NICOLAS
GISIN
FREE WILL

1
00:00:03,590 --> 00:00:02,230
this is a desolatory interview in

2
00:00:05,670 --> 00:00:03,600
keeping with the theme of the

3
00:00:07,590 --> 00:00:05,680
indeterminate and unfolding nature of

4
00:00:09,589 --> 00:00:07,600
time for those who were intrigued by

5
00:00:12,629 --> 00:00:09,599
louis el sando's comments on the blurred

6
00:00:14,950 --> 00:00:12,639
notion of the present i.e his metaphor

7
00:00:17,430 --> 00:00:14,960
of the cigarette that burns unevenly

8
00:00:19,429 --> 00:00:17,440
nicholas jisson's concept of thick time

9
00:00:20,710 --> 00:00:19,439
is the closest i've heard to a rigorous

10
00:00:22,710 --> 00:00:20,720
account of it

11
00:00:24,630 --> 00:00:22,720
nicholas jison is a professor at the

12
00:00:26,390 --> 00:00:24,640
university of geneva working on the

13
00:00:28,870 --> 00:00:26,400

foundations of quantum mechanics and

14
00:00:30,710 --> 00:00:28,880
quantum information both experimentally

15
00:00:32,950 --> 00:00:30,720
and theoretically in this episode we

16
00:00:35,670 --> 00:00:32,960
talk about the existence of free will

17
00:00:38,069 --> 00:00:35,680
the indeterminacy of reality and the

18
00:00:39,990 --> 00:00:38,079
unreality of the real numbers nicholas

19
00:00:41,910 --> 00:00:40,000
is one of the world renowned experts in

20
00:00:43,670 --> 00:00:41,920
quantum theory and we're extremely

21
00:00:45,430 --> 00:00:43,680
grateful that his first podcast

22
00:00:47,670 --> 00:00:45,440
appearance is on the theories of

23
00:00:48,709 --> 00:00:47,680
everything channel thank you professor

24
00:00:50,310 --> 00:00:48,719
click on the time stamp in the

25
00:00:52,790 --> 00:00:50,320
description if you'd like to skip this

26
00:00:55,029 --> 00:00:52,800
intro my name is kirchey mungle i'm a

27
00:00:57,510 --> 00:00:55,039
torontonian filmmaker with a background

28
00:00:59,990 --> 00:00:57,520
in mathematical physics dedicated to the

29
00:01:01,750 --> 00:01:00,000
explication of the variegated terrain of

30
00:01:03,750 --> 00:01:01,760
theories of everything from a

31
00:01:05,670 --> 00:01:03,760
theoretical physics perspective but as

32
00:01:07,510 --> 00:01:05,680
well as analyzing consciousness and

33
00:01:09,590 --> 00:01:07,520
seeing its potential connection to

34
00:01:11,510 --> 00:01:09,600
fundamental reality whatever that is

35
00:01:14,070 --> 00:01:11,520
essentially this channel is dedicated to

36
00:01:16,149 --> 00:01:14,080
exploring the under nature of reality

37
00:01:17,749 --> 00:01:16,159
the constitutional laws that govern it

38
00:01:20,149 --> 00:01:17,759

provided those laws exist at all and are

39
00:01:22,070 --> 00:01:20,159
even noble to us if you enjoy witnessing

40
00:01:24,789 --> 00:01:22,080
and engaging with others on the topics

41
00:01:27,030 --> 00:01:24,799
of psychology consciousness physics etc

42
00:01:28,710 --> 00:01:27,040
the channel's themes then do consider

43
00:01:30,550 --> 00:01:28,720
going to the discord and the subreddit

44
00:01:32,390 --> 00:01:30,560
which are linked in the description

45
00:01:34,069 --> 00:01:32,400
there's also a link to the patreon that

46
00:01:35,830 --> 00:01:34,079
is patreon.com

47
00:01:37,910 --> 00:01:35,840
kerchamungle if you'd like to support

48
00:01:39,670 --> 00:01:37,920
this podcast as the patrons and the

49
00:01:42,230 --> 00:01:39,680
sponsors are the only reasons that i'm

50
00:01:44,149 --> 00:01:42,240
able to have podcasts of this quality

51
00:01:46,389 --> 00:01:44,159
and this depth given that i can do this

52
00:01:48,230 --> 00:01:46,399
now full time thanks to both the patrons

53
00:01:50,550 --> 00:01:48,240
and the sponsors support speaking of

54
00:01:52,469 --> 00:01:50,560
sponsors there are two the first sponsor

55
00:01:53,910 --> 00:01:52,479
is brilliant during the winter break i

56
00:01:55,749 --> 00:01:53,920
decided to brush up on some of the

57
00:01:57,910 --> 00:01:55,759
fundamentals of physics particularly

58
00:01:59,830 --> 00:01:57,920
with regard to information theory as i'd

59
00:02:01,429 --> 00:01:59,840
like to interview chiara marletto on

60
00:02:03,109 --> 00:02:01,439
constructor theory which is heavily

61
00:02:04,789 --> 00:02:03,119
based in information theory now

62
00:02:06,149 --> 00:02:04,799
information theory is predicated on

63
00:02:08,469 --> 00:02:06,159

entropy at least there's a fundamental

64
00:02:10,229 --> 00:02:08,479
formula for entropy so i ended up taking

65
00:02:12,309 --> 00:02:10,239
the brilliant course i challenged myself

66
00:02:14,309 --> 00:02:12,319
to do one lesson per day and i took the

67
00:02:16,630 --> 00:02:14,319
course's random variable distributions

68
00:02:18,229 --> 00:02:16,640
and knowledge slash uncertainty what i

69
00:02:19,990 --> 00:02:18,239
loved is that despite knowing the

70
00:02:22,229 --> 00:02:20,000
formula for entropy which is essentially

71
00:02:24,150 --> 00:02:22,239
hammered into you as an undergraduate it

72
00:02:25,990 --> 00:02:24,160
seems like it comes down from the sky

73
00:02:27,670 --> 00:02:26,000
arbitrarily and with brilliant for the

74
00:02:29,270 --> 00:02:27,680
first time i was able to see how the

75
00:02:31,589 --> 00:02:29,280
formula for entropy which you're seeing

76
00:02:33,350 --> 00:02:31,599
right now is actually extremely natural

77
00:02:35,270 --> 00:02:33,360
and it'd be strange to define it in any

78
00:02:36,949 --> 00:02:35,280
other manner there are plenty of courses

79
00:02:38,229 --> 00:02:36,959
and you can even learn group theory

80
00:02:39,670 --> 00:02:38,239
which is what's being referenced when

81
00:02:42,550 --> 00:02:39,680
you hear that the standard model is

82
00:02:44,150 --> 00:02:42,560
predicated on u1 cross su 2 cross su 3

83
00:02:46,229 --> 00:02:44,160
those are league groups continuous lead

84
00:02:48,949 --> 00:02:46,239
groups visit brilliant.org

85
00:02:50,630 --> 00:02:48,959
tow t-o-e to get 20 off an annual

86
00:02:52,790 --> 00:02:50,640
subscription and i recommend that you

87
00:02:54,550 --> 00:02:52,800
don't stop before four lessons i think

88
00:02:56,309 --> 00:02:54,560

you'll be greatly surprised at the ease

89
00:02:58,229 --> 00:02:56,319
at which you can now comprehend subjects

90
00:03:00,949 --> 00:02:58,239
you previously had a difficult time

91
00:03:03,030 --> 00:03:00,959
grocking the second sponsor is algo now

92
00:03:05,030 --> 00:03:03,040
algo is an end-to-end supply chain

93
00:03:07,110 --> 00:03:05,040
optimization software company with

94
00:03:09,110 --> 00:03:07,120
software that helps business users

95
00:03:11,270 --> 00:03:09,120
optimize sales and operations planning

96
00:03:13,190 --> 00:03:11,280
to avoid stockouts reduce return and

97
00:03:15,589 --> 00:03:13,200
inventory write downs while reducing

98
00:03:18,790 --> 00:03:15,599
inventory investment it's a supply chain

99
00:03:20,869 --> 00:03:18,800
ai that drives smart roi headed by amjad

100
00:03:23,190 --> 00:03:20,879
hussein who's been a huge supporter of

101
00:03:26,229 --> 00:03:23,200
this podcast since near its inception in

102
00:03:28,149 --> 00:03:26,239
fact amjad has his own podcast on ai and

103
00:03:30,070 --> 00:03:28,159
consciousness and business growth and if

104
00:03:31,910 --> 00:03:30,080
you'd like to support the tow podcast

105
00:03:33,670 --> 00:03:31,920
then visit the link in the description

106
00:03:35,670 --> 00:03:33,680
to see amjad's podcast because

107
00:03:38,149 --> 00:03:35,680
subscribing to him or at least visiting

108
00:03:40,710 --> 00:03:38,159
supports the toe podcast indirectly

109
00:03:42,470 --> 00:03:40,720
thank you and enjoy i'm also interested

110
00:03:44,470 --> 00:03:42,480
in the topic of free will that's why

111
00:03:46,550 --> 00:03:44,480
you're here i was speaking with a

112
00:03:48,550 --> 00:03:46,560
professor of

113
00:03:50,229 --> 00:03:48,560

the of the philosophy of mathematics who

114
00:03:52,309 --> 00:03:50,239
referenced me an article of yours quite

115
00:03:53,589 --> 00:03:52,319
some time ago and ever since then i

116
00:03:55,670 --> 00:03:53,599
thought okay i want to speak to this

117
00:03:56,949 --> 00:03:55,680
person but i didn't have a reason to but

118
00:03:58,470 --> 00:03:56,959
now i do so

119
00:04:00,789 --> 00:03:58,480
thank you

120
00:04:02,229 --> 00:04:00,799
so which paper is that do you remember i

121
00:04:03,110 --> 00:04:02,239
don't remember you had the baker map and

122
00:04:05,030 --> 00:04:03,120
you were showing that there is

123
00:04:06,149 --> 00:04:05,040
indeterminacy with uh classical laws of

124
00:04:07,509 --> 00:04:06,159
physics and you don't need quantum

125
00:04:09,270 --> 00:04:07,519
mechanics to have that i don't recall

126
00:04:11,190 --> 00:04:09,280
exactly okay so it's not valuable yeah

127
00:04:12,869 --> 00:04:11,200
yeah i know i know which paper

128
00:04:14,789 --> 00:04:12,879
from what i gathered i've been watching

129
00:04:16,949 --> 00:04:14,799
plenty of your talks recently plenty and

130
00:04:19,189 --> 00:04:16,959
plenty of them and even i went through

131
00:04:21,030 --> 00:04:19,199
your book which is almost a decade old

132
00:04:22,950 --> 00:04:21,040
now called quantum chance

133
00:04:25,270 --> 00:04:22,960
which is a wonderful book

134
00:04:28,710 --> 00:04:25,280
delightful book

135
00:04:30,710 --> 00:04:28,720
most books about physics are or can be

136
00:04:33,110 --> 00:04:30,720
intimidating to someone who's not

137
00:04:34,390 --> 00:04:33,120
familiar with mathematics but this book

138
00:04:36,870 --> 00:04:34,400

was so

139
00:04:38,469 --> 00:04:36,880
winsome and childlike in its curiosity

140
00:04:39,590 --> 00:04:38,479
instead of bells and equality of bell's

141
00:04:40,950 --> 00:04:39,600
game

142
00:04:42,790 --> 00:04:40,960
you give the reader the impression that

143
00:04:44,469 --> 00:04:42,800
you're not speaking above them just

144
00:04:47,189 --> 00:04:44,479
changing bells and equality to bell's

145
00:04:49,110 --> 00:04:47,199
games it's a delightful conceptual shift

146
00:04:50,390 --> 00:04:49,120
that makes it much more lucid for those

147
00:04:52,310 --> 00:04:50,400
who are ordinarily intimidated by

148
00:04:54,310 --> 00:04:52,320
mathematics

149
00:04:56,550 --> 00:04:54,320
yeah you know the subject i find the

150
00:04:59,830 --> 00:04:56,560
subject fascinating i mean that's i

151
00:05:02,390 --> 00:04:59,840
spent my life on quantum physics quantum

152
00:05:04,390 --> 00:05:02,400
chants and so on indeterminacy

153
00:05:06,870 --> 00:05:04,400
and um i wanted to

154
00:05:08,790 --> 00:05:06,880
to allow everyone to to

155
00:05:11,749 --> 00:05:08,800
you know to share that

156
00:05:13,990 --> 00:05:11,759
fascination um

157
00:05:16,390 --> 00:05:14,000
so without mathematics indeed but also

158
00:05:18,550 --> 00:05:16,400
without hiding the the conceptual

159
00:05:20,870 --> 00:05:18,560
difficulties it's not trivial these

160
00:05:22,070 --> 00:05:20,880
things it's a major change in our

161
00:05:24,230 --> 00:05:22,080
worldview

162
00:05:25,029 --> 00:05:24,240
so it is i wouldn't say it's an easy

163
00:05:26,790 --> 00:05:25,039

book

164
00:05:28,629 --> 00:05:26,800
but the goal was indeed to allow

165
00:05:30,790 --> 00:05:28,639
everyone who is willing to make an

166
00:05:33,270 --> 00:05:30,800
intellectual efforts to

167
00:05:35,590 --> 00:05:33,280
to be able to to share some of this

168
00:05:39,029 --> 00:05:35,600
fascination and gain some understanding

169
00:05:39,909 --> 00:05:39,039
of why physicists are so excited about

170
00:05:42,870 --> 00:05:39,919
bell

171
00:05:43,909 --> 00:05:42,880
inequalities games and in determinism

172
00:05:45,909 --> 00:05:43,919
and so on

173
00:05:47,590 --> 00:05:45,919
even something as complicated sounding

174
00:05:48,790 --> 00:05:47,600
as a quantum random number generator

175
00:05:50,230 --> 00:05:48,800
which to many people they're like well

176
00:05:52,070 --> 00:05:50,240
firstly what is random and then it

177
00:05:53,590 --> 00:05:52,080
generates numbers and is quantum on top

178
00:05:55,270 --> 00:05:53,600
of that well you explain it's just a

179
00:05:57,189 --> 00:05:55,280
beam splitter and just think of it like

180
00:05:59,110 --> 00:05:57,199
zeros and ones on each side

181
00:06:01,749 --> 00:05:59,120
it's a splendid explanation of what's

182
00:06:03,749 --> 00:06:01,759
customarily complicated

183
00:06:05,590 --> 00:06:03,759
yeah and actually what is even very nice

184
00:06:07,270 --> 00:06:05,600
here so you know there is all these

185
00:06:09,590 --> 00:06:07,280
conceptual issues that you just

186
00:06:11,350 --> 00:06:09,600
mentioned which are not trivial you can

187
00:06:13,510 --> 00:06:11,360
make it relatively simple but not

188
00:06:15,670 --> 00:06:13,520

completely trivial certainly not but it

189
00:06:17,670 --> 00:06:15,680
goes all the way that now actually this

190
00:06:21,189 --> 00:06:17,680
startup company from my

191
00:06:23,029 --> 00:06:21,199
university group id queue

192
00:06:25,189 --> 00:06:23,039
they may put everything into a little

193
00:06:26,230 --> 00:06:25,199
chip which is just a few millimeter in

194
00:06:27,350 --> 00:06:26,240
size

195
00:06:29,670 --> 00:06:27,360
and um

196
00:06:31,430 --> 00:06:29,680
it's also lower power consumption so

197
00:06:33,909 --> 00:06:31,440
it's a it's a quantum render number

198
00:06:37,270 --> 00:06:33,919
generator that actually is used by

199
00:06:39,189 --> 00:06:37,280
samsung in some of their smartphones

200
00:06:41,270 --> 00:06:39,199
have you done much thinking about the

201
00:06:43,990 --> 00:06:41,280
nature of consciousness i know that

202
00:06:47,029 --> 00:06:44,000
you've spoken about free will and time

203
00:06:48,790 --> 00:06:47,039
and indeterminacy

204
00:06:51,029 --> 00:06:48,800
consciousness no you know i'm a

205
00:06:52,710 --> 00:06:51,039
physicist i'm not a philosopher so even

206
00:06:55,029 --> 00:06:52,720
about free will

207
00:06:57,189 --> 00:06:55,039
which is certainly uh something which i

208
00:06:59,510 --> 00:06:57,199
think uh is a

209
00:07:02,230 --> 00:06:59,520
an important concept but it's not a

210
00:07:05,589 --> 00:07:02,240
concept of physics

211
00:07:07,510 --> 00:07:05,599
so i you know unconsciousness

212
00:07:09,430 --> 00:07:07,520
probably even less so i don't know if

213
00:07:11,270 --> 00:07:09,440

it's less or but i mean there's a

214
00:07:14,950 --> 00:07:11,280
certain number of concepts that are

215
00:07:16,790 --> 00:07:14,960
completely outside of today's physics

216
00:07:19,909 --> 00:07:16,800
whether they will ever be

217
00:07:22,629 --> 00:07:19,919
within physics i don't know um

218
00:07:25,990 --> 00:07:22,639
so maybe i should indeed warn you and

219
00:07:28,150 --> 00:07:26,000
everyone uh listening to this that i'm

220
00:07:29,909 --> 00:07:28,160
not a philosopher i don't claim to be a

221
00:07:32,070 --> 00:07:29,919
philosopher

222
00:07:34,629 --> 00:07:32,080
and i certainly claim that

223
00:07:35,990 --> 00:07:34,639
consciousness free will the mind or

224
00:07:38,790 --> 00:07:36,000
things like that

225
00:07:41,270 --> 00:07:38,800
are fascinating concepts we all know

226
00:07:43,749 --> 00:07:41,280
that we we have that

227
00:07:47,270 --> 00:07:43,759
but these are not concepts that belong

228
00:07:49,589 --> 00:07:47,280
to today's physics possibly not even

229
00:07:51,189 --> 00:07:49,599
to future physics

230
00:07:54,230 --> 00:07:51,199
from what i gathered from my research

231
00:07:56,469 --> 00:07:54,240
into your views your philosophy

232
00:07:58,390 --> 00:07:56,479
so to speak

233
00:08:00,710 --> 00:07:58,400
you see free will and indeterminacy as

234
00:08:02,550 --> 00:08:00,720
not tied now is this correct

235
00:08:04,230 --> 00:08:02,560
why is it so yes

236
00:08:05,749 --> 00:08:04,240
ordinary i'm sure you know the ordinary

237
00:08:07,749 --> 00:08:05,759
view or not the ordinary i'm sure you

238
00:08:09,430 --> 00:08:07,759

know the common view in philosophy and

239
00:08:11,589 --> 00:08:09,440
even in physics some people who dabble

240
00:08:12,790 --> 00:08:11,599
in philosophy who are physicists think

241
00:08:15,350 --> 00:08:12,800
if you're going to have a notion of free

242
00:08:17,189 --> 00:08:15,360
will it's predicated on indeterminacy

243
00:08:19,430 --> 00:08:17,199
yeah so i certainly i'm certainly not a

244
00:08:20,629 --> 00:08:19,440
compatibilist i don't really understand

245
00:08:21,909 --> 00:08:20,639
how one could

246
00:08:24,390 --> 00:08:21,919
claim that

247
00:08:27,029 --> 00:08:24,400
you know the future is already given is

248
00:08:28,790 --> 00:08:27,039
already determined by the present and

249
00:08:30,550 --> 00:08:28,800
nevertheless we have free will i think

250
00:08:33,750 --> 00:08:30,560
that's a more

251
00:08:36,070 --> 00:08:33,760
a game of words so indeterminism is

252
00:08:38,070 --> 00:08:36,080
necessary but in determinism is

253
00:08:40,230 --> 00:08:38,080
certainly also not sufficient because

254
00:08:42,469 --> 00:08:40,240
free will is also not just randomness we

255
00:08:44,310 --> 00:08:42,479
don't want to make random

256
00:08:46,790 --> 00:08:44,320
decisions

257
00:08:49,910 --> 00:08:46,800
so it's much more complicated never

258
00:08:52,150 --> 00:08:49,920
determinism you know pure indeterminism

259
00:08:53,990 --> 00:08:52,160
is sufficient to explain free will this

260
00:08:55,590 --> 00:08:54,000
sense again free will is not part of

261
00:08:57,269 --> 00:08:55,600
today's physics

262
00:09:00,070 --> 00:08:57,279
and i would probably

263
00:09:02,070 --> 00:09:00,080

go even further and say that

264
00:09:02,790 --> 00:09:02,080
you know so i'm now going to give some

265
00:09:05,110 --> 00:09:02,800
uh

266
00:09:07,030 --> 00:09:05,120
some arguments and so on

267
00:09:10,070 --> 00:09:07,040
and everyone can then buy these

268
00:09:12,230 --> 00:09:10,080
arguments or reject them but in order to

269
00:09:13,750 --> 00:09:12,240
buy or reject these arguments you need

270
00:09:17,190 --> 00:09:13,760
some free will

271
00:09:19,269 --> 00:09:17,200
so somehow you need free will to start

272
00:09:21,430 --> 00:09:19,279
arguing to start

273
00:09:22,550 --> 00:09:21,440
doing philosophy or to start doing

274
00:09:23,750 --> 00:09:22,560
physics

275
00:09:25,990 --> 00:09:23,760
so

276
00:09:28,710 --> 00:09:26,000
probably the best i can say about free

277
00:09:31,509 --> 00:09:28,720
will is that is a prerequisite

278
00:09:34,389 --> 00:09:31,519
uh in order to uh to

279
00:09:37,750 --> 00:09:34,399
yeah to start arguing so in particular

280
00:09:39,509 --> 00:09:37,760
for philosophy and science in general

281
00:09:41,910 --> 00:09:39,519
when you say that free will is necessary

282
00:09:43,269 --> 00:09:41,920
in order to choose between truths in

283
00:09:44,710 --> 00:09:43,279
order for you to say this one is true

284
00:09:46,710 --> 00:09:44,720
and not this one

285
00:09:49,030 --> 00:09:46,720
then it sounds like you're tying free

286
00:09:50,949 --> 00:09:49,040
will to reason is that the case

287
00:09:53,829 --> 00:09:50,959
or to rationality

288
00:09:55,670 --> 00:09:53,839

to rationality yes absolutely no it's

289
00:09:56,870 --> 00:09:55,680
not a matter of being true or not true

290
00:09:59,829 --> 00:09:56,880
you know i mean

291
00:10:01,990 --> 00:09:59,839
you you may buy an argument or not and

292
00:10:04,150 --> 00:10:02,000
you may even change your mind in course

293
00:10:04,870 --> 00:10:04,160
of time

294
00:10:08,389 --> 00:10:04,880
but

295
00:10:11,030 --> 00:10:08,399
you need to be able to decide yeah now

296
00:10:12,230 --> 00:10:11,040
this argument that i just

297
00:10:14,470 --> 00:10:12,240
listened to

298
00:10:16,310 --> 00:10:14,480
is convincing or no this is not

299
00:10:17,990 --> 00:10:16,320
convincing enough

300
00:10:20,230 --> 00:10:18,000
i'm not going to change my mind because

301
00:10:22,069 --> 00:10:20,240
of that little argument so you need to

302
00:10:24,230 --> 00:10:22,079
make decisions about what kind of

303
00:10:26,150 --> 00:10:24,240
arguments you are going to buy and which

304
00:10:29,190 --> 00:10:26,160
one you're going to reject

305
00:10:30,630 --> 00:10:29,200
and so you need indeed this this ability

306
00:10:34,310 --> 00:10:30,640
of

307
00:10:37,269 --> 00:10:34,320
admitting or rejecting uh arguments

308
00:10:39,750 --> 00:10:37,279
uh in order to to start arguing or to to

309
00:10:41,269 --> 00:10:39,760
enter any debate and again philosophy

310
00:10:43,110 --> 00:10:41,279
science and all that

311
00:10:45,190 --> 00:10:43,120
i have a quote from you which says free

312
00:10:47,190 --> 00:10:45,200
will comes first in the logical order

313
00:10:49,110 --> 00:10:47,200

indeed without free will there's no way

314
00:10:50,230 --> 00:10:49,120
to make sense of anything and in

315
00:10:51,590 --> 00:10:50,240
particular there would be no

316
00:10:53,509 --> 00:10:51,600
understanding

317
00:10:55,190 --> 00:10:53,519
remember earlier in the conversation i

318
00:10:56,790 --> 00:10:55,200
said i i'm interested in the notion of

319
00:10:58,069 --> 00:10:56,800
time free will

320
00:11:00,069 --> 00:10:58,079
consciousness is well i see them as

321
00:11:01,750 --> 00:11:00,079
intimately tied and you mentioned well

322
00:11:02,949 --> 00:11:01,760
forget about consciousness who knows

323
00:11:04,710 --> 00:11:02,959
about that

324
00:11:06,550 --> 00:11:04,720
however right there you said free will

325
00:11:07,990 --> 00:11:06,560
is tied to understanding now penrose

326
00:11:09,110 --> 00:11:08,000
makes a connection between understanding

327
00:11:11,670 --> 00:11:09,120
and consciousness i don't know if you

328
00:11:13,590 --> 00:11:11,680
know that argument maybe not exactly i

329
00:11:15,750 --> 00:11:13,600
i've read so many things from penrose so

330
00:11:17,430 --> 00:11:15,760
probably it's maybe in the back of my

331
00:11:19,350 --> 00:11:17,440
mind but indeed i mean absolutely

332
00:11:21,750 --> 00:11:19,360
correct i mean free will in my opinion

333
00:11:24,389 --> 00:11:21,760
comes first in the logical order

334
00:11:26,870 --> 00:11:24,399
and because of that you know physics or

335
00:11:29,670 --> 00:11:26,880
science or psychology whatever

336
00:11:32,550 --> 00:11:29,680
cannot argue against free will

337
00:11:34,470 --> 00:11:32,560
because it rests on free will

338
00:11:36,550 --> 00:11:34,480

yes then now let's explain that because

339
00:11:38,630 --> 00:11:36,560
even to me as someone who's been looking

340
00:11:40,870 --> 00:11:38,640
into this that i found that to be a new

341
00:11:42,949 --> 00:11:40,880
notion i didn't encounter that before so

342
00:11:45,110 --> 00:11:42,959
firstly how did you come to that

343
00:11:48,069 --> 00:11:45,120
conclusion and then can you explain that

344
00:11:53,030 --> 00:11:50,310
how did i came to it i don't know i you

345
00:11:54,790 --> 00:11:53,040
know of your own free will you came to

346
00:12:12,949 --> 00:11:54,800
i

347
00:12:15,430 --> 00:12:12,959
evolved

348
00:12:18,629 --> 00:12:15,440
and at some point i was invited to a

349
00:12:20,550 --> 00:12:18,639
conference to deliver a talk of course

350
00:12:22,949 --> 00:12:20,560
and the conference was actually about

351
00:12:25,190 --> 00:12:22,959
time and i was a bit surprised to be

352
00:12:27,269 --> 00:12:25,200
invited but okay i thought this is

353
00:12:29,670 --> 00:12:27,279
really a good chance and so i

354
00:12:31,829 --> 00:12:29,680
i went to it and i i had of course to

355
00:12:34,550 --> 00:12:31,839
prepare myself and that's actually when

356
00:12:35,910 --> 00:12:34,560
i started really formulating these ideas

357
00:12:39,110 --> 00:12:35,920
a bit more

358
00:12:41,110 --> 00:12:39,120
in a more articulated way like you know

359
00:12:42,710 --> 00:12:41,120
stating that free will comes first in

360
00:12:44,550 --> 00:12:42,720
the logical order

361
00:12:45,910 --> 00:12:44,560
there is no understanding without free

362
00:12:48,470 --> 00:12:45,920
will and so on

363
00:12:49,509 --> 00:12:48,480

but then also when i

364
00:12:50,550 --> 00:12:49,519
uh

365
00:12:54,550 --> 00:12:50,560
during

366
00:12:56,470 --> 00:12:54,560
some colleagues

367
00:12:58,069 --> 00:12:56,480
mentioned in particular chris fox

368
00:12:59,110 --> 00:12:58,079
mentioned to me

369
00:13:01,110 --> 00:12:59,120
um

370
00:13:05,430 --> 00:13:01,120
that there's an old

371
00:13:06,710 --> 00:13:05,440
unknown essentially a french philosopher

372
00:13:11,350 --> 00:13:06,720
le quiere

373
00:13:14,629 --> 00:13:12,310
he was

374
00:13:17,190 --> 00:13:14,639
the queer was also very much influenced

375
00:13:20,870 --> 00:13:17,200
much more from myself certainly by

376
00:13:23,110 --> 00:13:20,880
religious beliefs so god was his problem

377
00:13:25,030 --> 00:13:23,120
how could god know everything and me

378
00:13:26,629 --> 00:13:25,040
still having free will

379
00:13:28,790 --> 00:13:26,639
that's the old version is it

380
00:13:29,990 --> 00:13:28,800
appreciative version of the free will

381
00:13:32,470 --> 00:13:30,000
debate

382
00:13:34,470 --> 00:13:32,480
um and like we came to the similar

383
00:13:36,069 --> 00:13:34,480
conclusion as myself but of course

384
00:13:37,910 --> 00:13:36,079
centuries before

385
00:13:38,870 --> 00:13:37,920
saying that actually free will comes

386
00:13:42,629 --> 00:13:38,880
first

387
00:13:45,110 --> 00:13:42,639
and without free will we cannot even

388
00:13:47,189 --> 00:13:45,120

start this kind of argument about god

389
00:13:48,389 --> 00:13:47,199
having a

390
00:13:49,269 --> 00:13:48,399
yeah full power

391
00:13:51,910 --> 00:13:49,279
and uh

392
00:13:52,290 --> 00:13:51,920
and so on or full knowledge

393
00:13:53,750 --> 00:13:52,300
um

394
00:13:56,069 --> 00:13:53,760
[Music]

395
00:13:58,069 --> 00:13:56,079
yeah so so i noticed that i was not the

396
00:14:00,230 --> 00:13:58,079
first and i thought that was kind of a

397
00:14:03,110 --> 00:14:00,240
nice discovery for me

398
00:14:05,350 --> 00:14:03,120
that this kind of idea were

399
00:14:08,389 --> 00:14:05,360
uh not entirely new

400
00:14:10,310 --> 00:14:08,399
but clearly also not very well known

401
00:14:12,310 --> 00:14:10,320
now let's explain

402
00:14:13,990 --> 00:14:12,320
what it means that free will comes first

403
00:14:17,030 --> 00:14:14,000
in the logical order

404
00:14:19,670 --> 00:14:17,040
if you start an argument

405
00:14:21,670 --> 00:14:19,680
and don't have any free will

406
00:14:23,509 --> 00:14:21,680
whether it is whether this argument is

407
00:14:26,629 --> 00:14:23,519
going to resonate

408
00:14:28,550 --> 00:14:26,639
is a purely let's say mechanical

409
00:14:30,949 --> 00:14:28,560
stuff you know if i

410
00:14:32,470 --> 00:14:30,959
hit my table here whether the table is

411
00:14:37,110 --> 00:14:32,480
going to resonate

412
00:14:39,189 --> 00:14:37,120
is just a matter of the mechanics of the

413
00:14:42,310 --> 00:14:39,199

resonant frequencies of this table and

414
00:14:45,990 --> 00:14:42,320
so on and how i hit it and so on

415
00:14:46,790 --> 00:14:46,000
but for an argument to resonate

416
00:14:48,310 --> 00:14:46,800
uh

417
00:14:52,629 --> 00:14:48,320
in me

418
00:14:54,310 --> 00:14:52,639
it's i think not just a matter of uh

419
00:14:55,829 --> 00:14:54,320
i don't know it's not a mechanical

420
00:14:58,550 --> 00:14:55,839
question

421
00:15:00,230 --> 00:14:58,560
some arguments are convincing some of us

422
00:15:01,829 --> 00:15:00,240
are not convincing and again that may

423
00:15:04,069 --> 00:15:01,839
change in the course of time you don't

424
00:15:08,310 --> 00:15:04,079
need to always be convinced by the same

425
00:15:10,150 --> 00:15:08,320
argument during all your life span

426
00:15:12,790 --> 00:15:10,160
so there must be something more and this

427
00:15:15,670 --> 00:15:12,800
something more is actually what we name

428
00:15:18,710 --> 00:15:15,680
free will this table has no free will it

429
00:15:19,910 --> 00:15:18,720
doesn't decide to resonate to my hitting

430
00:15:20,870 --> 00:15:19,920
it

431
00:15:23,350 --> 00:15:20,880
while

432
00:15:24,710 --> 00:15:23,360
you and me and everybody listening here

433
00:15:28,230 --> 00:15:24,720
and so on

434
00:15:29,509 --> 00:15:28,240
they may find points and now my argument

435
00:15:32,870 --> 00:15:29,519
uh

436
00:15:33,829 --> 00:15:32,880
in that it resonates to

437
00:15:35,990 --> 00:15:33,839
to them

438
00:15:38,310 --> 00:15:36,000

or that they are willing to buy it or at

439
00:15:40,710 --> 00:15:38,320
least to consider it or on the country

440
00:15:43,110 --> 00:15:40,720
they will just reject it but whatever

441
00:15:45,430 --> 00:15:43,120
they do it's like it's a free decision

442
00:15:47,749 --> 00:15:45,440
it's something that depends on them it's

443
00:15:49,030 --> 00:15:47,759
i don't think it is just a mechanical

444
00:15:49,910 --> 00:15:49,040
consequence

445
00:15:53,350 --> 00:15:49,920
of

446
00:15:55,350 --> 00:15:53,360
and so on

447
00:15:57,910 --> 00:15:55,360
so the way that i understand it is if i

448
00:16:00,550 --> 00:15:57,920
was to make a bridge resonate i throw

449
00:16:02,629 --> 00:16:00,560
wind at it and then it wobbles and

450
00:16:05,269 --> 00:16:02,639
that's a physical process now if i throw

451
00:16:06,870 --> 00:16:05,279
an idea at you or you to me if it

452
00:16:09,110 --> 00:16:06,880
resonates with me we haven't we use the

453
00:16:10,870 --> 00:16:09,120
same word resonate but we just mean well

454
00:16:13,110 --> 00:16:10,880
we use the same word resonate that is

455
00:16:14,870 --> 00:16:13,120
dependent not on the physics but on free

456
00:16:16,790 --> 00:16:14,880
will

457
00:16:18,629 --> 00:16:16,800
exactly i think that's that's exactly

458
00:16:20,230 --> 00:16:18,639
yeah i think that that's correct of

459
00:16:22,550 --> 00:16:20,240
course i know that some people will say

460
00:16:25,189 --> 00:16:22,560
no no this is a purely a physical

461
00:16:27,829 --> 00:16:25,199
phenomenon we don't i mean we first of

462
00:16:29,110 --> 00:16:27,839
all don't exist it's everything is just

463
00:16:30,870 --> 00:16:29,120

pure physics

464
00:16:32,870 --> 00:16:30,880
but i think

465
00:16:34,790 --> 00:16:32,880
going that far

466
00:16:36,629 --> 00:16:34,800
first assumes that physics really

467
00:16:39,110 --> 00:16:36,639
explains everything

468
00:16:41,430 --> 00:16:39,120
it all almost assumes in between the

469
00:16:42,470 --> 00:16:41,440
line that today's physics is close to an

470
00:16:45,189 --> 00:16:42,480
end

471
00:16:49,030 --> 00:16:45,199
which i consider ridiculous

472
00:16:54,550 --> 00:16:52,870
yeah and and i think it uh

473
00:16:57,590 --> 00:16:54,560
it bypasses

474
00:17:00,710 --> 00:16:57,600
the beauty of life the beauty of uh

475
00:17:04,470 --> 00:17:00,720
human beings including animals

476
00:17:06,870 --> 00:17:04,480
of livings living beings what do your

477
00:17:08,549 --> 00:17:06,880
colleagues say to you when you say

478
00:17:09,669 --> 00:17:08,559
well perhaps physics doesn't explain

479
00:17:11,829 --> 00:17:09,679
everything

480
00:17:13,750 --> 00:17:11,839
the reductionist account including our

481
00:17:15,270 --> 00:17:13,760
actions it goes from our actions to our

482
00:17:16,949 --> 00:17:15,280
neurobiology to the chemistry to the

483
00:17:20,549 --> 00:17:16,959
physics

484
00:17:22,150 --> 00:17:20,559
yeah

485
00:17:23,829 --> 00:17:22,160
again here um

486
00:17:26,230 --> 00:17:23,839
depends where we're talking about

487
00:17:29,430 --> 00:17:26,240
today's physics or even near future

488
00:17:32,070 --> 00:17:29,440

physics of physics in general so science

489
00:17:34,230 --> 00:17:32,080
is not at the end and will continue to

490
00:17:36,870 --> 00:17:34,240
develop and there will be new ideas and

491
00:17:40,310 --> 00:17:36,880
completely new things which will be

492
00:17:43,029 --> 00:17:40,320
totally surprising to today's physicist

493
00:17:45,270 --> 00:17:43,039
like quantum mechanics and relativity

494
00:17:49,430 --> 00:17:45,280
are completely

495
00:17:51,750 --> 00:17:49,440
foreign to uh 19th century physics

496
00:17:52,870 --> 00:17:51,760
so there will be more revolutions

497
00:17:54,950 --> 00:17:52,880
and um

498
00:17:57,110 --> 00:17:54,960
so maybe there's one thing which seems

499
00:18:00,070 --> 00:17:57,120
pretty clear is that today's physics

500
00:18:02,950 --> 00:18:00,080
doesn't explain free will consciousness

501
00:18:06,549 --> 00:18:04,230
could it be that

502
00:18:09,190 --> 00:18:06,559
future physics explain it certainly not

503
00:18:11,909 --> 00:18:09,200
near future now what is really the very

504
00:18:14,630 --> 00:18:11,919
far future of physics or science more

505
00:18:15,830 --> 00:18:14,640
generally of course i don't know

506
00:18:18,630 --> 00:18:15,840
but my

507
00:18:21,909 --> 00:18:18,640
claim is that free will being

508
00:18:24,150 --> 00:18:21,919
first in the logical order

509
00:18:27,029 --> 00:18:24,160
physics or science more generally and

510
00:18:29,590 --> 00:18:27,039
philosophy will never be able to fully

511
00:18:31,830 --> 00:18:29,600
explain freewheel of course we can

512
00:18:33,669 --> 00:18:31,840
explain part of it for instance today we

513
00:18:35,270 --> 00:18:33,679

understand much better i find in the

514
00:18:37,029 --> 00:18:35,280
19th century

515
00:18:38,150 --> 00:18:37,039
the difference between hardware and

516
00:18:40,390 --> 00:18:38,160
software

517
00:18:42,870 --> 00:18:40,400
and this distinction

518
00:18:45,430 --> 00:18:42,880
which is very common today but this is a

519
00:18:47,510 --> 00:18:45,440
useful distinction to to start even to

520
00:18:50,230 --> 00:18:47,520
think about you know the brain as just

521
00:18:52,950 --> 00:18:50,240
being the material part and maybe some

522
00:18:55,110 --> 00:18:52,960
software whatever that exactly means

523
00:18:57,750 --> 00:18:55,120
and things like that but at least we can

524
00:18:59,190 --> 00:18:57,760
start articulating ideas

525
00:19:00,870 --> 00:18:59,200
uh thanks to

526
00:19:02,950 --> 00:19:00,880
this distinction between software and

527
00:19:04,549 --> 00:19:02,960
hardware that were completely

528
00:19:08,549 --> 00:19:04,559
unthinkable

529
00:19:10,870 --> 00:19:08,559
uh 200 years ago 150 years ago

530
00:19:13,669 --> 00:19:10,880
so we can also expect that in the future

531
00:19:17,350 --> 00:19:13,679
there will be new uh concepts

532
00:19:19,990 --> 00:19:17,360
uh that's that we master or that

533
00:19:21,669 --> 00:19:20,000
the future scientists will master

534
00:19:24,310 --> 00:19:21,679
and that will help

535
00:19:26,789 --> 00:19:24,320
uh better articulating the problem of

536
00:19:28,710 --> 00:19:26,799
free will and consciousness and so on

537
00:19:32,070 --> 00:19:28,720
but i don't think we will ever come to

538
00:19:33,830 --> 00:19:32,080

an end in that if we will somehow some

539
00:19:37,350 --> 00:19:33,840
essence of free will

540
00:19:43,110 --> 00:19:41,190
outside the scope of of science

541
00:19:44,549 --> 00:19:43,120
and now yeah you also asked about my

542
00:19:52,630 --> 00:19:44,559
colleagues

543
00:19:54,789 --> 00:19:52,640
the vast majority of the physicists

544
00:19:57,590 --> 00:19:54,799
just don't care they are not going to

545
00:20:00,710 --> 00:19:57,600
listen at all we just don't care

546
00:20:01,909 --> 00:20:00,720
now among those that care

547
00:20:04,070 --> 00:20:01,919
you know

548
00:20:05,350 --> 00:20:04,080
they care after a few years

549
00:20:06,630 --> 00:20:05,360
usually

550
00:20:09,510 --> 00:20:06,640
uh and

551
00:20:11,590 --> 00:20:09,520
most of them which then i don't know

552
00:20:14,390 --> 00:20:11,600
i would they would listen to what i have

553
00:20:16,630 --> 00:20:14,400
to say they would not necessarily agree

554
00:20:18,470 --> 00:20:16,640
okay some have very strong opinions they

555
00:20:21,380 --> 00:20:18,480
are strongly compatibilist but they

556
00:20:22,630 --> 00:20:21,390
really thought about it that's okay

557
00:20:24,549 --> 00:20:22,640
[Music]

558
00:20:26,470 --> 00:20:24,559
and i guess we also quite a lot and i

559
00:20:28,230 --> 00:20:26,480
have already experienced quite a lot of

560
00:20:29,830 --> 00:20:28,240
my colleagues who are happy with what

561
00:20:31,510 --> 00:20:29,840
i'm saying

562
00:20:32,630 --> 00:20:31,520
but you know the happy is a small

563
00:20:35,110 --> 00:20:32,640

minority

564
00:20:37,830 --> 00:20:35,120
seriously unhappy is also a small small

565
00:20:39,270 --> 00:20:37,840
minority and the enormous majority just

566
00:20:40,470 --> 00:20:39,280
doesn't care

567
00:20:41,830 --> 00:20:40,480
and why do you think the majority

568
00:20:44,789 --> 00:20:41,840
doesn't care

569
00:20:50,549 --> 00:20:44,799
it's too ill-defined they'll say

570
00:20:54,070 --> 00:20:53,350
i don't exactly know how how they can

571
00:20:56,390 --> 00:20:54,080
not

572
00:20:57,590 --> 00:20:56,400
care about such important and deep

573
00:20:59,669 --> 00:20:57,600
questions

574
00:21:01,669 --> 00:20:59,679
maybe we just think that uh you know

575
00:21:03,350 --> 00:21:01,679
they have not been trained in that so

576
00:21:04,630 --> 00:21:03,360
they don't feel uh

577
00:21:07,510 --> 00:21:04,640
competent

578
00:21:10,070 --> 00:21:07,520
in this in this respect somehow

579
00:21:12,070 --> 00:21:10,080
probably also if some of my colleagues i

580
00:21:14,630 --> 00:21:12,080
tell them about some

581
00:21:16,549 --> 00:21:14,640
subtleties in biology they may also just

582
00:21:19,510 --> 00:21:16,559
say oh i i don't understand it it's

583
00:21:21,990 --> 00:21:19,520
outside my field of competence actually

584
00:21:23,669 --> 00:21:22,000
nowadays we get so specialized that you

585
00:21:25,270 --> 00:21:23,679
don't even need to change feel and go

586
00:21:27,110 --> 00:21:25,280
outside of physics

587
00:21:29,110 --> 00:21:27,120
for not understanding what the colleague

588
00:21:31,430 --> 00:21:29,120

is saying um

589
00:21:33,750 --> 00:21:31,440
and uh maybe it is uh

590
00:21:35,909 --> 00:21:33,760
it is uh

591
00:21:37,990 --> 00:21:35,919
yeah it's a way of protecting yourself

592
00:21:40,549 --> 00:21:38,000
just to say no notice i don't want to

593
00:21:42,149 --> 00:21:40,559
touch it's outside my little field

594
00:21:43,750 --> 00:21:42,159
of competence

595
00:21:45,350 --> 00:21:43,760
do you think what governs free will is

596
00:21:46,789 --> 00:21:45,360
mathematics or you think it's something

597
00:21:48,230 --> 00:21:46,799
completely different

598
00:21:50,710 --> 00:21:48,240
and this goes back to our reductionist

599
00:21:53,190 --> 00:21:50,720
account okay yeah mathematics we we

600
00:21:54,710 --> 00:21:53,200
should talk about mathematics and uh

601
00:21:56,310 --> 00:21:54,720
and determinism

602
00:21:57,510 --> 00:21:56,320
um but um

603
00:21:59,750 --> 00:21:57,520
no i think

604
00:22:02,549 --> 00:21:59,760
mathematics again and especially today's

605
00:22:03,669 --> 00:22:02,559
mathematics has very very little to say

606
00:22:07,270 --> 00:22:03,679
on

607
00:22:09,590 --> 00:22:07,280
uh

608
00:22:12,070 --> 00:22:09,600
and consciousness

609
00:22:13,669 --> 00:22:12,080
the reason i say that is that when one

610
00:22:15,909 --> 00:22:13,679
says well it's first in the logical

611
00:22:18,149 --> 00:22:15,919
order the way i'm thinking is of the

612
00:22:19,590 --> 00:22:18,159
traditional reductionist view and you go

613
00:22:21,350 --> 00:22:19,600

down and down until you get to physics

614
00:22:24,310 --> 00:22:21,360
and then sometimes people encapsulate

615
00:22:26,230 --> 00:22:24,320
physics into math and then if free will

616
00:22:27,909 --> 00:22:26,240
is first well then free will is prior to

617
00:22:29,830 --> 00:22:27,919
math is that the correct way of looking

618
00:22:31,590 --> 00:22:29,840
at it as these nested sets or is that

619
00:22:32,950 --> 00:22:31,600
different i shouldn't be thinking about

620
00:22:35,510 --> 00:22:32,960
it like that

621
00:22:36,630 --> 00:22:35,520
i don't think you should be thinking of

622
00:22:41,350 --> 00:22:36,640
nested

623
00:22:45,669 --> 00:22:43,350
i guess it's really a kind of different

624
00:22:51,669 --> 00:22:45,679
branch of

625
00:22:57,590 --> 00:22:54,789
and again mathematics

626
00:23:01,110 --> 00:22:57,600
in french we say

627
00:23:02,789 --> 00:23:01,120
the mathematics it's really a plural

628
00:23:04,470 --> 00:23:02,799
and indeed there are different

629
00:23:06,870 --> 00:23:04,480
sources of mathematics you can really

630
00:23:09,270 --> 00:23:06,880
think of mathematics as kind of

631
00:23:11,110 --> 00:23:09,280
you know this purely platonistic view

632
00:23:13,029 --> 00:23:11,120
where there are these mathematical

633
00:23:15,430 --> 00:23:13,039
objects existing

634
00:23:18,390 --> 00:23:15,440
you know outside of time outside of the

635
00:23:22,870 --> 00:23:20,549
they just have their own existence with

636
00:23:24,149 --> 00:23:22,880
their own rules

637
00:23:27,110 --> 00:23:24,159
um

638
00:23:31,510 --> 00:23:27,120

now again okay i'm probably not

639
00:23:33,830 --> 00:23:31,520
prepared to really argue these rules

640
00:23:36,230 --> 00:23:33,840
you know they depend on the axioms

641
00:23:36,950 --> 00:23:36,240
in principle but okay yeah quite a lot

642
00:23:39,430 --> 00:23:36,960
of

643
00:23:42,390 --> 00:23:39,440
basic things like you know the integers

644
00:23:44,390 --> 00:23:42,400
for instance the integer five

645
00:23:46,630 --> 00:23:44,400
does it exist by itself in this

646
00:23:48,710 --> 00:23:46,640
platonistic world i guess that's the

647
00:23:51,590 --> 00:23:48,720
view that most mathematicians would

648
00:23:55,669 --> 00:23:53,510
but there are there are different sorts

649
00:23:58,549 --> 00:23:55,679
of mathematics you have also mathematics

650
00:24:02,310 --> 00:23:58,559
where people were more thinking

651
00:24:05,750 --> 00:24:03,830
that the mathematical objects would

652
00:24:08,630 --> 00:24:05,760
themselves be

653
00:24:09,830 --> 00:24:08,640
processes that develop and evolve in

654
00:24:12,870 --> 00:24:09,840
time

655
00:24:15,830 --> 00:24:12,880
uh okay the best example here is uh

656
00:24:18,149 --> 00:24:15,840
intuitionistic mathematics that was

657
00:24:20,710 --> 00:24:18,159
mostly uh

658
00:24:23,430 --> 00:24:20,720
developed by brower

659
00:24:24,789 --> 00:24:23,440
a hundred years ago about about 100

660
00:24:26,149 --> 00:24:24,799
years ago

661
00:24:28,230 --> 00:24:26,159
there are still today some people

662
00:24:30,870 --> 00:24:28,240
developing this form of mathematics that

663
00:24:33,029 --> 00:24:30,880

come under the general umbrella of

664
00:24:35,029 --> 00:24:33,039
constructivists

665
00:24:38,390 --> 00:24:35,039
but in this specific form of

666
00:24:39,750 --> 00:24:38,400
constructivism called intuitionism

667
00:24:41,750 --> 00:24:39,760
you really have that already at the

668
00:24:44,070 --> 00:24:41,760
mathematical level

669
00:24:47,430 --> 00:24:44,080
even numbers like okay what we call real

670
00:24:49,669 --> 00:24:47,440
numbers are really evolving in time

671
00:24:52,549 --> 00:24:49,679
and then if mathematics includes that

672
00:24:55,269 --> 00:24:52,559
kind of and in unneeds the concept or

673
00:24:57,990 --> 00:24:55,279
introduces the concept of time already

674
00:25:00,149 --> 00:24:58,000
even at the level of numbers

675
00:25:01,750 --> 00:25:00,159
then that makes this sort of mathematics

676
00:25:03,830 --> 00:25:01,760
much closer

677
00:25:08,310 --> 00:25:03,840
and possibly better suited

678
00:25:09,830 --> 00:25:08,320
for for physics for science in general

679
00:25:13,110 --> 00:25:09,840
so when you see mathematics it's not

680
00:25:16,470 --> 00:25:14,950
many of the people watching don't know

681
00:25:18,230 --> 00:25:16,480
what constructivism what is a

682
00:25:21,110 --> 00:25:18,240
constructionist

683
00:25:23,350 --> 00:25:21,120
because it's not constructivism isn't it

684
00:25:24,710 --> 00:25:23,360
constructivist well definite that i know

685
00:25:26,310 --> 00:25:24,720
there's social constructivism in the

686
00:25:27,350 --> 00:25:26,320
social construction i don't want to mix

687
00:25:30,230 --> 00:25:27,360
that up

688
00:25:32,710 --> 00:25:30,240

well i know intuitionism and i've always

689
00:25:34,549 --> 00:25:32,720
seen intuitionism as the same as

690
00:25:36,470 --> 00:25:34,559
the constructionist view in mathematics

691
00:25:38,789 --> 00:25:36,480
but you just said that intuitionist is a

692
00:25:40,549 --> 00:25:38,799
specific subset of constructionist what

693
00:25:45,430 --> 00:25:40,559
would be an example of a constructionist

694
00:25:50,310 --> 00:25:47,990
so constructivist just means that every

695
00:25:52,630 --> 00:25:50,320
object one should be able to construct

696
00:25:55,029 --> 00:25:52,640
them now it depends do you want to be

697
00:25:57,269 --> 00:25:55,039
able to construct them now

698
00:25:58,230 --> 00:25:57,279
and period is done

699
00:26:00,390 --> 00:25:58,240
or

700
00:26:02,870 --> 00:26:00,400
is it enough to have a rule that tells

701
00:26:05,190 --> 00:26:02,880
you how the process of constructing

702
00:26:07,190 --> 00:26:05,200
these these objects

703
00:26:10,230 --> 00:26:07,200
develops in time

704
00:26:12,310 --> 00:26:10,240
so somehow they are never finished there

705
00:26:14,549 --> 00:26:12,320
are at least some of these processes

706
00:26:17,510 --> 00:26:14,559
that we never finished

707
00:26:19,110 --> 00:26:17,520
so they evolved in time and that's then

708
00:26:23,909 --> 00:26:19,120
intuitionism

709
00:26:26,070 --> 00:26:23,919
things can evolve in time admittedly

710
00:26:29,590 --> 00:26:26,080
brower when he developed that he was

711
00:26:30,710 --> 00:26:29,600
thinking about you know you may define a

712
00:26:32,390 --> 00:26:30,720
number

713
00:26:34,710 --> 00:26:32,400

uh

714
00:26:36,070 --> 00:26:34,720
depending on some mathematical

715
00:26:41,029 --> 00:26:36,080
conjecture

716
00:26:43,510 --> 00:26:41,039
turn out you know true or false the

717
00:26:47,430 --> 00:26:43,520
number may be you know zero one let's

718
00:26:49,750 --> 00:26:47,440
say and so the number is undefined until

719
00:26:51,830 --> 00:26:49,760
this conjecture this specific conjecture

720
00:26:53,350 --> 00:26:51,840
is solved but that brings now

721
00:26:56,630 --> 00:26:53,360
mathematics or this form of

722
00:26:58,710 --> 00:26:56,640
intuitionistic mathematics very much to

723
00:27:00,789 --> 00:26:58,720
what humans are able to do

724
00:27:01,990 --> 00:27:00,799
prove or not prove this uh

725
00:27:03,669 --> 00:27:02,000
conjecture

726
00:27:05,990 --> 00:27:03,679
while my understanding and other

727
00:27:07,110 --> 00:27:06,000
people's understanding of intuition is

728
00:27:09,909 --> 00:27:07,120
just that

729
00:27:12,470 --> 00:27:09,919
as time passes new information gets

730
00:27:15,750 --> 00:27:12,480
created continuously

731
00:27:21,110 --> 00:27:18,149
a number may evolve according to this

732
00:27:23,110 --> 00:27:21,120
new information

733
00:27:25,510 --> 00:27:23,120
so the standard view in mathematics is

734
00:27:27,669 --> 00:27:25,520
classical mathematics and that is to say

735
00:27:29,750 --> 00:27:27,679
that we're discovering it and it's

736
00:27:31,909 --> 00:27:29,760
timeless so the pythagorean theorem is

737
00:27:34,070 --> 00:27:31,919
timeless we just found it and it existed

738
00:27:36,230 --> 00:27:34,080

before humans now brower would say well

739
00:27:37,909 --> 00:27:36,240
it didn't exist until we discovered it

740
00:27:40,310 --> 00:27:37,919
and then brower was a type of

741
00:27:43,269 --> 00:27:40,320
intuitionist but that's a bit too

742
00:27:44,789 --> 00:27:43,279
anthropocentric so we say now well

743
00:27:47,269 --> 00:27:44,799
there's still intuitionism it's just

744
00:27:48,870 --> 00:27:47,279
that the universe itself reveals new

745
00:27:50,870 --> 00:27:48,880
information

746
00:27:52,870 --> 00:27:50,880
exactly

747
00:27:54,149 --> 00:27:52,880
it is correct but of course about the

748
00:27:57,110 --> 00:27:54,159
petagon

749
00:28:00,070 --> 00:27:57,120
theorem once it is on the table

750
00:28:02,149 --> 00:28:00,080
there's nothing more to to add on that

751
00:28:04,149 --> 00:28:02,159
but you can imagine that just a number

752
00:28:05,510 --> 00:28:04,159
that sounds let's say zero dot and then

753
00:28:06,870 --> 00:28:05,520
you have all the digits that come

754
00:28:08,149 --> 00:28:06,880
afterwards

755
00:28:11,269 --> 00:28:08,159
um

756
00:28:13,909 --> 00:28:11,279
and some of these far away uh digits may

757
00:28:17,110 --> 00:28:13,919
not yet be determined

758
00:28:20,470 --> 00:28:17,120
but those new information gets created

759
00:28:21,510 --> 00:28:20,480
these uh far down the series uh digits

760
00:28:23,830 --> 00:28:21,520
may get

761
00:28:25,350 --> 00:28:23,840
determined

762
00:28:27,990 --> 00:28:25,360
you should know that the audience for

763
00:28:29,190 --> 00:28:28,000

this is generally upper year

764
00:28:32,310 --> 00:28:29,200
undergrads

765
00:28:33,669 --> 00:28:32,320
so in math and physics so for them can

766
00:28:34,549 --> 00:28:33,679
you explain

767
00:28:36,549 --> 00:28:34,559
how

768
00:28:38,950 --> 00:28:36,559
indeterminacy arises in classical

769
00:28:41,510 --> 00:28:38,960
physics

770
00:28:43,110 --> 00:28:41,520
like a few arguments and you can also

771
00:28:44,230 --> 00:28:43,120
outline your views on the real numbers

772
00:28:45,510 --> 00:28:44,240
aren't real and so on because those are

773
00:28:47,590 --> 00:28:45,520
tight

774
00:28:48,470 --> 00:28:47,600
yeah yeah it's it's it's all connected

775
00:28:50,630 --> 00:28:48,480
indeed

776
00:28:53,029 --> 00:28:50,640
so very important uh

777
00:28:55,669 --> 00:28:53,039
to understand first is

778
00:28:57,830 --> 00:28:55,679
chaos in classical mechanics you have

779
00:28:59,909 --> 00:28:57,840
okay newton's law and all that and you

780
00:29:01,830 --> 00:28:59,919
may use hamiltonian's equation whatever

781
00:29:03,990 --> 00:29:01,840
the equation that you you learn at

782
00:29:06,470 --> 00:29:04,000
school and university

783
00:29:08,710 --> 00:29:06,480
um and usually one then gives us some

784
00:29:10,789 --> 00:29:08,720
examples and the examples will be a

785
00:29:12,870 --> 00:29:10,799
harmonic oscillator you know just a kind

786
00:29:15,590 --> 00:29:12,880
of pendulum that oscillates very

787
00:29:17,750 --> 00:29:15,600
regularly or you may have a

788
00:29:21,510 --> 00:29:17,760

i don't know

789
00:29:24,549 --> 00:29:21,520
a star or a planet orbiting its star

790
00:29:27,430 --> 00:29:24,559
like earth orbiting the sun which again

791
00:29:29,269 --> 00:29:27,440
is a very very regular motion

792
00:29:32,470 --> 00:29:29,279
but actually when you look at all the

793
00:29:35,510 --> 00:29:32,480
possible configurations of these uh

794
00:29:37,830 --> 00:29:35,520
mata particles you notice that

795
00:29:40,149 --> 00:29:37,840
almost all actually with probability one

796
00:29:41,669 --> 00:29:40,159
the system that you're going to consider

797
00:29:43,590 --> 00:29:41,679
actually

798
00:29:46,549 --> 00:29:43,600
is not regular

799
00:29:47,330 --> 00:29:46,559
but it's chaotic and by chaotic it means

800
00:29:48,470 --> 00:29:47,340
that's the

801
00:29:49,750 --> 00:29:48,480
[Music]

802
00:29:51,430 --> 00:29:49,760
the future

803
00:29:53,350 --> 00:29:51,440
of this

804
00:29:55,190 --> 00:29:53,360
set of particles

805
00:29:57,669 --> 00:29:55,200
depends

806
00:29:59,909 --> 00:29:57,679
super sensitively on the initial

807
00:30:02,230 --> 00:29:59,919
condition so you take an initial

808
00:30:04,870 --> 00:30:02,240
condition which is usually defined by a

809
00:30:07,110 --> 00:30:04,880
real number and now you change the

810
00:30:08,710 --> 00:30:07,120
digits number one thousand or one

811
00:30:10,630 --> 00:30:08,720
million whatever

812
00:30:12,789 --> 00:30:10,640
and of course initially you don't see

813
00:30:13,909 --> 00:30:12,799

any difference if you let these systems

814
00:30:16,549 --> 00:30:13,919
evolve

815
00:30:18,549 --> 00:30:16,559
but if the system is chaotic pretty

816
00:30:20,950 --> 00:30:18,559
quickly the system will evolve

817
00:30:23,430 --> 00:30:20,960
completely differently although you have

818
00:30:24,789 --> 00:30:23,440
only changed the digits

819
00:30:26,710 --> 00:30:24,799
1000

820
00:30:28,549 --> 00:30:26,720
positions down there the string of

821
00:30:31,430 --> 00:30:28,559
digits

822
00:30:34,149 --> 00:30:31,440
and then comes the question is that

823
00:30:35,990 --> 00:30:34,159
still a deterministic system or not

824
00:30:37,590 --> 00:30:36,000
so first of all obviously it is not

825
00:30:39,990 --> 00:30:37,600
deterministic in the sense that you

826
00:30:42,549 --> 00:30:40,000
cannot control all these digits it's

827
00:30:45,190 --> 00:30:42,559
it's beyond our technology but still you

828
00:30:46,710 --> 00:30:45,200
can now go more on the ontology side

829
00:30:49,029 --> 00:30:46,720
does this

830
00:30:51,269 --> 00:30:49,039
1 000 or 1 million

831
00:30:52,789 --> 00:30:51,279
digits really exist

832
00:30:54,070 --> 00:30:52,799
since ever

833
00:30:56,389 --> 00:30:54,080
and hence

834
00:30:58,870 --> 00:30:56,399
this chaotic system actually evolved in

835
00:31:01,669 --> 00:30:58,880
a fully deterministic way we don't know

836
00:31:04,389 --> 00:31:01,679
which way but it is deterministic

837
00:31:08,310 --> 00:31:04,399
or is it the case that this

838
00:31:10,149 --> 00:31:08,320

billion for millionth digit actually is

839
00:31:13,350 --> 00:31:10,159
undetermined

840
00:31:15,269 --> 00:31:13,360
at time t0 and hence the evolution of

841
00:31:18,389 --> 00:31:15,279
this chaotic system

842
00:31:20,470 --> 00:31:18,399
will be also undetermined as time passes

843
00:31:21,750 --> 00:31:20,480
this digit will get

844
00:31:28,789 --> 00:31:21,760
determined

845
00:31:30,870 --> 00:31:28,799
and if you think like that

846
00:31:33,190 --> 00:31:30,880
so if you replace classical mathematics

847
00:31:34,789 --> 00:31:33,200
by intuitionistic mathematics

848
00:31:38,789 --> 00:31:34,799
you make the same predictions

849
00:31:44,710 --> 00:31:41,269
but very importantly with intuitionistic

850
00:31:47,669 --> 00:31:44,720
mathematics you see that

851
00:31:51,590 --> 00:31:47,679
a chaotic classical system is no longer

852
00:31:53,750 --> 00:31:51,600
deterministic it becomes indeterministic

853
00:31:55,269 --> 00:31:53,760
although it is classical physics still

854
00:31:58,070 --> 00:31:55,279
although the equations are still

855
00:32:01,909 --> 00:31:58,080
newton's equations and all that

856
00:32:03,029 --> 00:32:01,919
and so indeed i i like to argue that is

857
00:32:04,710 --> 00:32:03,039
uh

858
00:32:07,509 --> 00:32:04,720
first of all that it already shows that

859
00:32:08,950 --> 00:32:07,519
just by changing the mathematics

860
00:32:10,789 --> 00:32:08,960
contrary to what we learned they are

861
00:32:12,230 --> 00:32:10,799
more fun one mathematics

862
00:32:14,070 --> 00:32:12,240
and if you go to another form of

863
00:32:17,269 --> 00:32:14,080

mathematics you don't change the

864
00:32:21,029 --> 00:32:17,279
prediction since all the empirical

865
00:32:21,750 --> 00:32:21,039
you know confirmation of physics remains

866
00:32:24,310 --> 00:32:21,760
but

867
00:32:27,590 --> 00:32:24,320
instead of presenting you with a

868
00:32:29,830 --> 00:32:27,600
deterministic worldview the same theory

869
00:32:31,990 --> 00:32:29,840
newton's theory in this case classical

870
00:32:34,389 --> 00:32:32,000
mechanics presents you with an

871
00:32:36,310 --> 00:32:34,399
indeterministic worldview

872
00:32:38,070 --> 00:32:36,320
so you see it's really you can choose

873
00:32:39,830 --> 00:32:38,080
you can use your free will to choose

874
00:32:40,789 --> 00:32:39,840
whether you prefer one or the other but

875
00:32:42,549 --> 00:32:40,799
it's not

876
00:32:43,430 --> 00:32:42,559
the facts that are going to choose for

877
00:32:45,190 --> 00:32:43,440
you

878
00:32:47,750 --> 00:32:45,200
and then there's one more argument which

879
00:32:50,070 --> 00:32:47,760
i'd like to put on the table

880
00:32:52,630 --> 00:32:50,080
you know a real number a typical real

881
00:32:54,710 --> 00:32:52,640
number you know this integer dot and

882
00:32:57,029 --> 00:32:54,720
then all these digits

883
00:32:59,029 --> 00:32:57,039
that contains actually an infinite

884
00:33:00,789 --> 00:32:59,039
amount of information because this

885
00:33:03,590 --> 00:33:00,799
series of digits

886
00:33:05,990 --> 00:33:03,600
they typically contain no structure at

887
00:33:07,430 --> 00:33:06,000
all it's not like one third one third

888
00:33:09,750 --> 00:33:07,440

it's zero dot and then you have only

889
00:33:11,750 --> 00:33:09,760
three free free that just repeats itself

890
00:33:14,389 --> 00:33:11,760
but a typical real number will have no

891
00:33:16,389 --> 00:33:14,399
structure at all and that means that if

892
00:33:18,789 --> 00:33:16,399
you want to describe it you have to give

893
00:33:20,950 --> 00:33:18,799
everything every every digit but there

894
00:33:23,590 --> 00:33:20,960
are infinitely many digits so that's

895
00:33:26,070 --> 00:33:23,600
infinitely many uh it's an infinite

896
00:33:28,310 --> 00:33:26,080
amount of information

897
00:33:29,909 --> 00:33:28,320
i know if you think that's

898
00:33:32,710 --> 00:33:29,919
you know you you make the assumption

899
00:33:34,549 --> 00:33:32,720
that in a finite volume of space

900
00:33:36,710 --> 00:33:34,559
you have only a finite

901
00:33:38,789 --> 00:33:36,720
amount of information you cannot pack

902
00:33:39,909 --> 00:33:38,799
infinite information into a finite

903
00:33:41,830 --> 00:33:39,919
volume

904
00:33:42,870 --> 00:33:41,840
then the natural consequence of this

905
00:33:44,789 --> 00:33:42,880
assumption

906
00:33:47,509 --> 00:33:44,799
is that if you have now

907
00:33:51,430 --> 00:33:47,519
be a ball or anything in your

908
00:33:53,909 --> 00:33:51,440
small volume finite volume

909
00:33:56,149 --> 00:33:53,919
the center of mass of that or any other

910
00:33:58,710 --> 00:33:56,159
degree of freedom cannot be faithfully

911
00:34:00,470 --> 00:33:58,720
described by a real number because if it

912
00:34:01,750 --> 00:34:00,480
would be a real number you would have to

913
00:34:03,990 --> 00:34:01,760

pack all this

914
00:34:05,509 --> 00:34:04,000
infinite information into your finite

915
00:34:08,149 --> 00:34:05,519
volume

916
00:34:10,470 --> 00:34:08,159
and so from that i uh yeah i concluded

917
00:34:11,510 --> 00:34:10,480
and i have a paper with this uh nice

918
00:34:14,069 --> 00:34:11,520
title

919
00:34:15,829 --> 00:34:14,079
real numbers are not really real

920
00:34:18,470 --> 00:34:15,839
you know these real numbers we've got

921
00:34:20,950 --> 00:34:18,480
cold wheel by day cat for easter

922
00:34:23,190 --> 00:34:20,960
historical reasons

923
00:34:24,710 --> 00:34:23,200
and we still use this terminology of

924
00:34:26,710 --> 00:34:24,720
real numbers

925
00:34:29,750 --> 00:34:26,720
but if you look at them from a physics

926
00:34:31,030 --> 00:34:29,760
point of view they're not really real

927
00:34:33,190 --> 00:34:31,040
usually people who say that the real

928
00:34:35,349 --> 00:34:33,200
numbers aren't real are a fan of digital

929
00:34:37,030 --> 00:34:35,359
physics that this computation underneath

930
00:34:39,190 --> 00:34:37,040
in the laws of physics or computation

931
00:34:42,149 --> 00:34:39,200
okay so stephen wolfram for example do

932
00:34:47,990 --> 00:34:45,190
not entirely i guess in part yes

933
00:34:50,069 --> 00:34:48,000
but what i add to that but i think it's

934
00:34:51,270 --> 00:34:50,079
important to add is really this idea

935
00:34:53,750 --> 00:34:51,280
that these

936
00:34:55,030 --> 00:34:53,760
these numbers are evolving in time so

937
00:34:57,670 --> 00:34:55,040
you still have for instance the

938
00:35:00,390 --> 00:34:57,680

continuum uh voltron would not have the

939
00:35:02,470 --> 00:35:00,400
continuum in this sense but with uh

940
00:35:05,190 --> 00:35:02,480
intuitionistic mathematics you have

941
00:35:08,150 --> 00:35:05,200
these numbers evolve and so this digit

942
00:35:11,109 --> 00:35:08,160
which is initially undetermined

943
00:35:13,430 --> 00:35:11,119
will get determined in proper time

944
00:35:15,670 --> 00:35:13,440
and uh and so the

945
00:35:18,230 --> 00:35:15,680
yeah first of all

946
00:35:20,230 --> 00:35:18,240
if this digit becomes very important

947
00:35:23,190 --> 00:35:20,240
let's say in a week time because it

948
00:35:26,150 --> 00:35:23,200
would determine the weather in a week

949
00:35:27,670 --> 00:35:26,160
um it cannot be that the weather in a

950
00:35:29,910 --> 00:35:27,680
time

951
00:35:32,069 --> 00:35:29,920
in one week from now the weather will be

952
00:35:34,150 --> 00:35:32,079
you know determined it will be sunny or

953
00:35:35,270 --> 00:35:34,160
rainy or in between but it will be

954
00:35:38,790 --> 00:35:35,280
something

955
00:35:40,069 --> 00:35:38,800
so at some point in time these chaotic

956
00:35:42,630 --> 00:35:40,079
systems

957
00:35:47,510 --> 00:35:42,640
they must

958
00:35:49,990 --> 00:35:47,520
it's not enough to have some granule

959
00:35:52,150 --> 00:35:50,000
granularity in it you need that they

960
00:35:54,870 --> 00:35:52,160
settle and in this sense i think that

961
00:35:56,790 --> 00:35:54,880
intuitionistic mathematics is a is an

962
00:35:59,109 --> 00:35:56,800
appropriate

963
00:36:01,190 --> 00:35:59,119

language mathematical language

964
00:36:04,230 --> 00:36:01,200
to describe this idea that although

965
00:36:06,950 --> 00:36:04,240
things may not be determined today the

966
00:36:09,510 --> 00:36:06,960
weather in a weak time from today

967
00:36:13,349 --> 00:36:09,520
is not yet determined but it will be

968
00:36:14,550 --> 00:36:13,359
determined in a weak time

969
00:36:16,710 --> 00:36:14,560
now how do you get from this

970
00:36:17,829 --> 00:36:16,720
intuitionist view to the view that time

971
00:36:19,430 --> 00:36:17,839
is thick

972
00:36:22,470 --> 00:36:19,440
that you can't pull out a single point

973
00:36:24,950 --> 00:36:22,480
of time there's much like molasses

974
00:36:29,030 --> 00:36:24,960
yeah yeah um

975
00:36:31,270 --> 00:36:29,040
okay this the argument here is

976
00:36:33,910 --> 00:36:31,280
if you have let's see imagine two

977
00:36:37,030 --> 00:36:33,920
processes or two numbers

978
00:36:39,829 --> 00:36:37,040
that initially are exactly the same

979
00:36:43,349 --> 00:36:39,839
but they evolve in time and maybe after

980
00:36:45,270 --> 00:36:43,359
some time they may split

981
00:36:47,990 --> 00:36:45,280
you know this new information that gets

982
00:36:49,349 --> 00:36:48,000
created as time passes may be

983
00:36:50,310 --> 00:36:49,359
different

984
00:36:52,390 --> 00:36:50,320
and so

985
00:36:54,630 --> 00:36:52,400
these two numbers

986
00:36:56,790 --> 00:36:54,640
now or even in the near future we can

987
00:36:58,950 --> 00:36:56,800
just not distinguish them because so far

988
00:37:01,270 --> 00:36:58,960

they are exactly the same

989
00:37:03,510 --> 00:37:01,280
but they may become different

990
00:37:04,550 --> 00:37:03,520
and so somehow

991
00:37:06,950 --> 00:37:04,560
you know

992
00:37:11,510 --> 00:37:06,960
these numbers they are they stick

993
00:37:13,430 --> 00:37:11,520
together be a bit like yeah yeah this is

994
00:37:15,349 --> 00:37:13,440
that you cannot really uh

995
00:37:16,550 --> 00:37:15,359
you know or honey you cannot really take

996
00:37:19,190 --> 00:37:16,560
out a

997
00:37:21,030 --> 00:37:19,200
molecule of honey they stick together

998
00:37:23,510 --> 00:37:21,040
and these numbers also kind of stick

999
00:37:25,510 --> 00:37:23,520
together and

1000
00:37:27,670 --> 00:37:25,520
that's uh that's where the the intuition

1001
00:37:29,109 --> 00:37:27,680
of this fake time in intuitionistic

1002
00:37:30,310 --> 00:37:29,119
mathematics

1003
00:37:33,510 --> 00:37:30,320
comes from

1004
00:37:36,550 --> 00:37:33,520
uh but i i'm not really uh

1005
00:37:39,670 --> 00:37:36,560
okay i don't claim that i have a

1006
00:37:42,470 --> 00:37:39,680
a full understanding of uh

1007
00:37:44,710 --> 00:37:42,480
of time in in nutritionistic mathematics

1008
00:37:47,510 --> 00:37:44,720
let's say can you give an example more

1009
00:37:48,870 --> 00:37:47,520
simply so let's say the number 2.00

1010
00:37:50,630 --> 00:37:48,880
let's imagine that we only know up to

1011
00:37:52,790 --> 00:37:50,640
three significant digits are you saying

1012
00:37:55,510 --> 00:37:52,800
that if there's a couple phenomenon that

1013
00:37:57,510 --> 00:37:55,520

has 2.00 as the

1014
00:37:59,190 --> 00:37:57,520
numerical value of them

1015
00:38:00,470 --> 00:37:59,200
and maybe it's position maybe another

1016
00:38:01,829 --> 00:38:00,480
one's charged i don't it doesn't matter

1017
00:38:04,390 --> 00:38:01,839
if i'm looking at them right now i say

1018
00:38:06,790 --> 00:38:04,400
they're the same they're both 2.00 but

1019
00:38:09,109 --> 00:38:06,800
later they may diverge and maybe 2.001

1020
00:38:11,190 --> 00:38:09,119
for this one 2.005 for this one yes how

1021
00:38:12,550 --> 00:38:11,200
does that have to do with being thick or

1022
00:38:16,390 --> 00:38:12,560
being like honey i don't see the

1023
00:38:19,270 --> 00:38:17,670
well it means that

1024
00:38:21,589 --> 00:38:19,280
at any time

1025
00:38:22,710 --> 00:38:21,599
now for instance you cannot distinguish

1026
00:38:25,030 --> 00:38:22,720
them

1027
00:38:27,109 --> 00:38:25,040
so they still stick together

1028
00:38:29,270 --> 00:38:27,119
although they are different in the sense

1029
00:38:30,790 --> 00:38:29,280
that as you said i mean in a in a second

1030
00:38:33,870 --> 00:38:30,800
or maybe in a day

1031
00:38:36,150 --> 00:38:33,880
it will be 2.001 for one of them and

1032
00:38:37,030 --> 00:38:36,160
2.005 for the hour so they clearly are

1033
00:38:38,790 --> 00:38:37,040
different

1034
00:38:39,990 --> 00:38:38,800
but nevertheless today they stick

1035
00:38:42,550 --> 00:38:40,000
together

1036
00:38:43,990 --> 00:38:42,560
ah ah okay so time gets increasingly

1037
00:38:45,510 --> 00:38:44,000
more specific

1038
00:38:47,349 --> 00:38:45,520

i mean sorry

1039
00:38:49,349 --> 00:38:47,359
is it it's not well i don't think i said

1040
00:38:50,870 --> 00:38:49,359
that correctly so correct what i said i

1041
00:38:51,990 --> 00:38:50,880
said time gets increasingly more

1042
00:38:54,069 --> 00:38:52,000
specific but it's more like the

1043
00:38:55,589 --> 00:38:54,079
quantities that we're measuring it or

1044
00:38:57,109 --> 00:38:55,599
the quantities that exist get more

1045
00:38:59,430 --> 00:38:57,119
specific

1046
00:39:01,510 --> 00:38:59,440
exactly the quantities that exist get

1047
00:39:04,069 --> 00:39:01,520
more specific or i would use the

1048
00:39:05,750 --> 00:39:04,079
terminology they get more determined i'm

1049
00:39:07,030 --> 00:39:05,760
trying to understand how is it that the

1050
00:39:08,390 --> 00:39:07,040
present is thick so you're saying the

1051
00:39:10,150 --> 00:39:08,400
present is thick because it then

1052
00:39:12,150 --> 00:39:10,160
fractionates later and that means that

1053
00:39:15,270 --> 00:39:12,160
any moment in the future is actually

1054
00:39:17,030 --> 00:39:15,280
less thick than a moment in the past

1055
00:39:19,510 --> 00:39:17,040
no i don't think so because it can

1056
00:39:22,069 --> 00:39:19,520
happen again in the future even once

1057
00:39:23,670 --> 00:39:22,079
it's 2.001 let's say it's settled for

1058
00:39:25,349 --> 00:39:23,680
2.001

1059
00:39:27,190 --> 00:39:25,359
but you still have the fit the same kind

1060
00:39:29,430 --> 00:39:27,200
of thickness for the next digit uh so

1061
00:39:31,190 --> 00:39:29,440
the all is obvious

1062
00:39:32,950 --> 00:39:31,200
it evolves forever

1063
00:39:34,310 --> 00:39:32,960

okay and they're all equally as thick

1064
00:39:35,589 --> 00:39:34,320
because they're all just indeterminate

1065
00:39:38,550 --> 00:39:35,599
at the last digit

1066
00:39:40,390 --> 00:39:38,560
whether the time is t 010 okay yeah if

1067
00:39:41,670 --> 00:39:40,400
you want to be more precise it's not a

1068
00:39:43,750 --> 00:39:41,680
matter of the digit it's really

1069
00:39:45,990 --> 00:39:43,760
additional information

1070
00:39:47,910 --> 00:39:46,000
but never mind the intuition is good

1071
00:39:50,550 --> 00:39:47,920
with these digits yes

1072
00:39:52,390 --> 00:39:50,560
many younger people especially don't

1073
00:39:53,270 --> 00:39:52,400
know about intuitionist mathematics they

1074
00:39:54,870 --> 00:39:53,280
don't even know that there's a

1075
00:39:56,710 --> 00:39:54,880
difference in mathematics they just

1076
00:39:58,710 --> 00:39:56,720
think it's classical mathematics so i'm

1077
00:40:00,390 --> 00:39:58,720
going to outline some of how and i'm

1078
00:40:02,790 --> 00:40:00,400
going to place a slide of yours up on

1079
00:40:04,630 --> 00:40:02,800
the screen how indeterministic physics

1080
00:40:07,270 --> 00:40:04,640
and intuitionist mathematics map on to

1081
00:40:09,990 --> 00:40:07,280
one another yeah probably yes yes yes

1082
00:40:12,870 --> 00:40:10,000
and there's a paper in the philosophy

1083
00:40:15,550 --> 00:40:12,880
journal syntase that appeared i think

1084
00:40:17,390 --> 00:40:15,560
last summer i think which is indeed

1085
00:40:19,510 --> 00:40:17,400
indeterministic physics and

1086
00:40:21,190 --> 00:40:19,520
intuitionistic mathematics something

1087
00:40:23,109 --> 00:40:21,200
like that is the title

1088
00:40:25,349 --> 00:40:23,119

so maybe you can just give a give a link

1089
00:40:27,109 --> 00:40:25,359
to that it's not a difficult paper okay

1090
00:40:29,270 --> 00:40:27,119
great i'll give a link to that now the

1091
00:40:32,069 --> 00:40:29,280
future is open in indeterministic

1092
00:40:34,309 --> 00:40:32,079
physics that gets analogized or mapped

1093
00:40:36,470 --> 00:40:34,319
onto or made equivalent with the law of

1094
00:40:38,550 --> 00:40:36,480
the excluded middle not being there okay

1095
00:40:40,069 --> 00:40:38,560
so firstly can you explain what the law

1096
00:40:41,349 --> 00:40:40,079
of the excluded middle is and then why

1097
00:40:43,510 --> 00:40:41,359
the heck that means that the future is

1098
00:40:45,430 --> 00:40:43,520
open

1099
00:40:47,190 --> 00:40:45,440
yeah so this law of the excluded middle

1100
00:40:49,910 --> 00:40:47,200
says so it's a part of let's say

1101
00:40:52,069 --> 00:40:49,920
classical logic classical mathematics

1102
00:40:53,589 --> 00:40:52,079
that says that every statement every

1103
00:40:56,550 --> 00:40:53,599
proposition

1104
00:40:58,309 --> 00:40:56,560
is ever true or false

1105
00:41:00,630 --> 00:40:58,319
so it cannot be something else it's even

1106
00:41:03,109 --> 00:41:00,640
true or false so if i'm not saying

1107
00:41:04,069 --> 00:41:03,119
uh it will be raining in exactly a year

1108
00:41:06,710 --> 00:41:04,079
time

1109
00:41:09,030 --> 00:41:06,720
in geneva in my guard let's say

1110
00:41:12,069 --> 00:41:09,040
this statement according to classical

1111
00:41:14,069 --> 00:41:12,079
logic has to be ever true and then for

1112
00:41:16,069 --> 00:41:14,079
sure it will rain or it is false and

1113
00:41:18,710 --> 00:41:16,079

then for sure it will not rain of course

1114
00:41:20,630 --> 00:41:18,720
i may be ignorant about whether it is

1115
00:41:22,470 --> 00:41:20,640
true or false for sure i mean don't talk

1116
00:41:25,109 --> 00:41:22,480
about about that

1117
00:41:28,470 --> 00:41:25,119
but the fact is that this proposition

1118
00:41:30,470 --> 00:41:28,480
has a true value consequently the future

1119
00:41:31,990 --> 00:41:30,480
because my statement my proposition here

1120
00:41:34,470 --> 00:41:32,000
is about the future

1121
00:41:36,630 --> 00:41:34,480
but if now this proposition has a true

1122
00:41:38,710 --> 00:41:36,640
value it means that this future

1123
00:41:40,550 --> 00:41:38,720
somehow already exists or at least is

1124
00:41:42,550 --> 00:41:40,560
already determined

1125
00:41:44,710 --> 00:41:42,560
that's determinism

1126
00:41:46,150 --> 00:41:44,720
now if i want to have a

1127
00:41:48,550 --> 00:41:46,160
a different view

1128
00:41:51,030 --> 00:41:48,560
saying that this weather in a year time

1129
00:41:54,950 --> 00:41:51,040
not only do i not know whether it will

1130
00:41:56,950 --> 00:41:54,960
be uh sony or any but it is truly

1131
00:41:59,270 --> 00:41:56,960
undetermined

1132
00:42:00,870 --> 00:41:59,280
it's not yet settled whether it will be

1133
00:42:02,390 --> 00:42:00,880
one way or the other

1134
00:42:05,190 --> 00:42:02,400
um

1135
00:42:07,349 --> 00:42:05,200
and then it means that a proposition

1136
00:42:09,990 --> 00:42:07,359
about this future whether

1137
00:42:12,470 --> 00:42:10,000
is never true nor false

1138
00:42:15,750 --> 00:42:12,480

it takes a third value and this third

1139
00:42:19,030 --> 00:42:15,760
value is just in determined

1140
00:42:21,990 --> 00:42:19,040
indeterminate indeterminate

1141
00:42:23,190 --> 00:42:22,000
so we have now a new sort of

1142
00:42:25,589 --> 00:42:23,200
of logic

1143
00:42:27,990 --> 00:42:25,599
which is no longer with two values it

1144
00:42:29,430 --> 00:42:28,000
has this third value but the third value

1145
00:42:30,470 --> 00:42:29,440
is not

1146
00:42:32,870 --> 00:42:30,480
50 50

1147
00:42:35,670 --> 00:42:32,880
or grey it just says

1148
00:42:38,069 --> 00:42:35,680
it is indeterminate

1149
00:42:40,470 --> 00:42:38,079
and this is certainly part of

1150
00:42:43,190 --> 00:42:40,480
intuitionistic mathematics

1151
00:42:45,430 --> 00:42:43,200
but you know i think it's also part of

1152
00:42:48,230 --> 00:42:45,440
everyone's okay everyone probably not

1153
00:42:50,230 --> 00:42:48,240
but most people intuition if i tell you

1154
00:42:52,710 --> 00:42:50,240
something about what happens in a year

1155
00:42:54,309 --> 00:42:52,720
time in a football match or about the

1156
00:42:56,390 --> 00:42:54,319
weather or

1157
00:43:00,630 --> 00:42:56,400
a volcano or whatever

1158
00:43:01,990 --> 00:43:00,640
well it is us of today indeterminate

1159
00:43:04,309 --> 00:43:02,000
you made me think of some personal

1160
00:43:05,829 --> 00:43:04,319
questions so this young nicholas when

1161
00:43:08,230 --> 00:43:05,839
you're sitting in philosophizing about

1162
00:43:09,910 --> 00:43:08,240
the nature of time and indeterminacy and

1163
00:43:11,030 --> 00:43:09,920

free will etc

1164
00:43:12,950 --> 00:43:11,040
and you meddled you meddled with

1165
00:43:14,309 --> 00:43:12,960
mathematics at the logical level so

1166
00:43:15,990 --> 00:43:14,319
there's different types of logic

1167
00:43:18,309 --> 00:43:16,000
mathematics is based on logic classical

1168
00:43:19,670 --> 00:43:18,319
logic and intuitionist logic did you

1169
00:43:21,829 --> 00:43:19,680
meddle so far

1170
00:43:23,910 --> 00:43:21,839
outside of intuitionist

1171
00:43:26,150 --> 00:43:23,920
logic such as grand priests pair

1172
00:43:27,910 --> 00:43:26,160
consistent logic or other forms of logic

1173
00:43:30,550 --> 00:43:27,920
or have you settled on intuitionists and

1174
00:43:34,230 --> 00:43:32,630
well so actually the the situation is

1175
00:43:36,710 --> 00:43:34,240
following i was

1176
00:43:38,470 --> 00:43:36,720
um okay thinking about that and indeed

1177
00:43:41,510 --> 00:43:38,480
the young nicola i was already thinking

1178
00:43:43,910 --> 00:43:41,520
about what's randomness now i i think

1179
00:43:44,870 --> 00:43:43,920
it's a super complicated concept

1180
00:43:45,670 --> 00:43:44,880
um

1181
00:43:47,670 --> 00:43:45,680
and

1182
00:43:50,630 --> 00:43:47,680
i don't remember now let's say five

1183
00:43:52,550 --> 00:43:50,640
years ago i was writing a paper

1184
00:43:55,109 --> 00:43:52,560
that appeared in another philosophy

1185
00:43:57,030 --> 00:43:55,119
journalist that's the that's the paper

1186
00:43:58,630 --> 00:43:57,040
which has the subtitle real numbers are

1187
00:43:59,990 --> 00:43:58,640
not really real

1188
00:44:01,990 --> 00:44:00,000

um and

1189
00:44:04,230 --> 00:44:02,000
okay and so then at some point i

1190
00:44:07,829 --> 00:44:04,240
presented that at the conference

1191
00:44:10,950 --> 00:44:07,839
and one of the the participants

1192
00:44:13,670 --> 00:44:10,960
cal posse who is actually a

1193
00:44:16,790 --> 00:44:13,680
professor of philosophy and logic in

1194
00:44:20,870 --> 00:44:19,270
mentioned to me this intuitionistic

1195
00:44:22,710 --> 00:44:20,880
mathematics so i didn't know

1196
00:44:24,309 --> 00:44:22,720
intuitionistic mathematics but clearly

1197
00:44:26,950 --> 00:44:24,319
what i was

1198
00:44:29,910 --> 00:44:26,960
adds with my my real numbers are not

1199
00:44:31,990 --> 00:44:29,920
really real i was somehow rediscovering

1200
00:44:34,550 --> 00:44:32,000
intuitionistic mathematics

1201
00:44:36,470 --> 00:44:34,560
trying to reinvent it of course i didn't

1202
00:44:39,670 --> 00:44:36,480
went as far as all these people doing

1203
00:44:42,390 --> 00:44:39,680
that it's an entire community

1204
00:44:44,710 --> 00:44:42,400
but so then thanks to to cal posse i

1205
00:44:47,030 --> 00:44:44,720
learned about it and he also

1206
00:44:49,109 --> 00:44:47,040
told me about it and it's not difficult

1207
00:44:51,750 --> 00:44:49,119
to understand because it's really just

1208
00:44:54,870 --> 00:44:51,760
corresponds quite closely to my

1209
00:44:56,710 --> 00:44:54,880
intuition about how things are going

1210
00:44:59,109 --> 00:44:56,720
and so i understood it and then i wrote

1211
00:45:01,270 --> 00:44:59,119
this over paper the syntase one

1212
00:45:02,870 --> 00:45:01,280
about indeterminist

1213
00:45:05,349 --> 00:45:02,880

indeterminism in physics and

1214
00:45:07,990 --> 00:45:05,359
intuitionistic mathematics

1215
00:45:10,790 --> 00:45:08,000
to show really how these two

1216
00:45:12,870 --> 00:45:10,800
connect to each other very nicely

1217
00:45:15,430 --> 00:45:12,880
but maybe i can come back to this real

1218
00:45:18,470 --> 00:45:15,440
number because i think many people many

1219
00:45:21,030 --> 00:45:18,480
of my colleagues have similar intuition

1220
00:45:23,430 --> 00:45:21,040
you know we all think we all many of us

1221
00:45:26,230 --> 00:45:23,440
think you know a real number you get all

1222
00:45:28,470 --> 00:45:26,240
these digits and then you know we can

1223
00:45:30,069 --> 00:45:28,480
think of the other digits they come one

1224
00:45:34,470 --> 00:45:30,079
after the other

1225
00:45:38,150 --> 00:45:36,550
in time you know one is he and then he

1226
00:45:39,349 --> 00:45:38,160
comes the next then comes the next then

1227
00:45:41,190 --> 00:45:39,359
comes the next

1228
00:45:43,030 --> 00:45:41,200
but actually proper classical

1229
00:45:45,510 --> 00:45:43,040
mathematics says something very

1230
00:45:48,230 --> 00:45:45,520
different proper classical mathematics

1231
00:45:49,510 --> 00:45:48,240
claims that a real number is this

1232
00:45:52,069 --> 00:45:49,520
infinite

1233
00:45:55,030 --> 00:45:52,079
series of numbers of digits this

1234
00:45:58,550 --> 00:45:55,040
infinite amount of information

1235
00:46:01,349 --> 00:45:58,560
comes all at once in zero time

1236
00:46:03,270 --> 00:46:01,359
so when you say let x 0 be the initial

1237
00:46:06,550 --> 00:46:03,280
condition

1238
00:46:08,470 --> 00:46:06,560

and x 0 you assume it's a real number or

1239
00:46:10,630 --> 00:46:08,480
even a bunch of real numbers if you have

1240
00:46:12,829 --> 00:46:10,640
many degrees of freedom it actually

1241
00:46:14,630 --> 00:46:12,839
means let there be

1242
00:46:16,470 --> 00:46:14,640
instantaneously buff

1243
00:46:19,190 --> 00:46:16,480
infinite information

1244
00:46:21,190 --> 00:46:19,200
and that's an enormous assumption and i

1245
00:46:22,870 --> 00:46:21,200
don't think most physicists really think

1246
00:46:24,790 --> 00:46:22,880
that way they really think okay there is

1247
00:46:25,750 --> 00:46:24,800
this number and there are some digits

1248
00:46:28,710 --> 00:46:25,760
and then

1249
00:46:31,510 --> 00:46:28,720
well who cares anyway but these numbers

1250
00:46:33,430 --> 00:46:31,520
these digits sorry they come really

1251
00:46:35,510 --> 00:46:33,440
one after the other and now we say one

1252
00:46:37,109 --> 00:46:35,520
after the other in time

1253
00:46:39,750 --> 00:46:37,119
and then you have intuitionistic

1254
00:46:41,910 --> 00:46:39,760
mathematics

1255
00:46:43,589 --> 00:46:41,920
part of the reason why many physicists

1256
00:46:45,829 --> 00:46:43,599
don't have much of a trouble with real

1257
00:46:48,390 --> 00:46:45,839
numbers is that i don't think they think

1258
00:46:50,630 --> 00:46:48,400
in terms of a billiard ball carrying its

1259
00:46:52,550 --> 00:46:50,640
position with it if it carried it like

1260
00:46:54,230 --> 00:46:52,560
on a piece of paper on a sticky note

1261
00:46:56,390 --> 00:46:54,240
metaphorically it would create a black

1262
00:46:57,750 --> 00:46:56,400
hole instantly typically unless it's

1263
00:47:00,630 --> 00:46:57,760

because the typical real number has

1264
00:47:03,270 --> 00:47:00,640
infinite okay so then the way they

1265
00:47:05,109 --> 00:47:03,280
you've explained it to me is that

1266
00:47:07,109 --> 00:47:05,119
you imagine it like the

1267
00:47:09,109 --> 00:47:07,119
electron or the billiard ball does carry

1268
00:47:11,829 --> 00:47:09,119
with its position that's that still a

1269
00:47:14,309 --> 00:47:11,839
metaphor or is that meant to be

1270
00:47:16,630 --> 00:47:14,319
taken more literally

1271
00:47:18,309 --> 00:47:16,640
if it's just the the center of mass of

1272
00:47:20,710 --> 00:47:18,319
course then it depends on the reference

1273
00:47:23,109 --> 00:47:20,720
frame anyway but you could imagine the

1274
00:47:26,630 --> 00:47:24,790
kinetic momentum

1275
00:47:29,510 --> 00:47:26,640
or you could also imagine just you have

1276
00:47:31,430 --> 00:47:29,520
a molecule or you have a little system

1277
00:47:32,630 --> 00:47:31,440
with morph and one particle and then the

1278
00:47:34,549 --> 00:47:32,640
relative

1279
00:47:35,670 --> 00:47:34,559
degrees of freedom you know the distance

1280
00:47:37,829 --> 00:47:35,680
between

1281
00:47:40,069 --> 00:47:37,839
a planet and its sun

1282
00:47:42,309 --> 00:47:40,079
this is really within the system

1283
00:47:44,470 --> 00:47:42,319
the system being the global thing

1284
00:47:46,390 --> 00:47:44,480
and then you can really think i mean

1285
00:47:47,750 --> 00:47:46,400
then it makes sense to to

1286
00:47:50,470 --> 00:47:47,760
to think that

1287
00:47:52,390 --> 00:47:50,480
these these relative degrees of freedom

1288
00:47:54,710 --> 00:47:52,400

are really represented by numbers

1289
00:47:56,950 --> 00:47:54,720
carrots by the system it's really

1290
00:47:59,670 --> 00:47:56,960
internal of it now you may say okay it

1291
00:48:02,390 --> 00:47:59,680
depends if i'm measuring that with uh

1292
00:48:04,630 --> 00:48:02,400
miles or kilometers or whatever

1293
00:48:06,710 --> 00:48:04,640
but that is indeed where

1294
00:48:09,030 --> 00:48:06,720
if we think in terms of the amount of

1295
00:48:10,549 --> 00:48:09,040
information it's the same

1296
00:48:12,630 --> 00:48:10,559
now if i really think in terms of the

1297
00:48:15,030 --> 00:48:12,640
digit of course if i change my units the

1298
00:48:16,950 --> 00:48:15,040
digits will change but the amount of

1299
00:48:18,470 --> 00:48:16,960
information will in both cases be

1300
00:48:20,870 --> 00:48:18,480
infinite

1301
00:48:22,870 --> 00:48:20,880
okay now getting to the reality of time

1302
00:48:24,309 --> 00:48:22,880
again the commonplace view in physics is

1303
00:48:25,910 --> 00:48:24,319
that arrow of time is an illusion in

1304
00:48:27,990 --> 00:48:25,920
fact time itself may be an illusion like

1305
00:48:29,190 --> 00:48:28,000
carla rivelli suggests because the laws

1306
00:48:30,870 --> 00:48:29,200
of nature as far as we have are

1307
00:48:32,950 --> 00:48:30,880
symmetric except for the second do you

1308
00:48:34,390 --> 00:48:32,960
see the second law as being what

1309
00:48:36,390 --> 00:48:34,400
engenders the

1310
00:48:38,950 --> 00:48:36,400
error of time or you see it as being so

1311
00:48:40,710 --> 00:48:38,960
much more fundamental

1312
00:48:42,950 --> 00:48:40,720
it's more fundamental it comes already

1313
00:48:48,470 --> 00:48:42,960

in the basic mathematics

1314
00:48:50,950 --> 00:48:48,480
information we create information as

1315
00:48:52,950 --> 00:48:50,960
time passes so the direction of time is

1316
00:48:55,109 --> 00:48:52,960
already built into the into our

1317
00:48:57,349 --> 00:48:55,119
mathematical language

1318
00:48:59,990 --> 00:48:57,359
and i think again that comes much closer

1319
00:49:01,510 --> 00:49:00,000
to the intuition that everyone has of

1320
00:49:03,990 --> 00:49:01,520
course if you learn too much of

1321
00:49:05,589 --> 00:49:04,000
classical mechanics or quantum mechanics

1322
00:49:07,109 --> 00:49:05,599
with the schrodinger equation

1323
00:49:09,109 --> 00:49:07,119
you may get

1324
00:49:10,790 --> 00:49:09,119
the feeling that because the equation

1325
00:49:13,030 --> 00:49:10,800
are time reversal

1326
00:49:15,349 --> 00:49:13,040
then time is an illusion

1327
00:49:17,270 --> 00:49:15,359
but that's because you use classical

1328
00:49:18,549 --> 00:49:17,280
mathematics to

1329
00:49:19,910 --> 00:49:18,559
describe

1330
00:49:20,950 --> 00:49:19,920
um

1331
00:49:22,950 --> 00:49:20,960
to uh

1332
00:49:25,270 --> 00:49:22,960
initial condition for this for this

1333
00:49:27,349 --> 00:49:25,280
equation for these evolution equations

1334
00:49:28,790 --> 00:49:27,359
now if you just use this different form

1335
00:49:31,109 --> 00:49:28,800
of mathematics

1336
00:49:33,510 --> 00:49:31,119
then even if the equation has still the

1337
00:49:35,589 --> 00:49:33,520
symmetry the initial condition no longer

1338
00:49:37,109 --> 00:49:35,599

has that symmetry

1339
00:49:38,790 --> 00:49:37,119
something i'm extremely excited about

1340
00:49:40,630 --> 00:49:38,800
exploring on this channel are different

1341
00:49:42,390 --> 00:49:40,640
approaches to quantum gravity and you

1342
00:49:44,549 --> 00:49:42,400
said in an offhand statement is that i

1343
00:49:46,549 --> 00:49:44,559
think we need a different understanding

1344
00:49:51,109 --> 00:49:46,559
of time in order to make a breakthrough

1345
00:49:55,670 --> 00:49:52,950
yes yes

1346
00:49:58,630 --> 00:49:55,680
yeah so indeed so quantum gravity that's

1347
00:50:00,630 --> 00:49:58,640
of course a huge challenge and uh

1348
00:50:02,230 --> 00:50:00,640
very little progress in the in the last

1349
00:50:04,710 --> 00:50:02,240
uh decades

1350
00:50:06,470 --> 00:50:04,720
uh okay maybe i'm going to annoy a few

1351
00:50:08,390 --> 00:50:06,480
of my colleagues but i don't think we

1352
00:50:10,069 --> 00:50:08,400
have made any breakthrough i think

1353
00:50:12,150 --> 00:50:10,079
that's a fair statement to be fair

1354
00:50:13,990 --> 00:50:12,160
professor almost everyone has a

1355
00:50:15,589 --> 00:50:14,000
variation of that statement that we need

1356
00:50:17,190 --> 00:50:15,599
a new understanding of x in order to

1357
00:50:18,710 --> 00:50:17,200
make progress in quantum gravity whether

1358
00:50:20,069 --> 00:50:18,720
we need a new understanding of space we

1359
00:50:21,190 --> 00:50:20,079
need a new understanding of strings we

1360
00:50:22,470 --> 00:50:21,200
need a new understanding of holographic

1361
00:50:27,190 --> 00:50:22,480
so why time

1362
00:50:30,549 --> 00:50:27,200
so time has plays a completely different

1363
00:50:33,030 --> 00:50:30,559

role in relativity so gravity and in

1364
00:50:35,670 --> 00:50:33,040
quantum mechanics uh you know in

1365
00:50:37,829 --> 00:50:35,680
relativity i mean that the usual picture

1366
00:50:39,430 --> 00:50:37,839
is this block universe where everything

1367
00:50:42,549 --> 00:50:39,440
is kind of frozen

1368
00:50:45,589 --> 00:50:42,559
since ever forever and there is no no

1369
00:50:47,829 --> 00:50:45,599
present or you have to add it by hand

1370
00:50:49,910 --> 00:50:47,839
and even einstein was a bit uh concerned

1371
00:50:52,630 --> 00:50:49,920
with the lack of the present

1372
00:50:55,990 --> 00:50:52,640
uh in quantum mechanics at least

1373
00:50:57,430 --> 00:50:56,000
the standard view is this indeterminacy

1374
00:50:59,349 --> 00:50:57,440
on the beam splitter with the two

1375
00:51:01,829 --> 00:50:59,359
detectors for instance

1376
00:51:03,589 --> 00:51:01,839
and so there there is clearly a process

1377
00:51:07,270 --> 00:51:03,599
going on nowadays

1378
00:51:09,190 --> 00:51:07,280
before the photon hits the detector and

1379
00:51:10,790 --> 00:51:09,200
gets localized in one or the other

1380
00:51:13,430 --> 00:51:10,800
detector

1381
00:51:15,349 --> 00:51:13,440
and there is a time after it has

1382
00:51:18,390 --> 00:51:15,359
triggered one and only one of the

1383
00:51:20,150 --> 00:51:18,400
detectors so there is clearly a passage

1384
00:51:21,990 --> 00:51:20,160
of time there

1385
00:51:23,589 --> 00:51:22,000
and now we have this uh

1386
00:51:25,510 --> 00:51:23,599
these two uh

1387
00:51:27,109 --> 00:51:25,520
basic theories

1388
00:51:30,390 --> 00:51:27,119

which

1389
00:51:32,069 --> 00:51:30,400
they fundamentally disagree about what

1390
00:51:34,069 --> 00:51:32,079
time is

1391
00:51:36,230 --> 00:51:34,079
and then how do you want you know to

1392
00:51:39,670 --> 00:51:36,240
develop

1393
00:51:42,150 --> 00:51:39,680
dynamical theory of quantum gravity

1394
00:51:44,309 --> 00:51:42,160
if we don't even agree on what time is

1395
00:51:47,829 --> 00:51:44,319
and whether this is you know whether the

1396
00:51:49,750 --> 00:51:47,839
passage of time is a real phenomenon us

1397
00:51:51,270 --> 00:51:49,760
in standard

1398
00:51:52,549 --> 00:51:51,280
quantum mechanics

1399
00:51:55,349 --> 00:51:52,559
or is it

1400
00:51:58,230 --> 00:51:55,359
just a kind of illusion us in the block

1401
00:52:00,309 --> 00:51:58,240
universe presented by relativity

1402
00:52:02,470 --> 00:52:00,319
so i think this is really a

1403
00:52:03,740 --> 00:52:02,480
fundamental issue and we need to be able

1404
00:52:05,589 --> 00:52:03,750
to

1405
00:52:06,710 --> 00:52:05,599
[Music]

1406
00:52:08,950 --> 00:52:06,720
yeah

1407
00:52:11,030 --> 00:52:08,960
if we want to do quantum gravity we need

1408
00:52:12,390 --> 00:52:11,040
to have one concept that is going to

1409
00:52:14,390 --> 00:52:12,400
unify that

1410
00:52:16,549 --> 00:52:14,400
i know i wouldn't say that i have solved

1411
00:52:19,510 --> 00:52:16,559
the problem i mean certainly not

1412
00:52:22,230 --> 00:52:19,520
but i uh my hope is that by you know

1413
00:52:23,589 --> 00:52:22,240

introducing indetermination also in

1414
00:52:26,069 --> 00:52:23,599
classical

1415
00:52:28,470 --> 00:52:26,079
pre-relativity mechanics

1416
00:52:30,710 --> 00:52:28,480
so newtonian mechanics but i have

1417
00:52:33,349 --> 00:52:30,720
already introduced uh indetermination

1418
00:52:35,109 --> 00:52:33,359
there so somehow i have brought at least

1419
00:52:37,670 --> 00:52:35,119
classical mechanics and quantum

1420
00:52:40,750 --> 00:52:37,680
mechanics closer together

1421
00:52:43,910 --> 00:52:40,760
i have also one paper on the

1422
00:52:45,990 --> 00:52:43,920
indeterminacy is relative so going one

1423
00:52:48,950 --> 00:52:46,000
more step in the direction of relativity

1424
00:52:50,630 --> 00:52:48,960
but okay this is maybe it's uh

1425
00:52:52,790 --> 00:52:50,640
i don't think we should enter that kind

1426
00:52:55,270 --> 00:52:52,800
of debate anyway it is still under

1427
00:52:57,670 --> 00:52:55,280
development but the goal is indeed to

1428
00:52:58,950 --> 00:52:57,680
bring also indetermination to uh

1429
00:53:00,950 --> 00:52:58,960
relativity

1430
00:53:02,950 --> 00:53:00,960
professor whenever you speak i have so

1431
00:53:04,950 --> 00:53:02,960
many questions that are there's so many

1432
00:53:06,390 --> 00:53:04,960
that come to my mind okay so first do

1433
00:53:08,630 --> 00:53:06,400
you have an idea as to the

1434
00:53:10,710 --> 00:53:08,640
discretization of space and time do you

1435
00:53:13,109 --> 00:53:10,720
think it's discrete okay

1436
00:53:15,750 --> 00:53:13,119
let me just be fair i don't know

1437
00:53:17,030 --> 00:53:15,760
the way i describe time in this uh

1438
00:53:18,710 --> 00:53:17,040

well like all the others in

1439
00:53:21,589 --> 00:53:18,720
intuitionistic mathematics it is

1440
00:53:24,069 --> 00:53:21,599
discrete is it fundamentally discrete is

1441
00:53:24,870 --> 00:53:24,079
it a technical problem today i don't

1442
00:53:26,630 --> 00:53:24,880
know

1443
00:53:28,230 --> 00:53:26,640
also you mentioned that

1444
00:53:29,670 --> 00:53:28,240
you were similar to that philosopher

1445
00:53:31,270 --> 00:53:29,680
which i forgot the name of i know

1446
00:53:32,790 --> 00:53:31,280
william james was influenced by someone

1447
00:53:35,270 --> 00:53:32,800
who published that person's work because

1448
00:53:37,190 --> 00:53:35,280
that person died young oh yeah so so the

1449
00:53:38,390 --> 00:53:37,200
okay the guy i mentioned before is le

1450
00:53:39,109 --> 00:53:38,400
quiere

1451
00:53:40,790 --> 00:53:39,119
uh

1452
00:53:42,950 --> 00:53:40,800
jacques le cui i think

1453
00:53:45,910 --> 00:53:42,960
and then there was indeed a person in

1454
00:53:48,230 --> 00:53:45,920
between le quiere and uh william james

1455
00:53:51,030 --> 00:53:48,240
and that's

1456
00:53:52,390 --> 00:53:51,040
i think also a french philosopher

1457
00:53:54,630 --> 00:53:52,400
the first one i'm not going to even try

1458
00:53:55,990 --> 00:53:54,640
to pronounce now that person le quiere

1459
00:53:56,950 --> 00:53:56,000
that's how i tried to pronounce it le

1460
00:53:57,910 --> 00:53:56,960
quiere

1461
00:54:00,549 --> 00:53:57,920
was

1462
00:54:02,870 --> 00:54:00,559
spurred by a religious instinct or these

1463
00:54:04,390 --> 00:54:02,880

religious questions you mentioned you

1464
00:54:06,069 --> 00:54:04,400
feel similar to him

1465
00:54:07,990 --> 00:54:06,079
so i'm curious about your religious

1466
00:54:10,950 --> 00:54:08,000
views

1467
00:54:12,549 --> 00:54:10,960
oh well

1468
00:54:15,030 --> 00:54:12,559
okay in some sense i'm certainly not a

1469
00:54:16,790 --> 00:54:15,040
religious person so i never go to church

1470
00:54:19,750 --> 00:54:16,800
or things like that

1471
00:54:21,750 --> 00:54:19,760
my children are not baptized and so on

1472
00:54:23,990 --> 00:54:21,760
um

1473
00:54:26,230 --> 00:54:24,000
but you know the fact that i spend time

1474
00:54:27,829 --> 00:54:26,240
thinking about free will

1475
00:54:28,790 --> 00:54:27,839
consciousness

1476
00:54:31,510 --> 00:54:28,800
time

1477
00:54:35,589 --> 00:54:31,520
you know it's really taking physics

1478
00:54:37,750 --> 00:54:35,599
a stretch maybe physics a bit beyond the

1479
00:54:39,990 --> 00:54:37,760
standard physics to to go in the

1480
00:54:42,069 --> 00:54:40,000
direction of philosophy and i mentioned

1481
00:54:44,150 --> 00:54:42,079
already two of my papers in philosophy

1482
00:54:46,549 --> 00:54:44,160
journals actually i have very little

1483
00:54:48,230 --> 00:54:46,559
publications in philosophy journals i

1484
00:54:50,390 --> 00:54:48,240
think i have four of them if i remember

1485
00:54:52,789 --> 00:54:50,400
well so it's very few compared to the

1486
00:54:55,430 --> 00:54:52,799
numbers of papers i have in physics so

1487
00:54:58,710 --> 00:54:55,440
i'm mostly really a physicist but i'm a

1488
00:55:01,270 --> 00:54:58,720

physicist with a kind of yeah i like

1489
00:55:03,750 --> 00:55:01,280
kind of broad view

1490
00:55:05,750 --> 00:55:03,760
and by that i mean that these questions

1491
00:55:07,109 --> 00:55:05,760
are important to me

1492
00:55:10,150 --> 00:55:07,119
now you may say

1493
00:55:11,829 --> 00:55:10,160
okay is that a religious

1494
00:55:14,789 --> 00:55:11,839
feeling or something like that i'm

1495
00:55:16,150 --> 00:55:14,799
certainly not following any uh you know

1496
00:55:18,230 --> 00:55:16,160
book uh

1497
00:55:19,190 --> 00:55:18,240
religious book or things now

1498
00:55:22,150 --> 00:55:19,200
no

1499
00:55:23,750 --> 00:55:22,160
okay let's talk about sabine haasenfeld

1500
00:55:25,270 --> 00:55:23,760
who says that the idea of free will is

1501
00:55:27,990 --> 00:55:25,280
both incompatible with the laws of

1502
00:55:31,589 --> 00:55:28,000
nature and entirely meaningless okay

1503
00:55:31,599 --> 00:55:36,789
yeah so i i know sabine

1504
00:55:40,630 --> 00:55:39,190
and i use actually so so she does a lot

1505
00:55:43,510 --> 00:55:40,640
of these videos

1506
00:55:46,309 --> 00:55:43,520
and i love most of them

1507
00:55:48,630 --> 00:55:46,319
now she has one indeed on freewheel and

1508
00:55:50,069 --> 00:55:48,640
actually i use that one when i give some

1509
00:55:53,670 --> 00:55:50,079
of my lectures

1510
00:55:55,270 --> 00:55:53,680
uh to um to illustrate how extreme some

1511
00:56:01,109 --> 00:55:55,280
physicists

1512
00:56:04,630 --> 00:56:01,119
can become and indeed in this video

1513
00:56:06,710 --> 00:56:04,640

sabine goes really a very long way and

1514
00:56:09,670 --> 00:56:06,720
you know claiming that if you believe in

1515
00:56:12,150 --> 00:56:09,680
free will you are denying signs

1516
00:56:14,950 --> 00:56:12,160
so she is really claiming that actually

1517
00:56:17,349 --> 00:56:14,960
science has answered the question in the

1518
00:56:21,430 --> 00:56:17,359
negative there is no free will

1519
00:56:25,109 --> 00:56:21,440
and this is in my opinion a clear

1520
00:56:26,950 --> 00:56:25,119
overstatement it's it's taking physics

1521
00:56:29,270 --> 00:56:26,960
as a religion somehow

1522
00:56:31,690 --> 00:56:29,280
and it's physics with classical

1523
00:56:33,670 --> 00:56:31,700
mathematics again we just discussed that

1524
00:56:36,230 --> 00:56:33,680
[Music]

1525
00:56:38,549 --> 00:56:36,240
and it's pretty strange that uh sabine

1526
00:56:40,630 --> 00:56:38,559
often felder makes that kind of mistake

1527
00:56:42,069 --> 00:56:40,640
because one of

1528
00:56:44,150 --> 00:56:42,079
her book

1529
00:56:46,309 --> 00:56:44,160
which i like very much i think it's

1530
00:56:47,430 --> 00:56:46,319
called lost in mathematics

1531
00:56:50,309 --> 00:56:47,440
actually

1532
00:56:54,870 --> 00:56:50,319
um yeah says we have to be careful we

1533
00:56:57,510 --> 00:56:54,880
the physicist have to be careful not to

1534
00:56:59,030 --> 00:56:57,520
overestimate

1535
00:57:01,750 --> 00:56:59,040
mathematics

1536
00:57:04,230 --> 00:57:01,760
you know in high energy physics

1537
00:57:07,349 --> 00:57:04,240
people try to uh

1538
00:57:10,069 --> 00:57:07,359

to guess the future theories just by the

1539
00:57:12,710 --> 00:57:10,079
beauty of mathematics by symmetries and

1540
00:57:13,340 --> 00:57:12,720
elegance and things like that

1541
00:57:14,870 --> 00:57:13,350
and um

1542
00:57:17,190 --> 00:57:14,880
[Music]

1543
00:57:19,589 --> 00:57:17,200
so she says no but maybe actually the

1544
00:57:20,789 --> 00:57:19,599
the the correct mathematics of the next

1545
00:57:25,510 --> 00:57:20,799
uh

1546
00:57:28,390 --> 00:57:25,520
as we

1547
00:57:30,549 --> 00:57:28,400
think or would like it to be

1548
00:57:32,870 --> 00:57:30,559
so okay that's a reasonable argument and

1549
00:57:35,190 --> 00:57:32,880
i certainly buy that argument but then

1550
00:57:39,990 --> 00:57:35,200
herself

1551
00:57:41,670 --> 00:57:40,000
takes classical platonistic mathematics

1552
00:57:44,309 --> 00:57:41,680
the truth

1553
00:57:46,710 --> 00:57:44,319
and because platonistic mathematics

1554
00:57:48,630 --> 00:57:46,720
considers only

1555
00:57:50,390 --> 00:57:48,640
objects mathematical objects that are

1556
00:57:52,549 --> 00:57:50,400
outside of time

1557
00:57:54,870 --> 00:57:52,559
it's a timeless language classical

1558
00:57:57,109 --> 00:57:54,880
mathematics and so when she concludes

1559
00:57:59,349 --> 00:57:57,119
that time cannot exist and that

1560
00:58:02,069 --> 00:57:59,359
everything has already to be settled so

1561
00:58:04,150 --> 00:58:02,079
she also believes strongly

1562
00:58:05,750 --> 00:58:04,160
in super determinism

1563
00:58:07,430 --> 00:58:05,760

you know everything is already

1564
00:58:08,630 --> 00:58:07,440
determined there is no quantum

1565
00:58:11,030 --> 00:58:08,640
randomness

1566
00:58:12,630 --> 00:58:11,040
bill inequality violations can be

1567
00:58:14,549 --> 00:58:12,640
explained by

1568
00:58:17,270 --> 00:58:14,559
super determinism

1569
00:58:20,069 --> 00:58:17,280
and yeah at least she's very consistent

1570
00:58:23,349 --> 00:58:20,079
that uh certainly grant her

1571
00:58:26,470 --> 00:58:23,359
but when when she claims that science

1572
00:58:28,630 --> 00:58:26,480
has proved it for instance

1573
00:58:31,270 --> 00:58:28,640
that free will is an illusion

1574
00:58:33,510 --> 00:58:31,280
uh she goes too far

1575
00:58:37,430 --> 00:58:33,520
and she goes too far by taking

1576
00:58:39,190 --> 00:58:37,440
mathematics too uh literally

1577
00:58:41,270 --> 00:58:39,200
can you quickly outline to the audience

1578
00:58:43,510 --> 00:58:41,280
what super determinism is perhaps what

1579
00:58:45,349 --> 00:58:43,520
you dislike about it

1580
00:58:46,950 --> 00:58:45,359
yeah well actually there are two things

1581
00:58:48,789 --> 00:58:46,960
that i dislike so firstly there's

1582
00:58:51,030 --> 00:58:48,799
already determinism let me come back to

1583
00:58:52,950 --> 00:58:51,040
that but so you know the entire future

1584
00:58:55,190 --> 00:58:52,960
like the entire past everything is

1585
00:58:57,190 --> 00:58:55,200
already determined doesn't mean that we

1586
00:58:59,270 --> 00:58:57,200
know it or it doesn't even mean that we

1587
00:59:00,789 --> 00:58:59,280
have any ability to

1588
00:59:02,190 --> 00:59:00,799

get that knowledge

1589
00:59:04,390 --> 00:59:02,200
but you know

1590
00:59:05,589 --> 00:59:04,400
ontologically fundamentally it is

1591
00:59:08,789 --> 00:59:05,599
already

1592
00:59:11,910 --> 00:59:08,799
that's determinism now when people say

1593
00:59:13,910 --> 00:59:11,920
super determinism they add an extra

1594
00:59:16,829 --> 00:59:13,920
little assumption

1595
00:59:22,069 --> 00:59:19,829
um okay it's that everything is

1596
00:59:23,910 --> 00:59:22,079
coordinated because you could still

1597
00:59:26,950 --> 00:59:23,920
imagine that you know this part of the

1598
00:59:29,349 --> 00:59:26,960
universe is entirely determined

1599
00:59:32,230 --> 00:59:29,359
that part is also entirely determined

1600
00:59:34,549 --> 00:59:32,240
but they are not yet connected so we are

1601
00:59:37,190 --> 00:59:34,559
still independent systems that exist in

1602
00:59:40,470 --> 00:59:37,200
the world now if you i if you also

1603
00:59:42,390 --> 00:59:40,480
reject the existence of in

1604
00:59:43,589 --> 00:59:42,400
independent systems

1605
00:59:45,990 --> 00:59:43,599
then this is

1606
00:59:47,829 --> 00:59:46,000
super determinism some other people

1607
00:59:49,829 --> 00:59:47,839
would probably

1608
00:59:51,750 --> 00:59:49,839
say that super the super of super

1609
00:59:54,309 --> 00:59:51,760
determinism means

1610
00:59:56,230 --> 00:59:54,319
a kind of conspiracy because when these

1611
00:59:57,829 --> 00:59:56,240
these different things not only needs to

1612
00:59:59,670 --> 00:59:57,839
be already

1613
01:00:01,910 --> 00:59:59,680

connected so not

1614
01:00:04,630 --> 01:00:01,920
independent but they have to be not

1615
01:00:06,630 --> 01:00:04,640
independent in a very specific way for

1616
01:00:09,670 --> 01:00:06,640
instance to explain the violation or the

1617
01:00:11,829 --> 01:00:09,680
apparent violation of bell inequality so

1618
01:00:13,750 --> 01:00:11,839
i certainly dislike completely the idea

1619
01:00:16,150 --> 01:00:13,760
that there exists no

1620
01:00:18,789 --> 01:00:16,160
systems in the universe

1621
01:00:20,789 --> 01:00:18,799
and actually my my view is

1622
01:00:23,109 --> 01:00:20,799
very clearly i mean physics has to be

1623
01:00:25,190 --> 01:00:23,119
able to tell stories physics should make

1624
01:00:26,789 --> 01:00:25,200
predictions we all know that and

1625
01:00:28,630 --> 01:00:26,799
predictions of course should agree with

1626
01:00:31,180 --> 01:00:28,640
the experiments

1627
01:00:32,789 --> 01:00:31,190
but physics is not only about

1628
01:00:35,750 --> 01:00:32,799
[Music]

1629
01:00:38,549 --> 01:00:35,760
sophisticated theories physics is also

1630
01:00:40,789 --> 01:00:38,559
about telling a story

1631
01:00:43,109 --> 01:00:40,799
you know when you go to a class or if

1632
01:00:45,109 --> 01:00:43,119
you teach us i did a lot

1633
01:00:47,670 --> 01:00:45,119
you never start by writing an equation

1634
01:00:50,069 --> 01:00:47,680
you start by telling a story

1635
01:00:52,630 --> 01:00:50,079
and for instance everyone knows

1636
01:00:54,870 --> 01:00:52,640
most people know that the tides are due

1637
01:00:57,349 --> 01:00:54,880
to the moon that attracts the water from

1638
01:00:59,109 --> 01:00:57,359

the ocean and so on and so on and you

1639
01:01:01,430 --> 01:00:59,119
don't need an equation for that story so

1640
01:01:03,750 --> 01:01:01,440
the stories are super important

1641
01:01:04,870 --> 01:01:03,760
in science in general and also in in

1642
01:01:07,990 --> 01:01:04,880
physics

1643
01:01:08,950 --> 01:01:08,000
but there are no stories without

1644
01:01:17,990 --> 01:01:08,960
time

1645
01:01:21,030 --> 01:01:18,000
moon attracts this water is something

1646
01:01:22,789 --> 01:01:21,040
that takes place in time if you remove

1647
01:01:25,349 --> 01:01:22,799
the time

1648
01:01:28,150 --> 01:01:25,359
there is no story any longer

1649
01:01:31,589 --> 01:01:28,160
um and how does time come in

1650
01:01:34,870 --> 01:01:31,599
for me time is very very much connected

1651
01:01:37,109 --> 01:01:34,880
to the actualization of uh

1652
01:01:39,109 --> 01:01:37,119
potentialities as aristotle would have

1653
01:01:41,430 --> 01:01:39,119
said you know to the fact that this new

1654
01:01:43,829 --> 01:01:41,440
information created

1655
01:01:46,870 --> 01:01:43,839
during the the course of time

1656
01:01:49,190 --> 01:01:46,880
uh so it has to do with indeterminism

1657
01:01:50,470 --> 01:01:49,200
and now so that already explains you why

1658
01:01:52,870 --> 01:01:50,480
i think if

1659
01:01:55,750 --> 01:01:52,880
we've just deterministic stories

1660
01:01:57,270 --> 01:01:55,760
i don't think we can really tell how

1661
01:01:59,190 --> 01:01:57,280
nature does it earlier in the

1662
01:02:01,029 --> 01:01:59,200
conversation you said indeterminacy is

1663
01:02:02,950 --> 01:02:01,039

the necessary condition for free will

1664
01:02:04,870 --> 01:02:02,960
it's not sufficient

1665
01:02:06,870 --> 01:02:04,880
however any indeterminate theory can be

1666
01:02:08,710 --> 01:02:06,880
made determinate with supplementary

1667
01:02:10,390 --> 01:02:08,720
variables we can talk about that just

1668
01:02:12,630 --> 01:02:10,400
for people who are wondering what the

1669
01:02:13,990 --> 01:02:12,640
heck that means and then similarly a

1670
01:02:16,069 --> 01:02:14,000
determinate theory can be made

1671
01:02:18,309 --> 01:02:16,079
indeterminate so they're equivalent

1672
01:02:20,390 --> 01:02:18,319
and thus is determinancy truly a

1673
01:02:21,910 --> 01:02:20,400
necessary condition for free will

1674
01:02:24,470 --> 01:02:21,920
yeah well the way to make an

1675
01:02:25,910 --> 01:02:24,480
indeterministic theory deterministic is

1676
01:02:27,510 --> 01:02:25,920
by adding

1677
01:02:32,710 --> 01:02:27,520
adding variables

1678
01:02:36,390 --> 01:02:32,720
is just to add all the future results of

1679
01:02:38,230 --> 01:02:36,400
all future events or future measurements

1680
01:02:40,390 --> 01:02:38,240
it's a trivial way of doing it it's not

1681
01:02:42,710 --> 01:02:40,400
very practical it's not very useful but

1682
01:02:45,430 --> 01:02:42,720
obviously you can always do that somehow

1683
01:02:47,109 --> 01:02:45,440
maybe one could say that instead of god

1684
01:02:49,190 --> 01:02:47,119
playing dice when

1685
01:02:51,190 --> 01:02:49,200
an event happen

1686
01:02:53,270 --> 01:02:51,200
god played all dies at the initial

1687
01:02:53,990 --> 01:02:53,280
condition at the big bang

1688
01:02:55,589 --> 01:02:54,000

and

1689
01:02:58,150 --> 01:02:55,599
coded all this

1690
01:03:00,789 --> 01:02:58,160
information of all these guys that he

1691
01:03:02,390 --> 01:03:00,799
played initially he coded it into the

1692
01:03:04,230 --> 01:03:02,400
initial conditions the initial

1693
01:03:05,910 --> 01:03:04,240
conditions of you know these real

1694
01:03:08,950 --> 01:03:05,920
numbers that contain all this

1695
01:03:11,029 --> 01:03:08,960
information of all future events

1696
01:03:13,349 --> 01:03:11,039
or in bohmian quantum mechanics it's a

1697
01:03:15,270 --> 01:03:13,359
similar idea you have these additional

1698
01:03:17,829 --> 01:03:15,280
variables that also contain infinite

1699
01:03:20,870 --> 01:03:17,839
information and that somehow in a clever

1700
01:03:23,190 --> 01:03:20,880
way code all the outcomes of all

1701
01:03:26,230 --> 01:03:23,200
possible future measurements

1702
01:03:27,670 --> 01:03:26,240
so you can always do that

1703
01:03:29,589 --> 01:03:27,680
but you don't want

1704
01:03:31,829 --> 01:03:29,599
just to be able to do it you want to be

1705
01:03:34,630 --> 01:03:31,839
able to do it in a faithful way you want

1706
01:03:36,870 --> 01:03:34,640
to describe nature in a faithful way

1707
01:03:38,309 --> 01:03:36,880
and adding the result of future

1708
01:03:41,270 --> 01:03:38,319
measurements

1709
01:03:42,870 --> 01:03:41,280
uh into your initial condition i don't

1710
01:03:44,870 --> 01:03:42,880
think this is uh

1711
01:03:47,430 --> 01:03:44,880
this is a faithful description when i

1712
01:03:49,430 --> 01:03:47,440
was speaking with carla rivelli he said

1713
01:03:51,029 --> 01:03:49,440

there are two interpretations of quantum

1714
01:03:53,430 --> 01:03:51,039
mechanics that he feels like are

1715
01:03:55,589 --> 01:03:53,440
consistent relational quantum mechanics

1716
01:03:57,829 --> 01:03:55,599
and then the many worlds

1717
01:03:59,589 --> 01:03:57,839
right of course but he doesn't like the

1718
01:04:01,349 --> 01:03:59,599
many world's interpretation so he

1719
01:04:03,430 --> 01:04:01,359
chooses the relational one

1720
01:04:05,430 --> 01:04:03,440
now from my understanding of your views

1721
01:04:07,190 --> 01:04:05,440
there can't be a wave function of the

1722
01:04:09,349 --> 01:04:07,200
universe because this can't just simply

1723
01:04:11,029 --> 01:04:09,359
evolve in time determinately is that an

1724
01:04:12,630 --> 01:04:11,039
incorrect reading

1725
01:04:14,309 --> 01:04:12,640
correct correct

1726
01:04:15,670 --> 01:04:14,319
okay now does that mean that you don't

1727
01:04:17,589 --> 01:04:15,680
believe in the many worlds

1728
01:04:21,750 --> 01:04:17,599
interpretation

1729
01:04:25,750 --> 01:04:23,430
an empty concept and i think the

1730
01:04:28,549 --> 01:04:25,760
explanatory power of many worlds is

1731
01:04:30,789 --> 01:04:28,559
essentially zero

1732
01:04:32,470 --> 01:04:30,799
uh again it's it's again one of these

1733
01:04:34,309 --> 01:04:32,480
things which is super deterministic you

1734
01:04:35,910 --> 01:04:34,319
know that is the initial wave function

1735
01:04:38,069 --> 01:04:35,920
of the universe and then everything

1736
01:04:40,549 --> 01:04:38,079
evolves according to that and there is

1737
01:04:42,630 --> 01:04:40,559
never any event that happens nothing

1738
01:04:45,829 --> 01:04:42,640

really happens it just is this unitary

1739
01:04:50,150 --> 01:04:45,839
evolution which is an enormous uh

1740
01:04:51,750 --> 01:04:50,160
rotation in this gigantic hilbert space

1741
01:04:53,270 --> 01:04:51,760
uh so that's something that there's

1742
01:04:54,870 --> 01:04:53,280
nothing happening there you cannot tell

1743
01:04:57,910 --> 01:04:54,880
a story here

1744
01:04:59,910 --> 01:04:57,920
um no no so my view and much closer i'm

1745
01:05:01,829 --> 01:04:59,920
not claiming that i have the solution to

1746
01:05:03,829 --> 01:05:01,839
all these problems but my

1747
01:05:05,910 --> 01:05:03,839
my feeling is much closer my heart is

1748
01:05:09,349 --> 01:05:05,920
much closer to a

1749
01:05:11,670 --> 01:05:09,359
spontaneous localization theory so

1750
01:05:13,349 --> 01:05:11,680
stochastic evolution of the the

1751
01:05:15,990 --> 01:05:13,359
schrodinger equation

1752
01:05:18,230 --> 01:05:16,000
and so in this way also the you know as

1753
01:05:20,150 --> 01:05:18,240
time passes this uh

1754
01:05:23,270 --> 01:05:20,160
schrodinger equation of this wave

1755
01:05:26,630 --> 01:05:23,280
function sorry gets i added

1756
01:05:29,349 --> 01:05:26,640
additional information a bit like my

1757
01:05:31,510 --> 01:05:29,359
numbers for classical mechanics and as

1758
01:05:33,750 --> 01:05:31,520
time passes this additional information

1759
01:05:37,270 --> 01:05:33,760
that gets added to the to the wave

1760
01:05:39,589 --> 01:05:37,280
function may localize it here or there

1761
01:05:41,430 --> 01:05:39,599
with appropriate probabilities and we

1762
01:05:43,029 --> 01:05:41,440
are stochastic equations doing that

1763
01:05:44,710 --> 01:05:43,039

perfectly i won't keep you for much

1764
01:05:46,549 --> 01:05:44,720
longer i know that you probably have to

1765
01:05:48,470 --> 01:05:46,559
get going soon so i'll just ask a couple

1766
01:05:50,150 --> 01:05:48,480
more questions now going back to when

1767
01:05:51,829 --> 01:05:50,160
you were younger and your little

1768
01:05:53,990 --> 01:05:51,839
nicholas was philosophizing in his

1769
01:05:55,589 --> 01:05:54,000
armchair and you dabbled with different

1770
01:05:57,829 --> 01:05:55,599
logical systems so we talked about

1771
01:06:00,150 --> 01:05:57,839
paraconsistence and intuitionist did you

1772
01:06:01,750 --> 01:06:00,160
dabble with questioning even if logic

1773
01:06:04,470 --> 01:06:01,760
should be the basis of mathematics

1774
01:06:08,789 --> 01:06:04,480
itself

1775
01:06:11,109 --> 01:06:08,799
um well when i did my phd in geneva

1776
01:06:11,910 --> 01:06:11,119
indeed a long time ago

1777
01:06:14,710 --> 01:06:11,920
my

1778
01:06:17,349 --> 01:06:14,720
phd advisor professor piron

1779
01:06:19,349 --> 01:06:17,359
was actually a guy working in in quantum

1780
01:06:21,029 --> 01:06:19,359
logic i don't think himself really

1781
01:06:22,710 --> 01:06:21,039
believes in quantum logic but there are

1782
01:06:23,829 --> 01:06:22,720
many people around and so we had

1783
01:06:25,589 --> 01:06:23,839
visitors

1784
01:06:27,589 --> 01:06:25,599
who were really uh

1785
01:06:29,750 --> 01:06:27,599
thinking of this quantum logic and that

1786
01:06:32,309 --> 01:06:29,760
by changing that the laws of logic we

1787
01:06:34,390 --> 01:06:32,319
could make sense of better sense of

1788
01:06:36,150 --> 01:06:34,400

quantum mechanics

1789
01:06:37,829 --> 01:06:36,160
i i don't think that this is an

1790
01:06:38,710 --> 01:06:37,839
interesting approach

1791
01:06:40,789 --> 01:06:38,720
um

1792
01:06:43,430 --> 01:06:40,799
i i think that that's

1793
01:06:45,510 --> 01:06:43,440
okay no so my answer to your question is

1794
01:06:47,670 --> 01:06:45,520
no

1795
01:06:49,829 --> 01:06:47,680
and again this is uh

1796
01:06:51,910 --> 01:06:49,839
so i'm i'm rejecting the law of the

1797
01:06:53,270 --> 01:06:51,920
excluded middle

1798
01:06:55,750 --> 01:06:53,280
essentially

1799
01:06:57,510 --> 01:06:55,760
about propositions that concern the

1800
01:07:00,309 --> 01:06:57,520
future

1801
01:07:03,430 --> 01:07:00,319
you know my bicycle now you may ask is

1802
01:07:05,750 --> 01:07:03,440
my bicycle on that side or on that side

1803
01:07:07,670 --> 01:07:05,760
well maybe i forgot actually i know but

1804
01:07:09,910 --> 01:07:07,680
suppose i forgot

1805
01:07:13,109 --> 01:07:09,920
even if i forgot why my bicycle is my

1806
01:07:15,750 --> 01:07:13,119
bicycle is definitely either there or

1807
01:07:17,990 --> 01:07:15,760
there it's not in an indeterminate

1808
01:07:20,390 --> 01:07:18,000
position

1809
01:07:22,470 --> 01:07:20,400
now if you ask me where will my bicycle

1810
01:07:25,589 --> 01:07:22,480
be in a weak time

1811
01:07:27,029 --> 01:07:25,599
that's indeterminate also today

1812
01:07:29,109 --> 01:07:27,039
one of my favorite ways of showing that

1813
01:07:31,109 --> 01:07:29,119

classical mechanics has indeterminacy

1814
01:07:32,710 --> 01:07:31,119
built in it is norton's dome have you

1815
01:07:34,950 --> 01:07:32,720
heard of norton's dome

1816
01:07:37,829 --> 01:07:34,960
yes yes i know that

1817
01:07:40,230 --> 01:07:37,839
yeah well but this is uh

1818
01:07:42,870 --> 01:07:40,240
okay it's a very nice example that that

1819
01:07:44,549 --> 01:07:42,880
shows that indeed you may have

1820
01:07:46,870 --> 01:07:44,559
initial conditions

1821
01:07:49,589 --> 01:07:46,880
that don't determine the the future of

1822
01:07:52,710 --> 01:07:49,599
these dynamical systems but you need

1823
01:07:54,870 --> 01:07:52,720
very specific dynamical systems now you

1824
01:07:57,109 --> 01:07:54,880
need this dome that's why it's called a

1825
01:08:00,390 --> 01:07:57,119
dome in such a way that if you have a

1826
01:08:02,470 --> 01:08:00,400
particle coming to that dome it will

1827
01:08:05,190 --> 01:08:02,480
okay if you don't through it hard enough

1828
01:08:06,309 --> 01:08:05,200
it will just go up and back again if you

1829
01:08:08,630 --> 01:08:06,319
throw it too far

1830
01:08:10,870 --> 01:08:08,640
it goes over it and goes to the other

1831
01:08:13,910 --> 01:08:10,880
side so there's precisely an initial

1832
01:08:15,990 --> 01:08:13,920
condition initial velocity such that it

1833
01:08:18,070 --> 01:08:16,000
will stop at the top

1834
01:08:19,910 --> 01:08:18,080
and that doesn't exist for all domes it

1835
01:08:21,990 --> 01:08:19,920
exists only for

1836
01:08:23,990 --> 01:08:22,000
very specific domes and for this very

1837
01:08:25,590 --> 01:08:24,000
specific dome so of course whether or

1838
01:08:27,269 --> 01:08:25,600

not the ball comes from that side or

1839
01:08:28,630 --> 01:08:27,279
from any side let's suppose it's a two

1840
01:08:30,870 --> 01:08:28,640
dimensional thing

1841
01:08:31,829 --> 01:08:30,880
but from any direction it can stop at

1842
01:08:34,229 --> 01:08:31,839
the top

1843
01:08:37,590 --> 01:08:34,239
which means now the initial condition it

1844
01:08:39,349 --> 01:08:37,600
may go at any time in any direction and

1845
01:08:41,349 --> 01:08:39,359
that will always be a solution of the

1846
01:08:44,550 --> 01:08:41,359
newton's equation

1847
01:08:47,430 --> 01:08:44,560
but so this is fascinating indeed but i

1848
01:08:48,950 --> 01:08:47,440
don't think it's super convincing

1849
01:08:50,630 --> 01:08:48,960
because

1850
01:08:51,669 --> 01:08:50,640
you know if you change

1851
01:08:55,510 --> 01:08:51,679
the

1852
01:08:57,510 --> 01:08:55,520
a little bit

1853
01:08:59,510 --> 01:08:57,520
it's gone i mean this uh this

1854
01:09:02,709 --> 01:08:59,520
peculiarity is gone

1855
01:09:04,829 --> 01:09:02,719
so you it it is not a generic feature

1856
01:09:08,470 --> 01:09:04,839
it's a feature of some very very

1857
01:09:10,630 --> 01:09:08,480
specific dome or potential as we call it

1858
01:09:11,990 --> 01:09:10,640
the reason why i like it is because i

1859
01:09:13,189 --> 01:09:12,000
know that it's predicated on real

1860
01:09:15,430 --> 01:09:13,199
numbers and so on so maybe that's

1861
01:09:17,510 --> 01:09:15,440
another dispute you have with it the

1862
01:09:19,510 --> 01:09:17,520
reason why i like it is that even in the

1863
01:09:20,870 --> 01:09:19,520

classical domain we can show that it

1864
01:09:22,229 --> 01:09:20,880
doesn't have certain continuity

1865
01:09:24,229 --> 01:09:22,239
condition and then because of that it

1866
01:09:25,430 --> 01:09:24,239
allows for multiple solutions and not

1867
01:09:27,349 --> 01:09:25,440
only that but you mentioned that it's

1868
01:09:29,510 --> 01:09:27,359
not a generic feature i don't know if

1869
01:09:31,189 --> 01:09:29,520
there's a result that says much like we

1870
01:09:32,870 --> 01:09:31,199
can say that the typical real number has

1871
01:09:34,149 --> 01:09:32,880
infinite information in it i don't know

1872
01:09:36,789 --> 01:09:34,159
if there's a result that says the

1873
01:09:38,229 --> 01:09:36,799
typical configuration of matter is that

1874
01:09:39,110 --> 01:09:38,239
which has a lipschitz continuity

1875
01:09:41,349 --> 01:09:39,120
condition i would think it's the

1876
01:09:43,189 --> 01:09:41,359
opposite i would think that

1877
01:09:45,590 --> 01:09:43,199
not satisfying the lipschitz continuity

1878
01:09:47,590 --> 01:09:45,600
condition would be typical if we have

1879
01:09:48,550 --> 01:09:47,600
the general space of functions

1880
01:09:51,349 --> 01:09:48,560
i don't know if that's true i don't know

1881
01:09:54,470 --> 01:09:51,359
if there's a result like that

1882
01:09:57,030 --> 01:09:54,480
okay um i also don't know

1883
01:09:59,590 --> 01:09:57,040
my bet is that this is very uh very

1884
01:10:03,110 --> 01:09:59,600
specific and generically we don't have

1885
01:10:04,870 --> 01:10:03,120
this phenomenon but i cannot

1886
01:10:06,470 --> 01:10:04,880
i'm not sure about that

1887
01:10:08,630 --> 01:10:06,480
my last question is with regard to

1888
01:10:14,790 --> 01:10:08,640

quantum gravity is there an approach

1889
01:10:19,590 --> 01:10:18,550
make relativity deterministic

1890
01:10:20,880 --> 01:10:19,600
but you know

1891
01:10:23,030 --> 01:10:20,890
that's a vast program

1892
01:10:24,470 --> 01:10:23,040
[Music]

1893
01:10:26,149 --> 01:10:24,480
okay now let's get to the audience

1894
01:10:28,470 --> 01:10:26,159
questions this one comes from steven e

1895
01:10:30,550 --> 01:10:28,480
robbins a great question to ask nicholas

1896
01:10:33,270 --> 01:10:30,560
is i'm curious if

1897
01:10:34,149 --> 01:10:33,280
he has looked at bergson time and free

1898
01:10:36,390 --> 01:10:34,159
will

1899
01:10:38,630 --> 01:10:36,400
wait yes i'm curious if he's looked at

1900
01:10:41,270 --> 01:10:38,640
burksen so that's it

1901
01:10:43,669 --> 01:10:41,280
yeah yeah so i i looked at it i read

1902
01:10:45,110 --> 01:10:43,679
some of it i mean it's too too large i

1903
01:10:48,550 --> 01:10:45,120
didn't read everything

1904
01:10:50,630 --> 01:10:48,560
uh certainly a lot of his writing

1905
01:10:52,550 --> 01:10:50,640
resonates

1906
01:10:53,990 --> 01:10:52,560
um

1907
01:10:55,830 --> 01:10:54,000
but somehow

1908
01:10:57,510 --> 01:10:55,840
that's where i'm i'm

1909
01:10:59,510 --> 01:10:57,520
a physicist much more fun and

1910
01:11:01,669 --> 01:10:59,520
philosopher and the excellent was

1911
01:11:04,630 --> 01:11:01,679
clearly a philosopher so at some point

1912
01:11:05,510 --> 01:11:04,640
it is kind of too vague i cannot really

1913
01:11:08,390 --> 01:11:05,520

you know

1914
01:11:10,390 --> 01:11:08,400
grasp it i cannot really anchor

1915
01:11:11,189 --> 01:11:10,400
on it and uh

1916
01:11:13,990 --> 01:11:11,199
and

1917
01:11:16,310 --> 01:11:14,000
yeah so for that reason uh i i

1918
01:11:18,550 --> 01:11:16,320
i think i cite him even in one of my

1919
01:11:21,430 --> 01:11:18,560
paper things like that so

1920
01:11:23,590 --> 01:11:21,440
i i'm certainly sympathetic

1921
01:11:26,470 --> 01:11:23,600
but um

1922
01:11:27,750 --> 01:11:26,480
it's not really my way of doing physics

1923
01:11:29,430 --> 01:11:27,760
or science

1924
01:11:32,350 --> 01:11:29,440
now this question comes from complex

1925
01:11:34,790 --> 01:11:32,360
plane at

1926
01:11:37,189 --> 01:11:34,800
k-e-k-u-l-e-6 does he think that the

1927
01:11:39,990 --> 01:11:37,199
denial of free will by physicists is an

1928
01:11:41,830 --> 01:11:40,000
attempt to make evidence fit a model now

1929
01:11:43,910 --> 01:11:41,840
chomsky says that it may be something

1930
01:11:45,830 --> 01:11:43,920
outside human cognitive abilities that

1931
01:11:51,750 --> 01:11:45,840
is free will to understand

1932
01:11:55,830 --> 01:11:53,750
i i don't really know again i mean for

1933
01:11:58,149 --> 01:11:55,840
me free will comes first

1934
01:11:59,110 --> 01:11:58,159
in this logical order so you need it to

1935
01:12:01,990 --> 01:11:59,120
start

1936
01:12:04,390 --> 01:12:02,000
arguing about the existence of free will

1937
01:12:06,070 --> 01:12:04,400
so somehow you cannot really deny the

1938
01:12:08,470 --> 01:12:06,080

existence of free will because if you

1939
01:12:10,229 --> 01:12:08,480
want to to argue against the existence

1940
01:12:13,510 --> 01:12:10,239
of free will you need free will to be

1941
01:12:15,350 --> 01:12:13,520
able to buy or not buy the argument

1942
01:12:17,510 --> 01:12:15,360
then someone may say well how is it that

1943
01:12:18,709 --> 01:12:17,520
you're choosing so and so because we use

1944
01:12:20,149 --> 01:12:18,719
our free will to choose among

1945
01:12:21,830 --> 01:12:20,159
possibilities are you saying there's

1946
01:12:24,229 --> 01:12:21,840
nothing that influences that is it

1947
01:12:26,149 --> 01:12:24,239
random how does that work no no no no so

1948
01:12:28,630 --> 01:12:26,159
of course we get influenced i mean

1949
01:12:31,110 --> 01:12:28,640
obviously we are under very heavy

1950
01:12:33,430 --> 01:12:31,120
influence and so so free will is not

1951
01:12:35,910 --> 01:12:33,440
something that we use continuously and

1952
01:12:38,550 --> 01:12:35,920
so on i mean most of our even decisions

1953
01:12:40,709 --> 01:12:38,560
are not so important and so on

1954
01:12:41,669 --> 01:12:40,719
and we get influenced by ads and

1955
01:12:43,189 --> 01:12:41,679
whatever

1956
01:12:45,350 --> 01:12:43,199
um

1957
01:12:47,590 --> 01:12:45,360
and they're also not random i mean they

1958
01:12:50,630 --> 01:12:47,600
might be partially random

1959
01:12:53,030 --> 01:12:50,640
you can for instance decide and whether

1960
01:12:54,790 --> 01:12:53,040
you go to a restaurant tonight or by

1961
01:12:57,830 --> 01:12:54,800
just tossing a coin

1962
01:13:00,950 --> 01:12:57,840
um so sometimes it will be but most of

1963
01:13:03,590 --> 01:13:00,960

the time it will be not random

1964
01:13:06,229 --> 01:13:03,600
and not predetermined

1965
01:13:08,870 --> 01:13:06,239
now you may say but who is now making

1966
01:13:09,990 --> 01:13:08,880
the decision is there a little guy in my

1967
01:13:12,390 --> 01:13:10,000
brain

1968
01:13:14,709 --> 01:13:12,400
well it should be myself so i i'm not

1969
01:13:15,790 --> 01:13:14,719
sitting in my brain or whatever so

1970
01:13:17,189 --> 01:13:15,800
that's where

1971
01:13:20,310 --> 01:13:17,199
[Music]

1972
01:13:23,189 --> 01:13:20,320
our understanding of what free will is

1973
01:13:25,350 --> 01:13:23,199
uh is limited we don't have this kind of

1974
01:13:27,350 --> 01:13:25,360
uh understanding

1975
01:13:30,149 --> 01:13:27,360
and maybe that comes also back to what

1976
01:13:32,390 --> 01:13:30,159
you asked initially about consciousness

1977
01:13:35,669 --> 01:13:32,400
somehow

1978
01:13:37,830 --> 01:13:35,679
am i i'm making conscious decisions not

1979
01:13:40,229 --> 01:13:37,840
always by the way but sometimes i'm

1980
01:13:40,740 --> 01:13:40,239
making conscious decisions

1981
01:13:42,310 --> 01:13:40,750
and um

1982
01:13:43,270 --> 01:13:42,320
[Music]

1983
01:13:43,910 --> 01:13:43,280
yeah

1984
01:13:45,110 --> 01:13:43,920
i i

1985
01:13:47,189 --> 01:13:45,120
[Music]

1986
01:13:49,030 --> 01:13:47,199
i'm not sure i have much more to add on

1987
01:13:51,030 --> 01:13:49,040
that

1988
01:13:53,030 --> 01:13:51,040

our decisions are extremely determined

1989
01:13:54,310 --> 01:13:53,040
by our environment but being extremely

1990
01:13:56,070 --> 01:13:54,320
determined it's not the same as being

1991
01:13:58,390 --> 01:13:56,080
fully determined

1992
01:14:00,390 --> 01:13:58,400
exactly exactly they there is room for

1993
01:14:01,910 --> 01:14:00,400
for some decisions there are clearly

1994
01:14:04,630 --> 01:14:01,920
some decisions

1995
01:14:06,870 --> 01:14:04,640
uh where we spend a lot of time thinking

1996
01:14:08,870 --> 01:14:06,880
about we really wait we discuss with

1997
01:14:10,950 --> 01:14:08,880
ourselves maybe also with our friends

1998
01:14:13,430 --> 01:14:10,960
and relatives

1999
01:14:15,830 --> 01:14:13,440
and they are clear also our discussions

2000
01:14:17,030 --> 01:14:15,840
decisions sorry that we don't really

2001
01:14:17,830 --> 01:14:17,040
care much

2002
01:14:21,830 --> 01:14:17,840
and

2003
01:14:23,990 --> 01:14:21,840
yeah

2004
01:14:26,830 --> 01:14:24,000
accept that we get uh

2005
01:14:28,550 --> 01:14:26,840
seriously influenced by the outside

2006
01:14:30,149 --> 01:14:28,560
world

2007
01:14:32,070 --> 01:14:30,159
professor thank you so much for spending

2008
01:14:34,390 --> 01:14:32,080
some of your time with me i appreciate

2009
01:14:36,709 --> 01:14:34,400
it i know it's late where you are

2010
01:14:37,830 --> 01:14:36,719
no it's okay it's 20 past

2011
01:14:42,870 --> 01:14:37,840
20

2012
01:14:45,030 --> 01:14:42,880
thank you very much for

2013
01:14:47,669 --> 01:14:45,040

for your time and uh

2014
01:14:49,750 --> 01:14:47,679
yeah tell me when that will be online

2015
01:14:51,350 --> 01:14:49,760
very good thank you thank you for your

2016
01:14:53,830 --> 01:14:51,360
interest in uh

2017
01:14:55,350 --> 01:14:53,840
in physics in science in free will and

2018
01:14:58,709 --> 01:14:55,360
in my

2019
01:15:01,350 --> 01:14:58,719
poor understanding of all those

2020
01:15:03,350 --> 01:15:01,360
thank you sir

2021
01:15:05,030 --> 01:15:03,360
the podcast is now finished if you'd

2022
01:15:08,229 --> 01:15:05,040
like to support conversations like this

2023
01:15:12,310 --> 01:15:08,239
then do consider going to patreon.com

2024
01:15:14,950 --> 01:15:12,320
c-u-r-t j-a-i-m-u-n-g-a-l

2025
01:15:16,790 --> 01:15:14,960
that is kurt jaimungle it's support from

2026
01:15:18,550 --> 01:15:16,800
the patrons and from the sponsors that