

1  
00:00:07,660 --> 00:00:11,538  
hello everybody and welcome to this

2  
00:00:09,740 --> 00:00:12,740  
week's Hubble hang out my name is Tony

3  
00:00:11,538 --> 00:00:14,419  
Darnell and I work at the Space

4  
00:00:12,740 --> 00:00:16,010  
Telescope Science Institute and this

5  
00:00:14,419 --> 00:00:19,339  
week we've got a really great hangout

6  
00:00:16,010 --> 00:00:22,810  
plan for you as we usually do we this

7  
00:00:19,339 --> 00:00:26,030  
week we are taking a look at some of the

8  
00:00:22,809 --> 00:00:28,609  
as we all as we had many times we you

9  
00:00:26,030 --> 00:00:30,800  
know Hubble has been sort of identified

10  
00:00:28,609 --> 00:00:33,229  
as you know using and looking at faraway

11  
00:00:30,800 --> 00:00:35,210  
distant objects but this week we're

12  
00:00:33,229 --> 00:00:36,979  
highlighting some objects where we

13  
00:00:35,210 --> 00:00:39,679  
inside the solar system a little bit

14  
00:00:36,979 --> 00:00:41,959  
closer to home and with this week today

15  
00:00:39,679 --> 00:00:44,929  
in fact we have released some new images

16  
00:00:41,960 --> 00:00:47,810  
new observations of Hubble's looking at

17  
00:00:44,929 --> 00:00:49,579  
Jupiter and we have with us members of

18  
00:00:47,810 --> 00:00:50,899  
the Hubble heritage team as well as some

19  
00:00:49,579 --> 00:00:52,189  
astronomers who have also helped with

20  
00:00:50,899 --> 00:00:54,049  
these observations but before I get

21  
00:00:52,189 --> 00:00:57,079  
started have a couple of announcements I

22  
00:00:54,049 --> 00:00:59,119  
want to make this week on Monday if you

23  
00:00:57,079 --> 00:01:02,480  
go to Space Telescope gorg there is a

24  
00:00:59,119 --> 00:01:04,840  
video contest it just opened up called

25  
00:01:02,479 --> 00:01:07,670  
ode to Hubble and if you would like to

26  
00:01:04,840 --> 00:01:09,620  
celebrate Hubble's 25th anniversary you

27  
00:01:07,670 --> 00:01:13,939  
are invited to make a video and submit

28  
00:01:09,620 --> 00:01:17,210  
it on YouTube and and then enter that

29

00:01:13,939 --> 00:01:20,798  
into the contest itself the the link is

30  
00:01:17,209 --> 00:01:22,939  
I only weapon on the event page here

31  
00:01:20,799 --> 00:01:24,229  
it's on the event as well as the

32  
00:01:22,939 --> 00:01:26,179  
description of the YouTube video that

33  
00:01:24,228 --> 00:01:28,670  
word they were broadcasting on so we

34  
00:01:26,180 --> 00:01:31,729  
hope you will join there are two

35  
00:01:28,670 --> 00:01:33,859  
categories if you are under 25 and if

36  
00:01:31,728 --> 00:01:35,750  
you are over 25 now if you're under 25

37  
00:01:33,859 --> 00:01:37,340  
that means that you don't know a world

38  
00:01:35,750 --> 00:01:39,349  
without the Hubble Space Telescope and

39  
00:01:37,340 --> 00:01:42,320  
we're affectionately calling you the

40  
00:01:39,349 --> 00:01:45,228  
Hubble generation for those of you over

41  
00:01:42,319 --> 00:01:54,669  
25 years old there's a separate category

42  
00:01:45,228 --> 00:01:57,109  
and the price it comes with jer his all

43  
00:01:54,670 --> 00:02:01,340

but the prize is really cool they are

44

00:01:57,109 --> 00:02:03,409

they are offering a piece of the solar

45

00:02:01,340 --> 00:02:06,170

array that actually was part of Hubble

46

00:02:03,409 --> 00:02:07,670

early on in its mission and as well as a

47

00:02:06,170 --> 00:02:10,759

plaque and a very good variety of other

48

00:02:07,670 --> 00:02:13,250

things so please check out the link

49

00:02:10,758 --> 00:02:16,719

below on the end in the description

50

00:02:13,250 --> 00:02:20,449

we hope to see your video soon now uh if

51

00:02:16,719 --> 00:02:22,490

so if you have any questions or issues

52

00:02:20,449 --> 00:02:25,159

like that just by all means let us know

53

00:02:22,490 --> 00:02:27,260

and we will help you and as much as we

54

00:02:25,159 --> 00:02:28,579

can and getting those videos submitted

55

00:02:27,259 --> 00:02:31,789

so we look forward to seeing what you've

56

00:02:28,580 --> 00:02:34,390

got this week so let's get to this

57

00:02:31,789 --> 00:02:37,579

hangout this week we are talking about

58  
00:02:34,389 --> 00:02:40,009  
Hubble has observed Jupiter and we've

59  
00:02:37,580 --> 00:02:42,469  
gotten some really great observations in

60  
00:02:40,009 --> 00:02:46,489  
fact there is a very somewhat rare

61  
00:02:42,469 --> 00:02:49,759  
conjunction that that happens every few

62  
00:02:46,489 --> 00:02:51,439  
I guess it's the guess it happens every

63  
00:02:49,759 --> 00:02:54,109  
few decades or something like that it

64  
00:02:51,439 --> 00:02:58,250  
was it was very a very rare event that

65  
00:02:54,110 --> 00:03:00,200  
we got here and with us is the members

66  
00:02:58,250 --> 00:03:02,090  
of the hubble heritage team and we

67  
00:03:00,199 --> 00:03:06,488  
invite your questions and comments also

68  
00:03:02,090 --> 00:03:09,259  
if you want to interact with us we have

69  
00:03:06,489 --> 00:03:13,310  
you can comment on the hubble hangout

70  
00:03:09,259 --> 00:03:16,039  
event that way on g+ you can also tweet

71  
00:03:13,310 --> 00:03:18,379  
at using the Hubble hang out hashtag as

72  
00:03:16,039 --> 00:03:19,489  
well as using the Q&A app that's

73  
00:03:18,379 --> 00:03:21,620  
actually the best way to interact

74  
00:03:19,489 --> 00:03:23,330  
because I'm monitoring that and you can

75  
00:03:21,620 --> 00:03:26,299  
also leave comments on the YouTube page

76  
00:03:23,330 --> 00:03:28,130  
that were broadcasting from so we're

77  
00:03:26,299 --> 00:03:31,790  
joining me as a as she always does is

78  
00:03:28,129 --> 00:03:34,699  
dr. carol christian she's the HST

79  
00:03:31,789 --> 00:03:36,560  
outreach scientist as well as the driver

80  
00:03:34,699 --> 00:03:39,169  
of the internet scott lewis at

81  
00:03:36,560 --> 00:03:41,239  
scientific scott hi Scott how's it going

82  
00:03:39,169 --> 00:03:44,149  
Tony really good thanks and thank you

83  
00:03:41,239 --> 00:03:48,230  
guys for joining me and so today's

84  
00:03:44,150 --> 00:03:50,689  
today's panel we have Zolt lavey he is

85  
00:03:48,229 --> 00:03:54,109  
the he's the guy who I think is one of

86

00:03:50,689 --> 00:03:56,900  
the one of the person's most prominent

87  
00:03:54,110 --> 00:03:59,120  
in the Hubble heritage team-highs old we

88  
00:03:56,900 --> 00:04:00,890  
also have dr. mike wong he's an

89  
00:03:59,120 --> 00:04:04,189  
astronomer at the University of

90  
00:04:00,889 --> 00:04:05,988  
California Berkeley hi Mike and do a

91  
00:04:04,189 --> 00:04:07,489  
straw she's the she's an astronomer at

92  
00:04:05,989 --> 00:04:10,280  
the Institute she's joining us also

93  
00:04:07,489 --> 00:04:12,590  
welcome everybody hello and you know and

94  
00:04:10,280 --> 00:04:14,750  
as oh let me start with you what have we

95  
00:04:12,590 --> 00:04:17,030  
got here we've got we've got some images

96  
00:04:14,750 --> 00:04:18,259  
and observations of Jupiter so why don't

97  
00:04:17,029 --> 00:04:22,459  
you describe a little bit what we've got

98  
00:04:18,259 --> 00:04:24,789  
here okay so we were able to get one

99  
00:04:22,459 --> 00:04:26,409  
orbit with Hubble

100  
00:04:24,790 --> 00:04:28,870

we were privileged enough to get one

101

00:04:26,410 --> 00:04:32,350

orbit to look at a fairly rare event the

102

00:04:28,870 --> 00:04:34,569

crossing of several moons across the

103

00:04:32,350 --> 00:04:38,170

face of Jupiter several Jupiter's moons

104

00:04:34,569 --> 00:04:41,469

across the face of Jupiter if I could

105

00:04:38,170 --> 00:04:47,020

start by opening my screen I can show

106

00:04:41,470 --> 00:04:53,320

you these images and what we have here

107

00:04:47,019 --> 00:04:57,029

is two images of Jupiter can you all see

108

00:04:53,319 --> 00:04:59,620

that it will all see it this line on the

109

00:04:57,029 --> 00:05:02,259

so there are two images of Jupiter taken

110

00:04:59,620 --> 00:05:04,840

at different times about roughly 40

111

00:05:02,259 --> 00:05:06,519

minutes apart so on the Left we see the

112

00:05:04,839 --> 00:05:09,189

disk of Jupiter with those bands of

113

00:05:06,519 --> 00:05:12,039

clouds dark and light clouds and then we

114

00:05:09,189 --> 00:05:14,170

see number of dots on top of it on the



115  
00:05:12,040 --> 00:05:16,720  
Left we see a kind of brown on the

116  
00:05:14,170 --> 00:05:21,610  
left-hand panel on the lower left we see

117  
00:05:16,720 --> 00:05:26,800  
a brownish image and that's the that's

118  
00:05:21,610 --> 00:05:30,040  
the moon Callisto to the lower right of

119  
00:05:26,800 --> 00:05:32,050  
that as a black dot right on the edge of

120  
00:05:30,040 --> 00:05:34,540  
Jupiter and that's a shadow of another

121  
00:05:32,050 --> 00:05:37,060  
moon Europa which we don't actually see

122  
00:05:34,540 --> 00:05:41,080  
in that image up towards the upper right

123  
00:05:37,060 --> 00:05:43,509  
we see a yellowish moon and that's IO a

124  
00:05:41,079 --> 00:05:46,959  
very interesting moon of Jupiter and to

125  
00:05:43,509 --> 00:05:50,139  
its upper right we see its shadow fairly

126  
00:05:46,959 --> 00:05:53,589  
sharp and distinct shadow and just below

127  
00:05:50,139 --> 00:05:55,899  
I oh we see another shadow and that's

128  
00:05:53,589 --> 00:05:59,859  
actually the shadow of Callisto which is

129  
00:05:55,899 --> 00:06:01,839  
way off to the lower left so the

130  
00:05:59,860 --> 00:06:05,110  
Callisto's shadow is much farther away

131  
00:06:01,839 --> 00:06:06,639  
from Callisto than iOS shadows away from

132  
00:06:05,110 --> 00:06:09,370  
it and that's because Maya was much

133  
00:06:06,639 --> 00:06:12,099  
closer to Jupiter also you may notice

134  
00:06:09,370 --> 00:06:14,410  
that Callisto's shadow is much fuzzier

135  
00:06:12,100 --> 00:06:16,960  
it's much less distinct and that's also

136  
00:06:14,410 --> 00:06:20,290  
because Callisto is much farther from

137  
00:06:16,959 --> 00:06:23,620  
the planet than iOS on the right we have

138  
00:06:20,290 --> 00:06:27,700  
the same basically the same view of

139  
00:06:23,620 --> 00:06:29,829  
Jupiter but everything's moved so the

140  
00:06:27,699 --> 00:06:31,659  
moons of all shifted because they're

141  
00:06:29,829 --> 00:06:34,839  
orbiting around Jupiter at a rather

142  
00:06:31,660 --> 00:06:38,409  
rapid clip and so I owe is now off

143

00:06:34,839 --> 00:06:41,318  
almost off the disk on the right hand

144  
00:06:38,408 --> 00:06:45,009  
right hand side and Europa now we can

145  
00:06:41,319 --> 00:06:48,129  
see Europa itself just inside the edge

146  
00:06:45,009 --> 00:06:50,800  
at the lower left and Europa shadow is

147  
00:06:48,129 --> 00:06:52,989  
off to its upper right and we still see

148  
00:06:50,800 --> 00:06:55,149  
Callisto moved over and close to the

149  
00:06:52,988 --> 00:06:58,238  
shadow so those are the basic oh that

150  
00:06:55,149 --> 00:07:00,189  
two images now you also have an

151  
00:06:58,238 --> 00:07:03,668  
animation of this I believe as well

152  
00:07:00,189 --> 00:07:05,499  
don't you uh yeah let me Scott maybe

153  
00:07:03,668 --> 00:07:09,218  
Scott can pull out can kill the enemy up

154  
00:07:05,499 --> 00:07:13,689  
here all right so these are so Mike let

155  
00:07:09,218 --> 00:07:15,519  
me were you involved in planning these

156  
00:07:13,689 --> 00:07:18,309  
ops all Scouts got it up now here we go

157  
00:07:15,519 --> 00:07:19,418

okay yeah so here is an animation why

158

00:07:18,309 --> 00:07:24,849

don't you describe this real quick for

159

00:07:19,418 --> 00:07:27,549

soul okay well we see individual frames

160

00:07:24,848 --> 00:07:30,998

we took during this observation with

161

00:07:27,550 --> 00:07:33,278

Hubble and we simply see the moon's

162

00:07:30,999 --> 00:07:35,679

marching across the planet as they orbit

163

00:07:33,278 --> 00:07:40,118

around Jupiter now this is a loop so you

164

00:07:35,678 --> 00:07:41,878

see it we have 24 individual frames so

165

00:07:40,119 --> 00:07:47,909

there's about a minute and a half

166

00:07:41,879 --> 00:07:50,588

between each frame so we simply see the

167

00:07:47,908 --> 00:07:52,418

Jupiter itself rotating and if you look

168

00:07:50,588 --> 00:07:54,788

very closely you can see that the

169

00:07:52,418 --> 00:07:57,248

different bands of clouds on Jupiter

170

00:07:54,788 --> 00:07:59,978

rotate at different speeds so there's

171

00:07:57,249 --> 00:08:02,979

clouds themselves are shifting across

172  
00:07:59,978 --> 00:08:06,878  
Jupiter and then above that we see the

173  
00:08:02,978 --> 00:08:11,199  
moon's moving across the face of Jupiter

174  
00:08:06,879 --> 00:08:14,199  
moons and their shadows so this is okay

175  
00:08:11,199 --> 00:08:16,989  
so this is uh so this is the animation

176  
00:08:14,199 --> 00:08:19,209  
of the observations themselves it

177  
00:08:16,988 --> 00:08:21,838  
Michael me and we get you in here looks

178  
00:08:19,209 --> 00:08:25,269  
a little bit this this particular arm

179  
00:08:21,838 --> 00:08:27,639  
set of observations up it shows up a

180  
00:08:25,269 --> 00:08:31,588  
pretty unique configuration of the moons

181  
00:08:27,639 --> 00:08:33,759  
of Jupiter and Jupiter itself would you

182  
00:08:31,588 --> 00:08:35,349  
describe a little bit were you involved

183  
00:08:33,759 --> 00:08:39,550  
in the planning of these observations at

184  
00:08:35,349 --> 00:08:41,528  
all or yeah it was this on purpose but

185  
00:08:39,549 --> 00:08:44,219  
it was getting getting getting these

186  
00:08:41,528 --> 00:08:46,980  
giving this conjunction oh yeah yeah we

187  
00:08:44,220 --> 00:08:50,829  
well we were alerted that the

188  
00:08:46,980 --> 00:08:52,310  
configuration was uh was coming up and

189  
00:08:50,828 --> 00:08:56,778  
so we we looked at

190  
00:08:52,309 --> 00:08:59,109  
when when we could actually observe this

191  
00:08:56,778 --> 00:09:03,710  
and a couple neat techniques were used

192  
00:08:59,110 --> 00:09:07,519  
but um well we were actually pretty

193  
00:09:03,710 --> 00:09:10,580  
lucky because Hubble has a 96 minute

194  
00:09:07,519 --> 00:09:13,610  
orbit around the earth and so half the

195  
00:09:10,580 --> 00:09:15,200  
time it can actually point at Jupiter

196  
00:09:13,610 --> 00:09:19,909  
it'll Jupiter will be on the other side

197  
00:09:15,200 --> 00:09:21,620  
of the the earth from from Hubble so we

198  
00:09:19,909 --> 00:09:25,338  
were lucky that Hubble was on the right

199  
00:09:21,620 --> 00:09:28,039  
side of the planet earth at the time

200

00:09:25,339 --> 00:09:32,930  
that these shadows were shadows and

201  
00:09:28,039 --> 00:09:34,969  
moons were transiting so we have it we

202  
00:09:32,929 --> 00:09:38,870  
have a diagram I think of the actual

203  
00:09:34,970 --> 00:09:40,190  
geometry of the of the the conjunction

204  
00:09:38,870 --> 00:09:42,200  
itself can you pull that up real quick I

205  
00:09:40,190 --> 00:09:44,690  
want to ask my question about the

206  
00:09:42,200 --> 00:09:46,190  
frequency at which these things you know

207  
00:09:44,690 --> 00:09:47,690  
this this config this particular

208  
00:09:46,190 --> 00:09:55,180  
configuration is actually pretty rare

209  
00:09:47,690 --> 00:10:02,450  
correct uh yeah it's pretty rare um and

210  
00:09:55,179 --> 00:10:06,679  
we actually did get a last year your

211  
00:10:02,450 --> 00:10:08,300  
various Great Red Spot with Hubble right

212  
00:10:06,679 --> 00:10:09,588  
and we did a hangout I believe we did

213  
00:10:08,299 --> 00:10:13,159  
that we did a hangout on that as well so

214  
00:10:09,589 --> 00:10:15,440

here's the configuration and the the of

215

00:10:13,159 --> 00:10:19,909

the geometry of the geometry of the of

216

00:10:15,440 --> 00:10:22,310

the alignment of these moons and give us

217

00:10:19,909 --> 00:10:26,838

some idea of just how how rare how often

218

00:10:22,309 --> 00:10:29,509

this happens um I didn't actually look

219

00:10:26,839 --> 00:10:32,750

at the amount of how how rare this is

220

00:10:29,509 --> 00:10:35,708

but the the things that have to be in

221

00:10:32,750 --> 00:10:40,820

place where this to be observed is that

222

00:10:35,708 --> 00:10:43,099

that the tilt of Jupiter's rotational

223

00:10:40,820 --> 00:10:46,010

plane which is where the moons are

224

00:10:43,100 --> 00:10:50,209

traveling has to be aligned such that

225

00:10:46,009 --> 00:10:52,370

the sun is shining what the Sun is lying

226

00:10:50,208 --> 00:10:54,679

in that plane and so it's a similar

227

00:10:52,370 --> 00:10:59,899

thing with eclipse is on the earth

228

00:10:54,679 --> 00:11:03,649

there's two times a year for for the



229  
00:10:59,899 --> 00:11:06,169  
earth to go into your clip season so we

230  
00:11:03,649 --> 00:11:09,889  
can see lunar eclipses or solar eclipses

231  
00:11:06,169 --> 00:11:11,269  
only only twice a year during a clip

232  
00:11:09,889 --> 00:11:13,879  
season that doesn't mean there's always

233  
00:11:11,269 --> 00:11:15,379  
going to be in eclipse but the

234  
00:11:13,879 --> 00:11:18,139  
configuration has to be right for that

235  
00:11:15,379 --> 00:11:21,039  
right I'm so same thing with a Jupiter

236  
00:11:18,139 --> 00:11:23,778  
twice twice a Jupiter year you'll have

237  
00:11:21,039 --> 00:11:27,349  
shadows going across the disk like this

238  
00:11:23,778 --> 00:11:29,059  
but for all three of these four three

239  
00:11:27,350 --> 00:11:32,810  
moons to be on the disk at one time is

240  
00:11:29,059 --> 00:11:35,539  
super rare right so occurred about twice

241  
00:11:32,809 --> 00:11:40,189  
and last 15 years and the next one will

242  
00:11:35,539 --> 00:11:42,409  
be 2032 mmm nice so it's pretty pretty

243  
00:11:40,190 --> 00:11:45,230  
awesome and pretty rare event to see

244  
00:11:42,409 --> 00:11:46,429  
this the way that we have it here and

245  
00:11:45,230 --> 00:11:48,620  
it's also great that Hubble like you

246  
00:11:46,429 --> 00:11:50,149  
said Mike was in a position where it

247  
00:11:48,620 --> 00:11:52,940  
could actually catch capture these

248  
00:11:50,149 --> 00:11:54,889  
things um so this is something that I

249  
00:11:52,940 --> 00:11:56,630  
want to come back a little bit to the

250  
00:11:54,889 --> 00:11:58,820  
image the images in the processing in

251  
00:11:56,629 --> 00:12:00,559  
just a second but this is something that

252  
00:11:58,820 --> 00:12:03,260  
we're releasing called up it's it's

253  
00:12:00,559 --> 00:12:05,149  
called Hubble heritage and these are

254  
00:12:03,259 --> 00:12:09,278  
observations at hubbell makes that's

255  
00:12:05,149 --> 00:12:11,480  
slightly different from normal Hubble

256  
00:12:09,278 --> 00:12:13,820  
programming time correct can you give us

257

00:12:11,480 --> 00:12:17,028  
a sense of what a Hubble heritage image

258  
00:12:13,820 --> 00:12:19,180  
is what is that program I'll help right

259  
00:12:17,028 --> 00:12:22,490  
Hubble heritage is a program to

260  
00:12:19,179 --> 00:12:25,639  
emphasize the aesthetics the visual

261  
00:12:22,490 --> 00:12:27,860  
appeal of the images not so much the

262  
00:12:25,639 --> 00:12:31,850  
signs I mean all the images all the data

263  
00:12:27,860 --> 00:12:34,639  
have science their science data so they

264  
00:12:31,850 --> 00:12:38,720  
have science they're important for

265  
00:12:34,639 --> 00:12:42,230  
science but we felt that that there are

266  
00:12:38,720 --> 00:12:44,720  
images which are have aesthetic value

267  
00:12:42,230 --> 00:12:48,709  
above and beyond their scientific value

268  
00:12:44,720 --> 00:12:51,470  
so Hubble heritage is hopes to find the

269  
00:12:48,708 --> 00:12:54,169  
best images from Hubble and distribute

270  
00:12:51,470 --> 00:12:56,569  
them as as aesthetic images in addition

271  
00:12:54,169 --> 00:13:00,439

to their science content so along with

272

00:12:56,568 --> 00:13:02,240

that we have been fortunate to have

273

00:13:00,440 --> 00:13:04,760

gotten a little bit of time on the

274

00:13:02,240 --> 00:13:06,230

telescope thanks to the various

275

00:13:04,759 --> 00:13:08,958

directors of the Space Telescope Science

276

00:13:06,230 --> 00:13:13,278

Institute have seen it important enough

277

00:13:08,958 --> 00:13:14,869

to first of all augment some of the

278

00:13:13,278 --> 00:13:17,870

observations that are already exists

279

00:13:14,870 --> 00:13:20,870

robble and with a some little

280

00:13:17,870 --> 00:13:22,820

more observing we could produce an image

281

00:13:20,870 --> 00:13:24,740

that would be better than what was

282

00:13:22,820 --> 00:13:26,750

possible from the data already existing

283

00:13:24,740 --> 00:13:30,049

in the archive and in some cases were

284

00:13:26,750 --> 00:13:32,028

able to propose to do images which have

285

00:13:30,049 --> 00:13:35,028

not been done before and then there are

286

00:13:32,028 --> 00:13:37,730  
special events like like this Jupiter

287

00:13:35,028 --> 00:13:41,330  
event which is kind of a special event

288

00:13:37,730 --> 00:13:43,220  
that its scientific value is relatively

289

00:13:41,330 --> 00:13:44,990  
minimal compared to some other different

290

00:13:43,220 --> 00:13:46,639  
other kinds of observations that you

291

00:13:44,990 --> 00:13:49,700  
could do but it might be of interest to

292

00:13:46,639 --> 00:13:52,338  
many many people and so we were again

293

00:13:49,700 --> 00:13:54,980  
fortunate enough to have one orbit

294

00:13:52,339 --> 00:13:58,730  
available on the telescope to make these

295

00:13:54,980 --> 00:14:00,500  
observations and so this is a you know a

296

00:13:58,730 --> 00:14:04,310  
group here group of people here at the

297

00:14:00,500 --> 00:14:07,669  
Institute and we propose these

298

00:14:04,309 --> 00:14:09,199  
observations we plan a man's kid and and

299

00:14:07,669 --> 00:14:11,299  
make the observations and then do the

300  
00:14:09,200 --> 00:14:14,028  
imaging from them and all the drive

301  
00:14:11,299 --> 00:14:16,459  
products and I was also going to comment

302  
00:14:14,028 --> 00:14:18,500  
as far as the events I mean when we talk

303  
00:14:16,460 --> 00:14:21,980  
about these among ourselves in the group

304  
00:14:18,500 --> 00:14:24,470  
we will say well is this one of these

305  
00:14:21,980 --> 00:14:26,300  
things where one would say this it would

306  
00:14:24,470 --> 00:14:28,070  
be a shame if Hubble didn't you know

307  
00:14:26,299 --> 00:14:29,809  
observe that or people would be

308  
00:14:28,070 --> 00:14:32,600  
interested in knowing what Hubble sees

309  
00:14:29,809 --> 00:14:35,750  
in this circumstance so there have been

310  
00:14:32,600 --> 00:14:40,310  
other circumstances like solar system

311  
00:14:35,750 --> 00:14:43,429  
objects like comets and other and this

312  
00:14:40,309 --> 00:14:45,019  
one for example where answerers you know

313  
00:14:43,429 --> 00:14:46,759  
do a lot of photography because they

314

00:14:45,019 --> 00:14:49,549  
have much more time than we do we have

315  
00:14:46,759 --> 00:14:51,860  
only you know this one orbit but it's

316  
00:14:49,549 --> 00:14:53,958  
good to have that and compare and you

317  
00:14:51,860 --> 00:14:55,820  
can really see a lot more detail on the

318  
00:14:53,958 --> 00:14:59,719  
Hubble observations but it also has a

319  
00:14:55,820 --> 00:15:02,028  
lot of synergy with the amateurs and I'm

320  
00:14:59,720 --> 00:15:06,110  
hoping that the professionals will also

321  
00:15:02,028 --> 00:15:10,250  
find this data useful in in the overall

322  
00:15:06,110 --> 00:15:12,919  
look look at Jupiter as a planet and how

323  
00:15:10,250 --> 00:15:15,289  
the clouds work and all that kind of

324  
00:15:12,919 --> 00:15:18,129  
stuff so as far as all Hubble

325  
00:15:15,289 --> 00:15:20,990  
observations of Jupiter it probably has

326  
00:15:18,129 --> 00:15:22,490  
long-term value in that sense no I'm

327  
00:15:20,990 --> 00:15:24,470  
glad you brought that up the the amateur

328  
00:15:22,490 --> 00:15:26,209

aspect of this because I've you know

329

00:15:24,470 --> 00:15:27,769

I've spent a lot of years looking at

330

00:15:26,208 --> 00:15:28,849

Jupiter also through a telescope and of

331

00:15:27,769 --> 00:15:31,370

course it's a very beautiful thing to

332

00:15:28,850 --> 00:15:31,730

look at through binoculars and stuff

333

00:15:31,370 --> 00:15:34,220

like

334

00:15:31,730 --> 00:15:37,789

but Susannah I wonder if I could get you

335

00:15:34,220 --> 00:15:40,850

to maybe you have a is this something

336

00:15:37,789 --> 00:15:42,828

that perhaps amateurs could look at

337

00:15:40,850 --> 00:15:45,079

through the through a telescope in fact

338

00:15:42,828 --> 00:15:46,489

you you also have a component where

339

00:15:45,078 --> 00:15:48,289

you're involved with the Galileo scope

340

00:15:46,490 --> 00:15:51,709

right with this up with this this kind

341

00:15:48,289 --> 00:15:55,069

of thing be visible through that yes so

342

00:15:51,708 --> 00:15:57,859

I have a right so you could use a small



343  
00:15:55,070 --> 00:15:59,329  
telescope that's capable of looking at

344  
00:15:57,860 --> 00:16:03,800  
Jupiter and then you would see the

345  
00:15:59,328 --> 00:16:05,838  
moon's crossing the face right and you

346  
00:16:03,799 --> 00:16:07,519  
can even see these through but not you

347  
00:16:05,839 --> 00:16:09,440  
can see the four Galilean moons

348  
00:16:07,519 --> 00:16:11,839  
especially the largest moons in

349  
00:16:09,440 --> 00:16:14,350  
binoculars or small telescopes things

350  
00:16:11,839 --> 00:16:17,000  
like that but these these transits these

351  
00:16:14,350 --> 00:16:19,100  
shadows across you can also facing

352  
00:16:17,000 --> 00:16:20,809  
through a small I don't know maybe a

353  
00:16:19,100 --> 00:16:24,139  
four inch or a little bit a little bit

354  
00:16:20,809 --> 00:16:25,458  
higher telescope because the the the you

355  
00:16:24,139 --> 00:16:27,230  
need to be able to see the bands of

356  
00:16:25,458 --> 00:16:29,958  
Jupiter and something that would let you

357  
00:16:27,230 --> 00:16:31,370  
get a little more resolving power out of

358  
00:16:29,958 --> 00:16:32,809  
it I think it's something like four

359  
00:16:31,370 --> 00:16:35,810  
inches they might let you see the

360  
00:16:32,809 --> 00:16:37,578  
transits or the shadows but hold up hold

361  
00:16:35,809 --> 00:16:39,979  
up your Galileo scope real quick let's

362  
00:16:37,578 --> 00:16:43,009  
take a look so this is this is something

363  
00:16:39,980 --> 00:16:44,420  
that is a well describe it what are you

364  
00:16:43,009 --> 00:16:47,028  
holding up there okay so what I'm

365  
00:16:44,419 --> 00:16:49,610  
holding up here is a better version of

366  
00:16:47,028 --> 00:16:51,350  
Galileo's telescope and originally in

367  
00:16:49,610 --> 00:16:53,629  
five years ago for the international

368  
00:16:51,350 --> 00:16:55,879  
year of astronomy people got together

369  
00:16:53,629 --> 00:16:58,240  
and wanted to have a telescope that was

370  
00:16:55,879 --> 00:17:02,778  
high optical quality but yet inexpensive

371

00:16:58,240 --> 00:17:04,609  
and the result was this I don't know it

372  
00:17:02,778 --> 00:17:06,910  
sure if you can see it is this telescope

373  
00:17:04,609 --> 00:17:10,338  
it's black plastic it's not very large

374  
00:17:06,910 --> 00:17:14,179  
it's about a couple of inches diameter

375  
00:17:10,338 --> 00:17:16,009  
right sort of similar in size to the one

376  
00:17:14,179 --> 00:17:19,309  
that Galileo used four hundred-odd years

377  
00:17:16,009 --> 00:17:22,009  
ago and the whole idea was to so that

378  
00:17:19,308 --> 00:17:25,240  
they would the intention was to have the

379  
00:17:22,009 --> 00:17:28,129  
optics be such that you could observe

380  
00:17:25,240 --> 00:17:29,960  
Jupiter's Jupiter's moons as well as

381  
00:17:28,130 --> 00:17:32,000  
Saturn and Saturn's rings so it's

382  
00:17:29,960 --> 00:17:34,400  
definitely a solar system type telescope

383  
00:17:32,000 --> 00:17:37,160  
okay there are other telescopes that you

384  
00:17:34,400 --> 00:17:40,940  
can use as well this one is just what

385  
00:17:37,160 --> 00:17:43,250

that I'm familiar with hahaha but that

386

00:17:40,940 --> 00:17:45,289  
one that one is a it's kind of like a

387

00:17:43,250 --> 00:17:47,000  
replica of the one that Galilee

388

00:17:45,289 --> 00:17:49,159  
use when he discovered these satellites

389

00:17:47,000 --> 00:17:52,819  
in the first place right except the

390

00:17:49,160 --> 00:17:55,009  
optics are way better pretty it's pretty

391

00:17:52,819 --> 00:17:57,049  
similar i mean the the number of lenses

392

00:17:55,009 --> 00:17:58,819  
and the configuration is very similar to

393

00:17:57,049 --> 00:18:00,950  
those very similar see of a spherical

394

00:17:58,819 --> 00:18:04,819  
lenses and so forth in here but i can

395

00:18:00,950 --> 00:18:08,029  
tell you that um is this particular

396

00:18:04,819 --> 00:18:09,200  
telescope is a chromatic hmm well you

397

00:18:08,029 --> 00:18:11,029  
got to describe what that is what is

398

00:18:09,200 --> 00:18:14,690  
that chromatic that means that you don't

399

00:18:11,029 --> 00:18:16,460  
see if you have like a cheap optics to

400  
00:18:14,690 --> 00:18:19,190  
telescopes you can see the colors

401  
00:18:16,460 --> 00:18:21,019  
separate right which means different

402  
00:18:19,190 --> 00:18:22,430  
band passes are different colors of

403  
00:18:21,019 --> 00:18:25,639  
light are focusing in different

404  
00:18:22,430 --> 00:18:29,990  
locations an a chromatic telescope of

405  
00:18:25,640 --> 00:18:31,970  
the size is ideal for looking at solar

406  
00:18:29,990 --> 00:18:33,529  
system objects because you see the

407  
00:18:31,970 --> 00:18:36,710  
colors as they really are you don't see

408  
00:18:33,529 --> 00:18:38,149  
that separation right so I if you'd like

409  
00:18:36,710 --> 00:18:40,819  
like she likes to zenna said if you look

410  
00:18:38,150 --> 00:18:42,470  
at it inexpensive telescopes and you

411  
00:18:40,819 --> 00:18:44,149  
look at a bright spot of light you'll

412  
00:18:42,470 --> 00:18:46,910  
see little prisms or a little little

413  
00:18:44,150 --> 00:18:48,470  
spreading out of light in the the

414  
00:18:46,910 --> 00:18:51,170  
imperfections in the optics causing it

415  
00:18:48,470 --> 00:18:53,450  
to basically act like a prism so this

416  
00:18:51,170 --> 00:18:56,769  
corrects for that and can you still get

417  
00:18:53,450 --> 00:18:59,390  
this telescope yes yes you can ok sir so

418  
00:18:56,769 --> 00:19:00,710  
you do a search for Galileo scope and

419  
00:18:59,390 --> 00:19:02,810  
you'll be able to get that and you can

420  
00:19:00,710 --> 00:19:05,180  
see these kinds of things that we're

421  
00:19:02,809 --> 00:19:07,099  
talking about here but Hubble is not a

422  
00:19:05,180 --> 00:19:09,289  
Galileo scope this is a little bit

423  
00:19:07,099 --> 00:19:11,929  
better a little bit a little bit of a

424  
00:19:09,289 --> 00:19:14,089  
step up before we transition that I'm

425  
00:19:11,930 --> 00:19:16,100  
with some amateur astronomers that I

426  
00:19:14,089 --> 00:19:18,019  
know they actually one from Stuart

427  
00:19:16,099 --> 00:19:20,359  
foreman who's up in the bay area here in

428

00:19:18,019 --> 00:19:23,299  
California did go out and observe with

429  
00:19:20,359 --> 00:19:25,369  
his telescope and he posted up his

430  
00:19:23,299 --> 00:19:27,440  
frames with the help of Mike Phillips

431  
00:19:25,369 --> 00:19:31,939  
who was an amateur astronomer in North

432  
00:19:27,440 --> 00:19:34,220  
Carolina and here is this is up on

433  
00:19:31,940 --> 00:19:37,190  
youtube so sure about as well but this

434  
00:19:34,220 --> 00:19:40,160  
is what he was able to see from the Bay

435  
00:19:37,190 --> 00:19:43,039  
Area name and this is his frames going

436  
00:19:40,160 --> 00:19:45,730  
back and forth yeah it's it's really

437  
00:19:43,039 --> 00:19:49,309  
cool that the Hubble heritage program

438  
00:19:45,730 --> 00:19:53,120  
decided to look at this system of

439  
00:19:49,309 --> 00:19:57,009  
transits because that these were

440  
00:19:53,119 --> 00:19:58,849  
observed by cassini and historically

441  
00:19:57,009 --> 00:20:00,650  
they were

442  
00:19:58,849 --> 00:20:03,379

some of the first solar system

443

00:20:00,650 --> 00:20:08,330

observations with a telescope and NASA

444

00:20:03,380 --> 00:20:11,690

likes to commemorate these contributors

445

00:20:08,329 --> 00:20:15,529

to astronomy by naming missions after

446

00:20:11,690 --> 00:20:16,840

them so Galileo was the name used for

447

00:20:15,529 --> 00:20:19,339

the mission to the Jupiter system

448

00:20:16,839 --> 00:20:21,289

Cassini the mission to the Saturn system

449

00:20:19,339 --> 00:20:24,980

that's still going around there and

450

00:20:21,289 --> 00:20:26,839

Hubble was also named after a famous

451

00:20:24,980 --> 00:20:29,990

astronomer who made fundamental

452

00:20:26,839 --> 00:20:32,240

contributions to science so it's really

453

00:20:29,990 --> 00:20:36,019

cool that I mean Cassini was the first

454

00:20:32,240 --> 00:20:39,410

to observe shadows of moons going across

455

00:20:36,019 --> 00:20:42,289

the disk of Jupiter and they they they

456

00:20:39,410 --> 00:20:44,840

led to the first precise determination



457  
00:20:42,289 --> 00:20:48,379  
of longitude difference between Paris

458  
00:20:44,839 --> 00:20:50,689  
and Copenhagen for example so a lot of

459  
00:20:48,380 --> 00:20:53,480  
good science was done based on these

460  
00:20:50,690 --> 00:20:56,840  
types of observations and now Hubble has

461  
00:20:53,480 --> 00:20:58,819  
captured images of it at you know much

462  
00:20:56,839 --> 00:21:00,829  
higher fidelity than those astronomers

463  
00:20:58,819 --> 00:21:02,629  
ever could have dreamed of yeah but the

464  
00:21:00,829 --> 00:21:04,909  
cool thing is is that with your own

465  
00:21:02,630 --> 00:21:07,150  
telescope you can see what Hubble is

466  
00:21:04,910 --> 00:21:10,130  
seeing maybe not with the same

467  
00:21:07,150 --> 00:21:11,870  
resolution mm-hmm but it's one of the

468  
00:21:10,130 --> 00:21:14,360  
few times and you can actually follow

469  
00:21:11,869 --> 00:21:16,729  
along with Hubble yeah right that's a

470  
00:21:14,359 --> 00:21:18,709  
good point uh so he Sonics that I

471  
00:21:16,730 --> 00:21:20,960  
actually before you go back to top

472  
00:21:18,710 --> 00:21:25,100  
besides that I just wanted to understand

473  
00:21:20,960 --> 00:21:28,460  
what okay so we we got this link to the

474  
00:21:25,099 --> 00:21:32,539  
public and to amateurs why should we

475  
00:21:28,460 --> 00:21:36,019  
study Jupiter or any object in the solar

476  
00:21:32,539 --> 00:21:39,079  
system with Hubble we have satellites

477  
00:21:36,019 --> 00:21:41,509  
that go there well we don't have

478  
00:21:39,079 --> 00:21:43,819  
actually have any missions in orbit

479  
00:21:41,509 --> 00:21:45,740  
around Jupiter right now the Juno

480  
00:21:43,819 --> 00:21:49,129  
mission is on its way there and it

481  
00:21:45,740 --> 00:21:50,870  
should arrive next year but it's not

482  
00:21:49,130 --> 00:21:53,120  
going to do the same type of things that

483  
00:21:50,869 --> 00:21:55,519  
Hubble can do so Hubble's main advantage

484  
00:21:53,119 --> 00:22:01,159  
well it has two main advantages for

485

00:21:55,519 --> 00:22:03,920  
studying Jupiter one is that it can it

486  
00:22:01,160 --> 00:22:05,180  
can sense in the ultraviolet so we can't

487  
00:22:03,920 --> 00:22:08,390  
do that from the ground because the

488  
00:22:05,180 --> 00:22:09,529  
Earth's atmosphere blocks ultraviolet

489  
00:22:08,390 --> 00:22:12,320  
good thing because we would die

490  
00:22:09,529 --> 00:22:14,388  
otherwise but

491  
00:22:12,319 --> 00:22:18,048  
the other the other advantage is that

492  
00:22:14,388 --> 00:22:20,148  
Hubble can take very sharp images at

493  
00:22:18,048 --> 00:22:22,460  
optical wavelengths so we can we can

494  
00:22:20,148 --> 00:22:26,089  
track motions of these clouds as they

495  
00:22:22,460 --> 00:22:28,130  
move and you can even see that in in the

496  
00:22:26,089 --> 00:22:31,129  
animation just over this one Hubble

497  
00:22:28,130 --> 00:22:36,409  
orbit so those that the animation on the

498  
00:22:31,130 --> 00:22:39,350  
on the Hubble site shows just maybe 50

499  
00:22:36,409 --> 00:22:41,360

minutes of these moons moving across

500

00:22:39,349 --> 00:22:44,959

Jupiter space but you can also see the

501

00:22:41,359 --> 00:22:46,490

clouds as they rotate well as Jupiter

502

00:22:44,960 --> 00:22:49,038

rotates you can see the clouds moving

503

00:22:46,490 --> 00:22:51,169

and they move at different speeds so

504

00:22:49,038 --> 00:22:55,369

some of the belts have different jet

505

00:22:51,169 --> 00:22:58,220

speeds than than other belts and by

506

00:22:55,369 --> 00:23:01,758

charting those motions you can see what

507

00:22:58,220 --> 00:23:03,528

the weather is on Jupiter and and we can

508

00:23:01,759 --> 00:23:06,970

understand the physics of atmospheres

509

00:23:03,528 --> 00:23:10,308

make parallels to the Earth's atmosphere

510

00:23:06,970 --> 00:23:12,259

in fact parallels to the oceans of Earth

511

00:23:10,308 --> 00:23:15,138

some of the board a sees like the Great

512

00:23:12,259 --> 00:23:17,808

Red Spot are types of vortices that are

513

00:23:15,138 --> 00:23:21,138

present in the oceans of the Earth and

514  
00:23:17,808 --> 00:23:25,339  
Jupiter is our closest example of what

515  
00:23:21,138 --> 00:23:28,189  
exoplanets are like and a lot of current

516  
00:23:25,339 --> 00:23:31,519  
interest is and finding planets around

517  
00:23:28,190 --> 00:23:34,940  
other stars but it's hard to study those

518  
00:23:31,519 --> 00:23:37,250  
in detail and by studying Jupiter we can

519  
00:23:34,940 --> 00:23:39,919  
sort of make analogy as to some of the

520  
00:23:37,250 --> 00:23:41,298  
processes there awesome thank i was

521  
00:23:39,919 --> 00:23:43,220  
gonna yeah i'm glad you brought that up

522  
00:23:41,298 --> 00:23:45,619  
Carol because I was ult was saying that

523  
00:23:43,220 --> 00:23:47,960  
you know primarily the Hubble heritage

524  
00:23:45,619 --> 00:23:49,788  
images are chosen for their aesthetic

525  
00:23:47,960 --> 00:23:51,829  
values but there's good science it can

526  
00:23:49,788 --> 00:23:54,319  
also be done but we also had the

527  
00:23:51,829 --> 00:23:56,119  
shrinking red spot this year too so that

528  
00:23:54,319 --> 00:23:59,480  
was another case where I guess her boat

529  
00:23:56,119 --> 00:24:01,189  
was useful for helping to monitor that's

530  
00:23:59,480 --> 00:24:03,200  
right that's right so there's a lot of

531  
00:24:01,190 --> 00:24:05,480  
good useful science that can be done

532  
00:24:03,200 --> 00:24:07,340  
using Hubble and primarily because as

533  
00:24:05,480 --> 00:24:10,190  
you as you point out Mike there's not a

534  
00:24:07,339 --> 00:24:11,599  
current mission around Jupiter 2 to make

535  
00:24:10,190 --> 00:24:13,759  
these observations so Hubble is very

536  
00:24:11,599 --> 00:24:15,439  
valuable in that sense so I have a

537  
00:24:13,759 --> 00:24:16,639  
question from charles bell and i think

538  
00:24:15,440 --> 00:24:19,370  
i'm going to give this to use old he

539  
00:24:16,638 --> 00:24:21,199  
goes some how do you keep the ccd camera

540  
00:24:19,369 --> 00:24:23,709  
pixels from saturating from such a

541  
00:24:21,200 --> 00:24:23,710  
bright object

542

00:24:24,759 --> 00:24:32,200  
hello zolt looks frozen well basically

543  
00:24:30,190 --> 00:24:35,140  
we we have to make sure the exposure is

544  
00:24:32,200 --> 00:24:38,259  
short enough and then it won't saturate

545  
00:24:35,140 --> 00:24:41,320  
right we have we have calculators based

546  
00:24:38,259 --> 00:24:43,869  
on the known spectrum of Astrophysical

547  
00:24:41,319 --> 00:24:45,759  
objects we can calculate through any

548  
00:24:43,869 --> 00:24:47,859  
filter on Hubble what's the right

549  
00:24:45,759 --> 00:24:50,019  
exposure time that's right that's again

550  
00:24:47,859 --> 00:24:51,399  
we don't care what never actually talked

551  
00:24:50,019 --> 00:24:53,369  
about this before have we the exposure

552  
00:24:51,400 --> 00:24:56,410  
time calculator there's a tool that

553  
00:24:53,369 --> 00:25:00,699  
astronomers can use to actually figure

554  
00:24:56,410 --> 00:25:04,740  
out what exposures to say or Hubble

555  
00:25:00,700 --> 00:25:04,740  
based on what they're looking at correct

556  
00:25:05,009 --> 00:25:12,250

Carol yes I'm here yes yes I mean the

557

00:25:09,660 --> 00:25:14,140

actually that would hell hole hang out

558

00:25:12,250 --> 00:25:17,140

not just things I know what is actually

559

00:25:14,140 --> 00:25:19,960

a good idea how you figure out how to do

560

00:25:17,140 --> 00:25:21,330

these observations and I think the

561

00:25:19,960 --> 00:25:24,759

beautiful thing about this particular

562

00:25:21,329 --> 00:25:28,000

observation in calculating the exposure

563

00:25:24,759 --> 00:25:30,160

time and also the beauty of the detector

564

00:25:28,000 --> 00:25:32,440

is that you get enough dynamic range

565

00:25:30,160 --> 00:25:34,930

that you can you can actually see the

566

00:25:32,440 --> 00:25:37,210

detail of the shadows which are very

567

00:25:34,930 --> 00:25:41,950

dark you can see the different

568

00:25:37,210 --> 00:25:44,920

brightnesses of the Jupiter bands and

569

00:25:41,950 --> 00:25:47,980

you can also see those moons which I I

570

00:25:44,920 --> 00:25:50,289

found now the long-case Callisto you



571  
00:25:47,980 --> 00:25:53,829  
have to adjust it a little bit to see

572  
00:25:50,289 --> 00:25:55,869  
that Callisto is pretty dark but still

573  
00:25:53,829 --> 00:25:57,369  
the fact that you can get the exposure

574  
00:25:55,869 --> 00:26:00,759  
time right that you get all that stuff

575  
00:25:57,369 --> 00:26:03,129  
at the same time i think is impressive

576  
00:26:00,759 --> 00:26:05,379  
for you guys who planned the observation

577  
00:26:03,130 --> 00:26:07,540  
i just was a cheerleader i had nothing

578  
00:26:05,380 --> 00:26:09,070  
to do with the exposure time right but

579  
00:26:07,539 --> 00:26:10,480  
that you know that is something that we

580  
00:26:09,069 --> 00:26:13,359  
we should we should have a hangout

581  
00:26:10,480 --> 00:26:15,250  
specifically on that is it pretty yeah

582  
00:26:13,359 --> 00:26:17,229  
it is that we did yeah there's there but

583  
00:26:15,250 --> 00:26:19,240  
there are tools as Mike pointed out that

584  
00:26:17,230 --> 00:26:20,860  
that Shauna murs can use to help figure

585  
00:26:19,240 --> 00:26:23,430  
out the exposure time so that's how they

586  
00:26:20,859 --> 00:26:25,959  
keep that's how I kept it from

587  
00:26:23,430 --> 00:26:28,410  
saturating such a such a bright object

588  
00:26:25,960 --> 00:26:31,269  
it's just a matter of figuring out the

589  
00:26:28,410 --> 00:26:34,720  
exposure time so I'm seeing a new term

590  
00:26:31,269 --> 00:26:37,480  
on the Q&A app huh blurs never heard

591  
00:26:34,720 --> 00:26:40,150  
that before hubli I kind of like Heather

592  
00:26:37,480 --> 00:26:44,558  
I had like couplers / Hubble huggers oh

593  
00:26:40,150 --> 00:26:46,240  
yeah no I I'm a hubble hugger but sev

594  
00:26:44,558 --> 00:26:48,460  
dust bunny goes good evening huh blurs

595  
00:26:46,240 --> 00:26:50,529  
and also we have a comp I have a

596  
00:26:48,460 --> 00:26:53,410  
question here from wired magazine hello

597  
00:26:50,529 --> 00:26:55,389  
huh blurs Nick Stockton here from wired

598  
00:26:53,410 --> 00:26:57,640  
magazine was wondering if observations

599

00:26:55,390 --> 00:26:59,020  
like these contribute and to Mike I'll

600  
00:26:57,640 --> 00:27:01,509  
I'll direct this to you since i'm not

601  
00:26:59,019 --> 00:27:03,460  
sure where his ult went was wondering if

602  
00:27:01,509 --> 00:27:06,009  
observations like these contribute to

603  
00:27:03,460 --> 00:27:07,808  
science of looking for exomoons that's

604  
00:27:06,009 --> 00:27:10,269  
happening with Kepler and other

605  
00:27:07,808 --> 00:27:12,308  
telescopes looking for exomoons so how

606  
00:27:10,269 --> 00:27:16,298  
does this do these observations help us

607  
00:27:12,308 --> 00:27:19,298  
with those sorts of observations uh not

608  
00:27:16,298 --> 00:27:23,829  
really but there there is kind of a tie

609  
00:27:19,298 --> 00:27:26,500  
into another program jPAS carpets and as

610  
00:27:23,829 --> 00:27:31,720  
an email about this earlier that that's

611  
00:27:26,500 --> 00:27:33,849  
all forwarded but the there was a

612  
00:27:31,720 --> 00:27:37,029  
program to look at jupiter when venus

613  
00:27:33,849 --> 00:27:39,639

transited across the Sun so Venus's

614

00:27:37,029 --> 00:27:41,289

shadow was falling on Jupiter now you

615

00:27:39,640 --> 00:27:43,059

wouldn't see it you would all you would

616

00:27:41,289 --> 00:27:46,980

see is the whole disk of Jupiter dimming

617

00:27:43,058 --> 00:27:50,649

a little bit but I don't believe that

618

00:27:46,980 --> 00:27:52,690

wait a minute whoa hold on so Venus was

619

00:27:50,650 --> 00:27:56,950

passing in front of the Sun as the

620

00:27:52,690 --> 00:28:00,279

originator and it was casting a shadow

621

00:27:56,950 --> 00:28:02,259

on Jupiter yeah but but not a resolve

622

00:28:00,279 --> 00:28:04,168

shadow so unlike these images where you

623

00:28:02,259 --> 00:28:06,879

see a black dot all you would

624

00:28:04,169 --> 00:28:10,720

theoretically see is Jupiter getting a

625

00:28:06,880 --> 00:28:13,870

little bit dimmer the problem is the

626

00:28:10,720 --> 00:28:15,700

signal-to-noise ratio so in order to

627

00:28:13,869 --> 00:28:17,709

actually see that you have to very

628  
00:28:15,700 --> 00:28:19,860  
precisely measure how bright Jupiter is

629  
00:28:17,710 --> 00:28:22,240  
but as you can see as it as it rotates

630  
00:28:19,859 --> 00:28:24,729  
spots are coming into view and leaving

631  
00:28:22,240 --> 00:28:26,710  
so there's a number of other reasons why

632  
00:28:24,730 --> 00:28:28,539  
Jupiter's total brightness is changing

633  
00:28:26,710 --> 00:28:30,490  
so I I don't think they were successful

634  
00:28:28,539 --> 00:28:34,569  
in that effort now when we look at

635  
00:28:30,490 --> 00:28:36,339  
exoplanets again a lot of times we're

636  
00:28:34,569 --> 00:28:39,369  
looking at small changes in brightness

637  
00:28:36,339 --> 00:28:43,449  
of the host star as the planet goes in

638  
00:28:39,369 --> 00:28:46,329  
front of the star so there again you

639  
00:28:43,450 --> 00:28:49,179  
need very high signal-to-noise to detect

640  
00:28:46,329 --> 00:28:51,129  
this very small change in brightness so

641  
00:28:49,179 --> 00:28:55,500  
a moon around another planet

642  
00:28:51,130 --> 00:28:58,900  
is another level of signal to noise I i

643  
00:28:55,500 --> 00:29:02,140  
I'm not really sure about whether that's

644  
00:28:58,900 --> 00:29:03,759  
been done or but I'm sure at some point

645  
00:29:02,140 --> 00:29:06,100  
it will be but you have all these other

646  
00:29:03,759 --> 00:29:08,259  
noise terms to worry about what changing

647  
00:29:06,099 --> 00:29:10,449  
brightness of sunspots and things like

648  
00:29:08,259 --> 00:29:16,210  
that can you can you tell us what the

649  
00:29:10,450 --> 00:29:20,680  
contrast ratio is or tail I said like

650  
00:29:16,210 --> 00:29:22,809  
between the shadow Venus and Jupiter was

651  
00:29:20,680 --> 00:29:29,019  
that like one in a million in one in ten

652  
00:29:22,809 --> 00:29:32,740  
million that I could calculate it thank

653  
00:29:29,019 --> 00:29:34,960  
you give me a car I think compared to

654  
00:29:32,740 --> 00:29:37,569  
the size of the Sun basically and Venus

655  
00:29:34,960 --> 00:29:39,430  
is very small so or the area of Venus

656

00:29:37,569 --> 00:29:42,970  
compared to the rave let's surface area

657  
00:29:39,430 --> 00:29:45,850  
yeah yes it never ceases to amaze me it

658  
00:29:42,970 --> 00:29:47,980  
amazed me how precise we can get our

659  
00:29:45,849 --> 00:29:51,490  
photometry these days I mean Kepler as

660  
00:29:47,980 --> 00:29:54,130  
as Nick pointed out is is you know it

661  
00:29:51,490 --> 00:29:56,680  
was looking for other earth-sized

662  
00:29:54,130 --> 00:29:59,800  
planets and then it's designed to

663  
00:29:56,680 --> 00:30:02,080  
measure tiny dips in brightness in these

664  
00:29:59,799 --> 00:30:04,119  
stars as planets pass in front and so

665  
00:30:02,079 --> 00:30:06,339  
the fact that we do this now with with

666  
00:30:04,119 --> 00:30:08,469  
things like Venus passing in front of

667  
00:30:06,339 --> 00:30:11,619  
the Sun and dimming Jupiter just blows

668  
00:30:08,470 --> 00:30:13,390  
me away that's that's amazing so anyway

669  
00:30:11,619 --> 00:30:18,429  
it's amazing I was just going to comment

670  
00:30:13,390 --> 00:30:23,470

that that Kepler as amazing as it is is

671

00:30:18,430 --> 00:30:26,019

barely able to reach find planets that

672

00:30:23,470 --> 00:30:30,309

are the size of the earth so to find a

673

00:30:26,019 --> 00:30:33,430

moon is really tough it's really hard i

674

00:30:30,309 --> 00:30:37,389

read the tickets especially if you had

675

00:30:33,430 --> 00:30:39,960

say you had an earth-sized moon not sure

676

00:30:37,390 --> 00:30:42,400

would be a moon it may be a binary

677

00:30:39,960 --> 00:30:45,840

planet at that point but if you had to

678

00:30:42,400 --> 00:30:50,290

puter's and then and then earth an

679

00:30:45,839 --> 00:30:53,799

earth-sized satellite around it it'd be

680

00:30:50,289 --> 00:30:56,139

very hard to tell you know in a

681

00:30:53,799 --> 00:30:58,539

situation where those two are passing in

682

00:30:56,140 --> 00:31:02,110

front of between us and the star and

683

00:30:58,539 --> 00:31:04,509

then sometimes the moon is in behind or

684

00:31:02,109 --> 00:31:04,689

in front and the dimming of the law that



685  
00:31:04,509 --> 00:31:08,319  
will

686  
00:31:04,690 --> 00:31:11,370  
be a really a level of precision that is

687  
00:31:08,319 --> 00:31:14,439  
beyond Kepler's capability at least

688  
00:31:11,369 --> 00:31:18,149  
right so that's a great question Nick

689  
00:31:14,440 --> 00:31:22,420  
thank you very much so timothy rent ram

690  
00:31:18,150 --> 00:31:24,880  
ram Pieri rent sorry Tim I'm messing

691  
00:31:22,420 --> 00:31:27,670  
your name up with so many moons and this

692  
00:31:24,880 --> 00:31:29,590  
maybe could go to Carol or Mike with so

693  
00:31:27,670 --> 00:31:32,800  
many moons does this make Jupiter's

694  
00:31:29,589 --> 00:31:33,970  
atmosphere complex in other words like I

695  
00:31:32,799 --> 00:31:35,980  
guess another way of putting that as

696  
00:31:33,970 --> 00:31:38,710  
does the moons of Jupiter up with within

697  
00:31:35,980 --> 00:31:40,390  
it there are many more than four does

698  
00:31:38,710 --> 00:31:44,079  
what effect does that have on Jupiter's

699  
00:31:40,390 --> 00:31:46,360  
atmosphere do you if any did when I

700  
00:31:44,079 --> 00:31:52,059  
guess to answer that question okay Mike

701  
00:31:46,359 --> 00:31:53,559  
gonna yes but he's the expert okay you

702  
00:31:52,059 --> 00:31:56,200  
gotta you gotta guess for Smike you're

703  
00:31:53,559 --> 00:32:01,990  
muted Oh Mike you're muted unmeet

704  
00:31:56,200 --> 00:32:03,880  
microphone and try again okay yeah yeah

705  
00:32:01,990 --> 00:32:05,109  
it's a minimal effect there's two ways

706  
00:32:03,880 --> 00:32:07,860  
that the moon's could affect the

707  
00:32:05,109 --> 00:32:10,750  
atmosphere they could either change the

708  
00:32:07,859 --> 00:32:13,000  
radiation or sunlight that would reach

709  
00:32:10,750 --> 00:32:21,730  
Jupiter or they could transfer material

710  
00:32:13,000 --> 00:32:24,220  
to Jupiter so these up actually we don't

711  
00:32:21,730 --> 00:32:27,039  
have any images prepared but hubble

712  
00:32:24,220 --> 00:32:28,480  
hubble ultra violent images show one of

713

00:32:27,039 --> 00:32:31,750  
the clearest links between the moon's

714  
00:32:28,480 --> 00:32:33,610  
and and the atmosphere so when you look

715  
00:32:31,750 --> 00:32:38,109  
at jupiter and ultraviolet with Hubble

716  
00:32:33,609 --> 00:32:39,369  
you can see at an auroral oval and it's

717  
00:32:38,109 --> 00:32:41,589  
a similar thing when you look at the

718  
00:32:39,369 --> 00:32:43,779  
earth the Northern Lights the Southern

719  
00:32:41,589 --> 00:32:46,149  
Lights they form an oval around the

720  
00:32:43,779 --> 00:32:49,149  
Magnetic Pole and Jupiter's moons

721  
00:32:46,150 --> 00:32:50,800  
actually have streams of particles that

722  
00:32:49,150 --> 00:32:52,960  
travel through the magnetic field and

723  
00:32:50,799 --> 00:32:55,149  
then hit the planet near the rural oval

724  
00:32:52,960 --> 00:32:57,610  
and you can see footprints of the moons

725  
00:32:55,150 --> 00:33:01,540  
and watch them as they go around the

726  
00:32:57,609 --> 00:33:04,449  
planet so there is a linkage there and

727  
00:33:01,539 --> 00:33:05,950

so it doesn't really affect the

728

00:33:04,450 --> 00:33:08,980

atmosphere that much but it's useful

729

00:33:05,950 --> 00:33:11,080

that there is this this linkage because

730

00:33:08,980 --> 00:33:12,789

it can help you study processes in the

731

00:33:11,079 --> 00:33:16,299

magnetosphere where these particles are

732

00:33:12,789 --> 00:33:18,519

traveling through space interesting

733

00:33:16,299 --> 00:33:20,589

thing though about that question is

734

00:33:18,519 --> 00:33:23,250

pattern is a different case so Saturn

735

00:33:20,589 --> 00:33:25,779

has these big rings they're not

736

00:33:23,250 --> 00:33:28,119

technically a moon or anything but they

737

00:33:25,779 --> 00:33:30,639

do they do affect the atmosphere there

738

00:33:28,119 --> 00:33:32,649

because the Rings are so big they can

739

00:33:30,640 --> 00:33:35,110

shade the atmosphere and you have

740

00:33:32,650 --> 00:33:37,500

seasonal changes if you could imagine

741

00:33:35,109 --> 00:33:40,329

floating around in Saturn's atmosphere

742  
00:33:37,500 --> 00:33:42,339  
depending on what latitude you're at you

743  
00:33:40,329 --> 00:33:45,069  
may see the Rings blocking the Sun and

744  
00:33:42,339 --> 00:33:46,629  
get a lot less sunlight than some other

745  
00:33:45,069 --> 00:33:49,329  
areas of the planet so that does affect

746  
00:33:46,630 --> 00:33:52,240  
the atmosphere of Saturn cool now

747  
00:33:49,329 --> 00:33:54,939  
Jupiter also has a small ring doesn't it

748  
00:33:52,240 --> 00:33:56,829  
yeah very faint ring very faint ring but

749  
00:33:54,940 --> 00:33:58,150  
it's not it's not enough i guess to make

750  
00:33:56,829 --> 00:34:00,220  
much of a difference in the atmosphere

751  
00:33:58,150 --> 00:34:01,390  
so okay good question timothy thank you

752  
00:34:00,220 --> 00:34:03,910  
very much there was a great question

753  
00:34:01,390 --> 00:34:05,350  
from charles bell it went away I guess

754  
00:34:03,910 --> 00:34:08,679  
he deleted it but I want to ask it

755  
00:34:05,349 --> 00:34:10,869  
anyway um and that is is there a minimum

756  
00:34:08,679 --> 00:34:12,940  
exposure time for Hubble and Carol if

757  
00:34:10,869 --> 00:34:15,250  
you may not know this I don't know but I

758  
00:34:12,940 --> 00:34:18,309  
know oh do is there okay good good mike

759  
00:34:15,250 --> 00:34:21,909  
is in a long time that you can take a

760  
00:34:18,309 --> 00:34:24,940  
minimum exposure time there there is and

761  
00:34:21,909 --> 00:34:27,610  
it depends not on the telescope but on

762  
00:34:24,940 --> 00:34:30,360  
the instrument or the camera the cam

763  
00:34:27,610 --> 00:34:32,950  
though these are these observations of

764  
00:34:30,360 --> 00:34:36,610  
the moon transits were taken with the

765  
00:34:32,949 --> 00:34:39,639  
wide field camera 3 or whips III as we

766  
00:34:36,610 --> 00:34:42,399  
affectionately call it and whips III has

767  
00:34:39,639 --> 00:34:44,500  
a minimum exposure time of less than

768  
00:34:42,398 --> 00:34:46,690  
half a second I don't remember precisely

769  
00:34:44,500 --> 00:34:51,010  
its point 3 or point 4 seconds is a

770

00:34:46,690 --> 00:34:55,690  
minimum I think it might be point 3 but

771  
00:34:51,010 --> 00:34:58,060  
anyways that I mean since we're talking

772  
00:34:55,690 --> 00:34:59,950  
about these technical things there's

773  
00:34:58,059 --> 00:35:01,719  
something really cool about this image

774  
00:34:59,949 --> 00:35:03,489  
sequence and I wish though it was still

775  
00:35:01,719 --> 00:35:05,859  
here because I forgot the exact number

776  
00:35:03,489 --> 00:35:07,209  
of frames that were taken you just need

777  
00:35:05,860 --> 00:35:10,809  
to look at that he said that it crashed

778  
00:35:07,210 --> 00:35:13,090  
she'll be back in 20 25 something like

779  
00:35:10,809 --> 00:35:15,519  
that what if you are there yes though

780  
00:35:13,090 --> 00:35:17,890  
when we do our science observations we

781  
00:35:15,519 --> 00:35:19,539  
like to capture the entire disk of the

782  
00:35:17,889 --> 00:35:22,389  
planet because it's really rare that we

783  
00:35:19,539 --> 00:35:25,300  
get to observe Jupiter with Hubble and

784  
00:35:22,389 --> 00:35:29,230

so we want to we want to observe the

785

00:35:25,300 --> 00:35:30,640

entire thing but for this sequence we

786

00:35:29,230 --> 00:35:32,320

had a different priority we wanted to

787

00:35:30,639 --> 00:35:35,559

get as many frames as we could

788

00:35:32,320 --> 00:35:37,930

build up with smooth animation and so we

789

00:35:35,559 --> 00:35:42,759

use frame we could use like a sub array

790

00:35:37,929 --> 00:35:44,230

only reading out part of the detector as

791

00:35:42,760 --> 00:35:47,710

old I'm talking about how we use that

792

00:35:44,230 --> 00:35:50,380

welcome back hi sorry about that that's

793

00:35:47,710 --> 00:35:52,539

alright so we use sub-arrays we only

794

00:35:50,380 --> 00:35:54,700

read out part of the detector and this

795

00:35:52,539 --> 00:35:58,480

allowed us to build up a whole bunch of

796

00:35:54,699 --> 00:36:01,029

frames without pausing to dump the

797

00:35:58,480 --> 00:36:03,369

buffer but basically we got a really

798

00:36:01,030 --> 00:36:05,380

smooth animation at the cost of cutting



799

00:36:03,369 --> 00:36:08,500

off the corners so if you look at that

800

00:36:05,380 --> 00:36:10,210

image we we don't have the entire planet

801

00:36:08,500 --> 00:36:12,190

there but we did that on purpose because

802

00:36:10,210 --> 00:36:14,829

we wanted to build up a smooth animation

803

00:36:12,190 --> 00:36:18,690

so I did want to backtrack but I did

804

00:36:14,829 --> 00:36:21,909

find that I'm Oh brilliant Mike yeah

805

00:36:18,690 --> 00:36:24,159

they're in this ultraviolet image to the

806

00:36:21,909 --> 00:36:27,460

left you can see sort of like a bright

807

00:36:24,159 --> 00:36:31,269

little comma feature I'm gonna go that's

808

00:36:27,460 --> 00:36:33,159

the IO foot yeah iOS no one just to show

809

00:36:31,269 --> 00:36:35,440

people it is on Hubble site as well if

810

00:36:33,159 --> 00:36:38,679

anybody wants to have that image awesome

811

00:36:35,440 --> 00:36:40,329

okay great okay so what I just tweeted

812

00:36:38,679 --> 00:36:42,549

it out along with the link and it's in

813  
00:36:40,329 --> 00:36:45,069  
the event page on Google debate well

814  
00:36:42,550 --> 00:36:48,490  
with the link thanks good I'm problem

815  
00:36:45,070 --> 00:36:51,760  
right so here's a question from wat van

816  
00:36:48,489 --> 00:36:54,489  
de van der haida I think seeing three

817  
00:36:51,760 --> 00:36:56,710  
moons transiting Jupiter is rare but has

818  
00:36:54,489 --> 00:36:59,199  
there ever been a quadruple transit in

819  
00:36:56,710 --> 00:37:02,199  
other words I Oh Callisto Europa and

820  
00:36:59,199 --> 00:37:04,089  
Ganymede has where I've ever been one

821  
00:37:02,199 --> 00:37:10,539  
with all four I've heard that's

822  
00:37:04,090 --> 00:37:13,059  
impossible hmm but I yeah I think the

823  
00:37:10,539 --> 00:37:17,860  
issue is that three of the moons are

824  
00:37:13,059 --> 00:37:21,340  
locked in Laplace resonance which means

825  
00:37:17,860 --> 00:37:25,420  
that their orbital periods are iOS four

826  
00:37:21,340 --> 00:37:29,530  
battle period is half the half the

827

00:37:25,420 --> 00:37:31,360  
duration of Europa's period and so on so

828  
00:37:29,530 --> 00:37:33,460  
I think there's a constraint that if

829  
00:37:31,360 --> 00:37:34,599  
some of the moons are on one side than

830  
00:37:33,460 --> 00:37:37,360  
the other one has to be on the other

831  
00:37:34,599 --> 00:37:39,789  
side or something like that okay I don't

832  
00:37:37,360 --> 00:37:42,010  
think it's possible i did want to

833  
00:37:39,789 --> 00:37:44,179  
mention and maybe zylle will not be

834  
00:37:42,010 --> 00:37:46,280  
happy i did but

835  
00:37:44,179 --> 00:37:51,009  
more than those three moons that

836  
00:37:46,280 --> 00:37:55,280  
actually transit yes that's right and no

837  
00:37:51,010 --> 00:37:57,530  
amateur caught this because it is so

838  
00:37:55,280 --> 00:38:02,019  
little it's really hard to see but there

839  
00:37:57,530 --> 00:38:04,790  
are little tiny turtles image is

840  
00:38:02,019 --> 00:38:08,239  
probably on the sequence that we capture

841  
00:38:04,789 --> 00:38:11,088

yeah yes it's very difficult to see you

842

00:38:08,239 --> 00:38:13,489

really are missing oh go ahead and blow

843

00:38:11,088 --> 00:38:15,739

the image up on a you know big screen

844

00:38:13,489 --> 00:38:20,209

and we're all that good oh I see yeah

845

00:38:15,739 --> 00:38:23,179

you have a mafia Phoebe yep this time

846

00:38:20,210 --> 00:38:26,990

I'm we'll see on TV oh they're just a

847

00:38:23,179 --> 00:38:29,690

little tiny dots Wow in fact you can see

848

00:38:26,989 --> 00:38:32,299

the shadows to do you have them to

849

00:38:29,690 --> 00:38:35,809

somebody have that yeah I can you kind

850

00:38:32,300 --> 00:38:38,300

of have to zoom in to see go yes well we

851

00:38:35,809 --> 00:38:42,470

have a good one we have a little video

852

00:38:38,300 --> 00:38:44,990

that we made that zoomed in that's not

853

00:38:42,469 --> 00:38:50,389

actually a post on Hubble side it is

854

00:38:44,989 --> 00:38:54,219

posted on the Hubble heritage site uh if

855

00:38:50,389 --> 00:38:59,539

I can let's see I can bring that up here

856  
00:38:54,219 --> 00:39:02,568  
maybe oh sorry no that's okay no I was

857  
00:38:59,539 --> 00:39:08,150  
gonna listen here on the country being

858  
00:39:02,568 --> 00:39:11,179  
asked questions on the spot cool which

859  
00:39:08,150 --> 00:39:15,710  
we knew that they would be crossing the

860  
00:39:11,179 --> 00:39:18,318  
face because we had a we had charts that

861  
00:39:15,710 --> 00:39:21,230  
showed the configuration as we were

862  
00:39:18,318 --> 00:39:23,210  
planning the observations um but we

863  
00:39:21,230 --> 00:39:27,019  
weren't sure that we would actually see

864  
00:39:23,210 --> 00:39:28,460  
them and sure enough when we we had to

865  
00:39:27,019 --> 00:39:31,250  
sort of even stretch them a little hard

866  
00:39:28,460 --> 00:39:33,289  
we had to adjust the contrast and

867  
00:39:31,250 --> 00:39:34,880  
brightness such that you could see these

868  
00:39:33,289 --> 00:39:37,068  
and then the other thing is that there's

869  
00:39:34,880 --> 00:39:39,559  
actually a little bit of noise and stuff

870  
00:39:37,068 --> 00:39:41,298  
and the images so it's in it and they're

871  
00:39:39,559 --> 00:39:44,150  
moving across the clouds which are very

872  
00:39:41,298 --> 00:39:46,130  
complex so you know it's a little hard

873  
00:39:44,150 --> 00:39:48,470  
to tell what what if you look at just

874  
00:39:46,130 --> 00:39:51,200  
one frame it's very difficult to tell

875  
00:39:48,469 --> 00:39:53,509  
what's a little tiny moon what's a cloud

876  
00:39:51,199 --> 00:39:55,279  
feature and what may be some noise in

877  
00:39:53,510 --> 00:39:57,110  
the detector but if you look at the

878  
00:39:55,280 --> 00:39:59,269  
frames in succession if you may

879  
00:39:57,110 --> 00:40:02,900  
take the movie and look at them you can

880  
00:39:59,269 --> 00:40:06,349  
see the marching across the frame and if

881  
00:40:02,900 --> 00:40:11,869  
I uh if I try to forget it up right now

882  
00:40:06,349 --> 00:40:13,009  
okay yeah yeah there it is and i'll put

883  
00:40:11,869 --> 00:40:14,239  
the link it out on twitter and

884

00:40:13,010 --> 00:40:16,670  
everything like that but this is phone

885  
00:40:14,239 --> 00:40:18,949  
at the hubble heritage site and i'll

886  
00:40:16,670 --> 00:40:20,090  
make it that's right heritage yeah and

887  
00:40:18,949 --> 00:40:21,230  
you should guys should bookmark that

888  
00:40:20,090 --> 00:40:24,320  
site there's a lot of cool stuff on

889  
00:40:21,230 --> 00:40:27,230  
their heritage does stsci edu a lot of

890  
00:40:24,320 --> 00:40:28,850  
cool stuff there so yeah I could see it

891  
00:40:27,230 --> 00:40:33,619  
now look at that well that is so awesome

892  
00:40:28,849 --> 00:40:35,269  
yeah right now is amazed that is a bike

893  
00:40:33,619 --> 00:40:38,750  
do you know how big those moons are I

894  
00:40:35,269 --> 00:40:40,400  
don't I haven't looked that up uh no I

895  
00:40:38,750 --> 00:40:41,989  
would have to look it up i am not really

896  
00:40:40,400 --> 00:40:44,269  
good at memorizing over there certainly

897  
00:40:41,989 --> 00:40:46,519  
tiny compared to the Galilean ones and

898  
00:40:44,269 --> 00:40:51,650

they are very small there but they're

899

00:40:46,519 --> 00:40:55,849

about an arcsecond that's diameter okay

900

00:40:51,650 --> 00:40:57,440

oh no no wait wait moms will get it no

901

00:40:55,849 --> 00:40:59,539

no we're not talking about together land

902

00:40:57,440 --> 00:41:02,269

moons right we're talking about the

903

00:40:59,539 --> 00:41:04,750

little tiny guy yeah yeah oh those

904

00:41:02,269 --> 00:41:08,960

they're less than that no way less alone

905

00:41:04,750 --> 00:41:11,119

um but I you know what I bet if we had

906

00:41:08,960 --> 00:41:13,940

captured these frames when those moves

907

00:41:11,119 --> 00:41:15,230

were just starting to cross the disk on

908

00:41:13,940 --> 00:41:17,269

the limb of Jupiter they would have

909

00:41:15,230 --> 00:41:19,400

stood out a little bit more this is

910

00:41:17,269 --> 00:41:23,000

something that Cassini actually noticed

911

00:41:19,400 --> 00:41:25,250

in their first you know the first

912

00:41:23,000 --> 00:41:27,619

telescopic observations of the Galilean



913  
00:41:25,250 --> 00:41:29,269  
satellites crossing the disk is that you

914  
00:41:27,619 --> 00:41:31,159  
could see them you could see the moons

915  
00:41:29,269 --> 00:41:33,619  
as they first through a small telescope

916  
00:41:31,159 --> 00:41:35,629  
but see the moons as they first touched

917  
00:41:33,619 --> 00:41:37,730  
Jupiter's edge but once they get towards

918  
00:41:35,630 --> 00:41:39,380  
them the center of the planet with a

919  
00:41:37,730 --> 00:41:42,349  
small chocolate you can't really see the

920  
00:41:39,380 --> 00:41:43,730  
moons and interesting so about that that

921  
00:41:42,349 --> 00:41:45,920  
was something that these early

922  
00:41:43,730 --> 00:41:48,639  
scientists used to figure out the

923  
00:41:45,920 --> 00:41:52,700  
Jupiter probably has an atmosphere

924  
00:41:48,639 --> 00:41:58,239  
because it it's brighter in the middle

925  
00:41:52,699 --> 00:42:01,219  
and dimmer around the edges so this

926  
00:41:58,239 --> 00:42:03,769  
basically just finding the light curve

927  
00:42:01,219 --> 00:42:06,619  
as the brightness changes is a technique

928  
00:42:03,769 --> 00:42:10,570  
that we use for exoplanets to but so for

929  
00:42:06,619 --> 00:42:13,519  
inquiring minds io is 36

930  
00:42:10,570 --> 00:42:17,510  
about thirty six hundred kilometers in

931  
00:42:13,519 --> 00:42:20,300  
diameter and Athiya is about 250 so less

932  
00:42:17,510 --> 00:42:23,950  
than ten times and thieving is a hundred

933  
00:42:20,300 --> 00:42:26,480  
sixteen so it's well pretty darn little

934  
00:42:23,949 --> 00:42:28,368  
little guys out little rocks out there

935  
00:42:26,480 --> 00:42:30,980  
that's a real tribute to Hubble be able

936  
00:42:28,369 --> 00:42:35,210  
to resolve its really great well I'm not

937  
00:42:30,980 --> 00:42:39,170  
really see you sooner so there but it

938  
00:42:35,210 --> 00:42:42,019  
tends to a thousand sir sighs yeah I'm a

939  
00:42:39,170 --> 00:42:44,900  
big moons okay they're so small they're

940  
00:42:42,019 --> 00:42:47,420  
not even round if you right right i was

941

00:42:44,900 --> 00:42:51,289  
noticing that when i lifted yeah so

942  
00:42:47,420 --> 00:42:53,300  
small to not even right 80 but those

943  
00:42:51,289 --> 00:42:54,980  
would be basically regular satellites

944  
00:42:53,300 --> 00:42:57,860  
they're not like captured asteroids or

945  
00:42:54,980 --> 00:43:00,740  
something are they no because these are

946  
00:42:57,860 --> 00:43:04,849  
very close to the planet um actually da

947  
00:43:00,739 --> 00:43:08,118  
mafia well it's I'm not sure to be

948  
00:43:04,849 --> 00:43:10,130  
honest um but they're consider regular

949  
00:43:08,119 --> 00:43:13,789  
satellites they they they orbit in

950  
00:43:10,130 --> 00:43:17,030  
Jupiter's equatorial plane Amal Tia has

951  
00:43:13,789 --> 00:43:19,009  
a faint ring associated with it too it's

952  
00:43:17,030 --> 00:43:21,740  
very closely aligned yeah but the

953  
00:43:19,010 --> 00:43:24,619  
irregular satellites they don't have to

954  
00:43:21,739 --> 00:43:27,529  
be in the equatorial you know orbiting

955  
00:43:24,619 --> 00:43:31,190

in Jupiter's equatorial plane some of

956

00:43:27,530 --> 00:43:33,830

those are just like at any angle in

957

00:43:31,190 --> 00:43:36,380

polar orbits whatever there are nothing

958

00:43:33,829 --> 00:43:39,858

about that Phoebe are two of the four

959

00:43:36,380 --> 00:43:44,059

inner satellites and there are inside

960

00:43:39,858 --> 00:43:45,920

the orbit of Io Europa and and you can

961

00:43:44,059 --> 00:43:48,920

even see that from the from the color

962

00:43:45,920 --> 00:43:52,849

composites yeah because if you look at

963

00:43:48,920 --> 00:43:55,309

how far did I Oh move yeah yeah in that

964

00:43:52,849 --> 00:43:58,900

image it's a small amount compared to

965

00:43:55,309 --> 00:44:01,789

how far did a Mafiya and Phoebe move so

966

00:43:58,900 --> 00:44:03,889

things that are closer to the planet are

967

00:44:01,789 --> 00:44:06,289

orbiting faster than things farther out

968

00:44:03,889 --> 00:44:08,690

so you can just see from this image

969

00:44:06,289 --> 00:44:10,099

which one's the closer one right in it

970  
00:44:08,690 --> 00:44:12,829  
and the fact that they are closer

971  
00:44:10,099 --> 00:44:16,009  
actually allows them to make a shadow

972  
00:44:12,829 --> 00:44:19,940  
where as if they were further out forget

973  
00:44:16,010 --> 00:44:21,300  
it yeah right so uh now that you're back

974  
00:44:19,940 --> 00:44:23,159  
sold and we we

975  
00:44:21,300 --> 00:44:26,910  
we we lost you there for a little bit i

976  
00:44:23,159 --> 00:44:29,699  
want to get to some of the nuts and

977  
00:44:26,909 --> 00:44:31,319  
bolts of the processing of the images

978  
00:44:29,699 --> 00:44:32,909  
and Charles I'm gonna get started with a

979  
00:44:31,320 --> 00:44:35,880  
question from Charles Bell who's asking

980  
00:44:32,909 --> 00:44:38,429  
could you show a preview or raw image of

981  
00:44:35,880 --> 00:44:40,410  
Jupiter before any processing to bring

982  
00:44:38,429 --> 00:44:42,659  
out bands across the disk I'm curious to

983  
00:44:40,409 --> 00:44:44,909  
know how you get the bands of Jupiter to

984  
00:44:42,659 --> 00:44:46,289  
show so clearly I don't worry so much

985  
00:44:44,909 --> 00:44:48,989  
about you probably don't have any raw

986  
00:44:46,289 --> 00:44:51,239  
I'm just handy but how do you get the

987  
00:44:48,989 --> 00:44:54,119  
the bands and and what what sort of

988  
00:44:51,239 --> 00:44:56,789  
techniques do you do to bring out some

989  
00:44:54,119 --> 00:44:57,900  
of these details well I'll have to say

990  
00:44:56,789 --> 00:45:00,750  
that we didn't really do anything

991  
00:44:57,900 --> 00:45:02,760  
special to make the band's appear they

992  
00:45:00,750 --> 00:45:06,480  
basically appear in the images and again

993  
00:45:02,760 --> 00:45:09,840  
if I show my screen I can show some of

994  
00:45:06,480 --> 00:45:14,579  
these images I don't have raw raw images

995  
00:45:09,840 --> 00:45:19,130  
but I have the individual images that we

996  
00:45:14,579 --> 00:45:22,710  
produced well it's that's interesting

997  
00:45:19,130 --> 00:45:25,410  
it's not showing up here I'm having all

998

00:45:22,710 --> 00:45:30,750  
kinds of technical difficulty I'm

999  
00:45:25,409 --> 00:45:36,739  
terribly sorry um I don't know why this

1000  
00:45:30,750 --> 00:45:39,989  
is not okay here we go yeah so this is

1001  
00:45:36,739 --> 00:45:42,419  
making the color composite right I was

1002  
00:45:39,989 --> 00:45:49,500  
good hoping to show my computer is not

1003  
00:45:42,420 --> 00:45:50,909  
cooperating with me um I I don't know

1004  
00:45:49,500 --> 00:45:53,280  
what's going on with this okay so

1005  
00:45:50,909 --> 00:45:55,379  
terribly sorry that's all right but the

1006  
00:45:53,280 --> 00:45:57,690  
images themselves as far as the you know

1007  
00:45:55,380 --> 00:46:00,480  
I think Charles is trying to get to he

1008  
00:45:57,690 --> 00:46:03,360  
apparently he is wondering you know are

1009  
00:46:00,480 --> 00:46:05,940  
there any ways in which you might be

1010  
00:46:03,360 --> 00:46:07,349  
able to maximize the the contrast or

1011  
00:46:05,940 --> 00:46:10,670  
maybe get the band's to show up a little

1012  
00:46:07,349 --> 00:46:14,250

bit better well one thing is we used

1013

00:46:10,670 --> 00:46:16,470

kind of specialized filters and these

1014

00:46:14,250 --> 00:46:19,349

are narrow band filters which isolate a

1015

00:46:16,469 --> 00:46:22,909

very narrow range of wavelengths or

1016

00:46:19,349 --> 00:46:25,199

colors out of the visible light spectrum

1017

00:46:22,909 --> 00:46:26,369

almost killed enlisted you have you can

1018

00:46:25,199 --> 00:46:28,859

see them right there that is your

1019

00:46:26,369 --> 00:46:32,159

shipping the listed ya there these are

1020

00:46:28,860 --> 00:46:33,130

these Hubble filter names so f 33 395

1021

00:46:32,159 --> 00:46:37,210

and F

1022

00:46:33,130 --> 00:46:40,390

2n + f6 31 in and those are codes for

1023

00:46:37,210 --> 00:46:42,278

telling us what the wavelength coverage

1024

00:46:40,389 --> 00:46:43,868

of these light of these filters are so

1025

00:46:42,278 --> 00:46:46,088

basically we have a you know 400

1026

00:46:43,869 --> 00:46:48,400

nanometers 500 nanometers and 600



1027  
00:46:46,088 --> 00:46:50,409  
nanometers basically in red green and

1028  
00:46:48,400 --> 00:46:52,028  
blue image basically red green and blue

1029  
00:46:50,409 --> 00:46:55,358  
although they're not exactly right

1030  
00:46:52,028 --> 00:46:57,369  
Greenville but anyway and they're called

1031  
00:46:55,358 --> 00:47:00,788  
narrow band filters which again sample a

1032  
00:46:57,369 --> 00:47:02,528  
very narrow range of colors and the only

1033  
00:47:00,789 --> 00:47:03,880  
reason the main reason the narrow band

1034  
00:47:02,528 --> 00:47:06,518  
filters are chosen is too because they

1035  
00:47:03,880 --> 00:47:08,970  
let in less light and Jupiter being

1036  
00:47:06,518 --> 00:47:11,229  
relatively bright a very bright object

1037  
00:47:08,969 --> 00:47:14,318  
especially for Hubble for a large

1038  
00:47:11,230 --> 00:47:16,150  
telescope it cuts down on the amount of

1039  
00:47:14,318 --> 00:47:18,068  
light so you can you can use reasonable

1040  
00:47:16,150 --> 00:47:19,599  
exposures if you're raising the

1041  
00:47:18,068 --> 00:47:21,909  
broadband filters we'd have to use

1042  
00:47:19,599 --> 00:47:24,640  
exposures or fractions of a second which

1043  
00:47:21,909 --> 00:47:26,949  
is harder to do with bubble and we would

1044  
00:47:24,639 --> 00:47:29,528  
run at some exposure time which all

1045  
00:47:26,949 --> 00:47:33,730  
right all right right we just talked

1046  
00:47:29,528 --> 00:47:36,548  
about that earlier so yes so using those

1047  
00:47:33,730 --> 00:47:40,179  
narrow band filters also isolates the

1048  
00:47:36,548 --> 00:47:43,659  
colors more sharply of the ban of the

1049  
00:47:40,179 --> 00:47:46,328  
bands in the atmosphere Jupiter so each

1050  
00:47:43,659 --> 00:47:49,000  
individual filter will isolate a

1051  
00:47:46,329 --> 00:47:51,700  
particular color and that increases the

1052  
00:47:49,000 --> 00:47:54,429  
contrast so if you're sampling a larger

1053  
00:47:51,699 --> 00:47:57,518  
range of colors from the white light

1054  
00:47:54,429 --> 00:48:00,278  
you're going to blur out the you're

1055

00:47:57,518 --> 00:48:03,008  
going to be mixing colors from what's in

1056  
00:48:00,278 --> 00:48:05,528  
the atmosphere and so those colors those

1057  
00:48:03,009 --> 00:48:07,329  
bands will be less distinct so Charles

1058  
00:48:05,528 --> 00:48:09,699  
I'm not sure what filters you're using

1059  
00:48:07,329 --> 00:48:11,559  
but one thing you can do is I mean see

1060  
00:48:09,699 --> 00:48:13,210  
if you can get narrower band filters so

1061  
00:48:11,559 --> 00:48:15,150  
when you take your images you might you

1062  
00:48:13,210 --> 00:48:19,119  
might get better results that way so

1063  
00:48:15,150 --> 00:48:21,519  
let's see also we also produce the

1064  
00:48:19,119 --> 00:48:24,039  
images in a way that we can we can

1065  
00:48:21,518 --> 00:48:25,959  
adjust the contrast and brightness I'm

1066  
00:48:24,039 --> 00:48:29,528  
just like you can with any photograph

1067  
00:48:25,960 --> 00:48:31,659  
and we kind of maximize that contrast to

1068  
00:48:29,528 --> 00:48:33,759  
show all those details but we also want

1069  
00:48:31,659 --> 00:48:35,230

to preserve details and the brightest

1070

00:48:33,759 --> 00:48:37,028

parts of the image on that and the

1071

00:48:35,230 --> 00:48:38,588

famous parts of the animal carcass parks

1072

00:48:37,028 --> 00:48:41,048

with the intern so we basically just

1073

00:48:38,588 --> 00:48:44,588

adjust the brightness and contrast so it

1074

00:48:41,048 --> 00:48:46,809

provides the best range of tones within

1075

00:48:44,588 --> 00:48:49,210

each individual image and then we

1076

00:48:46,809 --> 00:48:52,509

when we composite those together we end

1077

00:48:49,210 --> 00:48:55,179

up with a color image right so you're

1078

00:48:52,510 --> 00:48:56,980

just approached me about the processing

1079

00:48:55,179 --> 00:48:59,019

one of the things that's really

1080

00:48:56,980 --> 00:49:02,949

important is removing geometric

1081

00:48:59,019 --> 00:49:04,559

distortion though because it the the raw

1082

00:49:02,949 --> 00:49:06,699

Hubble images when they come down

1083

00:49:04,559 --> 00:49:09,460

Jupiter isn't the right shape that's

1084  
00:49:06,699 --> 00:49:10,960  
kind of stretched out and so we have to

1085  
00:49:09,460 --> 00:49:13,389  
we have to run a computer program that

1086  
00:49:10,960 --> 00:49:15,940  
unstretched is it back to what it would

1087  
00:49:13,389 --> 00:49:17,469  
naturally appear right so as you brought

1088  
00:49:15,940 --> 00:49:19,990  
that up that's a that's a function of

1089  
00:49:17,469 --> 00:49:22,539  
the the camera as well as the optical

1090  
00:49:19,989 --> 00:49:25,119  
path of Hubble as well right yeah yeah

1091  
00:49:22,539 --> 00:49:27,639  
that's mainly a telescope well it

1092  
00:49:25,119 --> 00:49:29,230  
depends on where so light is coming in

1093  
00:49:27,639 --> 00:49:31,569  
through the telescope and it falls on

1094  
00:49:29,230 --> 00:49:33,550  
what we call the focal plane of the

1095  
00:49:31,570 --> 00:49:35,110  
telescope and different instruments are

1096  
00:49:33,550 --> 00:49:37,210  
in different places of the focal plane

1097  
00:49:35,110 --> 00:49:40,269  
and we're from this camera where whoops

1098  
00:49:37,210 --> 00:49:41,860  
III is it's it's tilted a little bit

1099  
00:49:40,269 --> 00:49:43,900  
with respect to the focal plane so that

1100  
00:49:41,860 --> 00:49:45,519  
kind of stretches out everything right

1101  
00:49:43,900 --> 00:49:48,039  
and so we have a correction it's a known

1102  
00:49:45,519 --> 00:49:50,400  
correction that has to be done on all

1103  
00:49:48,039 --> 00:49:53,139  
images really not just ones of Jim

1104  
00:49:50,400 --> 00:49:54,700  
internship yeah that are taken with that

1105  
00:49:53,139 --> 00:49:56,259  
are taking with Hubble so here's a good

1106  
00:49:54,699 --> 00:49:58,359  
question for Michael S on the Q&A app

1107  
00:49:56,260 --> 00:50:01,060  
are there any Galilean moons large

1108  
00:49:58,360 --> 00:50:03,099  
enough or close enough from an observer

1109  
00:50:01,059 --> 00:50:05,170  
on the surface of Jupiter let's pretend

1110  
00:50:03,099 --> 00:50:09,940  
we're on Jupiter and looking up to

1111  
00:50:05,170 --> 00:50:12,070  
create a solar eclipse ow actually these

1112

00:50:09,940 --> 00:50:13,389  
shadows if you happen to be on Jupiter

1113  
00:50:12,070 --> 00:50:16,480  
and you're under knee in the shadow

1114  
00:50:13,389 --> 00:50:18,849  
passes over you that's eclipse right yep

1115  
00:50:16,480 --> 00:50:22,260  
that's exactly what it looks like from

1116  
00:50:18,849 --> 00:50:25,599  
space so if we were on the earth and

1117  
00:50:22,260 --> 00:50:27,550  
experiencing a solar eclipse then a

1118  
00:50:25,599 --> 00:50:29,529  
satellite would see a similar thing it

1119  
00:50:27,550 --> 00:50:31,720  
would see a dark spot on on the earth

1120  
00:50:29,530 --> 00:50:34,930  
from the Earth's moon the question

1121  
00:50:31,719 --> 00:50:36,789  
though is the relative size if you're if

1122  
00:50:34,929 --> 00:50:39,039  
you could stand on Jupiter and you're

1123  
00:50:36,789 --> 00:50:41,860  
looking back at the Sun what would be

1124  
00:50:39,039 --> 00:50:45,610  
the relative size of the side of the

1125  
00:50:41,860 --> 00:50:47,650  
moon and the Sun so from the earth the

1126  
00:50:45,610 --> 00:50:50,860

coincident it's coincidental that the

1127

00:50:47,650 --> 00:50:53,050

during solar eclipse the moon exactly

1128

00:50:50,860 --> 00:50:55,570

covers the disk of the Sun right that's

1129

00:50:53,050 --> 00:50:58,240

because the geometry between the

1130

00:50:55,570 --> 00:51:00,280

distance and the sizes is just such by

1131

00:50:58,239 --> 00:51:02,289

coincidence that they're the same

1132

00:51:00,280 --> 00:51:04,000

yeah yeah right that's a glad you

1133

00:51:02,289 --> 00:51:05,800

brought that up where the only play this

1134

00:51:04,000 --> 00:51:07,329

is one of the few places in the only

1135

00:51:05,800 --> 00:51:09,250

place i know of in sword where the where

1136

00:51:07,329 --> 00:51:12,759

the in solar system where our moon

1137

00:51:09,250 --> 00:51:15,610

exactly matches the apparent size of the

1138

00:51:12,760 --> 00:51:19,300

Sun in the sky and completely blocks it

1139

00:51:15,610 --> 00:51:21,130

out and only the only time Tony because

1140

00:51:19,300 --> 00:51:22,840

in the future as a moon gets farther



1141  
00:51:21,130 --> 00:51:24,730  
from the earth we're not gonna hobble

1142  
00:51:22,840 --> 00:51:28,360  
eclipse is anymore we'll just have

1143  
00:51:24,730 --> 00:51:32,260  
annular eclipses that's right so good ?

1144  
00:51:28,360 --> 00:51:35,140  
oh that was nice okay so okay so answer

1145  
00:51:32,260 --> 00:51:39,040  
that right if we if we look at the color

1146  
00:51:35,139 --> 00:51:41,679  
composite io shadow and Callisto shadow

1147  
00:51:39,039 --> 00:51:43,900  
now I'll shadow is really dark and sharp

1148  
00:51:41,679 --> 00:51:45,609  
which tells me that if you were inside

1149  
00:51:43,900 --> 00:51:48,849  
that shadow you would see a total solar

1150  
00:51:45,610 --> 00:51:52,900  
eclipse but Callisto shadow is really

1151  
00:51:48,849 --> 00:51:55,000  
blurry which tells me that if you were

1152  
00:51:52,900 --> 00:51:57,760  
there you would probably see an annulus

1153  
00:51:55,000 --> 00:52:02,500  
of solar brightness around around the

1154  
00:51:57,760 --> 00:52:04,980  
Sun there so it would be the sharpness

1155  
00:52:02,500 --> 00:52:08,980  
of the shadow means a lot as far as the

1156  
00:52:04,980 --> 00:52:12,630  
the ecliptic I clipped what's the word

1157  
00:52:08,980 --> 00:52:12,630  
I'm looking for it up season nevermind

1158  
00:52:14,550 --> 00:52:21,220  
yes nature of a play he lived he clipped

1159  
00:52:17,679 --> 00:52:23,619  
icity is the word I was good I don't

1160  
00:52:21,219 --> 00:52:26,199  
think that's a word I believe it I just

1161  
00:52:23,619 --> 00:52:33,130  
made it up include you think include 2

1162  
00:52:26,199 --> 00:52:35,619  
2day okay better all right so um alright

1163  
00:52:33,130 --> 00:52:37,539  
so Judy uh welcome back Judy it's good

1164  
00:52:35,619 --> 00:52:39,969  
to see you again she's commenting huh

1165  
00:52:37,539 --> 00:52:42,670  
blurs is okay makes the transition to

1166  
00:52:39,969 --> 00:52:44,889  
jwst easier we can we could be Webber's

1167  
00:52:42,670 --> 00:52:48,750  
one day try to come up with an analog to

1168  
00:52:44,889 --> 00:52:50,859  
Hubble huggers for web web well please

1169

00:52:48,750 --> 00:52:52,900  
okay I like I don't know about that one

1170  
00:52:50,860 --> 00:52:55,390  
will have to think about that will table

1171  
00:52:52,900 --> 00:52:56,860  
it so Scott how am i doing I am I would

1172  
00:52:55,389 --> 00:53:00,819  
you got anything for Twitter for us or

1173  
00:52:56,860 --> 00:53:03,519  
let me look at the youtube uh comments

1174  
00:53:00,820 --> 00:53:07,750  
I'm looking around right now okay I'm

1175  
00:53:03,519 --> 00:53:11,349  
screen sharing an image of a solar

1176  
00:53:07,750 --> 00:53:14,260  
eclipse caused by the moon as okay it's

1177  
00:53:11,349 --> 00:53:18,639  
a satellite looking down on the year

1178  
00:53:14,260 --> 00:53:21,430  
yeah a photograph of an eclipse as it

1179  
00:53:18,639 --> 00:53:23,710  
crosses the surface of the earth so

1180  
00:53:21,429 --> 00:53:25,449  
that's the shadow of the moon and you

1181  
00:53:23,710 --> 00:53:27,309  
can see a similar thing whether it's the

1182  
00:53:25,449 --> 00:53:31,500  
dark part in the middle the Umbra and

1183  
00:53:27,309 --> 00:53:34,779

then the number around it pretty cool

1184

00:53:31,500 --> 00:53:36,550

okay so there here's a comment from

1185

00:53:34,780 --> 00:53:39,120

YouTube I'll go ahead and put this up

1186

00:53:36,550 --> 00:53:43,120

and maybe somebody can comment on it

1187

00:53:39,119 --> 00:53:44,889

kuna a GQ from my youtube is going

1188

00:53:43,119 --> 00:53:47,019

looking at the picture posted on the NBC

1189

00:53:44,889 --> 00:53:49,239

News website which linked to this

1190

00:53:47,019 --> 00:53:51,429

YouTube site I can't figure out why the

1191

00:53:49,239 --> 00:53:53,889

shadows don't seem to be in a consistent

1192

00:53:51,429 --> 00:53:56,799

position with respect to the respective

1193

00:53:53,889 --> 00:53:59,049

moon's the bottom-left moon appears to

1194

00:53:56,800 --> 00:54:01,210

be casting a shadow as if the Sun is off

1195

00:53:59,050 --> 00:54:03,400

to the left in the photo and the top

1196

00:54:01,210 --> 00:54:05,619

right moon appears to be casting a

1197

00:54:03,400 --> 00:54:08,889

shadow as if the Sun was above and to

1198  
00:54:05,619 --> 00:54:10,179  
the right what am I missing here was

1199  
00:54:08,889 --> 00:54:15,489  
there some kind was some kind of

1200  
00:54:10,179 --> 00:54:17,230  
combined time lapse photo no no I think

1201  
00:54:15,489 --> 00:54:19,469  
it would really help to look at the

1202  
00:54:17,230 --> 00:54:22,630  
version of the the image where

1203  
00:54:19,469 --> 00:54:25,629  
everything is labeled because I think

1204  
00:54:22,630 --> 00:54:27,190  
what's going on is in an unlabeled image

1205  
00:54:25,630 --> 00:54:29,559  
it's hard to tell which shadow goes with

1206  
00:54:27,190 --> 00:54:31,809  
which move but all the moons are casting

1207  
00:54:29,559 --> 00:54:35,679  
shadows to the rights write the vector

1208  
00:54:31,809 --> 00:54:37,929  
is the same they're also the moons are

1209  
00:54:35,679 --> 00:54:41,500  
also at different distances yeah so the

1210  
00:54:37,929 --> 00:54:42,849  
shadows are offset but yeah I think Mike

1211  
00:54:41,500 --> 00:54:46,179  
you're right you have to look at those

1212  
00:54:42,849 --> 00:54:51,039  
labeled ones to connect with shadow goes

1213  
00:54:46,179 --> 00:54:53,019  
with which moon it is coming over your

1214  
00:54:51,039 --> 00:54:55,119  
left shoulder as you look at this yeah

1215  
00:54:53,019 --> 00:54:56,829  
way after you left show it's all

1216  
00:54:55,119 --> 00:54:58,719  
confusing because I Oh is right over

1217  
00:54:56,829 --> 00:55:01,779  
Callisto's shadow at something is that

1218  
00:54:58,719 --> 00:55:06,939  
in fact before our observation started

1219  
00:55:01,780 --> 00:55:09,940  
earlier on I o Shah though was passed

1220  
00:55:06,940 --> 00:55:12,519  
over Callisto's shadow stupid we

1221  
00:55:09,940 --> 00:55:14,619  
couldn't observe during that time past

1222  
00:55:12,519 --> 00:55:16,750  
you got so there's a lots of funny

1223  
00:55:14,619 --> 00:55:20,469  
little fan and my understand also is it

1224  
00:55:16,750 --> 00:55:23,260  
I oh actually got eclipsed by Callisto I

1225  
00:55:20,469 --> 00:55:26,039  
believe at some point so ah this is

1226

00:55:23,260 --> 00:55:27,720  
shadow cast over I oh no

1227  
00:55:26,039 --> 00:55:31,860  
been pulled again but again we couldn't

1228  
00:55:27,719 --> 00:55:34,079  
schedule that we also have limited

1229  
00:55:31,860 --> 00:55:40,470  
little little slice of typing we did

1230  
00:55:34,079 --> 00:55:41,819  
with our one orbit yeah it's pretty but

1231  
00:55:40,469 --> 00:55:45,119  
yeah you know there's so many little

1232  
00:55:41,820 --> 00:55:48,510  
things going on it's so dynamic all

1233  
00:55:45,119 --> 00:55:50,579  
right well folks I guess I can just

1234  
00:55:48,510 --> 00:55:52,560  
trying to Oh Jonathan posted sir

1235  
00:55:50,579 --> 00:55:55,769  
jonathan ive never posted something of a

1236  
00:55:52,559 --> 00:55:59,400  
pod it oh is it an astronomy picture of

1237  
00:55:55,769 --> 00:56:02,789  
the day I didn't see that I know the

1238  
00:55:59,400 --> 00:56:05,809  
same image that that that Carol put up

1239  
00:56:02,789 --> 00:56:08,820  
there is already broke number on there

1240  
00:56:05,809 --> 00:56:11,639

from 1999 but yeah I'm hoping it goes up

1241

00:56:08,820 --> 00:56:13,559

tomorrow for a pod okay awesome yes that

1242

00:56:11,639 --> 00:56:16,409

would be great okay well guys I guess

1243

00:56:13,559 --> 00:56:18,150

that's it for today this week will I

1244

00:56:16,409 --> 00:56:19,739

want to thank you sold and and Mike and

1245

00:56:18,150 --> 00:56:22,260

Susanna for joining us this has been a

1246

00:56:19,739 --> 00:56:25,319

great hangout lots of fun stuff next

1247

00:56:22,260 --> 00:56:27,330

week our hangout will be our we would

1248

00:56:25,320 --> 00:56:29,420

again it's another hangout in the in

1249

00:56:27,329 --> 00:56:32,699

sort of celebration of our 25th

1250

00:56:29,420 --> 00:56:35,159

anniversary of Hubble of Hubble's launch

1251

00:56:32,699 --> 00:56:37,109

where would be we will be looking at a

1252

00:56:35,159 --> 00:56:40,259

collection of pictures we've assembled

1253

00:56:37,110 --> 00:56:43,890

it's on our Hubble 25th org site would

1254

00:56:40,260 --> 00:56:46,650

be talking about 25 different images to



1255  
00:56:43,889 --> 00:56:48,359  
commemorate different science the

1256  
00:56:46,650 --> 00:56:49,860  
different science of missions and things

1257  
00:56:48,360 --> 00:56:51,900  
that Hubble is done throughout its

1258  
00:56:49,860 --> 00:56:54,240  
lifetime so we hope you will join us

1259  
00:56:51,900 --> 00:56:56,550  
then that will be next week thursday at

1260  
00:56:54,239 --> 00:57:00,809  
three o'clock so i guess that's it guys

1261  
00:56:56,550 --> 00:57:03,990  
uh Carol Scott ok thank you ringing all

1262  
00:57:00,809 --> 00:57:05,639  
right ok guys well I want to thank you

1263  
00:57:03,989 --> 00:57:08,279  
all for watching and we'll see you next

1264  
00:57:05,639 --> 00:57:10,170  
week and don't forget video contest we

1265  
00:57:08,280 --> 00:57:12,240  
hope to see your ode to Hubble video

1266  
00:57:10,170 --> 00:57:13,800  
soon so start start getting your

1267  
00:57:12,239 --> 00:57:15,779  
creative juices going and we hope to see

1268  
00:57:13,800 --> 00:57:17,910  
your videos real quick so that's it for

1269

00:57:15,780 --> 00:57:23,040

this week thank you all for watching and

1270

00:57:17,909 --> 00:57:27,859

I'll wait later hablar keep looking

1271

00:57:23,039 --> 00:57:27,860

obnoxious people looking at ours