
AbSciCon
2017
MESA, ARIZONA

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

2
00:00:16,510 --> 00:00:14,670
[Music]

3
00:00:19,390 --> 00:00:16,520
alright that said I'm going to give you

4
00:00:22,530 --> 00:00:19,400
mixed messages because these are slides

5
00:00:26,320 --> 00:00:22,540
that I didn't prepare at all I'm giving

6
00:00:28,840 --> 00:00:26,330
giving this talk for Casey who reminded

7
00:00:30,760 --> 00:00:28,850
me that he's at a New Horizons team

8
00:00:32,799 --> 00:00:30,770
he'll be here later in the week and so

9
00:00:38,470 --> 00:00:32,809
that's fine and I'm happy to give your

10
00:00:39,820 --> 00:00:38,480
poster imagine my surprise when I open

11
00:00:42,310 --> 00:00:39,830
my emails and like oh I'm giving the

12
00:00:44,590 --> 00:00:42,320
talk okay so this is not the talk that I

13
00:00:46,090 --> 00:00:44,600

would give now I'm a co-author in the

14
00:00:48,880 --> 00:00:46,100
last one I barely know what this is

15
00:00:51,490 --> 00:00:48,890
about so I'm going to use this as a

16
00:00:53,530 --> 00:00:51,500
demonstration of some basic astronomy

17
00:00:57,549 --> 00:00:53,540
science concepts perhaps but also how

18
00:00:59,920 --> 00:00:57,559
not to prepare and get to talk this is

19
00:01:03,060 --> 00:00:59,930
ultimately I talked about some spectra

20
00:01:05,380 --> 00:01:03,070
that were required using the IRT F

21
00:01:07,450 --> 00:01:05,390
telescope facility in the specs

22
00:01:09,400 --> 00:01:07,460
instrument and I want to just talk about

23
00:01:11,440 --> 00:01:09,410
what those are and what we're doing with

24
00:01:13,749 --> 00:01:11,450
them in the near future

25
00:01:16,630 --> 00:01:13,759
and it's the main result so far has been

26
00:01:19,690 --> 00:01:16,640
to get better spectral types of the

27
00:01:23,920 --> 00:01:19,700
stars that we've observed and this is

28
00:01:25,210 --> 00:01:23,930
important for bio signatures because if

29
00:01:27,940 --> 00:01:25,220
you're going to understand the chemistry

30
00:01:30,460 --> 00:01:27,950
on a planet then you're going to need to

31
00:01:32,050 --> 00:01:30,470
know what chemical compositions that

32
00:01:32,950 --> 00:01:32,060
that planet was made out of and you're

33
00:01:35,200 --> 00:01:32,960
going to want to know what is the

34
00:01:37,179 --> 00:01:35,210
spectral type of the star which affects

35
00:01:38,289 --> 00:01:37,189
the spectrum that impinges on the planet

36
00:01:39,570 --> 00:01:38,299
and determines photochemistry

37
00:01:42,010 --> 00:01:39,580
so all these things are important

38
00:01:44,590 --> 00:01:42,020

instead of saying that I'm going to call

39
00:01:46,380 --> 00:01:44,600
this a very nerds I RTF specs I don't

40
00:01:49,380 --> 00:01:46,390
think there are enough acronyms so

41
00:01:52,510 --> 00:01:49,390
exosystem spectral characterization and

42
00:01:54,819 --> 00:01:52,520
put on a graph you can't really read

43
00:01:56,770 --> 00:01:54,829
okay alright so this is something you

44
00:02:01,569 --> 00:01:56,780
should probably not do is give a list of

45
00:02:04,749 --> 00:02:01,579
things and you can't read and especially

46
00:02:06,280 --> 00:02:04,759
to start off with the list which I think

47
00:02:08,560 --> 00:02:06,290
I should just start with the conclusions

48
00:02:10,630 --> 00:02:08,570
which is that we can type the spectral

49
00:02:12,880 --> 00:02:10,640
types of stars much better using this

50
00:02:16,810 --> 00:02:12,890
infrared spectra where you need somebody

51
00:02:19,030 --> 00:02:16,820
to help us extract chemical abundances

52
00:02:19,990 --> 00:02:19,040
from these IR spectra and we'll show

53
00:02:22,479 --> 00:02:20,000
some of those results

54
00:02:23,949 --> 00:02:22,489
but instead Casey chose to say hey we

55
00:02:24,230 --> 00:02:23,959
got some new observing time and we're

56
00:02:27,290 --> 00:02:24,240
going

57
00:02:30,320 --> 00:02:27,300
- look at these host stars of in the

58
00:02:33,260 --> 00:02:30,330
infrared a few microns emission from 16

59
00:02:35,240 --> 00:02:33,270
of the best Kepler host stars with

60
00:02:37,460 --> 00:02:35,250
planets in the terrestrial habitable

61
00:02:39,200 --> 00:02:37,470
zone we're going to be observing these

62
00:02:40,490 --> 00:02:39,210
stars in June and we're going to get

63
00:02:42,650 --> 00:02:40,500

more data like the rest of the data

64
00:02:43,700 --> 00:02:42,660
you're going to see and we want to know

65
00:02:45,770 --> 00:02:43,710
what can we expect from these

66
00:02:47,240 --> 00:02:45,780
measurements and then we're going to

67
00:02:49,670 --> 00:02:47,250
look at some of the measurements we've

68
00:02:51,410 --> 00:02:49,680
already taken okay so this is all part

69
00:02:56,530 --> 00:02:51,420
of a survey that Casey's been involved

70
00:02:58,790 --> 00:02:56,540
with culty nerds it's 50 plus nerds

71
00:03:02,600 --> 00:02:58,800
targets so it sounds like senior

72
00:03:04,580 --> 00:03:02,610
scientist doesn't it yeah we have

73
00:03:06,800 --> 00:03:04,590
observed a number of systems that have

74
00:03:10,550 --> 00:03:06,810
some sort of circumstellar material and

75
00:03:13,310 --> 00:03:10,560
the infrared from about 0.8 microns to 5

76
00:03:17,360 --> 00:03:13,320
microns spectral resolution about a

77
00:03:19,970 --> 00:03:17,370
thousand to 2,000 with some pretty good

78
00:03:21,950 --> 00:03:19,980
photometry gives us some new interesting

79
00:03:27,620 --> 00:03:21,960
windows into what these spectral types

80
00:03:28,940 --> 00:03:27,630
are like so these graphs don't don't

81
00:03:30,530 --> 00:03:28,950
look at the middle one because you know

82
00:03:33,620 --> 00:03:30,540
that you can read that's the one you

83
00:03:35,930 --> 00:03:33,630
don't want to look at is yeah this is

84
00:03:38,090 --> 00:03:35,940
ridiculous do not ever kids don't put in

85
00:03:40,760 --> 00:03:38,100
a graph just puts labels that they're

86
00:03:42,740 --> 00:03:40,770
too small to read even on my laptop I

87
00:03:44,240 --> 00:03:42,750
can't even read them on your laptop he's

88
00:03:47,200 --> 00:03:44,250

just trying to say though we can get

89
00:03:52,810 --> 00:03:47,210
data and they kind of look like this and

90
00:03:58,970 --> 00:03:56,180
okay so the first thing we need to do is

91
00:04:01,310 --> 00:03:58,980
to figure out the spectral types of

92
00:04:02,360 --> 00:04:01,320
stars you'd think we could know this you

93
00:04:09,580 --> 00:04:02,370
guys are all familiar with spectral

94
00:04:12,890 --> 00:04:09,590
types oba FG km/l T and the mnemonic

95
00:04:14,990 --> 00:04:12,900
yeah and why right so only boring

96
00:04:20,199 --> 00:04:15,000
astronomers find gratification knowing

97
00:04:24,740 --> 00:04:23,330
so these are the different spectral

98
00:04:26,990 --> 00:04:24,750
types in the spectra that you can get of

99
00:04:28,939 --> 00:04:27,000
comparable quality to the spectra that

100
00:04:30,710 --> 00:04:28,949
we've obtained in the infrared you can

101
00:04:32,480 --> 00:04:30,720
see how many features that are and you

102
00:04:35,210 --> 00:04:32,490
can use these spectral features in these

103
00:04:37,640 --> 00:04:35,220
absorption lines to type them Rainer at

104
00:04:41,210 --> 00:04:37,650
all 2009 have done this for 200 stars

105
00:04:46,400 --> 00:04:41,220
f G M and K stars hey why should it be

106
00:04:49,430 --> 00:04:46,410
FG km don't you think FG m k okay so and

107
00:04:51,170 --> 00:04:49,440
they have been able to get em basically

108
00:04:52,700 --> 00:04:51,180
characterize the Stars based on the

109
00:04:54,650 --> 00:04:52,710
equivalent widths the depths of those

110
00:04:57,710 --> 00:04:54,660
absorption features that specific ones

111
00:05:01,060 --> 00:04:57,720
and build up a library of stars and and

112
00:05:03,350 --> 00:05:01,070
we have taken these stars and the colors

113
00:05:07,969 --> 00:05:03,360

obviously is from the legend that's at

114
00:05:10,340 --> 00:05:07,979
the bottom on the next slide so we have

115
00:05:12,860 --> 00:05:10,350
disks we have stars with disk we have

116
00:05:14,930 --> 00:05:12,870
stars with circumstellar material that

117
00:05:17,719 --> 00:05:14,940
seems to have followed a giant impact we

118
00:05:20,540 --> 00:05:17,729
have disk that of a planet observing the

119
00:05:22,340 --> 00:05:20,550
system or just hot dust anyway there are

120
00:05:28,340 --> 00:05:22,350
these different types of systems all

121
00:05:31,640 --> 00:05:28,350
with different circumstances

122
00:05:33,320 --> 00:05:31,650
okay we can characterize these obviously

123
00:05:36,549 --> 00:05:33,330
you need all this other information as

124
00:05:43,269 --> 00:05:41,159
okay so here are some representative

125
00:05:46,689 --> 00:05:43,279
spectra that we've taken so here's

126
00:05:49,239 --> 00:05:46,699
here's the important thing you need to

127
00:05:51,699 --> 00:05:49,249
ignore this graph you need to look at

128
00:05:53,679 --> 00:05:51,709
this one first so the first thing we do

129
00:05:56,769 --> 00:05:53,689
is we need to characterize the depth of

130
00:05:59,679 --> 00:05:56,779
the absorption features in particular

131
00:06:01,329 --> 00:05:59,689
wavelength and to know the depth of an

132
00:06:03,249 --> 00:06:01,339
absorption feature of course you want to

133
00:06:04,959 --> 00:06:03,259
know how much is that particular atomic

134
00:06:07,479 --> 00:06:04,969
transition absorbing out of the

135
00:06:09,159 --> 00:06:07,489
continuum starlight and to do that you

136
00:06:11,079 --> 00:06:09,169
need to know the continuum starlight and

137
00:06:12,609 --> 00:06:11,089
it's a real challenge in the infrared

138
00:06:14,589 --> 00:06:12,619

because there are so many spectral

139
00:06:16,779 --> 00:06:14,599
features that it's very hard to even fit

140
00:06:18,729 --> 00:06:16,789
a continuum and so you have to use

141
00:06:20,889 --> 00:06:18,739
smoothing of a spectrum to get a

142
00:06:22,659 --> 00:06:20,899
continuum like this then you can start

143
00:06:26,979 --> 00:06:22,669
to look at specific absorption features

144
00:06:29,739 --> 00:06:26,989
and get the depth of those features and

145
00:06:32,819 --> 00:06:29,749
now these are six atomic lines these two

146
00:06:36,579 --> 00:06:32,829
are magnesium these two are sodium and

147
00:06:39,099 --> 00:06:36,589
these are the depth of the absorption

148
00:06:41,609 --> 00:06:39,109
the equivalent widths as a function of

149
00:06:44,019 --> 00:06:41,619
the spectral type which is mostly just

150
00:06:46,899 --> 00:06:44,029
temperature here which is basically : K

151
00:06:48,879 --> 00:06:46,909
or M or whatever as a function of

152
00:06:50,979 --> 00:06:48,889
temperature but it turns out it's

153
00:06:53,289 --> 00:06:50,989
different if you're talking about a K

154
00:06:55,659 --> 00:06:53,299
star on the main sequence or if you're

155
00:06:58,209 --> 00:06:55,669
talking about a K star that is a giant

156
00:07:00,249 --> 00:06:58,219
star and so these red curves are showing

157
00:07:02,589 --> 00:07:00,259
what that library from Rainer at all

158
00:07:05,919 --> 00:07:02,599
2009 says are the equivalent widths if

159
00:07:07,929 --> 00:07:05,929
you're talking about K dwarfs G dwarfs

160
00:07:09,279 --> 00:07:07,939
etc and the blue and green lines are

161
00:07:13,599 --> 00:07:09,289
what those equivalents would be if

162
00:07:16,029 --> 00:07:13,609
you're talking about K Giants and so by

163
00:07:19,479 --> 00:07:16,039

looking at the equivalent width in a

164
00:07:21,789 --> 00:07:19,489
spectrum matching them to spectral types

165
00:07:23,319 --> 00:07:21,799
you can get some information about

166
00:07:25,449 --> 00:07:23,329
whether you're looking at a giant if it

167
00:07:28,389 --> 00:07:25,459
lines with the blue green bars here or

168
00:07:30,009 --> 00:07:28,399
red and it's important to do this in

169
00:07:32,139 --> 00:07:30,019
multiple lines because if you look at an

170
00:07:33,999 --> 00:07:32,149
equivalent with you could have it

171
00:07:35,949 --> 00:07:34,009
matching at this spectral type or this

172
00:07:41,439 --> 00:07:35,959
spectral type but it's not going to work

173
00:07:43,359 --> 00:07:41,449
that way for all of these stars and with

174
00:07:46,600 --> 00:07:43,369
with all of those lines so by looking at

175
00:07:48,700 --> 00:07:46,610
a multiple of multiplicity of lines you

176
00:07:50,500 --> 00:07:48,710
can get exact spectral types

177
00:07:54,430 --> 00:07:50,510
so it turns out that there was a star

178
00:07:56,650 --> 00:07:54,440
that type of 3 162 that was classified

179
00:07:59,890 --> 00:07:56,660
previously as a main-sequence star of a

180
00:08:03,490 --> 00:07:59,900
k4 to k7 type but instead it turns out

181
00:08:05,020 --> 00:08:03,500
to be K 2 class 3 giant and so this is

182
00:08:07,870 --> 00:08:05,030
very important that's not a star you

183
00:08:09,970 --> 00:08:07,880
would want to look for life around so

184
00:08:13,300 --> 00:08:09,980
this sort of basic work is very

185
00:08:17,080 --> 00:08:13,310
important to do and especially in the

186
00:08:19,090 --> 00:08:17,090
infrared here okay we can also look at

187
00:08:20,980 --> 00:08:19,100
emission lines that was absorption lines

188
00:08:23,830 --> 00:08:20,990

and we can look at equivalent widths of

189
00:08:25,870 --> 00:08:23,840
emission lines in a similar way and you

190
00:08:27,520 --> 00:08:25,880
can find out other information but in

191
00:08:31,870 --> 00:08:27,530
case you didn't tell me what happens

192
00:08:34,180 --> 00:08:31,880
here I'm going to skip that okay now

193
00:08:35,920 --> 00:08:34,190
another feature of the infrared is that

194
00:08:38,260 --> 00:08:35,930
you can start to look for circumstellar

195
00:08:41,560 --> 00:08:38,270
gas as well as dust and so first we want

196
00:08:43,990 --> 00:08:41,570
to talk about gas and in this wavelength

197
00:08:46,360 --> 00:08:44,000
range you have these overtones from Co

198
00:08:50,140 --> 00:08:46,370
emission and we do see this in a number

199
00:08:52,270 --> 00:08:50,150
of systems as you can read which system

200
00:08:55,300 --> 00:08:52,280
we're talking about here ok that's

201
00:08:57,040 --> 00:08:55,310
actually a reference that's ANOVA which

202
00:09:00,280 --> 00:08:57,050
is known to have Co emission and then

203
00:09:01,960 --> 00:09:00,290
this is 5100 which is a system plant

204
00:09:03,370 --> 00:09:01,970
information and it also is showing some

205
00:09:04,600 --> 00:09:03,380
CEOs or from solar got so that's

206
00:09:07,510 --> 00:09:04,610
something interesting that we can get

207
00:09:12,100 --> 00:09:07,520
out of the spectra and sometimes we see

208
00:09:14,560 --> 00:09:12,110
see own absorption as well so ha ok so

209
00:09:16,210 --> 00:09:14,570
this is 50 100 and it's showing Co a

210
00:09:18,280 --> 00:09:16,220
mission and you put that here to show

211
00:09:22,330 --> 00:09:18,290
you that we're seeing absorption of

212
00:09:24,190 --> 00:09:22,340
radiation from foreground material in

213
00:09:26,800 --> 00:09:24,200

front of some of these stars at exactly

214
00:09:29,650 --> 00:09:26,810
the wavelength that we see Co emission

215
00:09:31,270 --> 00:09:29,660
so we are seeing CEO absorption in front

216
00:09:36,130 --> 00:09:31,280
of some of these stars what does it mean

217
00:09:39,130 --> 00:09:36,140
I don't know but we're seeing it ok so

218
00:09:40,750 --> 00:09:39,140
now these are it don't you love it when

219
00:09:42,370 --> 00:09:40,760
a speaker gives up and what a pleasant

220
00:09:44,130 --> 00:09:42,380
surprise look at this slide I didn't

221
00:09:49,860 --> 00:09:44,140
know that was there ok

222
00:09:52,800 --> 00:09:49,870
this is a infrared spectra of F a F G

223
00:09:56,460 --> 00:09:52,810
and K stars and showing that a number of

224
00:09:59,340 --> 00:09:56,470
these systems show not just CEO emission

225
00:10:02,970 --> 00:09:59,350
access but actual continuum infrared

226
00:10:05,940 --> 00:10:02,980
emission excesses at four to five

227
00:10:08,460 --> 00:10:05,950
microns showing that there is dust in

228
00:10:12,960 --> 00:10:08,470
those systems that is emitting engineer

229
00:10:14,550 --> 00:10:12,970
for red and we can compare that to these

230
00:10:16,860 --> 00:10:14,560
same systems we can look at the infrared

231
00:10:19,610 --> 00:10:16,870
spectra at longer wavelengths okay and

232
00:10:25,050 --> 00:10:19,620
it turns out some of these systems have

233
00:10:27,090 --> 00:10:25,060
you can see which ones they they have

234
00:10:29,550 --> 00:10:27,100
they have cold emission in the farm Fred

235
00:10:31,560 --> 00:10:29,560
this is Spitzer data overlaid on these

236
00:10:33,480 --> 00:10:31,570
same systems with the specs data we've

237
00:10:35,670 --> 00:10:33,490
got so some of these dusty systems are

238
00:10:38,009 --> 00:10:35,680

indeed showing dust out in the Kuiper

239
00:10:41,069 --> 00:10:38,019
belt regions or in the mid infrared

240
00:10:42,780 --> 00:10:41,079
region so at one a you they emit in the

241
00:10:45,090 --> 00:10:42,790
mid infrared and you're seeing silicates

242
00:10:47,250 --> 00:10:45,100
or silica hot rock may be due to

243
00:10:49,319 --> 00:10:47,260
planetary collisions generating silica

244
00:10:52,980 --> 00:10:49,329
and then in other systems with planets

245
00:10:55,199 --> 00:10:52,990
we see Co emission and put HL tau here

246
00:10:58,980 --> 00:10:55,209
but HL tau is not in one of these and so

247
00:11:01,949 --> 00:10:58,990
let me go to the conclusions then got a

248
00:11:04,259 --> 00:11:01,959
lot of spectra from the Nerds survey

249
00:11:06,090 --> 00:11:04,269
they use the equivalent which measures

250
00:11:08,610 --> 00:11:06,100
at particular wavelengths of line to do

251
00:11:10,769 --> 00:11:08,620
better spectral typing of the stars but

252
00:11:13,110 --> 00:11:10,779
what we haven't done yet is converted

253
00:11:14,670 --> 00:11:13,120
the spectra into abundances high

254
00:11:17,069 --> 00:11:14,680
precision abundances of these species

255
00:11:19,069 --> 00:11:17,079
and whatever other things are emitting

256
00:11:22,319 --> 00:11:19,079
infrared and that would include a

257
00:11:24,120 --> 00:11:22,329
phosphorus I think so we are looking for

258
00:11:27,180 --> 00:11:24,130
people to help us do the spectral

259
00:11:29,639 --> 00:11:27,190
modeling of the spectra and in the

260
00:11:31,439 --> 00:11:29,649
infrared to get cellar abundances and I

261
00:11:36,020 --> 00:11:31,449
will stop there before I commit more

262
00:11:48,990 --> 00:11:38,100
we have time for a couple questions

263
00:11:53,550 --> 00:11:49,000

couple quick questions please I will

264
00:11:55,320 --> 00:11:53,560
text Katie okay though I should have

265
00:11:56,010 --> 00:11:55,330
practiced the talk but I was I don't

266
00:11:58,860 --> 00:11:56,020
know what I was doing

267
00:12:00,070 --> 00:11:58,870
okay thank you all right let's give our