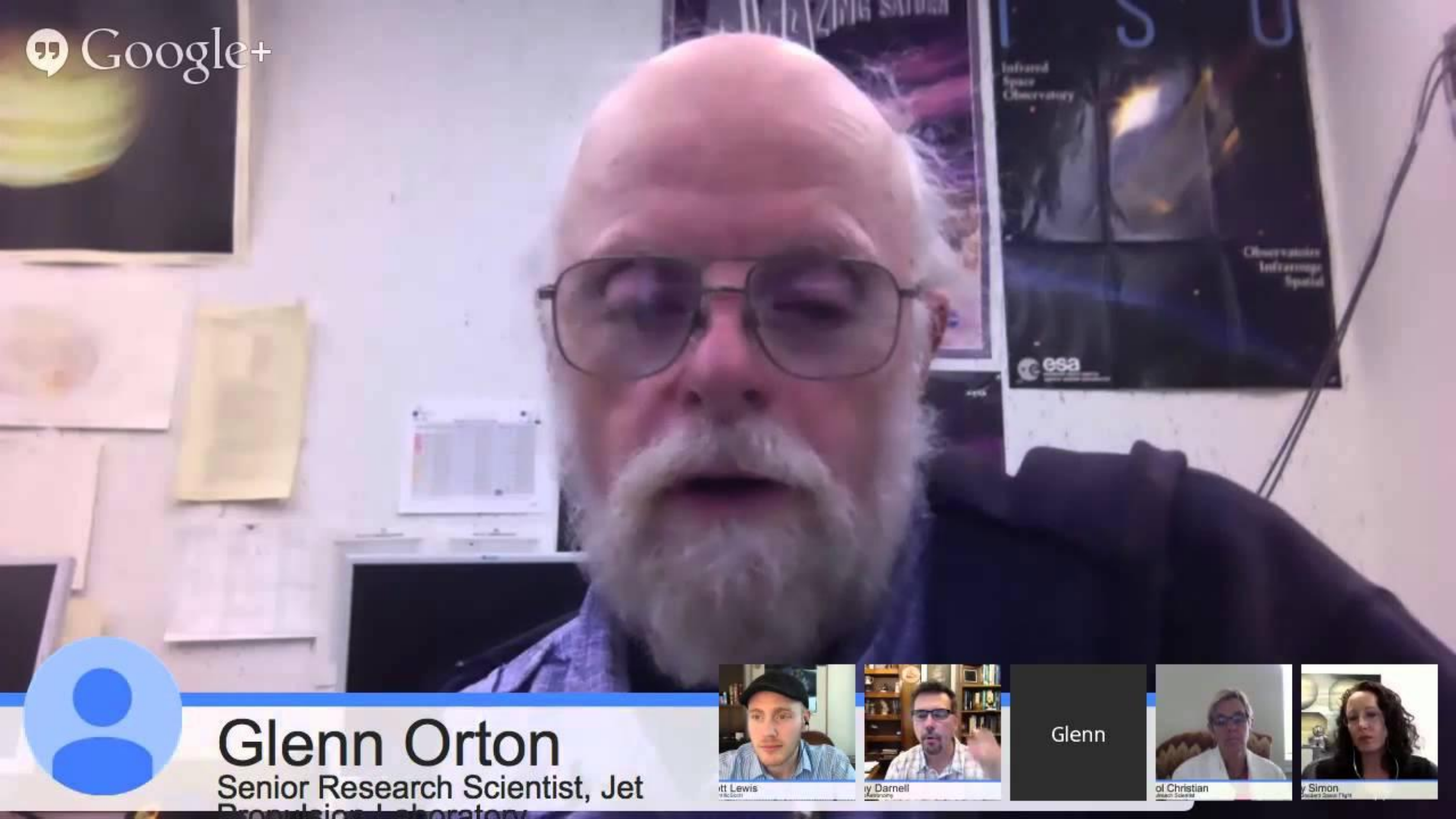
Google+
Infrared
Space
Observatory
esa
Glenn Orton
Senior Research Scientist, Jet
Glenn

1
00:00:06,260 --> 00:00:04,039
hello everybody and welcome to our

2
00:00:07,849 --> 00:00:06,270
latest Hubble hangout this is a place

3
00:00:10,400 --> 00:00:07,859
where you can come to learn about the

4
00:00:12,470 --> 00:00:10,410
latest news science and discoveries of

5
00:00:13,730 --> 00:00:12,480
the Hubble Space Telescope my name is

6
00:00:15,829 --> 00:00:13,740
Tony Darnell and I work at the Space

7
00:00:17,750 --> 00:00:15,839
Telescope Sciences to do and today we've

8
00:00:20,840 --> 00:00:17,760
got a really awesome hangout plan for

9
00:00:22,250 --> 00:00:20,850
you when when most people think of the

10
00:00:24,679 --> 00:00:22,260
Hubble Space Telescope and the science

11
00:00:26,990 --> 00:00:24,689
and observations it does we often think

12
00:00:28,460 --> 00:00:27,000
of peering into the deepest corners of

13
00:00:30,259 --> 00:00:28,470

the universe and looking at some of the

14
00:00:33,470 --> 00:00:30,269
most distant galaxies we've ever seen

15
00:00:35,720 --> 00:00:33,480
we've also looked at the amazing Hubble

16
00:00:38,090 --> 00:00:35,730
images of things within our own galaxy

17
00:00:40,940 --> 00:00:38,100
but these you know beautiful nebulae and

18
00:00:43,970 --> 00:00:40,950
star clusters and things like that but

19
00:00:46,160 --> 00:00:43,980
Hubble also spends a lot of time looking

20
00:00:47,810 --> 00:00:46,170
closer to home and by whom I mean within

21
00:00:49,940 --> 00:00:47,820
our own solar system and that's what

22
00:00:52,549 --> 00:00:49,950
we're gonna talk about today some reason

23
00:00:54,470 --> 00:00:52,559
and some not so recent observations made

24
00:00:58,099 --> 00:00:54,480
by Hubble of the largest planet in our

25
00:00:59,720 --> 00:00:58,109
solar system Jupiter so with me to

26
00:01:02,270 --> 00:00:59,730
discuss his latest Jupiter observations

27
00:01:03,770 --> 00:01:02,280
from Hubble is dr. Amy Simon she is the

28
00:01:05,840 --> 00:01:03,780
senior scientist for planetary

29
00:01:07,940 --> 00:01:05,850
atmospheres research for the solar

30
00:01:09,649 --> 00:01:07,950
system exploration division at NASA's

31
00:01:11,240 --> 00:01:09,659
Goddard Space Flight Center she is also

32
00:01:14,210 --> 00:01:11,250
a co-investigator of the Cassini

33
00:01:15,980 --> 00:01:14,220
composite infrared spectrometer and the

34
00:01:18,890 --> 00:01:15,990
deputy instrument scientists for the

35
00:01:20,719 --> 00:01:18,900
osiris-rex visible and near IR

36
00:01:22,010 --> 00:01:20,729
spectrometer now that has got to be the

37
00:01:24,950 --> 00:01:22,020
coolest name for an instrument I have

38
00:01:27,140 --> 00:01:24,960

ever heard osiris-rex so we got to talk

39
00:01:28,999 --> 00:01:27,150
more about that at some point - Amy with

40
00:01:30,140 --> 00:01:29,009
me also is dr. Glen Orton he's a

41
00:01:32,539 --> 00:01:30,150
planetary astronomer at the Jet

42
00:01:35,149 --> 00:01:32,549
Propulsion Laboratory in Pasadena he's

43
00:01:37,069 --> 00:01:35,159
interested in IR astronomy and I don't

44
00:01:38,859 --> 00:01:37,079
know of any astronomer around today who

45
00:01:41,060 --> 00:01:38,869
can't be interested in the infrared

46
00:01:43,999 --> 00:01:41,070
planetary atmospheres as well as

47
00:01:45,830 --> 00:01:44,009
extrasolar giant planets and hopefully a

48
00:01:47,719 --> 00:01:45,840
little bit later on we'll have dr. Mike

49
00:01:51,859 --> 00:01:47,729
Wong joining us he's from UC Berkeley

50
00:01:56,660 --> 00:01:51,869
who also works on planets and he's all

51
00:01:59,420 --> 00:01:56,670
he's a he is a member of the Mars

52
00:02:00,859 --> 00:01:59,430
Science Laboratory he he's a

53
00:02:02,870 --> 00:02:00,869
collaborator for that as well as these

54
00:02:05,929 --> 00:02:02,880
we work on the same instrument onboard

55
00:02:07,459 --> 00:02:05,939
curiosity so we're hoping he can he can

56
00:02:12,920 --> 00:02:07,469
join us a little bit later to discuss

57
00:02:13,730 --> 00:02:12,930
some of this - and of course I went oh

58
00:02:16,400 --> 00:02:13,740
so I went to

59
00:02:17,570 --> 00:02:16,410
everybody welcome you guys to to tell me

60
00:02:19,850 --> 00:02:17,580
talk about these and to help me

61
00:02:21,710 --> 00:02:19,860
facilitate this discussion with me today

62
00:02:23,390 --> 00:02:21,720
is also my colleague at Space Telescope

63
00:02:28,280 --> 00:02:23,400

Science Institute dr. Carol Christian

64
00:02:31,220 --> 00:02:28,290
whose insights and and perspective is

65
00:02:33,440 --> 00:02:31,230
always welcome here and dr. and almost

66
00:02:36,670 --> 00:02:33,450
said ah dr. Scott Lewis Scott Lewis from

67
00:02:39,260 --> 00:02:36,680
space fan news and no the cosmos comm

68
00:02:39,920 --> 00:02:39,270
welcome you everybody and let's go ahead

69
00:02:43,010 --> 00:02:39,930
and get started

70
00:02:45,710 --> 00:02:43,020
um I guess Amy let's start with you can

71
00:02:47,330 --> 00:02:45,720
you give us a general overview of what

72
00:02:51,440 --> 00:02:47,340
you're using the Hubble Space Telescope

73
00:02:53,210 --> 00:02:51,450
for in your studies of Jupiter okay well

74
00:02:55,220 --> 00:02:53,220
I study the winds and the clouds on

75
00:02:58,190 --> 00:02:55,230
Jupiter so I've been using Hubble now

76
00:03:00,500 --> 00:02:58,200
for 20 years actually it turns out for a

77
00:03:03,470 --> 00:03:00,510
variety of different projects and this

78
00:03:05,750 --> 00:03:03,480
particular project we wanted to look at

79
00:03:07,640 --> 00:03:05,760
the Great Red Spot on Jupiter because we

80
00:03:10,160 --> 00:03:07,650
have a network of amateur astronomers

81
00:03:12,380 --> 00:03:10,170
and they let us know that it looked like

82
00:03:13,580 --> 00:03:12,390
it was suddenly shrinking now we've

83
00:03:15,320 --> 00:03:13,590
known it's been shrinking for a long

84
00:03:17,030 --> 00:03:15,330
time but it looked like that rate had

85
00:03:18,770 --> 00:03:17,040
sped up so they brought it to our

86
00:03:20,840 --> 00:03:18,780
attention and we looked into it and

87
00:03:23,930 --> 00:03:20,850
basically requested the time with Hubble

88
00:03:27,340 --> 00:03:23,940

to look at that okay let's back up just

89
00:03:29,600 --> 00:03:27,350
a little bit though and it's interesting

90
00:03:30,940 --> 00:03:29,610
the audience know they can get a hold of

91
00:03:34,220 --> 00:03:30,950
us too so if they have any questions

92
00:03:36,500 --> 00:03:34,230
thank his garments that you guys comment

93
00:03:38,540 --> 00:03:36,510
and ask us questions on the G+ event

94
00:03:40,070 --> 00:03:38,550
page the YouTube page that we're

95
00:03:42,260 --> 00:03:40,080
broadcasting on as well as you could

96
00:03:44,120 --> 00:03:42,270
tweet to us using the hashtag Hubble

97
00:03:46,880 --> 00:03:44,130
hangouts thanks god I almost forgot why

98
00:03:49,610 --> 00:03:46,890
did for you I mean my ESP is tuned but

99
00:03:52,520 --> 00:03:49,620
not for the entire internet that's right

100
00:03:53,900 --> 00:03:52,530
so feel free dad to send us comments and

101
00:03:55,490 --> 00:03:53,910
questions we're monitoring all kinds of

102
00:03:56,720 --> 00:03:55,500
different activities here and we will

103
00:03:58,040 --> 00:03:56,730
hopefully have some time later in the

104
00:04:01,820 --> 00:03:58,050
Hangout and we'll get to those questions

105
00:04:03,890 --> 00:04:01,830
so Amy um the Great Red Spot on Jupiter

106
00:04:06,650 --> 00:04:03,900
give us a little background on just what

107
00:04:08,210 --> 00:04:06,660
give us the really basic background on

108
00:04:09,500 --> 00:04:08,220
what that is for those of us who you

109
00:04:10,910 --> 00:04:09,510
know maybe not know they don't know very

110
00:04:12,140 --> 00:04:10,920
much about Jupiter or they don't even

111
00:04:14,930 --> 00:04:12,150
know what we're talking about what is

112
00:04:17,720 --> 00:04:14,940
this thing so the Great Red Spot is kind

113
00:04:20,300 --> 00:04:17,730

of Jupiter's trademark feature it's a

114
00:04:22,130 --> 00:04:20,310
big storm in the atmosphere it's pretty

115
00:04:23,900 --> 00:04:22,140
much been there since we since we've

116
00:04:27,290 --> 00:04:23,910
ever looked with modern telescopes and

117
00:04:29,420 --> 00:04:27,300
it's kind of like a hurricane but it's

118
00:04:31,010 --> 00:04:29,430
in the opposite direction so instead of

119
00:04:34,939 --> 00:04:31,020
being a low pressure storm it's a high

120
00:04:36,890 --> 00:04:34,949
pressure so it's a very strong high

121
00:04:41,689 --> 00:04:36,900
velocity windstorm that's been around

122
00:04:44,930 --> 00:04:41,699
for at least 150 years and do we know so

123
00:04:47,320 --> 00:04:44,940
do we know what is driving the storm or

124
00:04:50,300 --> 00:04:47,330
is there any indication what might be

125
00:04:52,249 --> 00:04:50,310
keeping it going for so long actually we

126
00:04:53,540 --> 00:04:52,259
don't know storms cyclones and

127
00:04:56,059 --> 00:04:53,550
anticyclones on earth don't last

128
00:04:57,980 --> 00:04:56,069
anywhere near this long high pressure

129
00:04:59,659 --> 00:04:57,990
systems are more stable in low pressure

130
00:05:01,580 --> 00:04:59,669
systems and on earth of course

131
00:05:03,860 --> 00:05:01,590
hurricanes break up when they hit land

132
00:05:05,960 --> 00:05:03,870
often and we don't have land on Jupiter

133
00:05:07,490 --> 00:05:05,970
but nonetheless we have no reason why

134
00:05:08,719 --> 00:05:07,500
this storm should have lasted as long as

135
00:05:10,640 --> 00:05:08,729
it did so that's one of the big

136
00:05:13,460 --> 00:05:10,650
mysteries is what powers this torment

137
00:05:15,529 --> 00:05:13,470
keeps it around for so long you say at

138
00:05:17,930 --> 00:05:15,539

least 150 years do it is there any

139
00:05:19,670 --> 00:05:17,940
indication that you know something what

140
00:05:22,279 --> 00:05:19,680
was the first observations we ever had

141
00:05:24,050 --> 00:05:22,289
of the Great Red Spot so that's where it

142
00:05:27,230 --> 00:05:24,060
gets a little tricky we have definitive

143
00:05:29,270 --> 00:05:27,240
observations back to about 1870 it was

144
00:05:30,950 --> 00:05:29,280
well tracked from there forward so we we

145
00:05:33,379 --> 00:05:30,960
know exactly where it is and how big

146
00:05:35,450 --> 00:05:33,389
it's been since about 1870 but there are

147
00:05:37,339 --> 00:05:35,460
some very very early papers by Galileo

148
00:05:39,080 --> 00:05:37,349
and Cassini in the 1600s where they

149
00:05:41,029 --> 00:05:39,090
talked about a permanent spot but it

150
00:05:43,040 --> 00:05:41,039
kind of got mentioned once and never

151
00:05:46,879 --> 00:05:43,050
again so we don't know in between if

152
00:05:48,740 --> 00:05:46,889
it's the same storm yeah I guess I guess

153
00:05:50,209 --> 00:05:48,750
I always wonder if Galileo could really

154
00:05:51,769 --> 00:05:50,219
differentiate between what he was

155
00:05:54,019 --> 00:05:51,779
looking at with the features on the disk

156
00:05:56,480 --> 00:05:54,029
versus maybe the moons around around the

157
00:05:58,909 --> 00:05:56,490
planet - so I don't know there might

158
00:06:04,760 --> 00:05:58,919
have been a little confusion around that

159
00:06:07,339 --> 00:06:04,770
as well so yeah exactly so - Don Rogers

160
00:06:09,469 --> 00:06:07,349
and the in his book trying to join us

161
00:06:11,360 --> 00:06:09,479
who mentions that at some point that not

162
00:06:13,580 --> 00:06:11,370
very long after that there's a painting

163
00:06:15,680 --> 00:06:13,590

of Jupiter hanging in the Vatican museum

164
00:06:17,959 --> 00:06:15,690
with of all things looking like debris a

165
00:06:20,719 --> 00:06:17,969
great spot sitting in it so sort of

166
00:06:23,689 --> 00:06:20,729
undocumented evidence or someone's

167
00:06:25,309 --> 00:06:23,699
imagination of what should be there and

168
00:06:27,050 --> 00:06:25,319
what was this from I didn't hear the

169
00:06:31,790 --> 00:06:27,060
first part of what you said oh this is

170
00:06:35,540 --> 00:06:31,800
this is from John Rogers book follow-on

171
00:06:36,950 --> 00:06:35,550
to a study about the morphology of

172
00:06:39,260 --> 00:06:36,960
clouds and their history in the

173
00:06:41,060 --> 00:06:39,270
atmosphere of Jupiter Jupiter the giant

174
00:06:48,440 --> 00:06:41,070
planet

175
00:06:51,230 --> 00:06:48,450
University Press John Regina so yeah

176
00:06:53,510 --> 00:06:51,240
that's right get him in the hangout and

177
00:06:56,540 --> 00:06:53,520
we he didn't have a computer with with a

178
00:06:58,280 --> 00:06:56,550
laptop and I'm like anyway but this is

179
00:07:00,080 --> 00:06:58,290
standing in termination either there's

180
00:07:02,840 --> 00:07:00,090
some evidence and maybe something like

181
00:07:06,310 --> 00:07:02,850
that in that region but it's before 2015

182
00:07:09,680 --> 00:07:06,320
there's not very much conclusive okay so

183
00:07:12,320 --> 00:07:09,690
Amy you say we've we've this thing has

184
00:07:16,160 --> 00:07:12,330
been shrinking we know it's that this

185
00:07:17,420 --> 00:07:16,170
feature has been getting smaller but we

186
00:07:19,340 --> 00:07:17,430
and we've known this for quite some time

187
00:07:20,510 --> 00:07:19,350
right I mean this is not new news this

188
00:07:22,850 --> 00:07:20,520

is something we've known for a while how

189
00:07:25,070 --> 00:07:22,860
long has this been how long have we

190
00:07:27,740 --> 00:07:25,080
known that it's been getting smaller at

191
00:07:30,380 --> 00:07:27,750
least since the 1950s there was another

192
00:07:32,360 --> 00:07:30,390
book by an astronomer named peak in 1958

193
00:07:34,340 --> 00:07:32,370
and he documented it in his book that he

194
00:07:36,530 --> 00:07:34,350
thought it was shrinking but there was

195
00:07:38,690 --> 00:07:36,540
not a lot of high-quality observations a

196
00:07:40,460 --> 00:07:38,700
lot of this was based on transit timings

197
00:07:42,170 --> 00:07:40,470
where people literally watched the time

198
00:07:44,030 --> 00:07:42,180
when the Great Red Spot hit the center

199
00:07:46,880 --> 00:07:44,040
of the planet and when when it crossed

200
00:07:49,400 --> 00:07:46,890
over so they use that to estimate how

201
00:07:51,920 --> 00:07:49,410
big it is oh the observations don't have

202
00:07:54,050 --> 00:07:51,930
a lot of fidelity but they're actually

203
00:07:55,700 --> 00:07:54,060
quite good and so from that time forward

204
00:07:57,770 --> 00:07:55,710
we pretty much had some indication that

205
00:07:59,240 --> 00:07:57,780
it was shrinking and the rate seemed

206
00:08:03,740 --> 00:07:59,250
somewhat constant it varied a little bit

207
00:08:07,280 --> 00:08:03,750
now and again so it is getting it is

208
00:08:09,770 --> 00:08:07,290
getting smaller at a at a known rate

209
00:08:12,020 --> 00:08:09,780
then pretty much constant rate you're

210
00:08:13,820 --> 00:08:12,030
saying over the long term it's been a

211
00:08:17,150 --> 00:08:13,830
fairly constant rate so there's times

212
00:08:18,380 --> 00:08:17,160
where it gets smaller faster and slows

213
00:08:20,600 --> 00:08:18,390

down a little bit so that it does

214
00:08:22,910 --> 00:08:20,610
fluctuate somewhat absolutely okay

215
00:08:25,490 --> 00:08:22,920
what's the question

216
00:08:27,850 --> 00:08:25,500
yeah go ahead so I wanted ask Amy a

217
00:08:29,870 --> 00:08:27,860
Glenna question so we know that also

218
00:08:34,459 --> 00:08:29,880
both through ground-based observations

219
00:08:36,980 --> 00:08:34,469
and Hubble you all who do this research

220
00:08:39,230 --> 00:08:36,990
have seen other spots though right

221
00:08:41,420 --> 00:08:39,240
smaller spots and could you talk a

222
00:08:44,120 --> 00:08:41,430
little bit about what we know about the

223
00:08:46,520 --> 00:08:44,130
duration of those and how big they are

224
00:08:50,660 --> 00:08:46,530
and what their relationship might be

225
00:08:54,300 --> 00:08:50,670
like where on Jupiter's face they are

226
00:08:56,640 --> 00:08:54,310
and that's okay well Jupiter often

227
00:08:59,040 --> 00:08:56,650
a bad case of measles it has spots all

228
00:09:00,480 --> 00:08:59,050
over the place but primarily we see them

229
00:09:04,200 --> 00:09:00,490
in the southern hemisphere we don't know

230
00:09:05,790 --> 00:09:04,210
why most of them are pretty small in

231
00:09:08,400 --> 00:09:05,800
terms of the other round looking ones

232
00:09:10,410 --> 00:09:08,410
but some of them do last for quite some

233
00:09:13,110 --> 00:09:10,420
time so there were a bunch of them three

234
00:09:16,260 --> 00:09:13,120
of them that formed in 1939 we actually

235
00:09:18,180 --> 00:09:16,270
saw them form they they condensed down

236
00:09:19,890 --> 00:09:18,190
to three white storms they're all

237
00:09:22,590 --> 00:09:19,900
anticyclones just like the Great Red

238
00:09:23,730 --> 00:09:22,600

Spot and when they first formed they

239
00:09:26,130 --> 00:09:23,740
were kind of big they got a little bit

240
00:09:28,380 --> 00:09:26,140
smaller eventually they got close enough

241
00:09:30,269 --> 00:09:28,390
to each other they merged and then in

242
00:09:31,890 --> 00:09:30,279
2006 the one that was left turned red

243
00:09:33,900 --> 00:09:31,900
and that's actually the one we call Red

244
00:09:35,400 --> 00:09:33,910
Spot jr. now so it's smaller it's a

245
00:09:38,790 --> 00:09:35,410
little bit farther to the south but it's

246
00:09:40,440 --> 00:09:38,800
the same type of storm and so far that

247
00:09:44,220 --> 00:09:40,450
one hasn't gone away either but that

248
00:09:47,400 --> 00:09:44,230
one's only about 80 years old as you

249
00:09:48,870 --> 00:09:47,410
mention yeah now you mentioned the color

250
00:09:51,690 --> 00:09:48,880
that's another interesting thing about

251
00:09:53,310 --> 00:09:51,700
the color there is red but then you you

252
00:09:55,829 --> 00:09:53,320
just said there were other storms that

253
00:09:58,829 --> 00:09:55,839
were white so do we know what they began

254
00:10:01,430 --> 00:09:58,839
as white as well yeah wait we don't know

255
00:10:04,260 --> 00:10:01,440
most of most of them tend to be white on

256
00:10:06,270 --> 00:10:04,270
rare occasion we see one that turns red

257
00:10:08,040 --> 00:10:06,280
like that like Red Spot Gina did there's

258
00:10:09,480 --> 00:10:08,050
other small ones that form from time to

259
00:10:11,400 --> 00:10:09,490
time that are red they tend to be deeper

260
00:10:14,520 --> 00:10:11,410
in the atmosphere and they don't last

261
00:10:16,140 --> 00:10:14,530
very long but we don't we don't have a

262
00:10:20,880 --> 00:10:16,150
clue what the mechanism is it turns

263
00:10:23,130 --> 00:10:20,890

these red so Scott let's turn to the

264
00:10:26,640 --> 00:10:23,140
Hubble observations Scott's got the

265
00:10:28,620 --> 00:10:26,650
image up here on his screen now these

266
00:10:31,500 --> 00:10:28,630
are observations of the red spot going

267
00:10:34,890 --> 00:10:31,510
back to three different periods we had

268
00:10:38,370 --> 00:10:34,900
one in 95 with the wif picked to camera

269
00:10:41,640 --> 00:10:38,380
and again in 2009 with wipsy 3 and again

270
00:10:43,620 --> 00:10:41,650
with whip C 3 and 2014 are are these

271
00:10:47,160 --> 00:10:43,630
your observations Amy were you uh were

272
00:10:48,480 --> 00:10:47,170
you making these with the Hubble uh yes

273
00:10:49,890 --> 00:10:48,490
sir all Hubble I was actually involved

274
00:10:51,900 --> 00:10:49,900
in all three programs they were all done

275
00:10:53,730 --> 00:10:51,910
for different reasons but they nicely

276
00:10:57,990 --> 00:10:53,740
show how it's gotten quite a bit smaller

277
00:10:59,610 --> 00:10:58,000
since 1995 it really has I mean you can

278
00:11:01,079 --> 00:10:59,620
see this really does a nice and Scott

279
00:11:03,690 --> 00:11:01,089
also made an animated gif earlier

280
00:11:07,650 --> 00:11:03,700
yesterday that that kind of shows the

281
00:11:08,070 --> 00:11:07,660
morphology of it as well oh there it is

282
00:11:10,410 --> 00:11:08,080
okay

283
00:11:11,850 --> 00:11:10,420
well so you can see you can sort of see

284
00:11:13,410 --> 00:11:11,860
in this animation that it's you know

285
00:11:16,100 --> 00:11:13,420
getting getting a little bit smaller

286
00:11:18,090 --> 00:11:16,110
each time with each with each epic

287
00:11:21,120 --> 00:11:18,100
animation but I'll pull up here in a

288
00:11:29,360 --> 00:11:21,130

second this is this is still here from

289
00:11:36,060 --> 00:11:29,370
95 wow that's a pop and then here is 9

290
00:11:37,949 --> 00:11:36,070
and 14 so we can see it up up the the

291
00:11:43,460 --> 00:11:37,959
animation here in a second but frame by

292
00:11:47,269 --> 00:11:43,470
frame when this is the most recent one

293
00:11:50,730 --> 00:11:47,279
that's the previous one five years ago

294
00:11:53,310 --> 00:11:50,740
so we can see a big difference there in

295
00:11:55,050 --> 00:11:53,320
the penis size yeah stop right there for

296
00:11:56,490 --> 00:11:55,060
a second what is that thing on the upper

297
00:11:58,500 --> 00:11:56,500
right there upper left there what is

298
00:12:00,509 --> 00:11:58,510
that red spot there is that red that red

299
00:12:03,480 --> 00:12:00,519
Junior what is that no that's that's not

300
00:12:05,400 --> 00:12:03,490
red Junior that's probably a cyclonic

301
00:12:06,960 --> 00:12:05,410
feature again like I said we get these

302
00:12:08,699 --> 00:12:06,970
other little spots that form from time

303
00:12:11,639 --> 00:12:08,709
to time and they either get pulled apart

304
00:12:12,870 --> 00:12:11,649
or disappear on their own okay it's just

305
00:12:14,670 --> 00:12:12,880
another thing that's in the flow field

306
00:12:15,960 --> 00:12:14,680
near the Great Red Spot right if you

307
00:12:17,670 --> 00:12:15,970
tend to think of those as somewhat

308
00:12:20,730 --> 00:12:17,680
deeper in the atmosphere so the dark

309
00:12:24,000 --> 00:12:20,740
stuff you see there is our represents a

310
00:12:25,590 --> 00:12:24,010
clearing the clouds it's kind of the

311
00:12:26,550 --> 00:12:25,600
opposite of the red spot nice and so you

312
00:12:28,079 --> 00:12:26,560
have to be really careful not

313
00:12:30,210 --> 00:12:28,089

differentiating between the visible

314
00:12:33,600 --> 00:12:30,220
color and the real tomography of the

315
00:12:35,910 --> 00:12:33,610
pollen system so here's red jr. I went

316
00:12:37,889 --> 00:12:35,920
and got a high-res image of it so here's

317
00:12:40,530 --> 00:12:37,899
red jr. you can actually see the great

318
00:12:42,990 --> 00:12:40,540
red spot over here yeah and then here's

319
00:12:44,310 --> 00:12:43,000
red jr. that we're looking at right and

320
00:12:48,560 --> 00:12:44,320
so those are observations we took

321
00:12:50,970 --> 00:12:48,570
shortly after it turned red and to get a

322
00:12:53,100 --> 00:12:50,980
perspective of what we're looking at

323
00:12:58,139 --> 00:12:53,110
here's G burning again in the southern

324
00:13:03,090 --> 00:12:58,149
hemisphere so there's a great red spot

325
00:13:05,040 --> 00:13:03,100
and there's red spy jr. so I remember

326
00:13:08,120 --> 00:13:05,050
what when I was first starting out in my

327
00:13:09,990 --> 00:13:08,130
career I was voyager had just passed

328
00:13:12,870 --> 00:13:10,000
Jupiter and we got to see these

329
00:13:14,290 --> 00:13:12,880
time-lapse movies of the Jovian

330
00:13:16,030 --> 00:13:14,300
atmosphere and

331
00:13:17,710 --> 00:13:16,040
you know we got to see the band's kind

332
00:13:19,450 --> 00:13:17,720
of going along back you know sort of

333
00:13:21,310 --> 00:13:19,460
counter-rotating or going different

334
00:13:23,530 --> 00:13:21,320
directions and things like that what are

335
00:13:26,320 --> 00:13:23,540
the bands like what are what are those

336
00:13:27,880 --> 00:13:26,330
signify on Jupiter well you're exactly

337
00:13:29,680 --> 00:13:27,890
right the winds are very strongly

338
00:13:31,450 --> 00:13:29,690

east-west on Jupiter they don't change

339
00:13:33,550 --> 00:13:31,460
very much so if you're at any particular

340
00:13:37,150 --> 00:13:33,560
location year to year the wind speed

341
00:13:39,100 --> 00:13:37,160
doesn't vary very much at all so we

342
00:13:40,450 --> 00:13:39,110
think if we understand what's going on

343
00:13:42,670 --> 00:13:40,460
very well they're almost like Hadley

344
00:13:44,620 --> 00:13:42,680
cells on earth so when the wind shear is

345
00:13:46,510 --> 00:13:44,630
in one direction you actually get uplift

346
00:13:48,070 --> 00:13:46,520
and you should get more white clouds and

347
00:13:49,510 --> 00:13:48,080
when it's going the other direction you

348
00:13:50,740 --> 00:13:49,520
should get the clouds subsiding and

349
00:13:52,750 --> 00:13:50,750
clearing out and that's where you see

350
00:13:53,980 --> 00:13:52,760
the darker color now we also see a

351
00:13:55,660 --> 00:13:53,990
little thunderstorms and other things

352
00:13:56,890 --> 00:13:55,670
that pop up in those darker regions it's

353
00:13:58,420 --> 00:13:56,900
hard to see them in the white regions

354
00:14:00,490 --> 00:13:58,430
because that cloud is so high and thick

355
00:14:02,200 --> 00:14:00,500
so that's what we think we're seeing is

356
00:14:06,100 --> 00:14:02,210
basically the equivalent of Jupiter's

357
00:14:08,860 --> 00:14:06,110
Hadley cells what's that but what are

358
00:14:10,930 --> 00:14:08,870
what are those so on the earth the

359
00:14:12,820 --> 00:14:10,940
Hadley cells are basically how you drive

360
00:14:16,630 --> 00:14:12,830
the circulation from the equator to the

361
00:14:18,160 --> 00:14:16,640
poles and it creates by going north and

362
00:14:20,350 --> 00:14:18,170
south because we have a Coriolis force

363
00:14:22,750 --> 00:14:20,360

you also get East and West out of it at

364
00:14:24,820 --> 00:14:22,760
the same time so you end up getting the

365
00:14:26,560 --> 00:14:24,830
strong east easterly and westerly wind

366
00:14:30,910 --> 00:14:26,570
Jets on the earth from some of this

367
00:14:34,120 --> 00:14:30,920
circulation so these are really strong

368
00:14:35,680 --> 00:14:34,130
winds in different bands though right I

369
00:14:37,090 --> 00:14:35,690
mean some of the bands in Jupiter are

370
00:14:41,110 --> 00:14:37,100
going in different directions too I mean

371
00:14:42,490 --> 00:14:41,120
that's like the light the dark bands are

372
00:14:43,810 --> 00:14:42,500
both going and if those are really

373
00:14:46,150 --> 00:14:43,820
strong so you're saying that each one of

374
00:14:48,370 --> 00:14:46,160
those is one of those kinds of cells

375
00:14:50,770 --> 00:14:48,380
yeah though the winds are on the very

376
00:14:52,660 --> 00:14:50,780
edges of the bands and that cell kind of

377
00:14:54,490 --> 00:14:52,670
defines the distance between the two

378
00:14:55,660 --> 00:14:54,500
wind jets so you have an east wind jet

379
00:14:57,700 --> 00:14:55,670
and then a west wind jet and they

380
00:14:59,020 --> 00:14:57,710
alternate all the way to the poles Scott

381
00:15:00,400 --> 00:14:59,030
could you put another picture up just

382
00:15:01,960 --> 00:15:00,410
what it doesn't matter which one I'm

383
00:15:03,550 --> 00:15:01,970
gonna want to use it as a reference here

384
00:15:06,760 --> 00:15:03,560
for some of the bands on here because I

385
00:15:09,250 --> 00:15:06,770
wanna oh yeah the other thing that I

386
00:15:11,320 --> 00:15:09,260
think is remarkable is in the different

387
00:15:13,090 --> 00:15:11,330
images that you are showing and I'm sure

388
00:15:16,450 --> 00:15:13,100

every time you observe it the different

389
00:15:18,460 --> 00:15:16,460
kinds of turbulence in the bands and

390
00:15:21,220 --> 00:15:18,470
around the spot I mean sometimes there's

391
00:15:22,540 --> 00:15:21,230
really strong whirls around it and other

392
00:15:25,630 --> 00:15:22,550
times it kind of looks like there are

393
00:15:28,000 --> 00:15:25,640
waves around it and yet it persists it's

394
00:15:29,770 --> 00:15:28,010
pretty remarkable it's kind of true

395
00:15:33,130 --> 00:15:29,780
the planet I mean Jupiter's atmosphere

396
00:15:37,720 --> 00:15:33,140
is a fluid dynamicists dream extreme

397
00:15:45,400 --> 00:15:37,730
flow you've got turbulence you dynamic

398
00:15:49,300 --> 00:15:45,410
is so simple what it is it's global

399
00:15:52,720 --> 00:15:49,310
warming not really an answer but it's

400
00:15:56,410 --> 00:15:52,730
such a complex system of dynamics it's

401
00:15:58,930 --> 00:15:56,420
not an easy thing at all and seeing just

402
00:16:01,480 --> 00:15:58,940
how completely massive and how much

403
00:16:04,360 --> 00:16:01,490
larger in and in radius

404
00:16:05,590 --> 00:16:04,370
Jupiter is plus everything else going on

405
00:16:08,170 --> 00:16:05,600
its chemical composition is different

406
00:16:11,200 --> 00:16:08,180
the pressures and all the other things

407
00:16:14,380 --> 00:16:11,210
going on it's just beautiful and yeah I

408
00:16:16,830 --> 00:16:14,390
could totally see just if I was really

409
00:16:20,260 --> 00:16:16,840
into fluid dynamics which I'm not

410
00:16:22,390 --> 00:16:20,270
because that's really difficult but if I

411
00:16:25,030 --> 00:16:22,400
was this would just be a dream just to

412
00:16:26,440 --> 00:16:25,040
study this for the rest of my life it's

413
00:16:28,030 --> 00:16:26,450

interesting to note that region just

414
00:16:31,870 --> 00:16:28,040
northwest of the red spot that looked

415
00:16:33,610 --> 00:16:31,880
like stripes of things is a place where

416
00:16:36,250 --> 00:16:33,620
the DOS achievements are heading toward

417
00:16:39,700 --> 00:16:36,260
the red spot and getting mixed up in an

418
00:16:42,180 --> 00:16:39,710
extremely turbulent area note on those

419
00:16:44,830 --> 00:16:42,190
videos and see me videos that that's

420
00:16:46,630 --> 00:16:44,840
sending roiling and that's one of the

421
00:16:48,640 --> 00:16:46,640
places where I spectroscopically we see

422
00:16:50,170 --> 00:16:48,650
pristine ice which we don't see on

423
00:16:53,020 --> 00:16:50,180
anywhere else in the planet so let's go

424
00:16:55,720 --> 00:16:53,030
whose meaning moved up very fast so

425
00:16:57,460 --> 00:16:55,730
those are the seats of very strong

426
00:16:58,780 --> 00:16:57,470
vertical winds as well which we don't

427
00:17:02,530 --> 00:16:58,790
really otherwise have a good way of

428
00:17:03,610 --> 00:17:02,540
tracking so let's talk what so what are

429
00:17:05,320 --> 00:17:03,620
we talking about here what are some of

430
00:17:07,600 --> 00:17:05,330
the characteristics of this red spot in

431
00:17:09,640 --> 00:17:07,610
terms of what exactly is going on there

432
00:17:11,620 --> 00:17:09,650
I mean are we looking at you know what

433
00:17:13,810 --> 00:17:11,630
what kind of you know well first of all

434
00:17:17,590 --> 00:17:13,820
how high up is this in the atmosphere of

435
00:17:19,390 --> 00:17:17,600
Jupiter so the great red spot itself the

436
00:17:21,040 --> 00:17:19,400
the clouds all are at different heights

437
00:17:22,870 --> 00:17:21,050
so that's one thing you have to kind of

438
00:17:25,060 --> 00:17:22,880

get into your head is that we think

439
00:17:27,460 --> 00:17:25,070
there's water clouds deep down we think

440
00:17:29,050 --> 00:17:27,470
there's ammonia Isis should be the white

441
00:17:30,900 --> 00:17:29,060
clouds we see high up although I Scott

442
00:17:33,940 --> 00:17:30,910
as Glen says we don't see them

443
00:17:36,040 --> 00:17:33,950
spectroscopically very often but we

444
00:17:38,260 --> 00:17:36,050
think the clouds kind of vary from about

445
00:17:39,790 --> 00:17:38,270
one bar of pressure which is about the

446
00:17:40,660 --> 00:17:39,800
same as the pressure in the room you're

447
00:17:41,380 --> 00:17:40,670
sitting in now

448
00:17:43,150 --> 00:17:41,390
although

449
00:17:45,820 --> 00:17:43,160
to the stratosphere the Great Red Spot

450
00:17:47,950 --> 00:17:45,830
actually goes up all the way to the top

451
00:17:49,870 --> 00:17:47,960
of the troposphere so similar on the

452
00:17:52,300 --> 00:17:49,880
earth the clouds kind of stop between

453
00:17:53,770 --> 00:17:52,310
the troposphere and the stratosphere the

454
00:17:56,200 --> 00:17:53,780
highest ones on Jupiter hit about the

455
00:17:59,050 --> 00:17:56,210
same heights but so we're talking you

456
00:18:02,530 --> 00:17:59,060
know the equivalent of maybe 15 miles

457
00:18:05,710 --> 00:18:02,540
though above wow that's pretty that's

458
00:18:07,390 --> 00:18:05,720
amazing so the and and you know the wind

459
00:18:10,540 --> 00:18:07,400
speeds here I mean how do we how do we

460
00:18:12,160 --> 00:18:10,550
first of all I guess I'd like to know

461
00:18:13,810 --> 00:18:12,170
how we measure these things I mean we've

462
00:18:15,610 --> 00:18:13,820
got we look at things with Hubble and

463
00:18:17,110 --> 00:18:15,620

you see the images and you can take time

464
00:18:19,690 --> 00:18:17,120
lapse as you can get movies and stuff

465
00:18:21,400 --> 00:18:19,700
how do we know things like what what the

466
00:18:24,280 --> 00:18:21,410
things made of what you know what you

467
00:18:25,960 --> 00:18:24,290
know where how high up it is what wind

468
00:18:27,370 --> 00:18:25,970
and things like that and things like

469
00:18:29,800 --> 00:18:27,380
wind speeds what are the best ways of

470
00:18:31,420 --> 00:18:29,810
measuring these characteristics well I

471
00:18:33,340 --> 00:18:31,430
think way back when before we had really

472
00:18:35,560 --> 00:18:33,350
good observational data a lot of it was

473
00:18:37,930 --> 00:18:35,570
for models so we looked at what the

474
00:18:39,880 --> 00:18:37,940
temperature profile Jupiter should be

475
00:18:41,740 --> 00:18:39,890
and said well these various compounds

476
00:18:43,330 --> 00:18:41,750
should condense out and make laps so you

477
00:18:45,130 --> 00:18:43,340
should get water clouds at a certain

478
00:18:47,290 --> 00:18:45,140
pressure ammonia clouds at a different

479
00:18:49,870 --> 00:18:47,300
pressure now that we have much better

480
00:18:51,610 --> 00:18:49,880
imaging and spectroscopy we can test

481
00:18:54,610 --> 00:18:51,620
those theories and that's been one of

482
00:18:56,200 --> 00:18:54,620
our frustrations is just what we said

483
00:18:58,660 --> 00:18:56,210
before we should see ammonia ice all

484
00:19:00,070 --> 00:18:58,670
over the planet and we don't we should

485
00:19:01,510 --> 00:19:00,080
see other compounds all over the planet

486
00:19:03,310 --> 00:19:01,520
we know they're there but they're hard

487
00:19:06,190 --> 00:19:03,320
to see spectroscopically and some of it

488
00:19:07,450 --> 00:19:06,200

is that Jupiter has haze over everything

489
00:19:09,400 --> 00:19:07,460
and that kind of makes it hard to see

490
00:19:11,110 --> 00:19:09,410
certain things but in terms of winds

491
00:19:12,880 --> 00:19:11,120
winds are things we can do really well

492
00:19:14,680 --> 00:19:12,890
with things like Hubble because we can

493
00:19:16,750 --> 00:19:14,690
take time-lapse images and do exactly

494
00:19:20,490 --> 00:19:16,760
that we look at the same spot and watch

495
00:19:24,250 --> 00:19:20,500
the clouds move we can measure them did

496
00:19:25,450 --> 00:19:24,260
did any of you guys what were you guys

497
00:19:28,510 --> 00:19:25,460
I'm sure you guys were paying attention

498
00:19:30,940 --> 00:19:28,520
when the comet hale-bopp went into to

499
00:19:36,190 --> 00:19:30,950
Jupiter right should maker leave me now

500
00:19:37,990 --> 00:19:36,200
in levy nine you guys were watching that

501
00:19:39,750 --> 00:19:38,000
pretty intently to where you were there

502
00:19:44,050 --> 00:19:39,760
any surprises there did you guys

503
00:19:45,700 --> 00:19:44,060
everything was a surprise I mean as far

504
00:19:49,430 --> 00:19:45,710
as what you expect it might happen is

505
00:19:58,730 --> 00:19:52,669
and repeat when I hear surprise it to me

506
00:20:00,529 --> 00:19:58,740
like we expected anything from massive

507
00:20:03,529 --> 00:20:00,539
changes like the ones we actually saw to

508
00:20:06,350 --> 00:20:03,539
absolutely nothing and in fact the

509
00:20:07,850 --> 00:20:06,360
answer is all of the above all of the

510
00:20:10,279 --> 00:20:07,860
parts of the comet that were off the

511
00:20:13,100 --> 00:20:10,289
main line had nothing I mean no mass

512
00:20:14,779 --> 00:20:13,110
associated into the rest made them read

513
00:20:17,060 --> 00:20:14,789

new substantial changes both in the

514
00:20:19,009 --> 00:20:17,070
visual appearance that we saw with

515
00:20:23,240 --> 00:20:19,019
Hubble at the time then infrared and

516
00:20:25,580 --> 00:20:23,250
quite far enough yet in fact so this

517
00:20:27,350 --> 00:20:25,590
yeah I remember one night did you see a

518
00:20:29,840 --> 00:20:27,360
Scott did you see when it where'd you go

519
00:20:30,850 --> 00:20:29,850
are you there I'm here where you can't

520
00:20:34,220 --> 00:20:30,860
get me that easy

521
00:20:39,980 --> 00:20:34,230
looking for some time lapse images of

522
00:20:41,960 --> 00:20:39,990
that collision there yeah so I mean

523
00:20:43,730 --> 00:20:41,970
let's talk so that break the reason I

524
00:20:45,289 --> 00:20:43,740
bring that up is I wanna I wanted to

525
00:20:46,730 --> 00:20:45,299
talk a little bit about Jupiter's role

526
00:20:50,119 --> 00:20:46,740
in the solar system and one of the

527
00:20:52,460 --> 00:20:50,129
things I always hear about Jupiter or

528
00:20:56,720 --> 00:20:52,470
Jovi and I always want to say jovial

529
00:20:59,749 --> 00:20:56,730
planets I'm Jovian - is that they are

530
00:21:00,889 --> 00:20:59,759
actually a pretty important jupiter

531
00:21:02,629 --> 00:21:00,899
plays a pretty important role in our

532
00:21:04,399 --> 00:21:02,639
solar system recent has in the past in

533
00:21:06,049 --> 00:21:04,409
terms of clearing out these comets and

534
00:21:13,310 --> 00:21:06,059
kind of protecting earth a little bit is

535
00:21:15,680 --> 00:21:13,320
that right Glenn I think yes it's in

536
00:21:17,139 --> 00:21:15,690
part because of Jupiter's position one

537
00:21:21,529 --> 00:21:17,149
mass in the solar system

538
00:21:23,869 --> 00:21:21,539

yeah so you are interested in exoplanets

539
00:21:26,299 --> 00:21:23,879
and other in jupiter-sized planets

540
00:21:28,639 --> 00:21:26,309
around other stars systems

541
00:21:29,869 --> 00:21:28,649
how does Jupiter compare what's Jupiter

542
00:21:34,340 --> 00:21:29,879
like compared to the most of the other

543
00:21:38,060 --> 00:21:34,350
Joe Moses systems we know they're sort

544
00:21:40,220 --> 00:21:38,070
of a start with with a qualification

545
00:21:42,350 --> 00:21:40,230
that I can only talk about the things we

546
00:21:44,119 --> 00:21:42,360
happen to be able to see so there's an

547
00:21:45,919 --> 00:21:44,129
election effects starting effect there

548
00:21:47,990 --> 00:21:45,929
we don't see the really tiny things I

549
00:21:50,509 --> 00:21:48,000
mean we never see at this point not

550
00:21:52,009 --> 00:21:50,519
technology mercury around the Sun and so

551
00:21:54,080 --> 00:21:52,019
we're talking about figure things you're

552
00:21:55,970 --> 00:21:54,090
sort of moving down the things that the

553
00:22:00,859 --> 00:21:55,980
size of the earth slowly if you look

554
00:22:03,320 --> 00:22:00,869
kepler the Kepler mission but as it

555
00:22:05,720 --> 00:22:03,330
stands now the statistics paper

556
00:22:10,190 --> 00:22:05,730
most of the planets that we know in the

557
00:22:12,680 --> 00:22:10,200
known space are neptune size and jupiter

558
00:22:14,210 --> 00:22:12,690
is kind of an anomaly and our solar

559
00:22:17,630 --> 00:22:14,220
system in the race made up is kind of

560
00:22:19,610 --> 00:22:17,640
anomalous to many of these large sized

561
00:22:21,920 --> 00:22:19,620
planets are quite close into the Sun

562
00:22:24,620 --> 00:22:21,930
where favorite on Mars are even closer

563
00:22:26,210 --> 00:22:24,630

compared to our Sun but again I worry

564
00:22:29,900 --> 00:22:26,220
that that's a bit of a selection effect

565
00:22:32,570 --> 00:22:29,910
because the things we see most easy so

566
00:22:34,400 --> 00:22:32,580
what kind of the Jupiter's Jupiter's big

567
00:22:36,410 --> 00:22:34,410
being heard upon gorillas in our solar

568
00:22:39,170 --> 00:22:36,420
system then maybe many many others as

569
00:22:41,690 --> 00:22:39,180
well yeah I remember that I remember

570
00:22:44,090 --> 00:22:41,700
hearing that when when I wanted to

571
00:22:46,700 --> 00:22:44,100
Kepler news releases it was advertised

572
00:22:48,500 --> 00:22:46,710
that they you know that they were a

573
00:22:51,590 --> 00:22:48,510
little bit surprised at how many Neptune

574
00:22:53,750 --> 00:22:51,600
sized planets there were out there that

575
00:22:56,030 --> 00:22:53,760
you know as and did say that they were

576
00:22:59,090 --> 00:22:56,040
very close to their star like this so

577
00:23:01,790 --> 00:22:59,100
the okay so let's get back to the red

578
00:23:03,530 --> 00:23:01,800
spot for just a little bit it's

579
00:23:05,810 --> 00:23:03,540
shrinking we've known it's been

580
00:23:07,790 --> 00:23:05,820
shrinking for a while is it going to

581
00:23:09,380 --> 00:23:07,800
disappear do we have a rate at which it

582
00:23:11,270 --> 00:23:09,390
will no longer be there what's going to

583
00:23:14,300 --> 00:23:11,280
happen to anybody any any guesses any

584
00:23:18,650 --> 00:23:14,310
projections well we had looked at this

585
00:23:20,510 --> 00:23:18,660
actually earlier in I had a paper in

586
00:23:22,520 --> 00:23:20,520
2002 where we were looking at spacecraft

587
00:23:24,740 --> 00:23:22,530
data in particular a Voyager Galileo

588
00:23:26,630 --> 00:23:24,750

Hubble looking at the rate of shrinkage

589
00:23:30,200 --> 00:23:26,640
and at that point we were estimating it

590
00:23:32,240 --> 00:23:30,210
be round by about 2030 at the current

591
00:23:34,070 --> 00:23:32,250
rate it's sped up so if it state if it

592
00:23:36,830 --> 00:23:34,080
sustains this rate of shrinkage it'll be

593
00:23:38,570 --> 00:23:36,840
round even faster in terms of what does

594
00:23:39,620 --> 00:23:38,580
that mean is it going to go away well

595
00:23:41,030 --> 00:23:39,630
part of the problem is we don't

596
00:23:43,220 --> 00:23:41,040
understand what's sustaining it in the

597
00:23:44,750 --> 00:23:43,230
first place so one of the things we hope

598
00:23:46,130 --> 00:23:44,760
to do with those data is actually look

599
00:23:47,990 --> 00:23:46,140
at not just a great red spot but

600
00:23:50,240 --> 00:23:48,000
everything around it and see what else

601
00:23:51,680 --> 00:23:50,250
is changing so that we can determine if

602
00:23:53,480 --> 00:23:51,690
there's anything that feeds the great

603
00:23:55,670 --> 00:23:53,490
red spot that is slightly turned off now

604
00:23:57,500 --> 00:23:55,680
or if there's some other thing that

605
00:23:59,000 --> 00:23:57,510
counters it and so that's kind of the

606
00:24:02,990 --> 00:23:59,010
stuff we want to use this data in

607
00:24:04,340 --> 00:24:03,000
particular to look for so you brought up

608
00:24:05,690 --> 00:24:04,350
you know that's an interesting point we

609
00:24:07,220 --> 00:24:05,700
don't really know what's driving it so

610
00:24:07,910 --> 00:24:07,230
it's hard to say how long am I sustained

611
00:24:10,880 --> 00:24:07,920
itself

612
00:24:12,890 --> 00:24:10,890
now we've we just sent probes into

613
00:24:14,510 --> 00:24:12,900

Jupiter we were a probe I should say I

614
00:24:15,919 --> 00:24:14,520
was hoping Mike would be here by now we

615
00:24:18,379 --> 00:24:15,929
could talk a little bit more about

616
00:24:19,549 --> 00:24:18,389
but maybe maybe maybe you guys can leave

617
00:24:22,129 --> 00:24:19,559
me Glenn you can comment on this a

618
00:24:24,950 --> 00:24:22,139
little bit to the Jupiter probe back

619
00:24:27,320 --> 00:24:24,960
that was a part of the Galileo mission

620
00:24:30,320 --> 00:24:27,330
I was sent in to measure the atmospheres

621
00:24:33,440 --> 00:24:30,330
the map the atmosphere of Jupiter did it

622
00:24:35,299 --> 00:24:33,450
shed any light on this problem not

623
00:24:37,669 --> 00:24:35,309
particularly the probe itself went into

624
00:24:40,279 --> 00:24:37,679
a part of the planet that we wish her a

625
00:24:43,700 --> 00:24:40,289
little more commonplace that went into

626
00:24:45,440 --> 00:24:43,710
an extremely strange area which has the

627
00:24:48,649 --> 00:24:45,450
least cloudy parts of the planet

628
00:24:51,279 --> 00:24:48,659
completely cloudless and dry the

629
00:24:55,820 --> 00:24:51,289
gathering probe which went in December 7

630
00:24:58,489 --> 00:24:55,830
1995 this looked at one point and we

631
00:24:59,869 --> 00:24:58,499
realized supporting ground-based work at

632
00:25:04,039 --> 00:24:59,879
the claim that showed that it was coming

633
00:25:09,049 --> 00:25:04,049
into a region and that was quite strange

634
00:25:11,419 --> 00:25:09,059
so we really are careful to take not to

635
00:25:14,930 --> 00:25:11,429
extrapolate some of those data to the

636
00:25:17,330 --> 00:25:14,940
whole planet in general and the fact

637
00:25:19,129 --> 00:25:17,340
because of the lack of water and in part

638
00:25:22,129 --> 00:25:19,139

lack the clouds that we see in there we

639
00:25:24,580 --> 00:25:22,139
created them the Juno mission which is

640
00:25:27,169 --> 00:25:24,590
going to be using microwave to since

641
00:25:28,879 --> 00:25:27,179
there's deepest appear 100 bars of

642
00:25:32,680 --> 00:25:28,889
pressure to look for water and an

643
00:25:35,720 --> 00:25:32,690
ammonia in great blocks in the planet

644
00:25:38,180 --> 00:25:35,730
for mapping and vanie might remember

645
00:25:40,129 --> 00:25:38,190
more about the mapping what Galileo the

646
00:25:41,960 --> 00:25:40,139
orbiter to the orbiter instruments did

647
00:25:44,629 --> 00:25:41,970
for the Great Red Spot we had about

648
00:25:47,629 --> 00:25:44,639
three orbits election center targeted

649
00:25:48,769 --> 00:25:47,639
the red spot in some ways I don't know

650
00:25:49,669 --> 00:25:48,779
if you want to say any more about that

651
00:25:53,450 --> 00:25:49,679
yeah go ahead

652
00:26:01,909 --> 00:25:53,460
Scott's got a graphic up of a fully

653
00:26:07,239 --> 00:26:01,919
deployed this is what should have

654
00:26:10,310 --> 00:26:07,249
happened but if we could go back yeah

655
00:26:12,950 --> 00:26:10,320
yeah I'm listening scientist on Galileo

656
00:26:18,289 --> 00:26:12,960
and for the full remedy radiometer it's

657
00:26:23,119 --> 00:26:18,299
funny we got a whole punky here so

658
00:26:24,710 --> 00:26:23,129
you're welcome yeah so so Glenn's right

659
00:26:26,060 --> 00:26:24,720
though if you look at the region just

660
00:26:28,300 --> 00:26:26,070
north of the equator there's kind of

661
00:26:30,580 --> 00:26:28,310
grayish blueish areas and those the area

662
00:26:32,140 --> 00:26:30,590
with essentially new cloud and that's

663
00:26:33,820 --> 00:26:32,150

exactly where it went in we actually had

664
00:26:35,950 --> 00:26:33,830
Hubble data at the same time - we could

665
00:26:39,340 --> 00:26:35,960
show you exactly which hotspot or which

666
00:26:40,630 --> 00:26:39,350
opening it went in we call them hotspots

667
00:26:42,310 --> 00:26:40,640
because they glow in the infrared

668
00:26:45,580 --> 00:26:42,320
because the heat can come out without

669
00:26:47,680 --> 00:26:45,590
the clouds in the way but we did map get

670
00:26:49,960 --> 00:26:47,690
the red the Great Red Spot with Galileo

671
00:26:51,880 --> 00:26:49,970
and we were able to do to do some of

672
00:26:53,920 --> 00:26:51,890
these properties about cloud height and

673
00:26:56,650 --> 00:26:53,930
also measure the wind velocities at that

674
00:26:58,810 --> 00:26:56,660
time and you know again it's a very

675
00:27:02,590 --> 00:26:58,820
fierce storm we're talking 500 miles per

676
00:27:04,600 --> 00:27:02,600
hour or winds so okay well we're getting

677
00:27:06,640 --> 00:27:04,610
quite a few questions on the Q&A app and

678
00:27:09,640 --> 00:27:06,650
I've before - before - many of them

679
00:27:11,350 --> 00:27:09,650
scroll by I'm gonna go ahead and let me

680
00:27:13,570 --> 00:27:11,360
let me let me get one here's one from

681
00:27:16,270 --> 00:27:13,580
Michael Michael joban who asks I mean

682
00:27:18,700 --> 00:27:16,280
just selected here have others

683
00:27:23,110 --> 00:27:18,710
documented this finding before the HST

684
00:27:25,510 --> 00:27:23,120
stuff because I have seen the course I

685
00:27:27,400 --> 00:27:25,520
have seen the change over the years so I

686
00:27:28,900 --> 00:27:27,410
guess he wants to know is are there

687
00:27:31,330 --> 00:27:28,910
other telescopes besides Hubble

688
00:27:33,640 --> 00:27:31,340

recording this shrinking are this change

689
00:27:35,560 --> 00:27:33,650
in the red spot sure it's been primarily

690
00:27:38,080 --> 00:27:35,570
ground-based data and as I was saying

691
00:27:40,840 --> 00:27:38,090
John Rogers has it in his book and and

692
00:27:43,510 --> 00:27:40,850
piqué also has it in his book so 1950s

693
00:27:45,190 --> 00:27:43,520
in the 1995 so just from ground-based

694
00:27:47,350 --> 00:27:45,200
telescopes backyard telescopes we've

695
00:27:49,900 --> 00:27:47,360
been able to document the shrinking yeah

696
00:27:52,030 --> 00:27:49,910
it's it's the anomalous shrinking that

697
00:27:53,380 --> 00:27:52,040
accelerated shrinking actually it's an

698
00:27:56,380 --> 00:27:53,390
amateur observation that God is

699
00:27:58,180 --> 00:27:56,390
interested isn't it for sorwe so we rely

700
00:27:59,800 --> 00:27:58,190
to a large extent sometimes on the

701
00:28:02,020 --> 00:27:59,810
amateur community for information about

702
00:28:04,600 --> 00:28:02,030
what's going on yes--we we welcome

703
00:28:06,970 --> 00:28:04,610
citizen science yeah this is that's this

704
00:28:09,220 --> 00:28:06,980
is a good area where people can really

705
00:28:11,590 --> 00:28:09,230
contribute well I would imagine so Tony

706
00:28:14,530 --> 00:28:11,600
Michael is asking to give perspective on

707
00:28:17,710 --> 00:28:14,540
how big Jupiter is how many earths could

708
00:28:21,870 --> 00:28:17,720
fit inside inside all of Jupiter or the

709
00:28:24,490 --> 00:28:21,880
great all right let's just do red spot

710
00:28:26,350 --> 00:28:24,500
back when Voyager flew by and the Great

711
00:28:28,330 --> 00:28:26,360
Red Spot is bigger we used to say three

712
00:28:32,020 --> 00:28:28,340
Earth's and it's now more like

713
00:28:35,650 --> 00:28:32,030

one-and-a-half it's quite substantially

714
00:28:38,110 --> 00:28:35,660
smaller mm-hmm okay and here's from Hans

715
00:28:39,420 --> 00:28:38,120
milling is asking is the red spot always

716
00:28:43,050 --> 00:28:39,430
facing earth

717
00:28:45,570 --> 00:28:43,060
no she rotates very quickly about 10

718
00:28:47,100 --> 00:28:45,580
hours so we have to time it so the great

719
00:28:50,040 --> 00:28:47,110
red spots on the right side when we look

720
00:28:52,020 --> 00:28:50,050
but the red spot also moves it's not a

721
00:28:53,700 --> 00:28:52,030
fixed feature like a mountain so we have

722
00:28:55,680 --> 00:28:53,710
to track very carefully when we want to

723
00:28:58,830 --> 00:28:55,690
target with something like Hubble yeah I

724
00:29:00,420 --> 00:28:58,840
wish I there's a really nice animating

725
00:29:02,640 --> 00:29:00,430
you can get online where you could see

726
00:29:05,690 --> 00:29:02,650
the motions of the planet in its

727
00:29:07,860 --> 00:29:05,700
entirety both from Voyager as well as

728
00:29:09,540 --> 00:29:07,870
other animations and other observations

729
00:29:10,710 --> 00:29:09,550
that are really amazing to look at so

730
00:29:14,400 --> 00:29:10,720
you can definitely do a search on those

731
00:29:15,960 --> 00:29:14,410
and find out and virtual start party

732
00:29:18,540 --> 00:29:15,970
mode my other shows we're always trying

733
00:29:20,610 --> 00:29:18,550
to be able to see it it's never remember

734
00:29:22,080 --> 00:29:20,620
able to see it when we're observing live

735
00:29:23,700 --> 00:29:22,090
we always get it maybe half hour

736
00:29:26,100 --> 00:29:23,710
afterwards something that like that

737
00:29:29,070 --> 00:29:26,110
because it rotates so quickly and it's a

738
00:29:31,170 --> 00:29:29,080

moving target but it is a fun planet to

739
00:29:34,620 --> 00:29:31,180
look at that's fish you know

740
00:29:36,150 --> 00:29:34,630
ground-based amateur telescope well it's

741
00:29:39,930 --> 00:29:36,160
like Mike Wang has joined us hi Mike

742
00:29:41,430 --> 00:29:39,940
welcome hi thanks Mike is as I started

743
00:29:42,870 --> 00:29:41,440
to say before he's a research scientist

744
00:29:45,990 --> 00:29:42,880
at University of California at Berkeley

745
00:29:49,290 --> 00:29:46,000
he works on the Sam instrument onboard

746
00:29:51,600 --> 00:29:49,300
curiosity and you apparently are

747
00:29:55,080 --> 00:29:51,610
interested in the Great Red Spot as well

748
00:30:01,020 --> 00:29:55,090
correct right Mike yeah I'm I'm really a

749
00:30:03,120 --> 00:30:01,030
Jupiter guy but I started working with

750
00:30:05,490 --> 00:30:03,130
the Galileo probe mass spectrometer

751
00:30:08,270 --> 00:30:05,500
which you know took measurements as a

752
00:30:10,560 --> 00:30:08,280
definitive into Jupiter's atmosphere and

753
00:30:13,320 --> 00:30:10,570
the same team built this mass

754
00:30:15,420 --> 00:30:13,330
spectrometer that's on Mars so I working

755
00:30:17,460 --> 00:30:15,430
with them now okay well I've always

756
00:30:18,570 --> 00:30:17,470
wanted to do a curiosity hangout so I'm

757
00:30:20,730 --> 00:30:18,580
gonna have to bother you again at some

758
00:30:22,140 --> 00:30:20,740
point and I get you on on a Mars and

759
00:30:24,780 --> 00:30:22,150
curiosity hang on we talk about that a

760
00:30:27,030 --> 00:30:24,790
little bit but so yeah we just got

761
00:30:29,850 --> 00:30:27,040
through talking about some of the some

762
00:30:34,110 --> 00:30:29,860
of the things that was learned when we

763
00:30:36,240 --> 00:30:34,120

put when the probe went into Jupiter's

764
00:30:40,560 --> 00:30:36,250
atmosphere and Glenn was telling us that

765
00:30:43,890 --> 00:30:40,570
if we sent it into a pretty quiet part

766
00:30:47,670 --> 00:30:43,900
of a via of Jupiter and Hubble was

767
00:30:50,040 --> 00:30:47,680
watching when that happened the it

768
00:30:52,110 --> 00:30:50,050
didn't really give us any insights nor

769
00:30:53,340 --> 00:30:52,120
was it designed to I don't think to give

770
00:30:55,889 --> 00:30:53,350
us any insights into

771
00:30:57,509 --> 00:30:55,899
the great red spot itself but I thought

772
00:31:01,919 --> 00:30:57,519
I would ask now that you're here and you

773
00:31:03,870 --> 00:31:01,929
worked on the mission what what were

774
00:31:05,879 --> 00:31:03,880
there any things that stood out to you

775
00:31:12,509 --> 00:31:05,889
with the Jupiter or with the Galileo

776
00:31:13,889 --> 00:31:12,519
probe mission well actually one of the

777
00:31:17,580 --> 00:31:13,899
main goals was to figure out how much

778
00:31:19,169 --> 00:31:17,590
water is on Jupiter and and that did you

779
00:31:25,139 --> 00:31:19,179
guys talk about how that didn't work out

780
00:31:26,960 --> 00:31:25,149
so well the Juno mission no yeah well

781
00:31:29,970 --> 00:31:26,970
we'll get it a different way

782
00:31:33,629 --> 00:31:29,980
but actually some of the research we're

783
00:31:36,990 --> 00:31:33,639
doing uses vortices like the Great Red

784
00:31:39,659 --> 00:31:37,000
Spot and oval ba to figure out how much

785
00:31:43,710 --> 00:31:39,669
water is on Jupiter because when water

786
00:31:46,710 --> 00:31:43,720
clouds form this creates what some of us

787
00:31:49,200 --> 00:31:46,720
think this creates a stable layer and by

788
00:31:51,480 --> 00:31:49,210

figuring out how stable that layer is

789
00:31:52,669 --> 00:31:51,490
like kind of like an inversion that we

790
00:31:56,820 --> 00:31:52,679
talked about in the Earth's atmosphere

791
00:31:59,009 --> 00:31:56,830
we can we can use these vortices to

792
00:32:00,629 --> 00:31:59,019
figure out how stable that that air is

793
00:32:06,230 --> 00:32:00,639
and that gives you a clue about how much

794
00:32:11,999 --> 00:32:10,830
are you there Mike yeah did you yeah I

795
00:32:14,070 --> 00:32:12,009
lost you where you said he gives us a

796
00:32:16,440 --> 00:32:14,080
clue about and presumably it was about

797
00:32:18,629 --> 00:32:16,450
how much water vapors there yeah yeah

798
00:32:19,799 --> 00:32:18,639
okay all right yeah so yeah your

799
00:32:25,320 --> 00:32:19,809
connections a little bit a little bit

800
00:32:27,659 --> 00:32:25,330
jittery but all right about that okay so

801
00:32:30,180 --> 00:32:27,669
but actually Hubble did not observe

802
00:32:32,820 --> 00:32:30,190
right when the probe went in right

803
00:32:34,200 --> 00:32:32,830
there's all the biggest year okay I'm

804
00:32:36,869 --> 00:32:34,210
sorry I misunderstood what Amy said then

805
00:32:39,240 --> 00:32:36,879
I thought I thought I observed the spot

806
00:32:41,610 --> 00:32:39,250
it went into the opening it went into

807
00:32:43,889 --> 00:32:41,620
but not at the same time oh okay yeah

808
00:32:49,440 --> 00:32:43,899
Jupiter was Jupiter was really close to

809
00:32:51,450 --> 00:32:49,450
the Sun and Glenn actually he did some

810
00:32:54,360 --> 00:32:51,460
really fancy tricks to observe it from

811
00:32:56,749 --> 00:32:54,370
the ground yeah we the entire NASA and

812
00:32:59,100 --> 00:32:56,759
for a telescope facility with the

813
00:33:02,299 --> 00:32:59,110

largest filter I've ever seen which is

814
00:33:04,980 --> 00:33:02,309
three meters in size and it admitted the

815
00:33:06,870 --> 00:33:04,990
radiation at and greater than five

816
00:33:09,450 --> 00:33:06,880
microns and cut out everything else

817
00:33:11,550 --> 00:33:09,460
visible sort of like you know potato

818
00:33:14,310 --> 00:33:11,560
chip bag over the telescope and so we

819
00:33:16,980 --> 00:33:14,320
had did that and discovered there is a 5

820
00:33:19,050 --> 00:33:16,990
micron hot spot right where the probe

821
00:33:21,840 --> 00:33:19,060
was goes to go in and everything that we

822
00:33:23,880 --> 00:33:21,850
got from the probe coincided with the

823
00:33:25,770 --> 00:33:23,890
idea that this was in fact the kind of

824
00:33:28,350 --> 00:33:25,780
dry and cloudless area we expected from

825
00:33:32,460 --> 00:33:28,360
that kind of region that was a kind of

826
00:33:34,410 --> 00:33:32,470
strange it's also a Kudo in the to the

827
00:33:38,580 --> 00:33:34,420
need and the importance of ground-based

828
00:33:41,880 --> 00:33:38,590
observations of planets when missions go

829
00:33:45,420 --> 00:33:41,890
by and don't have all the resources they

830
00:33:47,010 --> 00:33:45,430
wouldn't like ok I want to get to

831
00:33:48,330 --> 00:33:47,020
another another question real quick that

832
00:33:50,400 --> 00:33:48,340
I don't think we answered this

833
00:33:53,970 --> 00:33:50,410
specifically but Hans milling is asking

834
00:33:55,890 --> 00:33:53,980
are the wind speeds the same around the

835
00:34:01,670 --> 00:33:55,900
Great Red Spot of presumably even though

836
00:34:03,810 --> 00:34:01,680
the red spot is shrinking so hey Hans

837
00:34:06,900 --> 00:34:03,820
actually we're still looking into that

838
00:34:08,700 --> 00:34:06,910

we just got the data and this is the

839
00:34:11,310 --> 00:34:08,710
main reason one of the main reasons why

840
00:34:16,050 --> 00:34:11,320
we went to Hubble to do this so we don't

841
00:34:19,919 --> 00:34:16,060
want to spill those beans quite yet stay

842
00:34:22,680 --> 00:34:19,929
tuned stay tuned I see presumably you're

843
00:34:24,080 --> 00:34:22,690
working on your paper now right well

844
00:34:31,260 --> 00:34:24,090
right

845
00:34:34,860 --> 00:34:31,270
Pancho's pitch okay so let's go let's

846
00:34:41,260 --> 00:34:39,220
are the just scroll past how long has

847
00:34:43,090 --> 00:34:41,270
the red has a red spot been on Jupiter

848
00:34:45,340 --> 00:34:43,100
and how long do you suppose it will last

849
00:34:48,340 --> 00:34:45,350
estimated time of course as from Tony

850
00:34:50,200 --> 00:34:48,350
Michael and I think we we've touched on

851
00:34:51,970 --> 00:34:50,210
this already a little bit amy said that

852
00:34:55,390 --> 00:34:51,980
we have observations of it going back at

853
00:34:59,080 --> 00:34:55,400
least 150 years and as far as the

854
00:35:02,200 --> 00:34:59,090
estimated time remaining as Amy also

855
00:35:04,030 --> 00:35:02,210
said we don't know what's driving it yet

856
00:35:06,250 --> 00:35:04,040
so it's hard to answer that question

857
00:35:08,670 --> 00:35:06,260
that we need to understand more of the

858
00:35:11,650 --> 00:35:08,680
dynamics of the red spot and you know

859
00:35:13,960 --> 00:35:11,660
this just highlights something that I

860
00:35:14,770 --> 00:35:13,970
find you know it's it's also true in

861
00:35:16,990 --> 00:35:14,780
solar physics

862
00:35:19,120 --> 00:35:17,000
it's amazing what we're still learning

863
00:35:21,130 --> 00:35:19,130

about the things very close to us like

864
00:35:22,690 --> 00:35:21,140
there's a lot about the Sun we don't

865
00:35:25,180 --> 00:35:22,700
know there's a lot about the planets

866
00:35:26,320 --> 00:35:25,190
we're still learning and so a lot of

867
00:35:27,690 --> 00:35:26,330
this stuff is coming out with

868
00:35:29,320 --> 00:35:27,700
observations like the tumble but

869
00:35:31,510 --> 00:35:29,330
unfortunately the answers to those

870
00:35:33,190 --> 00:35:31,520
questions aren't there's nothing

871
00:35:34,470 --> 00:35:33,200
definite there yet do you guys want to

872
00:35:37,030 --> 00:35:34,480
add anything to that

873
00:35:43,570 --> 00:35:37,040
yeah I actually want to add to that

874
00:35:45,850 --> 00:35:43,580
question because Amy and Glen so I

875
00:35:49,960 --> 00:35:45,860
thought that the Great Red Spot may have

876
00:35:51,850 --> 00:35:49,970
been seen by a Cassini in the 1600s what

877
00:35:54,100 --> 00:35:51,860
are the views about whether that's the

878
00:35:56,110 --> 00:35:54,110
same spot or not yeah we mentioned that

879
00:35:57,540 --> 00:35:56,120
briefly part of it is of course you know

880
00:36:00,460 --> 00:35:57,550
we know the optics weren't that great

881
00:36:02,950 --> 00:36:00,470
the original papers which I did go back

882
00:36:05,830 --> 00:36:02,960
and look up which were challenging to

883
00:36:08,140 --> 00:36:05,840
read to say the least it's not clear if

884
00:36:09,400 --> 00:36:08,150
it's the same latitude it might have

885
00:36:11,740 --> 00:36:09,410
even been the northern hemisphere not

886
00:36:13,480 --> 00:36:11,750
the southern and some of the

887
00:36:14,830 --> 00:36:13,490
descriptions don't seem to quite match

888
00:36:16,090 --> 00:36:14,840

up and the fact that we know that it's

889
00:36:18,820 --> 00:36:16,100
shrinking it would have been quite big

890
00:36:22,300 --> 00:36:18,830
back then so it may not be the same

891
00:36:23,800 --> 00:36:22,310
storm and you know as Glen also said

892
00:36:25,240 --> 00:36:23,810
earlier there's there's a picture that

893
00:36:27,970 --> 00:36:25,250
was found in the Vatican that showed

894
00:36:29,500 --> 00:36:27,980
Jupiter with a spot on it but it's kind

895
00:36:31,030 --> 00:36:29,510
of anecdotal evidence at this point we

896
00:36:33,340 --> 00:36:31,040
don't have enough to say for a fact that

897
00:36:35,530 --> 00:36:33,350
it's the same thing but it might be well

898
00:36:36,310 --> 00:36:35,540
I'm going in my TARDIS later this

899
00:36:38,020 --> 00:36:36,320
afternoon

900
00:36:40,390 --> 00:36:38,030
and I will take some pictures for you

901
00:36:44,340 --> 00:36:40,400
guys and beam them back and we will know

902
00:36:48,610 --> 00:36:47,440
pictures in in John's book

903
00:36:51,480 --> 00:36:48,620
or any of the pictures might get

904
00:36:54,370 --> 00:36:51,490
elsewhere on that show Jupiter in the

905
00:36:56,620 --> 00:36:54,380
1880s 1890's that show the red spot you

906
00:36:58,780 --> 00:36:56,630
can express the great red sausage this

907
00:37:01,720 --> 00:36:58,790
is three degrees of longitude the thing

908
00:37:05,020 --> 00:37:01,730
is big and if this isn't dropping down

909
00:37:09,520 --> 00:37:05,030
since then I think the idea the great

910
00:37:18,820 --> 00:37:09,530
rate of sausages and sausage yeah that's

911
00:37:22,660 --> 00:37:18,830
good okay let me move on Jan Kellner is

912
00:37:25,900 --> 00:37:22,670
asking does Jupiter have a solid core

913
00:37:35,350 --> 00:37:25,910

and if so how big is it and what's it

914
00:37:40,300 --> 00:37:35,360
made of anybody there's probably some

915
00:37:42,610 --> 00:37:40,310
heavy material metal silicon heavy

916
00:37:44,560 --> 00:37:42,620
things that form a core as they do in

917
00:37:46,380 --> 00:37:44,570
the pores of all the giant planets

918
00:37:49,510 --> 00:37:46,390
that's because Italy we presume that

919
00:37:52,450 --> 00:37:49,520
there is a mixture of solar like

920
00:37:54,250 --> 00:37:52,460
elements everywhere they were added to

921
00:37:57,790 --> 00:37:54,260
afterward nuts and the mysteries of how

922
00:37:59,290 --> 00:37:57,800
things formed there are theories and

923
00:38:01,300 --> 00:37:59,300
without direct evidence but there are

924
00:38:03,730 --> 00:38:01,310
theories on how much there is in each of

925
00:38:06,040 --> 00:38:03,740
these planets and that's about it it's

926
00:38:09,070 --> 00:38:06,050
not very big for Jupiter or Saturn and

927
00:38:13,570 --> 00:38:09,080
we measure in terms of several earths in

928
00:38:17,290 --> 00:38:13,580
terms of mass as I recall I'm quite

929
00:38:18,820 --> 00:38:17,300
happy to be corrected on any day now

930
00:38:20,950 --> 00:38:18,830
that's that's about what I would say to

931
00:38:23,650 --> 00:38:20,960
the best guess at the moment is two to

932
00:38:27,430 --> 00:38:23,660
three earth masses of heavy elements

933
00:38:31,420 --> 00:38:27,440
yeah okay okay now here's a here's a

934
00:38:34,060 --> 00:38:31,430
loaded question art and this comes from

935
00:38:36,520 --> 00:38:34,070
Chris Marshall are there any experiments

936
00:38:39,670 --> 00:38:36,530
that could provide more information on

937
00:38:44,080 --> 00:38:39,680
what's powering the Great Red Spot if

938
00:38:46,540 --> 00:38:44,090

money wasn't a limiter oh oh we're no

939
00:38:50,830 --> 00:38:46,550
object guys and send a lot of probes

940
00:38:53,050 --> 00:38:50,840
into Jupiter I mean it would it seems

941
00:38:56,740 --> 00:38:53,060
sort of ironic that's all do the money

942
00:38:58,750 --> 00:38:56,750
that mean send many probes into the

943
00:39:00,460 --> 00:38:58,760
aperture Venus which has in some ways

944
00:39:01,300 --> 00:39:00,470
that one of those homogeneous we know

945
00:39:03,880 --> 00:39:01,310
about

946
00:39:06,660 --> 00:39:03,890
I mean send one folder with most in

947
00:39:09,520 --> 00:39:06,670
homogeneous form that we see visually

948
00:39:12,280 --> 00:39:09,530
but that's life it stupid is pretty far

949
00:39:13,600 --> 00:39:12,290
away and he this is a lot closer there's

950
00:39:16,300 --> 00:39:13,610
a lot of challenges I would imagine and

951
00:39:17,590 --> 00:39:16,310
getting their wind speed all around the

952
00:39:20,530 --> 00:39:17,600
roads flying like send something into

953
00:39:22,150 --> 00:39:20,540
the red spot yeah probes well maybe you

954
00:39:25,230 --> 00:39:22,160
could send balloons that could get wind

955
00:39:29,650 --> 00:39:25,240
speeds rogue would give you maybe

956
00:39:30,790 --> 00:39:29,660
composition you know cloud densities at

957
00:39:33,580 --> 00:39:30,800
that location

958
00:39:38,500 --> 00:39:33,590
another great thing would be weather

959
00:39:42,150 --> 00:39:38,510
satellite around Jupiter mm-hmm that's

960
00:39:44,470 --> 00:39:42,160
because we've sent spacecraft there a

961
00:39:46,300 --> 00:39:44,480
you know they can't take images all the

962
00:39:48,250 --> 00:39:46,310
time and so we get bits and pieces here

963
00:39:50,500 --> 00:39:48,260

and there but a dedicated what a weather

964
00:39:51,760 --> 00:39:50,510
satellite around Jupiter or hey even

965
00:39:54,040 --> 00:39:51,770
around the earth but with a powerful

966
00:39:55,600 --> 00:39:54,050
telescope could get that job done Mike

967
00:40:00,120 --> 00:39:55,610
and I would both like a dedicated Hubble

968
00:40:02,770 --> 00:40:00,130
of our on yeah one of those two actually

969
00:40:04,900 --> 00:40:02,780
like my own Hubble Space Telescope to

970
00:40:06,700 --> 00:40:04,910
I'll get on that ground as well let's

971
00:40:16,620 --> 00:40:06,710
just yeah I'm sure if they mass mass

972
00:40:19,140 --> 00:40:16,630
produced it'll be cheaper right okay so

973
00:40:24,250 --> 00:40:19,150
here is one that's getting a lot of plus

974
00:40:26,560 --> 00:40:24,260
pluses here from Craig Landon are there

975
00:40:29,140 --> 00:40:26,570
any known similarities atmospherically

976
00:40:32,080 --> 00:40:29,150
between the Great Red Spot and a hexagon

977
00:40:33,910 --> 00:40:32,090
at the poles of Saturn similar

978
00:40:37,150 --> 00:40:33,920
composition different location due to

979
00:40:39,490 --> 00:40:37,160
weather factors well on Saturn the

980
00:40:41,230 --> 00:40:39,500
hexagon is part of a whole polar vortex

981
00:40:43,570 --> 00:40:41,240
polar flows are a little more

982
00:40:46,120 --> 00:40:43,580
complicated it's so it is still a vortex

983
00:40:48,040 --> 00:40:46,130
a storm that rotates and in that same

984
00:40:50,530 --> 00:40:48,050
sense but the polar regions are a little

985
00:40:53,620 --> 00:40:50,540
special they can actually make hexagons

986
00:40:55,960 --> 00:40:53,630
in a lab with rotating fluids and it

987
00:40:59,320 --> 00:40:55,970
just has to do with how winds move

988
00:41:01,200 --> 00:40:59,330

around flow moves around a pole in the

989
00:41:03,910 --> 00:41:01,210
case of the red spot it's not the pole

990
00:41:05,260 --> 00:41:03,920
okay yeah I'm glad you've been glad you

991
00:41:06,340 --> 00:41:05,270
sort of explain what that was because

992
00:41:09,190 --> 00:41:06,350
gonna ask you to tell us what the

993
00:41:11,770 --> 00:41:09,200
hexagon is so it's a polar flow whereas

994
00:41:14,050 --> 00:41:11,780
the red spot is is something much

995
00:41:15,250 --> 00:41:14,060
further down on the latitude scales yeah

996
00:41:18,790 --> 00:41:15,260
and it is similar

997
00:41:20,770 --> 00:41:18,800
the what we call the polar hexagon those

998
00:41:24,120 --> 00:41:20,780
who were experiencing pretty cold

999
00:41:28,620 --> 00:41:24,130
winters in the in the US this past yeah

1000
00:41:33,370 --> 00:41:28,630
the polar hexagon is you know it's also

1001
00:41:36,880 --> 00:41:33,380
a wind belt that's encircling the vortex

1002
00:41:38,680 --> 00:41:36,890
and it has waves on it and so in the

1003
00:41:41,200 --> 00:41:38,690
case of Jupiter and Saturn those waves

1004
00:41:43,660 --> 00:41:41,210
can become stable enough so that they

1005
00:41:47,740 --> 00:41:43,670
look like the sides of a hexagon and

1006
00:41:52,560 --> 00:41:47,750
also in labs you can get a Pentagon or a

1007
00:41:56,200 --> 00:41:52,570
septagon other other shapes as well okay

1008
00:42:11,680 --> 00:41:56,210
let's see and here's one from that's

1009
00:42:13,630 --> 00:42:11,690
good question Craig thank you we also

1010
00:42:15,609 --> 00:42:13,640
know that Jupiter has very strong

1011
00:42:19,620 --> 00:42:15,619
magnetic fields and that the magnetic

1012
00:42:23,050 --> 00:42:19,630
fields interact with its moon system and

1013
00:42:25,000 --> 00:42:23,060

the surrounding area does the magnetic

1014
00:42:27,520 --> 00:42:25,010
field have anything to do with or

1015
00:42:30,250 --> 00:42:27,530
influence the red spot that you know of

1016
00:42:32,260 --> 00:42:30,260
or any of these spots well the the

1017
00:42:34,150 --> 00:42:32,270
magnetic fields of course Drive Aurora's

1018
00:42:36,520 --> 00:42:34,160
on earth and on the other planets we do

1019
00:42:39,580 --> 00:42:36,530
see aurora on Jupiter and we can

1020
00:42:41,859 --> 00:42:39,590
actually see the magnetic footprint of

1021
00:42:44,109 --> 00:42:41,869
IO in the atmosphere as well so

1022
00:42:47,290 --> 00:42:44,119
basically wherever the medic medic field

1023
00:42:49,599 --> 00:42:47,300
intersects a planet or a moon rather it

1024
00:42:52,660 --> 00:42:49,609
can actually bring a footprint down on

1025
00:42:54,130 --> 00:42:52,670
to the Jupiter itself but it tends to be

1026
00:42:55,510 --> 00:42:54,140
very high up in the atmosphere that you

1027
00:42:57,849 --> 00:42:55,520
see it you see very localized heating

1028
00:43:00,220 --> 00:42:57,859
and so on but it's extremely high up in

1029
00:43:01,900 --> 00:43:00,230
the atmosphere I'm glad I don't know if

1030
00:43:05,109 --> 00:43:01,910
you want to add to that you know we can

1031
00:43:06,340 --> 00:43:05,119
if we look at wavelengths like 899 a

1032
00:43:10,270 --> 00:43:06,350
meter so we have a lot of methane

1033
00:43:14,490 --> 00:43:10,280
absorption like like 300 or further in

1034
00:43:17,140 --> 00:43:14,500
the infrared from ground we are

1035
00:43:18,670 --> 00:43:17,150
susceptible to seeing particles very

1036
00:43:20,830 --> 00:43:18,680
high in the atmosphere because there's

1037
00:43:24,340 --> 00:43:20,840
methane and hydrogen gas that are

1038
00:43:26,530 --> 00:43:24,350

absorbing all the photons before then

1039
00:43:28,270 --> 00:43:26,540
get flicked it back to us when we look

1040
00:43:29,130 --> 00:43:28,280
at the planet there we see one of the

1041
00:43:32,560 --> 00:43:29,140
highest things

1042
00:43:36,370 --> 00:43:32,570
brightest parts is the great red spot or

1043
00:43:39,250 --> 00:43:36,380
red spot jr. but other than that the

1044
00:43:41,770 --> 00:43:39,260
poles actually one of the most striking

1045
00:43:44,770 --> 00:43:41,780
parts of the planet because we presume

1046
00:43:46,990 --> 00:43:44,780
that particles are being created by this

1047
00:43:48,550 --> 00:43:47,000
interaction though chemistry driven by

1048
00:43:52,090 --> 00:43:48,560
energetic particles flowing down

1049
00:43:54,730 --> 00:43:52,100
magnetic field and is overall oval and

1050
00:43:56,530 --> 00:43:54,740
Morris I got a feel the derivative

1051
00:43:58,510 --> 00:43:56,540
displace compared with the rotation axis

1052
00:44:01,990 --> 00:43:58,520
so they can to be streaming out onto the

1053
00:44:04,120 --> 00:44:02,000
edges of the polar vortex itself some of

1054
00:44:06,310 --> 00:44:04,130
them hit and train that is corralled

1055
00:44:10,510 --> 00:44:06,320
into that polar vortex and some spread

1056
00:44:13,360 --> 00:44:10,520
outward more of them get pardon the

1057
00:44:16,300 --> 00:44:13,370
phrase sequestered inside the southern

1058
00:44:18,570 --> 00:44:16,310
polar vortex and in the north some of

1059
00:44:22,690 --> 00:44:18,580
them spill out so have this these two

1060
00:44:26,350 --> 00:44:22,700
very well defined vortices putting

1061
00:44:28,720 --> 00:44:26,360
Jupiter's sometimes has a not quite as

1062
00:44:31,300 --> 00:44:28,730
stable as a hexagon and Saturn but

1063
00:44:34,060 --> 00:44:31,310

Jupiter's polar vortex as boundaries and

1064
00:44:36,460 --> 00:44:34,070
waves that can move a bit more maybe you

1065
00:44:41,620 --> 00:44:36,470
know by sight either is excited from 20

1066
00:44:42,880 --> 00:44:41,630
million Brook and that this pollen would

1067
00:44:45,220 --> 00:44:42,890
what the amateurs would call a polar

1068
00:44:47,350 --> 00:44:45,230
hood but there's some stuff spreading

1069
00:44:49,570 --> 00:44:47,360
out because the vortex print me being

1070
00:44:51,220 --> 00:44:49,580
immoral local actually / sense that

1071
00:44:52,990 --> 00:44:51,230
boundary like spending things out in

1072
00:44:56,080 --> 00:44:53,000
that the keys for their software the

1073
00:44:59,290 --> 00:44:56,090
planet but direct influences on on the

1074
00:45:01,650 --> 00:44:59,300
right spot itself not so much as in none

1075
00:45:04,420 --> 00:45:01,660
that I know of

1076
00:45:06,880 --> 00:45:04,430
okay let's just take one more question

1077
00:45:08,200 --> 00:45:06,890
here that I we've already talked about

1078
00:45:10,390 --> 00:45:08,210
this just a little bit of a world will

1079
00:45:12,820 --> 00:45:10,400
address it directly from Jeff kesner

1080
00:45:14,350 --> 00:45:12,830
who's going I about the information II

1081
00:45:16,870 --> 00:45:14,360
interesting information that came out of

1082
00:45:20,470 --> 00:45:16,880
the study of clouds generated when comet

1083
00:45:22,360 --> 00:45:20,480
shoemaker 9 levy levy 9 I impacted I

1084
00:45:24,520 --> 00:45:22,370
believe we you know we talked about you

1085
00:45:26,500 --> 00:45:24,530
know Glenn it said that was basically an

1086
00:45:27,460 --> 00:45:26,510
amazing event in all respects but Mike

1087
00:45:28,450 --> 00:45:27,470
you weren't here when we talked about

1088
00:45:30,550 --> 00:45:28,460

that do you have anything to add about

1089
00:45:40,880 --> 00:45:30,560
that impact did you learn anything new

1090
00:45:46,940 --> 00:45:45,529
oh dude okay can you hear me now yeah I

1091
00:45:47,650 --> 00:45:46,950
can hear you know yeah yeah okay I'm

1092
00:45:51,979 --> 00:45:47,660
sorry

1093
00:45:54,309 --> 00:45:51,989
um well that I'm sure you guys covered

1094
00:45:57,380 --> 00:45:54,319
most of the stuff I would say like

1095
00:46:00,920 --> 00:45:57,390
mainly that this may have been an

1096
00:46:08,210 --> 00:46:00,930
asteroid it that hit the planet instead

1097
00:46:09,470 --> 00:46:08,220
of a comet in 2009 you mean yeah it was

1098
00:46:11,390 --> 00:46:09,480
that the question or what are we talking

1099
00:46:13,640 --> 00:46:11,400
about she make her look 9 did we learn

1100
00:46:15,650 --> 00:46:13,650
anything more about the what was it you

1101
00:46:20,900 --> 00:46:15,660
thought you learned about the planet if

1102
00:46:25,269 --> 00:46:20,910
the movie impact well actually at that

1103
00:46:29,630 --> 00:46:25,279
time I was a radio astronomer and so

1104
00:46:32,720 --> 00:46:29,640
totally make West Virginia know a lot of

1105
00:46:34,759 --> 00:46:32,730
exciting stuff happened the comet

1106
00:46:37,549 --> 00:46:34,769
brought a bunch of dust into the system

1107
00:46:39,979 --> 00:46:37,559
and you just talked about Aurora's well

1108
00:46:42,620 --> 00:46:39,989
Aurora's are caused when these charged

1109
00:46:44,059 --> 00:46:42,630
particles in the magnetosphere smashed

1110
00:46:46,579 --> 00:46:44,069
into the atmosphere at really high

1111
00:46:48,499 --> 00:46:46,589
velocities so you introduced a bunch of

1112
00:46:51,380 --> 00:46:48,509
dust into the system and that can soak

1113
00:46:54,890 --> 00:46:51,390

up some of these electrons and we saw

1114
00:46:58,130 --> 00:46:54,900
massive changes in the in the radiation

1115
00:46:59,930 --> 00:46:58,140
environment around Jupiter so that was

1116
00:47:02,029 --> 00:46:59,940
pretty cool and it gave me a one-week

1117
00:47:08,599 --> 00:47:02,039
trip into the remote mountains of West

1118
00:47:10,880 --> 00:47:08,609
Virginia where I mountain-bike okay it

1119
00:47:13,640 --> 00:47:10,890
did also deliver stuff into the upper

1120
00:47:16,729 --> 00:47:13,650
atmosphere and the first time in so it

1121
00:47:19,249 --> 00:47:16,739
created markers that we could use as we

1122
00:47:21,470 --> 00:47:19,259
watch the flow north-south which we

1123
00:47:23,809 --> 00:47:21,480
don't usually get to see visit so slow

1124
00:47:25,609 --> 00:47:23,819
and see things start to circulate so we

1125
00:47:27,470 --> 00:47:25,619
our first indications about the

1126
00:47:29,539 --> 00:47:27,480
circulation of berdiana north-south

1127
00:47:31,400 --> 00:47:29,549
circulation the planet starting to

1128
00:47:34,940 --> 00:47:31,410
gotten rid of but a little bit of

1129
00:47:36,979 --> 00:47:34,950
actually observational constraints and

1130
00:47:39,039 --> 00:47:36,989
that was from carbon monoxide is that

1131
00:47:42,140 --> 00:47:39,049
right

1132
00:47:47,120 --> 00:47:42,150
also there dis particularly well that's

1133
00:47:48,410 --> 00:47:47,130
right alright so what's what's coming up

1134
00:47:50,630 --> 00:47:48,420
or do you guys I mean I know you guys

1135
00:47:52,039 --> 00:47:50,640
are working on your your paper now for

1136
00:47:54,650 --> 00:47:52,049
based on the observations that were

1137
00:47:56,450 --> 00:47:54,660
taken any plans any

1138
00:47:59,210 --> 00:47:56,460

any future observations with Hubble

1139
00:48:04,010 --> 00:47:59,220
planned or is this pretty much it for

1140
00:48:05,300 --> 00:48:04,020
now we're at the mercy of the science

1141
00:48:07,790 --> 00:48:05,310
community right now we've submitted

1142
00:48:10,910 --> 00:48:07,800
proposals to to look some more of course

1143
00:48:14,690 --> 00:48:10,920
so well we'll just see if they they get

1144
00:48:18,080 --> 00:48:14,700
time Mike you have proposed for more

1145
00:48:20,330 --> 00:48:18,090
Hubble time then yes yes oh yeah and I

1146
00:48:21,800 --> 00:48:20,340
mean both sir archive time as well they

1147
00:48:26,980 --> 00:48:21,810
start looking a bit more carefully at

1148
00:48:30,500 --> 00:48:26,990
the past Great Red Spot it's a grid and

1149
00:48:32,600 --> 00:48:30,510
I jump off from that we will be looking

1150
00:48:35,930 --> 00:48:32,610
at Hubble I'll be applying for Hubble

1151
00:48:38,480 --> 00:48:35,940
data to be supporting the Juno mission

1152
00:48:44,320 --> 00:48:38,490
when that arrives as well and what's the

1153
00:48:47,450 --> 00:48:44,330
timeline for that mid 2016 too late 2017

1154
00:48:49,300 --> 00:48:47,460
a lot of the designated remote sensing

1155
00:48:52,190 --> 00:48:49,310
orbital and fairly early in the mission

1156
00:48:53,570 --> 00:48:52,200
unfortunately which is not very far from

1157
00:48:56,480 --> 00:48:53,580
the Sun so they're third from the

1158
00:48:59,930 --> 00:48:56,490
exclusion zone so exclusion zone but

1159
00:49:02,750 --> 00:48:59,940
we'll be looking for time Junior will be

1160
00:49:06,350 --> 00:49:02,760
looking into very narrow swathe launched

1161
00:49:11,540 --> 00:49:06,360
if it's a polar orbit ER and it's spin

1162
00:49:13,520 --> 00:49:11,550
stabilized so looking at the narrow

1163
00:49:16,460 --> 00:49:13,530

strip in longitude that grows a bit

1164
00:49:18,140 --> 00:49:16,470
wider toward the pole so we want to use

1165
00:49:21,680 --> 00:49:18,150
Hubble and other toss groups to provide

1166
00:49:24,500 --> 00:49:21,690
one context to that as well Jonah has

1167
00:49:27,530 --> 00:49:24,510
one camera and it simply is a methane

1168
00:49:30,590 --> 00:49:27,540
filter and wideband red-green-blue it's

1169
00:49:32,540 --> 00:49:30,600
largely education public outreach camera

1170
00:49:34,690 --> 00:49:32,550
we use it for scientific purposes but

1171
00:49:38,300 --> 00:49:34,700
it's not considered a space grade

1172
00:49:44,180 --> 00:49:38,310
instrument so and so as I heard the

1173
00:49:46,370 --> 00:49:44,190
white field camera 3 is okay alright

1174
00:49:48,740 --> 00:49:46,380
great well good luck on the proposal I

1175
00:49:51,650 --> 00:49:48,750
hope to get more Jupiter observations

1176
00:49:53,480 --> 00:49:51,660
from Hubble are these all the the three

1177
00:49:55,820 --> 00:49:53,490
epochs that we talked about already is

1178
00:49:58,010 --> 00:49:55,830
that been the three main times Carroll

1179
00:50:03,320 --> 00:49:58,020
that Hubble has looked at Jupiter do you

1180
00:50:06,740 --> 00:50:03,330
know of any others there's a lot no yeah

1181
00:50:08,069 --> 00:50:06,750
there are enough by Google's point is

1182
00:50:12,749 --> 00:50:08,079
that it does

1183
00:50:14,759 --> 00:50:12,759
help the archival observations and I'm

1184
00:50:16,680 --> 00:50:14,769
speaking for our guests but I would

1185
00:50:19,049 --> 00:50:16,690
guess that not only looking at the red

1186
00:50:21,539 --> 00:50:19,059
spot but looking at the rest of Jupiter

1187
00:50:23,309 --> 00:50:21,549
even when it doesn't have the red spot

1188
00:50:24,959 --> 00:50:23,319

in the field of view could be very

1189
00:50:26,549 --> 00:50:24,969
informative about the bands and the

1190
00:50:28,499 --> 00:50:26,559
circulation patterns because you have to

1191
00:50:30,630 --> 00:50:28,509
look at that as well so we've actually

1192
00:50:32,940 --> 00:50:30,640
looked at you quite a lot I mean we

1193
00:50:35,940 --> 00:50:32,950
looked at a lot of solar system objects

1194
00:50:38,519 --> 00:50:35,950
quite a lot couple there's always

1195
00:50:41,789 --> 00:50:38,529
changes in some often very surprising

1196
00:50:44,120 --> 00:50:41,799
ways yes and pretty much every every

1197
00:50:47,989 --> 00:50:44,130
imaging instrument on Hubble has

1198
00:50:50,130 --> 00:50:47,999
collected data on the Great Red Spot so

1199
00:50:52,349 --> 00:50:50,140
ideally we would like to compare data

1200
00:50:54,930 --> 00:50:52,359
from all these different instruments so

1201
00:50:57,599 --> 00:50:54,940
we can cover as much of its history as

1202
00:50:59,489 --> 00:50:57,609
we can at high resolution yeah one of

1203
00:51:03,420 --> 00:50:59,499
the things that interests me as much as

1204
00:51:07,529 --> 00:51:03,430
the dynamics and north-south east-west

1205
00:51:09,239 --> 00:51:07,539
flow is the color which is called both

1206
00:51:11,130 --> 00:51:09,249
Amy and Mike as well and it's

1207
00:51:15,719 --> 00:51:11,140
interesting that we see the red spot

1208
00:51:17,249 --> 00:51:15,729
that's buried deep color most often when

1209
00:51:18,870 --> 00:51:17,259
the rest of the material around it is

1210
00:51:21,239 --> 00:51:18,880
light in color which is kind of

1211
00:51:26,189 --> 00:51:21,249
anomalous I'm glad that this is one of

1212
00:51:28,259 --> 00:51:26,199
those which was say during Pioneer 1970s

1213
00:51:30,299 --> 00:51:28,269

you look at pioneer images and you see

1214
00:51:32,579 --> 00:51:30,309
the very white South Equatorial belt

1215
00:51:36,719 --> 00:51:32,589
because normally dark and the red spot

1216
00:51:38,519 --> 00:51:36,729
is very deep red toward Voyager the red

1217
00:51:40,319 --> 00:51:38,529
spots not quite so red and the material

1218
00:51:42,660 --> 00:51:40,329
around it is dark which is kind of

1219
00:51:44,039 --> 00:51:42,670
usually it is right now is really

1220
00:51:46,109 --> 00:51:44,049
interesting because in the tool around

1221
00:51:48,539 --> 00:51:46,119
it is dark and the red spot is really

1222
00:51:49,949 --> 00:51:48,549
really gray which is a little bit

1223
00:51:52,019 --> 00:51:49,959
different from any other time you've

1224
00:51:56,309 --> 00:51:52,029
looked at it so we're in an intriguing

1225
00:51:58,019 --> 00:51:56,319
epoch right now yeah it sounds like a

1226
00:52:01,049 --> 00:51:58,029
lot is going on with with with respect

1227
00:52:02,670 --> 00:52:01,059
to Jupiter right now so okay

1228
00:52:05,749 --> 00:52:02,680
well I guess we're about out of time now

1229
00:52:07,529 --> 00:52:05,759
I want to thank everybody for for

1230
00:52:08,849 --> 00:52:07,539
participating in this hangout this was

1231
00:52:09,839 --> 00:52:08,859
really interesting I really got a lot

1232
00:52:11,390 --> 00:52:09,849
out of it

1233
00:52:14,430 --> 00:52:11,400
we'll look for your paper hopefully

1234
00:52:15,989 --> 00:52:14,440
hopefully we'll be able to talk about a

1235
00:52:17,880 --> 00:52:15,999
few more things we didn't bring up here

1236
00:52:19,620 --> 00:52:17,890
at this particular time but there you

1237
00:52:21,780 --> 00:52:19,630
have it folks the Great Red Spot it's

1238
00:52:24,690 --> 00:52:21,790

shrinking its

1239
00:52:26,340 --> 00:52:24,700
getting rounder it's changing as we

1240
00:52:29,790 --> 00:52:26,350
speak and Hubble has been looking at it

1241
00:52:31,290 --> 00:52:29,800
and these all of these really very smart

1242
00:52:33,240 --> 00:52:31,300
people have been looking at Jupiter and

1243
00:52:34,740 --> 00:52:33,250
and telling us you know what they're

1244
00:52:37,110 --> 00:52:34,750
finding out so I hope you enjoyed this

1245
00:52:39,210 --> 00:52:37,120
hangout I want to thank you Amy Glenn

1246
00:52:41,550 --> 00:52:39,220
and Mike for joining us thank you all

1247
00:52:44,640 --> 00:52:41,560
very much and Carol Scott it's been a

1248
00:52:48,060 --> 00:52:44,650
lot of fun we're gonna be back for quick

1249
00:52:50,490 --> 00:52:48,070
programming notes Carol and Scott and I

1250
00:52:52,680 --> 00:52:50,500
will be doing these hangouts on a more

1251
00:52:54,690 --> 00:52:52,690
regular basis starting in June our next

1252
00:52:56,580 --> 00:52:54,700
hangout is June 12th we're gonna be

1253
00:52:59,010 --> 00:52:56,590
giving you guys a frontier fields update

1254
00:53:01,740 --> 00:52:59,020
on the frontier fields program so I hope

1255
00:53:04,830 --> 00:53:01,750
you guys can make it there and the time

1256
00:53:08,580 --> 00:53:04,840
will be 3 p.m. Eastern instead of 4 p.m.

1257
00:53:12,660 --> 00:53:08,590
Eastern which makes that seven o'clock

1258
00:53:14,520 --> 00:53:12,670
Greenwich Mean Time and so we hope you

1259
00:53:16,500 --> 00:53:14,530
guys can make it and we will see you