AbGradCon 2018

1
00:00:14,180 --> 00:00:12,980
[Music]

2
00:00:16,790 --> 00:00:14,190
thank you very much for this

3
00:00:18,680 --> 00:00:16,800
introduction so now you are already

4
00:00:20,510 --> 00:00:18,690
aware that I'm going to talk about bits

5
00:00:23,359 --> 00:00:20,520
of paleontology which may sound a bit

6
00:00:25,189 --> 00:00:23,369
weird for astrobiological science but

7
00:00:27,380 --> 00:00:25,199
I'm going to show you a bit of how we

8
00:00:29,540 --> 00:00:27,390
can use some new physical approaches to

9
00:00:33,770 --> 00:00:29,550
to understand these structures that we

10
00:00:36,190 --> 00:00:33,780
call micro fossils so micro fossils are

11
00:00:38,319 --> 00:00:36,200
very interesting for the proposals of

12
00:00:40,160 --> 00:00:38,329
astrobiology because they are

13
00:00:41,869 --> 00:00:40,170

morphological signatures of

14
00:00:44,660 --> 00:00:41,879
microorganisms that were preserved in

15
00:00:47,600 --> 00:00:44,670
the geological record and they are the

16
00:00:51,760 --> 00:00:47,610
earliest direct evidence of life that we

17
00:00:56,060 --> 00:00:51,770
have on earth and this we don't have

18
00:00:57,650 --> 00:00:56,070
nowadays rocks from the idæan but we do

19
00:01:00,740 --> 00:00:57,660
have well preserved with rocks from the

20
00:01:02,299 --> 00:01:00,750
arcane and studies these structures

21
00:01:04,490 --> 00:01:02,309
preserving these rocks give us also eye

22
00:01:07,700 --> 00:01:04,500
insight into the pallium governmental

23
00:01:10,760 --> 00:01:07,710
context bringing us a bit closer to to

24
00:01:14,020 --> 00:01:10,770
the first organisms and how this these

25
00:01:17,030 --> 00:01:14,030
artists were able to to to live in this

26
00:01:20,030 --> 00:01:17,040
ambient that was very different to what

27
00:01:21,920 --> 00:01:20,040
we know today and it's also interesting

28
00:01:23,990 --> 00:01:21,930
because we all have an insight of the

29
00:01:29,120 --> 00:01:24,000
early life the diversity and evolution

30
00:01:35,210 --> 00:01:29,130
and how life already was able to to to

31
00:01:37,940 --> 00:01:35,220
be in the Archaean so microprocessors

32
00:01:40,160 --> 00:01:37,950
are really interesting so we can we know

33
00:01:43,639 --> 00:01:40,170
that in Mars in the path of Mars we have

34
00:01:46,010 --> 00:01:43,649
a stable condition so we may have traces

35
00:01:48,050 --> 00:01:46,020
of life there so let's go look for them

36
00:01:51,139 --> 00:01:48,060
and this is one of the aims of NASA and

37
00:01:52,730 --> 00:01:51,149
easie for the next years but if you

38
00:01:55,460 --> 00:01:52,740

wants to look for life in Mars we need

39
00:01:58,370 --> 00:01:55,470
also to think so how we identify these

40
00:02:01,190 --> 00:01:58,380
churches so how these structures that we

41
00:02:03,260 --> 00:02:01,200
know earth look like and this especially

42
00:02:07,249 --> 00:02:03,270
if we're talking this about this really

43
00:02:09,889 --> 00:02:07,259
first micro fossils we have actually not

44
00:02:14,000 --> 00:02:09,899
a quite answer because every year I have

45
00:02:15,860 --> 00:02:14,010
new studies coming and quite it's a

46
00:02:17,750 --> 00:02:15,870
quite big descriptions of which are the

47
00:02:21,949 --> 00:02:17,760
earliest evidence of life of

48
00:02:23,539 --> 00:02:21,959
microfossils on earth and we have every

49
00:02:25,490 --> 00:02:23,549
year new studies claiming that they

50
00:02:29,020 --> 00:02:25,500
found the earliest micro fossils on

51
00:02:31,490 --> 00:02:29,030
earth and you feel a big discussions and

52
00:02:33,140 --> 00:02:31,500
one of the reasons of this is that

53
00:02:36,259 --> 00:02:33,150
actually micro fossils are quite

54
00:02:38,570 --> 00:02:36,269
challenging structures to study first

55
00:02:41,059 --> 00:02:38,580
reason is because they are micro metric

56
00:02:42,770 --> 00:02:41,069
size structures which means that for for

57
00:02:46,490 --> 00:02:42,780
analyzing them we require nanometric

58
00:02:49,280 --> 00:02:46,500
resolution they are organisms that are

59
00:02:51,410 --> 00:02:49,290
now rocks so they have an homogeneous

60
00:02:54,020 --> 00:02:51,420
density and this is an important thing

61
00:02:56,690 --> 00:02:54,030
because most of imaging techniques are

62
00:02:58,490 --> 00:02:56,700
based in the absorption and absorption

63
00:03:01,729 --> 00:02:58,500

is directly related to the density of

64
00:03:03,949 --> 00:03:01,739
the material and we cannot forget that

65
00:03:05,780 --> 00:03:03,959
this rocks best to billions of years of

66
00:03:07,910 --> 00:03:05,790
geological processing which means that

67
00:03:09,710 --> 00:03:07,920
first they are rare we don't have that

68
00:03:13,789 --> 00:03:09,720
many places on earth that we can find

69
00:03:16,880 --> 00:03:13,799
the really Archaean well-preserved rocks

70
00:03:18,800 --> 00:03:16,890
and one important thing is if we are

71
00:03:20,900 --> 00:03:18,810
going to talk about if these structures

72
00:03:22,580 --> 00:03:20,910
are really biogenic how we prove that

73
00:03:24,620 --> 00:03:22,590
what we find in the geological record

74
00:03:27,379 --> 00:03:24,630
are really remains of life and this is a

75
00:03:29,569 --> 00:03:27,389
very tricky question because we have a

76
00:03:32,839 --> 00:03:29,579
lot of structures that look like life

77
00:03:34,970 --> 00:03:32,849
but they are actually not a biotic

78
00:03:38,629 --> 00:03:34,980
informant so we have some examples here

79
00:03:41,659 --> 00:03:38,639
some some silica dialers and we have a

80
00:03:43,580 --> 00:03:41,669
very famous example of this Allen Hughes

81
00:03:47,629 --> 00:03:43,590
meteorite that they found the structures

82
00:03:49,879 --> 00:03:47,639
that look a lot like life bringing this

83
00:03:53,960 --> 00:03:49,889
idea of how can we prove what what we

84
00:03:55,640 --> 00:03:53,970
find is really life so the objective of

85
00:03:57,319 --> 00:03:55,650
my project is to try some new

86
00:04:01,250 --> 00:03:57,329
high-resolution imaging techniques

87
00:04:04,220 --> 00:04:01,260
looking for water structure of this

88
00:04:06,289 --> 00:04:04,230

strip of this of what we find in the

89
00:04:08,059 --> 00:04:06,299
geological record and looking for

90
00:04:11,449 --> 00:04:08,069
contributing about this by using the

91
00:04:15,439 --> 00:04:11,459
secretary to identify them so first

92
00:04:18,199 --> 00:04:15,449
technique the already introduced also

93
00:04:20,120 --> 00:04:18,209
called scanning laser confocal laser

94
00:04:23,480 --> 00:04:20,130
scanning microscopy we took some

95
00:04:26,570 --> 00:04:23,490
Brazilian micro fossils from 219 million

96
00:04:27,320 --> 00:04:26,580
years old we put them in this microscope

97
00:04:29,960 --> 00:04:27,330
we

98
00:04:32,270 --> 00:04:29,970
Karajan that is the graduated organic

99
00:04:34,580 --> 00:04:32,280
matter they it has autofluorescence

100
00:04:37,339 --> 00:04:34,590
property which means that we can image

101
00:04:40,640 --> 00:04:37,349
the the organic matter and see them in

102
00:04:43,939 --> 00:04:40,650
3d and we can have images of the the

103
00:04:46,850 --> 00:04:43,949
preserve of the karagin in microfossils

104
00:04:48,890 --> 00:04:46,860
we can do this for cyanobacteria we also

105
00:04:50,689 --> 00:04:48,900
did these to some pollen grains and

106
00:04:54,140 --> 00:04:50,699
pollens are much more resistant

107
00:04:55,790 --> 00:04:54,150
structures which which was interesting

108
00:04:57,920 --> 00:04:55,800
because we saw that actually we had

109
00:04:59,839 --> 00:04:57,930
different fluorescence wavelengths and

110
00:05:01,760 --> 00:04:59,849
this means that actually you have more

111
00:05:04,399 --> 00:05:01,770
than one type of organic matter here and

112
00:05:06,020 --> 00:05:04,409
this indicates that we may have a

113
00:05:08,420 --> 00:05:06,030

different level of geochemical

114
00:05:11,480 --> 00:05:08,430
maturation of this organic matter or

115
00:05:14,180 --> 00:05:11,490
also that we have different types of

116
00:05:16,909 --> 00:05:14,190
couraging indicating probably different

117
00:05:20,499 --> 00:05:16,919
biological compounds that that evoluted

118
00:05:23,149 --> 00:05:20,509
different during the geological system

119
00:05:26,089 --> 00:05:23,159
another thing we did we took pieces of

120
00:05:29,420 --> 00:05:26,099
rocks we we decide to do micro

121
00:05:30,709 --> 00:05:29,430
tomography we took them to the micro two

122
00:05:32,779 --> 00:05:30,719
models of the line of the Brazilian

123
00:05:36,950 --> 00:05:32,789
synchrotron so these are the only pieces

124
00:05:38,930 --> 00:05:36,960
of rocks we scan them and these are the

125
00:05:40,909 --> 00:05:38,940
pollen grains I just show you we could

126
00:05:42,939 --> 00:05:40,919
identify them inside as pieces of rocks

127
00:05:45,309 --> 00:05:42,949
because they have this Mickey Mouse

128
00:05:48,860 --> 00:05:45,319
morphology quite easy funded to

129
00:05:50,540 --> 00:05:48,870
recognize and we was interesting because

130
00:05:51,980 --> 00:05:50,550
this approach is totally non-destructive

131
00:05:53,450 --> 00:05:51,990
we just took a piece of rock we put

132
00:05:55,339 --> 00:05:53,460
there and managed to identify the

133
00:05:57,559 --> 00:05:55,349
structures but falling Ray's they are

134
00:06:01,519 --> 00:05:57,569
quite big if we are talking about micro

135
00:06:05,119 --> 00:06:01,529
posting they have more than 15 nano

136
00:06:07,749 --> 00:06:05,129
micro meters which is big for all for

137
00:06:11,180 --> 00:06:07,759
really microorganisms when we look for

138
00:06:13,850 --> 00:06:11,190

smaller structures we can see some some

139
00:06:16,459 --> 00:06:13,860
structures with this micro CT but they

140
00:06:18,019 --> 00:06:16,469
are not so easy to recognize and to

141
00:06:21,589 --> 00:06:18,029
understand if they are really forces or

142
00:06:23,659 --> 00:06:21,599
not and the reasons are the same way I

143
00:06:25,159 --> 00:06:23,669
just said they are we are talking about

144
00:06:27,320 --> 00:06:25,169
absorption techniques so they are

145
00:06:29,300 --> 00:06:27,330
homogeneous base and we are talking

146
00:06:33,439 --> 00:06:29,310
about the micro CT we are not achieving

147
00:06:35,629 --> 00:06:33,449
nanometric resolution so just a basic

148
00:06:38,429 --> 00:06:35,639
idea when we are talking about x-ray

149
00:06:41,070 --> 00:06:38,439
imaging we have an object and when we

150
00:06:43,049 --> 00:06:41,080
put them under the x-rays they absorb

151
00:06:44,820 --> 00:06:43,059
x-rays in the absorption of x-ray that

152
00:06:47,729 --> 00:06:44,830
the set is directly related to density

153
00:06:50,790 --> 00:06:47,739
so this is the reason that if we put our

154
00:06:52,889 --> 00:06:50,800
hand in the x-rays we will see the high

155
00:06:55,290 --> 00:06:52,899
density compounds but we are not really

156
00:06:58,079 --> 00:06:55,300
be able to distinguish the soft tissues

157
00:07:01,079 --> 00:06:58,089
the flesh and so on and if we're talking

158
00:07:03,239 --> 00:07:01,089
about a fossil we I we did this pretty

159
00:07:06,659 --> 00:07:03,249
in previous work we put a photo finish

160
00:07:09,540 --> 00:07:06,669
in inner-city scan of hospital and we

161
00:07:13,739 --> 00:07:09,550
could see some structures but not that

162
00:07:16,379 --> 00:07:13,749
many information so this is why I'm

163
00:07:17,939 --> 00:07:16,389

talking about absorption city but it's

164
00:07:21,059 --> 00:07:17,949
the same city that we do when we go to a

165
00:07:22,589 --> 00:07:21,069
hospital to do an exam but absorption is

166
00:07:24,540 --> 00:07:22,599
not the only thing happening when you

167
00:07:26,549 --> 00:07:24,550
have the x-rays interacting with with

168
00:07:30,389 --> 00:07:26,559
your object a lot of different things

169
00:07:32,639 --> 00:07:30,399
happen and the object has actually index

170
00:07:36,239 --> 00:07:32,649
of refraction that is complex in their

171
00:07:38,159 --> 00:07:36,249
index of refraction so this part is here

172
00:07:40,259 --> 00:07:38,169
is related to the absorption as I said

173
00:07:41,639 --> 00:07:40,269
but we also have this other part here

174
00:07:43,559 --> 00:07:41,649
that is actually related to another

175
00:07:46,529 --> 00:07:43,569
physical phenomena that is reflection

176
00:07:48,419 --> 00:07:46,539
refraction is also going on here so we

177
00:07:51,419 --> 00:07:48,429
may be able to explore this thing for

178
00:07:55,889 --> 00:07:51,429
seeing more information so if you have

179
00:07:58,109 --> 00:07:55,899
choo-choo x-ray waves coming they are in

180
00:08:02,639 --> 00:07:58,119
phase which means they have the both

181
00:08:04,529 --> 00:08:02,649
highs and lows together one will pass

182
00:08:06,209 --> 00:08:04,539
through your object it will be slowed

183
00:08:08,759 --> 00:08:06,219
down when passing to the object and when

184
00:08:10,949 --> 00:08:08,769
it's exit exit the object we they will

185
00:08:14,189 --> 00:08:10,959
not be any more in phase will have this

186
00:08:17,579 --> 00:08:14,199
phase change now and we can explore this

187
00:08:19,379 --> 00:08:17,589
to see if it as a contrast for the

188
00:08:21,749 --> 00:08:19,389

imaging in this take this type of

189
00:08:24,239 --> 00:08:21,759
approach is called phase contrast so

190
00:08:25,949 --> 00:08:24,249
coming back again to our fish we had

191
00:08:27,929 --> 00:08:25,959
this image with absorption city we took

192
00:08:30,149 --> 00:08:27,939
the same fish we did face contrast CT

193
00:08:31,859 --> 00:08:30,159
and now I have this image now we can see

194
00:08:35,029 --> 00:08:31,869
much more in from more more structures

195
00:08:37,379 --> 00:08:35,039
we can see a lot of different things and

196
00:08:40,469 --> 00:08:37,389
if you look to the stomach of this fish

197
00:08:42,329 --> 00:08:40,479
we can find this kind of last meal and

198
00:08:45,689 --> 00:08:42,339
if you cannot identify what it is I'll

199
00:08:47,639 --> 00:08:45,699
give you a clue and we did see this kind

200
00:08:49,889 --> 00:08:47,649
this is to show you how much more

201
00:08:52,140 --> 00:08:49,899
sensitive these phase countries are for

202
00:08:54,420 --> 00:08:52,150
forces so

203
00:08:55,920 --> 00:08:54,430
is really good for our micro sources

204
00:08:59,460 --> 00:08:55,930
right so let's try to expert

205
00:09:01,290 --> 00:08:59,470
phase-contrast in microphones so we did

206
00:09:03,090 --> 00:09:01,300
this and this technique we applied is

207
00:09:04,680 --> 00:09:03,100
called take over see we joined a

208
00:09:07,320 --> 00:09:04,690
congress abuse tomography so we did a

209
00:09:09,890 --> 00:09:07,330
phase contrast nano democracy using

210
00:09:12,990 --> 00:09:09,900
typography we put some micro process

211
00:09:17,160 --> 00:09:13,000
from Precambrian so we have this iron

212
00:09:20,040 --> 00:09:17,170
oxide preserved filaments of microbes we

213
00:09:21,960 --> 00:09:20,050

took them to the synchrotron source we

214
00:09:24,750 --> 00:09:21,970
use the six facts big line of the street

215
00:09:27,900 --> 00:09:24,760
light source and I will show you what we

216
00:09:30,990 --> 00:09:27,910
get with this technique so first thing

217
00:09:33,510 --> 00:09:31,000
that is very good we achieve the 52

218
00:09:37,040 --> 00:09:33,520
nanometer resolution which is great much

219
00:09:41,280 --> 00:09:37,050
higher than we could get with any other

220
00:09:43,260 --> 00:09:41,290
x-ray imaging so far we also have now

221
00:09:45,120 --> 00:09:43,270
the pixel intensity that is related to

222
00:09:47,160 --> 00:09:45,130
electron density because if the electron

223
00:09:51,000 --> 00:09:47,170
density of the compounds that gives the

224
00:09:52,890 --> 00:09:51,010
phase changes so we can extract the

225
00:09:54,990 --> 00:09:52,900
electron density which give us the best

226
00:09:56,730 --> 00:09:55,000
thing so we have also our information

227
00:09:59,670 --> 00:09:56,740
about what are these materials inside

228
00:10:02,400 --> 00:09:59,680
the fossils so we could identify clearly

229
00:10:04,500 --> 00:10:02,410
four different compounds in these micro

230
00:10:08,130 --> 00:10:04,510
fossils we have seen here the Sinica

231
00:10:09,810 --> 00:10:08,140
matrix we have these more wide

232
00:10:14,280 --> 00:10:09,820
structures that are more advanced they

233
00:10:16,380 --> 00:10:14,290
are the iron oxides that we already

234
00:10:18,690 --> 00:10:16,390
could see in red in the optical

235
00:10:21,150 --> 00:10:18,700
microscope and we have now the silica

236
00:10:22,980 --> 00:10:21,160
mixtures with the organic matter and you

237
00:10:24,540 --> 00:10:22,990
have also some really really low density

238
00:10:28,200 --> 00:10:24,550

structures that may have may be the

239
00:10:30,360 --> 00:10:28,210
degradation components the degradation

240
00:10:32,340 --> 00:10:30,370
cell membranes and septa that we had in

241
00:10:34,380 --> 00:10:32,350
the filament so just a little video to

242
00:10:36,090 --> 00:10:34,390
show you how it looks so we have here

243
00:10:38,910 --> 00:10:36,100
the the pillar of rock we have the

244
00:10:40,290 --> 00:10:38,920
filaments inside passing through it so

245
00:10:41,940 --> 00:10:40,300
we can see the the low density

246
00:10:43,890 --> 00:10:41,950
structures that I will mark here in blue

247
00:10:46,260 --> 00:10:43,900
we can see the body of the of the

248
00:10:47,940 --> 00:10:46,270
phosphor determine Green and I'm outside

249
00:10:50,580 --> 00:10:47,950
in orange and now we can have a 3d

250
00:10:52,710 --> 00:10:50,590
imaging knowing not only the

251
00:10:55,650 --> 00:10:52,720
morphological but also the the chemical

252
00:10:59,040 --> 00:10:55,660
information of this puzzle so we had

253
00:11:00,450 --> 00:10:59,050
before this image using visible light

254
00:11:02,250 --> 00:11:00,460
microscope and now we have this image

255
00:11:04,710 --> 00:11:02,260
much more information is the same

256
00:11:05,820 --> 00:11:04,720
structure and now we can see some

257
00:11:09,450 --> 00:11:05,830
features that we couldn't see

258
00:11:11,130 --> 00:11:09,460
for and we can even find a compound

259
00:11:17,130 --> 00:11:11,140
which can also help us to understand the

260
00:11:19,230 --> 00:11:17,140
cessation processes so conclusions using

261
00:11:22,230 --> 00:11:19,240
this different physical phenomena are

262
00:11:24,330 --> 00:11:22,240
allowing is allowing us to retrieve

263
00:11:27,870 --> 00:11:24,340

novel chemical and morphological

264
00:11:29,370 --> 00:11:27,880
information of microfossils the electron

265
00:11:31,290 --> 00:11:29,380
density contrasts with we can achieve

266
00:11:32,970 --> 00:11:31,300
this I cover fee associated with the

267
00:11:36,120 --> 00:11:32,980
nanometric resolution that we can also

268
00:11:38,220 --> 00:11:36,130
have with technique is able to give us

269
00:11:40,740 --> 00:11:38,230
some new insights into the most a lot

270
00:11:43,560 --> 00:11:40,750
more logical aspects and now we are able

271
00:11:45,650 --> 00:11:43,570
to start revisiting the biogenic

272
00:11:49,110 --> 00:11:45,660
secretaire that we design with the lower

273
00:11:50,520 --> 00:11:49,120
resolution imaging another very

274
00:11:52,260 --> 00:11:50,530
important thing is that we are talking

275
00:11:55,650 --> 00:11:52,270
about techniques that have little or no

276
00:11:57,540 --> 00:11:55,660
simple laws which is very important if

277
00:12:01,590 --> 00:11:57,550
we think now about bringing sample for

278
00:12:03,930 --> 00:12:01,600
Mars and we are proposing new approaches

279
00:12:06,060 --> 00:12:03,940
now for studying the the samples that

280
00:12:09,210 --> 00:12:06,070
will bring it in the near future for

281
00:12:11,700 --> 00:12:09,220
months so that's what we're doing

282
00:12:13,560 --> 00:12:11,710
thank you very much living with a little

283
00:12:15,810 --> 00:12:13,570
video of the new synchrotron that we are

284
00:12:18,210 --> 00:12:15,820
building in Brazil so will be open for

285
00:12:21,270 --> 00:12:18,220
your users soon so I hope some of you

286
00:12:23,760 --> 00:12:21,280
can go and use and Singleton's are open

287
00:12:33,360 --> 00:12:23,770
for the community so hope to see some of

288
00:12:35,310 --> 00:12:33,370

you so that's it thank you thank you

289
00:12:43,200 --> 00:12:35,320
very much large we have any questions

290
00:12:46,970 --> 00:12:43,210
I thought your talk was incredible great

291
00:12:50,130 --> 00:12:46,980
so I a question regarding the

292
00:12:53,010 --> 00:12:50,140
fossilization process have you maybe

293
00:12:57,060 --> 00:12:53,020
move this step further to build models

294
00:12:59,760 --> 00:12:57,070
for diagenesis we didn't but it's a

295
00:13:02,460 --> 00:12:59,770
possibility we don't have some studies

296
00:13:04,520 --> 00:13:02,470
that do in situ fossilization and one

297
00:13:06,870 --> 00:13:04,530
interesting thing would be really

298
00:13:08,430 --> 00:13:06,880
simulating this and you can measure in

299
00:13:10,200 --> 00:13:08,440
different times and seeing what happened

300
00:13:12,540 --> 00:13:10,210
because actually the preservation of

301
00:13:16,230 --> 00:13:12,550
this microarray music is is not to be

302
00:13:18,350 --> 00:13:16,240
quite fast doing silica criminalization

303
00:13:19,940 --> 00:13:18,360
so we still did

304
00:13:23,150 --> 00:13:19,950
but it's it's it's sure that it's

305
00:13:28,220 --> 00:13:23,160
possible so it's an interesting idea

306
00:13:43,810 --> 00:13:28,230
maybe for the future any further

307
00:13:48,560 --> 00:13:46,940
now this is a limitation of certain

308
00:13:53,120 --> 00:13:48,570
techniques because we cannot have

309
00:13:55,370 --> 00:13:53,130
portable synchrotrons so it's true we

310
00:14:00,560 --> 00:13:55,380
can we have other techniques aiming to

311
00:14:03,440 --> 00:14:00,570
find this stroke your signatures outside

312
00:14:07,759 --> 00:14:03,450
but they are limited compared to this

313
00:14:09,889 --> 00:14:07,769

one so we can have some clues but to

314
00:14:11,360 --> 00:14:09,899
have a really deep study we will really

315
00:14:19,730 --> 00:14:11,370
need to be simple so this is the biggest

316
00:14:23,360 --> 00:14:19,740
limitation for for looking for life any

317
00:14:25,240 --> 00:14:23,370
further questions okay thank you so much