Dr. Eric Furst

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University of Delaware

1
00:00:06,230 --> 00:00:03,189
let's take this opportunity to bring in

2
00:00:09,190 --> 00:00:06,240
a special guest dr eric first the

3
00:00:11,990 --> 00:00:09,200
principal investigator for the

4
00:00:13,430 --> 00:00:12,000
investigation known as in space 3 or

5
00:00:15,669 --> 00:00:13,440
investigating the structure of

6
00:00:17,990 --> 00:00:15,679
paramagnetic aggregates from colloidal

7
00:00:19,910 --> 00:00:18,000
emulsions he's coming to us live from

8
00:00:22,550 --> 00:00:19,920
his lab at the university of delaware

9
00:00:23,750 --> 00:00:22,560
welcome eric thank you thanks

10
00:00:26,070 --> 00:00:23,760
well say let's start off with a real

11
00:00:27,429 --> 00:00:26,080
simple question what is this experiment

12
00:00:29,910 --> 00:00:27,439
you're working on

13
00:00:32,229 --> 00:00:29,920

sure the the experiment is looking at

14
00:00:33,670 --> 00:00:32,239
fluids that we call magneto-rheological

15
00:00:35,910 --> 00:00:33,680
fluids and

16
00:00:37,990 --> 00:00:35,920
these are

17
00:00:39,910 --> 00:00:38,000
fluid materials that are composed of

18
00:00:42,310 --> 00:00:39,920
little tiny particles they're about a

19
00:00:43,510 --> 00:00:42,320
micrometer in dimension suspended in

20
00:00:45,510 --> 00:00:43,520
water

21
00:00:46,630 --> 00:00:45,520
that micron if you if you if you think

22
00:00:48,389 --> 00:00:46,640
about the

23
00:00:50,790 --> 00:00:48,399
dimension or the diameter of a human

24
00:00:52,229 --> 00:00:50,800
hair that's about 1 100th of the size of

25
00:00:54,630 --> 00:00:52,239
a human hair

26
00:00:57,110 --> 00:00:54,640
and these particles when they normally

27
00:00:58,869 --> 00:00:57,120
they float around and the whole material

28
00:01:00,950 --> 00:00:58,879
behaves like a fluid

29
00:01:02,310 --> 00:01:00,960
but when you apply a magnetic field to

30
00:01:04,310 --> 00:01:02,320
those samples

31
00:01:06,070 --> 00:01:04,320
those little little particles act like

32
00:01:08,310 --> 00:01:06,080
magnets and they start to line up and

33
00:01:10,070 --> 00:01:08,320
they assemble with one another and if

34
00:01:11,510 --> 00:01:10,080
you look at this fluid

35
00:01:14,070 --> 00:01:11,520
what we call the rheology of the

36
00:01:16,230 --> 00:01:14,080
material how it flows uh when you apply

37
00:01:18,070 --> 00:01:16,240
that field it goes from a liquid to a

38
00:01:19,510 --> 00:01:18,080

solid very suddenly

39
00:01:21,190 --> 00:01:19,520
and so we're investigating with these

40
00:01:23,270 --> 00:01:21,200
experiments some of the underlying

41
00:01:25,190 --> 00:01:23,280
phenomena some of the some of the

42
00:01:27,190 --> 00:01:25,200
details of how those particles come

43
00:01:30,149 --> 00:01:27,200
together and assemble into those

44
00:01:31,910 --> 00:01:30,159
structures and how we can control that

45
00:01:34,550 --> 00:01:31,920
you know right now we're looking at some

46
00:01:36,390 --> 00:01:34,560
recorded video of what we've

47
00:01:38,550 --> 00:01:36,400
affectionately dubbed the green blob

48
00:01:39,910 --> 00:01:38,560
here in mission control

49
00:01:41,270 --> 00:01:39,920
and i know what you you know what this

50
00:01:42,870 --> 00:01:41,280
looks like because you've been watching

51
00:01:44,069 --> 00:01:42,880
the results of your experiment can you

52
00:01:46,069 --> 00:01:44,079
explain a little bit what we're looking

53
00:01:47,830 --> 00:01:46,079
at here sure absolutely so it doesn't

54
00:01:50,230 --> 00:01:47,840
look like much but it's actually pretty

55
00:01:52,149 --> 00:01:50,240
exciting for us these are the the black

56
00:01:54,149 --> 00:01:52,159
regions are the particles and and so

57
00:01:55,910 --> 00:01:54,159
those are the dimensions there are

58
00:01:57,830 --> 00:01:55,920
several hundred microns they're about

59
00:01:59,590 --> 00:01:57,840
the size of a human hair so we're not

60
00:02:01,910 --> 00:01:59,600
seeing the individual particles but what

61
00:02:04,069 --> 00:02:01,920
we're seeing is how they come together

62
00:02:06,310 --> 00:02:04,079
and aggregate in the presence of pulsed

63
00:02:07,830 --> 00:02:06,320

magnetic fields the green that you're

64
00:02:09,430 --> 00:02:07,840
mentioning is just a light passing

65
00:02:11,510 --> 00:02:09,440
through our sample so that's what allows

66
00:02:13,270 --> 00:02:11,520
us to distinguish the assembled

67
00:02:14,710 --> 00:02:13,280
structure from just the surrounding

68
00:02:16,790 --> 00:02:14,720
fluid

69
00:02:18,710 --> 00:02:16,800
we monitor that structure we look at how

70
00:02:21,190 --> 00:02:18,720
it evolves with time

71
00:02:23,750 --> 00:02:21,200
especially as we toggle the field on and

72
00:02:25,430 --> 00:02:23,760
off and we characterize the growth of

73
00:02:27,910 --> 00:02:25,440
those structures and how they develop

74
00:02:30,630 --> 00:02:27,920
and that's that's giving us insight into

75
00:02:32,390 --> 00:02:30,640
not only the the fluid properties of

76
00:02:34,390 --> 00:02:32,400
these materials but

77
00:02:36,869 --> 00:02:34,400
giving us some sense of how tiny

78
00:02:39,190 --> 00:02:36,879
particles come together and and do what

79
00:02:42,869 --> 00:02:39,200
we call self-assemble or build greater

80
00:02:44,550 --> 00:02:42,879
structures uh from themselves

81
00:02:47,030 --> 00:02:44,560
um so specifically what kind of

82
00:02:49,509 --> 00:02:47,040
activities does is go are going on

83
00:02:52,630 --> 00:02:49,519
within space this week and and how does

84
00:02:54,869 --> 00:02:52,640
the crew help you set up the experiment

85
00:02:57,110 --> 00:02:54,879
oh i mean the the the the experiments

86
00:02:59,910 --> 00:02:57,120
that we're doing is it's a it's a number

87
00:03:03,350 --> 00:02:59,920
of our uh test run experiments um we

88
00:03:05,830 --> 00:03:03,360

have a a about 40 experiments that we r

89
00:03:07,509 --> 00:03:05,840
that we run through to test a matrix

90
00:03:09,110 --> 00:03:07,519
of uh field strength different

91
00:03:11,350 --> 00:03:09,120
conditions field strength field

92
00:03:13,350 --> 00:03:11,360
frequency uh and suspension

93
00:03:15,430 --> 00:03:13,360
concentration and and actually these

94
00:03:17,030 --> 00:03:15,440
particles are tiny particles that have

95
00:03:19,430 --> 00:03:17,040
they're they're like little ellipsoids

96
00:03:21,190 --> 00:03:19,440
or a little rice grain like particles in

97
00:03:22,790 --> 00:03:21,200
shape if you if you were to look at them

98
00:03:24,630 --> 00:03:22,800
under a microscope they would they would

99
00:03:25,830 --> 00:03:24,640
have that sort of uh

100
00:03:27,830 --> 00:03:25,840
shape to them

101
00:03:29,350 --> 00:03:27,840
we have actually made a couple

102
00:03:30,949 --> 00:03:29,360
different types of particles that have

103
00:03:33,750 --> 00:03:30,959
different lengths

104
00:03:35,670 --> 00:03:33,760
and so we're looking at experiments that

105
00:03:37,910 --> 00:03:35,680
ask you know how does particle shape

106
00:03:39,670 --> 00:03:37,920
affect these processes as well

107
00:03:41,110 --> 00:03:39,680
so the astronauts take our samples i

108
00:03:42,869 --> 00:03:41,120
don't know if you have an image of those

109
00:03:44,949 --> 00:03:42,879
i mean it's a simple vial the fluids

110
00:03:47,110 --> 00:03:44,959
dispersed in that vial they were sent up

111
00:03:48,949 --> 00:03:47,120
i think on oh i want to say the

112
00:03:51,110 --> 00:03:48,959
discovery on the second to last launch

113
00:03:52,710 --> 00:03:51,120

or maybe it was the endeavor

114
00:03:54,390 --> 00:03:52,720
about two years ago

115
00:03:56,630 --> 00:03:54,400
they've been up there and the astronauts

116
00:03:58,390 --> 00:03:56,640
take those samples they

117
00:04:00,229 --> 00:03:58,400
integrate them into our experiment which

118
00:04:01,429 --> 00:04:00,239
is in the microgravity sciences glove

119
00:04:03,030 --> 00:04:01,439
box

120
00:04:04,869 --> 00:04:03,040
and you know it's real film at that

121
00:04:06,789 --> 00:04:04,879
point they have to

122
00:04:08,789 --> 00:04:06,799
they set up the entire experiment

123
00:04:11,589 --> 00:04:08,799
capture it on video we get the downlink

124
00:04:13,750 --> 00:04:11,599
data we monitor it in real time and the

125
00:04:14,869 --> 00:04:13,760
key thing is that they record it on dv

126
00:04:16,870 --> 00:04:14,879
video

127
00:04:18,469 --> 00:04:16,880
and that's sent back eventually so that

128
00:04:20,629 --> 00:04:18,479
we can we can take that very high

129
00:04:22,950 --> 00:04:20,639
quality data and analyze it for our

130
00:04:25,430 --> 00:04:22,960
research results

131
00:04:27,590 --> 00:04:25,440
okay well how does doing this experiment

132
00:04:29,670 --> 00:04:27,600
on the space station as opposed to on

133
00:04:32,469 --> 00:04:29,680
earth make it possible

134
00:04:34,950 --> 00:04:32,479
oh well these particles are heavy uh and

135
00:04:37,270 --> 00:04:34,960
so if you were to do this experiment on

136
00:04:39,270 --> 00:04:37,280
the earth which we do we do we do

137
00:04:42,310 --> 00:04:39,280
experiments with these materials

138
00:04:43,990 --> 00:04:42,320

but the the limit is that they just fall

139
00:04:46,950 --> 00:04:44,000
out of suspension so they'll they'll

140
00:04:50,150 --> 00:04:46,960
rapidly what we call uh sediment right

141
00:04:52,390 --> 00:04:50,160
so uh instead of being fluid and mobile

142
00:04:54,230 --> 00:04:52,400
and moving around uh they just fall out

143
00:04:56,390 --> 00:04:54,240
now we can do experiments and it's sort

144
00:04:57,990 --> 00:04:56,400
of like 2d experiments because they end

145
00:04:59,990 --> 00:04:58,000
up making sort of pancake like

146
00:05:01,830 --> 00:05:00,000
structures on the bottom of our

147
00:05:04,070 --> 00:05:01,840
our sample vials and we can look at that

148
00:05:06,550 --> 00:05:04,080
with microscopy but the key with

149
00:05:09,029 --> 00:05:06,560
microgravity is you know i eliminate

150
00:05:10,870 --> 00:05:09,039
that whole effect of of having them

151
00:05:13,749 --> 00:05:10,880
sediment out and so

152
00:05:15,909 --> 00:05:13,759
that makes the results that we have here

153
00:05:16,790 --> 00:05:15,919
much more generalizable in the sense

154
00:05:19,189 --> 00:05:16,800
that

155
00:05:21,430 --> 00:05:19,199
what we see and how particles assemble

156
00:05:22,950 --> 00:05:21,440
and the structures that they form we

157
00:05:24,790 --> 00:05:22,960
feel that that can translate the

158
00:05:27,430 --> 00:05:24,800
particles of all different sizes and

159
00:05:29,350 --> 00:05:27,440
what we're especially interested in is

160
00:05:31,430 --> 00:05:29,360
particles that are really small

161
00:05:34,550 --> 00:05:31,440
nanoparticles that we can't necessarily

162
00:05:36,150 --> 00:05:34,560
do experiments easily like this with

163
00:05:37,749 --> 00:05:36,160

anywhere

164
00:05:39,830 --> 00:05:37,759
we're getting some insight into how

165
00:05:41,909 --> 00:05:39,840
nanoparticles assemble by doing these

166
00:05:44,310 --> 00:05:41,919
experiments and from that we're trying

167
00:05:45,909 --> 00:05:44,320
to figure out basically how we can take

168
00:05:47,430 --> 00:05:45,919
tiny particles and build bigger

169
00:05:49,590 --> 00:05:47,440
structures from that that gets back to

170
00:05:51,270 --> 00:05:49,600
that kind of self-assembly idea that

171
00:05:52,870 --> 00:05:51,280
we're talking about we think that that's

172
00:05:55,350 --> 00:05:52,880
going to give us new technologies new

173
00:05:56,950 --> 00:05:55,360
ways of manufacturing based on the idea

174
00:05:59,110 --> 00:05:56,960
of taking little building blocks these

175
00:06:01,270 --> 00:05:59,120
little particles and having them come

176
00:06:03,350 --> 00:06:01,280
together self-assemble into bigger

177
00:06:05,670 --> 00:06:03,360
functional structures

178
00:06:07,749 --> 00:06:05,680
so in a way is this kind of like the old

179
00:06:09,270 --> 00:06:07,759
star trek next generation concept of

180
00:06:10,710 --> 00:06:09,280
nanobots

181
00:06:13,430 --> 00:06:10,720
oh i don't know you'll have to fill me

182
00:06:15,029 --> 00:06:13,440
in on that i can't remember the nanobot

183
00:06:17,670 --> 00:06:15,039
stuff um

184
00:06:19,990 --> 00:06:17,680
uh and you know probably

185
00:06:22,070 --> 00:06:20,000
i dream of that

186
00:06:23,909 --> 00:06:22,080
in some ways the materials that we're

187
00:06:26,469 --> 00:06:23,919
trying to enable

188
00:06:28,390 --> 00:06:26,479

may seem more mundane they may be

189
00:06:30,710 --> 00:06:28,400
thermal barriers they may be materials

190
00:06:32,790 --> 00:06:30,720
that enable a

191
00:06:34,550 --> 00:06:32,800
better better utility of

192
00:06:36,150 --> 00:06:34,560
solar power

193
00:06:37,790 --> 00:06:36,160
you know those

194
00:06:39,909 --> 00:06:37,800
one of the things that we've learned in

195
00:06:41,189 --> 00:06:39,919
nanotechnology is how to build

196
00:06:43,270 --> 00:06:41,199
structures

197
00:06:45,590 --> 00:06:43,280
that are really tailored

198
00:06:47,510 --> 00:06:45,600
to to transport light or to transport

199
00:06:49,830 --> 00:06:47,520
energy

200
00:06:51,830 --> 00:06:49,840
the question that we have is can we have

201
00:06:54,469 --> 00:06:51,840
those types of structures build

202
00:06:56,070 --> 00:06:54,479
themselves basically self-assemble but

203
00:06:58,550 --> 00:06:56,080
they're not they're not self-assembling

204
00:07:00,790 --> 00:06:58,560
in a sort of intelligent way right as a

205
00:07:03,909 --> 00:07:00,800
nanobot might i guess to form a bigger

206
00:07:06,150 --> 00:07:03,919
organism it's a little it's a little

207
00:07:08,309 --> 00:07:06,160
less organized than that

208
00:07:10,230 --> 00:07:08,319
okay uh and

209
00:07:12,710 --> 00:07:10,240
these colloids

210
00:07:14,830 --> 00:07:12,720
let's try to relate them to something

211
00:07:16,309 --> 00:07:14,840
folks on the ground that would

212
00:07:18,390 --> 00:07:16,319
recognize uh

213
00:07:21,110 --> 00:07:18,400

some things are like paint where you

214
00:07:23,270 --> 00:07:21,120
have to stir it so off every so often to

215
00:07:24,790 --> 00:07:23,280
keep the paint particles into the liquid

216
00:07:26,710 --> 00:07:24,800
systems is that right

217
00:07:28,870 --> 00:07:26,720
that's right i mean and actually the

218
00:07:30,469 --> 00:07:28,880
colloid sort of refers to a specific

219
00:07:32,790 --> 00:07:30,479
length scale of matter and that that

220
00:07:33,990 --> 00:07:32,800
goes back to that that the idea that

221
00:07:36,469 --> 00:07:34,000
these particles are on the order of

222
00:07:38,629 --> 00:07:36,479
about a micrometer a colloid is usually

223
00:07:40,150 --> 00:07:38,639
a it's a it's a division of matter it's

224
00:07:42,629 --> 00:07:40,160
a piece of matter that's anywhere from

225
00:07:45,189 --> 00:07:42,639
about 10 nanometers uh to several

226
00:07:47,189 --> 00:07:45,199
micrometers so the micron range is a

227
00:07:51,029 --> 00:07:47,199
little bit larger size scale

228
00:07:53,589 --> 00:07:51,039
what that why that length scale is um

229
00:07:56,070 --> 00:07:53,599
uh uh uh unique

230
00:07:58,710 --> 00:07:56,080
is that it it confers on these particles

231
00:07:59,749 --> 00:07:58,720
the ability to move around by brownian

232
00:08:02,150 --> 00:07:59,759
motion

233
00:08:04,150 --> 00:08:02,160
all right and and and that that kind of

234
00:08:06,150 --> 00:08:04,160
gives the the systems this ability to

235
00:08:08,309 --> 00:08:06,160
self-assemble but if you go back to

236
00:08:11,110 --> 00:08:08,319
where where people seen colloids you see

237
00:08:14,070 --> 00:08:11,120
it every day milk is a colloid basically

238
00:08:16,309 --> 00:08:14,080

it's a it's a dispersion of fat droplets

239
00:08:18,150 --> 00:08:16,319
in water and that's why it's so opaque

240
00:08:19,110 --> 00:08:18,160
all those little droplets are scattering

241
00:08:20,710 --> 00:08:19,120
light

242
00:08:22,550 --> 00:08:20,720
and clearly they don't sediment out or

243
00:08:23,830 --> 00:08:22,560
they don't cream right

244
00:08:26,150 --> 00:08:23,840
so they're they're moving around by

245
00:08:28,629 --> 00:08:26,160
brownian motion in that fluid many of

246
00:08:30,629 --> 00:08:28,639
the consumer products that we use and

247
00:08:32,870 --> 00:08:30,639
and like you mentioned paints

248
00:08:35,750 --> 00:08:32,880
and things like that many foods have

249
00:08:38,149 --> 00:08:35,760
some aspect of being colloidal and so

250
00:08:40,870 --> 00:08:38,159
it's a it's a it's a landscape matter we

251
00:08:43,029 --> 00:08:40,880
use every day of our lives but we often

252
00:08:45,750 --> 00:08:43,039
don't recognize that and uh you know

253
00:08:47,350 --> 00:08:45,760
it's a really uh if you get into food

254
00:08:49,269 --> 00:08:47,360
and you get excited about those types of

255
00:08:51,030 --> 00:08:49,279
things you'll find yourself actually

256
00:08:52,870 --> 00:08:51,040
working in this whole field of colloid

257
00:08:54,949 --> 00:08:52,880
science and and you know from there you

258
00:08:57,829 --> 00:08:54,959
can do many things you can control how

259
00:08:59,430 --> 00:08:57,839
fluids flow you can uh you know try to

260
00:09:01,110 --> 00:08:59,440
make these self-assembling structures

261
00:09:03,030 --> 00:09:01,120
it's really quite exciting

262
00:09:05,190 --> 00:09:03,040
well how might you apply this for the

263
00:09:06,150 --> 00:09:05,200

benefit of folks on the earth well like

264
00:09:07,750 --> 00:09:06,160
i said

265
00:09:09,670 --> 00:09:07,760
the whole question of how we get

266
00:09:11,350 --> 00:09:09,680
particles to come together and sort of

267
00:09:13,750 --> 00:09:11,360
form structures this idea of

268
00:09:14,550 --> 00:09:13,760
self-assembly right that's really what

269
00:09:18,310 --> 00:09:14,560
we

270
00:09:20,470 --> 00:09:18,320
insight into and

271
00:09:21,670 --> 00:09:20,480
if you go back to the problem of of

272
00:09:24,389 --> 00:09:21,680
fabricating

273
00:09:26,230 --> 00:09:24,399
nanomaterials or nano devices right i

274
00:09:28,710 --> 00:09:26,240
mean we know that we can make nano

275
00:09:30,870 --> 00:09:28,720
devices like uh what we have today in

276
00:09:33,350 --> 00:09:30,880
microprocessors from this you know sort

277
00:09:35,269 --> 00:09:33,360
of what we refer to as a top-down method

278
00:09:36,870 --> 00:09:35,279
where we you know add materials we

279
00:09:39,509 --> 00:09:36,880
subtract materials we build up the

280
00:09:43,030 --> 00:09:39,519
structure in a pretty laborious you know

281
00:09:44,389 --> 00:09:43,040
batch operation with many many steps um

282
00:09:46,310 --> 00:09:44,399
you know that's that's great that gives

283
00:09:48,310 --> 00:09:46,320
us these functional devices that are

284
00:09:49,910 --> 00:09:48,320
super sophisticated and and those

285
00:09:51,829 --> 00:09:49,920
devices those structures you know they

286
00:09:53,590 --> 00:09:51,839
move charge around and and they can do

287
00:09:54,710 --> 00:09:53,600
computations with that

288
00:09:57,030 --> 00:09:54,720

um

289
00:09:59,990 --> 00:09:57,040
what we're looking for is

290
00:10:01,750 --> 00:10:00,000
a method of manufacturing where we could

291
00:10:05,190 --> 00:10:01,760
where it would be scalable where we

292
00:10:06,710 --> 00:10:05,200
could do large areas in a continuous

293
00:10:08,949 --> 00:10:06,720
process

294
00:10:10,550 --> 00:10:08,959
so very fast very rapid you know you're

295
00:10:12,150 --> 00:10:10,560
not going to make microprocessors with

296
00:10:14,470 --> 00:10:12,160
this but you might make your new

297
00:10:16,389 --> 00:10:14,480
photovoltaic device out of it or

298
00:10:18,630 --> 00:10:16,399
photovoltaic material or your new

299
00:10:20,230 --> 00:10:18,640
thermal barrier you know for an

300
00:10:22,630 --> 00:10:20,240
application i can imagine that would be

301
00:10:24,150 --> 00:10:22,640
a nice space application in some cases

302
00:10:25,350 --> 00:10:24,160
so

303
00:10:27,030 --> 00:10:25,360
ultimately this is really going to

304
00:10:29,269 --> 00:10:27,040
benefit people on earth because it gives

305
00:10:31,269 --> 00:10:29,279
us this insight into making and

306
00:10:32,550 --> 00:10:31,279
fabricating new materials and and

307
00:10:35,110 --> 00:10:32,560
essentially coming up with new

308
00:10:37,750 --> 00:10:35,120
manufacturing processes that harness

309
00:10:39,590 --> 00:10:37,760
nanotechnology

310
00:10:41,350 --> 00:10:39,600
well thanks uh hey tell us a little

311
00:10:42,870 --> 00:10:41,360
about yourself where you from where did

312
00:10:45,030 --> 00:10:42,880
you go to school

313
00:10:47,590 --> 00:10:45,040

well i i did my undergraduate degree at

314
00:10:48,870 --> 00:10:47,600
carnegie mellon and that's not too far

315
00:10:51,190 --> 00:10:48,880
from where i grew up i grew up in

316
00:10:52,949 --> 00:10:51,200
johnstown pennsylvania in western

317
00:10:54,150 --> 00:10:52,959
pennsylvania and

318
00:10:56,550 --> 00:10:54,160
i did my

319
00:10:58,389 --> 00:10:56,560
graduate work after being at carnegie

320
00:11:00,389 --> 00:10:58,399
mellon i did my graduate work at

321
00:11:01,829 --> 00:11:00,399
stanford university under

322
00:11:04,710 --> 00:11:01,839
the

323
00:11:06,150 --> 00:11:04,720
underrated advisor alice gasp

324
00:11:08,870 --> 00:11:06,160
and

325
00:11:10,710 --> 00:11:08,880
after that i did a postdoc in france

326
00:11:12,550 --> 00:11:10,720
working a little bit in biophysics so

327
00:11:14,630 --> 00:11:12,560
another area that's influenced by

328
00:11:15,990 --> 00:11:14,640
colloid science and i've been here at

329
00:11:17,590 --> 00:11:16,000
the university of delaware now for

330
00:11:19,190 --> 00:11:17,600
almost 12 years

331
00:11:21,350 --> 00:11:19,200
my entire education has been in chemical

332
00:11:24,389 --> 00:11:21,360
engineering but you can see

333
00:11:26,230 --> 00:11:24,399
that background really bridges all sorts

334
00:11:27,990 --> 00:11:26,240
of areas from the physical sciences the

335
00:11:30,710 --> 00:11:28,000
chemistry so it's been a really rich and

336
00:11:32,150 --> 00:11:30,720
rewarding uh trajectory

337
00:11:34,310 --> 00:11:32,160
and and how big is your team there at

338
00:11:36,790 --> 00:11:34,320

the university of delaware i have uh

339
00:11:38,550 --> 00:11:36,800
about seven phd students sorry it's not

340
00:11:40,949 --> 00:11:38,560
an approximate number they're i actually

341
00:11:43,190 --> 00:11:40,959
have seven phd students and two postdocs

342
00:11:45,110 --> 00:11:43,200
working with me directly usually we have

343
00:11:47,430 --> 00:11:45,120
a couple undergraduate graduates in the

344
00:11:49,750 --> 00:11:47,440
lab and i have one or two high school

345
00:11:51,910 --> 00:11:49,760
students working with us as well so it's

346
00:11:54,069 --> 00:11:51,920
a team of you know fluctuates between

347
00:11:56,550 --> 00:11:54,079
about 12 and 14 people all different

348
00:11:58,550 --> 00:11:56,560
stages in their education doing work in

349
00:12:00,870 --> 00:11:58,560
the lab and helping us out

350
00:12:02,710 --> 00:12:00,880
in all the experiments and and and and

351
00:12:04,710 --> 00:12:02,720
all the discovery of knowledge that

352
00:12:06,389 --> 00:12:04,720
comes with that

353
00:12:07,750 --> 00:12:06,399
well dr eric first from the university

354
00:12:09,750 --> 00:12:07,760
of delaware i want to thank you once

355
00:12:12,790 --> 00:12:09,760
again for being with us and explaining

356
00:12:14,949 --> 00:12:12,800
this uh very interesting experiment that

357
00:12:16,710 --> 00:12:14,959
has potential applications in so many

358
00:12:18,629 --> 00:12:16,720
areas of our lives we really appreciate