
Pedro Nogueira
Detecting a Population of Planets Around
Kepler's Faintest Stars

1
00:00:00,240 --> 00:00:10,890
[Music]

2
00:00:17,290 --> 00:00:15,270
hi I'm Pedro I'm a master student of

3
00:00:23,140 --> 00:00:17,300
national observatory

4
00:00:27,159 --> 00:00:23,150
I'm funding funded by parish so yeah

5
00:00:29,980 --> 00:00:27,169
this is the the our group my advisor one

6
00:00:31,860 --> 00:00:29,990
gas from value Observateur Benjamin

7
00:00:34,540 --> 00:00:31,870
wanted from the University of Chicago

8
00:00:39,130 --> 00:00:34,550
and simile the flow from the National

9
00:00:41,740 --> 00:00:39,140
Observatory in Brazil well let me

10
00:00:46,480 --> 00:00:41,750
introduce my my presentation with this

11
00:00:49,450 --> 00:00:46,490
glass slide for from an extra planetary

12
00:00:52,210 --> 00:00:49,460
presentation that sure was a cumulative

13
00:00:56,140 --> 00:00:52,220

number of detection of exoplanets

14
00:00:59,500 --> 00:00:56,150
through the years and the different

15
00:01:06,520 --> 00:00:59,510
colors refers to different methods of

16
00:01:10,630 --> 00:01:06,530
detection so we have sorry the most of

17
00:01:23,260 --> 00:01:10,640
them is LA were detected by tragedy and

18
00:01:31,850 --> 00:01:28,940
hi-yah okay sorry and that's due to a

19
00:01:37,370 --> 00:01:31,860
space telescope called Kepler there it

20
00:01:41,960 --> 00:01:37,380
was dedicated to the transit method and

21
00:01:45,830 --> 00:01:41,970
in my own self it founded by it found

22
00:01:50,980 --> 00:01:45,840
around 68 percent of all planets that we

23
00:01:56,120 --> 00:01:50,990
have until today and so yeah so like

24
00:02:00,020 --> 00:01:56,130
number genes give us a spoiler the

25
00:02:03,440 --> 00:02:00,030
Trinity method is is like we see a

26
00:02:05,780 --> 00:02:03,450
source of light like a star and we can

27
00:02:08,930 --> 00:02:05,790
track its brightness through the time

28
00:02:11,570 --> 00:02:08,940
producing a light curve so when

29
00:02:15,290 --> 00:02:11,580
something passes in front of the star in

30
00:02:18,830 --> 00:02:15,300
our line of sight like a planet we can

31
00:02:23,120 --> 00:02:18,840
see variation in the light curve we're

32
00:02:26,690 --> 00:02:23,130
decreasing after an increase of the flux

33
00:02:30,370 --> 00:02:26,700
or brightness so that is how we detect

34
00:02:35,060 --> 00:02:30,380
planets in the transit man method

35
00:02:37,880 --> 00:02:35,070
well the Kepler field of view has an

36
00:02:41,350 --> 00:02:37,890
area of one hundred and fifteen and

37
00:02:45,530 --> 00:02:41,360
fifteen point six square degrees the

38
00:02:50,600 --> 00:02:45,540

every ninety three days the telescope

39
00:02:53,690 --> 00:02:50,610
Rose 92 degrees but it preserves the

40
00:02:58,870 --> 00:02:53,700
same field of view and in this field of

41
00:03:03,940 --> 00:02:58,880
view we have around a 4.5 million stars

42
00:03:07,220 --> 00:03:03,950
but the Kepler team only observe it only

43
00:03:12,050 --> 00:03:07,230
bracket and producer light curves for

44
00:03:15,650 --> 00:03:12,060
just a piece of it because the technical

45
00:03:21,800 --> 00:03:15,660
limitations esteridge data so they chose

46
00:03:27,110 --> 00:03:21,810
the brightest stars here KP is the kappa

47
00:03:28,910 --> 00:03:27,120
magnitude in the in astronomy we less

48
00:03:32,300 --> 00:03:28,920
than magnitude

49
00:03:37,970 --> 00:03:32,310
is writer the source so it is yeah it's

50
00:03:41,510 --> 00:03:37,980
fuzzy okay and the other other stars

51
00:03:43,940 --> 00:03:41,520
were only observe it emits called

52
00:03:46,880 --> 00:03:43,950
full-frame image that contains all the

53
00:03:52,449 --> 00:03:46,890
oldest there's more than four million

54
00:03:56,210 --> 00:03:52,459
stars but they don't have light cars so

55
00:03:58,759 --> 00:03:56,220
we have eight F of s that were taken

56
00:04:02,030 --> 00:03:58,769
during the commission time of the

57
00:04:04,670 --> 00:04:02,040
telescope there are other four 5ff eyes

58
00:04:08,259 --> 00:04:04,680
we're thinking like a monthly with this

59
00:04:13,460 --> 00:04:08,269
time of exposure here I present you an

60
00:04:19,849 --> 00:04:13,470
example of one piece of one FFI that

61
00:04:24,800 --> 00:04:19,859
contains more than 30,000 stars and this

62
00:04:30,350 --> 00:04:24,810
is layout of one FFI we have here eight

63
00:04:34,010 --> 00:04:30,360

four of these minor squares and and the

64
00:04:37,719 --> 00:04:34,020
last image was when an example of one

65
00:04:41,420 --> 00:04:37,729
just piece of one FFI so we're doing

66
00:04:45,469 --> 00:04:41,430
hard math here eight four times

67
00:04:48,710 --> 00:04:45,479
53 FFI so we're dealing with this number

68
00:04:52,520 --> 00:04:48,720
of events all of them contain more

69
00:04:55,300 --> 00:04:52,530
thousands and thousands of stars so yeah

70
00:05:00,200 --> 00:04:55,310
it's a big data here

71
00:05:03,320 --> 00:05:00,210
well our goal is to is focusing updated

72
00:05:05,960 --> 00:05:03,330
statistics of planets around me Milky

73
00:05:07,580 --> 00:05:05,970
Way stars that is important to

74
00:05:11,600 --> 00:05:07,590
understand better the planetary

75
00:05:15,000 --> 00:05:11,610
formation models because we need more

76
00:05:17,280 --> 00:05:15,010
planes to be found to improve the

77
00:05:20,190 --> 00:05:17,290
the knowledge that we have about the

78
00:05:23,820 --> 00:05:20,200
formation of the planets we don't we

79
00:05:27,960 --> 00:05:23,830
have an issue between the planet Icarus

80
00:05:30,800 --> 00:05:27,970
rates from different methods so we need

81
00:05:33,510 --> 00:05:30,810
to attack this problem here and

82
00:05:39,230 --> 00:05:33,520
unfortunately we are focusing in

83
00:05:43,950 --> 00:05:39,240
fighting project errs because we have

84
00:05:47,010 --> 00:05:43,960
not very good time coverage hffi is like

85
00:05:52,260 --> 00:05:47,020
taking monthly and normally we have for

86
00:05:58,860 --> 00:05:52,270
a transit detection like time a coverage

87
00:06:01,380 --> 00:05:58,870
a in days not in most and with that hot

88
00:06:05,310 --> 00:06:01,390

Jupiters will characterize the their

89
00:06:08,460 --> 00:06:05,320
orbital periods and we as you and we

90
00:06:12,270 --> 00:06:08,470
expect more than 100 planetary systems

91
00:06:14,550 --> 00:06:12,280
to be found and as an extra will find

92
00:06:17,990 --> 00:06:14,560
new celestial bodies like eclipsing

93
00:06:20,850 --> 00:06:18,000
binaries variable stars and brown dwarfs

94
00:06:24,330 --> 00:06:20,860
okay so what you could ask me first

95
00:06:26,640 --> 00:06:24,340
searching so yes for a giant gas

96
00:06:29,430 --> 00:06:26,650
extremely hot planes there are

97
00:06:32,070 --> 00:06:29,440
inhabitable there is extremely

98
00:06:37,220 --> 00:06:32,080
environments where is the astrobiology

99
00:06:40,350 --> 00:06:37,230
in your work okay so we don't know the

100
00:06:43,170 --> 00:06:40,360
fraction of habitable claims because we

101
00:06:47,070 --> 00:06:43,180
don't know a lot of habitable planets we

102
00:06:50,550 --> 00:06:47,080
don't know a lot of planets that okay we

103
00:06:55,500 --> 00:06:50,560
just have four thousand planets found

104
00:07:00,720 --> 00:06:55,510
into today and we have millions of the

105
00:07:04,470 --> 00:07:00,730
stars in our Milky Way okay and to

106
00:07:07,500 --> 00:07:04,480
answer this question we need a better

107
00:07:10,950 --> 00:07:07,510
model of planet information and this

108
00:07:14,010 --> 00:07:10,960
model must explain all types of planets

109
00:07:17,460 --> 00:07:14,020
including these hot Jupiters so yeah

110
00:07:23,430 --> 00:07:17,470
after all we need more data we need more

111
00:07:26,640 --> 00:07:23,440
planets to answer this question so there

112
00:07:30,990 --> 00:07:26,650
were some previous works

113
00:07:36,030 --> 00:07:31,000

with this FFI data from Kepler like this

114
00:07:38,790 --> 00:07:36,040
this 2 1 here and we expected by the

115
00:07:41,910 --> 00:07:38,800
literature and previous works decrease

116
00:07:45,180 --> 00:07:41,920
of brightness of around 1% for giant

117
00:07:48,690 --> 00:07:45,190
planets our hot Jupiters in around 50%

118
00:07:52,980 --> 00:07:48,700
for eclipsing binary and then in the

119
00:07:56,520 --> 00:07:52,990
middle of it way we will find brown

120
00:08:03,870 --> 00:07:56,530
dwarfs like this this example here that

121
00:08:07,200 --> 00:08:03,880
represents the quiz of 3 percent of the

122
00:08:10,130 --> 00:08:07,210
brown dwarf passing in front of its it's

123
00:08:14,550 --> 00:08:10,140
M dwarf stars

124
00:08:20,550 --> 00:08:14,560
okay for that we use it we adapted the

125
00:08:24,090 --> 00:08:20,560
code that were buted to to the test f fi

126
00:08:26,909 --> 00:08:24,100
a image that tells is like the successor

127
00:08:30,870 --> 00:08:26,919
of kepler because Kepler is toppled to

128
00:08:35,730 --> 00:08:30,880
work last year so we adapted this code

129
00:08:40,110 --> 00:08:35,740
we are adapting this code so yeah we

130
00:08:43,440 --> 00:08:40,120
have different FF Ison see CDs so yeah

131
00:08:45,600 --> 00:08:43,450
this is the boring part we have to to

132
00:08:49,170 --> 00:08:45,610
modify the the things that the the

133
00:08:55,140 --> 00:08:49,180
matrices and all of this that that stuff

134
00:08:57,000 --> 00:08:55,150
and after we had to clean the image so

135
00:09:01,620 --> 00:08:57,010
you reuse it

136
00:09:04,410 --> 00:09:01,630
Sigma clip function that that we put a

137
00:09:08,430 --> 00:09:04,420
threshold and it removes all the

138
00:09:12,600 --> 00:09:08,440

outliers so that allows us to produce

139
00:09:16,680 --> 00:09:12,610
clean it image and noise image and the

140
00:09:20,810 --> 00:09:16,690
comparison of them showed to us that we

141
00:09:25,500 --> 00:09:20,820
have a noise in the clinic image that's

142
00:09:27,840 --> 00:09:25,510
that it is under the precision that we

143
00:09:30,750 --> 00:09:27,850
need to find hot Jupiters away it is

144
00:09:33,180 --> 00:09:30,760
good we need accuracy greater than one

145
00:09:36,329 --> 00:09:33,190
person okay

146
00:09:39,200 --> 00:09:36,339
then we have we had to align and

147
00:09:42,800 --> 00:09:39,210
combinate the image way

148
00:09:48,560 --> 00:09:42,810
here I have an example of one piece

149
00:09:51,680 --> 00:09:48,570
often and image and here I have the the

150
00:09:56,660 --> 00:09:51,690
reference frame that was created by

151
00:09:58,780 --> 00:09:56,670
stacking different image with the same

152
00:10:04,160 --> 00:09:58,790
field of view and the same orientation

153
00:10:09,350 --> 00:10:04,170
so looking at that looking at it they

154
00:10:13,970 --> 00:10:09,360
need the day they show like very similar

155
00:10:15,860 --> 00:10:13,980
but yeah we can detect the difference of

156
00:10:19,790 --> 00:10:15,870
1% by eye

157
00:10:22,100 --> 00:10:19,800
so for that we have to do some photon

158
00:10:28,220 --> 00:10:22,110
three-point some good photography here

159
00:10:30,650 --> 00:10:28,230
so we are doing that right now so we're

160
00:10:34,460 --> 00:10:30,660
having some some problems in this part

161
00:10:39,320 --> 00:10:34,470
but we are completely we are almost done

162
00:10:43,070 --> 00:10:39,330
the photometry after after that we have

163
00:10:46,700 --> 00:10:43,080

to compare to make difference between

164
00:10:51,170 --> 00:10:46,710
the reference frames and this the single

165
00:10:56,150 --> 00:10:51,180
and clear and FFI so this we will all

166
00:10:59,720 --> 00:10:56,160
allow us to produce 53 points for its

167
00:11:03,290 --> 00:10:59,730
light curve so then we have to create

168
00:11:07,130 --> 00:11:03,300
the light curves so here we we will have

169
00:11:11,320 --> 00:11:07,140
to do more than 4 million light curves

170
00:11:18,620 --> 00:11:11,330
with each one contains container

171
00:11:22,160 --> 00:11:18,630
containing the 53 points well then we

172
00:11:25,190 --> 00:11:22,170
will have to classify the classic 8d

173
00:11:27,440 --> 00:11:25,200
objects-- like in planets brown dwarfs

174
00:11:32,240 --> 00:11:27,450
eclipsing binaries and variable stars

175
00:11:35,330 --> 00:11:32,250
there there is some work today that is

176
00:11:41,870 --> 00:11:35,340
doing that I don't remember the the

177
00:11:46,610 --> 00:11:41,880
paper right okay then we have to do the

178
00:11:49,370 --> 00:11:46,620
appropriate characterization and finally

179
00:11:53,550 --> 00:11:49,380
oh my god finally

180
00:11:57,150 --> 00:11:53,560
we had to do some good statistical

181
00:12:00,570 --> 00:11:57,160
analysis here that will allow us to much

182
00:12:04,320 --> 00:12:00,580
you know like the hot Jupiters

183
00:12:07,079 --> 00:12:04,330
occurrence that way we need to to attack

184
00:12:10,829 --> 00:12:07,089
this problem of this of the difference

185
00:12:16,530 --> 00:12:10,839
between methods and we don't know okay

186
00:12:18,900 --> 00:12:16,540
so yeah just to recap we have a four

187
00:12:22,230 --> 00:12:18,910
point thirty five million lights curve

188
00:12:26,930 --> 00:12:22,240

should be created and analyze it after

189
00:12:31,200 --> 00:12:26,940
we we don't we we done we're the

190
00:12:34,500 --> 00:12:31,210
photometry and we expect this number of

191
00:12:38,100 --> 00:12:34,510
new hot Jupiters or more just

192
00:12:43,980 --> 00:12:38,110
extrapolating the the the data that we

193
00:12:51,290 --> 00:12:43,990
have for the Kepler and using the some

194
00:12:55,140 --> 00:12:51,300
explanted exoplanet catalog so that

195
00:12:58,680 --> 00:12:55,150
would increase in nineteen percent the

196
00:13:02,790 --> 00:12:58,690
sample of all the hot Jupiters that we

197
00:13:04,650 --> 00:13:02,800
we know today and this is important to

198
00:13:08,340 --> 00:13:04,660
understand better the planetary

199
00:13:11,310 --> 00:13:08,350
formation the planetary migration so it

200
00:13:16,010 --> 00:13:11,320
looks like a lot of more work to do

201
00:13:19,230 --> 00:13:16,020
well the the name problem here is the

202
00:13:23,850 --> 00:13:19,240
technical competition and the updation

203
00:13:30,410 --> 00:13:23,860
of the co so yeah that is the hard work

204
00:13:34,320 --> 00:13:30,420
here but yeah I had to end this by March

205
00:13:38,640 --> 00:13:34,330
yeah wish me luck okay

206
00:13:45,270 --> 00:13:38,650
and that's all yeah

207
00:13:58,390 --> 00:13:55,690
questions hi thank you for your hard

208
00:14:01,270 --> 00:13:58,400
work I know how how big the project is

209
00:14:02,710 --> 00:14:01,280
it's just not so very um I have a

210
00:14:03,280 --> 00:14:02,720
question do you don't have any plan to

211
00:14:05,620 --> 00:14:03,290
do

212
00:14:13,360 --> 00:14:05,630
sub or following observation on cake

213
00:14:17,140 --> 00:14:13,370

stars yeah yeah there's a step that we

214
00:14:21,490 --> 00:14:17,150
need to do but I don't think that I will

215
00:14:25,030 --> 00:14:21,500
finish this in my master so yeah

216
00:14:29,470 --> 00:14:25,040
the future is is I don't know the future

217
00:14:34,450 --> 00:14:29,480
so I don't know if I will be in this

218
00:14:37,630 --> 00:14:34,460
project in the and my PG but yeah this

219
00:14:38,860 --> 00:14:37,640
is the next step after all that so all

220
00:14:40,600 --> 00:14:38,870
the work that you are doing

221
00:14:43,180 --> 00:14:40,610
yeah it's based on the transit method

222
00:14:46,230 --> 00:14:43,190
that's Kepler did you're not gonna do

223
00:14:55,280 --> 00:14:46,240
any observation yourself or your body

224
00:15:00,270 --> 00:14:58,530
just real quick see you had a rough

225
00:15:04,890 --> 00:15:00,280
estimation of how many hot Jupiters she

226
00:15:06,540 --> 00:15:04,900
planned to potentially get with this had

227
00:15:07,710 --> 00:15:06,550
marred then well you said about more

228
00:15:10,290 --> 00:15:07,720
harm do you have any estimations for

229
00:15:19,710 --> 00:15:10,300
things like brown dwarfs or other planet

230
00:15:23,180 --> 00:15:19,720
types yeah well I also had a question

231
00:15:25,020 --> 00:15:23,190
especially with the large number of

232
00:15:26,730 --> 00:15:25,030
theta that you're going to go through

233
00:15:28,560 --> 00:15:26,740
I'm just wondering like do you have

234
00:15:30,330 --> 00:15:28,570
plans especially for like the

235
00:15:32,280 --> 00:15:30,340
characterizing between eclipsing

236
00:15:34,200 --> 00:15:32,290
binaries and such will you use something

237
00:15:36,450 --> 00:15:34,210
like machine learning algorithms to go

238
00:15:40,110 --> 00:15:36,460

through yeah I think that that is the

239
00:15:42,870 --> 00:15:40,120
next step I'm trying to learn that but

240
00:15:46,770 --> 00:15:42,880
we are in this photometer part and then

241
00:15:55,550 --> 00:15:46,780
we will have to do some like a machine

242
00:15:55,560 --> 00:16:00,140
any other questions