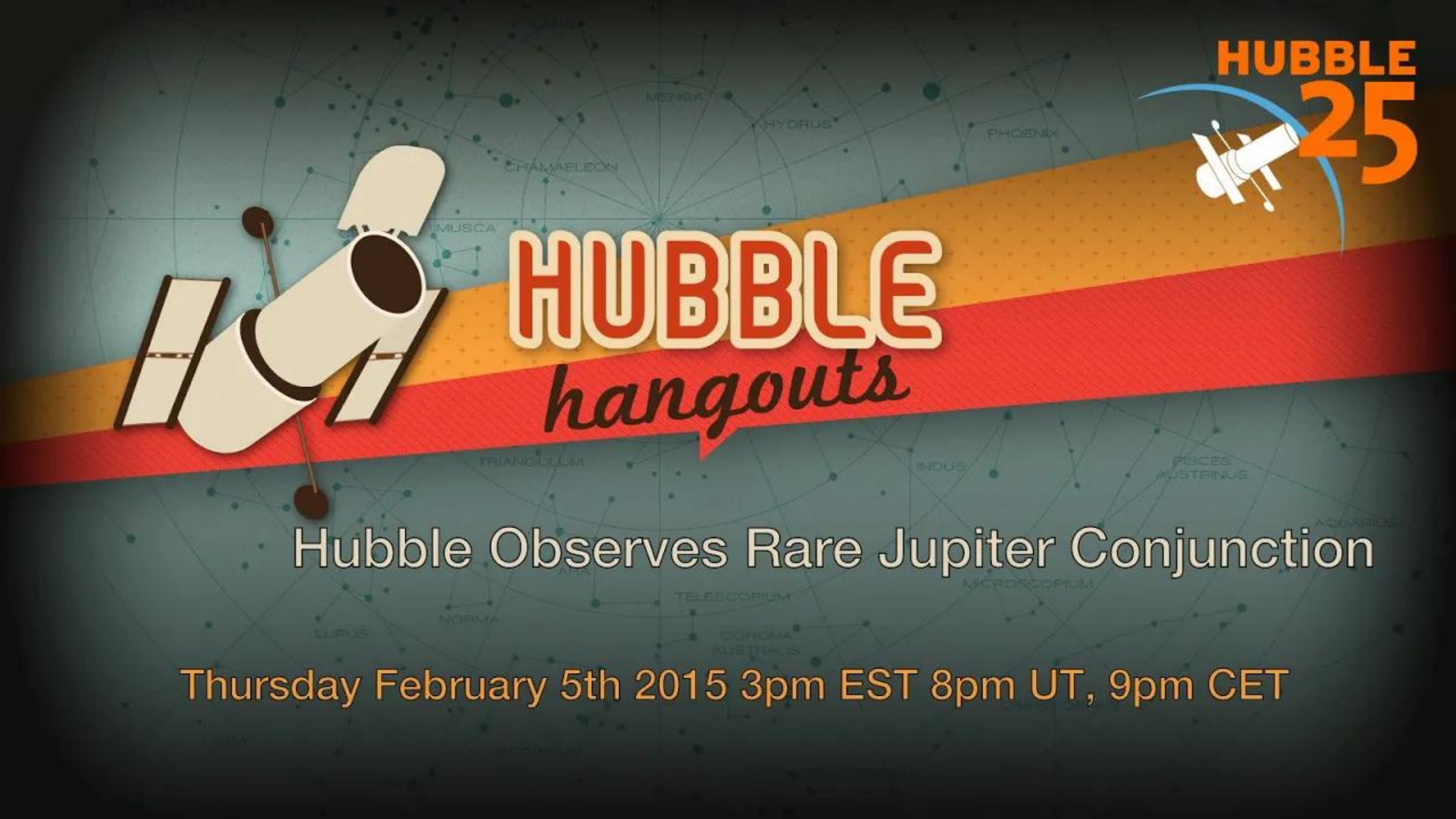
HUBBLE
25
HUBBLE
hangouts
Hubble Observes Rare Jupiter Conjunction
Thursday February 5th 2015 3pm EST 8pm UT, 9pm CET

1
00:00:11,529 --> 00:00:09,730
hello everybody and welcome to this

2
00:00:12,730 --> 00:00:11,539
week's Hubble hang out my name is Tony

3
00:00:14,409 --> 00:00:12,740
Darnell and I work at the Space

4
00:00:16,000 --> 00:00:14,419
Telescope Science Institute and this

5
00:00:19,330 --> 00:00:16,010
week we've got a really great hangout

6
00:00:22,800 --> 00:00:19,340
plan for you as we usually do we this

7
00:00:26,020 --> 00:00:22,810
week we are taking a look at some of the

8
00:00:28,600 --> 00:00:26,030
as we all as we had many times we you

9
00:00:30,790 --> 00:00:28,610
know Hubble has been sort of identified

10
00:00:33,220 --> 00:00:30,800
as you know using and looking at faraway

11
00:00:35,200 --> 00:00:33,230
distant objects but this week we're

12
00:00:36,970 --> 00:00:35,210
highlighting some objects where we

13
00:00:39,670 --> 00:00:36,980

inside the solar system a little bit

14
00:00:41,950 --> 00:00:39,680
closer to home and with this week today

15
00:00:44,920 --> 00:00:41,960
in fact we have released some new images

16
00:00:47,800 --> 00:00:44,930
new observations of Hubble's looking at

17
00:00:49,569 --> 00:00:47,810
Jupiter and we have with us members of

18
00:00:50,889 --> 00:00:49,579
the Hubble heritage team as well as some

19
00:00:52,180 --> 00:00:50,899
astronomers who have also helped with

20
00:00:54,040 --> 00:00:52,190
these observations but before I get

21
00:00:57,069 --> 00:00:54,050
started have a couple of announcements I

22
00:00:59,110 --> 00:00:57,079
want to make this week on Monday if you

23
00:01:02,470 --> 00:00:59,120
go to Space Telescope gorg there is a

24
00:01:04,830 --> 00:01:02,480
video contest it just opened up called

25
00:01:07,660 --> 00:01:04,840
ode to Hubble and if you would like to

26
00:01:09,610 --> 00:01:07,670
celebrate Hubble's 25th anniversary you

27
00:01:13,930 --> 00:01:09,620
are invited to make a video and submit

28
00:01:17,200 --> 00:01:13,940
it on YouTube and and then enter that

29
00:01:20,789 --> 00:01:17,210
into the contest itself the the link is

30
00:01:22,930 --> 00:01:20,799
I only weapon on the event page here

31
00:01:24,219 --> 00:01:22,940
it's on the event as well as the

32
00:01:26,170 --> 00:01:24,229
description of the YouTube video that

33
00:01:28,660 --> 00:01:26,180
word they were broadcasting on so we

34
00:01:31,719 --> 00:01:28,670
hope you will join there are two

35
00:01:33,850 --> 00:01:31,729
categories if you are under 25 and if

36
00:01:35,740 --> 00:01:33,860
you are over 25 now if you're under 25

37
00:01:37,330 --> 00:01:35,750
that means that you don't know a world

38
00:01:39,340 --> 00:01:37,340

without the Hubble Space Telescope and

39
00:01:42,310 --> 00:01:39,350
we're affectionately calling you the

40
00:01:45,219 --> 00:01:42,320
Hubble generation for those of you over

41
00:01:54,660 --> 00:01:45,229
25 years old there's a separate category

42
00:01:57,100 --> 00:01:54,670
and the price it comes with jer his all

43
00:02:01,330 --> 00:01:57,110
but the prize is really cool they are

44
00:02:03,399 --> 00:02:01,340
they are offering a piece of the solar

45
00:02:06,160 --> 00:02:03,409
array that actually was part of Hubble

46
00:02:07,660 --> 00:02:06,170
early on in its mission and as well as a

47
00:02:10,749 --> 00:02:07,670
plaque and a very good variety of other

48
00:02:13,240 --> 00:02:10,759
things so please check out the link

49
00:02:16,710 --> 00:02:13,250
below on the end in the description

50
00:02:20,440 --> 00:02:16,720
we hope to see your video soon now uh if

51
00:02:22,480 --> 00:02:20,450
so if you have any questions or issues

52
00:02:25,150 --> 00:02:22,490
like that just by all means let us know

53
00:02:27,250 --> 00:02:25,160
and we will help you and as much as we

54
00:02:28,570 --> 00:02:27,260
can and getting those videos submitted

55
00:02:31,780 --> 00:02:28,580
so we look forward to seeing what you've

56
00:02:34,380 --> 00:02:31,790
got this week so let's get to this

57
00:02:37,570 --> 00:02:34,390
hangout this week we are talking about

58
00:02:40,000 --> 00:02:37,580
Hubble has observed Jupiter and we've

59
00:02:42,460 --> 00:02:40,010
gotten some really great observations in

60
00:02:46,479 --> 00:02:42,470
fact there is a very somewhat rare

61
00:02:49,750 --> 00:02:46,489
conjunction that that happens every few

62
00:02:51,430 --> 00:02:49,760
I guess it's the guess it happens every

63
00:02:54,100 --> 00:02:51,440

few decades or something like that it

64
00:02:58,240 --> 00:02:54,110
was it was very a very rare event that

65
00:03:00,190 --> 00:02:58,250
we got here and with us is the members

66
00:03:02,080 --> 00:03:00,200
of the hubble heritage team and we

67
00:03:06,479 --> 00:03:02,090
invite your questions and comments also

68
00:03:09,250 --> 00:03:06,489
if you want to interact with us we have

69
00:03:13,300 --> 00:03:09,260
you can comment on the hubble hangout

70
00:03:16,030 --> 00:03:13,310
event that way on g+ you can also tweet

71
00:03:18,370 --> 00:03:16,040
at using the Hubble hang out hashtag as

72
00:03:19,479 --> 00:03:18,380
well as using the Q&A app that's

73
00:03:21,610 --> 00:03:19,489
actually the best way to interact

74
00:03:23,320 --> 00:03:21,620
because I'm monitoring that and you can

75
00:03:26,289 --> 00:03:23,330
also leave comments on the YouTube page

76
00:03:28,120 --> 00:03:26,299
that were broadcasting from so we're

77
00:03:31,780 --> 00:03:28,130
joining me as a as she always does is

78
00:03:34,690 --> 00:03:31,790
dr. carol christian she's the HST

79
00:03:36,550 --> 00:03:34,700
outreach scientist as well as the driver

80
00:03:39,160 --> 00:03:36,560
of the internet scott lewis at

81
00:03:41,229 --> 00:03:39,170
scientific scott hi Scott how's it going

82
00:03:44,140 --> 00:03:41,239
Tony really good thanks and thank you

83
00:03:48,220 --> 00:03:44,150
guys for joining me and so today's

84
00:03:50,680 --> 00:03:48,230
today's panel we have Zolt lavey he is

85
00:03:54,100 --> 00:03:50,690
the he's the guy who I think is one of

86
00:03:56,890 --> 00:03:54,110
the one of the person's most prominent

87
00:03:59,110 --> 00:03:56,900
in the Hubble heritage team-highs old we

88
00:04:00,880 --> 00:03:59,120

also have dr. mike wong he's an

89
00:04:04,180 --> 00:04:00,890
astronomer at the University of

90
00:04:05,979 --> 00:04:04,190
California Berkeley hi Mike and do a

91
00:04:07,479 --> 00:04:05,989
straw she's the she's an astronomer at

92
00:04:10,270 --> 00:04:07,489
the Institute she's joining us also

93
00:04:12,580 --> 00:04:10,280
welcome everybody hello and you know and

94
00:04:14,740 --> 00:04:12,590
as oh let me start with you what have we

95
00:04:17,020 --> 00:04:14,750
got here we've got we've got some images

96
00:04:18,250 --> 00:04:17,030
and observations of Jupiter so why don't

97
00:04:22,450 --> 00:04:18,260
you describe a little bit what we've got

98
00:04:24,780 --> 00:04:22,460
here okay so we were able to get one

99
00:04:26,400 --> 00:04:24,790
orbit with Hubble

100
00:04:28,860 --> 00:04:26,410
we were privileged enough to get one

101
00:04:32,340 --> 00:04:28,870
orbit to look at a fairly rare event the

102
00:04:34,560 --> 00:04:32,350
crossing of several moons across the

103
00:04:38,160 --> 00:04:34,570
face of Jupiter several Jupiter's moons

104
00:04:41,460 --> 00:04:38,170
across the face of Jupiter if I could

105
00:04:47,010 --> 00:04:41,470
start by opening my screen I can show

106
00:04:53,310 --> 00:04:47,020
you these images and what we have here

107
00:04:57,020 --> 00:04:53,320
is two images of Jupiter can you all see

108
00:04:59,610 --> 00:04:57,030
that it will all see it this line on the

109
00:05:02,250 --> 00:04:59,620
so there are two images of Jupiter taken

110
00:05:04,830 --> 00:05:02,260
at different times about roughly 40

111
00:05:06,510 --> 00:05:04,840
minutes apart so on the Left we see the

112
00:05:09,180 --> 00:05:06,520
disk of Jupiter with those bands of

113
00:05:12,030 --> 00:05:09,190

clouds dark and light clouds and then we

114
00:05:14,160 --> 00:05:12,040
see number of dots on top of it on the

115
00:05:16,710 --> 00:05:14,170
Left we see a kind of brown on the

116
00:05:21,600 --> 00:05:16,720
left-hand panel on the lower left we see

117
00:05:26,790 --> 00:05:21,610
a brownish image and that's the that's

118
00:05:30,030 --> 00:05:26,800
the moon Callisto to the lower right of

119
00:05:32,040 --> 00:05:30,040
that as a black dot right on the edge of

120
00:05:34,530 --> 00:05:32,050
Jupiter and that's a shadow of another

121
00:05:37,050 --> 00:05:34,540
moon Europa which we don't actually see

122
00:05:41,070 --> 00:05:37,060
in that image up towards the upper right

123
00:05:43,500 --> 00:05:41,080
we see a yellowish moon and that's IO a

124
00:05:46,950 --> 00:05:43,510
very interesting moon of Jupiter and to

125
00:05:50,130 --> 00:05:46,960
its upper right we see its shadow fairly

126
00:05:53,580 --> 00:05:50,140
sharp and distinct shadow and just below

127
00:05:55,890 --> 00:05:53,590
I oh we see another shadow and that's

128
00:05:59,850 --> 00:05:55,900
actually the shadow of Callisto which is

129
00:06:01,830 --> 00:05:59,860
way off to the lower left so the

130
00:06:05,100 --> 00:06:01,840
Callisto's shadow is much farther away

131
00:06:06,630 --> 00:06:05,110
from Callisto than iOS shadows away from

132
00:06:09,360 --> 00:06:06,640
it and that's because Maya was much

133
00:06:12,090 --> 00:06:09,370
closer to Jupiter also you may notice

134
00:06:14,400 --> 00:06:12,100
that Callisto's shadow is much fuzzier

135
00:06:16,950 --> 00:06:14,410
it's much less distinct and that's also

136
00:06:20,280 --> 00:06:16,960
because Callisto is much farther from

137
00:06:23,610 --> 00:06:20,290
the planet than iOS on the right we have

138
00:06:27,690 --> 00:06:23,620

the same basically the same view of

139
00:06:29,820 --> 00:06:27,700
Jupiter but everything's moved so the

140
00:06:31,650 --> 00:06:29,830
moons of all shifted because they're

141
00:06:34,830 --> 00:06:31,660
orbiting around Jupiter at a rather

142
00:06:38,399 --> 00:06:34,840
rapid clip and so I owe is now off

143
00:06:41,309 --> 00:06:38,409
almost off the disk on the right hand

144
00:06:44,999 --> 00:06:41,319
right hand side and Europa now we can

145
00:06:48,119 --> 00:06:45,009
see Europa itself just inside the edge

146
00:06:50,790 --> 00:06:48,129
at the lower left and Europa shadow is

147
00:06:52,979 --> 00:06:50,800
off to its upper right and we still see

148
00:06:55,139 --> 00:06:52,989
Callisto moved over and close to the

149
00:06:58,229 --> 00:06:55,149
shadow so those are the basic oh that

150
00:07:00,179 --> 00:06:58,239
two images now you also have an

151
00:07:03,659 --> 00:07:00,189
animation of this I believe as well

152
00:07:05,489 --> 00:07:03,669
don't you uh yeah let me Scott maybe

153
00:07:09,209 --> 00:07:05,499
Scott can pull out can kill the enemy up

154
00:07:13,679 --> 00:07:09,219
here all right so these are so Mike let

155
00:07:15,509 --> 00:07:13,689
me were you involved in planning these

156
00:07:18,299 --> 00:07:15,519
ops all Scouts got it up now here we go

157
00:07:19,409 --> 00:07:18,309
okay yeah so here is an animation why

158
00:07:24,839 --> 00:07:19,419
don't you describe this real quick for

159
00:07:27,540 --> 00:07:24,849
soul okay well we see individual frames

160
00:07:30,989 --> 00:07:27,550
we took during this observation with

161
00:07:33,269 --> 00:07:30,999
Hubble and we simply see the moon's

162
00:07:35,669 --> 00:07:33,279
marching across the planet as they orbit

163
00:07:40,109 --> 00:07:35,679

around Jupiter now this is a loop so you

164
00:07:41,869 --> 00:07:40,119
see it we have 24 individual frames so

165
00:07:47,899 --> 00:07:41,879
there's about a minute and a half

166
00:07:50,579 --> 00:07:47,909
between each frame so we simply see the

167
00:07:52,409 --> 00:07:50,589
Jupiter itself rotating and if you look

168
00:07:54,779 --> 00:07:52,419
very closely you can see that the

169
00:07:57,239 --> 00:07:54,789
different bands of clowns on Jupiter

170
00:07:59,969 --> 00:07:57,249
rotate at different speeds so there's

171
00:08:02,969 --> 00:07:59,979
clouds themselves are shifting across

172
00:08:06,869 --> 00:08:02,979
Jupiter and then above that we see the

173
00:08:11,189 --> 00:08:06,879
moon's moving across the face of Jupiter

174
00:08:14,189 --> 00:08:11,199
moons and their shadows so this is okay

175
00:08:16,979 --> 00:08:14,199
so this is uh so this is the animation

176
00:08:19,199 --> 00:08:16,989
of the observations themselves it

177
00:08:21,829 --> 00:08:19,209
Michael me and we get you in here looks

178
00:08:25,259 --> 00:08:21,839
a little bit this this particular arm

179
00:08:27,629 --> 00:08:25,269
set of observations up it shows up a

180
00:08:31,579 --> 00:08:27,639
pretty unique configuration of the moons

181
00:08:33,749 --> 00:08:31,589
of Jupiter and Jupiter itself would you

182
00:08:35,339 --> 00:08:33,759
describe a little bit were you involved

183
00:08:39,540 --> 00:08:35,349
in the planning of these observations at

184
00:08:41,519 --> 00:08:39,550
all or yeah it was this on purpose but

185
00:08:44,210 --> 00:08:41,529
it was getting getting getting these

186
00:08:46,970 --> 00:08:44,220
giving this conjunction oh yeah yeah we

187
00:08:50,819 --> 00:08:46,980
well we were alerted that the

188
00:08:52,300 --> 00:08:50,829

configuration was uh was coming up and

189
00:08:56,769 --> 00:08:52,310
so we we looked at

190
00:08:59,100 --> 00:08:56,779
when when we could actually observe this

191
00:09:03,700 --> 00:08:59,110
and a couple neat techniques were used

192
00:09:07,510 --> 00:09:03,710
but um well we were actually pretty

193
00:09:10,570 --> 00:09:07,520
lucky because Hubble has a 96 minute

194
00:09:13,600 --> 00:09:10,580
orbit around the earth and so half the

195
00:09:15,190 --> 00:09:13,610
time it can actually point at Jupiter

196
00:09:19,900 --> 00:09:15,200
it'll Jupiter will be on the other side

197
00:09:21,610 --> 00:09:19,910
of the the earth from from Hubble so we

198
00:09:25,329 --> 00:09:21,620
were lucky that Hubble was on the right

199
00:09:28,030 --> 00:09:25,339
side of the planet earth at the time

200
00:09:32,920 --> 00:09:28,040
that these shadows were shadows and

201
00:09:34,960 --> 00:09:32,930
moons were transiting so we have it we

202
00:09:38,860 --> 00:09:34,970
have a diagram I think of the actual

203
00:09:40,180 --> 00:09:38,870
geometry of the of the the conjunction

204
00:09:42,190 --> 00:09:40,190
itself can you pull that up real quick I

205
00:09:44,680 --> 00:09:42,200
want to ask my question about the

206
00:09:46,180 --> 00:09:44,690
frequency at which these things you know

207
00:09:47,680 --> 00:09:46,190
this this config this particular

208
00:09:55,170 --> 00:09:47,690
configuration is actually pretty rare

209
00:10:02,440 --> 00:09:55,180
correct uh yeah it's pretty rare um and

210
00:10:06,670 --> 00:10:02,450
we actually did get a last year your

211
00:10:08,290 --> 00:10:06,680
various Great Red Spot with Hubble right

212
00:10:09,579 --> 00:10:08,300
and we did a hangout I believe we did

213
00:10:13,150 --> 00:10:09,589

that we did a hangout on that as well so

214
00:10:15,430 --> 00:10:13,160
here's the configuration and the the of

215
00:10:19,900 --> 00:10:15,440
the geometry of the geometry of the of

216
00:10:22,300 --> 00:10:19,910
the alignment of these moons and give us

217
00:10:26,829 --> 00:10:22,310
some idea of just how how rare how often

218
00:10:29,500 --> 00:10:26,839
this happens um I didn't actually look

219
00:10:32,740 --> 00:10:29,510
at the amount of how how rare this is

220
00:10:35,699 --> 00:10:32,750
but the the things that have to be in

221
00:10:40,810 --> 00:10:35,709
place where this to be observed is that

222
00:10:43,090 --> 00:10:40,820
that the tilt of Jupiter's rotational

223
00:10:46,000 --> 00:10:43,100
plane which is where the moons are

224
00:10:50,199 --> 00:10:46,010
traveling has to be aligned such that

225
00:10:52,360 --> 00:10:50,209
the sun is shining what the Sun is lying

226
00:10:54,670 --> 00:10:52,370
in that plane and so it's a similar

227
00:10:59,890 --> 00:10:54,680
thing with eclipse is on the earth

228
00:11:03,640 --> 00:10:59,900
there's two times a year for for the

229
00:11:06,160 --> 00:11:03,650
earth to go into your clip season so we

230
00:11:09,879 --> 00:11:06,170
can see lunar eclipses or solar eclipses

231
00:11:11,259 --> 00:11:09,889
only only twice a year during a clip

232
00:11:13,870 --> 00:11:11,269
season that doesn't mean there's always

233
00:11:15,370 --> 00:11:13,880
going to be in eclipse but the

234
00:11:18,129 --> 00:11:15,380
configuration has to be right for that

235
00:11:21,030 --> 00:11:18,139
right I'm so same thing with a Jupiter

236
00:11:23,769 --> 00:11:21,040
twice twice a Jupiter year you'll have

237
00:11:27,340 --> 00:11:23,779
shadows going across the disk like this

238
00:11:29,050 --> 00:11:27,350

but for all three of these four three

239
00:11:32,800 --> 00:11:29,060
moons to be on the disk at one time is

240
00:11:35,530 --> 00:11:32,810
super rare right so occurred about twice

241
00:11:40,180 --> 00:11:35,540
and last 15 years and the next one will

242
00:11:42,400 --> 00:11:40,190
be 2032 mmm nice so it's pretty pretty

243
00:11:45,220 --> 00:11:42,410
awesome and pretty rare event to see

244
00:11:46,420 --> 00:11:45,230
this the way that we have it here and

245
00:11:48,610 --> 00:11:46,430
it's also great that Hubble like you

246
00:11:50,139 --> 00:11:48,620
said Mike was in a position where it

247
00:11:52,930 --> 00:11:50,149
could actually catch capture these

248
00:11:54,879 --> 00:11:52,940
things um so this is something that I

249
00:11:56,620 --> 00:11:54,889
want to come back a little bit to the

250
00:11:58,810 --> 00:11:56,630
image the images in the processing in

251
00:12:00,550 --> 00:11:58,820
just a second but this is something that

252
00:12:03,250 --> 00:12:00,560
we're releasing called up it's it's

253
00:12:05,139 --> 00:12:03,260
called Hubble heritage and these are

254
00:12:09,269 --> 00:12:05,149
observations at hubbell makes that's

255
00:12:11,470 --> 00:12:09,279
slightly different from normal Hubble

256
00:12:13,810 --> 00:12:11,480
programming time correct can you give us

257
00:12:17,019 --> 00:12:13,820
a sense of what a Hubble heritage image

258
00:12:19,170 --> 00:12:17,029
is what is that program I'll help right

259
00:12:22,480 --> 00:12:19,180
Hubble heritage is a program to

260
00:12:25,630 --> 00:12:22,490
emphasize the aesthetics the visual

261
00:12:27,850 --> 00:12:25,640
appeal of the images not so much the

262
00:12:31,840 --> 00:12:27,860
signs I mean all the images all the data

263
00:12:34,630 --> 00:12:31,850

have science their science data so they

264
00:12:38,710 --> 00:12:34,640
have science they're important for

265
00:12:42,220 --> 00:12:38,720
science but we felt that that there are

266
00:12:44,710 --> 00:12:42,230
images which are have aesthetic value

267
00:12:48,699 --> 00:12:44,720
above and beyond their scientific value

268
00:12:51,460 --> 00:12:48,709
so Hubble heritage is hopes to find the

269
00:12:54,160 --> 00:12:51,470
best images from Hubble and distribute

270
00:12:56,559 --> 00:12:54,170
them as as aesthetic images in addition

271
00:13:00,430 --> 00:12:56,569
to their science content so along with

272
00:13:02,230 --> 00:13:00,440
that we have been fortunate to have

273
00:13:04,750 --> 00:13:02,240
gotten a little bit of time on the

274
00:13:06,220 --> 00:13:04,760
telescope thanks to the various

275
00:13:08,949 --> 00:13:06,230
directors of the Space Telescope Science

276
00:13:13,269 --> 00:13:08,959
Institute have seen it important enough

277
00:13:14,860 --> 00:13:13,279
to first of all augment some of the

278
00:13:17,860 --> 00:13:14,870
observations that are already exists

279
00:13:20,860 --> 00:13:17,870
robble and with a some little

280
00:13:22,810 --> 00:13:20,870
more observing we could produce an image

281
00:13:24,730 --> 00:13:22,820
that would be better than what was

282
00:13:26,740 --> 00:13:24,740
possible from the data already existing

283
00:13:30,040 --> 00:13:26,750
in the archive and in some cases were

284
00:13:32,019 --> 00:13:30,050
able to propose to do images which have

285
00:13:35,019 --> 00:13:32,029
not been done before and then there are

286
00:13:37,720 --> 00:13:35,029
special events like like this Jupiter

287
00:13:41,320 --> 00:13:37,730
event which is kind of a special event

288
00:13:43,210 --> 00:13:41,330

that its scientific value is relatively

289
00:13:44,980 --> 00:13:43,220
minimal compared to some other different

290
00:13:46,630 --> 00:13:44,990
other kinds of observations that you

291
00:13:49,690 --> 00:13:46,640
could do but it might be of interest to

292
00:13:52,329 --> 00:13:49,700
many many people and so we were again

293
00:13:54,970 --> 00:13:52,339
fortunate enough to have one orbit

294
00:13:58,720 --> 00:13:54,980
available on the telescope to make these

295
00:14:00,490 --> 00:13:58,730
observations and so this is a you know a

296
00:14:04,300 --> 00:14:00,500
group here group of people here at the

297
00:14:07,660 --> 00:14:04,310
Institute and we propose these

298
00:14:09,190 --> 00:14:07,670
observations we plan a man's kid and and

299
00:14:11,290 --> 00:14:09,200
make the observations and then do the

300
00:14:14,019 --> 00:14:11,300
imaging from them and all the drive

301
00:14:16,450 --> 00:14:14,029
products and I was also going to comment

302
00:14:18,490 --> 00:14:16,460
as far as the events I mean when we talk

303
00:14:21,970 --> 00:14:18,500
about these among ourselves in the group

304
00:14:24,460 --> 00:14:21,980
we will say well is this one of these

305
00:14:26,290 --> 00:14:24,470
things where one would say this it would

306
00:14:28,060 --> 00:14:26,300
be a shame if Hubble didn't you know

307
00:14:29,800 --> 00:14:28,070
observe that or people would be

308
00:14:32,590 --> 00:14:29,810
interested in knowing what Hubble sees

309
00:14:35,740 --> 00:14:32,600
in this circumstance so there have been

310
00:14:40,300 --> 00:14:35,750
other circumstances like solar system

311
00:14:43,420 --> 00:14:40,310
objects like comets and other and this

312
00:14:45,010 --> 00:14:43,430
one for example where answerers you know

313
00:14:46,750 --> 00:14:45,020

do a lot of photography because they

314
00:14:49,540 --> 00:14:46,760
have much more time than we do we have

315
00:14:51,850 --> 00:14:49,550
only you know this one orbit but it's

316
00:14:53,949 --> 00:14:51,860
good to have that and compare and you

317
00:14:55,810 --> 00:14:53,959
can really see a lot more detail on the

318
00:14:59,710 --> 00:14:55,820
Hubble observations but it also has a

319
00:15:02,019 --> 00:14:59,720
lot of synergy with the amateurs and I'm

320
00:15:06,100 --> 00:15:02,029
hoping that the professionals will also

321
00:15:10,240 --> 00:15:06,110
find this data useful in in the overall

322
00:15:12,910 --> 00:15:10,250
look look at Jupiter as a planet and how

323
00:15:15,280 --> 00:15:12,920
the clouds work and all that kind of

324
00:15:18,120 --> 00:15:15,290
stuff so as far as all Hubble

325
00:15:20,980 --> 00:15:18,130
observations of Jupiter it probably has

326
00:15:22,480 --> 00:15:20,990
long-term value in that sense no I'm

327
00:15:24,460 --> 00:15:22,490
glad you brought that up the the amateur

328
00:15:26,199 --> 00:15:24,470
aspect of this because I've you know

329
00:15:27,760 --> 00:15:26,209
I've spent a lot of years looking at

330
00:15:28,840 --> 00:15:27,770
Jupiter also through a telescope and of

331
00:15:31,360 --> 00:15:28,850
course it's a very beautiful thing to

332
00:15:31,720 --> 00:15:31,370
look at through binoculars and stuff

333
00:15:34,210 --> 00:15:31,730
like

334
00:15:37,780 --> 00:15:34,220
but Susannah I wonder if I could get you

335
00:15:40,840 --> 00:15:37,790
to maybe you have a is this something

336
00:15:42,819 --> 00:15:40,850
that perhaps amateurs could look at

337
00:15:45,069 --> 00:15:42,829
through the through a telescope in fact

338
00:15:46,480 --> 00:15:45,079

you you also have a component where

339
00:15:48,280 --> 00:15:46,490
you're involved with the Galileo scope

340
00:15:51,699 --> 00:15:48,290
right with this up with this this kind

341
00:15:55,060 --> 00:15:51,709
of thing be visible through that yes so

342
00:15:57,850 --> 00:15:55,070
I have a right so you could use a small

343
00:15:59,319 --> 00:15:57,860
telescope that's capable of looking at

344
00:16:03,790 --> 00:15:59,329
Jupiter and then you would see the

345
00:16:05,829 --> 00:16:03,800
moon's crossing the face right and you

346
00:16:07,509 --> 00:16:05,839
can even see these through but not you

347
00:16:09,430 --> 00:16:07,519
can see the four Galilean moons

348
00:16:11,829 --> 00:16:09,440
especially the largest moons in

349
00:16:14,340 --> 00:16:11,839
binoculars or small telescopes things

350
00:16:16,990 --> 00:16:14,350
like that but these these transits these

351
00:16:19,090 --> 00:16:17,000
shadows across you can also facing

352
00:16:20,800 --> 00:16:19,100
through a small I don't know maybe a

353
00:16:24,129 --> 00:16:20,810
four inch or a little bit a little bit

354
00:16:25,449 --> 00:16:24,139
higher telescope because the the the you

355
00:16:27,220 --> 00:16:25,459
need to be able to see the bands of

356
00:16:29,949 --> 00:16:27,230
Jupiter and something that would let you

357
00:16:31,360 --> 00:16:29,959
get a little more resolving power out of

358
00:16:32,800 --> 00:16:31,370
it I think it's something like four

359
00:16:35,800 --> 00:16:32,810
inches they might let you see the

360
00:16:37,569 --> 00:16:35,810
transits or the shadows but hold up hold

361
00:16:39,970 --> 00:16:37,579
up your Galileo scope real quick let's

362
00:16:43,000 --> 00:16:39,980
take a look so this is this is something

363
00:16:44,410 --> 00:16:43,010

that is a well describe it what are you

364
00:16:47,019 --> 00:16:44,420
holding up there okay so what I'm

365
00:16:49,600 --> 00:16:47,029
holding up here is a better version of

366
00:16:51,340 --> 00:16:49,610
Galileo's telescope and originally in

367
00:16:53,620 --> 00:16:51,350
five years ago for the international

368
00:16:55,870 --> 00:16:53,630
year of astronomy people got together

369
00:16:58,230 --> 00:16:55,880
and wanted to have a telescope that was

370
00:17:02,769 --> 00:16:58,240
high optical quality but yet inexpensive

371
00:17:04,600 --> 00:17:02,779
and the result was this I don't know it

372
00:17:06,900 --> 00:17:04,610
sure if you can see it is this telescope

373
00:17:10,329 --> 00:17:06,910
it's black plastic it's not very large

374
00:17:14,169 --> 00:17:10,339
it's about a couple of inches diameter

375
00:17:16,000 --> 00:17:14,179
right sort of similar in size to the one

376
00:17:19,299 --> 00:17:16,010
that Galileo used four hundred-odd years

377
00:17:22,000 --> 00:17:19,309
ago and the whole idea was to so that

378
00:17:25,230 --> 00:17:22,010
they would the intention was to have the

379
00:17:28,120 --> 00:17:25,240
optics be such that you could observe

380
00:17:29,950 --> 00:17:28,130
Jupiter's Jupiter's moons as well as

381
00:17:31,990 --> 00:17:29,960
Saturn and Saturn's rings so it's

382
00:17:34,390 --> 00:17:32,000
definitely a solar system type telescope

383
00:17:37,150 --> 00:17:34,400
okay there are other telescopes that you

384
00:17:40,930 --> 00:17:37,160
can use as well this one is just what

385
00:17:43,240 --> 00:17:40,940
that I'm familiar with hahaha but that

386
00:17:45,280 --> 00:17:43,250
one that one is a it's kind of like a

387
00:17:46,990 --> 00:17:45,290
replica of the one that Galilee

388
00:17:49,150 --> 00:17:47,000

use when he discovered these satellites

389
00:17:52,810 --> 00:17:49,160
in the first place right except the

390
00:17:55,000 --> 00:17:52,820
optics are way better pretty it's pretty

391
00:17:57,040 --> 00:17:55,010
similar i mean the the number of lenses

392
00:17:58,810 --> 00:17:57,050
and the configuration is very similar to

393
00:18:00,940 --> 00:17:58,820
those very similar see of a spherical

394
00:18:04,810 --> 00:18:00,950
lenses and so forth in here but i can

395
00:18:08,020 --> 00:18:04,820
tell you that um is this particular

396
00:18:09,190 --> 00:18:08,030
telescope is a chromatic hmm well you

397
00:18:11,020 --> 00:18:09,200
got to describe what that is what is

398
00:18:14,680 --> 00:18:11,030
that chromatic that means that you don't

399
00:18:16,450 --> 00:18:14,690
see if you have like a cheap optics to

400
00:18:19,180 --> 00:18:16,460
telescopes you can see the colors

401
00:18:21,010 --> 00:18:19,190
separate right which means different

402
00:18:22,420 --> 00:18:21,020
band passes are different colors of

403
00:18:25,630 --> 00:18:22,430
light are focusing in different

404
00:18:29,980 --> 00:18:25,640
locations an a chromatic telescope of

405
00:18:31,960 --> 00:18:29,990
the size is ideal for looking at solar

406
00:18:33,520 --> 00:18:31,970
system objects because you see the

407
00:18:36,700 --> 00:18:33,530
colors as they really are you don't see

408
00:18:38,140 --> 00:18:36,710
that separation right so I if you'd like

409
00:18:40,810 --> 00:18:38,150
like she likes to zenna said if you look

410
00:18:42,460 --> 00:18:40,820
at it inexpensive telescopes and you

411
00:18:44,140 --> 00:18:42,470
look at a bright spot of light you'll

412
00:18:46,900 --> 00:18:44,150
see little prisms or a little little

413
00:18:48,460 --> 00:18:46,910

spreading out of light in the the

414
00:18:51,160 --> 00:18:48,470
imperfections in the optics causing it

415
00:18:53,440 --> 00:18:51,170
to basically act like a prism so this

416
00:18:56,760 --> 00:18:53,450
corrects for that and can you still get

417
00:18:59,380 --> 00:18:56,770
this telescope yes yes you can ok sir so

418
00:19:00,700 --> 00:18:59,390
you do a search for Galileo scope and

419
00:19:02,800 --> 00:19:00,710
you'll be able to get that and you can

420
00:19:05,170 --> 00:19:02,810
see these kinds of things that we're

421
00:19:07,090 --> 00:19:05,180
talking about here but Hubble is not a

422
00:19:09,280 --> 00:19:07,100
Galileo scope this is a little bit

423
00:19:11,920 --> 00:19:09,290
better a little bit a little bit of a

424
00:19:14,080 --> 00:19:11,930
step up before we transition that I'm

425
00:19:16,090 --> 00:19:14,090
with some amateur astronomers that I

426
00:19:18,010 --> 00:19:16,100
know they actually one from Stuart

427
00:19:20,350 --> 00:19:18,020
foreman who's up in the bay area here in

428
00:19:23,290 --> 00:19:20,360
California did go out and observe with

429
00:19:25,360 --> 00:19:23,300
his telescope and he posted up his

430
00:19:27,430 --> 00:19:25,370
frames with the help of Mike Phillips

431
00:19:31,930 --> 00:19:27,440
who was an amateur astronomer in North

432
00:19:34,210 --> 00:19:31,940
Carolina and here is this is up on

433
00:19:37,180 --> 00:19:34,220
youtube so sure about as well but this

434
00:19:40,150 --> 00:19:37,190
is what he was able to see from the Bay

435
00:19:43,030 --> 00:19:40,160
Area name and this is his frames going

436
00:19:45,720 --> 00:19:43,040
back and forth yeah it's it's really

437
00:19:49,300 --> 00:19:45,730
cool that the Hubble heritage program

438
00:19:53,110 --> 00:19:49,310

decided to look at this system of

439
00:19:57,000 --> 00:19:53,120
transits because that these were

440
00:19:58,840 --> 00:19:57,010
observed by cassini and historically

441
00:20:00,640 --> 00:19:58,850
they were

442
00:20:03,370 --> 00:20:00,650
some of the first solar system

443
00:20:08,320 --> 00:20:03,380
observations with a telescope and NASA

444
00:20:11,680 --> 00:20:08,330
likes to commemorate these contributors

445
00:20:15,520 --> 00:20:11,690
to astronomy by naming missions after

446
00:20:16,830 --> 00:20:15,530
them so Galileo was the name used for

447
00:20:19,330 --> 00:20:16,840
the mission to the Jupiter system

448
00:20:21,280 --> 00:20:19,340
Cassini the mission to the Saturn system

449
00:20:24,970 --> 00:20:21,290
that's still going around there and

450
00:20:26,830 --> 00:20:24,980
Hubble was also named after a famous

451
00:20:29,980 --> 00:20:26,840
astronomer who made fundamental

452
00:20:32,230 --> 00:20:29,990
contributions to science so it's really

453
00:20:36,010 --> 00:20:32,240
cool that I mean Cassini was the first

454
00:20:39,400 --> 00:20:36,020
to observe shadows of moons going across

455
00:20:42,280 --> 00:20:39,410
the disk of Jupiter and they they they

456
00:20:44,830 --> 00:20:42,290
led to the first precise determination

457
00:20:48,370 --> 00:20:44,840
of longitude difference between Paris

458
00:20:50,680 --> 00:20:48,380
and Copenhagen for example so a lot of

459
00:20:53,470 --> 00:20:50,690
good science was done based on these

460
00:20:56,830 --> 00:20:53,480
types of observations and now Hubble has

461
00:20:58,810 --> 00:20:56,840
captured images of it at you know much

462
00:21:00,820 --> 00:20:58,820
higher fidelity than those astronomers

463
00:21:02,620 --> 00:21:00,830

ever could have dreamed of yeah but the

464
00:21:04,900 --> 00:21:02,630
cool thing is is that with your own

465
00:21:07,140 --> 00:21:04,910
telescope you can see what Hubble is

466
00:21:10,120 --> 00:21:07,150
seeing maybe not with the same

467
00:21:11,860 --> 00:21:10,130
resolution mm-hmm but it's one of the

468
00:21:14,350 --> 00:21:11,870
few times and you can actually follow

469
00:21:16,720 --> 00:21:14,360
along with Hubble yeah right that's a

470
00:21:18,700 --> 00:21:16,730
good point uh so he Sonics that I

471
00:21:20,950 --> 00:21:18,710
actually before you go back to top

472
00:21:25,090 --> 00:21:20,960
besides that I just wanted to understand

473
00:21:28,450 --> 00:21:25,100
what okay so we we got this link to the

474
00:21:32,530 --> 00:21:28,460
public and to amateurs why should we

475
00:21:36,010 --> 00:21:32,540
study Jupiter or any object in the solar

476
00:21:39,070 --> 00:21:36,020
system with Hubble we have satellites

477
00:21:41,500 --> 00:21:39,080
that go there well we don't have

478
00:21:43,810 --> 00:21:41,510
actually have any missions in orbit

479
00:21:45,730 --> 00:21:43,820
around Jupiter right now the Juno

480
00:21:49,120 --> 00:21:45,740
mission is on its way there and it

481
00:21:50,860 --> 00:21:49,130
should arrive next year but it's not

482
00:21:53,110 --> 00:21:50,870
going to do the same type of things that

483
00:21:55,510 --> 00:21:53,120
Hubble can do so Hubble's main advantage

484
00:22:01,150 --> 00:21:55,520
well it has two main advantages for

485
00:22:03,910 --> 00:22:01,160
studying Jupiter one is that it can it

486
00:22:05,170 --> 00:22:03,920
can sense in the ultraviolet so we can't

487
00:22:08,380 --> 00:22:05,180
do that from the ground because the

488
00:22:09,520 --> 00:22:08,390

Earth's atmosphere blocks ultraviolet

489
00:22:12,310 --> 00:22:09,530
good thing because we would die

490
00:22:14,379 --> 00:22:12,320
otherwise but

491
00:22:18,039 --> 00:22:14,389
the other the other advantage is that

492
00:22:20,139 --> 00:22:18,049
Hubble can take very sharp images at

493
00:22:22,450 --> 00:22:20,149
optical wavelengths so we can we can

494
00:22:26,080 --> 00:22:22,460
track motions of these clouds as they

495
00:22:28,120 --> 00:22:26,090
move and you can even see that in in the

496
00:22:31,120 --> 00:22:28,130
animation just over this one Hubble

497
00:22:36,399 --> 00:22:31,130
orbit so those that the animation on the

498
00:22:39,340 --> 00:22:36,409
on the Hubble site shows just maybe 50

499
00:22:41,350 --> 00:22:39,350
minutes of these moons moving across

500
00:22:44,950 --> 00:22:41,360
Jupiter space but you can also see the

501
00:22:46,480 --> 00:22:44,960
clouds as they rotate well as Jupiter

502
00:22:49,029 --> 00:22:46,490
rotates you can see the clouds moving

503
00:22:51,159 --> 00:22:49,039
and they move at different speeds so

504
00:22:55,360 --> 00:22:51,169
some of the belts have different jet

505
00:22:58,210 --> 00:22:55,370
speeds than than other belts and by

506
00:23:01,749 --> 00:22:58,220
charting those motions you can see what

507
00:23:03,519 --> 00:23:01,759
the weather is on Jupiter and and we can

508
00:23:06,960 --> 00:23:03,529
understand the physics of atmospheres

509
00:23:10,299 --> 00:23:06,970
make parallels to the Earth's atmosphere

510
00:23:12,249 --> 00:23:10,309
in fact parallels to the oceans of Earth

511
00:23:15,129 --> 00:23:12,259
some of the board asees like the Great

512
00:23:17,799 --> 00:23:15,139
Red Spot are types of vortices that are

513
00:23:21,129 --> 00:23:17,809

present in the oceans of the Earth and

514
00:23:25,330 --> 00:23:21,139
Jupiter is our closest example of what

515
00:23:28,180 --> 00:23:25,340
exoplanets are like and a lot of current

516
00:23:31,509 --> 00:23:28,190
interest is and finding planets around

517
00:23:34,930 --> 00:23:31,519
other stars but it's hard to study those

518
00:23:37,240 --> 00:23:34,940
in detail and by studying Jupiter we can

519
00:23:39,909 --> 00:23:37,250
sort of make analogy as to some of the

520
00:23:41,289 --> 00:23:39,919
processes there awesome thank i was

521
00:23:43,210 --> 00:23:41,299
gonna yeah i'm glad you brought that up

522
00:23:45,610 --> 00:23:43,220
Carol because I was ult was saying that

523
00:23:47,950 --> 00:23:45,620
you know primarily the Hubble heritage

524
00:23:49,779 --> 00:23:47,960
images are chosen for their aesthetic

525
00:23:51,820 --> 00:23:49,789
values but there's good science it can

526
00:23:54,310 --> 00:23:51,830
also be done but we also had the

527
00:23:56,110 --> 00:23:54,320
shrinking red spot this year too so that

528
00:23:59,470 --> 00:23:56,120
was another case where I guess her boat

529
00:24:01,180 --> 00:23:59,480
was useful for helping to monitor that's

530
00:24:03,190 --> 00:24:01,190
right that's right so there's a lot of

531
00:24:05,470 --> 00:24:03,200
good useful science that can be done

532
00:24:07,330 --> 00:24:05,480
using Hubble and primarily because as

533
00:24:10,180 --> 00:24:07,340
you as you point out Mike there's not a

534
00:24:11,590 --> 00:24:10,190
current mission around Jupiter 2 to make

535
00:24:13,749 --> 00:24:11,600
these observations so Hubble is very

536
00:24:15,430 --> 00:24:13,759
valuable in that sense so I have a

537
00:24:16,629 --> 00:24:15,440
question from charles bell and i think

538
00:24:19,360 --> 00:24:16,639

i'm going to give this to use old he

539
00:24:21,190 --> 00:24:19,370
goes some how do you keep the ccd camera

540
00:24:24,750 --> 00:24:21,200
pixels from saturating from such a

541
00:24:32,190 --> 00:24:30,180
hello zolt looks frozen well basically

542
00:24:35,130 --> 00:24:32,200
we we have to make sure the exposure is

543
00:24:38,250 --> 00:24:35,140
short enough and then it won't saturate

544
00:24:41,310 --> 00:24:38,260
right we have we have calculators based

545
00:24:43,860 --> 00:24:41,320
on the known spectrum of Astrophysical

546
00:24:45,750 --> 00:24:43,870
objects we can calculate through any

547
00:24:47,850 --> 00:24:45,760
filter on Hubble what's the right

548
00:24:50,010 --> 00:24:47,860
exposure time that's right that's again

549
00:24:51,390 --> 00:24:50,020
we don't care what never actually talked

550
00:24:53,360 --> 00:24:51,400
about this before have we the exposure

551
00:24:56,400 --> 00:24:53,370
time calculator there's a tool that

552
00:25:00,690 --> 00:24:56,410
astronomers can use to actually figure

553
00:25:05,000 --> 00:25:00,700
out what exposures to say or Hubble

554
00:25:12,240 --> 00:25:09,650
Carol yes I'm here yes yes I mean the

555
00:25:14,130 --> 00:25:12,250
actually that would hell hole hang out

556
00:25:17,130 --> 00:25:14,140
not just things I know what is actually

557
00:25:19,950 --> 00:25:17,140
a good idea how you figure out how to do

558
00:25:21,320 --> 00:25:19,960
these observations and I think the

559
00:25:24,750 --> 00:25:21,330
beautiful thing about this particular

560
00:25:27,990 --> 00:25:24,760
observation in calculating the exposure

561
00:25:30,150 --> 00:25:28,000
time and also the beauty of the detector

562
00:25:32,430 --> 00:25:30,160
is that you get enough dynamic range

563
00:25:34,920 --> 00:25:32,440

that you can you can actually see the

564
00:25:37,200 --> 00:25:34,930
detail of the shadows which are very

565
00:25:41,940 --> 00:25:37,210
dark you can see the different

566
00:25:44,910 --> 00:25:41,950
brightnesses of the Jupiter bands and

567
00:25:47,970 --> 00:25:44,920
you can also see those moons which I I

568
00:25:50,280 --> 00:25:47,980
found now the long-case Callisto you

569
00:25:53,820 --> 00:25:50,290
have to adjust it a little bit to see

570
00:25:55,860 --> 00:25:53,830
that Callisto is pretty dark but still

571
00:25:57,360 --> 00:25:55,870
the fact that you can get the exposure

572
00:26:00,750 --> 00:25:57,370
time right that you get all that stuff

573
00:26:03,120 --> 00:26:00,760
at the same time i think is impressive

574
00:26:05,370 --> 00:26:03,130
for you guys who planned the observation

575
00:26:07,530 --> 00:26:05,380
i just was a cheerleader i had nothing

576
00:26:09,060 --> 00:26:07,540
to do with the exposure time right but

577
00:26:10,470 --> 00:26:09,070
that you know that is something that we

578
00:26:13,350 --> 00:26:10,480
we should we should have a hangout

579
00:26:15,240 --> 00:26:13,360
specifically on that is it pretty yeah

580
00:26:17,220 --> 00:26:15,250
it is that we did yeah there's there but

581
00:26:19,230 --> 00:26:17,230
there are tools as Mike pointed out that

582
00:26:20,850 --> 00:26:19,240
that Shauna murs can use to help figure

583
00:26:23,420 --> 00:26:20,860
out the exposure time so that's how they

584
00:26:25,950 --> 00:26:23,430
keep that's how I kept it from

585
00:26:28,400 --> 00:26:25,960
saturating such a such a bright object

586
00:26:31,260 --> 00:26:28,410
it's just a matter of figuring out the

587
00:26:34,710 --> 00:26:31,270
exposure time so I'm seeing a new term

588
00:26:37,470 --> 00:26:34,720

on the Q&A app huh blurs never heard

589
00:26:40,140 --> 00:26:37,480
that before hubli I kind of like Heather

590
00:26:44,549 --> 00:26:40,150
I had like couplers / Hubble huggers oh

591
00:26:46,230 --> 00:26:44,559
yeah no I I'm a hubble hugger but sev

592
00:26:48,450 --> 00:26:46,240
dust bunny goes good evening huh blurs

593
00:26:50,520 --> 00:26:48,460
and also we have a comp I have a

594
00:26:53,400 --> 00:26:50,530
question here from wired magazine hello

595
00:26:55,380 --> 00:26:53,410
huh blurs Nick Stockton here from wired

596
00:26:57,630 --> 00:26:55,390
magazine was wondering if observations

597
00:26:59,010 --> 00:26:57,640
like these contribute and to Mike I'll

598
00:27:01,500 --> 00:26:59,020
I'll direct this to you since i'm not

599
00:27:03,450 --> 00:27:01,510
sure where his ult went was wondering if

600
00:27:06,000 --> 00:27:03,460
observations like these contribute to

601
00:27:07,799 --> 00:27:06,010
science of looking for exomoons that's

602
00:27:10,260 --> 00:27:07,809
happening with Kepler and other

603
00:27:12,299 --> 00:27:10,270
telescopes looking for exomoons so how

604
00:27:16,289 --> 00:27:12,309
does this do these observations help us

605
00:27:19,289 --> 00:27:16,299
with those sorts of observations uh not

606
00:27:23,820 --> 00:27:19,299
really but there there is kind of a tie

607
00:27:26,490 --> 00:27:23,830
into another program jPAS carpets and as

608
00:27:31,710 --> 00:27:26,500
an email about this earlier that that's

609
00:27:33,840 --> 00:27:31,720
all forwarded but the there was a

610
00:27:37,020 --> 00:27:33,850
program to look at jupiter when venus

611
00:27:39,630 --> 00:27:37,030
transited across the Sun so Venus's

612
00:27:41,280 --> 00:27:39,640
shadow was falling on Jupiter now you

613
00:27:43,049 --> 00:27:41,290

wouldn't see it you would all you would

614
00:27:46,970 --> 00:27:43,059
see is the whole disk of Jupiter dimming

615
00:27:50,640 --> 00:27:46,980
a little bit but I don't believe that

616
00:27:52,680 --> 00:27:50,650
wait a minute whoa hold on so Venus was

617
00:27:56,940 --> 00:27:52,690
passing in front of the Sun as the

618
00:28:00,270 --> 00:27:56,950
originator and it was casting a shadow

619
00:28:02,250 --> 00:28:00,280
on Jupiter yeah but but not a resolve

620
00:28:04,159 --> 00:28:02,260
shadow so unlike these images where you

621
00:28:06,870 --> 00:28:04,169
see a black dot all you would

622
00:28:10,710 --> 00:28:06,880
theoretically see is Jupiter getting a

623
00:28:13,860 --> 00:28:10,720
little bit dimmer the problem is the

624
00:28:15,690 --> 00:28:13,870
signal-to-noise ratio so in order to

625
00:28:17,700 --> 00:28:15,700
actually see that you have to very

626
00:28:19,850 --> 00:28:17,710
precisely measure how bright Jupiter is

627
00:28:22,230 --> 00:28:19,860
but as you can see as it as it rotates

628
00:28:24,720 --> 00:28:22,240
spots are coming into view and leaving

629
00:28:26,700 --> 00:28:24,730
so there's a number of other reasons why

630
00:28:28,530 --> 00:28:26,710
Jupiter's total brightness is changing

631
00:28:30,480 --> 00:28:28,540
so I I don't think they were successful

632
00:28:34,560 --> 00:28:30,490
in that effort now when we look at

633
00:28:36,330 --> 00:28:34,570
exoplanets again a lot of times we're

634
00:28:39,360 --> 00:28:36,340
looking at small changes in brightness

635
00:28:43,440 --> 00:28:39,370
of the host star as the planet goes in

636
00:28:46,320 --> 00:28:43,450
front of the star so there again you

637
00:28:49,169 --> 00:28:46,330
need very high signal-to-noise to detect

638
00:28:51,120 --> 00:28:49,179

this very small change in brightness so

639
00:28:55,490 --> 00:28:51,130
a moon around another planet

640
00:28:58,890 --> 00:28:55,500
is another level of signal to noise I i

641
00:29:02,130 --> 00:28:58,900
I'm not really sure about whether that's

642
00:29:03,750 --> 00:29:02,140
been done or but I'm sure at some point

643
00:29:06,090 --> 00:29:03,760
it will be but you have all these other

644
00:29:08,250 --> 00:29:06,100
noise terms to worry about what changing

645
00:29:10,440 --> 00:29:08,260
brightness of sunspots and things like

646
00:29:16,200 --> 00:29:10,450
that can you can you tell us what the

647
00:29:20,670 --> 00:29:16,210
contrast ratio is or tail I said like

648
00:29:22,800 --> 00:29:20,680
between the shadow Venus and Jupiter was

649
00:29:29,010 --> 00:29:22,810
that like one in a million in one in ten

650
00:29:32,730 --> 00:29:29,020
million that I could calculate it thank

651
00:29:34,950 --> 00:29:32,740
you give me a car I think compared to

652
00:29:37,560 --> 00:29:34,960
the size of the Sun basically and Venus

653
00:29:39,420 --> 00:29:37,570
is very small so or the area of Venus

654
00:29:42,960 --> 00:29:39,430
compared to the rave let's surface area

655
00:29:45,840 --> 00:29:42,970
yeah yes it never ceases to amaze me it

656
00:29:47,970 --> 00:29:45,850
amazed me how precise we can get our

657
00:29:51,480 --> 00:29:47,980
photometry these days I mean Kepler as

658
00:29:54,120 --> 00:29:51,490
as Nick pointed out is is you know it

659
00:29:56,670 --> 00:29:54,130
was looking for other earth-sized

660
00:29:59,790 --> 00:29:56,680
planets and then it's designed to

661
00:30:02,070 --> 00:29:59,800
measure tiny dips in brightness in these

662
00:30:04,110 --> 00:30:02,080
stars as planets pass in front and so

663
00:30:06,330 --> 00:30:04,120

the fact that we do this now with with

664
00:30:08,460 --> 00:30:06,340
things like Venus passing in front of

665
00:30:11,610 --> 00:30:08,470
the Sun and dimming Jupiter just blows

666
00:30:13,380 --> 00:30:11,620
me away that's that's amazing so anyway

667
00:30:18,420 --> 00:30:13,390
it's amazing I was just going to comment

668
00:30:23,460 --> 00:30:18,430
that that Kepler as amazing as it is is

669
00:30:26,010 --> 00:30:23,470
barely able to reach find planets that

670
00:30:30,300 --> 00:30:26,020
are the size of the earth so to find a

671
00:30:33,420 --> 00:30:30,310
moon is really tough it's really hard i

672
00:30:37,380 --> 00:30:33,430
read the tickets especially if you had

673
00:30:39,950 --> 00:30:37,390
say you had an earth-sized moon not sure

674
00:30:42,390 --> 00:30:39,960
would be a moon it may be a binary

675
00:30:45,830 --> 00:30:42,400
planet at that point but if you had to

676
00:30:50,280 --> 00:30:45,840
piter's and then and then earth an

677
00:30:53,790 --> 00:30:50,290
earth-sized satellite around it it'd be

678
00:30:56,130 --> 00:30:53,800
very hard to tell you know in a

679
00:30:58,530 --> 00:30:56,140
situation where those two are passing in

680
00:31:02,100 --> 00:30:58,540
front of between us and the star and

681
00:31:04,500 --> 00:31:02,110
then sometimes the moon is in behind or

682
00:31:04,680 --> 00:31:04,510
in front and the dimming of the law that

683
00:31:08,310 --> 00:31:04,690
will

684
00:31:11,360 --> 00:31:08,320
be a really a level of precision that is

685
00:31:14,430 --> 00:31:11,370
beyond Kepler's capability at least

686
00:31:18,140 --> 00:31:14,440
right so that's a great question Nick

687
00:31:22,410 --> 00:31:18,150
thank you very much so timothy rent ram

688
00:31:24,870 --> 00:31:22,420

ram Pieri rent sorry Tim I'm messing

689
00:31:27,660 --> 00:31:24,880
your name up with so many moons and this

690
00:31:29,580 --> 00:31:27,670
maybe could go to Carol or Mike with so

691
00:31:32,790 --> 00:31:29,590
many moons does this make Jupiter's

692
00:31:33,960 --> 00:31:32,800
atmosphere complex in other words like I

693
00:31:35,970 --> 00:31:33,970
guess another way of putting that as

694
00:31:38,700 --> 00:31:35,980
does the moons of Jupiter up with within

695
00:31:40,380 --> 00:31:38,710
it there are many more than four does

696
00:31:44,070 --> 00:31:40,390
what effect does that have on Jupiter's

697
00:31:46,350 --> 00:31:44,080
atmosphere do you if any did when I

698
00:31:52,050 --> 00:31:46,360
guess to answer that question okay Mike

699
00:31:53,550 --> 00:31:52,060
gonna yes but he's the expert okay you

700
00:31:56,190 --> 00:31:53,560
gotta you gotta guess for Smike you're

701
00:32:01,980 --> 00:31:56,200
muted Oh Mike you're muted unmeet

702
00:32:03,870 --> 00:32:01,990
microphone and try again okay yeah yeah

703
00:32:05,100 --> 00:32:03,880
it's a minimal effect there's two ways

704
00:32:07,850 --> 00:32:05,110
that the moon's could affect the

705
00:32:10,740 --> 00:32:07,860
atmosphere they could either change the

706
00:32:12,990 --> 00:32:10,750
radiation or sunlight that would reach

707
00:32:21,720 --> 00:32:13,000
Jupiter or they could transfer material

708
00:32:24,210 --> 00:32:21,730
to Jupiter so these up actually we don't

709
00:32:27,030 --> 00:32:24,220
have any images prepared but hubble

710
00:32:28,470 --> 00:32:27,040
hubble ultra violent images show one of

711
00:32:31,740 --> 00:32:28,480
the clearest links between the moon's

712
00:32:33,600 --> 00:32:31,750
and and the atmosphere so when you look

713
00:32:38,100 --> 00:32:33,610

at jupiter and ultraviolet with Hubble

714
00:32:39,360 --> 00:32:38,110
you can see at an auroral oval and it's

715
00:32:41,580 --> 00:32:39,370
a similar thing when you look at the

716
00:32:43,770 --> 00:32:41,590
earth the Northern Lights the Southern

717
00:32:46,140 --> 00:32:43,780
Lights they form an oval around the

718
00:32:49,140 --> 00:32:46,150
Magnetic Pole and Jupiter's moons

719
00:32:50,790 --> 00:32:49,150
actually have streams of particles that

720
00:32:52,950 --> 00:32:50,800
travel through the magnetic field and

721
00:32:55,140 --> 00:32:52,960
then hit the planet near the rural oval

722
00:32:57,600 --> 00:32:55,150
and you can see footprints of the moons

723
00:33:01,530 --> 00:32:57,610
and watch them as they go around the

724
00:33:04,440 --> 00:33:01,540
planet so there is a linkage there and

725
00:33:05,940 --> 00:33:04,450
so it doesn't really affect the

726
00:33:08,970 --> 00:33:05,950
atmosphere that much but it's useful

727
00:33:11,070 --> 00:33:08,980
that there is this this linkage because

728
00:33:12,780 --> 00:33:11,080
it can help you study processes in the

729
00:33:16,290 --> 00:33:12,790
magnetosphere where these particles are

730
00:33:18,510 --> 00:33:16,300
traveling through space interesting

731
00:33:20,580 --> 00:33:18,520
thing though about that question is

732
00:33:23,240 --> 00:33:20,590
pattern is a different case so Saturn

733
00:33:25,770 --> 00:33:23,250
has these big rings they're not

734
00:33:28,110 --> 00:33:25,780
technically a moon or anything but they

735
00:33:30,630 --> 00:33:28,120
do they do affect the atmosphere there

736
00:33:32,640 --> 00:33:30,640
because the Rings are so big they can

737
00:33:35,100 --> 00:33:32,650
shade the atmosphere and you have

738
00:33:37,490 --> 00:33:35,110

seasonal changes if you could imagine

739
00:33:40,320 --> 00:33:37,500
floating around in Saturn's atmosphere

740
00:33:42,330 --> 00:33:40,330
depending on what latitude you're at you

741
00:33:45,060 --> 00:33:42,340
may see the Rings blocking the Sun and

742
00:33:46,620 --> 00:33:45,070
get a lot less sunlight than some other

743
00:33:49,320 --> 00:33:46,630
areas of the planet so that does affect

744
00:33:52,230 --> 00:33:49,330
the atmosphere of Saturn cool now

745
00:33:54,930 --> 00:33:52,240
Jupiter also has a small ring doesn't it

746
00:33:56,820 --> 00:33:54,940
yeah very faint ring very faint ring but

747
00:33:58,140 --> 00:33:56,830
it's not it's not enough i guess to make

748
00:34:00,210 --> 00:33:58,150
much of a difference in the atmosphere

749
00:34:01,380 --> 00:34:00,220
so okay good question timothy thank you

750
00:34:03,900 --> 00:34:01,390
very much there was a great question

751
00:34:05,340 --> 00:34:03,910
from charles bell it went away I guess

752
00:34:08,669 --> 00:34:05,350
he deleted it but I want to ask it

753
00:34:10,860 --> 00:34:08,679
anyway um and that is is there a minimum

754
00:34:12,930 --> 00:34:10,870
exposure time for Hubble and Carol if

755
00:34:15,240 --> 00:34:12,940
you may not know this I don't know but I

756
00:34:18,300 --> 00:34:15,250
know oh do is there okay good good mike

757
00:34:21,899 --> 00:34:18,310
is in a long time that you can take a

758
00:34:24,930 --> 00:34:21,909
minimum exposure time there there is and

759
00:34:27,600 --> 00:34:24,940
it depends not on the telescope but on

760
00:34:30,350 --> 00:34:27,610
the instrument or the camera the cam

761
00:34:32,940 --> 00:34:30,360
though these are these observations of

762
00:34:36,600 --> 00:34:32,950
the moon transits were taken with the

763
00:34:39,630 --> 00:34:36,610

wide field camera 3 or whips III as we

764
00:34:42,389 --> 00:34:39,640
affectionately call it and whips III has

765
00:34:44,490 --> 00:34:42,399
a minimum exposure time of less than

766
00:34:46,680 --> 00:34:44,500
half a second I don't remember precisely

767
00:34:51,000 --> 00:34:46,690
its point 3 or point 4 seconds is a

768
00:34:55,680 --> 00:34:51,010
minimum I think it might be point 3 but

769
00:34:58,050 --> 00:34:55,690
anyways that I mean since we're talking

770
00:34:59,940 --> 00:34:58,060
about these technical things there's

771
00:35:01,710 --> 00:34:59,950
something really cool about this image

772
00:35:03,480 --> 00:35:01,720
sequence and I wish though it was still

773
00:35:05,850 --> 00:35:03,490
here because I forgot the exact number

774
00:35:07,200 --> 00:35:05,860
of frames that were taken you just need

775
00:35:10,800 --> 00:35:07,210
to look at that he said that it crashed

776
00:35:13,080 --> 00:35:10,810
she'll be back in 20 25 something like

777
00:35:15,510 --> 00:35:13,090
that what if you are there yes though

778
00:35:17,880 --> 00:35:15,520
when we do our science observations we

779
00:35:19,530 --> 00:35:17,890
like to capture the entire disk of the

780
00:35:22,380 --> 00:35:19,540
planet because it's really rare that we

781
00:35:25,290 --> 00:35:22,390
get to observe Jupiter with Hubble and

782
00:35:29,220 --> 00:35:25,300
so we want to we want to observe the

783
00:35:30,630 --> 00:35:29,230
entire thing but for this sequence we

784
00:35:32,310 --> 00:35:30,640
had a different priority we wanted to

785
00:35:35,550 --> 00:35:32,320
get as many frames as we could

786
00:35:37,920 --> 00:35:35,560
build up with smooth animation and so we

787
00:35:42,750 --> 00:35:37,930
use frame we could use like a sub array

788
00:35:44,220 --> 00:35:42,760

only reading out part of the detector as

789
00:35:47,700 --> 00:35:44,230
old I'm talking about how we use that

790
00:35:50,370 --> 00:35:47,710
welcome back hi sorry about that that's

791
00:35:52,530 --> 00:35:50,380
alright so we use sub-arrays we only

792
00:35:54,690 --> 00:35:52,540
read out part of the detector and this

793
00:35:58,470 --> 00:35:54,700
allowed us to build up a whole bunch of

794
00:36:01,020 --> 00:35:58,480
frames without pausing to dump the

795
00:36:03,360 --> 00:36:01,030
buffer but basically we got a really

796
00:36:05,370 --> 00:36:03,370
smooth animation at the cost of cutting

797
00:36:08,490 --> 00:36:05,380
off the corners so if you look at that

798
00:36:10,200 --> 00:36:08,500
image we we don't have the entire planet

799
00:36:12,180 --> 00:36:10,210
there but we did that on purpose because

800
00:36:14,820 --> 00:36:12,190
we wanted to build up a smooth animation

801
00:36:18,680 --> 00:36:14,830
so I did want to backtrack but I did

802
00:36:21,900 --> 00:36:18,690
find that I'm Oh brilliant Mike yeah

803
00:36:24,150 --> 00:36:21,910
they're in this ultraviolet image to the

804
00:36:27,450 --> 00:36:24,160
left you can see sort of like a bright

805
00:36:31,260 --> 00:36:27,460
little comma feature I'm gonna go that's

806
00:36:33,150 --> 00:36:31,270
the IO foot yeah iOS no one just to show

807
00:36:35,430 --> 00:36:33,160
people it is on Hubble site as well if

808
00:36:38,670 --> 00:36:35,440
anybody wants to have that image awesome

809
00:36:40,320 --> 00:36:38,680
okay great okay so what I just tweeted

810
00:36:42,540 --> 00:36:40,330
it out along with the link and it's in

811
00:36:45,060 --> 00:36:42,550
the event page on Google debate well

812
00:36:48,480 --> 00:36:45,070
with the link thanks good I'm problem

813
00:36:51,750 --> 00:36:48,490

right so here's a question from wat van

814
00:36:54,480 --> 00:36:51,760
de van der haida I think seeing three

815
00:36:56,700 --> 00:36:54,490
moons transiting Jupiter is rare but has

816
00:36:59,190 --> 00:36:56,710
there ever been a quadruple transit in

817
00:37:02,190 --> 00:36:59,200
other words I Oh Callisto Europa and

818
00:37:04,080 --> 00:37:02,200
Ganymede has where I've ever been one

819
00:37:10,530 --> 00:37:04,090
with all four I've heard that's

820
00:37:13,050 --> 00:37:10,540
impossible hmm but I yeah I think the

821
00:37:17,850 --> 00:37:13,060
issue is that three of the moons are

822
00:37:21,330 --> 00:37:17,860
locked in Laplace resonance which means

823
00:37:25,410 --> 00:37:21,340
that their orbital periods are iOS four

824
00:37:29,520 --> 00:37:25,420
battle period is half the half the

825
00:37:31,350 --> 00:37:29,530
duration of Europa's period and so on so

826
00:37:33,450 --> 00:37:31,360
I think there's a constraint that if

827
00:37:34,590 --> 00:37:33,460
some of the moons are on one side than

828
00:37:37,350 --> 00:37:34,600
the other one has to be on the other

829
00:37:39,780 --> 00:37:37,360
side or something like that okay I don't

830
00:37:42,000 --> 00:37:39,790
think it's possible i did want to

831
00:37:44,170 --> 00:37:42,010
mention and maybe zylle will not be

832
00:37:46,270 --> 00:37:44,180
happy i did but

833
00:37:51,000 --> 00:37:46,280
more than those three moons that

834
00:37:55,270 --> 00:37:51,010
actually transit yes that's right and no

835
00:37:57,520 --> 00:37:55,280
amateur caught this because it is so

836
00:38:02,010 --> 00:37:57,530
little it's really hard to see but there

837
00:38:04,780 --> 00:38:02,020
are little tiny turtles image is

838
00:38:08,230 --> 00:38:04,790

probably on the sequence that we capture

839
00:38:11,079 --> 00:38:08,240
yeah yes it's very difficult to see you

840
00:38:13,480 --> 00:38:11,089
really are missing oh go ahead and blow

841
00:38:15,730 --> 00:38:13,490
the image up on a you know big screen

842
00:38:20,200 --> 00:38:15,740
and we're all that good oh I see yeah

843
00:38:23,170 --> 00:38:20,210
you have a mafia Phoebe yep this time

844
00:38:26,980 --> 00:38:23,180
I'm we'll see on TV oh they're just a

845
00:38:29,680 --> 00:38:26,990
little tiny dots Wow in fact you can see

846
00:38:32,290 --> 00:38:29,690
the shadows to do you have them to

847
00:38:35,799 --> 00:38:32,300
somebody have that yeah I can you kind

848
00:38:38,290 --> 00:38:35,809
of have to zoom in to see go yes well we

849
00:38:42,460 --> 00:38:38,300
have a good one we have a little video

850
00:38:44,980 --> 00:38:42,470
that we made that zoomed in that's not

851
00:38:50,380 --> 00:38:44,990
actually a post on Hubble side it is

852
00:38:54,210 --> 00:38:50,390
posted on the Hubble heritage site uh if

853
00:38:59,530 --> 00:38:54,220
I can let's see I can bring that up here

854
00:39:02,559 --> 00:38:59,540
maybe oh sorry no that's okay no I was

855
00:39:08,140 --> 00:39:02,569
gonna listen here on the country being

856
00:39:11,170 --> 00:39:08,150
asked questions on the spot cool which

857
00:39:15,700 --> 00:39:11,180
we knew that they would be crossing the

858
00:39:18,309 --> 00:39:15,710
face because we had a we had charts that

859
00:39:21,220 --> 00:39:18,319
showed the configuration as we were

860
00:39:23,200 --> 00:39:21,230
planning the observations um but we

861
00:39:27,010 --> 00:39:23,210
weren't sure that we would actually see

862
00:39:28,450 --> 00:39:27,020
them and sure enough when we we had to

863
00:39:31,240 --> 00:39:28,460

sort of even stretch them a little hard

864
00:39:33,280 --> 00:39:31,250
we had to adjust the contrast and

865
00:39:34,870 --> 00:39:33,290
brightness such that you could see these

866
00:39:37,059 --> 00:39:34,880
and then the other thing is that there's

867
00:39:39,549 --> 00:39:37,069
actually a little bit of noise and stuff

868
00:39:41,289 --> 00:39:39,559
and the images so it's in it and they're

869
00:39:44,140 --> 00:39:41,299
moving across the clouds which are very

870
00:39:46,120 --> 00:39:44,150
complex so you know it's a little hard

871
00:39:48,460 --> 00:39:46,130
to tell what what if you look at just

872
00:39:51,190 --> 00:39:48,470
one frame it's very difficult to tell

873
00:39:53,500 --> 00:39:51,200
what's a little tiny moon what's a cloud

874
00:39:55,270 --> 00:39:53,510
feature and what may be some noise in

875
00:39:57,100 --> 00:39:55,280
the detector but if you look at the

876
00:39:59,260 --> 00:39:57,110
frames in succession if you may

877
00:40:02,890 --> 00:39:59,270
take the movie and look at them you can

878
00:40:06,340 --> 00:40:02,900
see the marching across the frame and if

879
00:40:11,860 --> 00:40:06,350
I uh if I try to forget it up right now

880
00:40:13,000 --> 00:40:11,870
okay yeah yeah there it is and i'll put

881
00:40:14,230 --> 00:40:13,010
the link it out on twitter and

882
00:40:16,660 --> 00:40:14,240
everything like that but this is phone

883
00:40:18,940 --> 00:40:16,670
at the hubble heritage site and i'll

884
00:40:20,080 --> 00:40:18,950
make it that's right heritage yeah and

885
00:40:21,220 --> 00:40:20,090
you should guys should bookmark that

886
00:40:24,310 --> 00:40:21,230
site there's a lot of cool stuff on

887
00:40:27,220 --> 00:40:24,320
their heritage does stsci edu a lot of

888
00:40:28,840 --> 00:40:27,230

cool stuff there so yeah I could see it

889
00:40:33,610 --> 00:40:28,850
now look at that well that is so awesome

890
00:40:35,260 --> 00:40:33,620
yeah right now is amazed that is a bike

891
00:40:38,740 --> 00:40:35,270
do you know how big those moons are I

892
00:40:40,390 --> 00:40:38,750
don't I haven't looked that up uh no I

893
00:40:41,980 --> 00:40:40,400
would have to look it up i am not really

894
00:40:44,260 --> 00:40:41,990
good at memorizing over there certainly

895
00:40:46,510 --> 00:40:44,270
tiny compared to the Galilean ones and

896
00:40:51,640 --> 00:40:46,520
they are very small there but they're

897
00:40:55,840 --> 00:40:51,650
about an arcsecond that's diameter okay

898
00:40:57,430 --> 00:40:55,850
oh no no wait wait moms will get it no

899
00:40:59,530 --> 00:40:57,440
no we're not talking about together land

900
00:41:02,260 --> 00:40:59,540
moons right we're talking about the

901
00:41:04,740 --> 00:41:02,270
little tiny guy yeah yeah oh those

902
00:41:08,950 --> 00:41:04,750
they're less than that no way less alone

903
00:41:11,110 --> 00:41:08,960
um but I you know what I bet if we had

904
00:41:13,930 --> 00:41:11,120
captured these frames when those moves

905
00:41:15,220 --> 00:41:13,940
were just starting to cross the disk on

906
00:41:17,260 --> 00:41:15,230
the limb of Jupiter they would have

907
00:41:19,390 --> 00:41:17,270
stood out a little bit more this is

908
00:41:22,990 --> 00:41:19,400
something that Cassini actually noticed

909
00:41:25,240 --> 00:41:23,000
in their first you know the first

910
00:41:27,610 --> 00:41:25,250
telescopic observations of the Galilean

911
00:41:29,260 --> 00:41:27,620
satellites crossing the disk is that you

912
00:41:31,150 --> 00:41:29,270
could see them you could see the moons

913
00:41:33,610 --> 00:41:31,160

as they first through a small telescope

914
00:41:35,620 --> 00:41:33,620
but see the moons as they first touched

915
00:41:37,720 --> 00:41:35,630
Jupiter's edge but once they get towards

916
00:41:39,370 --> 00:41:37,730
them the center of the planet with a

917
00:41:42,340 --> 00:41:39,380
small chocolate you can't really see the

918
00:41:43,720 --> 00:41:42,350
moons and interesting so about that that

919
00:41:45,910 --> 00:41:43,730
was something that these early

920
00:41:48,630 --> 00:41:45,920
scientists used to figure out the

921
00:41:52,690 --> 00:41:48,640
Jupiter probably has an atmosphere

922
00:41:58,230 --> 00:41:52,700
because it it's brighter in the middle

923
00:42:01,210 --> 00:41:58,240
and dimmer around the edges so this

924
00:42:03,760 --> 00:42:01,220
basically just finding the light curve

925
00:42:06,610 --> 00:42:03,770
as the brightness changes is a technique

926
00:42:10,560 --> 00:42:06,620
that we use for exoplanets to but so for

927
00:42:13,510 --> 00:42:10,570
inquiring minds io is 36

928
00:42:17,500 --> 00:42:13,520
about thirty six hundred kilometers in

929
00:42:20,290 --> 00:42:17,510
diameter and Athiya is about 250 so less

930
00:42:23,940 --> 00:42:20,300
than ten times and thieving is a hundred

931
00:42:26,470 --> 00:42:23,950
sixteen so it's well pretty darn little

932
00:42:28,359 --> 00:42:26,480
little guys out little rocks out there

933
00:42:30,970 --> 00:42:28,369
that's a real tribute to Hubble be able

934
00:42:35,200 --> 00:42:30,980
to resolve its really great well I'm not

935
00:42:39,160 --> 00:42:35,210
really see you sooner so there but it

936
00:42:42,010 --> 00:42:39,170
tends to a thousand sir sighs yeah I'm a

937
00:42:44,890 --> 00:42:42,020
big moons okay they're so small they're

938
00:42:47,410 --> 00:42:44,900

not even round if you right right i was

939
00:42:51,280 --> 00:42:47,420
noticing that when i lifted yeah so

940
00:42:53,290 --> 00:42:51,290
small to not even right 80 but those

941
00:42:54,970 --> 00:42:53,300
would be basically regular satellites

942
00:42:57,850 --> 00:42:54,980
they're not like captured asteroids or

943
00:43:00,730 --> 00:42:57,860
something are they no because these are

944
00:43:04,840 --> 00:43:00,740
very close to the planet um actually da

945
00:43:08,109 --> 00:43:04,850
mafia well it's I'm not sure to be

946
00:43:10,120 --> 00:43:08,119
honest um but they're consider regular

947
00:43:13,780 --> 00:43:10,130
satellites they they they orbit in

948
00:43:17,020 --> 00:43:13,790
Jupiter's equatorial plane Amal Tia has

949
00:43:19,000 --> 00:43:17,030
a faint ring associated with it too it's

950
00:43:21,730 --> 00:43:19,010
very closely aligned yeah but the

951
00:43:24,609 --> 00:43:21,740
irregular satellites they don't have to

952
00:43:27,520 --> 00:43:24,619
be in the equatorial you know orbiting

953
00:43:31,180 --> 00:43:27,530
in Jupiter's equatorial plan some of

954
00:43:33,820 --> 00:43:31,190
those are just like at any angle in

955
00:43:36,370 --> 00:43:33,830
polar orbits whatever there are nothing

956
00:43:39,849 --> 00:43:36,380
about that Phoebe are two of the four

957
00:43:44,050 --> 00:43:39,859
inner satellites and there are inside

958
00:43:45,910 --> 00:43:44,060
the orbit of Io Europa and and you can

959
00:43:48,910 --> 00:43:45,920
even see that from the from the color

960
00:43:52,840 --> 00:43:48,920
composites yeah because if you look at

961
00:43:55,300 --> 00:43:52,850
how far did I Oh move yeah yeah in that

962
00:43:58,890 --> 00:43:55,310
image it's a small amount compared to

963
00:44:01,780 --> 00:43:58,900

how far did a Mafiya and Phoebe move so

964
00:44:03,880 --> 00:44:01,790
things that are closer to the planet are

965
00:44:06,280 --> 00:44:03,890
orbiting faster than things farther out

966
00:44:08,680 --> 00:44:06,290
so you can just see from this image

967
00:44:10,090 --> 00:44:08,690
which one's the closer one right in it

968
00:44:12,820 --> 00:44:10,100
and the fact that they are closer

969
00:44:16,000 --> 00:44:12,830
actually allows them to make a shadow

970
00:44:19,930 --> 00:44:16,010
where as if they were further out forget

971
00:44:21,290 --> 00:44:19,940
it yeah right so uh now that you're back

972
00:44:23,150 --> 00:44:21,300
sold and we we

973
00:44:26,900 --> 00:44:23,160
we we lost you there for a little bit i

974
00:44:29,690 --> 00:44:26,910
want to get to some of the nuts and

975
00:44:31,310 --> 00:44:29,700
bolts of the processing of the images

976
00:44:32,900 --> 00:44:31,320
and Charles I'm gonna get started with a

977
00:44:35,870 --> 00:44:32,910
question from Charles Bell who's asking

978
00:44:38,420 --> 00:44:35,880
could you show a preview or raw image of

979
00:44:40,400 --> 00:44:38,430
Jupiter before any processing to bring

980
00:44:42,650 --> 00:44:40,410
out bands across the disk I'm curious to

981
00:44:44,900 --> 00:44:42,660
know how you get the bands of Jupiter to

982
00:44:46,280 --> 00:44:44,910
show so clearly I don't worry so much

983
00:44:48,980 --> 00:44:46,290
about you probably don't have any raw

984
00:44:51,230 --> 00:44:48,990
I'm just handy but how do you get the

985
00:44:54,110 --> 00:44:51,240
the bands and and what what sort of

986
00:44:56,780 --> 00:44:54,120
techniques do you do to bring out some

987
00:44:57,890 --> 00:44:56,790
of these details well I'll have to say

988
00:45:00,740 --> 00:44:57,900

that we didn't really do anything

989
00:45:02,750 --> 00:45:00,750
special to make the band's appear they

990
00:45:06,470 --> 00:45:02,760
basically appear in the images and again

991
00:45:09,830 --> 00:45:06,480
if I show my screen I can show some of

992
00:45:14,570 --> 00:45:09,840
these images I don't have raw raw images

993
00:45:19,120 --> 00:45:14,580
but I have the individual images that we

994
00:45:22,700 --> 00:45:19,130
produced well it's that's interesting

995
00:45:25,400 --> 00:45:22,710
it's not showing up here I'm having all

996
00:45:30,740 --> 00:45:25,410
kinds of technical difficulty I'm

997
00:45:36,730 --> 00:45:30,750
terribly sorry um I don't know why this

998
00:45:39,980 --> 00:45:36,740
is not okay here we go yeah so this is

999
00:45:42,410 --> 00:45:39,990
making the color composite right I was

1000
00:45:49,490 --> 00:45:42,420
good hoping to show my computer is not

1001
00:45:50,900 --> 00:45:49,500
cooperating with me um I I don't know

1002
00:45:53,270 --> 00:45:50,910
what's going on with this okay so

1003
00:45:55,370 --> 00:45:53,280
terribly sorry that's all right but the

1004
00:45:57,680 --> 00:45:55,380
images themselves as far as the you know

1005
00:46:00,470 --> 00:45:57,690
I think Charles is trying to get to he

1006
00:46:03,350 --> 00:46:00,480
apparently he is wondering you know are

1007
00:46:05,930 --> 00:46:03,360
there any ways in which you might be

1008
00:46:07,340 --> 00:46:05,940
able to maximize the the contrast or

1009
00:46:10,660 --> 00:46:07,350
maybe get the band's to show up a little

1010
00:46:14,240 --> 00:46:10,670
bit better well one thing is we used

1011
00:46:16,460 --> 00:46:14,250
kind of specialized filters and these

1012
00:46:19,340 --> 00:46:16,470
are narrow band filters which isolate a

1013
00:46:22,900 --> 00:46:19,350

very narrow range of wavelengths or

1014
00:46:25,190 --> 00:46:22,910
colors out of the visible light spectrum

1015
00:46:26,360 --> 00:46:25,200
almost killed enlisted you have you can

1016
00:46:28,850 --> 00:46:26,370
see them right there that is your

1017
00:46:32,150 --> 00:46:28,860
shipping the listed ya there these are

1018
00:46:33,120 --> 00:46:32,160
these Hubble filter names so f 33 395

1019
00:46:37,200 --> 00:46:33,130
and F

1020
00:46:40,380 --> 00:46:37,210
2n + f6 31 in and those are codes for

1021
00:46:42,269 --> 00:46:40,390
telling us what the wavelength coverage

1022
00:46:43,859 --> 00:46:42,279
of these light of these filters are so

1023
00:46:46,079 --> 00:46:43,869
basically we have a you know 400

1024
00:46:48,390 --> 00:46:46,089
nanometers 500 nanometers and 600

1025
00:46:50,400 --> 00:46:48,400
nanometers basically in red green and

1026
00:46:52,019 --> 00:46:50,410
blue image basically red green and blue

1027
00:46:55,349 --> 00:46:52,029
although they're not exactly right

1028
00:46:57,359 --> 00:46:55,359
Greenville but anyway and they're called

1029
00:47:00,779 --> 00:46:57,369
narrow band filters which again sample a

1030
00:47:02,519 --> 00:47:00,789
very narrow range of colors and the only

1031
00:47:03,870 --> 00:47:02,529
reason the main reason the narrow band

1032
00:47:06,509 --> 00:47:03,880
filters are chosen is too because they

1033
00:47:08,960 --> 00:47:06,519
let in less light and Jupiter being

1034
00:47:11,220 --> 00:47:08,970
relatively bright a very bright object

1035
00:47:14,309 --> 00:47:11,230
especially for Hubble for a large

1036
00:47:16,140 --> 00:47:14,319
telescope it cuts down on the amount of

1037
00:47:18,059 --> 00:47:16,150
light so you can you can use reasonable

1038
00:47:19,589 --> 00:47:18,069

exposures if you're raising the

1039
00:47:21,900 --> 00:47:19,599
broadband filters we'd have to use

1040
00:47:24,630 --> 00:47:21,910
exposures or fractions of a second which

1041
00:47:26,940 --> 00:47:24,640
is harder to do with bubble and we would

1042
00:47:29,519 --> 00:47:26,950
run at some exposure time which all

1043
00:47:33,720 --> 00:47:29,529
right all right right we just talked

1044
00:47:36,539 --> 00:47:33,730
about that earlier so yes so using those

1045
00:47:40,170 --> 00:47:36,549
narrow band filters also isolates the

1046
00:47:43,650 --> 00:47:40,180
colors more sharply of the ban of the

1047
00:47:46,319 --> 00:47:43,660
bands in the atmosphere Jupiter so each

1048
00:47:48,990 --> 00:47:46,329
individual filter will isolate a

1049
00:47:51,690 --> 00:47:49,000
particular color and that increases the

1050
00:47:54,420 --> 00:47:51,700
contrast so if you're sampling a larger

1051
00:47:57,509 --> 00:47:54,430
range of colors from the white light

1052
00:48:00,269 --> 00:47:57,519
you're going to blur out the you're

1053
00:48:02,999 --> 00:48:00,279
going to be mixing colors from what's in

1054
00:48:05,519 --> 00:48:03,009
the atmosphere and so those colors those

1055
00:48:07,319 --> 00:48:05,529
bands will be less distinct so Charles

1056
00:48:09,690 --> 00:48:07,329
I'm not sure what filters you're using

1057
00:48:11,549 --> 00:48:09,700
but one thing you can do is I mean see

1058
00:48:13,200 --> 00:48:11,559
if you can get narrower band filters so

1059
00:48:15,140 --> 00:48:13,210
when you take your images you might you

1060
00:48:19,109 --> 00:48:15,150
might get better results that way so

1061
00:48:21,509 --> 00:48:19,119
let's see also we also produce the

1062
00:48:24,029 --> 00:48:21,519
images in a way that we can we can

1063
00:48:25,950 --> 00:48:24,039

adjust the contrast and brightness I'm

1064
00:48:29,519 --> 00:48:25,960
just like you can with any photograph

1065
00:48:31,650 --> 00:48:29,529
and we kind of maximize that contrast to

1066
00:48:33,749 --> 00:48:31,660
show all those details but we also want

1067
00:48:35,220 --> 00:48:33,759
to preserve details and the brightest

1068
00:48:37,019 --> 00:48:35,230
parts of the image on that and the

1069
00:48:38,579 --> 00:48:37,029
famous parts of the animal carcass parks

1070
00:48:41,039 --> 00:48:38,589
with the intern so we basically just

1071
00:48:44,579 --> 00:48:41,049
adjust the brightness and contrast so it

1072
00:48:46,800 --> 00:48:44,589
provides the best range of tones within

1073
00:48:49,200 --> 00:48:46,810
each individual image and then we

1074
00:48:52,500 --> 00:48:49,210
when we composite those together we end

1075
00:48:55,170 --> 00:48:52,510
up with a color image right so you're

1076
00:48:56,970 --> 00:48:55,180
just approached me about the processing

1077
00:48:59,010 --> 00:48:56,980
one of the things that's really

1078
00:49:02,940 --> 00:48:59,020
important is removing geometric

1079
00:49:04,550 --> 00:49:02,950
distortion though because it the the raw

1080
00:49:06,690 --> 00:49:04,560
Hubble images when they come down

1081
00:49:09,450 --> 00:49:06,700
Jupiter isn't the right shape that's

1082
00:49:10,950 --> 00:49:09,460
kind of stretched out and so we have to

1083
00:49:13,380 --> 00:49:10,960
we have to run a computer program that

1084
00:49:15,930 --> 00:49:13,390
unstretched is it back to what it would

1085
00:49:17,460 --> 00:49:15,940
naturally appear right so as you brought

1086
00:49:19,980 --> 00:49:17,470
that up that's a that's a function of

1087
00:49:22,530 --> 00:49:19,990
the the camera as well as the optical

1088
00:49:25,110 --> 00:49:22,540

path of Hubble as well right yeah yeah

1089
00:49:27,630 --> 00:49:25,120
that's mainly a telescope well it

1090
00:49:29,220 --> 00:49:27,640
depends on where so light is coming in

1091
00:49:31,560 --> 00:49:29,230
through the telescope and it falls on

1092
00:49:33,540 --> 00:49:31,570
what we call the focal plane of the

1093
00:49:35,100 --> 00:49:33,550
telescope and different instruments are

1094
00:49:37,200 --> 00:49:35,110
in different places of the focal plane

1095
00:49:40,260 --> 00:49:37,210
and we're from this camera where whoops

1096
00:49:41,850 --> 00:49:40,270
III is it's it's tilted a little bit

1097
00:49:43,890 --> 00:49:41,860
with respect to the focal plane so that

1098
00:49:45,510 --> 00:49:43,900
kind of stretches out everything right

1099
00:49:48,030 --> 00:49:45,520
and so we have a correction it's a known

1100
00:49:50,390 --> 00:49:48,040
correction that has to be done on all

1101
00:49:53,130 --> 00:49:50,400
images really not just ones of Jim

1102
00:49:54,690 --> 00:49:53,140
internship yeah that are taken with that

1103
00:49:56,250 --> 00:49:54,700
are taking with Hubble so here's a good

1104
00:49:58,350 --> 00:49:56,260
question for Michael S on the Q&A app

1105
00:50:01,050 --> 00:49:58,360
are there any Galilean moons large

1106
00:50:03,090 --> 00:50:01,060
enough or close enough from an observer

1107
00:50:05,160 --> 00:50:03,100
on the surface of Jupiter let's pretend

1108
00:50:09,930 --> 00:50:05,170
we're on Jupiter and looking up to

1109
00:50:12,060 --> 00:50:09,940
create a solar eclipse ow actually these

1110
00:50:13,380 --> 00:50:12,070
shadows if you happen to be on Jupiter

1111
00:50:16,470 --> 00:50:13,390
and you're under knee in the shadow

1112
00:50:18,840 --> 00:50:16,480
passes over you that's eclipse right yep

1113
00:50:22,250 --> 00:50:18,850

that's exactly what it looks like from

1114
00:50:25,590 --> 00:50:22,260
space so if we were on the earth and

1115
00:50:27,540 --> 00:50:25,600
experiencing a solar eclipse then a

1116
00:50:29,520 --> 00:50:27,550
satellite would see a similar thing it

1117
00:50:31,710 --> 00:50:29,530
would see a dark spot on on the earth

1118
00:50:34,920 --> 00:50:31,720
from the Earth's moon the question

1119
00:50:36,780 --> 00:50:34,930
though is the relative size if you're if

1120
00:50:39,030 --> 00:50:36,790
you could stand on Jupiter and you're

1121
00:50:41,850 --> 00:50:39,040
looking back at the Sun what would be

1122
00:50:45,600 --> 00:50:41,860
the relative size of the side of the

1123
00:50:47,640 --> 00:50:45,610
moon and the Sun so from the earth the

1124
00:50:50,850 --> 00:50:47,650
coincident it's coincidental that the

1125
00:50:53,040 --> 00:50:50,860
during solar eclipse the moon exactly

1126
00:50:55,560 --> 00:50:53,050
covers the disk of the Sun right that's

1127
00:50:58,230 --> 00:50:55,570
because the geometry between the

1128
00:51:00,270 --> 00:50:58,240
distance and the sizes is just such by

1129
00:51:02,280 --> 00:51:00,280
coincidence that they're the same

1130
00:51:03,990 --> 00:51:02,290
yeah yeah right that's a glad you

1131
00:51:05,790 --> 00:51:04,000
brought that up where the only play this

1132
00:51:07,320 --> 00:51:05,800
is one of the few places in the only

1133
00:51:09,240 --> 00:51:07,330
place i know of in sword where the where

1134
00:51:12,750 --> 00:51:09,250
the in solar system where our moon

1135
00:51:15,600 --> 00:51:12,760
exactly matches the apparent size of the

1136
00:51:19,290 --> 00:51:15,610
Sun in the sky and completely blocks it

1137
00:51:21,120 --> 00:51:19,300
out and only the only time Tony because

1138
00:51:22,830 --> 00:51:21,130

in the future as a moon gets farther

1139
00:51:24,720 --> 00:51:22,840
from the earth we're not gonna hobble

1140
00:51:28,350 --> 00:51:24,730
eclipse is anymore we'll just have

1141
00:51:32,250 --> 00:51:28,360
annular eclipses that's right so good ?

1142
00:51:35,130 --> 00:51:32,260
oh that was nice okay so okay so answer

1143
00:51:39,030 --> 00:51:35,140
that right if we if we look at the color

1144
00:51:41,670 --> 00:51:39,040
composite io shadow and Callisto shadow

1145
00:51:43,890 --> 00:51:41,680
now I'll shadow is really dark and sharp

1146
00:51:45,600 --> 00:51:43,900
which tells me that if you were inside

1147
00:51:48,840 --> 00:51:45,610
that shadow you would see a total solar

1148
00:51:52,890 --> 00:51:48,850
eclipse but Callisto shadow is really

1149
00:51:54,990 --> 00:51:52,900
blurry which tells me that if you were

1150
00:51:57,750 --> 00:51:55,000
there you would probably see an annulus

1151
00:52:02,490 --> 00:51:57,760
of solar brightness around around the

1152
00:52:04,970 --> 00:52:02,500
Sun there so it would be the sharpness

1153
00:52:08,970 --> 00:52:04,980
of the shadow means a lot as far as the

1154
00:52:14,540 --> 00:52:08,980
the ecliptic I clipped what's the word

1155
00:52:21,210 --> 00:52:17,670
yes nature of a play he lived he clipped

1156
00:52:23,610 --> 00:52:21,220
icity is the word I was good I don't

1157
00:52:26,190 --> 00:52:23,620
think that's a word I believe it I just

1158
00:52:33,120 --> 00:52:26,200
made it up include you think include 2

1159
00:52:35,610 --> 00:52:33,130
2day okay better all right so um alright

1160
00:52:37,530 --> 00:52:35,620
so Judy uh welcome back Judy it's good

1161
00:52:39,960 --> 00:52:37,540
to see you again she's commenting huh

1162
00:52:42,660 --> 00:52:39,970
blurs is okay makes the transition to

1163
00:52:44,880 --> 00:52:42,670

jwst easier we can we could be Webber's

1164
00:52:48,740 --> 00:52:44,890
one day try to come up with an analog to

1165
00:52:50,850 --> 00:52:48,750
Hubble huggers for web web well please

1166
00:52:52,890 --> 00:52:50,860
okay I like I don't know about that one

1167
00:52:55,380 --> 00:52:52,900
will have to think about that will table

1168
00:52:56,850 --> 00:52:55,390
it so Scott how am i doing I am I would

1169
00:53:00,810 --> 00:52:56,860
you got anything for Twitter for us or

1170
00:53:03,510 --> 00:53:00,820
let me look at the youtube uh comments

1171
00:53:07,740 --> 00:53:03,520
I'm looking around right now okay I'm

1172
00:53:11,340 --> 00:53:07,750
screen sharing an image of a solar

1173
00:53:14,250 --> 00:53:11,350
eclipse caused by the moon as okay it's

1174
00:53:18,630 --> 00:53:14,260
a satellite looking down on the year

1175
00:53:21,420 --> 00:53:18,640
yeah a photograph of an eclipse as it

1176
00:53:23,700 --> 00:53:21,430
crosses the surface of the earth so

1177
00:53:25,440 --> 00:53:23,710
that's the shadow of the moon and you

1178
00:53:27,300 --> 00:53:25,450
can see a similar thing whether it's the

1179
00:53:31,490 --> 00:53:27,310
dark part in the middle the Umbra and

1180
00:53:34,770 --> 00:53:31,500
then the number around it pretty cool

1181
00:53:36,540 --> 00:53:34,780
okay so there here's a comment from

1182
00:53:39,110 --> 00:53:36,550
YouTube I'll go ahead and put this up

1183
00:53:43,110 --> 00:53:39,120
and maybe somebody can comment on it

1184
00:53:44,880 --> 00:53:43,120
kuna a GQ from my youtube is going

1185
00:53:47,010 --> 00:53:44,890
looking at the picture posted on the NBC

1186
00:53:49,230 --> 00:53:47,020
News website which linked to this

1187
00:53:51,420 --> 00:53:49,240
YouTube site I can't figure out why the

1188
00:53:53,880 --> 00:53:51,430

shadows don't seem to be in a consistent

1189
00:53:56,790 --> 00:53:53,890
position with respect to the respective

1190
00:53:59,040 --> 00:53:56,800
moon's the bottom-left moon appears to

1191
00:54:01,200 --> 00:53:59,050
be casting a shadow as if the Sun is off

1192
00:54:03,390 --> 00:54:01,210
to the left in the photo and the top

1193
00:54:05,610 --> 00:54:03,400
right moon appears to be casting a

1194
00:54:08,880 --> 00:54:05,620
shadow as if the Sun was above and to

1195
00:54:10,170 --> 00:54:08,890
the right what am I missing here was

1196
00:54:15,480 --> 00:54:10,180
there some kind was some kind of

1197
00:54:17,220 --> 00:54:15,490
combined time lapse photo no no I think

1198
00:54:19,460 --> 00:54:17,230
it would really help to look at the

1199
00:54:22,620 --> 00:54:19,470
version of the the image where

1200
00:54:25,620 --> 00:54:22,630
everything is labeled because I think

1201
00:54:27,180 --> 00:54:25,630
what's going on is in an unlabeled image

1202
00:54:29,550 --> 00:54:27,190
it's hard to tell which shadow goes with

1203
00:54:31,800 --> 00:54:29,560
which move but all the moons are casting

1204
00:54:35,670 --> 00:54:31,810
shadows to the rights write the vector

1205
00:54:37,920 --> 00:54:35,680
is the same they're also the moons are

1206
00:54:41,490 --> 00:54:37,930
also at different distances yeah so the

1207
00:54:42,840 --> 00:54:41,500
shadows are offset but yeah I think Mike

1208
00:54:46,170 --> 00:54:42,850
you're right you have to look at those

1209
00:54:51,030 --> 00:54:46,180
labeled ones to connect with shadow goes

1210
00:54:53,010 --> 00:54:51,040
with which moon it is coming over your

1211
00:54:55,110 --> 00:54:53,020
left shoulder as you look at this yeah

1212
00:54:56,820 --> 00:54:55,120
way after you left show it's all

1213
00:54:58,710 --> 00:54:56,830

confusing because I Oh is right over

1214
00:55:01,770 --> 00:54:58,720
Callisto's shadow at something is that

1215
00:55:06,930 --> 00:55:01,780
in fact before our observation started

1216
00:55:09,930 --> 00:55:06,940
earlier on I o Shah though was passed

1217
00:55:12,510 --> 00:55:09,940
over Callisto's shadow stupid we

1218
00:55:14,610 --> 00:55:12,520
couldn't observe during that time past

1219
00:55:16,740 --> 00:55:14,620
you got so there's a lots of funny

1220
00:55:20,460 --> 00:55:16,750
little fan and my understand also is it

1221
00:55:23,250 --> 00:55:20,470
I oh actually got eclipsed by Callisto I

1222
00:55:26,030 --> 00:55:23,260
believe at some point so ah this is

1223
00:55:27,710 --> 00:55:26,040
shadow cast over I oh no

1224
00:55:31,850 --> 00:55:27,720
been pulled again but again we couldn't

1225
00:55:34,070 --> 00:55:31,860
schedule that we also have limited

1226
00:55:40,460 --> 00:55:34,080
little little slice of typing we did

1227
00:55:41,810 --> 00:55:40,470
with our one orbit yeah it's pretty but

1228
00:55:45,110 --> 00:55:41,820
yeah you know there's so many little

1229
00:55:48,500 --> 00:55:45,120
things going on it's so dynamic all

1230
00:55:50,570 --> 00:55:48,510
right well folks I guess I can just

1231
00:55:52,550 --> 00:55:50,580
trying to Oh Jonathan posted sir

1232
00:55:55,760 --> 00:55:52,560
jonathan ive never posted something of a

1233
00:55:59,390 --> 00:55:55,770
pod it oh is it an astronomy picture of

1234
00:56:02,780 --> 00:55:59,400
the day I didn't see that I know the

1235
00:56:05,800 --> 00:56:02,790
same image that that that Carol put up

1236
00:56:08,810 --> 00:56:05,810
there is already broke number on there

1237
00:56:11,630 --> 00:56:08,820
from 1999 but yeah I'm hoping it goes up

1238
00:56:13,550 --> 00:56:11,640

tomorrow for a pod okay awesome yes that

1239
00:56:16,400 --> 00:56:13,560
would be great okay well guys I guess

1240
00:56:18,140 --> 00:56:16,410
that's it for today this week will I

1241
00:56:19,730 --> 00:56:18,150
want to thank you sold and and Mike and

1242
00:56:22,250 --> 00:56:19,740
Susanna for joining us this has been a

1243
00:56:25,310 --> 00:56:22,260
great hangout lots of fun stuff next

1244
00:56:27,320 --> 00:56:25,320
week our hangout will be our we would

1245
00:56:29,410 --> 00:56:27,330
again it's another hangout in the in

1246
00:56:32,690 --> 00:56:29,420
sort of celebration of our 25th

1247
00:56:35,150 --> 00:56:32,700
anniversary of Hubble of Hubble's launch

1248
00:56:37,100 --> 00:56:35,160
where would be we will be looking at a

1249
00:56:40,250 --> 00:56:37,110
collection of pictures we've assembled

1250
00:56:43,880 --> 00:56:40,260
it's on our Hubble 25th org site would

1251
00:56:46,640 --> 00:56:43,890
be talking about 25 different images to

1252
00:56:48,350 --> 00:56:46,650
commemorate different science the

1253
00:56:49,850 --> 00:56:48,360
different science of missions and things

1254
00:56:51,890 --> 00:56:49,860
that Hubble is done throughout its

1255
00:56:54,230 --> 00:56:51,900
lifetime so we hope you will join us

1256
00:56:56,540 --> 00:56:54,240
then that will be next week thursday at

1257
00:57:00,800 --> 00:56:56,550
three o'clock so i guess that's it guys

1258
00:57:03,980 --> 00:57:00,810
uh Carol Scott ok thank you ringing all

1259
00:57:05,630 --> 00:57:03,990
right ok guys well I want to thank you

1260
00:57:08,270 --> 00:57:05,640
all for watching and we'll see you next

1261
00:57:10,160 --> 00:57:08,280
week and don't forget video contest we

1262
00:57:12,230 --> 00:57:10,170
hope to see your ode to Hubble video

1263
00:57:13,790 --> 00:57:12,240

soon so start start getting your

1264
00:57:15,770 --> 00:57:13,800
creative juices going and we hope to see

1265
00:57:17,900 --> 00:57:15,780
your videos real quick so that's it for

1266
00:57:23,030 --> 00:57:17,910
this week thank you all for watching and