
PAO

1
00:00:05,590 --> 00:00:03,429
hey everybody this is dan hewitt here in

2
00:00:06,950 --> 00:00:05,600
mission control houston i'm joined by dr

3
00:00:09,509 --> 00:00:06,960
tara rutley

4
00:00:11,190 --> 00:00:09,519
and uh this this is mission control

5
00:00:12,950 --> 00:00:11,200
you're joining us here now

6
00:00:14,150 --> 00:00:12,960
this is where we fly the international

7
00:00:15,990 --> 00:00:14,160
space station this is where all the

8
00:00:17,590 --> 00:00:16,000
flight controllers are monitoring

9
00:00:19,269 --> 00:00:17,600
everything that's going on on board as

10
00:00:21,349 --> 00:00:19,279
our astronauts are hard at work on

11
00:00:24,070 --> 00:00:21,359
maintenance and experiments and all

12
00:00:26,630 --> 00:00:24,080
kinds of things while they're flying 17

13
00:00:27,830 --> 00:00:26,640

500 miles an hour so welcome inside of

14
00:00:29,830 --> 00:00:27,840
mission control it's really great to

15
00:00:31,669 --> 00:00:29,840
have everybody here

16
00:00:33,190 --> 00:00:31,679
tara and i are really excited to take

17
00:00:38,069 --> 00:00:33,200
some of your questions so why don't we

18
00:00:41,750 --> 00:00:39,430
thank you

19
00:00:43,670 --> 00:00:41,760
did you want to take our questions now

20
00:00:45,830 --> 00:00:43,680
yeah we would love to take any questions

21
00:00:48,630 --> 00:00:45,840
you guys have right now

22
00:00:51,350 --> 00:00:48,640
okay so you did not want to brief us on

23
00:00:53,350 --> 00:00:51,360
anything right now we have time we have

24
00:00:55,270 --> 00:00:53,360
lots of questions so

25
00:00:56,869 --> 00:00:55,280
that's what you're telling us to do yep

26
00:00:58,470 --> 00:00:56,879
you got lots of questions we want to get

27
00:01:02,069 --> 00:00:58,480
them all

28
00:01:06,390 --> 00:01:04,310
hello my name is sebastian b switzer

29
00:01:07,990 --> 00:01:06,400
thank you for taking my question what

30
00:01:10,390 --> 00:01:08,000
types of science experiments are the

31
00:01:12,230 --> 00:01:10,400
astronauts working on in space

32
00:01:13,990 --> 00:01:12,240
ah very good question that's the best

33
00:01:16,710 --> 00:01:14,000
question because that's what i really

34
00:01:19,030 --> 00:01:16,720
love to talk about the most um right now

35
00:01:21,270 --> 00:01:19,040
they're on space station right and they

36
00:01:22,710 --> 00:01:21,280
do all kinds of science experiments if

37
00:01:24,550 --> 00:01:22,720
you can think about

38
00:01:26,230 --> 00:01:24,560

if you've ever participated in a science

39
00:01:27,109 --> 00:01:26,240
fair and you've done your science

40
00:01:29,350 --> 00:01:27,119
project

41
00:01:31,190 --> 00:01:29,360
imagine what might happen if you take

42
00:01:34,950 --> 00:01:31,200
gravity out of everything that you've

43
00:01:36,950 --> 00:01:34,960
done so imagine creating any kind of

44
00:01:38,630 --> 00:01:36,960
experiment that you could do here on

45
00:01:40,950 --> 00:01:38,640
earth but what would happen when you

46
00:01:43,109 --> 00:01:40,960
take gravity away and so more fun

47
00:01:44,789 --> 00:01:43,119
problems would be a lot more fun

48
00:01:46,469 --> 00:01:44,799
would be much more fun than what i did

49
00:01:49,270 --> 00:01:46,479
as a as a student in my science fair

50
00:01:50,870 --> 00:01:49,280
days but um so what they do and and the

51
00:01:53,590 --> 00:01:50,880
number one coolest thing i think that

52
00:01:55,830 --> 00:01:53,600
they work on is the human research they

53
00:01:58,149 --> 00:01:55,840
they test their own bodies uh for

54
00:02:00,230 --> 00:01:58,159
changes that occur in microgravity or as

55
00:02:01,749 --> 00:02:00,240
a result of staying in space

56
00:02:03,670 --> 00:02:01,759
where things are just different there's

57
00:02:05,270 --> 00:02:03,680
no gravity if you think about how our

58
00:02:07,590 --> 00:02:05,280
body is designed

59
00:02:09,589 --> 00:02:07,600
we have bones and muscles for a reason

60
00:02:11,510 --> 00:02:09,599
that's to to keep us upright against

61
00:02:13,190 --> 00:02:11,520
that gravity vector on earth but when

62
00:02:15,430 --> 00:02:13,200
you get out into space you don't have

63
00:02:17,430 --> 00:02:15,440

that gravity vector anymore so what

64
00:02:19,510 --> 00:02:17,440
they're finding is that our bones start

65
00:02:21,910 --> 00:02:19,520
to shrink i mean i'm sorry our bones

66
00:02:22,869 --> 00:02:21,920
start to get weaker our muscles start to

67
00:02:25,110 --> 00:02:22,879
shrink

68
00:02:26,309 --> 00:02:25,120
and so um that's just that's just one

69
00:02:29,110 --> 00:02:26,319
example of some of the changes that

70
00:02:30,790 --> 00:02:29,120
happen in the body but our heart changes

71
00:02:31,830 --> 00:02:30,800
size because it's pumping fluids

72
00:02:33,990 --> 00:02:31,840
differently

73
00:02:35,830 --> 00:02:34,000
so any system in the human body you can

74
00:02:37,190 --> 00:02:35,840
think of they're doing experiments to

75
00:02:39,910 --> 00:02:37,200
figure out what's going on with the

76
00:02:41,910 --> 00:02:39,920
changes in space not just human

77
00:02:44,630 --> 00:02:41,920
physiology though they're also doing

78
00:02:46,949 --> 00:02:44,640
some basic physics work looking at how

79
00:02:48,790 --> 00:02:46,959
fluid behaves differently without

80
00:02:50,869 --> 00:02:48,800
without the gravity vector you know the

81
00:02:53,350 --> 00:02:50,879
way that fluid behaves here on earth

82
00:02:55,110 --> 00:02:53,360
again that gravity vector drives a lot

83
00:02:56,949 --> 00:02:55,120
of how we drink out of a cup how we

84
00:02:58,630 --> 00:02:56,959
water our plants and how the plants will

85
00:03:00,869 --> 00:02:58,640
take up that water

86
00:03:03,270 --> 00:03:00,879
so it's different in space where we need

87
00:03:06,390 --> 00:03:03,280
water systems we need to understand how

88
00:03:09,350 --> 00:03:06,400

water behaves in space water tends to

89
00:03:10,710 --> 00:03:09,360
climb the walls of the of the containers

90
00:03:12,470 --> 00:03:10,720
that they're in and that's called

91
00:03:14,309 --> 00:03:12,480
capillary action and that happens on

92
00:03:15,110 --> 00:03:14,319
earth but in space it's much more

93
00:03:17,030 --> 00:03:15,120
pronounced because you don't have

94
00:03:18,470 --> 00:03:17,040
gravity pulling the liquid back down so

95
00:03:20,470 --> 00:03:18,480
we're trying to figure out

96
00:03:21,990 --> 00:03:20,480
what happens to the fluids and and it's

97
00:03:23,990 --> 00:03:22,000
important for when you're creating

98
00:03:26,630 --> 00:03:24,000
things like propellant

99
00:03:28,149 --> 00:03:26,640
and water recycling systems

100
00:03:30,070 --> 00:03:28,159
and anything that has to do with any

101
00:03:31,190 --> 00:03:30,080
kind of fluid in space and we learn much

102
00:03:32,949 --> 00:03:31,200
about how

103
00:03:34,470 --> 00:03:32,959
what happens in space we can apply it to

104
00:03:36,309 --> 00:03:34,480
earth and better ways to water our

105
00:03:38,550 --> 00:03:36,319
plants and things like that

106
00:03:40,309 --> 00:03:38,560
they also there's investigations that

107
00:03:42,789 --> 00:03:40,319
are looking and taking images of the

108
00:03:46,789 --> 00:03:42,799
earth and of the space sky to look at

109
00:03:49,750 --> 00:03:48,149
there are experiments that are looking

110
00:03:52,470 --> 00:03:49,760
at how

111
00:03:54,309 --> 00:03:52,480
bacteria and viruses behave because they

112
00:03:56,390 --> 00:03:54,319
behave very differently which has an

113
00:03:58,630 --> 00:03:56,400

impact on our crew but it also tells us

114
00:04:01,750 --> 00:03:58,640
something about how they how the the

115
00:04:03,270 --> 00:04:01,760
bugs treat us here on earth as well so i

116
00:04:05,270 --> 00:04:03,280
think just about

117
00:04:06,789 --> 00:04:05,280
every kind of uh

118
00:04:08,229 --> 00:04:06,799
every kind of discipline you can think

119
00:04:10,390 --> 00:04:08,239
of if you have an interest in any kind

120
00:04:12,070 --> 00:04:10,400
of science or engineering you could

121
00:04:13,429 --> 00:04:12,080
probably come up with any kind of

122
00:04:15,110 --> 00:04:13,439
thoughtful experiment that they are

123
00:04:17,349 --> 00:04:15,120
probably covering on space station right

124
00:04:18,629 --> 00:04:17,359
now okay definitely tara's favorite

125
00:04:21,189 --> 00:04:18,639
question

126
00:04:23,350 --> 00:04:21,199
all right let's move on to the next one

127
00:04:25,670 --> 00:04:23,360
thank you so much could i get both of

128
00:04:27,510 --> 00:04:25,680
your names we have some media in here

129
00:04:29,749 --> 00:04:27,520
with us and we'd like to share your

130
00:04:32,629 --> 00:04:29,759
names with our media so could i get both

131
00:04:34,950 --> 00:04:32,639
of your names yeah sure i'm dan hewitt

132
00:04:39,909 --> 00:04:34,960
h-u-o-t

133
00:04:46,150 --> 00:04:42,710
oh and your name tara uh-huh there it is

134
00:04:47,909 --> 00:04:46,160
yeah on the screen r-u-t-t-l-e okay

135
00:04:50,310 --> 00:04:47,919
okay great

136
00:05:03,510 --> 00:04:50,320
there we go okay thank you so much yes

137
00:05:06,790 --> 00:05:05,189
hi my name is amarya mitchell thank you

138
00:05:08,390 --> 00:05:06,800

for taking my question

139
00:05:13,189 --> 00:05:08,400
are there plans to take other

140
00:05:16,629 --> 00:05:14,870
i didn't quite catch that question did

141
00:05:21,590 --> 00:05:16,639
you are they going to take what with

142
00:05:26,230 --> 00:05:23,350
you did it great you just need to do it

143
00:05:29,510 --> 00:05:28,070
are there plans to take other

144
00:05:32,070 --> 00:05:29,520
vertebrates

145
00:05:34,070 --> 00:05:32,080
when the astronauts

146
00:05:35,670 --> 00:05:34,080
with the astronauts when colonizing

147
00:05:37,430 --> 00:05:35,680
another planet

148
00:05:39,029 --> 00:05:37,440
oh are there plans to take other

149
00:05:41,189 --> 00:05:39,039
vertebrates when the astronauts go to

150
00:05:43,110 --> 00:05:41,199
colonize other planets uh you know what

151
00:05:44,710 --> 00:05:43,120
that's a really good question i think

152
00:05:47,029 --> 00:05:44,720
the only way to find out if that's

153
00:05:49,189 --> 00:05:47,039
really necessary or what we might learn

154
00:05:51,110 --> 00:05:49,199
from doing that is to try it out on the

155
00:05:52,390 --> 00:05:51,120
space station first we don't know a

156
00:05:53,990 --> 00:05:52,400
whole lot about

157
00:05:56,629 --> 00:05:54,000
how vertebrates

158
00:05:58,390 --> 00:05:56,639
function in space and so before we would

159
00:06:00,710 --> 00:05:58,400
take them or figure out how we would use

160
00:06:02,950 --> 00:06:00,720
them on a planet we'd want to figure out

161
00:06:04,309 --> 00:06:02,960
how they even behave and react in space

162
00:06:06,309 --> 00:06:04,319
first but that's a really good and

163
00:06:08,390 --> 00:06:06,319

thought thought provoking question and

164
00:06:10,150 --> 00:06:08,400
we have had a couple of different types

165
00:06:12,629 --> 00:06:10,160
of animals already on board the station

166
00:06:14,469 --> 00:06:12,639
we just had a couple of spiders return

167
00:06:16,550 --> 00:06:14,479
fairly recently from a trip on board the

168
00:06:18,870 --> 00:06:16,560
station and they were able to adapt to

169
00:06:21,189 --> 00:06:18,880
microgravity and spin webs and actually

170
00:06:22,629 --> 00:06:21,199
adapted really quite well once they were

171
00:06:24,469 --> 00:06:22,639
up there and actually we also have

172
00:06:27,110 --> 00:06:24,479
another experiment going on right now

173
00:06:29,830 --> 00:06:27,120
where we have a bunch of tiny fish in a

174
00:06:32,469 --> 00:06:29,840
very specialized aquatic habitat they're

175
00:06:33,590 --> 00:06:32,479
called madoka fish and they're up there

176
00:06:35,670 --> 00:06:33,600
to try and

177
00:06:37,830 --> 00:06:35,680
see any type of bone loss that they go

178
00:06:39,909 --> 00:06:37,840
through because you know fish aren't is

179
00:06:42,070 --> 00:06:39,919
constrained by gravity quite as much as

180
00:06:44,710 --> 00:06:42,080
you or i you and i are down here on

181
00:06:46,870 --> 00:06:44,720
earth so we have experience experimented

182
00:06:49,510 --> 00:06:46,880
with a couple of different types of

183
00:06:51,510 --> 00:06:49,520
specimens from the animal kingdom but

184
00:06:53,830 --> 00:06:51,520
as far as anything like taking

185
00:06:55,909 --> 00:06:53,840
uh you know a dog with us to mars or

186
00:06:57,670 --> 00:06:55,919
something that might that might be

187
00:06:59,909 --> 00:06:57,680
something we do in the very distant

188
00:07:01,589 --> 00:06:59,919

future but right now we're really not

189
00:07:02,710 --> 00:07:01,599
sure all right

190
00:07:04,390 --> 00:07:02,720
all right great question though really

191
00:07:05,510 --> 00:07:04,400
cool

192
00:07:07,909 --> 00:07:05,520
thank you

193
00:07:10,710 --> 00:07:07,919
um i we were doing research the other

194
00:07:13,510 --> 00:07:10,720
day and um in one of the first space

195
00:07:16,309 --> 00:07:13,520
flights um you took a dog but i guess

196
00:07:18,629 --> 00:07:16,319
the dog did not survive and so that

197
00:07:20,390 --> 00:07:18,639
stimulated their curiosity about other

198
00:07:21,350 --> 00:07:20,400
vertebrates that's right they went

199
00:07:23,110 --> 00:07:21,360
before

200
00:07:25,029 --> 00:07:23,120
we did i think one of the first the

201
00:07:26,629 --> 00:07:25,039
first animal in space was a russian dog

202
00:07:28,550 --> 00:07:26,639
known as leica

203
00:07:30,629 --> 00:07:28,560
and i mean that was back when we were

204
00:07:33,029 --> 00:07:30,639
launching things and it was very very

205
00:07:35,909 --> 00:07:33,039
rudimentary and we weren't even sure

206
00:07:37,430 --> 00:07:35,919
if any bean could survive in space so

207
00:07:41,670 --> 00:07:37,440
that was one of the first experiments

208
00:07:41,680 --> 00:07:47,270
madeline hello my name

209
00:07:51,990 --> 00:07:49,830
what types of experiments do astronauts

210
00:07:54,150 --> 00:07:52,000
like to do the most

211
00:07:55,909 --> 00:07:54,160
i think the answer to that is whichever

212
00:07:57,589 --> 00:07:55,919
ones they get to put their hands on

213
00:07:59,510 --> 00:07:57,599

which experiments do the astronauts like

214
00:08:01,670 --> 00:07:59,520
to do the most i think it

215
00:08:03,270 --> 00:08:01,680
most from when i talk to them it's just

216
00:08:06,629 --> 00:08:03,280
whichever ones they can participate in

217
00:08:09,029 --> 00:08:06,639
because um you know

218
00:08:11,670 --> 00:08:09,039
everybody has a drive for for for

219
00:08:13,510 --> 00:08:11,680
figuring things out that may not even be

220
00:08:15,749 --> 00:08:13,520
in their own area of interest so we may

221
00:08:18,070 --> 00:08:15,759
have a scientist who's up there who has

222
00:08:19,749 --> 00:08:18,080
a background in human physiology or the

223
00:08:21,270 --> 00:08:19,759
human body but

224
00:08:22,869 --> 00:08:21,280
how cool is it to be able to do flame

225
00:08:24,550 --> 00:08:22,879
experiments when flames behave

226
00:08:26,469 --> 00:08:24,560
differently in in the microgravity

227
00:08:28,869 --> 00:08:26,479
environment so it's my understanding i

228
00:08:30,150 --> 00:08:28,879
think anyone that they can they can do

229
00:08:32,070 --> 00:08:30,160
themselves

230
00:08:34,230 --> 00:08:32,080
because some of the experiments are um

231
00:08:36,070 --> 00:08:34,240
automated and not all have to be done by

232
00:08:38,149 --> 00:08:36,080
the astronauts but so they just like

233
00:08:40,310 --> 00:08:38,159
getting up there and doing doing any

234
00:08:42,469 --> 00:08:40,320
number of them

235
00:08:44,710 --> 00:08:42,479
very good questions we just

236
00:08:47,750 --> 00:08:44,720
thank you we just uh completed our

237
00:08:49,509 --> 00:08:47,760
biology unit so we were studying genetic

238
00:08:55,430 --> 00:08:49,519

modification i have a student with a

239
00:09:00,310 --> 00:08:57,670
hello my name is christian smith thank

240
00:09:02,630 --> 00:09:00,320
you for taking my question uh are you

241
00:09:05,350 --> 00:09:02,640
doing any research on genetically

242
00:09:07,269 --> 00:09:05,360
modified organisms in outer space

243
00:09:10,389 --> 00:09:07,279
yeah i think the coolest one that i can

244
00:09:12,790 --> 00:09:10,399
think of offhand is uh how bacteria

245
00:09:15,350 --> 00:09:12,800
behave differently in space that's a

246
00:09:16,870 --> 00:09:15,360
really good question um and and there

247
00:09:18,710 --> 00:09:16,880
are so many experiments on that but the

248
00:09:20,790 --> 00:09:18,720
one i like the most is bacteria and

249
00:09:22,949 --> 00:09:20,800
there's one that they have found

250
00:09:24,870 --> 00:09:22,959
that behaves much differently and it's

251
00:09:26,550 --> 00:09:24,880
one that you and i can relate to that

252
00:09:28,710 --> 00:09:26,560
makes you sick to your stomach if you've

253
00:09:31,110 --> 00:09:28,720
ever eaten some food that

254
00:09:32,949 --> 00:09:31,120
has made you sick the bacteria in that

255
00:09:34,870 --> 00:09:32,959
is called salmonella one of those could

256
00:09:37,269 --> 00:09:34,880
potentially be called salmonella and we

257
00:09:39,590 --> 00:09:37,279
found out that salmonella become more

258
00:09:41,910 --> 00:09:39,600
aggressive in space they just become

259
00:09:44,310 --> 00:09:41,920
nastier and and scientists wanted to

260
00:09:45,829 --> 00:09:44,320
find out why and so they they took the

261
00:09:47,750 --> 00:09:45,839
some samples back that have flown on

262
00:09:49,350 --> 00:09:47,760
space and and they looked at them here

263
00:09:52,550 --> 00:09:49,360

on the ground in their laboratories and

264
00:09:55,350 --> 00:09:52,560
they did find genetic modifications

265
00:09:57,910 --> 00:09:55,360
one particular gene that became much

266
00:10:00,949 --> 00:09:57,920
more what's called upregulated or much

267
00:10:04,150 --> 00:10:00,959
more active in affecting the behavior of

268
00:10:05,990 --> 00:10:04,160
those salmonella bacteria why that is

269
00:10:08,389 --> 00:10:06,000
it's still hard to say

270
00:10:10,630 --> 00:10:08,399
some of the scientists think that

271
00:10:13,430 --> 00:10:10,640
because salmonella like to live inside

272
00:10:15,750 --> 00:10:13,440
your intestines and your intestines are

273
00:10:17,670 --> 00:10:15,760
a low fluid shear environment or an

274
00:10:19,990 --> 00:10:17,680
environment that doesn't cause a lot of

275
00:10:22,470 --> 00:10:20,000
turbulence uh it's just like what they

276
00:10:24,389 --> 00:10:22,480
grew in microgravity where where fluid

277
00:10:26,230 --> 00:10:24,399
doesn't it's not turbulent it's also

278
00:10:28,230 --> 00:10:26,240
something called low shear so they think

279
00:10:29,990 --> 00:10:28,240
that the microgravity environment is

280
00:10:31,910 --> 00:10:30,000
similar to what is inside of your

281
00:10:34,230 --> 00:10:31,920
intestine and that's what makes these

282
00:10:35,030 --> 00:10:34,240
bacteria

283
00:10:37,190 --> 00:10:35,040
just

284
00:10:40,710 --> 00:10:37,200
upregulate that that one gene that makes

285
00:10:45,590 --> 00:10:43,750
okay that is fascinating thank you uh

286
00:10:47,750 --> 00:10:45,600
isha

287
00:10:49,910 --> 00:10:47,760
has a question um

288
00:10:52,710 --> 00:10:49,920

lately our research has been focused on

289
00:10:54,949 --> 00:10:52,720
the planet so we were wondering if isha

290
00:10:56,870 --> 00:10:54,959
came up with this question

291
00:10:59,269 --> 00:10:56,880
um hi my name is isha thank you for

292
00:11:01,110 --> 00:10:59,279
taking my question what are we learning

293
00:11:03,750 --> 00:11:01,120
on the space station that will help us

294
00:11:05,269 --> 00:11:03,760
understand the solar system

295
00:11:08,230 --> 00:11:05,279
awesome question

296
00:11:09,750 --> 00:11:08,240
we have a couple of external

297
00:11:11,350 --> 00:11:09,760
what we call payloads a couple of

298
00:11:13,750 --> 00:11:11,360
external pieces of hardware that are

299
00:11:15,590 --> 00:11:13,760
outside on the space station trust

300
00:11:17,670 --> 00:11:15,600
and they're scanning the skies for

301
00:11:18,949 --> 00:11:17,680
changes in cosmic

302
00:11:21,509 --> 00:11:18,959
patterns

303
00:11:24,230 --> 00:11:21,519
things like changes in x-ray sources

304
00:11:25,910 --> 00:11:24,240
that could potentially identify

305
00:11:27,829 --> 00:11:25,920
some events that we've not seen before

306
00:11:31,430 --> 00:11:27,839
for example there's one

307
00:11:34,230 --> 00:11:31,440
payload called maxi and it has it

308
00:11:35,990 --> 00:11:34,240
registered a signature change in the sky

309
00:11:37,350 --> 00:11:36,000
that said that showed for the first time

310
00:11:39,910 --> 00:11:37,360
ever

311
00:11:41,990 --> 00:11:39,920
that it was an indicator that a star had

312
00:11:43,990 --> 00:11:42,000
gotten too close to a black hole and the

313
00:11:46,630 --> 00:11:44,000

black hole started shredding the star

314
00:11:48,230 --> 00:11:46,640
and so the events the x-ray events that

315
00:11:50,710 --> 00:11:48,240
came from that

316
00:11:53,110 --> 00:11:50,720
were picked up and measured by this maxi

317
00:11:55,509 --> 00:11:53,120
payload and it was the first time ever

318
00:11:56,870 --> 00:11:55,519
that astrophysicists were able to see

319
00:11:58,550 --> 00:11:56,880
something like that actually happening

320
00:12:00,069 --> 00:11:58,560
because it always been thought about and

321
00:12:02,870 --> 00:12:00,079
they always thought it happened but we'd

322
00:12:04,470 --> 00:12:02,880
never seen it before so understanding

323
00:12:05,990 --> 00:12:04,480
what happens in our solar system

324
00:12:07,350 --> 00:12:06,000
especially when you're talking about a

325
00:12:10,230 --> 00:12:07,360
star that might orbit too close to a

326
00:12:11,910 --> 00:12:10,240
black hole says a lot about how we might

327
00:12:13,350 --> 00:12:11,920
venture out further

328
00:12:20,230 --> 00:12:13,360
there's also

329
00:12:22,389 --> 00:12:20,240
that is doing an investigation

330
00:12:23,590 --> 00:12:22,399
called geoflow and they take the

331
00:12:24,949 --> 00:12:23,600
components of what they thought the

332
00:12:27,110 --> 00:12:24,959
earth might have

333
00:12:28,870 --> 00:12:27,120
been made of in the very beginning and

334
00:12:32,150 --> 00:12:28,880
they put it inside of this chamber

335
00:12:34,150 --> 00:12:32,160
that's a fluid a fluid chamber and

336
00:12:35,829 --> 00:12:34,160
basically recreate the events of how we

337
00:12:37,350 --> 00:12:35,839
thought the earth might have been formed

338
00:12:39,110 --> 00:12:37,360

and the way the reason it's done on the

339
00:12:41,350 --> 00:12:39,120
space station is because it's

340
00:12:42,870 --> 00:12:41,360
microgravity it's it's missing that

341
00:12:44,150 --> 00:12:42,880
earth's gravity and that's a critical

342
00:12:47,110 --> 00:12:44,160
part of how the earth would have been

343
00:12:49,030 --> 00:12:47,120
formed and so this is called geoflow and

344
00:12:51,030 --> 00:12:49,040
it's uh being done by our european

345
00:12:52,710 --> 00:12:51,040
partners and so when the information

346
00:12:54,150 --> 00:12:52,720
comes back from that that'll advance our

347
00:12:56,389 --> 00:12:54,160
knowledge of how our own planet was

348
00:12:58,389 --> 00:12:56,399
formed and give us even further insights

349
00:13:01,269 --> 00:12:58,399
as to how other planets are being formed

350
00:13:05,509 --> 00:13:02,629
you mentioned

351
00:13:08,069 --> 00:13:05,519
radiation and one of our questions had

352
00:13:15,990 --> 00:13:08,079
students have a question related to that

353
00:13:20,389 --> 00:13:18,389
hello my name is thomas thank you for

354
00:13:23,269 --> 00:13:20,399
taking my question

355
00:13:25,910 --> 00:13:23,279
are the astronauts exposed to any types

356
00:13:27,910 --> 00:13:25,920
of harmful radiation

357
00:13:31,190 --> 00:13:27,920
fall in outer space

358
00:13:32,949 --> 00:13:31,200
another good question so the uh vehicle

359
00:13:34,470 --> 00:13:32,959
itself the space yes there's lots of

360
00:13:37,030 --> 00:13:34,480
radiation out in space when you leave

361
00:13:39,269 --> 00:13:37,040
the earth's atmosphere quite certainly

362
00:13:41,509 --> 00:13:39,279
and so any vehicle or space suit that

363
00:13:43,910 --> 00:13:41,519

you create has to take that into account

364
00:13:44,949 --> 00:13:43,920
for crew health and so the space station

365
00:13:47,430 --> 00:13:44,959
itself

366
00:13:50,230 --> 00:13:47,440
is con consists of material that works

367
00:13:53,350 --> 00:13:50,240
to shield the crew against the harmful

368
00:13:55,509 --> 00:13:53,360
radiation effects and and then also in

369
00:13:57,750 --> 00:13:55,519
addition to the materials that are used

370
00:13:58,949 --> 00:13:57,760
we have a number of radiation detectors

371
00:14:00,870 --> 00:13:58,959
and a lot of different types of

372
00:14:02,470 --> 00:14:00,880
radiation detectors that are positioned

373
00:14:05,350 --> 00:14:02,480
all around the inside of the space

374
00:14:06,870 --> 00:14:05,360
station that can constantly tell us

375
00:14:08,870 --> 00:14:06,880
sends the signal down to the earth so

376
00:14:10,550 --> 00:14:08,880
the scientists are constantly evaluating

377
00:14:13,750 --> 00:14:10,560
the radiation amounts that the crew are

378
00:14:15,670 --> 00:14:13,760
being exposed to and so it's definitely

379
00:14:17,829 --> 00:14:15,680
a big health issue

380
00:14:19,030 --> 00:14:17,839
and it's very real and

381
00:14:20,710 --> 00:14:19,040
and definitely there are lots of

382
00:14:22,629 --> 00:14:20,720
measures in place to try to protect the

383
00:14:24,949 --> 00:14:22,639
crew from that kind of exposure

384
00:14:26,710 --> 00:14:24,959
but the space station being where it is

385
00:14:29,030 --> 00:14:26,720
it's only a few hundred miles off the

386
00:14:30,790 --> 00:14:29,040
surface so it's still kind of protected

387
00:14:33,509 --> 00:14:30,800
the thing that really protects us from

388
00:14:35,990 --> 00:14:33,519

radiation from the sun and intergalactic

389
00:14:37,430 --> 00:14:36,000
things is our magnetosphere so the

390
00:14:39,269 --> 00:14:37,440
station's still close enough that it's

391
00:14:41,030 --> 00:14:39,279
really protected by that but it's as

392
00:14:43,110 --> 00:14:41,040
soon as we decide to start going really

393
00:14:44,629 --> 00:14:43,120
far out like when we want to go to mars

394
00:14:47,509 --> 00:14:44,639
that are astronauts will be a lot more

395
00:14:48,870 --> 00:14:47,519
susceptible so we're developing new

396
00:14:50,949 --> 00:14:48,880
methods onboard the station for

397
00:14:52,870 --> 00:14:50,959
detecting and protecting

398
00:14:54,710 --> 00:14:52,880
and those will be really important as we

399
00:14:56,470 --> 00:14:54,720
start to move you know millions and

400
00:14:58,710 --> 00:14:56,480
millions of miles away from the earth

401
00:15:01,350 --> 00:14:58,720
yep

402
00:15:03,269 --> 00:15:01,360
thank you so much um just uh you're

403
00:15:05,269 --> 00:15:03,279
speaking about radiation do they wear

404
00:15:09,509 --> 00:15:05,279
sunscreen do they have to worry about

405
00:15:12,470 --> 00:15:11,110
i think that they actually have to i

406
00:15:13,990 --> 00:15:12,480
don't think they get that but they

407
00:15:15,750 --> 00:15:14,000
actually have to take vitamin d increase

408
00:15:17,670 --> 00:15:15,760
vitamin d doses

409
00:15:19,590 --> 00:15:17,680
but um i think their spacesuits and all

410
00:15:20,710 --> 00:15:19,600
that protect them enough

411
00:15:22,310 --> 00:15:20,720
yep

412
00:15:25,030 --> 00:15:22,320
okay

413
00:15:27,269 --> 00:15:25,040

anna anna we have another student with a

414
00:15:28,629 --> 00:15:27,279
question about the experiences of

415
00:15:33,509 --> 00:15:28,639
gravity and

416
00:15:36,790 --> 00:15:35,350
hi my name is anna thank you for taking

417
00:15:38,550 --> 00:15:36,800
my question

418
00:15:40,710 --> 00:15:38,560
since the astronauts are experienced

419
00:15:43,590 --> 00:15:40,720
less gravity how does this affect their

420
00:15:45,110 --> 00:15:43,600
skeleton or bone mass oh yeah a really

421
00:15:47,509 --> 00:15:45,120
good question and that's that's the

422
00:15:49,350 --> 00:15:47,519
number one um thing that we need to work

423
00:15:52,470 --> 00:15:49,360
on if we're going to go beyond low earth

424
00:15:53,910 --> 00:15:52,480
orbit and stay for longer out in periods

425
00:15:55,749 --> 00:15:53,920
in space

426
00:15:57,509 --> 00:15:55,759
because you're not constantly working

427
00:15:59,910 --> 00:15:57,519
against the gravity environment think

428
00:16:02,389 --> 00:15:59,920
about all day you stand you sit you walk

429
00:16:04,949 --> 00:16:02,399
you climb up stairs you use your muscles

430
00:16:06,870 --> 00:16:04,959
to get you around and then in the

431
00:16:08,150 --> 00:16:06,880
microgravity environment really they're

432
00:16:09,829 --> 00:16:08,160
just kind of floating around and they

433
00:16:12,389 --> 00:16:09,839
can use their muscles to push off and

434
00:16:15,269 --> 00:16:12,399
get them where they need to go um and so

435
00:16:17,110 --> 00:16:15,279
definitely um there starts to be uh it's

436
00:16:18,470 --> 00:16:17,120
use it or lose it so you're you know if

437
00:16:20,389 --> 00:16:18,480
you've ever exercised and then you

438
00:16:21,910 --> 00:16:20,399

stopped you you probably can tell your

439
00:16:23,670 --> 00:16:21,920
muscles will start to

440
00:16:25,509 --> 00:16:23,680
to get smaller and it's the same with

441
00:16:26,710 --> 00:16:25,519
them they'll lose some muscle mass and

442
00:16:29,430 --> 00:16:26,720
they'll lose some

443
00:16:31,749 --> 00:16:29,440
bone mass but what they do

444
00:16:33,910 --> 00:16:31,759
on orbit what they're finding is as they

445
00:16:36,069 --> 00:16:33,920
keep up with their exercise well they

446
00:16:37,910 --> 00:16:36,079
have very high resistive exercise that

447
00:16:40,069 --> 00:16:37,920
they do it's similar to weightlifting

448
00:16:41,509 --> 00:16:40,079
they have cardiovascular exercise on the

449
00:16:43,350 --> 00:16:41,519
treadmill that they do and they also

450
00:16:45,590 --> 00:16:43,360
have a cycle ergometer up there which is

451
00:16:48,069 --> 00:16:45,600
a stationary bike and with the

452
00:16:49,990 --> 00:16:48,079
combination of those three and also

453
00:16:51,829 --> 00:16:50,000
eating the right kind of diets and fish

454
00:16:53,670 --> 00:16:51,839
is a big one because it's got omega-3

455
00:16:55,430 --> 00:16:53,680
fatty acid which helps

456
00:16:57,110 --> 00:16:55,440
preserve bone

457
00:16:58,949 --> 00:16:57,120
and if they eat all their calories which

458
00:17:01,509 --> 00:16:58,959
is important for energy and they take

459
00:17:02,389 --> 00:17:01,519
their vitamin d doses because they lack

460
00:17:06,069 --> 00:17:02,399
sun

461
00:17:08,150 --> 00:17:06,079
important for bone if they do all those

462
00:17:09,990 --> 00:17:08,160
things then they're shut what we're

463
00:17:13,189 --> 00:17:10,000

seeing is we're able to maintain the

464
00:17:16,150 --> 00:17:13,199
bone mass so we're the the crew seems to

465
00:17:18,069 --> 00:17:16,160
not be losing as much of bone mass and

466
00:17:19,590 --> 00:17:18,079
now one second thing we want to worry

467
00:17:21,990 --> 00:17:19,600
about with the bones is although we may

468
00:17:23,510 --> 00:17:22,000
be tainting bone mass in terms of

469
00:17:24,949 --> 00:17:23,520
minerals

470
00:17:26,630 --> 00:17:24,959
what about the strength we don't know

471
00:17:27,990 --> 00:17:26,640
much about the quality that's being

472
00:17:29,990 --> 00:17:28,000
maintained on the bone so there's

473
00:17:31,350 --> 00:17:30,000
actually a lot more research that needs

474
00:17:33,590 --> 00:17:31,360
to be done on what's going on on the

475
00:17:35,669 --> 00:17:33,600
inside of the bone so it's we're keeping

476
00:17:37,110 --> 00:17:35,679
the bone mass there but what you know

477
00:17:39,270 --> 00:17:37,120
what's the structure like on the inside

478
00:17:40,870 --> 00:17:39,280
of the bone is it fragile is it brittle

479
00:17:42,710 --> 00:17:40,880
because if it is then we could have

480
00:17:44,710 --> 00:17:42,720
issues with fracture and we don't want

481
00:17:46,390 --> 00:17:44,720
to see hip fractures or bone fractures

482
00:17:48,630 --> 00:17:46,400
if we get all the way out to

483
00:17:50,310 --> 00:17:48,640
mars or wherever we're headed

484
00:17:51,909 --> 00:17:50,320
you know we and we get back on something

485
00:17:54,070 --> 00:17:51,919
that's a terrestrial environment that

486
00:17:56,390 --> 00:17:54,080
has some gravity vector we want to make

487
00:17:57,350 --> 00:17:56,400
sure our bones are strong enough that we

488
00:17:59,990 --> 00:17:57,360

don't

489
00:18:01,510 --> 00:18:00,000
encounter breaks and fractures and want

490
00:18:03,669 --> 00:18:01,520
to make sure our muscles are strong

491
00:18:05,669 --> 00:18:03,679
enough to get us to to be able to move

492
00:18:07,909 --> 00:18:05,679
around and carry the weight of our space

493
00:18:10,549 --> 00:18:07,919
suit and and get us from point a to

494
00:18:12,710 --> 00:18:10,559
point b so bone and muscle in addition

495
00:18:14,230 --> 00:18:12,720
to radiation are the bigger biggest

496
00:18:17,270 --> 00:18:14,240
things that we need to overcome as

497
00:18:19,029 --> 00:18:17,280
humans and and learn and understand to

498
00:18:22,710 --> 00:18:19,039
be able to get us out past low earth

499
00:18:26,950 --> 00:18:24,789
wow thank you

500
00:18:29,270 --> 00:18:26,960
speaking of breaking things i have a

501
00:18:31,190 --> 00:18:29,280
question with a student with a question

502
00:18:37,430 --> 00:18:31,200
related to um

503
00:18:40,549 --> 00:18:39,190
hi my name is will thank you for taking

504
00:18:42,710 --> 00:18:40,559
my question

505
00:18:45,510 --> 00:18:42,720
what happens if the space station is hit

506
00:18:47,909 --> 00:18:45,520
by space debris ah well the right the

507
00:18:48,630 --> 00:18:47,919
first answer is always prevention right

508
00:18:54,549 --> 00:18:48,640
so

509
00:18:57,510 --> 00:18:54,559
things that we are always doing is

510
00:18:59,830 --> 00:18:57,520
looking out ahead at the at the patterns

511
00:19:02,230 --> 00:18:59,840
of of space debris that are approaching

512
00:19:04,470 --> 00:19:02,240
or near anywhere near the space station

513
00:19:07,430 --> 00:19:04,480

and so um there's a whole group of

514
00:19:09,510 --> 00:19:07,440
people that that that's their only job

515
00:19:11,510 --> 00:19:09,520
and so if we see something that might be

516
00:19:13,590 --> 00:19:11,520
getting a little too close

517
00:19:14,789 --> 00:19:13,600
or something of something we want to

518
00:19:17,110 --> 00:19:14,799
watch

519
00:19:18,070 --> 00:19:17,120
then the teams on the ground here get

520
00:19:20,390 --> 00:19:18,080
together

521
00:19:22,630 --> 00:19:20,400
decide on whether the crew should be

522
00:19:24,630 --> 00:19:22,640
alerted and sometimes i believe we can

523
00:19:26,549 --> 00:19:24,640
do things to move the vehicle even right

524
00:19:28,390 --> 00:19:26,559
if we had to in extreme cases we have

525
00:19:30,070 --> 00:19:28,400
the ability to do things known as debris

526
00:19:32,390 --> 00:19:30,080
avoidance maneuvers where we'll have

527
00:19:34,710 --> 00:19:32,400
thrusters either on a spacecraft

528
00:19:36,630 --> 00:19:34,720
visiting the station that'll then be

529
00:19:38,470 --> 00:19:36,640
fired and they can actually raise the

530
00:19:39,590 --> 00:19:38,480
altitude and kind of get it up out of

531
00:19:41,990 --> 00:19:39,600
the way

532
00:19:43,590 --> 00:19:42,000
and i mean that's done for any object

533
00:19:45,510 --> 00:19:43,600
that we're able to track and we can

534
00:19:47,590 --> 00:19:45,520
track very small objects while they're

535
00:19:49,990 --> 00:19:47,600
in space but the other problem is there

536
00:19:51,909 --> 00:19:50,000
are a lot of very even smaller objects

537
00:19:54,310 --> 00:19:51,919
that we can't always track the station

538
00:19:56,950 --> 00:19:54,320

will actually be you know hit by dust

539
00:19:58,789 --> 00:19:56,960
sized particles which may not seem like

540
00:20:00,549 --> 00:19:58,799
much but when you're traveling at the

541
00:20:02,470 --> 00:20:00,559
speeds you're traveling at they can

542
00:20:04,789 --> 00:20:02,480
leave marks they can leave dents they

543
00:20:06,710 --> 00:20:04,799
can actually damage the station if it

544
00:20:08,230 --> 00:20:06,720
were to actually be hit by something

545
00:20:10,230 --> 00:20:08,240
there are a number of procedures in

546
00:20:12,149 --> 00:20:10,240
place so the astronauts would always be

547
00:20:13,909 --> 00:20:12,159
safe they have spacecraft they could

548
00:20:16,470 --> 00:20:13,919
shelter in and come back down to earth

549
00:20:18,630 --> 00:20:16,480
immediately they can seal off different

550
00:20:21,029 --> 00:20:18,640
sections of the station with hatches so

551
00:20:22,470 --> 00:20:21,039
they are there are things in place that

552
00:20:24,070 --> 00:20:22,480
should that ever happen and we don't

553
00:20:28,390 --> 00:20:24,080
catch it and maneuver out of the way in

554
00:20:35,270 --> 00:20:31,350
wow great so there's no chance of being

555
00:20:37,029 --> 00:20:35,280
hit by a uh orbiting planet

556
00:20:39,110 --> 00:20:37,039
it's too big

557
00:20:41,669 --> 00:20:39,120
we see that one coming

558
00:20:43,990 --> 00:20:41,679
okay okay go ahead we have a question

559
00:20:46,870 --> 00:20:44,000
related to uh planets

560
00:20:48,789 --> 00:20:46,880
hi my name is caitlin and thank you for

561
00:20:50,789 --> 00:20:48,799
taking my question

562
00:20:53,430 --> 00:20:50,799
are the astronauts able to see the

563
00:20:55,750 --> 00:20:53,440

planets from the space station

564
00:20:58,470 --> 00:20:55,760
oh that is a good question

565
00:21:00,710 --> 00:20:58,480
you know i i don't think so

566
00:21:02,310 --> 00:21:00,720
they are every once in a while um we

567
00:21:03,909 --> 00:21:02,320
actually i don't know if you guys

568
00:21:04,870 --> 00:21:03,919
followed when we did the big transit of

569
00:21:06,310 --> 00:21:04,880
venus

570
00:21:08,549 --> 00:21:06,320
a couple of months back but one of our

571
00:21:10,390 --> 00:21:08,559
astronauts was actually able to you know

572
00:21:12,390 --> 00:21:10,400
take photographs and that was as venus

573
00:21:14,390 --> 00:21:12,400
was crossing right in front of the sun

574
00:21:16,630 --> 00:21:14,400
and we were able to see venus very well

575
00:21:18,870 --> 00:21:16,640
through telescopes all over the planet

576
00:21:21,029 --> 00:21:18,880
but our astronauts are able to see and

577
00:21:22,870 --> 00:21:21,039
they can see them generally like you and

578
00:21:24,630 --> 00:21:22,880
i can see them because again

579
00:21:26,470 --> 00:21:24,640
they are in space but they're only a few

580
00:21:28,710 --> 00:21:26,480
hundred miles away and when you talk

581
00:21:30,950 --> 00:21:28,720
about planets they're tens and hundreds

582
00:21:32,789 --> 00:21:30,960
and millions of miles away so anything

583
00:21:34,870 --> 00:21:32,799
that they could see is really what you

584
00:21:36,789 --> 00:21:34,880
can see down here maybe just a little

585
00:21:39,190 --> 00:21:36,799
bit clearer

586
00:21:44,070 --> 00:21:39,200
that's a good question okay interesting

587
00:21:47,669 --> 00:21:46,230
hi my name is sequoia and thank you for

588
00:21:49,510 --> 00:21:47,679

taking my question

589
00:21:51,430 --> 00:21:49,520
what are some of the new planets

590
00:21:53,190 --> 00:21:51,440
recently discovered

591
00:21:53,990 --> 00:21:53,200
oh yeah that's a good question now i

592
00:21:55,669 --> 00:21:54,000
read

593
00:21:58,470 --> 00:21:55,679
something that came out just yesterday

594
00:22:00,789 --> 00:21:58,480
from nasa's kepler telescope mission

595
00:22:02,310 --> 00:22:00,799
and um so if you're interested in how

596
00:22:03,990 --> 00:22:02,320
we're discovering new planets i would

597
00:22:06,870 --> 00:22:04,000
check out the kepler

598
00:22:09,590 --> 00:22:06,880
mission site uh it seems like um

599
00:22:11,430 --> 00:22:09,600
kepler's been running since i think 2009

600
00:22:13,350 --> 00:22:11,440
and so its sole job is to look for

601
00:22:14,870 --> 00:22:13,360
potential new planets or candidate

602
00:22:17,990 --> 00:22:14,880
planets and

603
00:22:20,549 --> 00:22:18,000
and i believe um yesterday came out

604
00:22:23,830 --> 00:22:20,559
saying that there had been about 461

605
00:22:26,310 --> 00:22:23,840
potential new planet planet candidates

606
00:22:28,870 --> 00:22:26,320
discovered and i think of of all of

607
00:22:30,710 --> 00:22:28,880
those lately um four of those are in

608
00:22:31,430 --> 00:22:30,720
what are called the habitable zone or

609
00:22:33,590 --> 00:22:31,440
they're

610
00:22:35,510 --> 00:22:33,600
all near the roughly this a little bit

611
00:22:37,350 --> 00:22:35,520
bigger than earth but also um have the

612
00:22:40,470 --> 00:22:37,360
potential to have water on the on the

613
00:22:42,470 --> 00:22:40,480

surface so um so that was really neat

614
00:22:43,750 --> 00:22:42,480
when i read that and um and so you

615
00:22:46,549 --> 00:22:43,760
should definitely check out the kepler

616
00:22:47,909 --> 00:22:46,559
telescope mission site

617
00:22:49,190 --> 00:22:47,919
and now we have time for

618
00:22:51,590 --> 00:22:49,200
questions

619
00:22:53,029 --> 00:22:51,600
okay go ahead we have one related to

620
00:22:55,830 --> 00:22:53,039
that um

621
00:22:57,110 --> 00:22:55,840
about new planet discovery

622
00:22:59,270 --> 00:22:57,120
hi my name is

623
00:23:01,029 --> 00:22:59,280
thank you for taking my question

624
00:23:03,909 --> 00:23:01,039
which planet looks to be the most

625
00:23:05,669 --> 00:23:03,919
promising for human habitation

626
00:23:08,470 --> 00:23:05,679
as of right now i'd have to say mars

627
00:23:09,909 --> 00:23:08,480
would you i would agree i mean when

628
00:23:12,630 --> 00:23:09,919
you're talking about the planets in our

629
00:23:14,630 --> 00:23:12,640
solar system the closest ones

630
00:23:16,230 --> 00:23:14,640
if you're going to inhabit a planet with

631
00:23:18,470 --> 00:23:16,240
humans it's got to be a solid planet

632
00:23:21,029 --> 00:23:18,480
like ours the only ones that fit that

633
00:23:22,470 --> 00:23:21,039
are the ones in our immediate area the

634
00:23:24,390 --> 00:23:22,480
issues with the other ones you know

635
00:23:26,950 --> 00:23:24,400
mercury you're much too close to the sun

636
00:23:28,870 --> 00:23:26,960
it's very far away it's a lot smaller it

637
00:23:30,230 --> 00:23:28,880
doesn't really offer everything an

638
00:23:31,190 --> 00:23:30,240

atmosphere things like that that we

639
00:23:33,590 --> 00:23:31,200
would need

640
00:23:35,590 --> 00:23:33,600
venus is the exact opposite it has such

641
00:23:37,590 --> 00:23:35,600
a huge atmosphere and so much pressure

642
00:23:39,750 --> 00:23:37,600
that if you were to stand on the surface

643
00:23:41,590 --> 00:23:39,760
of venus you would literally be crushed

644
00:23:44,149 --> 00:23:41,600
and so we couldn't really inhabit that

645
00:23:46,549 --> 00:23:44,159
one but mars is basically kind of a

646
00:23:48,549 --> 00:23:46,559
miniature earth it doesn't have nearly

647
00:23:50,470 --> 00:23:48,559
the atmosphere it's very small

648
00:23:51,750 --> 00:23:50,480
atmosphere compared to us and it doesn't

649
00:23:53,830 --> 00:23:51,760
quite offer the same radiation

650
00:23:55,990 --> 00:23:53,840
protection but it's close enough and

651
00:23:57,909 --> 00:23:56,000
like us enough that we could that would

652
00:24:00,230 --> 00:23:57,919
be our best candidate to

653
00:24:01,669 --> 00:24:00,240
go and inhabit

654
00:24:03,750 --> 00:24:01,679
but really good question i think that's

655
00:24:05,590 --> 00:24:03,760
all the time that we have for today but

656
00:24:08,149 --> 00:24:05,600
i really want to thank you guys for some

657
00:24:09,350 --> 00:24:08,159
pretty awesome questions today i hope

658
00:24:11,029 --> 00:24:09,360
you enjoy your time here in mission

659
00:24:12,470 --> 00:24:11,039
control with us and

660
00:24:14,149 --> 00:24:12,480
maybe we'll hear from you guys again

661
00:24:16,630 --> 00:24:14,159
soon