
AbSciCon
2017
MESA, ARIZONA

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

2
00:00:17,500 --> 00:00:14,400
[Music]

3
00:00:19,840 --> 00:00:17,510
okay hello everyone my name is Jake

4
00:00:21,070 --> 00:00:19,850
Hansen and I'm here to share some work

5
00:00:23,460 --> 00:00:21,080
that I've been doing with Steve -

6
00:00:25,870 --> 00:00:23,470
regarding disintegrating planets and

7
00:00:28,540 --> 00:00:25,880
hopefully it's not too confusing that

8
00:00:31,269 --> 00:00:28,550
Owens talk was about hydrodynamic escape

9
00:00:33,460 --> 00:00:31,279
from normal planets and these are

10
00:00:35,950 --> 00:00:33,470
disintegrating planets much lower mass

11
00:00:37,900 --> 00:00:35,960
regime but still exhibiting hydrodynamic

12
00:00:40,920 --> 00:00:37,910
escape and I think there is some overlap

13
00:00:43,390 --> 00:00:40,930

but I haven't been able to think about

14
00:00:44,530 --> 00:00:43,400
the details of exactly how they overlap

15
00:00:47,229 --> 00:00:44,540
so hopefully it doesn't confuse you

16
00:00:53,500 --> 00:00:47,239
hopefully it's enlightening to some

17
00:00:56,500 --> 00:00:53,510
bones research ok ok so why care about

18
00:00:57,670 --> 00:00:56,510
integrating planets at all the reason

19
00:00:59,110 --> 00:00:57,680
that disintegrating planets are

20
00:01:00,910 --> 00:00:59,120
important is because it's one of the few

21
00:01:03,359 --> 00:01:00,920
ways that we can get simultaneous mass

22
00:01:07,210 --> 00:01:03,369
and Composition constraints

23
00:01:09,100 --> 00:01:07,220
observational about planets the

24
00:01:10,600 --> 00:01:09,110
distribution of planet composition of

25
00:01:12,100 --> 00:01:10,610
the function of mass is ultimately

26
00:01:14,109 --> 00:01:12,110
what's going to constrain which

27
00:01:17,020 --> 00:01:14,119
planetary processes are possible so

28
00:01:19,600 --> 00:01:17,030
things relevant for life such as abiotic

29
00:01:20,859 --> 00:01:19,610
outgassing and tectonic activity are

30
00:01:22,300 --> 00:01:20,869
going to be constrained by planetary

31
00:01:23,679 --> 00:01:22,310
compositions so we're going to have and

32
00:01:26,200 --> 00:01:23,689
we're going to need to have a handle on

33
00:01:28,530 --> 00:01:26,210
the distribution of composition if we

34
00:01:31,960 --> 00:01:28,540
want to constrain the abiotic signature

35
00:01:33,550 --> 00:01:31,970
so in other words how I'm viewing this

36
00:01:35,770 --> 00:01:33,560
problem is we're getting Starlight

37
00:01:38,020 --> 00:01:35,780
passing through an atmosphere that we

38
00:01:40,149 --> 00:01:38,030

hope is from a planet teeming with life

39
00:01:42,550 --> 00:01:40,159
and the spectral signatures of that life

40
00:01:45,190 --> 00:01:42,560
are imprinted in the spectrum and we

41
00:01:47,050 --> 00:01:45,200
catch it with JWST but we need to be

42
00:01:49,569 --> 00:01:47,060
able to separate that from a abiotic

43
00:01:51,580 --> 00:01:49,579
world that also has spectral signatures

44
00:01:53,230 --> 00:01:51,590
in its atmosphere and that's going to

45
00:01:56,160 --> 00:01:53,240
depend on the compositions of the planet

46
00:01:58,780 --> 00:01:56,170
through the distribution of composition

47
00:02:01,660 --> 00:01:58,790
how you actually can get a composition

48
00:02:03,700 --> 00:02:01,670
is actually a very involved process the

49
00:02:04,990 --> 00:02:03,710
first step is to understand how these

50
00:02:06,429 --> 00:02:05,000
planets are disintegrating which is

51
00:02:09,280 --> 00:02:06,439
through Parker winds which is a steady

52
00:02:11,319 --> 00:02:09,290
state mass loss hydrodynamic mass loss

53
00:02:12,990 --> 00:02:11,329
and then we're going to use the per

54
00:02:14,949 --> 00:02:13,000
queuing formalism to constrain what

55
00:02:17,470 --> 00:02:14,959
properties are allowed so the mere

56
00:02:19,030 --> 00:02:17,480
existence of a steady state parker wind

57
00:02:20,979 --> 00:02:19,040
actually puts some constraints on what

58
00:02:22,240 --> 00:02:20,989
mass planet you can have as well as the

59
00:02:24,690 --> 00:02:22,250
mean molecular weight for that planet's

60
00:02:26,530 --> 00:02:24,700
atmosphere so this is different than

61
00:02:28,210 --> 00:02:26,540
other forms of escape

62
00:02:29,589 --> 00:02:28,220
that are not steady states this project

63
00:02:32,800 --> 00:02:29,599

is all through the lens of steady state

64
00:02:34,750 --> 00:02:32,810
and then once we have the mass we can

65
00:02:36,339 --> 00:02:34,760
calculate the velocity structure of the

66
00:02:37,869 --> 00:02:36,349
wind so ultimately these winds are

67
00:02:39,759 --> 00:02:37,879
accelerated beyond the escape velocity

68
00:02:42,220 --> 00:02:39,769
of the planet and so the velocity

69
00:02:44,289 --> 00:02:42,230
structure tells you when the wind will

70
00:02:45,759 --> 00:02:44,299
escape and then we're also going to

71
00:02:47,440 --> 00:02:45,769
couple the velocity structure to a

72
00:02:50,289 --> 00:02:47,450
mineral condensation code so that's

73
00:02:52,110 --> 00:02:50,299
really the unique portion of this

74
00:02:54,759 --> 00:02:52,120
project is going to be coupling the

75
00:02:56,559 --> 00:02:54,769
hydrodynamic escapes from my parker

76
00:02:58,479 --> 00:02:56,569
winds to a condensation code that tells

77
00:03:00,699 --> 00:02:58,489
you how gas vapor condenses into dust

78
00:03:03,119 --> 00:03:00,709
and that's ultimately well ultimately

79
00:03:07,000 --> 00:03:03,129
what you want to compare to spectra from

80
00:03:08,649 --> 00:03:07,010
JWST but unfortunately for you all this

81
00:03:10,270 --> 00:03:08,659
project is just focused on the first

82
00:03:12,399 --> 00:03:10,280
portion of this project so what can you

83
00:03:15,360 --> 00:03:12,409
learn about planets that are hydro

84
00:03:17,710 --> 00:03:15,370
dynamically losing mass via Parker winds

85
00:03:18,940 --> 00:03:17,720
it's a little bit more about integrating

86
00:03:20,289 --> 00:03:18,950
planets you may be surprised to know

87
00:03:23,080 --> 00:03:20,299
that there's only four known

88
00:03:25,390 --> 00:03:23,090

disintegrating planetary systems three

89
00:03:27,699 --> 00:03:25,400
around M stars and one around a white

90
00:03:30,280 --> 00:03:27,709
dwarf observations tell us that these

91
00:03:33,460 --> 00:03:30,290
planets are extremely low mass there's

92
00:03:36,250 --> 00:03:33,470
upper limits on their masses they're hot

93
00:03:40,150 --> 00:03:36,260
rocky and ultra short orbits so periods

94
00:03:42,460 --> 00:03:40,160
of order of one day you can back out the

95
00:03:43,839 --> 00:03:42,470
mass loss rates from the transit depths

96
00:03:46,030 --> 00:03:43,849
and people have calculated that it's

97
00:03:48,580 --> 00:03:46,040
about one earth mass per GigE or mass

98
00:03:50,289 --> 00:03:48,590
loss rate so for a low mass mercury mass

99
00:03:52,960 --> 00:03:50,299
planet the mass loss rates are quite

100
00:03:54,640 --> 00:03:52,970
substantial and the general thinking is

101
00:03:56,500 --> 00:03:54,650
just these planets are too hot to hold

102
00:03:57,909 --> 00:03:56,510
on to the material so surface materials

103
00:04:00,009 --> 00:03:57,919
being vaporized this is different than

104
00:04:01,689 --> 00:04:00,019
losing an atmosphere and that vaporized

105
00:04:05,470 --> 00:04:01,699
material then forms an atmosphere which

106
00:04:07,539 --> 00:04:05,480
is kicked off as for how they're

107
00:04:09,009 --> 00:04:07,549
actually detected there's two big

108
00:04:10,720 --> 00:04:09,019
telltale signs that you're looking at

109
00:04:13,569 --> 00:04:10,730
it's integrating planet the first is

110
00:04:15,819 --> 00:04:13,579
variable transit depth you can see this

111
00:04:18,310 --> 00:04:15,829
is a periodic signal but it varies in

112
00:04:20,500 --> 00:04:18,320
depth and the second is an asymmetric

113
00:04:22,779 --> 00:04:20,510

transit profile so you can see the

114
00:04:25,060 --> 00:04:22,789
ingress is a much steeper gradient than

115
00:04:26,680 --> 00:04:25,070
the egress and that's due to the diffuse

116
00:04:31,240 --> 00:04:26,690
portion of the tail taking a long time

117
00:04:32,649 --> 00:04:31,250
to exit the face of the star so I've

118
00:04:34,600 --> 00:04:32,659
mentioned Parker winds a few times a

119
00:04:36,700 --> 00:04:34,610
little bit of historical context they

120
00:04:39,040 --> 00:04:36,710
were originally developed by Eugene

121
00:04:40,220 --> 00:04:39,050
Parker to describe the solar wind so

122
00:04:42,620 --> 00:04:40,230
it's the exact same physics

123
00:04:44,600 --> 00:04:42,630
from solar wind physics but now we're

124
00:04:46,940 --> 00:04:44,610
applying them to exoplanet so we're you

125
00:04:50,630 --> 00:04:46,950
know 40 50 years 60 years behind but

126
00:04:52,280 --> 00:04:50,640
we're there now and Cayman told me that

127
00:04:54,730 --> 00:04:52,290
if I put too many equations he would

128
00:04:57,350 --> 00:04:54,740
personally kick me off the stage but I

129
00:04:59,450 --> 00:04:57,360
slimmed it down and these are the basics

130
00:05:01,970 --> 00:04:59,460
all that you really need to know is that

131
00:05:03,980 --> 00:05:01,980
it's a force equation where gravity and

132
00:05:05,840 --> 00:05:03,990
pressure is trying to balance if the

133
00:05:07,880 --> 00:05:05,850
right-hand side of that top equation 0

134
00:05:09,710 --> 00:05:07,890
that's hydrostatic equilibrium if you

135
00:05:11,630 --> 00:05:09,720
allow for a nonzero acceleration then

136
00:05:12,830 --> 00:05:11,640
you'll get the potential for a parker

137
00:05:14,690 --> 00:05:12,840
winds the only other piece of

138
00:05:16,580 --> 00:05:14,700

information you need are a law for

139
00:05:18,320 --> 00:05:16,590
conservation of mass and an equation of

140
00:05:23,060 --> 00:05:18,330
state which we have some a polytope here

141
00:05:25,850 --> 00:05:23,070
and then the results we'll see how many

142
00:05:27,470 --> 00:05:25,860
is too many here the results is that you

143
00:05:29,120 --> 00:05:27,480
get the wind velocity as a function of

144
00:05:31,820 --> 00:05:29,130
distance so that's really what we're

145
00:05:34,280 --> 00:05:31,830
after this dimensionless variable psy is

146
00:05:36,500 --> 00:05:34,290
velocity and distance is it mentioned

147
00:05:37,820 --> 00:05:36,510
this where you'll see and then we also

148
00:05:39,110 --> 00:05:37,830
have the June's parameter which is the

149
00:05:40,550 --> 00:05:39,120
ratio of the gravitational potential

150
00:05:42,530 --> 00:05:40,560
energy to the thermal energy and that

151
00:05:45,110 --> 00:05:42,540
kind of characterizes the likelihood of

152
00:05:48,470 --> 00:05:45,120
of planets have this wind that was

153
00:05:50,690 --> 00:05:48,480
abstract if we were to imagine putting

154
00:05:53,240 --> 00:05:50,700
mercury in a radiation environment of

155
00:05:55,240 --> 00:05:53,250
2100 Kelvin we could ask ourself what

156
00:05:57,710 --> 00:05:55,250
would happen to our beloved mercury and

157
00:05:59,810 --> 00:05:57,720
basically you can see that winds can

158
00:06:01,370 --> 00:05:59,820
develop and about eight mercury radii

159
00:06:03,080 --> 00:06:01,380
away the wind would reach escape

160
00:06:05,750 --> 00:06:03,090
velocity so mercury would undergo mass

161
00:06:07,820 --> 00:06:05,760
loss what you don't see in this plot

162
00:06:09,500 --> 00:06:07,830
that's very important is that the mean

163
00:06:11,690 --> 00:06:09,510

molecular weight of the atmosphere is

164
00:06:14,330 --> 00:06:11,700
incredibly fine-tuned for this plot this

165
00:06:16,580 --> 00:06:14,340
is a six hydrogen mass atmosphere if I

166
00:06:18,620 --> 00:06:16,590
try to do the same thing for five or

167
00:06:21,920 --> 00:06:18,630
seven there's no Parker wind solution

168
00:06:23,690 --> 00:06:21,930
and so the generalization of that is

169
00:06:26,210 --> 00:06:23,700
that there's two different regimes for

170
00:06:28,520 --> 00:06:26,220
Parker winds to you have to operate

171
00:06:30,170 --> 00:06:28,530
between them in the upper regime so you

172
00:06:32,030 --> 00:06:30,180
can see this is planet mass and

173
00:06:34,010 --> 00:06:32,040
atmospheric mean molecular weight and

174
00:06:35,720 --> 00:06:34,020
the upper regime your planet is too

175
00:06:38,480 --> 00:06:35,730
massive or cold for your wind to

176
00:06:40,190 --> 00:06:38,490
overcome gravity in these shaded regions

177
00:06:42,170 --> 00:06:40,200
those are different temperatures that

178
00:06:44,390 --> 00:06:42,180
would have a Parker wind solutions you

179
00:06:46,400 --> 00:06:44,400
can see for mercury if you knew the mass

180
00:06:47,780 --> 00:06:46,410
then you could calculate there's a very

181
00:06:49,490 --> 00:06:47,790
small mean molecular weight that would

182
00:06:51,590 --> 00:06:49,500
allow for a study state Parker wind to

183
00:06:54,090 --> 00:06:51,600
develop and these are for different

184
00:06:56,100 --> 00:06:54,100
temperatures and the lower regime is

185
00:06:59,370 --> 00:06:56,110
of the more subtle one in this regime

186
00:07:01,260 --> 00:06:59,380
the you can think of as too little mass

187
00:07:02,790 --> 00:07:01,270
for wins but I think it's easier to

188
00:07:05,790 --> 00:07:02,800

think of it as having too much thermal

189
00:07:07,380 --> 00:07:05,800
energy for wins to hold their shape so a

190
00:07:10,530 --> 00:07:07,390
parker wind is a subsonic to supersonic

191
00:07:12,780 --> 00:07:10,540
wind and if you start your surface lots

192
00:07:15,330 --> 00:07:12,790
velocity supersonic there's no solution

193
00:07:17,370 --> 00:07:15,340
that kind of keeps that structure

194
00:07:19,860 --> 00:07:17,380
propagating outward your your equation

195
00:07:21,600 --> 00:07:19,870
blows up and you basically don't have a

196
00:07:23,580 --> 00:07:21,610
wind so that's not to say these planets

197
00:07:26,370 --> 00:07:23,590
can't lose mass they probably are losing

198
00:07:28,710 --> 00:07:26,380
mass through non steady state means but

199
00:07:30,570 --> 00:07:28,720
it is there is a lower limit for steady

200
00:07:31,890 --> 00:07:30,580
state Parker wins and so the

201
00:07:33,720 --> 00:07:31,900
implications of that are that these

202
00:07:35,010 --> 00:07:33,730
Parker winds are extremely fine tuned if

203
00:07:37,170 --> 00:07:35,020
you want to assume steady state mass

204
00:07:39,570 --> 00:07:37,180
loss you have to be in a very small

205
00:07:42,690 --> 00:07:39,580
parameter space what you would expect

206
00:07:44,760 --> 00:07:42,700
instead is for a periodic or sporadic

207
00:07:46,940 --> 00:07:44,770
mass loss corresponding to brief periods

208
00:07:49,890 --> 00:07:46,950
of time in the Parker wind regime and

209
00:07:52,080 --> 00:07:49,900
the process itself may be self regulated

210
00:07:54,480 --> 00:07:52,090
or throttled so you can imagine building

211
00:07:56,130 --> 00:07:54,490
up an atmosphere slowly heating your

212
00:07:57,150 --> 00:07:56,140
surface temperature until eventually you

213
00:07:59,130 --> 00:07:57,160

reach the point where you're in the

214
00:08:00,810 --> 00:07:59,140
steady state mass loss regime all of a

215
00:08:03,840 --> 00:08:00,820
sudden you get these bulk ejection

216
00:08:05,550 --> 00:08:03,850
events and then you cool down and get

217
00:08:07,830 --> 00:08:05,560
back to where you started originally and

218
00:08:09,990 --> 00:08:07,840
so it's my tip of the hat towards the

219
00:08:11,790 --> 00:08:10,000
alien mega-structure stars perhaps this

220
00:08:13,590 --> 00:08:11,800
is it but I would like to share this

221
00:08:16,920 --> 00:08:13,600
quote with you from a BuzzFeed article

222
00:08:18,240 --> 00:08:16,930
it says no amount of extreme mass so far

223
00:08:21,060 --> 00:08:18,250
has figured out what is going on with

224
00:08:22,230 --> 00:08:21,070
star named pic4 6 - 85 - and I kind of

225
00:08:23,940 --> 00:08:22,240
laughed a sext I thought it sounds

226
00:08:27,570 --> 00:08:23,950
childish and I thought wait that's

227
00:08:30,600 --> 00:08:27,580
basically exactly exactly what it is so

228
00:08:32,370 --> 00:08:30,610
anyways a few applications of this we

229
00:08:35,670 --> 00:08:32,380
can look at something like 55 Cancri E

230
00:08:38,550 --> 00:08:35,680
you see it's a super earth very hot 2000

231
00:08:41,070 --> 00:08:38,560
Kelvin the period is less than a day and

232
00:08:43,469 --> 00:08:41,080
high density so it fits the bill for

233
00:08:48,510 --> 00:08:43,479
what a disintegrating planet should be

234
00:08:51,150 --> 00:08:48,520
but if you plot the mass if you plot the

235
00:08:52,860 --> 00:08:51,160
mass of 55 Cancri you can see that there

236
00:08:55,140 --> 00:08:52,870
is absolutely no reasonable temperature

237
00:08:57,510 --> 00:08:55,150
so the green line is 3000 Kelvin surface

238
00:09:00,210 --> 00:08:57,520

the blue is 1300 you can see there's no

239
00:09:03,930 --> 00:09:00,220
solution that comes in contact with the

240
00:09:06,260 --> 00:09:03,940
mass of almost 10 earth mass it's just

241
00:09:08,120 --> 00:09:06,270
too massive of a planet

242
00:09:10,340 --> 00:09:08,130
so if we try to lower the mass of the

243
00:09:13,460 --> 00:09:10,350
planet so this is the point eight five

244
00:09:15,260 --> 00:09:13,470
earth-mass planet Trappist 1b this

245
00:09:16,910 --> 00:09:15,270
planet if it were a two thousand Kelvin

246
00:09:19,010 --> 00:09:16,920
it could it would have a solution for

247
00:09:20,840 --> 00:09:19,020
Parker winds but the problem is that

248
00:09:23,930 --> 00:09:20,850
it's at 400 kelvins

249
00:09:25,280 --> 00:09:23,940
this planet is just too cold and ideally

250
00:09:26,750 --> 00:09:25,290
I would like to show you something in

251
00:09:28,910 --> 00:09:26,760
the other regime of this to a planet

252
00:09:30,590 --> 00:09:28,920
that's too small or too hot for a Parker

253
00:09:32,210 --> 00:09:30,600
wind but the problem is that if you get

254
00:09:33,710 --> 00:09:32,220
planets that are that low of mass we

255
00:09:35,720 --> 00:09:33,720
have no way of detecting them to begin

256
00:09:38,329 --> 00:09:35,730
with unless so disintegrating so

257
00:09:39,980 --> 00:09:38,339
basically I have two examples for

258
00:09:42,290 --> 00:09:39,990
planets that are too massive or too cold

259
00:09:44,990 --> 00:09:42,300
but no examples for too hot or too light

260
00:09:46,670 --> 00:09:45,000
because they're impossible to detect but

261
00:09:48,560 --> 00:09:46,680
we do have these known disintegrating

262
00:09:51,590 --> 00:09:48,570
planets these are low-mass planets that

263
00:09:53,720 --> 00:09:51,600

exhibit almost steady state mass loss

264
00:09:55,760 --> 00:09:53,730
and I say almost because each period

265
00:09:58,130 --> 00:09:55,770
they are continuously losing mass but

266
00:10:02,000 --> 00:09:58,140
those small variations in transit depths

267
00:10:06,079 --> 00:10:02,010
show that it's not perfectly hydro it's

268
00:10:08,180 --> 00:10:06,089
not a perfectly steady state system so

269
00:10:09,860 --> 00:10:08,190
this plot now these these colors regions

270
00:10:11,300 --> 00:10:09,870
show the solution space for those

271
00:10:12,889 --> 00:10:11,310
different planets so I said there were

272
00:10:14,540 --> 00:10:12,899
four but two of them have the same

273
00:10:15,769 --> 00:10:14,550
effective temperature so here I'm taking

274
00:10:18,740 --> 00:10:15,779
the surface temperature to be the

275
00:10:20,240 --> 00:10:18,750
effective temperature and you can see

276
00:10:22,069 --> 00:10:20,250
this is the allowed solution space and

277
00:10:23,990 --> 00:10:22,079
even without knowing the molecular

278
00:10:26,000 --> 00:10:24,000
weight of these planet's atmosphere you

279
00:10:27,740 --> 00:10:26,010
can put a constraint on their mass just

280
00:10:28,670 --> 00:10:27,750
by assuming that the mean molecular

281
00:10:30,949 --> 00:10:28,680
weight of the atmosphere is somewhere

282
00:10:32,269 --> 00:10:30,959
less than 60 if you were to get better

283
00:10:33,710 --> 00:10:32,279
constraints on the mean molecular

284
00:10:35,090 --> 00:10:33,720
weights of this atmosphere you could put

285
00:10:37,400 --> 00:10:35,100
very tight constraints on the allowed

286
00:10:39,019 --> 00:10:37,410
mass for these planets but without the

287
00:10:40,280 --> 00:10:39,029
mean molecular weight constraint you can

288
00:10:41,900 --> 00:10:40,290

still concern them to be somewhere

289
00:10:43,910 --> 00:10:41,910
between 10 to the negative 3 earth mass

290
00:10:45,319 --> 00:10:43,920
and one or it's not so the upper limit

291
00:10:48,170 --> 00:10:45,329
obviously is not that surprising you

292
00:10:50,510 --> 00:10:48,180
need a very small mass planet to be able

293
00:10:52,850 --> 00:10:50,520
to eject to end but the lower limit is

294
00:10:54,920 --> 00:10:52,860
somewhat counterintuitive and that's

295
00:10:58,880 --> 00:10:54,930
basically because I think the wind can't

296
00:11:01,370 --> 00:10:58,890
hold its shape so anyways the part that

297
00:11:03,380 --> 00:11:01,380
would be nice to tell you more about is

298
00:11:04,970 --> 00:11:03,390
the mineral condensation portion so I

299
00:11:07,550 --> 00:11:04,980
can give you a small teaser for that and

300
00:11:09,380 --> 00:11:07,560
basically what you do is you assume your

301
00:11:11,600 --> 00:11:09,390
planetary parameters so you assume your

302
00:11:13,670 --> 00:11:11,610
surface temperature and stoichiometric

303
00:11:15,290 --> 00:11:13,680
composition and then you calculate the

304
00:11:16,879 --> 00:11:15,300
velocity profile of your wind so your

305
00:11:18,949 --> 00:11:16,889
wind profile depends on your

306
00:11:21,169 --> 00:11:18,959
our mass and surface temperature and

307
00:11:23,749 --> 00:11:21,179
then you will compute two relevant time

308
00:11:25,849 --> 00:11:23,759
scales the first is basically the time

309
00:11:28,729 --> 00:11:25,859
scale for gas to condense onto grains

310
00:11:30,379 --> 00:11:28,739
and the second is the time for the win

311
00:11:32,660 --> 00:11:30,389
the time scale for the wind to diffuse

312
00:11:33,710 --> 00:11:32,670
if you set these two time scales equal

313
00:11:35,869 --> 00:11:33,720

you can calculate what's called the

314
00:11:37,609 --> 00:11:35,879
freeze-out radius which is defined as

315
00:11:40,369 --> 00:11:37,619
the point beyond which the wind is

316
00:11:43,909 --> 00:11:40,379
moving too fast for your particles to

317
00:11:45,379 --> 00:11:43,919
condense and so that will be the final

318
00:11:48,379 --> 00:11:45,389
distance at which you're actively

319
00:11:50,659 --> 00:11:48,389
condensing minerals and then what what

320
00:11:52,280 --> 00:11:50,669
the plan is is to iteratively condense

321
00:11:53,960 --> 00:11:52,290
from the surface out to this freeze-out

322
00:11:56,299 --> 00:11:53,970
radius and compute your mineral

323
00:11:59,090 --> 00:11:56,309
abundances and then compare that to

324
00:12:01,099 --> 00:11:59,100
observed spectrum and in theory you can

325
00:12:02,869 --> 00:12:01,109
go the other way but obviously this

326
00:12:05,769 --> 00:12:02,879
isn't the portion that we worked out in

327
00:12:07,639 --> 00:12:05,779
all the detail so in summary

328
00:12:08,689 --> 00:12:07,649
compositional constraints are very

329
00:12:10,249 --> 00:12:08,699
important because we're going to need

330
00:12:13,939 --> 00:12:10,259
them to put constraints on the abiotic

331
00:12:15,650 --> 00:12:13,949
signatures of planets disintegrating

332
00:12:17,150 --> 00:12:15,660
planets allow simultaneous mass and

333
00:12:20,929 --> 00:12:17,160
compositional constraints which is very

334
00:12:22,789 --> 00:12:20,939
important and the main results from this

335
00:12:26,449 --> 00:12:22,799
soccer that parker winds are very

336
00:12:28,009 --> 00:12:26,459
fine-tuned solution space and a periodic

337
00:12:29,629 --> 00:12:28,019
or throttled mass loss is probably more

338
00:12:31,309 --> 00:12:29,639

likely where you pass in and out of this

339
00:12:34,189 --> 00:12:31,319
regime where you're capable of launching

340
00:12:36,739 --> 00:12:34,199
steady-state winds and for the known

341
00:12:37,639 --> 00:12:36,749
planets the mass constraints that we

342
00:12:40,100 --> 00:12:37,649
would put on them are somewhere between

343
00:12:41,960 --> 00:12:40,110
10 to the negative 3 and 1's mass i just

344
00:12:43,850 --> 00:12:41,970
like to quickly thank Steve for his help

345
00:12:44,869 --> 00:12:43,860
as well as my adviser Sarah Walker in

346
00:12:46,929 --> 00:12:44,879
the rest of our group for their help and

347
00:12:50,119 --> 00:12:46,939
advice and if you have any questions

348
00:12:57,740 --> 00:12:50,129
please email me at Jake Hansen asu.edu

349
00:13:00,530 --> 00:12:59,640
thanks Jake we have about three minutes

350
00:13:05,250 --> 00:13:00,540
for questions

351
00:13:07,080 --> 00:13:05,260
Wanda hi Jake I am so sorry that I did

352
00:13:12,170 --> 00:13:07,090
not mention this previously I see you

353
00:13:17,100 --> 00:13:12,180
almost every day but you do realize that

354
00:13:18,870 --> 00:13:17,110
wd1 145 and the body that's orbiting it

355
00:13:22,200 --> 00:13:18,880
and what you're calling a disintegrating

356
00:13:24,630 --> 00:13:22,210
planet is on a nearly circular orbit

357
00:13:27,810 --> 00:13:24,640
that passes through the white door Roche

358
00:13:30,420 --> 00:13:27,820
radius at least twice during orbit right

359
00:13:33,360 --> 00:13:30,430
that's wise disintegrating but Parker

360
00:13:36,680 --> 00:13:33,370
wind treatment that is applicable to the

361
00:13:40,410 --> 00:13:36,690
other planets I don't think you should

362
00:13:44,460 --> 00:13:40,420
include the WD one one four five rocky

363
00:13:46,110 --> 00:13:44,470

body with it okay alright I do yeah the

364
00:13:49,470 --> 00:13:46,120
this treatment is just for a given

365
00:13:51,210 --> 00:13:49,480
surface temperature and so I guess for

366
00:13:53,610 --> 00:13:51,220
the point of my argument it's just a

367
00:13:55,740 --> 00:13:53,620
theoretical planet in that system would

368
00:13:57,180 --> 00:13:55,750
have this math constraint and that

369
00:13:59,400 --> 00:13:57,190
system is also complicated because

370
00:14:02,370 --> 00:13:59,410
there's the six different bodies and so

371
00:14:05,430 --> 00:14:02,380
I would say the be known disintegrating

372
00:14:07,650 --> 00:14:05,440
planets the canonical ones that I'm

373
00:14:09,870 --> 00:14:07,660
thinking about are the three around the

374
00:14:11,940 --> 00:14:09,880
M stars okay good yeah the white dwarf

375
00:14:14,070 --> 00:14:11,950
is a little ratchet in this whole mess

376
00:14:15,810 --> 00:14:14,080
right no but they're the reason why

377
00:14:17,130 --> 00:14:15,820
they're just integrating right cuz it's

378
00:14:18,510 --> 00:14:17,140
passing through the roof yeah and that

379
00:14:22,710 --> 00:14:18,520
is not the case for any of the other sir

380
00:14:25,440 --> 00:14:22,720
okay hi Russell dietrich University of

381
00:14:28,410 --> 00:14:25,450
Washington I was curious if the Parker

382
00:14:30,030 --> 00:14:28,420
wind if it's ever if the mass loss is

383
00:14:33,210 --> 00:14:30,040
ever really strong enough that you would

384
00:14:36,630 --> 00:14:33,220
get some change in the orbit of the

385
00:14:38,190 --> 00:14:36,640
planet do you see or orbital be K would

386
00:14:40,200 --> 00:14:38,200
you expect orbital decay or anything

387
00:14:42,210 --> 00:14:40,210
like that well unfortunately don't have

388
00:14:45,540 --> 00:14:42,220

many of these systems but there was the

389
00:14:47,430 --> 00:14:45,550
2014 wrap-up or at all papers there

390
00:14:48,990 --> 00:14:47,440
seems to be a feedback mechanism where

391
00:14:51,330 --> 00:14:49,000
you see the depth of the transit on a

392
00:14:52,620 --> 00:14:51,340
year average is getting shallower and

393
00:14:54,450 --> 00:14:52,630
shallower and so that seems to imply

394
00:14:57,090 --> 00:14:54,460
that this planet is losing so much mass

395
00:14:59,220 --> 00:14:57,100
that the feedback from the mass loss has

396
00:15:00,990 --> 00:14:59,230
affected the mass of the planet itself

397
00:15:03,270 --> 00:15:01,000
in a way that dictates the mass loss

398
00:15:04,950 --> 00:15:03,280
again so you can see a feedback process

399
00:15:07,580 --> 00:15:04,960
that the amount of mass is oozing is

400
00:15:10,970 --> 00:15:07,590
actively affecting its future mass loss

401
00:15:12,380 --> 00:15:10,980
but that's the only case that had some

402
00:15:16,519 --> 00:15:12,390
sort of feedback mechanism

403
00:15:18,380 --> 00:15:16,529
thanks we have time for one more hi Bill

404
00:15:21,820 --> 00:15:18,390
diamond from the SETI Institute just a

405
00:15:25,790 --> 00:15:21,830
question on the graph you had with the

406
00:15:27,680 --> 00:15:25,800
various light curve depths because they

407
00:15:30,440 --> 00:15:27,690
did seem quite random but they didn't

408
00:15:32,990 --> 00:15:30,450
seem to me to indicate a trend toward

409
00:15:34,400 --> 00:15:33,000
you know suggesting continual mass loss

410
00:15:35,390 --> 00:15:34,410
they seemed kind of all over the place

411
00:15:38,660 --> 00:15:35,400
mm-hmm

412
00:15:40,280 --> 00:15:38,670
so I think that what's the point that

413
00:15:41,810 --> 00:15:40,290

I'm trying to make with the steady state

414
00:15:43,490 --> 00:15:41,820
mass off of those planets is the fact

415
00:15:45,769 --> 00:15:43,500
that they're continuously losing mass

416
00:15:48,710 --> 00:15:45,779
puts them in and around the steady-state

417
00:15:50,480 --> 00:15:48,720
regime and so when I talk about the

418
00:15:53,600 --> 00:15:50,490
throttle to a periodic mass loss what

419
00:15:56,720 --> 00:15:53,610
I'm thinking of as planets that are far

420
00:15:58,400 --> 00:15:56,730
from the regime of losing mass via

421
00:16:00,380 --> 00:15:58,410
Parker wins and then they enter the

422
00:16:02,240 --> 00:16:00,390
regime briefly only to lose an

423
00:16:04,160 --> 00:16:02,250
atmosphere and then go back to being far

424
00:16:05,840 --> 00:16:04,170
from the regime and so I picture these

425
00:16:08,090 --> 00:16:05,850
planets as at least being close to the

426
00:16:11,390 --> 00:16:08,100
steady-state regime and the fact that

427
00:16:13,010 --> 00:16:11,400
they're variable the depth of the

428
00:16:14,990 --> 00:16:13,020
transit is variable I take to mean that

429
00:16:16,700 --> 00:16:15,000
obviously the surface temperature those

430
00:16:18,170 --> 00:16:16,710
planets isn't fixed and you do get

431
00:16:19,700 --> 00:16:18,180
fluctuations in the amount of mass

432
00:16:21,770 --> 00:16:19,710
you're actually losing but they're very