
AbSciCon
2017
MESA, ARIZONA

1
00:00:12,250 --> 00:00:06,150
you

2
00:00:17,920 --> 00:00:15,060
[Music]

3
00:00:19,780 --> 00:00:17,930
all right thank you very much I'm a

4
00:00:22,179 --> 00:00:19,790
member of the GPI instrument team as

5
00:00:24,280 --> 00:00:22,189
well as the X plan of survey team I'm a

6
00:00:27,880 --> 00:00:24,290
co-lead for the debris disc science and

7
00:00:29,950 --> 00:00:27,890
today I'll give you a update on the

8
00:00:38,490 --> 00:00:29,960
progress of our survey now that is

9
00:00:44,500 --> 00:00:41,619
great so the purpose of our survey is to

10
00:00:51,729 --> 00:00:44,510
explore this region between 5 and 50 au

11
00:01:00,610 --> 00:00:51,739
for young jupiter-mass planets let's see

12
00:01:02,860 --> 00:01:00,620
roughly some kind of work right here all

13
00:01:04,630 --> 00:01:02,870

right good all right in this region

14
00:01:08,320 --> 00:01:04,640
right here this is a plot of semi-major

15
00:01:11,560 --> 00:01:08,330
axis versus planet mass previous direct

16
00:01:14,230 --> 00:01:11,570
imaging surveys were sensitive to wider

17
00:01:16,270 --> 00:01:14,240
separation planets and now we're

18
00:01:18,130 --> 00:01:16,280
extending to this region here which is

19
00:01:20,740 --> 00:01:18,140
beginning to overlap with the radio

20
00:01:24,399 --> 00:01:20,750
velocity detected planets between 5 and

21
00:01:27,730 --> 00:01:24,409
10 and you we've been awarded 890 hours

22
00:01:30,280 --> 00:01:27,740
of Gemini South time making this one the

23
00:01:32,499 --> 00:01:30,290
largest and most Ematic surveys for

24
00:01:35,050 --> 00:01:32,509
extrasolar planets the other large

25
00:01:38,289 --> 00:01:35,060
survey is being conducted by sphere on

26
00:01:46,020 --> 00:01:38,299
the VLT we have 600 targets that we plan

27
00:01:48,850 --> 00:01:46,030
to observe so far we've observed 340 G

28
00:01:50,530 --> 00:01:48,860
pi is specifically designed for high

29
00:01:52,090 --> 00:01:50,540
contrast imaging it's a facility

30
00:01:53,950 --> 00:01:52,100
instrument though so there are many

31
00:01:57,460 --> 00:01:53,960
users and principal investigators

32
00:01:59,770 --> 00:01:57,470
outside of the G PI's team who are

33
00:02:02,499 --> 00:01:59,780
interested in for example imaging pre

34
00:02:04,300 --> 00:02:02,509
main sequence stars or some targets

35
00:02:06,190 --> 00:02:04,310
which are not on our reserve catalogue

36
00:02:09,280 --> 00:02:06,200
you need a star that's brighter than

37
00:02:11,680 --> 00:02:09,290
ninth magnitude to serve as a natural

38
00:02:14,140 --> 00:02:11,690

guide star has a relatively small field

39
00:02:17,650 --> 00:02:14,150
of view of 2.8 arc seconds by 2.8 arc

40
00:02:19,780 --> 00:02:17,660
seconds and it achieves a relatively low

41
00:02:23,699 --> 00:02:19,790
spectral resolution in that

42
00:02:31,380 --> 00:02:28,630
the survey started in December of 2014

43
00:02:33,660 --> 00:02:31,390
it's strictly conducted in the H band

44
00:02:36,390 --> 00:02:33,670
and we also have a dual channel

45
00:02:38,710 --> 00:02:36,400
polarimetry mode where we search for

46
00:02:43,720 --> 00:02:38,720
polarization signatures from scattering

47
00:02:46,270 --> 00:02:43,730
from dust grains around stars the the

48
00:02:48,610 --> 00:02:46,280
sample of stars was developed in a

49
00:02:51,990 --> 00:02:48,620
period of three years preceding the

50
00:02:55,629 --> 00:02:52,000
survey by Jenny patients and in Suk song

51
00:02:58,300 --> 00:02:55,639
and we've selected stars that are all

52
00:03:03,970 --> 00:02:58,310
roughly younger than 300 million years

53
00:03:05,800 --> 00:03:03,980
and within 150 parsec these are the

54
00:03:08,619 --> 00:03:05,810
directly image planets so far with cheap

55
00:03:11,679 --> 00:03:08,629
I three of these have three of these

56
00:03:15,750 --> 00:03:11,689
systems are previously known HR 8799 9

57
00:03:20,409 --> 00:03:15,760
508 6b and beta pick B and our new

58
00:03:22,300 --> 00:03:20,419
detection is 51 Airy p51 Airy is

59
00:03:26,349 --> 00:03:22,310
actually part of the beta pick moving

60
00:03:28,689 --> 00:03:26,359
group so it's age is 20 million years it

61
00:03:32,170 --> 00:03:28,699
is a hierarchical triple system so

62
00:03:33,550 --> 00:03:32,180
there's a 2,000 a you to the south or

63
00:03:37,890 --> 00:03:33,560

roughly an arc minute to the south

64
00:03:41,680 --> 00:03:37,900
there's a close pair of binary M dwarfs

65
00:03:44,469 --> 00:03:41,690
the mass of 51 a DB is roughly 2 to 3

66
00:03:47,110 --> 00:03:44,479
Jupiter masses and because it's such a

67
00:03:49,899 --> 00:03:47,120
young system it was imaged many times

68
00:03:51,699 --> 00:03:49,909
before by the previous generation of

69
00:03:54,129 --> 00:03:51,709
instrumentation so this really

70
00:03:56,740 --> 00:03:54,139
highlights the fact that this improved

71
00:03:59,409 --> 00:03:56,750
contrast provided by G PI really makes a

72
00:04:05,559 --> 00:03:59,419
difference in our exploration parameter

73
00:04:07,780 --> 00:04:05,569
space the spectrum shows deep methane

74
00:04:10,210 --> 00:04:07,790
absorption so much like here's the

75
00:04:13,030 --> 00:04:10,220
methane band here and H band we see this

76
00:04:17,229 --> 00:04:13,040
absorption so it's very much like our

77
00:04:22,649 --> 00:04:17,239
own Jupiter Eric Nielsen one of our

78
00:04:24,790 --> 00:04:22,659
postdocs is developing our sensitivity

79
00:04:26,770 --> 00:04:24,800
assessing the sensitivity of our survey

80
00:04:29,110 --> 00:04:26,780
after 300 stars and this is our

81
00:04:32,130 --> 00:04:29,120
sensitivity plot our current sensitivity

82
00:04:33,900 --> 00:04:32,140
plot as function of planet mass

83
00:04:37,140 --> 00:04:33,910
whose 10 Jupiter masses at semi-major

84
00:04:39,660 --> 00:04:37,150
axis previous surveys would not have

85
00:04:41,610 --> 00:04:39,670
been sensitive to planets in this regime

86
00:04:43,710 --> 00:04:41,620
and this is in fact what GPI is

87
00:04:46,380 --> 00:04:43,720
accomplishing and this point shows the

88
00:04:48,840 --> 00:04:46,390

detection of 51 re B it's very

89
00:04:51,150 --> 00:04:48,850
interesting now now this is a plot of

90
00:04:53,940 --> 00:04:51,160
our entire sample so far but you can

91
00:04:57,330 --> 00:04:53,950
split the sample up into the different

92
00:05:00,560 --> 00:04:57,340
spectra the stellar masses and this is

93
00:05:03,210 --> 00:05:00,570
quite interesting if you look at our our

94
00:05:08,040 --> 00:05:03,220
sensitivity limits as function of

95
00:05:10,440 --> 00:05:08,050
spectral type or stellar mass all the

96
00:05:14,250 --> 00:05:10,450
extrasolar planets are detected around

97
00:05:17,550 --> 00:05:14,260
higher mass stars so we were sensitive

98
00:05:19,560 --> 00:05:17,560
indeed to jupiter-mass planets at this

99
00:05:21,420 --> 00:05:19,570
range of semi-major axis around lower

100
00:05:23,460 --> 00:05:21,430
mass stars but they have not been

101
00:05:26,400 --> 00:05:23,470
detected they're not there so there

102
00:05:28,740 --> 00:05:26,410
seems to be a strong correlation of the

103
00:05:32,790 --> 00:05:28,750
frequency of giant planets in the 5 to

104
00:05:36,210 --> 00:05:32,800
58 you read semi-major axis region with

105
00:05:38,910 --> 00:05:36,220
stellar mass we still want to finish our

106
00:05:43,200 --> 00:05:38,920
survey to see if this is confirmed this

107
00:05:45,840 --> 00:05:43,210
is real and in fact as we image the

108
00:05:50,900 --> 00:05:45,850
remainder of our sample and other 260

109
00:05:56,190 --> 00:05:53,400
here's an image gallery of the debris

110
00:05:58,500 --> 00:05:56,200
disks we've imaged the structure and

111
00:06:01,140 --> 00:05:58,510
morphology of these debris disks can

112
00:06:03,180 --> 00:06:01,150
indicate the presence of sub

113
00:06:06,090 --> 00:06:03,190

jupiter-mass planets that aren't

114
00:06:07,560 --> 00:06:06,100
directly detected but modified through

115
00:06:12,090 --> 00:06:07,570
gravitational perturbations the

116
00:06:13,620 --> 00:06:12,100
structure of the debris disks so for the

117
00:06:16,500 --> 00:06:13,630
remainder of the talk I wanted to

118
00:06:19,350 --> 00:06:16,510
highlight sort of the wider impact of G

119
00:06:21,120 --> 00:06:19,360
pie and I'll discuss two systems which

120
00:06:24,600 --> 00:06:21,130
both have debris disks and directly

121
00:06:26,100 --> 00:06:24,610
image planets one is HD 106 906 where

122
00:06:29,880 --> 00:06:26,110
the central star is actually a binary

123
00:06:31,980 --> 00:06:29,890
pair of f5 stars age 30 million years

124
00:06:33,960 --> 00:06:31,990
and ska sin and I'll also talk about

125
00:06:37,640 --> 00:06:33,970
beta pick which is a more massive star

126
00:06:41,840 --> 00:06:37,650
at 19.3 parsec in age 20 million years

127
00:06:45,590 --> 00:06:41,850
so first with 106 906 the

128
00:06:47,390 --> 00:06:45,600
extrasolar planet 106 906 be has 11

129
00:06:51,290 --> 00:06:47,400
Jupiter masses but it's at a very wide

130
00:06:55,070 --> 00:06:51,300
separation it's at 700 au from the star

131
00:06:57,530 --> 00:06:55,080
and this was in fact detected previous

132
00:06:59,680 --> 00:06:57,540
to the start of the G PI survey by

133
00:07:02,540 --> 00:06:59,690
Vanessa Bailey at all here in Arizona

134
00:07:05,510 --> 00:07:02,550
and with G PI what we accomplished is

135
00:07:07,970 --> 00:07:05,520
the detection of scattered light from

136
00:07:10,520 --> 00:07:07,980
the the debris disc surrounding the

137
00:07:12,320 --> 00:07:10,530
primary and the new result and it's

138
00:07:14,690 --> 00:07:12,330

quite surprising is that the debris disc

139
00:07:15,620 --> 00:07:14,700
detected with G PI it's position angle

140
00:07:19,220 --> 00:07:15,630
is misaligned

141
00:07:22,820 --> 00:07:19,230
with that of the star we looked at

142
00:07:25,250 --> 00:07:22,830
archival HST images and saw features in

143
00:07:27,110 --> 00:07:25,260
the outer region which suggested a

144
00:07:29,540 --> 00:07:27,120
highly perturbed debris disc and what

145
00:07:31,910 --> 00:07:29,550
I'm showing you here is our latest data

146
00:07:34,310 --> 00:07:31,920
using HST States this is unpublished to

147
00:07:37,640 --> 00:07:34,320
data the observations were made just six

148
00:07:39,770 --> 00:07:37,650
weeks ago confirming that the morphology

149
00:07:42,950 --> 00:07:39,780
of the outer disk is highly perturbed

150
00:07:44,540 --> 00:07:42,960
this is not instrumental this is the

151
00:07:47,600 --> 00:07:44,550
actual structure of the debris disk

152
00:07:50,540 --> 00:07:47,610
showing a long and flat westward

153
00:07:52,850 --> 00:07:50,550
extension and a radially truncated this

154
00:07:56,930 --> 00:07:52,860
is roughly 300 au and vertically

155
00:07:59,000 --> 00:07:56,940
distended eastern side as if the whole

156
00:08:02,690 --> 00:07:59,010
system is in the state of dynamical

157
00:08:04,610 --> 00:08:02,700
upheaval may be analogous to our own

158
00:08:07,990 --> 00:08:04,620
solar system's period of late heavy

159
00:08:11,030 --> 00:08:08,000
bombardment this work has already

160
00:08:13,340 --> 00:08:11,040
inspired two Theory papers that have

161
00:08:16,990 --> 00:08:13,350
come out investigating how the planet or

162
00:08:20,990 --> 00:08:17,000
a passing star could invoke these

163
00:08:23,690 --> 00:08:21,000

asymmetries we also have looked at the

164
00:08:24,980 --> 00:08:23,700
Alma cycle one data which is a non

165
00:08:27,140 --> 00:08:24,990
detection in the sense that the

166
00:08:31,700 --> 00:08:27,150
signal-to-noise of the cycle one data is

167
00:08:35,959 --> 00:08:31,710
two and a half or two sigma but the

168
00:08:37,430 --> 00:08:35,969
orientation of these contours is exactly

169
00:08:40,370 --> 00:08:37,440
aligned with the position angle of the

170
00:08:44,600 --> 00:08:40,380
disc and we've applied for cycle five

171
00:08:50,970 --> 00:08:44,610
Alma time to discover the spatial

172
00:08:55,450 --> 00:08:53,740
we'll be on to beta pick beta pick has

173
00:08:57,940 --> 00:08:55,460
always been known to be an edge-on

174
00:09:00,760 --> 00:08:57,950
system since it was first discovered in

175
00:09:03,460 --> 00:09:00,770
1984 so when the planet was discovered

176
00:09:06,040 --> 00:09:03,470
beta pick be an actual question was you

177
00:09:08,380 --> 00:09:06,050
have a directly image planet the system

178
00:09:10,390 --> 00:09:08,390
is edge on is this a unique case in

179
00:09:12,820 --> 00:09:10,400
nature where we would be able to

180
00:09:14,350 --> 00:09:12,830
characterize an extrasolar planet not

181
00:09:21,280 --> 00:09:14,360
only because it's directly imaged but

182
00:09:23,080 --> 00:09:21,290
because it will also transit the star so

183
00:09:24,910 --> 00:09:23,090
we've been monitoring beta picked B over

184
00:09:26,920 --> 00:09:24,920
the last three years using G PI we've

185
00:09:30,640 --> 00:09:26,930
published three papers on this and in

186
00:09:34,720 --> 00:09:30,650
our last paper we've determined the

187
00:09:37,920 --> 00:09:34,730
orbital elements very precisely here you

188
00:09:42,070 --> 00:09:37,930

can see that you can see the time here

189
00:09:43,600 --> 00:09:42,080
and that beta pick B is now about to

190
00:09:46,780 --> 00:09:43,610
transit in front of the star

191
00:09:48,970 --> 00:09:46,790
unfortunately our analysis indicates

192
00:09:51,970 --> 00:09:48,980
through this work by graduate student

193
00:09:55,150 --> 00:09:51,980
Jason Wang at Berkeley that the the

194
00:09:57,240 --> 00:09:55,160
orbital elements aren't a show that the

195
00:09:59,650 --> 00:09:57,250
inclination is not exactly a John

196
00:10:01,540 --> 00:09:59,660
unfortunately the planet will not pass

197
00:10:07,690 --> 00:10:01,550
in front of the star it's just missing

198
00:10:09,430 --> 00:10:07,700
it by 0.2 au or 10 mili arcseconds the

199
00:10:11,200 --> 00:10:09,440
good news is the hill sphere of the

200
00:10:13,900 --> 00:10:11,210
planet is transiting so this is an

201
00:10:17,170 --> 00:10:13,910
opportunity to search for planetary

202
00:10:20,200 --> 00:10:17,180
rings the what G PI has provided is this

203
00:10:22,930 --> 00:10:20,210
ephemeris for the transit which is now

204
00:10:25,120 --> 00:10:22,940
being used by many groups all around the

205
00:10:28,590 --> 00:10:25,130
world to monitor beta pick for planetary

206
00:10:31,840 --> 00:10:28,600
rings the hill sphere has already oops

207
00:10:34,870 --> 00:10:31,850
the hill sphere has already started

208
00:10:37,690 --> 00:10:34,880
passing in front of the star in early

209
00:10:41,050 --> 00:10:37,700
April by June 20th half a hill sphere

210
00:10:44,440 --> 00:10:41,060
will be in front of the star and closed

211
00:10:46,090 --> 00:10:44,450
approaches August 31st problem is that

212
00:10:48,750 --> 00:10:46,100
beta pick is at right ascension six

213
00:10:52,210 --> 00:10:48,760

hours so you can observe it from most

214
00:10:54,730 --> 00:10:52,220
observatories in the summer so we have

215
00:10:58,120 --> 00:10:54,740
two solutions we have a Hubble program

216
00:11:00,610 --> 00:10:58,130
to monitor beta pick using whiskey three

217
00:11:03,220 --> 00:11:00,620
uva's in spatial scanning mode we've

218
00:11:07,210 --> 00:11:03,230
already obtained data at two epochs

219
00:11:09,760 --> 00:11:07,220
or the ingress and we will re observe

220
00:11:11,860 --> 00:11:09,770
beta pick in July in August to see if

221
00:11:13,900 --> 00:11:11,870
there's been any extinction of life due

222
00:11:16,840 --> 00:11:13,910
to foreground dust surrounding the

223
00:11:20,410 --> 00:11:16,850
planet we also have collaborated with

224
00:11:22,240 --> 00:11:20,420
teams in Antarctica it turns out that

225
00:11:24,850 --> 00:11:22,250
Antarctica is a great place for

226
00:11:28,390 --> 00:11:24,860
astronomy in July and August because

227
00:11:30,250 --> 00:11:28,400
it's always dark there the the Chinese

228
00:11:33,070 --> 00:11:30,260
and French have transit monitoring

229
00:11:37,030 --> 00:11:33,080
telescopes there the Chinese at dome a

230
00:11:39,070 --> 00:11:37,040
and the French at dome C and the French

231
00:11:41,620 --> 00:11:39,080
in particular will be monitoring beta

232
00:11:44,410 --> 00:11:41,630
pick 24 hours a day seven days a week

233
00:11:50,170 --> 00:11:44,420
through all of July and August searching

234
00:11:53,500 --> 00:11:50,180
for ring signatures what do we expect to

235
00:11:55,960 --> 00:11:53,510
find well what about moons the transit

236
00:11:57,820 --> 00:11:55,970
depths of a moon of moons is roughly a

237
00:11:59,980 --> 00:11:57,830
micro max so we don't have that

238
00:12:03,460 --> 00:11:59,990

precision our precision is roughly a

239
00:12:05,710 --> 00:12:03,470
millimes so that is very very good for

240
00:12:07,870 --> 00:12:05,720
detecting rings and if the structure of

241
00:12:10,780 --> 00:12:07,880
rings shows gaps maybe we could also

242
00:12:15,820 --> 00:12:10,790
infer the presence of circum planetary

243
00:12:18,580 --> 00:12:15,830
moons okay so that was a brief summary

244
00:12:20,850 --> 00:12:18,590
of what we've accomplished with with g

245
00:12:24,460 --> 00:12:20,860
pi to date loud covered one new

246
00:12:26,440 --> 00:12:24,470
extrasolar planet we've determined the

247
00:12:29,170 --> 00:12:26,450
orbital elements of the other extra

248
00:12:31,780 --> 00:12:29,180
planets we can characterize their

249
00:12:34,180 --> 00:12:31,790
atmospheres through the spectra that we

250
00:12:37,240 --> 00:12:34,190
obtain with G PI and there's a much

251
00:12:40,570 --> 00:12:37,250
broader impact with follow-up HST and

252
00:12:44,320 --> 00:12:40,580
Alma imaging as well as hopefully with

253
00:12:46,000 --> 00:12:44,330
JWST in the future and this transit

254
00:12:48,130 --> 00:12:46,010
monitoring campaign of beta pick is

255
00:12:50,530 --> 00:12:48,140
ongoing with the potential of

256
00:12:52,440 --> 00:12:50,540
discovering planetary rings around

257
00:12:57,560 --> 00:12:52,450
another planet thank

258
00:13:00,120 --> 00:12:57,570
[Applause]

259
00:13:01,350 --> 00:13:00,130
excellent thank you we have about three

260
00:13:02,490 --> 00:13:01,360
minutes for questions so if you have a

261
00:13:16,930 --> 00:13:02,500
question please come up to the mic

262
00:13:24,610 --> 00:13:19,840
okay well I think we'll thank you very

263
00:13:30,520 --> 00:13:24,620

much on to our next speaker oh we have a

264
00:13:32,710 --> 00:13:30,530
question Oh perfect thanks Paul

265
00:13:34,030 --> 00:13:32,720
it's great to see the results coming

266
00:13:36,430 --> 00:13:34,040
along and I want to ask about the

267
00:13:40,120 --> 00:13:36,440
sensitivity plot you showed earlier in

268
00:13:43,020 --> 00:13:40,130
your talk we had the contours yeah

269
00:13:46,420 --> 00:13:43,030
and was there an assumption in those

270
00:13:49,210 --> 00:13:46,430
sensitivity calculations of if each star

271
00:13:53,410 --> 00:13:49,220
had one planet then we should have seen

272
00:13:56,680 --> 00:13:53,420
seen it - this many stars or was it

273
00:13:59,650 --> 00:13:56,690
driven by a current rates of it was

274
00:14:03,010 --> 00:13:59,660
really rare occurence rates yeah so we

275
00:14:07,120 --> 00:14:03,020
were in fact using some of the

276
00:14:09,790 --> 00:14:07,130
occurrence rates in terms of the the

277
00:14:12,520 --> 00:14:09,800
distribution of orbital elements is that

278
00:14:14,740 --> 00:14:12,530
from RV surveys is that what you're

279
00:14:16,960 --> 00:14:14,750
asking right yeah I know the activity of

280
00:14:20,080 --> 00:14:16,970
obvious stops Peter out once you get to

281
00:14:22,030 --> 00:14:20,090
know yeah we were all but although some

282
00:14:27,670 --> 00:14:22,040
of the assumptions have to do with the

283
00:14:30,040 --> 00:14:27,680
RV statistics from from coming at Al and