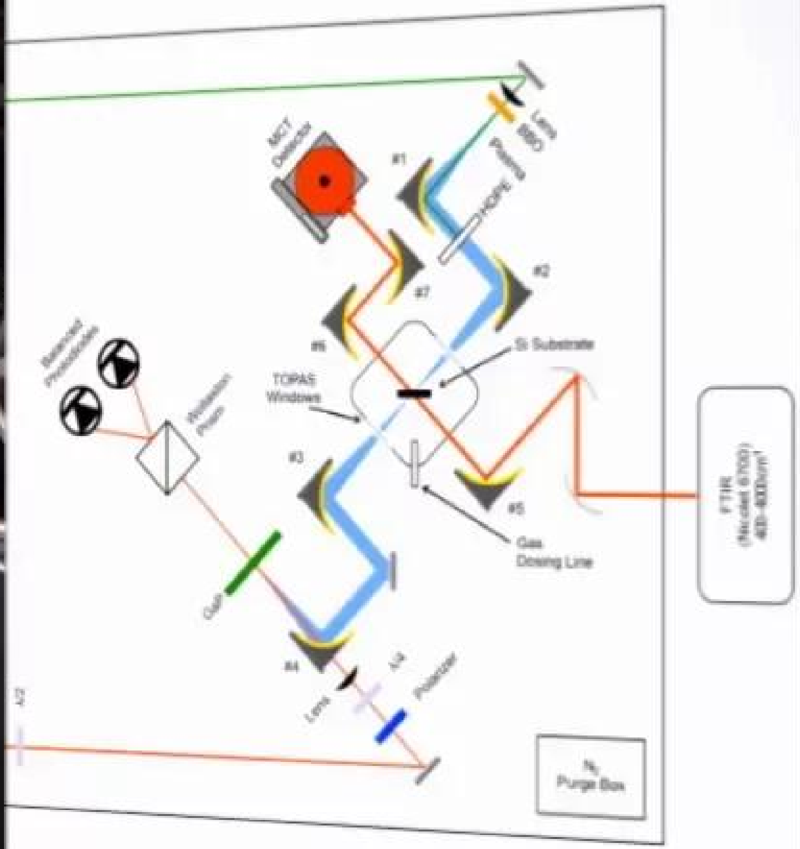
HOW THz?


Gas Dosing Line
Si Substrate


MCT Detector
#1
#2
#3
#4
#5
#6
#7
Si Substrate
TOPAS Windows
Gas Dosing Line
GaP
Lens
Polarizer
FTIR
N₂ Purge Box

1
00:00:12,440 --> 00:00:09,440
we talk about some novel work we're

2
00:00:16,310 --> 00:00:12,450
doing trying to do understand my

3
00:00:18,650 --> 00:00:16,320
observations of Isis in a new way so I

4
00:00:20,330 --> 00:00:18,660
brought this up before but why Isis well

5
00:00:23,060 --> 00:00:20,340
of the hundred and eighty molecules

6
00:00:25,400 --> 00:00:23,070
detected in space anything you want to

7
00:00:27,470 --> 00:00:25,410
make larger than methanol probably has

8
00:00:29,240 --> 00:00:27,480
to be made on a grain surface so these

9
00:00:31,160 --> 00:00:29,250
are the places you want to look if you

10
00:00:34,400 --> 00:00:31,170
want to understand complex molecule

11
00:00:36,080 --> 00:00:34,410
formation one of the problems we run

12
00:00:38,569 --> 00:00:36,090
into now is that these are the only

13
00:00:39,860 --> 00:00:38,579

molecules we have actually detected in a

14
00:00:42,080 --> 00:00:39,870
night's these are the only molecules

15
00:00:44,450 --> 00:00:42,090
we've detected where we think they're

16
00:00:47,029 --> 00:00:44,460
frozen out in forming everything bigger

17
00:00:49,400 --> 00:00:47,039
and most of the other species are just

18
00:00:51,500 --> 00:00:49,410
not observed so far and this is a big

19
00:00:53,180 --> 00:00:51,510
this is a big impediment to actually

20
00:00:55,779 --> 00:00:53,190
understanding ice chemistry because

21
00:00:58,970 --> 00:00:55,789
interstellar observations are how we

22
00:01:00,560 --> 00:00:58,980
reconcile our theory with what's

23
00:01:02,990 --> 00:01:00,570
actually going on and if we can't detect

24
00:01:06,620 --> 00:01:03,000
bigger more complicated things this is a

25
00:01:09,260 --> 00:01:06,630
problem so I we're a terahertz

26
00:01:10,340 --> 00:01:09,270
spectroscopy group so we obviously want

27
00:01:12,710 --> 00:01:10,350
to try to solve this problem with

28
00:01:15,140 --> 00:01:12,720
terahertz spectroscopy so terahertz is

29
00:01:17,450 --> 00:01:15,150
sometimes called the far infrared it's

30
00:01:19,550 --> 00:01:17,460
very long wavelengths infrared radiation

31
00:01:22,270 --> 00:01:19,560
or verging on very high frequency

32
00:01:24,499 --> 00:01:22,280
microwave it spans the two and so the

33
00:01:26,990 --> 00:01:24,509
transitions usually see here are either

34
00:01:28,870 --> 00:01:27,000
very low frequency large amplitude

35
00:01:31,700 --> 00:01:28,880
vibrations from single molecules or

36
00:01:33,380 --> 00:01:31,710
collective vibrations of solids and it's

37
00:01:36,140 --> 00:01:33,390
the collective vibrations of solids we

38
00:01:37,910 --> 00:01:36,150

want to go after and what we want to do

39
00:01:40,190 --> 00:01:37,920
is exploit the fact that it's very long

40
00:01:42,499 --> 00:01:40,200
wavelengths so this is two optical

41
00:01:44,690 --> 00:01:42,509
images of discs and you'll notice

42
00:01:47,330 --> 00:01:44,700
they're very fuzzy and opaque so there's

43
00:01:49,910 --> 00:01:47,340
mass here it's obstructing all of the

44
00:01:52,130 --> 00:01:49,920
optical photons dust is extremely opaque

45
00:01:53,660 --> 00:01:52,140
at optical frequencies as you go lower

46
00:01:55,130 --> 00:01:53,670
and lower in frequency the disc gets

47
00:01:56,749 --> 00:01:55,140
more and more transparent and you can

48
00:01:58,429 --> 00:01:56,759
start seeing through it but all the

49
00:02:00,469 --> 00:01:58,439
really interesting stuff in the disc the

50
00:02:01,940 --> 00:02:00,479
ice especially is all completely

51
00:02:03,740 --> 00:02:01,950
obscured because the outer edge of the

52
00:02:08,089 --> 00:02:03,750
disc is just blocking all of the light

53
00:02:10,760 --> 00:02:08,099
and so this I put this light up before

54
00:02:12,020 --> 00:02:10,770
but really quickly I this is really

55
00:02:14,030 --> 00:02:12,030
important because if we want to actually

56
00:02:16,280 --> 00:02:14,040
see into the really into

57
00:02:17,869 --> 00:02:16,290
in parts of protoplanetary discs the

58
00:02:19,699 --> 00:02:17,879
interesting stuff is happening in the

59
00:02:23,390 --> 00:02:19,709
mid plane that's where ice is freezing

60
00:02:26,059 --> 00:02:23,400
out ice freeze out drives aggregation of

61
00:02:28,009 --> 00:02:26,069
small dust grains into bigger ones in

62
00:02:29,809 --> 00:02:28,019
fact ice is probably how you get over

63
00:02:31,759 --> 00:02:29,819

the centimeter problem building up

64
00:02:34,960 --> 00:02:31,769
bigger and bigger particles generally

65
00:02:37,339 --> 00:02:34,970
requires icy bodies and it also whoops

66
00:02:41,569 --> 00:02:37,349
see if it's going to change it also

67
00:02:43,369 --> 00:02:41,579
requires a mass transport so this is

68
00:02:44,839 --> 00:02:43,379
going to be what drives the composition

69
00:02:47,509 --> 00:02:44,849
of your planet's and where all your

70
00:02:50,210 --> 00:02:47,519
organics end up and all your water and

71
00:02:51,890 --> 00:02:50,220
the problem is if you want to look at

72
00:02:54,110 --> 00:02:51,900
the mid plane of the disk you're only

73
00:02:55,490 --> 00:02:54,120
going to see very little in so if you

74
00:02:57,259 --> 00:02:55,500
want to see in towards the center where

75
00:02:59,030 --> 00:02:57,269
the ice is actually freezing out you

76
00:03:01,699 --> 00:02:59,040
need a way to look at it so

77
00:03:04,369 --> 00:03:01,709
traditionally the way I observations are

78
00:03:06,140 --> 00:03:04,379
done is through trans absorption

79
00:03:08,330 --> 00:03:06,150
spectroscopy so you have starred in the

80
00:03:10,640 --> 00:03:08,340
background you have ice along the line

81
00:03:14,240 --> 00:03:10,650
of sight and then you detect absorption

82
00:03:15,559 --> 00:03:14,250
of this but the problem is as you build

83
00:03:17,449 --> 00:03:15,569
up more and more dust in the line of

84
00:03:19,520 --> 00:03:17,459
sight well it gets a fake very quickly

85
00:03:21,589 --> 00:03:19,530
at terahertz frequencies though the dust

86
00:03:23,300 --> 00:03:21,599
is completely transparent and light goes

87
00:03:24,800 --> 00:03:23,310
right through unless it's absorbed by

88
00:03:27,979 --> 00:03:24,810

the ice or at least it's far more

89
00:03:29,689 --> 00:03:27,989
transparent I and the other thing that's

90
00:03:31,460 --> 00:03:29,699
very helpful is that you need a

91
00:03:33,229 --> 00:03:31,470
background star in the infrared so to do

92
00:03:35,330 --> 00:03:33,239
an emission experiment to get ice to

93
00:03:37,039 --> 00:03:35,340
emit you'd have to heat it up to several

94
00:03:38,449 --> 00:03:37,049
hundred Kelvin if you heed nice to

95
00:03:41,449 --> 00:03:38,459
several hundred Kelvin the ice is

96
00:03:43,490 --> 00:03:41,459
evaporated already so the only way to do

97
00:03:45,770 --> 00:03:43,500
it is absorption so you have to find a

98
00:03:47,300 --> 00:03:45,780
place with ice and then a star in the

99
00:03:49,369 --> 00:03:47,310
background that hasn't desorbed your ice

100
00:03:51,229 --> 00:03:49,379
so there's a very limited number of

101
00:03:55,369 --> 00:03:51,239
places we can actually observe ice in

102
00:03:57,110 --> 00:03:55,379
space I so that's the problem we want to

103
00:03:59,750 --> 00:03:57,120
do this with terahertz but the problem

104
00:04:01,399 --> 00:03:59,760
is terahertz spectra of Isis and far

105
00:04:03,020 --> 00:04:01,409
infrared don't really exist or they're

106
00:04:04,550 --> 00:04:03,030
fairly limited turns out making

107
00:04:07,909 --> 00:04:04,560
terahertz photons is actually very

108
00:04:09,920 --> 00:04:07,919
difficult so we go through a lot of

109
00:04:12,020 --> 00:04:09,930
trouble to make them it's a big

110
00:04:14,929 --> 00:04:12,030
complicated slide but basically what we

111
00:04:17,509 --> 00:04:14,939
do is we take an ultra-fast laser so few

112
00:04:19,099 --> 00:04:17,519
tens of femtosecond long pulse we focus

113
00:04:21,589 --> 00:04:19,109

it down to a point and we generate a

114
00:04:23,600 --> 00:04:21,599
plasma so this is our little plasma it

115
00:04:25,610 --> 00:04:23,610
throws off a huge amount of optical

116
00:04:27,860 --> 00:04:25,620
night that's very pretty but sadly we

117
00:04:30,409 --> 00:04:27,870
just lock it so

118
00:04:33,020 --> 00:04:30,419
it also gives off very intense very

119
00:04:34,879 --> 00:04:33,030
broad band terahertz pulses so these

120
00:04:37,400 --> 00:04:34,889
things span many hundreds of wave

121
00:04:39,379 --> 00:04:37,410
numbers all at once and so what we're

122
00:04:40,730 --> 00:04:39,389
going to do is collect them and focus

123
00:04:43,700 --> 00:04:40,740
them through a substrate they've already

124
00:04:46,700 --> 00:04:43,710
been a couple descriptions of how we do

125
00:04:49,580 --> 00:04:46,710
how you make these but our ice chamber

126
00:04:52,340 --> 00:04:49,590
is a small little hv system it's a

127
00:04:54,439 --> 00:04:52,350
silicon substrate and cryostat so we can

128
00:04:56,750 --> 00:04:54,449
change the temperature from anything to

129
00:04:59,540 --> 00:04:56,760
about 10 Kelvin up to 300 if we want and

130
00:05:02,600 --> 00:04:59,550
then we just dose in whatever ice we

131
00:05:05,629 --> 00:05:02,610
want to form mixtures layers or just

132
00:05:07,100 --> 00:05:05,639
pure samples and we deposited on the

133
00:05:09,710 --> 00:05:07,110
substrate and then just do a fairly

134
00:05:11,900 --> 00:05:09,720
simple beers law absorption experiment

135
00:05:15,590 --> 00:05:11,910
we just look at the absorption through

136
00:05:17,570 --> 00:05:15,600
and this is sort of the band width of

137
00:05:21,050 --> 00:05:17,580
our instruments so we can see everything

138
00:05:23,480 --> 00:05:21,060

from about a few wave numbers up to 250

139
00:05:25,580 --> 00:05:23,490
and so now if we can do spectroscopy

140
00:05:28,070 --> 00:05:25,590
here we need an observatory that can

141
00:05:29,960 --> 00:05:28,080
match that and so I've mentioned almond

142
00:05:31,550 --> 00:05:29,970
a little bit with the image of HL tau it

143
00:05:33,529 --> 00:05:31,560
actually is pretty limited it only

144
00:05:35,990 --> 00:05:33,539
covers the first terahertz a bandwidth

145
00:05:38,540 --> 00:05:36,000
we do there's Herschel spire and packs

146
00:05:40,100 --> 00:05:38,550
which have ok coverage but these are

147
00:05:42,589 --> 00:05:40,110
actually now defunct they're sitting at

148
00:05:44,210 --> 00:05:42,599
l2 but they're out of liquid helium so

149
00:05:45,650 --> 00:05:44,220
they're not running anymore there's only

150
00:05:47,120 --> 00:05:45,660
one Observatory in the world that can

151
00:05:51,350 --> 00:05:47,130
cover the bandwidth we want and that's

152
00:05:53,210 --> 00:05:51,360
Sofia's Fifi instrument so to do sort of

153
00:05:55,250 --> 00:05:53,220
just testing we've never done anything

154
00:05:57,020 --> 00:05:55,260
like this the pretty obvious case is to

155
00:05:59,029 --> 00:05:57,030
go look at water water is the biggest

156
00:06:00,320 --> 00:05:59,039
component of any interstellar ice so

157
00:06:02,960 --> 00:06:00,330
you'd like to start with water so this

158
00:06:05,629 --> 00:06:02,970
is a spectra that Brett recorded of

159
00:06:07,279 --> 00:06:05,639
crystal and water ice at 10 Kelvin it's

160
00:06:11,360 --> 00:06:07,289
nice and pretty we get a very strong

161
00:06:14,540 --> 00:06:11,370
peak here and if you look at the Fifi

162
00:06:16,790 --> 00:06:14,550
coverage we have perfect over map except

163
00:06:18,469 --> 00:06:16,800

that right now Fifi is missing a filter

164
00:06:22,909 --> 00:06:18,479
so we can't actually cover this range

165
00:06:24,320 --> 00:06:22,919
and it's really sad I so just for a

166
00:06:26,990 --> 00:06:24,330
minute I want to stop and tell you what

167
00:06:29,060 --> 00:06:27,000
Fifi is it is an instrument hooked to

168
00:06:31,550 --> 00:06:29,070
the back of this telescope it's on a 747

169
00:06:35,360 --> 00:06:31,560
we fly it up to 40,000 feet and then

170
00:06:37,850 --> 00:06:35,370
open the door in flight and then use one

171
00:06:40,180 --> 00:06:37,860
meter telescope in the back to track an

172
00:06:41,600 --> 00:06:40,190
object through turbulent so it's got a

173
00:06:43,279 --> 00:06:41,610
massive cyst

174
00:06:45,409 --> 00:06:43,289
that keeps the telescope pointed even

175
00:06:47,779 --> 00:06:45,419
when the planes jumping up and down so

176
00:06:50,809 --> 00:06:47,789
we're able to track an object as we fly

177
00:06:53,629 --> 00:06:50,819
through the sky and get really nice data

178
00:06:56,119 --> 00:06:53,639
so it's a really fantastic thing but it

179
00:06:58,429 --> 00:06:56,129
doesn't quite work for water yet what it

180
00:07:00,379 --> 00:06:58,439
does work for is co to co 2 is one of

181
00:07:02,179 --> 00:07:00,389
the next most abundant constituents in a

182
00:07:04,610 --> 00:07:02,189
nice so it's another obvious place to go

183
00:07:06,709 --> 00:07:04,620
so this is actually a spectra from

184
00:07:09,200 --> 00:07:06,719
bretts thesis we can make crystal and

185
00:07:11,179 --> 00:07:09,210
co2 ice at different temperatures and we

186
00:07:13,399 --> 00:07:11,189
have two very nice modes that pop up

187
00:07:15,559 --> 00:07:13,409
right in the middle of the Sofia band so

188
00:07:16,879 --> 00:07:15,569

we can cover both we also have this

189
00:07:19,670 --> 00:07:16,889
really interesting thing which is the

190
00:07:22,490 --> 00:07:19,680
band position shift with frequency North

191
00:07:24,379 --> 00:07:22,500
temperature so anytime you observe one

192
00:07:26,240 --> 00:07:24,389
of these Isis you immediately know its

193
00:07:28,159 --> 00:07:26,250
temperature very precisely and you get

194
00:07:29,929 --> 00:07:28,169
the information for free which is very

195
00:07:32,600 --> 00:07:29,939
helpful for understanding the physics of

196
00:07:34,309 --> 00:07:32,610
whatever you're looking at I so we'd

197
00:07:35,779 --> 00:07:34,319
like to know what these are it actually

198
00:07:38,269 --> 00:07:35,789
turns out to be very important to know

199
00:07:40,339 --> 00:07:38,279
what these two modes are these are

200
00:07:43,070 --> 00:07:40,349
crystalline modes so this is the mo

201
00:07:45,260 --> 00:07:43,080
frequency one the it's crystal and co2

202
00:07:47,269 --> 00:07:45,270
ice buying layers moving back and forth

203
00:07:49,579 --> 00:07:47,279
between each other this is just an

204
00:07:53,570 --> 00:07:49,589
optical phone on and then the higher

205
00:07:55,640 --> 00:07:53,580
frequency one is there we go I co2

206
00:07:58,490 --> 00:07:55,650
molecules bands moving back and forth

207
00:07:59,959 --> 00:07:58,500
and so it's really cool but one of the

208
00:08:02,480 --> 00:07:59,969
issues here is that this requires

209
00:08:04,939 --> 00:08:02,490
crystal and co2 to work you have to have

210
00:08:07,070 --> 00:08:04,949
an ordered crystal and ice to get these

211
00:08:09,290 --> 00:08:07,080
modes to show up so we can actually

212
00:08:11,929 --> 00:08:09,300
prove that if we go through and make an

213
00:08:13,790 --> 00:08:11,939

amorphous ice if we deposit in ice at 10

214
00:08:15,409 --> 00:08:13,800
Kelvin where the molecules don't have

215
00:08:17,240 --> 00:08:15,419
enough energy to rearrange you get this

216
00:08:18,860 --> 00:08:17,250
sort of amorphous mixture that can't

217
00:08:21,409 --> 00:08:18,870
crystallize and if you try to take a

218
00:08:24,050 --> 00:08:21,419
spectra you get a flat line so this is

219
00:08:25,909 --> 00:08:24,060
good and bad for observations it means

220
00:08:28,100 --> 00:08:25,919
that we're now sensitive to composition

221
00:08:30,350 --> 00:08:28,110
two so once you heat a nice up if you

222
00:08:32,329 --> 00:08:30,360
cool it back down it'll stay crystal and

223
00:08:34,459 --> 00:08:32,339
it will not lose that crystalline

224
00:08:37,159 --> 00:08:34,469
structure but if it's if it was never

225
00:08:38,899 --> 00:08:37,169
heated up it will never make a

226
00:08:40,550 --> 00:08:38,909
crystalline structure so this is good

227
00:08:42,380 --> 00:08:40,560
and bad because now we can track the

228
00:08:44,360 --> 00:08:42,390
thermal history of the ice if you see a

229
00:08:45,889 --> 00:08:44,370
10 Kelvin ice but its crystalline you

230
00:08:47,509 --> 00:08:45,899
know at some point that ice was exposed

231
00:08:48,800 --> 00:08:47,519
to much warmer temperatures and then

232
00:08:51,410 --> 00:08:48,810
cooled off and that can be very useful

233
00:08:54,139 --> 00:08:51,420
for understanding dynamics the problem

234
00:08:55,100 --> 00:08:54,149
is if a nice never saw a temperature

235
00:08:58,579 --> 00:08:55,110
warm enough to crystal

236
00:09:01,370 --> 00:08:58,589
is it then the line of sight that has no

237
00:09:03,170 --> 00:09:01,380
co2 or amorphous co2 looks identical and

238
00:09:05,180 --> 00:09:03,180

you can't tell if you have no co2 there

239
00:09:10,880 --> 00:09:05,190
or if it's just not warm enough to

240
00:09:12,800 --> 00:09:10,890
crystallize so this is the Fifi band so

241
00:09:15,259 --> 00:09:12,810
this actually works out beautifully now

242
00:09:17,030 --> 00:09:15,269
the trick is that we want to go out and

243
00:09:19,550 --> 00:09:17,040
do something with this telescope that

244
00:09:21,769 --> 00:09:19,560
was never intended so Fifi was meant for

245
00:09:24,680 --> 00:09:21,779
small narrow spectral lines these lines

246
00:09:27,620 --> 00:09:24,690
are our lines are a few wave numbers

247
00:09:29,360 --> 00:09:27,630
wide the mines were suppose that this

248
00:09:31,579 --> 00:09:29,370
instrument was intended to see were

249
00:09:33,949 --> 00:09:31,589
tense the hundreds of wave numbers wide

250
00:09:36,170 --> 00:09:33,959
it was never meant to see something this

251
00:09:39,650 --> 00:09:36,180
broad as a observing mode that was never

252
00:09:41,960 --> 00:09:39,660
tested and so this is going to be tricky

253
00:09:44,509 --> 00:09:41,970
because like I said we're in a 747 at

254
00:09:45,949 --> 00:09:44,519
40,000 feet bouncing around now we fly

255
00:09:48,050 --> 00:09:45,959
that high to get above most of the

256
00:09:49,490 --> 00:09:48,060
Earth's water but there's still a little

257
00:09:51,740 --> 00:09:49,500
bit of atmospheric water so now you have

258
00:09:53,569 --> 00:09:51,750
a changing atmosphere in a bouncing

259
00:09:56,389 --> 00:09:53,579
telescope and what you have to do is do

260
00:09:58,790 --> 00:09:56,399
67 individual integrations across this

261
00:10:00,740 --> 00:09:58,800
band to get enough data to actually see

262
00:10:03,019 --> 00:10:00,750
this broad feature and this is something

263
00:10:04,970 --> 00:10:03,029

nobody thought we nobody ever thought

264
00:10:07,490 --> 00:10:04,980
someone would try and so this was

265
00:10:09,290 --> 00:10:07,500
totally speculative to see if you we

266
00:10:11,269 --> 00:10:09,300
could even get something that would be

267
00:10:13,400 --> 00:10:11,279
stable over the course of an observation

268
00:10:14,300 --> 00:10:13,410
and so we propose this to the Fifi

269
00:10:16,579 --> 00:10:14,310
instrument team and they were

270
00:10:19,310 --> 00:10:16,589
surprisingly excited about it and really

271
00:10:22,400 --> 00:10:19,320
wanted us to give it a go so we picked

272
00:10:25,189 --> 00:10:22,410
the target in GC 7538 it's actually got

273
00:10:27,620 --> 00:10:25,199
two different sources irs-1 it's more

274
00:10:29,269 --> 00:10:27,630
processed and has very little co2 that's

275
00:10:31,220 --> 00:10:29,279
going to be our reference source we know

276
00:10:33,560 --> 00:10:31,230
from infrared observations there is no

277
00:10:36,350 --> 00:10:33,570
real co2 ice there and then we have IRS

278
00:10:38,540 --> 00:10:36,360
9 it's dimmer but it has very abundant

279
00:10:40,639 --> 00:10:38,550
co2 I some of the most abundant co2 ice

280
00:10:43,130 --> 00:10:40,649
observed in space so what we're going to

281
00:10:45,860 --> 00:10:43,140
do is observe both of them back and

282
00:10:47,540 --> 00:10:45,870
forth simultaneously as we fly and see

283
00:10:50,120 --> 00:10:47,550
if we can actually get stable base lines

284
00:10:52,340 --> 00:10:50,130
and so this is very new we got this

285
00:10:54,769 --> 00:10:52,350
about a month ago from the Fifi team so

286
00:10:57,439 --> 00:10:54,779
this just came down I so what we do

287
00:10:59,150 --> 00:10:57,449
black in red or individual scans so we

288
00:11:01,040 --> 00:10:59,160

started in the center and then worked

289
00:11:03,500 --> 00:11:01,050
out to the outside and then filled back

290
00:11:06,319 --> 00:11:03,510
in on the edges and so each one of these

291
00:11:08,000 --> 00:11:06,329
is an individual scan and it's actually

292
00:11:08,900 --> 00:11:08,010
worked surprisingly well for us so all

293
00:11:11,860 --> 00:11:08,910
these big dips

294
00:11:14,660 --> 00:11:11,870
our atmospheric water absorption but

295
00:11:17,570 --> 00:11:14,670
everything's tracking so stuff we did 50

296
00:11:19,580 --> 00:11:17,580
minutes after this follows the pattern

297
00:11:22,010 --> 00:11:19,590
exactly everything lines up nicely and

298
00:11:24,020 --> 00:11:22,020
it's shockingly stable as we're bouncing

299
00:11:26,660 --> 00:11:24,030
around in the atmosphere so this is a

300
00:11:27,860 --> 00:11:26,670
really promising start it's you know it

301
00:11:29,690 --> 00:11:27,870
proves that we can actually get the

302
00:11:31,760 --> 00:11:29,700
telescope up there working and observe

303
00:11:33,230 --> 00:11:31,770
something this broad without having the

304
00:11:36,050 --> 00:11:33,240
atmosphere completely ruined the

305
00:11:38,000 --> 00:11:36,060
observations we can do a background

306
00:11:39,860 --> 00:11:38,010
subtraction and it's pretty clear that

307
00:11:41,900 --> 00:11:39,870
we don't correctly subtract out the

308
00:11:43,730 --> 00:11:41,910
water lines so this is going to be the

309
00:11:45,230 --> 00:11:43,740
ongoing thing is this is something

310
00:11:47,480 --> 00:11:45,240
that's known in optical and infrared

311
00:11:49,520 --> 00:11:47,490
observations is that atmospheric water

312
00:11:51,410 --> 00:11:49,530
subtraction is really tricky the models

313
00:11:53,570 --> 00:11:51,420

that they have an infrared are very good

314
00:11:55,490 --> 00:11:53,580
so the next step is going to be starting

315
00:11:57,830 --> 00:11:55,500
to apply these methods too far infrared

316
00:11:59,270 --> 00:11:57,840
observations to really subtract the

317
00:12:00,890 --> 00:11:59,280
water out and get at the very weak

318
00:12:04,010 --> 00:12:00,900
absorption features that we hope were

319
00:12:05,690 --> 00:12:04,020
here all right with that I'd like to

320
00:12:07,400 --> 00:12:05,700
thank the rest of the Blake group our

321
00:12:23,600 --> 00:12:07,410
funding sources and you guys for your

322
00:12:26,570 --> 00:12:23,610
attention so questions really exciting

323
00:12:29,480 --> 00:12:26,580
work so I was just wondering if her show

324
00:12:32,270 --> 00:12:29,490
packs covers the same spectra Herschel

325
00:12:34,310 --> 00:12:32,280
packs covers some of the same spectra so

326
00:12:36,020 --> 00:12:34,320
there's archival data and Thomas

327
00:12:38,150 --> 00:12:36,030
Hennings put up a slide where he shows

328
00:12:41,030 --> 00:12:38,160
that water ice absorption the

329
00:12:42,590 --> 00:12:41,040
calibration is really tough so we're

330
00:12:44,570 --> 00:12:42,600
going to be working with them a lot to

331
00:12:46,760 --> 00:12:44,580
figure out because packs and fefe are

332
00:12:48,770 --> 00:12:46,770
identical instruments fifi exists

333
00:12:51,290 --> 00:12:48,780
because they built a backup of packs and

334
00:12:55,850 --> 00:12:51,300
they just had it laying around and so

335
00:12:58,130 --> 00:12:55,860
now they put it on telescope people yep

336
00:13:01,340 --> 00:12:58,140
it's on okay i know people working on

337
00:13:03,650 --> 00:13:01,350
her show digit pack stay there trying to

338
00:13:06,650 --> 00:13:03,660

calibrate it i don't think they trust

339
00:13:08,180 --> 00:13:06,660
ice calibration yet by skating there

340
00:13:10,730 --> 00:13:08,190
soon yeah so Thomas Hennings got a

341
00:13:12,590 --> 00:13:10,740
little bit but yeah this is a tricky

342
00:13:14,690 --> 00:13:12,600
process this is not what this instrument

343
00:13:23,329 --> 00:13:14,700
was designed for so calibration is going

344
00:13:33,809 --> 00:13:30,600
alright well oh yeah yeah unfortunately

345
00:13:36,749 --> 00:13:33,819
not it's either going to be pitch black

346
00:13:38,100 --> 00:13:36,759
in here or like this we can take a vote

347
00:13:42,179 --> 00:13:38,110
but I figured people don't want to fall