PUBLIC LECTURE SERIES

The Nancy Grace Roman Space Telescope

Featuring Guest Speakers:
Jennifer Wiseman & Julie McEnery

1
00:00:07,190 --> 00:00:03,909
welcome to the space telescope

2
00:00:08,710 --> 00:00:07,200
public lecture series today's talk is on

3
00:00:11,030 --> 00:00:08,720
the nancy grace roman

4
00:00:11,990 --> 00:00:11,040
space telescope with two special

5
00:00:14,390 --> 00:00:12,000
presenters

6
00:00:16,230 --> 00:00:14,400
jennifer wiseman and julie mcenery of

7
00:00:19,510 --> 00:00:16,240
the nasa goddard space flight

8
00:00:21,750 --> 00:00:19,520
center i'm dr frank summers of the space

9
00:00:23,750 --> 00:00:21,760
telescope science institute and it is my

10
00:00:25,910 --> 00:00:23,760
pleasure to be your host

11
00:00:27,830 --> 00:00:25,920
and i want to note that our public

12
00:00:29,029 --> 00:00:27,840
lecture series will continue to be

13
00:00:32,870 --> 00:00:29,039

online only

14
00:00:35,030 --> 00:00:32,880
until further notice also have to thank

15
00:00:36,709 --> 00:00:35,040
our amazing tech team who gets you this

16
00:00:39,350 --> 00:00:36,719
uh this online version of it

17
00:00:41,430 --> 00:00:39,360
thomas marufu and grant justice they do

18
00:00:43,590 --> 00:00:41,440
amazing things behind the scene

19
00:00:45,190 --> 00:00:43,600
and i really really appreciate their

20
00:00:48,549 --> 00:00:45,200
work

21
00:00:50,470 --> 00:00:48,559
upcoming next month on november

22
00:00:52,069 --> 00:00:50,480
10th that will be a special date i

23
00:00:53,990 --> 00:00:52,079
should have added that special date

24
00:00:55,189 --> 00:00:54,000
there because election day is of course

25
00:00:57,110 --> 00:00:55,199
november 3rd

26
00:00:58,630 --> 00:00:57,120
there will be no public lecture series

27
00:01:01,349 --> 00:00:58,640
on election day

28
00:01:01,670 --> 00:01:01,359
instead the week after on november 10th

29
00:01:04,070 --> 00:01:01,680
uh

30
00:01:06,469 --> 00:01:04,080
hearing the light how sonification

31
00:01:09,590 --> 00:01:06,479
deepens our understanding of the cosmos

32
00:01:11,670 --> 00:01:09,600
and makes astronomy more accessible

33
00:01:13,429 --> 00:01:11,680
that i think is probably another

34
00:01:14,149 --> 00:01:13,439
candidate for one of the longest titles

35
00:01:16,870 --> 00:01:14,159
we've had

36
00:01:19,109 --> 00:01:16,880
but scott fleming clara brasser and

37
00:01:20,710 --> 00:01:19,119
jennifer cutler will explain it all to

38
00:01:22,149 --> 00:01:20,720

you they've got this great program

39
00:01:23,429 --> 00:01:22,159
called astronomify

40
00:01:25,270 --> 00:01:23,439
and they'll give it give you all the

41
00:01:27,510 --> 00:01:25,280
details next month

42
00:01:29,429 --> 00:01:27,520
in december mitchell rowalsky will be

43
00:01:30,550 --> 00:01:29,439
talking about shaping galaxies with

44
00:01:34,710 --> 00:01:30,560
supermassive

45
00:01:35,429 --> 00:01:34,720
holes at the cores of galaxies can

46
00:01:38,069 --> 00:01:35,439
actually

47
00:01:39,429 --> 00:01:38,079
change things on galactic scales it's

48
00:01:40,550 --> 00:01:39,439
really cool

49
00:01:42,789 --> 00:01:40,560
and he'll tell you about that in

50
00:01:45,590 --> 00:01:42,799
december and then in

51
00:01:46,469 --> 00:01:45,600
january another special date because we

52
00:01:50,630 --> 00:01:46,479
have the

53
00:01:52,469 --> 00:01:50,640
double a s meeting and the double a s

54
00:01:54,230 --> 00:01:52,479
meeting is going to be late this year so

55
00:01:57,270 --> 00:01:54,240
we're pushing it all the way back

56
00:01:59,910 --> 00:01:57,280
to january 19th for the

57
00:02:01,830 --> 00:01:59,920
darkest secrets of the universe you're

58
00:02:04,709 --> 00:02:01,840
definitely going to want to hit this one

59
00:02:06,389 --> 00:02:04,719
this is a friend of mine from uc santa

60
00:02:09,190 --> 00:02:06,399
cruz raja gupta

61
00:02:10,469 --> 00:02:09,200
kurta he's an amazing speaker and you're

62
00:02:13,270 --> 00:02:10,479
definitely going to want to see

63
00:02:14,949 --> 00:02:13,280

that if you want to keep up with the

64
00:02:18,869 --> 00:02:14,959
public lecture series and what's

65
00:02:21,990 --> 00:02:18,879
coming up go to our website stsci.edu

66
00:02:25,350 --> 00:02:22,000
public hyphen lectures there you

67
00:02:25,990 --> 00:02:25,360
will find the webcasts on the left you

68
00:02:28,309 --> 00:02:26,000
can see that

69
00:02:29,350 --> 00:02:28,319
we have links to our youtube playlist as

70
00:02:31,589 --> 00:02:29,360
well as the webcast

71
00:02:33,670 --> 00:02:31,599
archive that they handle here at the

72
00:02:35,910 --> 00:02:33,680
space telescope science institute

73
00:02:37,670 --> 00:02:35,920
and on the right you can see that there

74
00:02:38,470 --> 00:02:37,680
you can subscribe and get our lecture

75
00:02:41,110 --> 00:02:38,480
announcements

76
00:02:44,229 --> 00:02:41,120
which is basically two emails per month

77
00:02:46,390 --> 00:02:44,239
to remind you of the upcoming lectures

78
00:02:47,990 --> 00:02:46,400
also on the website are the details of

79
00:02:50,550 --> 00:02:48,000
the upcoming lectures

80
00:02:52,390 --> 00:02:50,560
usually about a month before we have a

81
00:02:54,229 --> 00:02:52,400
detailed abstract

82
00:02:56,309 --> 00:02:54,239
that's put on there and if you click on

83
00:02:57,030 --> 00:02:56,319
each of these especially after they have

84
00:02:59,509 --> 00:02:57,040
been gone

85
00:03:00,229 --> 00:02:59,519
you have the complete details of the

86
00:03:02,630 --> 00:03:00,239
lecture

87
00:03:04,470 --> 00:03:02,640
as well as a link to view the webcast

88
00:03:07,670 --> 00:03:04,480

both on sdsei

89
00:03:10,550 --> 00:03:07,680
and on youtube

90
00:03:11,910 --> 00:03:10,560
for email as i said the announcements

91
00:03:12,710 --> 00:03:11,920
it's easiest just to sign up on the

92
00:03:14,470 --> 00:03:12,720
website

93
00:03:16,309 --> 00:03:14,480
but if you want a different reminder you

94
00:03:17,030 --> 00:03:16,319
can also subscribe to our youtube

95
00:03:19,990 --> 00:03:17,040
channel

96
00:03:21,270 --> 00:03:20,000
youtube.com hubble space telescope all

97
00:03:24,309 --> 00:03:21,280
one word

98
00:03:25,190 --> 00:03:24,319
you'll get the notices not only of these

99
00:03:27,270 --> 00:03:25,200
live events

100
00:03:28,309 --> 00:03:27,280
but also when we post new videos which

101
00:03:30,869 --> 00:03:28,319
we do

102
00:03:32,229 --> 00:03:30,879
on a regular basis finally if you have

103
00:03:34,229 --> 00:03:32,239
comments or questions

104
00:03:36,110 --> 00:03:34,239
you can send them to the email address

105
00:03:39,589 --> 00:03:36,120
public lecture

106
00:03:40,789 --> 00:03:39,599
stsci.edu you can also follow us on

107
00:03:43,830 --> 00:03:40,799
social media

108
00:03:46,149 --> 00:03:43,840
hubble space telescope for the

109
00:03:47,750 --> 00:03:46,159
james webb space telescope that launches

110
00:03:49,509 --> 00:03:47,760
in 13 months

111
00:03:51,110 --> 00:03:49,519
and for the space telescope science

112
00:03:54,070 --> 00:03:51,120
institute in general

113
00:03:54,869 --> 00:03:54,080

facebook twitter youtube and instagram i

114
00:03:57,350 --> 00:03:54,879
myself do a

115
00:03:57,910 --> 00:03:57,360
tiny bit tiny tiny bit on facebook and

116
00:04:01,110 --> 00:03:57,920
twitter

117
00:04:03,270 --> 00:04:01,120
and you can follow me there

118
00:04:07,270 --> 00:04:03,280
now our news from the universe for

119
00:04:10,390 --> 00:04:09,750
the first story tonight illuminating the

120
00:04:14,070 --> 00:04:10,400
gases

121
00:04:16,069 --> 00:04:14,080
halo of andromeda so they often

122
00:04:17,110 --> 00:04:16,079
say there's more to the universe than

123
00:04:20,150 --> 00:04:17,120
meets the eye

124
00:04:21,990 --> 00:04:20,160
and that's also true in astronomy

125
00:04:24,230 --> 00:04:22,000
let's give you an example of this galaxy

126
00:04:24,710 --> 00:04:24,240
cluster this galaxy cluster is the name

127
00:04:30,550 --> 00:04:24,720
of

128
00:04:34,150 --> 00:04:33,189
not all things in astronomy have nice

129
00:04:35,430 --> 00:04:34,160
have fun names

130
00:04:37,510 --> 00:04:35,440
this one just happens to have its

131
00:04:39,670 --> 00:04:37,520
catalog name but this is the view

132
00:04:41,510 --> 00:04:39,680
in optical light visible light this is

133
00:04:44,390 --> 00:04:41,520
as how hubble sees it

134
00:04:46,790 --> 00:04:44,400
but if we add to this the view from the

135
00:04:49,510 --> 00:04:46,800
chandra x-ray observatory

136
00:04:50,870 --> 00:04:49,520
then you can see that there is a lot

137
00:04:53,990 --> 00:04:50,880
more to this cluster

138
00:04:56,710 --> 00:04:54,000

than meets the eye the x-ray

139
00:04:57,350 --> 00:04:56,720
shows up this hot gas that permeates the

140
00:05:03,749 --> 00:04:57,360
cluster

141
00:05:05,430 --> 00:05:03,759
that there is more to galaxies than just

142
00:05:06,150 --> 00:05:05,440
what we see there's a lot more stuff

143
00:05:08,950 --> 00:05:06,160
there's a

144
00:05:10,710 --> 00:05:08,960
big gaseous halo of stuff around the

145
00:05:12,870 --> 00:05:10,720
cluster of galaxies

146
00:05:13,990 --> 00:05:12,880
now when galaxies gather together into

147
00:05:17,430 --> 00:05:14,000
these clusters

148
00:05:19,029 --> 00:05:17,440
the intra the cluster gas heats up to

149
00:05:21,189 --> 00:05:19,039
hundreds of thousands to millions of

150
00:05:23,510 --> 00:05:21,199
degrees and it glows in x-rays

151
00:05:25,990 --> 00:05:23,520
and that's makes it easy to spot this

152
00:05:28,790 --> 00:05:26,000
extra material for these clusters

153
00:05:30,710 --> 00:05:28,800
but what about an individual galaxy like

154
00:05:32,390 --> 00:05:30,720
the andromeda galaxy

155
00:05:33,909 --> 00:05:32,400
this isn't part of a cluster it's just

156
00:05:35,830 --> 00:05:33,919
part of our local group and the local

157
00:05:36,950 --> 00:05:35,840
group isn't mixed up and all the gas is

158
00:05:39,990 --> 00:05:36,960
heated and everything

159
00:05:43,350 --> 00:05:40,000
so how are we going to find the halo

160
00:05:44,550 --> 00:05:43,360
of material around andromeda well let me

161
00:05:47,350 --> 00:05:44,560
first state that

162
00:05:48,230 --> 00:05:47,360
i'm not talking about the stellar halo

163
00:05:50,150 --> 00:05:48,240

this image

164
00:05:51,350 --> 00:05:50,160
here and you can see that tiny little

165
00:05:53,909 --> 00:05:51,360
box there

166
00:05:54,710 --> 00:05:53,919
that's this blow up image of that tiny

167
00:05:56,950 --> 00:05:54,720
little box that's

168
00:05:59,110 --> 00:05:56,960
well outside the main part of the galaxy

169
00:05:59,830 --> 00:05:59,120
we call that the stellar halo of

170
00:06:02,230 --> 00:05:59,840
andromeda

171
00:06:02,950 --> 00:06:02,240
and that's the stars that orbit around

172
00:06:04,309 --> 00:06:02,960
andromeda

173
00:06:06,070 --> 00:06:04,319
that are still part of the galaxy are

174
00:06:08,150 --> 00:06:06,080
still bound to it and that's

175
00:06:10,070 --> 00:06:08,160
well that's relatively close in for the

176
00:06:13,749 --> 00:06:10,080
hail that we're talking about

177
00:06:16,469 --> 00:06:13,759
gaseous halo of

178
00:06:17,029 --> 00:06:16,479
andromeda and it extends out like 10

179
00:06:19,430 --> 00:06:17,039
times

180
00:06:20,790 --> 00:06:19,440
further than the galaxy itself we want

181
00:06:23,110 --> 00:06:20,800
to figure out is there

182
00:06:23,990 --> 00:06:23,120
gas like around that cluster of galaxies

183
00:06:27,430 --> 00:06:24,000
extending

184
00:06:29,189 --> 00:06:27,440
way way out into the universe but

185
00:06:30,550 --> 00:06:29,199
how are we going to do that it's not

186
00:06:33,029 --> 00:06:30,560
glowing at x-ray

187
00:06:33,990 --> 00:06:33,039
x-ray wavelengths so we need something

188
00:06:37,029 --> 00:06:34,000

to illuminate

189
00:06:37,510 --> 00:06:37,039
it and what we use we use something

190
00:06:40,870 --> 00:06:37,520
called

191
00:06:43,990 --> 00:06:40,880
quasars now the term quasar used to mean

192
00:06:46,309 --> 00:06:44,000
quasi-stellar radio source okay and you

193
00:06:50,150 --> 00:06:46,319
can see these five objects here

194
00:06:52,870 --> 00:06:50,160
these are what look like stars

195
00:06:53,350 --> 00:06:52,880
but they're actually supermassive black

196
00:06:56,309 --> 00:06:53,360
holes

197
00:06:57,270 --> 00:06:56,319
at the cores of galaxies shining across

198
00:06:59,510 --> 00:06:57,280
the universe

199
00:07:02,150 --> 00:06:59,520
so these are very distant galaxies with

200
00:07:04,150 --> 00:07:02,160
extremely bright sources in them

201
00:07:06,390 --> 00:07:04,160
and they can be used as sort of like

202
00:07:10,230 --> 00:07:06,400
flashlights to look through the stuff

203
00:07:13,909 --> 00:07:10,240
in between us so what they did

204
00:07:17,270 --> 00:07:13,919
is they went out and they found 43

205
00:07:19,749 --> 00:07:17,280
quasars in the area around andromeda

206
00:07:22,550 --> 00:07:19,759
and they examined the light of those 43

207
00:07:25,029 --> 00:07:22,560
quasars to see if they could see the gas

208
00:07:26,390 --> 00:07:25,039
around andromeda absorb some of the

209
00:07:29,830 --> 00:07:26,400
light of the quasar

210
00:07:30,870 --> 00:07:29,840
studied it with the cosmic origin

211
00:07:34,629 --> 00:07:30,880
spectrograph

212
00:07:36,790 --> 00:07:34,639
in ionized carbon silicon and oxygen

213
00:07:38,710 --> 00:07:36,800

to try and understand the density of

214
00:07:41,510 --> 00:07:38,720
this gaseous halo

215
00:07:43,029 --> 00:07:41,520
out distances and what did they find

216
00:07:45,670 --> 00:07:43,039
well it's sort of illustrated in this

217
00:07:48,869 --> 00:07:45,680
diagram but they found that there was an

218
00:07:49,670 --> 00:07:48,879
inner halo that's really disruptive and

219
00:07:52,629 --> 00:07:49,680
dynamic and

220
00:07:54,230 --> 00:07:52,639
active and it's probably disrupted by

221
00:07:56,869 --> 00:07:54,240
supernovae going on

222
00:07:57,270 --> 00:07:56,879
in the andromeda galaxy and the various

223
00:07:59,510 --> 00:07:57,280
things

224
00:08:00,390 --> 00:07:59,520
the dynamics of happening inside it as

225
00:08:02,869 --> 00:08:00,400
well as there was an

226
00:08:04,230 --> 00:08:02,879
outer halo an outer gaseous halo that

227
00:08:07,029 --> 00:08:04,240
was calmer

228
00:08:08,550 --> 00:08:07,039
and actually was warmer and hotter all

229
00:08:12,150 --> 00:08:08,560
right so you're looking in

230
00:08:13,510 --> 00:08:12,160
in the in these um uh in all of these

231
00:08:15,189 --> 00:08:13,520
lines of sight they were able to

232
00:08:16,950 --> 00:08:15,199
actually get a radial distribution and

233
00:08:19,830 --> 00:08:16,960
find that there was an inner halo

234
00:08:22,070 --> 00:08:19,840
and an outer halo and in fact that outer

235
00:08:24,469 --> 00:08:22,080
halo stretched for 1.3

236
00:08:26,070 --> 00:08:24,479
million light years away from the center

237
00:08:29,110 --> 00:08:26,080
of andromeda

238
00:08:31,029 --> 00:08:29,120

now if you know andromeda it's only

239
00:08:32,630 --> 00:08:31,039
two and a half million light years from

240
00:08:34,870 --> 00:08:32,640
the milky way

241
00:08:36,709 --> 00:08:34,880
that's half the distance 1.3 million

242
00:08:39,269 --> 00:08:36,719
light years of this gaseous halo

243
00:08:40,070 --> 00:08:39,279
so if the milky way has a similar size

244
00:08:43,829 --> 00:08:40,080
galactic

245
00:08:45,750 --> 00:08:43,839
halo then the two gaseous halos are

246
00:08:46,870 --> 00:08:45,760
close to touching now they're they're

247
00:08:48,710 --> 00:08:46,880
close to overlapping

248
00:08:50,470 --> 00:08:48,720
you know the two galaxies themselves

249
00:08:51,590 --> 00:08:50,480
they won't collide for another four

250
00:08:53,509 --> 00:08:51,600
billion years

251
00:08:55,509 --> 00:08:53,519
but it looks like the gaseous halos

252
00:08:58,790 --> 00:08:55,519
might actually get close to touching

253
00:09:00,630 --> 00:08:58,800
relatively soon so this is a great study

254
00:09:01,829 --> 00:09:00,640
looking along these 43 different lines

255
00:09:04,870 --> 00:09:01,839
of sight

256
00:09:06,870 --> 00:09:04,880
in order to find out the gaseous

257
00:09:10,070 --> 00:09:06,880
structure of the gas around the

258
00:09:13,190 --> 00:09:12,389
and this is a cool image this is an

259
00:09:16,150 --> 00:09:13,200
artistic

260
00:09:17,430 --> 00:09:16,160
view that if we could see that on the

261
00:09:20,710 --> 00:09:17,440
night sky

262
00:09:23,910 --> 00:09:20,720
just how huge this would be

263
00:09:27,110 --> 00:09:23,920

it would extend um approximately

264
00:09:29,030 --> 00:09:27,120
40 to 60 degrees across and

265
00:09:30,550 --> 00:09:29,040
that would be quite quite a sight

266
00:09:32,870 --> 00:09:30,560
certainly the largest thing on the night

267
00:09:35,990 --> 00:09:35,110
our second story today do you like your

268
00:09:39,110 --> 00:09:36,000
dark matter

269
00:09:40,710 --> 00:09:39,120
smooth or extra chunky

270
00:09:42,550 --> 00:09:40,720
now that's usually the question people

271
00:09:45,269 --> 00:09:42,560
would ask about peanut butter

272
00:09:47,509 --> 00:09:45,279
but actually i've been able to twist it

273
00:09:49,590 --> 00:09:47,519
and make it apply to dark matter

274
00:09:51,110 --> 00:09:49,600
so let's go back to that galaxy cluster

275
00:09:53,829 --> 00:09:51,120
that i showed you okay and

276
00:09:54,470 --> 00:09:53,839
there you see the the the the visible

277
00:09:57,910 --> 00:09:54,480
light

278
00:10:00,150 --> 00:09:57,920
it but if i take

279
00:10:01,269 --> 00:10:00,160
off the visible and i only show you the

280
00:10:05,110 --> 00:10:01,279
x-ray

281
00:10:08,389 --> 00:10:05,120
relatively smooth

282
00:10:11,829 --> 00:10:08,399
and the x-rays have been traditionally

283
00:10:13,990 --> 00:10:11,839
taken as a proxy for

284
00:10:15,750 --> 00:10:14,000
the distribution of the dark matter in

285
00:10:17,750 --> 00:10:15,760
these clusters of galaxies

286
00:10:18,870 --> 00:10:17,760
so there is a little bit of substructure

287
00:10:20,949 --> 00:10:18,880
in the x-rays

288
00:10:22,949 --> 00:10:20,959

but basically we've sort of assumed that

289
00:10:23,910 --> 00:10:22,959
the dark matter is relatively smoothly

290
00:10:25,590 --> 00:10:23,920
distributed

291
00:10:27,750 --> 00:10:25,600
around these clusters of galaxies and

292
00:10:28,389 --> 00:10:27,760
actually it's been a sort of study for

293
00:10:31,670 --> 00:10:28,399
years

294
00:10:34,630 --> 00:10:31,680
how much substructure is there in

295
00:10:35,990 --> 00:10:34,640
clusters of galaxies but x-rays aren't

296
00:10:38,069 --> 00:10:36,000
the only way to measure where the dark

297
00:10:39,829 --> 00:10:38,079
matter is in a cluster of galaxies

298
00:10:41,509 --> 00:10:39,839
you can also use something called

299
00:10:45,110 --> 00:10:41,519
gravitational lensing

300
00:10:48,470 --> 00:10:45,120
and this is another galaxy cluster max j

301
00:10:49,110 --> 00:10:48,480
1206 and it exhibits these gravitational

302
00:10:52,630 --> 00:10:49,120
lensing

303
00:10:54,389 --> 00:10:52,640
outgrowth of

304
00:10:56,310 --> 00:10:54,399
general relativity and if you've been

305
00:10:57,190 --> 00:10:56,320
listening to me you probably know what

306
00:10:59,509 --> 00:10:57,200
i'm going to tell you

307
00:11:00,470 --> 00:10:59,519
it's my three-word summary of general

308
00:11:01,670 --> 00:11:00,480
relativity

309
00:11:03,590 --> 00:11:01,680
all you really need to know about

310
00:11:06,630 --> 00:11:03,600
general relativity in three words

311
00:11:09,670 --> 00:11:06,640
ready for it mass

312
00:11:11,590 --> 00:11:09,680
warps space okay

313
00:11:12,870 --> 00:11:11,600

that's what you need to know about

314
00:11:14,949 --> 00:11:12,880
general relativity

315
00:11:15,910 --> 00:11:14,959
and it's demonstrated in this cluster of

316
00:11:19,350 --> 00:11:15,920
galaxies

317
00:11:21,670 --> 00:11:19,360
by these two images and the mass

318
00:11:23,030 --> 00:11:21,680
of this cluster is so massive that is

319
00:11:25,269 --> 00:11:23,040
warped the space

320
00:11:26,630 --> 00:11:25,279
and the light from galaxies passing

321
00:11:29,110 --> 00:11:26,640
through this warp space

322
00:11:31,269 --> 00:11:29,120
has become stretched out and formed

323
00:11:34,310 --> 00:11:31,279
these arcane streaks

324
00:11:36,630 --> 00:11:34,320
across across the image and these very

325
00:11:39,430 --> 00:11:36,640
large arcs and streaks are indicative of

326
00:11:41,430 --> 00:11:39,440
the large scale distribution of matter

327
00:11:42,470 --> 00:11:41,440
and from these gravitational lensing you

328
00:11:45,750 --> 00:11:42,480
can understand

329
00:11:46,790 --> 00:11:45,760
the total mass in the cluster but what

330
00:11:48,949 --> 00:11:46,800
they wanted to do

331
00:11:50,470 --> 00:11:48,959
was study the substructure how much

332
00:11:52,949 --> 00:11:50,480
detail is in there

333
00:11:53,670 --> 00:11:52,959
so they went looking with hubble on

334
00:11:56,310 --> 00:11:53,680
several

335
00:11:56,710 --> 00:11:56,320
of these very large clusters to try and

336
00:11:59,910 --> 00:11:56,720
find

337
00:12:03,030 --> 00:11:59,920
out how much detail is there

338
00:12:04,949 --> 00:12:03,040

and how much clumping of matter right

339
00:12:06,230 --> 00:12:04,959
and so here are three examples from the

340
00:12:10,150 --> 00:12:06,240
exact same image

341
00:12:11,910 --> 00:12:10,160
of small scale structure small scale

342
00:12:13,509 --> 00:12:11,920
gravitational lensing events that

343
00:12:15,430 --> 00:12:13,519
indicate matter is

344
00:12:17,030 --> 00:12:15,440
clumped on smaller scales not on the

345
00:12:19,670 --> 00:12:17,040
whole scale of cluster but on

346
00:12:20,470 --> 00:12:19,680
sub clumps within the cluster so here

347
00:12:23,350 --> 00:12:20,480
we're seeing

348
00:12:24,069 --> 00:12:23,360
the uh individual lenses at very small

349
00:12:25,910 --> 00:12:24,079
scales

350
00:12:27,430 --> 00:12:25,920
indicating there's a lot of dark matter

351
00:12:30,949 --> 00:12:27,440
clumped in there

352
00:12:33,990 --> 00:12:30,959
right so the conclusion

353
00:12:36,230 --> 00:12:34,000
was that it was extra chunky

354
00:12:37,670 --> 00:12:36,240
that compared to the previous

355
00:12:40,389 --> 00:12:37,680
observations and compared to the

356
00:12:43,350 --> 00:12:40,399
simulations they do of galaxy clusters

357
00:12:43,910 --> 00:12:43,360
that there was 10 times more small-scale

358
00:12:45,590 --> 00:12:43,920
lensing

359
00:12:47,269 --> 00:12:45,600
or the strength of the small-scale

360
00:12:50,550 --> 00:12:47,279
lensing was 10 times

361
00:12:53,110 --> 00:12:50,560
more than they had anticipated

362
00:12:54,470 --> 00:12:53,120
so if you go back to the x-rays you've

363
00:12:56,710 --> 00:12:54,480

got your smooth

364
00:12:57,829 --> 00:12:56,720
distribution of dark matter but if you

365
00:13:00,069 --> 00:12:57,839
go to your small

366
00:13:01,190 --> 00:13:00,079
scale gravitational lensing you get your

367
00:13:03,910 --> 00:13:01,200
extra chunky

368
00:13:05,190 --> 00:13:03,920
version of dark matter and which one of

369
00:13:07,190 --> 00:13:05,200
these is correct

370
00:13:08,230 --> 00:13:07,200
well they're both going to be correct in

371
00:13:10,790 --> 00:13:08,240
some scales

372
00:13:12,870 --> 00:13:10,800
but we need to of course do more study

373
00:13:15,509 --> 00:13:12,880
this has brought up the idea that

374
00:13:17,269 --> 00:13:15,519
maybe there's some clumping on smaller

375
00:13:19,110 --> 00:13:17,279
scales than what we've heretofore

376
00:13:20,870 --> 00:13:19,120
assumed in dark matter

377
00:13:22,710 --> 00:13:20,880
and we're going to invest of course

378
00:13:25,590 --> 00:13:22,720
we're going to investigate it more

379
00:13:26,949 --> 00:13:25,600
and i'm told that the uh nancy grace

380
00:13:28,629 --> 00:13:26,959
roman space telescope

381
00:13:29,990 --> 00:13:28,639
will be able to add to this i'm not

382
00:13:32,230 --> 00:13:30,000
exactly sure how

383
00:13:33,030 --> 00:13:32,240
maybe they cover it in the talk today

384
00:13:35,910 --> 00:13:33,040
but this

385
00:13:36,550 --> 00:13:35,920
is a really cool result in terms of what

386
00:13:38,710 --> 00:13:36,560
is the

387
00:13:39,590 --> 00:13:38,720
status of the dark matter on small

388
00:13:43,189 --> 00:13:39,600

smaller scales

389
00:13:47,509 --> 00:13:46,310
all right so that's our news and now

390
00:13:50,629 --> 00:13:47,519
let's go to

391
00:13:54,470 --> 00:13:50,639
our our speakers today our first

392
00:13:57,670 --> 00:13:54,480
speaker today is dr jennifer wiseman

393
00:14:00,310 --> 00:13:57,680
of the goddard space flight center she

394
00:14:02,470 --> 00:14:00,320
is the senior project scientist for the

395
00:14:05,870 --> 00:14:02,480
hubble space telescope mission

396
00:14:07,990 --> 00:14:05,880
at goddard she is also a senior

397
00:14:09,590 --> 00:14:08,000
astrophysicist at goddard space flight

398
00:14:12,310 --> 00:14:09,600
center she studies

399
00:14:13,910 --> 00:14:12,320
star formation um and she really you

400
00:14:15,030 --> 00:14:13,920
know does that across the spectrum she's

401
00:14:17,110 --> 00:14:15,040
you know looking looking at

402
00:14:19,269 --> 00:14:17,120
many different wavelengths in order to

403
00:14:20,230 --> 00:14:19,279
study how the process of how stars were

404
00:14:23,590 --> 00:14:20,240
born

405
00:14:29,269 --> 00:14:23,600
in

406
00:14:29,990 --> 00:14:29,279
um and she has a special merit to her

407
00:14:33,870 --> 00:14:30,000
name

408
00:14:35,430 --> 00:14:33,880
in that she discovered a comet back in

409
00:14:36,790 --> 00:14:35,440
1987

410
00:14:38,470 --> 00:14:36,800
so jennifer if you would start your

411
00:14:41,750 --> 00:14:38,480
screen share ladies and gentlemen

412
00:14:43,590 --> 00:14:41,760
dr jennifer wiseman hi okay let me see

413
00:14:45,189 --> 00:14:43,600

if this will work i'm glad to be here

414
00:14:49,670 --> 00:14:45,199
today

415
00:14:55,829 --> 00:14:52,790
all right so is that working

416
00:15:00,069 --> 00:14:55,839
yes okay

417
00:15:03,750 --> 00:15:00,079
today we are talking about a new

418
00:15:04,870 --> 00:15:03,760
telescope a major observatory that nasa

419
00:15:08,389 --> 00:15:04,880
is developing

420
00:15:12,470 --> 00:15:08,399
right now it's called the nancy grace

421
00:15:14,230 --> 00:15:12,480
roman space telescope

422
00:15:16,629 --> 00:15:14,240
and yet i'm going to tell you a little

423
00:15:19,910 --> 00:15:16,639
bit about the background behind

424
00:15:21,750 --> 00:15:19,920
the roman space telescope that has to do

425
00:15:24,230 --> 00:15:21,760
with what i work with which is the

426
00:15:26,470 --> 00:15:24,240
hubble space telescope

427
00:15:28,389 --> 00:15:26,480
and the namesake of the roman space

428
00:15:30,710 --> 00:15:28,399
telescope nancy grace

429
00:15:32,310 --> 00:15:30,720
roman so how how do all these things fit

430
00:15:35,590 --> 00:15:32,320
together that's my

431
00:15:37,910 --> 00:15:35,600
job and then after me dr julie mchenry

432
00:15:40,550 --> 00:15:37,920
will tell you more about the details

433
00:15:43,749 --> 00:15:40,560
of the nancy grace roman space telescope

434
00:15:47,590 --> 00:15:43,759
and the science that it will achieve

435
00:15:49,110 --> 00:15:47,600
um but my work with nasa is with hubble

436
00:15:51,269 --> 00:15:49,120
and if you want to know more about

437
00:15:53,990 --> 00:15:51,279
hubble we have wonderful uh

438
00:15:58,389 --> 00:15:54,000

website nasa.gov hubble and we're active

439
00:16:03,430 --> 00:16:00,949
how does hubble relate to this new

440
00:16:06,150 --> 00:16:03,440
observatory being developed the nancy

441
00:16:07,990 --> 00:16:06,160
grace roman space telescope there's a

442
00:16:11,749 --> 00:16:08,000
kind of artist's conception of what the

443
00:16:15,430 --> 00:16:11,759
roman space telescope will look like

444
00:16:18,710 --> 00:16:15,440
well let's talk about this fantastic

445
00:16:19,749 --> 00:16:18,720
person after whom this new telescope is

446
00:16:24,389 --> 00:16:19,759
named dr

447
00:16:26,710 --> 00:16:24,399
nancy grace roman sadly dr roman passed

448
00:16:30,069 --> 00:16:26,720
away a couple of years ago

449
00:16:31,110 --> 00:16:30,079
but her light still shines on our world

450
00:16:34,470 --> 00:16:31,120
and in particular

451
00:16:35,990 --> 00:16:34,480
on the astronomy world and the astronomy

452
00:16:38,790 --> 00:16:36,000
enterprise that she

453
00:16:40,150 --> 00:16:38,800
really set the foundations for let me

454
00:16:41,110 --> 00:16:40,160
tell you a little bit about this

455
00:16:44,470 --> 00:16:41,120
fantastic

456
00:16:48,949 --> 00:16:44,480
person who

457
00:16:51,110 --> 00:16:48,959
was dr nancy grace roman

458
00:16:52,389 --> 00:16:51,120
while she herself was an accomplished

459
00:16:54,790 --> 00:16:52,399
astronomer

460
00:16:55,590 --> 00:16:54,800
and really a pioneer in the field she

461
00:16:59,030 --> 00:16:55,600
was the

462
00:17:01,430 --> 00:16:59,040
first woman on the astronomy faculty at

463
00:17:04,630 --> 00:17:01,440

the university of chicago which is a

464
00:17:07,829 --> 00:17:04,640
powerhouse for astrophysics

465
00:17:09,029 --> 00:17:07,839
and then she became the first chief of

466
00:17:11,669 --> 00:17:09,039
astronomy

467
00:17:13,510 --> 00:17:11,679
and also solar physics at nasa i mean

468
00:17:14,789 --> 00:17:13,520
this is remarkable this is right toward

469
00:17:18,470 --> 00:17:14,799
the very beginning

470
00:17:20,390 --> 00:17:18,480
of the agency as a whole and they were

471
00:17:21,750 --> 00:17:20,400
just setting up you know what would be

472
00:17:24,150 --> 00:17:21,760
nasa's role in

473
00:17:26,069 --> 00:17:24,160
science and she held that first position

474
00:17:27,270 --> 00:17:26,079
she was the first woman to hold an

475
00:17:31,510 --> 00:17:27,280
executive position

476
00:17:35,750 --> 00:17:31,520
at nasa so really a brave pioneer

477
00:17:39,110 --> 00:17:35,760
but in that role she was a driving

478
00:17:42,070 --> 00:17:39,120
force to build the foundation

479
00:17:43,510 --> 00:17:42,080
and the execution of nasa's space

480
00:17:46,390 --> 00:17:43,520
telescopes

481
00:17:48,150 --> 00:17:46,400
and a lot of nasa science in fact a lot

482
00:17:50,549 --> 00:17:48,160
of people don't realize that the hubble

483
00:17:53,909 --> 00:17:50,559
space telescope was not the first

484
00:17:55,710 --> 00:17:53,919
space telescope there was a group of

485
00:17:58,150 --> 00:17:55,720
telescopes called the orbiting

486
00:18:00,470 --> 00:17:58,160
astronomical observatories

487
00:18:02,870 --> 00:18:00,480
and even orbiting solar observatories

488
00:18:05,990 --> 00:18:02,880

and nancy grace roman

489
00:18:08,789 --> 00:18:06,000
was the driving leader behind these

490
00:18:10,950 --> 00:18:08,799
observatories these oao observatories

491
00:18:13,350 --> 00:18:10,960
that were kind of experiments could we

492
00:18:16,070 --> 00:18:13,360
do astronomy from space

493
00:18:17,270 --> 00:18:16,080
and that set the stage for hubble she

494
00:18:19,669 --> 00:18:17,280
was also

495
00:18:20,710 --> 00:18:19,679
instrumental in a space telescope known

496
00:18:23,270 --> 00:18:20,720
as the international

497
00:18:24,710 --> 00:18:23,280
ultraviolet explorer and she was

498
00:18:26,630 --> 00:18:24,720
involved with other

499
00:18:28,470 --> 00:18:26,640
types of space related science

500
00:18:31,909 --> 00:18:28,480
experiments that were on gemini

501
00:18:33,909 --> 00:18:31,919
apollo and even skylab

502
00:18:35,230 --> 00:18:33,919
she was instrumental in establishing a

503
00:18:39,029 --> 00:18:35,240
whole new era of

504
00:18:40,710 --> 00:18:39,039
space-based astronomical instrumentation

505
00:18:42,789 --> 00:18:40,720
and research the kinds of things we

506
00:18:43,990 --> 00:18:42,799
depend on now for doing the kinds of

507
00:18:45,990 --> 00:18:44,000
astronomy that

508
00:18:48,310 --> 00:18:46,000
we take for granted now that can be done

509
00:18:50,230 --> 00:18:48,320
from space we need instrumentation to be

510
00:18:53,350 --> 00:18:50,240
able to do that

511
00:18:57,350 --> 00:18:53,360
but she's most well known for being the

512
00:18:58,549 --> 00:18:57,360
the the powering force the figurehead at

513
00:19:00,950 --> 00:18:58,559

nasa that really

514
00:19:03,350 --> 00:19:00,960
pushed the idea of a large space

515
00:19:04,310 --> 00:19:03,360
telescope that became the hubble space

516
00:19:06,150 --> 00:19:04,320
telescope

517
00:19:07,990 --> 00:19:06,160
so she's affectionately called the

518
00:19:12,230 --> 00:19:08,000
mother of hubble

519
00:19:15,029 --> 00:19:12,240
and we still so much appreciate dr roman

520
00:19:16,710 --> 00:19:15,039
she because of that was the recipient

521
00:19:18,470 --> 00:19:16,720
and all her work was the recipient of

522
00:19:19,590 --> 00:19:18,480
nasa's exceptional scientific

523
00:19:22,549 --> 00:19:19,600
achievement medal

524
00:19:23,990 --> 00:19:22,559
amongst many other awards and throughout

525
00:19:27,110 --> 00:19:24,000
her lifetime and career

526
00:19:30,230 --> 00:19:27,120
she was a champion of women in astronomy

527
00:19:32,789 --> 00:19:30,240
and a strong advocate of stem for

528
00:19:33,830 --> 00:19:32,799
all young people and people considering

529
00:19:36,830 --> 00:19:33,840
careers

530
00:19:37,990 --> 00:19:36,840
so this is an overview of this

531
00:19:39,669 --> 00:19:38,000
inspirational

532
00:19:42,470 --> 00:19:39,679
person and i had the privilege of

533
00:19:45,029 --> 00:19:42,480
meeting dr roman in recent years

534
00:19:45,510 --> 00:19:45,039
and she was just as inspiring to me in

535
00:19:47,669 --> 00:19:45,520
these

536
00:19:50,150 --> 00:19:47,679
last years of her life as she was to

537
00:19:52,150 --> 00:19:50,160
people decades earlier

538
00:19:53,270 --> 00:19:52,160

let me explore a little bit more into

539
00:19:59,990 --> 00:19:53,280
her

540
00:20:01,350 --> 00:20:00,000
dr roman told us that she was born

541
00:20:05,990 --> 00:20:01,360
curious

542
00:20:09,669 --> 00:20:06,000
back in 1925 and she attributes a lot of

543
00:20:12,070 --> 00:20:09,679
her uh interest in nature

544
00:20:14,390 --> 00:20:12,080
and in space to her mother her mother

545
00:20:17,750 --> 00:20:14,400
encouraged her to go outside and look up

546
00:20:20,789 --> 00:20:17,760
to go stargazing to look at the auroras

547
00:20:25,350 --> 00:20:20,799
even at a very early age she was given

548
00:20:29,350 --> 00:20:25,360
books about the sky and looking at stars

549
00:20:32,230 --> 00:20:29,360
her father was a scientist and

550
00:20:33,830 --> 00:20:32,240
you know encouraged her to play kind of

551
00:20:35,510 --> 00:20:33,840
mental math games

552
00:20:38,390 --> 00:20:35,520
things like that all these things from

553
00:20:40,549 --> 00:20:38,400
her parents really encouraged her to

554
00:20:42,070 --> 00:20:40,559
think about the natural world to go into

555
00:20:44,789 --> 00:20:42,080
science and even at age

556
00:20:48,149 --> 00:20:44,799
10 she started an astronomy club and by

557
00:20:52,950 --> 00:20:48,159
age 12 she decided that she wanted to be

558
00:20:55,029 --> 00:20:52,960
an astronomer and so she did

559
00:20:57,350 --> 00:20:55,039
she was undaunted by the fact that

560
00:20:59,510 --> 00:20:57,360
astronomy was really not considered at

561
00:21:00,710 --> 00:20:59,520
that time to be an appropriate career

562
00:21:03,430 --> 00:21:00,720
for a woman

563
00:21:04,310 --> 00:21:03,440

an appropriate life path but she went on

564
00:21:07,029 --> 00:21:04,320
anyway

565
00:21:08,310 --> 00:21:07,039
got her bachelor's degree at swarthmore

566
00:21:10,230 --> 00:21:08,320
college and was

567
00:21:12,270 --> 00:21:10,240
got really on fire for the field of

568
00:21:13,830 --> 00:21:12,280
astronomy in her college years in the

569
00:21:16,230 --> 00:21:13,840
1940s

570
00:21:18,390 --> 00:21:16,240
went on and got a phd from the

571
00:21:20,630 --> 00:21:18,400
university of chicago

572
00:21:22,549 --> 00:21:20,640
and worked at the yerkes observatory

573
00:21:24,310 --> 00:21:22,559
which is affiliated with the university

574
00:21:27,350 --> 00:21:24,320
of chicago

575
00:21:29,110 --> 00:21:27,360
performing for front research that

576
00:21:30,390 --> 00:21:29,120
actually landed one of her research

577
00:21:34,390 --> 00:21:30,400
papers as one of the

578
00:21:37,110 --> 00:21:34,400
100 most important astronomy papers

579
00:21:38,230 --> 00:21:37,120
she was an assistant professor at yerkes

580
00:21:41,110 --> 00:21:38,240
and

581
00:21:43,990 --> 00:21:41,120
really led the field as a research

582
00:21:46,390 --> 00:21:44,000
scientist for many years

583
00:21:47,029 --> 00:21:46,400
but about the time later on in her

584
00:21:50,789 --> 00:21:47,039
career

585
00:21:55,029 --> 00:21:50,799
in the 1950s the nasa

586
00:21:55,430 --> 00:21:55,039
space agency was being formed and she

587
00:21:58,390 --> 00:21:55,440
was

588
00:22:00,549 --> 00:21:58,400

asked by one of the people helping to

589
00:22:01,510 --> 00:22:00,559
formulate what this new agency would be

590
00:22:03,350 --> 00:22:01,520
like

591
00:22:05,590 --> 00:22:03,360
if she knew anybody that would be

592
00:22:10,230 --> 00:22:05,600
interested in developing a space

593
00:22:12,549 --> 00:22:10,240
science program within nasa

594
00:22:14,549 --> 00:22:12,559
given that women didn't have a lot of

595
00:22:17,110 --> 00:22:14,559
opportunities to become

596
00:22:18,149 --> 00:22:17,120
tenured professors in astronomy those

597
00:22:23,669 --> 00:22:18,159
days

598
00:22:27,510 --> 00:22:25,590
asked if she knew anyone who would want

599
00:22:28,070 --> 00:22:27,520
to set up a space astronomy program at

600
00:22:31,590 --> 00:22:28,080
nasa

601
00:22:32,470 --> 00:22:31,600
she said yeah i would and she was given

602
00:22:35,110 --> 00:22:32,480
that chance

603
00:22:37,990 --> 00:22:35,120
so she became the head of observational

604
00:22:39,909 --> 00:22:38,000
astronomy way back in 1959

605
00:22:41,110 --> 00:22:39,919
and was the first formal chief of

606
00:22:44,630 --> 00:22:41,120
astronomy

607
00:22:45,990 --> 00:22:44,640
in starting in 1960 you know right at

608
00:22:49,350 --> 00:22:46,000
the birth years of

609
00:22:52,390 --> 00:22:49,360
nasa and in her role there

610
00:22:55,270 --> 00:22:52,400
she worked very hard to establish a

611
00:22:55,590 --> 00:22:55,280
strong foundation for science at nasa

612
00:22:58,789 --> 00:22:55,600
that

613
00:23:01,110 --> 00:22:58,799

still remains she was the driving force

614
00:23:03,190 --> 00:23:01,120
between behind these first

615
00:23:07,029 --> 00:23:03,200
space astronomy observatories that i

616
00:23:10,149 --> 00:23:07,039
mentioned and also solar observatories

617
00:23:13,270 --> 00:23:10,159
and she also became very adept at

618
00:23:16,230 --> 00:23:13,280
advocating for space astronomy to

619
00:23:17,029 --> 00:23:16,240
the powers that be to scientists to

620
00:23:19,750 --> 00:23:17,039
industry

621
00:23:22,390 --> 00:23:19,760
to politicians to government leaders to

622
00:23:24,870 --> 00:23:22,400
even the government budgeting offices

623
00:23:27,270 --> 00:23:24,880
she knew how to make the case that space

624
00:23:30,630 --> 00:23:27,280
astronomy would be effective

625
00:23:32,950 --> 00:23:30,640
and it would be important for the nation

626
00:23:35,430 --> 00:23:32,960
to get telescopes above the earth's

627
00:23:36,070 --> 00:23:35,440
atmosphere would give us a clearer view

628
00:23:37,669 --> 00:23:36,080
of space

629
00:23:39,669 --> 00:23:37,679
beyond and would help us develop

630
00:23:43,029 --> 00:23:39,679
technologies that we could use

631
00:23:45,269 --> 00:23:43,039
in many aspects of our national

632
00:23:46,549 --> 00:23:45,279
technological growth so here you see a

633
00:23:49,830 --> 00:23:46,559
couple of pictures

634
00:23:50,310 --> 00:23:49,840
of dr roman at nasa the one on the right

635
00:23:52,789 --> 00:23:50,320
is with

636
00:23:57,029 --> 00:23:52,799
the solar orbiting solar observatory

637
00:24:01,269 --> 00:23:59,830
she is however most well remembered for

638
00:24:04,510 --> 00:24:01,279

her advocacy for

639
00:24:07,029 --> 00:24:04,520
a large general purpose space

640
00:24:09,190 --> 00:24:07,039
observatory larger than these

641
00:24:11,350 --> 00:24:09,200
preliminary orbiting astronomical

642
00:24:13,510 --> 00:24:11,360
observatories

643
00:24:14,630 --> 00:24:13,520
this was something that became her

644
00:24:16,630 --> 00:24:14,640
passion

645
00:24:17,669 --> 00:24:16,640
she worked with the scientific community

646
00:24:21,029 --> 00:24:17,679
including

647
00:24:22,630 --> 00:24:21,039
dr lyman spitzer who's now kind of known

648
00:24:24,549 --> 00:24:22,640
informally as the father of the hubble

649
00:24:26,789 --> 00:24:24,559
space telescope and he

650
00:24:28,950 --> 00:24:26,799
at her instigation led a national

651
00:24:32,230 --> 00:24:28,960
academy of sciences study on

652
00:24:35,350 --> 00:24:32,240
the scientific uses that could be

653
00:24:38,230 --> 00:24:35,360
gleaned from having a large telescope in

654
00:24:42,070 --> 00:24:38,240
space and it was this kind of thing that

655
00:24:44,470 --> 00:24:42,080
started to drum up the popular support

656
00:24:46,310 --> 00:24:44,480
not only in the public but primarily

657
00:24:47,590 --> 00:24:46,320
initially in the scientific community

658
00:24:50,630 --> 00:24:47,600
and in government

659
00:24:53,190 --> 00:24:50,640
for putting an observatory on a space

660
00:24:54,549 --> 00:24:53,200
platform that could be a general purpose

661
00:24:57,430 --> 00:24:54,559
observatory

662
00:24:59,510 --> 00:24:57,440
and eventually that led to a real solid

663
00:25:02,230 --> 00:24:59,520

opportunity that she put together the

664
00:25:05,510 --> 00:25:02,240
first announcement in 1977 of an

665
00:25:07,990 --> 00:25:05,520
opportunity for scientific participation

666
00:25:08,789 --> 00:25:08,000
in a large space telescope mission which

667
00:25:11,669 --> 00:25:08,799
was later

668
00:25:15,510 --> 00:25:11,679
named the hubble space telescope after

669
00:25:17,029 --> 00:25:15,520
astronomer edwin hubble

670
00:25:18,950 --> 00:25:17,039
now remember there had to be a lot of

671
00:25:21,269 --> 00:25:18,960
thinking about this we now take these

672
00:25:22,549 --> 00:25:21,279
space observatories for granted but

673
00:25:24,630 --> 00:25:22,559
there are lots of different ideas

674
00:25:26,149 --> 00:25:24,640
floating around so just as an aside i

675
00:25:29,350 --> 00:25:26,159
want to show you

676
00:25:31,750 --> 00:25:29,360
one of the initial schematics of what a

677
00:25:33,990 --> 00:25:31,760
space telescope might look like

678
00:25:35,029 --> 00:25:34,000
back in the 1960s and if you'll notice

679
00:25:37,590 --> 00:25:35,039
in this picture the

680
00:25:38,789 --> 00:25:37,600
astronomer is actually there inside the

681
00:25:40,710 --> 00:25:38,799
telescope

682
00:25:42,870 --> 00:25:40,720
orbiting the earth now wouldn't that be

683
00:25:44,710 --> 00:25:42,880
fun um as somebody who works with the

684
00:25:46,870 --> 00:25:44,720
hubble space telescope mission i wish i

685
00:25:48,630 --> 00:25:46,880
could actually go there and

686
00:25:50,870 --> 00:25:48,640
be there in person if i had the

687
00:25:52,870 --> 00:25:50,880
appropriate space suit

688
00:25:55,029 --> 00:25:52,880

but it was soon realized that this was

689
00:25:57,269 --> 00:25:55,039
impractical and unnecessary that you

690
00:25:58,630 --> 00:25:57,279
could transmit commands to the telescope

691
00:26:00,230 --> 00:25:58,640
remotely from the ground

692
00:26:02,390 --> 00:26:00,240
and then bring the data back from the

693
00:26:05,029 --> 00:26:02,400
telescope to the ground

694
00:26:05,430 --> 00:26:05,039
so lots of ideas had to be worked

695
00:26:09,750 --> 00:26:05,440
through

696
00:26:12,149 --> 00:26:09,760
over the years but eventually in 1990

697
00:26:14,149 --> 00:26:12,159
the the space telescope the large space

698
00:26:17,350 --> 00:26:14,159
telescope idea was realized it was

699
00:26:20,149 --> 00:26:17,360
launched into space on the space shuttle

700
00:26:22,710 --> 00:26:20,159
successfully based on all that

701
00:26:26,230 --> 00:26:22,720
foundational advocacy and wisdom and

702
00:26:29,430 --> 00:26:26,240
expertise of dr nancy grace roman

703
00:26:32,149 --> 00:26:29,440
and now of course we are

704
00:26:34,149 --> 00:26:32,159
celebrating the 30th anniversary of the

705
00:26:37,029 --> 00:26:34,159
hubble space telescope we're now

706
00:26:38,549 --> 00:26:37,039
spoiled on all the investigations and

707
00:26:40,789 --> 00:26:38,559
the images hubble has given us

708
00:26:43,909 --> 00:26:40,799
everything from the solar system

709
00:26:44,470 --> 00:26:43,919
to nebulae and to galaxies and deep

710
00:26:47,909 --> 00:26:44,480
space

711
00:26:50,070 --> 00:26:47,919
as a general purpose observatory

712
00:26:51,430 --> 00:26:50,080
dr roman has received many awards in

713
00:26:53,430 --> 00:26:51,440

recognition

714
00:26:56,549 --> 00:26:53,440
some of them include the federal women's

715
00:26:59,590 --> 00:26:56,559
award in 1962 and you see the picture

716
00:27:01,830 --> 00:26:59,600
there on the left with president kennedy

717
00:27:03,510 --> 00:27:01,840
she's received many awards from nasa

718
00:27:05,430 --> 00:27:03,520
including the outstanding leadership

719
00:27:05,990 --> 00:27:05,440
award and the exceptional scientific

720
00:27:08,710 --> 00:27:06,000
achievement

721
00:27:10,470 --> 00:27:08,720
award she received a women in aerospace

722
00:27:13,029 --> 00:27:10,480
lifetime achievement award and three

723
00:27:15,350 --> 00:27:13,039
honorary doctor of science degrees

724
00:27:17,750 --> 00:27:15,360
and there she is in the lower right in

725
00:27:19,110 --> 00:27:17,760
recent years talking with nobel laureate

726
00:27:22,470 --> 00:27:19,120
dr

727
00:27:26,230 --> 00:27:24,549
that should be john mather not james

728
00:27:28,230 --> 00:27:26,240
mather

729
00:27:30,789 --> 00:27:28,240
and of course her favorite award was

730
00:27:33,830 --> 00:27:30,799
that she was uh

731
00:27:34,870 --> 00:27:33,840
she was the model for a lego set

732
00:27:37,830 --> 00:27:34,880
honoring

733
00:27:39,430 --> 00:27:37,840
women in science and women in space

734
00:27:42,630 --> 00:27:39,440
related careers so

735
00:27:45,350 --> 00:27:42,640
there's a dr roman at the legoland

736
00:27:47,669 --> 00:27:45,360
discovery center in boston

737
00:27:48,549 --> 00:27:47,679
and on the right there with margaret

738
00:27:51,830 --> 00:27:48,559

hamilton

739
00:27:52,549 --> 00:27:51,840
and they're at home proudly showing off

740
00:27:58,230 --> 00:27:52,559
her

741
00:28:00,389 --> 00:27:58,240
uh you can i think still

742
00:28:03,029 --> 00:28:00,399
to find this if you look carefully you

743
00:28:06,149 --> 00:28:03,039
can find your own nancy grace roman

744
00:28:09,830 --> 00:28:08,230
all through her life not only when she

745
00:28:12,149 --> 00:28:09,840
was working at nasa but for all these

746
00:28:14,230 --> 00:28:12,159
years later she's inspired people

747
00:28:16,070 --> 00:28:14,240
of all ages she made it part of her

748
00:28:18,789 --> 00:28:16,080
life's mission to encourage people

749
00:28:21,590 --> 00:28:18,799
so you see in these images even from

750
00:28:22,950 --> 00:28:21,600
back in the 1960s she met with students

751
00:28:25,110 --> 00:28:22,960
to encourage them

752
00:28:26,230 --> 00:28:25,120
and then decades later she's still

753
00:28:28,070 --> 00:28:26,240
showing up

754
00:28:30,310 --> 00:28:28,080
at nasa goddard space flight center

755
00:28:31,350 --> 00:28:30,320
where i work to encourage the hubble

756
00:28:34,630 --> 00:28:31,360
team that's us

757
00:28:37,269 --> 00:28:34,640
down there in the lower center and

758
00:28:39,510 --> 00:28:37,279
uh there's a fellowship named after her

759
00:28:40,549 --> 00:28:39,520
now the nancy grace roman fellowship

760
00:28:42,389 --> 00:28:40,559
with one of the

761
00:28:43,990 --> 00:28:42,399
recipients of that fellowship for

762
00:28:46,630 --> 00:28:44,000
technology work in the upper

763
00:28:47,350 --> 00:28:46,640

right and the lower right there she is

764
00:28:49,029 --> 00:28:47,360
at a school

765
00:28:51,510 --> 00:28:49,039
encouraging young people so she

766
00:28:53,430 --> 00:28:51,520
continued her interest in space science

767
00:28:55,190 --> 00:28:53,440
showing up at colloquia

768
00:28:57,190 --> 00:28:55,200
all the way through the end of her life

769
00:29:02,549 --> 00:28:57,200
and encouraging people

770
00:29:07,269 --> 00:29:05,990
and there she is uh getting a crystal

771
00:29:08,950 --> 00:29:07,279
hubble from the

772
00:29:11,029 --> 00:29:08,960
goddard space flight center center

773
00:29:13,510 --> 00:29:11,039
director a few years ago

774
00:29:15,350 --> 00:29:13,520
and encouraging women who work with the

775
00:29:16,149 --> 00:29:15,360
hubble mission even now they're in the

776
00:29:18,070 --> 00:29:16,159
lower right

777
00:29:19,830 --> 00:29:18,080
and in the upper left she seemed to be

778
00:29:20,549 --> 00:29:19,840
enjoying being in the hubble control

779
00:29:23,110 --> 00:29:20,559
room

780
00:29:24,230 --> 00:29:23,120
on camera as we interviewed her and got

781
00:29:25,830 --> 00:29:24,240
some of her

782
00:29:29,909 --> 00:29:25,840
her thoughts and reflections on the

783
00:29:33,430 --> 00:29:32,549
so uh nancy grace roman set the

784
00:29:36,310 --> 00:29:33,440
foundation

785
00:29:38,230 --> 00:29:36,320
for space-based astronomy particularly

786
00:29:39,510 --> 00:29:38,240
the hubble space telescope and now that

787
00:29:42,389 --> 00:29:39,520
has led into

788
00:29:44,630 --> 00:29:42,399

many other space telescope platforms

789
00:29:46,710 --> 00:29:44,640
including the chandra x-ray observatory

790
00:29:48,870 --> 00:29:46,720
that's still operating very well

791
00:29:50,549 --> 00:29:48,880
the james webb space telescope that will

792
00:29:53,269 --> 00:29:50,559
launch next year

793
00:29:54,950 --> 00:29:53,279
and the nancy grace roman space

794
00:29:55,510 --> 00:29:54,960
telescope which you'll be hearing more

795
00:29:58,870 --> 00:29:55,520
about

796
00:30:01,909 --> 00:29:58,880
uh today and i like this quote

797
00:30:03,990 --> 00:30:01,919
uh for from her where she says i'm glad

798
00:30:05,110 --> 00:30:04,000
that i ignored the many people who told

799
00:30:08,470 --> 00:30:05,120
me i could not be

800
00:30:12,070 --> 00:30:08,480
an astronomer we're glad too

801
00:30:15,110 --> 00:30:12,080
dr roman all right just a couple more

802
00:30:17,909 --> 00:30:15,120
words about space telescopes um

803
00:30:20,149 --> 00:30:17,919
the hubble space telescope is fantastic

804
00:30:21,830 --> 00:30:20,159
because it is orbiting above the earth's

805
00:30:24,950 --> 00:30:21,840
atmosphere it gets the sharp

806
00:30:27,430 --> 00:30:24,960
images such as this clear view of a very

807
00:30:29,909 --> 00:30:27,440
crowded star cluster omega centauri you

808
00:30:32,149 --> 00:30:29,919
can differentiate star from star because

809
00:30:34,389 --> 00:30:32,159
the angular resolution is so good we're

810
00:30:35,510 --> 00:30:34,399
not affected by the blurring of earth's

811
00:30:38,870 --> 00:30:35,520
atmosphere

812
00:30:41,669 --> 00:30:38,880
we see the beauty and the scientific

813
00:30:44,549 --> 00:30:41,679

detail and differentiation between stars

814
00:30:46,549 --> 00:30:44,559
in crowded regions like this

815
00:30:50,070 --> 00:30:46,559
and we're celebrating hubble's 30th

816
00:30:50,710 --> 00:30:50,080
birthday because hubble has been kept in

817
00:30:53,430 --> 00:30:50,720
tip-top

818
00:30:54,549 --> 00:30:53,440
shape astronaut servicing of the hubble

819
00:30:56,549 --> 00:30:54,559
observatory

820
00:30:58,870 --> 00:30:56,559
time and time again over the years has

821
00:31:00,549 --> 00:30:58,880
enabled repairs enhancements and mission

822
00:31:02,870 --> 00:31:00,559
life extension so we

823
00:31:05,110 --> 00:31:02,880
actually expect hubble to keep operating

824
00:31:07,990 --> 00:31:05,120
for quite a few more years to come

825
00:31:10,549 --> 00:31:08,000
in this decade and perhaps beyond and

826
00:31:13,669 --> 00:31:10,559
this is good news for science because

827
00:31:17,350 --> 00:31:13,679
we have new observatories coming online

828
00:31:19,110 --> 00:31:17,360
and hubble cannot do everything

829
00:31:21,350 --> 00:31:19,120
neither can the other observatories

830
00:31:23,029 --> 00:31:21,360
these are complementary observatories

831
00:31:24,710 --> 00:31:23,039
we're accustomed to these beautiful

832
00:31:27,509 --> 00:31:24,720
images from hubble

833
00:31:28,149 --> 00:31:27,519
uh like the 25th anniversary image here

834
00:31:30,470 --> 00:31:28,159
of a

835
00:31:32,470 --> 00:31:30,480
massive recently formed star cluster

836
00:31:36,149 --> 00:31:32,480
westerland 2 with its

837
00:31:38,470 --> 00:31:36,159
birth nebula and the 30th anniversary

838
00:31:39,110 --> 00:31:38,480

image of another star-forming region and

839
00:31:46,870 --> 00:31:39,120
a

840
00:31:48,870 --> 00:31:46,880
in our neighboring sister little sister

841
00:31:50,870 --> 00:31:48,880
dwarf galaxy

842
00:31:52,549 --> 00:31:50,880
and even looking at other galaxies in

843
00:31:55,269 --> 00:31:52,559
spectacular detail

844
00:31:55,909 --> 00:31:55,279
but hubble has a quite small field of

845
00:31:58,470 --> 00:31:55,919
view

846
00:31:59,590 --> 00:31:58,480
meaning the area in the sky that hubble

847
00:32:03,190 --> 00:31:59,600
sees

848
00:32:05,029 --> 00:32:03,200
is not very large so here's a comparison

849
00:32:07,269 --> 00:32:05,039
of the field of view

850
00:32:09,909 --> 00:32:07,279
that kind of swath of the sky that you

851
00:32:12,230 --> 00:32:09,919
can see in one pointing

852
00:32:14,470 --> 00:32:12,240
with hubble down in the lower center

853
00:32:17,590 --> 00:32:14,480
there that little blue box compared to

854
00:32:18,149 --> 00:32:17,600
roman which is that big kind of funny

855
00:32:21,669 --> 00:32:18,159
shaped

856
00:32:23,509 --> 00:32:21,679
red red outlined area in the background

857
00:32:25,990 --> 00:32:23,519
there is andromeda we've already heard

858
00:32:29,110 --> 00:32:26,000
about the andromeda galaxy

859
00:32:31,509 --> 00:32:29,120
from dr summers but that's a hubble

860
00:32:33,590 --> 00:32:31,519
a region that hubble has imaged but it

861
00:32:36,950 --> 00:32:33,600
took hubble hundreds of pointings

862
00:32:40,549 --> 00:32:36,960
to cover that region of

863
00:32:42,310 --> 00:32:40,559

the andromeda galaxy and to stitch all

864
00:32:44,470 --> 00:32:42,320
those images together roman

865
00:32:45,430 --> 00:32:44,480
could look in just a couple of pointings

866
00:32:48,870 --> 00:32:45,440
and see

867
00:32:51,110 --> 00:32:48,880
that area before you here's another way

868
00:32:54,230 --> 00:32:51,120
of looking at it to scale with the moon

869
00:32:57,269 --> 00:32:54,240
there's the andromeda galaxy

870
00:32:59,669 --> 00:32:57,279
with the moon to scale next to it to

871
00:33:01,669 --> 00:32:59,679
just show that the size scale

872
00:33:02,789 --> 00:33:01,679
and if you look carefully in the upper

873
00:33:05,669 --> 00:33:02,799
left you see

874
00:33:07,110 --> 00:33:05,679
that little red uh footprint there that

875
00:33:09,350 --> 00:33:07,120
little square is how much

876
00:33:10,149 --> 00:33:09,360
that hubble can see in one pointing so

877
00:33:14,070 --> 00:33:10,159
to cover

878
00:33:16,549 --> 00:33:14,080
even a big chunk of this galaxy and make

879
00:33:18,470 --> 00:33:16,559
a stitched together image hubble had to

880
00:33:19,750 --> 00:33:18,480
look at hundreds do hundreds of

881
00:33:21,590 --> 00:33:19,760
pointings

882
00:33:23,669 --> 00:33:21,600
but the roman telescope will have a

883
00:33:25,669 --> 00:33:23,679
field of view a hundred times larger

884
00:33:27,990 --> 00:33:25,679
than hubble's and so

885
00:33:29,269 --> 00:33:28,000
as you see if you look at that little

886
00:33:31,110 --> 00:33:29,279
area in the middle

887
00:33:32,310 --> 00:33:31,120
covered by the the little white squares

888
00:33:35,350 --> 00:33:32,320

all of that together

889
00:33:37,430 --> 00:33:35,360
is what roman can see in one pointing so

890
00:33:38,310 --> 00:33:37,440
the roman footprint is bigger it's more

891
00:33:40,710 --> 00:33:38,320
efficient

892
00:33:41,990 --> 00:33:40,720
at looking at wide swaths of the sky and

893
00:33:44,950 --> 00:33:42,000
looking at survey

894
00:33:46,630 --> 00:33:44,960
surveying large areas of the sky so dr

895
00:33:48,310 --> 00:33:46,640
mchenry will explain why that's

896
00:33:50,950 --> 00:33:48,320
important to us

897
00:33:51,990 --> 00:33:50,960
there's another comparison which is the

898
00:33:53,669 --> 00:33:52,000
the wavelengths of

899
00:33:56,549 --> 00:33:53,679
light so if you look at this image you

900
00:33:58,950 --> 00:33:56,559
can compare the hubble telescope mirror

901
00:33:59,830 --> 00:33:58,960
on the left it's 2.4 meter mirror is the

902
00:34:01,990 --> 00:33:59,840
same as that

903
00:34:04,710 --> 00:34:02,000
for the roman telescope which used to be

904
00:34:07,190 --> 00:34:04,720
called wfirst

905
00:34:09,270 --> 00:34:07,200
and the webb telescope's mirror diameter

906
00:34:12,310 --> 00:34:09,280
will be much bigger 6.5

907
00:34:14,069 --> 00:34:12,320
5 meters it'll be very sensitive but if

908
00:34:15,109 --> 00:34:14,079
you look at the bottom there you'll see

909
00:34:16,950 --> 00:34:15,119
the different kinds of

910
00:34:18,710 --> 00:34:16,960
light that these different telescopes

911
00:34:21,030 --> 00:34:18,720
pick up so you see

912
00:34:23,190 --> 00:34:21,040
wavelengths of light in that rainbow all

913
00:34:24,710 --> 00:34:23,200

the way from ultraviolet light

914
00:34:27,510 --> 00:34:24,720
through the visible range of the

915
00:34:29,909 --> 00:34:27,520
spectrum and on into infrared light

916
00:34:31,669 --> 00:34:29,919
and you'll see the hubble range there

917
00:34:34,069 --> 00:34:31,679
underneath that hubble seas

918
00:34:35,909 --> 00:34:34,079
into ultraviolet part of the spectrum

919
00:34:37,669 --> 00:34:35,919
all through the visible piece and a

920
00:34:38,710 --> 00:34:37,679
little bit into the infrared part of the

921
00:34:40,550 --> 00:34:38,720
spectrum

922
00:34:43,109 --> 00:34:40,560
the roman telescope will see some

923
00:34:44,470 --> 00:34:43,119
visible light and also into the infrared

924
00:34:46,629 --> 00:34:44,480
part of the spectrum

925
00:34:48,790 --> 00:34:46,639
and the webb telescope will see much

926
00:34:50,230 --> 00:34:48,800
deeper into the infrared part of the

927
00:34:51,829 --> 00:34:50,240
light spectrum

928
00:34:54,069 --> 00:34:51,839
so if we compare the different

929
00:34:55,750 --> 00:34:54,079
capabilities of these observatories in

930
00:34:57,030 --> 00:34:55,760
terms of the wavelengths of light that

931
00:34:59,510 --> 00:34:57,040
they see

932
00:35:00,470 --> 00:34:59,520
and the fields of view that they can

933
00:35:02,390 --> 00:35:00,480
pick up

934
00:35:04,390 --> 00:35:02,400
you see that these telescopes are

935
00:35:06,950 --> 00:35:04,400
complementary and they can do

936
00:35:08,950 --> 00:35:06,960
complementary types of science that will

937
00:35:11,430 --> 00:35:08,960
really help one another

938
00:35:13,589 --> 00:35:11,440

so we're very excited in astronomy that

939
00:35:14,230 --> 00:35:13,599
it looks like later this decade we'll

940
00:35:17,270 --> 00:35:14,240
have

941
00:35:19,349 --> 00:35:17,280
the roman space telescope as well as the

942
00:35:20,950 --> 00:35:19,359
james webb space telescope and the

943
00:35:24,230 --> 00:35:20,960
hubble space telescope

944
00:35:27,589 --> 00:35:24,240
operating at the same time to give us

945
00:35:29,750 --> 00:35:27,599
complementary information each providing

946
00:35:33,270 --> 00:35:29,760
capabilities that the others cannot

947
00:35:35,270 --> 00:35:33,280
provide so with that i hope you've

948
00:35:38,310 --> 00:35:35,280
enjoyed this introduction to the nancy

949
00:35:40,390 --> 00:35:38,320
grace roman space telescope

950
00:35:41,750 --> 00:35:40,400
telling you a little bit about the

951
00:35:44,470 --> 00:35:41,760
fantastic

952
00:35:47,030 --> 00:35:44,480
namesake dr nancy grace roman and how

953
00:35:48,710 --> 00:35:47,040
she inspired the hubble space telescope

954
00:35:51,030 --> 00:35:48,720
which has now set the stage for these

955
00:35:53,270 --> 00:35:51,040
subsequent space observatories

956
00:35:54,950 --> 00:35:53,280
that are opening new vistas for us on

957
00:35:57,030 --> 00:35:54,960
the universe

958
00:35:57,990 --> 00:35:57,040
i thank you very much for your interest

959
00:36:00,710 --> 00:35:58,000
and i'll hand it over

960
00:36:02,790 --> 00:36:00,720
now to our next speaker dr julie mcmahon

961
00:36:04,710 --> 00:36:02,800
thank you jennifer that was great

962
00:36:06,630 --> 00:36:04,720
um if you could stop your screen share

963
00:36:09,030 --> 00:36:06,640

and let julie start hers

964
00:36:10,390 --> 00:36:09,040
um what i really liked about your talk

965
00:36:13,430 --> 00:36:10,400
jennifer was that

966
00:36:15,270 --> 00:36:13,440
you get the impression that you know um

967
00:36:16,630 --> 00:36:15,280
kennedy was sort of the vision vision

968
00:36:17,910 --> 00:36:16,640
that talked about we're going to the

969
00:36:20,069 --> 00:36:17,920
moon and everything

970
00:36:22,069 --> 00:36:20,079
um and here you've highlighted the fact

971
00:36:24,470 --> 00:36:22,079
that it's nancy grace roman

972
00:36:26,710 --> 00:36:24,480
along with lyman spitzer who sort of act

973
00:36:28,470 --> 00:36:26,720
as the scientific visionaries of nasa

974
00:36:30,150 --> 00:36:28,480
during the 1960s because

975
00:36:31,670 --> 00:36:30,160
it's more than just space that nasa was

976
00:36:34,390 --> 00:36:31,680
created for

977
00:36:36,470 --> 00:36:34,400
and you've highlighted you know i want

978
00:36:39,030 --> 00:36:36,480
to say unsung heroes but

979
00:36:40,069 --> 00:36:39,040
certainly the ones who don't get as much

980
00:36:43,910 --> 00:36:40,079
commentary in the popular

981
00:36:44,950 --> 00:36:43,920
press yes all right so our second

982
00:36:48,069 --> 00:36:44,960
speaker today

983
00:36:51,990 --> 00:36:48,079
is julie mcenery um and she

984
00:36:53,190 --> 00:36:52,000
is also a senior project scientist at

985
00:36:54,790 --> 00:36:53,200
goddard space flight center

986
00:36:56,550 --> 00:36:54,800
but she's the senior project scientist

987
00:36:58,150 --> 00:36:56,560
for the roman space telescope as you

988
00:37:01,030 --> 00:36:58,160

might guess

989
00:37:01,990 --> 00:37:01,040
she also has her phd in his long and

990
00:37:04,870 --> 00:37:02,000
illustrious

991
00:37:06,230 --> 00:37:04,880
career of science observations but she

992
00:37:08,950 --> 00:37:06,240
likes to talk about

993
00:37:10,390 --> 00:37:08,960
extreme explosions and as we were

994
00:37:12,870 --> 00:37:10,400
chatting before this she said

995
00:37:13,670 --> 00:37:12,880
and she even goes further across the

996
00:37:16,710 --> 00:37:13,680
spectrum

997
00:37:19,589 --> 00:37:16,720
than uh dr weissman does

998
00:37:21,430 --> 00:37:19,599
in terms of her observations uh you can

999
00:37:24,950 --> 00:37:21,440
see in her background she is from

1000
00:37:27,270 --> 00:37:24,960
ireland having been born in dublin

1001
00:37:29,030 --> 00:37:27,280
and yeah i'm really looking forward to

1002
00:37:30,390 --> 00:37:29,040
hearing about the upcoming roman space

1003
00:37:37,910 --> 00:37:30,400
telescope ladies and gentlemen

1004
00:37:41,589 --> 00:37:39,829
so the um the nazi grace roman space

1005
00:37:44,630 --> 00:37:41,599
telescope is the next

1006
00:37:45,270 --> 00:37:44,640
uh nasa astrophysics mission um to be

1007
00:37:47,589 --> 00:37:45,280
launched

1008
00:37:48,390 --> 00:37:47,599
after the james webb space telescope and

1009
00:37:52,710 --> 00:37:48,400
as jennifer

1010
00:37:56,710 --> 00:37:55,670
roman features a primary mirror that's

1011
00:37:59,589 --> 00:37:56,720
the same size

1012
00:38:00,950 --> 00:37:59,599
as that on the hubble space telescope

1013
00:38:03,190 --> 00:38:00,960

but we have a field of view

1014
00:38:04,710 --> 00:38:03,200
that's 100 times larger so i'm

1015
00:38:06,630 --> 00:38:04,720
illustrating this here with this

1016
00:38:08,550 --> 00:38:06,640
um ground-based image of the eagle

1017
00:38:10,150 --> 00:38:08,560
nebula with a very famous

1018
00:38:12,390 --> 00:38:10,160
uh hubble image of the pillars of

1019
00:38:15,910 --> 00:38:12,400
creation um in the

1020
00:38:16,710 --> 00:38:15,920
in the center but something i want to

1021
00:38:21,510 --> 00:38:16,720
emphasize

1022
00:38:23,910 --> 00:38:21,520
is that um since our primary feature is

1023
00:38:25,990 --> 00:38:23,920
having a very large field of view we're

1024
00:38:27,270 --> 00:38:26,000
designed to do surveys we're designed to

1025
00:38:28,950 --> 00:38:27,280
explore the sky

1026
00:38:31,510 --> 00:38:28,960
in quite a different way than you do

1027
00:38:34,150 --> 00:38:31,520
with uh with a narrow field instrument

1028
00:38:36,710 --> 00:38:34,160
we've optimized the observatory to be

1029
00:38:40,470 --> 00:38:36,720
very very good at conducting surveys

1030
00:38:43,430 --> 00:38:40,480
so one example of this is um

1031
00:38:45,270 --> 00:38:43,440
is observations of the andromeda galaxy

1032
00:38:47,510 --> 00:38:45,280
there was a large hubble survey that was

1033
00:38:51,109 --> 00:38:47,520
conducted using over 400

1034
00:38:52,950 --> 00:38:51,119
pointings that same uh

1035
00:38:55,510 --> 00:38:52,960
set of observations could be conducted

1036
00:38:57,349 --> 00:38:55,520
with roman with just two pointings

1037
00:39:00,230 --> 00:38:57,359
but the point that i want to make is

1038
00:39:04,069 --> 00:39:00,240

that the roman space telescope

1039
00:39:06,470 --> 00:39:04,079
is optimized to uh slew across the sky

1040
00:39:07,109 --> 00:39:06,480
effectively to settle and be ready to

1041
00:39:09,030 --> 00:39:07,119
take

1042
00:39:10,630 --> 00:39:09,040
observations quickly and effectively so

1043
00:39:13,670 --> 00:39:10,640
we spend more time

1044
00:39:15,510 --> 00:39:13,680
taking science observations we

1045
00:39:17,349 --> 00:39:15,520
don't pass through the south atlantic

1046
00:39:20,390 --> 00:39:17,359
anomaly we're not blocked by the

1047
00:39:22,870 --> 00:39:20,400
uh by the earth so for this particular

1048
00:39:25,190 --> 00:39:22,880
uh observation we don't do it a hundred

1049
00:39:26,870 --> 00:39:25,200
times faster we don't do it 200 times

1050
00:39:29,510 --> 00:39:26,880
faster

1051
00:39:30,470 --> 00:39:29,520
roman could make this observation of

1052
00:39:33,030 --> 00:39:30,480
andromeda

1053
00:39:33,510 --> 00:39:33,040
over a thousand times uh more quickly

1054
00:39:36,470 --> 00:39:33,520
than

1055
00:39:37,430 --> 00:39:36,480
hubble and we use those capabilities to

1056
00:39:39,349 --> 00:39:37,440
explore

1057
00:39:41,349 --> 00:39:39,359
uh the universe in quite a different way

1058
00:39:43,910 --> 00:39:41,359
because now we're not

1059
00:39:45,349 --> 00:39:43,920
point so much pointing the telescope at

1060
00:39:47,750 --> 00:39:45,359
an object that we know about

1061
00:39:49,349 --> 00:39:47,760
we can survey large regions of the sky

1062
00:39:51,030 --> 00:39:49,359
and just see what's there

1063
00:39:53,030 --> 00:39:51,040

we can come back to the same patch of

1064
00:39:55,190 --> 00:39:53,040
sky over and over again

1065
00:39:56,550 --> 00:39:55,200
and see what changes see what new

1066
00:39:58,310 --> 00:39:56,560
transients there are what

1067
00:40:00,230 --> 00:39:58,320
what is what has popped up and i'll

1068
00:40:03,270 --> 00:40:00,240
describe some of the science that we can

1069
00:40:05,190 --> 00:40:03,280
get from that uh later in this talk

1070
00:40:07,990 --> 00:40:05,200
uh but another point that i want to make

1071
00:40:09,670 --> 00:40:08,000
is that um

1072
00:40:11,109 --> 00:40:09,680
since we've got a much larger field of

1073
00:40:12,630 --> 00:40:11,119
view

1074
00:40:14,230 --> 00:40:12,640
and we're spending a larger amount of

1075
00:40:17,910 --> 00:40:14,240
our time uh taking

1076
00:40:22,710 --> 00:40:20,950
and we have the same resolution

1077
00:40:24,390 --> 00:40:22,720
we have an enormous number of pixels

1078
00:40:26,550 --> 00:40:24,400
each roman

1079
00:40:27,430 --> 00:40:26,560
image is the equivalent of a 300

1080
00:40:31,190 --> 00:40:27,440
megapixel

1081
00:40:34,230 --> 00:40:31,200
um photograph so what that means

1082
00:40:34,790 --> 00:40:34,240
is that with uh roman we will be sending

1083
00:40:37,109 --> 00:40:34,800
down

1084
00:40:38,470 --> 00:40:37,119
an extremely large amount of data to the

1085
00:40:40,950 --> 00:40:38,480
ground

1086
00:40:43,109 --> 00:40:40,960
our software our data repositories will

1087
00:40:45,349 --> 00:40:43,119
need to be extremely large

1088
00:40:47,430 --> 00:40:45,359

and we anticipate that this is going to

1089
00:40:49,349 --> 00:40:47,440
drive a change in how astronomers

1090
00:40:51,270 --> 00:40:49,359
use and access the data because the old

1091
00:40:53,109 --> 00:40:51,280
model of going to a data center and

1092
00:40:55,829 --> 00:40:53,119
downloading the data and

1093
00:40:57,349 --> 00:40:55,839
analyzing it on your home computer is no

1094
00:40:58,790 --> 00:40:57,359
longer going to be the natural way of

1095
00:41:02,710 --> 00:40:58,800
doing things and instead

1096
00:41:06,069 --> 00:41:02,720
we anticipate that people will log in

1097
00:41:07,670 --> 00:41:06,079
to the data center and run

1098
00:41:10,230 --> 00:41:07,680
their software and their analysis

1099
00:41:15,270 --> 00:41:10,240
routines in place without having to move

1100
00:41:22,309 --> 00:41:18,309
roman has several mission objectives

1101
00:41:24,870 --> 00:41:22,319
that drive how we designed this mission

1102
00:41:27,670 --> 00:41:24,880
we want to explore uh dark energy and

1103
00:41:31,990 --> 00:41:27,680
the fate of the universe

1104
00:41:34,470 --> 00:41:32,000
we want to conduct a complete study of

1105
00:41:35,109 --> 00:41:34,480
of the mass distributions of planets

1106
00:41:38,470 --> 00:41:35,119
around

1107
00:41:39,109 --> 00:41:38,480
stars we're going to use our wide field

1108
00:41:42,710 --> 00:41:39,119
of view

1109
00:41:45,829 --> 00:41:42,720
um and our capabilities in the infrared

1110
00:41:48,790 --> 00:41:45,839
to conduct a groundbreaking uh survey um

1111
00:41:49,990 --> 00:41:48,800
across various different places in the

1112
00:41:53,430 --> 00:41:50,000
in the universe

1113
00:41:56,150 --> 00:41:53,440

and then finally we also have um

1114
00:41:57,430 --> 00:41:56,160
a technology demonstration where we can

1115
00:42:01,190 --> 00:41:57,440
directly image

1116
00:42:07,589 --> 00:42:03,109
so let me start with the first of these

1117
00:42:11,109 --> 00:42:09,270
if you think about what the universe is

1118
00:42:13,510 --> 00:42:11,119
made of

1119
00:42:15,510 --> 00:42:13,520
um the matter that we can see the stars

1120
00:42:18,950 --> 00:42:15,520
the galaxies the dust

1121
00:42:22,790 --> 00:42:18,960
us um make up only five percent

1122
00:42:26,630 --> 00:42:25,670
uh planck risks cmv observations have

1123
00:42:30,390 --> 00:42:26,640
told us

1124
00:42:33,750 --> 00:42:30,400
that around 27 percent of the universe

1125
00:42:36,870 --> 00:42:33,760
is made up of this so-called dark matter

1126
00:42:39,589 --> 00:42:36,880
this is a type of matter that

1127
00:42:41,430 --> 00:42:39,599
interacts via gravity but does not

1128
00:42:45,030 --> 00:42:41,440
interact with normal matter

1129
00:42:46,630 --> 00:42:45,040
uh in any strong way

1130
00:42:48,470 --> 00:42:46,640
we don't know the nature of dark matter

1131
00:42:48,950 --> 00:42:48,480
but we do know it exists because we can

1132
00:42:51,030 --> 00:42:48,960
see

1133
00:42:54,470 --> 00:42:51,040
its gravitational effects on the

1134
00:42:59,109 --> 00:42:57,430
68 of what the universe is made of is of

1135
00:43:02,150 --> 00:42:59,119
this very mysterious

1136
00:43:03,910 --> 00:43:02,160
uh force called dark energy and it's a

1137
00:43:05,430 --> 00:43:03,920
repulsive force and it was discovered in

1138
00:43:09,190 --> 00:43:05,440

1998 when

1139
00:43:11,430 --> 00:43:09,200
um uh astronomers uh realized that

1140
00:43:13,510 --> 00:43:11,440
after the big bang instead of continuing

1141
00:43:15,990 --> 00:43:13,520
to expand and then slowly slowly

1142
00:43:17,990 --> 00:43:16,000
slowing down but in fact the universe

1143
00:43:21,910 --> 00:43:18,000
was accelerating

1144
00:43:22,870 --> 00:43:21,920
and the um quantity that causes that

1145
00:43:25,589 --> 00:43:22,880
acceleration

1146
00:43:26,550 --> 00:43:25,599
is known as dark energy so if we want to

1147
00:43:28,230 --> 00:43:26,560
understand

1148
00:43:29,910 --> 00:43:28,240
the structure and evolution of the

1149
00:43:32,950 --> 00:43:29,920
universe we need to understand

1150
00:43:34,550 --> 00:43:32,960
both dark energy because it it drives

1151
00:43:35,670 --> 00:43:34,560
how things are moving away from

1152
00:43:37,430 --> 00:43:35,680
everything else

1153
00:43:39,750 --> 00:43:37,440
but we also need to understand dark

1154
00:43:42,630 --> 00:43:39,760
matter because it's

1155
00:43:45,190 --> 00:43:42,640
most of the mass on which gravity acts

1156
00:43:54,150 --> 00:43:45,200
so it determines how clustered

1157
00:43:55,510 --> 00:43:54,160
objects are

1158
00:43:58,069 --> 00:43:55,520
so one of the ways that you could do

1159
00:44:01,349 --> 00:43:58,079
this is to imagine if you go back to

1160
00:44:03,750 --> 00:44:01,359
uh shortly after the big bang where the

1161
00:44:06,309 --> 00:44:03,760
universe is relatively smooth uh with

1162
00:44:08,870 --> 00:44:06,319
some small fluctuations that will later

1163
00:44:10,550 --> 00:44:08,880

grow into being the structure of the

1164
00:44:12,790 --> 00:44:10,560
galaxy clusters and galaxies

1165
00:44:14,950 --> 00:44:12,800
uh around us as the universe can

1166
00:44:17,430 --> 00:44:14,960
continues to um expand

1167
00:44:19,349 --> 00:44:17,440
the typical uh distance between those

1168
00:44:22,069 --> 00:44:19,359
structures will also expand

1169
00:44:22,950 --> 00:44:22,079
so if we can measure the distribution of

1170
00:44:26,470 --> 00:44:22,960
galaxies

1171
00:44:27,030 --> 00:44:26,480
as a function of redshift which is the

1172
00:44:28,390 --> 00:44:27,040
same

1173
00:44:30,390 --> 00:44:28,400
as measuring the distribution of

1174
00:44:33,589 --> 00:44:30,400
galaxies as a function of

1175
00:44:35,750 --> 00:44:33,599
time looking back into the universe

1176
00:44:38,230 --> 00:44:35,760
we're getting some information about how

1177
00:44:39,990 --> 00:44:38,240
the universe has expanded

1178
00:44:44,870 --> 00:44:40,000
and as a result getting information

1179
00:44:48,630 --> 00:44:47,030
something else that we can do and this

1180
00:44:51,270 --> 00:44:48,640
was uh mentioned

1181
00:44:51,910 --> 00:44:51,280
in the in the introduction is that the

1182
00:44:54,710 --> 00:44:51,920
presence

1183
00:44:55,030 --> 00:44:54,720
of dark matter in clusters of galaxies

1184
00:44:58,870 --> 00:44:55,040
uh

1185
00:45:01,990 --> 00:44:58,880
causes the galaxies behind them

1186
00:45:03,670 --> 00:45:02,000
to be uh lensed to be uh have their

1187
00:45:07,030 --> 00:45:03,680
shape

1188
00:45:09,349 --> 00:45:07,040

bent by the effect of passing through

1189
00:45:11,750 --> 00:45:09,359
the gravitational potential

1190
00:45:12,390 --> 00:45:11,760
and if we measure the shape of all of

1191
00:45:16,870 --> 00:45:12,400
these

1192
00:45:19,109 --> 00:45:16,880
those galaxies

1193
00:45:20,710 --> 00:45:19,119
we can make a measurement of the

1194
00:45:22,630 --> 00:45:20,720
distribution of dark matter as a

1195
00:45:25,270 --> 00:45:22,640
function of distance in the universe

1196
00:45:26,790 --> 00:45:25,280
and this gives us extremely important

1197
00:45:29,589 --> 00:45:26,800
information not just about

1198
00:45:31,589 --> 00:45:29,599
um about the structure of the universe

1199
00:45:33,349 --> 00:45:31,599
but also about the clumpiness of dark

1200
00:45:35,109 --> 00:45:33,359
matter

1201
00:45:36,710 --> 00:45:35,119
and it's important to understand the

1202
00:45:38,390 --> 00:45:36,720
complements of dark matter because that

1203
00:45:42,309 --> 00:45:38,400
in turn can tell us something about the

1204
00:45:48,550 --> 00:45:45,910
so with um this very large field of view

1205
00:45:50,710 --> 00:45:48,560
on the nancy grace roman space telescope

1206
00:45:52,470 --> 00:45:50,720
we plan to conduct a survey that will

1207
00:45:53,829 --> 00:45:52,480
cover thousands of square degrees on the

1208
00:45:56,550 --> 00:45:53,839
sky

1209
00:45:57,349 --> 00:45:56,560
and in that survey we'll measure uh the

1210
00:45:59,510 --> 00:45:57,359
position

1211
00:46:00,710 --> 00:45:59,520
and distance to hundreds of millions of

1212
00:46:03,270 --> 00:46:00,720
galaxies

1213
00:46:04,710 --> 00:46:03,280

and make a three-dimensional map of the

1214
00:46:06,309 --> 00:46:04,720
universe

1215
00:46:07,910 --> 00:46:06,319
for a fraction of those galaxies we're

1216
00:46:09,670 --> 00:46:07,920
also going to be able to precisely

1217
00:46:12,829 --> 00:46:09,680
measure their shape

1218
00:46:15,990 --> 00:46:12,839
and with that uh we can get

1219
00:46:20,230 --> 00:46:16,000
a mapping of dark of the dark matter

1220
00:46:23,349 --> 00:46:21,990
this is something that we can do because

1221
00:46:25,589 --> 00:46:23,359
we have a large field of view

1222
00:46:28,470 --> 00:46:25,599
because we can survey large fractions of

1223
00:46:30,069 --> 00:46:28,480
the of the sky

1224
00:46:31,829 --> 00:46:30,079
we're not just going to do that one

1225
00:46:35,670 --> 00:46:31,839
large survey

1226
00:46:36,790 --> 00:46:35,680
we also plan to um look at a patch of

1227
00:46:40,390 --> 00:46:36,800
sky

1228
00:46:41,109 --> 00:46:40,400
away from our galaxy and go back and

1229
00:46:44,069 --> 00:46:41,119
point there

1230
00:46:45,430 --> 00:46:44,079
every five days and in that patch of sky

1231
00:46:46,309 --> 00:46:45,440
we'll be monitoring hundreds of

1232
00:46:49,190 --> 00:46:46,319
thousands

1233
00:46:50,390 --> 00:46:49,200
of galaxies and if a supernova goes off

1234
00:46:52,309 --> 00:46:50,400
in those galaxies

1235
00:46:53,510 --> 00:46:52,319
we will be able to make a measurement of

1236
00:46:55,750 --> 00:46:53,520
that supernova

1237
00:46:57,270 --> 00:46:55,760
and a subset of supernova are what's

1238
00:47:00,390 --> 00:46:57,280

known as a standard candle

1239
00:47:02,390 --> 00:47:00,400
that we um by making measurements of how

1240
00:47:05,990 --> 00:47:02,400
the light changes as a function of time

1241
00:47:06,550 --> 00:47:06,000
we can infer how bright that supernova

1242
00:47:08,470 --> 00:47:06,560
really

1243
00:47:10,069 --> 00:47:08,480
is so it's a little bit like having a

1244
00:47:11,589 --> 00:47:10,079
standard headlamp that you if you know

1245
00:47:13,670 --> 00:47:11,599
how bright the headlamp is

1246
00:47:15,589 --> 00:47:13,680
you can tell by how bright it appears

1247
00:47:17,589 --> 00:47:15,599
how far away it is if something

1248
00:47:19,349 --> 00:47:17,599
is far away it'll appear dimmer as it

1249
00:47:22,710 --> 00:47:19,359
comes closer to you it's brighter

1250
00:47:24,150 --> 00:47:22,720
similarly with the supernova that um

1251
00:47:25,910 --> 00:47:24,160
we can measure the distance to the

1252
00:47:27,670 --> 00:47:25,920
supernova um

1253
00:47:29,670 --> 00:47:27,680
by understanding it by measuring its

1254
00:47:31,349 --> 00:47:29,680
apparent brightness

1255
00:47:34,790 --> 00:47:31,359
we'll see tens of thousands of

1256
00:47:37,990 --> 00:47:36,549
we can measure the redshift to the

1257
00:47:38,630 --> 00:47:38,000
supernova so we'll get also get a

1258
00:47:41,270 --> 00:47:38,640
measure

1259
00:47:41,910 --> 00:47:41,280
of the of the velocity and so this gives

1260
00:47:43,990 --> 00:47:41,920
us uh

1261
00:47:46,069 --> 00:47:44,000
another measure a completely independent

1262
00:47:48,870 --> 00:47:46,079
measure of the expansion history

1263
00:47:50,549 --> 00:47:48,880

of the universe and what the nancy grace

1264
00:47:52,230 --> 00:47:50,559
roman space telescope will do we'll take

1265
00:47:55,430 --> 00:47:52,240
each of these three

1266
00:47:58,630 --> 00:47:55,440
uh techniques to understand

1267
00:47:59,910 --> 00:47:58,640
um dark energy dark matter and modified

1268
00:48:01,829 --> 00:47:59,920
theories of gravity

1269
00:48:03,589 --> 00:48:01,839
because if the expansion history of the

1270
00:48:05,190 --> 00:48:03,599
universe is inconsistent with what we

1271
00:48:08,950 --> 00:48:05,200
see from the growth of structure

1272
00:48:11,910 --> 00:48:08,960
it may point to a modified theory of

1273
00:48:13,510 --> 00:48:11,920
general relativity to make these

1274
00:48:16,470 --> 00:48:13,520
observations we have to have

1275
00:48:17,750 --> 00:48:16,480
an exquisite ability to measure the

1276
00:48:19,990 --> 00:48:17,760
shapes of galaxies

1277
00:48:21,750 --> 00:48:20,000
we have to have an exquisite ability to

1278
00:48:24,710 --> 00:48:21,760
measure the brightness

1279
00:48:26,150 --> 00:48:24,720
of uh of supernovae so one of the things

1280
00:48:28,549 --> 00:48:26,160
that we've been very careful of

1281
00:48:29,589 --> 00:48:28,559
with in the with the nancy grace roman

1282
00:48:31,950 --> 00:48:29,599
observatory

1283
00:48:35,109 --> 00:48:31,960
is designing a telescope that is

1284
00:48:36,950 --> 00:48:35,119
exquisitely precise we'll understand the

1285
00:48:40,069 --> 00:48:36,960
point spread function the shape

1286
00:48:44,790 --> 00:48:40,079
that a star makes in our um you know

1287
00:48:48,630 --> 00:48:44,800
in our camera to one part and a thousand

1288
00:48:50,230 --> 00:48:48,640

uh we have a an ability to translate

1289
00:48:51,910 --> 00:48:50,240
the intensity that we measure in the

1290
00:48:53,670 --> 00:48:51,920
detector to our understanding of what

1291
00:48:53,990 --> 00:48:53,680
that means for the object we're looking

1292
00:48:56,230 --> 00:48:54,000
at

1293
00:48:57,990 --> 00:48:56,240
a factor of 10 better than hubble and

1294
00:48:59,589 --> 00:48:58,000
it's these kinds of things that allow us

1295
00:49:01,910 --> 00:48:59,599
to take the groundbreaking

1296
00:49:03,349 --> 00:49:01,920
observations of large slots of the sky

1297
00:49:07,430 --> 00:49:03,359
into

1298
00:49:10,309 --> 00:49:07,440
unprecedented measurements of cosmology

1299
00:49:12,069 --> 00:49:10,319
but we don't just look away from our

1300
00:49:15,270 --> 00:49:12,079
galaxy

1301
00:49:17,270 --> 00:49:15,280
we also plan to point our telescope

1302
00:49:19,349 --> 00:49:17,280
towards the galactic center towards the

1303
00:49:22,630 --> 00:49:19,359
bulge of our galaxy

1304
00:49:24,870 --> 00:49:22,640
uh we plan to monitor a region

1305
00:49:25,829 --> 00:49:24,880
towards the center two square degrees in

1306
00:49:27,270 --> 00:49:25,839
size

1307
00:49:28,829 --> 00:49:27,280
and in that region there are hundreds of

1308
00:49:30,870 --> 00:49:28,839
millions of stars that we will be

1309
00:49:34,390 --> 00:49:30,880
monitoring

1310
00:49:35,910 --> 00:49:34,400
brightness of those stars every 15

1311
00:49:36,470 --> 00:49:35,920
minutes and the reason that we're doing

1312
00:49:39,990 --> 00:49:36,480
that

1313
00:49:42,470 --> 00:49:40,000

is uh also related to um

1314
00:49:43,349 --> 00:49:42,480
an effect of uh of gravity and we're

1315
00:49:46,630 --> 00:49:43,359
using that

1316
00:49:48,950 --> 00:49:46,640
we're looking for

1317
00:49:49,829 --> 00:49:48,960
changes in the brightness of stars that

1318
00:49:52,390 --> 00:49:49,839
are produced from

1319
00:49:52,950 --> 00:49:52,400
when another star or another star with a

1320
00:49:55,430 --> 00:49:52,960
planet

1321
00:49:56,630 --> 00:49:55,440
passes in front of the background star

1322
00:49:59,270 --> 00:49:56,640
so what we will be doing

1323
00:50:00,790 --> 00:49:59,280
is monitoring a star while monitoring

1324
00:50:03,829 --> 00:50:00,800
millions of stars

1325
00:50:05,670 --> 00:50:03,839
um and uh some

1326
00:50:07,589 --> 00:50:05,680
re it's rare but we are looking at a lot

1327
00:50:09,670 --> 00:50:07,599
of stars some fraction of the time

1328
00:50:11,190 --> 00:50:09,680
a foreground star with an exoplanet will

1329
00:50:14,549 --> 00:50:11,200
pass in front

1330
00:50:17,670 --> 00:50:17,109
and as the star the foreground star

1331
00:50:20,710 --> 00:50:17,680
passes

1332
00:50:22,950 --> 00:50:20,720
in front of the background star

1333
00:50:24,870 --> 00:50:22,960
it acts as a gravitational lens and it

1334
00:50:27,270 --> 00:50:24,880
causes the background star to increase

1335
00:50:30,230 --> 00:50:27,280
in brightness and you see a second

1336
00:50:32,630 --> 00:50:30,240
smaller sharper increase in brightness

1337
00:50:36,390 --> 00:50:32,640
caused by the exoplanet that is in orbit

1338
00:50:40,309 --> 00:50:36,400

around the foreground star and from this

1339
00:50:43,510 --> 00:50:40,319
we can make a measure of exoplanet

1340
00:50:46,230 --> 00:50:43,520
uh masses and distances um

1341
00:50:47,750 --> 00:50:46,240
in the icy giant part of our solar

1342
00:50:48,630 --> 00:50:47,760
system that are currently completely

1343
00:50:50,549 --> 00:50:48,640
inaccessible

1344
00:50:53,030 --> 00:50:50,559
to other surveys and give us a much more

1345
00:50:55,829 --> 00:50:53,040
complete picture of an exoplanet census

1346
00:50:58,309 --> 00:50:55,839
in our galaxy

1347
00:50:59,670 --> 00:50:58,319
we expect to see thousands of these

1348
00:51:03,510 --> 00:50:59,680
exoplanets

1349
00:51:06,309 --> 00:51:03,520
and i'd like to come back to um

1350
00:51:07,990 --> 00:51:06,319
one of the uh the introduction when we

1351
00:51:10,069 --> 00:51:08,000
were talking about

1352
00:51:11,190 --> 00:51:10,079
a desire to understand the clumpiness of

1353
00:51:14,230 --> 00:51:11,200
dark matter

1354
00:51:15,510 --> 00:51:14,240
if there are small dense clumps of dark

1355
00:51:17,750 --> 00:51:15,520
matter in our galaxy

1356
00:51:18,710 --> 00:51:17,760
that happen to pass in front of

1357
00:51:21,349 --> 00:51:18,720
background stars

1358
00:51:23,589 --> 00:51:21,359
we will also see a lensing signal from

1359
00:51:24,630 --> 00:51:23,599
that so this technique doesn't just help

1360
00:51:27,510 --> 00:51:24,640
us find

1361
00:51:29,109 --> 00:51:27,520
um extrasolar planets this technique

1362
00:51:31,190 --> 00:51:29,119
will also allow us to find

1363
00:51:33,910 --> 00:51:31,200

free-floating neutron stars it'll allow

1364
00:51:34,790 --> 00:51:33,920
us to find small clumps of dark matter

1365
00:51:38,950 --> 00:51:34,800
in our

1366
00:51:42,870 --> 00:51:40,870
so i'd like to say a few a little few

1367
00:51:46,230 --> 00:51:42,880
words about how

1368
00:51:48,870 --> 00:51:46,240
uh how the observatory works

1369
00:51:49,670 --> 00:51:48,880
so light comes in it hits our primary

1370
00:51:52,390 --> 00:51:49,680
mirror which

1371
00:51:53,829 --> 00:51:52,400
is 2.4 meters in diameter so around the

1372
00:51:55,670 --> 00:51:53,839
same size as hubble

1373
00:51:57,109 --> 00:51:55,680
then it gets reflected back to a

1374
00:52:00,630 --> 00:51:57,119
secondary mirror

1375
00:52:02,390 --> 00:52:00,640
it passes through um uh two pieces of

1376
00:52:13,670 --> 00:52:02,400
optics ah you're going too fast

1377
00:52:20,150 --> 00:52:17,349
okay um it goes through two pieces

1378
00:52:21,190 --> 00:52:20,160
uh two folding mirrors it then hits a

1379
00:52:24,069 --> 00:52:21,200
tertiary mirror

1380
00:52:24,630 --> 00:52:24,079
that is uh we require three curved

1381
00:52:28,069 --> 00:52:24,640
mirrors

1382
00:52:28,870 --> 00:52:28,079
in roman because the third mirror is

1383
00:52:32,150 --> 00:52:28,880
required

1384
00:52:33,750 --> 00:52:32,160
to correct optical aberrations such a

1385
00:52:36,710 --> 00:52:33,760
large field of view

1386
00:52:37,910 --> 00:52:36,720
the light then continues through a

1387
00:52:40,390 --> 00:52:37,920
filtered wheel

1388
00:52:41,670 --> 00:52:40,400

so we can choose which filter to take

1389
00:52:44,309 --> 00:52:41,680
the observations to

1390
00:52:46,790 --> 00:52:44,319
view the universe in different in

1391
00:52:47,829 --> 00:52:46,800
different waveforms and then finally the

1392
00:52:51,190 --> 00:52:47,839
light goes through

1393
00:52:53,430 --> 00:52:51,200
to the um to our focal plane

1394
00:52:54,549 --> 00:52:53,440
which is a set of 18 detectors and each

1395
00:53:00,549 --> 00:52:54,559
one of these

1396
00:53:04,710 --> 00:53:00,559
uh detectors is 4096 by 4096 pixels wide

1397
00:53:07,349 --> 00:53:04,720
so the entire um camera of roman

1398
00:53:07,750 --> 00:53:07,359
the main on the main instrument is this

1399
00:53:11,030 --> 00:53:07,760
uh

1400
00:53:12,549 --> 00:53:11,040
set of 18 detectors that we use to cover

1401
00:53:13,829 --> 00:53:12,559
the sky and that's what makes the kind

1402
00:53:15,829 --> 00:53:13,839
of space invader

1403
00:53:19,829 --> 00:53:15,839
shape uh that you see when people are

1404
00:53:28,549 --> 00:53:23,349
okay we've seen that so let's move on

1405
00:53:31,910 --> 00:53:28,559
um we've mentioned that um

1406
00:53:33,990 --> 00:53:31,920
dr wiseman mentioned that um roman

1407
00:53:35,750 --> 00:53:34,000
focuses observations in the near

1408
00:53:36,630 --> 00:53:35,760
infrared who do not have the capability

1409
00:53:39,670 --> 00:53:36,640
to continue

1410
00:53:40,950 --> 00:53:39,680
observations down to the optical uh but

1411
00:53:42,230 --> 00:53:40,960
that's a good match for the kind of

1412
00:53:43,829 --> 00:53:42,240
science that we want to do

1413
00:53:45,670 --> 00:53:43,839

in the search for exoplanets we need to

1414
00:53:47,750 --> 00:53:45,680
have a height it would look somewhere

1415
00:53:49,349 --> 00:53:47,760
there's a high density of stars

1416
00:53:50,870 --> 00:53:49,359
so we want to look towards the galactic

1417
00:53:54,390 --> 00:53:50,880
bulge and the galactic bulges

1418
00:53:56,950 --> 00:53:54,400
uh is full of dust and the dust

1419
00:53:57,670 --> 00:53:56,960
absorption of the light that we're

1420
00:54:00,150 --> 00:53:57,680
trying to

1421
00:54:01,829 --> 00:54:00,160
view is much lower in the near infrared

1422
00:54:03,430 --> 00:54:01,839
than it is invisible

1423
00:54:04,710 --> 00:54:03,440
we're also interested in understanding

1424
00:54:05,829 --> 00:54:04,720
the structure and evolution of the

1425
00:54:07,589 --> 00:54:05,839
universe which means

1426
00:54:09,750 --> 00:54:07,599
that we want to take observations at

1427
00:54:13,589 --> 00:54:09,760
large redshifts

1428
00:54:22,230 --> 00:54:13,599
to

1429
00:54:22,790 --> 00:54:22,240
and you can see this in the image at the

1430
00:54:26,230 --> 00:54:22,800
bottom

1431
00:54:29,670 --> 00:54:26,240
it shows a comparison of um the light

1432
00:54:31,190 --> 00:54:29,680
from uh galaxies at a redshift of uh two

1433
00:54:33,589 --> 00:54:31,200
between the near infrared and the

1434
00:54:34,150 --> 00:54:33,599
visible and by making observations in

1435
00:54:36,470 --> 00:54:34,160
the near

1436
00:54:38,069 --> 00:54:36,480
infrared we're improving our ability to

1437
00:54:41,109 --> 00:54:38,079
be able to measure

1438
00:54:48,069 --> 00:54:41,119

this precisely the shapes of galaxies

1439
00:54:54,230 --> 00:54:51,349
another difference between roman

1440
00:54:55,270 --> 00:54:54,240
and uh hubble is that the hubble space

1441
00:54:59,430 --> 00:54:55,280
telescope

1442
00:55:02,150 --> 00:54:59,440
is in orbit um in low earth orbit around

1443
00:55:02,710 --> 00:55:02,160
our earth so what you see here is our

1444
00:55:05,990 --> 00:55:02,720
earth

1445
00:55:09,750 --> 00:55:06,000
roman

1446
00:55:13,349 --> 00:55:09,760
is all the way out here at l2 uh the sun

1447
00:55:16,470 --> 00:55:13,359
uh lagrange point

1448
00:55:17,430 --> 00:55:16,480
and what this allows us to do is uh in

1449
00:55:19,349 --> 00:55:17,440
this orbit

1450
00:55:20,630 --> 00:55:19,359
it means that the earth is not blocking

1451
00:55:23,190 --> 00:55:20,640
the field of view

1452
00:55:25,109 --> 00:55:23,200
so we can have those very dense

1453
00:55:27,030 --> 00:55:25,119
observations and observation every 15

1454
00:55:28,150 --> 00:55:27,040
minutes for months at a time of galactic

1455
00:55:30,230 --> 00:55:28,160
bulge

1456
00:55:31,990 --> 00:55:30,240
this orbit also allows us to have a

1457
00:55:33,750 --> 00:55:32,000
region of the sky that is continuously

1458
00:55:36,470 --> 00:55:33,760
visible for years at a time

1459
00:55:38,230 --> 00:55:36,480
so that we can monitor that patchy of

1460
00:55:40,789 --> 00:55:38,240
the sky for several years

1461
00:55:42,309 --> 00:55:40,799
for uh to search for and characterize

1462
00:55:45,030 --> 00:55:42,319
supernovae

1463
00:55:46,549 --> 00:55:45,040

this orbit also means that we're in a

1464
00:55:48,069 --> 00:55:46,559
thermally stable

1465
00:55:49,910 --> 00:55:48,079
environment and since one of the

1466
00:55:52,069 --> 00:55:49,920
requirements on this mission is that

1467
00:55:53,190 --> 00:55:52,079
that we have a very precise

1468
00:55:56,390 --> 00:55:53,200
understanding

1469
00:55:59,589 --> 00:55:56,400
of um our point spread function

1470
00:56:02,150 --> 00:55:59,599
that requires keeping every part of the

1471
00:56:03,510 --> 00:56:02,160
observatory very stable relative to

1472
00:56:07,349 --> 00:56:03,520
relative to

1473
00:56:11,750 --> 00:56:09,670
we have a second instrument um the

1474
00:56:13,750 --> 00:56:11,760
second instrument on roman is a techno

1475
00:56:14,870 --> 00:56:13,760
it is an exciting technology uh

1476
00:56:19,109 --> 00:56:14,880
demonstration

1477
00:56:20,630 --> 00:56:19,119
to directly image exoplanets themselves

1478
00:56:23,030 --> 00:56:20,640
and this is an extremely challenging

1479
00:56:23,670 --> 00:56:23,040
problem if you um if you have a sunlight

1480
00:56:26,630 --> 00:56:23,680
star

1481
00:56:27,510 --> 00:56:26,640
and you have a hot exo jupiter it's the

1482
00:56:31,910 --> 00:56:27,520
equivalent

1483
00:56:34,470 --> 00:56:31,920
of trying to um distinguish a firefly

1484
00:56:36,150 --> 00:56:34,480
next to a lighthouse the problem gets

1485
00:56:38,069 --> 00:56:36,160
even worse if you're interested

1486
00:56:40,230 --> 00:56:38,079
in imaging earth-like planets because

1487
00:56:41,750 --> 00:56:40,240
now the light of the earth-like planet

1488
00:56:42,309 --> 00:56:41,760

is a billion times fainter than the

1489
00:56:44,230 --> 00:56:42,319
light

1490
00:56:46,150 --> 00:56:44,240
of the nearby star so it's the

1491
00:56:49,910 --> 00:56:46,160
equivalent of trying to find

1492
00:56:53,109 --> 00:56:49,920
one biolet luminescent

1493
00:56:54,549 --> 00:56:53,119
algae next to a star that sounds like an

1494
00:56:58,150 --> 00:56:54,559
incredibly challenging

1495
00:57:00,950 --> 00:56:58,160
um problem and to solve this problem

1496
00:57:01,910 --> 00:57:00,960
uh we have to find a way of blocking the

1497
00:57:04,630 --> 00:57:01,920
light

1498
00:57:06,789 --> 00:57:04,640
of the star so that we can see the

1499
00:57:10,230 --> 00:57:06,799
planet itself

1500
00:57:13,750 --> 00:57:10,240
and we do this is uh

1501
00:57:16,630 --> 00:57:13,760
an interleave um we do this

1502
00:57:17,589 --> 00:57:16,640
by um uh with an instrument known as a

1503
00:57:19,910 --> 00:57:17,599
coronagraph

1504
00:57:22,069 --> 00:57:19,920
and to sort of come back to a connection

1505
00:57:25,190 --> 00:57:22,079
with nancy grace roman she was actually

1506
00:57:26,630 --> 00:57:25,200
uh the first person just the author of

1507
00:57:29,270 --> 00:57:26,640
the first paper to suggest

1508
00:57:31,270 --> 00:57:29,280
using space telescopes to directly image

1509
00:57:34,549 --> 00:57:31,280
exoplanets so this is another example

1510
00:57:36,870 --> 00:57:34,559
of uh how visionary she was

1511
00:57:37,829 --> 00:57:36,880
so how what we do with this is we don't

1512
00:57:41,030 --> 00:57:37,839
just have

1513
00:57:42,950 --> 00:57:41,040

a single solid disc

1514
00:57:44,309 --> 00:57:42,960
that blocks the light of the star

1515
00:57:46,630 --> 00:57:44,319
instead

1516
00:57:49,670 --> 00:57:46,640
we put in a complicated shaped mask that

1517
00:57:52,069 --> 00:57:49,680
uses the properties of light

1518
00:57:53,430 --> 00:57:52,079
along with the block to cause the light

1519
00:57:55,750 --> 00:57:53,440
to interfere with itself

1520
00:57:57,270 --> 00:57:55,760
and produce a dark hole in the center of

1521
00:58:00,390 --> 00:57:57,280
the field of view that blocks the light

1522
00:58:03,510 --> 00:58:02,710
that allows us to see the exoplanet but

1523
00:58:05,510 --> 00:58:03,520
that itself

1524
00:58:07,829 --> 00:58:05,520
would not be sufficient because small

1525
00:58:10,390 --> 00:58:07,839
deviations of the optics

1526
00:58:12,150 --> 00:58:10,400
cause small shifts in the wavelength

1527
00:58:15,670 --> 00:58:12,160
that will completely wash out the signal

1528
00:58:18,950 --> 00:58:15,680
as you see um here so what we have

1529
00:58:22,710 --> 00:58:18,960
is a set of deformable mirrors and these

1530
00:58:25,349 --> 00:58:22,720
mirrors have hundreds of little pistons

1531
00:58:26,230 --> 00:58:25,359
that change the shape of the mirror to

1532
00:58:27,670 --> 00:58:26,240
correct

1533
00:58:30,390 --> 00:58:27,680
for the distortions that are being

1534
00:58:33,510 --> 00:58:30,400
produced by the optics of the telescope

1535
00:58:36,470 --> 00:58:33,520
and this corrects the signal and allows

1536
00:58:37,430 --> 00:58:36,480
the exoplanet the faint exothermist to

1537
00:58:40,549 --> 00:58:37,440
be directly

1538
00:58:42,630 --> 00:58:40,559

image and we can do better with more uh

1539
00:58:43,349 --> 00:58:42,640
data analysis to in fact pull out a

1540
00:58:46,069 --> 00:58:43,359
second

1541
00:58:48,829 --> 00:58:46,079
exoplanet here so in this particular

1542
00:58:55,190 --> 00:58:48,839
system there are two

1543
00:58:58,470 --> 00:58:57,030
so with this coronagraph we're going to

1544
00:58:59,589 --> 00:58:58,480
do a lot a lot of things for the first

1545
00:59:02,230 --> 00:58:59,599
time

1546
00:59:04,470 --> 00:59:02,240
we have ultra precise waveform sensing

1547
00:59:06,470 --> 00:59:04,480
and control which we need so that we can

1548
00:59:08,309 --> 00:59:06,480
drive the deformable mirrors which will

1549
00:59:09,829 --> 00:59:08,319
be the first example of using deformable

1550
00:59:12,230 --> 00:59:09,839
mirrors in space

1551
00:59:13,430 --> 00:59:12,240
uh we use these complex uh chronograph

1552
00:59:15,750 --> 00:59:13,440
masks that feel

1553
00:59:18,150 --> 00:59:15,760
i mean to me feels a little bit like um

1554
00:59:21,349 --> 00:59:18,160
physics magic in action

1555
00:59:25,190 --> 00:59:21,359
to get an extraordinary ability

1556
00:59:27,829 --> 00:59:25,200
to see faint objects next to very bright

1557
00:59:31,109 --> 00:59:29,270
and this is the end of what i wanted to

1558
00:59:35,829 --> 00:59:31,119
say i

1559
00:59:38,549 --> 00:59:35,839
focused on a couple of science topics

1560
00:59:39,750 --> 00:59:38,559
and i focused on um our understanding of

1561
00:59:40,470 --> 00:59:39,760
the structure and evolution of the

1562
00:59:43,030 --> 00:59:40,480
universe

1563
00:59:43,910 --> 00:59:43,040

and our ability to find and characterize

1564
00:59:46,549 --> 00:59:43,920
extrasolar

1565
00:59:48,150 --> 00:59:46,559
uh planets but we're going to do so much

1566
00:59:50,069 --> 00:59:48,160
more than that

1567
00:59:51,589 --> 00:59:50,079
the survey that will find those large

1568
00:59:53,589 --> 00:59:51,599
number of galaxies is

1569
00:59:55,990 --> 00:59:53,599
of course can study those galaxies too

1570
00:59:58,390 --> 00:59:56,000
we'll find many many quasars

1571
00:59:59,349 --> 00:59:58,400
uh we'll find everything that is

1572
01:00:01,829 --> 00:59:59,359
changing

1573
01:00:02,630 --> 01:00:01,839
in those uh in those regions and this

1574
01:00:05,190 --> 01:00:02,640
opens up

1575
01:00:06,230 --> 01:00:05,200
an extraordinary amount of science the

1576
01:00:07,589 --> 01:00:06,240
precision

1577
01:00:09,990 --> 01:00:07,599
with which we're designing this

1578
01:00:10,789 --> 01:00:10,000
observatory will allow us to precisely

1579
01:00:13,990 --> 01:00:10,799
measure

1580
01:00:17,829 --> 01:00:14,000
the positions of stars and as we go back

1581
01:00:19,270 --> 01:00:17,839
to the same uh um observation

1582
01:00:21,349 --> 01:00:19,280
time and time again we will have the

1583
01:00:23,670 --> 01:00:21,359
ability to uh measure

1584
01:00:25,589 --> 01:00:23,680
changes in the positions of those stars

1585
01:00:28,630 --> 01:00:25,599
and really understand the populations

1586
01:00:29,670 --> 01:00:28,640
and evolution of stars in our galaxy um

1587
01:00:33,109 --> 01:00:29,680
so i'll stop here

1588
01:00:36,309 --> 01:00:33,119

um with one final comment is that

1589
01:00:37,990 --> 01:00:36,319
um when the nancy grace roman space

1590
01:00:38,470 --> 01:00:38,000
telescope launches in the middle of the

1591
01:00:41,589 --> 01:00:38,480
next

1592
01:00:44,230 --> 01:00:41,599
of this decade um i really hope

1593
01:00:45,670 --> 01:00:44,240
that the most exciting science result is

1594
01:00:46,470 --> 01:00:45,680
something that i haven't been able to

1595
01:00:49,190 --> 01:00:46,480
imagine

1596
01:00:51,190 --> 01:00:49,200
something that has emerged because we're

1597
01:00:53,030 --> 01:00:51,200
using this observatory to

1598
01:00:54,230 --> 01:00:53,040
view the universe in a different way

1599
01:00:56,470 --> 01:00:54,240
than we were able to

1600
01:00:58,309 --> 01:00:56,480
uh before that we no longer have to look

1601
01:01:00,150 --> 01:00:58,319
under a lamppost we don't have to make

1602
01:01:01,430 --> 01:01:00,160
so much choices about where to look we

1603
01:01:03,589 --> 01:01:01,440
can

1604
01:01:05,510 --> 01:01:03,599
look somewhere and wait to see what

1605
01:01:06,230 --> 01:01:05,520
appears and that i find tremendously

1606
01:01:09,430 --> 01:01:06,240
exciting

1607
01:01:13,750 --> 01:01:09,440
thank you thank you julie that

1608
01:01:15,270 --> 01:01:13,760
is tremendously exciting um you know

1609
01:01:17,589 --> 01:01:15,280
it's the first time i've seen all those

1610
01:01:18,549 --> 01:01:17,599
various programs laid out on a single

1611
01:01:20,789 --> 01:01:18,559
slide because

1612
01:01:22,230 --> 01:01:20,799
you know when we uh simplify it to try

1613
01:01:23,510 --> 01:01:22,240

and explain it to people

1614
01:01:25,349 --> 01:01:23,520
and we try and go all right there are

1615
01:01:27,270 --> 01:01:25,359
three or four messages right but you

1616
01:01:28,710 --> 01:01:27,280
i love it that you were able to put that

1617
01:01:31,109 --> 01:01:28,720
full slide up there and that

1618
01:01:33,589 --> 01:01:31,119
uh that that's gotten gotten me even

1619
01:01:36,549 --> 01:01:33,599
more excited

1620
01:01:39,109 --> 01:01:36,559
um we've had some lively talk on our

1621
01:01:41,190 --> 01:01:39,119
chat on youtube a tremendous number of

1622
01:01:44,069 --> 01:01:41,200
viewers here today

1623
01:01:46,069 --> 01:01:44,079
and jennifer i invite you to turn on

1624
01:01:48,390 --> 01:01:46,079
your video and join us

1625
01:01:49,349 --> 01:01:48,400
and if we have some questions and i'm

1626
01:01:51,510 --> 01:01:49,359
going to start

1627
01:01:52,630 --> 01:01:51,520
by asking a question that i wanted to

1628
01:01:56,309 --> 01:01:52,640
ask about

1629
01:01:57,430 --> 01:01:56,319
um this is that um the data model that

1630
01:01:59,990 --> 01:01:57,440
we're doing okay

1631
01:02:02,069 --> 01:02:00,000
and in particular with the time domain

1632
01:02:05,109 --> 01:02:02,079
astronomy that we're getting into

1633
01:02:07,190 --> 01:02:05,119
um it's it really is to me

1634
01:02:09,349 --> 01:02:07,200
the synchronicity of cloud computing

1635
01:02:11,670 --> 01:02:09,359
becoming such a ubiquitous

1636
01:02:16,950 --> 01:02:11,680
this this decade um is really going to

1637
01:02:22,470 --> 01:02:19,990
yeah i mean so i think that

1638
01:02:23,829 --> 01:02:22,480

um the upcoming decade is going to be

1639
01:02:27,589 --> 01:02:23,839
transformational

1640
01:02:27,990 --> 01:02:27,599
in how we do astronomy we're entering an

1641
01:02:31,829 --> 01:02:28,000
era

1642
01:02:34,710 --> 01:02:31,839
where all data is available to people

1643
01:02:35,510 --> 01:02:34,720
almost immediately we're entering an era

1644
01:02:37,670 --> 01:02:35,520
where

1645
01:02:39,510 --> 01:02:37,680
the rapid prompt analysis of data and

1646
01:02:41,829 --> 01:02:39,520
identifying interesting things

1647
01:02:42,710 --> 01:02:41,839
in those data sets can trigger

1648
01:02:45,270 --> 01:02:42,720
observations

1649
01:02:47,670 --> 01:02:45,280
in other observatories which will open

1650
01:02:49,190 --> 01:02:47,680
up entirely new possibility in studying

1651
01:02:50,390 --> 01:02:49,200
uh things that are varying in the time

1652
01:02:53,670 --> 01:02:50,400
domain

1653
01:02:55,190 --> 01:02:53,680
i think that the model of cloud

1654
01:02:58,470 --> 01:02:55,200
computing where

1655
01:03:02,150 --> 01:02:58,480
the astronomer does the analysis out

1656
01:03:03,510 --> 01:03:02,160
of all publicly available data at a

1657
01:03:05,589 --> 01:03:03,520
central repository

1658
01:03:07,670 --> 01:03:05,599
that has lots of computing is going to

1659
01:03:10,870 --> 01:03:07,680
be very um

1660
01:03:12,230 --> 01:03:10,880
uh open um and inclusive in the

1661
01:03:13,829 --> 01:03:12,240
community because you will no longer

1662
01:03:16,549 --> 01:03:13,839
have to be at a special place

1663
01:03:18,230 --> 01:03:16,559

that has access to telescope time you'll

1664
01:03:19,029 --> 01:03:18,240
no longer have to be at a place that has

1665
01:03:20,870 --> 01:03:19,039
access to

1666
01:03:22,950 --> 01:03:20,880
large large computers so i think we're

1667
01:03:25,990 --> 01:03:22,960
going to see the democratization

1668
01:03:27,270 --> 01:03:26,000
of um of science and i think that means

1669
01:03:29,270 --> 01:03:27,280
that we're going to have more great

1670
01:03:30,309 --> 01:03:29,280
minds looking at the fabulous data

1671
01:03:31,589 --> 01:03:30,319
that's coming from all of these

1672
01:03:31,910 --> 01:03:31,599
observatories and we're going to have an

1673
01:03:33,990 --> 01:03:31,920
even

1674
01:03:35,910 --> 01:03:34,000
better science return which i also hope

1675
01:03:38,309 --> 01:03:35,920
i can't predict

1676
01:03:39,990 --> 01:03:38,319
i i we're always hopeful that we can't

1677
01:03:41,190 --> 01:03:40,000
predict just how wonderful

1678
01:03:43,270 --> 01:03:41,200
uh the results are going to be from

1679
01:03:44,870 --> 01:03:43,280
these missions if i could just add

1680
01:03:48,470 --> 01:03:44,880
something to that

1681
01:03:50,710 --> 01:03:48,480
it is it is uh i hope obvious from what

1682
01:03:52,950 --> 01:03:50,720
uh dr mchenry just said that we need

1683
01:03:54,870 --> 01:03:52,960
people in the field who are not only

1684
01:03:56,390 --> 01:03:54,880
experts in astronomy and

1685
01:03:59,990 --> 01:03:56,400
physics but we need people who are

1686
01:04:03,510 --> 01:04:00,000
experts in computers computer science

1687
01:04:07,190 --> 01:04:03,520
data management um that's critical

1688
01:04:08,870 --> 01:04:07,200

to the the successful uh acquisition and

1689
01:04:10,950 --> 01:04:08,880
use of all the data that these

1690
01:04:12,309 --> 01:04:10,960
telescopes are bringing us and will be

1691
01:04:13,670 --> 01:04:12,319
bringing us so um

1692
01:04:15,349 --> 01:04:13,680
we need lots of different kinds of

1693
01:04:17,029 --> 01:04:15,359
expertise

1694
01:04:18,870 --> 01:04:17,039
all right and we are joined by grant

1695
01:04:21,270 --> 01:04:18,880
justice who has been monitoring

1696
01:04:22,630 --> 01:04:21,280
the chat more carefully than i am grant

1697
01:04:24,470 --> 01:04:22,640
uh give us a few ques

1698
01:04:25,990 --> 01:04:24,480
few of those amazing questions that were

1699
01:04:29,349 --> 01:04:26,000
asked sure

1700
01:04:30,870 --> 01:04:29,359
um absolutely i just want to since

1701
01:04:32,789 --> 01:04:30,880
we got a little bit of this yesterday

1702
01:04:34,630 --> 01:04:32,799
during the briefing i want to say that

1703
01:04:35,029 --> 01:04:34,640
one of the things that interests me most

1704
01:04:38,309 --> 01:04:35,039
about

1705
01:04:39,510 --> 01:04:38,319
roman is because of the size of the

1706
01:04:42,710 --> 01:04:39,520
field of view

1707
01:04:45,510 --> 01:04:42,720
we're collecting more data kind of

1708
01:04:48,230 --> 01:04:45,520
in the background per se and that data

1709
01:04:50,470 --> 01:04:48,240
will be archived so even if your star or

1710
01:04:52,789 --> 01:04:50,480
your observation is not a part of

1711
01:04:54,150 --> 01:04:52,799
directly what it is pointed at there's

1712
01:04:56,230 --> 01:04:54,160
so much more of the sky

1713
01:04:58,549 --> 01:04:56,240

that we'll be able to use and everyone

1714
01:05:00,309 --> 01:04:58,559
like you said will be able to use

1715
01:05:02,549 --> 01:05:00,319
because it's covering so much more area

1716
01:05:04,150 --> 01:05:02,559
there'll be this huge repository

1717
01:05:05,510 --> 01:05:04,160
which is exciting for the amount of

1718
01:05:07,270 --> 01:05:05,520
papers that could come out of it because

1719
01:05:09,670 --> 01:05:07,280
hubble already gets a lot and it's

1720
01:05:11,510 --> 01:05:09,680
such a larger field of view but yes

1721
01:05:13,029 --> 01:05:11,520
wonderful questions thank you everyone

1722
01:05:14,069 --> 01:05:13,039
in the audience for today this has been

1723
01:05:17,349 --> 01:05:14,079
wonderful

1724
01:05:21,190 --> 01:05:17,359
um so will

1725
01:05:22,630 --> 01:05:21,200
roman uh be using our solar system or

1726
01:05:24,470 --> 01:05:22,640
any of the existing

1727
01:05:26,630 --> 01:05:24,480
calibrations that we have i know on

1728
01:05:28,309 --> 01:05:26,640
hubble for like single gyro mode

1729
01:05:30,150 --> 01:05:28,319
and especially when we have issues we

1730
01:05:33,349 --> 01:05:30,160
use guide stars

1731
01:05:35,190 --> 01:05:33,359
to make up for the positional accuracy

1732
01:05:38,230 --> 01:05:35,200
when the gyros go out

1733
01:05:40,309 --> 01:05:38,240
um what will nancy grace

1734
01:05:43,029 --> 01:05:40,319
be using or do we have any idea at this

1735
01:05:48,309 --> 01:05:46,069
well um our main instrument the

1736
01:05:51,430 --> 01:05:48,319
wide-field instrument

1737
01:05:54,069 --> 01:05:51,440
is used um

1738
01:05:54,710 --> 01:05:54,079

to follow uh guide stars so we typically

1739
01:05:58,069 --> 01:05:54,720
pick

1740
01:06:01,430 --> 01:05:58,079
um a section of the um of the instrument

1741
01:06:04,789 --> 01:06:01,440
um to use um

1742
01:06:07,670 --> 01:06:04,799
uh we're in a different orbit um

1743
01:06:09,829 --> 01:06:07,680
than hubble so that changes uh some of

1744
01:06:11,589 --> 01:06:09,839
the things that we can use we don't for

1745
01:06:12,230 --> 01:06:11,599
example have the benefit of being able

1746
01:06:16,069 --> 01:06:12,240
to

1747
01:06:18,789 --> 01:06:16,079
leverage the magnetic field on um

1748
01:06:19,190 --> 01:06:18,799
on the earth but because we're designed

1749
01:06:22,870 --> 01:06:19,200
with

1750
01:06:24,390 --> 01:06:22,880
have such a large field of view the

1751
01:06:27,990 --> 01:06:24,400
large field of view means

1752
01:06:31,750 --> 01:06:28,000
that if we're doing the uh the survey

1753
01:06:34,390 --> 01:06:31,760
we if we design the survey correctly

1754
01:06:35,190 --> 01:06:34,400
we can use observations of different

1755
01:06:37,750 --> 01:06:35,200
rotations

1756
01:06:38,950 --> 01:06:37,760
of the field of view with the standard

1757
01:06:41,750 --> 01:06:38,960
stars there

1758
01:06:43,109 --> 01:06:41,760
to really nail down very precisely uh

1759
01:06:44,069 --> 01:06:43,119
where we're pointing and what the

1760
01:06:45,670 --> 01:06:44,079
response

1761
01:06:47,270 --> 01:06:45,680
of our instrument is across the large

1762
01:06:49,349 --> 01:06:47,280
field of view and

1763
01:06:50,470 --> 01:06:49,359

can i just extend that question to going

1764
01:06:54,069 --> 01:06:50,480
um i think some

1765
01:06:55,510 --> 01:06:54,079
people want to um is there much uh

1766
01:06:57,430 --> 01:06:55,520
is roman actually going to be looking

1767
01:06:59,190 --> 01:06:57,440
much at solar system objects

1768
01:07:00,710 --> 01:06:59,200
um we can speak for hubble having you

1769
01:07:02,630 --> 01:07:00,720
know done uh you know

1770
01:07:03,829 --> 01:07:02,640
the opel program with its yearly look at

1771
01:07:06,309 --> 01:07:03,839
the the

1772
01:07:07,029 --> 01:07:06,319
atmospheres of the uh the outer planets

1773
01:07:09,510 --> 01:07:07,039
um

1774
01:07:10,390 --> 01:07:09,520
uh is does the solar system play a large

1775
01:07:14,390 --> 01:07:10,400
role in

1776
01:07:16,789 --> 01:07:14,400
in romans work um

1777
01:07:19,270 --> 01:07:16,799
we will have uh interesting capabilities

1778
01:07:22,390 --> 01:07:19,280
of the at the solar system it's not

1779
01:07:25,029 --> 01:07:22,400
um solar system observations aren't

1780
01:07:25,750 --> 01:07:25,039
um driving how we're building and

1781
01:07:27,990 --> 01:07:25,760
developing

1782
01:07:28,950 --> 01:07:28,000
um the observatory but of course once we

1783
01:07:32,230 --> 01:07:28,960
launch

1784
01:07:33,829 --> 01:07:32,240
um we fully intend to look wherever

1785
01:07:36,789 --> 01:07:33,839
we're going to get great science

1786
01:07:38,309 --> 01:07:36,799
um so there are um groups of people in

1787
01:07:39,829 --> 01:07:38,319
the community who are developing the

1788
01:07:43,190 --> 01:07:39,839

science case for what we could do

1789
01:07:44,069 --> 01:07:43,200
with um with roman in our in our solar

1790
01:07:45,510 --> 01:07:44,079
system

1791
01:07:48,789 --> 01:07:45,520
and can we take this question to

1792
01:07:50,549 --> 01:07:48,799
jennifer and say jennifer how did the

1793
01:07:52,470 --> 01:07:50,559
expectations for what hubble would look

1794
01:07:54,710 --> 01:07:52,480
at and what it ended up looking at over

1795
01:07:57,270 --> 01:07:54,720
its 30-year history change over the

1796
01:07:58,950 --> 01:07:57,280
history of the telescope oh well that's

1797
01:08:02,549 --> 01:07:58,960
a fabulous question so

1798
01:08:04,390 --> 01:08:02,559
when hubble was uh was designed i mean

1799
01:08:06,069 --> 01:08:04,400
there were certainly ideas of what we

1800
01:08:08,390 --> 01:08:06,079
would use hubble for and we did

1801
01:08:11,029 --> 01:08:08,400
we have done that and continue to in

1802
01:08:12,630 --> 01:08:11,039
particular measuring the expansion rate

1803
01:08:15,910 --> 01:08:12,640
of the universe that was

1804
01:08:16,870 --> 01:08:15,920
a primary goal of for hubble and of

1805
01:08:18,950 --> 01:08:16,880
course people

1806
01:08:20,950 --> 01:08:18,960
assumed we would be using hubble to look

1807
01:08:21,669 --> 01:08:20,960
at the planets in our solar system as

1808
01:08:23,749 --> 01:08:21,679
well

1809
01:08:24,789 --> 01:08:23,759
and we we've done that but by having

1810
01:08:27,510 --> 01:08:24,799
hubble

1811
01:08:28,709 --> 01:08:27,520
uh working for decades and including

1812
01:08:30,870 --> 01:08:28,719
getting improved

1813
01:08:33,510 --> 01:08:30,880

instruments put on hubble over the years

1814
01:08:34,630 --> 01:08:33,520
and innovative techniques of using

1815
01:08:36,550 --> 01:08:34,640
hubble

1816
01:08:39,030 --> 01:08:36,560
we've started doing things that were not

1817
01:08:40,309 --> 01:08:39,040
even thought about or imagined when

1818
01:08:42,789 --> 01:08:40,319
hubble was designed

1819
01:08:44,390 --> 01:08:42,799
like studying the atmospheres of

1820
01:08:46,789 --> 01:08:44,400
exoplanets

1821
01:08:47,990 --> 01:08:46,799
orbiting other stars i mean when hubble

1822
01:08:49,990 --> 01:08:48,000
was designed we didn't even know if

1823
01:08:51,349 --> 01:08:50,000
there were planets orbiting other stars

1824
01:08:55,269 --> 01:08:51,359
other than the sun

1825
01:08:58,229 --> 01:08:55,279
and then this tall time domain

1826
01:08:59,110 --> 01:08:58,239
capability because if you if you have a

1827
01:09:01,269 --> 01:08:59,120
telescope

1828
01:09:03,430 --> 01:09:01,279
operating for decades you can look back

1829
01:09:05,269 --> 01:09:03,440
over and over and over again at

1830
01:09:07,269 --> 01:09:05,279
phenomena in our own solar system for

1831
01:09:09,110 --> 01:09:07,279
example and see how things change so

1832
01:09:09,910 --> 01:09:09,120
getting back to planets in our solar

1833
01:09:12,309 --> 01:09:09,920
system

1834
01:09:14,630 --> 01:09:12,319
we've been able to see things change

1835
01:09:17,990 --> 01:09:14,640
such as the the the weather the

1836
01:09:19,269 --> 01:09:18,000
the storms on jupiter uh are changing in

1837
01:09:22,390 --> 01:09:19,279
fact we just released a

1838
01:09:25,430 --> 01:09:22,400

marvelous jupiter image

1839
01:09:27,829 --> 01:09:25,440
just a few days ago that show

1840
01:09:30,229 --> 01:09:27,839
how the great red spot the big hurricane

1841
01:09:31,990 --> 01:09:30,239
on jupiter is is shrinking and changing

1842
01:09:33,749 --> 01:09:32,000
color and morphology a little bit and

1843
01:09:35,030 --> 01:09:33,759
new storms are cropping up and even

1844
01:09:36,709 --> 01:09:35,040
looking in ultra

1845
01:09:38,709 --> 01:09:36,719
and other wavelengths of light like in

1846
01:09:41,030 --> 01:09:38,719
the ultraviolet we've discovered things

1847
01:09:42,149 --> 01:09:41,040
like auroras on other planets and things

1848
01:09:44,229 --> 01:09:42,159
like that so

1849
01:09:46,149 --> 01:09:44,239
uh lots of interesting things and i

1850
01:09:47,030 --> 01:09:46,159
haven't even mentioned but you know dark

1851
01:09:49,510 --> 01:09:47,040
matter and dark

1852
01:09:51,749 --> 01:09:49,520
energy things like that that hubble has

1853
01:09:54,470 --> 01:09:51,759
become so keen at detecting

1854
01:09:56,550 --> 01:09:54,480
or detecting the effects of i should say

1855
01:09:58,790 --> 01:09:56,560
were not really imagined

1856
01:10:00,790 --> 01:09:58,800
as one of the primary possibilities for

1857
01:10:03,910 --> 01:10:00,800
hubble when it was designed

1858
01:10:05,270 --> 01:10:03,920
so i expect that roman will be finding

1859
01:10:07,350 --> 01:10:05,280
things that we

1860
01:10:09,189 --> 01:10:07,360
we don't even imagine yet and that's

1861
01:10:11,270 --> 01:10:09,199
part of the excitement of building an

1862
01:10:13,110 --> 01:10:11,280
observatory with a new capability or new

1863
01:10:16,390 --> 01:10:13,120

capabilities is that

1864
01:10:18,470 --> 01:10:16,400
yes there are some things that drive the

1865
01:10:20,550 --> 01:10:18,480
the passion for building the telescope

1866
01:10:22,310 --> 01:10:20,560
some questions you want to answer

1867
01:10:25,270 --> 01:10:22,320
but there will be things we haven't even

1868
01:10:28,790 --> 01:10:25,280
imagined that this new observatory

1869
01:10:31,990 --> 01:10:28,800
will discover and will inform

1870
01:10:33,350 --> 01:10:32,000
you know our future questions okay grant

1871
01:10:35,350 --> 01:10:33,360
what's next

1872
01:10:36,470 --> 01:10:35,360
uh that segues us pretty well into

1873
01:10:39,350 --> 01:10:36,480
another one which

1874
01:10:40,310 --> 01:10:39,360
how much better is the detector on roman

1875
01:10:42,790 --> 01:10:40,320
going to be

1876
01:10:44,950 --> 01:10:42,800
at discovering exoplanets finding out

1877
01:10:48,709 --> 01:10:44,960
information about atmospheres that sort

1878
01:10:56,830 --> 01:10:51,910
so the um the detector on

1879
01:10:59,750 --> 01:10:56,840
um on roman

1880
01:11:02,550 --> 01:10:59,760
um its

1881
01:11:03,669 --> 01:11:02,560
main feature is that it's larger which

1882
01:11:07,270 --> 01:11:03,679
of course is not

1883
01:11:10,070 --> 01:11:07,280
you know not you know for any given spot

1884
01:11:11,350 --> 01:11:10,080
um it's not that much better it's got a

1885
01:11:14,470 --> 01:11:11,360
slightly

1886
01:11:17,590 --> 01:11:14,480
um finer pixelization

1887
01:11:18,070 --> 01:11:17,600
than the equivalent uh near ir detector

1888
01:11:22,229 --> 01:11:18,080

on

1889
01:11:24,550 --> 01:11:22,239
factor

1890
01:11:25,990 --> 01:11:24,560
the detectors themselves primary

1891
01:11:29,830 --> 01:11:26,000
difference is that

1892
01:11:32,950 --> 01:11:29,840
um our system is designed to be

1893
01:11:37,189 --> 01:11:32,960
very very well calibrated

1894
01:11:39,189 --> 01:11:37,199
so we have um an understanding

1895
01:11:40,870 --> 01:11:39,199
so it's not really a sensitivity issue

1896
01:11:44,229 --> 01:11:40,880
it's we have an understanding

1897
01:11:45,750 --> 01:11:44,239
of um uh how to

1898
01:11:48,630 --> 01:11:45,760
translate the light we see in the

1899
01:11:51,990 --> 01:11:48,640
detector to what we're seeing from the

1900
01:11:54,229 --> 01:11:52,000
star or the exoplanet and that we keep

1901
01:11:55,430 --> 01:11:54,239
that performance very very stable as a

1902
01:11:57,750 --> 01:11:55,440
function of time

1903
01:11:58,870 --> 01:11:57,760
which means that um our ability to

1904
01:12:01,510 --> 01:11:58,880
interpret

1905
01:12:02,310 --> 01:12:01,520
and measure very very precisely the

1906
01:12:05,510 --> 01:12:02,320
change

1907
01:12:08,790 --> 01:12:05,520
in star brightness as a function of uh

1908
01:12:12,310 --> 01:12:08,800
time to indicate the presence of

1909
01:12:15,590 --> 01:12:12,320
of planets is particularly good

1910
01:12:18,229 --> 01:12:15,600
okay that segues me into our

1911
01:12:18,870 --> 01:12:18,239
next question which one of the viewers

1912
01:12:21,590 --> 01:12:18,880
noticed

1913
01:12:22,229 --> 01:12:21,600

that the visibility bands in the

1914
01:12:25,990 --> 01:12:22,239
spectrum

1915
01:12:29,110 --> 01:12:26,000
overlap some hubble jwst

1916
01:12:31,030 --> 01:12:29,120
and uh nancy grace real men will

1917
01:12:32,630 --> 01:12:31,040
like there are areas where they overlap

1918
01:12:34,709 --> 01:12:32,640
what is the strength

1919
01:12:36,390 --> 01:12:34,719
behind that what is the reasoning behind

1920
01:12:37,430 --> 01:12:36,400
that i mean obviously more than one

1921
01:12:38,870 --> 01:12:37,440
source but

1922
01:12:41,990 --> 01:12:38,880
the audience would like a little more

1923
01:12:47,189 --> 01:12:44,870
well i can give one example of where i

1924
01:12:48,950 --> 01:12:47,199
think it's going to be

1925
01:12:50,470 --> 01:12:48,960
useful i mean of course on roman we're

1926
01:12:51,510 --> 01:12:50,480
following in the sort of hallowed

1927
01:12:55,110 --> 01:12:51,520
footsteps of

1928
01:12:56,709 --> 01:12:55,120
uh of hubble and um if we

1929
01:12:58,229 --> 01:12:56,719
uh one of the things that i think is

1930
01:13:01,350 --> 01:12:58,239
pretty particularly exciting

1931
01:13:04,550 --> 01:13:01,360
uh about having roman follow hubble

1932
01:13:08,070 --> 01:13:04,560
and have an overlap in the same waveband

1933
01:13:10,790 --> 01:13:08,080
range is that we can go and look

1934
01:13:11,350 --> 01:13:10,800
at the same things that hubble looked at

1935
01:13:13,669 --> 01:13:11,360
but

1936
01:13:15,830 --> 01:13:13,679
10 years 20 years after hubble made

1937
01:13:16,229 --> 01:13:15,840
those those observations so hubble can

1938
01:13:19,350 --> 01:13:16,239

help

1939
01:13:21,110 --> 01:13:19,360
provide us with a reference

1940
01:13:22,550 --> 01:13:21,120
against which we can compare our

1941
01:13:22,870 --> 01:13:22,560
observations so we don't have to do it

1942
01:13:25,189 --> 01:13:22,880
all

1943
01:13:26,709 --> 01:13:25,199
ourselves and that's very important if

1944
01:13:28,870 --> 01:13:26,719
we want to do something like measure

1945
01:13:30,310 --> 01:13:28,880
proper motion of stars where having a

1946
01:13:31,910 --> 01:13:30,320
long baseline

1947
01:13:33,590 --> 01:13:31,920
really is what's going to enable those

1948
01:13:36,070 --> 01:13:33,600
observations so

1949
01:13:37,430 --> 01:13:36,080
you know if at some point in the past uh

1950
01:13:40,470 --> 01:13:37,440
hubble has spent

1951
01:13:41,910 --> 01:13:40,480
a large amount of time doing a survey we

1952
01:13:45,270 --> 01:13:41,920
can redo that survey

1953
01:13:47,030 --> 01:13:45,280
uh very quickly but we can't leverage

1954
01:13:49,110 --> 01:13:47,040
anything like the benefit without having

1955
01:13:52,950 --> 01:13:49,120
that reference from uh from hubble to

1956
01:13:55,750 --> 01:13:52,960
compare our new observations against

1957
01:13:56,470 --> 01:13:55,760
and jennifer do you um anticipate seeing

1958
01:13:58,790 --> 01:13:56,480
uh compare

1959
01:14:00,229 --> 01:13:58,800
i mean we've talked a lot at least at

1960
01:14:00,709 --> 01:14:00,239
the space telescope science institute

1961
01:14:02,709 --> 01:14:00,719
doing

1962
01:14:03,990 --> 01:14:02,719
hubble versus web comparisons against

1963
01:14:05,430 --> 01:14:04,000

spitzer and everything

1964
01:14:07,270 --> 01:14:05,440
there's multi-wavelengths astronomy that

1965
01:14:08,070 --> 01:14:07,280
both of you said were critical to your

1966
01:14:09,669 --> 01:14:08,080
research

1967
01:14:11,750 --> 01:14:09,679
and how do you envision that going

1968
01:14:15,270 --> 01:14:11,760
forward oh it's going to be

1969
01:14:17,510 --> 01:14:15,280
fantastic in terms of what this offers

1970
01:14:17,990 --> 01:14:17,520
so of course you want overlap in some of

1971
01:14:20,310 --> 01:14:18,000
these

1972
01:14:21,990 --> 01:14:20,320
wavelengths of light so you can kind of

1973
01:14:25,270 --> 01:14:22,000
cross correlate to make sure

1974
01:14:27,750 --> 01:14:25,280
and cross calibrate as well and as

1975
01:14:28,709 --> 01:14:27,760
as as julie mentioned you know hubble

1976
01:14:30,550 --> 01:14:28,719
gives you this long

1977
01:14:32,470 --> 01:14:30,560
time baseline which kind of helps

1978
01:14:33,270 --> 01:14:32,480
compare what the new observations will

1979
01:14:35,830 --> 01:14:33,280
give us

1980
01:14:36,630 --> 01:14:35,840
but hubble also gives the complementary

1981
01:14:38,950 --> 01:14:36,640
wavelengths

1982
01:14:39,990 --> 01:14:38,960
let's say ultraviolet light observations

1983
01:14:43,750 --> 01:14:40,000
that neither web

1984
01:14:44,390 --> 01:14:43,760
nor roman can achieve and so you can

1985
01:14:47,030 --> 01:14:44,400
then

1986
01:14:47,830 --> 01:14:47,040
get this wonderful a collection of

1987
01:14:49,270 --> 01:14:47,840
information

1988
01:14:51,189 --> 01:14:49,280

let's say when you're looking at

1989
01:14:52,950 --> 01:14:51,199
exoplanets

1990
01:14:55,189 --> 01:14:52,960
hubble can tell us things about the

1991
01:14:56,709 --> 01:14:55,199
atmospheres of exoplanets that you can

1992
01:14:59,030 --> 01:14:56,719
only detect

1993
01:15:00,709 --> 01:14:59,040
in ultraviolet light and that gives you

1994
01:15:02,229 --> 01:15:00,719
a piece of information

1995
01:15:04,310 --> 01:15:02,239
that you can connect with the

1996
01:15:06,229 --> 01:15:04,320
information that let's say only the web

1997
01:15:09,030 --> 01:15:06,239
telescope can get out in the

1998
01:15:10,229 --> 01:15:09,040
deeper realms of the infrared part of

1999
01:15:11,910 --> 01:15:10,239
the spectrum

2000
01:15:15,030 --> 01:15:11,920
and gives you a more complete

2001
01:15:17,350 --> 01:15:15,040
understanding of the composition of that

2002
01:15:18,950 --> 01:15:17,360
spectrum and meanwhile you've got roman

2003
01:15:21,350 --> 01:15:18,960
actually detecting

2004
01:15:23,590 --> 01:15:21,360
a lot more sources for us to look at and

2005
01:15:26,229 --> 01:15:23,600
giving us a lot of information i mean

2006
01:15:28,149 --> 01:15:26,239
hubble's wonderful at following up and

2007
01:15:30,390 --> 01:15:28,159
looking in great detail at some

2008
01:15:31,750 --> 01:15:30,400
particular source but hubble is

2009
01:15:33,510 --> 01:15:31,760
i don't want to use the word terrible

2010
01:15:36,630 --> 01:15:33,520
but hubble is less

2011
01:15:38,149 --> 01:15:36,640
adept at surveying the sky to find out

2012
01:15:42,070 --> 01:15:38,159
what's going on in

2013
01:15:43,350 --> 01:15:42,080

wide areas of the sky so we're excited

2014
01:15:46,229 --> 01:15:43,360
about the fact that

2015
01:15:46,790 --> 01:15:46,239
this roman telescope will be able to

2016
01:15:50,390 --> 01:15:46,800
find

2017
01:15:52,630 --> 01:15:50,400
things going on in all parts of the sky

2018
01:15:53,430 --> 01:15:52,640
quickly and efficiently and then we can

2019
01:15:56,229 --> 01:15:53,440
hone in

2020
01:15:58,149 --> 01:15:56,239
on with hubble on the details of very

2021
01:16:00,149 --> 01:15:58,159
interesting objects and sources

2022
01:16:01,669 --> 01:16:00,159
and look in the wavelength ranges that

2023
01:16:02,950 --> 01:16:01,679
only hubble can achieve

2024
01:16:04,709 --> 01:16:02,960
to complement what these other

2025
01:16:07,350 --> 01:16:04,719
observatories are

2026
01:16:09,590 --> 01:16:07,360
are finding as well i mean i could say

2027
01:16:13,189 --> 01:16:09,600
this this suite of space telescopes

2028
01:16:16,870 --> 01:16:13,199
would be you know quite the dream of uh

2029
01:16:19,430 --> 01:16:16,880
nancy grace roman back in the 60s

2030
01:16:19,990 --> 01:16:19,440
all right one last question all right

2031
01:16:22,390 --> 01:16:20,000
i'm gonna end

2032
01:16:23,030 --> 01:16:22,400
it on this because i love i love this

2033
01:16:24,790 --> 01:16:23,040
question

2034
01:16:28,390 --> 01:16:24,800
i like your shirt by the way grant

2035
01:16:32,630 --> 01:16:30,950
um if you are needing computer science

2036
01:16:34,470 --> 01:16:32,640
majors in the near future

2037
01:16:35,910 --> 01:16:34,480
what would you encourage encourage

2038
01:16:38,550 --> 01:16:35,920

current students or

2039
01:16:40,070 --> 01:16:38,560
people who are interested in stem to

2040
01:16:42,229 --> 01:16:40,080
look into or to go into

2041
01:16:43,990 --> 01:16:42,239
so they can realistically focus on a

2042
01:16:45,350 --> 01:16:44,000
career doing the kinds of things that

2043
01:16:47,510 --> 01:16:45,360
you do

2044
01:16:49,990 --> 01:16:47,520
or to support the projects that we have

2045
01:16:52,790 --> 01:16:50,000
going that are so amazing

2046
01:16:54,390 --> 01:16:52,800
sure well i'm gonna quickly hand this

2047
01:16:55,430 --> 01:16:54,400
over to the others because i'm not a

2048
01:16:58,630 --> 01:16:55,440
computer

2049
01:17:02,790 --> 01:16:58,640
scientist myself but um but i know

2050
01:17:04,630 --> 01:17:02,800
that we rely on uh people not only

2051
01:17:05,830 --> 01:17:04,640
developing computer hardware but

2052
01:17:08,709 --> 01:17:05,840
developing computer

2053
01:17:11,270 --> 01:17:08,719
software to handle everything from

2054
01:17:13,510 --> 01:17:11,280
controlling the observatory

2055
01:17:14,790 --> 01:17:13,520
you know processing commands things of

2056
01:17:18,149 --> 01:17:14,800
that nature

2057
01:17:18,790 --> 01:17:18,159
to handling these very large data sets

2058
01:17:22,070 --> 01:17:18,800
and the

2059
01:17:24,070 --> 01:17:22,080
image processing the data processing is

2060
01:17:25,270 --> 01:17:24,080
particularly important as well as

2061
01:17:27,669 --> 01:17:25,280
archiving

2062
01:17:28,390 --> 01:17:27,679
i mean we have and as was discussed

2063
01:17:31,510 --> 01:17:28,400

earlier

2064
01:17:32,390 --> 01:17:31,520
we have a big archiving challenge coming

2065
01:17:35,430 --> 01:17:32,400
up and hubble

2066
01:17:35,750 --> 01:17:35,440
already has a marvelous archive as well

2067
01:17:39,430 --> 01:17:35,760
as

2068
01:17:41,270 --> 01:17:39,440
the

2069
01:17:43,430 --> 01:17:41,280
professional papers coming out now that

2070
01:17:45,590 --> 01:17:43,440
are based on hubble data are based on

2071
01:17:47,350 --> 01:17:45,600
scientists looking into the archive of

2072
01:17:48,229 --> 01:17:47,360
data that's already been collected by

2073
01:17:51,350 --> 01:17:48,239
hubble

2074
01:17:54,149 --> 01:17:51,360
and effectively being able to glean

2075
01:17:55,830 --> 01:17:54,159
to use that data so we need computer

2076
01:17:58,229 --> 01:17:55,840
specialists who can build both the

2077
01:17:59,830 --> 01:17:58,239
hardware and the software to enable all

2078
01:18:01,669 --> 01:17:59,840
of these things but i don't know if

2079
01:18:03,590 --> 01:18:01,679
julie you want to be more specific about

2080
01:18:05,510 --> 01:18:03,600
what you think is going to be needed

2081
01:18:08,310 --> 01:18:05,520
i will interject here for a minute

2082
01:18:11,110 --> 01:18:08,320
because that's a common misconception

2083
01:18:13,430 --> 01:18:11,120
about working where we do or being

2084
01:18:16,149 --> 01:18:13,440
involved in the sort of things we do

2085
01:18:16,950 --> 01:18:16,159
you do not have to be a computer science

2086
01:18:19,669 --> 01:18:16,960
major to do

2087
01:18:20,709 --> 01:18:19,679
amazing things and like help nasa's

2088
01:18:23,270 --> 01:18:20,719

mission along

2089
01:18:24,870 --> 01:18:23,280
like frank and i work for the public the

2090
01:18:26,630 --> 01:18:24,880
office of public outreach

2091
01:18:28,470 --> 01:18:26,640
obviously frank is hilariously more

2092
01:18:31,430 --> 01:18:28,480
qualified than i am

2093
01:18:32,630 --> 01:18:31,440
but we can still take a lot of these

2094
01:18:34,709 --> 01:18:32,640
things and

2095
01:18:36,790 --> 01:18:34,719
put them in ways to get them out to the

2096
01:18:37,510 --> 01:18:36,800
public to do these sorts of lectures

2097
01:18:40,870 --> 01:18:37,520
like you

2098
01:18:43,990 --> 01:18:40,880
you do not have to be nancy grace roman

2099
01:18:46,149 --> 01:18:44,000
to do amazing things in astronomy

2100
01:18:47,590 --> 01:18:46,159
you don't there are many ways in many

2101
01:18:50,470 --> 01:18:47,600
fields you can get in there

2102
01:18:52,870 --> 01:18:50,480
and actually be a part of what we do

2103
01:18:55,990 --> 01:18:52,880
sorry i just wanted to interject that

2104
01:18:57,590 --> 01:18:56,000
thanks so i think there's two um there's

2105
01:18:58,310 --> 01:18:57,600
two ways to answer your question the

2106
01:19:01,590 --> 01:18:58,320
first is

2107
01:19:04,070 --> 01:19:01,600
um if you're um a high school student

2108
01:19:05,110 --> 01:19:04,080
and trying to decide you know how do i

2109
01:19:07,430 --> 01:19:05,120
get involved in

2110
01:19:09,110 --> 01:19:07,440
all of this um i would suggest don't

2111
01:19:12,709 --> 01:19:09,120
stress too much about it

2112
01:19:15,910 --> 01:19:12,719
um go into um any kind of stem

2113
01:19:19,189 --> 01:19:15,920

uh topic and it's almost always possible

2114
01:19:22,470 --> 01:19:19,199
um to uh to um

2115
01:19:25,030 --> 01:19:22,480
nudge your career in the direction of

2116
01:19:26,790 --> 01:19:25,040
of uh astronomy and astrophysics if

2117
01:19:29,750 --> 01:19:26,800
you're starting off with the basis

2118
01:19:30,550 --> 01:19:29,760
of physics or chemistry or or

2119
01:19:33,510 --> 01:19:30,560
mathematics

2120
01:19:34,470 --> 01:19:33,520
or computer science um i think that the

2121
01:19:37,910 --> 01:19:34,480
importance

2122
01:19:38,550 --> 01:19:37,920
of all aspects of computer science is

2123
01:19:41,750 --> 01:19:38,560
going to

2124
01:19:44,149 --> 01:19:41,760
part

2125
01:19:45,669 --> 01:19:44,159
because i think some of the one of the

2126
01:19:46,149 --> 01:19:45,679
frontiers where i think we're going to

2127
01:19:47,750 --> 01:19:46,159
see

2128
01:19:49,430 --> 01:19:47,760
some of the greatest insights and some

2129
01:19:52,070 --> 01:19:49,440
of the greatest leaps forward

2130
01:19:53,750 --> 01:19:52,080
or where people can use artificial

2131
01:19:55,750 --> 01:19:53,760
intelligence and machine learning to

2132
01:19:56,229 --> 01:19:55,760
have the computers do the thinking for

2133
01:20:00,070 --> 01:19:56,239
you

2134
01:20:01,030 --> 01:20:00,080
but we're heading towards a a volume of

2135
01:20:02,470 --> 01:20:01,040
data

2136
01:20:04,470 --> 01:20:02,480
a fraction of the universe that we're

2137
01:20:07,510 --> 01:20:04,480
looking at with a frequency

2138
01:20:09,430 --> 01:20:07,520

that is really beyond the scale for any

2139
01:20:11,750 --> 01:20:09,440
individual person to look at

2140
01:20:12,629 --> 01:20:11,760
and identify interesting things we have

2141
01:20:15,669 --> 01:20:12,639
to make

2142
01:20:19,110 --> 01:20:15,679
the computers do the thinking um for us

2143
01:20:21,910 --> 01:20:19,120
um so i think that um there's enormous

2144
01:20:22,790 --> 01:20:21,920
opportunity to leverage um the

2145
01:20:24,709 --> 01:20:22,800
developments

2146
01:20:27,189 --> 01:20:24,719
in artificial intelligence and machine

2147
01:20:31,110 --> 01:20:27,199
learning that is informing how netflix

2148
01:20:34,629 --> 01:20:31,120
picks which movie to offer me

2149
01:20:36,149 --> 01:20:34,639
um to instead tell me um this is the set

2150
01:20:37,110 --> 01:20:36,159
of galaxies that you're going to be

2151
01:20:39,270 --> 01:20:37,120
interested in or

2152
01:20:40,550 --> 01:20:39,280
this is something unusual go and have a

2153
01:20:43,030 --> 01:20:40,560
go and have a

2154
01:20:44,709 --> 01:20:43,040
have a look so i think that um you know

2155
01:20:46,629 --> 01:20:44,719
you've touched on what i think

2156
01:20:47,990 --> 01:20:46,639
could be one of the other revolutions

2157
01:20:50,950 --> 01:20:48,000
that we see in the next

2158
01:20:52,310 --> 01:20:50,960
um uh in the next decade you know

2159
01:20:53,990 --> 01:20:52,320
there's access to the data and

2160
01:20:55,430 --> 01:20:54,000
centralized access to the data but i

2161
01:20:56,390 --> 01:20:55,440
think there's also going to be

2162
01:21:00,070 --> 01:20:56,400
leveraging

2163
01:21:02,470 --> 01:21:00,080

computers as our partners in um

2164
01:21:03,990 --> 01:21:02,480
in finding interest in discovery in the

2165
01:21:05,270 --> 01:21:04,000
data in a way that we just haven't done

2166
01:21:07,030 --> 01:21:05,280
before

2167
01:21:08,550 --> 01:21:07,040
thank you that's uh extremely important

2168
01:21:11,750 --> 01:21:08,560
that machine learning is

2169
01:21:12,229 --> 01:21:11,760
growing by leaps and bounds and it will

2170
01:21:14,390 --> 01:21:12,239
become

2171
01:21:15,590 --> 01:21:14,400
more and more important in science as we

2172
01:21:18,310 --> 01:21:15,600
go forward

2173
01:21:18,629 --> 01:21:18,320
all right so that is it for today i want

2174
01:21:21,189 --> 01:21:18,639
to

2175
01:21:22,870 --> 01:21:21,199
thank you all for these wonderful talks

2176
01:21:25,830 --> 01:21:22,880
i want to remind everybody

2177
01:21:26,709 --> 01:21:25,840
that on november 10th not november 3rd

2178
01:21:28,870 --> 01:21:26,719
on november 3rd

2179
01:21:30,950 --> 01:21:28,880
go out and vote i don't care who you

2180
01:21:32,149 --> 01:21:30,960
vote for just get out and do your civic

2181
01:21:34,390 --> 01:21:32,159
duty and vote

2182
01:21:35,270 --> 01:21:34,400
but on november 10th after the voting's

2183
01:21:37,669 --> 01:21:35,280
all over

2184
01:21:38,310 --> 01:21:37,679
and maybe we have have a result we don't

2185
01:21:41,430 --> 01:21:38,320
know

2186
01:21:43,830 --> 01:21:41,440
on november 10th come here again and we

2187
01:21:44,709 --> 01:21:43,840
will hear from uh scott fleming clara

2188
01:21:46,790 --> 01:21:44,719

brasser

2189
01:21:47,910 --> 01:21:46,800
and jennifer cutler talking about

2190
01:21:50,790 --> 01:21:47,920
hearing the light

2191
01:21:51,350 --> 01:21:50,800
sonification of astronomy data ways to

2192
01:21:55,030 --> 01:21:51,360
get ad

2193
01:21:56,790 --> 01:21:55,040
data by listening to it that will be fun

2194
01:21:59,430 --> 01:21:56,800
and we'll see you then thank you