40:30,790 --> 00:40:28,079
we can look through

999
00:40:33,030 --> 00:40:30,800
very dusty areas where stars and planets

1000
00:40:35,030 --> 00:40:33,040
are being formed look through them to

1001
00:40:37,109 --> 00:40:35,040
see those young stars to study those

1002
00:40:39,109 --> 00:40:37,119
young stars that were previously hidden

1003
00:40:41,670 --> 00:40:39,119
at visible wavelengths

1004
00:40:43,270 --> 00:40:41,680
this is actually hubble imagery

1005
00:40:45,829 --> 00:40:43,280
that really just scratches the surface

1006
00:40:49,270 --> 00:40:45,839
of what we what we were able to study

1007
00:40:50,870 --> 00:40:49,280
and web has much greater clarity

1008
00:40:54,630 --> 00:40:50,880
and incredible spectroscopic

1009
00:41:00,470 --> 00:40:54,640
capabilities to study what is in these

1010
00:41:04,150 --> 00:41:01,910
and

1011
00:41:07,510 --> 00:41:04,160
that spectroscopic capability really

1012
00:41:09,990 --> 00:41:07,520
comes into studying the makeup not just

1013
00:41:10,950 --> 00:41:10,000

finding the stars behind this dust in

1014
00:41:15,589 --> 00:41:10,960
these

1015
00:41:17,349 --> 00:41:15,599
nurseries but studying what's there

1016
00:41:20,069 --> 00:41:17,359
using the incredible spectroscopic

1017
00:41:22,710 --> 00:41:20,079
capabilities of web to study very

1018
00:41:24,870 --> 00:41:22,720
interesting molecules as i mentioned

1019
00:41:26,470 --> 00:41:24,880
that just happen to

1020
00:41:30,790 --> 00:41:26,480
emit fluoresce

1021
00:41:34,630 --> 00:41:32,470
webb will be able to study our solar

1022
00:41:36,790 --> 00:41:34,640
system you may have seen a very cool

1023
00:41:38,950 --> 00:41:36,800
image of jupiter that was taken during

1024
00:41:42,069 --> 00:41:38,960
commissioning testing

1025
00:41:43,510 --> 00:41:42,079
and that's just scratching the surface

1026
00:41:46,069 --> 00:41:43,520
because that was taken as a

1027
00:41:47,829 --> 00:41:46,079
commissioning test not as actual science

1028
00:41:50,390 --> 00:41:47,839
data but there are lots of programs

1029
00:41:51,670 --> 00:41:50,400
within the first year to study

1030
00:41:57,589 --> 00:41:51,680
all four

1031
00:41:59,589 --> 00:41:57,599
mars also the kuiper belt also i believe

1032
00:42:02,950 --> 00:41:59,599
the asteroid belt but definitely the

1033
00:42:03,990 --> 00:42:02,960
moons of the giant planets as well

1034
00:42:05,910 --> 00:42:04,000
um

1035
00:42:06,950 --> 00:42:05,920
you can see here that

1036
00:42:09,829 --> 00:42:06,960
uh

1037
00:42:11,990 --> 00:42:09,839
atmospheric patterns in the giant

1038
00:42:14,230 --> 00:42:12,000

planets really come to life and we're

1039
00:42:18,710 --> 00:42:14,240
also studying the molecular makeup of

1040
00:42:22,710 --> 00:42:20,710
infrared light

1041
00:42:25,990 --> 00:42:22,720
is heat as we said

1042
00:42:29,109 --> 00:42:26,000
and um it is especially tuned to the

1043
00:42:31,990 --> 00:42:29,119
heat of young hot planets

1044
00:42:34,710 --> 00:42:32,000
so the earth is at about

1045
00:42:36,630 --> 00:42:34,720
6000 degrees kelvin or sorry the sun is

1046
00:42:39,430 --> 00:42:36,640
at about 6000 degrees kelvin the earth

1047
00:42:40,230 --> 00:42:39,440
is at about 300 degrees kelvin

1048
00:42:42,230 --> 00:42:40,240
webb

1049
00:42:45,510 --> 00:42:42,240
can look at things that are about as hot

1050
00:42:46,710 --> 00:42:45,520
as the earth and slightly hotter

1051
00:42:49,030 --> 00:42:46,720
which

1052
00:42:51,430 --> 00:42:49,040
includes exoplanets that are pretty

1053
00:42:53,349 --> 00:42:51,440
close into their star what we call hot

1054
00:42:55,589 --> 00:42:53,359
jupiters which we know there are a lot

1055
00:43:00,870 --> 00:42:58,790
webb can actually detect the heat from

1056
00:43:02,790 --> 00:43:00,880
those hot jupiters

1057
00:43:04,309 --> 00:43:02,800
um and do what we call a technique

1058
00:43:05,670 --> 00:43:04,319
called direct imaging where you block

1059
00:43:07,270 --> 00:43:05,680
out the light from the central star

1060
00:43:11,030 --> 00:43:07,280
using chronograph

1061
00:43:13,270 --> 00:43:11,040
and directly image directly see the heat

1062
00:43:15,270 --> 00:43:13,280
signature from

1063
00:43:17,270 --> 00:43:15,280

hot exoplanets

1064
00:43:18,790 --> 00:43:17,280
this is an example of a system called hr

1065
00:43:20,710 --> 00:43:18,800
8799

1066
00:43:22,870 --> 00:43:20,720
this was taken using ground-based data

1067
00:43:25,030 --> 00:43:22,880
the keck observatory but web has this

1068
00:43:26,790 --> 00:43:25,040
capability and will study systems like

1069
00:43:28,309 --> 00:43:26,800
that and we'll probably discover new

1070
00:43:30,230 --> 00:43:28,319
planets

1071
00:43:32,550 --> 00:43:30,240
using this technique

1072
00:43:35,270 --> 00:43:32,560
that is uniquely

1073
00:43:37,190 --> 00:43:35,280
a infrared capability because that is

1074
00:43:38,870 --> 00:43:37,200
where those planets emit the most

1075
00:43:43,829 --> 00:43:38,880
strongly that's where their heat

1076
00:43:48,870 --> 00:43:47,670
and finally but definitely not least

1077
00:43:51,430 --> 00:43:48,880
is

1078
00:43:53,829 --> 00:43:51,440
studying exoplanet atmospheres

1079
00:43:55,829 --> 00:43:53,839
shown here is what we call a spectra

1080
00:43:58,870 --> 00:43:55,839
which i've alluded to the process of

1081
00:44:00,550 --> 00:43:58,880
spectroscopy is collecting a spectra

1082
00:44:02,390 --> 00:44:00,560
collecting light

1083
00:44:05,190 --> 00:44:02,400
that has been split

1084
00:44:07,750 --> 00:44:05,200
from one single light color into many

1085
00:44:09,270 --> 00:44:07,760
many colors or what we call wavelength

1086
00:44:11,589 --> 00:44:09,280
lengths

1087
00:44:13,910 --> 00:44:11,599
wavelength is just a proxy for color or

1088
00:44:15,270 --> 00:44:13,920

color as a proxy for wavelength you can

1089
00:44:16,870 --> 00:44:15,280
consider all of these different

1090
00:44:19,030 --> 00:44:16,880
wavelengths

1091
00:44:21,349 --> 00:44:19,040
and this is a spectra of what we would

1092
00:44:24,630 --> 00:44:21,359
expect the earth to look like

1093
00:44:26,870 --> 00:44:24,640
where you see features like water ozone

1094
00:44:29,589 --> 00:44:26,880
carbon dioxide methane

1095
00:44:32,950 --> 00:44:29,599
very interesting molecules molecules

1096
00:44:38,550 --> 00:44:32,960
that we associate with life on earth

1097
00:44:41,270 --> 00:44:38,560
and that are very prominent in emission

1098
00:44:43,109 --> 00:44:41,280
at infrared wavelengths

1099
00:44:45,670 --> 00:44:43,119
infrared wavelengths

1100
00:44:48,069 --> 00:44:45,680
are the area of the electromagnetic

1101
00:44:52,390 --> 00:44:48,079
spectrum that you want to study

1102
00:44:55,510 --> 00:44:54,470
the habitability

1103
00:44:56,950 --> 00:44:55,520
or the

1104
00:45:00,470 --> 00:44:56,960
appearance

1105
00:45:02,630 --> 00:45:00,480
of the signature of

1106
00:45:05,190 --> 00:45:02,640
organic molecules

1107
00:45:06,069 --> 00:45:05,200
in extrasolar planets or

1108
00:45:07,670 --> 00:45:06,079
in

1109
00:45:09,829 --> 00:45:07,680
cellular nurseries

1110
00:45:12,710 --> 00:45:09,839
um or planetary nebula

1111
00:45:14,470 --> 00:45:12,720
any astronomical object

1112
00:45:15,910 --> 00:45:14,480
if you stu if you look at infrared

1113
00:45:18,950 --> 00:45:15,920

wavelengths that's where you're going to

1114
00:45:21,109 --> 00:45:18,960
see these really interesting molecules

1115
00:45:22,870 --> 00:45:21,119
like carbon dioxide like water like

1116
00:45:23,670 --> 00:45:22,880
methane things that

1117
00:45:25,910 --> 00:45:23,680
we

1118
00:45:27,990 --> 00:45:25,920
in our anthropomorphic view

1119
00:45:29,190 --> 00:45:28,000
associate with life

1120
00:45:31,270 --> 00:45:29,200
um

1121
00:45:34,470 --> 00:45:31,280
but that are very abundant and

1122
00:45:38,150 --> 00:45:34,480
interesting and chemically reactive

1123
00:45:43,030 --> 00:45:41,190
so in the interest of time

1124
00:45:45,030 --> 00:45:43,040
let's get down to business i'm sure

1125
00:45:47,589 --> 00:45:45,040
you've all seen these before so it's not

1126
00:45:49,910 --> 00:45:47,599
quite the big reveal

1127
00:45:49,920 --> 00:45:53,589
it is amazing

1128
00:45:57,109 --> 00:45:55,510
to talk about what web was supposed to

1129
00:45:59,349 --> 00:45:57,119
do what it could have done and then

1130
00:46:00,470 --> 00:45:59,359
actually look at what it did

1131
00:46:04,390 --> 00:46:00,480
and

1132
00:46:06,069 --> 00:46:04,400
this was just the first shot

1133
00:46:08,790 --> 00:46:06,079
so the first image that was revealed for

1134
00:46:09,829 --> 00:46:08,800
james webb by president biden

1135
00:46:13,030 --> 00:46:09,839
was

1136
00:46:15,430 --> 00:46:13,040
what we call webb's first deep field

1137
00:46:20,150 --> 00:46:15,440
it's an image of the

1138
00:46:25,910 --> 00:46:23,190

and in this image

1139
00:46:30,710 --> 00:46:25,920
that only took a matter of hours now

1140
00:46:34,069 --> 00:46:32,390
and ultra deep field and the extreme

1141
00:46:35,829 --> 00:46:34,079
deep field and all of the deep field

1142
00:46:39,589 --> 00:46:35,839
surveys that have been done

1143
00:46:41,589 --> 00:46:39,599
have been on the order of days or weeks

1144
00:46:52,309 --> 00:46:41,599
this image

1145
00:47:02,710 --> 00:46:52,319
off the bat

1146
00:47:06,550 --> 00:47:04,710
i'm at a loss for words because i was at

1147
00:47:07,829 --> 00:47:06,560
a loss for words when we first found

1148
00:47:11,270 --> 00:47:07,839
this

1149
00:47:13,510 --> 00:47:11,280
it is it is stunning it is mind-blowing

1150
00:47:14,950 --> 00:47:13,520
and it is just scratching the surface of

1151
00:47:16,309 --> 00:47:14,960
what webb can do

1152
00:47:18,870 --> 00:47:16,319
there are

1153
00:47:20,390 --> 00:47:18,880
hundreds if not thousands of galaxies

1154
00:47:22,549 --> 00:47:20,400
i'm not gonna lie i haven't sat down and

1155
00:47:24,630 --> 00:47:22,559
counted by myself

1156
00:47:26,710 --> 00:47:24,640
in this image

1157
00:47:28,630 --> 00:47:26,720
and the understanding that web has given

1158
00:47:29,990 --> 00:47:28,640
us in two hours

1159
00:47:33,349 --> 00:47:30,000
of a filter

1160
00:47:33,359 --> 00:47:39,109
is mind-blowing

1161
00:47:43,349 --> 00:47:41,589
the other amazing thing that's not in

1162
00:47:45,910 --> 00:47:43,359
here but you can see in our press

1163
00:47:47,270 --> 00:47:45,920

releases from july 12

1164
00:47:50,630 --> 00:47:47,280
is that not only do we get this

1165
00:47:53,349 --> 00:47:50,640
beautiful image but we can actually

1166
00:47:56,710 --> 00:47:53,359
because of how big and powerful

1167
00:47:59,270 --> 00:47:56,720
and precise web is we can actually not

1168
00:48:01,750 --> 00:47:59,280
just see that galaxy that is 13.1

1169
00:48:04,870 --> 00:48:01,760
billion years old but we can tell you

1170
00:48:09,109 --> 00:48:07,750
and this enables that study of galaxies

1171
00:48:12,069 --> 00:48:09,119
over time

1172
00:48:14,950 --> 00:48:12,079
from not just a more morphological

1173
00:48:17,430 --> 00:48:14,960
perspective but from a chemical

1174
00:48:19,670 --> 00:48:17,440
and uh you know much deeper

1175
00:48:21,589 --> 00:48:19,680
understanding

1176
00:48:23,829 --> 00:48:21,599
i'm telling you when we first got this

1177
00:48:25,910 --> 00:48:23,839
data i was sitting in the room with with

1178
00:48:28,470 --> 00:48:25,920
a bunch of astronomers i myself am not a

1179
00:48:30,790 --> 00:48:28,480
galaxy person or a cosmologist

1180
00:48:32,829 --> 00:48:30,800
but the people who study galaxies when

1181
00:48:36,230 --> 00:48:32,839
we first saw the

1182
00:48:38,630 --> 00:48:36,240
spectra very very easy to gather from a

1183
00:48:40,710 --> 00:48:38,640
13 billion year old

1184
00:48:45,349 --> 00:48:40,720
galaxy

1185
00:48:49,030 --> 00:48:46,829
speaking of

1186
00:48:50,549 --> 00:48:49,040
spectra the next thing that was released

1187
00:48:51,910 --> 00:48:50,559
from webb was the specter of an

1188
00:48:54,470 --> 00:48:51,920

exoplanet

1189
00:48:57,430 --> 00:48:54,480
again just scratching the surface of

1190
00:48:58,870 --> 00:48:57,440
what webb will do for exoplanets

1191
00:49:01,190 --> 00:48:58,880
what's really interesting about this

1192
00:49:03,430 --> 00:49:01,200
planet wasp 96b and you can see here

1193
00:49:05,589 --> 00:49:03,440
that web has detected a signature of

1194
00:49:06,950 --> 00:49:05,599
water in the atmosphere

1195
00:49:08,470 --> 00:49:06,960
um

1196
00:49:10,390 --> 00:49:08,480
is that

1197
00:49:11,670 --> 00:49:10,400
it's not just water and as you can see

1198
00:49:13,589 --> 00:49:11,680
the model

1199
00:49:14,790 --> 00:49:13,599
matches the data but it's not exactly

1200
00:49:16,630 --> 00:49:14,800
precise

1201
00:49:18,390 --> 00:49:16,640
and that's because

1202
00:49:19,670 --> 00:49:18,400
the web data

1203
00:49:21,829 --> 00:49:19,680
has

1204
00:49:23,030 --> 00:49:21,839
confirmed the existence of clouds and

1205
00:49:25,430 --> 00:49:23,040
haze

1206
00:49:26,870 --> 00:49:25,440
in a water dominated atmosphere of this

1207
00:49:29,270 --> 00:49:26,880
planet

1208
00:49:31,190 --> 00:49:29,280
but it also shows us that there are

1209
00:49:33,030 --> 00:49:31,200
improvements to the model that need to

1210
00:49:33,990 --> 00:49:33,040
be made in order to accurately reflect

1211
00:49:36,549 --> 00:49:34,000
the data

1212
00:49:38,870 --> 00:49:36,559
that's what precision data that's what

1213
00:49:40,309 --> 00:49:38,880

web is going to do for us it's not just

1214
00:49:41,910 --> 00:49:40,319
give us data but it's going to improve

1215
00:49:44,630 --> 00:49:41,920
the models

1216
00:49:46,630 --> 00:49:44,640
that are modeling the data and so

1217
00:49:49,510 --> 00:49:46,640
there's this positive feedback loop

1218
00:49:52,470 --> 00:49:49,520
where really good technology informs and

1219
00:49:54,710 --> 00:49:52,480
observations inform theory and then

1220
00:49:55,589 --> 00:49:54,720
theory models observations

1221
00:49:59,109 --> 00:49:55,599
um

1222
00:50:01,990 --> 00:49:59,119
and as scientists we keep pushing

1223
00:50:02,710 --> 00:50:02,000
the limits in that way

1224
00:50:05,349 --> 00:50:02,720
but

1225
00:50:07,510 --> 00:50:05,359
in one transit of an exoplanet

1226
00:50:08,950 --> 00:50:07,520
web has proven that it has incredible

1227
00:50:10,230 --> 00:50:08,960
stability

1228
00:50:11,589 --> 00:50:10,240
precision

1229
00:50:12,630 --> 00:50:11,599
and

1230
00:50:19,109 --> 00:50:12,640
can

1231
00:50:24,150 --> 00:50:21,750
the southern ring nebula is an example

1232
00:50:26,950 --> 00:50:24,160
of a planetary nebula

1233
00:50:28,790 --> 00:50:26,960
which is the death of a

1234
00:50:31,030 --> 00:50:28,800
lower mass star

1235
00:50:33,349 --> 00:50:31,040
and as the star dies

1236
00:50:34,309 --> 00:50:33,359
and burns successive layers

1237
00:50:36,309 --> 00:50:34,319
of

1238
00:50:38,309 --> 00:50:36,319

its material

1239
00:50:40,630 --> 00:50:38,319
it sheds its shell

1240
00:50:42,309 --> 00:50:40,640
it sheds material it gets blown out you

1241
00:50:44,150 --> 00:50:42,319
may have heard of a supernova but this

1242
00:50:47,109 --> 00:50:44,160
is a smaller version

1243
00:50:49,270 --> 00:50:47,119
um called the planetary nebula and you

1244
00:50:55,750 --> 00:50:49,280
see

1245
00:50:57,430 --> 00:50:55,760
the actual morphology the actual shape

1246
00:50:58,309 --> 00:50:57,440
and structure

1247
00:50:59,270 --> 00:50:58,319
of

1248
00:51:04,549 --> 00:50:59,280
this

1249
00:51:06,230 --> 00:51:04,559
system is because it's actually a binary

1250
00:51:08,710 --> 00:51:06,240
system there are two stars at the center

1251
00:51:11,270 --> 00:51:08,720
orbiting each other one of them has died

1252
00:51:12,790 --> 00:51:11,280
and so the gravitation gravity from the

1253
00:51:15,589 --> 00:51:12,800
other star

1254
00:51:16,790 --> 00:51:15,599
has influenced the shape of this nebula

1255
00:51:19,349 --> 00:51:16,800
but

1256
00:51:21,430 --> 00:51:19,359
using the clarity that webb provides us

1257
00:51:23,750 --> 00:51:21,440
at near infrared wavelengths

1258
00:51:25,910 --> 00:51:23,760
and the additional detail at

1259
00:51:27,829 --> 00:51:25,920
mid infrared wavelengths we can study

1260
00:51:29,589 --> 00:51:27,839
the dynamics of this system

1261
00:51:31,349 --> 00:51:29,599
of how the star died

1262
00:51:33,030 --> 00:51:31,359
how the you know the gravitational

1263
00:51:34,790 --> 00:51:33,040

interaction between these two stars

1264
00:51:37,829 --> 00:51:34,800
impacted that

1265
00:51:40,390 --> 00:51:37,839
and i mean

1266
00:51:43,510 --> 00:51:40,400
it's just stunning also i this this

1267
00:51:46,390 --> 00:51:44,710
so

1268
00:51:48,549 --> 00:51:46,400
in addition to studying where stars are

1269
00:51:50,470 --> 00:51:48,559
born and the environments in which

1270
00:51:52,790 --> 00:51:50,480
they're being born by being able to see

1271
00:51:55,829 --> 00:51:52,800
through nebula we can see

1272
00:51:57,589 --> 00:51:55,839
what happens when stars die and study

1273
00:51:59,510 --> 00:51:57,599
both the physical processes and also the

1274
00:52:01,190 --> 00:51:59,520
chemical makeup of

1275
00:52:03,270 --> 00:52:01,200
these ejecta

1276
00:52:04,630 --> 00:52:03,280
to understand the full cell or life

1277
00:52:07,109 --> 00:52:04,640
cycle process

1278
00:52:12,950 --> 00:52:07,119
in addition to the study of

1279
00:52:17,750 --> 00:52:15,510
speaking of galaxy evolution

1280
00:52:20,549 --> 00:52:17,760
as i mentioned one of the key things

1281
00:52:23,349 --> 00:52:20,559
that happens in a galaxy's lifetime is

1282
00:52:25,030 --> 00:52:23,359
mergers interactions with other galaxies

1283
00:52:29,670 --> 00:52:25,040
as shown here

1284
00:52:34,309 --> 00:52:32,390
what's really interesting here is this

1285
00:52:35,510 --> 00:52:34,319
red part in the middle of these top

1286
00:52:38,790 --> 00:52:35,520
galaxies

1287
00:52:41,190 --> 00:52:38,800
that that are that is the dust that is

1288
00:52:43,270 --> 00:52:41,200

um highlighted that is that is that is

1289
00:52:45,990 --> 00:52:43,280
that whose heat we are seeing

1290
00:52:47,430 --> 00:52:46,000
the dust from these interacting galaxies

1291
00:52:49,190 --> 00:52:47,440
that have been

1292
00:52:50,710 --> 00:52:49,200
merging and interacting and you can see

1293
00:52:51,670 --> 00:52:50,720
one at the top and sort of two at the

1294
00:52:54,390 --> 00:52:51,680
bottom

1295
00:52:57,430 --> 00:52:54,400
that have interfaced and you can see

1296
00:53:00,150 --> 00:52:57,440
where the dust has been smeared out as

1297
00:53:01,349 --> 00:53:00,160
they gravitationally interacted

1298
00:53:04,150 --> 00:53:01,359
um

1299
00:53:06,150 --> 00:53:04,160
i like to call this the the dragon and

1300
00:53:08,230 --> 00:53:06,160
if you look at the mid infrared image

1301
00:53:10,549 --> 00:53:08,240
that was published um

1302
00:53:12,230 --> 00:53:10,559
it's very bejeweled tones and it's it's

1303
00:53:13,349 --> 00:53:12,240
very beautiful it's like a dragon

1304
00:53:16,320 --> 00:53:13,359
boarding

1305
00:53:19,750 --> 00:53:17,430
[Music]

1306
00:53:21,910 --> 00:53:19,760
but again the clarity here of looking at

1307
00:53:24,950 --> 00:53:21,920
these galaxy interactions

1308
00:53:26,630 --> 00:53:24,960
studying the dust and very complementary

1309
00:53:29,109 --> 00:53:26,640
to what hubble sees when it looks at

1310
00:53:30,309 --> 00:53:29,119
interacting galaxies

1311
00:53:32,630 --> 00:53:30,319
is going to

1312
00:53:38,069 --> 00:53:32,640
provide a wealth of information to

1313
00:53:42,150 --> 00:53:39,510

and then

1314
00:53:44,549 --> 00:53:42,160
finally but not finally because it is my

1315
00:53:46,630 --> 00:53:44,559
absolute favorite image ever

1316
00:53:49,670 --> 00:53:46,640
is the karina nebula

1317
00:53:51,109 --> 00:53:49,680
um this star forming region

1318
00:53:53,910 --> 00:53:51,119
really shows us

1319
00:53:55,109 --> 00:53:53,920
the capabilities both of infrared and

1320
00:53:57,750 --> 00:53:55,119
near-infrared and mid-infrared

1321
00:53:59,829 --> 00:53:57,760
wavelengths where you can see stars

1322
00:54:00,630 --> 00:53:59,839
coming through this nebula but you also

1323
00:54:03,589 --> 00:54:00,640
see

1324
00:54:04,549 --> 00:54:03,599
a rich structure of

1325
00:54:07,990 --> 00:54:04,559
this

1326
00:54:10,549 --> 00:54:08,000
that

1327
00:54:11,589 --> 00:54:10,559
is just teeming with nascent stars and

1328
00:54:13,670 --> 00:54:11,599
planets

1329
00:54:15,670 --> 00:54:13,680
and using the combination of these

1330
00:54:17,910 --> 00:54:15,680
different wavelengths we can study the

1331
00:54:20,630 --> 00:54:17,920
material that's there and we can look

1332
00:54:24,309 --> 00:54:20,640
into that material to see what's inside

1333
00:54:26,710 --> 00:54:24,319
as these stars and planets are forming

1334
00:54:29,270 --> 00:54:26,720
there's so many things in this image

1335
00:54:31,109 --> 00:54:29,280
that and it's such a high resolution

1336
00:54:32,950 --> 00:54:31,119
detailed image thanks to web's

1337
00:54:34,230 --> 00:54:32,960
capabilities

1338
00:54:36,230 --> 00:54:34,240

that

1339
00:54:37,030 --> 00:54:36,240
it is hard to know what to talk about

1340
00:54:38,630 --> 00:54:37,040
but

1341
00:54:40,390 --> 00:54:38,640
there are new structures here that i

1342
00:54:41,750 --> 00:54:40,400
think are going to require new science

1343
00:54:44,069 --> 00:54:41,760
uh

1344
00:54:47,510 --> 00:54:44,079
explanations for example this thing sort

1345
00:54:48,710 --> 00:54:47,520
of in the middle lower center left that

1346
00:54:50,069 --> 00:54:48,720
um

1347
00:54:53,349 --> 00:54:50,079
looks like

1348
00:54:55,670 --> 00:54:53,359
a crane like a swan cleaning its neck

1349
00:54:58,470 --> 00:54:55,680
who knows we can we can't explain those

1350
00:55:00,309 --> 00:54:58,480
just from what we know right now and so

1351
00:55:02,390 --> 00:55:00,319
just this image alone

1352
00:55:07,829 --> 00:55:02,400
is going to push

1353
00:55:12,630 --> 00:55:07,839
astronomers to figure out new phenomenon

1354
00:55:15,829 --> 00:55:13,430
and

1355
00:55:17,670 --> 00:55:15,839
finally i would be remiss if i didn't

1356
00:55:19,990 --> 00:55:17,680
very briefly mention the result that

1357
00:55:22,309 --> 00:55:20,000
came out just today

1358
00:55:24,789 --> 00:55:22,319
of the cartwheel galaxy

1359
00:55:27,990 --> 00:55:24,799
and this was an iconic target

1360
00:55:31,030 --> 00:55:28,000
that hubble looked at many years ago

1361
00:55:32,470 --> 00:55:31,040
and that's shown here on the left

1362
00:55:42,230 --> 00:55:32,480
and

1363
00:55:44,950 --> 00:55:42,240

i think the two biggest

1364
00:55:47,589 --> 00:55:44,960
striking differences to me are one

1365
00:55:51,270 --> 00:55:47,599
the vibrancy of the dust lanes in the

1366
00:55:53,030 --> 00:55:51,280
spiral galaxy which is exactly what webb

1367
00:55:56,069 --> 00:55:53,040
mid infrared wavelengths

1368
00:55:57,670 --> 00:55:56,079
are are good at highlighting is is that

1369
00:55:59,990 --> 00:55:57,680
dust coming through so we're not just

1370
00:56:02,150 --> 00:56:00,000
seeing stars not gas we're seeing the

1371
00:56:05,349 --> 00:56:02,160
dust structure the dust lanes of the

1372
00:56:10,870 --> 00:56:07,990
but also the galaxies in the background

1373
00:56:13,589 --> 00:56:10,880
webb is so powerful that it

1374
00:56:18,150 --> 00:56:13,599
just can't not see

1375
00:56:20,950 --> 00:56:18,950
so

1376
00:56:22,470 --> 00:56:20,960
please go back and if you haven't seen

1377
00:56:24,470 --> 00:56:22,480
this on today's news it was just

1378
00:56:26,950 --> 00:56:24,480
released this morning

1379
00:56:28,870 --> 00:56:26,960
as the latest uh

1380
00:56:32,230 --> 00:56:28,880
imagery from web

1381
00:56:34,549 --> 00:56:32,240
and we do expect to have uh new results

1382
00:56:36,549 --> 00:56:34,559
from web every two to three weeks

1383
00:56:37,589 --> 00:56:36,559
um from here on out

1384
00:56:40,069 --> 00:56:37,599
um

1385
00:56:42,069 --> 00:56:40,079
and there should be new scientific

1386
00:56:44,710 --> 00:56:42,079
results science peer-reviewed scientific

1387
00:56:49,190 --> 00:56:44,720
results coming out um

1388
00:56:54,789 --> 00:56:52,870

so stay tuned because

1389
00:56:56,870 --> 00:56:54,799
as we've talked about what web could do

1390
00:56:59,670 --> 00:56:56,880
and what it has done already and by

1391
00:57:02,710 --> 00:56:59,680
already i mean in the past three weeks

1392
00:57:05,589 --> 00:57:02,720
of what is surely to be a

1393
00:57:07,910 --> 00:57:05,599
beautiful decade-long if not more

1394
00:57:09,030 --> 00:57:07,920
mission

1395
00:57:12,309 --> 00:57:09,040
the

1396
00:57:15,430 --> 00:57:12,319
impact on every aspect of astronomy from

1397
00:57:18,230 --> 00:57:15,440
the early universe to our nearest

1398
00:57:20,069 --> 00:57:18,240
neighbors in our solar system

1399
00:57:22,710 --> 00:57:20,079
is going to be

1400
00:57:25,589 --> 00:57:22,720
mind-blowing

1401
00:57:29,030 --> 00:57:25,599
and so with that i will take questions

1402
00:57:34,470 --> 00:57:31,510
all right alex thank you very much for

1403
00:57:37,430 --> 00:57:34,480
that that was a good great overview not

1404
00:57:40,150 --> 00:57:37,440
only the history that led up to these uh

1405
00:57:41,750 --> 00:57:40,160
amazing new observations but a showcase

1406
00:57:45,430 --> 00:57:41,760
of the uh

1407
00:57:47,349 --> 00:57:45,440
of webb's first images and spectra and

1408
00:57:49,670 --> 00:57:47,359
of course we always want to

1409
00:57:51,510 --> 00:57:49,680
notate spectra because you know a lot of

1410
00:57:53,430 --> 00:57:51,520
the infrared science will be done with

1411
00:57:56,069 --> 00:57:53,440
these amazing spectra

1412
00:57:58,950 --> 00:57:56,079
did you know what percentage of of webs

1413
00:58:00,630 --> 00:57:58,960

of observations will be images versus

1414
00:58:03,190 --> 00:58:00,640
spectra

1415
00:58:06,309 --> 00:58:03,200
yeah that's a great question and um

1416
00:58:09,190 --> 00:58:06,319
the number is i think 76 of the first

1417
00:58:12,069 --> 00:58:09,200
year of science is spectroscopic

1418
00:58:13,270 --> 00:58:12,079
observations so well we love beautiful

1419
00:58:16,069 --> 00:58:13,280
images

1420
00:58:19,190 --> 00:58:16,079
astronomers really appreciate the fact

1421
00:58:21,910 --> 00:58:19,200
that when you break down light into its

1422
00:58:24,549 --> 00:58:21,920
component wavelengths or colors you get

1423
00:58:26,789 --> 00:58:24,559
the most information like what is there

1424
00:58:29,109 --> 00:58:26,799
and how fast is it moving and how far

1425
00:58:31,109 --> 00:58:29,119
away it is all that information can be

1426
00:58:33,030 --> 00:58:31,119
gleaned from a spectra

1427
00:58:35,910 --> 00:58:33,040
and all of that is extremely valuable in

1428
00:58:38,789 --> 00:58:35,920
understanding these phenomena right yeah

1429
00:58:41,510 --> 00:58:38,799
so much of the physics of the object uh

1430
00:58:44,069 --> 00:58:41,520
shows up in the spectra and uh instead

1431
00:58:45,990 --> 00:58:44,079
of the just the images although you know

1432
00:58:47,829 --> 00:58:46,000
the the you gotta keep them happy with

1433
00:58:50,870 --> 00:58:47,839
the images so you're gonna have to keep

1434
00:58:53,190 --> 00:58:50,880
pumping those out every few weeks right

1435
00:58:55,990 --> 00:58:53,200
yes they they will they will not go

1436
00:58:58,789 --> 00:58:56,000
anywhere and um you know as we've seen

1437
00:59:00,710 --> 00:58:58,799
they do not disappoint

1438
00:59:02,390 --> 00:59:00,720

okay uh why don't you stop your screen

1439
00:59:04,390 --> 00:59:02,400
share um

1440
00:59:05,829 --> 00:59:04,400
and um i have

1441
00:59:08,630 --> 00:59:05,839
one question that came up in the chat

1442
00:59:10,789 --> 00:59:08,640
that i wanted to ask you first um

1443
00:59:13,430 --> 00:59:10,799
so you mentioned that you've got 20

1444
00:59:15,510 --> 00:59:13,440
years of fuel for station keeping all

1445
00:59:17,430 --> 00:59:15,520
right so it can it can do its vibrating

1446
00:59:19,510 --> 00:59:17,440
orbit around the l2 point for about 20

1447
00:59:20,950 --> 00:59:19,520
years which i think is amazing because i

1448
00:59:23,109 --> 00:59:20,960
think the

1449
00:59:24,150 --> 00:59:23,119
the spec on that was five to ten years

1450
00:59:25,270 --> 00:59:24,160
right

1451
00:59:27,670 --> 00:59:25,280
um

1452
00:59:29,829 --> 00:59:27,680
what are there other limitations to the

1453
00:59:31,589 --> 00:59:29,839
lifetime of web besides that station

1454
00:59:33,670 --> 00:59:31,599
keeping

1455
00:59:35,589 --> 00:59:33,680
so yes that's a good question and you

1456
00:59:37,430 --> 00:59:35,599
know i i would lie if i said no we're

1457
00:59:39,910 --> 00:59:37,440
just gonna you know

1458
00:59:41,510 --> 00:59:39,920
it's unlimited um

1459
00:59:43,030 --> 00:59:41,520
right we didn't think we'd get 30 years

1460
00:59:46,710 --> 00:59:43,040
out of hubble either but you know we'll

1461
00:59:49,910 --> 00:59:46,720
see that's true but hubble is what is

1462
00:59:53,349 --> 00:59:49,920
and has been serviced right so the

1463
00:59:56,710 --> 00:59:53,359

instruments on hubble have been repaired

1464
00:59:57,589 --> 00:59:56,720
and replaced several times

1465
01:00:00,150 --> 00:59:57,599
um

1466
01:00:02,390 --> 01:00:00,160
so that's a key factor is that you know

1467
01:00:03,910 --> 01:00:02,400
electronics fail your cell phone only

1468
01:00:05,670 --> 01:00:03,920
works a couple of years i mean whether

1469
01:00:08,150 --> 01:00:05,680
or not that's

1470
01:00:09,990 --> 01:00:08,160
given by the company but electronics

1471
01:00:13,270 --> 01:00:10,000
naturally you know they they have a

1472
01:00:14,390 --> 01:00:13,280
limited lifetime and so unfortunately

1473
01:00:17,190 --> 01:00:14,400
that is the case

1474
01:00:18,390 --> 01:00:17,200
for web instrumentation um

1475
01:00:20,870 --> 01:00:18,400
you know

1476
01:00:22,630 --> 01:00:20,880
so we're not i can't promise none of

1477
01:00:24,630 --> 01:00:22,640
these have been inspect none of the

1478
01:00:27,430 --> 01:00:24,640
instruments you know were built or

1479
01:00:29,510 --> 01:00:27,440
promised for a 20-year life lifespan

1480
01:00:30,789 --> 01:00:29,520
they were for a five to ten year

1481
01:00:32,390 --> 01:00:30,799
lifespan

1482
01:00:34,630 --> 01:00:32,400
um and

1483
01:00:36,390 --> 01:00:34,640
if you know if any one of them fails the

1484
01:00:39,109 --> 01:00:36,400
other three will still work

1485
01:00:39,910 --> 01:00:39,119
um so there's a lot of of longevity

1486
01:00:41,270 --> 01:00:39,920
there

1487
01:00:48,789 --> 01:00:41,280
um

1488
01:00:51,109 --> 01:00:48,799

the uh impact of micro meteorites

1489
01:00:53,990 --> 01:00:51,119
um fortunately

1490
01:00:55,109 --> 01:00:54,000
the both the sun shield and the tow and

1491
01:00:56,549 --> 01:00:55,119
the mirrors

1492
01:00:59,109 --> 01:00:56,559
were designed

1493
01:01:00,870 --> 01:00:59,119
to really be quite robust against

1494
01:01:03,349 --> 01:01:00,880
micrometeorites

1495
01:01:06,069 --> 01:01:03,359
the sun shield is designed with this

1496
01:01:09,030 --> 01:01:06,079
sort of knit pattern so that if any

1497
01:01:11,670 --> 01:01:09,040
object breaks the sunshield at a point

1498
01:01:13,430 --> 01:01:11,680
it only propagates a very small distance

1499
01:01:15,510 --> 01:01:13,440
and so it just it doesn't rip the whole

1500
01:01:17,510 --> 01:01:15,520
thing it just rips a very small space

1501
01:01:20,230 --> 01:01:17,520
which really maintains you know the the

1502
01:01:21,510 --> 01:01:20,240
thermal capacity of the sunshield

1503
01:01:22,789 --> 01:01:21,520
um

1504
01:01:25,510 --> 01:01:22,799
and

1505
01:01:27,109 --> 01:01:25,520
a few weeks ago there was a rather

1506
01:01:29,670 --> 01:01:27,119
largest micro meteor impact

1507
01:01:31,190 --> 01:01:29,680
micrometeorite impact on the

1508
01:01:33,589 --> 01:01:31,200
um

1509
01:01:35,109 --> 01:01:33,599
uh maine mirrors and

1510
01:01:37,270 --> 01:01:35,119
as you can see

1511
01:01:39,030 --> 01:01:37,280
it's still doing really great webb was

1512
01:01:40,950 --> 01:01:39,040
very intentionally

1513
01:01:42,789 --> 01:01:40,960

made knowing that it was going to face

1514
01:01:45,510 --> 01:01:42,799
the extremes of the space environment

1515
01:01:47,910 --> 01:01:45,520
right um the 18 mirror segments can be

1516
01:01:51,270 --> 01:01:47,920
individually moved to refocus the

1517
01:01:53,589 --> 01:01:51,280
telescope very well so even if there is

1518
01:01:55,589 --> 01:01:53,599
a ding to one of the segments or one or

1519
01:01:57,910 --> 01:01:55,599
two segment gold segments go offline

1520
01:02:00,950 --> 01:01:57,920
completely the entire telescope can

1521
01:02:02,230 --> 01:02:00,960
still refocus and work beautifully

1522
01:02:04,829 --> 01:02:02,240
so

1523
01:02:06,549 --> 01:02:04,839
there are potential limitations to the

1524
01:02:08,710 --> 01:02:06,559
lifetime um

1525
01:02:09,990 --> 01:02:08,720
but it's hard to say

1526
01:02:11,910 --> 01:02:10,000
you know

1527
01:02:14,309 --> 01:02:11,920
if and when

1528
01:02:15,270 --> 01:02:14,319
any of those will

1529
01:02:16,870 --> 01:02:15,280
become

1530
01:02:18,950 --> 01:02:16,880
you know cosmic ray hits are

1531
01:02:21,430 --> 01:02:18,960
unpredictable right they're random

1532
01:02:23,270 --> 01:02:21,440
and hubble's had its share of cosmic ray

1533
01:02:26,390 --> 01:02:23,280
hits and i'm sure we'll we'll have it

1534
01:02:29,510 --> 01:02:26,400
share too uh let's just hope that they

1535
01:02:32,549 --> 01:02:29,520
push off way into the future okay

1536
01:02:34,710 --> 01:02:32,559
all right um grant why don't you join us

1537
01:02:36,870 --> 01:02:34,720
i'm looking over here to my left at my

1538
01:02:39,190 --> 01:02:36,880

laptop and i'm seeing lots of questions

1539
01:02:40,470 --> 01:02:39,200
in the chat coming up now that the talk

1540
01:02:43,829 --> 01:02:40,480
is over so

1541
01:02:45,750 --> 01:02:43,839
grant why don't you turn on your um

1542
01:02:48,710 --> 01:02:45,760
on your

1543
01:02:50,549 --> 01:02:48,720
video and uh come on and uh pull up some

1544
01:02:53,430 --> 01:02:50,559
of the questions you found from the

1545
01:02:55,029 --> 01:02:53,440
chat absolutely thank you for such a

1546
01:02:57,750 --> 01:02:55,039
good talk so far alex there's been

1547
01:03:02,069 --> 01:02:57,760
questions all throughout the chat

1548
01:03:05,430 --> 01:03:02,079
um so let's get us started

1549
01:03:07,670 --> 01:03:05,440
what makes james webb able to study such

1550
01:03:10,230 --> 01:03:07,680
bright objects without saturating the

1551
01:03:14,309 --> 01:03:10,240
detectors give you a chance to

1552
01:03:20,870 --> 01:03:16,870
well there is micro shutters as well uh

1553
01:03:22,230 --> 01:03:20,880
so web does have uh the ability to

1554
01:03:24,309 --> 01:03:22,240
um

1555
01:03:26,870 --> 01:03:24,319
pick and choose

1556
01:03:29,029 --> 01:03:26,880
very disparate sources of the sky thanks

1557
01:03:31,349 --> 01:03:29,039
to a very precise and

1558
01:03:33,990 --> 01:03:31,359
elaborate thing called a microshutter

1559
01:03:39,670 --> 01:03:37,589
but i think in terms of brightness

1560
01:03:41,510 --> 01:03:39,680
there actually was concern that a few

1561
01:03:43,829 --> 01:03:41,520
things in our solar system might be too

1562
01:03:46,230 --> 01:03:43,839
bright for webb

1563
01:03:47,589 --> 01:03:46,240

you know it

1564
01:03:49,829 --> 01:03:47,599
you're really only talking about things

1565
01:03:51,670 --> 01:03:49,839
like maybe mars jupiter saturn because

1566
01:03:52,950 --> 01:03:51,680
they're big and close by

1567
01:03:59,190 --> 01:03:52,960
um

1568
01:04:05,029 --> 01:04:02,630
it it's it's it's it's been it's been

1569
01:04:07,750 --> 01:04:05,039
handled i

1570
01:04:11,029 --> 01:04:07,760
i don't actually know why it it

1571
01:04:15,349 --> 01:04:12,870
well i mean it's a matter of exposure

1572
01:04:17,510 --> 01:04:15,359
time right you can set the i mean

1573
01:04:19,029 --> 01:04:17,520
with how we have that they sort of have

1574
01:04:21,190 --> 01:04:19,039
the problem in that you've got the orbit

1575
01:04:23,670 --> 01:04:21,200
around earth that sort of sets sort of a

1576
01:04:25,589 --> 01:04:23,680
typical exposure time but web doesn't

1577
01:04:27,670 --> 01:04:25,599
have that problem web is you know free

1578
01:04:29,430 --> 01:04:27,680
floating well i mean it has its orbit

1579
01:04:31,190 --> 01:04:29,440
but that doesn't that's like that does

1580
01:04:33,349 --> 01:04:31,200
that's a month orbit so that doesn't

1581
01:04:35,670 --> 01:04:33,359
really affect anything so you can really

1582
01:04:38,150 --> 01:04:35,680
set the exposure time like you would you

1583
01:04:40,230 --> 01:04:38,160
know um an slr camera you can set the

1584
01:04:41,829 --> 01:04:40,240
exposure for longer or shorter and if

1585
01:04:43,589 --> 01:04:41,839
it's a brighter object you take the

1586
01:04:47,270 --> 01:04:43,599
shorter exposure

1587
01:04:49,510 --> 01:04:47,280
um yeah i can't imagine webb having a

1588
01:04:51,349 --> 01:04:49,520

minimum exposure that would would

1589
01:04:52,870 --> 01:04:51,359
saturate with with jupiter we've already

1590
01:04:54,710 --> 01:04:52,880
seen jupiter right

1591
01:04:55,990 --> 01:04:54,720
yeah yeah and and you know the specs for

1592
01:04:59,109 --> 01:04:56,000
webb were

1593
01:05:00,630 --> 01:04:59,119
were to be able to study jupiter so

1594
01:05:01,829 --> 01:05:00,640
you know when they originally planned it

1595
01:05:03,349 --> 01:05:01,839
they weren't going to plan something

1596
01:05:04,309 --> 01:05:03,359
that was so sensitive that was just

1597
01:05:05,670 --> 01:05:04,319
gonna

1598
01:05:08,630 --> 01:05:05,680
yeah

1599
01:05:10,870 --> 01:05:08,640
and i was very glad that um uh the web

1600
01:05:12,309 --> 01:05:10,880
mission uh released that uh image of

1601
01:05:14,069 --> 01:05:12,319
jupiter just to because there was a

1602
01:05:16,150 --> 01:05:14,079
question in the chat like well can it

1603
01:05:18,150 --> 01:05:16,160
study planets too or anything because

1604
01:05:20,230 --> 01:05:18,160
you know i mean web is a general purpose

1605
01:05:22,230 --> 01:05:20,240
observatory planets stars nebulae

1606
01:05:23,589 --> 01:05:22,240
galaxies all the way to the edge of the

1607
01:05:25,910 --> 01:05:23,599
universe

1608
01:05:27,750 --> 01:05:25,920
and it's past all of the uh moving

1609
01:05:29,109 --> 01:05:27,760
target tests so moving target

1610
01:05:31,109 --> 01:05:29,119
acquisition making sure that it can

1611
01:05:33,430 --> 01:05:31,119
follow things in our solar system which

1612
01:05:37,270 --> 01:05:33,440
move very fast relative to the

1613
01:05:38,470 --> 01:05:37,280

background um because they're nearby

1614
01:05:42,710 --> 01:05:38,480
so

1615
01:05:44,470 --> 01:05:42,720
asteroid and comet shots

1616
01:05:45,750 --> 01:05:44,480
and that leads us directly into our next

1617
01:05:47,430 --> 01:05:45,760
one which is

1618
01:05:50,710 --> 01:05:47,440
could you explain the difference in the

1619
01:05:52,390 --> 01:05:50,720
diffraction spikes that we see between

1620
01:05:55,349 --> 01:05:52,400
let me get to

1621
01:05:57,990 --> 01:05:55,359
james webb and hubble

1622
01:05:59,910 --> 01:05:58,000
yes in short um

1623
01:06:02,710 --> 01:05:59,920
the very cool

1624
01:06:05,990 --> 01:06:02,720
star flakes snowflake um

1625
01:06:08,309 --> 01:06:06,000
looking web diffraction pattern is a

1626
01:06:10,789 --> 01:06:08,319
result both of the shape of the primary

1627
01:06:12,630 --> 01:06:10,799
mirror the hexagonal shape versus web

1628
01:06:15,510 --> 01:06:12,640
versus hubble circle

1629
01:06:17,510 --> 01:06:15,520
and the fact that the geometry of the

1630
01:06:20,549 --> 01:06:17,520
optics includes a

1631
01:06:21,990 --> 01:06:20,559
secondary mirror on a

1632
01:06:23,750 --> 01:06:22,000
tripod

1633
01:06:24,710 --> 01:06:23,760
strut thing

1634
01:06:26,470 --> 01:06:24,720
so

1635
01:06:28,950 --> 01:06:26,480
i can't do it justice if you go to

1636
01:06:30,789 --> 01:06:28,960
webtelescope.org

1637
01:06:32,870 --> 01:06:30,799
and look at the infographics there there

1638
01:06:35,430 --> 01:06:32,880

is a really cool infographic that

1639
01:06:38,630 --> 01:06:35,440
beautifully very cleanly explains

1640
01:06:39,510 --> 01:06:38,640
exactly how we get this six plus two

1641
01:06:43,109 --> 01:06:39,520
kind of

1642
01:06:45,510 --> 01:06:43,119
pattern diffraction pattern based on the

1643
01:06:47,109 --> 01:06:45,520
physics and geometry of the optical

1644
01:06:48,870 --> 01:06:47,119
system

1645
01:06:50,309 --> 01:06:48,880
right but it's a it's a it's a great way

1646
01:06:52,230 --> 01:06:50,319
to for folks to be able to sit there and

1647
01:06:54,150 --> 01:06:52,240
go that's a hubble image that's a web

1648
01:06:56,230 --> 01:06:54,160
image okay yeah yeah i think it i think

1649
01:06:59,270 --> 01:06:56,240
is that's really good because you know

1650
01:07:02,870 --> 01:06:59,280
um it's it's pretty clear once you once

1651
01:07:05,670 --> 01:07:02,880
you see the the diffraction spikes

1652
01:07:08,470 --> 01:07:05,680
all right what next we got greg grant

1653
01:07:13,349 --> 01:07:08,480
sure um when you were talking before you

1654
01:07:15,029 --> 01:07:13,359
referenced water detection with wasp 96b

1655
01:07:19,349 --> 01:07:15,039
what do you mean when you say water

1656
01:07:20,950 --> 01:07:19,359
detection is it atmospheric is it

1657
01:07:24,549 --> 01:07:20,960
actual like

1658
01:07:25,990 --> 01:07:24,559
not you is it actual water um that is on

1659
01:07:28,710 --> 01:07:26,000
the surface of the planet or is it

1660
01:07:31,510 --> 01:07:28,720
what's detected in the atmosphere

1661
01:07:34,309 --> 01:07:31,520
so that's a good question um when we

1662
01:07:36,710 --> 01:07:34,319
study exoplanets we generally study the

1663
01:07:40,069 --> 01:07:36,720

upper parts of their atmosphere

1664
01:07:41,589 --> 01:07:40,079
in this case this is a detection of an

1665
01:07:43,910 --> 01:07:41,599
exoplanet

1666
01:07:45,829 --> 01:07:43,920
passing in front of a star

1667
01:07:48,710 --> 01:07:45,839
and the light from the star

1668
01:07:49,910 --> 01:07:48,720
actually goes through the atmosphere of

1669
01:07:52,069 --> 01:07:49,920
the planet

1670
01:07:54,150 --> 01:07:52,079
and as the light from the star goes

1671
01:07:55,430 --> 01:07:54,160
through the atmosphere of the planet

1672
01:07:59,670 --> 01:07:55,440
light waves

1673
01:08:01,750 --> 01:07:59,680
and by looking at the spectra

1674
01:08:04,390 --> 01:08:01,760
we can tell that those absorbed light

1675
01:08:07,109 --> 01:08:04,400
waves coincide with what

1676
01:08:08,950 --> 01:08:07,119
water vapor would absorb

1677
01:08:10,549 --> 01:08:08,960
and so we're detecting water vapor in

1678
01:08:13,190 --> 01:08:10,559
the atmosphere and really in the upper

1679
01:08:15,670 --> 01:08:13,200
atmosphere mostly of

1680
01:08:17,030 --> 01:08:15,680
um of the exoplanet

1681
01:08:18,870 --> 01:08:17,040
right and it's important of course to

1682
01:08:21,349 --> 01:08:18,880
get the infrared version because

1683
01:08:23,349 --> 01:08:21,359
infrared observations because there's so

1684
01:08:26,709 --> 01:08:23,359
many of the water and carbon dioxide and

1685
01:08:29,349 --> 01:08:26,719
methane lines in the infrared that

1686
01:08:31,030 --> 01:08:29,359
you don't see in the visible light

1687
01:08:32,630 --> 01:08:31,040
exactly

1688
01:08:33,990 --> 01:08:32,640

awesome

1689
01:08:36,390 --> 01:08:34,000
so

1690
01:08:38,390 --> 01:08:36,400
oh this is actually an interesting one

1691
01:08:41,110 --> 01:08:38,400
so web is designed to look for galaxies

1692
01:08:44,149 --> 01:08:41,120
further away but it sees

1693
01:08:46,390 --> 01:08:44,159
ir wavelengths shorter than spitzer

1694
01:08:51,669 --> 01:08:46,400
why wasn't spitzer able to observe some

1695
01:08:55,269 --> 01:08:53,030
yeah

1696
01:08:56,870 --> 01:08:55,279
detectors that is about 50 times bigger

1697
01:08:58,470 --> 01:08:56,880
than spencer

1698
01:09:00,470 --> 01:08:58,480
that's all

1699
01:09:03,269 --> 01:09:00,480
yeah that's

1700
01:09:05,669 --> 01:09:03,279
the you know the resolution of a 0.8

1701
01:09:07,829 --> 01:09:05,679
meter telescope versus a 6.5 meter

1702
01:09:10,870 --> 01:09:07,839
telescope um

1703
01:09:13,430 --> 01:09:10,880
gives it that that ability

1704
01:09:15,110 --> 01:09:13,440
kind of like collecting power oh and the

1705
01:09:17,110 --> 01:09:15,120
light collecting

1706
01:09:20,070 --> 01:09:17,120
both of them i think i've been impressed

1707
01:09:22,709 --> 01:09:20,080
by the efficiency of web um when they

1708
01:09:25,269 --> 01:09:22,719
showed that uh the systems on web are

1709
01:09:26,470 --> 01:09:25,279
you know 10 above spec

1710
01:09:28,470 --> 01:09:26,480
you know and

1711
01:09:30,070 --> 01:09:28,480
just obviously from the first images

1712
01:09:32,070 --> 01:09:30,080
that you're showing how deep you're

1713
01:09:35,910 --> 01:09:32,080

getting in just

1714
01:09:38,070 --> 01:09:35,920
uh these short exposures uh that has um

1715
01:09:39,749 --> 01:09:38,080
really been impressive

1716
01:09:42,149 --> 01:09:39,759
yeah when you send something you know

1717
01:09:45,030 --> 01:09:42,159
that's so expensive up into space and

1718
01:09:46,709 --> 01:09:45,040
time really is its currency to know that

1719
01:09:48,630 --> 01:09:46,719
it can do such good science in a very

1720
01:09:50,550 --> 01:09:48,640
amount of very small amount of time

1721
01:09:52,229 --> 01:09:50,560
just you know

1722
01:09:53,829 --> 01:09:52,239
you know even if it doesn't last for 30

1723
01:09:56,149 --> 01:09:53,839
years the efficiency with which it can

1724
01:09:57,590 --> 01:09:56,159
do science means that its scientific

1725
01:09:59,910 --> 01:09:57,600
potential is

1726
01:10:01,590 --> 01:09:59,920
you know as good as hubble's

1727
01:10:04,630 --> 01:10:01,600
maybe hopefully

1728
01:10:06,229 --> 01:10:04,640
oh definitely and i believe we have said

1729
01:10:09,110 --> 01:10:06,239
this on the channel before but it bears

1730
01:10:11,270 --> 01:10:09,120
repeating uh what was the difference in

1731
01:10:12,950 --> 01:10:11,280
observation time between the hubble deep

1732
01:10:15,750 --> 01:10:12,960
field and the web deep field just to

1733
01:10:17,430 --> 01:10:15,760
give people an idea of how much that

1734
01:10:19,830 --> 01:10:17,440
scale is

1735
01:10:22,870 --> 01:10:19,840
yeah that's a good and a good a good

1736
01:10:24,630 --> 01:10:22,880
comment and it's not really fair the the

1737
01:10:27,189 --> 01:10:24,640
the things that have been put out on the

1738
01:10:29,910 --> 01:10:27,199

internet right now of comparing the s

1739
01:10:31,590 --> 01:10:29,920
max field because the s max field was

1740
01:10:34,149 --> 01:10:31,600
not a deep observation that people have

1741
01:10:36,310 --> 01:10:34,159
been showing of of the the hubble

1742
01:10:38,470 --> 01:10:36,320
observation of that same field so

1743
01:10:41,189 --> 01:10:38,480
it's not really apples and apples but a

1744
01:10:42,790 --> 01:10:41,199
hubble deep field um for example the the

1745
01:10:46,229 --> 01:10:42,800
hubble deep field

1746
01:10:48,870 --> 01:10:46,239
was i think 87 hours of exposure time

1747
01:10:49,910 --> 01:10:48,880
and the web one was

1748
01:10:52,790 --> 01:10:49,920
uh

1749
01:10:55,510 --> 01:10:52,800
12 total for

1750
01:10:57,990 --> 01:10:55,520
near infrared and mid infrared

1751
01:10:59,910 --> 01:10:58,000
so it's really a almost a factor of 10

1752
01:11:02,470 --> 01:10:59,920
difference to get the same depth

1753
01:11:04,470 --> 01:11:02,480
it's mind-blowing yeah and and one of

1754
01:11:06,870 --> 01:11:04,480
the really cool things about this is

1755
01:11:09,830 --> 01:11:06,880
that you know even in say the planetary

1756
01:11:10,790 --> 01:11:09,840
nebula image or the uh stefan's quintet

1757
01:11:12,390 --> 01:11:10,800
image

1758
01:11:13,830 --> 01:11:12,400
that there are

1759
01:11:15,270 --> 01:11:13,840
tremendous numbers of background

1760
01:11:16,070 --> 01:11:15,280
galaxies that show up because they're

1761
01:11:18,310 --> 01:11:16,080
just

1762
01:11:20,470 --> 01:11:18,320
show up brighter and once you redshift

1763
01:11:22,229 --> 01:11:20,480

those galaxies they're in the infrared

1764
01:11:23,270 --> 01:11:22,239
and they show up so much

1765
01:11:25,669 --> 01:11:23,280
more

1766
01:11:27,510 --> 01:11:25,679
so much brighter and um you know there's

1767
01:11:29,030 --> 01:11:27,520
just a tremendous number of background

1768
01:11:30,630 --> 01:11:29,040
galaxies even in

1769
01:11:32,229 --> 01:11:30,640
images that aren't meant to be deep

1770
01:11:33,590 --> 01:11:32,239
fields

1771
01:11:35,590 --> 01:11:33,600
yeah

1772
01:11:36,950 --> 01:11:35,600
that actually leads right into the next

1773
01:11:38,709 --> 01:11:36,960
one which is

1774
01:11:40,310 --> 01:11:38,719
uh in the image of the karina nebula

1775
01:11:44,149 --> 01:11:40,320
someone noticed that they were able to

1776
01:11:46,870 --> 01:11:44,159
see what looked like stars either in the

1777
01:11:49,990 --> 01:11:46,880
actual like orc cloud or

1778
01:11:51,590 --> 01:11:50,000
just behind that observation

1779
01:11:54,390 --> 01:11:51,600
and that's one of the things that jwst

1780
01:11:57,110 --> 01:11:54,400
is able to do being infrared so would

1781
01:12:00,390 --> 01:11:57,120
you expand a little bit more about the

1782
01:12:02,229 --> 01:12:00,400
ability to observe stars through or in

1783
01:12:05,750 --> 01:12:02,239
the dust

1784
01:12:07,830 --> 01:12:05,760
yeah so this is you know this is

1785
01:12:09,590 --> 01:12:07,840
one of the coolest demos i've ever seen

1786
01:12:11,510 --> 01:12:09,600
is

1787
01:12:13,350 --> 01:12:11,520
if you hold a trash bag up to an

1788
01:12:14,390 --> 01:12:13,360

infrared camera

1789
01:12:15,990 --> 01:12:14,400
you can actually see right through the

1790
01:12:17,590 --> 01:12:16,000
trash bag so our eyes can't see it

1791
01:12:20,870 --> 01:12:17,600
through a trash bag but an infrared

1792
01:12:23,030 --> 01:12:20,880
camera can that's kind of the same thing

1793
01:12:24,310 --> 01:12:23,040
with stars is that our eyes can't see

1794
01:12:25,910 --> 01:12:24,320
through the dust

1795
01:12:27,669 --> 01:12:25,920
it's basically like put a giant trash

1796
01:12:29,430 --> 01:12:27,679
bag in front of your face but with an

1797
01:12:31,189 --> 01:12:29,440
infrared camera

1798
01:12:33,430 --> 01:12:31,199
bam you can see right through

1799
01:12:35,350 --> 01:12:33,440
alternatively what's really interesting

1800
01:12:37,830 --> 01:12:35,360
is that if you hold a piece of glass up

1801
01:12:39,910 --> 01:12:37,840
to an infrared camera you can see right

1802
01:12:41,510 --> 01:12:39,920
through it the infrared camera can't see

1803
01:12:42,550 --> 01:12:41,520
squat

1804
01:12:44,790 --> 01:12:42,560
so

1805
01:12:46,390 --> 01:12:44,800
it's really different wavelengths see

1806
01:12:48,070 --> 01:12:46,400
through different materials

1807
01:12:50,390 --> 01:12:48,080
and so here

1808
01:12:53,270 --> 01:12:50,400
you know so in an image where it just

1809
01:12:54,870 --> 01:12:53,280
looks like dark lanes of dust

1810
01:12:58,310 --> 01:12:54,880
webb just sees right through it to the

1811
01:13:00,630 --> 01:12:58,320
other side or depending on how how what

1812
01:13:02,870 --> 01:13:00,640
the opacity is and the exact wavelength

1813
01:13:05,270 --> 01:13:02,880

can see like kind of to the middle

1814
01:13:07,350 --> 01:13:05,280
um so yes there are a lot of stars here

1815
01:13:09,350 --> 01:13:07,360
and and and new stars that we've never

1816
01:13:10,470 --> 01:13:09,360
seen before in this image of the korean

1817
01:13:13,830 --> 01:13:10,480
nebula

1818
01:13:15,830 --> 01:13:13,840
um thanks to the the depth

1819
01:13:20,550 --> 01:13:15,840
that near-infrared wavelengths give us

1820
01:13:27,430 --> 01:13:24,550
um oh i like this one uh since jwst is

1821
01:13:30,149 --> 01:13:27,440
in motion obviously it has a short

1822
01:13:32,950 --> 01:13:30,159
elliptical orbit of it of its own

1823
01:13:36,790 --> 01:13:32,960
does that produce any noticeable doppler

1824
01:13:42,550 --> 01:13:39,590
um that's a good question if

1825
01:13:45,350 --> 01:13:42,560
i i don't think so i mean it's it's a

1826
01:13:46,709 --> 01:13:45,360
legitimate question but they would all

1827
01:13:48,550 --> 01:13:46,719
be

1828
01:13:51,669 --> 01:13:48,560
calibrated out in the processing

1829
01:13:54,070 --> 01:13:51,679
software so we haven't seen any

1830
01:13:56,390 --> 01:13:54,080
yeah hubble's moving at 17 000 miles per

1831
01:13:58,950 --> 01:13:56,400
hour right so we've been able to do this

1832
01:14:02,070 --> 01:13:58,960
quite well for 32 years we can handle it

1833
01:14:04,470 --> 01:14:02,080
for web too yeah the earth is moving

1834
01:14:06,790 --> 01:14:04,480
the earth is moving the the telescopes

1835
01:14:10,630 --> 01:14:06,800
are moving we've we've got all that

1836
01:14:12,550 --> 01:14:10,640
taken care of so that's a solved problem

1837
01:14:15,750 --> 01:14:12,560
so we did touch on this a little bit or

1838
01:14:18,550 --> 01:14:15,760

you did in your talk but

1839
01:14:20,790 --> 01:14:18,560
knowing that there's really only

1840
01:14:23,830 --> 01:14:20,800
one

1841
01:14:25,189 --> 01:14:23,840
finite resource on web which is the

1842
01:14:26,950 --> 01:14:25,199
i believe it's the station keeping

1843
01:14:28,870 --> 01:14:26,960
thrusters correct just to keep it in

1844
01:14:32,470 --> 01:14:28,880
orbital position

1845
01:14:35,270 --> 01:14:32,480
what do we have an idea for an expected

1846
01:14:37,510 --> 01:14:35,280
life versus a possible life for the web

1847
01:14:40,390 --> 01:14:37,520
mission

1848
01:14:42,870 --> 01:14:40,400
i would say we're basically expecting 10

1849
01:14:44,470 --> 01:14:42,880
years now

1850
01:14:46,550 --> 01:14:44,480
good 10 years

1851
01:14:48,630 --> 01:14:46,560
let's be conservative at this point you

1852
01:14:50,709 --> 01:14:48,640
know yeah we've only got a few months

1853
01:14:52,630 --> 01:14:50,719
worth of experience operating this

1854
01:14:53,990 --> 01:14:52,640
telescope but

1855
01:14:56,630 --> 01:14:54,000
if everything keeps going like this it

1856
01:15:00,950 --> 01:14:56,640
could be really great but

1857
01:15:05,830 --> 01:15:03,430
um all right so

1858
01:15:06,870 --> 01:15:05,840
what determines what web is going to

1859
01:15:08,470 --> 01:15:06,880
observe

1860
01:15:11,189 --> 01:15:08,480
we've talked about this on the channel

1861
01:15:12,390 --> 01:15:11,199
before as far as like discretionary time

1862
01:15:14,149 --> 01:15:12,400
from

1863
01:15:16,630 --> 01:15:14,159

the director which is how we got the

1864
01:15:18,790 --> 01:15:16,640
first deep fields and obviously like

1865
01:15:21,189 --> 01:15:18,800
double blind proposals but could you

1866
01:15:23,189 --> 01:15:21,199
talk a little bit about that

1867
01:15:24,470 --> 01:15:23,199
yeah that's a really good question and

1868
01:15:25,590 --> 01:15:24,480
actually that's a lot of the bread and

1869
01:15:28,709 --> 01:15:25,600
butter of the work of the space

1870
01:15:31,669 --> 01:15:28,719
telescope science institute is

1871
01:15:34,630 --> 01:15:31,679
figuring out what web and hubble will

1872
01:15:37,830 --> 01:15:34,640
look at um and it is not a

1873
01:15:40,550 --> 01:15:37,840
uh it's it's not really our choice but

1874
01:15:42,070 --> 01:15:40,560
instead we opera we we run processes

1875
01:15:43,750 --> 01:15:42,080
very rigorous

1876
01:15:45,590 --> 01:15:43,760
selection processes

1877
01:15:48,950 --> 01:15:45,600
um so

1878
01:15:51,910 --> 01:15:48,960
what happens is every year we put out a

1879
01:15:53,990 --> 01:15:51,920
call to anyone but generally is

1880
01:15:54,870 --> 01:15:54,000
responded to by astronomers across the

1881
01:15:57,189 --> 01:15:54,880
world

1882
01:15:59,590 --> 01:15:57,199
to say i would like to use your

1883
01:16:01,590 --> 01:15:59,600
telescope hubble or web and i would like

1884
01:16:04,070 --> 01:16:01,600
to look at this thing for this reason

1885
01:16:05,110 --> 01:16:04,080
and this number of hours

1886
01:16:07,189 --> 01:16:05,120
and

1887
01:16:09,830 --> 01:16:07,199
space telescope science institute

1888
01:16:11,990 --> 01:16:09,840

gathers a group of astronomers to

1889
01:16:12,709 --> 01:16:12,000
rigorously evaluate those proposals and

1890
01:16:14,709 --> 01:16:12,719
say

1891
01:16:15,990 --> 01:16:14,719
these are the most valuable ones in

1892
01:16:17,030 --> 01:16:16,000
terms of the science that they will

1893
01:16:18,950 --> 01:16:17,040
deliver

1894
01:16:21,510 --> 01:16:18,960
so this is what they should look at

1895
01:16:24,470 --> 01:16:21,520
um so most of

1896
01:16:26,790 --> 01:16:24,480
the time on web over the next decade

1897
01:16:29,830 --> 01:16:26,800
will be chosen by um

1898
01:16:32,070 --> 01:16:29,840
a peer-reviewed process

1899
01:16:33,270 --> 01:16:32,080
some of the time especially in the next

1900
01:16:36,709 --> 01:16:33,280
year or two

1901
01:16:40,790 --> 01:16:36,719
has been promised to certain astronomers

1902
01:16:42,390 --> 01:16:40,800
um and who have spent decades themselves

1903
01:16:43,990 --> 01:16:42,400
working for web

1904
01:16:45,910 --> 01:16:44,000
and so people who

1905
01:16:48,390 --> 01:16:45,920
created some of the original science

1906
01:16:49,270 --> 01:16:48,400
goals some of the science instruments

1907
01:16:51,110 --> 01:16:49,280
um

1908
01:16:53,270 --> 01:16:51,120
so they they've given years of their

1909
01:16:54,709 --> 01:16:53,280
life to web and in return they get some

1910
01:16:56,790 --> 01:16:54,719
guaranteed time

1911
01:16:58,310 --> 01:16:56,800
um as well as as you mentioned the

1912
01:17:01,669 --> 01:16:58,320
director of the space telescope science

1913
01:17:04,310 --> 01:17:01,679

institute um in his position gets some

1914
01:17:05,669 --> 01:17:04,320
sort of guaranteed time of his own

1915
01:17:06,870 --> 01:17:05,679
um

1916
01:17:08,550 --> 01:17:06,880
to make sure that there's other

1917
01:17:13,270 --> 01:17:08,560
opportunities that don't get missed for

1918
01:17:16,950 --> 01:17:15,270
what kind of and

1919
01:17:19,590 --> 01:17:16,960
i i just wanted to comment on that

1920
01:17:21,110 --> 01:17:19,600
because you know what you recognize is

1921
01:17:22,709 --> 01:17:21,120
that when we run these telescope

1922
01:17:24,390 --> 01:17:22,719
assignment committees we bring in

1923
01:17:25,750 --> 01:17:24,400
hundreds of astronomers to do the

1924
01:17:26,709 --> 01:17:25,760
evaluation

1925
01:17:29,270 --> 01:17:26,719
and

1926
01:17:31,510 --> 01:17:29,280
that you know only about 10 of the

1927
01:17:34,550 --> 01:17:31,520
proposals actually make it through

1928
01:17:36,870 --> 01:17:34,560
um so i mean that they the amount of

1929
01:17:38,229 --> 01:17:36,880
people who want to use hubble and web is

1930
01:17:40,630 --> 01:17:38,239
always going to be much much greater

1931
01:17:43,430 --> 01:17:40,640
than we have time uh

1932
01:17:44,790 --> 01:17:43,440
available so you know it's um it's

1933
01:17:46,790 --> 01:17:44,800
something that

1934
01:17:49,030 --> 01:17:46,800
this is a very valuable resource and

1935
01:17:56,470 --> 01:17:49,040
that we make sure that only the best

1936
01:18:00,390 --> 01:17:58,550
all right um so

1937
01:18:02,790 --> 01:18:00,400
let's move on uh there was a question

1938
01:18:04,149 --> 01:18:02,800

about the lagrange point

1939
01:18:05,830 --> 01:18:04,159
so

1940
01:18:07,189 --> 01:18:05,840
i talked a little bit about the orbit

1941
01:18:09,189 --> 01:18:07,199
already but

1942
01:18:12,950 --> 01:18:09,199
what exactly is the lagrange point and

1943
01:18:15,270 --> 01:18:12,960
why was it chosen for web to

1944
01:18:17,030 --> 01:18:15,280
be more or less stationary there for its

1945
01:18:19,189 --> 01:18:17,040
observations

1946
01:18:21,590 --> 01:18:19,199
yeah so just briefly that's a good

1947
01:18:23,590 --> 01:18:21,600
question um and i didn't explain this as

1948
01:18:26,310 --> 01:18:23,600
well as i could have

1949
01:18:28,149 --> 01:18:26,320
a lagrange point and in this case you

1950
01:18:30,229 --> 01:18:28,159
know the the the second lagrange point

1951
01:18:32,870 --> 01:18:30,239
there there are five lagrange points for

1952
01:18:35,830 --> 01:18:32,880
any sort of two bodies two bodies

1953
01:18:37,510 --> 01:18:35,840
orbiting each other there's five points

1954
01:18:38,630 --> 01:18:37,520
around those bodies

1955
01:18:39,430 --> 01:18:38,640
where

1956
01:18:41,590 --> 01:18:39,440
the

1957
01:18:43,430 --> 01:18:41,600
gravity of those two bodies kind of

1958
01:18:45,110 --> 01:18:43,440
cancels each other out for lack of a

1959
01:18:47,030 --> 01:18:45,120
better term

1960
01:18:48,070 --> 01:18:47,040
um and so it means you can kind of hang

1961
01:18:49,910 --> 01:18:48,080
out there

1962
01:18:52,550 --> 01:18:49,920
and so one of them is this place the

1963
01:18:54,950 --> 01:18:52,560

second lagrange point um

1964
01:18:57,110 --> 01:18:54,960
and uh of all of the points that you can

1965
01:18:57,910 --> 01:18:57,120
kind of hang out around earth and the

1966
01:19:00,790 --> 01:18:57,920
sun

1967
01:19:02,310 --> 01:19:00,800
the second lagrange point is one where

1968
01:19:07,189 --> 01:19:02,320
you're on

1969
01:19:08,630 --> 01:19:07,199
earth and the sun at all times

1970
01:19:09,430 --> 01:19:08,640
um

1971
01:19:12,149 --> 01:19:09,440
so

1972
01:19:13,910 --> 01:19:12,159
in short that's why we chose it um you

1973
01:19:15,750 --> 01:19:13,920
can read a lot more about lagrange

1974
01:19:18,229 --> 01:19:15,760
points and and how they come up in

1975
01:19:19,750 --> 01:19:18,239
orbital dynamics um

1976
01:19:20,950 --> 01:19:19,760
online but

1977
01:19:22,790 --> 01:19:20,960
it it

1978
01:19:24,470 --> 01:19:22,800
it is it means that we don't have to

1979
01:19:25,830 --> 01:19:24,480
carry a lot of fuel we don't have to use

1980
01:19:26,870 --> 01:19:25,840
a lot of fuel

1981
01:19:29,910 --> 01:19:26,880
and

1982
01:19:32,390 --> 01:19:29,920
we can always keep our precious

1983
01:19:34,950 --> 01:19:32,400
telescope in the shade

1984
01:19:36,870 --> 01:19:34,960
of the sun shield

1985
01:19:38,310 --> 01:19:36,880
okay grant i'm gonna jump in here

1986
01:19:40,630 --> 01:19:38,320
because we only have one time for one

1987
01:19:43,750 --> 01:19:40,640
more question and uh it's a question

1988
01:19:45,669 --> 01:19:43,760

that always comes up uh is james webb

1989
01:19:47,990 --> 01:19:45,679
going to be able to detect life on

1990
01:19:49,430 --> 01:19:48,000
another planet

1991
01:19:52,070 --> 01:19:49,440
that's one of the questions that i

1992
01:19:54,390 --> 01:19:52,870
yes

1993
01:19:55,990 --> 01:19:54,400
you know you're you know we're gonna get

1994
01:19:58,229 --> 01:19:56,000
the we get that question all the time

1995
01:20:01,270 --> 01:19:58,239
yeah i mean and you know what are the

1996
01:20:08,870 --> 01:20:06,470
web is a very important piece of um

1997
01:20:11,830 --> 01:20:08,880
you know nasa's and all dare i say

1998
01:20:14,629 --> 01:20:11,840
humanities you know

1999
01:20:17,110 --> 01:20:14,639
looking for for life out there

2000
01:20:20,629 --> 01:20:19,830
webb can see

2001
01:20:22,550 --> 01:20:20,639
webb

2002
01:20:25,430 --> 01:20:22,560
is able to

2003
01:20:27,830 --> 01:20:25,440
detect atmospheres of

2004
01:20:29,270 --> 01:20:27,840
smaller planets approaching the size of

2005
01:20:31,189 --> 01:20:29,280
the earth

2006
01:20:33,350 --> 01:20:31,199
um

2007
01:20:35,830 --> 01:20:33,360
that we've never been able to detect

2008
01:20:37,830 --> 01:20:35,840
before because they were too good the

2009
01:20:38,709 --> 01:20:37,840
atmospheric signature was too small too

2010
01:20:39,669 --> 01:20:38,719
faint

2011
01:20:41,910 --> 01:20:39,679
um

2012
01:20:44,149 --> 01:20:41,920
and we haven't had this capability at

2013
01:20:45,669 --> 01:20:44,159

infrared wavelengths before where we

2014
01:20:49,510 --> 01:20:45,679
said very interesting things like

2015
01:20:50,709 --> 01:20:49,520
methane carbon dioxide water hangout

2016
01:20:53,830 --> 01:20:50,719
so

2017
01:20:55,270 --> 01:20:53,840
webb is going to be able to detect

2018
01:20:57,830 --> 01:20:55,280
atmospheres

2019
01:20:58,950 --> 01:20:57,840
of much smaller planets than previously

2020
01:21:00,390 --> 01:20:58,960
done

2021
01:21:01,990 --> 01:21:00,400
at

2022
01:21:03,910 --> 01:21:02,000
areas of the electromagnetic spectrum

2023
01:21:04,790 --> 01:21:03,920
that are very interesting

2024
01:21:07,110 --> 01:21:04,800
for

2025
01:21:09,510 --> 01:21:07,120
habitability studies

2026
01:21:10,229 --> 01:21:09,520
so that's that's the step that web does

2027
01:21:11,830 --> 01:21:10,239
web

2028
01:21:14,229 --> 01:21:11,840
says hey

2029
01:21:17,189 --> 01:21:14,239
we found some cool stuff on some things

2030
01:21:18,629 --> 01:21:17,199
that may have a rocky surface

2031
01:21:21,669 --> 01:21:18,639
there's a lot of steps to go from there

2032
01:21:24,550 --> 01:21:21,679
to find life but it's a fun start

2033
01:21:27,270 --> 01:21:24,560
yeah um you know i think you know the

2034
01:21:29,590 --> 01:21:27,280
the major question for that is what if

2035
01:21:32,310 --> 01:21:29,600
we if there were a a signature of

2036
01:21:35,189 --> 01:21:32,320
biology of biological processes in the

2037
01:21:37,110 --> 01:21:35,199
atmosphere what is that have we defined

2038
01:21:40,470 --> 01:21:37,120

that well enough to be able to tell it

2039
01:21:42,310 --> 01:21:40,480
even if we did we did see it um so

2040
01:21:44,229 --> 01:21:42,320
it's you know our detectors are

2041
01:21:45,830 --> 01:21:44,239
improving but also the other side of the

2042
01:21:47,750 --> 01:21:45,840
equation has to improve enough so that

2043
01:21:50,070 --> 01:21:47,760
we can say yes this is an undeniable

2044
01:21:51,830 --> 01:21:50,080
signature because you know

2045
01:21:53,510 --> 01:21:51,840
the universe works in so many different

2046
01:21:55,270 --> 01:21:53,520
ways that um

2047
01:21:56,790 --> 01:21:55,280
i mean even earth you know the life

2048
01:21:59,189 --> 01:21:56,800
forms we found on our earth are have

2049
01:22:02,390 --> 01:21:59,199
have defied our expectations as we keep

2050
01:22:05,510 --> 01:22:02,400
looking so exactly so mother nature is

2051
01:22:07,830 --> 01:22:05,520
very very inventive and an undefinable

2052
01:22:10,470 --> 01:22:07,840
undeniable signature i'm not sure we

2053
01:22:12,390 --> 01:22:10,480
know what that is just yet okay

2054
01:22:14,390 --> 01:22:12,400
all right alex thank you so much for

2055
01:22:16,550 --> 01:22:14,400
this uh introduction to web

2056
01:22:19,110 --> 01:22:16,560
um uh folks we're gonna be hearing a lot

2057
01:22:21,430 --> 01:22:19,120
more about web over the next uh months

2058
01:22:24,390 --> 01:22:21,440
and years stay tuned it's gonna be

2059
01:22:26,070 --> 01:22:24,400
exciting uh next month however we will

2060
01:22:27,430 --> 01:22:26,080
not hear about webb well we'll hear

2061
01:22:29,669 --> 01:22:27,440
about something that's uh that

2062
01:22:31,830 --> 01:22:29,679
approaches one of the web science topics

2063
01:22:34,629 --> 01:22:31,840

uh first light unveiling the properties

2064
01:22:36,629 --> 01:22:34,639
of galaxies at cosmic dawn which is one

2065
01:22:39,350 --> 01:22:36,639
of those science things that we'll work

2066
01:22:42,229 --> 01:22:39,360
on from guido roberts porsani we'll see