2017 Astrobiology Graduate Conference

CHARLOTTESVILLE, VA

1
00:00:00,790 --> 00:00:08,110
[Music]

2
00:00:13,549 --> 00:00:11,360
okay thank you very much so I'm Mikkel

3
00:00:15,490 --> 00:00:13,559
Becky I'm a French I'm but I'm working

4
00:00:19,120 --> 00:00:15,500
in Berlin at the German Aerospace Center

5
00:00:21,920 --> 00:00:19,130
at the DLR and I'm going to talk about

6
00:00:25,700 --> 00:00:21,930
how to find life on Mars as you heard in

7
00:00:27,650 --> 00:00:25,710
the song but to do that we exposed some

8
00:00:30,230 --> 00:00:27,660
samples in space on the biomech

9
00:00:33,020 --> 00:00:30,240
experiments on the Expos r2 platform and

10
00:00:35,780 --> 00:00:33,030
I've been looking at preservation of

11
00:00:39,619 --> 00:00:35,790
Raman bio signatures from different

12
00:00:41,860 --> 00:00:39,629
organisms after space exposure so as you

13
00:00:44,840 --> 00:00:41,870

may know we have been to Mars in the

14
00:00:46,850 --> 00:00:44,850
1967 t6 with the Viking landers to

15
00:00:48,860 --> 00:00:46,860
really search for light there and wait

16
00:00:50,720 --> 00:00:48,870
so it's been 40 years since we really

17
00:00:53,389 --> 00:00:50,730
sent dedicated mission to search for

18
00:00:55,939 --> 00:00:53,399
life on Mars and a few days ago it's

19
00:00:57,380 --> 00:00:55,949
always also 40 years in the first hours

20
00:01:01,040 --> 00:00:57,390
was released I don't know if it's a

21
00:01:03,200 --> 00:01:01,050
coincidence or not but so we are almost

22
00:01:05,840 --> 00:01:03,210
ready to go back with new tools to

23
00:01:07,570 --> 00:01:05,850
really search for biosignatures as we

24
00:01:11,149 --> 00:01:07,580
heard those things that we can think

25
00:01:13,820 --> 00:01:11,159
were made by life on Mars and one of the

26
00:01:16,160 --> 00:01:13,830
tools we will be that will be doing this

27
00:01:18,770 --> 00:01:16,170
job will be Raman spectrometer although

28
00:01:21,140 --> 00:01:18,780
we we hope so so in the next two

29
00:01:24,230 --> 00:01:21,150
missions the next two Rovers to Mars x0

30
00:01:26,570 --> 00:01:24,240
algumas Rover 2020 and the moss 2020

31
00:01:29,780 --> 00:01:26,580
Rover from NASA will carry raman

32
00:01:32,330 --> 00:01:29,790
instruments to Mars but as we learned

33
00:01:34,190 --> 00:01:32,340
from the Viking missions we had to

34
00:01:37,130 --> 00:01:34,200
understand much more about life on Earth

35
00:01:39,679 --> 00:01:37,140
before we can find it elsewhere and so

36
00:01:41,719 --> 00:01:39,689
that's one of the goals of the this bio

37
00:01:44,389 --> 00:01:41,729
max experiment that we sent into space

38
00:01:47,569 --> 00:01:44,399

and so we are looking at lots of

39
00:01:50,420 --> 00:01:47,579
different microorganisms from Mars

40
00:01:52,010 --> 00:01:50,430
analog environments on earth and after

41
00:01:55,429 --> 00:01:52,020
exposing them to different conditions

42
00:01:58,429 --> 00:01:55,439
and specially simulated Mars conditions

43
00:02:00,700 --> 00:01:58,439
to see what we can detect after this

44
00:02:03,620 --> 00:02:00,710
exposure what we can expect to detect

45
00:02:07,459 --> 00:02:03,630
with the search instruments such Raman

46
00:02:09,169 --> 00:02:07,469
instruments on Mars so to simulate of

47
00:02:11,180 --> 00:02:09,179
course Martian conditions we can either

48
00:02:12,620 --> 00:02:11,190
use the ground-based facilities like

49
00:02:15,500 --> 00:02:12,630
Mars chambers

50
00:02:17,510 --> 00:02:15,510
to simulate radiations and so on but of

51
00:02:20,300 --> 00:02:17,520
course when you want all the combined

52
00:02:22,490 --> 00:02:20,310
effects of Martian environment stresses

53
00:02:24,920 --> 00:02:22,500
you can go to space and so there have

54
00:02:27,140 --> 00:02:24,930
been a lot of not a lot but a few

55
00:02:29,720 --> 00:02:27,150
platforms to do these jobs so the by

56
00:02:32,030 --> 00:02:29,730
open platforms or first those on the on

57
00:02:35,360 --> 00:02:32,040
the space shuttle or a long-duration

58
00:02:37,310 --> 00:02:35,370
exposure facility of NASA and but at the

59
00:02:40,400 --> 00:02:37,320
European Space Agency we've been doing

60
00:02:43,130 --> 00:02:40,410
with this with the expose platform so we

61
00:02:46,670 --> 00:02:43,140
had three missions so far on the exposed

62
00:02:48,470 --> 00:02:46,680
ER and our to the last one and so I was

63
00:02:50,810 --> 00:02:48,480

I had the chance to be involved in in

64
00:02:52,670 --> 00:02:50,820
this mission for during my PhD and now

65
00:02:55,390 --> 00:02:52,680
during my postdoc to analyze the the

66
00:02:59,330 --> 00:02:55,400
results from the samples that came back

67
00:03:02,270 --> 00:02:59,340
so this mission was launched in 2014 in

68
00:03:03,740 --> 00:03:02,280
July it was installed on the outside of

69
00:03:05,900 --> 00:03:03,750
the International Space Station in

70
00:03:08,630 --> 00:03:05,910
August on the Russian segment so that's

71
00:03:11,180 --> 00:03:08,640
why it's called expose our and so it

72
00:03:13,610 --> 00:03:11,190
began exposure in October we removed the

73
00:03:17,600 --> 00:03:13,620
cover and so on and the samples came

74
00:03:20,870 --> 00:03:17,610
back to earth last last June March and

75
00:03:23,510 --> 00:03:20,880
June so after 16 months in in low-earth

76
00:03:25,790 --> 00:03:23,520
orbit so in the space environment of the

77
00:03:28,370 --> 00:03:25,800
space station outside of the space

78
00:03:30,110 --> 00:03:28,380
station so it's not exactly like you

79
00:03:33,080 --> 00:03:30,120
would find on Mars but you have a still

80
00:03:36,440 --> 00:03:33,090
all the cosmic radiations the UVs we are

81
00:03:39,950 --> 00:03:36,450
stimulating all of that and so there

82
00:03:41,600 --> 00:03:39,960
were three biological experiments on

83
00:03:44,120 --> 00:03:41,610
expose and one has four chemical

84
00:03:46,220 --> 00:03:44,130
experiments and among the biology were

85
00:03:48,920 --> 00:03:46,230
the bio max experiments led by a my

86
00:03:51,170 --> 00:03:48,930
supervisor at Yale or in Berlin so that

87
00:03:53,810 --> 00:03:51,180
stands for biology and Mars experiments

88
00:03:55,699 --> 00:03:53,820

and as I said the big goal was to look

89
00:03:58,460 --> 00:03:55,709
at the stability and detection of

90
00:04:01,130 --> 00:03:58,470
biomolecules and there are these masla

91
00:04:04,250 --> 00:04:01,140
conditions and space conditions in order

92
00:04:06,170 --> 00:04:04,260
to create bio signature database for the

93
00:04:09,020 --> 00:04:06,180
future mass mission to really try to

94
00:04:11,030 --> 00:04:09,030
guide these missions to see what we can

95
00:04:13,699 --> 00:04:11,040
expect to find from all the examples we

96
00:04:15,949 --> 00:04:13,709
have on earth and also as a byproduct of

97
00:04:18,050 --> 00:04:15,959
course because we are we are exposing

98
00:04:20,120 --> 00:04:18,060
organisms we want to see the endurance

99
00:04:22,730 --> 00:04:20,130
of these different extremophiles under

100
00:04:24,860 --> 00:04:22,740
these conditions to assess the

101
00:04:25,740 --> 00:04:24,870
habitability of Mars a little panspermia

102
00:04:28,530 --> 00:04:25,750
theory

103
00:04:30,870 --> 00:04:28,540
and also we have some kombucha samples

104
00:04:33,210 --> 00:04:30,880
who might be useful to with report

105
00:04:35,250 --> 00:04:33,220
immune system of astronauts and also of

106
00:04:40,560 --> 00:04:35,260
course to test for future space

107
00:04:42,690 --> 00:04:40,570
exploration instruments so we had it's a

108
00:04:44,730 --> 00:04:42,700
big group in biomech so we had 27

109
00:04:47,010 --> 00:04:44,740
collaborating institutes from all around

110
00:04:50,640 --> 00:04:47,020
the world actually and so we were able

111
00:04:53,340 --> 00:04:50,650
to able to expose 15 different organisms

112
00:04:55,980 --> 00:04:53,350
from the free domain of life and nine

113
00:04:58,530 --> 00:04:55,990

different biomolecules so isolated

114
00:05:01,740 --> 00:04:58,540
molecules from these organisms or others

115
00:05:04,230 --> 00:05:01,750
and we mix them also with the 2mass

116
00:05:06,870 --> 00:05:04,240
regulate simulants and one lunar analog

117
00:05:08,700 --> 00:05:06,880
to see also what is the interplay

118
00:05:10,620 --> 00:05:08,710
between the minerals and the organisms

119
00:05:13,020 --> 00:05:10,630
or the minerals and the molecules to see

120
00:05:15,510 --> 00:05:13,030
if there there can be better preserved

121
00:05:17,970 --> 00:05:15,520
in certain minerals or if we can enhance

122
00:05:22,560 --> 00:05:17,980
the destruction of the molecules in

123
00:05:24,840 --> 00:05:22,570
other cases and so just a bit technical

124
00:05:27,300 --> 00:05:24,850
details for the mission so we had three

125
00:05:29,790 --> 00:05:27,310
trays on exposed by omics was here in

126
00:05:33,030 --> 00:05:29,800
the red part so the first ray was a

127
00:05:36,690 --> 00:05:33,040
space so it was fully evacuated to space

128
00:05:38,880 --> 00:05:36,700
vacuum and it had so many geum fluoride

129
00:05:41,070 --> 00:05:38,890
windows to have the food UV radiation

130
00:05:43,830 --> 00:05:41,080
from the sun and the second ray which

131
00:05:45,840 --> 00:05:43,840
was filled with mars like atmosphere so

132
00:05:48,690 --> 00:05:45,850
mars like gas at six mini bar pressure

133
00:05:50,909 --> 00:05:48,700
and co2 mainly and it had the cutoff

134
00:05:52,290 --> 00:05:50,919
filter for the UVs at 200 nanometers to

135
00:05:56,820 --> 00:05:52,300
recreate the martian atmosphere

136
00:05:58,710 --> 00:05:56,830
conditions and we had also a top and the

137
00:06:00,480 --> 00:05:58,720
bottom layers to have the fully exposed

138
00:06:02,520 --> 00:06:00,490

samples and the bottom to serve as a

139
00:06:05,490 --> 00:06:02,530
dark control in space to see what is the

140
00:06:07,350 --> 00:06:05,500
difference between UV radiations or the

141
00:06:09,270 --> 00:06:07,360
samples on year irradiated with the

142
00:06:11,969 --> 00:06:09,280
cosmic ray and Uniting radiation from

143
00:06:14,460 --> 00:06:11,979
the sun and so on and at the same time

144
00:06:16,830 --> 00:06:14,470
we had also experiments on the ground to

145
00:06:19,170 --> 00:06:16,840
serve as a control also on the ground to

146
00:06:21,000 --> 00:06:19,180
serve as the reference samples so here

147
00:06:23,100 --> 00:06:21,010
of course we cannot recreate the fully

148
00:06:25,530 --> 00:06:23,110
Uniting radiation spectrum that's why we

149
00:06:27,750 --> 00:06:25,540
go to space so we but we can recreate

150
00:06:30,240 --> 00:06:27,760
mostly the UV radiation vacuum and

151
00:06:32,100 --> 00:06:30,250
martian temperature and then martian

152
00:06:34,290 --> 00:06:32,110
atmosphere and also temperature cycles

153
00:06:36,930 --> 00:06:34,300
that samples are in parallel

154
00:06:41,370 --> 00:06:36,940
experiencing into space

155
00:06:43,740 --> 00:06:41,380
so what I was looking at mainly in the

156
00:06:46,290 --> 00:06:43,750
last few months were carotenoid

157
00:06:50,100 --> 00:06:46,300
molecules comprised in a cyanobacteria

158
00:06:52,770 --> 00:06:50,110
and green algae is so carotenoids are a

159
00:06:55,740 --> 00:06:52,780
very wide variety of molecules present

160
00:06:57,750 --> 00:06:55,750
in many many different organisms mostly

161
00:06:59,910 --> 00:06:57,760
photosynthetic s-- because they are they

162
00:07:02,610 --> 00:06:59,920
act as a secondary pigments for

163
00:07:05,010 --> 00:07:02,620

photosynthesis but they have also lots

164
00:07:08,630 --> 00:07:05,020
of different functions like they could

165
00:07:11,490 --> 00:07:08,640
be some prevail prebiotic lipids also

166
00:07:13,320 --> 00:07:11,500
yeah you know if interest but they're

167
00:07:15,620 --> 00:07:13,330
also very powerful antioxidant molecules

168
00:07:18,780 --> 00:07:15,630
so they are found in lots of

169
00:07:20,940 --> 00:07:18,790
extremophiles yeah organisms that live

170
00:07:22,560 --> 00:07:20,950
in a very harsh conditions and that have

171
00:07:24,240 --> 00:07:22,570
to deal with lots of stresses and so

172
00:07:27,270 --> 00:07:24,250
they are these molecules are very

173
00:07:29,940 --> 00:07:27,280
powerful to scavenge reactive oxygen

174
00:07:31,140 --> 00:07:29,950
species for instance and also what is

175
00:07:34,080 --> 00:07:31,150
very interesting is that they have a

176
00:07:36,510 --> 00:07:34,090
very high preservation potential like

177
00:07:39,120 --> 00:07:36,520
you can detect some cotton weeds by

178
00:07:41,820 --> 00:07:39,130
Raman in a 1.4 million years or all the

179
00:07:44,760 --> 00:07:41,830
samples and events the byproducts in a

180
00:07:48,030 --> 00:07:44,770
billion years old samples by GCMs so

181
00:07:50,760 --> 00:07:48,040
it's quite a good molecular and by Raman

182
00:07:53,820 --> 00:07:50,770
yes it has a very distinct Raman spectra

183
00:07:55,800 --> 00:07:53,830
so it could be very good to detect them

184
00:07:59,700 --> 00:07:55,810
on Mars when could potential by a

185
00:08:02,580 --> 00:07:59,710
Martian bio signature so so these two

186
00:08:04,860 --> 00:08:02,590
organisms yes so we had a gnostic

187
00:08:06,810 --> 00:08:04,870
cyanobacteria from antarctica and the

188
00:08:09,870 --> 00:08:06,820

sparrow cyst is green algae from

189
00:08:12,480 --> 00:08:09,880
Spitsbergen from the bulb art and so

190
00:08:14,970 --> 00:08:12,490
they I can go into resting stage and

191
00:08:18,440 --> 00:08:14,980
accumulate this cotton weights as you

192
00:08:21,530 --> 00:08:18,450
see this orange reddish color there and

193
00:08:25,200 --> 00:08:21,540
so we prepared this was done by our

194
00:08:27,210 --> 00:08:25,210
colleague Thomas Layla in Potsdam so we

195
00:08:28,560 --> 00:08:27,220
prepared them as I said in contact with

196
00:08:30,390 --> 00:08:28,570
these Martian mineral networks

197
00:08:33,089 --> 00:08:30,400
to see what is the interplay between the

198
00:08:36,029 --> 00:08:33,099
all the minerals and the cells and if

199
00:08:39,029 --> 00:08:36,039
you can protect on nor destroy more the

200
00:08:40,709 --> 00:08:39,039
bio signatures and so they were plated

201
00:08:42,930 --> 00:08:40,719
on these different analogs and as you

202
00:08:44,580 --> 00:08:42,940
can see under them the microscope here

203
00:08:46,110 --> 00:08:44,590
here you have the big colonies of Na

204
00:08:49,440 --> 00:08:46,120
stock and all the little dots here

205
00:08:52,170 --> 00:08:49,450
others versus these green algea cells

206
00:08:54,720 --> 00:08:52,180
and the first results of course is that

207
00:08:56,819 --> 00:08:54,730
they survived after 16 months into space

208
00:08:58,440 --> 00:08:56,829
they came back and our colleague Thomas

209
00:09:00,870 --> 00:08:58,450
Leia put them in culture and they were

210
00:09:03,600 --> 00:09:00,880
growing again no problem for them so

211
00:09:06,329 --> 00:09:03,610
that's already quite a quite a result

212
00:09:07,889 --> 00:09:06,339
not so surprising because as I said in

213
00:09:09,720 --> 00:09:07,899

the previous missions we've seen that

214
00:09:12,540 --> 00:09:09,730
lots of different organisms can survive

215
00:09:14,850 --> 00:09:12,550
space exposures we've been we have seen

216
00:09:17,129 --> 00:09:14,860
all from older cyanobacteria that they

217
00:09:19,800 --> 00:09:17,139
can survive after 16 months or even

218
00:09:21,780 --> 00:09:19,810
longer into space even some green algae

219
00:09:23,490 --> 00:09:21,790
is also have been already exposed

220
00:09:27,120 --> 00:09:23,500
tardigrades might for the most famous

221
00:09:29,670 --> 00:09:27,130
water bears yet has the password yeah

222
00:09:32,220 --> 00:09:29,680
but so we have already yeah yeah some

223
00:09:34,439 --> 00:09:32,230
examples of organism that survived but

224
00:09:36,689 --> 00:09:34,449
still when you add more and more that

225
00:09:39,210 --> 00:09:36,699
can survive this condition it's already

226
00:09:41,160 --> 00:09:39,220
good and so what I've been doing

227
00:09:44,160 --> 00:09:41,170
specifically it's looking at them by

228
00:09:46,430 --> 00:09:44,170
Raman spectroscopy so looking at if you

229
00:09:49,350 --> 00:09:46,440
don't know Raman is inelastic

230
00:09:52,110 --> 00:09:49,360
scattered light that is created by an

231
00:09:54,960 --> 00:09:52,120
excitation of monochromatic light on the

232
00:09:57,090 --> 00:09:54,970
samples and you have this this

233
00:09:59,970 --> 00:09:57,100
fingerprints of the of the different

234
00:10:02,040 --> 00:09:59,980
molecules that are very distinct and so

235
00:10:04,110 --> 00:10:02,050
it can be used for bio for biomolecules

236
00:10:06,420 --> 00:10:04,120
but mostly also for mineralogy so it's

237
00:10:08,220 --> 00:10:06,430
very good for mouse to have the mineral

238
00:10:10,019 --> 00:10:08,230

context but also in if you have a

239
00:10:12,900 --> 00:10:10,029
biomolecule there you could detect it

240
00:10:15,180 --> 00:10:12,910
and what can we see with cyanobacteria

241
00:10:17,850 --> 00:10:15,190
and green algae so this is the typical

242
00:10:19,560 --> 00:10:17,860
Raman spectra of carotenoids so you have

243
00:10:22,230 --> 00:10:19,570
the three peaks with the vibrations of

244
00:10:26,880 --> 00:10:22,240
the carbon-carbon regions and carbon

245
00:10:29,009 --> 00:10:26,890
methane essence but what we have in in

246
00:10:30,750 --> 00:10:29,019
these organisms are not of course single

247
00:10:32,579 --> 00:10:30,760
molecules but two pool of all the

248
00:10:36,420 --> 00:10:32,589
different cutting weeds expressing them

249
00:10:38,250 --> 00:10:36,430
so like so this spectra actually is not

250
00:10:41,639 --> 00:10:38,260
from one molecule but from the whole

251
00:10:44,220 --> 00:10:41,649
pool of the molecules and so we can do

252
00:10:47,490 --> 00:10:44,230
different images that are already

253
00:10:50,610 --> 00:10:47,500
different lines cancer to see the

254
00:10:52,740 --> 00:10:50,620
intensity or draw maps from the from the

255
00:10:54,569 --> 00:10:52,750
sample theory from the nostril colony so

256
00:10:59,009 --> 00:10:54,579
you can do the intensity map of the

257
00:11:02,009 --> 00:10:59,019
carotenoid signal on them and and these

258
00:11:03,030 --> 00:11:02,019
are the results after space exposure so

259
00:11:05,129 --> 00:11:03,040
as I said we have

260
00:11:06,720 --> 00:11:05,139
all the different minerals here and

261
00:11:09,329 --> 00:11:06,730
there here we have the top and bottom

262
00:11:11,759 --> 00:11:09,339
positions so these are the intensity

263
00:11:14,069 --> 00:11:11,769

maps so the first thing you can see is

264
00:11:17,040 --> 00:11:14,079
that you have signal everywhere even

265
00:11:18,990 --> 00:11:17,050
after 16 months into space so it's not

266
00:11:20,730 --> 00:11:19,000
really surprising because they survived

267
00:11:23,220 --> 00:11:20,740
so it shouldn't be completely destroyed

268
00:11:24,930 --> 00:11:23,230
because they can even grow after that

269
00:11:27,780 --> 00:11:24,940
but still the signal is completely

270
00:11:29,639 --> 00:11:27,790
preserved and if you take the average of

271
00:11:32,490 --> 00:11:29,649
the spectra you have almost no

272
00:11:34,800 --> 00:11:32,500
difference in in the in the spectra of

273
00:11:36,480 --> 00:11:34,810
all these conditions either on the

274
00:11:39,540 --> 00:11:36,490
different minerals or without minerals

275
00:11:42,960 --> 00:11:39,550
at all so that's already quite a

276
00:11:46,829 --> 00:11:42,970
promising result but yeah we try to go a

277
00:11:49,129 --> 00:11:46,839
bit into more details too to see if we

278
00:11:51,540 --> 00:11:49,139
can ever if we can quantify this

279
00:11:53,970 --> 00:11:51,550
preservation and this is still very

280
00:11:55,650 --> 00:11:53,980
preliminary I need to have students to

281
00:11:59,460 --> 00:11:55,660
code for me because I'm not very good at

282
00:12:02,189 --> 00:11:59,470
that to analyze all this data but what

283
00:12:04,259 --> 00:12:02,199
we can see is the intensity maximum of

284
00:12:07,829 --> 00:12:04,269
the signal that we are that we obtain

285
00:12:09,930 --> 00:12:07,839
from the raman spectra and here for for

286
00:12:11,819 --> 00:12:09,940
the moment it's a bit rough but we still

287
00:12:14,340 --> 00:12:11,829
we still see no difference for the

288
00:12:17,160 --> 00:12:14,350

nostril examples in the maximum

289
00:12:18,990 --> 00:12:17,170
intensity more or less it's a bit

290
00:12:20,819 --> 00:12:19,000
different for those Ferro sistas of all

291
00:12:23,269 --> 00:12:20,829
the green algae so the green energies

292
00:12:26,670 --> 00:12:23,279
are eukaryotes or more it advanced

293
00:12:28,620 --> 00:12:26,680
organisms and first of all it's a bit

294
00:12:30,210 --> 00:12:28,630
more difficult to spot them when there

295
00:12:32,579 --> 00:12:30,220
are mixed with minerals because of

296
00:12:34,559 --> 00:12:32,589
course you cannot see the big colonies

297
00:12:37,170 --> 00:12:34,569
of Na stock on these samples so you the

298
00:12:39,540 --> 00:12:37,180
coverage may vary you can pick your

299
00:12:41,939 --> 00:12:39,550
randomly some some some places to

300
00:12:43,980 --> 00:12:41,949
analyze but it's not it's not the same

301
00:12:46,710 --> 00:12:43,990
everywhere and here we have some

302
00:12:49,620 --> 00:12:46,720
differences between the so the different

303
00:12:51,689 --> 00:12:49,630
minerals used or without minerals and

304
00:12:55,110 --> 00:12:51,699
the different minerals used as we have a

305
00:12:57,600 --> 00:12:55,120
huge fluorescence coming up so I didn't

306
00:13:00,210 --> 00:12:57,610
say but we have a green laser so that's

307
00:13:02,629 --> 00:13:00,220
the same as we I'm using here and so

308
00:13:05,300 --> 00:13:02,639
that's the problem for photosensitive or

309
00:13:07,530 --> 00:13:05,310
biological molecules to analyze with the

310
00:13:09,780 --> 00:13:07,540
visible laser because you produce a lot

311
00:13:12,329 --> 00:13:09,790
of fluorescence out of it so that could

312
00:13:13,890 --> 00:13:12,339
be a problem for Mars too and here it's

313
00:13:15,840 --> 00:13:13,900

a bit messy and we

314
00:13:18,450 --> 00:13:15,850
lots of differences but we still need to

315
00:13:20,940 --> 00:13:18,460
go very a bit more into details about

316
00:13:22,620 --> 00:13:20,950
that and to see the trends between with

317
00:13:25,620 --> 00:13:22,630
all minerals and with the minerals what

318
00:13:27,480 --> 00:13:25,630
are the real the effects that they have

319
00:13:29,400 --> 00:13:27,490
but it seems that the minerals that can

320
00:13:32,490 --> 00:13:29,410
protect a bit more than without the

321
00:13:33,990 --> 00:13:32,500
minerals here so that's yeah that's for

322
00:13:36,900 --> 00:13:34,000
the moment that's what we have so they

323
00:13:39,060 --> 00:13:36,910
are very promising sign of bio

324
00:13:41,640 --> 00:13:39,070
signatures that we can detect by Raman

325
00:13:44,700 --> 00:13:41,650
and hopefully on Mars in the future and

326
00:13:46,710 --> 00:13:44,710
we have also a statistical method and

327
00:13:49,079 --> 00:13:46,720
their assessments and we have as I

328
00:13:50,730 --> 00:13:49,089
showed you many different organisms also

329
00:13:53,040 --> 00:13:50,740
containing iodine weights so we will

330
00:13:55,320 --> 00:13:53,050
compare with all of them and see what we

331
00:13:57,750 --> 00:13:55,330
can what we can say for a future

332
00:14:01,120 --> 00:13:57,760
database and hopefully what we can

333
00:14:13,880 --> 00:14:01,130
detect on Mars in the future thank you

334
00:14:21,240 --> 00:14:17,160
which kind of media you use for to grow

335
00:14:25,410 --> 00:14:21,250
your back tears so the not stock there

336
00:14:28,350 --> 00:14:25,420
are BG 11 the typical sign of bacteria

337
00:14:32,340 --> 00:14:28,360
okay so in that experiments you study

338
00:14:35,490 --> 00:14:32,350

the the physical effect of physical

339
00:14:39,480 --> 00:14:35,500
parameters on your bacteria you not

340
00:14:42,269 --> 00:14:39,490
mimic the mass environment chemical

341
00:14:44,280 --> 00:14:42,279
properties in your media right no no

342
00:14:46,440 --> 00:14:44,290
yeah not so much okay we just have the

343
00:14:48,750 --> 00:14:46,450
minerals mixed with that but yeah

344
00:14:50,850 --> 00:14:48,760
so molar area you use the same

345
00:14:53,370 --> 00:14:50,860
concentration of the chemicals also

346
00:14:58,079 --> 00:14:53,380
which are present on the mass in your

347
00:15:00,390 --> 00:14:58,089
media no no no no no yeah just the

348
00:15:03,300 --> 00:15:00,400
mineral analogues are analog mixture

349
00:15:05,699 --> 00:15:03,310
minerals of what we can find on Mars but

350
00:15:08,460 --> 00:15:05,709
not with the medium and so on not no so

351
00:15:11,040 --> 00:15:08,470
just to see the video connections in

352
00:15:12,720 --> 00:15:11,050
there are some small effects is there

353
00:15:15,449 --> 00:15:12,730
any change with the growth rates and

354
00:15:16,490 --> 00:15:15,459
growth pattern of abdui bacteria in

355
00:15:20,040 --> 00:15:16,500
space

356
00:15:21,720 --> 00:15:20,050
no no they are completely desiccated and

357
00:15:24,360 --> 00:15:21,730
so on so when they come back like we put

358
00:15:26,230 --> 00:15:24,370
them in normal liquid medium or we

359
00:15:28,269 --> 00:15:26,240
played them and so on and

360
00:15:30,220 --> 00:15:28,279
so know that we dilute them and played

361
00:15:39,340 --> 00:15:30,230
them so there is no no influence on that

362
00:15:41,829 --> 00:15:39,350
thank you it's interesting is if I've

363
00:15:44,380 --> 00:15:41,839

wonder if you've looked or if anyone's

364
00:15:46,120 --> 00:15:44,390
looked at transcriptomics before and

365
00:15:51,820 --> 00:15:46,130
after something into space to see if

366
00:15:53,590 --> 00:15:51,830
their gene expression changes ya know we

367
00:15:56,290 --> 00:15:53,600
send them we send these samples for

368
00:15:58,000 --> 00:15:56,300
single cell and a DNA analysis but

369
00:15:59,500 --> 00:15:58,010
that's not fun that's not from Swiss

370
00:16:03,550 --> 00:15:59,510
family I don't know why they are doing

371
00:16:05,500 --> 00:16:03,560
that okay but now there are in this you

372
00:16:08,199 --> 00:16:05,510
gated form so that's that's just going

373
00:16:11,650 --> 00:16:08,209
to be repair mechanisms activated after

374
00:16:14,380 --> 00:16:11,660
when you put them back so these are yeah

375
00:16:15,730 --> 00:16:14,390
maybe you will have like that you can go

376
00:16:17,769 --> 00:16:15,740
simulate this on the ground it's not

377
00:16:19,810 --> 00:16:17,779
fair you can accumulate accumulate

378
00:16:21,880 --> 00:16:19,820
damage and that's just the capacity of

379
00:16:23,889 --> 00:16:21,890
the cells to to have enough repair

380
00:16:26,460 --> 00:16:23,899
mechanisms they can repair all these

381
00:16:29,410 --> 00:16:26,470
damages but that's what they are

382
00:16:31,150 --> 00:16:29,420
experiencing anyway in the already on

383
00:16:33,760 --> 00:16:31,160
earth like we are in on terrific and so

384
00:16:38,019 --> 00:16:33,770
on they have to so that's yeah that's

385
00:16:41,949 --> 00:16:38,029
what they are good that's here what

386
00:16:44,170 --> 00:16:41,959
makes Raman spectroscopy special in your

387
00:16:46,750 --> 00:16:44,180
case is it because you have some

388
00:16:50,170 --> 00:16:46,760

symmetrical molecules like they all have

389
00:16:51,940 --> 00:16:50,180
center of inversion I think yeah

390
00:16:55,090 --> 00:16:51,950
discontinuity yeah because there are

391
00:16:57,070 --> 00:16:55,100
pigments so they absorb and the in the

392
00:16:59,019 --> 00:16:57,080
visible spectrum so when you use a

393
00:17:01,420 --> 00:16:59,029
visible laser spectrum they have a

394
00:17:04,240 --> 00:17:01,430
resonance effect so you can you enhance

395
00:17:06,640 --> 00:17:04,250
the Raman signal a lot and so you can

396
00:17:09,069 --> 00:17:06,650
detect them very easily so that's what

397
00:17:11,230 --> 00:17:09,079
that's why these molecules are model

398
00:17:15,400 --> 00:17:11,240
molecules for ramen for biosignatures

399
00:17:16,990 --> 00:17:15,410
and and then yeah the good thing about

400
00:17:18,970 --> 00:17:17,000
ramen is that it's a non-destructive

401
00:17:20,319 --> 00:17:18,980
method so you can use very low laser

402
00:17:21,549 --> 00:17:20,329
powers and so on and you're not

403
00:17:23,230 --> 00:17:21,559
destroying them

404
00:17:24,730 --> 00:17:23,240
you're not destroying the molecules so

405
00:17:27,419 --> 00:17:24,740
then you can use another technique to

406
00:17:30,790 --> 00:17:27,429
confirm as we are that we need a lot of

407
00:17:33,730 --> 00:17:30,800
evidences to make an assumption about

408
00:17:35,840 --> 00:17:33,740
the bio signature really so you can have

409
00:17:38,000 --> 00:17:35,850
a first glance with that and then use