
AbSciCon
2017
MESA, ARIZONA

1
00:00:16,349 --> 00:00:12,250
[Music]

2
00:00:17,910 --> 00:00:16,359
first I want to thank everyone for not

3
00:00:19,710 --> 00:00:17,920
only staying to the last day but also

4
00:00:21,269 --> 00:00:19,720
the talk right before lunch or all

5
00:00:24,659 --> 00:00:21,279
troupers so I'll try to keep it brief

6
00:00:25,740 --> 00:00:24,669
for your sake so first I'm going to go

7
00:00:27,569 --> 00:00:25,750
over you know some stuff that you've

8
00:00:29,819 --> 00:00:27,579
heard a lot in this section that próxima

9
00:00:32,220 --> 00:00:29,829
B has a very uncertain formation there's

10
00:00:35,040 --> 00:00:32,230
three main formation pathways that could

11
00:00:36,630 --> 00:00:35,050
have preceded Institute for mation where

12
00:00:38,580 --> 00:00:36,640
it formed effectively where we see today

13
00:00:41,310 --> 00:00:38,590

it could have formed farther out in the

14
00:00:43,170 --> 00:00:41,320
disk and migrated inward or it could

15
00:00:44,550 --> 00:00:43,180
have formed via some dynamic instability

16
00:00:46,170 --> 00:00:44,560
where it formed somewhere in the disk

17
00:00:47,850 --> 00:00:46,180
and some planet planets scattering

18
00:00:51,060 --> 00:00:47,860
catapulted the planet to where it is

19
00:00:52,920 --> 00:00:51,070
today and in those processes Proxima

20
00:00:54,330 --> 00:00:52,930
beat could be water rich or poor today

21
00:00:56,130 --> 00:00:54,340
it could have a lot of volatile the

22
00:00:57,780 --> 00:00:56,140
hydrogen envelope like Rodrigo talked

23
00:00:59,580 --> 00:00:57,790
about earlier but these are things that

24
00:01:02,069 --> 00:00:59,590
are rather poorly constrained and need a

25
00:01:04,319 --> 00:01:02,079
lot of modeling and additionally you

26
00:01:06,719 --> 00:01:04,329
know as we heard about earlier with no

27
00:01:10,560 --> 00:01:06,729
radius constraint we can't exactly pin

28
00:01:12,630 --> 00:01:10,570
down what mass it is exactly so there is

29
00:01:14,459 --> 00:01:12,640
still regions of parameter space albeit

30
00:01:15,840 --> 00:01:14,469
unlikely from what we saw earlier that

31
00:01:17,760 --> 00:01:15,850
it could have an extended hydrogen

32
00:01:19,139 --> 00:01:17,770
envelope and be a mini Neptune but

33
00:01:21,980 --> 00:01:19,149
there's a lot of modeling that needs to

34
00:01:24,179 --> 00:01:21,990
be done to constrain these things

35
00:01:25,919 --> 00:01:24,189
additionally as Rodrigo pointed out pre

36
00:01:27,419 --> 00:01:25,929
main-sequence water loss in this planet

37
00:01:29,160 --> 00:01:27,429
is going to be very important to

38
00:01:31,080 --> 00:01:29,170

understand how much water exists on it

39
00:01:33,090 --> 00:01:31,090
today if it's formed with a lot of water

40
00:01:34,559 --> 00:01:33,100
in the beginning so as you can see on

41
00:01:37,620 --> 00:01:34,569
the right-hand side here

42
00:01:40,019 --> 00:01:37,630
Proxima be if it existed at its current

43
00:01:42,300 --> 00:01:40,029
orbit for its entire lifetime existed

44
00:01:43,649 --> 00:01:42,310
within or sorry interior to the

45
00:01:45,959 --> 00:01:43,659
habitable zone it to be careful with

46
00:01:48,899 --> 00:01:45,969
that interior to the apples own for

47
00:01:51,089 --> 00:01:48,909
around 170 million years you know with

48
00:01:52,559 --> 00:01:51,099
some uncertainty and during that time as

49
00:01:55,409 --> 00:01:52,569
Rodrigo showed it could have undergone

50
00:01:57,120 --> 00:01:55,419
some substantial water loss with you

51
00:01:59,429 --> 00:01:57,130
know several Earth oceans maybe up to

52
00:02:02,730 --> 00:01:59,439
ten Earth oceans being lost depending on

53
00:02:04,319 --> 00:02:02,740
your model parameters further

54
00:02:06,480 --> 00:02:04,329
complicating this as we saw on an

55
00:02:08,400 --> 00:02:06,490
earlier talk by Rory Barnes that tides

56
00:02:10,740 --> 00:02:08,410
are definitely going to be important for

57
00:02:12,270 --> 00:02:10,750
any M dwarf planet residing in the

58
00:02:14,699 --> 00:02:12,280
habitable zone of their host stars and

59
00:02:17,309 --> 00:02:14,709
these tides can tend to circularize the

60
00:02:19,290 --> 00:02:17,319
orbits dance obliquity z-- drive tidal

61
00:02:20,970 --> 00:02:19,300
heating and it can place the orbit in a

62
00:02:23,040 --> 00:02:20,980
tidally locked state where it could be

63
00:02:24,960 --> 00:02:23,050

in some flavor of a spin orbit residence

64
00:02:27,100 --> 00:02:24,970
you know a 3 to 2 or 1/2

65
00:02:28,900 --> 00:02:27,110
potentially and this you know as we saw

66
00:02:30,880 --> 00:02:28,910
earlier in GCM modeling by Tony del

67
00:02:32,620 --> 00:02:30,890
Genio can be very important for

68
00:02:35,050 --> 00:02:32,630
understanding what the planet looks like

69
00:02:37,150 --> 00:02:35,060
today depending on its composition so

70
00:02:40,080 --> 00:02:37,160
these are all very extremely important

71
00:02:42,760 --> 00:02:40,090
for understanding Proxima beat today

72
00:02:45,310 --> 00:02:42,770
so with these for physics in mind you

73
00:02:47,230 --> 00:02:45,320
know we need to simulate these in a very

74
00:02:49,000 --> 00:02:47,240
cohesive framework to understand what

75
00:02:51,100 --> 00:02:49,010
Proxima beat can be today so for big

76
00:02:54,160 --> 00:02:51,110
ones we have tides the evolution of the

77
00:02:56,380 --> 00:02:54,170
star itself atmospheric escape is where

78
00:02:58,960 --> 00:02:56,390
ego talk talked about and the Earth's

79
00:03:00,850 --> 00:02:58,970
like interior physics that can drive you

80
00:03:02,890 --> 00:03:00,860
know the formation of a core and can

81
00:03:06,280 --> 00:03:02,900
actually couple with these different

82
00:03:08,110 --> 00:03:06,290
models especially the tidal balls so we

83
00:03:10,060 --> 00:03:08,120
do is we actually couple these for all

84
00:03:11,830 --> 00:03:10,070
these physics in a framework v planet

85
00:03:14,500 --> 00:03:11,840
that's presented in barns at all 2017

86
00:03:16,510 --> 00:03:14,510
which is still under review we use the

87
00:03:19,060 --> 00:03:16,520
title evolution the compensated leg

88
00:03:20,500 --> 00:03:19,070

model of frost melo at all 2008 the

89
00:03:22,990 --> 00:03:20,510
stellar evolution we use young style

90
00:03:25,660 --> 00:03:23,000
tracks that are appropriate for low mass

91
00:03:27,460 --> 00:03:25,670
stars like Proxima use a third one D

92
00:03:29,500 --> 00:03:27,470
thermal interior code developed by Peter

93
00:03:31,270 --> 00:03:29,510
Driscoll and collaborators and finally

94
00:03:33,150 --> 00:03:31,280
we use the atmospheric escape formalism

95
00:03:36,880 --> 00:03:33,160
of the air cave at all which is a

96
00:03:38,199 --> 00:03:36,890
representative Rodrigo's 2015 paper now

97
00:03:40,030 --> 00:03:38,209
I want to be careful I want to claim

98
00:03:41,740 --> 00:03:40,040
that we're not modeling everything in

99
00:03:43,210 --> 00:03:41,750
the system as my Klein pointed out

100
00:03:44,860 --> 00:03:43,220
there's a lot of higher-order physics

101
00:03:47,020 --> 00:03:44,870
that need to be resolved for a very

102
00:03:48,550 --> 00:03:47,030
robust estimation but if we're going to

103
00:03:51,100 --> 00:03:48,560
simulate all these different physics to

104
00:03:52,930 --> 00:03:51,110
understand how Proxima B is today and if

105
00:03:55,180 --> 00:03:52,940
I want to simulate all these on a PhD

106
00:03:57,490 --> 00:03:55,190
time scale we have to use these 1d

107
00:03:59,410 --> 00:03:57,500
models in this framework so we can still

108
00:04:02,290 --> 00:03:59,420
come up with some robust statistical

109
00:04:04,120 --> 00:04:02,300
conclusions now I want to say that I am

110
00:04:06,759 --> 00:04:04,130
committing a cardinal sin of this

111
00:04:08,949 --> 00:04:06,769
session I'm not working in a Bayesian

112
00:04:10,810 --> 00:04:08,959
framework but before you throw things at

113
00:04:12,220 --> 00:04:10,820

me I want to mention that when you

114
00:04:14,650 --> 00:04:12,230
combine all these physics this is a

115
00:04:16,810 --> 00:04:14,660
massive parameter space upwards of 30

116
00:04:18,460 --> 00:04:16,820
parameters so even though V planet is

117
00:04:20,199 --> 00:04:18,470
blazingly fast I don't care how much

118
00:04:22,000 --> 00:04:20,209
computer time you have you're not going

119
00:04:23,980 --> 00:04:22,010
to resolve every single dimension now

120
00:04:25,930 --> 00:04:23,990
this is stuff we're working on but here

121
00:04:28,030 --> 00:04:25,940
I present some bookend and member

122
00:04:29,650 --> 00:04:28,040
simulations just so we can see how these

123
00:04:31,810 --> 00:04:29,660
different flavors of evolution actually

124
00:04:33,279 --> 00:04:31,820
progress so we can have an idea of how

125
00:04:35,920 --> 00:04:33,289
these different physics actually couple

126
00:04:37,580 --> 00:04:35,930
in reality so first one thing I would

127
00:04:39,470 --> 00:04:37,590
have note about the tides here we

128
00:04:40,910 --> 00:04:39,480
work with the constant phase light phase

129
00:04:43,760 --> 00:04:40,920
like model and that has to do with this

130
00:04:45,380 --> 00:04:43,770
nebulous parameter Q and Q effectively

131
00:04:47,660 --> 00:04:45,390
just parameter eise's how efficient it

132
00:04:49,490 --> 00:04:47,670
tides are how fast the tides proceed so

133
00:04:51,200 --> 00:04:49,500
on the left here small title Q is

134
00:04:53,390 --> 00:04:51,210
consistent with an earth-like planet

135
00:04:56,300 --> 00:04:53,400
where you have these surface oceans

136
00:04:58,040 --> 00:04:56,310
driving very fast tidal evolutions this

137
00:05:00,260 --> 00:04:58,050
is efficient dissipation and a large

138
00:05:02,840 --> 00:05:00,270

tidal queue could be some planet with a

139
00:05:05,120 --> 00:05:02,850
very extended atmosphere like in Neptune

140
00:05:07,250 --> 00:05:05,130
let's say so these large tidal queues of

141
00:05:10,340 --> 00:05:07,260
order like 10 to the 4 let's say lead to

142
00:05:12,140 --> 00:05:10,350
inefficient dissipation so in our

143
00:05:15,530 --> 00:05:12,150
coupled title model we effectively take

144
00:05:16,760 --> 00:05:15,540
the harmonic mean of the tidal Q and if

145
00:05:18,260 --> 00:05:16,770
anyone was asking about why that's

146
00:05:20,090 --> 00:05:18,270
physically justified I'll be happy to

147
00:05:23,030 --> 00:05:20,100
get into that later but effectively what

148
00:05:25,520 --> 00:05:23,040
we do is we include a thermal interior

149
00:05:27,590 --> 00:05:25,530
portion a portion due to oceans and an

150
00:05:29,750 --> 00:05:27,600
envelope in this onion planet model

151
00:05:32,210 --> 00:05:29,760
represented schematically below and we

152
00:05:34,070 --> 00:05:32,220
simulate three major cases the first one

153
00:05:36,500 --> 00:05:34,080
is no ocean case where we just have the

154
00:05:38,660 --> 00:05:36,510
1d earth model Peter Driscoll driving

155
00:05:40,490 --> 00:05:38,670
the evolution of the planet and its

156
00:05:42,320 --> 00:05:40,500
growth of the mantle and the internal

157
00:05:46,190 --> 00:05:42,330
core of the planet actually gives it a

158
00:05:48,160 --> 00:05:46,200
title Q of a few hundreds webside now in

159
00:05:50,720 --> 00:05:48,170
our second case the ocean case we just

160
00:05:52,990 --> 00:05:50,730
slap on an ocean of the planet assuming

161
00:05:55,250 --> 00:05:53,000
a liquid surface ocean with the title Q

162
00:05:57,370 --> 00:05:55,260
consistent of Earth which is you know

163
00:06:00,410 --> 00:05:57,380

mostly tightly driven by its oceans and

164
00:06:02,330 --> 00:06:00,420
we compute the net tidal Q this way but

165
00:06:04,400 --> 00:06:02,340
when the planet is in the runaway

166
00:06:05,810 --> 00:06:04,410
greenhouse phase there's not going to be

167
00:06:07,430 --> 00:06:05,820
any liquid water present on the surface

168
00:06:09,410 --> 00:06:07,440
instead it's going to be in some steam

169
00:06:11,810 --> 00:06:09,420
atmosphere so we neglect that term from

170
00:06:14,120 --> 00:06:11,820
our calculations so in our final case

171
00:06:15,500 --> 00:06:14,130
the envelope case is our full onion of a

172
00:06:18,380 --> 00:06:15,510
planet where we have all these different

173
00:06:19,910 --> 00:06:18,390
terms and we use an envelope Q of 10 to

174
00:06:23,570 --> 00:06:19,920
the 4 consistent with that of Neptune

175
00:06:25,280 --> 00:06:23,580
drive-bys and Hamilton 2008 but again

176
00:06:26,570 --> 00:06:25,290
there's a caveat when the envelope is

177
00:06:29,000 --> 00:06:26,580
actually present that's going to be

178
00:06:30,350 --> 00:06:29,010
exerting a high pressure on the water so

179
00:06:32,870 --> 00:06:30,360
it's likely going to be super critical

180
00:06:35,480 --> 00:06:32,880
so we again neglect the ocean term while

181
00:06:36,440 --> 00:06:35,490
the envelope is present so now we're

182
00:06:38,300 --> 00:06:36,450
going to look at how some of these

183
00:06:40,220 --> 00:06:38,310
parameters evolve as function of time so

184
00:06:42,200 --> 00:06:40,230
here we have the title Q as a function

185
00:06:44,570 --> 00:06:42,210
of time for our cases and note that we

186
00:06:46,610 --> 00:06:44,580
also have this Cpl case which is just

187
00:06:48,590 --> 00:06:46,620
our base case effectively where we have

188
00:06:49,850 --> 00:06:48,600

a constant tidal queue of 12 through the

189
00:06:50,690 --> 00:06:49,860
whole simulation just as a good

190
00:06:53,120 --> 00:06:50,700
reference for it

191
00:06:55,450 --> 00:06:53,130
so you can see the envelope ocean and

192
00:06:58,370 --> 00:06:55,460
ocean case are all dominated by this

193
00:07:00,440 --> 00:06:58,380
interior evolution as they all progress

194
00:07:01,910 --> 00:07:00,450
to a title cue of a few hundreds and

195
00:07:03,950 --> 00:07:01,920
then you see this abrupt phase

196
00:07:05,360 --> 00:07:03,960
transition and this occurs when the

197
00:07:07,250 --> 00:07:05,370
planet actually leaves the runaway

198
00:07:09,290 --> 00:07:07,260
greenhouse phase there's some you know

199
00:07:11,750 --> 00:07:09,300
epic monsoon where all the oceans

200
00:07:13,460 --> 00:07:11,760
condense and this leads to very rapid

201
00:07:15,140 --> 00:07:13,470
tidal evolution as the tidal keep

202
00:07:16,880 --> 00:07:15,150
plummets and we can see how this

203
00:07:19,100 --> 00:07:16,890
actually impacts the orbits if we look

204
00:07:21,650 --> 00:07:19,110
at this orbital eccentricity on the left

205
00:07:23,750 --> 00:07:21,660
and the semi-major axis on the right so

206
00:07:26,030 --> 00:07:23,760
again for both of these cases you see

207
00:07:27,860 --> 00:07:26,040
that it's pretty much the mantle the

208
00:07:30,650 --> 00:07:27,870
thermal interior dominating this tight

209
00:07:32,810 --> 00:07:30,660
little evolution during the during the

210
00:07:34,430 --> 00:07:32,820
runaway greenhouse phase and again when

211
00:07:36,020 --> 00:07:34,440
you leave that phase that's when the

212
00:07:37,790 --> 00:07:36,030
tides really turn on you have this

213
00:07:39,650 --> 00:07:37,800

orbital circularization and your

214
00:07:43,160 --> 00:07:39,660
semi-major axis starts to decay due to

215
00:07:44,810 --> 00:07:43,170
efficient tidal dissipation now we can

216
00:07:46,580 --> 00:07:44,820
look at tidal heating to see what goes

217
00:07:47,510 --> 00:07:46,590
on here now you see a spike that I'll

218
00:07:49,760 --> 00:07:47,520
get to that

219
00:07:51,350 --> 00:07:49,770
so you see initially that the new ocean

220
00:07:53,060 --> 00:07:51,360
case the thermal interior again

221
00:07:55,070 --> 00:07:53,070
dominates earlier but you see this

222
00:07:57,140 --> 00:07:55,080
little bouncing of the envelope here

223
00:07:59,150 --> 00:07:57,150
what's going on here so what this

224
00:08:01,940 --> 00:07:59,160
actually is as the planet is losing

225
00:08:03,830 --> 00:08:01,950
hydrogen due to hydrodynamic escape the

226
00:08:06,680 --> 00:08:03,840
radius actually changes and we use a

227
00:08:08,270 --> 00:08:06,690
some ATO bat models from Eric Lopez I

228
00:08:10,160 --> 00:08:08,280
believe to actually calculate the radius

229
00:08:11,240 --> 00:08:10,170
as a function of hydrogen mass here so

230
00:08:14,150 --> 00:08:11,250
that's what's going on for this little

231
00:08:16,040 --> 00:08:14,160
wiggling now again as you guess it this

232
00:08:18,200 --> 00:08:16,050
spike is due to oceans condensing the

233
00:08:20,720 --> 00:08:18,210
efficient tides turn on and you get some

234
00:08:23,030 --> 00:08:20,730
substantial tidal heating actually in

235
00:08:25,190 --> 00:08:23,040
excess of IO which is of order two watts

236
00:08:27,590 --> 00:08:25,200
per meter squared now this planet isn't

237
00:08:30,530 --> 00:08:27,600
going to be throwing up its guts like IO

238
00:08:33,620 --> 00:08:30,540

is instead this title dissipation mostly

239
00:08:35,480 --> 00:08:33,630
happens at the ocean rock interface here

240
00:08:37,760 --> 00:08:35,490
so this could warm the ocean but

241
00:08:40,490 --> 00:08:37,770
probably not appreciably at this tidal

242
00:08:42,050 --> 00:08:40,500
heat flux but for closer in planets you

243
00:08:43,430 --> 00:08:42,060
know as the tidal forces get stronger

244
00:08:45,620 --> 00:08:43,440
depending on your orbital distance to

245
00:08:47,210 --> 00:08:45,630
the star you can get more substantial

246
00:08:49,790 --> 00:08:47,220
title heating in a scenario like this

247
00:08:51,290 --> 00:08:49,800
and that was explored in a 2013 paper by

248
00:08:53,660 --> 00:08:51,300
Rory but I won't get into that anymore

249
00:08:55,790 --> 00:08:53,670
and then finally let's look at how the

250
00:08:57,290 --> 00:08:55,800
hydrogen envelope on the Left that mass

251
00:08:59,600 --> 00:08:57,300
and the water content on the right

252
00:09:01,640 --> 00:08:59,610
actually vary as a function of time so

253
00:09:03,199 --> 00:09:01,650
in our two cases where we actually have

254
00:09:05,150 --> 00:09:03,209
liquid water we have the Oh

255
00:09:07,669 --> 00:09:05,160
in case in blue which doesn't have the

256
00:09:10,819 --> 00:09:07,679
iodine envelope and then and then the

257
00:09:12,290 --> 00:09:10,829
envelope case in the orange line which

258
00:09:15,290 --> 00:09:12,300
does have a hydrogen envelope hence its

259
00:09:16,699 --> 00:09:15,300
name we can see that the envelope

260
00:09:18,590 --> 00:09:16,709
actually decreases due to the

261
00:09:22,009 --> 00:09:18,600
hydrodynamic escape such that the entire

262
00:09:24,769 --> 00:09:22,019
envelope has been not pushed off the

263
00:09:27,290 --> 00:09:24,779

planet but it fully escaped by around 80

264
00:09:28,400 --> 00:09:27,300
mega years or so and in this time it's

265
00:09:29,780 --> 00:09:28,410
interesting if you look at the water

266
00:09:32,329 --> 00:09:29,790
curve you see that that hydrogen

267
00:09:35,329 --> 00:09:32,339
envelope has protected the surface water

268
00:09:37,069 --> 00:09:35,339
in this case and this can be in of

269
00:09:37,879 --> 00:09:37,079
course once you see the oceans condense

270
00:09:40,669 --> 00:09:37,889
and you lead the runaway greenhouse

271
00:09:42,559 --> 00:09:40,679
phase there's no water in the atmosphere

272
00:09:44,960 --> 00:09:42,569
that could be subject to fatalis and

273
00:09:46,639 --> 00:09:44,970
subsequent escape but if you look in

274
00:09:48,470 --> 00:09:46,649
this case you can see that the hydrogen

275
00:09:51,590 --> 00:09:48,480
envelope can actually be very efficient

276
00:09:52,730 --> 00:09:51,600
in preserving some surface water so you

277
00:09:54,379 --> 00:09:52,740
see it doesn't lose anything the

278
00:09:56,929 --> 00:09:54,389
envelope is present and in this you know

279
00:09:58,970 --> 00:09:56,939
obviously fine-tuned case we end up with

280
00:10:00,980 --> 00:09:58,980
roughly one earth ocean of water which

281
00:10:02,449 --> 00:10:00,990
is excellent now again like Rodrigo I'm

282
00:10:04,009 --> 00:10:02,459
not going to claim to a solve Proxima

283
00:10:05,840 --> 00:10:04,019
Centauri B but these are some

284
00:10:07,519 --> 00:10:05,850
interesting cases that must be

285
00:10:08,809 --> 00:10:07,529
considered for a planet like this

286
00:10:12,019 --> 00:10:08,819
especially when there are large

287
00:10:13,759 --> 00:10:12,029
uncertainties on its formation so I'll

288
00:10:16,129 --> 00:10:13,769

conclude and say that coupling these

289
00:10:17,660 --> 00:10:16,139
physics like although they are 1d models

290
00:10:19,160 --> 00:10:17,670
and they are rather simple but they're

291
00:10:21,289 --> 00:10:19,170
very important to understand the

292
00:10:23,509 --> 00:10:21,299
cohesive evolution of sussel such a

293
00:10:26,030 --> 00:10:23,519
system especially when there are non

294
00:10:28,220 --> 00:10:26,040
zero cases that can lead to a habitable

295
00:10:30,289 --> 00:10:28,230
Proxima B today you know as an optimist

296
00:10:32,840 --> 00:10:30,299
is what I hope for albeit likely you

297
00:10:34,429 --> 00:10:32,850
know it's unlikely and we have this code

298
00:10:36,439 --> 00:10:34,439
bee planet that allows us to couple

299
00:10:38,359 --> 00:10:36,449
these and simulate a large number of

300
00:10:40,910 --> 00:10:38,369
these not necessarily you know 10 to the

301
00:10:42,980 --> 00:10:40,920
40 or so but still enough that we can do

302
00:10:45,350 --> 00:10:42,990
some sort of these Bayesian Alice's that

303
00:10:47,269 --> 00:10:45,360
Rodrigo presented earlier and of course

304
00:10:48,889 --> 00:10:47,279
this depends a lot a lot on its

305
00:10:50,749 --> 00:10:48,899
formation which needs to be constrained

306
00:10:53,119 --> 00:10:50,759
by models in terms of how much water it

307
00:10:55,189 --> 00:10:53,129
has and its hydrogen envelope and of

308
00:10:56,720 --> 00:10:55,199
course this is a huge parameter space to

309
00:10:59,210 --> 00:10:56,730
explore so if we are going to do any

310
00:11:01,069 --> 00:10:59,220
sort of Bayesian stuff with this coupled

311
00:11:02,900 --> 00:11:01,079
model we have to speed it up and I will

312
00:11:04,850 --> 00:11:02,910
you know plug myself of course that this

313
00:11:06,470 --> 00:11:04,860

is some work I'm doing with using

314
00:11:08,119 --> 00:11:06,480
machine learning to actually speed this

315
00:11:09,919 --> 00:11:08,129
up and appropriately sample high

316
00:11:11,299 --> 00:11:09,929
dimensional parameter spaces and with

317
00:11:16,940 --> 00:11:11,309
that I'll be happy to take any questions

318
00:11:20,730 --> 00:11:19,440
thank you very much David so yeah we do

319
00:11:26,730 --> 00:11:20,740
have time for questions for those of you

320
00:11:29,510 --> 00:11:26,740
who are not too hungry I could go ahead

321
00:11:31,830 --> 00:11:29,520
and get your coffee earlier as well I

322
00:11:33,780 --> 00:11:31,840
have a question sort of for all the

323
00:11:35,040 --> 00:11:33,790
speakers in this they talked about this

324
00:11:37,530 --> 00:11:35,050
beep planet model is this model

325
00:11:39,540 --> 00:11:37,540
eventually going to be available somehow

326
00:11:42,330 --> 00:11:39,550
to the community of interested Koreans

327
00:11:44,580 --> 00:11:42,340
from these type of models I guess that's

328
00:11:46,200 --> 00:11:44,590
my more of a question for me yeah so I

329
00:11:47,430 --> 00:11:46,210
yeah that is that is definitely the goal

330
00:11:49,170 --> 00:11:47,440
and we are working towards that so uh

331
00:11:50,970 --> 00:11:49,180
you know I can't give you a precise time

332
00:11:52,440 --> 00:11:50,980
frame but hopefully within the next year

333
00:11:54,420 --> 00:11:52,450
or so we'll be a being able to really

334
00:11:57,510 --> 00:11:54,430
set to the public so we're working

335
00:11:59,160 --> 00:11:57,520
towards our plan and this is a

336
00:12:01,410 --> 00:11:59,170
potentially naive question this is not

337
00:12:02,820 --> 00:12:01,420
my field of expertise can you use the

338
00:12:05,370 --> 00:12:02,830

known or upper limits on the

339
00:12:06,780 --> 00:12:05,380
eccentricity for proxy Envy to back out

340
00:12:09,030 --> 00:12:06,790
and say whether there's a notion or not

341
00:12:11,640 --> 00:12:09,040
you've got if there's a notion it should

342
00:12:12,990 --> 00:12:11,650
have a title dissipation and you should

343
00:12:15,870 --> 00:12:13,000
have a circular orbit if it's very good

344
00:12:17,370 --> 00:12:15,880
at anticipating an orbital energy but if

345
00:12:19,610 --> 00:12:17,380
there if it's an eccentric orbit you can

346
00:12:22,680 --> 00:12:19,620
argue that there can't be much ocean um

347
00:12:24,420 --> 00:12:22,690
so I think in this case whether or not

348
00:12:25,740 --> 00:12:24,430
there is an ocean or not is

349
00:12:27,600 --> 00:12:25,750
predominantly dominated by the

350
00:12:29,160 --> 00:12:27,610
uncertainties on our atmospheric escape

351
00:12:30,930 --> 00:12:29,170
model I guess where we go spoke about

352
00:12:32,340 --> 00:12:30,940
earlier referencing him a lot that

353
00:12:35,850 --> 00:12:32,350
there's just a substantial uncertainty

354
00:12:38,460 --> 00:12:35,860
with the planets previous XUV luminosity

355
00:12:40,200 --> 00:12:38,470
evolution which we do try to model in

356
00:12:42,000 --> 00:12:40,210
terms of its eccentricities higher

357
00:12:45,090 --> 00:12:42,010
eccentricity you get more orbit average

358
00:12:48,360 --> 00:12:45,100
flux right that is not a case we probed

359
00:12:50,610 --> 00:12:48,370
here but even with if we just evolve it

360
00:12:52,740 --> 00:12:50,620
with an exome tricity of 0.35 and keep

361
00:12:55,040 --> 00:12:52,750
that constant it's still that luminosity

362
00:12:57,540 --> 00:12:55,050
evolution that's driving this although

363
00:12:59,100 --> 00:12:57,550

when you get into a framework like this

364
00:13:00,990 --> 00:12:59,110
that's when we can start to split hairs

365
00:13:03,120 --> 00:13:01,000
and see like okay how much oceans you

366
00:13:04,890 --> 00:13:03,130
actually need to begin with if you start

367
00:13:07,650 --> 00:13:04,900
in a high luminosity state and with our

368
00:13:09,480 --> 00:13:07,660
Cpl model it's not strictly valid at

369
00:13:11,520 --> 00:13:09,490
higher eccentricities like that we need

370
00:13:12,780 --> 00:13:11,530
to switch to a CTL model for example

371
00:13:14,760 --> 00:13:12,790
they can handle these higher

372
00:13:18,180 --> 00:13:14,770
eccentricities but here we focus more on

373
00:13:20,940 --> 00:13:18,190
the low eccentricity regime thank you

374
00:13:26,500 --> 00:13:24,820
all right any more questions all right

375
00:13:27,790 --> 00:13:26,510
well then I thank you all for coming to

376
00:13:30,490 --> 00:13:27,800
this session when I could break for

377
00:13:32,710 --> 00:13:30,500
lunch before we go I want you know I

378
00:13:35,019 --> 00:13:32,720
remind you all to to please fill out the

379
00:13:36,820 --> 00:13:35,029
survey formula that you can get at the

380
00:13:39,130 --> 00:13:36,830
kiosk across from the registration desk

381
00:13:40,750 --> 00:13:39,140
but let's say I go ahead and thank all