

PUBLIC LECTURE SERIES



Webb in Three Acts: The Telescope, The Science, The Legacy

Featuring Guest Speakers :
Klaus Pontoppidan,
Bonnie Meinke,
Alexandra Lockwood

1
00:00:04,190 --> 00:00:01,520
I checked the weather report here in

2
00:00:05,950 --> 00:00:04,200
Baltimore if there's snow tonight it's

3
00:00:08,330 --> 00:00:05,960
not going to happen till it's supposedly

4
00:00:10,970 --> 00:00:08,340
not gonna happen till after 11 o'clock

5
00:00:12,589 --> 00:00:10,980
so we finish at 9:30 you should have

6
00:01:35,859 --> 00:00:12,599
plenty of time to get home unless you

7
00:01:35,869 --> 00:02:18,610
oh my gosh that's great

8
00:02:31,720 --> 00:02:22,390
all right Kelvin we're ready

9
00:02:33,369 --> 00:02:31,730
you've got the thumbs up okay good

10
00:02:35,830 --> 00:02:33,379
evening ladies and gentlemen and welcome

11
00:02:38,259 --> 00:02:35,840
to the Space Telescope public lecture

12
00:02:40,990 --> 00:02:38,269
series I'm your host dr. Frank summers

13
00:02:46,690 --> 00:02:41,000

of the office of public outreach and

14

00:02:48,520 --> 00:02:46,700

when you came in there are lithographs

15

00:02:51,039 --> 00:02:48,530

on the table here our lithograph tonight

16

00:02:53,229 --> 00:02:51,049

is the Eagle Nebula m16 these are the

17

00:02:56,380 --> 00:02:53,239

pillars of creation in the Eagle Nebula

18

00:02:57,910 --> 00:02:56,390

scene in both visible light and infrared

19

00:03:00,610 --> 00:02:57,920

light and this will have special

20

00:03:06,099 --> 00:03:00,620

significance for our talk about infrared

21

00:03:08,710 --> 00:03:06,109

telescopes tonight our talk is it's not

22

00:03:11,920 --> 00:03:08,720

working all right so let's go here our

23

00:03:15,220 --> 00:03:11,930

talk is web in three acts the telescope

24

00:03:17,170 --> 00:03:15,230

the science the legacy we have three

25

00:03:20,500 --> 00:03:17,180

speakers to take care of those three

26
00:03:23,050 --> 00:03:20,510
parts and I'll introduce them later but

27
00:03:26,110 --> 00:03:23,060
we're gonna get a good look at the James

28
00:03:28,449 --> 00:03:26,120
Webb Space Telescope tonight next month

29
00:03:31,479 --> 00:03:28,459
we have the wildest weather in the

30
00:03:33,280 --> 00:03:31,489
universe by Hannah wake furred and in

31
00:03:36,190 --> 00:03:33,290
that she's not talking about just in our

32
00:03:39,550 --> 00:03:36,200
solar system but also in other planetary

33
00:03:41,619 --> 00:03:39,560
systems the new planetary systems that

34
00:03:45,580 --> 00:03:41,629
we have found and the weather that we

35
00:03:47,890 --> 00:03:45,590
would do Sanh those planets on March we

36
00:03:49,900 --> 00:03:47,900
have Mia boville coming back again she's

37
00:03:52,059 --> 00:03:49,910
given some wonderful talks the last

38
00:03:54,670 --> 00:03:52,069

couple of years and she decided she was

39

00:03:56,500 --> 00:03:54,680

going to have some fun with her title so

40

00:03:59,530 --> 00:03:56,510

it's called mapping the United

41

00:04:02,920 --> 00:03:59,540

Federation of Planets an astronomers

42

00:04:05,530 --> 00:04:02,930

Guide to the galaxy so she will be using

43

00:04:08,860 --> 00:04:05,540

lots and lots of Star Trek references

44

00:04:11,170 --> 00:04:08,870

okay but she will also be putting them

45

00:04:13,420 --> 00:04:11,180

in context of our actual scientific

46

00:04:16,199 --> 00:04:13,430

knowledge of the galaxy so if you were

47

00:04:21,339 --> 00:04:16,209

on a combination of a fact and fiction

48

00:04:23,529 --> 00:04:21,349

come to us see in march in april susanna

49

00:04:25,689 --> 00:04:23,539

datastore is going to talk and she's did

50

00:04:26,830 --> 00:04:25,699

not give me an actual topic she just

51
00:04:28,209 --> 00:04:26,840
said i'll talk about something about

52
00:04:31,420 --> 00:04:28,219
cosmology because everybody loves

53
00:04:31,960 --> 00:04:31,430
cosmology so in the next month or so I

54
00:04:34,150 --> 00:04:31,970
will

55
00:04:36,640 --> 00:04:34,160
get an actual title out of her but you

56
00:04:37,810 --> 00:04:36,650
guys do love Kamal cosmology right yeah

57
00:04:41,320 --> 00:04:37,820
so you're gonna come no matter what

58
00:04:45,010 --> 00:04:41,330
all right great if you would like to

59
00:04:46,870 --> 00:04:45,020
keep up with what's going on you can go

60
00:04:48,460 --> 00:04:46,880
to our website if you just sort of put

61
00:04:50,440 --> 00:04:48,470
in your favorite search engine

62
00:04:52,570 --> 00:04:50,450
Hubble public talks you'll find this

63
00:04:54,670 --> 00:04:52,580

webpage and you can see we've got a list

64

00:04:58,480 --> 00:04:54,680

of the upcoming lectures we've got links

65

00:05:01,720 --> 00:04:58,490

to the webcasting which are live when we

66

00:05:04,870 --> 00:05:01,730

are doing it live now as well as links

67

00:05:07,390 --> 00:05:04,880

to the past lectures we've been on

68

00:05:10,800 --> 00:05:07,400

YouTube since spring of 2014 and we have

69

00:05:14,620 --> 00:05:10,810

been on the stsci webcasting site since

70

00:05:17,410 --> 00:05:14,630

2005 so we're approaching 13 years of

71

00:05:19,690 --> 00:05:17,420

astronomy lectures on our webcasting

72

00:05:21,220 --> 00:05:19,700

site that's one of the reasons I ask you

73

00:05:22,930 --> 00:05:21,230

all to get a hand to our webcasting

74

00:05:25,240 --> 00:05:22,940

folks at the beginning because they do

75

00:05:28,660 --> 00:05:25,250

such an amazing job in archiving these

76
00:05:31,870 --> 00:05:28,670
wonderful talks you can also sign up for

77
00:05:36,550 --> 00:05:31,880
our email list that will send you

78
00:05:38,380 --> 00:05:36,560
reminders of the talks every month this

79
00:05:41,260 --> 00:05:38,390
is the email one which is sort of

80
00:05:45,010 --> 00:05:41,270
redundant now that we have the sign up

81
00:05:46,540 --> 00:05:45,020
on our webpage you can also however send

82
00:05:52,090 --> 00:05:46,550
us comments and questions to public

83
00:05:55,030 --> 00:05:52,100
lecture at STScl dot edu social media we

84
00:05:56,920 --> 00:05:55,040
have Facebook we have not one but two

85
00:05:59,710 --> 00:05:56,930
Twitter accounts we have YouTube we have

86
00:06:02,500 --> 00:05:59,720
Instagram we actually ought to get the J

87
00:06:05,260 --> 00:06:02,510
toasty ones up on here now that we're

88
00:06:06,430 --> 00:06:05,270

getting closer to Jos T launch so yeah

89

00:06:08,590 --> 00:06:06,440

all right

90

00:06:12,760 --> 00:06:08,600

my apologies it'll be fixed for next

91

00:06:14,500 --> 00:06:12,770

month okay using space telescope around

92

00:06:16,750 --> 00:06:14,510

all right here right now I also

93

00:06:18,909 --> 00:06:16,760

occasionally have post on a blog in

94

00:06:22,120 --> 00:06:18,919

Facebook Google+ and Twitter and you can

95

00:06:23,920 --> 00:06:22,130

get those if you like these across the

96

00:06:26,200 --> 00:06:23,930

street we have the Maryland Space Grant

97

00:06:27,730 --> 00:06:26,210

consortium Observatory

98

00:06:30,100 --> 00:06:27,740

the Maryland Space Grant Observatory

99

00:06:32,230 --> 00:06:30,110

will not be open tonight if you looked

100

00:06:35,950 --> 00:06:32,240

up you didn't see many stars if any on

101
00:06:37,480 --> 00:06:35,960
your way in it's cloudy actually the

102
00:06:39,340 --> 00:06:37,490
fact that it's cold is really good

103
00:06:41,260 --> 00:06:39,350
because when it's cold the air is still

104
00:06:42,730 --> 00:06:41,270
and be a really good night okay some of

105
00:06:45,340 --> 00:06:42,740
the best nights observing or when you're

106
00:06:47,740 --> 00:06:45,350
totally freezing your butt off okay

107
00:06:50,890 --> 00:06:47,750
unfortunately clouds are never help

108
00:06:52,870 --> 00:06:50,900
whether it's cold or warm so they will

109
00:06:54,940 --> 00:06:52,880
not they do have open houses on Friday

110
00:06:58,780 --> 00:06:54,950
evenings if you go to MDI space grant o

111
00:07:00,520 --> 00:06:58,790
RG they have this page here where you

112
00:07:02,770 --> 00:07:00,530
can find the observatory status they

113
00:07:04,810 --> 00:07:02,780

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

114

00:07:07,720 --> 00:07:04,820

every Friday as to whether they're

115

00:07:10,030 --> 00:07:07,730

opening up on those Fridays ok so come

116

00:07:11,560 --> 00:07:10,040

back to and visit us in future lecture

117

00:07:13,480 --> 00:07:11,570

series and maybe we'll be open but

118

00:07:17,620 --> 00:07:13,490

certainly you can try every Friday on

119

00:07:22,900 --> 00:07:17,630

that and now the news from the universe

120

00:07:24,850 --> 00:07:22,910

for January 2018 our first story is a

121

00:07:29,950 --> 00:07:24,860

month old

122

00:07:31,240 --> 00:07:29,960

it is our Yuletide stars so every year

123

00:07:33,520 --> 00:07:31,250

we have to put out something for

124

00:07:35,170 --> 00:07:33,530

holidays right and they go through a

125

00:07:37,030 --> 00:07:35,180

selection process and they come up with

126

00:07:41,200 --> 00:07:37,040

something and this year they came up

127

00:07:43,510 --> 00:07:41,210

with the globular cluster Messier 79 and

128

00:07:45,520 --> 00:07:43,520

this was brought up in our news meeting

129

00:07:50,290 --> 00:07:45,530

and they said ok what can we do with

130

00:07:51,670 --> 00:07:50,300

this to make this holiday and we were

131

00:07:53,500 --> 00:07:51,680

batting around ideas and I came up with

132

00:07:55,960 --> 00:07:53,510

something I said well you know we could

133

00:07:57,160 --> 00:07:55,970

do this thing that we did and I'm not

134

00:08:00,370 --> 00:07:57,170

going to tell you the idea because it'll

135

00:08:03,070 --> 00:08:00,380

show up in just a second and I said you

136

00:08:05,320 --> 00:08:03,080

know that might be work and they held me

137

00:08:06,940 --> 00:08:05,330

to it so I can't with this idea in the

138

00:08:09,760 --> 00:08:06,950

middle of a meeting just off the top of

139

00:08:13,660 --> 00:08:09,770

my head and they made me follow through

140

00:08:15,910 --> 00:08:13,670

it so the team and I got together and we

141

00:08:18,340 --> 00:08:15,920

put together a little visualization of

142

00:08:28,630 --> 00:08:18,350

this globular star cluster with a

143

00:08:30,580 --> 00:08:28,640

surprise holiday theme at the end so

144

00:08:32,469 --> 00:08:30,590

this is one of our normal zooms in on

145

00:08:36,969 --> 00:08:32,479

the night sky to show you where Messier

146

00:08:38,740 --> 00:08:36,979

79 is and it really is deeply hidden

147

00:08:41,469 --> 00:08:38,750

there we start to see the cluster this

148

00:08:43,209 --> 00:08:41,479

is a ground-based version of it but as

149

00:08:45,550 --> 00:08:43,219

we zoom in you find out that Hubble

150

00:08:47,560 --> 00:08:45,560

doesn't see that wide field version it

151

00:08:51,250 --> 00:08:47,570

doesn't even see this version it sees

152

00:08:54,010 --> 00:08:51,260

the very central region of this globular

153

00:08:57,730 --> 00:08:54,020

star cluster and to give you a feel of a

154

00:08:59,060 --> 00:08:57,740

3d we created this 3d visualization it

155

00:09:01,580 --> 00:08:59,070

has the same similar

156

00:09:04,790 --> 00:09:01,590

statistical properties as this m79

157

00:09:12,410 --> 00:09:04,800

globular star cluster and then as we

158

00:09:22,280 --> 00:09:12,420

pull out our idea of a stellar snow

159

00:09:25,670 --> 00:09:22,290

globe is revealed so this will teach me

160

00:09:29,690 --> 00:09:25,680

to speak up during meetings we also

161

00:09:32,510 --> 00:09:29,700

created this version which is just the

162

00:09:34,400 --> 00:09:32,520

snow globe spinning and it actually is

163

00:09:35,660 --> 00:09:34,410

on a loop so you could play this put

164

00:09:37,460 --> 00:09:35,670

this in the background of your holiday

165

00:09:40,460 --> 00:09:37,470

party next year and you could have that

166

00:09:47,410 --> 00:09:40,470

snow globe spinning infinitely with the

167

00:09:54,950 --> 00:09:51,170

our second story tonight finding defects

168

00:09:56,270 --> 00:09:54,960

in the star formation Factory yes there

169

00:10:00,260 --> 00:09:56,280

are people who have to find those

170

00:10:01,940 --> 00:10:00,270

defects all right so this is the star

171

00:10:05,150 --> 00:10:01,950

formation Factory I'm talking about it's

172

00:10:07,880 --> 00:10:05,160

called the Orion Nebula and this is a

173

00:10:10,670 --> 00:10:07,890

star forming region and there are

174

00:10:13,730 --> 00:10:10,680

several thousand stars about four

175

00:10:15,800 --> 00:10:13,740

thousand stars that have just formed and

176

00:10:17,720 --> 00:10:15,810

when we say just swarmed on astronomical

177

00:10:19,280 --> 00:10:17,730

timescales that's two million years ago

178

00:10:21,200 --> 00:10:19,290

okay so they're stars in the Orion

179

00:10:25,450 --> 00:10:21,210

Nebula that are two million years old

180

00:10:28,280 --> 00:10:25,460

but not all things that collapse are

181

00:10:30,220 --> 00:10:28,290

massive enough to form stars okay so if

182

00:10:32,390 --> 00:10:30,230

you're this is a star formation Factory

183

00:10:35,660 --> 00:10:32,400

sometimes you get some defects that are

184

00:10:37,910 --> 00:10:35,670

too small to form stars okay and it's

185

00:10:39,380 --> 00:10:37,920

important for us as astronomers to try

186

00:10:41,450 --> 00:10:39,390

and understand when you've got a

187

00:10:43,700 --> 00:10:41,460

collapsing nebula you've got a gas cloud

188

00:10:45,320 --> 00:10:43,710

that's collapsing to form objects what

189

00:10:47,420 --> 00:10:45,330

percentage of that material goes into

190

00:10:48,860 --> 00:10:47,430

stars what percentage of the material

191

00:10:50,240 --> 00:10:48,870

goes into planets we really want to know

192

00:10:52,220 --> 00:10:50,250

that too and we're searching that in

193

00:10:53,600 --> 00:10:52,230

other ways but what percentage of it

194

00:10:56,390 --> 00:10:53,610

goes into something that's bigger than a

195

00:10:59,200 --> 00:10:56,400

planet but smaller than a star and

196

00:11:02,870 --> 00:10:59,210

that's what we call brown dwarfs okay

197

00:11:05,480 --> 00:11:02,880

brown dwarfs are range from basically 15

198

00:11:08,090 --> 00:11:05,490

times Jupiter's mass to about 70 times

199

00:11:09,950 --> 00:11:08,100

Jupiter's mass okay something that's you

200

00:11:12,190 --> 00:11:09,960

know and that's when you get what we

201
00:11:14,410 --> 00:11:12,200
call deuterium fusion

202
00:11:16,000 --> 00:11:14,420
now the main-sequence stars are powered

203
00:11:18,370 --> 00:11:16,010
by hydrogen fusion the fusion of

204
00:11:20,800 --> 00:11:18,380
hydrogen into helium is what powers the

205
00:11:23,280 --> 00:11:20,810
Sun and other main-sequence stars but

206
00:11:26,769 --> 00:11:23,290
deuterium which is called heavy hydrogen

207
00:11:29,860 --> 00:11:26,779
that is not as a long-term sustained

208
00:11:31,900 --> 00:11:29,870
fusion it will flare up it will last for

209
00:11:34,269 --> 00:11:31,910
a while and then it will fade away so

210
00:11:37,000 --> 00:11:34,279
these brown dwarfs are extremely faint

211
00:11:40,629 --> 00:11:37,010
and compared to stars they're extremely

212
00:11:43,150 --> 00:11:40,639
cool they're so cool that water

213
00:11:46,660 --> 00:11:43,160

molecules will form in their atmosphere

214

00:11:49,540 --> 00:11:46,670

and you can actually detect them by

215

00:11:52,300 --> 00:11:49,550

looking for water molecules and where do

216

00:11:57,069 --> 00:11:52,310

the water molecules show up in the

217

00:11:59,550 --> 00:11:57,079

infrared so this is just a single filter

218

00:12:03,180 --> 00:11:59,560

from Hubble in the near-infrared and

219

00:12:07,120 --> 00:12:03,190

those circles are around certain

220

00:12:09,370 --> 00:12:07,130

detections of these brown dwarfs now

221

00:12:15,069 --> 00:12:09,380

what they did is they look in the water

222

00:12:18,430 --> 00:12:15,079

vapor line to find 1,200 really red

223

00:12:20,740 --> 00:12:18,440

candidates ok candidates that could have

224

00:12:23,079 --> 00:12:20,750

brown dwarfs and what they're really

225

00:12:26,199 --> 00:12:23,089

looking for was finding those faint red

226

00:12:28,780 --> 00:12:26,209

stars that had brown dwarf companions

227

00:12:33,579 --> 00:12:28,790

around them okay because you often get

228

00:12:36,610 --> 00:12:33,589

companions and they found 17 brown dwarf

229

00:12:40,480 --> 00:12:36,620

companions around these red dwarf stars

230

00:12:42,490 --> 00:12:40,490

as well as three planetary-mass

231

00:12:45,639 --> 00:12:42,500

companions three that were below the

232

00:12:46,930 --> 00:12:45,649

level of the brown dwarf masts and into

233

00:12:48,790 --> 00:12:46,940

the planetary mass now those are only

234

00:12:51,939 --> 00:12:48,800

candidates okay they can't confirm those

235

00:12:54,280 --> 00:12:51,949

in fact all 17 are candidates but in

236

00:12:56,500 --> 00:12:54,290

talking with one of the researchers he

237

00:12:59,199 --> 00:12:56,510

said there's like a 95% confidence level

238

00:13:00,699 --> 00:12:59,209

in all 17 of them that they are actual

239

00:13:02,710 --> 00:13:00,709

brown dwarfs it's the planetary ones

240

00:13:05,290 --> 00:13:02,720

that are really small that they can't be

241

00:13:06,550 --> 00:13:05,300

totally sure about so these are their

242

00:13:09,160 --> 00:13:06,560

locations and if you want to see what

243

00:13:13,350 --> 00:13:09,170

they look like this is the highly

244

00:13:15,790 --> 00:13:13,360

processed images yeah really difficult

245

00:13:18,370 --> 00:13:15,800

my laser pointer isn't working sorry

246

00:13:20,230 --> 00:13:18,380

about that but what you see on the in

247

00:13:23,019 --> 00:13:20,240

each of those images on the left is the

248

00:13:25,350 --> 00:13:23,029

star and on the right is the small

249

00:13:27,360 --> 00:13:25,360

pixels of the brow

250

00:13:29,220 --> 00:13:27,370

or companion all right and so you can

251

00:13:31,560 --> 00:13:29,230

see the star itself is only about five

252

00:13:33,750 --> 00:13:31,570

or six pixels across and the brown dwarf

253

00:13:36,180 --> 00:13:33,760

companion is only one or two pixels

254

00:13:38,009 --> 00:13:36,190

across and the detector and those are

255

00:13:40,710 --> 00:13:38,019

still actually unresolved they're really

256

00:13:43,440 --> 00:13:40,720

smaller than an individual pixel at that

257

00:13:47,430 --> 00:13:43,450

scale so you're really having to work

258

00:13:50,460 --> 00:13:47,440

deep into the data to be able to pull

259

00:13:52,740 --> 00:13:50,470

this out but hey that's what science is

260

00:13:54,540 --> 00:13:52,750

at the cutting edge we don't get

261

00:13:56,340 --> 00:13:54,550

gorgeous pictures we just get these

262

00:13:58,680 --> 00:13:56,350

little tiny little pixel things and

263

00:14:02,670 --> 00:13:58,690

being able to pull out these brown dwarf

264

00:14:05,519 --> 00:14:02,680

companions now needless to say this will

265

00:14:07,470 --> 00:14:05,529

change immeasurably when we have the

266

00:14:10,160 --> 00:14:07,480

james webb space telescope that has

267

00:14:12,240 --> 00:14:10,170

hubble resolution but in the infrared

268

00:14:14,519 --> 00:14:12,250

wavelengths and can see these much more

269

00:14:17,250 --> 00:14:14,529

clearly and i would tell you all about

270

00:14:19,019 --> 00:14:17,260

that but that's the job of our speakers

271

00:14:21,269 --> 00:14:19,029

here tonight so i'll leave it to them to

272

00:14:24,090 --> 00:14:21,279

discuss how the James Webb will take

273

00:14:26,759 --> 00:14:24,100

this and take it to the next level and

274

00:14:32,550 --> 00:14:26,769

really get good census of the brown

275

00:14:34,650 --> 00:14:32,560

dwarfs in the Orion Nebula alright so

276

00:14:39,269 --> 00:14:34,660

now I move on to our featured speakers

277

00:14:42,180 --> 00:14:39,279

tonight they are Bonnie Meinke and Klaus

278

00:14:44,430 --> 00:14:42,190

pontoppidan from the J toasty mission

279

00:14:47,280 --> 00:14:44,440

office as well as Alexander Lockwood

280

00:14:49,380 --> 00:14:47,290

from the Office of public outreach and I

281

00:14:51,120 --> 00:14:49,390

didn't memorize their titles so Bonnie

282

00:14:54,389 --> 00:14:51,130

gave me a title that they are just

283

00:14:56,160 --> 00:14:54,399

absolutely amazing people doing amazing

284

00:14:58,199 --> 00:14:56,170

work here at the Space Telescope Science

285

00:15:00,600 --> 00:14:58,209

Institute so ladies and gentlemen an

286

00:15:01,940 --> 00:15:00,610

amazing team to discuss the James Webb

287

00:15:22,800 --> 00:15:01,950

Space Telescope gimme a hand

288

00:15:31,090 --> 00:15:25,240

is does his work yeah

289

00:15:35,740 --> 00:15:31,100

ah good all right so so my name is Klaus

290

00:15:37,090 --> 00:15:35,750

pontoppidan my official title is deputy

291

00:15:38,560 --> 00:15:37,100

project scientist for the James Webb

292

00:15:43,750 --> 00:15:38,570

Space Telescope here at the Institute

293

00:15:46,150 --> 00:15:43,760

bonnie has the same title and alex is C

294

00:15:49,630 --> 00:15:46,160

is the communications lead polygraph

295

00:15:50,800 --> 00:15:49,640

outreach arm for database T so what we

296

00:15:53,700 --> 00:15:50,810

gonna do with this talk is we're gonna

297

00:15:56,140 --> 00:15:53,710

tag-team it and we gave it three titles

298

00:15:57,190 --> 00:15:56,150

the telescope designs in the legacy and

299

00:15:59,140 --> 00:15:57,200

I'm gonna do the telescope and then

300

00:16:01,300 --> 00:15:59,150

after that I'm gonna give it over to to

301
00:16:05,260 --> 00:16:01,310
Bonnie to talk about science and then

302
00:16:08,770 --> 00:16:05,270
Alex to to talk about the legacy alright

303
00:16:11,830 --> 00:16:08,780
so just to introduce this arm you may

304
00:16:13,270 --> 00:16:11,840
have seen these before I'm not sure what

305
00:16:16,600 --> 00:16:13,280
do we do at the Institute here that's

306
00:16:19,300 --> 00:16:16,610
how how is it related to to the web well

307
00:16:21,640 --> 00:16:19,310
I mean Institute hasn't existed for four

308
00:16:23,800 --> 00:16:21,650
decades now supporting the operations of

309
00:16:27,910 --> 00:16:23,810
the Hubble Space Telescope as you as you

310
00:16:30,640 --> 00:16:27,920
all know very well we're operated by an

311
00:16:32,110 --> 00:16:30,650
organization called the association of

312
00:16:34,840 --> 00:16:32,120
universities for research in astronomy

313
00:16:37,030 --> 00:16:34,850

or aura for short and we're basically a

314

00:16:40,060 --> 00:16:37,040

NASA contract and NASA contracts us to

315

00:16:44,080 --> 00:16:40,070

to run the science part of of its

316

00:16:45,970 --> 00:16:44,090

astronomical space missions and as is

317

00:16:48,550 --> 00:16:45,980

true for Hubble has been true it's true

318

00:16:50,470 --> 00:16:48,560

for the wide field Infrared Survey

319

00:16:53,890 --> 00:16:50,480

telescope and it's true for the James

320

00:16:56,800 --> 00:16:53,900

Webb Space Telescope as well and so

321

00:17:00,190 --> 00:16:56,810

another way to look at it in terms of

322

00:17:04,030 --> 00:17:00,200

roles here is that you need to do many

323

00:17:06,670 --> 00:17:04,040

things to make an astronomy mission I do

324

00:17:08,290 --> 00:17:06,680

have to have our oversight of the

325

00:17:11,710 --> 00:17:08,300

mission and the policy and if somebody

326

00:17:13,480 --> 00:17:11,720

has to drive it from the get-go so NASA

327

00:17:15,550 --> 00:17:13,490

is doing that and the James Webb Space

328

00:17:16,990 --> 00:17:15,560

Telescope is a partnership with European

329

00:17:19,600 --> 00:17:17,000

Space Agency and the Canadian

330

00:17:21,790 --> 00:17:19,610

base agency and so they provide the the

331

00:17:23,530 --> 00:17:21,800

oversight in the policy of cooking new

332

00:17:25,110 --> 00:17:23,540

technology you know gonna have a Space

333

00:17:28,630 --> 00:17:25,120

Telescope unless you have some hardware

334

00:17:30,850 --> 00:17:28,640

and so so that is built in case of James

335

00:17:34,360 --> 00:17:30,860

Webb by Goddard Space Flight Center just

336

00:17:36,010 --> 00:17:34,370

just south of here as well as partners

337

00:17:38,590 --> 00:17:36,020

from the industry Northrop Grumman is

338

00:17:40,690 --> 00:17:38,600

the prime contractor for James Webb I

339

00:17:42,880 --> 00:17:40,700

know also other partners like Ball

340

00:17:45,250 --> 00:17:42,890

Aerospace but then of course you need

341

00:17:47,140 --> 00:17:45,260

science right without without science

342

00:17:51,820 --> 00:17:47,150

you know all your habits is a piece of

343

00:17:54,400 --> 00:17:51,830

machinery and so the Institute here is

344

00:17:56,220 --> 00:17:54,410

responsible for for operating the

345

00:17:59,230 --> 00:17:56,230

telescope for scientists

346

00:18:01,840 --> 00:17:59,240

we are the interface between the

347

00:18:04,420 --> 00:18:01,850

observatory and the international

348

00:18:06,520 --> 00:18:04,430

astronomical community and the same as

349

00:18:07,960 --> 00:18:06,530

as for the Hubble Space Telescope so

350

00:18:11,800 --> 00:18:07,970

anything that has to do with science is

351

00:18:16,300 --> 00:18:11,810

is centered at the at the Institute all

352

00:18:17,860 --> 00:18:16,310

right so the telescope well so we have

353

00:18:20,020 --> 00:18:17,870

the Hubble Space Telescope you all all

354

00:18:23,350 --> 00:18:20,030

know that very well and we we love that

355

00:18:24,760 --> 00:18:23,360

very much you all familiar with the with

356

00:18:27,160 --> 00:18:24,770

the beautiful data and the beautiful

357

00:18:28,720 --> 00:18:27,170

images that Hubble has returned so these

358

00:18:31,330 --> 00:18:28,730

are all these are all Hubble images

359

00:18:34,840 --> 00:18:31,340

taken in the indivisible wavelengths

360

00:18:38,770 --> 00:18:34,850

range in the optical visible with with

361

00:18:41,200 --> 00:18:38,780

our eyes and has been operating for many

362

00:18:42,400 --> 00:18:41,210

years now you know this isn't this

363

00:18:45,430 --> 00:18:42,410

awesome you know what more do you need

364

00:18:47,110 --> 00:18:45,440

than this you know how do you do some

365

00:18:50,500 --> 00:18:47,120

how do you do the next big thing what

366

00:18:51,640 --> 00:18:50,510

what what is that going to be well so so

367

00:18:52,990 --> 00:18:51,650

so one of the some of the things that

368

00:18:54,670 --> 00:18:53,000

that Hubble has been doing and really

369

00:18:58,800 --> 00:18:54,680

showing us that these deep fields of

370

00:19:01,150 --> 00:18:58,810

galaxies high-redshift galaxies to

371

00:19:03,280 --> 00:19:01,160

enormous distances in the universe and

372

00:19:04,930 --> 00:19:03,290

it looks back in time of course ah to

373

00:19:10,270 --> 00:19:04,940

the not quite the beginning of the

374

00:19:13,000 --> 00:19:10,280

universe but but but but close and and

375

00:19:17,230 --> 00:19:13,010

and deep exposures with with Hubble has

376

00:19:19,780 --> 00:19:17,240

you know has has revealed faint galaxies

377

00:19:24,160 --> 00:19:19,790

at at the edge of where of detection

378

00:19:26,230 --> 00:19:24,170

here this is related to the to the

379

00:19:30,190 --> 00:19:26,240

original concept of the James Webb Space

380

00:19:30,880 --> 00:19:30,200

Telescope as it was conceived already

381

00:19:38,650 --> 00:19:30,890

back in the mid

382

00:19:40,900 --> 00:19:38,660

90s it was realized that if you want to

383

00:19:43,510 --> 00:19:40,910

go really to the weight to the back to

384

00:19:45,280 --> 00:19:43,520

the beginning of the universe you have

385

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

to take into account cosmological

386

00:19:47,920 --> 00:19:45,920

redshift

387

00:19:51,460 --> 00:19:47,930

all right so essentially what happens is

388

00:19:53,020 --> 00:19:51,470

where the galaxy emits light and I said

389

00:19:56,470 --> 00:19:53,030

light travel through the universe to

390

00:19:57,910 --> 00:19:56,480

light stretches and becomes redder and

391

00:20:01,210 --> 00:19:57,920

by the time it reaches to us and can be

392

00:20:02,890 --> 00:20:01,220

quite red and if the galaxy is old

393

00:20:04,270 --> 00:20:02,900

enough if the light was emitted long

394

00:20:07,060 --> 00:20:04,280

enough to go that means if the galaxy is

395

00:20:09,310 --> 00:20:07,070

far enough away that that red shift that

396

00:20:11,500 --> 00:20:09,320

cosmological redshift is large enough to

397

00:20:13,570 --> 00:20:11,510

shift that light out of the wavelength

398

00:20:16,840 --> 00:20:13,580

range if James Webb right it becomes to

399

00:20:19,090 --> 00:20:16,850

read it becomes infrared and basically

400

00:20:20,740 --> 00:20:19,100

the galaxy disappears from U of Hubble

401
00:20:22,870 --> 00:20:20,750
and you won't need no longer see it and

402
00:20:26,110 --> 00:20:22,880
in order to see that galaxy

403
00:20:27,930 --> 00:20:26,120
you'd need sensitive Space Telescope

404
00:20:31,300 --> 00:20:27,940
that operates at longer wavelengths than

405
00:20:33,640 --> 00:20:31,310
Hubble indi in the infrared and that was

406
00:20:35,920 --> 00:20:33,650
the original impetus for James Webb it

407
00:20:38,080 --> 00:20:35,930
was to be able to see the first galaxies

408
00:20:40,000 --> 00:20:38,090
first light in the universe by going to

409
00:20:43,810 --> 00:20:40,010
the infrared to see the most red shifted

410
00:20:48,490 --> 00:20:46,740
of course today this is decades to go

411
00:20:49,780 --> 00:20:48,500
other people have looked at this

412
00:20:51,580 --> 00:20:49,790
telescope and you're like well you know

413
00:20:53,530 --> 00:20:51,590

you have this big infrared telescope and

414

00:20:56,470 --> 00:20:53,540

you could do this awesome science when

415

00:20:57,940 --> 00:20:56,480

this was first started there was no such

416

00:20:59,710 --> 00:20:57,950

thing as exoplanets and now we have

417

00:21:01,090 --> 00:20:59,720

thousands of exoplanets and so a lot of

418

00:21:03,250 --> 00:21:01,100

work has been going into the James Webb

419

00:21:05,410 --> 00:21:03,260

to make sure that it can also get

420

00:21:07,000 --> 00:21:05,420

great data in in the area of exoplanets

421

00:21:10,090 --> 00:21:07,010

and this goes on and on for many many

422

00:21:12,340 --> 00:21:10,100

different science areas all right so

423

00:21:14,110 --> 00:21:12,350

what let me say a few more things about

424

00:21:16,330 --> 00:21:14,120

the infrared here so here we have our

425

00:21:19,810 --> 00:21:16,340

just visible rainbow just to give you

426

00:21:22,330 --> 00:21:19,820

some context from from blue to red

427

00:21:25,030 --> 00:21:22,340

high-energy low-energy short wavelength

428

00:21:26,920 --> 00:21:25,040

long wavelength of course this is only a

429

00:21:29,980 --> 00:21:26,930

very very small part of the of the

430

00:21:31,480 --> 00:21:29,990

electromagnetic spectrum to the to the

431

00:21:34,230 --> 00:21:31,490

high-energy side you have ultraviolet

432

00:21:36,220 --> 00:21:34,240

radiation x-rays gamma rays these all

433

00:21:38,080 --> 00:21:36,230

wavelengths that are very unhealthy to

434

00:21:39,970 --> 00:21:38,090

humans so you don't want to expose

435

00:21:43,510 --> 00:21:39,980

yourself too much to those because they

436

00:21:44,450 --> 00:21:43,520

break chemical bonds and can give you

437

00:21:46,250 --> 00:21:44,460

all sorts of

438

00:21:47,750 --> 00:21:46,260

nasty effects going to the other way

439

00:21:49,400 --> 00:21:47,760

it's low energy you get infrared

440

00:21:50,660 --> 00:21:49,410

microwave you can heat your food but

441

00:21:55,550 --> 00:21:50,670

it's not going to break your molecules

442

00:21:57,500 --> 00:21:55,560

apart so it's a lot safer point here is

443

00:22:00,170 --> 00:21:57,510

that the visible is only a tiny tiny

444

00:22:02,420 --> 00:22:00,180

fraction of the of the introspect of the

445

00:22:04,490 --> 00:22:02,430

electromagnetic spectrum and so James

446

00:22:06,560 --> 00:22:04,500

Webb is going to give us a lot of the

447

00:22:08,090 --> 00:22:06,570

infrared or access to that so here's how

448

00:22:10,910 --> 00:22:08,100

here's an indication of that you have

449

00:22:12,800 --> 00:22:10,920

the range of Hubble goes out a little

450

00:22:15,350 --> 00:22:12,810

bit into the near-infrared around to

451
00:22:17,990 --> 00:22:15,360
about 1.8 micron or something like that

452
00:22:19,910 --> 00:22:18,000
and then it stops data bisti is going to

453
00:22:23,200 --> 00:22:19,920
be a little bit into the visible

454
00:22:25,550 --> 00:22:23,210
actually goes down to about yellow light

455
00:22:27,380 --> 00:22:25,560
and it's going to go way into the

456
00:22:28,790 --> 00:22:27,390
infrared beyond the near-infrared what

457
00:22:31,040 --> 00:22:28,800
we call the mid infrared or the thermal

458
00:22:37,280 --> 00:22:31,050
infrared out to twenty-eight micron and

459
00:22:39,380 --> 00:22:37,290
a little bit so in terms of of grasp

460
00:22:41,210 --> 00:22:39,390
there's actually a wider grasp in terms

461
00:22:42,500 --> 00:22:41,220
of wavelength of data vis T than and for

462
00:22:46,400 --> 00:22:42,510
Hubble so there's a lot of things in

463
00:22:48,350 --> 00:22:46,410

there all right so so people got back in

464

00:22:51,920 --> 00:22:48,360

the mid 90s got together and thought

465

00:22:53,210 --> 00:22:51,930

okay so how do we do this and there's a

466

00:22:54,590 --> 00:22:53,220

number of challenges with making an

467

00:22:56,450 --> 00:22:54,600

infrared Space Telescope and it's not

468

00:22:57,740 --> 00:22:56,460

gonna end up not gonna look like like

469

00:22:59,810 --> 00:22:57,750

hubble so this is an early sketch

470

00:23:03,950 --> 00:22:59,820

actually you know essentially on a piece

471

00:23:05,630 --> 00:23:03,960

of napkin considering what such a Space

472

00:23:07,100 --> 00:23:05,640

Telescope might look like well for one

473

00:23:10,820 --> 00:23:07,110

thing is you need you know there had to

474

00:23:13,640 --> 00:23:10,830

be a large mirror in it and so you can

475

00:23:15,770 --> 00:23:13,650

see this here you can see a deployable

476

00:23:17,180 --> 00:23:15,780

mirror this here that doesn't even have

477

00:23:19,670 --> 00:23:17,190

a filled aperture that's actually gaps

478

00:23:20,840 --> 00:23:19,680

in between and the idea here is that you

479

00:23:23,270 --> 00:23:20,850

have something that was folded up and

480

00:23:25,460 --> 00:23:23,280

falls out once you're in orbit so you

481

00:23:26,660 --> 00:23:25,470

can fit into a rocket so that's one

482

00:23:27,920 --> 00:23:26,670

thing to note about another thing to

483

00:23:29,810 --> 00:23:27,930

know about is there's no baffle all

484

00:23:31,970 --> 00:23:29,820

right so so Hubble is enclosed into a

485

00:23:33,650 --> 00:23:31,980

tube in order to make this deployment

486

00:23:36,890 --> 00:23:33,660

here you couldn't have have a tube

487

00:23:38,480 --> 00:23:36,900

around it so there's no baffle and the

488

00:23:41,390 --> 00:23:38,490

final thing to note is this big thing

489

00:23:43,580 --> 00:23:41,400

that it sits on and that's a that's a

490

00:23:45,140 --> 00:23:43,590

Sun shield and the reason you need a Sun

491

00:23:47,270 --> 00:23:45,150

shield they said to have an infertility

492

00:23:49,340 --> 00:23:47,280

up that is sensitive that can see faint

493

00:23:50,990 --> 00:23:49,350

things needed to be super cold

494

00:23:52,820 --> 00:23:51,000

I really really called Hubble it's kind

495

00:23:54,380 --> 00:23:52,830

of room temperature this has to be much

496

00:23:56,540 --> 00:23:54,390

much much colder and we'll go into that

497

00:23:58,070 --> 00:23:56,550

a little bit more detail so in order to

498

00:24:00,110 --> 00:23:58,080

keep this cold you

499

00:24:01,340 --> 00:24:00,120

have soul sunlight shining directly on

500

00:24:04,310 --> 00:24:01,350

it so you have to have this big

501
00:24:06,830 --> 00:24:04,320
insulating shield to protect it from the

502
00:24:08,419 --> 00:24:06,840
Sun it also means that that you know

503
00:24:10,940 --> 00:24:08,429
there are some limitations and where you

504
00:24:14,060 --> 00:24:10,950
can point because you can't turn this R

505
00:24:15,680 --> 00:24:14,070
to face the Sun I mean if if the if the

506
00:24:17,990 --> 00:24:15,690
telescope itself would ever see the Sun

507
00:24:21,710 --> 00:24:18,000
it would heat up and and ruin your your

508
00:24:23,389 --> 00:24:21,720
day alright so what we have now today is

509
00:24:26,029 --> 00:24:23,399
is something that looks more like that

510
00:24:27,649 --> 00:24:26,039
comes from the napkin ends up it subs

511
00:24:30,560 --> 00:24:27,659
like this here and so you have to go far

512
00:24:33,019 --> 00:24:30,570
away from from the both the earth and

513
00:24:35,389 --> 00:24:33,029

the moon because the earth is is like a

514

00:24:37,279 --> 00:24:35,399

big heat lamp as well and so it goes a

515

00:24:40,190 --> 00:24:37,289

million miles away from the earth down

516

00:24:41,269 --> 00:24:40,200

to a point in space called L2 which is

517

00:24:42,649 --> 00:24:41,279

point of balance between the

518

00:24:46,279 --> 00:24:42,659

gravitational field of the Sun and the

519

00:24:49,009 --> 00:24:46,289

earth but I find it fascinating that

520

00:24:51,350 --> 00:24:49,019

from that all drawing and what it looks

521

00:24:53,210 --> 00:24:51,360

like today I mean you can kind of

522

00:24:54,769 --> 00:24:53,220

recognize it has the elements it has no

523

00:25:01,029 --> 00:24:54,779

baffle it has a deployable mirror and

524

00:25:03,259 --> 00:25:01,039

has a big Sun shield alright alright so

525

00:25:05,180 --> 00:25:03,269

let me talk a little bit more about so

526

00:25:06,560 --> 00:25:05,190

the the general application of infrared

527

00:25:09,019 --> 00:25:06,570

as well and so Frank talked a little bit

528

00:25:10,940 --> 00:25:09,029

about that just just earlier like one

529

00:25:12,680 --> 00:25:10,950

thing is you can you can see very faint

530

00:25:13,509 --> 00:25:12,690

galaxies but you can do so much more

531

00:25:16,700 --> 00:25:13,519

than that

532

00:25:20,029 --> 00:25:16,710

so hey here's an example here you can

533

00:25:21,590 --> 00:25:20,039

look at at the formation of stars and

534

00:25:23,870 --> 00:25:21,600

planets for example here so here if you

535

00:25:25,490 --> 00:25:23,880

got on a dark night on a dark place

536

00:25:27,080 --> 00:25:25,500

that's much darker than Baltimore or

537

00:25:28,460 --> 00:25:27,090

most places on the East Coast but if

538

00:25:30,379 --> 00:25:28,470

you're lucky you can you'll have access

539

00:25:33,740 --> 00:25:30,389

to a to a dark place like this you can

540

00:25:36,860 --> 00:25:33,750

see the Milky Way yes up here is you see

541

00:25:38,149 --> 00:25:36,870

you there that's a laser yeah up here

542

00:25:40,730 --> 00:25:38,159

you have close the center of the Milky

543

00:25:42,500 --> 00:25:40,740

Way and you also see that the Milky Way

544

00:25:43,850 --> 00:25:42,510

is you know there's a bright still a

545

00:25:47,269 --> 00:25:43,860

background field but there's and there's

546

00:25:50,180 --> 00:25:47,279

lots of dark clouds in those dark clouds

547

00:25:53,210 --> 00:25:50,190

of course are consist of gas and dust

548

00:25:54,649 --> 00:25:53,220

and this is where stars form so you can

549

00:25:55,940 --> 00:25:54,659

zoom into one of the places let me let

550

00:25:58,669 --> 00:25:55,950

me go back here so you can see here this

551
00:26:02,629 --> 00:25:58,679
go to a better image here assuming that

552
00:26:06,049 --> 00:26:02,639
that region here low resolution Frank

553
00:26:07,430 --> 00:26:06,059
does you can enhance this this is a one

554
00:26:10,220 --> 00:26:07,440
of the nearest star forming regions it's

555
00:26:11,380 --> 00:26:10,230
about four times near three or four

556
00:26:13,539 --> 00:26:11,390
times nearer than or

557
00:26:16,539 --> 00:26:13,549
and Frank showed this it's called a few

558
00:26:19,440 --> 00:26:16,549
cos this is an area that forms stars

559
00:26:21,730 --> 00:26:19,450
much like our Sun so low-mass stars and

560
00:26:24,070 --> 00:26:21,740
but it's really dominating and you can

561
00:26:25,480 --> 00:26:24,080
see these streamers here of dust that's

562
00:26:28,660 --> 00:26:25,490
what you see and again these are visible

563
00:26:30,190 --> 00:26:28,670

visible images you can make a bigger

564

00:26:31,720 --> 00:26:30,200

telescope you can make a deeper

565

00:26:32,740 --> 00:26:31,730

integration here and you see more more

566

00:26:35,110 --> 00:26:32,750

structure here again it's the same

567

00:26:37,960 --> 00:26:35,120

region it's just a longer integration

568

00:26:40,660 --> 00:26:37,970

time with a bigger telescope can zoom in

569

00:26:43,090 --> 00:26:40,670

on that yeah and you see more of this

570

00:26:45,580 --> 00:26:43,100

this dark cloud he don't he can also

571

00:26:47,020 --> 00:26:45,590

enhance that so again we have dark cloud

572

00:26:48,850 --> 00:26:47,030

here so I wants you to focus in this

573

00:26:49,630 --> 00:26:48,860

area here very dark but not much is

574

00:26:54,909 --> 00:26:49,640

going on there

575

00:26:58,090 --> 00:26:54,919

zoom in again here Wow enhance okay this

576

00:27:00,370 --> 00:26:58,100

is very dark again this is a low mass

577

00:27:02,799 --> 00:27:00,380

star forming region once you go to the

578

00:27:04,810 --> 00:27:02,809

to the infrared let's go a little bit

579

00:27:08,289 --> 00:27:04,820

into the infrared to start with that but

580

00:27:09,640 --> 00:27:08,299

also note that you see the dark cloudy

581

00:27:11,169 --> 00:27:09,650

and you see around it there's there's

582

00:27:12,970 --> 00:27:11,179

some light here this is actually light

583

00:27:15,250 --> 00:27:12,980

that's scattered off of dust grains from

584

00:27:16,330 --> 00:27:15,260

stars in the surrounding area so you see

585

00:27:18,610 --> 00:27:16,340

a little bit of light there when you go

586

00:27:20,710 --> 00:27:18,620

into the near-infrared just you know to

587

00:27:22,870 --> 00:27:20,720

micro 2 micrometers or so it looks like

588

00:27:26,169 --> 00:27:22,880

this so all the scattered light fades

589

00:27:28,810 --> 00:27:26,179

away and you start to see these these

590

00:27:31,450 --> 00:27:28,820

red things inside the cloud these are

591

00:27:34,060 --> 00:27:31,460

forming young stars that were there were

592

00:27:35,860 --> 00:27:34,070

hidden before and you see look and you

593

00:27:38,650 --> 00:27:35,870

see a lot of these these more widely

594

00:27:40,659 --> 00:27:38,660

stars he's a background stars so stars

595

00:27:41,950 --> 00:27:40,669

located behind the cloud but there's

596

00:27:43,600 --> 00:27:41,960

more to it than that so this is just to

597

00:27:46,390 --> 00:27:43,610

my friend so so the Hubble can sort of

598

00:27:48,850 --> 00:27:46,400

almost which this kind of infrared James

599

00:27:51,280 --> 00:27:48,860

Webb can do more all right so if you

600

00:27:54,010 --> 00:27:51,290

continue a journey into the mid infrared

601
00:27:56,830 --> 00:27:54,020
into the thermal infrared this area

602
00:27:59,740 --> 00:27:56,840
looks like this and what you see now is

603
00:28:02,200 --> 00:27:59,750
that dust itself starts to shine so in a

604
00:28:04,720 --> 00:28:02,210
near infrared you see through dust in

605
00:28:07,150 --> 00:28:04,730
the mid infrared dust itself lights up

606
00:28:09,789 --> 00:28:07,160
so here you see this bright areas here

607
00:28:12,310 --> 00:28:09,799
these are actually tiny dust grains that

608
00:28:15,360 --> 00:28:12,320
are made of it's kind of like a smog

609
00:28:18,580 --> 00:28:15,370
it's made of complex organic chemistry

610
00:28:21,340 --> 00:28:18,590
those light up brightly you also see

611
00:28:23,380 --> 00:28:21,350
these red stars now you know these

612
00:28:24,649 --> 00:28:23,390
scattered in among these these blue

613
00:28:26,269 --> 00:28:24,659

stars the

614

00:28:27,979 --> 00:28:26,279

nustar's you just regular starter in

615

00:28:29,389 --> 00:28:27,989

infrared and emit infrared this will be

616

00:28:31,580 --> 00:28:29,399

blue these are background stars just

617

00:28:32,659 --> 00:28:31,590

boring old stars with nothing under

618

00:28:35,060 --> 00:28:32,669

although of course many of them will

619

00:28:37,369 --> 00:28:35,070

have planets but the red ones here those

620

00:28:38,779 --> 00:28:37,379

are stars that have protoplanetary discs

621

00:28:41,629 --> 00:28:38,789

around them so they're surrounded by

622

00:28:43,159 --> 00:28:41,639

discs of gas and dust that are circling

623

00:28:45,169 --> 00:28:43,169

around them and those discs actively

624

00:28:47,149 --> 00:28:45,179

forming planets so when you go to the

625

00:28:49,580 --> 00:28:47,159

midden for this it's it's very easy to

626

00:28:51,139 --> 00:28:49,590

pick out the objects that are right now

627

00:28:56,659 --> 00:28:51,149

currently forming planets it's the red

628

00:28:59,629 --> 00:28:56,669

ones and and so and this is an example

629

00:29:04,639 --> 00:28:59,639

of what you gain from going to longer

630

00:29:07,339 --> 00:29:04,649

wavelengths and and Hubble beyond the

631

00:29:10,339 --> 00:29:07,349

original galaxy formation case and so

632

00:29:13,099 --> 00:29:10,349

why is it that that that you see dust in

633

00:29:15,680 --> 00:29:13,109

and mid-infrared wavelengths well what

634

00:29:18,889 --> 00:29:15,690

you can do is is you can look at this

635

00:29:20,960 --> 00:29:18,899

relation here between temperature and

636

00:29:23,719 --> 00:29:20,970

wavelengths so anything that has a

637

00:29:25,789 --> 00:29:23,729

temperature emits light if it's if it's

638

00:29:29,659 --> 00:29:25,799

hot enough you know you can get white

639

00:29:31,940 --> 00:29:29,669

hot iron for example that emits light on

640

00:29:34,159 --> 00:29:31,950

its own because it's hot enough and

641

00:29:35,779 --> 00:29:34,169

stars emit light because they're hot in

642

00:29:37,879 --> 00:29:35,789

offices so starts a thousands of degrees

643

00:29:39,649 --> 00:29:37,889

on their surface and so we can see them

644

00:29:41,629 --> 00:29:39,659

you look at the Sun it emits lights on

645

00:29:43,070 --> 00:29:41,639

its own the earth it we're standing on

646

00:29:44,960 --> 00:29:43,080

it's also emitting light but we can see

647

00:29:47,029 --> 00:29:44,970

it because it emits light in the

648

00:29:48,320 --> 00:29:47,039

infrared because it's cooler and so this

649

00:29:50,869 --> 00:29:48,330

is just to give an indication of

650

00:29:53,419 --> 00:29:50,879

relation between the temperature of an

651
00:29:55,129 --> 00:29:53,429
object you know different planets and in

652
00:29:58,070 --> 00:29:55,139
the solar system and what wavelengths

653
00:29:59,930 --> 00:29:58,080
their peak emission comes out at so you

654
00:30:01,279 --> 00:29:59,940
have stars here through the visible once

655
00:30:04,190 --> 00:30:01,289
you go out into the infrared you have

656
00:30:05,749 --> 00:30:04,200
Venus comes here that peaks at 4-4

657
00:30:08,719 --> 00:30:05,759
micron or something like that

658
00:30:10,549 --> 00:30:08,729
earth itself itself emission peaks at

659
00:30:12,680 --> 00:30:10,559
around 10 micrometers and then if you

660
00:30:14,330 --> 00:30:12,690
garden the outer solar system you end up

661
00:30:16,129 --> 00:30:14,340
in in beyond the mid infrared what's

662
00:30:18,200 --> 00:30:16,139
called the far infrared so something

663
00:30:22,099 --> 00:30:18,210

like Pluto emits most of it light slide

664

00:30:23,960 --> 00:30:22,109

at you know 70 80 micro meters beyond

665

00:30:26,719 --> 00:30:23,970

what j-dub is T can do but you can see

666

00:30:29,719 --> 00:30:26,729

that that that the data was T range here

667

00:30:31,009 --> 00:30:29,729

the web range is is perfect if you're

668

00:30:34,639 --> 00:30:31,019

interested in looking at things that

669

00:30:35,960 --> 00:30:34,649

have room temperature and of course you

670

00:30:37,450 --> 00:30:35,970

are right because we're interested in

671

00:30:39,580 --> 00:30:37,460

looking at planets with room temp

672

00:30:44,110 --> 00:30:39,590

for example we're interested in look in

673

00:30:46,779 --> 00:30:44,120

understanding dust and material in in

674

00:30:48,970 --> 00:30:46,789

planet-forming regions that that is much

675

00:30:51,070 --> 00:30:48,980

like you know what we're surrounded yeah

676

00:30:52,180 --> 00:30:51,080

in in this room so if you're not so

677

00:30:53,560 --> 00:30:52,190

lesson is if you want to look at cool

678

00:30:55,210 --> 00:30:53,570

cool things you want to go to the middle

679

00:30:58,659 --> 00:30:55,220

into there to the infrared and

680

00:31:01,360 --> 00:30:58,669

particularly the median fret alright so

681

00:31:02,740 --> 00:31:01,370

in terms of size for that so again you

682

00:31:07,440 --> 00:31:02,750

want to be cold you want to be big this

683

00:31:12,010 --> 00:31:07,450

is James Webb compared to to Hubble

684

00:31:15,070 --> 00:31:12,020

they're actually about in in a sense the

685

00:31:17,019 --> 00:31:15,080

data base T is not that that much much

686

00:31:19,200 --> 00:31:17,029

bigger that's actually in terms of mass

687

00:31:21,789 --> 00:31:19,210

not a much different and and then Hubble

688

00:31:25,659 --> 00:31:21,799

but because it has this this sort of

689

00:31:27,880 --> 00:31:25,669

modern design with no baffle dominated

690

00:31:31,450 --> 00:31:27,890

by Sun shield which is really very thin

691

00:31:33,190 --> 00:31:31,460

layers of insulating material you can

692

00:31:38,200 --> 00:31:33,200

get a much bigger telescope for the same

693

00:31:41,350 --> 00:31:38,210

for the same kind of of mass here is

694

00:31:44,019 --> 00:31:41,360

here is the design related to keeping a

695

00:31:47,710 --> 00:31:44,029

telescope cool so you'll have this side

696

00:31:49,630 --> 00:31:47,720

here which is always facing the Sun it's

697

00:31:53,590 --> 00:31:49,640

a warm side and so that contains the

698

00:31:55,240 --> 00:31:53,600

spacecraft communications computer all

699

00:31:56,490 --> 00:31:55,250

those things it's actually quite hot

700

00:31:59,620 --> 00:31:56,500

about a hundred eighty five degrees

701
00:32:01,630 --> 00:31:59,630
Fahrenheit and then as a cold side here

702
00:32:04,990 --> 00:32:01,640
with all the with the science payload is

703
00:32:06,549 --> 00:32:05,000
because has all the optics light comes

704
00:32:10,029 --> 00:32:06,559
in here bounces off the primary because

705
00:32:11,860 --> 00:32:10,039
the secondary goes into this package

706
00:32:13,600 --> 00:32:11,870
here which is the the instrument package

707
00:32:16,120 --> 00:32:13,610
so all the science instrument cameras

708
00:32:19,269 --> 00:32:16,130
and things like that sits it behind the

709
00:32:22,299 --> 00:32:19,279
the primary mirror here and is also on

710
00:32:24,700 --> 00:32:22,309
the cold side about minus 400 degrees

711
00:32:26,409 --> 00:32:24,710
Fahrenheit so you can imagine the

712
00:32:28,060 --> 00:32:26,419
temperature gradient across here is

713
00:32:29,380 --> 00:32:28,070

enormous through these five layers of

714

00:32:31,000 --> 00:32:29,390

Sun shield it's it's quite an

715

00:32:37,260 --> 00:32:31,010

engineering feat to to make that

716

00:32:40,600 --> 00:32:37,270

possible so what do you get from having

717

00:32:43,690 --> 00:32:40,610

a large telescope that is cold in the

718

00:32:46,090 --> 00:32:43,700

infrared well we can compare what in a

719

00:32:48,730 --> 00:32:46,100

million Fred what Webb can do compared

720

00:32:49,960 --> 00:32:48,740

to what has been possible in the past

721

00:32:51,010 --> 00:32:49,970

for example with the Spitzer Space

722

00:32:53,170 --> 00:32:51,020

Telescope

723

00:32:55,690 --> 00:32:53,180

we may have heard about which is NASA's

724

00:32:59,290 --> 00:32:55,700

last infrared telescope which was an 85

725

00:33:03,580 --> 00:32:59,300

centimeter mirror right so just over

726

00:33:05,620 --> 00:33:03,590

over a couple of feet so if you look at

727

00:33:08,260 --> 00:33:05,630

the science case where you're looking at

728

00:33:09,820 --> 00:33:08,270

star formation the star forming region I

729

00:33:11,410 --> 00:33:09,830

showed you and many others and Orion

730

00:33:13,510 --> 00:33:11,420

itself is all contained within this

731

00:33:14,890 --> 00:33:13,520

little circle here and in our galaxy

732

00:33:19,390 --> 00:33:14,900

it's quite far it's about eight

733

00:33:22,300 --> 00:33:19,400

kiloparsecs to the to the center once

734

00:33:24,430 --> 00:33:22,310

you go you go to web and you apply that

735

00:33:27,700 --> 00:33:24,440

to the same kind of science looking at

736

00:33:29,800 --> 00:33:27,710

young stars how far away in the galaxy

737

00:33:31,480 --> 00:33:29,810

can you can you do the same kind of

738

00:33:34,150 --> 00:33:31,490

science at Spitzer could do in the in

739

00:33:38,620 --> 00:33:34,160

the solar neighborhood well it expands

740

00:33:40,650 --> 00:33:38,630

our horizon like this and we web will

741

00:33:43,450 --> 00:33:40,660

allow us to do the same kind of science

742

00:33:45,580 --> 00:33:43,460

but across the galaxy two completely

743

00:33:46,930 --> 00:33:45,590

different regions we can we can look at

744

00:33:49,030 --> 00:33:46,940

star and planet information near the

745

00:33:51,910 --> 00:33:49,040

galactic center we can look go to the

746

00:33:54,070 --> 00:33:51,920

other side look for our you know what

747

00:33:56,560 --> 00:33:54,080

happens if you're you're out in areas

748

00:33:58,530 --> 00:33:56,570

where you don't have as much dust where

749

00:34:01,240 --> 00:33:58,540

less was formed with it's more quiet and

750

00:34:05,160 --> 00:34:01,250

we can really understand

751

00:34:08,889 --> 00:34:05,170

planets and stars in in a galactic

752

00:34:10,899 --> 00:34:08,899

context and a galactic sense all right

753

00:34:13,659 --> 00:34:10,909

compared to people this is how big it is

754

00:34:15,820 --> 00:34:13,669

so this is a model was at Goddard at

755

00:34:18,520 --> 00:34:15,830

this point here and see some of the

756

00:34:20,710 --> 00:34:18,530

people who've been working on it so it's

757

00:34:24,010 --> 00:34:20,720

about tennis court size once it's fully

758

00:34:26,950 --> 00:34:24,020

deployed of course you can't fit that

759

00:34:29,710 --> 00:34:26,960

into a rocket so so Webb will be

760

00:34:32,620 --> 00:34:29,720

launched by the European Space Agency in

761

00:34:34,330 --> 00:34:32,630

an area in five from Kourou in in South

762

00:34:36,790 --> 00:34:34,340

America and so here's an example of that

763

00:34:39,010 --> 00:34:36,800

and you can look inside the Ariane 5

764

00:34:41,230 --> 00:34:39,020

fairing here and you can see how Webb

765

00:34:43,570 --> 00:34:41,240

will be all folded up the sides will

766

00:34:46,180 --> 00:34:43,580

have come back from the from the primary

767

00:34:48,220 --> 00:34:46,190

mirror in orbit they get folded out and

768

00:34:52,180 --> 00:34:48,230

the Sun shield is also folded up into

769

00:34:53,649 --> 00:34:52,190

two pallets and sit along the the mirror

770

00:34:55,480 --> 00:34:53,659

so it's again it's a quite an

771

00:34:57,910 --> 00:34:55,490

engineering feat to make this all fit

772

00:35:02,110 --> 00:34:57,920

together so it can fit inside and in an

773

00:35:04,540 --> 00:35:02,120

area in five there's a lot of progress

774

00:35:08,920 --> 00:35:04,550

has been made on the telescope

775

00:35:10,960 --> 00:35:08,930

so here is here's a recent image from

776

00:35:14,320 --> 00:35:10,970

this is from Goddard when it was still

777

00:35:16,780 --> 00:35:14,330

there fully deployed science payload you

778

00:35:19,150 --> 00:35:16,790

can see the golden mirror here covered

779

00:35:21,670 --> 00:35:19,160

in gold for the best reflectivity in the

780

00:35:23,710 --> 00:35:21,680

in the infrared so I was covered in gold

781

00:35:27,280 --> 00:35:23,720

because he's a secondary up here also

782

00:35:29,980 --> 00:35:27,290

also covered in gold this is the the

783

00:35:31,600 --> 00:35:29,990

instrument module as you can see sea

784

00:35:33,460 --> 00:35:31,610

instruments that are bolted onto the

785

00:35:35,380 --> 00:35:33,470

sides here so it has four instruments in

786

00:35:37,990 --> 00:35:35,390

here I'll show you an overview of those

787

00:35:40,810 --> 00:35:38,000

a bit later here you can see the

788

00:35:47,980 --> 00:35:40,820

instrument package put in place behind

789

00:35:50,560 --> 00:35:47,990

the the primary mirror and after it was

790

00:35:53,470 --> 00:35:50,570

all completed the science payload at at

791

00:35:56,940 --> 00:35:53,480

Goddard was transported to Johnson Space

792

00:36:00,840 --> 00:35:56,950

Center in in Texas where underwent

793

00:36:06,250 --> 00:36:00,850

extensive tests with the inside this big

794

00:36:07,870 --> 00:36:06,260

vacuum cryogenic vacuum chamber had to

795

00:36:12,640 --> 00:36:07,880

be very big this was originally built

796

00:36:14,109 --> 00:36:12,650

for for testing Apollo and so so the

797

00:36:16,060 --> 00:36:14,119

whole the whole science payload was

798

00:36:16,990 --> 00:36:16,070

tested all together in there and that

799

00:36:19,150 --> 00:36:17,000

test has just been successfully

800

00:36:23,200 --> 00:36:19,160

completed and it's out of that that

801
00:36:25,390 --> 00:36:23,210
chamber again and here you have the the

802
00:36:28,030 --> 00:36:25,400
sunshield they'll be as a spacecraft

803
00:36:29,530 --> 00:36:28,040
pass underneath here with all that

804
00:36:32,950 --> 00:36:29,540
basically these are the two pieces at

805
00:36:35,220 --> 00:36:32,960
the left of the observatory so the

806
00:36:37,300 --> 00:36:35,230
science payload he'll be shipped to

807
00:36:39,430 --> 00:36:37,310
Northrop Grumman in California

808
00:36:40,840 --> 00:36:39,440
where the Sun shield is and will be made

809
00:36:42,640 --> 00:36:40,850
it two together and it'll be a number of

810
00:36:43,599 --> 00:36:42,650
tests all together with a spacecraft all

811
00:36:45,660 --> 00:36:43,609
together and for the first time you'll

812
00:36:48,099 --> 00:36:45,670
be able to see the whole thing together

813
00:36:49,210 --> 00:36:48,109

instead of looking at at artist's

814

00:36:50,680 --> 00:36:49,220

impressions and that's the best

815

00:36:52,870 --> 00:36:50,690

essentially last step that integration

816

00:36:54,609 --> 00:36:52,880

and testing then it'll be packed up and

817

00:36:58,450 --> 00:36:54,619

shipped to to South America for launch

818

00:37:03,550 --> 00:36:58,460

which is slated for the second quarter

819

00:37:04,870 --> 00:37:03,560

right now of 2019 at the end of you know

820

00:37:06,520 --> 00:37:04,880

you might want to stick around to the

821

00:37:10,270 --> 00:37:06,530

end of this presentation because there's

822

00:37:13,050 --> 00:37:10,280

we have a very very very cool little

823

00:37:18,280 --> 00:37:13,060

video that shows the Assembly of this so

824

00:37:22,170 --> 00:37:18,290

it looks nice alright so

825

00:37:27,760 --> 00:37:25,240

in the Observatory name before called

826

00:37:28,990 --> 00:37:27,770

near speck near kam Mirian nearest point

827

00:37:31,600 --> 00:37:29,000

of this year is that this is what it's

828

00:37:33,880 --> 00:37:31,610

called a focal plane so essentially when

829

00:37:36,010 --> 00:37:33,890

you're pointed on the sky each

830

00:37:37,800 --> 00:37:36,020

instrument points at some place in the

831

00:37:40,240 --> 00:37:37,810

sky the same time but not the same place

832

00:37:42,580 --> 00:37:40,250

so here near kam that's a near infrared

833

00:37:44,590 --> 00:37:42,590

camera that will point at this part of

834

00:37:48,130 --> 00:37:44,600

the sky Miri which is emit infrared

835

00:37:49,780 --> 00:37:48,140

instrument pointer to sky the same time

836

00:37:51,640 --> 00:37:49,790

but a slightly different different spot

837

00:37:53,410 --> 00:37:51,650

so it's actually possible to operate

838

00:37:55,030 --> 00:37:53,420

more than one instrument at the same

839

00:37:56,860 --> 00:37:55,040

time and can take pictures with both

840

00:37:57,850 --> 00:37:56,870

near cam and with Miri at the same time

841

00:38:00,010 --> 00:37:57,860

they're just looking at slightly

842

00:38:03,340 --> 00:38:00,020

different spots in the sky and if you're

843

00:38:06,160 --> 00:38:03,350

smart you might say if you're mapping a

844

00:38:07,720 --> 00:38:06,170

larger region and by stepping the

845

00:38:09,310 --> 00:38:07,730

telescope you know maybe over here and

846

00:38:10,720 --> 00:38:09,320

taking another image stepping it over

847

00:38:12,640 --> 00:38:10,730

here taking another image stepping it

848

00:38:15,160 --> 00:38:12,650

over here take another image and so on

849

00:38:17,350 --> 00:38:15,170

you might have an overlap region where

850

00:38:19,210 --> 00:38:17,360

where both instruments are taking are

851
00:38:20,830 --> 00:38:19,220
taking data I want you to collect

852
00:38:23,350 --> 00:38:20,840
everything and so they are observing

853
00:38:28,270 --> 00:38:23,360
strategies that do that new speck is

854
00:38:30,130 --> 00:38:28,280
just spectroscopy in an infrared and the

855
00:38:33,760 --> 00:38:30,140
new is here that's that's the instrument

856
00:38:35,650 --> 00:38:33,770
that'll be or a lot of that instrument

857
00:38:38,200 --> 00:38:35,660
will be used to to take spectra of

858
00:38:39,250 --> 00:38:38,210
transiting exoplanets and and Barney is

859
00:38:43,690 --> 00:38:39,260
going to talk a little bit more about

860
00:38:45,880 --> 00:38:43,700
that later an important part of Webb

861
00:38:48,100 --> 00:38:45,890
compared to Hubble is that it's not just

862
00:38:50,170 --> 00:38:48,110
imaging there's coarsest and imaging

863
00:38:52,390 --> 00:38:50,180

modes you know all the wavelengths but

864

00:38:54,670 --> 00:38:52,400

it has lots and lots of four instruments

865

00:38:55,570 --> 00:38:54,680

that do spectroscopy and like why do you

866

00:38:58,600 --> 00:38:55,580

do spectroscopy

867

00:39:01,450 --> 00:38:58,610

well imaging typically will tell you

868

00:39:03,910 --> 00:39:01,460

where things are but spectroscopy will

869

00:39:06,310 --> 00:39:03,920

tell you what they're made of so if

870

00:39:10,030 --> 00:39:06,320

you're interested in say looking at

871

00:39:12,700 --> 00:39:10,040

what's the composition of planet-forming

872

00:39:14,350 --> 00:39:12,710

disks or a young star or galaxy you take

873

00:39:15,730 --> 00:39:14,360

a spectrum of it and it'll really reveal

874

00:39:18,160 --> 00:39:15,740

what's what what's there in particular

875

00:39:19,600 --> 00:39:18,170

like for example is I said interested in

876

00:39:22,000 --> 00:39:19,610

if there's water there you'd need a

877

00:39:24,130 --> 00:39:22,010

spectrum typically to to tell you that

878

00:39:28,000 --> 00:39:24,140

and also will tell you properties of

879

00:39:29,020 --> 00:39:28,010

that example how hot it is and so we

880

00:39:32,740 --> 00:39:29,030

expect to be lots and lots of

881

00:39:36,700 --> 00:39:32,750

spectroscopy done with with Webb alright

882

00:39:39,040 --> 00:39:36,710

so at the end of the telescope part I'll

883

00:39:57,370 --> 00:39:39,050

hand it on to Barney talk about the

884

00:40:02,700 --> 00:39:57,380

science okay hi really okay so yes I'm

885

00:40:10,270 --> 00:40:06,370

there's you know the class was talking

886

00:40:13,120 --> 00:40:10,280

about how great of a history Webb

887

00:40:16,510 --> 00:40:13,130

telescope has had in coming to what it

888

00:40:21,120 --> 00:40:16,520

is today and it came up do you know the

889

00:40:24,880 --> 00:40:21,130

original cases for the science wise were

890

00:40:26,680 --> 00:40:24,890

we're very far away from home you know

891

00:40:30,010 --> 00:40:26,690

there there are these these early early

892

00:40:31,690 --> 00:40:30,020

galaxies and then as the cases all

893

00:40:35,290 --> 00:40:31,700

develop the science cases developed

894

00:40:36,460 --> 00:40:35,300

there really settled on four big topics

895

00:40:39,610 --> 00:40:36,470

so I'm going to take you guys through

896

00:40:43,600 --> 00:40:39,620

these four big topics one of them still

897

00:40:45,910 --> 00:40:43,610

remain remains the first light in the

898

00:40:48,880 --> 00:40:45,920

universe so some of those first galaxies

899

00:40:52,210 --> 00:40:48,890

to form in the universe how did that

900

00:40:55,660 --> 00:40:52,220

happen how do those galaxies then grow

901
00:40:58,240 --> 00:40:55,670
over cosmic time some of that work is

902
00:41:01,660 --> 00:40:58,250
motivated again by by Hubble and other

903
00:41:05,680 --> 00:41:01,670
telescopes looking at all these

904
00:41:08,110 --> 00:41:05,690
different epochs of galaxies then we

905
00:41:10,750 --> 00:41:08,120
come to how do stars and planets form

906
00:41:13,120 --> 00:41:10,760
we're getting closer to home and smaller

907
00:41:14,530 --> 00:41:13,130
and smaller show you tell you guys a

908
00:41:17,100 --> 00:41:14,540
little bit more about that and finally

909
00:41:20,940 --> 00:41:17,110
what our planetary atmospheres made of

910
00:41:24,220 --> 00:41:20,950
so over the course of all the science of

911
00:41:26,140 --> 00:41:24,230
and the science case made for Webb as it

912
00:41:29,260 --> 00:41:26,150
was being developed we discovered

913
00:41:31,270 --> 00:41:29,270

exoplanets and we started looking at

914

00:41:33,040 --> 00:41:31,280

them and we'd be developed techniques

915

00:41:38,020 --> 00:41:33,050

for actually being able to probe their

916

00:41:40,960 --> 00:41:38,030

atmospheres so this is a these four big

917

00:41:44,980 --> 00:41:40,970

themes may seem obvious to us right now

918

00:41:47,140 --> 00:41:44,990

but it's been such a long

919

00:41:49,540 --> 00:41:47,150

with a lot of people involved that that

920

00:41:51,010 --> 00:41:49,550

these weren't necessarily what we

921

00:41:53,590 --> 00:41:51,020

thought we'd be able to get out of this

922

00:41:57,820 --> 00:41:53,600

telescope when it first started I'll

923

00:42:00,870 --> 00:41:57,830

also add that like Hubble I'm sure even

924

00:42:04,920 --> 00:42:00,880

more things will come out of Webb so

925

00:42:07,480 --> 00:42:04,930

back to these these are these first

926

00:42:11,190 --> 00:42:07,490

first light and the epoch of

927

00:42:14,080 --> 00:42:11,200

reionization so this is a graphic of

928

00:42:16,660 --> 00:42:14,090

cosmic time basically so we start all

929

00:42:20,110 --> 00:42:16,670

the way over here with the Big Bang

930

00:42:22,210 --> 00:42:20,120

okay who's heard of the Big Bang pants

931

00:42:23,800 --> 00:42:22,220

okay good you got I see a lot of regular

932

00:42:26,260 --> 00:42:23,810

faces out there too so okay I figured if

933

00:42:29,290 --> 00:42:26,270

you guys need okay so everything's the

934

00:42:32,830 --> 00:42:29,300

universe starts basically okay

935

00:42:34,780 --> 00:42:32,840

then there's it's just a big soupy mess

936

00:42:38,320 --> 00:42:34,790

basically that's that's the technical

937

00:42:40,330 --> 00:42:38,330

term for it a soupy mess and you go

938

00:42:44,850 --> 00:42:40,340

through what's what's called radiation

939

00:42:48,940 --> 00:42:44,860

era and the dark ages and then we

940

00:42:52,690 --> 00:42:48,950

photons come flooding out and we call it

941

00:42:54,910 --> 00:42:52,700

the epoch of reionisation so from

942

00:42:57,490 --> 00:42:54,920

that we start being able to so that from

943

00:42:59,830 --> 00:42:57,500

this epoch of reorganisation particles

944

00:43:04,000 --> 00:42:59,840

start coming together we start getting

945

00:43:07,000 --> 00:43:04,010

little little protons and neutrons and

946

00:43:09,430 --> 00:43:07,010

those you know those those early that

947

00:43:12,990 --> 00:43:09,440

that early stuff the the hydrogen and

948

00:43:15,640 --> 00:43:13,000

the helium starts forming some stars and

949

00:43:19,480 --> 00:43:15,650

eventually all that stuff comes together

950

00:43:23,110 --> 00:43:19,490

and forms those first galaxies okay and

951
00:43:24,940 --> 00:43:23,120
then from there we have you know a whole

952
00:43:28,060 --> 00:43:24,950
bunch of stuff happens and then we have

953
00:43:31,030 --> 00:43:28,070
the beautiful jewel box gem box that we

954
00:43:32,440 --> 00:43:31,040
now have of galaxies in things we've

955
00:43:34,180 --> 00:43:32,450
seen that are part of popular culture

956
00:43:36,220 --> 00:43:34,190
like the Hubble Deep fields

957
00:43:39,760 --> 00:43:36,230
so you're regulars I'm sure you have the

958
00:43:43,150 --> 00:43:39,770
lithograph of that so give you guys a

959
00:43:47,890 --> 00:43:43,160
kind of an interesting view of what I

960
00:43:54,370 --> 00:43:47,900
just talked about but with beautiful

961
00:43:55,930 --> 00:43:54,380
animation you see stuff starting to all

962
00:43:57,560 --> 00:43:55,940
these little stars these first stars

963
00:44:00,260 --> 00:43:57,570

starting to come

964

00:44:07,670 --> 00:44:00,270

together eventually we get we get lots

965

00:44:12,280 --> 00:44:07,680

of galaxies forming we get this kind of

966

00:44:15,050 --> 00:44:12,290

thing happening and this is what we're

967

00:44:18,160 --> 00:44:15,060

looking for we're looking for these

968

00:44:20,840 --> 00:44:18,170

first stars and galaxies to form

969

00:44:24,070 --> 00:44:20,850

eventually start populating the entire

970

00:44:26,840 --> 00:44:24,080

universe gravitationally interact and

971

00:44:29,180 --> 00:44:26,850

hopefully hopefully we can see the light

972

00:44:32,570 --> 00:44:29,190

from those okay and this will give us a

973

00:44:34,820 --> 00:44:32,580

bit a greater appreciation and better

974

00:44:37,540 --> 00:44:34,830

understanding of what's going on out

975

00:44:40,640 --> 00:44:37,550

there how are all of these galaxies

976
00:44:43,490 --> 00:44:40,650
forming how are they evolving what do

977
00:44:46,310 --> 00:44:43,500
they look like as they're evolving so

978
00:44:48,710 --> 00:44:46,320
white right now with Hubble we've been

979
00:44:51,650 --> 00:44:48,720
able to look back with things like the

980
00:44:54,110 --> 00:44:51,660
Hubble Ultra Deep Field back even

981
00:44:56,900 --> 00:44:54,120
further with special projects like the

982
00:45:00,380 --> 00:44:56,910
frontier fields which used gravitational

983
00:45:04,010 --> 00:45:00,390
lensing to be able to probe even farther

984
00:45:06,410 --> 00:45:04,020
back toward more distant galaxies but

985
00:45:08,870 --> 00:45:06,420
really all we've seen or maybe you know

986
00:45:12,320 --> 00:45:08,880
if you compare it to a human life span

987
00:45:14,660 --> 00:45:12,330
something like a toddler okay what we

988
00:45:16,850 --> 00:45:14,670

may be maybe an infant but maybe like

989

00:45:18,980 --> 00:45:16,860

eight nine months old what we want to

990

00:45:22,520 --> 00:45:18,990

see are those baby baby pictures those

991

00:45:26,210 --> 00:45:22,530

infants that newborn and we want to see

992

00:45:29,390 --> 00:45:26,220

that that chubby squishy little face and

993

00:45:31,700 --> 00:45:29,400

see what exactly the full lifespan of

994

00:45:34,730 --> 00:45:31,710

galaxies has been in our universe so

995

00:45:37,460 --> 00:45:34,740

that's really important to us and you

996

00:45:38,990 --> 00:45:37,470

see just that get to get to this you

997

00:45:42,380 --> 00:45:39,000

know up a point today where we can look

998

00:45:45,620 --> 00:45:42,390

out through any soda straw out into the

999

00:45:50,090 --> 00:45:45,630

universe and see a jewel box of galaxies

1000

00:45:52,070 --> 00:45:50,100

of all different types so and to be able

1001
00:45:54,800 --> 00:45:52,080
to look at those galaxies that are

1002
00:45:58,040 --> 00:45:54,810
closer in and more modern or

1003
00:46:00,410 --> 00:45:58,050
contemporary and see what is going on

1004
00:46:02,090 --> 00:46:00,420
inside of those galaxies so this this

1005
00:46:06,560 --> 00:46:02,100
comes back to that second science theme

1006
00:46:10,790 --> 00:46:06,570
of of the the galaxy evolution and what

1007
00:46:11,540 --> 00:46:10,800
galaxies are looking like today so you

1008
00:46:13,640 --> 00:46:11,550
see this

1009
00:46:17,030 --> 00:46:13,650
perfectly divided down the middle this

1010
00:46:20,600 --> 00:46:17,040
is the infrared side and this is the

1011
00:46:23,290 --> 00:46:20,610
visible side so you may have seen this

1012
00:46:25,670 --> 00:46:23,300
side of the whole thing the visible side

1013
00:46:28,640 --> 00:46:25,680

because I believe we also have beautiful

1014

00:46:30,110 --> 00:46:28,650

Hubble images of this in the lithographs

1015

00:46:32,660 --> 00:46:30,120

that you may have received at public

1016

00:46:35,330 --> 00:46:32,670

lecture series you can see these bright

1017

00:46:37,630 --> 00:46:35,340

spots of star formation in here you

1018

00:46:40,730 --> 00:46:37,640

could also see these dark dust lanes

1019

00:46:44,840 --> 00:46:40,740

here that's all the dark parts here are

1020

00:46:46,910 --> 00:46:44,850

those dust lanes where the visible light

1021

00:46:50,150 --> 00:46:46,920

of what's going on in this galaxy can't

1022

00:46:55,400 --> 00:46:50,160

get through to our eyes or to Hubble's

1023

00:46:58,730 --> 00:46:55,410

eyes it can't pass through that dust but

1024

00:47:00,890 --> 00:46:58,740

when we look in the infrared all that

1025

00:47:02,300 --> 00:47:00,900

dust is glowing so we can see what's

1026
00:47:05,600 --> 00:47:02,310
going on with that dust so you see that

1027
00:47:07,700 --> 00:47:05,610
these dark lanes here suddenly become

1028
00:47:09,530 --> 00:47:07,710
the brightest thing and what we're

1029
00:47:13,730 --> 00:47:09,540
looking at in the infrared so that's

1030
00:47:15,470 --> 00:47:13,740
what we're hoping for with with Webb is

1031
00:47:17,720 --> 00:47:15,480
we're going to study these sorts of

1032
00:47:20,690 --> 00:47:17,730
things we're going to look at these dust

1033
00:47:22,430 --> 00:47:20,700
lanes in nearby galaxies and look for

1034
00:47:25,250 --> 00:47:22,440
what's happening there and how they're

1035
00:47:31,900 --> 00:47:25,260
glowing and trace map out all that that

1036
00:47:35,810 --> 00:47:31,910
dust and learn some more about it okay

1037
00:47:40,160 --> 00:47:35,820
third topic that I mentioned earlier was

1038
00:47:42,970 --> 00:47:40,170

the formation of stars and planets and I

1039

00:47:47,120 --> 00:47:42,980

think this is one that really strikes

1040

00:47:49,130 --> 00:47:47,130

people's imaginations because we're

1041

00:47:52,490 --> 00:47:49,140

living it every day you know you're

1042

00:47:55,520 --> 00:47:52,500

you're in you're living on a planet in a

1043

00:47:57,830 --> 00:47:55,530

solar system that has a star and so

1044

00:48:00,770 --> 00:47:57,840

every day you can look up at the sky and

1045

00:48:05,390 --> 00:48:00,780

think well how did that get there how

1046

00:48:07,250 --> 00:48:05,400

are we here and on a very everyday level

1047

00:48:10,550 --> 00:48:07,260

it's there so what we're looking at here

1048

00:48:13,070 --> 00:48:10,560

is something that Webb will be able to

1049

00:48:16,700 --> 00:48:13,080

look at which would be an early a

1050

00:48:19,640 --> 00:48:16,710

newborn star a forming star and with a

1051

00:48:24,400 --> 00:48:19,650

forming star you get this big disk of

1052

00:48:28,980 --> 00:48:24,410

gas and dust around it you get jets

1053

00:48:33,180 --> 00:48:28,990

I mean out of it of of really really hot

1054

00:48:38,950 --> 00:48:33,190

gas particles things like that then

1055

00:48:41,590 --> 00:48:38,960

inside you have the new star for me so

1056

00:48:43,240 --> 00:48:41,600

I'm gonna take this you know there we go

1057

00:48:45,100 --> 00:48:43,250

oh it's on repeat I didn't realize you

1058

00:48:48,010 --> 00:48:45,110

did that thank you

1059

00:48:51,070 --> 00:48:48,020

so we have this slider here that takes

1060

00:48:55,090 --> 00:48:51,080

you from the visible to the infrared of

1061

00:48:56,530 --> 00:48:55,100

this image and you can see those Jets I

1062

00:48:59,820 --> 00:48:56,540

was talking about when you look at it

1063

00:49:02,890 --> 00:48:59,830

and the visible all we see is that new

1064

00:49:05,770 --> 00:49:02,900

forming star right there the rest of it

1065

00:49:07,450 --> 00:49:05,780

is all dark dark dust because we can't

1066

00:49:11,260 --> 00:49:07,460

see light visible light coming through

1067

00:49:14,650 --> 00:49:11,270

it but in the infrared right here you

1068

00:49:17,650 --> 00:49:14,660

get to see those Jets become visible and

1069

00:49:24,550 --> 00:49:17,660

so we can learn more about how these

1070

00:49:26,620 --> 00:49:24,560

stars are forming and how what what

1071

00:49:28,120 --> 00:49:26,630

processes are happening and how they're

1072

00:49:32,350 --> 00:49:28,130

affecting the environment around those

1073

00:49:36,030 --> 00:49:32,360

stars one of the other things we can

1074

00:49:40,750 --> 00:49:36,040

look at as as Klaus mentioned earlier is

1075

00:49:42,460 --> 00:49:40,760

a spectra so doing spectroscopy I'm sure

1076

00:49:44,170 --> 00:49:42,470

many of you regular public lecture

1077

00:49:48,610 --> 00:49:44,180

series goes have heard about

1078

00:49:50,560 --> 00:49:48,620

spectroscopy a lot looking at what stuff

1079

00:49:54,100 --> 00:49:50,570

is made of what's really going on in

1080

00:49:56,050 --> 00:49:54,110

there so you get a taste of of a couple

1081

00:50:00,070 --> 00:49:56,060

of things here with web new ways to

1082

00:50:03,280 --> 00:50:00,080

probe these discs of material forming

1083

00:50:06,010 --> 00:50:03,290

around these stars so the new stars have

1084

00:50:09,340 --> 00:50:06,020

big protoplanetary discs okay you can

1085

00:50:14,260 --> 00:50:09,350

see them up here do I have a thing right

1086

00:50:16,900 --> 00:50:14,270

there yeah with the the star around it

1087

00:50:19,240 --> 00:50:16,910

with a big disc you know kind of like a

1088

00:50:21,400 --> 00:50:19,250

plate a frisbee something like that

1089

00:50:25,420 --> 00:50:21,410

around it and what we can do is we can

1090

00:50:28,030 --> 00:50:25,430

start to probe what is going on in those

1091

00:50:31,210 --> 00:50:28,040

discs and by probing what's in those

1092

00:50:34,420 --> 00:50:31,220

discs we can find in torino with

1093

00:50:37,250 --> 00:50:34,430

wavelength of light you see these the

1094

00:50:40,160 --> 00:50:37,260

spikes are telling us what's there

1095

00:50:43,070 --> 00:50:40,170

you see a couple interesting places

1096

00:50:45,020 --> 00:50:43,080

labeled here with with different types

1097

00:50:48,020 --> 00:50:45,030

of molecules so you see carbon dioxide

1098

00:50:49,930 --> 00:50:48,030

there something that maybe maybe you

1099

00:50:51,620 --> 00:50:49,940

don't want some major season in there

1100

00:50:55,070 --> 00:50:51,630

you wouldn't want it in your house

1101
00:50:56,390 --> 00:50:55,080
anyway so then we have so that's that's

1102
00:50:57,470 --> 00:50:56,400
an interesting way to probe it and see

1103
00:50:59,810 --> 00:50:57,480
what's going on there cuz seeing what

1104
00:51:04,100 --> 00:50:59,820
stuff is made of tells us part of how

1105
00:51:06,380 --> 00:51:04,110
it's made and and maybe how things

1106
00:51:08,810 --> 00:51:06,390
evolve because you can start out with

1107
00:51:10,280 --> 00:51:08,820
discs you know different stuffs gonna

1108
00:51:11,630 --> 00:51:10,290
form in different places in the discs

1109
00:51:15,050 --> 00:51:11,640
because you get further away from the

1110
00:51:17,600 --> 00:51:15,060
star discs is gonna get cooler and so

1111
00:51:21,680 --> 00:51:17,610
maybe you get you get more Isis stuff

1112
00:51:25,190 --> 00:51:21,690
that can can live as ice farther farther

1113
00:51:26,690 --> 00:51:25,200

out at cooler temperatures and they may

1114

00:51:29,780 --> 00:51:26,700

be that means a different type of planet

1115

00:51:32,300 --> 00:51:29,790

could form maybe that means the liquid

1116

00:51:34,940 --> 00:51:32,310

water or frozen water could hang out for

1117

00:51:37,670 --> 00:51:34,950

longer so all those things are building

1118

00:51:41,270 --> 00:51:37,680

this this model of what what we expect

1119

00:51:46,300 --> 00:51:41,280

in a solar system as it forms one of the

1120

00:51:51,290 --> 00:51:46,310

other things we can do is I don't know

1121

00:51:53,600 --> 00:51:51,300

oops sorry is Klaus mentioned this a

1122

00:51:58,150 --> 00:51:53,610

little bit too he had an image of it was

1123

00:52:00,920 --> 00:51:58,160

a coronagraph so that's that's basically

1124

00:52:04,490 --> 00:52:00,930

blocking out the light of the star to

1125

00:52:07,130 --> 00:52:04,500

see what's happening around it I think I

1126

00:52:10,070 --> 00:52:07,140

have another image of that coming up as

1127

00:52:11,540 --> 00:52:10,080

I talk about planetary atmospheres so

1128

00:52:13,700 --> 00:52:11,550

that's that force one planetary

1129

00:52:15,950 --> 00:52:13,710

atmospheres and this is one of the ones

1130

00:52:19,550 --> 00:52:15,960

that's you know it's a it's a field

1131

00:52:21,290 --> 00:52:19,560

that's really gotten big in the last

1132

00:52:24,470 --> 00:52:21,300

decade probably in the last five years

1133

00:52:26,420 --> 00:52:24,480

even as we explore these worlds and

1134

00:52:30,560 --> 00:52:26,430

we've gone from being able to just see

1135

00:52:32,240 --> 00:52:30,570

hot Jupiters to being able to see what

1136

00:52:35,420 --> 00:52:32,250

is going to be happening in atmospheres

1137

00:52:37,490 --> 00:52:35,430

of terrestrial type planets around other

1138

00:52:39,710 --> 00:52:37,500

stars and that's that's really the

1139

00:52:44,720 --> 00:52:39,720

promise of web so who here heard about

1140

00:52:46,850 --> 00:52:44,730

the Trappist system okay so this this

1141

00:52:50,150 --> 00:52:46,860

this came out about a year ago now it's

1142

00:52:53,630 --> 00:52:50,160

a star with seven plane

1143

00:52:55,940 --> 00:52:53,640

surround it many of them are around

1144

00:52:59,660 --> 00:52:55,950

maybe a little bit bigger than Earth

1145

00:53:00,950 --> 00:52:59,670

size they're all in what would be are

1146

00:53:02,720 --> 00:53:00,960

some of them are in what would be

1147

00:53:06,230 --> 00:53:02,730

considered the habitable zone of that

1148

00:53:09,200 --> 00:53:06,240

star so able to have liquid water on

1149

00:53:11,270 --> 00:53:09,210

them one of the big cool things that web

1150

00:53:14,120 --> 00:53:11,280

can do is when we find systems like that

1151
00:53:15,680 --> 00:53:14,130
to go and probe those atmospheres and

1152
00:53:17,330 --> 00:53:15,690
I'll show you a little bit about how

1153
00:53:22,130 --> 00:53:17,340
that how we do that you can do this with

1154
00:53:25,100 --> 00:53:22,140
with Jupiter's too so what we have here

1155
00:53:26,600 --> 00:53:25,110
is the same this is the same system okay

1156
00:53:29,000 --> 00:53:26,610
just two ways of looking at it one of

1157
00:53:30,440 --> 00:53:29,010
them is what you'd look what we'd see if

1158
00:53:33,590 --> 00:53:30,450
you were in the system you'd see this a

1159
00:53:38,720 --> 00:53:33,600
planet coming around or beating around

1160
00:53:41,270 --> 00:53:38,730
its star going to the backside okay but

1161
00:53:42,740 --> 00:53:41,280
down here is what we'd see if we just

1162
00:53:50,270 --> 00:53:42,750
looked at the light coming from that

1163
00:53:51,890 --> 00:53:50,280

system we would see the as this it do

1164

00:53:54,110 --> 00:53:51,900

you see where it dips there that's where

1165

00:53:56,030 --> 00:53:54,120

the planet went in front of the star and

1166

00:53:59,180 --> 00:53:56,040

blocked out the light of the of the star

1167

00:54:00,920 --> 00:53:59,190

but then when it goes behind the star

1168

00:54:03,230 --> 00:54:00,930

you see there's another little dip

1169

00:54:06,020 --> 00:54:03,240

that's because this planet is shining in

1170

00:54:09,620 --> 00:54:06,030

its own light so wait when it goes

1171

00:54:11,990 --> 00:54:09,630

behind the star we're losing some of the

1172

00:54:15,650 --> 00:54:12,000

light of the whole system because the

1173

00:54:16,580 --> 00:54:15,660

star is locking out to the planet and in

1174

00:54:25,100 --> 00:54:16,590

doing this

1175

00:54:26,450 --> 00:54:25,110

doing is being able to probe what's the

1176

00:54:29,210 --> 00:54:26,460

first of all there's a planet there

1177

00:54:31,460 --> 00:54:29,220

second of all what's what is in that

1178

00:54:34,090 --> 00:54:31,470

plan that's atmosphere as it as it goes

1179

00:54:40,790 --> 00:54:34,100

in and out because we can also do this

1180

00:54:42,800 --> 00:54:40,800

spectroscopically okay next we have I

1181

00:54:44,770 --> 00:54:42,810

mentioned this earlier choreography so

1182

00:54:49,730 --> 00:54:44,780

one of the cool things the web can do is

1183

00:54:52,940 --> 00:54:49,740

to look at directly image planets around

1184

00:54:56,120 --> 00:54:52,950

other stars not just look at the dip

1185

00:54:59,570 --> 00:54:56,130

look for the dip in light so to give you

1186

00:55:03,079 --> 00:54:59,580

a comparison point this is what earth

1187

00:55:07,219 --> 00:55:03,089

looks like compared to the Sun so it's

1188

00:55:08,839 --> 00:55:07,229

a teeny tiny and if you know you can

1189

00:55:10,519 --> 00:55:08,849

imagine if it was if it was out here it

1190

00:55:12,859 --> 00:55:10,529

would it would be very very dim it's

1191

00:55:15,469 --> 00:55:12,869

like you know a little Firefly next to a

1192

00:55:18,469 --> 00:55:15,479

bright street lamp very difficult to see

1193

00:55:20,180 --> 00:55:18,479

unless you hold up your hand and block

1194

00:55:21,920 --> 00:55:20,190

out that street lamp and then all of a

1195

00:55:24,739 --> 00:55:21,930

sudden you can see oh there's like five

1196

00:55:28,190 --> 00:55:24,749

fireflies right there so that's kind of

1197

00:55:30,769 --> 00:55:28,200

what's what's going on here we can find

1198

00:55:32,539 --> 00:55:30,779

exoplanets you see where they are here

1199

00:55:34,459 --> 00:55:32,549

but you can't see them right so hold up

1200

00:55:38,209 --> 00:55:34,469

your hand block out the light of that

1201
00:55:43,940 --> 00:55:38,219
star and all of a sudden they are

1202
00:55:46,219 --> 00:55:43,950
revealed we get these these exoplanets

1203
00:55:49,640 --> 00:55:46,229
here which which we've seen this is a

1204
00:55:52,339 --> 00:55:49,650
from the Keck telescope but which also

1205
00:55:53,719 --> 00:55:52,349
has a coronagraph but when will will

1206
00:55:55,880 --> 00:55:53,729
have a coronagraph and be able to do

1207
00:55:57,559 --> 00:55:55,890
this type of measurement too so we're

1208
00:55:59,299 --> 00:55:57,569
we're hitting it from all angles with

1209
00:56:01,579 --> 00:55:59,309
web we're really gonna it's going to be

1210
00:56:04,880 --> 00:56:01,589
a workhorse for characterizing

1211
00:56:06,979 --> 00:56:04,890
exoplanets so far many of the space

1212
00:56:08,299 --> 00:56:06,989
telescopes we've had and even even some

1213
00:56:11,569 --> 00:56:08,309

ground-based ones are all about

1214

00:56:14,180 --> 00:56:11,579

detecting exoplanets we're there we know

1215

00:56:18,829 --> 00:56:14,190

exoplanets exist there's a lot of them

1216

00:56:21,890 --> 00:56:18,839

they're very exciting we we now know

1217

00:56:26,410 --> 00:56:21,900

that on average in our galaxy every

1218

00:56:29,829 --> 00:56:26,420

every star has one planet that's

1219

00:56:32,539 --> 00:56:29,839

incredibly exciting that's amazing but

1220

00:56:34,519 --> 00:56:32,549

we've also seen that there's a lot of

1221

00:56:37,039 --> 00:56:34,529

types of planets that could be out there

1222

00:56:39,140 --> 00:56:37,049

and Webb's job will be to characterize

1223

00:56:41,120 --> 00:56:39,150

those and figure out exactly what's

1224

00:56:44,329 --> 00:56:41,130

going on with these different systems

1225

00:56:47,630 --> 00:56:44,339

and to bring it back home ultimately

1226
00:56:50,569 --> 00:56:47,640
help us figure out is our system weird

1227
00:56:52,579 --> 00:56:50,579
are we typical what's going on with

1228
00:56:55,130 --> 00:56:52,589
earth what's going on with our solar

1229
00:56:58,430 --> 00:56:55,140
system okay

1230
00:57:00,229 --> 00:56:58,440
I mentioned characterizing awesome and

1231
00:57:01,999 --> 00:57:00,239
are we weird one of the things that

1232
00:57:06,140 --> 00:57:02,009
probably leads us to think we're kind of

1233
00:57:12,469 --> 00:57:06,150
weird some people call it special is we

1234
00:57:16,320 --> 00:57:12,479
have life on Earth and while Webb is not

1235
00:57:19,170 --> 00:57:16,330
a life finder its mission is not to

1236
00:57:23,130 --> 00:57:19,180
find alien life anywhere one of the

1237
00:57:26,420 --> 00:57:23,140
things it can do with spectroscopy is to

1238
00:57:30,840 --> 00:57:26,430

study these atmospheres and look for

1239

00:57:32,820 --> 00:57:30,850

various molecules that are abundant in

1240

00:57:34,530 --> 00:57:32,830

those atmospheres and this tells us

1241

00:57:38,850 --> 00:57:34,540

about what's going on there so for

1242

00:57:40,260 --> 00:57:38,860

example if it finds carbon dioxide that

1243

00:57:42,510 --> 00:57:40,270

could mean that you know things are

1244

00:57:44,670 --> 00:57:42,520

breathing the way that we breathe or it

1245

00:57:50,250 --> 00:57:44,680

could mean that there is volcanic

1246

00:57:53,570 --> 00:57:50,260

activity on on that planet if if there's

1247

00:57:56,040 --> 00:57:53,580

methane there could be some sort of

1248

00:57:57,540 --> 00:57:56,050

natural geologic process causing that

1249

00:58:00,450 --> 00:57:57,550

methane but there could also be the

1250

00:58:05,010 --> 00:58:00,460

presence of anaerobic bacteria which Oh

1251
00:58:07,380 --> 00:58:05,020
exciting and of course water vapor might

1252
00:58:09,270 --> 00:58:07,390
indicate some sort of liquid water on

1253
00:58:12,090 --> 00:58:09,280
the surface which then would indicate

1254
00:58:13,770 --> 00:58:12,100
habitability of course none of these

1255
00:58:15,660 --> 00:58:13,780
things guarantee that there's life on

1256
00:58:18,390 --> 00:58:15,670
these place on these planets but it's

1257
00:58:20,070 --> 00:58:18,400
all about building the case right we're

1258
00:58:21,810 --> 00:58:20,080
still in a fact-finding mission that's

1259
00:58:23,940 --> 00:58:21,820
what science is so we're trying to just

1260
00:58:29,150 --> 00:58:23,950
find find what we can put the pieces

1261
00:58:32,220 --> 00:58:29,160
together pieces of the puzzle okay and

1262
00:58:33,600 --> 00:58:32,230
with that as we're putting the pieces of

1263
00:58:52,710 --> 00:58:33,610

the puzzle together I'll turn it over to

1264

00:59:00,940 --> 00:58:56,200

okay okay so the final piece of the

1265

00:59:03,700 --> 00:59:00,950

puzzle web s class explained was built

1266

00:59:05,109 --> 00:59:03,710

on Hubble's legacy and as bonnie has

1267

00:59:06,849 --> 00:59:05,119

told you about the science of the

1268

00:59:08,740 --> 00:59:06,859

mission it's going to be incredible and

1269

00:59:12,250 --> 00:59:08,750

really leave its own legacy and just

1270

00:59:13,720 --> 00:59:12,260

like Hubble found galaxies in this area

1271

00:59:16,210 --> 00:59:13,730

of the sky that looked like nothing and

1272

00:59:18,430 --> 00:59:16,220

just like Hubble found exoplanet

1273

00:59:21,970 --> 00:59:18,440

atmospheres Webb will find things that

1274

00:59:24,130 --> 00:59:21,980

we can't even anticipate and this is

1275

00:59:25,270 --> 00:59:24,140

really mind-boggling but how do we get

1276

00:59:28,120 --> 00:59:25,280

there

1277

00:59:29,319 --> 00:59:28,130

so as Klaus mentioned this has been more

1278

00:59:34,000 --> 00:59:29,329

than 20 years in the making

1279

00:59:36,099 --> 00:59:34,010

so before here today and it's launching

1280

00:59:38,829 --> 00:59:36,109

in about a year and a half that is only

1281

00:59:40,569 --> 00:59:38,839

you know 10% less than 10% of the

1282

00:59:43,240 --> 00:59:40,579

timeline that people have been working

1283

00:59:45,390 --> 00:59:43,250

on this mission here's a few of the

1284

00:59:48,790 --> 00:59:45,400

highlights of that timeline pulled out

1285

00:59:51,370 --> 00:59:48,800

that image that beautiful napkin drawing

1286

00:59:54,160 --> 00:59:51,380

that Klaus showed you before is right

1287

00:59:56,620 --> 00:59:54,170

around here in 95 so again over 20 years

1288

01:00:01,510 --> 00:59:56,630

ago people who are born in 97 are now

1289

01:00:03,700 --> 01:00:01,520

allowed to buy alcohol oh my god so this

1290

01:00:04,960 --> 01:00:03,710

is really we're all really feeling this

1291

01:00:10,210 --> 01:00:04,970

I remember when I was an undergraduate

1292

01:00:13,960 --> 01:00:10,220

and web was gonna launch in 2013 so now

1293

01:00:15,550 --> 01:00:13,970

it's gonna launch in 2019 and so here in

1294

01:00:17,140 --> 01:00:15,560

2002 it actually got named the James

1295

01:00:18,910 --> 01:00:17,150

Webb Space Telescope before that it was

1296

01:00:22,030 --> 01:00:18,920

approved as the next generation space

1297

01:00:23,920 --> 01:00:22,040

telescope and since then we've been

1298

01:00:25,569 --> 01:00:23,930

doing construction we have the

1299

01:00:28,720 --> 01:00:25,579

complicated instruments we have that

1300

01:00:31,900 --> 01:00:28,730

giant folding primary mirror we have a

1301

01:00:34,089 --> 01:00:31,910

Sun shield that is you know layers with

1302

01:00:38,050 --> 01:00:34,099

thickness and smaller than a plastic bag

1303

01:00:42,069 --> 01:00:38,060

and all of these things have been built

1304

01:00:43,270 --> 01:00:42,079

tested tested again tested again the Sun

1305

01:00:46,000 --> 01:00:43,280

shield I heard was folded and unfolded

1306

01:00:48,370 --> 01:00:46,010

five times to make sure that you know

1307

01:00:50,079 --> 01:00:48,380

despite being very very thin so that it

1308

01:00:53,319 --> 01:00:50,089

was less weight it's still very strong

1309

01:00:56,710 --> 01:00:53,329

and can be unfolded in space safely and

1310

01:00:58,089 --> 01:00:56,720

as of only a few days ago there was a

1311

01:01:00,940 --> 01:00:58,099

press release out of Johnson Space

1312

01:01:02,530 --> 01:01:00,950

Flight Center that said that testing on

1313

01:01:04,059 --> 01:01:02,540

the optical telescope instrument which

1314

01:01:04,990 --> 01:01:04,069

is our beautiful primary mirror you see

1315

01:01:07,150 --> 01:01:05,000

and

1316

01:01:08,430 --> 01:01:07,160

instrument module so all the instruments

1317

01:01:11,020 --> 01:01:08,440

on the back of the primary mirror

1318

01:01:15,160 --> 01:01:11,030

everything's good to go it is now being

1319

01:01:16,359 --> 01:01:15,170

shipped to California so this is the

1320

01:01:17,740 --> 01:01:16,369

time line of people who have been

1321

01:01:20,859 --> 01:01:17,750

working for over 20 years on this

1322

01:01:23,109 --> 01:01:20,869

telescope well why the real mission here

1323

01:01:24,609 --> 01:01:23,119

despite all of this engineering feats is

1324

01:01:25,990 --> 01:01:24,619

the science that's coming out of it and

1325

01:01:27,280 --> 01:01:26,000

they're from people who've been thinking

1326
01:01:30,510 --> 01:01:27,290
about the science for more than twenty

1327
01:01:33,400 --> 01:01:30,520
years the science portion the science

1328
01:01:35,020 --> 01:01:33,410
observations that will be taken over the

1329
01:01:36,820 --> 01:01:35,030
course of Webb's lifetime fall into

1330
01:01:38,530 --> 01:01:36,830
three different categories the first

1331
01:01:41,740 --> 01:01:38,540
category is called guaranteed time

1332
01:01:43,780 --> 01:01:41,750
observations I'll explain what each of

1333
01:01:45,970 --> 01:01:43,790
these mean in just a second

1334
01:01:48,370 --> 01:01:45,980
the second category and this is so here

1335
01:01:49,930 --> 01:01:48,380
into time observations these have begun

1336
01:01:50,920 --> 01:01:49,940
people these are people who've been

1337
01:01:53,620 --> 01:01:50,930
working on the mission since the

1338
01:01:54,609 --> 01:01:53,630

beginning they get this time then

1339

01:01:57,430 --> 01:01:54,619

there's early really science

1340

01:01:59,770 --> 01:01:57,440

observations which the call for that and

1341

01:02:01,930 --> 01:01:59,780

the release of those observations was

1342

01:02:02,920 --> 01:02:01,940

just made in November or the release of

1343

01:02:04,390 --> 01:02:02,930

the observations the call was made

1344

01:02:05,500 --> 01:02:04,400

earlier but the release of what those

1345

01:02:07,030 --> 01:02:05,510

targets are just made in November

1346

01:02:08,859 --> 01:02:07,040

everything's available online if you'd

1347

01:02:11,050 --> 01:02:08,869

like to know what the telescope will be

1348

01:02:12,520 --> 01:02:11,060

looking at as and all of these will be

1349

01:02:15,550 --> 01:02:12,530

taken in the very beginning of the

1350

01:02:17,349 --> 01:02:15,560

telescopes mission lifetime and made

1351

01:02:18,609 --> 01:02:17,359

available to the community so that

1352

01:02:21,339 --> 01:02:18,619

people can know what the telescope can

1353

01:02:22,839 --> 01:02:21,349

do immediately and then finally what we

1354

01:02:24,880 --> 01:02:22,849

have what we call geo or general

1355

01:02:26,349 --> 01:02:24,890

observation time general observers time

1356

01:02:28,750 --> 01:02:26,359

and this is open to anyone in the entire

1357

01:02:29,920 --> 01:02:28,760

world it's not just space telescopes not

1358

01:02:32,530 --> 01:02:29,930

just the u.s. it's not just people

1359

01:02:34,329 --> 01:02:32,540

affiliated with NASA or ISA or CSA any

1360

01:02:35,890 --> 01:02:34,339

of the space agencies it's anyone anyone

1361

01:02:38,650 --> 01:02:35,900

in the world can propose for time on

1362

01:02:41,859 --> 01:02:38,660

this but Space Telescope and that is the

1363

01:02:44,829 --> 01:02:41,869

same for Hubble although all of these

1364

01:02:46,329 --> 01:02:44,839

things are vetted so you can try but you

1365

01:02:47,290 --> 01:02:46,339

might want to might not want to spend

1366

01:02:48,849 --> 01:02:47,300

your time because there's a lot of

1367

01:02:51,820 --> 01:02:48,859

really qualified scientists who are

1368

01:02:54,430 --> 01:02:51,830

gonna be going after this time and and

1369

01:02:56,859 --> 01:02:54,440

do some great science with it so as I

1370

01:02:58,930 --> 01:02:56,869

mentioned here we are today will launch

1371

01:03:00,460 --> 01:02:58,940

about six months later we'll actually

1372

01:03:01,990 --> 01:03:00,470

start to get data out because it takes a

1373

01:03:02,440 --> 01:03:02,000

while to get out a million miles into

1374

01:03:04,120 --> 01:03:02,450

space

1375

01:03:05,770 --> 01:03:04,130

it takes a while to open up this big

1376

01:03:07,780 --> 01:03:05,780

beautiful telescope it takes a while to

1377

01:03:09,160 --> 01:03:07,790

cool down the instruments because they

1378

01:03:10,630 --> 01:03:09,170

started here on earth and they get out

1379

01:03:15,820 --> 01:03:10,640

from space in there some of them are

1380

01:03:16,870 --> 01:03:15,830

operating at seven degrees so all that

1381

01:03:17,900 --> 01:03:16,880

takes a while it's going to be many

1382

01:03:19,099 --> 01:03:17,910

months between

1383

01:03:20,839 --> 01:03:19,109

launch the telescope and when it's ready

1384

01:03:22,760 --> 01:03:20,849

to give a science but when it does that

1385

01:03:23,900 --> 01:03:22,770

it's going to give us these three

1386

01:03:26,120 --> 01:03:23,910

different types of science and I

1387

01:03:28,460 --> 01:03:26,130

apologize if the colors aren't super

1388

01:03:30,500 --> 01:03:28,470

clear here but this is green purple and

1389

01:03:31,609 --> 01:03:30,510

pink and again the green observation is

1390

01:03:33,170 --> 01:03:31,619

the early-release science will be the

1391

01:03:34,720 --> 01:03:33,180

first observations taken that I'll be

1392

01:03:37,220 --> 01:03:34,730

taking in the first few months and

1393

01:03:38,870 --> 01:03:37,230

immediately made available and this is

1394

01:03:41,059 --> 01:03:38,880

kind of a unique thing but it's really

1395

01:03:43,490 --> 01:03:41,069

great it means people law scientists put

1396

01:03:44,660 --> 01:03:43,500

a lot of work to take observations then

1397

01:03:47,270 --> 01:03:44,670

then are immediately available to

1398

01:03:49,549 --> 01:03:47,280

everyone to look at and say what can

1399

01:03:51,859 --> 01:03:49,559

Webb do how can I do it what's its

1400

01:03:54,079 --> 01:03:51,869

capabilities how do we use it best going

1401

01:03:55,670 --> 01:03:54,089

forward and then you have these

1402

01:03:57,470 --> 01:03:55,680

guaranteed time observations that all be

1403

01:03:58,849 --> 01:03:57,480

taken in the first few years and then

1404

01:04:01,069 --> 01:03:58,859

the general observer time the time

1405

01:04:02,690 --> 01:04:01,079

that's open to the entire world over the

1406

01:04:05,120 --> 01:04:02,700

entire astronomical community is really

1407

01:04:06,289 --> 01:04:05,130

who will be using it goes on for the

1408

01:04:08,870 --> 01:04:06,299

lifetime of the mission which is

1409

01:04:13,460 --> 01:04:08,880

guaranteed five years hopefully up to

1410

01:04:15,319 --> 01:04:13,470

ten years so about those programs a

1411

01:04:16,760 --> 01:04:15,329

little more again there's people who've

1412

01:04:19,160 --> 01:04:16,770

been working on this for over twenty

1413

01:04:20,720 --> 01:04:19,170

years and they get some time

1414

01:04:22,130 --> 01:04:20,730

automatically on the telescope because

1415

01:04:23,599 --> 01:04:22,140

they put and they put in the grace work

1416

01:04:24,650 --> 01:04:23,609

they put in the legwork so those are

1417

01:04:28,099 --> 01:04:24,660

called guaranteed to have observations

1418

01:04:30,079 --> 01:04:28,109

and that's going to be a chunk of the

1419

01:04:32,000 --> 01:04:30,089

first couple of years of observations a

1420

01:04:33,680 --> 01:04:32,010

very small portion was a very

1421

01:04:36,680 --> 01:04:33,690

competitive selection for what we call

1422

01:04:38,420 --> 01:04:36,690

early release science and these people

1423

01:04:40,069 --> 01:04:38,430

get to look at objects in the sky that

1424

01:04:42,589 --> 01:04:40,079

they want to look at but they don't get

1425

01:04:44,240 --> 01:04:42,599

to keep the data which is which is we

1426
01:04:45,920 --> 01:04:44,250
call proprietary you normally you get to

1427
01:04:47,390 --> 01:04:45,930
keep the data just for you to work on

1428
01:04:49,339 --> 01:04:47,400
for a little bit these people said no

1429
01:04:51,589 --> 01:04:49,349
I'm gonna propose I'm gonna find things

1430
01:04:52,279 --> 01:04:51,599
out in the sky and I'm gonna share it

1431
01:04:54,710 --> 01:04:52,289
with everyone

1432
01:04:56,900 --> 01:04:54,720
immediately so that everyone knows what

1433
01:04:58,370 --> 01:04:56,910
the telescope can do and so you're gonna

1434
01:05:02,170 --> 01:04:58,380
see a lot of stuff coming out of these

1435
01:05:06,470 --> 01:05:02,180
you know is sort of soon after telescope

1436
01:05:08,569 --> 01:05:06,480
launches and and comes comes alive and

1437
01:05:11,150 --> 01:05:08,579
then finally we have the general

1438
01:05:13,190 --> 01:05:11,160

observer pool now the topics are all the

1439

01:05:15,410 --> 01:05:13,200

topics the body covered you know from

1440

01:05:18,859 --> 01:05:15,420

solar system exoplanets protoplanetary

1441

01:05:23,150 --> 01:05:18,869

discs assembly of galaxies first light

1442

01:05:26,690 --> 01:05:23,160

the first galaxies you know lensing

1443

01:05:27,740 --> 01:05:26,700

gravitational lensing of objects things

1444

01:05:30,980 --> 01:05:27,750

in our solar system

1445

01:05:31,269 --> 01:05:30,990

asteroids direct imaging of exoplanets

1446

01:05:33,519 --> 01:05:31,279

with

1447

01:05:35,649 --> 01:05:33,529

pornography transmissions are trust me

1448

01:05:37,120 --> 01:05:35,659

of exoplanets all of that is covered in

1449

01:05:39,459 --> 01:05:37,130

all three it's going to be covered in

1450

01:05:41,019 --> 01:05:39,469

all three of these programs so well we

1451

01:05:42,069 --> 01:05:41,029

do just there is a distinction and a

1452

01:05:44,979 --> 01:05:42,079

reason that we have all of these

1453

01:05:46,599 --> 01:05:44,989

different things really you're gonna see

1454

01:05:48,309 --> 01:05:46,609

all of this great science coming out and

1455

01:05:50,169 --> 01:05:48,319

it's gonna cover the gamut and you're

1456

01:05:51,849 --> 01:05:50,179

not really gonna know but this is really

1457

01:05:53,769 --> 01:05:51,859

this is really there's a lot of people

1458

01:05:55,329 --> 01:05:53,779

have been working really hard on this on

1459

01:06:00,819 --> 01:05:55,339

behalf of the community on behalf of

1460

01:06:02,709 --> 01:06:00,829

this giant space telescope so from from

1461

01:06:04,419 --> 01:06:02,719

this and looking at the science well

1462

01:06:06,819 --> 01:06:04,429

where are we now we're here today and

1463

01:06:10,959 --> 01:06:06,829

let's give you a little bit just what to

1464

01:06:13,390 --> 01:06:10,969

look forward to in the next two years so

1465

01:06:16,689 --> 01:06:13,400

right now we are here while we were here

1466

01:06:18,370 --> 01:06:16,699

we were just past here Paul out in 2017

1467

01:06:20,499 --> 01:06:18,380

we finished our instrument a mirror

1468

01:06:21,699 --> 01:06:20,509

testing at Johnson Space Center that

1469

01:06:24,849 --> 01:06:21,709

went really well this is a beautiful

1470

01:06:26,679 --> 01:06:24,859

picture that was actually shared and

1471

01:06:28,919 --> 01:06:26,689

believe it was the Atlantic magazine

1472

01:06:32,049 --> 01:06:28,929

there's a few people who shared this as

1473

01:06:33,699 --> 01:06:32,059

one of the hopeful images of the year

1474

01:06:35,140 --> 01:06:33,709

like they put together thirty-five

1475

01:06:37,329 --> 01:06:35,150

hopeful images and this was one of them

1476

01:06:40,179 --> 01:06:37,339

because this is what our society can do

1477

01:06:43,870 --> 01:06:40,189

and where it's going really tackling

1478

01:06:47,679 --> 01:06:43,880

these these feats so this is this was

1479

01:06:49,659 --> 01:06:47,689

after it came out of chamber a next it's

1480

01:06:52,209 --> 01:06:49,669

going to Northrop Grumman space park out

1481

01:06:54,339 --> 01:06:52,219

in Redondo Beach California Northrop

1482

01:06:56,589 --> 01:06:54,349

Grumman will take this giant Sun shield

1483

01:06:58,359 --> 01:06:56,599

put it with the telescope element AB

1484

01:07:00,669 --> 01:06:58,369

this what we call the spacecraft bust

1485

01:07:01,989 --> 01:07:00,679

put everything together and if you

1486

01:07:05,620 --> 01:07:01,999

happen to be out and on to beach

1487

01:07:06,069 --> 01:07:05,630

sometime early summer late summer early

1488

01:07:08,169 --> 01:07:06,079

fall

1489

01:07:09,989 --> 01:07:08,179

you can go maybe see this thing all

1490

01:07:15,640 --> 01:07:09,999

fully assembled and it'll allow you

1491

01:07:20,130 --> 01:07:15,650

because it's very amazing next fall next

1492

01:07:22,569 --> 01:07:20,140

phone something next fall next fall Oh

1493

01:07:24,549 --> 01:07:22,579

next fall will they complete the

1494

01:07:26,199 --> 01:07:24,559

integration of spacecraft and the

1495

01:07:27,339 --> 01:07:26,209

instruments and the optical telescope

1496

01:07:29,589 --> 01:07:27,349

and the Sun shield this giant thing

1497

01:07:33,009 --> 01:07:29,599

they'll pack it up and they will send it

1498

01:07:35,939 --> 01:07:33,019

on its way to French Guiana that is

1499

01:07:39,609 --> 01:07:35,949

launching this giant rocket the Ariane 5

1500

01:07:43,659 --> 01:07:39,619

next spring between what would you say

1501
01:07:44,680 --> 01:07:43,669
spring and then it will be operated out

1502
01:07:46,779 --> 01:07:44,690
of this building

1503
01:07:50,319 --> 01:07:46,789
the mission operations Control Center is

1504
01:07:52,120 --> 01:07:50,329
just up there and that is what it looks

1505
01:07:54,400 --> 01:07:52,130
like you probably can't go up there but

1506
01:07:56,160 --> 01:07:54,410
it is that's what it looks like so you

1507
01:07:58,390 --> 01:07:56,170
know missing much now you've seen it

1508
01:08:02,950 --> 01:07:58,400
it's a bunch of computers because that's

1509
01:08:05,049 --> 01:08:02,960
what we do nowadays so after it gets

1510
01:08:08,589 --> 01:08:05,059
launched from here it'll go out into

1511
01:08:11,890 --> 01:08:08,599
space it'll take about 24 to 29 days to

1512
01:08:13,450 --> 01:08:11,900
get out to what I think one of you

1513
01:08:13,930 --> 01:08:13,460

referred to as LTV it cost referred to

1514

01:08:15,940 --> 01:08:13,940

as I2

1515

01:08:17,439 --> 01:08:15,950

this lagrangian point it's basically

1516

01:08:18,939 --> 01:08:17,449

just a place where it can hang out and

1517

01:08:19,479 --> 01:08:18,949

we don't have to keep pumping it and to

1518

01:08:22,150 --> 01:08:19,489

be there

1519

01:08:24,820 --> 01:08:22,160

it'll just happily drift in space and

1520

01:08:27,280 --> 01:08:24,830

follow along with the earth at this I2

1521

01:08:29,769 --> 01:08:27,290

point in the meantime the Sun shield

1522

01:08:31,329 --> 01:08:29,779

opens up the telescope opens up if you

1523

01:08:32,349 --> 01:08:31,339

haven't seen the deployment we think

1524

01:08:33,700 --> 01:08:32,359

some of you have seen it so we're not

1525

01:08:34,959 --> 01:08:33,710

sure we're not showing that deployment

1526

01:08:37,300 --> 01:08:34,969

sequence today but if you haven't seen

1527

01:08:37,780 --> 01:08:37,310

it every time I watch it it blows my

1528

01:08:39,579 --> 01:08:37,790

mind

1529

01:08:41,169 --> 01:08:39,589

you are unfolding something the size of

1530

01:08:44,169 --> 01:08:41,179

a tennis court outlet space by itself

1531

01:08:46,419 --> 01:08:44,179

it's really mind-boggling and it takes

1532

01:08:48,070 --> 01:08:46,429

days to do that and we're checking all

1533

01:08:49,300 --> 01:08:48,080

the instruments it'll take a month to

1534

01:08:51,220 --> 01:08:49,310

get out here but then it'll take another

1535

01:08:52,390 --> 01:08:51,230

five months to cool down check

1536

01:08:54,220 --> 01:08:52,400

everything out all of those newer

1537

01:08:56,079 --> 01:08:54,230

segments have to be aligned there's also

1538

01:08:59,919 --> 01:08:56,089

a really cool animation online of all of

1539

01:09:00,970 --> 01:08:59,929

this mirror segments going to make sure

1540

01:09:03,249 --> 01:09:00,980

that they're all looking at the same

1541

01:09:04,630 --> 01:09:03,259

thing at the same time that was Hubble's

1542

01:09:06,669 --> 01:09:04,640

problem is that it wasn't properly

1543

01:09:07,660 --> 01:09:06,679

polished so we took care of that by

1544

01:09:09,939 --> 01:09:07,670

having lots of different mirrors that we

1545

01:09:13,740 --> 01:09:09,949

can move around but you got a you gotta

1546

01:09:20,650 --> 01:09:18,370

and then and then we find ourselves post

1547

01:09:22,090 --> 01:09:20,660

post what we call launch and

1548

01:09:25,570 --> 01:09:22,100

commissioning where we check out the

1549

01:09:28,329 --> 01:09:25,580

telescope about 170 180 days after

1550

01:09:30,160 --> 01:09:28,339

launch we are at the most important part

1551
01:09:33,999 --> 01:09:36,170
which is where we get all of that good

1552
01:09:36,939 --> 01:09:39,009
science and this will be the legacy of

1553
01:09:39,039 --> 01:09:41,949
web just like Hubble has had a

1554
01:09:41,769 --> 01:09:43,049
legacy and continues on and we look

1555
01:09:43,829 --> 01:09:45,779
forward to the next generation of space

1556
01:09:45,729 --> 01:09:47,839
telescopes after web but in the meantime

1557
01:09:47,709 --> 01:09:49,739
we're going to show you a really cool

1558
01:09:52,209 --> 01:09:54,719
video of all of this getting put

1559
01:09:54,610 --> 01:09:57,219
together and this is this is footage

1560
01:09:58,120 --> 01:09:59,620
from I think from Ball Aerospace from

1561
01:10:01,570 --> 01:10:02,130
Goddard Space Flight Center from Houston

1562
01:10:03,790 --> 01:10:04,580
and also from northrup-grumman so this

1563
01:10:06,070 --> 01:10:06,800

is a really poor lapse that all of us

1564

01:10:09,339 --> 01:10:06,080

find really awesome so we figured you

1565

01:10:20,800 --> 01:10:09,349

would to it runs like two or three

1566

01:10:22,270 --> 01:10:20,810

minutes so I guess we should talk

1567

01:10:23,589 --> 01:10:22,280

through it just a little bit okay we can

1568

01:10:27,550 --> 01:10:23,599

just tell you what's going on so that's

1569

01:10:30,160 --> 01:10:27,560

the the spacecraft element so so what is

1570

01:10:32,080 --> 01:10:30,170

gonna thrust out into space now I'm not

1571

01:10:36,220 --> 01:10:32,090

an engineer but we're gonna go through

1572

01:10:37,930 --> 01:10:36,230

this so this is in probably Northrop

1573

01:10:40,839 --> 01:10:37,940

Grumman is cleanroom because they did

1574

01:10:42,070 --> 01:10:40,849

the spacecraft so then they're gonna

1575

01:10:43,780 --> 01:10:42,080

shove it in a box for a little bit and

1576

01:10:48,879 --> 01:10:43,790

do some testing on it and that comes

1577

01:10:53,229 --> 01:10:48,889

back out and you could just see how many

1578

01:10:56,830 --> 01:10:53,239

people are working on this thing so now

1579

01:10:58,600 --> 01:10:56,840

as you can see there's a they're

1580

01:11:00,310 --> 01:10:58,610

starting to attach the pallets that have

1581

01:11:01,930 --> 01:11:00,320

the sun shield on them again this is all

1582

01:11:03,850 --> 01:11:01,940

at Northrop Grumman and so there's these

1583

01:11:05,649 --> 01:11:03,860

giant things again think of this the

1584

01:11:07,990 --> 01:11:05,659

size of a tennis court this whole thing

1585

01:11:10,959 --> 01:11:08,000

and so they're laying down and there's

1586

01:11:13,320 --> 01:11:10,969

this special material that very very

1587

01:11:15,790 --> 01:11:13,330

very thin but very durable and

1588

01:11:17,589 --> 01:11:15,800

reflective to get rid of all of that

1589

01:11:19,060 --> 01:11:17,599

heat from the Sun from the earth from

1590

01:11:20,620 --> 01:11:19,070

the moon that we don't want because we

1591

01:11:23,439 --> 01:11:20,630

only want heat from objects out in the

1592

01:11:26,620 --> 01:11:23,449

space so this is the frame of the sun

1593

01:11:29,919 --> 01:11:26,630

shield it's a nice cool kite because i

1594

01:11:31,180 --> 01:11:29,929

don't put a giant kite in space and then

1595

01:11:36,270 --> 01:11:31,190

you can see they're adding the layers of

1596

01:11:39,040 --> 01:11:36,280

the sun shield and spreading them out

1597

01:11:54,859 --> 01:11:39,050

really really thin really slow this is a

1598

01:11:59,390 --> 01:11:57,020

and they can see they're lifting up all

1599

01:12:01,820 --> 01:11:59,400

the layers layers do have spacers in

1600

01:12:03,550 --> 01:12:01,830

between so they shouldn't catch on each

1601
01:12:07,220 --> 01:12:03,560
other as the whole thing is deploying

1602
01:12:08,839 --> 01:12:07,230
all of this has been thought of multiple

1603
01:12:11,450 --> 01:12:08,849
times in multiple ways and tested

1604
01:12:12,890 --> 01:12:11,460
multiple times as you can see now

1605
01:12:17,270 --> 01:12:12,900
they're folding up the palettes of the

1606
01:12:19,129 --> 01:12:17,280
sunshield for the for the the the way

1607
01:12:23,359 --> 01:12:19,139
that it's gonna be packed for when it

1608
01:12:25,160 --> 01:12:23,369
goes into space they're the the actual

1609
01:12:27,709 --> 01:12:25,170
mirror will be in the center here with

1610
01:12:30,530 --> 01:12:27,719
the instrument module but right now

1611
01:12:33,500 --> 01:12:30,540
they're just testing the Sun field and

1612
01:12:37,939 --> 01:12:33,510
everything in a faker that's the

1613
01:13:07,470 --> 01:12:37,949

official term for it so this just

1614

01:13:25,320 --> 01:13:10,530

this is not gonna work in space on its

1615

01:13:28,710 --> 01:13:25,330

own oh you wish so now they're showing

1616

01:13:29,280 --> 01:13:28,720

how the center part to deploy the

1617

01:13:30,960 --> 01:13:29,290

sunshield

1618

01:13:32,310 --> 01:13:30,970

everything's folded up it's fold it's

1619

01:13:34,440 --> 01:13:32,320

folded up in these pallets and then

1620

01:13:36,900 --> 01:13:34,450

stacked up so they have to unfold the

1621

01:13:39,450 --> 01:13:36,910

pallets pull out into the kite shape and

1622

01:13:40,710 --> 01:13:39,460

then pull up the center part and all of

1623

01:13:42,330 --> 01:13:40,720

the layers so that there's these five

1624

01:13:44,630 --> 01:13:42,340

layers and that they sit separate from

1625

01:13:47,400 --> 01:13:44,640

each other so that they don't conduct

1626

01:13:49,380 --> 01:13:47,410

but instead just each one of them

1627

01:13:51,210 --> 01:13:49,390

provides a blocking and then here

1628

01:13:52,860 --> 01:13:51,220

they're tightening the sun shield to

1629

01:13:54,990 --> 01:13:52,870

make sure that it'll stay in that

1630

01:13:57,570 --> 01:13:55,000

configuration and it doesn't break and

1631

01:13:59,280 --> 01:13:57,580

it doesn't and you and actually you can

1632

01:14:00,600 --> 01:13:59,290

see you can see some well you could see

1633

01:14:01,920 --> 01:14:00,610

some of the structure on the Sun shield

1634

01:14:05,580 --> 01:14:01,930

there you could see that it wasn't a

1635

01:14:07,290 --> 01:14:05,590

flat piece there was some like so what

1636

01:14:09,300 --> 01:14:07,300

looked like crosshairs or some some

1637

01:14:10,920 --> 01:14:09,310

plaid stuff those are called RIP stops

1638

01:14:12,479 --> 01:14:10,930

and it's actually designed so that if

1639

01:14:14,790 --> 01:14:12,489

there was like a tiny micro meteorite

1640

01:14:16,320 --> 01:14:14,800

that flew through it it would just break

1641

01:14:21,180 --> 01:14:16,330

one small part of it it wouldn't rip the

1642

01:14:28,880 --> 01:14:21,190

whole thing so it's I mean the thoughts

1643

01:14:47,740 --> 01:14:35,150

[Applause]

1644

01:14:53,980 --> 01:14:47,750

I know if we can handle this audience

1645

01:15:06,080 --> 01:15:04,580

questions right there so they're the

1646

01:15:07,580 --> 01:15:06,090

question I have to repeat the question

1647

01:15:12,950 --> 01:15:07,590

for the webcam that's my main purpose

1648

01:15:16,160 --> 01:15:12,960

here so so what is the launch site is it

1649

01:15:19,990 --> 01:15:16,170

Peru or is it yeah it's it's Guiana it's

1650

01:15:21,830 --> 01:15:20,000

kuru is is the area in French Guiana

1651

01:15:23,810 --> 01:15:21,840

that yeah sorry

1652

01:15:27,820 --> 01:15:23,820

so it sounds like Peru sometimes this is

1653

01:15:50,090 --> 01:15:27,830

kuru it's a European spaceport cool yeah

1654

01:15:51,440 --> 01:15:50,100

okay all the way in the back okay okay

1655

01:15:56,380 --> 01:15:51,450

well she finds it let's take another

1656

01:16:03,830 --> 01:15:59,240

what is the probability that a star has

1657

01:16:09,890 --> 01:16:03,840

a planet around it in our galaxy we it's

1658

01:16:16,070 --> 01:16:09,900

it's it's it's on average one planet per

1659

01:16:20,270 --> 01:16:16,080

star at least one right so you're gonna

1660

01:16:21,710 --> 01:16:20,280

say yeah I I'm I've never heard it said

1661

01:16:30,290 --> 01:16:21,720

is what's the probability a star has a

1662

01:16:33,020 --> 01:16:30,300

planet but so yeah basically everything

1663

01:16:36,500 --> 01:16:33,030

has a star everything has a planet so at

1664

01:16:38,450 --> 01:16:36,510

least one okay so it for everything you

1665

01:16:40,400 --> 01:16:38,460

see up in the night sky you're looking

1666

01:16:42,230 --> 01:16:40,410

at planet as well as the star all right

1667

01:16:43,960 --> 01:16:42,240

have you got the slide okay is this is

1668

01:16:46,660 --> 01:16:43,970

this the one you were talking about

1669

01:17:10,930 --> 01:16:46,670

first form equipped like the one with

1670

01:17:12,880 --> 01:17:10,940

the zoomit that one okay how about you

1671

01:17:27,970 --> 01:17:12,890

ask your question and we'll find the

1672

01:17:29,920 --> 01:17:27,980

right thing so so what is that that

1673

01:17:35,200 --> 01:17:29,930

interesting thing in the upper left it's

1674

01:17:38,740 --> 01:17:35,210

a good question that that is is almost

1675

01:17:40,360 --> 01:17:38,750

certainly a reflection of the optical

1676

01:17:42,070 --> 01:17:40,370

element of the telescope so you can

1677

01:17:47,890 --> 01:17:42,080

actually you can see the primary mirror

1678

01:17:49,600 --> 01:17:47,900

and and some of the the rods that the

1679

01:17:51,820 --> 01:17:49,610

secondary mirror is hanging on so if you

1680

01:17:53,320 --> 01:17:51,830

have something very bright and you feel

1681

01:17:56,370 --> 01:17:53,330

it's just a camera reflection it's the

1682

01:17:58,300 --> 01:17:56,380

same if you if you take a picture of

1683

01:18:02,980 --> 01:17:58,310

something bright like the Sun with a

1684

01:18:04,390 --> 01:18:02,990

regular reflex camera you sometimes you

1685

01:18:07,060 --> 01:18:04,400

get out you get a reflection somewhere

1686

01:18:14,610 --> 01:18:07,070

the system and you'll get a little image

1687

01:18:22,510 --> 01:18:16,900

so what's the rate of the data transfer

1688

01:18:26,900 --> 01:18:22,520

from 1/2 to earth what how fast is the

1689

01:18:38,270 --> 01:18:34,140

if I can remember the exact number the

1690

01:18:41,250 --> 01:18:38,280

the data recorder is is a few tens of

1691

01:18:44,520 --> 01:18:41,260

gigabytes and it gets domed once a day

1692

01:18:50,820 --> 01:18:44,530

or so so the data rate is pretty fast

1693

01:19:00,240 --> 01:18:50,830

but it's not super fast all right

1694

01:19:02,640 --> 01:19:00,250

question down here alright so what

1695

01:19:04,860 --> 01:19:02,650

percentage your efficiency do you get

1696

01:19:07,740 --> 01:19:04,870

for observing versus say calibrations

1697

01:19:10,950 --> 01:19:07,750

and other testing and such Wow some some

1698

01:19:12,990 --> 01:19:10,960

good questions here so that really it

1699

01:19:17,880 --> 01:19:13,000

really depends on what what you're

1700

01:19:21,000 --> 01:19:17,890

observing right so on on the for example

1701

01:19:22,620 --> 01:19:21,010

in the science cases of looking for

1702

01:19:24,060 --> 01:19:22,630

faint galaxies at the edge of the

1703

01:19:25,530 --> 01:19:24,070

universe where you're gonna park a

1704

01:19:28,590 --> 01:19:25,540

telescope in a space and just make

1705

01:19:33,540 --> 01:19:28,600

really long integrations efficiency is

1706

01:19:34,920 --> 01:19:33,550

about 70% of course they'll be it's a

1707

01:19:36,390 --> 01:19:34,930

very sensitive telescopes there'll be

1708

01:19:37,770 --> 01:19:36,400

lots of science done with much brighter

1709

01:19:40,550 --> 01:19:37,780

targets where you don't spend as much

1710

01:19:43,940 --> 01:19:40,560

time and then it'll be worse than that

1711

01:19:47,160 --> 01:19:43,950

okay so we got a question from online

1712

01:19:49,830 --> 01:19:47,170

what is going is the coolant going to be

1713

01:19:52,170 --> 01:19:49,840

a significance constraint on JT or C

1714

01:19:53,430 --> 01:19:52,180

observing and since I know the answer

1715

01:19:55,470 --> 01:19:53,440

the question I'll ask the follow-up

1716

01:19:57,000 --> 01:19:55,480

question if it's not the coolant what

1717

01:20:00,900 --> 01:19:57,010

might be the constraint on the lifetime

1718

01:20:02,490 --> 01:20:00,910

of the telescope right so there's no

1719

01:20:06,180 --> 01:20:02,500

there's no coolant that's a consumable

1720

01:20:09,600 --> 01:20:06,190

at the telescope there's a there's a

1721

01:20:10,950 --> 01:20:09,610

there's one cooler for for Miri that's

1722

01:20:12,180 --> 01:20:10,960

an active cooler but it's a closed cycle

1723

01:20:16,380 --> 01:20:12,190

cooler so it works like a refrigerator

1724

01:20:18,060 --> 01:20:16,390

it's a pump that compresses I guess and

1725

01:20:19,680 --> 01:20:18,070

so there's nothing lost so that's not a

1726

01:20:24,000 --> 01:20:19,690

consumable consume main consumable is

1727

01:20:25,820 --> 01:20:24,010

propellant so the l2 orbit is not a

1728

01:20:27,930 --> 01:20:25,830

stable orbit so you have to use

1729

01:20:33,780 --> 01:20:27,940

essentially rocket fuels to keep it in

1730

01:20:36,420 --> 01:20:33,790

place you also have to use fuel to well

1731

01:20:39,180 --> 01:20:36,430

so so basically the because you have

1732

01:20:39,780 --> 01:20:39,190

that big Sun shield it actually gets

1733

01:20:41,670 --> 01:20:39,790

pushed

1734

01:20:45,780 --> 01:20:41,680

by the solar wind and so the particles

1735

01:20:47,070 --> 01:20:45,790

from the Sun and so that if you didn't

1736

01:20:48,750 --> 01:20:47,080

do anything with the telescope it would

1737

01:20:51,600 --> 01:20:48,760

actually start to rotate and eventually

1738

01:20:53,160 --> 01:20:51,610

tumble and so you don't want that so you

1739

01:20:55,040 --> 01:20:53,170

have a reaction wheel on it that spins

1740

01:20:57,540 --> 01:20:55,050

up to counteract that rotation

1741

01:20:59,280 --> 01:20:57,550

eventually that reaches its limit and

1742

01:21:02,010 --> 01:20:59,290

you have to make a burn to spin that

1743

01:21:05,460 --> 01:21:02,020

wheel down again and so that also uses

1744

01:21:08,610 --> 01:21:05,470

propellant so so the ultimate consumer

1745

01:21:10,410 --> 01:21:08,620

Bowl is rocket fuel so the question you

1746

01:21:12,900 --> 01:21:10,420

know with that is that is then that they

1747

01:21:15,870 --> 01:21:12,910

ask is so what what do we expect is a

1748

01:21:18,810 --> 01:21:15,880

lifetime for jato st how many years how

1749

01:21:21,030 --> 01:21:18,820

many decades how about that we were

1750

01:21:23,280 --> 01:21:21,040

issued counted in decades the

1751

01:21:24,690 --> 01:21:23,290

requirement is five years ah but it's

1752

01:21:26,930 --> 01:21:24,700

not gonna be launched with less

1753

01:21:30,210 --> 01:21:26,940

propellant than for at least 10 years

1754

01:21:32,790 --> 01:21:30,220

and so that means that it can live for

1755

01:21:34,740 --> 01:21:32,800

10 years even maybe a bit more but it's

1756

01:21:36,300 --> 01:21:34,750

possible that something you know parts

1757

01:21:38,000 --> 01:21:36,310

of some instruments might break between

1758

01:21:41,490 --> 01:21:38,010

the 5 and the 10 year mark

1759

01:21:49,550 --> 01:21:41,500

hopefully not okay in the middle of the

1760

01:21:55,530 --> 01:21:51,840

so what is the resolution of James Webb

1761

01:21:59,280 --> 01:21:55,540

compared to Hubble alright so so you can

1762

01:21:59,760 --> 01:21:59,290

you can you can calculate that fairly

1763

01:22:04,380 --> 01:21:59,770

easily

1764

01:22:06,570 --> 01:22:04,390

um so the Hubble has a two point for me

1765

01:22:08,820 --> 01:22:06,580

to telescope and data beasty has a six

1766

01:22:11,730 --> 01:22:08,830

and a half metre telescope and so the

1767

01:22:13,710 --> 01:22:11,740

raloo the resolution scales linearly

1768

01:22:19,250 --> 01:22:13,720

with that it also scales with wavelength

1769

01:22:22,410 --> 01:22:19,260

so let's say you the mirror of Webb is

1770

01:22:24,630 --> 01:22:22,420

about two and a half times the size of

1771

01:22:25,860 --> 01:22:24,640

Hubble and so the same wavelength the

1772

01:22:27,090 --> 01:22:25,870

resolution will be two-and-a-half times

1773

01:22:29,600 --> 01:22:27,100

better but you're not at the same

1774

01:22:32,940 --> 01:22:29,610

wavelength unit about you know two to

1775

01:22:35,100 --> 01:22:32,950

five to ten times longer wavelength and

1776

01:22:36,720 --> 01:22:35,110

so then you scale scale back down again

1777

01:22:38,400 --> 01:22:36,730

so this is the that's a complicated

1778

01:22:46,620 --> 01:22:38,410

answer the the simple answer is it'll be

1779

01:22:49,070 --> 01:22:46,630

about the same resolution this would

1780

01:22:52,020 --> 01:22:49,080

they look the same then

1781

01:22:53,549 --> 01:22:52,030

it would have the same similar sharpness

1782

01:22:55,979 --> 01:22:53,559

but it will look quite different because

1783

01:22:59,279 --> 01:22:55,989

you'd be looking at and say dust instead

1784

01:23:00,809 --> 01:22:59,289

of stars but but as he said at the same

1785

01:23:03,359 --> 01:23:00,819

wavelength it'll be two knife times

1786

01:23:04,829 --> 01:23:03,369

sharper okay it a couple times sharper

1787

01:23:06,149 --> 01:23:04,839

it's just if you're looking at the

1788

01:23:07,259 --> 01:23:06,159

longer wavelengths it'll be about the

1789

01:23:15,540 --> 01:23:07,269

same okay

1790

01:23:16,979 --> 01:23:15,550

so in front here right yeah this

1791

01:23:18,869 --> 01:23:16,989

question came up on the chat as well

1792

01:23:20,879 --> 01:23:18,879

they're worried that web would be

1793

01:23:24,089 --> 01:23:20,889

restricted because it has to point away

1794

01:23:25,199 --> 01:23:24,099

from the Sun in what it can observe yeah

1795

01:23:27,449 --> 01:23:25,209

they said that's an excellent question

1796

01:23:32,000 --> 01:23:27,459

as well aw it's a bit a bit of geometry

1797

01:23:34,979 --> 01:23:32,010

there so it orbits web orbits the Sun

1798

01:23:36,299 --> 01:23:34,989

along with the earth and so the answer

1799

01:23:39,270 --> 01:23:36,309

is actually that it can observe every

1800

01:23:41,759 --> 01:23:39,280

place in the sky but because the Sun

1801

01:23:43,859 --> 01:23:41,769

shield will point to the earth the

1802

01:23:47,009 --> 01:23:43,869

telescope will point you know either up

1803

01:23:48,629 --> 01:23:47,019

or down all the way around like a circle

1804

01:23:50,189 --> 01:23:48,639

like that so you imagine you'll have a

1805

01:23:52,529 --> 01:23:50,199

circle on the sky that looks like that

1806

01:23:55,020 --> 01:23:52,539

over the course of a year that circle

1807

01:23:57,299 --> 01:23:55,030

will move all the way around and scan

1808

01:23:59,909 --> 01:23:57,309

the entire sky so if you have an object

1809

01:24:00,989 --> 01:23:59,919

that is very close to the clip let's say

1810

01:24:02,339 --> 01:24:00,999

the Sun and the earth if you have a

1811

01:24:05,219 --> 01:24:02,349

target it's very close to the ecliptic

1812

01:24:06,659 --> 01:24:05,229

pole you can observe it all the time if

1813

01:24:08,459 --> 01:24:06,669

you have a target that it's pointed

1814

01:24:24,779 --> 01:24:08,469

directly away from the Sun earth plane

1815

01:24:26,309 --> 01:24:24,789

you can observe it twice a year so if

1816

01:24:27,809 --> 01:24:26,319

you want to do a really long observing

1817

01:24:30,750 --> 01:24:27,819

time do you have other special points in

1818

01:24:31,859 --> 01:24:30,760

the sky you have to be pointed at yes it

1819

01:24:35,009 --> 01:24:31,869

has to be has to be a very long

1820

01:24:38,009 --> 01:24:35,019

observing time so so any any given point

1821

01:24:41,669 --> 01:24:38,019

will have a couple of weeks of potential

1822

01:24:44,099 --> 01:24:41,679

time and if you really want a cool way

1823

01:24:46,469 --> 01:24:44,109

to visualize this stay tuned to those

1824

01:24:48,929 --> 01:24:46,479

social media accounts that Frank shared

1825

01:24:50,040 --> 01:24:48,939

earlier in about a month maybe a month

1826

01:24:51,839 --> 01:24:50,050

and a half they'll be a really cool

1827

01:24:53,879 --> 01:24:51,849

animation to show you exactly what web

1828

01:25:00,040 --> 01:24:53,889

can see in the sky and explain that

1829

01:25:10,900 --> 01:25:08,860

okay other questions over there so how

1830

01:25:15,940 --> 01:25:10,910

long will Hubble operate and will Jade

1831

01:25:20,740 --> 01:25:15,950

OST and Hubble overlap I'll take this

1832

01:25:24,190 --> 01:25:20,750

okay so Hubble is doing really well

1833

01:25:26,050 --> 01:25:24,200

April is Hubble's 28th birthday and so

1834

01:25:28,530 --> 01:25:26,060

we are expecting good things it's in

1835

01:25:31,780 --> 01:25:28,540

good health it looks good

1836

01:25:35,350 --> 01:25:31,790

so yes we anticipate that Hubble and

1837

01:25:36,700 --> 01:25:35,360

Webb will observe simultaneously and one

1838

01:25:38,140 --> 01:25:36,710

of the cool things you can do with this

1839

01:25:40,660 --> 01:25:38,150

I'm putting in a plug for my own thing

1840

01:25:41,380 --> 01:25:40,670

here is because they're about a million

1841

01:25:45,340 --> 01:25:41,390

miles apart

1842

01:25:48,310 --> 01:25:45,350

think about your two eyes and what what

1843

01:25:52,480 --> 01:25:48,320

does having two eyes by you yeah

1844

01:25:55,000 --> 01:25:52,490

depth perception so one of the cool

1845

01:25:57,220 --> 01:25:55,010

things we might be able to do with Webb

1846

01:26:01,330 --> 01:25:57,230

and Hubble at the same time is look at

1847

01:26:03,100 --> 01:26:01,340

objects and be able to get some some

1848

01:26:04,870 --> 01:26:03,110

depth perception there especially things

1849

01:26:06,790 --> 01:26:04,880

close to us so solar system objects

1850

01:26:09,190 --> 01:26:06,800

things like that I'm a planetary person

1851
01:26:10,990 --> 01:26:09,200
so I'm really into this idea okay that's

1852
01:26:14,020 --> 01:26:11,000
that's why I kick Klaus out of the way I

1853
01:26:15,730 --> 01:26:14,030
want to answer that one but my

1854
01:26:16,750 --> 01:26:15,740
understanding is it won't be good much

1855
01:26:19,450 --> 01:26:16,760
beyond Jupiter

1856
01:26:22,330 --> 01:26:19,460
maybe asteroid belt would be a yeah yeah

1857
01:26:24,910 --> 01:26:22,340
yeah we have cool things like the active

1858
01:26:27,400 --> 01:26:24,920
asteroids that are shooting out Jets and

1859
01:26:29,230 --> 01:26:27,410
you know some you know three-dimensional

1860
01:26:32,490 --> 01:26:29,240
information on that you can just some

1861
01:26:34,690 --> 01:26:32,500
great stereo views of rocks

1862
01:26:38,040 --> 01:26:34,700
it'll be like going to Mars again

1863
01:26:40,870 --> 01:26:38,050

[Laughter]

1864

01:26:48,010 --> 01:26:40,880

alright sorry we're just having fun

1865

01:26:50,530 --> 01:26:48,020

question here another question that came

1866

01:26:52,780 --> 01:26:50,540

up in our chat online are there research

1867

01:26:55,480 --> 01:26:52,790

proposals that have been submitted

1868

01:26:59,080 --> 01:26:55,490

and/or approved we know what Webb is

1869

01:27:00,940 --> 01:26:59,090

gonna look at first we know some of the

1870

01:27:02,890 --> 01:27:00,950

things that Webb will look at first so

1871

01:27:04,540 --> 01:27:02,900

these are what Alex was talking about so

1872

01:27:09,310 --> 01:27:04,550

I'm gonna let her keep answering that

1873

01:27:13,330 --> 01:27:09,320

question okay I will just pull up the

1874

01:27:15,220 --> 01:27:13,340

slides because you know I do extra work

1875

01:27:18,549 --> 01:27:15,230

the answer is yes we have these

1876

01:27:21,010 --> 01:27:18,559

proposals and so two of the three types

1877

01:27:22,569 --> 01:27:21,020

that I mentioned this is fun

1878

01:27:26,589 --> 01:27:22,579

two of the three types that I mentioned

1879

01:27:28,689 --> 01:27:26,599

the programs and the ers programs the

1880

01:27:30,370 --> 01:27:28,699

guaranteed time observations which is

1881

01:27:31,990 --> 01:27:30,380

that time that we give to those people

1882

01:27:34,990 --> 01:27:32,000

who've worked on this for five ten

1883

01:27:37,450 --> 01:27:35,000

twenty years this purple graph here of

1884

01:27:39,939 --> 01:27:37,460

people working they get time they get a

1885

01:27:44,709 --> 01:27:39,949

couple of thousand hours in the first

1886

01:27:46,779 --> 01:27:44,719

couple of years and then this directors

1887

01:27:47,859 --> 01:27:46,789

discretionary early release science was

1888

01:27:50,830 --> 01:27:47,869

picked by the director of the Space

1889

01:27:52,419 --> 01:27:50,840

Telescope Institute as science cases to

1890

01:27:54,250 --> 01:27:52,429

demonstrate the capabilities of the

1891

01:27:56,529 --> 01:27:54,260

telescope and will be released

1892

01:27:58,510 --> 01:27:56,539

immediately and taken in the first

1893

01:28:00,459 --> 01:27:58,520

couple of months after launch these

1894

01:28:02,890 --> 01:28:00,469

programs are already decided they're

1895

01:28:07,720 --> 01:28:02,900

available online there's 13 programs

1896

01:28:09,339 --> 01:28:07,730

under the ers and there's well if you

1897

01:28:12,490 --> 01:28:09,349

break them down into programs a couple

1898

01:28:15,879 --> 01:28:12,500

of dozen programs for GTOs under a few

1899

01:28:17,080 --> 01:28:15,889

key people the the key people who were

1900

01:28:19,240 --> 01:28:17,090

part of the program from the beginning

1901
01:28:20,890 --> 01:28:19,250
they got time and they said this is what

1902
01:28:23,979 --> 01:28:20,900
I want to spend my time on you can

1903
01:28:25,959 --> 01:28:23,989
review all of this it's online if you

1904
01:28:27,850 --> 01:28:25,969
want that link come after it so we can

1905
01:28:30,040 --> 01:28:27,860
get it to you it's long but all of this

1906
01:28:34,810 --> 01:28:30,050
information is available online if you

1907
01:28:36,549 --> 01:28:34,820
just google JWST early release science

1908
01:28:39,520 --> 01:28:36,559
you'll get an article that explains all

1909
01:28:42,490 --> 01:28:39,530
of the things and again this covers

1910
01:28:43,810 --> 01:28:42,500
solar system objects all of the for

1911
01:28:46,810 --> 01:28:43,820
science themes that Bonnie talked about

1912
01:28:49,240 --> 01:28:46,820
and we do know these already these will

1913
01:28:52,540 --> 01:28:49,250

be decided in the summer and you'll hear

1914

01:28:55,109 --> 01:28:52,550

about them probably July for the first

1915

01:28:58,000 --> 01:28:55,119

round of general observer observations

1916

01:28:59,080 --> 01:28:58,010

from then on these are already decided

1917

01:29:02,229 --> 01:28:59,090

and they'll be taken at the beginning

1918

01:29:05,620 --> 01:29:02,239

from then on we'll have several calls

1919

01:29:07,479 --> 01:29:05,630

for people to submit ideas and as we get

1920

01:29:09,729 --> 01:29:07,489

back data from web and find out what it

1921

01:29:11,649 --> 01:29:09,739

can do that'll spark ideas for new

1922

01:29:13,390 --> 01:29:11,659

proposals and so for the lifetime of the

1923

01:29:14,770 --> 01:29:13,400

mission we'll keep asking the

1924

01:29:16,240 --> 01:29:14,780

astronomical community for what they

1925

01:29:18,069 --> 01:29:16,250

want to do with the telescope and it

1926

01:29:19,240 --> 01:29:18,079

will keep getting answers but thus far

1927

01:29:21,430 --> 01:29:19,250

the programs that have already been

1928

01:29:24,399 --> 01:29:21,440

approved fall into these two buckets and

1929

01:29:26,620 --> 01:29:24,409

you can find them online ok we have time

1930

01:29:29,620 --> 01:29:26,630

for one last question if anybody has it

1931

01:29:31,209 --> 01:29:29,630

going once help take it and go what's

1932

01:29:51,610 --> 01:29:31,219

the last question make it good make it

1933

01:29:54,340 --> 01:29:51,620

good cuz it's the last one okay so

1934

01:29:56,970 --> 01:29:54,350

alright so obviously there's tons are

1935

01:29:59,350 --> 01:29:56,980

really cool science we can do with web

1936

01:30:02,379 --> 01:29:59,360

what's the plans for the telescopes

1937

01:30:04,990 --> 01:30:02,389

beyond web that will replace Hubble and

1938

01:30:12,810 --> 01:30:05,000

Webb in the 2030s who wants to answer

1939

01:30:16,290 --> 01:30:12,820

that question well okay so so there's

1940

01:30:18,610 --> 01:30:16,300

yeah I don't I don't hurt myself here so

1941

01:30:21,310 --> 01:30:18,620

there there's there's the wide-field

1942

01:30:23,229 --> 01:30:21,320

infrared telescope which is under

1943

01:30:27,189 --> 01:30:23,239

construction at the moment which is a

1944

01:30:30,580 --> 01:30:27,199

near infrared telescope that has Hubble

1945

01:30:33,340 --> 01:30:30,590

sized but it has a hundred times the

1946

01:30:34,959 --> 01:30:33,350

field of view so make Hubble like

1947

01:30:36,430 --> 01:30:34,969

pictures but it'll be a hundred times

1948

01:30:37,959 --> 01:30:36,440

bigger

1949

01:30:39,100 --> 01:30:37,969

just watch the survey telescope so

1950

01:30:41,680 --> 01:30:39,110

that's approved and that's under

1951

01:30:45,129 --> 01:30:41,690

construction beyond that for the 2030s

1952

01:30:48,189 --> 01:30:45,139

there's a process ongoing that happens

1953

01:30:50,229 --> 01:30:48,199

every decade in the United States it's

1954

01:30:54,280 --> 01:30:50,239

called a decadal survey and that

1955

01:31:04,439 --> 01:30:54,290

consists of the community historical

1956

01:31:10,750 --> 01:31:07,990

right so the community gets together and

1957

01:31:13,330 --> 01:31:10,760

they they think about what they might

1958

01:31:16,000 --> 01:31:13,340

want to do for the following decade in

1959

01:31:18,820 --> 01:31:16,010

this case for the 2030s today so so so

1960

01:31:21,310 --> 01:31:18,830

datums T was the selection for \$2000

1961

01:31:23,590 --> 01:31:21,320

stores the selection for 2010 we need a

1962

01:31:25,390 --> 01:31:23,600

selection for the 2020s one other so

1963

01:31:27,850 --> 01:31:25,400

there's four concepts for new flagship

1964

01:31:30,879 --> 01:31:27,860

telescopes and one of them is an

1965

01:31:33,729 --> 01:31:30,889

infrared telescope ah that goes beyond

1966

01:31:37,229 --> 01:31:33,739

in wavelength even WOD TMT does it

1967

01:31:40,450 --> 01:31:37,239

covers from five micron to 660 micron

1968

01:31:42,570 --> 01:31:40,460

but it'll be between a sow

1969

01:31:45,100 --> 01:31:42,580

10,000 times more sensitive than

1970

01:31:46,300 --> 01:31:45,110

anything has been done before so that's

1971

01:31:48,160 --> 01:31:46,310

that's new frontier it's called the

1972

01:31:49,660 --> 01:31:48,170

origin space telescope and you can

1973

01:31:51,280 --> 01:31:49,670

google that and look it up that's one of

1974

01:31:53,290 --> 01:31:51,290

the one of the concepts now the other

1975

01:31:55,800 --> 01:31:53,300

concepts as well there's a there's also

1976

01:31:59,410 --> 01:31:55,810

a concept it's called leVoir which is

1977

01:32:02,530 --> 01:31:59,420

the next optical telescope which is a 15

1978

01:32:05,020 --> 01:32:02,540

meter telescope that's going to follow

1979

01:32:07,510 --> 01:32:05,030

up on Hubble so that's going to be some

1980

01:32:09,220 --> 01:32:07,520

tough decisions to make for the

1981

01:32:11,620 --> 01:32:09,230

astronomical community of what is the

1982

01:32:12,970 --> 01:32:11,630

best the best way to spend money going

1983

01:32:16,420 --> 01:32:12,980

forward for the 2030s will be

1984

01:32:18,130 --> 01:32:16,430

interesting okay so that's all we have

1985

01:32:19,390 --> 01:32:18,140

time for tonight if you have more

1986

01:32:21,700 --> 01:32:19,400

questions or things you can come down

1987

01:32:24,070 --> 01:32:21,710

the speaker's will be here next month

1988

01:32:27,670 --> 01:32:24,080

February 6 which is only just a couple

1989

01:32:29,229 --> 01:32:27,680

of weeks away the wildest weather in the