
AbSciCon
2019

1
00:00:00,790 --> 00:00:07,320
[Music]

2
00:00:12,640 --> 00:00:09,030
[Applause]

3
00:00:14,260 --> 00:00:12,650
so I'm going to talk about molecules are

4
00:00:18,010 --> 00:00:14,270
a bit more complex than what Maksym

5
00:00:21,359 --> 00:00:18,020
which is talking about but using the

6
00:00:23,800 --> 00:00:21,369
same kind of processes to form them so

7
00:00:26,259 --> 00:00:23,810
while I was interested in that first is

8
00:00:28,660 --> 00:00:26,269
because we know that for several decades

9
00:00:30,519 --> 00:00:28,670
lab experiments have shown that the

10
00:00:33,970 --> 00:00:30,529
photochemistry are very simple ices such

11
00:00:35,860 --> 00:00:33,980
as water methanol co co 2 CH 4 NH 3

12
00:00:38,470 --> 00:00:35,870
leads to the formation of very complex

13
00:00:41,530 --> 00:00:38,480

molecules such as amino acids and

14
00:00:43,180 --> 00:00:41,540
amplifiers and some nuclear bases - so

15
00:00:45,040 --> 00:00:43,190
there's a lot of work had been done that

16
00:00:50,350 --> 00:00:45,050
different labs and what we're trying to

17
00:00:53,700 --> 00:00:50,360
simulate in the simulations is to to

18
00:00:56,110 --> 00:00:53,710
like simulate the the conversation of

19
00:00:58,780 --> 00:00:56,120
volatize like Isis such as methanol

20
00:01:01,540 --> 00:00:58,790
water etc encore grains and it radiates

21
00:01:05,259 --> 00:01:01,550
them with photons sometimes electrons

22
00:01:08,980 --> 00:01:05,269
and we see that this induces very

23
00:01:10,240 --> 00:01:08,990
complex chemistry in this Isis and leads

24
00:01:13,000 --> 00:01:10,250
to the formation of very complex

25
00:01:15,160 --> 00:01:13,010
molecules and what is interesting at the

26
00:01:17,380 --> 00:01:15,170
same time is that all those molecules

27
00:01:20,530 --> 00:01:17,390
have been seen also in me right so if

28
00:01:22,690 --> 00:01:20,540
you analyze carbonaceous meteorite such

29
00:01:25,360 --> 00:01:22,700
as Murchison you see a lot of the same

30
00:01:28,240 --> 00:01:25,370
kind of compounds like amino acids and

31
00:01:30,340 --> 00:01:28,250
Fugue molecules nuclear bases and one

32
00:01:32,440 --> 00:01:30,350
the one family of Markey that was left

33
00:01:36,700 --> 00:01:32,450
out for a long time in the lab at least

34
00:01:39,340 --> 00:01:36,710
was the sugar derivatives and so George

35
00:01:41,740 --> 00:01:39,350
Cooper in 2001 published this paper and

36
00:01:44,500 --> 00:01:41,750
where he found a lot of sugar

37
00:01:48,850 --> 00:01:44,510
derivatives in Murchison and marry me

38
00:01:51,190 --> 00:01:48,860

right and as you can see here actually

39
00:01:53,500 --> 00:01:51,200
what he found is like only one very

40
00:01:55,750 --> 00:01:53,510
small sugar in a lot of sugar

41
00:01:58,149 --> 00:01:55,760
derivatives such as sugar alcohol and

42
00:01:59,830 --> 00:01:58,159
sugar acids are also a lot of other

43
00:02:05,440 --> 00:01:59,840
things that we talked about maybe later

44
00:02:07,840 --> 00:02:05,450
but until very recently until I started

45
00:02:10,240 --> 00:02:07,850
to actually start to figure out how the

46
00:02:13,000 --> 00:02:10,250
way to to search for this sugar

47
00:02:14,680 --> 00:02:13,010
derivative in in the lab it was not

48
00:02:16,730 --> 00:02:14,690
something very common and I will explain

49
00:02:19,100 --> 00:02:16,740
why right after and

50
00:02:22,190 --> 00:02:19,110
after that other people got interested

51
00:02:26,360 --> 00:02:22,200
in that and Kannada is here found ribose

52
00:02:29,270 --> 00:02:26,370
in in in one of those lab experiments we

53
00:02:30,830 --> 00:02:29,280
should talk about that also later and so

54
00:02:32,840 --> 00:02:30,840
the reason why it's very complicated to

55
00:02:34,610 --> 00:02:32,850
do for sugars into this residues is

56
00:02:37,310 --> 00:02:34,620
because these videos are made of a lot

57
00:02:39,770 --> 00:02:37,320
of very different molecules very complex

58
00:02:42,110 --> 00:02:39,780
molecules and sugars themselves you have

59
00:02:44,150 --> 00:02:42,120
a lot of different possibilities you can

60
00:02:45,440 --> 00:02:44,160
go this is only from like three to six

61
00:02:47,480 --> 00:02:45,450
carbon atoms you can see how many

62
00:02:50,480 --> 00:02:47,490
different sugars you have and I'm only

63
00:02:52,340 --> 00:02:50,490

showing one enantiomer to music you have

64
00:02:56,840 --> 00:02:52,350
also like the the mirror image of all

65
00:02:59,690 --> 00:02:56,850
these two this is another view of the

66
00:03:00,920 --> 00:02:59,700
same molecules and just to show this is

67
00:03:03,650 --> 00:03:00,930
the only one that was found in

68
00:03:05,660 --> 00:03:03,660
meteorites but also you also have like

69
00:03:08,000 --> 00:03:05,670
so sugar acids when you replace the

70
00:03:09,770 --> 00:03:08,010
terminal carbon here by a carboxylic

71
00:03:14,510 --> 00:03:09,780
acid group and if you replace it with

72
00:03:16,010 --> 00:03:14,520
another alcohol group here you have all

73
00:03:18,350 --> 00:03:16,020
the sugar alcohols and again you

74
00:03:20,000 --> 00:03:18,360
multiply that by two and because you

75
00:03:23,030 --> 00:03:20,010
have two innocuous for almost all of

76
00:03:25,400 --> 00:03:23,040
those something very difficult to that

77
00:03:28,090 --> 00:03:25,410
sugars can exist in like linear form

78
00:03:31,250 --> 00:03:28,100
about so in cyclic forms either like

79
00:03:34,250 --> 00:03:31,260
five carbon rings or like six carbon

80
00:03:37,250 --> 00:03:34,260
ring so you also not apply that again so

81
00:03:41,030 --> 00:03:37,260
you can imagine how complex it is but so

82
00:03:43,790 --> 00:03:41,040
I try to find a method so we can still

83
00:03:45,580 --> 00:03:43,800
see these molecules and see if we can

84
00:03:48,980 --> 00:03:45,590
compare with what we found in meteorites

85
00:03:54,590 --> 00:03:48,990
so we do that in the lab using a vacuum

86
00:03:56,090 --> 00:03:54,600
chamber where we go down to pressures

87
00:03:59,240 --> 00:03:56,100
about like ten to the minus eight tours

88
00:04:04,640 --> 00:03:59,250

and we cool down a substrate down to

89
00:04:07,250 --> 00:04:04,650
about 10k and we deposit gases that we

90
00:04:10,010 --> 00:04:07,260
premix ahead of time and we deposit them

91
00:04:12,590 --> 00:04:10,020
on this cold substrate and form ice

92
00:04:17,150 --> 00:04:12,600
films that we're going to irradiate with

93
00:04:19,550 --> 00:04:17,160
a hydrogen lamp that emits photons like

94
00:04:24,140 --> 00:04:19,560
lime and iPhone photons and other

95
00:04:25,580 --> 00:04:24,150
photons in the h2 transition range so as

96
00:04:26,629 --> 00:04:25,590
you can see it's very pretty

97
00:04:28,700 --> 00:04:26,639
lamp

98
00:04:30,589 --> 00:04:28,710
and actually we spend hours staring at

99
00:04:35,659 --> 00:04:30,599
it every time we make it it's so pretty

100
00:04:38,240 --> 00:04:35,669
so pretty so for this experiment we did

101
00:04:39,589 --> 00:04:38,250
something very simple we just mix water

102
00:04:41,450 --> 00:04:39,599
in methanol because we know there are

103
00:04:44,540 --> 00:04:41,460
very abundant in Astrophysical

104
00:04:48,589 --> 00:04:44,550
environments as Maxime just talked about

105
00:04:50,749 --> 00:04:48,599
and so we departed them on a substrate

106
00:04:53,619 --> 00:04:50,759
at a 10 K and we're ready with this

107
00:04:56,420 --> 00:04:53,629
beautiful lamp for about 20 hours and

108
00:04:58,969 --> 00:04:56,430
after we we are done with the radiation

109
00:05:01,790 --> 00:04:58,979
we warm up to room temperature and we

110
00:05:05,540 --> 00:05:01,800
recover what is left on the substrate

111
00:05:07,339 --> 00:05:05,550
which is a molecule of residue and we

112
00:05:09,350 --> 00:05:07,349
analyze that with chemical techniques so

113
00:05:12,610 --> 00:05:09,360

that gas chromatography with different

114
00:05:15,409 --> 00:05:12,620
methods here so one of the first

115
00:05:18,499 --> 00:05:15,419
experiments I did I just mix a water in

116
00:05:21,170 --> 00:05:18,509
methanol in a two-to-one proportions and

117
00:05:23,450 --> 00:05:21,180
you can see this is the chromatograph we

118
00:05:25,420 --> 00:05:23,460
obtained so we just separate basically

119
00:05:28,279 --> 00:05:25,430
all the compounds inside of this

120
00:05:31,279 --> 00:05:28,289
complicated mixture and we could

121
00:05:33,740 --> 00:05:31,289
identify a few compounds in this

122
00:05:36,200 --> 00:05:33,750
chromatogram those are all the sugar

123
00:05:38,749 --> 00:05:36,210
alcohols from three to five carbons here

124
00:05:41,480 --> 00:05:38,759
and you can see also that the in the

125
00:05:43,959 --> 00:05:41,490
abundance of those compounds decreases

126
00:05:46,579 --> 00:05:43,969
with the with the size of the compound

127
00:05:49,059 --> 00:05:46,589
and if you look at the smaller features

128
00:05:54,200 --> 00:05:49,069
you can also see that we can have some

129
00:05:57,230 --> 00:05:54,210
sugars here three and four carbon and a

130
00:05:59,570 --> 00:05:57,240
few sugar acids if you summarize that in

131
00:06:01,189 --> 00:05:59,580
a table you can see that in this very

132
00:06:04,309 --> 00:06:01,199
simple experiment with just water and

133
00:06:06,290 --> 00:06:04,319
methanol you can make a lot of sugar

134
00:06:08,329 --> 00:06:06,300
alcohols which are the most abundant

135
00:06:11,600 --> 00:06:08,339
compounds and then a little bit less of

136
00:06:12,890 --> 00:06:11,610
sugars and less sugar acids this is not

137
00:06:15,050 --> 00:06:12,900
what we see in meteorites in meteorites

138
00:06:18,110 --> 00:06:15,060

we see a lot of sugar alcohols and we

139
00:06:22,579 --> 00:06:18,120
see a lot of sugar acids but only one

140
00:06:25,839 --> 00:06:22,589
sugar was actually identified just to

141
00:06:29,869 --> 00:06:25,849
give you a for comparison in this sample

142
00:06:31,909 --> 00:06:29,879
this number corresponds to about 109 and

143
00:06:33,950 --> 00:06:31,919
19 animals in the sample which

144
00:06:35,659 --> 00:06:33,960
corresponds more or less at what you can

145
00:06:36,560 --> 00:06:35,669
find in one gram of the Murchison

146
00:06:40,260 --> 00:06:36,570
meteorite

147
00:06:42,600 --> 00:06:40,270
so according to that table but what I

148
00:06:45,510 --> 00:06:42,610
think is going on in those samples is

149
00:06:47,430 --> 00:06:45,520
that you start with methanol and you

150
00:06:49,170 --> 00:06:47,440
start to polymerize it somehow so you

151
00:06:51,480 --> 00:06:49,180
put three together you get a glycerol

152
00:06:54,390 --> 00:06:51,490
and you can add more and more and make

153
00:06:56,850 --> 00:06:54,400
more and more complex sugar alcohols and

154
00:06:58,439 --> 00:06:56,860
if you oxidize then you start to make

155
00:07:00,150 --> 00:06:58,449
the sugars and the sugar acid so

156
00:07:02,249 --> 00:07:00,160
basically if you go from here to here

157
00:07:05,279 --> 00:07:02,259
the abundance should decrease because

158
00:07:07,140 --> 00:07:05,289
you have no steps to form those

159
00:07:10,740 --> 00:07:07,150
molecules and this is more as what I see

160
00:07:13,230 --> 00:07:10,750
in the experiments so in another

161
00:07:14,939 --> 00:07:13,240
experiment here published in 2016 where

162
00:07:18,900 --> 00:07:14,949
they found a ribose in one of these

163
00:07:21,300 --> 00:07:18,910

experiments they also kind of agree with

164
00:07:23,010 --> 00:07:21,310
what I just said because they have a lot

165
00:07:23,850 --> 00:07:23,020
of different compounds they found more

166
00:07:29,070 --> 00:07:23,860
than I did

167
00:07:31,980 --> 00:07:29,080
and if you look at this five carbon

168
00:07:35,400 --> 00:07:31,990
compounds here you have the sugar

169
00:07:40,800 --> 00:07:35,410
alcohols made in bigger abundance than

170
00:07:44,400 --> 00:07:40,810
the sugars and then the sugar acids so

171
00:07:47,670 --> 00:07:44,410
in this table then I started to think

172
00:07:51,899 --> 00:07:47,680
about what about the other part of of

173
00:07:55,800 --> 00:07:51,909
this table here can we find any deoxy

174
00:07:58,740 --> 00:07:55,810
sugar derivatives in just those residues

175
00:08:01,620 --> 00:07:58,750
and so I looked at the literature and

176
00:08:04,170 --> 00:08:01,630
see if anybody had talked about like a

177
00:08:07,140 --> 00:08:04,180
way to form for example deoxyribose

178
00:08:10,680 --> 00:08:07,150
which is the sugar of the DNA in the lab

179
00:08:15,089 --> 00:08:10,690
and I found a very old paper from 1962

180
00:08:17,129 --> 00:08:15,099
where they mix these small molecules in

181
00:08:18,450 --> 00:08:17,139
the presence of a catalyst at 50 C and

182
00:08:21,149 --> 00:08:18,460
they could make a little bit of

183
00:08:23,670 --> 00:08:21,159
deoxyribose and other people that I

184
00:08:27,210 --> 00:08:23,680
found and more written that it's a very

185
00:08:33,300 --> 00:08:27,220
complex like protocol here a very

186
00:08:36,000 --> 00:08:33,310
specific light source and also at 37 C

187
00:08:38,820 --> 00:08:36,010
and starting from ribose and arabinose

188
00:08:40,860 --> 00:08:38,830

here they could actually get rid of the

189
00:08:43,380 --> 00:08:40,870
which group here to make the oxy

190
00:08:46,050 --> 00:08:43,390
variable somehow but that's all I found

191
00:08:48,420 --> 00:08:46,060
about the formation of deoxyribose in

192
00:08:50,380 --> 00:08:48,430
non-biological like processes in the lab

193
00:08:53,079 --> 00:08:50,390
and so I look

194
00:08:54,009 --> 00:08:53,089
for the oxy ribosomes in the same kind

195
00:08:57,180 --> 00:08:54,019
of samples

196
00:09:00,160 --> 00:08:57,190
starting from water and methanol and I

197
00:09:02,259 --> 00:09:00,170
could find it so and to make sure that

198
00:09:04,420 --> 00:09:02,269
this was no contamination I did really

199
00:09:06,940 --> 00:09:04,430
do the experiments with carbon 13

200
00:09:10,840 --> 00:09:06,950
methanol and so that appears also here

201
00:09:13,990 --> 00:09:10,850
this is a comparison of the mass spectra

202
00:09:16,180 --> 00:09:14,000
with a standard and in the same sample I

203
00:09:19,389 --> 00:09:16,190
look for ribose and I found it too and

204
00:09:22,420 --> 00:09:19,399
so I could see I could confirm previous

205
00:09:24,220 --> 00:09:22,430
results also and and I could also try to

206
00:09:25,660 --> 00:09:24,230
figure out what is the relative

207
00:09:28,509 --> 00:09:25,670
proportion between deoxyribose and

208
00:09:30,610 --> 00:09:28,519
ribose in those experiments something I

209
00:09:32,470 --> 00:09:30,620
also found interesting that this these

210
00:09:35,199 --> 00:09:32,480
Peaks here correspond to something that

211
00:09:36,880 --> 00:09:35,209
we don't have a standard for so VD was

212
00:09:39,579 --> 00:09:36,890
very hard to determine what it was but

213
00:09:43,150 --> 00:09:39,589

we think it's one of its the only

214
00:09:45,940 --> 00:09:43,160
actually isomer of deoxyribose that has

215
00:09:46,720 --> 00:09:45,950
exactly the same mass spectrum George

216
00:09:48,490 --> 00:09:46,730
Cooper call it

217
00:09:51,910 --> 00:09:48,500
VOCs ILO's I don't think it's official

218
00:09:53,290 --> 00:09:51,920
but that's what we think it is and it's

219
00:09:58,840 --> 00:09:53,300
pretty cool because it's very abundant

220
00:10:02,050 --> 00:09:58,850
too and so if you measure the abundance

221
00:10:06,670 --> 00:10:02,060
of ribose and deoxyribose in every

222
00:10:11,050 --> 00:10:06,680
sample and you try to get the ratios you

223
00:10:14,170 --> 00:10:11,060
can see that it's pretty like wide it

224
00:10:15,670 --> 00:10:14,180
goes from point 2 to 3 point 3 which

225
00:10:17,230 --> 00:10:15,680
means that sometimes ribose is the most

226
00:10:19,780 --> 00:10:17,240
abundant compound and sometimes

227
00:10:23,470 --> 00:10:19,790
deoxyribose is more abundant what it

228
00:10:25,689 --> 00:10:23,480
shows is that it's very hard to to

229
00:10:27,819 --> 00:10:25,699
figure out what kind of mechanism leads

230
00:10:29,139 --> 00:10:27,829
to the formation of deoxyribose in that

231
00:10:31,689 --> 00:10:29,149
case we don't know if it's made from

232
00:10:36,130 --> 00:10:31,699
small molecules to bigger ones or from

233
00:10:38,380 --> 00:10:36,140
ribose that has lost an orange group to

234
00:10:40,360 --> 00:10:38,390
deoxyribose and probably none of the

235
00:10:41,259 --> 00:10:40,370
mechanism can be rolled out so it's

236
00:10:44,680 --> 00:10:41,269
probably a combination of different

237
00:10:46,150 --> 00:10:44,690
mechanism and I'm not sure this supports

238
00:10:49,090 --> 00:10:46,160

like a pure foremost we actually make

239
00:10:52,600 --> 00:10:49,100
mechanism because I'm pressurized to

240
00:10:55,900 --> 00:10:52,610
make sure a lot of different things so I

241
00:10:59,260 --> 00:10:55,910
also look for other deoxy sugar

242
00:11:02,050 --> 00:10:59,270
derivatives in the same samples and in

243
00:11:02,869 --> 00:11:02,060
meteorites George found a lot of deoxy

244
00:11:05,689 --> 00:11:02,879
sugar

245
00:11:07,879 --> 00:11:05,699
but I couldn't find any what I did found

246
00:11:12,919 --> 00:11:07,889
though is a lot of deoxy sugar alcohols

247
00:11:16,340 --> 00:11:12,929
with 3 and 4 carbons so all here and a

248
00:11:19,669 --> 00:11:16,350
meteorite George measured new samples

249
00:11:22,009 --> 00:11:19,679
using the same method to compare and he

250
00:11:25,309 --> 00:11:22,019
found a few of them 2 3 & 4 carbon atoms

251
00:11:28,819 --> 00:11:25,319
and those two were found in the in the

252
00:11:31,849 --> 00:11:28,829
residues but I couldn't find the the

253
00:11:34,039 --> 00:11:31,859
third one in my samples and also we

254
00:11:36,889 --> 00:11:34,049
couldn't find any deoxyribose or any

255
00:11:39,009 --> 00:11:36,899
like alcohol or acid equivalent of

256
00:11:43,099 --> 00:11:39,019
deoxyribose in the middle heads

257
00:11:46,129 --> 00:11:43,109
so to summarize the irradiation of water

258
00:11:47,509 --> 00:11:46,139
and methanol ice mixture leads to the

259
00:11:49,729 --> 00:11:47,519
formation of very complex molecules

260
00:11:51,739 --> 00:11:49,739
including sugar and deoxy sugar

261
00:11:56,960 --> 00:11:51,749
derivatives between e deoxyribose and

262
00:11:58,460 --> 00:11:56,970
ribose i talked about the mechanism i

263
00:12:03,590 --> 00:11:58,470

don't think it's a pure for most

264
00:12:05,749 --> 00:12:03,600
reaction and so the distribution of this

265
00:12:07,399 --> 00:12:05,759
compounds is very different from from

266
00:12:08,869 --> 00:12:07,409
what we see in meteorites and so we need

267
00:12:10,699 --> 00:12:08,879
to understand why it can be for

268
00:12:12,729 --> 00:12:10,709
different reasons because the the

269
00:12:15,829 --> 00:12:12,739
starting mixture is different from what

270
00:12:17,329 --> 00:12:15,839
the the ices are made of in in

271
00:12:19,159 --> 00:12:17,339
Astrophysical environment is one

272
00:12:22,579 --> 00:12:19,169
possibility and another possibility is

273
00:12:25,699 --> 00:12:22,589
also because those residues could be

274
00:12:29,869 --> 00:12:25,709
like altered with like aqueous adoration

275
00:12:33,590 --> 00:12:29,879
in meteorites and asteroids and lead to

276
00:12:37,399 --> 00:12:33,600
a different distribution and so we have

277
00:12:38,960 --> 00:12:37,409
to to study that in more detail so I

278
00:12:42,769 --> 00:12:38,970
would like to thank all the co-authors

279
00:12:45,710 --> 00:12:42,779
of for this work all the people who got

280
00:12:48,109 --> 00:12:45,720
involved on point and funding from NASA

281
00:12:49,579 --> 00:12:48,119
programs and you for your attention and

282
00:12:54,800 --> 00:12:49,589
if you have any question I'd be happy to

283
00:13:22,380 --> 00:12:58,800
Thank You Misha do we have any questions

284
00:13:24,300 --> 00:13:22,390
for the port so when I meant what I was

285
00:13:26,250 --> 00:13:24,310
talking about like we don't know which

286
00:13:28,620 --> 00:13:26,260
mechanism lead to that is because we

287
00:13:31,350 --> 00:13:28,630
only see the results right but it's

288
00:13:33,480 --> 00:13:31,360

probably a combination of like making

289
00:13:34,890 --> 00:13:33,490
something bigger and then destroying it

290
00:13:36,690 --> 00:13:34,900
and making it bigger again it's probably

291
00:13:38,550 --> 00:13:36,700
a very complex combination of

292
00:13:41,160 --> 00:13:38,560
destruction and formation of different

293
00:13:44,670 --> 00:13:41,170
different compounds that lead eventually

294
00:13:47,190 --> 00:13:44,680
to the formation of so in globally it

295
00:13:48,840 --> 00:13:47,200
goes to complexity but it's not a

296
00:13:52,380 --> 00:13:48,850
straight line definitely probably goes

297
00:14:00,360 --> 00:13:52,390
up and down many times all right we have

298
00:14:02,700 --> 00:14:00,370
another one here can you distinguish

299
00:14:05,550 --> 00:14:02,710
between two Prime and three prime deoxy

300
00:14:09,480 --> 00:14:05,560
ribose and if so what how do you explain

301
00:14:12,810 --> 00:14:09,490
where you only get one so I got a

302
00:14:14,520 --> 00:14:12,820
standard only for the for the two so I

303
00:14:18,270 --> 00:14:14,530
didn't have a standard for the three so

304
00:14:20,820 --> 00:14:18,280
maybe it's also there but I couldn't I

305
00:14:22,710 --> 00:14:20,830
couldn't look for it so and again it's

306
00:14:23,970 --> 00:14:22,720
like the other deoxys I love the saying

307
00:14:27,150 --> 00:14:23,980
we don't have the standard so we can

308
00:14:29,550 --> 00:14:27,160
guess and this one was very easy I guess

309
00:14:31,500 --> 00:14:29,560
to guess because it was the spectrum is

310
00:14:32,760 --> 00:14:31,510
very similar to the two deoxyribose

311
00:14:35,460 --> 00:14:32,770
before the other one I don't think we

312
00:14:37,920 --> 00:14:35,470
have the standard I like do you do I

313
00:14:39,210 --> 00:14:37,930

don't know if it exists actually just

314
00:14:42,020 --> 00:14:39,220
standard exists for the three

315
00:14:47,490 --> 00:14:42,030
deoxyribose I don't know probably

316
00:14:50,580 --> 00:14:47,500
alright last question so J snorky NASA

317
00:14:52,980 --> 00:14:50,590
Goddard your Isis or your residues are

318
00:14:56,100 --> 00:14:52,990
arguably much fresher than meteorite and

319
00:14:59,580 --> 00:14:56,110
so you may consider that the

320
00:15:01,060 --> 00:14:59,590
decomposition rate of deoxy sugars are

321
00:15:05,200 --> 00:15:01,070
far slower than

322
00:15:07,920 --> 00:15:05,210
of regular sugars there's Laura day 2005

323
00:15:12,850 --> 00:15:07,930
sorry 1995 paper that might be helpful

324
00:15:15,550 --> 00:15:12,860
so actually that's why George tried to

325
00:15:17,020 --> 00:15:15,560
analyze those new samples of murchison

326
00:15:19,750 --> 00:15:17,030
to look for deoxyribose because he

327
00:15:21,730 --> 00:15:19,760
thought also that it there would be more

328
00:15:24,820 --> 00:15:21,740
chance to find it there but but he

329
00:15:27,070 --> 00:15:24,830
couldn't like for sure said that that he

330
00:15:30,010 --> 00:15:27,080
could see it there so he preferred to

331
00:15:31,720 --> 00:15:30,020
say we did just didn't see it but yeah I