PUBLIC LECTURE SERIES

The Importance of Small Objects: Exocomets

Featuring Guest Speaker:
Isabel Rebollido

1
00:00:05,749 --> 00:00:03,030
welcome everybody to

2
00:00:07,030 --> 00:00:05,759
the august space telescope public

3
00:00:08,870 --> 00:00:07,040
lecture series

4
00:00:11,830 --> 00:00:08,880
we have an exciting talk today on the

5
00:00:15,030 --> 00:00:11,840
importance of small objects exo-comets

6
00:00:16,950 --> 00:00:15,040
by dr isabel rebellito from the space

7
00:00:19,750 --> 00:00:16,960
telescope science institute

8
00:00:20,950 --> 00:00:19,760
um before we get into her presentation i

9
00:00:23,990 --> 00:00:20,960
wanted to go over

10
00:00:27,029 --> 00:00:24,000
a few things here so

11
00:00:29,990 --> 00:00:27,039
first uh who am i

12
00:00:30,870 --> 00:00:30,000
your normal host is not here this month

13
00:00:33,350 --> 00:00:30,880

uh i am

14
00:00:34,950 --> 00:00:33,360
uh dr brandon lawton i am an astronomer

15
00:00:37,030 --> 00:00:34,960
in the office of public outreach i

16
00:00:39,110 --> 00:00:37,040
am colleagues with frank summers who

17
00:00:41,510 --> 00:00:39,120
normally does this hosting job

18
00:00:42,709 --> 00:00:41,520
but frank is enjoying himself this month

19
00:00:45,190 --> 00:00:42,719
somewhere

20
00:00:46,549 --> 00:00:45,200
and secluded place where he doesn't have

21
00:00:50,069 --> 00:00:46,559
secure internet so

22
00:00:52,950 --> 00:00:50,079
i am uh happily your host this month

23
00:00:53,590 --> 00:00:52,960
um and we also of course have coming

24
00:00:55,189 --> 00:00:53,600
back

25
00:00:57,590 --> 00:00:55,199
every month our special thanks to our

26
00:00:58,709 --> 00:00:57,600
amazing tech team uh thomas marufu and

27
00:01:00,630 --> 00:00:58,719
grant justice

28
00:01:03,990 --> 00:01:00,640
who are making sure that everything runs

29
00:01:07,030 --> 00:01:06,310
all right um just some previews for

30
00:01:10,070 --> 00:01:07,040
upcoming

31
00:01:12,390 --> 00:01:10,080
public lecture series in september we

32
00:01:14,149 --> 00:01:12,400
have a very provocative title astrology

33
00:01:14,950 --> 00:01:14,159
versus astronomy what's the difference

34
00:01:18,070 --> 00:01:14,960
really

35
00:01:19,590 --> 00:01:18,080
uh by nicole uh rulanatham

36
00:01:21,590 --> 00:01:19,600
from the space telescope science

37
00:01:22,950 --> 00:01:21,600
institute she is a postdoctoral

38
00:01:25,749 --> 00:01:22,960

researcher here

39
00:01:29,350 --> 00:01:25,759
in october we have how dark is space by

40
00:01:32,390 --> 00:01:29,360
todd lauer from the nsf and noir lab

41
00:01:33,590 --> 00:01:32,400
so i encourage you all to watch the next

42
00:01:37,749 --> 00:01:33,600
several

43
00:01:41,670 --> 00:01:40,710
as a reminder you can find our public

44
00:01:44,789 --> 00:01:41,680
lecture series

45
00:01:47,429 --> 00:01:44,799
on our website the sdsci.edu

46
00:01:48,230 --> 00:01:47,439
public lectures if you go there you'll

47
00:01:50,149 --> 00:01:48,240
find

48
00:01:52,230 --> 00:01:50,159
webcasts are on the left there you'll

49
00:01:54,630 --> 00:01:52,240
see that you can find the webcasts

50
00:01:56,870 --> 00:01:54,640
on the youtube playlist webcast archive

51
00:01:58,789 --> 00:01:56,880
um you can also sign up to get emails

52
00:02:00,550 --> 00:01:58,799
for announcements lecture announcements

53
00:02:04,389 --> 00:02:00,560
on who is going to be um

54
00:02:08,150 --> 00:02:05,910
uh if you scroll down on that page

55
00:02:08,949 --> 00:02:08,160
you'll notice that we have listed the

56
00:02:10,790 --> 00:02:08,959
upcoming

57
00:02:12,070 --> 00:02:10,800
public lecture series which i just

58
00:02:13,510 --> 00:02:12,080
mentioned to you all in the previous

59
00:02:16,150 --> 00:02:13,520
slide

60
00:02:17,750 --> 00:02:16,160
um and so if you click on one and so for

61
00:02:18,949 --> 00:02:17,760
in fact if you look you also notice at

62
00:02:20,550 --> 00:02:18,959
the bottom there's past

63
00:02:22,550 --> 00:02:20,560

public lecture series so if you click on

64
00:02:24,550 --> 00:02:22,560
that past one from july the armchair

65
00:02:26,790 --> 00:02:24,560
astrophysics volume 2

66
00:02:28,470 --> 00:02:26,800
and up pops up information on that

67
00:02:30,390 --> 00:02:28,480
public lecture

68
00:02:32,309 --> 00:02:30,400
you'll notice that you can access the

69
00:02:35,750 --> 00:02:32,319
public lecture after this date

70
00:02:39,589 --> 00:02:35,760
via the sdsci webcast at the top or

71
00:02:43,030 --> 00:02:41,509
and again if you want to get more

72
00:02:44,630 --> 00:02:43,040
information you can sign up at the

73
00:02:47,110 --> 00:02:44,640
website for announcements

74
00:02:47,670 --> 00:02:47,120
you can subscribe to our youtube channel

75
00:02:51,030 --> 00:02:47,680
which is

76
00:02:52,550 --> 00:02:51,040
youtube.com hubble space telescope

77
00:02:54,790 --> 00:02:52,560
you'll get new videos and notices and

78
00:02:56,550 --> 00:02:54,800
reminders of live events there

79
00:02:58,630 --> 00:02:56,560
if you have comments or questions you

80
00:03:04,630 --> 00:02:58,640
can please send them in to public

81
00:03:06,309 --> 00:03:04,640
lecture at sdsci.edu

82
00:03:07,670 --> 00:03:06,319
of course please follow us on social

83
00:03:10,309 --> 00:03:07,680
media we have

84
00:03:12,070 --> 00:03:10,319
um there are many stsci and nasa social

85
00:03:14,390 --> 00:03:12,080
media accounts that cover very

86
00:03:16,390 --> 00:03:14,400
our various missions that we work with

87
00:03:18,309 --> 00:03:16,400
um including hubble web roman

88
00:03:19,750 --> 00:03:18,319

and of course our space telescope

89
00:03:22,149 --> 00:03:19,760
science institute accounts

90
00:03:23,350 --> 00:03:22,159
um i've listed them there and you can so

91
00:03:25,350 --> 00:03:23,360
you can find them

92
00:03:27,750 --> 00:03:25,360
i won't keep this slide up for too long

93
00:03:28,789 --> 00:03:27,760
but if you don't jot them down here and

94
00:03:31,830 --> 00:03:28,799
you want to look back

95
00:03:32,789 --> 00:03:31,840
by all means go back to this recording

96
00:03:34,550 --> 00:03:32,799
and you can find

97
00:03:36,229 --> 00:03:34,560
our accounts or you can search for them

98
00:03:40,789 --> 00:03:36,239
on facebook twitter youtube and

99
00:03:44,149 --> 00:03:42,630
okay so this is the part of the

100
00:03:45,990 --> 00:03:44,159
presentation where frank would usually

101
00:03:47,430 --> 00:03:46,000
do a news from the universe and i'm

102
00:03:48,309 --> 00:03:47,440
going to sort of put that on its head a

103
00:03:50,070 --> 00:03:48,319
little bit

104
00:03:51,670 --> 00:03:50,080
i'm going to do news from the earth and

105
00:03:54,229 --> 00:03:51,680
what i mean by that is i'm going to

106
00:03:56,390 --> 00:03:54,239
give you some brief updates um before

107
00:03:59,429 --> 00:03:56,400
our featured presenter on

108
00:04:02,869 --> 00:03:59,439
uh three big nasa missions that have had

109
00:04:03,750 --> 00:04:02,879
some great uh some great updates and

110
00:04:06,229 --> 00:04:03,760
events

111
00:04:08,630 --> 00:04:06,239
that happen over the last month and i'll

112
00:04:12,070 --> 00:04:08,640
start by showing you this slide here

113
00:04:12,869 --> 00:04:12,080

which is a slide of nasa flagship

114
00:04:15,429 --> 00:04:12,879
missions

115
00:04:16,390 --> 00:04:15,439
that have come out of what's called the

116
00:04:21,670 --> 00:04:16,400
decadal

117
00:04:23,909 --> 00:04:21,680
by astrophysicists in the united states

118
00:04:24,870 --> 00:04:23,919
that is done every 10 years that

119
00:04:27,590 --> 00:04:24,880
outlines

120
00:04:27,990 --> 00:04:27,600
the astronomy or astrophysics priorities

121
00:04:31,670 --> 00:04:28,000
that

122
00:04:34,310 --> 00:04:31,680
decade

123
00:04:36,469 --> 00:04:34,320
and based off of those provide

124
00:04:37,670 --> 00:04:36,479
recommendations for the type of mission

125
00:04:40,629 --> 00:04:37,680
that should launch

126
00:04:42,550 --> 00:04:40,639
and these are the outcomes of those

127
00:04:45,430 --> 00:04:42,560
previous decadal studies

128
00:04:48,070 --> 00:04:45,440
um that have been funded uh so of course

129
00:04:50,390 --> 00:04:48,080
you see hubble was the first in 1990

130
00:04:51,749 --> 00:04:50,400
and then the chandra x-ray observatory

131
00:04:54,469 --> 00:04:51,759
and then there's spitzer

132
00:04:56,150 --> 00:04:54,479
and webb is launching in later this year

133
00:04:57,909 --> 00:04:56,160
and then the nancy grace roman space

134
00:05:01,110 --> 00:04:57,919
telescope

135
00:05:03,350 --> 00:05:01,120
know

136
00:05:04,710 --> 00:05:03,360
follow a planned follow these planned

137
00:05:06,469 --> 00:05:04,720
studies and they're they're launched for

138
00:05:08,230 --> 00:05:06,479

very specific reasons and very specific

139
00:05:11,350 --> 00:05:08,240
science goals but they're also

140
00:05:13,990 --> 00:05:11,360
general observatories and they study um

141
00:05:15,270 --> 00:05:14,000
astrophysics broadly in very specific

142
00:05:17,189 --> 00:05:15,280
wavelength ranges

143
00:05:18,550 --> 00:05:17,199
and with very specific instruments and

144
00:05:19,990 --> 00:05:18,560
capabilities

145
00:05:21,909 --> 00:05:20,000
but what i want to do today is i want to

146
00:05:25,350 --> 00:05:21,919
give updates on three of these

147
00:05:28,790 --> 00:05:25,360
um hubble webb and roman

148
00:05:31,670 --> 00:05:28,800
so we'll start with hubble so hubble

149
00:05:32,870 --> 00:05:31,680
good news it's back to science so if you

150
00:05:35,670 --> 00:05:32,880
attended last month

151
00:05:37,590 --> 00:05:35,680
frank gave an update on some problems

152
00:05:40,070 --> 00:05:37,600
that uh that hubble had it entered a

153
00:05:42,710 --> 00:05:40,080
safe mode on june 13th

154
00:05:44,950 --> 00:05:42,720
um and what happened on june 13th was

155
00:05:46,950 --> 00:05:44,960
that hubble's payload computer halted

156
00:05:48,070 --> 00:05:46,960
and the payload computer controls and

157
00:05:50,150 --> 00:05:48,080
coordinates

158
00:05:51,590 --> 00:05:50,160
the observatory's onboard science

159
00:05:52,070 --> 00:05:51,600
instruments there's multiple science

160
00:05:55,189 --> 00:05:52,080
instruments

161
00:05:57,270 --> 00:05:55,199
on hubble and the payload the paler the

162
00:05:59,749 --> 00:05:57,280
payload computer halted

163
00:06:01,189 --> 00:05:59,759

and uh the main computer failed to

164
00:06:02,150 --> 00:06:01,199
receive a signal from the payload

165
00:06:04,629 --> 00:06:02,160
computer

166
00:06:06,790 --> 00:06:04,639
and the that all resides in what's this

167
00:06:08,469 --> 00:06:06,800
complicated um thing called the science

168
00:06:09,189 --> 00:06:08,479
instrument command and data handling

169
00:06:11,350 --> 00:06:09,199
unit

170
00:06:13,830 --> 00:06:11,360
which is a very interesting um acronym

171
00:06:15,749 --> 00:06:13,840
there but it that automatically placed

172
00:06:17,830 --> 00:06:15,759
hubble science instruments into a safe

173
00:06:21,029 --> 00:06:17,840
mode to protect them

174
00:06:24,070 --> 00:06:21,039
and then from that um what happened was

175
00:06:25,510 --> 00:06:24,080
many engineers and scientists from many

176
00:06:27,749 --> 00:06:25,520
places including goddard and the space

177
00:06:29,350 --> 00:06:27,759
telescope science institute got together

178
00:06:31,029 --> 00:06:29,360
to study this event and to try to

179
00:06:31,990 --> 00:06:31,039
understand what was causing it and what

180
00:06:34,710 --> 00:06:32,000
happened

181
00:06:35,990 --> 00:06:34,720
um you can see on the right at the top a

182
00:06:37,990 --> 00:06:36,000
picture of

183
00:06:39,510 --> 00:06:38,000
the science instrument command and data

184
00:06:42,629 --> 00:06:39,520
handling unit

185
00:06:45,430 --> 00:06:42,639
of which um of which the

186
00:06:46,629 --> 00:06:45,440
payload computer is part of and in the

187
00:06:48,870 --> 00:06:46,639
middle there you see

188
00:06:50,710 --> 00:06:48,880

um various folks at nasa's goddard space

189
00:06:52,550 --> 00:06:50,720
flight center working to resolve this

190
00:06:54,950 --> 00:06:52,560
issue

191
00:06:55,830 --> 00:06:54,960
and on july 14th nasa identified a

192
00:06:57,909 --> 00:06:55,840
possible cause

193
00:06:59,909 --> 00:06:57,919
the inter the information gathered after

194
00:07:02,150 --> 00:06:59,919
a series of multi-day tests

195
00:07:03,990 --> 00:07:02,160
led the hubble team to determine that

196
00:07:06,390 --> 00:07:04,000
the possible cause of the problem was

197
00:07:07,189 --> 00:07:06,400
in what's called the power control unit

198
00:07:11,270 --> 00:07:07,199
which resides

199
00:07:13,270 --> 00:07:11,280
the science instrument command and data

200
00:07:16,390 --> 00:07:13,280
handling unit

201
00:07:18,629 --> 00:07:16,400
and based off of their tests um the

202
00:07:21,029 --> 00:07:18,639
the fix was to switch to backup hardware

203
00:07:24,469 --> 00:07:21,039
and so on july 15th they switched to

204
00:07:25,749 --> 00:07:24,479
a backup power control unit backup

205
00:07:28,070 --> 00:07:25,759
science instrument command and data

206
00:07:30,230 --> 00:07:28,080
handling unit um and then

207
00:07:32,469 --> 00:07:30,240
that was successful and starting july

208
00:07:34,309 --> 00:07:32,479
17th science observations restarted

209
00:07:35,830 --> 00:07:34,319
and the first science observat some of

210
00:07:36,629 --> 00:07:35,840
the first science observations that were

211
00:07:38,469 --> 00:07:36,639
done

212
00:07:39,990 --> 00:07:38,479
you can see in the lower right there the

213
00:07:41,749 --> 00:07:40,000

the black and white um

214
00:07:44,390 --> 00:07:41,759
images there but you can see some

215
00:07:46,710 --> 00:07:44,400
interesting images of galaxies from

216
00:07:48,150 --> 00:07:46,720
a program led by julian del canton at

217
00:07:50,150 --> 00:07:48,160
the university of washington

218
00:07:51,670 --> 00:07:50,160
so that let us know that things were

219
00:07:52,550 --> 00:07:51,680
back in business and things were working

220
00:07:53,749 --> 00:07:52,560
properly

221
00:07:55,990 --> 00:07:53,759
of course this isn't the end of the

222
00:07:59,189 --> 00:07:56,000
story this was a long

223
00:08:01,510 --> 00:07:59,199
roughly month long hiatus on science um

224
00:08:02,710 --> 00:08:01,520
but the the teams are still going to be

225
00:08:04,950 --> 00:08:02,720
you know exploring

226
00:08:05,990 --> 00:08:04,960
further the cause and and and what they

227
00:08:08,309 --> 00:08:06,000
can do um

228
00:08:10,309 --> 00:08:08,319
going forward um but everything's

229
00:08:13,270 --> 00:08:10,319
working now on the on the backup

230
00:08:15,189 --> 00:08:13,280
system and science is back and or hubble

231
00:08:18,950 --> 00:08:15,199
science is back in business

232
00:08:23,510 --> 00:08:21,029
um the james webb space telescope is

233
00:08:26,230 --> 00:08:23,520
continuing to prepare for launch

234
00:08:27,670 --> 00:08:26,240
so testing progress continues there are

235
00:08:29,029 --> 00:08:27,680
three big things that's happened in the

236
00:08:30,950 --> 00:08:29,039
last month or so

237
00:08:32,790 --> 00:08:30,960
one the deployable tower assembly

238
00:08:34,709 --> 00:08:32,800

testing has been completed

239
00:08:35,829 --> 00:08:34,719
the tower was fully extended for the

240
00:08:37,990 --> 00:08:35,839
last time just it was

241
00:08:39,589 --> 00:08:38,000
as it will do in space and testing teams

242
00:08:40,790 --> 00:08:39,599
then lowered the tower and locked it

243
00:08:43,829 --> 00:08:40,800
into place

244
00:08:45,509 --> 00:08:43,839
to prepare for launch now

245
00:08:47,509 --> 00:08:45,519
from this top right image here it might

246
00:08:48,949 --> 00:08:47,519
be hard to see but the the deployable

247
00:08:51,430 --> 00:08:48,959
tower assembly unit

248
00:08:52,310 --> 00:08:51,440
assembly unit here is essentially the

249
00:08:54,790 --> 00:08:52,320
piece that

250
00:08:56,470 --> 00:08:54,800
connects the main mirror to the rest of

251
00:08:59,030 --> 00:08:56,480
the structure down here that includes

252
00:09:00,790 --> 00:08:59,040
the sun shield and so after launch

253
00:09:02,230 --> 00:09:00,800
right everything is going to unfold and

254
00:09:03,750 --> 00:09:02,240
the main mirror is actually going to

255
00:09:05,269 --> 00:09:03,760
lift away

256
00:09:06,870 --> 00:09:05,279
from the rest of that structure it going

257
00:09:09,829 --> 00:09:06,880
to lift up so that it

258
00:09:11,910 --> 00:09:09,839
there's a separation between the mirror

259
00:09:14,310 --> 00:09:11,920
and the rest of that structure so it can

260
00:09:15,269 --> 00:09:14,320
passively cool and get cold in space so

261
00:09:19,910 --> 00:09:15,279
that all worked

262
00:09:22,470 --> 00:09:19,920
subsystem was

263
00:09:24,230 --> 00:09:22,480

cover was removed um basically if you're

264
00:09:24,870 --> 00:09:24,240
going to take images of space it's good

265
00:09:27,430 --> 00:09:24,880
to

266
00:09:29,110 --> 00:09:27,440
remove uh you know like on your camera

267
00:09:30,630 --> 00:09:29,120
remove your lens cover that's basically

268
00:09:31,590 --> 00:09:30,640
equivalent to what this was they removed

269
00:09:33,670 --> 00:09:31,600
the cover

270
00:09:36,150 --> 00:09:33,680
uh the web so-called lens cap has been

271
00:09:37,590 --> 00:09:36,160
removed in preparation for launch um so

272
00:09:39,829 --> 00:09:37,600
that's great news

273
00:09:41,590 --> 00:09:39,839
and then the unitized palette structure

274
00:09:43,829 --> 00:09:41,600
um was stowed for launch

275
00:09:45,910 --> 00:09:43,839
um so engineers folded the pallets in

276
00:09:47,269 --> 00:09:45,920
preparation for launch

277
00:09:49,190 --> 00:09:47,279
and the unitized pallet structure are

278
00:09:50,710 --> 00:09:49,200
part of web's complex folding mechanism

279
00:09:53,509 --> 00:09:50,720
so if you look in the bottom right

280
00:09:54,790 --> 00:09:53,519
corner you'll notice that um there's

281
00:09:56,310 --> 00:09:54,800
sort of that

282
00:09:57,990 --> 00:09:56,320
that part that's kind of coming up in

283
00:09:59,430 --> 00:09:58,000
the lower right kind of lifting up

284
00:10:01,509 --> 00:09:59,440
and you'll notice there's like that

285
00:10:02,069 --> 00:10:01,519
hatch or that that structure that's

286
00:10:04,710 --> 00:10:02,079
underneath

287
00:10:06,550 --> 00:10:04,720
the folded up sun shield um that is the

288
00:10:09,190 --> 00:10:06,560

unitized pallet structure and it

289
00:10:10,630 --> 00:10:09,200
it secures the sun shield and it secures

290
00:10:11,990 --> 00:10:10,640
that part of the telescope so it can

291
00:10:14,230 --> 00:10:12,000
fold up safely

292
00:10:16,310 --> 00:10:14,240
and be safe during launch and then

293
00:10:18,790 --> 00:10:16,320
deploy once it's in space

294
00:10:20,949 --> 00:10:18,800
um the space telescope science institute

295
00:10:23,670 --> 00:10:20,959
continues launch preparations

296
00:10:25,350 --> 00:10:23,680
so sdsci is the science and missions up

297
00:10:27,269 --> 00:10:25,360
mission operations center for the web

298
00:10:29,509 --> 00:10:27,279
space telescope

299
00:10:30,870 --> 00:10:29,519
a ground segment system has been tested

300
00:10:33,110 --> 00:10:30,880
and finalized

301
00:10:34,790 --> 00:10:33,120
and vips and media will be on site at

302
00:10:38,230 --> 00:10:34,800
the space telescope science institute in

303
00:10:39,750 --> 00:10:38,240
baltimore maryland for launch

304
00:10:41,590 --> 00:10:39,760
okay so good things are happening for

305
00:10:42,470 --> 00:10:41,600
web it's a mission that's preparing for

306
00:10:44,470 --> 00:10:42,480
launch

307
00:10:46,069 --> 00:10:44,480
now the the nancy grace roman space

308
00:10:48,949 --> 00:10:46,079
telescope is a mission that

309
00:10:49,990 --> 00:10:48,959
is a few years out it's in the it's uh

310
00:10:53,190 --> 00:10:50,000
being designed

311
00:10:55,110 --> 00:10:53,200
and the engineering is happening

312
00:10:56,310 --> 00:10:55,120
um in the last month it passed a key

313
00:10:59,430 --> 00:10:56,320

design milestone

314
00:11:01,750 --> 00:10:59,440
so um on july 23rd

315
00:11:03,670 --> 00:11:01,760
uh 2021 the nancy grace roman space

316
00:11:05,190 --> 00:11:03,680
telescope successfully completed the

317
00:11:07,590 --> 00:11:05,200
critical design review

318
00:11:08,630 --> 00:11:07,600
of the mission's ground systems so the

319
00:11:10,630 --> 00:11:08,640
ground systems

320
00:11:12,710 --> 00:11:10,640
are spread over multiple institutions

321
00:11:13,990 --> 00:11:12,720
including the space telescope science

322
00:11:15,750 --> 00:11:14,000
institute in baltimore

323
00:11:17,509 --> 00:11:15,760
uh the goddard space flight center in

324
00:11:20,230 --> 00:11:17,519
greenbelt maryland and

325
00:11:21,430 --> 00:11:20,240
um caltech ipac in pasadena california

326
00:11:23,509 --> 00:11:21,440
and the ground systems

327
00:11:24,870 --> 00:11:23,519
are basically the the systems that are

328
00:11:27,190 --> 00:11:24,880
responsible for

329
00:11:28,790 --> 00:11:27,200
collecting the science data from roman

330
00:11:31,110 --> 00:11:28,800
storing them and so on

331
00:11:32,949 --> 00:11:31,120
the space telescope science institute is

332
00:11:34,389 --> 00:11:32,959
the science operations center

333
00:11:37,030 --> 00:11:34,399
for the nancy grace roman space

334
00:11:39,190 --> 00:11:37,040
telescope the nasa goddard space flight

335
00:11:41,829 --> 00:11:39,200
center is the mission operations center

336
00:11:43,590 --> 00:11:41,839
and caltech ipac in pasadena california

337
00:11:45,269 --> 00:11:43,600
is the science support center so we all

338
00:11:48,870 --> 00:11:45,279

work together to make sure

339
00:11:49,430 --> 00:11:48,880
that the data is cared for once it comes

340
00:11:51,590 --> 00:11:49,440
back to

341
00:11:53,910 --> 00:11:51,600
to earth after romans starts doing

342
00:11:55,509 --> 00:11:53,920
science in the mid 2020s

343
00:11:56,949 --> 00:11:55,519
so the passing of the critical design

344
00:11:59,750 --> 00:11:56,959
review means that

345
00:12:01,350 --> 00:11:59,760
that the plan for science operations

346
00:12:03,590 --> 00:12:01,360
provides all the necessary data

347
00:12:05,590 --> 00:12:03,600
processing and archiving capabilities

348
00:12:07,350 --> 00:12:05,600
and that means that now the mission can

349
00:12:08,710 --> 00:12:07,360
proceed to the next phase which is

350
00:12:10,310 --> 00:12:08,720
building and testing

351
00:12:12,069 --> 00:12:10,320
the newly designed systems that will

352
00:12:13,190 --> 00:12:12,079
enable planning and scheduling of roman

353
00:12:16,389 --> 00:12:13,200
observations

354
00:12:18,230 --> 00:12:16,399
and managing the resulting data and

355
00:12:20,310 --> 00:12:18,240
that is quite a feat there's a lot of

356
00:12:22,550 --> 00:12:20,320
data that we expect from the nancy grace

357
00:12:27,430 --> 00:12:22,560
roman space telescope

358
00:12:29,670 --> 00:12:27,440
is a telescope that's basically the size

359
00:12:31,430 --> 00:12:29,680
of the hubble space telescope it has

360
00:12:34,790 --> 00:12:31,440
similar image

361
00:12:37,829 --> 00:12:34,800
resolution image quality but it has

362
00:12:38,710 --> 00:12:37,839
well over 100 times the field of view of

363
00:12:40,389 --> 00:12:38,720

hubble

364
00:12:42,310 --> 00:12:40,399
so we're going to get a lot of data it's

365
00:12:43,509 --> 00:12:42,320
a survey style mission so you can see in

366
00:12:45,190 --> 00:12:43,519
the bottom right

367
00:12:48,150 --> 00:12:45,200
the amount of data we're expecting from

368
00:12:51,190 --> 00:12:48,160
the nancy grace roman space telescope

369
00:12:53,110 --> 00:12:51,200
over 30 years we've had about 172

370
00:12:54,629 --> 00:12:53,120
terabytes of data from hubble

371
00:12:57,030 --> 00:12:54,639
we're going to get we're going to get

372
00:12:58,069 --> 00:12:57,040
about 20 000 terabytes in just five

373
00:13:01,030 --> 00:12:58,079
years

374
00:13:01,829 --> 00:13:01,040
from roman so there's a lot of work to

375
00:13:05,030 --> 00:13:01,839
be done

376
00:13:07,509 --> 00:13:05,040
to prepare um ground systems archives

377
00:13:08,949 --> 00:13:07,519
and so on to store the data and make the

378
00:13:12,710 --> 00:13:08,959
data available

379
00:13:14,949 --> 00:13:12,720
for everyone to use okay

380
00:13:16,550 --> 00:13:14,959
so i just some some good news on these

381
00:13:18,310 --> 00:13:16,560
big missions and there's a lot of great

382
00:13:21,430 --> 00:13:18,320
science that are going to come from

383
00:13:23,269 --> 00:13:21,440
from hubble webb and and roman um

384
00:13:25,430 --> 00:13:23,279
and i just want to make the point before

385
00:13:28,629 --> 00:13:25,440
i introduce tonight's speaker that

386
00:13:31,910 --> 00:13:28,639
uh none of these missions really replace

387
00:13:34,949 --> 00:13:31,920
the other missions right so there's no

388
00:13:37,430 --> 00:13:34,959

there's no um i would never use a

389
00:13:39,269 --> 00:13:37,440
i would never use a term of like hubble

390
00:13:41,509 --> 00:13:39,279
2.0 or anything like that because these

391
00:13:43,269 --> 00:13:41,519
missions are complementary to hubble

392
00:13:44,550 --> 00:13:43,279
so they all have special things that

393
00:13:46,949 --> 00:13:44,560
they do and

394
00:13:49,030 --> 00:13:46,959
unique things that they do hubble will

395
00:13:49,990 --> 00:13:49,040
continue to be our ultraviolet eye on

396
00:13:51,509 --> 00:13:50,000
the sky

397
00:13:53,110 --> 00:13:51,519
none of these other telescopes can look

398
00:13:55,350 --> 00:13:53,120
at ultraviolet um

399
00:13:56,790 --> 00:13:55,360
and certainly no other space telescope

400
00:13:58,710 --> 00:13:56,800
can look at ultraviolet and the

401
00:14:01,509 --> 00:13:58,720
capability that hubble can

402
00:14:03,189 --> 00:14:01,519
webb is going to be an amazing eye on

403
00:14:06,150 --> 00:14:03,199
the sky for infrared science

404
00:14:07,509 --> 00:14:06,160
and spectroscopy and again roman is

405
00:14:08,870 --> 00:14:07,519
going to do infrared but it's going to

406
00:14:11,670 --> 00:14:08,880
have a larger survey

407
00:14:12,949 --> 00:14:11,680
so it's going to um it's going to say

408
00:14:15,110 --> 00:14:12,959
what we often say is

409
00:14:17,509 --> 00:14:15,120
is web will see deeper web has a bigger

410
00:14:19,750 --> 00:14:17,519
mirror more sensitive to infrared

411
00:14:20,710 --> 00:14:19,760
and roman will see wider it's going to

412
00:14:22,710 --> 00:14:20,720
see more of the sky

413
00:14:24,230 --> 00:14:22,720

and hubble light quality so i hope

414
00:14:25,750 --> 00:14:24,240
you're all excited about the

415
00:14:28,069 --> 00:14:25,760
the these new missions that are coming

416
00:14:29,269 --> 00:14:28,079
up and and you know we hope for many

417
00:14:31,750 --> 00:14:29,279
more years of hubble and that they can

418
00:14:34,069 --> 00:14:31,760
work together

419
00:14:35,430 --> 00:14:34,079
and with that i am going to introduce uh

420
00:14:38,069 --> 00:14:35,440
tonight's featured speaker

421
00:14:40,230 --> 00:14:38,079
dr isabel rubble guitto from the space

422
00:14:42,949 --> 00:14:40,240
telescope science institute

423
00:14:43,350 --> 00:14:42,959
who will talk to us on the importance of

424
00:14:46,150 --> 00:14:43,360
small

425
00:14:47,430 --> 00:14:46,160
objects exo-comets and i am actually

426
00:14:49,590 --> 00:14:47,440
going to stop um

427
00:14:51,110 --> 00:14:49,600
sharing my slides and i will introduce

428
00:14:54,069 --> 00:14:51,120
her but i want to give her

429
00:14:55,189 --> 00:14:54,079
a chance to put up her title slide so i

430
00:14:59,750 --> 00:14:55,199
am going to

431
00:15:04,550 --> 00:14:59,760
stop sharing and i will introduce her

432
00:15:07,829 --> 00:15:07,030
all right so as isabel brings up her

433
00:15:11,189 --> 00:15:07,839
slides

434
00:15:12,389 --> 00:15:11,199
um so let me introduce her so isabelle

435
00:15:14,230 --> 00:15:12,399
obtained her

436
00:15:16,790 --> 00:15:14,240
physics degree at the university of

437
00:15:19,269 --> 00:15:16,800
santiago de compostela in spain with a

438
00:15:21,430 --> 00:15:19,279

bachelor thesis focused on

439
00:15:23,189 --> 00:15:21,440
the nuclear processes of novae events

440
00:15:24,470 --> 00:15:23,199
and after that she obtained her master's

441
00:15:25,509 --> 00:15:24,480
degree in astrophysics from the

442
00:15:28,150 --> 00:15:25,519
university

443
00:15:29,910 --> 00:15:28,160
of la laguna and tenerife spain with a

444
00:15:31,829 --> 00:15:29,920
master thesis focused on the study of

445
00:15:34,230 --> 00:15:31,839
kepler-light curves and variations in

446
00:15:36,550 --> 00:15:34,240
the brightnesses of exoplanets

447
00:15:38,550 --> 00:15:36,560
she spent one year at the european space

448
00:15:39,509 --> 00:15:38,560
agency center in madrid working with dr

449
00:15:42,870 --> 00:15:39,519
bruno marin

450
00:15:44,949 --> 00:15:42,880
and dr alvaro rebus in transition discs

451
00:15:47,269 --> 00:15:44,959
transition this are where we believe

452
00:15:49,269 --> 00:15:47,279
planet formation takes place

453
00:15:51,189 --> 00:15:49,279
and that led isabelle to start a phd

454
00:15:53,030 --> 00:15:51,199
also in madrid focused on the gaseous

455
00:15:54,230 --> 00:15:53,040
component of disks around main sequence

456
00:15:56,790 --> 00:15:54,240
adult stars

457
00:15:58,790 --> 00:15:56,800
and particularly the presence of exo

458
00:16:00,230 --> 00:15:58,800
comets in these environments

459
00:16:02,150 --> 00:16:00,240
isabelle did her phd under the

460
00:16:05,590 --> 00:16:02,160
supervision of dr eva villaver

461
00:16:07,189 --> 00:16:05,600
and dr benjamin montecinos

462
00:16:08,629 --> 00:16:07,199
she is currently a postdoctoral

463
00:16:09,910 --> 00:16:08,639

researcher at the space telescope

464
00:16:12,629 --> 00:16:09,920
science institute working

465
00:16:13,269 --> 00:16:12,639
with dr marshall perrin and dr christine

466
00:16:14,870 --> 00:16:13,279
chen

467
00:16:16,870 --> 00:16:14,880
and she is currently studying the disc

468
00:16:18,710 --> 00:16:16,880
around the famous star beta pic

469
00:16:20,310 --> 00:16:18,720
and follow and follow up as well as

470
00:16:21,749 --> 00:16:20,320
studies in exocomets around main

471
00:16:23,670 --> 00:16:21,759
sequence stars

472
00:16:25,990 --> 00:16:23,680
and its relevance in the architecture

473
00:16:28,310 --> 00:16:26,000
and composition of planetary systems

474
00:16:30,150 --> 00:16:28,320
so in addition to her fantastic research

475
00:16:31,910 --> 00:16:30,160
that she'll tell you about today

476
00:16:33,509 --> 00:16:31,920
isabelle is also a member of the women

477
00:16:34,230 --> 00:16:33,519
in astronomy committee of the spanish

478
00:16:37,910 --> 00:16:34,240
astronomic

479
00:16:39,430 --> 00:16:37,920
participated in multiple outreach

480
00:16:41,749 --> 00:16:39,440
activities both with students of all

481
00:16:44,310 --> 00:16:41,759
ages and gender focused outreach

482
00:16:45,110 --> 00:16:44,320
um and she also used to play uh football

483
00:16:47,509 --> 00:16:45,120
or as

484
00:16:48,470 --> 00:16:47,519
we say in this in the united states

485
00:16:49,829 --> 00:16:48,480
soccer

486
00:16:51,350 --> 00:16:49,839
she played that in spain while she was

487
00:16:52,310 --> 00:16:51,360
in high school and while studying for a

488
00:16:54,230 --> 00:16:52,320

physics degree

489
00:16:55,350 --> 00:16:54,240
and she also paints and plays guitar in

490
00:17:00,470 --> 00:16:55,360
her spare time

491
00:17:03,829 --> 00:17:02,310
great thank you so much brendan can you

492
00:17:04,789 --> 00:17:03,839
hear me well see my slides and

493
00:17:06,789 --> 00:17:04,799
everything

494
00:17:08,710 --> 00:17:06,799
okay uh thank you for a very nice

495
00:17:11,590 --> 00:17:08,720
presentation and introduction

496
00:17:13,270 --> 00:17:11,600
um indeed all these space missions are

497
00:17:13,829 --> 00:17:13,280
incredibly exciting we're looking for

498
00:17:16,710 --> 00:17:13,839
one

499
00:17:17,189 --> 00:17:16,720
so much for web this year um and i'm

500
00:17:20,309 --> 00:17:17,199
gonna

501
00:17:23,429 --> 00:17:20,319
talk today about uh exocomets which is

502
00:17:26,630 --> 00:17:23,439
uh basically my phd work um

503
00:17:28,549 --> 00:17:26,640
but i'm gonna try to put the focus

504
00:17:29,669 --> 00:17:28,559
on why these subjects are important and

505
00:17:31,990 --> 00:17:29,679
not only

506
00:17:34,470 --> 00:17:32,000
uh the scientific work that i did which

507
00:17:36,070 --> 00:17:34,480
i'm also going to talk about

508
00:17:38,070 --> 00:17:36,080
so the first thing i would like to

509
00:17:40,549 --> 00:17:38,080
mention is how

510
00:17:42,390 --> 00:17:40,559
we are biased towards ignoring this type

511
00:17:45,510 --> 00:17:42,400
of small bodies because

512
00:17:47,590 --> 00:17:45,520
it is so exciting to think about

513
00:17:49,350 --> 00:17:47,600

finding life in a planet or finding a

514
00:17:52,150 --> 00:17:49,360
planet that can host life

515
00:17:53,350 --> 00:17:52,160
outside the solar system uh where i

516
00:17:55,990 --> 00:17:53,360
don't know we could find

517
00:17:57,750 --> 00:17:56,000
animals or aliens that are green uh or

518
00:18:00,150 --> 00:17:57,760
gray with huge eyes

519
00:18:02,070 --> 00:18:00,160
but uh planetary systems are not just

520
00:18:04,630 --> 00:18:02,080
the star and the planets actually

521
00:18:05,510 --> 00:18:04,640
um they look something more similar to

522
00:18:07,909 --> 00:18:05,520
this

523
00:18:08,870 --> 00:18:07,919
um we do have a star we do have planets

524
00:18:11,350 --> 00:18:08,880
but we do have

525
00:18:11,909 --> 00:18:11,360
a lot of other components in the systems

526
00:18:15,350 --> 00:18:11,919
there is

527
00:18:17,510 --> 00:18:15,360
might have moons

528
00:18:18,789 --> 00:18:17,520
just like it happens in our solar system

529
00:18:22,390 --> 00:18:18,799
and there is also

530
00:18:24,310 --> 00:18:22,400
um less a

531
00:18:25,909 --> 00:18:24,320
smaller fraction of the mass contained

532
00:18:29,590 --> 00:18:25,919
in dust in the system

533
00:18:32,710 --> 00:18:29,600
you can see some here and also gas

534
00:18:34,310 --> 00:18:32,720
means very small amounts um

535
00:18:36,230 --> 00:18:34,320
but yeah planetary systems are very

536
00:18:39,350 --> 00:18:36,240
complex and

537
00:18:42,710 --> 00:18:39,360
how do we get here so it all starts

538
00:18:44,150 --> 00:18:42,720

when a star collapses from a huge cloud

539
00:18:47,270 --> 00:18:44,160
which is

540
00:18:51,270 --> 00:18:47,280
tens of thousands of astronomical units

541
00:18:53,669 --> 00:18:51,280
um in size astronomical units for

542
00:18:54,390 --> 00:18:53,679
those who might be uh not familiar with

543
00:18:55,990 --> 00:18:54,400
the term

544
00:18:59,590 --> 00:18:56,000
is the distance between the earth and

545
00:19:02,470 --> 00:18:59,600
the sun so it's it's a large distance

546
00:19:03,029 --> 00:19:02,480
so these things are huge um and they're

547
00:19:04,789 --> 00:19:03,039
just like

548
00:19:06,070 --> 00:19:04,799
gas clouds that are floating in the

549
00:19:09,510 --> 00:19:06,080
interstellar space

550
00:19:10,070 --> 00:19:09,520
and when they collapse um they start to

551
00:19:15,130 --> 00:19:10,080
uh

552
00:19:16,470 --> 00:19:15,140
started to

553
00:19:19,270 --> 00:19:16,480
[Music]

554
00:19:19,669 --> 00:19:19,280
locate in the center of the cloud and

555
00:19:22,390 --> 00:19:19,679
that

556
00:19:24,310 --> 00:19:22,400
eventually forms a star but not all of

557
00:19:26,070 --> 00:19:24,320
the material it's in the star so if you

558
00:19:27,430 --> 00:19:26,080
follow this very nice diagram you see

559
00:19:30,870 --> 00:19:27,440
that the cloud

560
00:19:32,710 --> 00:19:30,880
it's shrinking as it collapses um

561
00:19:33,990 --> 00:19:32,720
and there are like some zones with

562
00:19:37,510 --> 00:19:34,000
higher density that is

563
00:19:38,310 --> 00:19:37,520

what's gonna form the star but there is

564
00:19:40,390 --> 00:19:38,320
also some material

565
00:19:41,830 --> 00:19:40,400
that it's located in the disk that at

566
00:19:45,190 --> 00:19:41,840
this point is like

567
00:19:46,870 --> 00:19:45,200
hundreds or less than astronomical units

568
00:19:48,230 --> 00:19:46,880
um so it's it's very small compared to

569
00:19:51,350 --> 00:19:48,240
the original cloud but it's

570
00:19:53,590 --> 00:19:51,360
more or less the same material

571
00:19:55,270 --> 00:19:53,600
and that material that it's not in the

572
00:19:58,470 --> 00:19:55,280
star it's what's gonna form

573
00:20:00,870 --> 00:19:58,480
eventually the planets um

574
00:20:02,870 --> 00:20:00,880
just so you know our solar system

575
00:20:03,510 --> 00:20:02,880
depending on how you measure it and what

576
00:20:05,590 --> 00:20:03,520
components

577
00:20:08,390 --> 00:20:05,600
you take into account but it's around

578
00:20:09,669 --> 00:20:08,400
like 50 definitely less than 100

579
00:20:11,350 --> 00:20:09,679
astronomical units

580
00:20:12,870 --> 00:20:11,360
apart from like the earth cloud that

581
00:20:14,870 --> 00:20:12,880
it's further on

582
00:20:17,750 --> 00:20:14,880
so this is a very complex and long

583
00:20:21,350 --> 00:20:17,760
process and the outcomes of that process

584
00:20:23,669 --> 00:20:21,360
does not only depend on the material

585
00:20:25,430 --> 00:20:23,679
of the original cloud but also on how it

586
00:20:28,470 --> 00:20:25,440
collapses

587
00:20:29,990 --> 00:20:28,480
and how the dynamics

588
00:20:31,990 --> 00:20:30,000

behave in the process of planet

589
00:20:35,270 --> 00:20:32,000
information and we believe

590
00:20:37,110 --> 00:20:35,280
something uh that we believe that what's

591
00:20:40,390 --> 00:20:37,120
happening is something like this

592
00:20:41,510 --> 00:20:40,400
um where we start off uh imagine that we

593
00:20:43,350 --> 00:20:41,520
already have the star

594
00:20:45,350 --> 00:20:43,360
i'm not gonna go into how it starts from

595
00:20:48,390 --> 00:20:45,360
that's uh that's another story

596
00:20:50,470 --> 00:20:48,400
um we already have the star but it the

597
00:20:52,950 --> 00:20:50,480
system is still very immature

598
00:20:53,990 --> 00:20:52,960
so the disk that it's around the star is

599
00:20:56,310 --> 00:20:54,000
huge

600
00:20:58,310 --> 00:20:56,320
it's very flare that means that the

601
00:21:00,230 --> 00:20:58,320
scale height is huge

602
00:21:02,230 --> 00:21:00,240
um and there is a lot of material in

603
00:21:03,750 --> 00:21:02,240
there but most of it is gas and this is

604
00:21:05,510 --> 00:21:03,760
what we call a protoplanetary disk

605
00:21:08,149 --> 00:21:05,520
because we don't have planets yet

606
00:21:09,750 --> 00:21:08,159
but we will have them um and so in that

607
00:21:12,310 --> 00:21:09,760
protocol that it is there's

608
00:21:13,669 --> 00:21:12,320
mainly two things happening uh one that

609
00:21:16,149 --> 00:21:13,679
the stars are treating some of its

610
00:21:18,789 --> 00:21:16,159
material because it's still growing

611
00:21:19,669 --> 00:21:18,799
but it's also radiating an enormous

612
00:21:23,110 --> 00:21:19,679
amount

613
00:21:24,789 --> 00:21:23,120

of very energetic photons

614
00:21:26,390 --> 00:21:24,799
and those photons interact with the

615
00:21:26,870 --> 00:21:26,400
material in the disk with the gas in the

616
00:21:28,950 --> 00:21:26,880
disk

617
00:21:29,990 --> 00:21:28,960
and blow it away so some material of the

618
00:21:31,350 --> 00:21:30,000
disk is being lost

619
00:21:33,110 --> 00:21:31,360
to the interstellar medium and some

620
00:21:36,149 --> 00:21:33,120
material of the disk is being

621
00:21:37,110 --> 00:21:36,159
accreted onto the star um as this

622
00:21:38,470 --> 00:21:37,120
process goes on

623
00:21:41,750 --> 00:21:38,480
what happens is that this starts to

624
00:21:45,190 --> 00:21:41,760
settle the the scale height decreases

625
00:21:46,870 --> 00:21:45,200
we start to have a lot of dust

626
00:21:48,390 --> 00:21:46,880
pebbles the materials start secreting

627
00:21:51,669 --> 00:21:48,400
into solids

628
00:21:53,669 --> 00:21:51,679
the temperature is also lower and

629
00:21:55,830 --> 00:21:53,679
as the process goes on it might even

630
00:21:58,390 --> 00:21:55,840
clear a small

631
00:21:58,870 --> 00:21:58,400
gap between the star and the disk as you

632
00:22:02,230 --> 00:21:58,880
see

633
00:22:04,950 --> 00:22:02,240
here in this part um

634
00:22:05,669 --> 00:22:04,960
there is still photovoltaic processes

635
00:22:08,390 --> 00:22:05,679
but

636
00:22:10,110 --> 00:22:08,400
the solids are growing we might have

637
00:22:12,710 --> 00:22:10,120
planetesimas the first

638
00:22:14,310 --> 00:22:12,720

protoplantationals a lot of dust and

639
00:22:17,590 --> 00:22:14,320
eventually

640
00:22:21,990 --> 00:22:17,600
all the material settles it's in a disk

641
00:22:23,750 --> 00:22:22,000
with not a very large scale height

642
00:22:25,590 --> 00:22:23,760
and this is what we call at every disk

643
00:22:28,470 --> 00:22:25,600
and this is basically

644
00:22:29,270 --> 00:22:28,480
the last stage of the process of planet

645
00:22:32,310 --> 00:22:29,280
formation

646
00:22:34,710 --> 00:22:32,320
but in this stage we still have

647
00:22:35,830 --> 00:22:34,720
a lot of things going on the disc is

648
00:22:38,310 --> 00:22:35,840
full of dust

649
00:22:39,750 --> 00:22:38,320
um it's supposed to be depleted of gas

650
00:22:41,590 --> 00:22:39,760
all the gas has been either accrued

651
00:22:43,990 --> 00:22:41,600
onto the star or lost interstellar

652
00:22:47,510 --> 00:22:44,000
medium or aggregated

653
00:22:49,830 --> 00:22:47,520
into solids so we basically have dust

654
00:22:51,029 --> 00:22:49,840
and we have planetesimals or maybe even

655
00:22:53,510 --> 00:22:51,039
planets

656
00:22:54,070 --> 00:22:53,520
and those bodies are still interacting

657
00:22:57,510 --> 00:22:54,080
in between

658
00:22:59,590 --> 00:22:57,520
them this is not a completely stable

659
00:23:00,950 --> 00:22:59,600
system so there is a lot of things going

660
00:23:03,029 --> 00:23:00,960
on here

661
00:23:04,310 --> 00:23:03,039
but what we think this looks like this

662
00:23:07,110 --> 00:23:04,320
kind of systems looks like

663
00:23:08,230 --> 00:23:07,120

it's more or less like this um so we

664
00:23:11,669 --> 00:23:08,240
would have the star

665
00:23:14,710 --> 00:23:11,679
and we would have um a range of bodies

666
00:23:17,110 --> 00:23:14,720
and material located along the disk

667
00:23:18,630 --> 00:23:17,120
and we know that the material in the

668
00:23:19,990 --> 00:23:18,640
disk is at different temperatures

669
00:23:21,590 --> 00:23:20,000
because it's at different distances from

670
00:23:21,990 --> 00:23:21,600
the start so it kind of makes sense that

671
00:23:25,029 --> 00:23:22,000
what's

672
00:23:27,830 --> 00:23:25,039
closer to the star it's hotter than when

673
00:23:30,070 --> 00:23:27,840
that the material that is further out so

674
00:23:31,270 --> 00:23:30,080
uh if we look at the dust that is very

675
00:23:33,430 --> 00:23:31,280
very close to the star

676
00:23:35,350 --> 00:23:33,440
it's really really hot but if we look at

677
00:23:36,710 --> 00:23:35,360
the dust that is very very far from the

678
00:23:39,430 --> 00:23:36,720
start it's really really cold

679
00:23:41,190 --> 00:23:39,440
we're talking about thousands of calving

680
00:23:42,710 --> 00:23:41,200
of difference maybe one thousand or two

681
00:23:45,830 --> 00:23:42,720
thousand kelvin difference

682
00:23:47,510 --> 00:23:45,840
between one um zone and the other and in

683
00:23:50,549 --> 00:23:47,520
between we have the planets

684
00:23:53,590 --> 00:23:50,559
um and we also have the

685
00:23:54,710 --> 00:23:53,600
belts that could be formed in our in our

686
00:23:58,070 --> 00:23:54,720
system

687
00:23:59,350 --> 00:23:58,080
and this is um again a hundred

688
00:24:02,390 --> 00:23:59,360

astronomical units

689
00:24:04,310 --> 00:24:02,400
uh this halo might stand uh further than

690
00:24:07,669 --> 00:24:04,320
that we know that there are disks

691
00:24:10,230 --> 00:24:07,679
that are bigger way bigger than this um

692
00:24:11,190 --> 00:24:10,240
but this is just like a model of what we

693
00:24:14,789 --> 00:24:11,200
think

694
00:24:17,669 --> 00:24:14,799
like and of course depending

695
00:24:18,230 --> 00:24:17,679
on what zone of the system we want to

696
00:24:20,390 --> 00:24:18,240
see

697
00:24:21,269 --> 00:24:20,400
we actually try to look at different

698
00:24:23,110 --> 00:24:21,279
wavelengths

699
00:24:26,230 --> 00:24:23,120
so at different let's say with different

700
00:24:27,590 --> 00:24:26,240
eyes um

701
00:24:30,390 --> 00:24:27,600
the material that is really close to the

702
00:24:33,669 --> 00:24:30,400
star usually emits around

703
00:24:36,630 --> 00:24:33,679
two microns of wavelength so there

704
00:24:37,590 --> 00:24:36,640
um it's still very bright uh in the near

705
00:24:39,990 --> 00:24:37,600
infrared

706
00:24:42,310 --> 00:24:40,000
we don't we would not be able to see it

707
00:24:44,070 --> 00:24:42,320
uh radiating terminally with our eyes

708
00:24:47,110 --> 00:24:44,080
because we only see in the visible range

709
00:24:49,029 --> 00:24:47,120
and this is already the infrared

710
00:24:50,950 --> 00:24:49,039
but if we want to observe the one that

711
00:24:52,230 --> 00:24:50,960
it's in the outer regions we have to go

712
00:24:53,430 --> 00:24:52,240
to 60 microns

713
00:24:55,269 --> 00:24:53,440

which is a completely different

714
00:24:58,710 --> 00:24:55,279
wavelength and we need

715
00:25:00,149 --> 00:24:58,720
a completely uh different instrument

716
00:25:02,230 --> 00:25:00,159
that say to actually

717
00:25:03,430 --> 00:25:02,240
uh see that compared to what we have

718
00:25:05,830 --> 00:25:03,440
closer to the star

719
00:25:06,549 --> 00:25:05,840
so this is fairly difficult to study um

720
00:25:09,590 --> 00:25:06,559
all together

721
00:25:11,510 --> 00:25:09,600
we usually go by chunks um

722
00:25:13,669 --> 00:25:11,520
but this might also seem familiar to

723
00:25:13,990 --> 00:25:13,679
some of you uh it doesn't look weird

724
00:25:16,149 --> 00:25:14,000
right

725
00:25:17,430 --> 00:25:16,159
where if we are interested in the solar

726
00:25:19,830 --> 00:25:17,440
system this kind of

727
00:25:20,789 --> 00:25:19,840
looks like it um and that's because our

728
00:25:24,390 --> 00:25:20,799
solar system

729
00:25:27,990 --> 00:25:24,400
uh it's like the first model of how

730
00:25:31,190 --> 00:25:28,000
planets formed it's the first outcome of

731
00:25:34,630 --> 00:25:31,200
planet formation that we knew um

732
00:25:37,350 --> 00:25:34,640
until not so long ago the only one and

733
00:25:37,830 --> 00:25:37,360
so this is the solar system is what we

734
00:25:43,269 --> 00:25:37,840
use

735
00:25:44,230 --> 00:25:43,279
for uh determining the planet formation

736
00:25:45,830 --> 00:25:44,240
theories

737
00:25:47,350 --> 00:25:45,840
uh so as you can see like in the

738
00:25:49,990 --> 00:25:47,360

previous um

739
00:25:50,549 --> 00:25:50,000
diagram we have here the solid system

740
00:25:55,510 --> 00:25:50,559
with

741
00:25:57,590 --> 00:25:55,520
planets the terrestrial planets

742
00:25:59,190 --> 00:25:57,600
inside of the asteroid belt the sun is

743
00:26:02,950 --> 00:25:59,200
here

744
00:26:05,110 --> 00:26:02,960
we have a large chunk of asteroids

745
00:26:06,549 --> 00:26:05,120
between mars and jupiter which is the

746
00:26:09,990 --> 00:26:06,559
asteroid belt

747
00:26:10,310 --> 00:26:10,000
and we look further out here you can see

748
00:26:12,230 --> 00:26:10,320
that

749
00:26:14,710 --> 00:26:12,240
it's jupiter it's utter neurons and

750
00:26:15,750 --> 00:26:14,720
neptune and the dwarf planets pluton

751
00:26:17,350 --> 00:26:15,760
sedna

752
00:26:20,230 --> 00:26:17,360
and we also have what's called the

753
00:26:22,310 --> 00:26:20,240
kuiper belt which is um

754
00:26:24,070 --> 00:26:22,320
also a belt of asteroids and small

755
00:26:27,269 --> 00:26:24,080
bodies but

756
00:26:27,750 --> 00:26:27,279
with a higher content in ice just

757
00:26:30,470 --> 00:26:27,760
because

758
00:26:30,950 --> 00:26:30,480
it is further from the sun so it can

759
00:26:33,110 --> 00:26:30,960
have

760
00:26:34,630 --> 00:26:33,120
materials that at high temperatures are

761
00:26:38,070 --> 00:26:34,640
gaseous

762
00:26:39,190 --> 00:26:38,080
in the form of solids and yeah so this

763
00:26:41,190 --> 00:26:39,200

is very similar to

764
00:26:42,630 --> 00:26:41,200
to the diagram that i was showing before

765
00:26:44,789 --> 00:26:42,640
you see um

766
00:26:46,710 --> 00:26:44,799
the terrestrial zone but here the

767
00:26:48,789 --> 00:26:46,720
asteroid also would be this

768
00:26:49,750 --> 00:26:48,799
and this would be the kuiper belt um

769
00:26:53,350 --> 00:26:49,760
here so

770
00:26:56,310 --> 00:26:53,360
this is um the like the model

771
00:26:57,669 --> 00:26:56,320
of what we think a planetary system kind

772
00:27:00,470 --> 00:26:57,679
of look like looks like

773
00:27:02,789 --> 00:27:00,480
we know um after many many studies and

774
00:27:05,350 --> 00:27:02,799
after the discovery of 4000 exoplanets

775
00:27:06,149 --> 00:27:05,360
that this is not like this all the time

776
00:27:08,950 --> 00:27:06,159
we can have

777
00:27:09,510 --> 00:27:08,960
the giant planets very close to star we

778
00:27:12,549 --> 00:27:09,520
can have

779
00:27:13,750 --> 00:27:12,559
only small planets um depending on the

780
00:27:17,669 --> 00:27:13,760
star that we're looking at

781
00:27:20,389 --> 00:27:17,679
we believe that that might be related on

782
00:27:20,950 --> 00:27:20,399
the mass of the star the spectro but we

783
00:27:24,149 --> 00:27:20,960
really don't

784
00:27:26,230 --> 00:27:24,159
know we're still trying to figure out

785
00:27:27,750 --> 00:27:26,240
um what's going on and if there is a

786
00:27:29,990 --> 00:27:27,760
correlation on

787
00:27:31,269 --> 00:27:30,000
between uh the the architecture of the

788
00:27:33,269 --> 00:27:31,279

planetary system and the

789
00:27:34,789 --> 00:27:33,279
and the type of star that it surrounds

790
00:27:36,870 --> 00:27:34,799
it um

791
00:27:38,549 --> 00:27:36,880
and so going back to solar system we are

792
00:27:41,830 --> 00:27:38,559
actually really lucky

793
00:27:42,950 --> 00:27:41,840
um the moment we're leaving because we

794
00:27:44,870 --> 00:27:42,960
have reached now

795
00:27:46,950 --> 00:27:44,880
the point in science where we can

796
00:27:49,590 --> 00:27:46,960
actually go

797
00:27:51,669 --> 00:27:49,600
near these objects are around uh the

798
00:27:54,630 --> 00:27:51,679
earth and the terrestrial planets

799
00:27:55,190 --> 00:27:54,640
um and we have been even further on um

800
00:27:57,669 --> 00:27:55,200
and just

801
00:27:58,950 --> 00:27:57,679
look at them look how the asteroids in

802
00:28:02,870 --> 00:27:58,960
the asteroid belt

803
00:28:07,029 --> 00:28:02,880
or the comets look like and i

804
00:28:10,950 --> 00:28:07,039
really love this image of comet 67p

805
00:28:13,909 --> 00:28:10,960
this is uh up so up until now i showed

806
00:28:14,389 --> 00:28:13,919
like pictures or diagrams but this is a

807
00:28:18,230 --> 00:28:14,399
real

808
00:28:19,190 --> 00:28:18,240
image this is um how the comment looks

809
00:28:21,830 --> 00:28:19,200
like

810
00:28:23,110 --> 00:28:21,840
and it's impressive you can see it has a

811
00:28:26,310 --> 00:28:23,120
really weird shape

812
00:28:29,430 --> 00:28:26,320
um it was usually called a duck

813
00:28:30,389 --> 00:28:29,440

because it has like body and head um i i

814
00:28:34,389 --> 00:28:30,399
was at isa

815
00:28:37,750 --> 00:28:34,399
at the moment um the rosetta mission

816
00:28:40,950 --> 00:28:37,760
um reached 67p so um

817
00:28:43,830 --> 00:28:40,960
this is kind of like um a special

818
00:28:45,510 --> 00:28:43,840
object for me um and you can also see

819
00:28:47,669 --> 00:28:45,520
there is a lot of material

820
00:28:48,950 --> 00:28:47,679
evaporating from the surface because

821
00:28:51,750 --> 00:28:48,960
this object used to be

822
00:28:53,190 --> 00:28:51,760
um really really far away from the sun

823
00:28:55,590 --> 00:28:53,200
so it has a lot of ice

824
00:28:57,350 --> 00:28:55,600
and the moment it started to come to the

825
00:28:59,029 --> 00:28:57,360
inner regions closer to the sun it

826
00:29:02,070 --> 00:28:59,039
started of operating material

827
00:29:04,310 --> 00:29:02,080
and that allowed to investigate uh the

828
00:29:05,350 --> 00:29:04,320
composition and also the dynamics of how

829
00:29:08,389 --> 00:29:05,360
a comet

830
00:29:11,590 --> 00:29:08,399
moves let's say around the solar system

831
00:29:12,950 --> 00:29:11,600
so thanks to the mission in the space

832
00:29:13,830 --> 00:29:12,960
missions we have now we can do this sort

833
00:29:17,190 --> 00:29:13,840
of stuff

834
00:29:20,310 --> 00:29:17,200
um and moreover we actually landed

835
00:29:21,669 --> 00:29:20,320
on this comet um i think it's the only

836
00:29:24,710 --> 00:29:21,679
comet we have landed on

837
00:29:27,750 --> 00:29:24,720
um unfortunately

838
00:29:29,990 --> 00:29:27,760

the lander did not fall properly

839
00:29:31,909 --> 00:29:30,000
so it was kind of upside down so some of

840
00:29:34,389 --> 00:29:31,919
the experiments they wanted to do

841
00:29:36,149 --> 00:29:34,399
were not possible some of some others

842
00:29:38,149 --> 00:29:36,159
were possible to do

843
00:29:39,350 --> 00:29:38,159
it also wasn't lucky that it fell on a

844
00:29:42,149 --> 00:29:39,360
shaded area

845
00:29:43,590 --> 00:29:42,159
and it needed the the sun for powering

846
00:29:46,070 --> 00:29:43,600
it had some solar panels

847
00:29:47,029 --> 00:29:46,080
so yeah it lasted way less than we

848
00:29:50,230 --> 00:29:47,039
expected

849
00:29:51,830 --> 00:29:50,240
um and and we could there was some

850
00:29:53,350 --> 00:29:51,840
science that could not be done but still

851
00:29:54,870 --> 00:29:53,360
it was a great mission it was really

852
00:29:58,549 --> 00:29:54,880
important that we have

853
00:30:00,950 --> 00:29:58,559
really really great data from coming 67p

854
00:30:02,389 --> 00:30:00,960
um but this is not the only body in the

855
00:30:04,789 --> 00:30:02,399
solar system that

856
00:30:06,230 --> 00:30:04,799
uh we as humans have visited ourselves

857
00:30:09,669 --> 00:30:06,240
or with robots

858
00:30:12,549 --> 00:30:09,679
there's actually a bunch of them um

859
00:30:13,830 --> 00:30:12,559
earth of course we're all here right a

860
00:30:16,950 --> 00:30:13,840
couple of astronauts

861
00:30:18,789 --> 00:30:16,960
um orbiting um the moon

862
00:30:20,870 --> 00:30:18,799
and we have been to the moon a couple of

863
00:30:23,750 --> 00:30:20,880

times um

864
00:30:24,870 --> 00:30:23,760
and the rest of the bodies here we have

865
00:30:27,110 --> 00:30:24,880
actually not

866
00:30:29,269 --> 00:30:27,120
been as like a human being has not been

867
00:30:32,789 --> 00:30:29,279
in there but we have sent robots

868
00:30:34,950 --> 00:30:32,799
or um space missions that landed on them

869
00:30:38,470 --> 00:30:34,960
that were in those surfaces

870
00:30:38,870 --> 00:30:38,480
so um this is coming 67p that's the one

871
00:30:42,070 --> 00:30:38,880
that

872
00:30:42,950 --> 00:30:42,080
i was mentioning um this is asteriskawa

873
00:30:46,149 --> 00:30:42,960
i think

874
00:30:49,269 --> 00:30:46,159
this was the first the first small body

875
00:30:52,630 --> 00:30:49,279
that we put uh lander on

876
00:30:55,909 --> 00:30:52,640
i believe it was 2005. um

877
00:30:57,830 --> 00:30:55,919
so yeah we we have been studying um

878
00:30:58,950 --> 00:30:57,840
the small bodies in the solar system

879
00:31:01,909 --> 00:30:58,960
very carefully

880
00:31:03,669 --> 00:31:01,919
for some years now and i think this is

881
00:31:07,909 --> 00:31:03,679
the last one the asteroid

882
00:31:11,190 --> 00:31:07,919
ryogu that was visited by hayabusa two

883
00:31:13,430 --> 00:31:11,200
two years ago 2019 um and of course

884
00:31:16,470 --> 00:31:13,440
there's like mars venus

885
00:31:17,990 --> 00:31:16,480
and titan one of the moons in the solar

886
00:31:21,430 --> 00:31:18,000
system that we have visited

887
00:31:23,669 --> 00:31:21,440
uh that it's very important for um

888
00:31:25,669 --> 00:31:23,679

for australia biology research because

889
00:31:28,870 --> 00:31:25,679
it has um

890
00:31:30,870 --> 00:31:28,880
a cycle of methane i think um

891
00:31:31,990 --> 00:31:30,880
so yeah we have visited the surface of

892
00:31:36,230 --> 00:31:32,000
many bodies in the solar

893
00:31:38,310 --> 00:31:36,240
system and some of these bodies

894
00:31:39,830 --> 00:31:38,320
like the moon are really really

895
00:31:43,509 --> 00:31:39,840
important for the presence

896
00:31:44,710 --> 00:31:43,519
of life on earth this might not seem

897
00:31:45,430 --> 00:31:44,720
really obvious but there are some

898
00:31:47,509 --> 00:31:45,440
effects

899
00:31:49,110 --> 00:31:47,519
that the moon causes on the earth that

900
00:31:51,269 --> 00:31:49,120
we all know about

901
00:31:52,630 --> 00:31:51,279
like for example the tides um we are

902
00:31:54,870 --> 00:31:52,640
very

903
00:31:55,990 --> 00:31:54,880
familiar with tides we know that the

904
00:31:59,990 --> 00:31:56,000
gravitational effect

905
00:32:03,190 --> 00:32:00,000
that the moon causes on the earth

906
00:32:06,630 --> 00:32:03,200
generates tides um and that it's

907
00:32:09,830 --> 00:32:06,640
a thing that happens and that allows

908
00:32:12,470 --> 00:32:09,840
um the life in the oceans or

909
00:32:14,310 --> 00:32:12,480
maybe not that allows but that

910
00:32:16,230 --> 00:32:14,320
influences the life in the oceans

911
00:32:18,230 --> 00:32:16,240
but there is one thing that it's maybe

912
00:32:20,389 --> 00:32:18,240
more important that the moon does

913
00:32:22,230 --> 00:32:20,399

is that it stabilizes the axis of the

914
00:32:25,190 --> 00:32:22,240
earth the earth is not

915
00:32:27,509 --> 00:32:25,200
um completely so the axis of the earth

916
00:32:30,870 --> 00:32:27,519
is not completely perpendicular to

917
00:32:33,029 --> 00:32:30,880
the plane of the orbit of the earth

918
00:32:34,710 --> 00:32:33,039
it's tilted 23 degrees and that's what

919
00:32:36,789 --> 00:32:34,720
causes seasons

920
00:32:38,230 --> 00:32:36,799
so that it's allowed by the moon if it

921
00:32:39,029 --> 00:32:38,240
were not for the moon we would not have

922
00:32:42,149 --> 00:32:39,039
seasons

923
00:32:42,630 --> 00:32:42,159
and probably um the axis of the earth

924
00:32:45,750 --> 00:32:42,640
would

925
00:32:47,590 --> 00:32:45,760
um just uh move around like crazy and we

926
00:32:49,669 --> 00:32:47,600
would have crazy weather

927
00:32:51,509 --> 00:32:49,679
we are already doing that i know but

928
00:32:53,269 --> 00:32:51,519
that's a different thing at least

929
00:32:54,710 --> 00:32:53,279
uh the moon is not messing up with our

930
00:32:57,350 --> 00:32:54,720
weather it's taking care of us

931
00:32:59,269 --> 00:32:57,360
so yeah thanks moon um so moon is really

932
00:33:02,149 --> 00:32:59,279
important for life on earth so

933
00:33:04,710 --> 00:33:02,159
when looking um outside to other planets

934
00:33:08,070 --> 00:33:04,720
maybe we should consider how effects

935
00:33:10,710 --> 00:33:08,080
moons could have on other planets um

936
00:33:11,909 --> 00:33:10,720
but not only the moon has influence on

937
00:33:13,909 --> 00:33:11,919
life on earth

938
00:33:16,149 --> 00:33:13,919

um we're not so sure about this but we

939
00:33:19,590 --> 00:33:16,159
think comets and asteroids are also

940
00:33:23,269 --> 00:33:19,600
fundamental for uh life on earth

941
00:33:24,710 --> 00:33:23,279
um one of the mechanisms that

942
00:33:26,310 --> 00:33:24,720
are used to explain the presence of

943
00:33:29,430 --> 00:33:26,320
water on earth because

944
00:33:30,789 --> 00:33:29,440
if we just consider the moment of

945
00:33:33,430 --> 00:33:30,799
earth's formation

946
00:33:35,190 --> 00:33:33,440
it would not have been possible to have

947
00:33:38,310 --> 00:33:35,200
the huge amount of water we have

948
00:33:41,669 --> 00:33:38,320
now in oceans river in the

949
00:33:43,990 --> 00:33:41,679
arctic um in in the form of ice

950
00:33:45,430 --> 00:33:44,000
it would have just evaporated um so the

951
00:33:47,750 --> 00:33:45,440
water must have

952
00:33:49,909 --> 00:33:47,760
come from somewhere else uh one of the

953
00:33:51,909 --> 00:33:49,919
theories is that it actually came

954
00:33:53,750 --> 00:33:51,919
either in carbon assists concretes that

955
00:33:56,950 --> 00:33:53,760
are a type of asteroids

956
00:33:57,909 --> 00:33:56,960
or in main belt comets um so those

957
00:34:00,310 --> 00:33:57,919
bodies

958
00:34:01,909 --> 00:34:00,320
do have a lot of water ice because they

959
00:34:04,389 --> 00:34:01,919
were formed

960
00:34:05,110 --> 00:34:04,399
way further from the sand than earth was

961
00:34:07,990 --> 00:34:05,120
formed

962
00:34:09,030 --> 00:34:08,000
so just by dynamical interactions in

963
00:34:12,069 --> 00:34:09,040

between the

964
00:34:12,629 --> 00:34:12,079
the solar system um these bodies could

965
00:34:15,430 --> 00:34:12,639
have

966
00:34:16,629 --> 00:34:15,440
collided with earth um and just dropped

967
00:34:20,149 --> 00:34:16,639
an insane amount

968
00:34:22,149 --> 00:34:20,159
of material including water

969
00:34:23,270 --> 00:34:22,159
and we have some meteorites of carbon

970
00:34:26,550 --> 00:34:23,280
chondroids

971
00:34:28,950 --> 00:34:26,560
that apparently um indicate that

972
00:34:29,829 --> 00:34:28,960
the type of water that is found in

973
00:34:32,069 --> 00:34:29,839
meteorites

974
00:34:33,030 --> 00:34:32,079
would be compatible with what's found on

975
00:34:36,470 --> 00:34:33,040
earth

976
00:34:37,750 --> 00:34:36,480
but this is just um hypothesis uh

977
00:34:40,629 --> 00:34:37,760
obviously it's really hard to prove

978
00:34:41,829 --> 00:34:40,639
something like this um for example 67p

979
00:34:42,629 --> 00:34:41,839
the comment that i was talking about

980
00:34:45,510 --> 00:34:42,639
before

981
00:34:46,790 --> 00:34:45,520
actually showed a different type of

982
00:34:49,030 --> 00:34:46,800
water

983
00:34:50,550 --> 00:34:49,040
regarding the isotope level than the

984
00:34:52,149 --> 00:34:50,560
water that is found on earth

985
00:34:53,990 --> 00:34:52,159
so that kind of ruled out the theory

986
00:34:55,510 --> 00:34:54,000
that it was comets but then other type

987
00:34:58,310 --> 00:34:55,520
of comets were found that actually

988
00:34:58,870 --> 00:34:58,320

have much more water and have the same

989
00:35:00,950 --> 00:34:58,880
um

990
00:35:02,870 --> 00:35:00,960
isotopes ratio than the water on earth

991
00:35:06,310 --> 00:35:02,880
so this is sort of for coming and going

992
00:35:08,710 --> 00:35:06,320
but it's um kind of very established

993
00:35:11,030 --> 00:35:08,720
that comets and asteroids had something

994
00:35:14,550 --> 00:35:11,040
to do with the amount of water we have

995
00:35:17,750 --> 00:35:14,560
um there is also some theories that are

996
00:35:21,510 --> 00:35:17,760
um obviously very hard to prove

997
00:35:23,990 --> 00:35:21,520
that life itself came from outer space

998
00:35:25,109 --> 00:35:24,000
um in a comet that just collided on

999
00:35:27,349 --> 00:35:25,119
earth and left

1000
00:35:29,510 --> 00:35:27,359
the basic amino acids or even maybe

1001
00:35:33,670 --> 00:35:29,520
proteins

1002
00:35:35,750 --> 00:35:33,680
took needed to form life um so

1003
00:35:38,069 --> 00:35:35,760
there's um theory that it could have

1004
00:35:39,829 --> 00:35:38,079
come even from the intergalactic space

1005
00:35:41,430 --> 00:35:39,839
which is not from the solar system and

1006
00:35:42,790 --> 00:35:41,440
there's also

1007
00:35:45,109 --> 00:35:42,800
obviously claims that it could have come

1008
00:35:46,470 --> 00:35:45,119
from mars we just we just don't know

1009
00:35:48,390 --> 00:35:46,480
but it's something that it's out there

1010
00:35:50,310 --> 00:35:48,400
and that is it's something that

1011
00:35:52,790 --> 00:35:50,320
we think of and we consider when trying

1012
00:35:53,510 --> 00:35:52,800
to explain uh the characteristics of the

1013
00:35:58,150 --> 00:35:53,520

earth

1014
00:36:00,470 --> 00:35:58,160
obviously these bodies are really really

1015
00:36:01,750 --> 00:36:00,480
important like moons asteroids comets

1016
00:36:03,750 --> 00:36:01,760
are really really important when

1017
00:36:05,430 --> 00:36:03,760
considering habitability and when

1018
00:36:08,870 --> 00:36:05,440
considering the presence of life

1019
00:36:10,710 --> 00:36:08,880
in other planets so um

1020
00:36:11,990 --> 00:36:10,720
how do we find these bodies outside our

1021
00:36:15,270 --> 00:36:12,000
solar system

1022
00:36:17,349 --> 00:36:15,280
where are these bodies so um

1023
00:36:19,030 --> 00:36:17,359
they are really difficult to find it is

1024
00:36:22,310 --> 00:36:19,040
really difficult to find planets

1025
00:36:23,109 --> 00:36:22,320
and up until a couple of years ago 10

1026
00:36:25,750 --> 00:36:23,119
years ago

1027
00:36:26,390 --> 00:36:25,760
we barely knew any planets uh now we

1028
00:36:28,069 --> 00:36:26,400
know like

1029
00:36:30,310 --> 00:36:28,079
four thousand more than four thousand of

1030
00:36:32,710 --> 00:36:30,320
them but um

1031
00:36:34,150 --> 00:36:32,720
it was not so common years ago so it's

1032
00:36:35,829 --> 00:36:34,160
it's hard to find planets and it's

1033
00:36:37,750 --> 00:36:35,839
really really hard to find small bodies

1034
00:36:40,870 --> 00:36:37,760
because they're way smaller than planets

1035
00:36:44,390 --> 00:36:40,880
uh we do have some workarounds

1036
00:36:48,230 --> 00:36:44,400
um so i'm gonna start with moons um

1037
00:36:51,510 --> 00:36:48,240
this is kind of controversial um

1038
00:36:53,910 --> 00:36:51,520

no moons to these they have been

1039
00:36:54,630 --> 00:36:53,920
found around planets outside the solar

1040
00:36:57,670 --> 00:36:54,640
system

1041
00:37:00,710 --> 00:36:57,680
there was a claim for one uh but the

1042
00:37:02,950 --> 00:37:00,720
just the same authors that um published

1043
00:37:06,069 --> 00:37:02,960
evidence for uh for our next moon

1044
00:37:08,069 --> 00:37:06,079
um retracted it they said that um

1045
00:37:09,430 --> 00:37:08,079
it was probably an error with the data

1046
00:37:11,670 --> 00:37:09,440
that um

1047
00:37:13,750 --> 00:37:11,680
it's not that it's not there just that

1048
00:37:16,550 --> 00:37:13,760
it's not so clear that it's there

1049
00:37:17,589 --> 00:37:16,560
so we have no evidence at all about

1050
00:37:19,430 --> 00:37:17,599
exomoons

1051
00:37:21,589 --> 00:37:19,440
um and there's a couple of techniques to

1052
00:37:24,790 --> 00:37:21,599
look for them um

1053
00:37:25,910 --> 00:37:24,800
the one that i think it's more easy to

1054
00:37:29,030 --> 00:37:25,920
understand it's

1055
00:37:31,030 --> 00:37:29,040
the one uh of the transits so we

1056
00:37:34,870 --> 00:37:31,040
basically have the light of the star

1057
00:37:36,630 --> 00:37:34,880
um constant let's say the like the star

1058
00:37:38,630 --> 00:37:36,640
does not vary even though if there is

1059
00:37:40,950 --> 00:37:38,640
variations we can also account for them

1060
00:37:42,069 --> 00:37:40,960
we can model them and as the tran the

1061
00:37:45,190 --> 00:37:42,079
planet transits

1062
00:37:46,950 --> 00:37:45,200
um the the light of the star drops a

1063
00:37:48,230 --> 00:37:46,960

little bit it looks like a lot here but

1064
00:37:49,670 --> 00:37:48,240
it's actually just a little bit so we

1065
00:37:53,109 --> 00:37:49,680
have to be very precise

1066
00:37:55,190 --> 00:37:53,119
um and when the planet passes um

1067
00:37:57,430 --> 00:37:55,200
we go back to the normal amount of light

1068
00:37:59,750 --> 00:37:57,440
of the star but then the moon passes

1069
00:38:01,910 --> 00:37:59,760
and the moon creates another even

1070
00:38:03,910 --> 00:38:01,920
smaller transit

1071
00:38:05,349 --> 00:38:03,920
so this would be one way to find them to

1072
00:38:08,230 --> 00:38:05,359
actually look for these

1073
00:38:09,510 --> 00:38:08,240
double transits uh but this is really

1074
00:38:11,349 --> 00:38:09,520
really difficult to do

1075
00:38:13,030 --> 00:38:11,359
uh and then there is some other uh

1076
00:38:14,470 --> 00:38:13,040
techniques also based on

1077
00:38:16,470 --> 00:38:14,480
on the variations on the light of the

1078
00:38:17,990 --> 00:38:16,480
star um but they're

1079
00:38:21,349 --> 00:38:18,000
way more complicated and didn't want to

1080
00:38:24,470 --> 00:38:21,359
get uh into that too much

1081
00:38:25,270 --> 00:38:24,480
so let's move on um to the next small

1082
00:38:29,270 --> 00:38:25,280
bodies which are

1083
00:38:31,910 --> 00:38:29,280
asteroids um so asteroids are

1084
00:38:32,870 --> 00:38:31,920
already found in debris disks this is

1085
00:38:35,510 --> 00:38:32,880
the first

1086
00:38:36,950 --> 00:38:35,520
stage of planet formation where we can

1087
00:38:40,069 --> 00:38:36,960
try to find them

1088
00:38:42,710 --> 00:38:40,079

um but they're small

1089
00:38:43,990 --> 00:38:42,720
and they're dark they don't bright or

1090
00:38:46,710 --> 00:38:44,000
shine or anything

1091
00:38:47,589 --> 00:38:46,720
so we actually have a hard time trying

1092
00:38:50,870 --> 00:38:47,599
to find them

1093
00:38:54,790 --> 00:38:50,880
but we what we can do is try to find

1094
00:38:56,150 --> 00:38:54,800
um uh indirect outcome of asteroids

1095
00:38:58,950 --> 00:38:56,160
which is dust

1096
00:39:00,069 --> 00:38:58,960
so dust is actually found also in the

1097
00:39:02,710 --> 00:39:00,079
solar system

1098
00:39:03,190 --> 00:39:02,720
um and in many many planetary systems

1099
00:39:06,710 --> 00:39:03,200
because

1100
00:39:09,589 --> 00:39:06,720
when asteroids collide um they break

1101
00:39:11,270 --> 00:39:09,599
they break down and they release a large

1102
00:39:13,990 --> 00:39:11,280
amount of dust

1103
00:39:15,750 --> 00:39:14,000
that it's found around sorry around the

1104
00:39:17,030 --> 00:39:15,760
terrestrial planets are in the asteroid

1105
00:39:19,510 --> 00:39:17,040
belt in the kuiper belt

1106
00:39:21,190 --> 00:39:19,520
and we can see that um when looking at

1107
00:39:22,230 --> 00:39:21,200
the light of the star in different

1108
00:39:24,390 --> 00:39:22,240
wavelengths

1109
00:39:25,670 --> 00:39:24,400
so uh with different light with

1110
00:39:27,510 --> 00:39:25,680
different energy

1111
00:39:29,510 --> 00:39:27,520
um i will try to explain this a bit

1112
00:39:31,829 --> 00:39:29,520
later um

1113
00:39:33,589 --> 00:39:31,839

we can see that there is not always the

1114
00:39:34,630 --> 00:39:33,599
same amount of light depending on the

1115
00:39:36,310 --> 00:39:34,640
energy of the light

1116
00:39:37,990 --> 00:39:36,320
let's say this is more blue and this is

1117
00:39:40,950 --> 00:39:38,000
more red um

1118
00:39:43,510 --> 00:39:40,960
so we know for example our sun writes uh

1119
00:39:46,950 --> 00:39:43,520
shines a lot in the green color

1120
00:39:49,990 --> 00:39:46,960
um but not so much on the blue

1121
00:39:52,230 --> 00:39:50,000
and not so much on the red um

1122
00:39:53,670 --> 00:39:52,240
so this is depending on the temperature

1123
00:39:57,109 --> 00:39:53,680
of the star mostly

1124
00:40:00,630 --> 00:39:57,119
um but then uh we have

1125
00:40:02,470 --> 00:40:00,640
found that some stars do not bright

1126
00:40:04,069 --> 00:40:02,480
do not shine or do not emit the light

1127
00:40:08,309 --> 00:40:04,079
that we expect

1128
00:40:10,230 --> 00:40:08,319
them to emit uh but they do emit more

1129
00:40:11,829 --> 00:40:10,240
for example when we reach the infrared

1130
00:40:15,109 --> 00:40:11,839
region

1131
00:40:17,670 --> 00:40:15,119
there are stars that are

1132
00:40:18,309 --> 00:40:17,680
way way brighter than we would expect so

1133
00:40:20,390 --> 00:40:18,319
this is

1134
00:40:21,990 --> 00:40:20,400
how we respect the the light of the star

1135
00:40:23,910 --> 00:40:22,000
and this is what we actually see

1136
00:40:25,990 --> 00:40:23,920
so what is happening here so what is

1137
00:40:28,309 --> 00:40:26,000
happening here is that a lot of material

1138
00:40:29,349 --> 00:40:28,319

around the the disc it's absorbing the

1139
00:40:31,349 --> 00:40:29,359
light of the star

1140
00:40:32,390 --> 00:40:31,359
and re-emitting it in a different

1141
00:40:35,510 --> 00:40:32,400
wavelength

1142
00:40:38,950 --> 00:40:35,520
um so dust lags a lot

1143
00:40:40,870 --> 00:40:38,960
um to emit in infrared wavelengths

1144
00:40:42,550 --> 00:40:40,880
and so that's why if there is a lot of

1145
00:40:43,910 --> 00:40:42,560
dust there is a lot of material that

1146
00:40:45,589 --> 00:40:43,920
it's emitting in this infrared

1147
00:40:46,870 --> 00:40:45,599
wavelength satellite that it has just

1148
00:40:50,309 --> 00:40:46,880
absorbed from star

1149
00:40:52,230 --> 00:40:50,319
so we have this huge bump um

1150
00:40:53,349 --> 00:40:52,240
in the spectra of the star in sorry in

1151
00:40:54,630 --> 00:40:53,359
the light of the star

1152
00:40:56,390 --> 00:40:54,640
that it's not actually coming from the

1153
00:40:59,670 --> 00:40:56,400
star it's just coming from the dust

1154
00:41:00,550 --> 00:40:59,680
um and the asteroid belt also can emit

1155
00:41:03,109 --> 00:41:00,560
some light

1156
00:41:04,470 --> 00:41:03,119
uh but because it is closer to the star

1157
00:41:07,670 --> 00:41:04,480
it is hotter it is

1158
00:41:08,790 --> 00:41:07,680
more energetic it's um completely

1159
00:41:11,430 --> 00:41:08,800
different wavelength

1160
00:41:13,430 --> 00:41:11,440
and it's really hard to see um compared

1161
00:41:15,190 --> 00:41:13,440
to the to the light of the star

1162
00:41:17,589 --> 00:41:15,200
so yeah this is this is the way we have

1163
00:41:20,230 --> 00:41:17,599

to to detect asteroids just by

1164
00:41:21,349 --> 00:41:20,240
the outcome of their collisions the dust

1165
00:41:24,710 --> 00:41:21,359
and we do know

1166
00:41:27,270 --> 00:41:24,720
a lot of um a lot of systems that

1167
00:41:28,790 --> 00:41:27,280
have a lot of dust and therefore they

1168
00:41:31,430 --> 00:41:28,800
probably have

1169
00:41:31,990 --> 00:41:31,440
a lot of asteroids or plantationals in

1170
00:41:34,870 --> 00:41:32,000
them

1171
00:41:35,670 --> 00:41:34,880
um and these are like in the images in

1172
00:41:37,589 --> 00:41:35,680
the infrared

1173
00:41:39,030 --> 00:41:37,599
uh you can see they're very very bright

1174
00:41:40,550 --> 00:41:39,040
um because

1175
00:41:42,950 --> 00:41:40,560
that's really like swimming in the

1176
00:41:43,349 --> 00:41:42,960
infrared um and the star here we cannot

1177
00:41:44,870 --> 00:41:43,359
see it

1178
00:41:46,550 --> 00:41:44,880
it's it's also really bright but we

1179
00:41:47,270 --> 00:41:46,560
cannot see it because it's obscured with

1180
00:41:50,309 --> 00:41:47,280
this

1181
00:41:52,069 --> 00:41:50,319
um physical

1182
00:41:53,829 --> 00:41:52,079
dot that it's it's actually a thing that

1183
00:41:55,589 --> 00:41:53,839
we put on telescopes to

1184
00:41:57,030 --> 00:41:55,599
to block the light of the star and it's

1185
00:42:00,309 --> 00:41:57,040
called a chronograph

1186
00:42:03,030 --> 00:42:00,319
um so yeah we can see

1187
00:42:04,150 --> 00:42:03,040
the outcome of the presence of asteroids

1188
00:42:06,390 --> 00:42:04,160

um

1189
00:42:08,150 --> 00:42:06,400
there is a type of asteroid though that

1190
00:42:11,190 --> 00:42:08,160
some people have tried to look for

1191
00:42:13,190 --> 00:42:11,200
there are called the trojan asteroids um

1192
00:42:14,630 --> 00:42:13,200
in our solar system the most massive

1193
00:42:17,910 --> 00:42:14,640
planet is jupiter

1194
00:42:20,950 --> 00:42:17,920
and it has a special effect it's it's

1195
00:42:22,870 --> 00:42:20,960
it's gravity has special effects on on

1196
00:42:26,069 --> 00:42:22,880
the asteroids that are around them

1197
00:42:29,990 --> 00:42:26,079
um what it tends to do it's to

1198
00:42:32,069 --> 00:42:30,000
um attract asteroids to share the orbit

1199
00:42:33,990 --> 00:42:32,079
so they they rotate around the sun in

1200
00:42:37,030 --> 00:42:34,000
the same orbits jupiter does

1201
00:42:38,630 --> 00:42:37,040
but in these special points um

1202
00:42:40,550 --> 00:42:38,640
there are a specific distance from the

1203
00:42:42,390 --> 00:42:40,560
sun as well so it's a combination of the

1204
00:42:44,470 --> 00:42:42,400
gravity of jupiter and the sun

1205
00:42:46,790 --> 00:42:44,480
um and so it's it's like they're

1206
00:42:47,109 --> 00:42:46,800
following jupiter along its orbit or

1207
00:42:50,309 --> 00:42:47,119
like

1208
00:42:51,109 --> 00:42:50,319
protecting it or something um so this is

1209
00:42:53,750 --> 00:42:51,119
what we call

1210
00:42:54,470 --> 00:42:53,760
um the the trojan asteroids that are

1211
00:42:56,790 --> 00:42:54,480
located

1212
00:42:59,990 --> 00:42:56,800
uh normally in these lagrangian points

1213
00:43:02,150 --> 00:43:00,000

which are just like um

1214
00:43:03,990 --> 00:43:02,160
points where the gravity and the sun of

1215
00:43:06,550 --> 00:43:04,000
the in the case of sources the sun

1216
00:43:07,910 --> 00:43:06,560
and the planets are combined um and we

1217
00:43:08,790 --> 00:43:07,920
don't think this happens in other

1218
00:43:10,550 --> 00:43:08,800
planetary systems

1219
00:43:11,670 --> 00:43:10,560
of course like it's it's a physical

1220
00:43:12,550 --> 00:43:11,680
thing it's a mathematical thing it

1221
00:43:14,470 --> 00:43:12,560
happens

1222
00:43:16,630 --> 00:43:14,480
um so there is people that are trying to

1223
00:43:19,190 --> 00:43:16,640
find this asteroid so far

1224
00:43:20,150 --> 00:43:19,200
that i know they have not found evidence

1225
00:43:21,430 --> 00:43:20,160
of it yet

1226
00:43:22,470 --> 00:43:21,440
but it's a really cool project if you

1227
00:43:23,589 --> 00:43:22,480
want to check it out it's called the

1228
00:43:27,270 --> 00:43:23,599
troy project because

1229
00:43:28,870 --> 00:43:27,280
it's true um so yeah really interesting

1230
00:43:31,430 --> 00:43:28,880
uh let's hope to see

1231
00:43:32,069 --> 00:43:31,440
if they find anything in the near future

1232
00:43:34,630 --> 00:43:32,079
um

1233
00:43:36,150 --> 00:43:34,640
and so without further ado i'm gonna go

1234
00:43:39,589 --> 00:43:36,160
to my favorite ones

1235
00:43:40,069 --> 00:43:39,599
which are the comments um they are just

1236
00:43:41,270 --> 00:43:40,079
my favorite

1237
00:43:43,109 --> 00:43:41,280
ones because i spend so much time

1238
00:43:44,790 --> 00:43:43,119

studying them that i feel like

1239
00:43:46,150 --> 00:43:44,800
i have a bit more knowledge so i like

1240
00:43:49,589 --> 00:43:46,160
them so much

1241
00:43:53,190 --> 00:43:49,599
uh but to talk about comments i'm

1242
00:43:54,710 --> 00:43:53,200
gonna make a quick parenthesis here

1243
00:43:55,990 --> 00:43:54,720
and talk about wavelength which is

1244
00:43:57,190 --> 00:43:56,000
something that i've been commenting

1245
00:44:00,710 --> 00:43:57,200
about on the talk but

1246
00:44:03,750 --> 00:44:00,720
um just hold with me

1247
00:44:06,150 --> 00:44:03,760
um so the light if you

1248
00:44:07,829 --> 00:44:06,160
liked rock music from the 70s you know

1249
00:44:10,870 --> 00:44:07,839
the light

1250
00:44:11,589 --> 00:44:10,880
when it passes through a prism it

1251
00:44:14,950 --> 00:44:11,599
separates

1252
00:44:17,030 --> 00:44:14,960
into a rainbow if you like rainbows you

1253
00:44:20,150 --> 00:44:17,040
probably also know this

1254
00:44:23,510 --> 00:44:20,160
but if we put it

1255
00:44:27,670 --> 00:44:23,520
through a very very fine prism

1256
00:44:30,309 --> 00:44:27,680
we can actually see a lot of features

1257
00:44:31,430 --> 00:44:30,319
in that rainbow if we do it with the

1258
00:44:34,069 --> 00:44:31,440
light of the sun

1259
00:44:34,710 --> 00:44:34,079
we get something like this we do get a

1260
00:44:38,630 --> 00:44:34,720
rainbow

1261
00:44:42,069 --> 00:44:38,640
vertical lines that

1262
00:44:43,190 --> 00:44:42,079
um are marking uh very specific

1263
00:44:45,430 --> 00:44:43,200

characteristics

1264
00:44:46,790 --> 00:44:45,440
of the sun it's like the fingerprints

1265
00:44:48,309 --> 00:44:46,800
it's something that's found in the sun

1266
00:44:49,910 --> 00:44:48,319
that could not be found in any other

1267
00:44:53,030 --> 00:44:49,920
star

1268
00:44:55,430 --> 00:44:53,040
so it kind of helps us

1269
00:44:56,390 --> 00:44:55,440
study it very well and what is causing

1270
00:44:59,030 --> 00:44:56,400
these fingerprints

1271
00:45:01,270 --> 00:44:59,040
this this features is basically the

1272
00:45:03,589 --> 00:45:01,280
material in the photosphere of the sun

1273
00:45:05,670 --> 00:45:03,599
so the sun produces light and that light

1274
00:45:08,069 --> 00:45:05,680
um goes through the whole

1275
00:45:09,829 --> 00:45:08,079
solar system this one astronomical unit

1276
00:45:13,030 --> 00:45:09,839
until it reaches the earth

1277
00:45:14,470 --> 00:45:13,040
and that light um it's also going

1278
00:45:17,910 --> 00:45:14,480
through the photosphere of the sun

1279
00:45:20,069 --> 00:45:17,920
there is material surrounding the sun

1280
00:45:21,510 --> 00:45:20,079
that that light transverses and that

1281
00:45:23,349 --> 00:45:21,520
material

1282
00:45:24,710 --> 00:45:23,359
is absorbing the light emitted from the

1283
00:45:26,230 --> 00:45:24,720
sun um

1284
00:45:28,150 --> 00:45:26,240
and if you know a little bit about

1285
00:45:30,069 --> 00:45:28,160
atomic physics or molecular physics

1286
00:45:32,150 --> 00:45:30,079
you will know that each atom and each

1287
00:45:36,230 --> 00:45:32,160
molecule have their very

1288
00:45:38,630 --> 00:45:36,240

specific light that they like to absorb

1289
00:45:39,589 --> 00:45:38,640
and that's what creates a very specific

1290
00:45:42,790 --> 00:45:39,599
line

1291
00:45:45,430 --> 00:45:42,800
so for example um i

1292
00:45:47,750 --> 00:45:45,440
think these are the sodium ones so

1293
00:45:50,870 --> 00:45:47,760
sodium really really likes

1294
00:45:51,670 --> 00:45:50,880
that particularly type of yellow so it

1295
00:45:55,349 --> 00:45:51,680
will absorb it

1296
00:45:57,910 --> 00:45:55,359
and will create this feature so we

1297
00:45:59,510 --> 00:45:57,920
try to not only take this into account

1298
00:46:02,630 --> 00:45:59,520
but also take into account how

1299
00:46:03,430 --> 00:46:02,640
much the sun brides in each different

1300
00:46:06,550 --> 00:46:03,440
color

1301
00:46:10,390 --> 00:46:06,560
um we can find something like this um

1302
00:46:13,349 --> 00:46:10,400
which i think it's a very cool uh plot

1303
00:46:14,950 --> 00:46:13,359
so this that it's um more transparent in

1304
00:46:16,230 --> 00:46:14,960
the background it's actually what the

1305
00:46:18,870 --> 00:46:16,240
sun emits

1306
00:46:21,270 --> 00:46:18,880
um and you see it emits a lot here this

1307
00:46:23,670 --> 00:46:21,280
is the visible light that we can see

1308
00:46:24,550 --> 00:46:23,680
um and this small features that you have

1309
00:46:27,829 --> 00:46:24,560
seen before

1310
00:46:28,630 --> 00:46:27,839
are these dents are the ones causing

1311
00:46:30,710 --> 00:46:28,640
distance

1312
00:46:31,910 --> 00:46:30,720
and the more resolution we have the more

1313
00:46:36,710 --> 00:46:31,920

dense we can see

1314
00:46:39,349 --> 00:46:36,720
and the more elements we can identify um

1315
00:46:41,589 --> 00:46:39,359
for example here you can see this is the

1316
00:46:43,349 --> 00:46:41,599
light that it's emitted by the sun

1317
00:46:45,670 --> 00:46:43,359
but this is only the light that breaches

1318
00:46:46,950 --> 00:46:45,680
us and that's because this light is also

1319
00:46:49,990 --> 00:46:46,960
passing through another

1320
00:46:50,710 --> 00:46:50,000
atmosphere our own atmosphere um and

1321
00:46:54,829 --> 00:46:50,720
these

1322
00:46:57,750 --> 00:46:54,839
huge chunks here um it's our atmosphere

1323
00:46:59,270 --> 00:46:57,760
absorbing all the infrared light and

1324
00:47:01,670 --> 00:46:59,280
this is absorbed by the water

1325
00:47:02,630 --> 00:47:01,680
in our atmosphere so we basically cannot

1326
00:47:05,829 --> 00:47:02,640
see

1327
00:47:06,550 --> 00:47:05,839
um cannot try to look for water from the

1328
00:47:10,309 --> 00:47:06,560
earth

1329
00:47:13,510 --> 00:47:10,319
because the light that would be um

1330
00:47:14,710 --> 00:47:13,520
absorbed by water in other planetary

1331
00:47:16,790 --> 00:47:14,720
systems in other planets

1332
00:47:18,390 --> 00:47:16,800
it's already absorbed by our planet so

1333
00:47:21,670 --> 00:47:18,400
it's really difficult to see

1334
00:47:23,829 --> 00:47:21,680
and here it's a very important part also

1335
00:47:25,109 --> 00:47:23,839
because uh our atmosphere is absorbing

1336
00:47:28,470 --> 00:47:25,119
all of these light

1337
00:47:29,829 --> 00:47:28,480
which is very energetic and it can cause

1338
00:47:34,309 --> 00:47:29,839

cancer and this is why

1339
00:47:35,670 --> 00:47:34,319
we wear a sunscreen in the summer

1340
00:47:38,069 --> 00:47:35,680
or if we're going to be in the sun for a

1341
00:47:39,589 --> 00:47:38,079
long time um so yeah thank you

1342
00:47:42,950 --> 00:47:39,599
atmosphere

1343
00:47:45,829 --> 00:47:42,960
so um going back to comets uh

1344
00:47:46,549 --> 00:47:45,839
if we um zoom in and we have a very high

1345
00:47:49,829 --> 00:47:46,559
resolution

1346
00:47:52,390 --> 00:47:49,839
in this region in the visible region um

1347
00:47:54,069 --> 00:47:52,400
we can see all of these features all of

1348
00:47:57,270 --> 00:47:54,079
these tiny tiny features

1349
00:48:00,549 --> 00:47:57,280
um we can see them located in here

1350
00:48:03,430 --> 00:48:00,559
and i'm gonna zoom in in a region like

1351
00:48:04,470 --> 00:48:03,440
here more or less and this is one of

1352
00:48:06,309 --> 00:48:04,480
those features

1353
00:48:07,910 --> 00:48:06,319
this is not for the sun this is for the

1354
00:48:11,510 --> 00:48:07,920
star beta pictoris

1355
00:48:13,670 --> 00:48:11,520
and this is a feature this is assuming

1356
00:48:16,950 --> 00:48:13,680
in one of the features and this one is

1357
00:48:22,150 --> 00:48:19,990
and if you pay attention to it

1358
00:48:24,549 --> 00:48:22,160
it's very obvious that there is not only

1359
00:48:26,710 --> 00:48:24,559
that feature but this feature

1360
00:48:28,150 --> 00:48:26,720
so what is this this is caused by the

1361
00:48:30,390 --> 00:48:28,160
calcium

1362
00:48:31,670 --> 00:48:30,400
in the photosphere of this star of beta

1363
00:48:34,390 --> 00:48:31,680

pictoris

1364
00:48:35,990 --> 00:48:34,400
so these must be caused by the calcium

1365
00:48:38,470 --> 00:48:36,000
located somewhere else

1366
00:48:39,510 --> 00:48:38,480
and we believe we're pretty sure that

1367
00:48:41,910 --> 00:48:39,520
this calcium

1368
00:48:44,069 --> 00:48:41,920
um it's actually located in the

1369
00:48:47,990 --> 00:48:44,079
circumstellar medium of the star so it's

1370
00:48:50,309 --> 00:48:48,000
very close to star it's it's in the disk

1371
00:48:51,109 --> 00:48:50,319
and then other thing you can see in this

1372
00:48:53,910 --> 00:48:51,119
image

1373
00:48:54,710 --> 00:48:53,920
is that depending on the date there is

1374
00:48:59,109 --> 00:48:54,720
also these

1375
00:49:05,109 --> 00:49:03,190
that must be calcium somewhere else

1376
00:49:06,549 --> 00:49:05,119
this is always in the gaseous form by

1377
00:49:08,950 --> 00:49:06,559
the way um

1378
00:49:11,190 --> 00:49:08,960
so the explanation for this first please

1379
00:49:14,069 --> 00:49:11,200
note this is 1987.

1380
00:49:15,589 --> 00:49:14,079
um i was not born by then the

1381
00:49:18,870 --> 00:49:15,599
explanation for this was this

1382
00:49:22,710 --> 00:49:18,880
given uh 10 years later

1383
00:49:24,470 --> 00:49:22,720
which is basically this is a comet um

1384
00:49:26,630 --> 00:49:24,480
we have a star here and we are looking

1385
00:49:28,309 --> 00:49:26,640
from here and if a comet passes in front

1386
00:49:31,190 --> 00:49:28,319
of the star

1387
00:49:32,790 --> 00:49:31,200
with his huge tail of gas that it's

1388
00:49:33,430 --> 00:49:32,800

evaporating because it's really close to

1389
00:49:36,230 --> 00:49:33,440
star

1390
00:49:38,230 --> 00:49:36,240
it will create one of these features uh

1391
00:49:40,069 --> 00:49:38,240
in the calcium line which is

1392
00:49:41,589 --> 00:49:40,079
the one that i'm showing here so every

1393
00:49:44,150 --> 00:49:41,599
time a comment passes by

1394
00:49:45,829 --> 00:49:44,160
it generates one of these so these

1395
00:49:48,230 --> 00:49:45,839
things that are seen here are

1396
00:49:49,349 --> 00:49:48,240
comments around other stars a star

1397
00:49:53,510 --> 00:49:49,359
different than the sun they're

1398
00:49:57,190 --> 00:49:53,520
exo comets again this was 1987 it was

1399
00:49:59,270 --> 00:49:57,200
crazy to say this was um

1400
00:50:01,109 --> 00:49:59,280
and exo comets because we didn't even

1401
00:50:02,870 --> 00:50:01,119
have detected the first comet

1402
00:50:05,270 --> 00:50:02,880
sorry the first planet by then we didn't

1403
00:50:07,030 --> 00:50:05,280
have exoplanets how could this be exodus

1404
00:50:08,309 --> 00:50:07,040
so they had to call them falling

1405
00:50:11,349 --> 00:50:08,319
evaporating bodies

1406
00:50:14,470 --> 00:50:11,359
uh not to upset the community

1407
00:50:15,829 --> 00:50:14,480
but comets in the solar system have two

1408
00:50:18,230 --> 00:50:15,839
different faces

1409
00:50:19,589 --> 00:50:18,240
a gaseous one and a dusty one that

1410
00:50:22,150 --> 00:50:19,599
sometimes we can distinguish

1411
00:50:23,190 --> 00:50:22,160
sometimes we can't and these that i have

1412
00:50:26,309 --> 00:50:23,200
just showed you

1413
00:50:29,030 --> 00:50:26,319

is the gaseous phase so

1414
00:50:29,910 --> 00:50:29,040
what happens with the dusty face well

1415
00:50:33,270 --> 00:50:29,920
what happens

1416
00:50:35,030 --> 00:50:33,280
is that we can also see it but um the

1417
00:50:35,910 --> 00:50:35,040
first time we detected an exocomet it

1418
00:50:38,069 --> 00:50:35,920
was this

1419
00:50:39,510 --> 00:50:38,079
uh this was actually reported in 2016

1420
00:50:41,510 --> 00:50:39,520
but the paper did not came out until

1421
00:50:43,510 --> 00:50:41,520
2018

1422
00:50:44,950 --> 00:50:43,520
and this was done with kepler data with

1423
00:50:46,230 --> 00:50:44,960
space telescope kepler

1424
00:50:48,230 --> 00:50:46,240
which was a mission that took

1425
00:50:50,470 --> 00:50:48,240
photometric points so it measured the

1426
00:50:53,430 --> 00:50:50,480
light coming from the star

1427
00:50:54,309 --> 00:50:53,440
at different times and you could see how

1428
00:50:57,589 --> 00:50:54,319
it drops

1429
00:51:00,870 --> 00:50:57,599
here uh in a very weird shark fin

1430
00:51:02,549 --> 00:51:00,880
shape um and these are comets

1431
00:51:04,470 --> 00:51:02,559
uh and the explanation for this weird

1432
00:51:07,750 --> 00:51:04,480
shape is just this one

1433
00:51:11,270 --> 00:51:07,760
so comets have a very hard solid

1434
00:51:11,990 --> 00:51:11,280
nucleus that it's basically made of rock

1435
00:51:14,390 --> 00:51:12,000
and ice

1436
00:51:16,710 --> 00:51:14,400
and then they have a huge tail that has

1437
00:51:19,589 --> 00:51:16,720
less and less material the further

1438
00:51:20,150 --> 00:51:19,599

you are from the comet so what we have

1439
00:51:22,630 --> 00:51:20,160
is

1440
00:51:24,069 --> 00:51:22,640
um an ingress so when the comet starts

1441
00:51:25,910 --> 00:51:24,079
passing in front of the star

1442
00:51:27,430 --> 00:51:25,920
that looks like a solid body so it looks

1443
00:51:29,670 --> 00:51:27,440
like the transit of a planet

1444
00:51:31,270 --> 00:51:29,680
and then as the comet passes by we have

1445
00:51:32,470 --> 00:51:31,280
less and less material because the tail

1446
00:51:34,950 --> 00:51:32,480
fades away

1447
00:51:36,309 --> 00:51:34,960
so it has this kind of exponential delay

1448
00:51:39,430 --> 00:51:36,319
you think it's really cool

1449
00:51:42,710 --> 00:51:39,440
um so we do detect comets in gas

1450
00:51:45,910 --> 00:51:42,720
and we do detect comets in um

1451
00:51:47,190 --> 00:51:45,920
in photometry the dust part um but we

1452
00:51:50,309 --> 00:51:47,200
only know a handful of

1453
00:51:52,710 --> 00:51:50,319
stars that actually have comets and

1454
00:51:54,950 --> 00:51:52,720
this is a very nice plot from a sorry

1455
00:51:57,430 --> 00:51:54,960
table from paper that came out this year

1456
00:51:59,430 --> 00:51:57,440
and they have these four stars where

1457
00:52:00,069 --> 00:51:59,440
they say okay we know these are comments

1458
00:52:01,990 --> 00:52:00,079
we have

1459
00:52:03,109 --> 00:52:02,000
proof in different wavelengths or with

1460
00:52:05,750 --> 00:52:03,119
different methods

1461
00:52:06,470 --> 00:52:05,760
and we know these have comments but we

1462
00:52:09,349 --> 00:52:06,480
think

1463
00:52:10,470 --> 00:52:09,359

um some of these also have comments

1464
00:52:12,230 --> 00:52:10,480
we're just not sure

1465
00:52:13,270 --> 00:52:12,240
yet because we come we have only seen

1466
00:52:14,069 --> 00:52:13,280
like a couple of them and these

1467
00:52:15,430 --> 00:52:14,079
variations are

1468
00:52:17,270 --> 00:52:15,440
really really small because comets are

1469
00:52:18,950 --> 00:52:17,280
very small so these

1470
00:52:21,109 --> 00:52:18,960
are all these stars are still being

1471
00:52:24,870 --> 00:52:21,119
studied to check if they're comments

1472
00:52:25,510 --> 00:52:24,880
or not um and this is uh what we know

1473
00:52:26,870 --> 00:52:25,520
about the

1474
00:52:28,790 --> 00:52:26,880
characteristics of the stars that have

1475
00:52:31,990 --> 00:52:28,800
comets um

1476
00:52:34,150 --> 00:52:32,000
basically what we see here is that

1477
00:52:35,589 --> 00:52:34,160
the stars that have comets are rotating

1478
00:52:36,950 --> 00:52:35,599
really fast this is the rotational

1479
00:52:38,870 --> 00:52:36,960
velocity of the star

1480
00:52:40,069 --> 00:52:38,880
um the ones with comets are the yellow

1481
00:52:41,910 --> 00:52:40,079
ones um

1482
00:52:43,829 --> 00:52:41,920
and we also see that they have a

1483
00:52:45,990 --> 00:52:43,839
particular color that is corresponding

1484
00:52:48,630 --> 00:52:46,000
with the stars that are quite hot um

1485
00:52:50,309 --> 00:52:48,640
these stars are called a type stars um

1486
00:52:52,390 --> 00:52:50,319
they're not the hottest ones

1487
00:52:53,430 --> 00:52:52,400
but they're definitely hotter and larger

1488
00:52:55,829 --> 00:52:53,440

than the sun

1489
00:52:57,910 --> 00:52:55,839
and we also see that again the variable

1490
00:53:00,390 --> 00:52:57,920
assertions are the exocomets

1491
00:53:01,829 --> 00:53:00,400
the exocomic candidate stars there is no

1492
00:53:04,150 --> 00:53:01,839
trend with age

1493
00:53:05,109 --> 00:53:04,160
initially we would expect to have a lot

1494
00:53:07,349 --> 00:53:05,119
of comets

1495
00:53:09,589 --> 00:53:07,359
in stars that are very young because

1496
00:53:11,750 --> 00:53:09,599
they are really dynamically active

1497
00:53:13,750 --> 00:53:11,760
the the system is still trying to settle

1498
00:53:14,549 --> 00:53:13,760
down so there's a lot of interactions

1499
00:53:16,230 --> 00:53:14,559
and so on

1500
00:53:18,150 --> 00:53:16,240
but we actually find it in stars that

1501
00:53:20,630 --> 00:53:18,160
are fairly old

1502
00:53:21,349 --> 00:53:20,640
so so yeah we cannot we do not have a

1503
00:53:24,630 --> 00:53:21,359
constraint

1504
00:53:25,670 --> 00:53:24,640
on on when do this exocomic phenomenon

1505
00:53:28,790 --> 00:53:25,680
happen

1506
00:53:31,910 --> 00:53:28,800
um i'm going to talk real quick about

1507
00:53:35,430 --> 00:53:31,920
uh beta victories which is like

1508
00:53:37,670 --> 00:53:35,440
the model star for exo

1509
00:53:38,790 --> 00:53:37,680
comets but it's a mother this model star

1510
00:53:42,069 --> 00:53:38,800
for many many things

1511
00:53:44,069 --> 00:53:42,079
so um if you remember it was the

1512
00:53:46,150 --> 00:53:44,079
star that i was talking about before

1513
00:53:46,710 --> 00:53:46,160

this is the first star where exo-comets

1514
00:53:50,630 --> 00:53:46,720
were found

1515
00:53:51,990 --> 00:53:50,640
in 1987 um but it's it's very

1516
00:53:52,549 --> 00:53:52,000
interesting for many other things like

1517
00:53:55,030 --> 00:53:52,559
it's

1518
00:53:56,630 --> 00:53:55,040
an a-type star as i told before which

1519
00:53:57,990 --> 00:53:56,640
means it's hotter than the sun it's

1520
00:54:00,230 --> 00:53:58,000
larger than the sun

1521
00:54:02,549 --> 00:54:00,240
it's fairly young it's only 23 million

1522
00:54:04,870 --> 00:54:02,559
years old

1523
00:54:06,069 --> 00:54:04,880
well the sun it's way older it's

1524
00:54:09,109 --> 00:54:06,079
thousands

1525
00:54:10,069 --> 00:54:09,119
of millions years it has a very high

1526
00:54:12,390 --> 00:54:10,079
rotational velocity

1527
00:54:13,589 --> 00:54:12,400
like the stars where we have found these

1528
00:54:17,030 --> 00:54:13,599
type of comets

1529
00:54:19,349 --> 00:54:17,040
um it's fairly close uh i know

1530
00:54:21,430 --> 00:54:19,359
10 to the 14th mile sounds really far

1531
00:54:24,710 --> 00:54:21,440
away but it's only 19 per seconds away

1532
00:54:25,430 --> 00:54:24,720
fairly close um and it has a very bright

1533
00:54:28,470 --> 00:54:25,440
disc

1534
00:54:30,390 --> 00:54:28,480
so the the fraction of the light

1535
00:54:31,829 --> 00:54:30,400
of the star compared to sorry of the

1536
00:54:32,230 --> 00:54:31,839
dust compared to the light of the star

1537
00:54:34,470 --> 00:54:32,240
is

1538
00:54:35,750 --> 00:54:34,480

quite high uh to be honest so it has

1539
00:54:37,510 --> 00:54:35,760
this huge disc

1540
00:54:39,829 --> 00:54:37,520
of material around the stars that would

1541
00:54:42,230 --> 00:54:39,839
be here um

1542
00:54:43,750 --> 00:54:42,240
and it it's a really cool disc because

1543
00:54:46,069 --> 00:54:43,760
it has two discs

1544
00:54:46,870 --> 00:54:46,079
so it has the primary disc um that we

1545
00:54:49,030 --> 00:54:46,880
see here

1546
00:54:50,309 --> 00:54:49,040
but it it also has like a tilted

1547
00:54:53,430 --> 00:54:50,319
secondary disc

1548
00:54:56,309 --> 00:54:53,440
uh which it gets weird and

1549
00:54:57,910 --> 00:54:56,319
it happens that in this secondary disk

1550
00:55:01,829 --> 00:54:57,920
or

1551
00:55:04,789 --> 00:55:01,839
disk there is actually a planet

1552
00:55:06,870 --> 00:55:04,799
um that was found with imaging so this

1553
00:55:10,150 --> 00:55:06,880
is a system that we know so far that has

1554
00:55:14,630 --> 00:55:10,160
a disc that has exocomets that has

1555
00:55:17,750 --> 00:55:14,640
um a planet um it has a tilted disc

1556
00:55:18,309 --> 00:55:17,760
but um it also has a second planet that

1557
00:55:21,109 --> 00:55:18,319
has found

1558
00:55:21,750 --> 00:55:21,119
that was found in in video velocity and

1559
00:55:26,069 --> 00:55:21,760
this

1560
00:55:27,510 --> 00:55:26,079
is a animation of the comets we see in

1561
00:55:31,190 --> 00:55:27,520
beta victories through

1562
00:55:34,150 --> 00:55:31,200
several nights months days

1563
00:55:35,349 --> 00:55:34,160

and you see how extreme the variations

1564
00:55:39,109 --> 00:55:35,359
are

1565
00:55:39,750 --> 00:55:39,119
around this star um here you see like

1566
00:55:41,349 --> 00:55:39,760
this is

1567
00:55:43,190 --> 00:55:41,359
the combination of all those variations

1568
00:55:46,309 --> 00:55:43,200
so there is like a preferential

1569
00:55:48,069 --> 00:55:46,319
um velocity for these comets but

1570
00:55:49,430 --> 00:55:48,079
you see that there's thousands of them

1571
00:55:51,750 --> 00:55:49,440
basically every time we look into beta

1572
00:55:55,030 --> 00:55:51,760
pic we see there's a lot of comments

1573
00:55:57,589 --> 00:55:55,040
um so going back to

1574
00:55:58,309 --> 00:55:57,599
the other exocomet stars you see that

1575
00:56:01,829 --> 00:55:58,319
the picture is

1576
00:56:03,190 --> 00:56:01,839
here um along with a couple others that

1577
00:56:03,990 --> 00:56:03,200
we are fairly sure they have exo

1578
00:56:05,750 --> 00:56:04,000
comments

1579
00:56:07,430 --> 00:56:05,760
and then we have a bunch of them that we

1580
00:56:11,109 --> 00:56:07,440
think they have exo comets

1581
00:56:14,069 --> 00:56:11,119
but um they don't so

1582
00:56:14,870 --> 00:56:14,079
there is at least these two that we have

1583
00:56:17,910 --> 00:56:14,880
found

1584
00:56:19,670 --> 00:56:17,920
that the variations we see um

1585
00:56:21,190 --> 00:56:19,680
this type of lines like the calcium line

1586
00:56:23,670 --> 00:56:21,200
i showed you are not

1587
00:56:25,190 --> 00:56:23,680
actually produced by comets they're just

1588
00:56:26,710 --> 00:56:25,200

produced by some other things

1589
00:56:28,950 --> 00:56:26,720
and the first one i'm going to talk

1590
00:56:30,789 --> 00:56:28,960
about is hr10

1591
00:56:32,390 --> 00:56:30,799
and this was one of the canonical

1592
00:56:35,270 --> 00:56:32,400
exo-comment stars like

1593
00:56:35,589 --> 00:56:35,280
this was in several papers saying oh

1594
00:56:37,829 --> 00:56:35,599
this

1595
00:56:39,589 --> 00:56:37,839
star has definitely extra comets we see

1596
00:56:42,230 --> 00:56:39,599
a lot of variations

1597
00:56:44,230 --> 00:56:42,240
um and when we started it we did see a

1598
00:56:46,470 --> 00:56:44,240
lot of variations

1599
00:56:49,589 --> 00:56:46,480
check this out for example this is again

1600
00:56:52,870 --> 00:56:49,599
the same calcium line

1601
00:56:54,710 --> 00:56:52,880
but um we see that there is like

1602
00:56:56,950 --> 00:56:54,720
a component here that looks like the

1603
00:56:58,470 --> 00:56:56,960
component of the circumstellar gas

1604
00:57:00,630 --> 00:56:58,480
that it's around the star like in the

1605
00:57:03,109 --> 00:57:00,640
disk and then we see some variations

1606
00:57:04,390 --> 00:57:03,119
coming here coming here coming here so

1607
00:57:07,750 --> 00:57:04,400
yeah it looks like

1608
00:57:08,950 --> 00:57:07,760
it has exo comets but we did a very

1609
00:57:11,589 --> 00:57:08,960
thorough study

1610
00:57:12,069 --> 00:57:11,599
uh through many many nights and even

1611
00:57:14,309 --> 00:57:12,079
combined

1612
00:57:15,750 --> 00:57:14,319
it with years of observations and what

1613
00:57:19,030 --> 00:57:15,760

we found is that

1614
00:57:22,230 --> 00:57:19,040
uh this feature appears to be moving

1615
00:57:24,470 --> 00:57:22,240
uh further away in this case um and then

1616
00:57:27,270 --> 00:57:24,480
at some point it comes back

1617
00:57:29,589 --> 00:57:27,280
and if you plot the two features that we

1618
00:57:31,990 --> 00:57:29,599
can separate here for example

1619
00:57:33,270 --> 00:57:32,000
we find this um so the features are

1620
00:57:36,069 --> 00:57:33,280
actually coming and going

1621
00:57:37,829 --> 00:57:36,079
you see this is from uh 30 years ago i

1622
00:57:40,789 --> 00:57:37,839
think or so 20 something

1623
00:57:42,309 --> 00:57:40,799
um so the features come and go following

1624
00:57:43,829 --> 00:57:42,319
this this is where we did the study

1625
00:57:47,270 --> 00:57:43,839
where we have a lot of data

1626
00:57:48,789 --> 00:57:47,280
um what does this mean um so it just

1627
00:57:51,750 --> 00:57:48,799
means that this is not

1628
00:57:53,349 --> 00:57:51,760
start with exocomets is two stars with

1629
00:57:55,109 --> 00:57:53,359
two disks each

1630
00:57:57,109 --> 00:57:55,119
that are orbiting each other in a very

1631
00:58:01,030 --> 00:57:57,119
particular configuration

1632
00:58:04,710 --> 00:58:01,040
um and so it appears that it's only one

1633
00:58:07,589 --> 00:58:04,720
and it has um a common

1634
00:58:09,430 --> 00:58:07,599
circumstellarist so just one disk and

1635
00:58:11,990 --> 00:58:09,440
variations that could be exocomets

1636
00:58:13,030 --> 00:58:12,000
but it's not it's just it just happens

1637
00:58:15,750 --> 00:58:13,040
to be stars with

1638
00:58:17,109 --> 00:58:15,760

very similar temperatures um in a very

1639
00:58:18,870 --> 00:58:17,119
particular orbit they're

1640
00:58:20,309 --> 00:58:18,880
even really really close so it's really

1641
00:58:23,589 --> 00:58:20,319
hard to tell them apart

1642
00:58:25,829 --> 00:58:23,599
um so yeah it was just a bad coincidence

1643
00:58:28,309 --> 00:58:25,839
that we could only rule out after

1644
00:58:30,230 --> 00:58:28,319
years and years and years of research

1645
00:58:33,349 --> 00:58:30,240
and there is another one that was

1646
00:58:35,829 --> 00:58:33,359
uh harder to to rule out

1647
00:58:37,670 --> 00:58:35,839
is this one this is also very dear to me

1648
00:58:41,270 --> 00:58:37,680
because this is like the first

1649
00:58:41,829 --> 00:58:41,280
um star that came out of my phd thesis

1650
00:58:44,710 --> 00:58:41,839
work

1651
00:58:46,710 --> 00:58:44,720
um published by one of my supervisors um

1652
00:58:49,589 --> 00:58:46,720
and we found well he found

1653
00:58:51,030 --> 00:58:49,599
that there was a lot of variations um i

1654
00:58:53,990 --> 00:58:51,040
took some of these observations

1655
00:58:55,589 --> 00:58:54,000
this is like very there to me um and it

1656
00:58:58,789 --> 00:58:55,599
does look that there are comments it

1657
00:58:59,910 --> 00:58:58,799
does look like there is variations in

1658
00:59:03,109 --> 00:58:59,920
there

1659
00:59:05,109 --> 00:59:03,119
but after again months a couple of years

1660
00:59:05,990 --> 00:59:05,119
of study where we took a lot a lot a lot

1661
00:59:08,549 --> 00:59:06,000
of data

1662
00:59:09,109 --> 00:59:08,559
we found out that this is actually not

1663
00:59:12,150 --> 00:59:09,119

comets

1664
00:59:14,710 --> 00:59:12,160
it's just that there is um

1665
00:59:15,589 --> 00:59:14,720
the star is pulsating it's like wobbling

1666
00:59:17,829 --> 00:59:15,599
like this

1667
00:59:19,589 --> 00:59:17,839
um and it's expelling some material to

1668
00:59:21,750 --> 00:59:19,599
the to the disk around it

1669
00:59:22,950 --> 00:59:21,760
and it looks like there is a variation i

1670
00:59:24,630 --> 00:59:22,960
mean there is a variation in the

1671
00:59:26,549 --> 00:59:24,640
circumstellar material to be fair

1672
00:59:28,390 --> 00:59:26,559
but it's not caused by comets is caused

1673
00:59:31,670 --> 00:59:28,400
by the star

1674
00:59:35,030 --> 00:59:31,680
um but no fear because

1675
00:59:38,150 --> 00:59:35,040
we do find some comments

1676
00:59:39,670 --> 00:59:38,160
still um this was one of the ones that

1677
00:59:40,950 --> 00:59:39,680
the stars that we found have comments

1678
00:59:44,549 --> 00:59:40,960
from my phd thesis

1679
00:59:46,789 --> 00:59:44,559
this is a tiny comment here um

1680
00:59:48,309 --> 00:59:46,799
and this is actually a very particular a

1681
00:59:50,630 --> 00:59:48,319
particularly interesting star

1682
00:59:52,630 --> 00:59:50,640
because it has everything just like not

1683
00:59:54,230 --> 00:59:52,640
like metal victories but

1684
00:59:56,710 --> 00:59:54,240
feels like better victories because it

1685
00:59:57,670 --> 00:59:56,720
has um availabilities that it's really

1686
01:00:00,309 --> 00:59:57,680
really bright

1687
01:00:01,109 --> 01:00:00,319
it has some excess here uh if you

1688
01:00:03,109 --> 01:00:01,119

remember this

1689
01:00:04,309 --> 01:00:03,119
is the light that we spec from the star

1690
01:00:06,230 --> 01:00:04,319
and this would be the disk

1691
01:00:07,510 --> 01:00:06,240
but it also has some access here that we

1692
01:00:10,870 --> 01:00:07,520
think comes

1693
01:00:12,870 --> 01:00:10,880
from carbon in the disk so there might

1694
01:00:14,950 --> 01:00:12,880
be like a recent giant collision or

1695
01:00:15,349 --> 01:00:14,960
something that is releasing carbon so

1696
01:00:16,710 --> 01:00:15,359
that's

1697
01:00:18,870 --> 01:00:16,720
really really exciting it could also be

1698
01:00:21,109 --> 01:00:18,880
causing the extra comets um

1699
01:00:23,430 --> 01:00:21,119
and and we have even observed this with

1700
01:00:25,589 --> 01:00:23,440
an image so we know the disk is there

1701
01:00:27,270 --> 01:00:25,599
um so yeah this is one of the targets

1702
01:00:30,309 --> 01:00:27,280
that i'm most excited about

1703
01:00:34,710 --> 01:00:30,319
for the future um yeah

1704
01:00:37,030 --> 01:00:34,720
and so what's next um so

1705
01:00:37,910 --> 01:00:37,040
it's really hard to study exocomets um

1706
01:00:40,069 --> 01:00:37,920
they're very

1707
01:00:41,990 --> 01:00:40,079
time expensive you need to spend a lot

1708
01:00:43,109 --> 01:00:42,000
of nights in the telescope and take a

1709
01:00:45,670 --> 01:00:43,119
lot of data

1710
01:00:47,030 --> 01:00:45,680
to figure out to even try to catch one

1711
01:00:47,750 --> 01:00:47,040
of these events because they're highly

1712
01:00:49,750 --> 01:00:47,760
sporadic

1713
01:00:51,030 --> 01:00:49,760

you might be observing for i don't know

1714
01:00:53,430 --> 01:00:51,040
a year and not catch

1715
01:00:54,309 --> 01:00:53,440
any uh events except for the victories

1716
01:00:57,030 --> 01:00:54,319
where it's happening

1717
01:00:58,230 --> 01:00:57,040
every hour but for other stars it's not

1718
01:01:00,230 --> 01:00:58,240
that common

1719
01:01:02,789 --> 01:01:00,240
so it takes a lot of time it takes a lot

1720
01:01:03,829 --> 01:01:02,799
of money overall because you have to pay

1721
01:01:05,750 --> 01:01:03,839
someone to be there

1722
01:01:06,870 --> 01:01:05,760
like a student or a researcher or

1723
01:01:08,549 --> 01:01:06,880
someone

1724
01:01:09,990 --> 01:01:08,559
and you have to take the telescope for

1725
01:01:10,950 --> 01:01:10,000
yourself and other people need to do

1726
01:01:14,549 --> 01:01:10,960
research as well

1727
01:01:16,309 --> 01:01:14,559
so it's really really hard to do it um

1728
01:01:18,470 --> 01:01:16,319
but these sexual comments leave other

1729
01:01:20,230 --> 01:01:18,480
traces that we can actually follow

1730
01:01:21,750 --> 01:01:20,240
um when they evaporate because they

1731
01:01:24,710 --> 01:01:21,760
release gas and that

1732
01:01:25,109 --> 01:01:24,720
sometimes stays in the system so what we

1733
01:01:29,750 --> 01:01:25,119
do

1734
01:01:32,870 --> 01:01:29,760
it's try to go to antennas to long

1735
01:01:35,030 --> 01:01:32,880
wavelength um observatories like

1736
01:01:36,150 --> 01:01:35,040
these images we're taking with alma and

1737
01:01:38,710 --> 01:01:36,160
these traces

1738
01:01:40,710 --> 01:01:38,720

co gas that it's in the outer region of

1739
01:01:43,990 --> 01:01:40,720
the system that we believed

1740
01:01:47,109 --> 01:01:44,000
um has has originated

1741
01:01:49,670 --> 01:01:47,119
in secondary um

1742
01:01:50,630 --> 01:01:49,680
processes so collisions or evaporation

1743
01:01:53,270 --> 01:01:50,640
of bodies

1744
01:01:55,270 --> 01:01:53,280
so these gas that we are seeing here um

1745
01:01:55,829 --> 01:01:55,280
is not a result of the planet formation

1746
01:01:59,510 --> 01:01:55,839
process

1747
01:02:01,990 --> 01:01:59,520
itself but was generated afterwards um

1748
01:02:02,950 --> 01:02:02,000
with the release of gas from the the

1749
01:02:05,829 --> 01:02:02,960
small bodies

1750
01:02:06,950 --> 01:02:05,839
in these systems so this looks like the

1751
01:02:09,670 --> 01:02:06,960
path to follow

1752
01:02:10,710 --> 01:02:09,680
to to go on studying exo comments

1753
01:02:13,190 --> 01:02:10,720
because it's

1754
01:02:14,470 --> 01:02:13,200
let's say less time expensive we cannot

1755
01:02:16,789 --> 01:02:14,480
study the dynamics of

1756
01:02:18,549 --> 01:02:16,799
the comments like this but it looks like

1757
01:02:21,510 --> 01:02:18,559
we could at least study the presence

1758
01:02:23,670 --> 01:02:21,520
and we could somehow study um some more

1759
01:02:24,230 --> 01:02:23,680
volatile materials because calcium is

1760
01:02:27,750 --> 01:02:24,240
not like

1761
01:02:30,710 --> 01:02:27,760
the best um tracer for volatiles that we

1762
01:02:32,789 --> 01:02:30,720
could be interested on like water

1763
01:02:33,829 --> 01:02:32,799

so so there is a lot of a lot of the

1764
01:02:35,750 --> 01:02:33,839
community is trying

1765
01:02:36,870 --> 01:02:35,760
it's focusing now on this type of

1766
01:02:38,789 --> 01:02:36,880
studies um

1767
01:02:40,069 --> 01:02:38,799
at long wavelengths of this gas that

1768
01:02:47,589 --> 01:02:40,079
it's

1769
01:02:50,630 --> 01:02:47,599
and one um really exciting

1770
01:02:53,349 --> 01:02:50,640
project we have for the future it's to

1771
01:02:55,109 --> 01:02:53,359
try to use james webb uh to study this

1772
01:02:57,829 --> 01:02:55,119
gas

1773
01:02:58,789 --> 01:02:57,839
so james webb will be launched late

1774
01:03:01,589 --> 01:02:58,799
october

1775
01:03:03,270 --> 01:03:01,599
early november or just around maybe

1776
01:03:04,549 --> 01:03:03,280
before christmas we hope we hope it

1777
01:03:06,549 --> 01:03:04,559
depends on the aryan

1778
01:03:08,390 --> 01:03:06,559
rockets so let's hope everything goes

1779
01:03:11,270 --> 01:03:08,400
well um

1780
01:03:12,150 --> 01:03:11,280
it's the next uh nasa big telescope it's

1781
01:03:14,950 --> 01:03:12,160
also

1782
01:03:16,870 --> 01:03:14,960
uh the collaboration with issa and the

1783
01:03:19,270 --> 01:03:16,880
canadian space agency

1784
01:03:21,510 --> 01:03:19,280
so um it's going to be like the success

1785
01:03:23,109 --> 01:03:21,520
the successor of hubble but as brandon

1786
01:03:24,950 --> 01:03:23,119
told at the beginning

1787
01:03:27,109 --> 01:03:24,960
no one will replace hubble javelins or

1788
01:03:29,670 --> 01:03:27,119

ultraviolet eye in the sky but this

1789
01:03:31,589 --> 01:03:29,680
would be our infrared eye in the sky now

1790
01:03:34,870 --> 01:03:31,599
that we don't have spitzer anymore

1791
01:03:37,990 --> 01:03:34,880
uh which was the previous uh mission

1792
01:03:40,390 --> 01:03:38,000
i think brandon also mentioned it um

1793
01:03:41,430 --> 01:03:40,400
and nasa oh sorry and james webb will do

1794
01:03:44,870 --> 01:03:41,440
something

1795
01:03:47,829 --> 01:03:44,880
really really important for the study of

1796
01:03:49,589 --> 01:03:47,839
life in other planetary systems for this

1797
01:03:53,029 --> 01:03:49,599
study of the chemical compositions of

1798
01:03:54,950 --> 01:03:53,039
the planet's resistance which is access

1799
01:03:56,789 --> 01:03:54,960
wavelengths that we could not do we

1800
01:03:58,710 --> 01:03:56,799
cannot observe from earth

1801
01:03:59,990 --> 01:03:58,720
and it will do it with a really high

1802
01:04:03,270 --> 01:04:00,000
spatial resolution

1803
01:04:04,630 --> 01:04:03,280
and with higher um um spectral

1804
01:04:08,150 --> 01:04:04,640
resolution that we have

1805
01:04:11,349 --> 01:04:08,160
uh until now um so so it's gonna

1806
01:04:12,230 --> 01:04:11,359
allow us to look at this these are some

1807
01:04:13,589 --> 01:04:12,240
of the instruments

1808
01:04:15,990 --> 01:04:13,599
sorry the instruments that are on board

1809
01:04:18,390 --> 01:04:16,000
of james webb so we will observe

1810
01:04:19,349 --> 01:04:18,400
from them from the red from the end of

1811
01:04:22,630 --> 01:04:19,359
the visible

1812
01:04:25,029 --> 01:04:22,640
to quite into the medium infrared

1813
01:04:26,789 --> 01:04:25,039

um and it will if you remember that the

1814
01:04:28,630 --> 01:04:26,799
the plot from before

1815
01:04:30,150 --> 01:04:28,640
it will allow us to look into these

1816
01:04:33,190 --> 01:04:30,160
chunks of

1817
01:04:35,510 --> 01:04:33,200
um of light that our atmosphere is

1818
01:04:37,510 --> 01:04:35,520
um absorbing and we cannot see from

1819
01:04:38,630 --> 01:04:37,520
earth so we will be able to do this from

1820
01:04:40,309 --> 01:04:38,640
space

1821
01:04:41,829 --> 01:04:40,319
and if you remember these chunks of

1822
01:04:45,190 --> 01:04:41,839
light that are absorbed from

1823
01:04:47,589 --> 01:04:45,200
our atmosphere are absorbed by water

1824
01:04:48,630 --> 01:04:47,599
so that means uh james webb will allow

1825
01:04:50,950 --> 01:04:48,640
us to look

1826
01:04:52,470 --> 01:04:50,960
uh for water in those systems because

1827
01:04:54,309 --> 01:04:52,480
our atmosphere would no longer be a

1828
01:04:56,630 --> 01:04:54,319
problem

1829
01:04:57,430 --> 01:04:56,640
and with this i hope you enjoyed the

1830
01:04:59,349 --> 01:04:57,440
talk

1831
01:05:03,990 --> 01:04:59,359
i thank you so much for coming and i'll

1832
01:05:07,829 --> 01:05:07,349
great thank you isabel um there's a lot

1833
01:05:09,270 --> 01:05:07,839
of inter

1834
01:05:11,349 --> 01:05:09,280
there's a lot of great conversations

1835
01:05:13,750 --> 01:05:11,359
going on in the uh

1836
01:05:14,470 --> 01:05:13,760
in the youtube chat i will just say that

1837
01:05:16,390 --> 01:05:14,480
if you are

1838
01:05:17,990 --> 01:05:16,400

in the youtube chat and you you miss

1839
01:05:20,309 --> 01:05:18,000
frank summers um

1840
01:05:21,029 --> 01:05:20,319
feel free to write down in in there and

1841
01:05:23,430 --> 01:05:21,039
give him a

1842
01:05:25,190 --> 01:05:23,440
wish for a happy uh vacation that'll be

1843
01:05:28,549 --> 01:05:25,200
a nice surprise when he sees that

1844
01:05:31,109 --> 01:05:28,559
um and

1845
01:05:31,910 --> 01:05:31,119
yeah i have a lot of questions i so my

1846
01:05:33,670 --> 01:05:31,920
when i watch

1847
01:05:35,510 --> 01:05:33,680
uh your presentation isabel and and

1848
01:05:38,069 --> 01:05:35,520
we'll get to some questions in the chat

1849
01:05:39,270 --> 01:05:38,079
what struck me was that uh you are doing

1850
01:05:42,549 --> 01:05:39,280
really hard work

1851
01:05:45,589 --> 01:05:42,559
this is really difficult work um

1852
01:05:47,589 --> 01:05:45,599
you know i when i did my phd i i did it

1853
01:05:49,510 --> 01:05:47,599
on on using spectroscopy of very

1854
01:05:50,950 --> 01:05:49,520
difficult to detect lines and things

1855
01:05:52,789 --> 01:05:50,960
and i thought that was hard but this

1856
01:05:54,950 --> 01:05:52,799
also looks very

1857
01:05:55,910 --> 01:05:54,960
very very difficult and so um kudos to

1858
01:05:59,349 --> 01:05:55,920
you and your team for

1859
01:06:01,029 --> 01:05:59,359
for taking this on um i'll start with a

1860
01:06:02,390 --> 01:06:01,039
question and then maybe grant can let us

1861
01:06:02,789 --> 01:06:02,400
know if there's some good questions from

1862
01:06:08,549 --> 01:06:02,799
the

1863
01:06:12,390 --> 01:06:08,559

uh let me see which one do i want to

1864
01:06:15,910 --> 01:06:14,069
i i guess i'll start with where you

1865
01:06:16,309 --> 01:06:15,920
ended which you ended with with james

1866
01:06:22,390 --> 01:06:16,319
webb

1867
01:06:23,589 --> 01:06:22,400
what other big breakthroughs in in the

1868
01:06:25,270 --> 01:06:23,599
field in your

1869
01:06:26,950 --> 01:06:25,280
in this field where will it come from

1870
01:06:28,950 --> 01:06:26,960
are there other particular telescopes or

1871
01:06:31,990 --> 01:06:28,960
techniques that's going to help us

1872
01:06:35,430 --> 01:06:32,000
um explore exocomics

1873
01:06:35,910 --> 01:06:35,440
yeah so um alma is doing a great job

1874
01:06:38,870 --> 01:06:35,920
with this

1875
01:06:40,470 --> 01:06:38,880
almighty interferometer that it's

1876
01:06:42,470 --> 01:06:40,480
located in chile

1877
01:06:44,309 --> 01:06:42,480
it's a bunch of antennas and the more

1878
01:06:46,069 --> 01:06:44,319
antennas you use just let's say the

1879
01:06:49,270 --> 01:06:46,079
higher resolution you get

1880
01:06:51,349 --> 01:06:49,280
so it has incredible resolving power

1881
01:06:52,309 --> 01:06:51,359
um and it allows us to actually look

1882
01:06:54,950 --> 01:06:52,319
into the systems

1883
01:06:56,630 --> 01:06:54,960
and see how they look like what's the

1884
01:06:57,670 --> 01:06:56,640
structure if there are rings in their

1885
01:06:59,589 --> 01:06:57,680
gaps

1886
01:07:00,950 --> 01:06:59,599
where is the gas located what's the

1887
01:07:02,230 --> 01:07:00,960
temperature of the gas what's the

1888
01:07:05,270 --> 01:07:02,240

composition

1889
01:07:08,950 --> 01:07:05,280
so um a lot of people are turning

1890
01:07:12,309 --> 01:07:08,960
uh to this type of of observatories

1891
01:07:13,029 --> 01:07:12,319
to do so from ground um i mentioned alma

1892
01:07:16,069 --> 01:07:13,039
but there's

1893
01:07:17,670 --> 01:07:16,079
pla apex there's a bunch of

1894
01:07:19,750 --> 01:07:17,680
observatories that are really good to do

1895
01:07:21,510 --> 01:07:19,760
so and i think

1896
01:07:23,349 --> 01:07:21,520
like if people are interested small

1897
01:07:24,710 --> 01:07:23,359
telescopes are also going to play a part

1898
01:07:26,470 --> 01:07:24,720
because these stars are really really

1899
01:07:27,990 --> 01:07:26,480
bright um

1900
01:07:29,829 --> 01:07:28,000
so you can just observe it with a small

1901
01:07:32,789 --> 01:07:29,839
telescope which are not so

1902
01:07:34,309 --> 01:07:32,799
pressured in terms of of observing time

1903
01:07:35,829 --> 01:07:34,319
so not as many people in the community

1904
01:07:37,270 --> 01:07:35,839
are demanding them

1905
01:07:40,710 --> 01:07:37,280
so so they could also play a role in

1906
01:07:43,829 --> 01:07:42,710
um i'll do a quick follow-up before i

1907
01:07:47,349 --> 01:07:43,839
before i turn it over

1908
01:07:50,390 --> 01:07:47,359
uh i'm curious if

1909
01:07:53,510 --> 01:07:50,400
if if roman will have any

1910
01:07:55,190 --> 01:07:53,520
any advantages here with its ability to

1911
01:07:56,069 --> 01:07:55,200
survey large patches of the sky i don't

1912
01:07:58,630 --> 01:07:56,079
know if

1913
01:08:01,109 --> 01:07:58,640

if for example if microlensing is a

1914
01:08:04,710 --> 01:08:01,119
technique that's helpful for finding

1915
01:08:07,990 --> 01:08:04,720
um moons maybe not comets but moons um

1916
01:08:08,630 --> 01:08:08,000
yeah definitely so there is a lot like

1917
01:08:10,150 --> 01:08:08,640
i'm not

1918
01:08:11,829 --> 01:08:10,160
expert in ones i just like them pretty

1919
01:08:14,549 --> 01:08:11,839
much very much um

1920
01:08:15,990 --> 01:08:14,559
um there is a lot of proposals on

1921
01:08:17,189 --> 01:08:16,000
techniques that could be used to look

1922
01:08:18,870 --> 01:08:17,199
for moons

1923
01:08:20,390 --> 01:08:18,880
and definitely necro lands you could

1924
01:08:23,030 --> 01:08:20,400
microlens it could be one

1925
01:08:24,149 --> 01:08:23,040
but uh as you know microlensing is

1926
01:08:25,669 --> 01:08:24,159
really difficult to use

1927
01:08:27,269 --> 01:08:25,679
because we depend on so many

1928
01:08:29,910 --> 01:08:27,279
astronomical factors

1929
01:08:31,269 --> 01:08:29,920
um so it's probably not the most

1930
01:08:33,189 --> 01:08:31,279
reliable like we could

1931
01:08:34,390 --> 01:08:33,199
we should not count on microlensing

1932
01:08:37,510 --> 01:08:34,400
alone to find moons

1933
01:08:40,789 --> 01:08:37,520
we should have a backup plan yeah

1934
01:08:42,870 --> 01:08:40,799
yeah so so i think there is where

1935
01:08:44,309 --> 01:08:42,880
other missions like tests for example

1936
01:08:45,829 --> 01:08:44,319
are going to provide a lot of data they

1937
01:08:47,590 --> 01:08:45,839
have just announced that test is going

1938
01:08:48,870 --> 01:08:47,600

to improve a lot the cadence of the data

1939
01:08:52,070 --> 01:08:48,880
that they're taking

1940
01:08:53,349 --> 01:08:52,080
um so so yeah i think those type of

1941
01:08:55,990 --> 01:08:53,359
missions are going to play a role

1942
01:08:58,070 --> 01:08:56,000
in detecting moons okay and i i would be

1943
01:08:59,990 --> 01:08:58,080
a bad host if i didn't quickly explain a

1944
01:09:02,870 --> 01:09:00,000
technical term i just introduced

1945
01:09:03,910 --> 01:09:02,880
so um so for the audience uh

1946
01:09:07,110 --> 01:09:03,920
microlensing

1947
01:09:10,229 --> 01:09:07,120
is a technique in which you actually use

1948
01:09:13,829 --> 01:09:10,239
um gravitational lensing the mass of

1949
01:09:16,470 --> 01:09:13,839
a um the mass of of the object

1950
01:09:17,990 --> 01:09:16,480
to brighten essentially the light of a

1951
01:09:19,910 --> 01:09:18,000
background object so

1952
01:09:22,070 --> 01:09:19,920
roman will stare at lots and lots of

1953
01:09:23,910 --> 01:09:22,080
stars as it surveys

1954
01:09:26,390 --> 01:09:23,920
and sometimes those stars may just

1955
01:09:28,950 --> 01:09:26,400
brighten because a foreground planet

1956
01:09:30,789 --> 01:09:28,960
comes between us and that star and its

1957
01:09:33,269 --> 01:09:30,799
gravitational influence will actually

1958
01:09:33,990 --> 01:09:33,279
redirect the light and brighten it and

1959
01:09:35,669 --> 01:09:34,000
so we can use

1960
01:09:37,829 --> 01:09:35,679
that it's called microlensing we can use

1961
01:09:41,590 --> 01:09:37,839
that technique to discover planets and

1962
01:09:45,590 --> 01:09:41,600
and um maybe moons um

1963
01:09:49,749 --> 01:09:45,600

okay uh grant are there any um

1964
01:09:53,829 --> 01:09:49,759
questions from chat that we should

1965
01:09:57,270 --> 01:09:53,839
pick up absolutely chad has been

1966
01:09:58,709 --> 01:09:57,280
chad has been lively in a good way in a

1967
01:10:01,270 --> 01:09:58,719
good way yeah

1968
01:10:01,990 --> 01:10:01,280
so let's go ahead and get us started off

1969
01:10:04,070 --> 01:10:02,000
we've had a little

1970
01:10:05,270 --> 01:10:04,080
back and forth conversation um are you

1971
01:10:08,470 --> 01:10:05,280
familiar

1972
01:10:12,510 --> 01:10:08,480
uh dr raybury with um

1973
01:10:19,270 --> 01:10:12,520
the un was it un2

1974
01:10:22,630 --> 01:10:21,830
no okay all right no i'm sorry i'm i'm

1975
01:10:25,110 --> 01:10:22,640
no no no no no

1976
01:10:26,470 --> 01:10:25,120
by the way isa is fine um no need for

1977
01:10:29,590 --> 01:10:26,480
okay

1978
01:10:30,550 --> 01:10:29,600
um i am not an expert on comets in the

1979
01:10:33,590 --> 01:10:30,560
solar system

1980
01:10:35,110 --> 01:10:33,600
at all um it was just a important part

1981
01:10:37,189 --> 01:10:35,120
of my research and specifically when

1982
01:10:39,270 --> 01:10:37,199
putting together my thesis to

1983
01:10:40,470 --> 01:10:39,280
put it into context of what happens in

1984
01:10:43,350 --> 01:10:40,480
the solar system

1985
01:10:45,189 --> 01:10:43,360
so that's why i know something about

1986
01:10:48,070 --> 01:10:45,199
like carbonaceous countries and

1987
01:10:49,910 --> 01:10:48,080
and i know about 67p basically because i

1988
01:10:51,430 --> 01:10:49,920

was at isa when philae was landing and

1989
01:10:52,470 --> 01:10:51,440
there was a huge party and everybody was

1990
01:10:56,229 --> 01:10:52,480
super excited

1991
01:10:58,149 --> 01:10:56,239
but in no way i am an expert on comments

1992
01:11:00,149 --> 01:10:58,159
it's all good i figured i would ask just

1993
01:11:01,430 --> 01:11:00,159
because there was a discussion going on

1994
01:11:03,830 --> 01:11:01,440
but it's one of the hardest things to

1995
01:11:04,390 --> 01:11:03,840
explain about these talks is we all have

1996
01:11:06,310 --> 01:11:04,400
such

1997
01:11:07,669 --> 01:11:06,320
narrow fields of knowledge because

1998
01:11:09,510 --> 01:11:07,679
there's so much

1999
01:11:11,110 --> 01:11:09,520
of it and it intersects with so many

2000
01:11:14,070 --> 01:11:11,120
different disciplines

2001
01:11:14,550 --> 01:11:14,080
it's sometimes difficult to to get that

2002
01:11:17,590 --> 01:11:14,560
like

2003
01:11:19,510 --> 01:11:17,600
just because you were an expert on um

2004
01:11:21,030 --> 01:11:19,520
like exo comments or what have you

2005
01:11:24,790 --> 01:11:21,040
doesn't necessarily mean that

2006
01:11:27,910 --> 01:11:24,800
you'll be able to answer questions that

2007
01:11:31,830 --> 01:11:27,920
yeah so uh moving on to the next one

2008
01:11:34,310 --> 01:11:31,840
um i think this is a little bit

2009
01:11:35,110 --> 01:11:34,320
here we go how are the radial velocities

2010
01:11:37,189 --> 01:11:35,120
determined

2011
01:11:40,390 --> 01:11:37,199
is it doppler shift of the light or

2012
01:11:43,750 --> 01:11:40,400
using wobble or how is that determined

2013
01:11:47,270 --> 01:11:43,760

um okay so i assume it's asking about

2014
01:11:50,070 --> 01:11:47,280
the radial velocity of the comets um yes

2015
01:11:51,750 --> 01:11:50,080
okay so uh we always determine the

2016
01:11:53,189 --> 01:11:51,760
radial velocity of the comet space

2017
01:11:54,870 --> 01:11:53,199
the velocity of the comets based on the

2018
01:11:58,630 --> 01:11:54,880
radial velocity of the star

2019
01:12:01,590 --> 01:11:58,640
usually determined

2020
01:12:02,229 --> 01:12:01,600
by doppler shift of the of the spectral

2021
01:12:04,149 --> 01:12:02,239
features

2022
01:12:06,070 --> 01:12:04,159
we know the nominal value of the

2023
01:12:09,830 --> 01:12:06,080
wavelength of the features

2024
01:12:11,110 --> 01:12:09,840
so when we observe those values are not

2025
01:12:12,950 --> 01:12:11,120
usually the nominal ones they are

2026
01:12:14,630 --> 01:12:12,960
shifted uh depending

2027
01:12:16,390 --> 01:12:14,640
on the radial velocity of the star with

2028
01:12:19,110 --> 01:12:16,400
respect to earth

2029
01:12:21,030 --> 01:12:19,120
um which we also have to account for

2030
01:12:22,310 --> 01:12:21,040
corrections because earth is not always

2031
01:12:24,390 --> 01:12:22,320
in the same position

2032
01:12:25,910 --> 01:12:24,400
um so yeah we usually determine the

2033
01:12:28,229 --> 01:12:25,920
radial velocity of the star

2034
01:12:30,070 --> 01:12:28,239
and that's our zero and depending how

2035
01:12:33,110 --> 01:12:30,080
fast the comet is moving like towards

2036
01:12:36,950 --> 01:12:33,120
blue or red and then we

2037
01:12:40,070 --> 01:12:36,960
determine the velocity of the comets

2038
01:12:41,270 --> 01:12:40,080

okay thank you um brandon i'm gonna

2039
01:12:42,550 --> 01:12:41,280
search through i'm gonna turn it over

2040
01:12:43,750 --> 01:12:42,560
for you another one of your questions

2041
01:12:48,070 --> 01:12:43,760
that you have

2042
01:12:50,550 --> 01:12:48,080
sure sure so um isa i

2043
01:12:51,669 --> 01:12:50,560
i saw early on that you you so you did a

2044
01:12:55,189 --> 01:12:51,679
lot of work

2045
01:12:57,430 --> 01:12:55,199
amazing work going back decades to

2046
01:12:58,950 --> 01:12:57,440
actually find out that that that what

2047
01:13:01,750 --> 01:12:58,960
you were seeing were not comets but

2048
01:13:04,950 --> 01:13:01,760
actually the orientation of two stars

2049
01:13:06,950 --> 01:13:04,960
um and i'm just curious

2050
01:13:08,229 --> 01:13:06,960
maybe this is more of a a theory

2051
01:13:09,590 --> 01:13:08,239
question but

2052
01:13:11,270 --> 01:13:09,600
you know when you have these multiple

2053
01:13:15,430 --> 01:13:11,280
star systems

2054
01:13:17,350 --> 01:13:15,440
um do we think we can still have

2055
01:13:18,950 --> 01:13:17,360
like a robust equivalent of a kuiper

2056
01:13:21,270 --> 01:13:18,960
belt or an oort cloud a commentary

2057
01:13:23,510 --> 01:13:21,280
system in those systems or are they

2058
01:13:25,590 --> 01:13:23,520
too disturbed and they get thrown out do

2059
01:13:28,870 --> 01:13:25,600
those exist

2060
01:13:30,149 --> 01:13:28,880
good question um i have no idea this is

2061
01:13:31,990 --> 01:13:30,159
something that we've been discussing

2062
01:13:34,550 --> 01:13:32,000
particularly with the system

2063
01:13:35,750 --> 01:13:34,560

because there are two big stars they're

2064
01:13:39,270 --> 01:13:35,760
bigger than the sun

2065
01:13:42,470 --> 01:13:39,280
um roughly eight type stars are like two

2066
01:13:44,149 --> 01:13:42,480
solar radii um because the radius of

2067
01:13:45,990 --> 01:13:44,159
of one of these stars is double the

2068
01:13:47,910 --> 01:13:46,000
rates of the sun and there are only two

2069
01:13:50,950 --> 01:13:47,920
astronomical units apart

2070
01:13:52,229 --> 01:13:50,960
um and we know both of them have uh

2071
01:13:55,669 --> 01:13:52,239
circumstellar material

2072
01:13:58,709 --> 01:13:55,679
very close to them so there

2073
01:14:00,470 --> 01:13:58,719
it must be interacting right

2074
01:14:01,750 --> 01:14:00,480
but it's something we have not been able

2075
01:14:04,550 --> 01:14:01,760
to prove yet

2076
01:14:06,390 --> 01:14:04,560
um we do have some smaller features that

2077
01:14:08,630 --> 01:14:06,400
i did not comment on

2078
01:14:09,510 --> 01:14:08,640
um but in the paper they are mentioned

2079
01:14:12,630 --> 01:14:09,520
and we

2080
01:14:15,750 --> 01:14:12,640
think uh that is

2081
01:14:18,950 --> 01:14:15,760
somehow present in the interaction

2082
01:14:20,870 --> 01:14:18,960
of the stars or somehow um

2083
01:14:22,790 --> 01:14:20,880
appears from the interaction of the two

2084
01:14:25,270 --> 01:14:22,800
circumstantial mediums but we don't know

2085
01:14:26,550 --> 01:14:25,280
it's it's really hard to prove but it

2086
01:14:28,229 --> 01:14:26,560
would be

2087
01:14:30,950 --> 01:14:28,239
expected that there is some some

2088
01:14:34,950 --> 01:14:30,960

interaction in between them

2089
01:14:38,550 --> 01:14:34,960
great great grant did you have a

2090
01:14:39,590 --> 01:14:38,560
another question yet yeah i'm looking at

2091
01:14:42,870 --> 01:14:39,600
them right now

2092
01:14:44,550 --> 01:14:42,880
sure okay so

2093
01:14:45,990 --> 01:14:44,560
here's one and i agree with your

2094
01:14:47,990 --> 01:14:46,000
analysis of tests

2095
01:14:49,350 --> 01:14:48,000
i'm really excited about that mission

2096
01:14:52,790 --> 01:14:49,360
that was one of my favorite

2097
01:14:55,669 --> 01:14:52,800
talks that we had um but

2098
01:14:56,229 --> 01:14:55,679
how do we find the systems for us to

2099
01:14:58,790 --> 01:14:56,239
follow

2100
01:14:59,990 --> 01:14:58,800
up on them and test is one of the ways

2101
01:15:03,430 --> 01:15:00,000
that we do so but

2102
01:15:05,669 --> 01:15:03,440
how is it that you initially identify um

2103
01:15:06,550 --> 01:15:05,679
some sort of terrestrial body like this

2104
01:15:08,149 --> 01:15:06,560
and then

2105
01:15:09,750 --> 01:15:08,159
follow it up with a telescope or do you

2106
01:15:11,270 --> 01:15:09,760
start with a large like a larger

2107
01:15:13,030 --> 01:15:11,280
observatory

2108
01:15:15,189 --> 01:15:13,040
okay so this is a great question because

2109
01:15:16,790 --> 01:15:15,199
it's really really difficult to identify

2110
01:15:19,669 --> 01:15:16,800
targets

2111
01:15:21,750 --> 01:15:19,679
we don't know why there is no

2112
01:15:23,590 --> 01:15:21,760
explanation yet to this

2113
01:15:25,270 --> 01:15:23,600

why we find the exocomets around eight

2114
01:15:26,950 --> 01:15:25,280
type stars which are stars with a

2115
01:15:28,470 --> 01:15:26,960
particular temperature around

2116
01:15:30,790 --> 01:15:28,480
eight thousand nine thousand ten

2117
01:15:32,470 --> 01:15:30,800
thousand kelvin um

2118
01:15:34,070 --> 01:15:32,480
with this radius that is twice the

2119
01:15:35,669 --> 01:15:34,080
radius of the sun

2120
01:15:37,270 --> 01:15:35,679
we don't know why we find hexagons

2121
01:15:39,830 --> 01:15:37,280
around them but we kind of

2122
01:15:40,390 --> 01:15:39,840
know that we have to bias or search

2123
01:15:42,310 --> 01:15:40,400
towards

2124
01:15:43,910 --> 01:15:42,320
those stars because that's where we find

2125
01:15:46,310 --> 01:15:43,920
them um

2126
01:15:48,390 --> 01:15:46,320
even though uh we knew that we also

2127
01:15:51,350 --> 01:15:48,400
tried other spectral types like we had a

2128
01:15:52,070 --> 01:15:51,360
range between uh g-type stars which is

2129
01:15:55,189 --> 01:15:52,080
the sort of the

2130
01:15:59,030 --> 01:15:55,199
the spectral type of the sun to uh b

2131
01:16:02,470 --> 01:15:59,040
type stars so it's it goes o

2132
01:16:06,630 --> 01:16:02,480
o b a f k g

2133
01:16:08,390 --> 01:16:06,640
i think um so so we had a range

2134
01:16:09,830 --> 01:16:08,400
of spectral types and we tried to look

2135
01:16:11,910 --> 01:16:09,840
in them just for

2136
01:16:14,709 --> 01:16:11,920
statistics purpose to see if we found

2137
01:16:17,990 --> 01:16:14,719
any uh but we also buy a store sample

2138
01:16:18,630 --> 01:16:18,000

heavily on the fact that uh there was

2139
01:16:20,149 --> 01:16:18,640
already

2140
01:16:22,070 --> 01:16:20,159
circumstellar material around those

2141
01:16:24,790 --> 01:16:22,080
stars so we chose a lot

2142
01:16:25,830 --> 01:16:24,800
of disks of debris disks so it starts

2143
01:16:27,910 --> 01:16:25,840
with every disks

2144
01:16:29,430 --> 01:16:27,920
we chose a lot of stars where we knew

2145
01:16:32,550 --> 01:16:29,440
there were previous

2146
01:16:36,950 --> 01:16:32,560
detections of comets we chose stars

2147
01:16:39,110 --> 01:16:36,960
with anomalous abundances so for example

2148
01:16:41,270 --> 01:16:39,120
we do not expect the same amount of

2149
01:16:41,990 --> 01:16:41,280
metals in every star in the photosphere

2150
01:16:44,790 --> 01:16:42,000
of every star

2151
01:16:47,110 --> 01:16:44,800
but we do expect the same ratios so if

2152
01:16:48,709 --> 01:16:47,120
for some reason a star had a weird ratio

2153
01:16:50,630 --> 01:16:48,719
of material of metals

2154
01:16:52,229 --> 01:16:50,640
we would select that star to look for

2155
01:16:53,270 --> 01:16:52,239
exo-comets because we assume there is

2156
01:16:55,430 --> 01:16:53,280
something going on

2157
01:16:56,950 --> 01:16:55,440
in its circumstance medium and we also

2158
01:16:57,750 --> 01:16:56,960
chose stars that were really young for

2159
01:16:59,669 --> 01:16:57,760
example

2160
01:17:01,669 --> 01:16:59,679
because they are starting to settle so

2161
01:17:04,550 --> 01:17:01,679
they have a lot of dynamical activity

2162
01:17:05,830 --> 01:17:04,560
um so yeah the sample that i used for my

2163
01:17:08,390 --> 01:17:05,840

thesis and the sample that

2164
01:17:09,990 --> 01:17:08,400
is the samples that it's usually used by

2165
01:17:11,430 --> 01:17:10,000
people that study this type of phenomena

2166
01:17:14,390 --> 01:17:11,440
are really really biased

2167
01:17:15,430 --> 01:17:14,400
towards stars with lots of dust so very

2168
01:17:20,790 --> 01:17:15,440
bright discs

2169
01:17:24,709 --> 01:17:23,110
with that answers fascinating yeah that

2170
01:17:27,990 --> 01:17:24,719
was yeah

2171
01:17:30,870 --> 01:17:28,000
a plus question on that one so

2172
01:17:33,669 --> 01:17:30,880
just just you know for my thesis it was

2173
01:17:38,390 --> 01:17:33,679
a 117 stars that we studied

2174
01:17:41,430 --> 01:17:38,400
wow and we found comets in around uh 25.

2175
01:17:42,830 --> 01:17:41,440
so personal follow-up to that once you

2176
01:17:46,550 --> 01:17:42,840
have

2177
01:17:48,229 --> 01:17:46,560
more like um more access to it like with

2178
01:17:49,669 --> 01:17:48,239
further test messages or what have you

2179
01:17:52,870 --> 01:17:49,679
how is the

2180
01:17:54,310 --> 01:17:52,880
how are we expanding the results rather

2181
01:17:57,590 --> 01:17:54,320
than just

2182
01:17:58,310 --> 01:17:57,600
judging by more like arbitrary metrics

2183
01:18:01,430 --> 01:17:58,320
or

2184
01:18:03,590 --> 01:18:01,440
composition like is is there a better

2185
01:18:04,709 --> 01:18:03,600
method moving forward or is it just

2186
01:18:07,830 --> 01:18:04,719
distance and

2187
01:18:09,669 --> 01:18:07,840
proximity you mean in terms of where to

2188
01:18:12,870 --> 01:18:09,679

look for comments

2189
01:18:15,270 --> 01:18:12,880
yeah yeah so um

2190
01:18:16,470 --> 01:18:15,280
my thesis work was and and most of the

2191
01:18:18,310 --> 01:18:16,480
comments that i talked about

2192
01:18:20,149 --> 01:18:18,320
are found in spectroscopy and test is a

2193
01:18:21,030 --> 01:18:20,159
photometric mission so it does kind of

2194
01:18:24,229 --> 01:18:21,040
slightly different

2195
01:18:27,110 --> 01:18:24,239
thing um we can find

2196
01:18:27,669 --> 01:18:27,120
comets with photometry kepler has proven

2197
01:18:30,790 --> 01:18:27,679
that

2198
01:18:33,350 --> 01:18:30,800
exocomets

2199
01:18:34,390 --> 01:18:33,360
uh infotometry for beta peak uh which is

2200
01:18:37,590 --> 01:18:34,400
like our model

2201
01:18:40,070 --> 01:18:37,600
uh star for this uh studies um

2202
01:18:41,510 --> 01:18:40,080
so it can be done it's just really

2203
01:18:44,550 --> 01:18:41,520
difficult because you need

2204
01:18:47,910 --> 01:18:44,560
a lot of data um and maybe you are

2205
01:18:49,750 --> 01:18:47,920
i think i don't want to say any

2206
01:18:51,590 --> 01:18:49,760
stupid thing but i think it was like a

2207
01:18:54,550 --> 01:18:51,600
hundred days of observations for the

2208
01:18:55,350 --> 01:18:54,560
victories and they found three comments

2209
01:18:59,350 --> 01:18:55,360
so it's

2210
01:19:00,950 --> 01:18:59,360
it's really um very time expensive

2211
01:19:02,790 --> 01:19:00,960
that's why for example test is a very

2212
01:19:04,630 --> 01:19:02,800
good option because it will be observing

2213
01:19:06,390 --> 01:19:04,640

the stars nonetheless because

2214
01:19:08,390 --> 01:19:06,400
it's it's a survey so it will observe a

2215
01:19:10,550 --> 01:19:08,400
lot of them um

2216
01:19:12,070 --> 01:19:10,560
but yeah it's kind of at this point this

2217
01:19:14,550 --> 01:19:12,080
is still kind of random

2218
01:19:16,790 --> 01:19:14,560
we do not know where to point rewards

2219
01:19:20,790 --> 01:19:16,800
look

2220
01:19:23,030 --> 01:19:20,800
i love the the sheer two sides of

2221
01:19:26,070 --> 01:19:23,040
astronomy you have very

2222
01:19:29,030 --> 01:19:26,080
dedicated fantastic

2223
01:19:31,270 --> 01:19:29,040
instruments that are down to like the

2224
01:19:35,270 --> 01:19:31,280
photon and then it's like well

2225
01:19:36,390 --> 01:19:35,280
just point it that way like the the

2226
01:19:41,189 --> 01:19:36,400
conjunction of those two

2227
01:19:41,199 --> 01:19:45,030
it's so very human i love it

2228
01:19:49,590 --> 01:19:47,830
all right um let's see going down

2229
01:19:50,790 --> 01:19:49,600
through the chat here uh brandon feel

2230
01:19:53,590 --> 01:19:50,800
free to take another while i left

2231
01:19:55,110 --> 01:19:53,600
sure sure i'll take another uh question

2232
01:19:56,790 --> 01:19:55,120
here um

2233
01:19:59,030 --> 01:19:56,800
uh so this is the first time i've

2234
01:20:01,270 --> 01:19:59,040
actually heard that the first exo comet

2235
01:20:03,270 --> 01:20:01,280
was basically detected in 1987. i mean

2236
01:20:04,149 --> 01:20:03,280
it was detected before

2237
01:20:06,790 --> 01:20:04,159
and i know you said there's some

2238
01:20:09,750 --> 01:20:06,800

controversy about claiming that or

2239
01:20:11,110 --> 01:20:09,760
or they they didn't necessarily call it

2240
01:20:13,270 --> 01:20:11,120
an exo comment i don't

2241
01:20:15,350 --> 01:20:13,280
use phrase that but the idea that we we

2242
01:20:16,310 --> 01:20:15,360
may have found x that there's data that

2243
01:20:19,270 --> 01:20:16,320
exists

2244
01:20:20,629 --> 01:20:19,280
with exocomets in them from 1987 is

2245
01:20:23,750 --> 01:20:20,639
fascinating to me

2246
01:20:27,189 --> 01:20:23,760
and um so my question is

2247
01:20:29,430 --> 01:20:27,199
how how much information now that

2248
01:20:31,750 --> 01:20:29,440
we kind of know better what to look for

2249
01:20:32,229 --> 01:20:31,760
do you think exists in archival data

2250
01:20:34,390 --> 01:20:32,239
across

2251
01:20:36,070 --> 01:20:34,400
our missions that are just sitting there

2252
01:20:38,870 --> 01:20:36,080
to be explored

2253
01:20:40,070 --> 01:20:38,880
i i cannot even start to think about it

2254
01:20:41,830 --> 01:20:40,080
it's something

2255
01:20:43,270 --> 01:20:41,840
i would really love to do go through

2256
01:20:46,470 --> 01:20:43,280
spectroscopic data

2257
01:20:49,270 --> 01:20:46,480
now that we are getting so much better

2258
01:20:51,110 --> 01:20:49,280
at studying and analyzing large amounts

2259
01:20:51,830 --> 01:20:51,120
of data with machine learning or

2260
01:20:54,390 --> 01:20:51,840
whatever

2261
01:20:56,550 --> 01:20:54,400
new techniques we have if i would love

2262
01:20:57,110 --> 01:20:56,560
to just go through archives try collect

2263
01:20:59,430 --> 01:20:57,120

all the high

2264
01:21:00,390 --> 01:20:59,440
resolution spectroscopic data do a

2265
01:21:03,510 --> 01:21:00,400
search

2266
01:21:05,189 --> 01:21:03,520
um it's really difficult for other

2267
01:21:07,030 --> 01:21:05,199
reasons like

2268
01:21:08,550 --> 01:21:07,040
the data is treated in different ways

2269
01:21:09,110 --> 01:21:08,560
and you should do an homogeneous

2270
01:21:11,270 --> 01:21:09,120
treatment

2271
01:21:13,110 --> 01:21:11,280
through all of them to to compare and

2272
01:21:14,310 --> 01:21:13,120
stuff like that

2273
01:21:18,070 --> 01:21:14,320
but it has been done for better

2274
01:21:20,229 --> 01:21:18,080
victories uh there was a paper in 2014

2275
01:21:22,390 --> 01:21:20,239
that was published in nature that is

2276
01:21:23,189 --> 01:21:22,400
studied thousands of exo comments around

2277
01:21:26,310 --> 01:21:23,199
beta peak

2278
01:21:27,189 --> 01:21:26,320
um i think there were two thousand or

2279
01:21:29,510 --> 01:21:27,199
maybe more

2280
01:21:31,030 --> 01:21:29,520
um and they actually found some very

2281
01:21:32,950 --> 01:21:31,040
interesting things because they had so

2282
01:21:35,270 --> 01:21:32,960
so many data from so so many years

2283
01:21:36,310 --> 01:21:35,280
um like there are like two families of

2284
01:21:38,229 --> 01:21:36,320
comets

2285
01:21:39,350 --> 01:21:38,239
um they are consistent with two

2286
01:21:42,229 --> 01:21:39,360
different locations

2287
01:21:43,830 --> 01:21:42,239
and they actually have kind of different

2288
01:21:45,750 --> 01:21:43,840

compositions

2289
01:21:46,870 --> 01:21:45,760
it's kind of bold to assume that and to

2290
01:21:49,590 --> 01:21:46,880
say that but

2291
01:21:51,430 --> 01:21:49,600
they they do we do see that they have

2292
01:21:52,149 --> 01:21:51,440
different amounts of calcium and sodium

2293
01:21:54,870 --> 01:21:52,159
in them

2294
01:21:55,750 --> 01:21:54,880
so so there's two families of exocomets

2295
01:21:57,750 --> 01:21:55,760
in beta peak and

2296
01:21:59,510 --> 01:21:57,760
the only reason we know that is because

2297
01:22:00,790 --> 01:21:59,520
we reached the point where we had 30

2298
01:22:03,830 --> 01:22:00,800
years of data

2299
01:22:07,750 --> 01:22:03,840
wow wow

2300
01:22:09,510 --> 01:22:07,760
yeah it reminds me of of some of those

2301
01:22:10,870 --> 01:22:09,520
results that we've had in the last 10

2302
01:22:13,189 --> 01:22:10,880
years where

2303
01:22:13,910 --> 01:22:13,199
um people have discovered you know

2304
01:22:17,510 --> 01:22:13,920
planets

2305
01:22:19,590 --> 01:22:17,520
example that are on the archive that

2306
01:22:20,709 --> 01:22:19,600
you know as as he says you were saying

2307
01:22:22,310 --> 01:22:20,719
as our machine learning and our

2308
01:22:24,470 --> 01:22:22,320
techniques improve

2309
01:22:25,750 --> 01:22:24,480
the data is there to do a reanalysis and

2310
01:22:26,870 --> 01:22:25,760
you find things that you didn't see

2311
01:22:31,110 --> 01:22:26,880
before

2312
01:22:34,950 --> 01:22:33,270
oh and you're muted there you go very

2313
01:22:37,189 --> 01:22:34,960

much so yeah

2314
01:22:38,870 --> 01:22:37,199
so i'll get us our last question here we

2315
01:22:39,990 --> 01:22:38,880
have time for probably about one more

2316
01:22:43,510 --> 01:22:40,000
and we'll call it

2317
01:22:45,430 --> 01:22:43,520
um observations by alma

2318
01:22:48,310 --> 01:22:45,440
have they provided any data of

2319
01:22:51,669 --> 01:22:51,110
all right so comets is that or exocomets

2320
01:22:55,270 --> 01:22:51,679
i'm sorry

2321
01:22:57,189 --> 01:22:55,280
yeah um okay so uh to look for extra

2322
01:22:59,189 --> 01:22:57,199
comments what we do is like examine

2323
01:23:00,629 --> 01:22:59,199
uh time series of data so we compare

2324
01:23:02,390 --> 01:23:00,639
like we take

2325
01:23:04,229 --> 01:23:02,400
one spectra one fourth metric point now

2326
01:23:05,590 --> 01:23:04,239
and then another one in 15 minutes or

2327
01:23:08,709 --> 01:23:05,600
whatever we compare

2328
01:23:09,430 --> 01:23:08,719
um that it's really expensive to do with

2329
01:23:12,790 --> 01:23:09,440
alma

2330
01:23:14,709 --> 01:23:12,800
time to detect gas

2331
01:23:16,629 --> 01:23:14,719
it's a completely different wavelength

2332
01:23:19,990 --> 01:23:16,639
it's a completely different instrument

2333
01:23:23,030 --> 01:23:20,000
um but what we do see from alma data

2334
01:23:24,870 --> 01:23:23,040
it's the outcome of the exocomets we see

2335
01:23:27,350 --> 01:23:24,880
the gas that they have released

2336
01:23:28,550 --> 01:23:27,360
in the medium that it's revolving around

2337
01:23:29,590 --> 01:23:28,560
the stack that was released by

2338
01:23:32,470 --> 01:23:29,600

collisions

2339
01:23:33,030 --> 01:23:32,480
or by evaporating comets or whatever and

2340
01:23:35,189 --> 01:23:33,040
and

2341
01:23:37,110 --> 01:23:35,199
that's what alma is capable to to give

2342
01:23:37,990 --> 01:23:37,120
to us and it's also very important the

2343
01:23:40,149 --> 01:23:38,000
fact that it's

2344
01:23:41,030 --> 01:23:40,159
volatile materials so it's materials

2345
01:23:43,830 --> 01:23:41,040
that evaporate

2346
01:23:44,470 --> 01:23:43,840
at very low temperatures unlike calcium

2347
01:23:47,350 --> 01:23:44,480
calcium is

2348
01:23:48,070 --> 01:23:47,360
metal right um it's a refractorial a

2349
01:23:50,229 --> 01:23:48,080
metallic

2350
01:23:52,229 --> 01:23:50,239
we call a metal in in astrophysics it's

2351
01:23:55,110 --> 01:23:52,239
a refractory material it needs

2352
01:23:56,070 --> 01:23:55,120
thousands of kelvin of temperature to

2353
01:23:57,430 --> 01:23:56,080
evaporate

2354
01:23:59,910 --> 01:23:57,440
so it has to be really really close to

2355
01:24:02,950 --> 01:23:59,920
the star but in contrast to that

2356
01:24:03,750 --> 01:24:02,960
the volatiles are very easily evaporated

2357
01:24:07,189 --> 01:24:03,760
so they're found

2358
01:24:10,229 --> 01:24:07,199
at long distances from the start and

2359
01:24:10,470 --> 01:24:10,239
they are not only easy to find far away

2360
01:24:14,310 --> 01:24:10,480
and

2361
01:24:18,149 --> 01:24:14,320
very very important

2362
01:24:25,030 --> 01:24:21,990
okay all right so awesome

2363
01:24:26,149 --> 01:24:25,040

thank you very much both of you brandon

2364
01:24:29,750 --> 01:24:26,159
for

2365
01:24:30,149 --> 01:24:29,760
filling in and being our our lovely host

2366
01:24:31,750 --> 01:24:30,159
and

2367
01:24:34,629 --> 01:24:31,760
i hope you're getting a lot of rest

2368
01:24:38,790 --> 01:24:37,590
and um isabel thank you so much for uh

2369
01:24:42,629 --> 01:24:38,800
for coming and talking

2370
01:24:45,910 --> 01:24:42,639
and i'll let you finish this up yeah

2371
01:24:49,350 --> 01:24:45,920
yeah i'm very happy and um so again

2372
01:24:51,750 --> 01:24:49,360
just a reminder that um we have

2373
01:24:53,669 --> 01:24:51,760
we have uh what was it i have to look at

2374
01:24:57,030 --> 01:24:53,679
my presentation again

2375
01:25:00,070 --> 01:24:57,040
um to see what the next dates are

2376
01:25:02,470 --> 01:25:00,080
i'll just remind you all real quick so

2377
01:25:03,189 --> 01:25:02,480
uh september 7th we have astrology

2378
01:25:04,870 --> 01:25:03,199
versus uh

2379
01:25:06,390 --> 01:25:04,880
versus astronomy what's the difference

2380
01:25:09,350 --> 01:25:06,400
really um

2381
01:25:10,070 --> 01:25:09,360
and so please join us for that and um

2382
01:25:12,390 --> 01:25:10,080
frank

2383
01:25:13,910 --> 01:25:12,400
should should be back but if he's not

2384
01:25:14,709 --> 01:25:13,920
then there's an issue but i'm happy to

2385
01:25:17,910 --> 01:25:14,719
fill in

2386
01:25:21,110 --> 01:25:17,920
um and uh in october how dark is space

2387
01:25:21,990 --> 01:25:21,120
uh and so yeah we have a couple of a

2388
01:25:23,990 --> 01:25:22,000

really great

2389
01:25:25,510 --> 01:25:24,000
public lecture series coming up and

2390
01:25:28,070 --> 01:25:25,520
thank you all for joining us

2391
01:25:29,030 --> 01:25:28,080
and thank you isa yeah thank you very