
PAO

1
00:00:03,909 --> 00:00:02,790
good morning welcome to the

2
00:00:06,230 --> 00:00:03,919
international space station flight

3
00:00:08,390 --> 00:00:06,240
control room as we mentioned earlier in

4
00:00:09,990 --> 00:00:08,400
the hour uh this week the crew surpassed

5
00:00:11,589 --> 00:00:10,000
a record they had previously said on

6
00:00:13,910 --> 00:00:11,599
number of hours that they spent working

7
00:00:15,270 --> 00:00:13,920
on science this week and here to tell us

8
00:00:16,630 --> 00:00:15,280
a little bit about that we have vic

9
00:00:19,109 --> 00:00:16,640
cooley who is the lead increment

10
00:00:20,790 --> 00:00:19,119
scientist for this expedition so thank

11
00:00:22,470 --> 00:00:20,800
you so much for joining us vic thanks

12
00:00:24,230 --> 00:00:22,480
brandi it's a pleasure to be here we're

13
00:00:25,670 --> 00:00:24,240

glad to have you well so first of all

14
00:00:28,070 --> 00:00:25,680
why don't you tell us a little bit about

15
00:00:29,429 --> 00:00:28,080
what a lead increment scientist is what

16
00:00:31,830 --> 00:00:29,439
does that mean

17
00:00:33,990 --> 00:00:31,840
well um i'm a head of a team that's an

18
00:00:36,069 --> 00:00:34,000
international team that consists of nasa

19
00:00:39,590 --> 00:00:36,079
scientists but also partner scientists

20
00:00:41,590 --> 00:00:39,600
from our partners jaxa the japanese

21
00:00:44,069 --> 00:00:41,600
space agency the european space agency

22
00:00:45,029 --> 00:00:44,079
and also the canadian space agency so

23
00:00:46,869 --> 00:00:45,039
you

24
00:00:50,229 --> 00:00:46,879
get them all rounded up on

25
00:00:52,069 --> 00:00:50,239
we meet weekly and our primary objective

26
00:00:54,709 --> 00:00:52,079
or our

27
00:00:56,470 --> 00:00:54,719
routine product is every week we put out

28
00:00:58,790 --> 00:00:56,480
a list of priorities

29
00:01:01,270 --> 00:00:58,800
that for the next four weeks

30
00:01:03,590 --> 00:01:01,280
to indicate which science sessions

31
00:01:05,990 --> 00:01:03,600
should be higher priority than others

32
00:01:07,910 --> 00:01:06,000
as as our audience is probably aware the

33
00:01:09,510 --> 00:01:07,920
the tightest resource the one that often

34
00:01:12,070 --> 00:01:09,520
limits how much science we can do on

35
00:01:14,390 --> 00:01:12,080
orbit is crew time so that's the

36
00:01:16,789 --> 00:01:14,400
resource we're most often focused on but

37
00:01:18,469 --> 00:01:16,799
other times it's bandwidth or up mass or

38
00:01:20,870 --> 00:01:18,479

some other resource that the

39
00:01:22,630 --> 00:01:20,880
investigations need okay and so when you

40
00:01:24,230 --> 00:01:22,640
say you set priorities that means you

41
00:01:26,230 --> 00:01:24,240
decide which experiments are going to be

42
00:01:27,350 --> 00:01:26,240
the priorities or is is that the way to

43
00:01:28,789 --> 00:01:27,360
describe it

44
00:01:31,030 --> 00:01:28,799
yes and it's probably more accurate to

45
00:01:33,270 --> 00:01:31,040
say we decide which sessions or which

46
00:01:35,190 --> 00:01:33,280
runs of which experiments take priority

47
00:01:36,710 --> 00:01:35,200
in a given week okay

48
00:01:39,350 --> 00:01:36,720
a lot of our experiments are on the crew

49
00:01:41,350 --> 00:01:39,360
members themselves and those uh have

50
00:01:43,590 --> 00:01:41,360
requirements that are defined by how

51
00:01:45,510 --> 00:01:43,600
long the crew member has been on orbit

52
00:01:47,670 --> 00:01:45,520
so for example we'll collect blood at

53
00:01:49,830 --> 00:01:47,680
flight day 15 and at flight day 30 and

54
00:01:51,990 --> 00:01:49,840
then again at flight day 45

55
00:01:53,510 --> 00:01:52,000
and the intervals start to increase as

56
00:01:55,270 --> 00:01:53,520
the crew member stays there longer and

57
00:01:57,190 --> 00:01:55,280
longer such that the last interval could

58
00:01:59,510 --> 00:01:57,200
be as big as 60 days whereas the first

59
00:02:02,310 --> 00:01:59,520
interval is only 15 days okay

60
00:02:03,109 --> 00:02:02,320
so those are pretty well tightly defined

61
00:02:04,870 --> 00:02:03,119
uh

62
00:02:05,910 --> 00:02:04,880
windows at which we need to conduct

63
00:02:08,309 --> 00:02:05,920

those

64
00:02:10,150 --> 00:02:08,319
blood collection sessions other

65
00:02:11,910 --> 00:02:10,160
experiments in the physical sciences

66
00:02:13,510 --> 00:02:11,920
area and i'll talk about some of those

67
00:02:14,710 --> 00:02:13,520
later today

68
00:02:16,550 --> 00:02:14,720
don't have

69
00:02:18,229 --> 00:02:16,560
tightly defined

70
00:02:20,229 --> 00:02:18,239
timing requirements when the sessions

71
00:02:23,110 --> 00:02:20,239
have to occur however some of those

72
00:02:25,670 --> 00:02:23,120
experiments do have specimens or samples

73
00:02:27,910 --> 00:02:25,680
which can be shelf life limited because

74
00:02:29,750 --> 00:02:27,920
they would coagulate or something like

75
00:02:30,630 --> 00:02:29,760
that if they're there for too long so we

76
00:02:32,550 --> 00:02:30,640
have to take those kind of

77
00:02:35,830 --> 00:02:32,560
considerations in mind

78
00:02:37,910 --> 00:02:35,840
we also have to consider

79
00:02:40,949 --> 00:02:37,920
when is the return flight for a

80
00:02:42,790 --> 00:02:40,959
particular set of samples and so a lot

81
00:02:44,390 --> 00:02:42,800
of different considerations go into

82
00:02:46,390 --> 00:02:44,400
deciding what are the priorities for a

83
00:02:48,150 --> 00:02:46,400
given week it sounds like a pretty

84
00:02:48,949 --> 00:02:48,160
difficult scheduling question to get

85
00:02:50,790 --> 00:02:48,959
through

86
00:02:53,270 --> 00:02:50,800
well there's lots of teams involved that

87
00:02:54,630 --> 00:02:53,280
actually do the scheduling after we set

88
00:02:56,630 --> 00:02:54,640

the priorities

89
00:02:58,390 --> 00:02:56,640
uh but it's it's very enjoyable to work

90
00:02:59,990 --> 00:02:58,400
with this international team and learn

91
00:03:01,350 --> 00:03:00,000
about all the science that all the

92
00:03:02,869 --> 00:03:01,360
wonderful science that we're doing on

93
00:03:04,949 --> 00:03:02,879
the space station and in almost any

94
00:03:07,110 --> 00:03:04,959
discipline that you can't imagine i bet

95
00:03:08,470 --> 00:03:07,120
yeah well i think um the record that

96
00:03:11,910 --> 00:03:08,480
we're setting this week i guess at the

97
00:03:14,309 --> 00:03:11,920
end of today will be 67 hours of uh time

98
00:03:18,630 --> 00:03:14,319
spent on science that's correct that's

99
00:03:21,509 --> 00:03:18,640
67 hours this week uh by uh our three us

100
00:03:23,589 --> 00:03:21,519
os crew members kevin ford tom marshburn

101
00:03:25,350 --> 00:03:23,599
and chris hadfield of the canadian space

102
00:03:27,030 --> 00:03:25,360
agency and so that doesn't even count

103
00:03:28,630 --> 00:03:27,040
the the russian experiments that the

104
00:03:29,910 --> 00:03:28,640
russian crew members are doing on the

105
00:03:32,550 --> 00:03:29,920
other end of the space station that's

106
00:03:34,390 --> 00:03:32,560
correct it does not okay well 67 hours

107
00:03:37,670 --> 00:03:34,400
that's pretty good i think it just is a

108
00:03:39,509 --> 00:03:37,680
little over our last record was 66. i i

109
00:03:42,070 --> 00:03:39,519
was thinking 65 but

110
00:03:43,990 --> 00:03:42,080
it's it's uh it's very close uh but

111
00:03:45,430 --> 00:03:44,000
we're happy to set the record i bet

112
00:03:46,470 --> 00:03:45,440
that's great so what what are some of

113
00:03:47,589 --> 00:03:46,480

the things i've been working on this

114
00:03:50,070 --> 00:03:47,599
week

115
00:03:52,070 --> 00:03:50,080
well um today i've i've picked four

116
00:03:53,429 --> 00:03:52,080
experiments that there's kind of a theme

117
00:03:56,229 --> 00:03:53,439
involved they're all in the fluid

118
00:03:58,390 --> 00:03:56,239
physics area and actually we could call

119
00:03:59,990 --> 00:03:58,400
this fluid physics week because i know

120
00:04:02,949 --> 00:04:00,000
two earlier interviews you've had this

121
00:04:04,949 --> 00:04:02,959
week with dr eric first of the in space

122
00:04:07,190 --> 00:04:04,959
experiment and

123
00:04:08,949 --> 00:04:07,200
dr mark weislogel of portland state

124
00:04:11,670 --> 00:04:08,959
university

125
00:04:13,670 --> 00:04:11,680
for the cfe or capillary flow experiment

126
00:04:16,550 --> 00:04:13,680
they have both been interviewed on on

127
00:04:18,870 --> 00:04:16,560
this particular program this this hour

128
00:04:20,229 --> 00:04:18,880
on previous days this week i'll talk a

129
00:04:21,990 --> 00:04:20,239
little bit about those trying not to

130
00:04:24,310 --> 00:04:22,000
duplicate things they've said but also

131
00:04:26,469 --> 00:04:24,320
talk about two partner experiments from

132
00:04:27,590 --> 00:04:26,479
the european space agency the geoflow

133
00:04:31,189 --> 00:04:27,600
experiment

134
00:04:32,950 --> 00:04:31,199
and from the japanese space agency the

135
00:04:35,510 --> 00:04:32,960
marangoni experiment

136
00:04:38,710 --> 00:04:35,520
i think this is a video of geoflow yes

137
00:04:40,310 --> 00:04:38,720
this is a geoflow video

138
00:04:42,870 --> 00:04:40,320

first of all the the name is very

139
00:04:45,590 --> 00:04:42,880
appropriate because it it

140
00:04:49,189 --> 00:04:45,600
it examines the flow in

141
00:04:51,189 --> 00:04:49,199
in the center of our earth so geo flow

142
00:04:52,629 --> 00:04:51,199
in this case we have a set of hardware

143
00:04:55,430 --> 00:04:52,639
on board that

144
00:04:56,790 --> 00:04:55,440
uh it's two concentric spheres with oil

145
00:04:58,310 --> 00:04:56,800
in between those spheres and these

146
00:04:59,990 --> 00:04:58,320
spheres aren't that big they're the

147
00:05:01,270 --> 00:05:00,000
outer sphere is about the size of a

148
00:05:02,950 --> 00:05:01,280
volleyball

149
00:05:05,270 --> 00:05:02,960
and their inner sphere is about the size

150
00:05:06,790 --> 00:05:05,280
of a of a hardball baseball

151
00:05:09,670 --> 00:05:06,800
and in between those two concentric

152
00:05:11,590 --> 00:05:09,680
spheres is this silicon oil now

153
00:05:13,590 --> 00:05:11,600
there's a voltage difference between the

154
00:05:15,510 --> 00:05:13,600
inner sphere and the outer sphere and

155
00:05:17,590 --> 00:05:15,520
that produces

156
00:05:19,990 --> 00:05:17,600
a force field much like our gravity

157
00:05:22,469 --> 00:05:20,000
field which is you know centered at the

158
00:05:24,469 --> 00:05:22,479
center of the earth in this model of the

159
00:05:26,230 --> 00:05:24,479
earth that gravity field is centered at

160
00:05:27,670 --> 00:05:26,240
the center of the inner sphere or the

161
00:05:30,150 --> 00:05:27,680
baseball sphere

162
00:05:32,230 --> 00:05:30,160
so it's it's not uh you know you could

163
00:05:34,070 --> 00:05:32,240

say well we're going to space to

164
00:05:36,310 --> 00:05:34,080
eliminate gravity but yet you want

165
00:05:38,390 --> 00:05:36,320
gravity well this is a this is a

166
00:05:39,990 --> 00:05:38,400
miniature gravity model and that it's

167
00:05:42,390 --> 00:05:40,000
centered at the center of that inner

168
00:05:47,110 --> 00:05:43,990
you can also apply a temperature

169
00:05:49,189 --> 00:05:47,120
difference which creates

170
00:05:51,350 --> 00:05:49,199
flow inside

171
00:05:52,870 --> 00:05:51,360
between those concentric spheres and the

172
00:05:53,830 --> 00:05:52,880
model that you saw previously in the

173
00:05:57,189 --> 00:05:53,840
video

174
00:06:00,070 --> 00:05:57,199
was an interferomic

175
00:06:02,550 --> 00:06:00,080
imaging of that flow you can see those

176
00:06:04,710 --> 00:06:02,560
inner cells simulating the molten flow

177
00:06:07,430 --> 00:06:04,720
of the mantle of the earth this is

178
00:06:09,270 --> 00:06:07,440
important to understand the flow uh in

179
00:06:10,550 --> 00:06:09,280
the mantle of the earth where so that we

180
00:06:12,950 --> 00:06:10,560
can understand

181
00:06:15,189 --> 00:06:12,960
uh volcano and earthquake dynamics more

182
00:06:17,350 --> 00:06:15,199
and what causes them and perhaps improve

183
00:06:19,990 --> 00:06:17,360
our capabilities of predicting those

184
00:06:22,550 --> 00:06:20,000
phenomena but it also has applications

185
00:06:26,469 --> 00:06:22,560
for uh spherical ball bearings for heat

186
00:06:28,629 --> 00:06:26,479
exchangers and and for uh other

187
00:06:30,950 --> 00:06:28,639
mechanical designs that we need to make

188
00:06:32,870 --> 00:06:30,960

to improve our productivity and industry

189
00:06:35,189 --> 00:06:32,880
on earth okay and i think real quick you

190
00:06:37,189 --> 00:06:35,199
said interferomic flow is what is

191
00:06:40,870 --> 00:06:37,199
interferometer well it's a technique

192
00:06:43,590 --> 00:06:40,880
using light and i think it may um

193
00:06:45,510 --> 00:06:43,600
uh use laser sensors laser

194
00:06:47,189 --> 00:06:45,520
interferometry but i'm not 100 sure

195
00:06:49,270 --> 00:06:47,199
about that there's there's different

196
00:06:51,589 --> 00:06:49,280
wavelengths of optical and even sound

197
00:06:54,950 --> 00:06:51,599
waves where you can use interferometry

198
00:06:56,950 --> 00:06:54,960
and basically it allows you to

199
00:06:58,469 --> 00:06:56,960
make

200
00:07:00,469 --> 00:06:58,479
assessments of

201
00:07:02,469 --> 00:07:00,479
moving

202
00:07:05,189 --> 00:07:02,479
inside of a substance that you can't see

203
00:07:07,270 --> 00:07:05,199
visibly in this case you can see the

204
00:07:10,150 --> 00:07:07,280
motion as we clearly saw in the video

205
00:07:13,029 --> 00:07:10,160
there of the oil even though we can't

206
00:07:13,990 --> 00:07:13,039
and you if there's oil moving

207
00:07:17,350 --> 00:07:14,000
say it

208
00:07:19,909 --> 00:07:17,360
three centimeters deep into the oil we

209
00:07:21,990 --> 00:07:19,919
can detect what is the velocity profile

210
00:07:24,230 --> 00:07:22,000
all the way through that depth and at

211
00:07:26,790 --> 00:07:24,240
various steps much like much like mri

212
00:07:29,270 --> 00:07:26,800
can do with with imaging our bodies this

213
00:07:31,589 --> 00:07:29,280

interferometry method is using to

214
00:07:34,629 --> 00:07:31,599
visualize the flow field all through

215
00:07:35,430 --> 00:07:34,639
that concentric annulus of of silicon

216
00:07:38,950 --> 00:07:35,440
oil

217
00:07:40,710 --> 00:07:38,960
okay and you said this um these small

218
00:07:42,230 --> 00:07:40,720
models i guess basically that we're

219
00:07:43,670 --> 00:07:42,240
looking at on space station help us

220
00:07:44,710 --> 00:07:43,680
understand better what's going on inside

221
00:07:48,869 --> 00:07:44,720
the earth

222
00:07:51,350 --> 00:07:48,879
yes and also in the atmosphere and in

223
00:07:53,990 --> 00:07:51,360
in the ocean circular or the

224
00:07:56,150 --> 00:07:54,000
world ocean circulation and atmospheric

225
00:07:58,469 --> 00:07:56,160
circulation on a global scale it's

226
00:08:00,869 --> 00:07:58,479
interesting a very uh

227
00:08:02,070 --> 00:08:00,879
interesting way that uh what the work

228
00:08:03,909 --> 00:08:02,080
that we're doing on the space station

229
00:08:05,510 --> 00:08:03,919
helps us learn more about the it is and

230
00:08:08,070 --> 00:08:05,520
and that's just one

231
00:08:09,909 --> 00:08:08,080
more of the unique applications that the

232
00:08:12,230 --> 00:08:09,919
international space station offers as a

233
00:08:14,230 --> 00:08:12,240
laboratory you know obviously there's no

234
00:08:16,710 --> 00:08:14,240
gravity there or gravity is exactly

235
00:08:18,710 --> 00:08:16,720
canceled out by the centrifugal orbiting

236
00:08:21,029 --> 00:08:18,720
of the space station

237
00:08:22,869 --> 00:08:21,039
and because of that we can have this

238
00:08:24,950 --> 00:08:22,879

small model of the earth and because of

239
00:08:26,550 --> 00:08:24,960
the very clever application of this

240
00:08:28,390 --> 00:08:26,560
voltage difference between the inner and

241
00:08:31,430 --> 00:08:28,400
the outer sphere we can actually

242
00:08:32,469 --> 00:08:31,440
simulate the earth centered gravity with

243
00:08:34,870 --> 00:08:32,479
this

244
00:08:37,029 --> 00:08:34,880
sphere centered gravity field produced

245
00:08:39,190 --> 00:08:37,039
by the voltage difference

246
00:08:40,550 --> 00:08:39,200
okay well i think that's just one of

247
00:08:42,469 --> 00:08:40,560
several experiments you want to tell us

248
00:08:44,870 --> 00:08:42,479
about what was the next one yeah that's

249
00:08:46,870 --> 00:08:44,880
uh that's one in the in this theme of

250
00:08:49,110 --> 00:08:46,880
fluid physics experiments obviously the

251
00:08:50,470 --> 00:08:49,120
the silicon is the fluid there but let

252
00:08:53,110 --> 00:08:50,480
me just talk a little bit about why we

253
00:08:55,910 --> 00:08:53,120
do fluid physics in space um

254
00:08:58,389 --> 00:08:55,920
we usually want to either eliminate

255
00:09:01,190 --> 00:08:58,399
sedimentation or convection which are

256
00:09:03,430 --> 00:09:01,200
both gravity driven processes

257
00:09:05,590 --> 00:09:03,440
if we can eliminate one or both of those

258
00:09:09,190 --> 00:09:05,600
we can unmask

259
00:09:11,990 --> 00:09:09,200
more subtle flow processes or transport

260
00:09:13,430 --> 00:09:12,000
mechanisms so sedimentation is i guess

261
00:09:15,590 --> 00:09:13,440
particles

262
00:09:17,829 --> 00:09:15,600
falling to the bottom settle out you

263
00:09:19,269 --> 00:09:17,839

know much like when you toss a rock into

264
00:09:21,269 --> 00:09:19,279
a lake it's going to sink to the bottom

265
00:09:22,949 --> 00:09:21,279
that's a you know a gross example of

266
00:09:25,829 --> 00:09:22,959
sedimentation but

267
00:09:28,150 --> 00:09:25,839
uh particles will slowly sink uh even if

268
00:09:30,230 --> 00:09:28,160
they're just slightly heavier than the

269
00:09:32,150 --> 00:09:30,240
than the water or whatever medium

270
00:09:34,790 --> 00:09:32,160
they're in they will eventually sink to

271
00:09:37,269 --> 00:09:34,800
the bottom and convection is heat

272
00:09:40,550 --> 00:09:37,279
related convection is when hot air rises

273
00:09:44,230 --> 00:09:40,560
okay or or warm fluids rise uh in the

274
00:09:47,110 --> 00:09:44,240
atmosphere and the ocean you know

275
00:09:49,670 --> 00:09:47,120
in whatever container of fluid you have

276
00:09:52,230 --> 00:09:49,680
the warmer fluid or warmer gas will rise

277
00:09:54,230 --> 00:09:52,240
to the top in a gravity field but that

278
00:09:56,150 --> 00:09:54,240
gravity field doesn't exist or is

279
00:09:58,470 --> 00:09:56,160
canceled out completely

280
00:10:01,190 --> 00:09:58,480
in the case of the space station lab

281
00:10:03,509 --> 00:10:01,200
and so those transport processes

282
00:10:06,550 --> 00:10:03,519
sedimentation and convection are

283
00:10:08,870 --> 00:10:06,560
eliminated and we can investigate

284
00:10:11,190 --> 00:10:08,880
explore and measure

285
00:10:14,069 --> 00:10:11,200
the more subtle transport processes

286
00:10:16,550 --> 00:10:14,079
which which are on earth are dominated

287
00:10:18,870 --> 00:10:16,560
by convection and sedimentation

288
00:10:20,949 --> 00:10:18,880

and it prevents us from

289
00:10:23,430 --> 00:10:20,959
seeing and measuring those more subtle

290
00:10:26,230 --> 00:10:23,440
transport processes which are really

291
00:10:28,710 --> 00:10:26,240
important when it comes to optimizing

292
00:10:30,870 --> 00:10:28,720
manufacturing methods for example for

293
00:10:34,310 --> 00:10:30,880
semiconductors and optical crystals on

294
00:10:35,430 --> 00:10:34,320
the ground okay so that's why we do it

295
00:10:37,269 --> 00:10:35,440
in space

296
00:10:39,269 --> 00:10:37,279
that's it it's exactly right and it's

297
00:10:41,190 --> 00:10:39,279
really at a research at a fundamental

298
00:10:43,030 --> 00:10:41,200
level because it you know it's we can

299
00:10:45,190 --> 00:10:43,040
talk about the applications that it

300
00:10:46,389 --> 00:10:45,200
might have to semiconductor

301
00:10:49,269 --> 00:10:46,399
uh

302
00:10:50,870 --> 00:10:49,279
improvements and optical crystals and

303
00:10:52,230 --> 00:10:50,880
and other types of manufacturing

304
00:10:54,949 --> 00:10:52,240
processes

305
00:10:57,190 --> 00:10:54,959
metallurgy for example

306
00:11:01,190 --> 00:10:57,200
it turns out that

307
00:11:03,750 --> 00:11:01,200
surface tension is a is a many transport

308
00:11:05,750 --> 00:11:03,760
processes are driven by surface tension

309
00:11:08,069 --> 00:11:05,760
and surface tension is one of those more

310
00:11:10,630 --> 00:11:08,079
subtle transport processes

311
00:11:13,509 --> 00:11:10,640
but on orbit you can measure it and it

312
00:11:17,269 --> 00:11:13,519
turns out that at a micro level even in

313
00:11:19,509 --> 00:11:17,279

a 1g field on earth at the micro scale

314
00:11:20,630 --> 00:11:19,519
that surface tension or those surface

315
00:11:23,990 --> 00:11:20,640
tension

316
00:11:25,829 --> 00:11:24,000
driven phenomenon come into play and are

317
00:11:28,870 --> 00:11:25,839
very important in understanding the

318
00:11:32,069 --> 00:11:28,880
dynamics of crystal growth even on earth

319
00:11:34,150 --> 00:11:32,079
so don't assume that just because we're

320
00:11:36,870 --> 00:11:34,160
making these discoveries on the space

321
00:11:39,030 --> 00:11:36,880
station we would have to use them to

322
00:11:41,590 --> 00:11:39,040
produce materials on the space station

323
00:11:43,509 --> 00:11:41,600
that would be prohibitively expensive we

324
00:11:45,750 --> 00:11:43,519
can use what we discover on the space

325
00:11:46,870 --> 00:11:45,760
station in manufacturing processes on

326
00:11:47,990 --> 00:11:46,880
the earth

327
00:11:49,509 --> 00:11:48,000
okay

328
00:11:51,590 --> 00:11:49,519
well i think the next one you were going

329
00:11:54,389 --> 00:11:51,600
to tell us about was in space

330
00:11:55,590 --> 00:11:54,399
yes in space i believe dr eric first

331
00:11:57,430 --> 00:11:55,600
earlier this week

332
00:11:59,269 --> 00:11:57,440
he's the main principal investigator

333
00:12:01,110 --> 00:11:59,279
from the university of delaware he

334
00:12:03,750 --> 00:12:01,120
talked about this investigation i'll

335
00:12:05,470 --> 00:12:03,760
talk about it a little bit more

336
00:12:08,150 --> 00:12:05,480
inspace uses

337
00:12:09,350 --> 00:12:08,160
magneto-rheological fluids it has

338
00:12:10,870 --> 00:12:09,360

particles

339
00:12:14,389 --> 00:12:10,880
in it that

340
00:12:15,509 --> 00:12:14,399
when there's a magnetic field around

341
00:12:28,389 --> 00:12:15,519
the

342
00:12:31,350 --> 00:12:28,399
when when this magnetic field is pulsed

343
00:12:32,310 --> 00:12:31,360
at a at a frequency say 10 hertz or 15

344
00:12:33,990 --> 00:12:32,320
hertz

345
00:12:36,710 --> 00:12:34,000
cycles per second

346
00:12:38,310 --> 00:12:36,720
those particles will self-assemble

347
00:12:40,470 --> 00:12:38,320
whereas when the magnetic field is

348
00:12:43,430 --> 00:12:40,480
turned off they're either randomly

349
00:12:44,949 --> 00:12:43,440
dispersed in in orbit or on

350
00:12:46,870 --> 00:12:44,959
on earth they would sink to the bottom

351
00:12:47,829 --> 00:12:46,880
they would set them out so here's a case

352
00:12:51,750 --> 00:12:47,839
where we're

353
00:12:54,150 --> 00:12:51,760
sedimentation

354
00:12:57,670 --> 00:12:54,160
transport process and now we can study

355
00:13:00,710 --> 00:12:57,680
how these particles self-assemble

356
00:13:03,269 --> 00:13:00,720
at the nano particle level it turns out

357
00:13:05,269 --> 00:13:03,279
they assemble themselves into structures

358
00:13:07,990 --> 00:13:05,279
and it changes the viscosity of the

359
00:13:09,829 --> 00:13:08,000
fluid and this density is stickiness

360
00:13:11,590 --> 00:13:09,839
basically no it's not stickiness but

361
00:13:13,750 --> 00:13:11,600
thickness if you've ever changed your

362
00:13:14,710 --> 00:13:13,760
motor oil or bought motor oil when you

363
00:13:18,150 --> 00:13:14,720

buy

364
00:13:21,030 --> 00:13:18,160
5w30 or 10w30 that five or that 10 or

365
00:13:23,670 --> 00:13:21,040
the 30. that's a measure of viscosity

366
00:13:25,670 --> 00:13:23,680
so viscosity is thickness and

367
00:13:27,590 --> 00:13:25,680
the the viscosity or the thickness of a

368
00:13:29,350 --> 00:13:27,600
fluid is a very important engineering

369
00:13:31,110 --> 00:13:29,360
property it's a very important design

370
00:13:34,069 --> 00:13:31,120
property

371
00:13:36,949 --> 00:13:34,079
if you want a machine or you're designed

372
00:13:39,030 --> 00:13:36,959
to do something you may depend on the

373
00:13:41,189 --> 00:13:39,040
viscosity of the fluid

374
00:13:44,310 --> 00:13:41,199
remaining constant or it actually

375
00:13:46,710 --> 00:13:44,320
changes with temperature and somehow in

376
00:13:48,470 --> 00:13:46,720
most cases that's an undesirable effect

377
00:13:50,470 --> 00:13:48,480
but we have to live with it because

378
00:13:52,870 --> 00:13:50,480
that's how it works in nature

379
00:13:54,470 --> 00:13:52,880
it turns out that though this pulsing

380
00:13:56,550 --> 00:13:54,480
magnetic field

381
00:13:58,629 --> 00:13:56,560
may be another way to control the

382
00:14:00,389 --> 00:13:58,639
viscosity of a fluid and it's it's

383
00:14:04,310 --> 00:14:00,399
already it's been used for decades in

384
00:14:05,590 --> 00:14:04,320
things like seismic damping systems for

385
00:14:06,790 --> 00:14:05,600
uh

386
00:14:09,350 --> 00:14:06,800
earthquake

387
00:14:12,310 --> 00:14:09,360
pre or dam prevention of damage to

388
00:14:15,110 --> 00:14:12,320

buildings during earthquakes and also

389
00:14:17,509 --> 00:14:15,120
prevention of

390
00:14:20,470 --> 00:14:17,519
large amplitude uh swaying motions and

391
00:14:22,629 --> 00:14:20,480
bridges during during uh wind gusts or

392
00:14:25,670 --> 00:14:22,639
or earthquakes in that case also it's

393
00:14:27,189 --> 00:14:25,680
also used as damping in in high end uh

394
00:14:29,670 --> 00:14:27,199
in suspension systems and high-end

395
00:14:31,590 --> 00:14:29,680
vehicles and in washing machines for for

396
00:14:33,829 --> 00:14:31,600
that matter okay

397
00:14:35,990 --> 00:14:33,839
um i think let's see we've got two more

398
00:14:37,990 --> 00:14:36,000
to go ready yes the other two

399
00:14:40,230 --> 00:14:38,000
experiments are the capillary flow

400
00:14:42,389 --> 00:14:40,240
experiment which mark weiss local talked

401
00:14:45,590 --> 00:14:42,399
about i think just yesterday

402
00:14:46,550 --> 00:14:45,600
in this slide here you can see um the

403
00:14:48,629 --> 00:14:46,560
four

404
00:14:50,389 --> 00:14:48,639
vials on the right uh there's actually a

405
00:14:53,350 --> 00:14:50,399
cartoon on the left that shows the cross

406
00:14:56,150 --> 00:14:53,360
section uh this is called the capillary

407
00:14:59,829 --> 00:14:56,160
flow experiment and this is the interior

408
00:15:01,990 --> 00:14:59,839
corner vessel or interior corner flow

409
00:15:03,430 --> 00:15:02,000
icf vessel

410
00:15:05,509 --> 00:15:03,440
in this case the

411
00:15:07,829 --> 00:15:05,519
you can see the interior corner in that

412
00:15:11,269 --> 00:15:07,839
bottom left corner it's a 50 degree

413
00:15:14,550 --> 00:15:11,279

angle corner and it actually simulates

414
00:15:16,710 --> 00:15:14,560
a straw or a half of a straw if you can

415
00:15:18,470 --> 00:15:16,720
can think of it in that abstract term

416
00:15:20,069 --> 00:15:18,480
we're all familiar with how

417
00:15:22,629 --> 00:15:20,079
a fluid will

418
00:15:24,230 --> 00:15:22,639
literally flow uphill if the straw

419
00:15:27,590 --> 00:15:24,240
diameter is small enough that's the

420
00:15:29,509 --> 00:15:27,600
capillary capillary action hence the

421
00:15:31,030 --> 00:15:29,519
the name for this experiment

422
00:15:33,670 --> 00:15:31,040
um

423
00:15:36,710 --> 00:15:33,680
in this case that corner

424
00:15:40,389 --> 00:15:36,720
the fluid will flow up that corner

425
00:15:42,949 --> 00:15:40,399
against gravity and in the zero g case

426
00:15:44,949 --> 00:15:42,959
it flows quite fast within a few seconds

427
00:15:48,150 --> 00:15:44,959
of introducing fluid into that interior

428
00:15:50,710 --> 00:15:48,160
corner flow it moves along

429
00:15:53,030 --> 00:15:50,720
um and i can't say up because there is

430
00:15:55,509 --> 00:15:53,040
no up in space but it moves along that

431
00:15:57,509 --> 00:15:55,519
corner of its own accord

432
00:16:00,389 --> 00:15:57,519
due to the

433
00:16:04,310 --> 00:16:00,399
cohe adhesion overcoming the forces of

434
00:16:07,030 --> 00:16:04,320
cohesion the the adhesion of the fluid

435
00:16:09,910 --> 00:16:07,040
towards the surface of the vessel

436
00:16:13,110 --> 00:16:09,920
is pulling that fluid along that corner

437
00:16:15,110 --> 00:16:13,120
and it it can actually

438
00:16:16,230 --> 00:16:15,120

move the fluid from as you saw in the

439
00:16:17,670 --> 00:16:16,240
diagram

440
00:16:19,990 --> 00:16:17,680
as you proceed from the left to the

441
00:16:21,749 --> 00:16:20,000
right the fluid is moving from the

442
00:16:23,990 --> 00:16:21,759
bottom of the vessel or the lower

443
00:16:26,389 --> 00:16:24,000
portion to the upper portion displacing

444
00:16:28,629 --> 00:16:26,399
the bubble which starts at the top and

445
00:16:30,949 --> 00:16:28,639
and then ends up at the bottom

446
00:16:33,670 --> 00:16:30,959
so this also is a quite wonderful

447
00:16:35,509 --> 00:16:33,680
discovery because it it's a bubble pump

448
00:16:37,269 --> 00:16:35,519
as well as a liquid pump

449
00:16:39,590 --> 00:16:37,279
first of all the applications for this

450
00:16:41,749 --> 00:16:39,600
uh in space would be that

451
00:16:43,829 --> 00:16:41,759
uh fluids don't

452
00:16:45,829 --> 00:16:43,839
uh don't you know settle to the bottom

453
00:16:47,749 --> 00:16:45,839
of a vessel in space they because

454
00:16:50,310 --> 00:16:47,759
there's no gravity they can spread out

455
00:16:52,150 --> 00:16:50,320
they can become separated into different

456
00:16:55,189 --> 00:16:52,160
sections of the volume

457
00:16:57,030 --> 00:16:55,199
so we can use this method to replace

458
00:16:58,629 --> 00:16:57,040
mechanical pumps we can use the

459
00:17:00,470 --> 00:16:58,639
capillary flow action and that's how

460
00:17:03,509 --> 00:17:00,480
we're designing fuel tanks for future

461
00:17:05,669 --> 00:17:03,519
vehicles to move the fluid to a desired

462
00:17:07,750 --> 00:17:05,679
section of the tank great so we can

463
00:17:09,669 --> 00:17:07,760

hopefully make use of that in the future

464
00:17:11,750 --> 00:17:09,679
i think we're i'm sorry just about out

465
00:17:13,829 --> 00:17:11,760
of time so we should run on to the next

466
00:17:17,590 --> 00:17:13,839
uh let's talk about the marangoni

467
00:17:20,710 --> 00:17:17,600
experiment the marangoni is a is a fluid

468
00:17:21,750 --> 00:17:20,720
transport process which is very subtle

469
00:17:23,110 --> 00:17:21,760
and

470
00:17:25,909 --> 00:17:23,120
hard to

471
00:17:27,909 --> 00:17:25,919
measure on earth it it turns out that

472
00:17:28,950 --> 00:17:27,919
this experiment involves

473
00:17:50,789 --> 00:17:28,960
a

474
00:17:53,110 --> 00:17:50,799
low on the left

475
00:17:55,669 --> 00:17:53,120
this so this is a very subtle uh

476
00:17:57,909 --> 00:17:55,679
transport process that we can use to

477
00:18:00,150 --> 00:17:57,919
improve our designs of

478
00:18:02,150 --> 00:18:00,160
optical crystals and semiconductors on

479
00:18:03,990 --> 00:18:02,160
the ground if we understand more the

480
00:18:05,990 --> 00:18:04,000
dynamics of it in this particular

481
00:18:08,789 --> 00:18:06,000
application of marangoni where you is

482
00:18:10,630 --> 00:18:08,799
called the ultrasonic velocity profile

483
00:18:12,710 --> 00:18:10,640
that's another

484
00:18:15,750 --> 00:18:12,720
measurement method to

485
00:18:17,270 --> 00:18:15,760
investigate the flow field inside the

486
00:18:20,150 --> 00:18:17,280
column of fluid

487
00:18:21,510 --> 00:18:20,160
so at every for virtually every

488
00:18:24,549 --> 00:18:21,520

uh

489
00:18:27,029 --> 00:18:24,559
millimeter of of depth into that fluid

490
00:18:29,110 --> 00:18:27,039
and across a wide cross section we know

491
00:18:30,789 --> 00:18:29,120
exactly what the velocity profile is at

492
00:18:32,070 --> 00:18:30,799
the micro level

493
00:18:33,990 --> 00:18:32,080
well let me wrap up with one last

494
00:18:35,669 --> 00:18:34,000
question um with such a range of

495
00:18:36,950 --> 00:18:35,679
experiments are you ever surprised by

496
00:18:38,390 --> 00:18:36,960
the things that people come up with the

497
00:18:39,990 --> 00:18:38,400
ways that we can use the space station

498
00:18:42,950 --> 00:18:40,000
for unique research

499
00:18:44,950 --> 00:18:42,960
i i am almost every day and and that is

500
00:18:47,669 --> 00:18:44,960
one of the the neat things about my job

501
00:18:50,390 --> 00:18:47,679
is that i i get the chance to learn uh

502
00:18:52,549 --> 00:18:50,400
about uh just the beauty of science and

503
00:18:56,710 --> 00:18:52,559
and the nature that surrounds all of us

504
00:18:59,110 --> 00:18:56,720
and it is amazing the the ways we are

505
00:19:01,029 --> 00:18:59,120
discovering to use the

506
00:19:02,950 --> 00:19:01,039
the unique properties of the

507
00:19:05,110 --> 00:19:02,960
international space station as a science

508
00:19:07,510 --> 00:19:05,120
laboratory it's it's just truly amazing

509
00:19:08,789 --> 00:19:07,520
and i'm very happy to be a part of that

510
00:19:10,150 --> 00:19:08,799
well thanks so much for coming and

511
00:19:13,029 --> 00:19:10,160
talking with us again this was vic

512
00:19:15,270 --> 00:19:13,039
cooley congratulations on uh surpassing

513
00:19:17,270 --> 00:19:15,280

the former record and making it to 67

514
00:19:19,110 --> 00:19:17,280
hours of research done on the space

515
00:19:20,789 --> 00:19:19,120
station this week thank you very much we