
AB
GRAD
CON23

1
00:00:04,230 --> 00:00:11,589
[Music]

2
00:00:14,990 --> 00:00:13,490
hi everyone

3
00:00:16,670 --> 00:00:15,000
um I'm just going to make a quick note

4
00:00:18,590 --> 00:00:16,680
before we start that it's great to be an

5
00:00:19,970 --> 00:00:18,600
astrobiology conference because the

6
00:00:22,790 --> 00:00:19,980
background slides are going to go much

7
00:00:24,349 --> 00:00:22,800
more smoothly I presented the sort of

8
00:00:27,830 --> 00:00:24,359
microscopy conference a few months back

9
00:00:29,689 --> 00:00:27,840
and it was a different experience so

10
00:00:31,250 --> 00:00:29,699
thank you all for being here

11
00:00:32,810 --> 00:00:31,260
um and being you

12
00:00:34,729 --> 00:00:32,820
um so

13
00:00:36,049 --> 00:00:34,739

um I'm going to talk uh this is going to

14
00:00:38,270 --> 00:00:36,059
be a little bit of a pivot from some of

15
00:00:40,970 --> 00:00:38,280
the previous talks but I'm going to talk

16
00:00:45,049 --> 00:00:40,980
um about some of the methods that I've

17
00:00:49,010 --> 00:00:45,059
been working on to actually detect life

18
00:00:51,650 --> 00:00:49,020
on a mission a life detection mission to

19
00:00:53,330 --> 00:00:51,660
Europa or Enceladus I'm also going to

20
00:00:56,689 --> 00:00:53,340
make a note so I'm going to be talking

21
00:00:58,490 --> 00:00:56,699
about uh a life life detection missions

22
00:01:02,150 --> 00:00:58,500
to Europa and Enceladus as a target for

23
00:01:03,410 --> 00:01:02,160
this but um once you have a space

24
00:01:05,090 --> 00:01:03,420
capable microscope this could

25
00:01:06,410 --> 00:01:05,100
potentially be applied to like all sorts

26
00:01:08,450 --> 00:01:06,420
of destinations so there's lots of fun

27
00:01:11,210 --> 00:01:08,460
possibilities here

28
00:01:13,730 --> 00:01:11,220
the aforementioned background slides so

29
00:01:15,109 --> 00:01:13,740
um when we're picking destinations to

30
00:01:15,890 --> 00:01:15,119
look for life

31
00:01:18,410 --> 00:01:15,900
um

32
00:01:20,149 --> 00:01:18,420
there's uh we like to look for places

33
00:01:22,730 --> 00:01:20,159
that have habitable conditions things

34
00:01:26,749 --> 00:01:22,740
that have liquid water abundant energy

35
00:01:29,390 --> 00:01:26,759
sources and conditions that are suitable

36
00:01:31,850 --> 00:01:29,400
for uh Life as we know it or as we might

37
00:01:33,950 --> 00:01:31,860
predict it may exist and

38
00:01:35,210 --> 00:01:33,960

um I'm just gonna let Enceladus and

39
00:01:36,770 --> 00:01:35,220
Europa sit up there because we've

40
00:01:38,990 --> 00:01:36,780
already heard a lot of justifications as

41
00:01:40,550 --> 00:01:39,000
to why those are promising targets to

42
00:01:42,050 --> 00:01:40,560
find those conditions and why we might

43
00:01:45,530 --> 00:01:42,060
have had

44
00:01:48,230 --> 00:01:45,540
um an uh origin of life or uh living

45
00:01:50,749 --> 00:01:48,240
organisms currently there

46
00:01:51,950 --> 00:01:50,759
um but when we're searching for life we

47
00:01:54,170 --> 00:01:51,960
also have to think about how we're

48
00:01:55,910 --> 00:01:54,180
actually going to look for it and so

49
00:01:58,670 --> 00:01:55,920
um we can kind of break down life into

50
00:02:02,630 --> 00:01:58,680
some of the key components that make it

51
00:02:04,749 --> 00:02:02,640
up things like uh catalysts that help it

52
00:02:07,550 --> 00:02:04,759
uh metabolize

53
00:02:09,589 --> 00:02:07,560
things like information storage polymers

54
00:02:10,609 --> 00:02:09,599
so DNA or RNA and earth-based life and

55
00:02:12,530 --> 00:02:10,619
that might look very different for

56
00:02:16,369 --> 00:02:12,540
extraterrestrial life

57
00:02:18,830 --> 00:02:16,379
um and also compartments life on on

58
00:02:21,350 --> 00:02:18,840
Earth Life as we know it loves to put

59
00:02:23,510 --> 00:02:21,360
things inside of membranes and then

60
00:02:25,790 --> 00:02:23,520
sometimes they put those membranes

61
00:02:28,610 --> 00:02:25,800
inside other membranes and have them

62
00:02:30,890 --> 00:02:28,620
connect to other even more membranes but

63
00:02:33,830 --> 00:02:30,900

those that packaging really helps it do

64
00:02:37,369 --> 00:02:33,840
some interesting chemistry

65
00:02:40,190 --> 00:02:37,379
um and so when we're then thinking about

66
00:02:43,009 --> 00:02:40,200
this in the context of a mission

67
00:02:44,869 --> 00:02:43,019
um we can start to think about how we

68
00:02:46,910 --> 00:02:44,879
might actually observe that and what

69
00:02:48,589 --> 00:02:46,920
analytical approaches we need to take to

70
00:02:51,589 --> 00:02:48,599
try and get at that

71
00:02:52,670 --> 00:02:51,599
um and so I put the like giant table up

72
00:02:55,369 --> 00:02:52,680
here

73
00:02:57,110 --> 00:02:55,379
um because uh these are all things that

74
00:02:59,390 --> 00:02:57,120
people are working on

75
00:03:01,670 --> 00:02:59,400
um for Life detection instrumentation

76
00:03:03,770 --> 00:03:01,680
but we're going to be focusing for this

77
00:03:05,270 --> 00:03:03,780
talk on containers

78
00:03:08,030 --> 00:03:05,280
um and so

79
00:03:10,790 --> 00:03:08,040
um the reason for that is

80
00:03:13,190 --> 00:03:10,800
um that again as mentioned life loves to

81
00:03:14,690 --> 00:03:13,200
package things into compartments and

82
00:03:18,050 --> 00:03:14,700
those compartments can be directly

83
00:03:20,869 --> 00:03:18,060
observable by using a microscope to look

84
00:03:23,630 --> 00:03:20,879
for morphology and also for the

85
00:03:25,670 --> 00:03:23,640
collocalization of certain key chemical

86
00:03:26,270 --> 00:03:25,680
biomarkers

87
00:03:28,970 --> 00:03:26,280
um

88
00:03:32,030 --> 00:03:28,980

so in

89
00:03:33,710 --> 00:03:32,040
um our team we're working on um a

90
00:03:35,750 --> 00:03:33,720
microscopy system that we call a

91
00:03:37,009 --> 00:03:35,760
luminescence imager for exploration or

92
00:03:39,290 --> 00:03:37,019
life

93
00:03:42,770 --> 00:03:39,300
um and there is uh two key hardware

94
00:03:44,930 --> 00:03:42,780
components of this system one is the

95
00:03:46,190 --> 00:03:44,940
fluidic subsystem and this is to deal

96
00:03:48,410 --> 00:03:46,200
with

97
00:03:51,770 --> 00:03:48,420
um the actual sample processing and

98
00:03:53,509 --> 00:03:51,780
preparation for Imaging something so um

99
00:03:55,250 --> 00:03:53,519
my background full disclosure is

100
00:03:58,130 --> 00:03:55,260
actually not an astrobiology it's in

101
00:04:00,410 --> 00:03:58,140
fluorescence microscopy and

102
00:04:02,630 --> 00:04:00,420
um you know I spent like five or six

103
00:04:05,030 --> 00:04:02,640
years in grad school just moving fluids

104
00:04:06,830 --> 00:04:05,040
around in tubes and like preparing

105
00:04:09,470 --> 00:04:06,840
things on slides before they actually

106
00:04:10,850 --> 00:04:09,480
get to the microscope I've been told it

107
00:04:14,089 --> 00:04:10,860
would be expensive to send me to

108
00:04:15,470 --> 00:04:14,099
Enceladus so uh this is this is my

109
00:04:18,110 --> 00:04:15,480
replacement

110
00:04:20,210 --> 00:04:18,120
um and then the other end is the actual

111
00:04:21,830 --> 00:04:20,220
microscope itself so the optic system

112
00:04:22,909 --> 00:04:21,840
which is going to have all of the things

113
00:04:25,010 --> 00:04:22,919

that you need to actually take your

114
00:04:27,409 --> 00:04:25,020
pretty pictures

115
00:04:29,629 --> 00:04:27,419
um so I'm gonna break down what goes

116
00:04:33,110 --> 00:04:29,639
into these systems a little bit so the

117
00:04:35,030 --> 00:04:33,120
fluidic subsystem that uh like uh silver

118
00:04:39,110 --> 00:04:35,040
plate on top

119
00:04:42,530 --> 00:04:39,120
um is the rotary filter stage and so the

120
00:04:44,930 --> 00:04:42,540
um the stage can do seven individual

121
00:04:46,850 --> 00:04:44,940
experiments um and so that accounts for

122
00:04:48,950 --> 00:04:46,860
originally this was designed with the

123
00:04:50,810 --> 00:04:48,960
Europa Lander Mission Concept in mind

124
00:04:53,930 --> 00:04:50,820
where there would be three separate

125
00:04:56,749 --> 00:04:53,940
samples each with a replicate and then a

126
00:04:59,090 --> 00:04:56,759
procedural blank and then each of those

127
00:04:59,770 --> 00:04:59,100
individually has

128
00:05:04,730 --> 00:04:59,780
um

129
00:05:07,730 --> 00:05:04,740
three uh filters of different sizes

130
00:05:10,010 --> 00:05:07,740
um and so uh that basically will let you

131
00:05:13,189 --> 00:05:10,020
sort out particles so the filters are 10

132
00:05:16,010 --> 00:05:13,199
microns 1.2 microns and uh 0.2 microns

133
00:05:18,650 --> 00:05:16,020
in size and that's just so you don't end

134
00:05:19,850 --> 00:05:18,660
up with larger particles obscuring any

135
00:05:21,890 --> 00:05:19,860
of the smaller particles that you're

136
00:05:24,950 --> 00:05:21,900
trying to image in your sample

137
00:05:27,830 --> 00:05:24,960
um and that way you're not missing any

138
00:05:28,790 --> 00:05:27,840

of the like good stuff that might be

139
00:05:29,450 --> 00:05:28,800
there

140
00:05:31,670 --> 00:05:29,460
um

141
00:05:33,230 --> 00:05:31,680
there you use all it's also attached to

142
00:05:34,730 --> 00:05:33,240
the fluidix manifold which is the part

143
00:05:37,550 --> 00:05:34,740
that actually moves all of the liquids

144
00:05:40,689 --> 00:05:37,560
and fluids around and it also has a lot

145
00:05:44,570 --> 00:05:40,699
of sensors for pressure pH conductivity

146
00:05:46,550 --> 00:05:44,580
and also crucially some storage for the

147
00:05:47,930 --> 00:05:46,560
fluorescent stains that I'm going to be

148
00:05:49,550 --> 00:05:47,940
talking about a little bit later in the

149
00:05:50,450 --> 00:05:49,560
talk

150
00:05:52,790 --> 00:05:50,460
um

151
00:05:54,650 --> 00:05:52,800
and then these were the filters that I

152
00:05:57,050 --> 00:05:54,660
mentioned earlier and so uh this is

153
00:05:59,510 --> 00:05:57,060
again for sample size sorting but

154
00:06:01,070 --> 00:05:59,520
they're also made of a silicon nitrate

155
00:06:02,629 --> 00:06:01,080
substrate that has a low fluorescence

156
00:06:06,350 --> 00:06:02,639
background

157
00:06:08,870 --> 00:06:06,360
um and this whole system has passed

158
00:06:12,290 --> 00:06:08,880
Environmental Testing so um one thing

159
00:06:15,230 --> 00:06:12,300
about microscopes and also uh you know

160
00:06:17,469 --> 00:06:15,240
fluid fluidix has a fair bit of space

161
00:06:20,390 --> 00:06:17,479
flight Heritage but in general Hardware

162
00:06:22,490 --> 00:06:20,400
uh can break and I'm sure everyone who's

163
00:06:24,590 --> 00:06:22,500

worked in a lab is dealt with a lot of

164
00:06:26,150 --> 00:06:24,600
like issues before so you want to make

165
00:06:27,529 --> 00:06:26,160
sure these things are robust and you can

166
00:06:29,870 --> 00:06:27,539
actually get it to where you want to

167
00:06:33,890 --> 00:06:29,880
launch it to

168
00:06:37,790 --> 00:06:33,900
um the optic subsystem is a nice small

169
00:06:39,350 --> 00:06:37,800
compact box and so um this is a 10

170
00:06:43,850 --> 00:06:39,360
centimeter by 10 centimeter by 13

171
00:06:45,590 --> 00:06:43,860
centimeter Cube I have uh an image on my

172
00:06:47,330 --> 00:06:45,600
phone that I didn't upload to the

173
00:06:49,790 --> 00:06:47,340
presentation because the image quality

174
00:06:53,749 --> 00:06:49,800
is not that good but for context that's

175
00:06:56,150 --> 00:06:53,759
about as tall as a banana which is very

176
00:06:59,150 --> 00:06:56,160
small for like a benchtop fluorescence

177
00:07:01,850 --> 00:06:59,160
microscope um there is like fancier

178
00:07:04,129 --> 00:07:01,860
microscopes can sometimes be like the

179
00:07:05,870 --> 00:07:04,139
size of of a person if you're trying to

180
00:07:07,670 --> 00:07:05,880
do crazy like two Photon lifetime

181
00:07:09,890 --> 00:07:07,680
Imaging or something but even an Epi

182
00:07:11,990 --> 00:07:09,900
fluorescent scope would probably occupy

183
00:07:13,550 --> 00:07:12,000
like this Podium normally and there'd be

184
00:07:15,950 --> 00:07:13,560
a lot of like miscellaneous kind of

185
00:07:18,409 --> 00:07:15,960
assorted parts so it's a really nice

186
00:07:20,510 --> 00:07:18,419
little system

187
00:07:23,390 --> 00:07:20,520
and so that contains all of the

188
00:07:24,890 --> 00:07:23,400

excitation LEDs emission filters all the

189
00:07:27,710 --> 00:07:24,900
Optics

190
00:07:30,409 --> 00:07:27,720
um and so uh this table is just kind of

191
00:07:33,170 --> 00:07:30,419
going through what the different uh bits

192
00:07:36,589 --> 00:07:33,180
of Hardware that we have are and

193
00:07:38,870 --> 00:07:36,599
um to kind of like give the the the high

194
00:07:42,409 --> 00:07:38,880
level Summary of why this is relevant

195
00:07:44,210 --> 00:07:42,419
um basically we have three LEDs that are

196
00:07:46,730 --> 00:07:44,220
common excitation wavelengths for

197
00:07:48,170 --> 00:07:46,740
different fluorescent stains that can

198
00:07:50,749 --> 00:07:48,180
also excite different types of

199
00:07:52,909 --> 00:07:50,759
autofluorescence and then

200
00:07:55,670 --> 00:07:52,919
um one thing that's actually relatively

201
00:07:56,930 --> 00:07:55,680
unique to this microscope certainly no

202
00:07:59,629 --> 00:07:56,940
microscopes I've worked with previously

203
00:08:01,610 --> 00:07:59,639
have had this is the 275 nanometer LED

204
00:08:03,409 --> 00:08:01,620
so that's actually fairly far in the

205
00:08:05,450 --> 00:08:03,419
ultraviolet range

206
00:08:08,529 --> 00:08:05,460
um and that's really good at exciting

207
00:08:11,870 --> 00:08:08,539
protein fluorescence so uh tryptophan

208
00:08:14,150 --> 00:08:11,880
phenylalanine the various aromatic amino

209
00:08:16,730 --> 00:08:14,160
acid side chains actually fluoresce

210
00:08:18,409 --> 00:08:16,740
quite brightly in the ultraviolet and so

211
00:08:21,469 --> 00:08:18,419
that can help image native fluorescent

212
00:08:24,050 --> 00:08:21,479
of samples and also excite the

213
00:08:25,369 --> 00:08:24,060

fluorescence of many different kinds of

214
00:08:26,710 --> 00:08:25,379
minerals

215
00:08:31,309 --> 00:08:26,720
um

216
00:08:32,570 --> 00:08:31,319
the objective is also set up to help uh

217
00:08:35,209 --> 00:08:32,580
well it's

218
00:08:37,250 --> 00:08:35,219
robust a space flight but also the part

219
00:08:39,350 --> 00:08:37,260
that I think is super fun is that it

220
00:08:41,449 --> 00:08:39,360
most objectives actually can't collect

221
00:08:43,010 --> 00:08:41,459
light in that ultraviolet range

222
00:08:46,310 --> 00:08:43,020
um so it is a custom objective that's

223
00:08:48,590 --> 00:08:46,320
built for those sorts of experiments

224
00:08:52,190 --> 00:08:48,600
um it has a Piezo stage that lets us do

225
00:08:54,410 --> 00:08:52,200
automated Z stacking and this is also

226
00:08:57,170 --> 00:08:54,420
been subjected to environmental and

227
00:08:58,730 --> 00:08:57,180
shock and vibrational testing and also

228
00:09:00,650 --> 00:08:58,740
radiation testing

229
00:09:02,990 --> 00:09:00,660
um to the specifications of the Europa

230
00:09:08,329 --> 00:09:03,000
Lander mission

231
00:09:10,070 --> 00:09:08,339
so um we're now on our ongoing work is

232
00:09:13,250 --> 00:09:10,080
actually characterizing this microscope

233
00:09:16,190 --> 00:09:13,260
by Imaging different types of samples to

234
00:09:18,949 --> 00:09:16,200
see what the the the limits are of what

235
00:09:20,690 --> 00:09:18,959
we can detect so um this sample is just

236
00:09:23,030 --> 00:09:20,700
kind of showing uh some of the bright

237
00:09:24,530 --> 00:09:23,040
some bright field images from a sample

238
00:09:27,769 --> 00:09:24,540

that was collected from Lake undersea in

239
00:09:30,470 --> 00:09:27,779
Antarctica and so um I'm showing here

240
00:09:33,590 --> 00:09:30,480
the 10 Micron and 1.2 Micron filters to

241
00:09:36,470 --> 00:09:33,600
kind of highlight that um we can image

242
00:09:38,810 --> 00:09:36,480
the the objects at

243
00:09:42,170 --> 00:09:38,820
um of very different sizes and you can

244
00:09:44,269 --> 00:09:42,180
see the physical uh size of the little

245
00:09:48,230 --> 00:09:44,279
uh holes there

246
00:09:51,650 --> 00:09:48,240
um and so if we were to just put this

247
00:09:53,870 --> 00:09:51,660
all onto one filter that microbial matte

248
00:09:55,490 --> 00:09:53,880
looking thing on the the

249
00:09:57,290 --> 00:09:55,500
your left

250
00:09:59,150 --> 00:09:57,300
um would probably obscure some of the

251
00:10:01,370 --> 00:09:59,160
smaller objects that we're seeing in the

252
00:10:01,910 --> 00:10:01,380
other filter sizes

253
00:10:03,350 --> 00:10:01,920
um

254
00:10:04,910 --> 00:10:03,360
and so

255
00:10:07,250 --> 00:10:04,920
um as I mentioned earlier we can also

256
00:10:08,509 --> 00:10:07,260
excite native fluorescence and so we can

257
00:10:10,670 --> 00:10:08,519
correlate this as well with the bright

258
00:10:12,290 --> 00:10:10,680
field images so we can take an image of

259
00:10:15,350 --> 00:10:12,300
an object say oh hey that looks

260
00:10:17,509 --> 00:10:15,360
interesting I wonder what that is look

261
00:10:18,829 --> 00:10:17,519
at the you know native fluorescence in

262
00:10:21,009 --> 00:10:18,839
different ranges and get a sense of okay

263
00:10:23,269 --> 00:10:21,019

wait we've got a bunch of like

264
00:10:25,009 --> 00:10:23,279
Organics that are fluorescing in the UV

265
00:10:27,970 --> 00:10:25,019
range that are all localized on this

266
00:10:31,790 --> 00:10:27,980
object that's pretty exciting

267
00:10:33,949 --> 00:10:31,800
and then we can also then stain the

268
00:10:35,990 --> 00:10:33,959
sample with fluorescent stains to look

269
00:10:39,130 --> 00:10:36,000
for more specific chemical signatures

270
00:10:41,990 --> 00:10:39,140
and so in this case I'm showing the same

271
00:10:44,810 --> 00:10:42,000
sample after it's been treated with a

272
00:10:47,870 --> 00:10:44,820
stain for primary amines and another one

273
00:10:50,690 --> 00:10:47,880
that stains lipids and so we can look

274
00:10:53,530 --> 00:10:50,700
for both the presence of those molecules

275
00:10:56,630 --> 00:10:53,540
but also their co-localization in space

276
00:10:58,190 --> 00:10:56,640
and this is a really like unique and

277
00:11:00,590 --> 00:10:58,200
Powerful kind of data that you can get

278
00:11:02,690 --> 00:11:00,600
from the microscope is not just like

279
00:11:04,610 --> 00:11:02,700
what compounds are there but seeing that

280
00:11:06,889 --> 00:11:04,620
they're associating with each other kind

281
00:11:10,030 --> 00:11:06,899
of gives you a good piece of evidence

282
00:11:12,050 --> 00:11:10,040
that you might be seeing some

283
00:11:15,230 --> 00:11:12,060
disequilibrium and some living

284
00:11:19,850 --> 00:11:18,350
um microscopy data is also

285
00:11:24,590 --> 00:11:19,860
large

286
00:11:26,750 --> 00:11:24,600
types of data that we've talked about in

287
00:11:29,150 --> 00:11:26,760
this conference so far but certainly

288
00:11:31,730 --> 00:11:29,160

large enough that if you were trying to

289
00:11:34,370 --> 00:11:31,740
send all of this data back from Europa

290
00:11:38,389 --> 00:11:34,380
or Enceladus it would be more

291
00:11:40,069 --> 00:11:38,399
complicated to handle and so one of the

292
00:11:44,810 --> 00:11:40,079
things that we're able to do on this

293
00:11:48,829 --> 00:11:44,820
microscope is actually take a z-stack of

294
00:11:51,230 --> 00:11:48,839
of images and compress it down to a

295
00:11:53,990 --> 00:11:51,240
single image that's much less in data

296
00:11:56,210 --> 00:11:54,000
volume and so the image I'm showing

297
00:11:59,030 --> 00:11:56,220
right now is

298
00:12:00,350 --> 00:11:59,040
um an image set of images that were

299
00:12:02,870 --> 00:12:00,360
automatically collected at different

300
00:12:04,250 --> 00:12:02,880
focal planes in the sample

301
00:12:06,290 --> 00:12:04,260
um and then after it's run through the

302
00:12:08,690 --> 00:12:06,300
compression routine you end up with a

303
00:12:11,750 --> 00:12:08,700
single in Focus image and you're now

304
00:12:13,730 --> 00:12:11,760
suddenly gone from megabytes of data to

305
00:12:15,410 --> 00:12:13,740
kilobytes of data

306
00:12:18,710 --> 00:12:15,420
um and then

307
00:12:22,550 --> 00:12:18,720
um you can even go further with that and

308
00:12:24,350 --> 00:12:22,560
you'll notice that this sample has uh

309
00:12:26,750 --> 00:12:24,360
bright objects against a dark background

310
00:12:28,970 --> 00:12:26,760
we don't actually care what the like

311
00:12:30,829 --> 00:12:28,980
Photon shot noise is on the background

312
00:12:33,230 --> 00:12:30,839
for our purposes that might as well just

313
00:12:35,269 --> 00:12:33,240

all be zero and so the final compression

314
00:12:37,910 --> 00:12:35,279
step is actually taking that and setting

315
00:12:40,130 --> 00:12:37,920
it to zero and so we're just recording

316
00:12:42,650 --> 00:12:40,140
um the actual bright objects that are

317
00:12:44,030 --> 00:12:42,660
detected in the image and so that all

318
00:12:45,470 --> 00:12:44,040
reduces the data size quite

319
00:12:47,569 --> 00:12:45,480
substantially

320
00:12:49,129 --> 00:12:47,579
um without really getting rid of any of

321
00:12:52,190 --> 00:12:49,139
the information that we actually want to

322
00:12:56,150 --> 00:12:54,889
um so how would this work in in a

323
00:12:57,290 --> 00:12:56,160
mission I just talked about a lot of

324
00:12:59,449 --> 00:12:57,300
different parts and now I'm going to

325
00:13:01,670 --> 00:12:59,459
bring it all back together into how this

326
00:13:05,509 --> 00:13:01,680
system could be implemented

327
00:13:07,069 --> 00:13:05,519
um so and I have the little Europa

328
00:13:10,129 --> 00:13:07,079
Lander picture there

329
00:13:12,230 --> 00:13:10,139
um but basically uh we pretend that the

330
00:13:14,930 --> 00:13:12,240
microscope is somewhere in that Lander

331
00:13:17,509 --> 00:13:14,940
um you would take your sample process it

332
00:13:19,670 --> 00:13:17,519
pump it through the fluidic system you

333
00:13:22,310 --> 00:13:19,680
can image it on the microscope you're

334
00:13:25,310 --> 00:13:22,320
going to end up with megabytes of data

335
00:13:27,350 --> 00:13:25,320
that you can then compress back down to

336
00:13:30,290 --> 00:13:27,360
your kilobytes of data send it back to

337
00:13:32,509 --> 00:13:30,300
your ground-based Observer that will

338
00:13:34,610 --> 00:13:32,519

then be able to say oh okay cool we got

339
00:13:36,050 --> 00:13:34,620
a microbial mat on Europa time to hit

340
00:13:38,210 --> 00:13:36,060
the Press

341
00:13:42,350 --> 00:13:40,910
and so uh yeah just briefly

342
00:13:45,050 --> 00:13:42,360
acknowledgments there's been a lot of

343
00:13:47,329 --> 00:13:45,060
funding that's gone into this

344
00:14:02,150 --> 00:13:47,339
um and um I'll be happy to take any

345
00:14:06,710 --> 00:14:04,730
great talk uh this is Chad pazoriski at

346
00:14:08,569 --> 00:14:06,720
Georgia Tech so

347
00:14:10,610 --> 00:14:08,579
um I'm really happy that you touched on

348
00:14:12,350 --> 00:14:10,620
uh compression first of all uh of the

349
00:14:13,850 --> 00:14:12,360
data because that's incredibly important

350
00:14:16,009 --> 00:14:13,860
and

351
00:14:18,050 --> 00:14:16,019
um I was also really thrilled that you

352
00:14:19,310 --> 00:14:18,060
talked about the um sample prep and

353
00:14:20,509 --> 00:14:19,320
fluidics because I think that's

354
00:14:23,870 --> 00:14:20,519
something that a lot of people don't

355
00:14:26,329 --> 00:14:23,880
consider for these NCG missions uh my

356
00:14:29,389 --> 00:14:26,339
question has to do with

357
00:14:32,990 --> 00:14:29,399
um comparing uh microscopy and staining

358
00:14:35,389 --> 00:14:33,000
with uh perhaps something like Raman or

359
00:14:37,009 --> 00:14:35,399
IR where you could get information about

360
00:14:38,870 --> 00:14:37,019
at least functional groups of the

361
00:14:41,569 --> 00:14:38,880
Organics present and co-locate things

362
00:14:44,030 --> 00:14:41,579
that I imagine similar resolution

363
00:14:46,610 --> 00:14:44,040

spatially but you wouldn't need to

364
00:14:49,189 --> 00:14:46,620
include those processing steps so would

365
00:14:51,410 --> 00:14:49,199
you advocate for a system that's I guess

366
00:14:52,910 --> 00:14:51,420
maybe not redundant but but has both of

367
00:14:54,829 --> 00:14:52,920
those features or do you think one is

368
00:14:56,210 --> 00:14:54,839
better than the other yes this is

369
00:14:57,829 --> 00:14:56,220
actually a super interesting discussion

370
00:14:59,990 --> 00:14:57,839
and we can definitely also talk more

371
00:15:01,850 --> 00:15:00,000
about it at lunch but the the high level

372
00:15:03,610 --> 00:15:01,860
thing that I'm going to say is that um

373
00:15:07,009 --> 00:15:03,620
you you get

374
00:15:08,389 --> 00:15:07,019
you're going to have different pros and

375
00:15:09,910 --> 00:15:08,399
cons and get different types of data

376
00:15:12,829 --> 00:15:09,920
those techniques so if you're doing

377
00:15:15,949 --> 00:15:12,839
let's if you want to get spatially

378
00:15:17,269 --> 00:15:15,959
correlated Ramen data when you're

379
00:15:20,449 --> 00:15:17,279
building a microscope and you're trying

380
00:15:21,829 --> 00:15:20,459
to image something unless you're using a

381
00:15:25,189 --> 00:15:21,839
super resolution technique you're

382
00:15:28,310 --> 00:15:25,199
limited by diffraction in terms of like

383
00:15:29,870 --> 00:15:28,320
the the resolution that you can get and

384
00:15:31,490 --> 00:15:29,880
that is proportional to the wavelength

385
00:15:34,850 --> 00:15:31,500
that you're using so when you start to

386
00:15:36,470 --> 00:15:34,860
get into like the IR you know range and

387
00:15:39,590 --> 00:15:36,480
things like that

388
00:15:41,930 --> 00:15:39,600

um your spatial resolution starts to be

389
00:15:44,930 --> 00:15:41,940
more limited than it is in the optical

390
00:15:47,090 --> 00:15:44,940
range the flip side is you're right you

391
00:15:48,230 --> 00:15:47,100
can get precise chemical information out

392
00:15:51,590 --> 00:15:48,240
without

393
00:15:55,670 --> 00:15:51,600
um you know adding labels and so I think

394
00:15:57,590 --> 00:15:55,680
that definitely those are uh like

395
00:15:59,930 --> 00:15:57,600
in in in in the perfect mission

396
00:16:04,189 --> 00:15:59,940
architecture I think you do both

397
00:16:05,750 --> 00:16:04,199
um but you know and um unfortunate you

398
00:16:07,250 --> 00:16:05,760
know it's it's it's unfortunate that we

399
00:16:08,930 --> 00:16:07,260
can't send all the instruments that we

400
00:16:11,090 --> 00:16:08,940
want out there but like in my ideal

401
00:16:13,129 --> 00:16:11,100
world I think those that would be a

402
00:16:14,090 --> 00:16:13,139
powerful like correlative technique

403
00:16:17,090 --> 00:16:14,100
there

404
00:16:19,250 --> 00:16:17,100
um to kind of get a a strong sense of

405
00:16:25,069 --> 00:16:19,260
what you're seeing in your sample

406
00:16:25,079 --> 00:16:33,610
foreign

407
00:16:38,930 --> 00:16:37,069
again thanks for an awesome talk this is

408
00:16:40,850 --> 00:16:38,940
really exciting so I was wondering what

409
00:16:45,110 --> 00:16:40,860
sample prep looks like

410
00:16:46,610 --> 00:16:45,120
um in the Rover or whatever and um what

411
00:16:47,810 --> 00:16:46,620
the capabilities are for that so could

412
00:16:49,249 --> 00:16:47,820
you actually do like incubation

413
00:16:50,810 --> 00:16:49,259

experiments and then look at it with

414
00:16:52,069 --> 00:16:50,820
microscopy or is it coming straight from

415
00:16:53,150 --> 00:16:52,079
the environment going straight to the

416
00:16:56,870 --> 00:16:53,160
microscope

417
00:16:59,990 --> 00:16:56,880
yeah so um it's the

418
00:17:02,090 --> 00:17:00,000
the the design that we had in mind for

419
00:17:03,889 --> 00:17:02,100
for sample prep here and when I said I

420
00:17:06,230 --> 00:17:03,899
say we it's not

421
00:17:08,030 --> 00:17:06,240
um us this was kind of the built around

422
00:17:10,309 --> 00:17:08,040
the Europa Lander specifications but

423
00:17:12,169 --> 00:17:10,319
essentially you'd have a sample cup that

424
00:17:15,409 --> 00:17:12,179
would collect an ice sample and melt it

425
00:17:18,409 --> 00:17:15,419
down and so that was kind of the um

426
00:17:20,870 --> 00:17:18,419
the initial like thoughts behind um the

427
00:17:22,309 --> 00:17:20,880
design here but the fluidics processing

428
00:17:23,750 --> 00:17:22,319
system can basically handle anything

429
00:17:25,069 --> 00:17:23,760
that's in a liquid state but the

430
00:17:28,909 --> 00:17:25,079
assumption would be that it's a

431
00:17:30,549 --> 00:17:28,919
relatively unprocessed field sample

432
00:17:33,230 --> 00:17:30,559
um

433
00:17:34,730 --> 00:17:33,240
relatively unprocessed because obviously

434
00:17:36,110 --> 00:17:34,740
if it's like ice or something and you're

435
00:17:38,090 --> 00:17:36,120
melting it down you are still doing

436
00:17:39,590 --> 00:17:38,100
something to that sample

437
00:17:42,950 --> 00:17:39,600
um

438
00:17:42,960 --> 00:17:46,610

okay we have time for one more question

439
00:17:51,110 --> 00:17:49,850
hi thank you for the great talk

440
00:17:53,990 --> 00:17:51,120
um

441
00:17:57,110 --> 00:17:54,000
my question is uh maybe I missed that

442
00:18:01,010 --> 00:17:57,120
you mentioned how

443
00:18:04,250 --> 00:18:01,020
are you going to differentiate uh

444
00:18:04,970 --> 00:18:04,260
any other particles

445
00:18:08,930 --> 00:18:04,980
um

446
00:18:13,210 --> 00:18:08,940
from the living materials like can you

447
00:18:16,010 --> 00:18:13,220
specifically stain genetic material or

448
00:18:17,810 --> 00:18:16,020
anything biological

449
00:18:19,310 --> 00:18:17,820
yeah so that's actually that's a great

450
00:18:23,090 --> 00:18:19,320
question and

451
00:18:24,230 --> 00:18:23,100
um so the the the the goal here is to

452
00:18:27,110 --> 00:18:24,240
kind of pick up as many different

453
00:18:29,690 --> 00:18:27,120
breadcrumbs as you as as we can to try

454
00:18:31,130 --> 00:18:29,700
and uh differentiate and so you

455
00:18:32,630 --> 00:18:31,140
mentioned stains for genetic material

456
00:18:34,070 --> 00:18:32,640
one of the stains that we would be

457
00:18:36,049 --> 00:18:34,080
launching with this is a stain for

458
00:18:40,190 --> 00:18:36,059
nucleic acids

459
00:18:43,370 --> 00:18:40,200
um now obviously that would be really

460
00:18:44,870 --> 00:18:43,380
awesome if we found DNA on Europa or

461
00:18:46,549 --> 00:18:44,880
Enceladus but

462
00:18:48,289 --> 00:18:46,559
um there's it's kind of an open question

463
00:18:49,970 --> 00:18:48,299

whether we would

464
00:18:52,610 --> 00:18:49,980
um and

465
00:18:54,590 --> 00:18:52,620
um so the idea behind looking for the

466
00:18:57,289 --> 00:18:54,600
something like the co-localization of

467
00:19:00,950 --> 00:18:57,299
amines and lipids is that that gives you

468
00:19:02,330 --> 00:19:00,960
a more like agnostic idea of like hey

469
00:19:04,070 --> 00:19:02,340
that might be living material because

470
00:19:06,470 --> 00:19:04,080
you've got these you know chemical

471
00:19:09,409 --> 00:19:06,480
signatures that are co-locating

472
00:19:10,610 --> 00:19:09,419
um the other thing is um so one of our

473
00:19:12,529 --> 00:19:10,620
um collaborators actually the person who

474
00:19:14,890 --> 00:19:12,539
helped build the microscope

475
00:19:17,810 --> 00:19:14,900
um is has some ongoing work

476
00:19:20,630 --> 00:19:17,820
characterizing the fluorescence of uh

477
00:19:22,130 --> 00:19:20,640
diff of a wide library of minerals to

478
00:19:23,870 --> 00:19:22,140
get a sense of like what they would

479
00:19:26,650 --> 00:19:23,880
potentially look like

480
00:19:29,690 --> 00:19:26,660
um on the the microscope so we can

481
00:19:30,830 --> 00:19:29,700
hopefully differentiate between that and

482
00:19:32,630 --> 00:19:30,840
things that might be a little bit more

483
00:19:35,750 --> 00:19:32,640
biological but spectroscopically and

484
00:19:37,190 --> 00:19:35,760
then also you know morphologically

485
00:19:40,190 --> 00:19:37,200
um

486
00:19:45,900 --> 00:19:40,200
yeah a great question