
AbSciCon
2017
MESA, ARIZONA

1
00:00:02,120 --> 00:00:12,430
you

2
00:00:16,460 --> 00:00:14,780
while Tess is not here today to give her

3
00:00:17,810 --> 00:00:16,470
talk so that's a bit unfortunate but

4
00:00:21,769 --> 00:00:17,820
maybe it's better because her slides

5
00:00:24,560 --> 00:00:21,779
wouldn't have been here but the whole

6
00:00:25,940 --> 00:00:24,570
point of kind of having us in this room

7
00:00:26,990 --> 00:00:25,950
getting this talk is to try to bring a

8
00:00:28,999 --> 00:00:27,000
new perspective to thinking about

9
00:00:30,170 --> 00:00:29,009
exoplanet biosignatures and it's

10
00:00:33,020 --> 00:00:30,180
actually a discussion that really would

11
00:00:35,300 --> 00:00:33,030
be had if having these kind of methods

12
00:00:36,860 --> 00:00:35,310
in a different room at apps icon so John

13
00:00:38,240 --> 00:00:36,870

can we actually bring some of the

14
00:00:40,280 --> 00:00:38,250
techniques that we're using in different

15
00:00:44,599 --> 00:00:40,290
areas into thinking about exoplanet bio

16
00:00:47,900 --> 00:00:44,609
signatures and so I am originally

17
00:00:49,670 --> 00:00:47,910
scientist I work primarily on thinking

18
00:00:51,529 --> 00:00:49,680
about living systems and one of the

19
00:00:53,209 --> 00:00:51,539
things I think is really intriguing to

20
00:00:55,610 --> 00:00:53,219
me about exoplanets is the opportunity

21
00:00:57,410 --> 00:00:55,620
actually to think about life from an

22
00:00:58,729 --> 00:00:57,420
entirely different perspective and so

23
00:01:00,830 --> 00:00:58,739
what I would hope is that we can

24
00:01:02,209 --> 00:01:00,840
actually take advantage of a unique

25
00:01:04,220 --> 00:01:02,219
opportunity that we're going to get with

26
00:01:06,380 --> 00:01:04,230
exoplanets to get more information about

27
00:01:09,380 --> 00:01:06,390
building series for living systems and

28
00:01:11,090 --> 00:01:09,390
so that's actually my ultimate goal but

29
00:01:15,290 --> 00:01:11,100
what we're trying to do is actually look

30
00:01:17,719 --> 00:01:15,300
at atmospheres more from a systems

31
00:01:19,310 --> 00:01:17,729
perspective and so what people do in

32
00:01:20,420 --> 00:01:19,320
other areas of science that are thinking

33
00:01:22,850 --> 00:01:20,430
about living systems from more

34
00:01:26,600 --> 00:01:22,860
quantitative perspective is actually try

35
00:01:30,770 --> 00:01:26,610
to think about the network structure of

36
00:01:32,149 --> 00:01:30,780
living systems and what I mean by this

37
00:01:34,819 --> 00:01:32,159
so how many people here actually on

38
00:01:37,249 --> 00:01:34,829

Facebook a lot of people how many people

39
00:01:39,139 --> 00:01:37,259
are tweeting right now okay you're a

40
00:01:41,990 --> 00:01:39,149
part of a network you may not know it

41
00:01:43,399 --> 00:01:42,000
that you are and so what happens on

42
00:01:44,929 --> 00:01:43,409
Facebook if you want to represent that

43
00:01:46,999 --> 00:01:44,939
mathematically what the structure of

44
00:01:49,399 --> 00:01:47,009
Facebook is you can do that in a

45
00:01:50,929 --> 00:01:49,409
graphical representation and so each

46
00:01:52,969 --> 00:01:50,939
person is we raised their hand raise

47
00:01:54,380 --> 00:01:52,979
your hand again you would be a node how

48
00:01:55,520 --> 00:01:54,390
many people are and you're friends with

49
00:01:58,279 --> 00:01:55,530
other people in this room probably

50
00:02:00,080 --> 00:01:58,289
everybody yeah okay so there would be

51
00:02:03,440 --> 00:02:00,090
connections between the people in this

52
00:02:06,590 --> 00:02:03,450
room and we could actually build a

53
00:02:08,359 --> 00:02:06,600
network structure to describe that as it

54
00:02:09,830 --> 00:02:08,369
turns out when you do that for living

55
00:02:11,450 --> 00:02:09,840
systems when you do that for social

56
00:02:14,120 --> 00:02:11,460
systems or you do it for chemical

57
00:02:15,140 --> 00:02:14,130
systems you end up realizing that

58
00:02:17,480 --> 00:02:15,150
there's a lot of statistical

59
00:02:18,980 --> 00:02:17,490
regularities in that structure and so

60
00:02:20,390 --> 00:02:18,990
that's actually the topological

61
00:02:22,250 --> 00:02:20,400
properties of the networks that we study

62
00:02:23,809 --> 00:02:22,260
and so what I'm going to talk about at

63
00:02:25,180 --> 00:02:23,819

2:45 in another room which hopefully

64
00:02:27,890 --> 00:02:25,190
will have my flies

65
00:02:30,830 --> 00:02:27,900
is actually the biochemical Network

66
00:02:31,910 --> 00:02:30,840
structure of the biosphere as a whole so

67
00:02:34,070 --> 00:02:31,920
one of the things that we've been doing

68
00:02:36,380 --> 00:02:34,080
in my group is actually looking at the

69
00:02:38,630 --> 00:02:36,390
structure of reactions with inside

70
00:02:40,160 --> 00:02:38,640
individual organisms at the level of

71
00:02:41,899 --> 00:02:40,170
entire communities and at the level of

72
00:02:43,640 --> 00:02:41,909
the biosphere as a whole and they have a

73
00:02:46,910 --> 00:02:43,650
lot of statistical regularities across

74
00:02:48,830 --> 00:02:46,920
those scales as it turns out some of

75
00:02:51,890 --> 00:02:48,840
those statistical regularities are also

76
00:02:53,449 --> 00:02:51,900
apparent and atmospheres of planets so

77
00:02:55,490 --> 00:02:53,459
some networks serious being Network

78
00:02:56,720 --> 00:02:55,500
serious they'd like to study systems in

79
00:02:59,150 --> 00:02:56,730
all kinds of different areas have

80
00:03:01,819 --> 00:02:59,160
actually published a few papers looking

81
00:03:03,770 --> 00:03:01,829
at the network structure of chemical

82
00:03:05,270 --> 00:03:03,780
reaction networks in atmospheres and I

83
00:03:06,530 --> 00:03:05,280
think this is a literature that people

84
00:03:08,150 --> 00:03:06,540
max the planet community maybe are not

85
00:03:09,830 --> 00:03:08,160
aware of it's a very small literature

86
00:03:12,559 --> 00:03:09,840
I've only been able to come across less

87
00:03:14,270 --> 00:03:12,569
than 10 papers doing this but I think

88
00:03:16,009 --> 00:03:14,280

it's been incredibly promising Avenue

89
00:03:17,599 --> 00:03:16,019
for thinking about atmospheres not just

90
00:03:19,699 --> 00:03:17,609
in terms of their molecular constituents

91
00:03:21,140 --> 00:03:19,709
but their actual structure like what is

92
00:03:22,520 --> 00:03:21,150
the structure of an atmosphere from this

93
00:03:25,970 --> 00:03:22,530
kind of perspective that's relevant to

94
00:03:27,710 --> 00:03:25,980
living system and so I think I'm just

95
00:03:29,900 --> 00:03:27,720
going to go in my slides at this point I

96
00:03:31,220 --> 00:03:29,910
think I have to okay so I'm just going

97
00:03:32,839 --> 00:03:31,230
to you guys are just going to cheese or

98
00:03:34,720 --> 00:03:32,849
of you know this kind of new approach to

99
00:03:36,740 --> 00:03:34,730
thinking about bio signatures and then

100
00:03:38,449 --> 00:03:36,750
really actually the whole point of this

101
00:03:39,409 --> 00:03:38,459
was to open this as a conversation for

102
00:03:42,500 --> 00:03:39,419
thinking about things a little bit

103
00:03:44,690 --> 00:03:42,510
differently so so these few papers have

104
00:03:46,940 --> 00:03:44,700
actually demonstrated that there might

105
00:03:49,610 --> 00:03:46,950
be some features just looking at the

106
00:03:52,240 --> 00:03:49,620
atmospheres in our own solar system that

107
00:03:55,659 --> 00:03:52,250
are different between Earth and other

108
00:03:57,770 --> 00:03:55,669
atmospheres and so for those of you that

109
00:04:00,199 --> 00:03:57,780
raised your hands for Facebook raise

110
00:04:01,819 --> 00:04:00,209
your hands again okay so what kind of

111
00:04:03,589 --> 00:04:01,829
statistical regularities am I talking

112
00:04:05,990 --> 00:04:03,599
about how many people in this room have

113
00:04:07,460 --> 00:04:06,000

more than 100 friends on Facebook okay

114
00:04:10,520 --> 00:04:07,470
how many people are more than 200

115
00:04:13,520 --> 00:04:10,530
friends okay how many people have more

116
00:04:16,789 --> 00:04:13,530
than 300 friends how many people have

117
00:04:18,890 --> 00:04:16,799
more than 400 friends I'm not raising my

118
00:04:20,750 --> 00:04:18,900
hand more I was lost long ago I'm one of

119
00:04:23,300 --> 00:04:20,760
those yeah well our hips 500 friends

120
00:04:25,279 --> 00:04:23,310
okay so so what we just saw was actually

121
00:04:27,290 --> 00:04:25,289
a distribution of how many friends

122
00:04:28,700 --> 00:04:27,300
people have and you can look at those

123
00:04:30,170 --> 00:04:28,710
kinds of distributions and if you look

124
00:04:32,300 --> 00:04:30,180
at them and biochemical networks they

125
00:04:34,969 --> 00:04:32,310
actually have a power-law distribution

126
00:04:36,110 --> 00:04:34,979
and that kind of property is one of the

127
00:04:37,430 --> 00:04:36,120
kind of properties that we think is

128
00:04:38,960 --> 00:04:37,440
actually relevant to by a lot

129
00:04:40,940 --> 00:04:38,970
organization and so if you look at

130
00:04:43,370 --> 00:04:40,950
Earth's atmosphere if you actually

131
00:04:45,770 --> 00:04:43,380
inventoried how many reactions molecules

132
00:04:47,390 --> 00:04:45,780
participate in in Earth's atmosphere it

133
00:04:49,940 --> 00:04:47,400
would follow a similar distribution how

134
00:04:52,460 --> 00:04:49,950
you guys raise your hands but if you

135
00:04:55,880 --> 00:04:52,470
look at the atmosphere of Mars or Venus

136
00:04:57,740 --> 00:04:55,890
or Titan the preliminary analysis people

137
00:04:59,480 --> 00:04:57,750
done suggest that it's not really quite

138
00:05:00,860 --> 00:04:59,490

that distribution it might be more

139
00:05:03,140 --> 00:05:00,870
homogeneous so there might be more

140
00:05:04,400 --> 00:05:03,150
people with a hundred friends everybody

141
00:05:05,780 --> 00:05:04,410
has the same number of friends and there

142
00:05:09,080 --> 00:05:05,790
aren't those anomalies that have a

143
00:05:10,910 --> 00:05:09,090
thousand friends so the heterogeneity of

144
00:05:12,440 --> 00:05:10,920
the distribution of having really

145
00:05:16,100 --> 00:05:12,450
popular people having justin bieber's

146
00:05:18,620 --> 00:05:16,110
for example is really indicative of

147
00:05:22,340 --> 00:05:18,630
living systems it leads to robustness

148
00:05:24,080 --> 00:05:22,350
and living systems and it's actually

149
00:05:25,820 --> 00:05:24,090
could potentially be a bio signature and

150
00:05:27,830 --> 00:05:25,830
so what we're interested in doing is

151
00:05:29,990 --> 00:05:27,840
actually doing more rigorous analysis of

152
00:05:31,760 --> 00:05:30,000
different planetary atmospheres to try

153
00:05:33,050 --> 00:05:31,770
to figure out if this really is a robust

154
00:05:34,760 --> 00:05:33,060
bio signature if it's not just an

155
00:05:36,530 --> 00:05:34,770
artifact of our models what are the

156
00:05:37,280 --> 00:05:36,540
conditions that give rise to this kind

157
00:05:38,960 --> 00:05:37,290
of structure in the Earth's atmosphere

158
00:05:40,490 --> 00:05:38,970
that makes it different from the

159
00:05:44,120 --> 00:05:40,500
atmospheres of other worlds and how can

160
00:05:46,250 --> 00:05:44,130
we actually use that in exoplanets can

161
00:05:49,100 --> 00:05:46,260
we just wrecked ly detect this kind of

162
00:05:51,070 --> 00:05:49,110
structure at a systems level and so it

163
00:05:53,270 --> 00:05:51,080

becomes a really kind of interesting

164
00:05:54,470 --> 00:05:53,280
problem for understanding atmospheres

165
00:05:56,000 --> 00:05:54,480
and how they're coupled to a biosphere

166
00:05:57,500 --> 00:05:56,010
because the way the way I actually think

167
00:05:59,630 --> 00:05:57,510
about it you have this network of all

168
00:06:01,640 --> 00:05:59,640
the chemistry on a serviceable planet

169
00:06:02,990 --> 00:06:01,650
that biology catalyzes and you have an

170
00:06:05,570 --> 00:06:03,000
atmosphere and those are actually two

171
00:06:07,010 --> 00:06:05,580
coupled networks that are overlaid over

172
00:06:08,360 --> 00:06:07,020
each other and one is driving the other

173
00:06:10,520 --> 00:06:08,370
right so can we actually think about

174
00:06:13,610 --> 00:06:10,530
them at that global scale of the

175
00:06:14,990 --> 00:06:13,620
reaction network structure and so that

176
00:06:16,940 --> 00:06:15,000
would actually be the ultimate hope so

177
00:06:19,400 --> 00:06:16,950
I'm going to finish my song and dance

178
00:06:21,380 --> 00:06:19,410
routine because I think I could go on

179
00:06:22,730 --> 00:06:21,390
for this forever but actually since we

180
00:06:24,409 --> 00:06:22,740
have the time maybe it'd be good to have

181
00:06:28,640 --> 00:06:24,419
like some community comment questions

182
00:06:31,780 --> 00:06:28,650
discussion and yeah we'll see how that

183
00:06:33,980 --> 00:06:31,790
goes how much more time do I have you

184
00:06:36,980 --> 00:06:33,990
including questions have about nine more

185
00:06:39,020 --> 00:06:36,990
minutes but but first let's give you a

186
00:06:40,730 --> 00:06:39,030
really deep round of applause

187
00:06:44,219 --> 00:06:40,740
that's really

188
00:06:47,850 --> 00:06:44,229

without slides and everyone will

189
00:06:50,730 --> 00:06:47,860
remember so I'm so I actually really

190
00:06:53,730 --> 00:06:50,740
like this just them yes come on up

191
00:06:56,399 --> 00:06:53,740
questions please wow this is so cool and

192
00:06:57,959 --> 00:06:56,409
it's so ironic because what you're

193
00:06:59,219 --> 00:06:57,969
talking about is the ultimate kind of

194
00:07:03,450 --> 00:06:59,229
visualization

195
00:07:04,950 --> 00:07:03,460
I know data I know ya see it we've been

196
00:07:07,170 --> 00:07:04,960
doing a similar thing with minerals and

197
00:07:09,029 --> 00:07:07,180
we find that we think we're also seeing

198
00:07:11,909 --> 00:07:09,039
a bio signature on earth with the

199
00:07:13,379 --> 00:07:11,919
distribution of minerals in the

200
00:07:15,119 --> 00:07:13,389
opportunity place it's a particular

201
00:07:17,339 --> 00:07:15,129
frequency distribution called a large

202
00:07:18,930 --> 00:07:17,349
number of rare event distribution but it

203
00:07:22,770 --> 00:07:18,940
seems like that's not found on any other

204
00:07:24,209 --> 00:07:22,780
at least rest your body in our system we

205
00:07:27,719 --> 00:07:24,219
also are seeing really interesting

206
00:07:29,790 --> 00:07:27,729
Network topologies which is a different

207
00:07:31,170 --> 00:07:29,800
thing and again I mean that's what the

208
00:07:32,999 --> 00:07:31,180
power of networks you're seeing lots of

209
00:07:36,330 --> 00:07:33,009
different dimensions so so do you have

210
00:07:39,689 --> 00:07:36,340
any of the network metric did you ask

211
00:07:41,969 --> 00:07:39,699
about sure sure yes I'm really glad that

212
00:07:43,529 --> 00:07:41,979
you're looking at minerals and so so one

213
00:07:45,869 --> 00:07:43,539

thing I'd like to do is start connecting

214
00:07:47,249 --> 00:07:45,879
like the Earth's geochemical networks of

215
00:07:48,959 --> 00:07:47,259
biochemical networks atmospheric

216
00:07:50,399 --> 00:07:48,969
networks to do this kind of analysis but

217
00:07:52,559 --> 00:07:50,409
but the kind of things we're looking at

218
00:07:54,450 --> 00:07:52,569
so traditionally people look at the

219
00:07:56,070 --> 00:07:54,460
degree distribution it's a technical

220
00:07:58,320 --> 00:07:56,080
term for like hand waving that we just

221
00:08:01,320 --> 00:07:58,330
did which is actually looking at how

222
00:08:03,959 --> 00:08:01,330
connected individual molecules are and

223
00:08:05,490 --> 00:08:03,969
then plotting that connectivity in a

224
00:08:07,469 --> 00:08:05,500
rank order fashion and fitting it with a

225
00:08:10,260 --> 00:08:07,479
nice power law but it turns out to be

226
00:08:12,890 --> 00:08:10,270
really hard to fit a power law to

227
00:08:15,510 --> 00:08:12,900
networks in a statistically rigorous way

228
00:08:16,980 --> 00:08:15,520
so I am more in favor of using other

229
00:08:18,600 --> 00:08:16,990
measures besides just the degree

230
00:08:20,730 --> 00:08:18,610
sequence for trying to understand the

231
00:08:22,950 --> 00:08:20,740
structure of these networks so some of

232
00:08:26,129 --> 00:08:22,960
the things that we've been looking at

233
00:08:29,490 --> 00:08:26,139
our things like the clustering and the

234
00:08:33,329 --> 00:08:29,500
network so for example if I'm friends

235
00:08:36,779 --> 00:08:33,339
with Sean and Sean knows Hillary and

236
00:08:39,120 --> 00:08:36,789
Hillary knows Nancy and Nancy knows Sean

237
00:08:41,399 --> 00:08:39,130
they form a triangle among my friends

238
00:08:42,899 --> 00:08:41,409

and I can count how many triangles among

239
00:08:44,040 --> 00:08:42,909
my friends there are in the system and

240
00:08:47,220 --> 00:08:44,050
that actually becomes a statistical

241
00:08:48,269 --> 00:08:47,230
property of the network and so we can

242
00:08:49,860 --> 00:08:48,279
look at that

243
00:08:50,750 --> 00:08:49,870
we've been looking at average path

244
00:08:53,810 --> 00:08:50,760
length

245
00:08:55,579 --> 00:08:53,820
so you can look at how far it takes to

246
00:08:56,990 --> 00:08:55,589
get from one individual to another so

247
00:08:58,100 --> 00:08:57,000
how many chemical reactions does it take

248
00:09:00,079 --> 00:08:58,110
to get from one species to another

249
00:09:01,280 --> 00:09:00,089
species in the network so probably most

250
00:09:03,110 --> 00:09:01,290
people this room have heard of like six

251
00:09:04,250 --> 00:09:03,120
degrees of separation that's actually

252
00:09:05,960 --> 00:09:04,260
where that comes from is from network

253
00:09:08,120 --> 00:09:05,970
science that you actually literally in a

254
00:09:11,180 --> 00:09:08,130
social network or only six people away

255
00:09:12,260 --> 00:09:11,190
from anybody on the planet and that was

256
00:09:15,949 --> 00:09:12,270
an experiment that was done that was

257
00:09:17,750 --> 00:09:15,959
pretty cool so that's another one and so

258
00:09:19,670 --> 00:09:17,760
so there's all these kinds of we could

259
00:09:21,170 --> 00:09:19,680
get into more technical conversation

260
00:09:22,130 --> 00:09:21,180
later but I'd really like to hear more

261
00:09:24,440 --> 00:09:22,140
about what you're doing they missed your

262
00:09:26,870 --> 00:09:24,450
talk on that this morning so so that'd

263
00:09:28,730 --> 00:09:26,880

be great I'll go to the next question hi

264
00:09:29,990 --> 00:09:28,740
Joshua Chris Hanson Tom University of

265
00:09:32,210 --> 00:09:30,000
Washington so I might be wrong about

266
00:09:34,310 --> 00:09:32,220
this but I suspect that a lot of the

267
00:09:37,310 --> 00:09:34,320
complexity in the network of Earth's

268
00:09:39,230 --> 00:09:37,320
atmosphere is attributable to traces by

269
00:09:40,519 --> 00:09:39,240
genetic species mm-hmm and so I'm

270
00:09:42,740 --> 00:09:40,529
wondering about the detectability of

271
00:09:44,480 --> 00:09:42,750
these so network properties yeah the

272
00:09:46,970 --> 00:09:44,490
planets what would you well so so

273
00:09:52,370 --> 00:09:46,980
interesting this is a great question so

274
00:09:53,960 --> 00:09:52,380
I I think even if you had trace species

275
00:09:56,870 --> 00:09:53,970
in the network they could they could

276
00:09:59,660 --> 00:09:56,880
change the structure of the network

277
00:10:02,180 --> 00:09:59,670
enough to be detectable but a lot of the

278
00:10:03,650 --> 00:10:02,190
stuff that we're looking at is global

279
00:10:04,880 --> 00:10:03,660
properties of the network so they will

280
00:10:06,650 --> 00:10:04,890
be things that are statistically

281
00:10:08,780 --> 00:10:06,660
averaged over the entire network so

282
00:10:10,519 --> 00:10:08,790
you'll count for example how many

283
00:10:11,960 --> 00:10:10,529
friends in each individual and network

284
00:10:14,690 --> 00:10:11,970
has and then look at the average over

285
00:10:16,610 --> 00:10:14,700
the entire network you can also look at

286
00:10:19,240 --> 00:10:16,620
those as local measures and how they're

287
00:10:22,190 --> 00:10:19,250
distributed in the network but since

288
00:10:24,310 --> 00:10:22,200

you're trying to infer the properties of

289
00:10:27,350 --> 00:10:24,320
the structure of the network as a whole

290
00:10:32,449 --> 00:10:27,360
it's not as sensitive as you would think

291
00:10:35,480 --> 00:10:32,459
to individual species and so it is in

292
00:10:37,250 --> 00:10:35,490
principle possible maybe because we're

293
00:10:39,500 --> 00:10:37,260
looking at it in a statistical sense to

294
00:10:40,519 --> 00:10:39,510
be able to infer those properties does

295
00:10:45,410 --> 00:10:40,529
that make sense in the context to your

296
00:10:48,530 --> 00:10:45,420
question hi Emma Jablonski hi I was

297
00:10:50,480 --> 00:10:48,540
somewhat early question um you said that

298
00:10:55,610 --> 00:10:50,490
there is a difference between the

299
00:10:58,310 --> 00:10:55,620
network artifacts in the earth versus

300
00:10:59,810 --> 00:10:58,320
some of the other planets in room is any

301
00:11:00,249 --> 00:10:59,820
of that attributable to the amount of

302
00:11:02,139 --> 00:11:00,259
data

303
00:11:04,719 --> 00:11:02,149
available yeah so actually that's a big

304
00:11:07,179 --> 00:11:04,729
problem and that's one of the things

305
00:11:09,099 --> 00:11:07,189
that we're actually actively working to

306
00:11:10,659 --> 00:11:09,109
try to get to the bottom of and so I

307
00:11:11,919 --> 00:11:10,669
since I didn't have my five I didn't

308
00:11:14,409 --> 00:11:11,929
really mention my collaborators on this

309
00:11:15,669 --> 00:11:14,419
but fit sighs Tessa Fisher there's two

310
00:11:18,189 --> 00:11:15,679
other students made repairs and Smith

311
00:11:20,379 --> 00:11:18,199
and coral Ruiz working on this and we

312
00:11:21,609 --> 00:11:20,389
also have my Klein and Jim Lyons a ASU

313
00:11:22,809 --> 00:11:21,619

that are giving sort of atmospheric

314
00:11:24,759 --> 00:11:22,819
expertise which is one of the nice

315
00:11:25,989 --> 00:11:24,769
things about if you we have a network

316
00:11:27,400 --> 00:11:25,999
scientist next one atmospheric

317
00:11:32,079 --> 00:11:27,410
scientists in the same hallway which is

318
00:11:33,429 --> 00:11:32,089
kinda fun but but so they're the reason

319
00:11:34,989 --> 00:11:33,439
I mentioned that now is that Jim and

320
00:11:36,819 --> 00:11:34,999
Mike are trying to help bring story the

321
00:11:39,159 --> 00:11:36,829
expertise about the biases and different

322
00:11:41,319 --> 00:11:39,169
models because there are a lot of them

323
00:11:43,210 --> 00:11:41,329
and one of the bigger problems is that

324
00:11:44,799 --> 00:11:43,220
the network for Earth is huge by

325
00:11:48,669 --> 00:11:44,809
comparison space what we know is Mars

326
00:11:50,139 --> 00:11:48,679
for example and so that's actually one

327
00:11:51,819 --> 00:11:50,149
of the reasons I don't trust the degree

328
00:11:54,129 --> 00:11:51,829
sequence for example so if you want to

329
00:11:56,829 --> 00:11:54,139
fit like a power law to a network that

330
00:11:58,449 --> 00:11:56,839
has you know 30 nodes like what we look

331
00:12:00,069 --> 00:11:58,459
at with margins network that we've been

332
00:12:01,269 --> 00:12:00,079
analyzing so far compared to one that

333
00:12:03,879 --> 00:12:01,279
has a couple hundred nodes like the

334
00:12:05,979 --> 00:12:03,889
earth Network your fits are much more

335
00:12:08,409 --> 00:12:05,989
reliable for Earth than for Mars so I

336
00:12:10,499 --> 00:12:08,419
think what we need to do is look at the

337
00:12:12,759 --> 00:12:10,509
properties that are not necessarily as

338
00:12:17,019 --> 00:12:12,769

dependent on how large your network is

339
00:12:19,749 --> 00:12:17,029
so that's one another one is that a lot

340
00:12:22,119 --> 00:12:19,759
of times with these so even when you're

341
00:12:23,889 --> 00:12:22,129
looking at biochemical networks you can

342
00:12:25,419 --> 00:12:23,899
construct those from genomic data but

343
00:12:29,079 --> 00:12:25,429
oftentimes we don't have all the genomic

344
00:12:31,840 --> 00:12:29,089
data and there are a lot of analyses

345
00:12:34,359 --> 00:12:31,850
done on these kind of networks to show

346
00:12:35,859 --> 00:12:34,369
that they're robust in terms of these

347
00:12:37,569 --> 00:12:35,869
sort of like global measurements that

348
00:12:40,150 --> 00:12:37,579
we're taking to say if you knocked out

349
00:12:41,379 --> 00:12:40,160
10% of nodes to try to represent the

350
00:12:43,210 --> 00:12:41,389
fact that maybe we don't know 10 percent

351
00:12:44,889 --> 00:12:43,220
of the genes in the genome and so how

352
00:12:45,999 --> 00:12:44,899
accurately are we actually getting a

353
00:12:49,029 --> 00:12:46,009
picture of that structure of that

354
00:12:53,949 --> 00:12:49,039
network so they are robust to sort of a

355
00:12:55,749 --> 00:12:53,959
certain degree of missing data but it

356
00:12:57,009 --> 00:12:55,759
depends on how unknown your unknown is

357
00:12:58,539 --> 00:12:57,019
so if we're missing several hundred

358
00:13:01,449 --> 00:12:58,549
reactions when we like 300 that we have

359
00:13:03,990 --> 00:13:01,459
a big problem but if it's our 330 but if

360
00:13:06,870 --> 00:13:04,000
it's you know 30 and we're missing 10

361
00:13:10,050 --> 00:13:06,880
that's not so problematic so yeah so

362
00:13:11,880 --> 00:13:10,060
that's where I think this is is is

363
00:13:13,350 --> 00:13:11,890

fruitful to start having these kind of

364
00:13:14,970 --> 00:13:13,360
conversations because from the network

365
00:13:16,530 --> 00:13:14,980
side you know we know how to do these

366
00:13:18,540 --> 00:13:16,540
analyses in relation to what's the story

367
00:13:20,700 --> 00:13:18,550
in biology but from a Mystere site I

368
00:13:22,650 --> 00:13:20,710
really rely on my colleague to tell me

369
00:13:23,970 --> 00:13:22,660
what models are actually giving accurate

370
00:13:28,190 --> 00:13:23,980
picture of an atmosphere and what's

371
00:13:31,680 --> 00:13:28,200
missing you time for one more question

372
00:13:35,700 --> 00:13:31,690
um doesn't that fantastic tilt great

373
00:13:39,300 --> 00:13:35,710
graphics thank you it was on your mind I

374
00:13:42,150 --> 00:13:39,310
know it isn't so is a census a power-law

375
00:13:44,390 --> 00:13:42,160
distribution for the poor network of

376
00:13:46,920 --> 00:13:44,400
Earth means you've got one or two

377
00:13:49,380 --> 00:13:46,930
species the rat with a huge number of

378
00:13:50,880 --> 00:13:49,390
different things yeah so you have a few

379
00:13:53,520 --> 00:13:50,890
species that react with a huge number

380
00:13:57,120 --> 00:13:53,530
okay so isn't that just oxygen yes so

381
00:14:00,150 --> 00:13:57,130
what your talent is right yes Yuki so

382
00:14:01,350 --> 00:14:00,160
oxygen is a huge bias in the structure

383
00:14:04,050 --> 00:14:01,360
of the network and so one of the

384
00:14:06,270 --> 00:14:04,060
questions that we have is is maybe the

385
00:14:08,820 --> 00:14:06,280
structure Mars Earth atmosphere

386
00:14:10,920 --> 00:14:08,830
completely attributable to oxygen or

387
00:14:12,270 --> 00:14:10,930
does it involve other biogenic gases and

388
00:14:14,520 --> 00:14:12,280

how is that actually driving the

389
00:14:16,110 --> 00:14:14,530
structure and we have looked at some

390
00:14:19,020 --> 00:14:16,120
models for early Earth and don't have

391
00:14:21,030 --> 00:14:19,030
the data to show but but early Earth

392
00:14:22,770 --> 00:14:21,040
networks tend to be heterogeneous -

393
00:14:24,750 --> 00:14:22,780
they're just not as heterogeneous as

394
00:14:26,640 --> 00:14:24,760
modern earth so I think that there still

395
00:14:29,430 --> 00:14:26,650
are some opportunities besides the

396
00:14:30,450 --> 00:14:29,440
oxygen story to look at that and so one

397
00:14:31,350 --> 00:14:30,460
of the things that we'd like to do

398
00:14:33,270 --> 00:14:31,360
moving forward is look at different

399
00:14:36,180 --> 00:14:33,280
classes of chemical species and see how

400
00:14:39,480 --> 00:14:36,190
they change the structure of networks so

401
00:14:41,280 --> 00:14:39,490
try to build up more of a theory that is

402
00:14:42,750 --> 00:14:41,290
coupled to the way we think about

403
00:14:43,920 --> 00:14:42,760
chemistry and atmospheres in the way we

404
00:14:45,060 --> 00:14:43,930
think about the network structure that

405
00:14:47,340 --> 00:14:45,070
those chemistry's so you could actually

406
00:14:48,660 --> 00:14:47,350
have more like be able to predict based

407
00:14:50,610 --> 00:14:48,670
on certain sets of molecules being

408
00:14:52,800 --> 00:14:50,620
present what that kind of structure you

409
00:14:54,090 --> 00:14:52,810
want a big list of gases I know that's

410
00:14:55,650 --> 00:14:54,100
why we're going to talk all right

411
00:14:57,490 --> 00:14:55,660
another resounding round of applause for