2017 Astrobiology Graduate Conference

CHARLOTTESVILLE, VA

1
00:00:00,790 --> 00:00:08,200
[Music]

2
00:00:13,160 --> 00:00:10,940
as much as we'd love science to just be

3
00:00:17,359 --> 00:00:13,170
about science it's unfortunately kind of

4
00:00:20,660 --> 00:00:17,369
mostly about money um and so it's really

5
00:00:24,769 --> 00:00:20,670
important I think to get some exposure

6
00:00:29,450 --> 00:00:24,779
to how you get money and how you move

7
00:00:31,310 --> 00:00:29,460
from there so you may or may not have

8
00:00:34,549 --> 00:00:31,320
that opportunity in your graduate career

9
00:00:37,100 --> 00:00:34,559
and so what we have is we have a little

10
00:00:40,280 --> 00:00:37,110
retreat a proposal writing retreat every

11
00:00:41,869 --> 00:00:40,290
year before AB grad con where you get

12
00:00:46,190 --> 00:00:41,879
the opportunity to work in a small group

13
00:00:49,330 --> 00:00:46,200

and put together a complete proposal so

14
00:00:52,369 --> 00:00:49,340
this year we had everybody answer roses

15
00:00:56,500 --> 00:00:52,379
solicitation call so that's the main

16
00:00:59,000 --> 00:00:56,510
NASA sort of single Pi grant

17
00:01:01,610 --> 00:00:59,010
solicitation every year but there's a

18
00:01:05,359 --> 00:01:01,620
lot of different calls within that broad

19
00:01:08,060 --> 00:01:05,369
roses perspective and so this year as

20
00:01:11,030 --> 00:01:08,070
Sonny was saying we had 25 participants

21
00:01:13,910 --> 00:01:11,040
in nine groups of two or three people

22
00:01:17,330 --> 00:01:13,920
and they had a little over two days to

23
00:01:19,580 --> 00:01:17,340
write a full grant which includes

24
00:01:22,490 --> 00:01:19,590
obviously the science proposal but also

25
00:01:23,780 --> 00:01:22,500
the budget the data management plan you

26
00:01:26,390 --> 00:01:23,790
have to think about things like overhead

27
00:01:27,740 --> 00:01:26,400
and fringe benefits sort of all the

28
00:01:30,770 --> 00:01:27,750
nitty-gritty stuff that you may or may

29
00:01:35,899 --> 00:01:30,780
not see um in your day to day life as a

30
00:01:37,160 --> 00:01:35,909
graduate student and it uh so people

31
00:01:39,740 --> 00:01:37,170
signed up to work really hard this

32
00:01:41,660 --> 00:01:39,750
weekend but it's not just hard work

33
00:01:45,710 --> 00:01:41,670
people have fun too and it wasn't just

34
00:01:46,880 --> 00:01:45,720
the organizers um and so it's it's a

35
00:01:49,639 --> 00:01:46,890
really great opportunity and I would

36
00:01:52,370 --> 00:01:49,649
like to encourage anyone to apply next

37
00:01:54,170 --> 00:01:52,380
year it's I I mean talk to the people

38
00:01:57,590 --> 00:01:54,180

who went can everybody who went stand up

39
00:02:01,310 --> 00:01:57,600
actually so it was a significant portion

40
00:02:02,810 --> 00:02:01,320
this year so um talk to them see if they

41
00:02:06,530 --> 00:02:02,820
think it was worthwhile I think it's

42
00:02:09,979 --> 00:02:06,540
worthwhile and I didn't encourage you to

43
00:02:12,110 --> 00:02:09,989
apply next year as well part of the

44
00:02:13,360 --> 00:02:12,120
process is writing the proposal but we

45
00:02:15,640 --> 00:02:13,370
also have

46
00:02:17,559 --> 00:02:15,650
we'll turn their proposals in and then

47
00:02:20,589 --> 00:02:17,569
everyone gets the opportunity to review

48
00:02:22,539 --> 00:02:20,599
other proposals and then the next day

49
00:02:24,729 --> 00:02:22,549
after everyone's reviewed the proposals

50
00:02:27,039 --> 00:02:24,739
we go through and we do a mock review

51
00:02:28,390 --> 00:02:27,049
session where you go through and get to

52
00:02:30,280 --> 00:02:28,400
go through the process of receiving

53
00:02:33,190 --> 00:02:30,290
feedback and talking in sort of a panel

54
00:02:38,380 --> 00:02:33,200
situation um so that's also a really

55
00:02:41,229 --> 00:02:38,390
useful thing and from that we pick we

56
00:02:43,600 --> 00:02:41,239
rank the proposals and we well on yeah

57
00:02:46,990 --> 00:02:43,610
Frank the proposals and pick and so we

58
00:02:49,809 --> 00:02:47,000
had three proposals that um sort of

59
00:02:52,990 --> 00:02:49,819
stood out and so we had group 2 which

60
00:02:55,420 --> 00:02:53,000
was the spectra Poehler spectra of

61
00:02:57,819 --> 00:02:55,430
polarimetry catalog for expedited

62
00:02:59,920 --> 00:02:57,829
surface characterization and UV

63
00:03:02,080 --> 00:02:59,930

radiation the double-edged sword in

64
00:03:04,690 --> 00:03:02,090
prebiotic chemistry but our winners who

65
00:03:06,580 --> 00:03:04,700
will be hearing from next where the

66
00:03:08,289 --> 00:03:06,590
exploring radiation effects on the

67
00:03:10,000 --> 00:03:08,299
surface of Europa and implications for

68
00:03:12,190 --> 00:03:10,010
prebiotic molecules synthesis and

69
00:03:17,490 --> 00:03:12,200
distribution one of the things we

70
00:03:20,740 --> 00:03:17,500
encouraged is budgeting reasonably um

71
00:03:22,750 --> 00:03:20,750
but you'll see that as long as you

72
00:03:24,819 --> 00:03:22,760
budget reasonably within what you

73
00:03:27,039 --> 00:03:24,829
propose to do we gave a little

74
00:03:29,740 --> 00:03:27,049
flexibility on the size of the overall

75
00:03:36,590 --> 00:03:29,750
budget ah but we'll be hearing from them

76
00:04:03,809 --> 00:03:40,640
[Applause]

77
00:04:07,750 --> 00:04:05,890
all right hi everybody

78
00:04:08,860 --> 00:04:07,760
so I'm Zoe I'm currently at Harvard

79
00:04:13,119 --> 00:04:08,870
University in the Department of

80
00:04:15,820 --> 00:04:13,129
astronomy I'm Deidre I am a second year

81
00:04:18,550 --> 00:04:15,830
grad student at Georgia Tech I'm Chris

82
00:04:21,039 --> 00:04:18,560
I'm a PhD student here at UVA steady

83
00:04:22,480 --> 00:04:21,049
astrochemistry all right and like we

84
00:04:24,370 --> 00:04:22,490
just said we're going to be discussing

85
00:04:26,020 --> 00:04:24,380
our proposal exploring a radiation

86
00:04:28,240 --> 00:04:26,030
effects on the surface of Europa and

87
00:04:29,980 --> 00:04:28,250
modifications in implications for

88
00:04:32,620 --> 00:04:29,990

prebiotic molecules synthesis and

89
00:04:36,580 --> 00:04:32,630
distribution which we submitted to the

90
00:04:38,110 --> 00:04:36,590
e4 habitable worlds program okay so the

91
00:04:40,480 --> 00:04:38,120
overall science objectives for our

92
00:04:42,700 --> 00:04:40,490
proposal here basically the main point

93
00:04:45,610 --> 00:04:42,710
we want to determine is the identity and

94
00:04:47,400 --> 00:04:45,620
abundance of various chemicals in the

95
00:04:50,710 --> 00:04:47,410
subsurface ocean on Europa

96
00:04:52,690 --> 00:04:50,720
so Europa has a pretty harsh a radiation

97
00:04:54,520 --> 00:04:52,700
environment so we were going to first

98
00:04:56,890 --> 00:04:54,530
with our first science objective s1

99
00:04:59,200 --> 00:04:56,900
model the radiation driven non

100
00:05:02,110 --> 00:04:59,210
equilibrium chemistry on the surface ice

101
00:05:03,879 --> 00:05:02,120
and then we're also going to be able to

102
00:05:05,529 --> 00:05:03,889
attract the abundances of different

103
00:05:08,590 --> 00:05:05,539
molecules that are formed on the icy

104
00:05:10,930 --> 00:05:08,600
shell as a function of time but these

105
00:05:13,170 --> 00:05:10,940
molecules on the surface of Europa are

106
00:05:16,450 --> 00:05:13,180
not very useful and then of themselves

107
00:05:18,370 --> 00:05:16,460
for prebiotic chemistry so then we want

108
00:05:20,409 --> 00:05:18,380
to model how many of those get down to

109
00:05:23,409 --> 00:05:20,419
the surface or to the subsurface ocean

110
00:05:25,480 --> 00:05:23,419
so we use convective ice transport

111
00:05:27,790 --> 00:05:25,490
models to get the transport rates for

112
00:05:29,409 --> 00:05:27,800
these complex organic molecules and then

113
00:05:31,270 --> 00:05:29,419

finally our third science objective is

114
00:05:32,830 --> 00:05:31,280
to understand what further chemical

115
00:05:35,680 --> 00:05:32,840
reactions can occur once you get these

116
00:05:37,120 --> 00:05:35,690
molecules into the aqueous phase so in

117
00:05:39,820 --> 00:05:37,130
aqueous phase you could have such

118
00:05:41,860 --> 00:05:39,830
reactions as hydrolysis decomposition or

119
00:05:43,990 --> 00:05:41,870
further chemical Network reactions

120
00:05:46,120 --> 00:05:44,000
polymerization this will affect the

121
00:05:49,270 --> 00:05:46,130
chemistry that ultimately occurs

122
00:05:51,430 --> 00:05:49,280
so we're seeding molecules from the icy

123
00:05:53,350 --> 00:05:51,440
surface and then getting them down into

124
00:05:59,409 --> 00:05:53,360
the aqueous ocean and seeing what

125
00:06:02,200 --> 00:05:59,419
happens out of there so the relevance of

126
00:06:05,350 --> 00:06:02,210
our research has been echoed throughout

127
00:06:09,219 --> 00:06:05,360
many NASA documents the decadal survey

128
00:06:10,839 --> 00:06:09,229
the astrobiology roadmap the current

129
00:06:13,300 --> 00:06:10,849
science plan the science Mission

130
00:06:16,189 --> 00:06:13,310
Directorate but most importantly the

131
00:06:17,899 --> 00:06:16,199
roses solicitation for habitable world

132
00:06:20,149 --> 00:06:17,909
some of the major touchstones for

133
00:06:22,040 --> 00:06:20,159
habitable worlds are covered under our

134
00:06:25,279 --> 00:06:22,050
research specifically determining

135
00:06:28,399 --> 00:06:25,289
processes and conditions that create and

136
00:06:33,350 --> 00:06:28,409
maintain habitable environments and the

137
00:06:34,520 --> 00:06:33,360
search for habitable environments to

138
00:06:43,100 --> 00:06:34,530

explore the possibility of

139
00:06:45,170 --> 00:06:43,110
extraterrestrial extant life right so in

140
00:06:47,179 --> 00:06:45,180
europa you've got two things which are

141
00:06:49,209 --> 00:06:47,189
good for making prebiotic molecules also

142
00:06:52,369 --> 00:06:49,219
destroying them but you've got ice

143
00:06:54,499 --> 00:06:52,379
you've also got irradiation what can you

144
00:06:55,879 --> 00:06:54,509
do with that well there are tons of

145
00:06:57,800 --> 00:06:55,889
experiments out there where you take

146
00:06:59,510 --> 00:06:57,810
mixed ices and you've been barred them

147
00:07:01,820 --> 00:06:59,520
with radiation and you can make cool

148
00:07:07,369 --> 00:07:01,830
things things is cool or cooler than

149
00:07:08,540 --> 00:07:07,379
glycine so yeah so normally we think of

150
00:07:09,860 --> 00:07:08,550
radiation as being something which

151
00:07:12,980 --> 00:07:09,870
breaks things down and that's certainly

152
00:07:15,469 --> 00:07:12,990
true but it can also make things so one

153
00:07:18,469 --> 00:07:15,479
of our technical objectives in fact t1

154
00:07:21,140 --> 00:07:18,479
is to constrain a model that we have to

155
00:07:23,420 --> 00:07:21,150
simulate the chemistry of a and

156
00:07:25,850 --> 00:07:23,430
irradiated ice so that we can model

157
00:07:28,519 --> 00:07:25,860
which kinds of molecules would form in

158
00:07:30,829 --> 00:07:28,529
your open ice analogs so just to

159
00:07:32,480 --> 00:07:30,839
convince you that there's plenty of a

160
00:07:36,769 --> 00:07:32,490
radiation to go around for everyone on

161
00:07:39,890 --> 00:07:36,779
Europa here we have a table showing a

162
00:07:42,230 --> 00:07:39,900
solar system body and the amount of REMS

163
00:07:45,589 --> 00:07:42,240

per day that you would expect there now

164
00:07:47,269 --> 00:07:45,599
REMS per day tells you roughly how much

165
00:07:49,760 --> 00:07:47,279
you'd have to worry about starting to

166
00:07:51,589 --> 00:07:49,770
glow the more REMS per day the more

167
00:07:55,249 --> 00:07:51,599
glowy that you would get in some

168
00:07:57,920 --> 00:07:55,259
alternate reality so take a look at

169
00:08:01,309 --> 00:07:57,930
Earth so the average fairly low good for

170
00:08:03,709 --> 00:08:01,319
us even the max is still insignificant

171
00:08:05,959 --> 00:08:03,719
compared to the REMS per day experienced

172
00:08:07,730 --> 00:08:05,969
on Europa so there's plenty of radiation

173
00:08:09,619 --> 00:08:07,740
and of course it's Europa so there's

174
00:08:11,420 --> 00:08:09,629
plenty of ice so you mix the two and you

175
00:08:15,890 --> 00:08:11,430
can make potentially some very cool

176
00:08:18,559 --> 00:08:15,900
things all right and then once we have

177
00:08:19,939 --> 00:08:18,569
those chemical models from the first

178
00:08:21,619 --> 00:08:19,949
technical objectives we also want to

179
00:08:23,329 --> 00:08:21,629
verify these and explore some more

180
00:08:25,610 --> 00:08:23,339
parameter space with our second

181
00:08:27,379 --> 00:08:25,620
technical objective so for this we're

182
00:08:28,730 --> 00:08:27,389
going to build and test an ice

183
00:08:30,290 --> 00:08:28,740
irradiation apparatus

184
00:08:32,240 --> 00:08:30,300
so here we're going to be able to

185
00:08:33,980 --> 00:08:32,250
deposit various types of Isis so

186
00:08:36,530 --> 00:08:33,990
different chemical compositions to try

187
00:08:38,510 --> 00:08:36,540
to mimic the Europen ice or variations

188
00:08:40,580 --> 00:08:38,520

to that then we also want to have

189
00:08:43,190 --> 00:08:40,590
several radiation setups here to really

190
00:08:44,120 --> 00:08:43,200
mimic the radiation environment on the

191
00:08:46,580 --> 00:08:44,130
surface of Europa

192
00:08:50,290 --> 00:08:46,590
this would include protons electrons and

193
00:08:52,430 --> 00:08:50,300
photons over a wide range of energies so

194
00:08:54,260 --> 00:08:52,440
instead of just being able to radiate

195
00:08:56,660 --> 00:08:54,270
say at one wavelength through photons or

196
00:08:59,420 --> 00:08:56,670
one energy for protons our setup is

197
00:09:01,250 --> 00:08:59,430
going to be able to scan a range of

198
00:09:03,980 --> 00:09:01,260
energies in order to be able to really

199
00:09:05,720 --> 00:09:03,990
explore parameters faced and see how the

200
00:09:07,940 --> 00:09:05,730
radiation environment on Europa would

201
00:09:11,240 --> 00:09:07,950
actually drive certain chemistry

202
00:09:12,890 --> 00:09:11,250
processes so then on the other side what

203
00:09:14,750 --> 00:09:12,900
are we going to be able to do to detect

204
00:09:16,130 --> 00:09:14,760
these molecules so the detection

205
00:09:18,140 --> 00:09:16,140
equipment will include something like

206
00:09:20,330 --> 00:09:18,150
mass spectrometry and then a variety of

207
00:09:22,520 --> 00:09:20,340
absorption instrumentation including UV

208
00:09:24,890 --> 00:09:22,530
vis and IR so here we'll be able to

209
00:09:26,960 --> 00:09:24,900
irradiated types of Isis deposit at

210
00:09:29,000 --> 00:09:26,970
different deposition temperatures with

211
00:09:30,560 --> 00:09:29,010
various irradiation sources and

212
00:09:32,810 --> 00:09:30,570
combinations of these at a variety of

213
00:09:38,030 --> 00:09:32,820

energies and then be able to detect the

214
00:09:40,730 --> 00:09:38,040
outputs and characterize them okay so

215
00:09:43,490 --> 00:09:40,740
our third technical objective is to

216
00:09:45,080 --> 00:09:43,500
study the stability of the complex

217
00:09:47,210 --> 00:09:45,090
organic molecules that are made on the

218
00:09:50,300 --> 00:09:47,220
surface by the irradiation chemistry and

219
00:09:52,520 --> 00:09:50,310
to see if they can survive the perilous

220
00:09:55,460 --> 00:09:52,530
journey from the outer brittle cold

221
00:09:58,400 --> 00:09:55,470
shell where they're made as I mentioned

222
00:10:00,980 --> 00:09:58,410
subject to significant irradiation all

223
00:10:03,170 --> 00:10:00,990
the way down mmm and they gets abducted

224
00:10:05,420 --> 00:10:03,180
in this sort of surface plate tectonic

225
00:10:07,940 --> 00:10:05,430
activity that brings them down into the

226
00:10:10,730 --> 00:10:07,950
warmer convecting ice layer from there

227
00:10:12,950 --> 00:10:10,740
they can move over time from the top of

228
00:10:15,560 --> 00:10:12,960
the convecting ice layer down to the ice

229
00:10:17,330 --> 00:10:15,570
water interface and at the ice water

230
00:10:20,300 --> 00:10:17,340
interface get introduced to the

231
00:10:22,660 --> 00:10:20,310
subsurface ocean so what we want to know

232
00:10:25,910 --> 00:10:22,670
is can these molecules survive

233
00:10:29,180 --> 00:10:25,920
chemically in the time it takes to go

234
00:10:31,490 --> 00:10:29,190
from the surface to the subsurface ocean

235
00:10:35,450 --> 00:10:31,500
so we can run additional models to do

236
00:10:37,790 --> 00:10:35,460
that and this leads to our fourth

237
00:10:39,980 --> 00:10:37,800
technical objective is that we want to

238
00:10:42,680 --> 00:10:39,990

look at the existing solid state

239
00:10:44,690 --> 00:10:42,690
convective models try to run them

240
00:10:47,810 --> 00:10:44,700
see what we get for the rates of

241
00:10:51,200 --> 00:10:47,820
transport from the surface again down to

242
00:10:53,270 --> 00:10:51,210
the ice liquid interface see if we know

243
00:10:55,100 --> 00:10:53,280
how much is surviving and the rate it

244
00:10:58,910 --> 00:10:55,110
takes to get from the top to the bottom

245
00:11:00,320 --> 00:10:58,920
of the ice shell then we can say how

246
00:11:03,140 --> 00:11:00,330
many of these complex organic molecules

247
00:11:05,600 --> 00:11:03,150
are being introduced to again the far

248
00:11:09,740 --> 00:11:05,610
more biologically friendly environment

249
00:11:12,820 --> 00:11:09,750
of the subsurface ocean our final

250
00:11:15,430 --> 00:11:12,830
technically objectively to look at the

251
00:11:20,120 --> 00:11:15,440
polymerization and decomposition

252
00:11:24,920 --> 00:11:20,130
composition rates of complex organic

253
00:11:28,130 --> 00:11:24,930
molecules and in the Europan subsurface

254
00:11:31,160 --> 00:11:28,140
ocean this can be done using the many

255
00:11:33,320 --> 00:11:31,170
analytical facilities available to us at

256
00:11:36,110 --> 00:11:33,330
Georgia Tech's core facilities so we

257
00:11:38,570 --> 00:11:36,120
have two different mass spec core

258
00:11:40,580 --> 00:11:38,580
facilities we have spectroscopy

259
00:11:43,490 --> 00:11:40,590
equipment and we also have a bio

260
00:11:47,590 --> 00:11:43,500
analytical facility and that's where we

261
00:11:54,640 --> 00:11:47,600
intend to look at these synthesized

262
00:11:58,190 --> 00:11:54,650
comms so our budget is rather generous

263
00:12:01,430 --> 00:11:58,200

but we think that it is understandable

264
00:12:03,680 --> 00:12:01,440
given the scope of our research it will

265
00:12:05,900 --> 00:12:03,690
be split into three different sections

266
00:12:06,890 --> 00:12:05,910
for each of the Co eyes at each of the

267
00:12:10,640 --> 00:12:06,900
institutions

268
00:12:13,220 --> 00:12:10,650
we plan to hire three graduate students

269
00:12:18,650 --> 00:12:13,230
in addition to a researcher and we need

270
00:12:20,810 --> 00:12:18,660
our salaries and we also require a to

271
00:12:24,100 --> 00:12:20,820
buy a supercomputer we need the ISO

272
00:12:30,079 --> 00:12:24,110
radiation equipment we need time on our

273
00:12:33,230 --> 00:12:30,089
core facility equipment as well yes so

274
00:12:37,940 --> 00:12:33,240
for the low low low low price of two

275
00:12:39,920 --> 00:12:37,950
mega dollars and sixty mega cents you

276
00:12:44,300 --> 00:12:39,930
too can have a fully functioning

277
00:12:46,329 --> 00:12:44,310
radiation chemistry lab / group so just

278
00:12:48,890 --> 00:12:46,339
to summarize and bring it all together

279
00:12:51,140 --> 00:12:48,900
we feel that our proposal is definitely

280
00:12:54,560 --> 00:12:51,150
closely tied to the habitable habitable

281
00:12:56,350 --> 00:12:54,570
worlds goal of determining the processes

282
00:12:59,480 --> 00:12:56,360
and conditions that create and maintain

283
00:13:02,630 --> 00:12:59,490
habitable environments the surface of

284
00:13:04,400 --> 00:13:02,640
radiation could create the complex

285
00:13:06,230 --> 00:13:04,410
molecules that can then be introduced

286
00:13:07,850 --> 00:13:06,240
into a more habitable environment so

287
00:13:11,030 --> 00:13:07,860
again we feel this is connected there

288
00:13:13,220 --> 00:13:11,040

and once again walking through what we

289
00:13:15,860 --> 00:13:13,230
hope to do we hope to simulate and

290
00:13:18,020 --> 00:13:15,870
experiment surface irradiation processes

291
00:13:20,030 --> 00:13:18,030
to see what you can form we're not

292
00:13:22,310 --> 00:13:20,040
coming into this with any expectations

293
00:13:24,560 --> 00:13:22,320
we want to look at the kinds of complex

294
00:13:27,079 --> 00:13:24,570
molecules you can make using appropriate

295
00:13:28,820 --> 00:13:27,089
ice analogs and then we want to see if

296
00:13:31,010 --> 00:13:28,830
they can survive over geophysical

297
00:13:32,900 --> 00:13:31,020
timescales to be transported from the

298
00:13:34,970 --> 00:13:32,910
brittle surface to the subsurface ocean

299
00:13:37,730 --> 00:13:34,980
and then we want to see what kinds of

300
00:13:40,070 --> 00:13:37,740
neat and more prebiotic chemistry they

301
00:13:43,250 --> 00:13:40,080
can do in the aqueous subsurface ocean

302
00:13:45,050 --> 00:13:43,260
so just to finish of course the

303
00:13:47,170 --> 00:13:45,060
background is a very nice Jacques

304
00:13:51,140 --> 00:13:47,180
Cousteau's undersea world of Europen

305
00:13:53,210 --> 00:13:51,150
exobiology and you see anticipating

306
00:13:55,040 --> 00:13:53,220
perhaps some life and the hydrothermal

307
00:13:57,650 --> 00:13:55,050
vent analog to what we see here on earth

308
00:13:59,390 --> 00:13:57,660
and that's certainly one place where you

309
00:14:01,280 --> 00:13:59,400
might find life at the sort of liminal

310
00:14:03,020 --> 00:14:01,290
zone between two different phases of a

311
00:14:05,390 --> 00:14:03,030
planet between the solid phase and the

312
00:14:07,790 --> 00:14:05,400
liquid phase but if you look at the top

313
00:14:09,199 --> 00:14:07,800

there's the ice water layer and so we're

314
00:14:11,030 --> 00:14:09,209
proposing that perhaps that could be

315
00:14:13,640 --> 00:14:11,040
also very interesting in terms of

316
00:14:14,420 --> 00:14:13,650
astrobiology if you look at environments

317
00:14:15,920 --> 00:14:14,430
like Antarctica

318
00:14:17,810 --> 00:14:15,930
these are also very important

319
00:14:21,310 --> 00:14:17,820
environments for life and for the

320
00:14:33,180 --> 00:14:21,320
ecosystem there so thank you very much

321
00:14:45,100 --> 00:14:37,270
okay do have any questions quick

322
00:14:48,010 --> 00:14:45,110
questions okay yeah so now that you have

323
00:14:52,530 --> 00:14:48,020
this nice experimental setup that's

324
00:14:56,410 --> 00:14:52,540
really expensive I assume you can use it

325
00:14:59,590 --> 00:14:56,420
to study other possibly habitable worlds

326
00:15:01,570 --> 00:14:59,600
what's next after Europa yeah so that's

327
00:15:03,250 --> 00:15:01,580
a great point this isn't just a one and

328
00:15:04,480 --> 00:15:03,260
done deal this isn't you know a million

329
00:15:06,430 --> 00:15:04,490
dollars for only three years of research

330
00:15:09,400 --> 00:15:06,440
this can be used for long periods after

331
00:15:12,040 --> 00:15:09,410
that so the next main thing that comes

332
00:15:14,620 --> 00:15:12,050
to mind is to do this for comment Isis

333
00:15:16,540 --> 00:15:14,630
or interstellar ices interstellar dust

334
00:15:17,980 --> 00:15:16,550
particles that kind of thing so there

335
00:15:20,380 --> 00:15:17,990
you have a larger variety of the

336
00:15:23,200 --> 00:15:20,390
composition of those materials so you

337
00:15:25,300 --> 00:15:23,210
might look at more co2 ices or Co ices

338
00:15:28,030 --> 00:15:25,310

and really see what you can get on the

339
00:15:43,900 --> 00:15:28,040
interstellar phase chemistry happening

340
00:15:46,030 --> 00:15:43,910
or on comet surfaces so what is a sort

341
00:15:49,210 --> 00:15:46,040
of hand waving estimate for the

342
00:15:51,820 --> 00:15:49,220
subduction rate from the surface and I

343
00:15:53,770 --> 00:15:51,830
guess as a secondary follow-up do you

344
00:15:57,030 --> 00:15:53,780
expect the mass loading from the top

345
00:16:00,070 --> 00:15:57,040
down to be comparable to the bottom

346
00:16:01,840 --> 00:16:00,080
these are excellent questions I am NOT a

347
00:16:03,880 --> 00:16:01,850
geologist so I have no idea what the

348
00:16:15,710 --> 00:16:03,890
answer is but if you fund us we will

349
00:16:21,420 --> 00:16:19,290
okay just a quick piggyback on that last

350
00:16:24,630 --> 00:16:21,430
comment there are some people that

351
00:16:26,550 --> 00:16:24,640
suggest that the Europen crust is

352
00:16:29,340 --> 00:16:26,560
actually quite thick which will you have

353
00:16:31,380 --> 00:16:29,350
this problem of rigidity and lack of

354
00:16:33,509 --> 00:16:31,390
conductive flow convective flow excuse

355
00:16:35,639 --> 00:16:33,519
me versus if you have rapid turnover

356
00:16:36,930 --> 00:16:35,649
then you also have a more oxidizing

357
00:16:39,569 --> 00:16:36,940
potentially a more oxidizing environment

358
00:16:40,620 --> 00:16:39,579
which changes your chemistry's hold it

359
00:16:44,610 --> 00:16:40,630
how would you address those two

360
00:16:46,740 --> 00:16:44,620
scenarios well so that would come into

361
00:16:48,540 --> 00:16:46,750
play in terms of the rate at which the

362
00:16:50,130 --> 00:16:48,550
species would come from the brittle

363
00:16:52,440 --> 00:16:50,140

surface to whatever the aqueous

364
00:16:54,000 --> 00:16:52,450
environment would be so we would try to

365
00:16:55,829 --> 00:16:54,010
use the models in there are existing

366
00:16:58,829 --> 00:16:55,839
models and they take into account not

367
00:17:01,680 --> 00:16:58,839
only the convective ice model of the

368
00:17:03,509 --> 00:17:01,690
open ice structure but also the more

369
00:17:06,419 --> 00:17:03,519
brittle other type in which case I

370
00:17:08,309 --> 00:17:06,429
believe you probably have faster arrival

371
00:17:10,110 --> 00:17:08,319
of the complex organics produced on the

372
00:17:11,549 --> 00:17:10,120
surface on the subsurface ocean if it

373
00:17:13,530 --> 00:17:11,559
didn't have to convect all the way

374
00:17:20,900 --> 00:17:13,540
through so there's a thinner ice model