



**BRIAN  
GREENE**

**FASTER  
THAN LIGHT  
MANIFOLD**

1  
00:00:05,090 --> 00:00:02,930  
I've opened up about certain experiences

2  
00:00:07,249 --> 00:00:05,100  
that at the time were absolutely

3  
00:00:09,350 --> 00:00:07,259  
terrifying anything that takes your mind

4  
00:00:13,009 --> 00:00:09,360  
into a different place that ultimately

5  
00:00:15,890 --> 00:00:13,019  
you learn something from fits within the

6  
00:00:19,010 --> 00:00:15,900  
genre of exploration of Altered States

7  
00:00:23,929 --> 00:00:21,109  
today we talk about Consciousness time

8  
00:00:26,269 --> 00:00:23,939  
travel String Theory quantum gravity and

9  
00:00:28,910 --> 00:00:26,279  
wormholes Brian Greene is a theoretical

10  
00:00:30,769 --> 00:00:28,920  
physicist a mathematician and a string

11  
00:00:32,990 --> 00:00:30,779  
theorist who is best known for his work

12  
00:00:34,490 --> 00:00:33,000  
on mirror symmetry and flop transitions

13  
00:00:36,650 --> 00:00:34,500

Brian's also a professor at Columbia

14

00:00:38,630 --> 00:00:36,660

University as well as the chairman of

15

00:00:40,430 --> 00:00:38,640

the world Science Festival and the

16

00:00:42,770 --> 00:00:40,440

author of several popular books on

17

00:00:44,630 --> 00:00:42,780

physics including the elegant Universe

18

00:00:46,430 --> 00:00:44,640

this was a purposefully desultory

19

00:00:48,350 --> 00:00:46,440

interview which brought us both to

20

00:00:50,450 --> 00:00:48,360

uncomfortable ground comfortably you'll

21

00:00:51,709 --> 00:00:50,460

see what I mean my name's Kurt J Mongol

22

00:00:53,750 --> 00:00:51,719

I have a background in mathematical

23

00:00:55,430 --> 00:00:53,760

physics this podcast is called theories

24

00:00:57,350 --> 00:00:55,440

of everything is dedicated to the

25

00:00:59,689 --> 00:00:57,360

exploration of theories of everything

26  
00:01:01,549 --> 00:00:59,699  
from a theoretical physics perspective

27  
00:01:03,049 --> 00:01:01,559  
but as well as exploring the role

28  
00:01:05,390 --> 00:01:03,059  
Consciousness has to the fundamental

29  
00:01:07,609 --> 00:01:05,400  
laws of nature each sponsor as well as

30  
00:01:09,830 --> 00:01:07,619  
the patrons improves the quality of the

31  
00:01:11,810 --> 00:01:09,840  
videos drastically it improves the depth

32  
00:01:13,250 --> 00:01:11,820  
it improves the frequency and it goes

33  
00:01:14,690 --> 00:01:13,260  
toward paying the staff for instance

34  
00:01:16,190 --> 00:01:14,700  
someone who's editing this full time

35  
00:01:18,050 --> 00:01:16,200  
right now and then we have an operations

36  
00:01:20,210 --> 00:01:18,060  
manager in that vein I want to thank

37  
00:01:21,530 --> 00:01:20,220  
today's sponsor brilliant if you're

38  
00:01:23,210 --> 00:01:21,540

familiar with toe you're familiar with

39

00:01:25,370 --> 00:01:23,220

brilliant but for those who don't know

40

00:01:26,990 --> 00:01:25,380

Brilliance is a place where you go to

41

00:01:28,910 --> 00:01:27,000

learn math science and engineering

42

00:01:31,010 --> 00:01:28,920

through these bite-sized Interactive

43

00:01:32,570 --> 00:01:31,020

Learning experiences for example and I

44

00:01:34,130 --> 00:01:32,580

keep saying this I would like to do a

45

00:01:36,770 --> 00:01:34,140

podcast on information Theory

46

00:01:39,109 --> 00:01:36,780

particularly Chiara marletto which is

47

00:01:40,670 --> 00:01:39,119

David Deutsch's student has a theory of

48

00:01:42,649 --> 00:01:40,680

everything that she puts forward called

49

00:01:44,749 --> 00:01:42,659

Constructor Theory which is heavily

50

00:01:46,490 --> 00:01:44,759

contingent on information Theory so I

51  
00:01:48,170 --> 00:01:46,500  
took their course on random variable

52  
00:01:50,270 --> 00:01:48,180  
distributions and knowledge and

53  
00:01:52,249 --> 00:01:50,280  
uncertainty in order to learn a bit more

54  
00:01:54,050 --> 00:01:52,259  
about entropy now there's this formula

55  
00:01:56,030 --> 00:01:54,060  
for entropy essentially hammered into

56  
00:01:57,950 --> 00:01:56,040  
you as an undergraduate which seems to

57  
00:01:59,749 --> 00:01:57,960  
have fallen from the sky however when

58  
00:02:01,249 --> 00:01:59,759  
you take Brilliance course it was the

59  
00:02:04,010 --> 00:02:01,259  
first time that I could see that it's an

60  
00:02:06,230 --> 00:02:04,020  
extremely clear and intuitive formula

61  
00:02:08,029 --> 00:02:06,240  
that is to say that it would be

62  
00:02:11,029 --> 00:02:08,039  
unnatural to Define it in any other

63  
00:02:13,190 --> 00:02:11,039

manner visit brilliant.org toe that is

64

00:02:14,990 --> 00:02:13,200

t-o-e to get 20 off the annual

65

00:02:17,630 --> 00:02:15,000

subscription and I recommend that you

66

00:02:19,430 --> 00:02:17,640

don't stop before four lessons I think

67

00:02:20,990 --> 00:02:19,440

you'll be greatly surprised that the

68

00:02:23,150 --> 00:02:21,000

ease at which you can now comprehend

69

00:02:25,070 --> 00:02:23,160

subjects you previously had a difficult

70

00:02:26,270 --> 00:02:25,080

time grocking at some point I'll also go

71

00:02:28,369 --> 00:02:26,280

through the courses and give a

72

00:02:29,449 --> 00:02:28,379

recommendation in order if you'd like to

73

00:02:31,670 --> 00:02:29,459

support the theories of everything

74

00:02:33,530 --> 00:02:31,680

podcast and help assist that is the

75

00:02:35,510 --> 00:02:33,540

improved video quality the depth the

76  
00:02:37,369 --> 00:02:35,520  
frequency of the podcast and paying the

77  
00:02:39,010 --> 00:02:37,379  
staff then do consider going to

78  
00:02:41,390 --> 00:02:39,020  
patreon.com

79  
00:02:43,009 --> 00:02:41,400  
kurtjimungle the link is on screen as

80  
00:02:44,509 --> 00:02:43,019  
well as in the description there's a

81  
00:02:46,610 --> 00:02:44,519  
custom amount as well as already

82  
00:02:48,229 --> 00:02:46,620  
delineated tiers either way your

83  
00:02:51,430 --> 00:02:48,239  
viewership is thank you enough enjoy

84  
00:02:54,350 --> 00:02:51,440  
this episode with Brian Greene

85  
00:02:56,570 --> 00:02:54,360  
Professor Brian Greene it's an honor to

86  
00:02:58,790 --> 00:02:56,580  
speak with you I've been researching you

87  
00:03:00,770 --> 00:02:58,800  
since I was young and also as I've

88  
00:03:02,330 --> 00:03:00,780

gotten older it's an honor thank you for

89

00:03:03,589 --> 00:03:02,340

coming on thank you appreciate that

90

00:03:04,970 --> 00:03:03,599

thank you so much

91

00:03:05,869 --> 00:03:04,980

what have you been working on in the

92

00:03:07,250 --> 00:03:05,879

past year and what do you hope to

93

00:03:08,030 --> 00:03:07,260

accomplish in the next year and this

94

00:03:10,250 --> 00:03:08,040

year

95

00:03:12,470 --> 00:03:10,260

well uh yeah I've been working on some

96

00:03:14,570 --> 00:03:12,480

strange things of late which I'm almost

97

00:03:17,149 --> 00:03:14,580

afraid to talk about but since they've

98

00:03:18,589 --> 00:03:17,159

been published I I guess I shouldn't at

99

00:03:21,050 --> 00:03:18,599

all hold back

100

00:03:22,790 --> 00:03:21,060

but it sounds a little kooky

101  
00:03:25,790 --> 00:03:22,800  
uh it sounds like the kind of things

102  
00:03:29,089 --> 00:03:25,800  
that I receive in you know emails and

103  
00:03:31,670 --> 00:03:29,099  
crank letters for the past 30 years it

104  
00:03:35,390 --> 00:03:31,680  
it has to do with questioning whether

105  
00:03:38,330 --> 00:03:35,400  
the speed of light really is the limit

106  
00:03:41,449 --> 00:03:38,340  
for Signal transmission

107  
00:03:43,250 --> 00:03:41,459  
and we all know that as anyone who's

108  
00:03:47,270 --> 00:03:43,260  
taken basic physics studied special

109  
00:03:50,630 --> 00:03:47,280  
relativity that it's an absolutely well

110  
00:03:53,869 --> 00:03:50,640  
established fact that locally

111  
00:03:55,910 --> 00:03:53,879  
the speed of light is the limit for

112  
00:03:58,070 --> 00:03:55,920  
Signal transmission obviously going back

113  
00:04:01,270 --> 00:03:58,080

to Einstein and a gazillion experiment

114

00:04:04,369 --> 00:04:01,280

since but there are some unusual

115

00:04:06,649 --> 00:04:04,379

contexts that theories like string

116

00:04:10,550 --> 00:04:06,659

theory suggest

117

00:04:13,369 --> 00:04:10,560

and those contacts suggest that the

118

00:04:15,949 --> 00:04:13,379

overall shape of space might be

119

00:04:18,590 --> 00:04:15,959

non-trivial in the sense that it might

120

00:04:21,349 --> 00:04:18,600

not just sort of go on forever space my

121

00:04:24,650 --> 00:04:21,359

curve back on itself and you can ask

122

00:04:26,330 --> 00:04:24,660

yourself what if the universe is in the

123

00:04:28,129 --> 00:04:26,340

shape of a loop or at least there are

124

00:04:29,930 --> 00:04:28,139

dimensions that are looped that as you

125

00:04:31,310 --> 00:04:29,940

go out in One Direction you go far

126  
00:04:32,450 --> 00:04:31,320  
enough you'll come back to your starting

127  
00:04:35,270 --> 00:04:32,460  
point

128  
00:04:37,490 --> 00:04:35,280  
and so we began to study signal

129  
00:04:39,409 --> 00:04:37,500  
Transmission in universes where the

130  
00:04:42,770 --> 00:04:39,419  
signal could go all the way around the

131  
00:04:44,990 --> 00:04:42,780  
universe and root to its destination

132  
00:04:46,689 --> 00:04:45,000  
and we found in certain circumstances

133  
00:04:51,010 --> 00:04:46,699  
that I'd be happy to

134  
00:04:55,490 --> 00:04:51,020  
elaborate that you could have signals

135  
00:04:57,409 --> 00:04:55,500  
going in that unusual trajectory that

136  
00:04:59,810 --> 00:04:57,419  
would get to their destination faster

137  
00:05:01,730 --> 00:04:59,820  
than the signal that would seemingly be

138  
00:05:04,330 --> 00:05:01,740

the quicker one moving

139

00:05:08,210 --> 00:05:04,340

right through the space-time without

140

00:05:10,310 --> 00:05:08,220

traversing these these closed curves and

141

00:05:12,890 --> 00:05:10,320

so we found that there are signals that

142

00:05:14,749 --> 00:05:12,900

can go from here to there faster than

143

00:05:16,850 --> 00:05:14,759

the speed of light this is related to

144

00:05:19,129 --> 00:05:16,860

the topology of the universe and not the

145

00:05:21,050 --> 00:05:19,139

variable speed of light yeah this is not

146

00:05:24,170 --> 00:05:21,060

a variable speed of light

147

00:05:25,129 --> 00:05:24,180

type of contribution as you know as

148

00:05:26,529 --> 00:05:25,139

you're making a reference to there's

149

00:05:29,150 --> 00:05:26,539

been a whole

150

00:05:31,430 --> 00:05:29,160

industry that

151  
00:05:33,409 --> 00:05:31,440  
for various physicists pursued over the

152  
00:05:35,270 --> 00:05:33,419  
course of many years wondering about

153  
00:05:37,310 --> 00:05:35,280  
whether the speed of light might vary

154  
00:05:39,650 --> 00:05:37,320  
through time at temporal dependence to

155  
00:05:41,270 --> 00:05:39,660  
the speed of light very interesting idea

156  
00:05:43,490 --> 00:05:41,280  
I really don't know that there's much

157  
00:05:44,510 --> 00:05:43,500  
evidence for it nor is there much

158  
00:05:47,510 --> 00:05:44,520  
evidence for what I'm talking about

159  
00:05:50,330 --> 00:05:47,520  
either so this is like throwing stones

160  
00:05:52,490 --> 00:05:50,340  
in a glass house but be that as it may

161  
00:05:55,490 --> 00:05:52,500  
you're right it all has to do with the

162  
00:05:58,029 --> 00:05:55,500  
topology of space and if that topology

163  
00:06:01,150 --> 00:05:58,039

is non-trivial if they're

164

00:06:05,210 --> 00:06:01,160

non-contractable Loops in that space

165

00:06:07,550 --> 00:06:05,220

then that allows for qualitatively

166

00:06:11,029 --> 00:06:07,560

different trajectories for signals

167

00:06:13,189 --> 00:06:11,039

and when you take those into account you

168

00:06:15,650 --> 00:06:13,199

find that the signals can have a net

169

00:06:17,090 --> 00:06:15,660

speed that's faster than the speed of

170

00:06:19,810 --> 00:06:17,100

light and moreover

171

00:06:23,930 --> 00:06:19,820

it starts to sound a little bit kooky

172

00:06:25,610 --> 00:06:23,940

but when you take special relativity you

173

00:06:26,689 --> 00:06:25,620

learn that if signal can go faster in

174

00:06:28,610 --> 00:06:26,699

the speed of light then there are

175

00:06:32,450 --> 00:06:28,620

observers according to whom that signal

176

00:06:34,790 --> 00:06:32,460

may arrive at its destination prior to

177

00:06:38,930 --> 00:06:34,800

the time at which was emitted

178

00:06:40,790 --> 00:06:38,940

and indeed we find examples of that in

179

00:06:43,430 --> 00:06:40,800

other words we find examples where you

180

00:06:46,249 --> 00:06:43,440

can send a signal into the past

181

00:06:47,809 --> 00:06:46,259

and again I hesitate saying this but you

182

00:06:50,749 --> 00:06:47,819

asked me the question of what I've been

183

00:06:53,390 --> 00:06:50,759

working on lately so I feel I need to

184

00:06:55,670 --> 00:06:53,400

answer fully and truthfully

185

00:06:57,890 --> 00:06:55,680

um I hesitate to say this because this

186

00:07:00,170 --> 00:06:57,900

has sort of been the playground

187

00:07:03,230 --> 00:07:00,180

of kind of

188

00:07:05,629 --> 00:07:03,240

thinkers who wanted to upset Einstein

189

00:07:07,610 --> 00:07:05,639

and become the new Einstein to try to

190

00:07:09,590 --> 00:07:07,620

find some flaw out in the special

191

00:07:11,930 --> 00:07:09,600

activity this is not a flaw from the

192

00:07:13,610 --> 00:07:11,940

special relativity it's a feature of the

193

00:07:15,050 --> 00:07:13,620

special relativity when applied to a

194

00:07:17,210 --> 00:07:15,060

universe that has one of these

195

00:07:19,610 --> 00:07:17,220

non-trivial topologies

196

00:07:21,830 --> 00:07:19,620

so a close timeline curve doesn't go

197

00:07:23,990 --> 00:07:21,840

against general relativity girdle had a

198

00:07:26,210 --> 00:07:24,000

solution that has close timeline curves

199

00:07:27,230 --> 00:07:26,220

are you suggesting some amendment to a

200

00:07:29,330 --> 00:07:27,240

general relativity or are you just

201  
00:07:30,830 --> 00:07:29,340  
saying look the actual structure of

202  
00:07:32,390 --> 00:07:30,840  
space time or the shape of it is

203  
00:07:36,529 --> 00:07:32,400  
different so you're not proposing new

204  
00:07:39,050 --> 00:07:36,539  
laws no no laws yeah and so you know the

205  
00:07:42,050 --> 00:07:39,060  
whole notion of closed time like curves

206  
00:07:45,589 --> 00:07:42,060  
is a tricky one that's that's one where

207  
00:07:49,610 --> 00:07:45,599  
there's a full trajectory that gets back

208  
00:07:53,629 --> 00:07:49,620  
to its starting point prior to when it

209  
00:07:56,089 --> 00:07:53,639  
departed and we don't exactly find those

210  
00:07:59,330 --> 00:07:56,099  
kind of structures in these theories so

211  
00:08:01,490 --> 00:07:59,340  
if I send a signal out into space and

212  
00:08:03,770 --> 00:08:01,500  
send it somehow into the past and then

213  
00:08:07,010 --> 00:08:03,780

someone in the past gets that signal and

214

00:08:11,089 --> 00:08:07,020

fires back toward me the return signal

215

00:08:13,430 --> 00:08:11,099

will always get to me in at least no

216

00:08:16,129 --> 00:08:13,440

time in other words it won't be that I

217

00:08:17,629 --> 00:08:16,139

get the signal prior to I the moment

218

00:08:20,930 --> 00:08:17,639

when I admitted it

219

00:08:23,210 --> 00:08:20,940

so this would allow for interesting

220

00:08:25,369 --> 00:08:23,220

things such as you know we've always

221

00:08:27,710 --> 00:08:25,379

worried well worry it's probably too

222

00:08:29,930 --> 00:08:27,720

strong a word we've always noted that if

223

00:08:32,329 --> 00:08:29,940

we discover intelligent life out there

224

00:08:34,430 --> 00:08:32,339

in the cosmos and it's very far away

225

00:08:36,290 --> 00:08:34,440

how are we going to have a conversation

226

00:08:37,969 --> 00:08:36,300

right we send out a signal hey how you

227

00:08:40,010 --> 00:08:37,979

guys doing and what do we do we wait

228

00:08:41,750 --> 00:08:40,020

like a hundred thousand years or a

229

00:08:44,050 --> 00:08:41,760

million years for the return signal and

230

00:08:47,990 --> 00:08:44,060

by that point we've forgotten that we're

231

00:08:50,150 --> 00:08:48,000

in a conversation at all but in the

232

00:08:51,710 --> 00:08:50,160

theories that I'm describing now with

233

00:08:54,650 --> 00:08:51,720

these universes with these non-trivial

234

00:08:58,370 --> 00:08:54,660

topologies you can send a signal out

235

00:09:01,490 --> 00:08:58,380

into space and the person can get it and

236

00:09:04,970 --> 00:09:01,500

respond and you will receive it in in

237

00:09:07,310 --> 00:09:04,980

virtually no time in as little time as

238

00:09:09,350 --> 00:09:07,320

as one can imagine and so you can have a

239

00:09:10,970 --> 00:09:09,360

real-time conversation

240

00:09:12,769 --> 00:09:10,980

with someone who's in an arbitrary

241

00:09:14,750 --> 00:09:12,779

distance so I think that's pretty

242

00:09:17,210 --> 00:09:14,760

startling and mind-boggling and kind of

243

00:09:20,030 --> 00:09:17,220

wonderful and who knows if any of these

244

00:09:23,329 --> 00:09:20,040

ideas happen to be true it would allow

245

00:09:26,150 --> 00:09:23,339

for conversations that in the more usual

246

00:09:28,370 --> 00:09:26,160

setting would just be impossible but no

247

00:09:30,230 --> 00:09:28,380

it's no amendment to general relativity

248

00:09:32,329 --> 00:09:30,240

it's no change at all to the fundamental

249

00:09:34,130 --> 00:09:32,339

laws that's the kind of fun thing about

250

00:09:36,350 --> 00:09:34,140

this approach you know if you come along

251  
00:09:38,870 --> 00:09:36,360  
and say well let's now bend the laws of

252  
00:09:41,329 --> 00:09:38,880  
physics as we knew it in the past change

253  
00:09:43,310 --> 00:09:41,339  
it in some way sure obviously you're

254  
00:09:45,889 --> 00:09:43,320  
going to get some new effects but then

255  
00:09:47,990 --> 00:09:45,899  
it all depends on the utility of it

256  
00:09:51,530 --> 00:09:48,000  
depends on was that amendment was that

257  
00:09:53,449 --> 00:09:51,540  
changed at all reasonable so we're not

258  
00:09:56,150 --> 00:09:53,459  
changing the laws of physics at all

259  
00:10:00,650 --> 00:09:56,160  
we're just considering

260  
00:10:02,810 --> 00:10:00,660  
shapes of space that are very natural in

261  
00:10:05,449 --> 00:10:02,820  
certain unified theories like string

262  
00:10:07,190 --> 00:10:05,459  
theory you know collusa Klein type

263  
00:10:10,130 --> 00:10:07,200

theories that people study in the past

264

00:10:13,370 --> 00:10:10,140

and just examining conventional physics

265

00:10:15,350 --> 00:10:13,380

in a new setting as opposed to new

266

00:10:17,449 --> 00:10:15,360

physics in either conventional or new

267

00:10:20,030 --> 00:10:17,459

setting is any of this related to

268

00:10:22,310 --> 00:10:20,040

wormholes or is this separate

269

00:10:24,889 --> 00:10:22,320

it is definitely separate

270

00:10:27,829 --> 00:10:24,899

from wormholes in

271

00:10:31,070 --> 00:10:27,839

the conventional way that people think

272

00:10:33,290 --> 00:10:31,080

about wormholes but there is

273

00:10:34,550 --> 00:10:33,300

um a deep Association in the following

274

00:10:38,570 --> 00:10:34,560

sense

275

00:10:41,210 --> 00:10:38,580

if you are looking at a signal that's

276

00:10:42,949 --> 00:10:41,220

traversing say you know a circular

277

00:10:45,650 --> 00:10:42,959

dimension of space

278

00:10:48,230 --> 00:10:45,660

one of the most profitable ways

279

00:10:51,110 --> 00:10:48,240

scientifically of studying that is to

280

00:10:53,810 --> 00:10:51,120

imagine cutting that Circle and opening

281

00:10:55,430 --> 00:10:53,820

it up into a line saying infinite line

282

00:10:58,310 --> 00:10:55,440

and then just having global

283

00:11:00,350 --> 00:10:58,320

identifications point zero identified

284

00:11:03,170 --> 00:11:00,360

with two pi r identified with four Pi

285

00:11:05,090 --> 00:11:03,180

with 6 pi r and so forth and in that way

286

00:11:07,009 --> 00:11:05,100

you effectively have a circle because of

287

00:11:09,110 --> 00:11:07,019

those identifications but you've

288

00:11:12,889 --> 00:11:09,120

unraveled it into a more conventional

289

00:11:16,490 --> 00:11:12,899

shape a line and then when a signal goes

290

00:11:18,470 --> 00:11:16,500

from zero say to two pi r which really

291

00:11:20,750 --> 00:11:18,480

in some sense happening is the signal is

292

00:11:22,190 --> 00:11:20,760

then in essence jumping through a

293

00:11:23,509 --> 00:11:22,200

wormhole and going back to its starting

294

00:11:26,509 --> 00:11:23,519

point

295

00:11:29,509 --> 00:11:26,519

and so you can reframe everything that

296

00:11:32,329 --> 00:11:29,519

I'm talking about using the language of

297

00:11:34,850 --> 00:11:32,339

wormholes but wormholes are not as

298

00:11:36,829 --> 00:11:34,860

essential to the story as it might be in

299

00:11:39,530 --> 00:11:36,839

certain other applications where you

300

00:11:41,449 --> 00:11:39,540

start to worry about things like well is

301  
00:11:43,130 --> 00:11:41,459  
it Wormhole traversable will it stay

302  
00:11:45,650 --> 00:11:43,140  
open long enough for someone to actually

303  
00:11:47,990 --> 00:11:45,660  
go through for a signal to go through in

304  
00:11:49,970 --> 00:11:48,000  
this case a wormhole is really more of a

305  
00:11:53,030 --> 00:11:49,980  
technique a mathematical technique for

306  
00:11:56,030 --> 00:11:53,040  
analyzing the situation as opposed to

307  
00:11:58,430 --> 00:11:56,040  
being fundamental to the whole idea

308  
00:12:00,590 --> 00:11:58,440  
so this year your plans are what to work

309  
00:12:02,569 --> 00:12:00,600  
on this Theory some more or

310  
00:12:03,410 --> 00:12:02,579  
yeah that we're gonna definitely present

311  
00:12:05,329 --> 00:12:03,420  
you know

312  
00:12:07,490 --> 00:12:05,339  
look and what is this called by the way

313  
00:12:10,130 --> 00:12:07,500

sorry is there a name for this

314

00:12:11,509 --> 00:12:10,140

or a paper that people can look up yeah

315

00:12:15,590 --> 00:12:11,519

if you're written a couple of papers on

316

00:12:17,990 --> 00:12:15,600

it the the most recent one has the title

317

00:12:19,550 --> 00:12:18,000

Back to the Future

318

00:12:21,889 --> 00:12:19,560

which um

319

00:12:23,930 --> 00:12:21,899

the editors at physical review D

320

00:12:25,850 --> 00:12:23,940

initially sent the paper back and said

321

00:12:28,790 --> 00:12:25,860

we like the paper but you got to change

322

00:12:30,949 --> 00:12:28,800

the title because it's like we just

323

00:12:32,530 --> 00:12:30,959

don't have titles like that and I have

324

00:12:35,509 --> 00:12:32,540

to say I kind of took a little bit

325

00:12:37,490 --> 00:12:35,519

offenses too strong a word but you know

326

00:12:39,230 --> 00:12:37,500

we wrote back to them and said sure

327

00:12:42,410 --> 00:12:39,240

there's a cultural reference it's kind

328

00:12:44,750 --> 00:12:42,420

of fun but it's not just the cultural

329

00:12:48,530 --> 00:12:44,760

reference for a cultural reference's

330

00:12:50,990 --> 00:12:48,540

sake we truly are talking about a signal

331

00:12:54,230 --> 00:12:51,000

that can travel from us

332

00:12:55,910 --> 00:12:54,240

back to the past and then into the

333

00:12:58,910 --> 00:12:55,920

future because as I said before the

334

00:13:01,730 --> 00:12:58,920

return signal always gets to us in a

335

00:13:04,430 --> 00:13:01,740

non-negative amount of time so it's it's

336

00:13:06,670 --> 00:13:04,440

Back to the Future it's like a perfect

337

00:13:10,370 --> 00:13:06,680

description of what we're talking about

338

00:13:12,949 --> 00:13:10,380

and to their credit the editors at

339

00:13:16,250 --> 00:13:12,959

physical review D finally said yeah okay

340

00:13:19,449 --> 00:13:16,260

you're right it works so the paper was

341

00:13:22,610 --> 00:13:19,459

accepted with that somewhat perhaps

342

00:13:25,930 --> 00:13:22,620

loose sounding title but one that really

343

00:13:28,129 --> 00:13:25,940

does have a descriptive

344

00:13:30,769 --> 00:13:28,139

approach to what we're talking about

345

00:13:32,389 --> 00:13:30,779

that's spot on and so yeah if people

346

00:13:35,650 --> 00:13:32,399

want to see the technical details that

347

00:13:38,449 --> 00:13:35,660

would be a paper to look at

348

00:13:40,970 --> 00:13:38,459

and you have an event coming up at least

349

00:13:42,650 --> 00:13:40,980

here in Toronto on January 26th if I'm

350

00:13:44,150 --> 00:13:42,660

not mistaken so that's about a week from

351  
00:13:45,889 --> 00:13:44,160  
now when this is being published when

352  
00:13:47,210 --> 00:13:45,899  
you're seeing this can you tell myself a

353  
00:13:48,050 --> 00:13:47,220  
little bit about that in the audience as

354  
00:13:52,610 --> 00:13:48,060  
well

355  
00:13:55,370 --> 00:13:52,620  
yeah absolutely so the uh it's a talk at

356  
00:13:57,230 --> 00:13:55,380  
Roy Thompson Hall I've never been there

357  
00:14:00,290 --> 00:13:57,240  
before but at least the pictures look

358  
00:14:03,410 --> 00:14:00,300  
like it's a quite beautiful venue and

359  
00:14:06,949 --> 00:14:03,420  
it's a a journey that I'm going to take

360  
00:14:09,949 --> 00:14:06,959  
the audience on from the beginning of

361  
00:14:12,230 --> 00:14:09,959  
time up to the present and out toward

362  
00:14:15,949 --> 00:14:12,240  
the farthest that science can take us

363  
00:14:18,650 --> 00:14:15,959

toward the end toward eternity

364

00:14:20,930 --> 00:14:18,660

and my point in taking the audience on

365

00:14:23,629 --> 00:14:20,940

this journey will be partly to

366

00:14:26,509 --> 00:14:23,639

illuminate some of the key scientific

367

00:14:29,449 --> 00:14:26,519

ideas that that guide the cosmological

368

00:14:31,610 --> 00:14:29,459

unfolding on the largest of scales and

369

00:14:34,490 --> 00:14:31,620

the largest of time scales

370

00:14:37,190 --> 00:14:34,500

but I also want to give people a sense

371

00:14:41,449 --> 00:14:37,200

of what science says about how we fit in

372

00:14:45,470 --> 00:14:41,459

to this Cosmic order from this broadest

373

00:14:48,290 --> 00:14:45,480

this largest perspective and so we will

374

00:14:51,189 --> 00:14:48,300

be covering the formation of stars and

375

00:14:54,590 --> 00:14:51,199

galaxies a little discussion about how

376

00:14:57,350 --> 00:14:54,600

entropy and life interplay and play off

377

00:14:58,790 --> 00:14:57,360

of one another and then once we get to

378

00:15:00,590 --> 00:14:58,800

the present we'll turn our attention

379

00:15:03,470 --> 00:15:00,600

toward the future and see how it all

380

00:15:05,509 --> 00:15:03,480

comes crashing down when you look at

381

00:15:08,290 --> 00:15:05,519

sufficiently large time scales as

382

00:15:13,030 --> 00:15:08,300

entropy gains the upper hand

383

00:15:18,430 --> 00:15:13,040

and I'll conclude the evening with some

384

00:15:20,810 --> 00:15:18,440

remarks on how one might interpret this

385

00:15:23,689 --> 00:15:20,820

large-scale understanding of the cosmos

386

00:15:26,509 --> 00:15:23,699

in more human terms and how it is that

387

00:15:29,629 --> 00:15:26,519

perhaps this perspective Can Shed light

388

00:15:34,069 --> 00:15:29,639

on the age-old questions of of meaning

389

00:15:36,050 --> 00:15:34,079

and purpose which occupy all of us in

390

00:15:38,449 --> 00:15:36,060

one way or another so how does it shed

391

00:15:41,449 --> 00:15:38,459

light on those on meaning and purpose

392

00:15:43,610 --> 00:15:41,459

well objectively

393

00:15:44,870 --> 00:15:43,620

so well you should come to the uh the

394

00:15:47,750 --> 00:15:44,880

evening but I'm more than happy to

395

00:15:50,030 --> 00:15:47,760

discuss it now in in Broad Strokes so

396

00:15:51,590 --> 00:15:50,040

look you said objectively and I would

397

00:15:53,150 --> 00:15:51,600

say I I don't know that objectively

398

00:15:55,250 --> 00:15:53,160

there is an answer I think it is

399

00:15:57,290 --> 00:15:55,260

ultimately the subject of search that

400

00:15:59,990 --> 00:15:57,300

each human being is ultimately on to try

401  
00:16:02,930 --> 00:16:00,000  
to make sense of their life make sense

402  
00:16:05,689 --> 00:16:02,940  
of their existence but what this

403  
00:16:08,449 --> 00:16:05,699  
perspective does for me and I found that

404  
00:16:13,030 --> 00:16:08,459  
it resonates with many people

405  
00:16:16,189 --> 00:16:13,040  
it it shows us how unbelievably

406  
00:16:17,629 --> 00:16:16,199  
astoundingly unlikely our own existence

407  
00:16:22,090 --> 00:16:17,639  
is

408  
00:16:24,889 --> 00:16:22,100  
against the spectrum of possible

409  
00:16:27,110 --> 00:16:24,899  
combinations of base pairs of DNA

410  
00:16:29,569 --> 00:16:27,120  
against the spectrum of possible

411  
00:16:32,389 --> 00:16:29,579  
molecular configurations against the

412  
00:16:34,850 --> 00:16:32,399  
spectrum of possible outcome of quantum

413  
00:16:37,249 --> 00:16:34,860

processes right that that stretch from

414

00:16:38,629 --> 00:16:37,259

the beginning until today that each of

415

00:16:41,389 --> 00:16:38,639

them could have turned out one way

416

00:16:43,009 --> 00:16:41,399

versus the way they did yielding

417

00:16:47,269 --> 00:16:43,019

Universe in which we wouldn't be here

418

00:16:51,410 --> 00:16:47,279

against these astounding odds were here

419

00:16:54,110 --> 00:16:51,420

and to me that's the beginning of the

420

00:16:57,889 --> 00:16:54,120

most fruitful compelling and satisfying

421

00:17:01,009 --> 00:16:57,899

approach to finding some sense of

422

00:17:04,309 --> 00:17:01,019

purpose or meaning because rather than

423

00:17:07,010 --> 00:17:04,319

looking out to the universe which we see

424

00:17:10,309 --> 00:17:07,020

in many philosophies and frankly many

425

00:17:13,069 --> 00:17:10,319

religions looking out to the cosmos to

426  
00:17:14,809 --> 00:17:13,079  
bestow upon us some Ultimate answers

427  
00:17:15,829 --> 00:17:14,819  
some ultimate meaning some ultimate

428  
00:17:18,169 --> 00:17:15,839  
purpose

429  
00:17:20,929 --> 00:17:18,179  
this understanding of the cosmological

430  
00:17:22,929 --> 00:17:20,939  
timeline and the astounding unlikeliness

431  
00:17:27,049 --> 00:17:22,939  
of our own existence

432  
00:17:29,890 --> 00:17:27,059  
turns the spotlight inward it turns the

433  
00:17:32,270 --> 00:17:29,900  
spotlight to a recognition of how

434  
00:17:35,350 --> 00:17:32,280  
astounding it is not only that we exist

435  
00:17:38,630 --> 00:17:35,360  
but we have the powers that our

436  
00:17:40,010 --> 00:17:38,640  
particulate Arrangement endows us with

437  
00:17:41,210 --> 00:17:40,020  
look what we can do we can have this

438  
00:17:44,029 --> 00:17:41,220

conversation

439

00:17:45,830 --> 00:17:44,039

we can figure out the past there aren't

440

00:17:48,650 --> 00:17:45,840

many other life forms that we're aware

441

00:17:51,470 --> 00:17:48,660

of that can do that we can imagine the

442

00:17:54,710 --> 00:17:51,480

future again not many life forms have

443

00:17:56,870 --> 00:17:54,720

been able to work out a testable science

444

00:17:58,450 --> 00:17:56,880

that can give us insight into things

445

00:18:01,010 --> 00:17:58,460

that haven't yet happened to the Future

446

00:18:03,830 --> 00:18:01,020

and the power of the human mind to do

447

00:18:06,770 --> 00:18:03,840

all that and and to create Beauty in the

448

00:18:09,770 --> 00:18:06,780

world and to illuminate mystery in the

449

00:18:11,690 --> 00:18:09,780

world and and to experience The Wonder

450

00:18:15,590 --> 00:18:11,700

of it all

451  
00:18:20,210 --> 00:18:15,600  
to me that is where a deep kind of

452  
00:18:23,270 --> 00:18:20,220  
gratitude emerges and that gratitude is

453  
00:18:26,330 --> 00:18:23,280  
for the mere existence of human beings

454  
00:18:28,250 --> 00:18:26,340  
and it's not dependent upon whether

455  
00:18:31,669 --> 00:18:28,260  
we're going to have some lasting Legacy

456  
00:18:33,289 --> 00:18:31,679  
it rather is just focused on the fact

457  
00:18:35,510 --> 00:18:33,299  
that we're here at all and that we can

458  
00:18:39,830 --> 00:18:35,520  
do the things that we can do and with

459  
00:18:42,350 --> 00:18:39,840  
that comes in appreciation which for me

460  
00:18:44,510 --> 00:18:42,360  
is deeply compelling and satisfying

461  
00:18:47,510 --> 00:18:44,520  
regardless of my understanding of how

462  
00:18:50,810 --> 00:18:47,520  
evanescent it all is

463  
00:18:56,510 --> 00:18:53,570

I do and I think that

464

00:19:00,650 --> 00:18:56,520

the fear of death is

465

00:19:03,470 --> 00:19:00,660

one of the major driving forces of of

466

00:19:06,529 --> 00:19:03,480

the human species both as a species as a

467

00:19:10,250 --> 00:19:06,539

whole and as individuals and this is not

468

00:19:12,650 --> 00:19:10,260

you know an original thought when I was

469

00:19:15,350 --> 00:19:12,660

I guess way back in college I

470

00:19:18,590 --> 00:19:15,360

encountered a book called the denial of

471

00:19:22,370 --> 00:19:18,600

death by Ernest Becker who himself was

472

00:19:26,169 --> 00:19:22,380

channeling and developing ideas of other

473

00:19:29,810 --> 00:19:26,179

Rock one of the great early

474

00:19:32,950 --> 00:19:29,820

psychologists who was in the Freudian

475

00:19:37,190 --> 00:19:32,960

school to begin with and then really

476

00:19:41,930 --> 00:19:37,200

plowed his own path and this idea that

477

00:19:44,270 --> 00:19:41,940

we humans are a rare life form that not

478

00:19:47,510 --> 00:19:44,280

only can we imagine the future as I

479

00:19:49,310 --> 00:19:47,520

mentioned before but we recognize that

480

00:19:52,909 --> 00:19:49,320

if we looked far enough into that future

481

00:19:57,549 --> 00:19:52,919

we're not there we recognize that we're

482

00:20:01,669 --> 00:19:57,559

mortal and that recognition of mortality

483

00:20:05,470 --> 00:20:01,679

fights against the urge for

484

00:20:11,510 --> 00:20:05,480

influence Legacy a

485

00:20:14,810 --> 00:20:11,520

lasting part of us we urge that we don't

486

00:20:18,350 --> 00:20:14,820

get washed away by the by the Relentless

487

00:20:21,049 --> 00:20:18,360

Winds of time and yet that

488

00:20:23,810 --> 00:20:21,059

is not the way the universe is

489

00:20:25,610 --> 00:20:23,820

constructed and so the fear of

490

00:20:27,350 --> 00:20:25,620

everything we love everything we care

491

00:20:31,549 --> 00:20:27,360

about everything we develop everything

492

00:20:33,770 --> 00:20:31,559

that we worry about and spend energy and

493

00:20:37,430 --> 00:20:33,780

time on that it all goes away

494

00:20:40,250 --> 00:20:37,440

to me is one of the deep insights and

495

00:20:41,990 --> 00:20:40,260

the Deep motivators for how we humans

496

00:20:44,510 --> 00:20:42,000

behave

497

00:20:46,850 --> 00:20:44,520

have you ever inhabited a dark state of

498

00:20:49,669 --> 00:20:46,860

mind for a prolonged period of time so

499

00:20:52,190 --> 00:20:49,679

for instance contemplation of

500

00:20:54,470 --> 00:20:52,200

suicide or ideation on the supposed

501  
00:20:55,610 --> 00:20:54,480  
objective meaninglessness of the world

502  
00:20:57,470 --> 00:20:55,620  
and that you have to find it

503  
00:21:00,350 --> 00:20:57,480  
subjectively but maybe it was Fringe to

504  
00:21:04,789 --> 00:21:00,360  
your sanity yeah well I would say that

505  
00:21:07,610 --> 00:21:04,799  
I've never gotten thankfully to the

506  
00:21:11,510 --> 00:21:07,620  
place of sort of suicidal ideation and

507  
00:21:13,789 --> 00:21:11,520  
again you know anybody who has uh you

508  
00:21:17,630 --> 00:21:13,799  
know seek out help and guidance because

509  
00:21:19,970 --> 00:21:17,640  
there there are ways to get to a better

510  
00:21:23,690 --> 00:21:19,980  
place but I have certainly

511  
00:21:25,909 --> 00:21:23,700  
inhabited Dark Places and some of it has

512  
00:21:28,490 --> 00:21:25,919  
come from the things that we're talking

513  
00:21:31,070 --> 00:21:28,500

about when you think about the cosmos

514

00:21:34,430 --> 00:21:31,080

and the laws of physics and our little

515

00:21:38,169 --> 00:21:34,440

tiny planet Earth just floating in this

516

00:21:40,970 --> 00:21:38,179

vast perhaps infinitely vast Darkness

517

00:21:43,010 --> 00:21:40,980

there is a way that if you take that in

518

00:21:44,570 --> 00:21:43,020

emotionally as opposed to just purely

519

00:21:47,330 --> 00:21:44,580

intellectually

520

00:21:52,070 --> 00:21:47,340

it can take you to a place of of

521

00:21:55,250 --> 00:21:52,080

darkness and fear foreboding and I have

522

00:21:57,289 --> 00:21:55,260

explored that on occasion so how have

523

00:21:59,330 --> 00:21:57,299

you gotten out of that well one solution

524

00:22:02,390 --> 00:21:59,340

may be to separate the intellect and the

525

00:22:04,190 --> 00:22:02,400

motion and just explore the vastness of

526

00:22:05,870 --> 00:22:04,200

the cosmos intellectually rather than

527

00:22:07,850 --> 00:22:05,880

emotionally because it may it may feel

528

00:22:11,810 --> 00:22:07,860

you may feel daunted

529

00:22:14,330 --> 00:22:11,820

or you could say hey look maybe the fact

530

00:22:16,549 --> 00:22:14,340

that we're finite and temporarily bound

531

00:22:18,110 --> 00:22:16,559

isn't what matters most because it's

532

00:22:19,610 --> 00:22:18,120

like going to a suffering child and

533

00:22:21,649 --> 00:22:19,620

saying oh that doesn't matter that the

534

00:22:25,010 --> 00:22:21,659

child's being tortured by some serial

535

00:22:27,289 --> 00:22:25,020

killer it's finite hahaha like that's

536

00:22:29,630 --> 00:22:27,299

not that's that doesn't help anyone so

537

00:22:32,149 --> 00:22:29,640

sure the fact that we're small spatially

538

00:22:34,250 --> 00:22:32,159

or a small temporarily yeah and and and

539

00:22:35,870 --> 00:22:34,260

you know the answer to your question

540

00:22:37,970 --> 00:22:35,880

there have been I mean without going

541

00:22:41,090 --> 00:22:37,980

into great detail there certainly have

542

00:22:42,710 --> 00:22:41,100

been periods of my life luckily they've

543

00:22:45,590 --> 00:22:42,720

not been

544

00:22:48,289 --> 00:22:45,600

incredibly long but there have certainly

545

00:22:51,409 --> 00:22:48,299

been periods when I wasn't exactly sure

546

00:22:52,850 --> 00:22:51,419

how to find my way out of the dark

547

00:22:59,270 --> 00:22:52,860

space

548

00:23:01,909 --> 00:22:59,280

and ultimately what really helped me was

549

00:23:06,649 --> 00:23:01,919

along the lines of what you're saying to

550

00:23:11,090 --> 00:23:06,659

blend the the human emotion which can be

551  
00:23:14,570 --> 00:23:11,100  
Terror of mortality that can be a sense

552  
00:23:18,230 --> 00:23:14,580  
of insignificance against the cosmic

553  
00:23:20,570 --> 00:23:18,240  
order but to blend that with a

554  
00:23:22,750 --> 00:23:20,580  
recognition that sure we may be

555  
00:23:26,690 --> 00:23:22,760  
insignificant but

556  
00:23:29,149 --> 00:23:26,700  
we as a species may have figured out

557  
00:23:31,909 --> 00:23:29,159  
How the Universe began and how it

558  
00:23:34,669 --> 00:23:31,919  
evolved and we may have figured out what

559  
00:23:37,730 --> 00:23:34,679  
laws of physics are in operation both

560  
00:23:40,130 --> 00:23:37,740  
here but also throughout the entirety of

561  
00:23:42,590 --> 00:23:40,140  
an infinite Cosmos we may have figured

562  
00:23:45,289 --> 00:23:42,600  
out laws that are relevant not just

563  
00:23:46,390 --> 00:23:45,299

today and yesterday but perhaps relevant

564

00:23:49,490 --> 00:23:46,400

all the way

565

00:23:52,430 --> 00:23:49,500

13.8 billion years ago and may continue

566

00:23:53,930 --> 00:23:52,440

to be relevant a hundred billion or a

567

00:23:57,409 --> 00:23:53,940

trillion or who knows how many years

568

00:24:00,830 --> 00:23:57,419

into the future and so if you allow

569

00:24:04,070 --> 00:24:00,840

yourself to feel part of that human

570

00:24:06,490 --> 00:24:04,080

journey and that human achievement I

571

00:24:09,169 --> 00:24:06,500

have found that that can

572

00:24:13,010 --> 00:24:09,179

assuage some of the darkness and make

573

00:24:15,649 --> 00:24:13,020

one feel a connection to a larger Cosmos

574

00:24:19,549 --> 00:24:15,659

and that connection to that large or

575

00:24:22,490 --> 00:24:19,559

Cosmos for me has certainly helped to

576

00:24:24,289 --> 00:24:22,500

pull me from a place of smallness and

577

00:24:26,890 --> 00:24:24,299

and feeling of darkness and

578

00:24:30,830 --> 00:24:26,900

insignificance to at least a connection

579

00:24:32,210 --> 00:24:30,840

that ameliorated those qualities and

580

00:24:34,070 --> 00:24:32,220

those feelings

581

00:24:35,510 --> 00:24:34,080

approximately how old were you when you

582

00:24:38,149 --> 00:24:35,520

were going through this period if you

583

00:24:41,510 --> 00:24:38,159

don't mind me asking I you know it's a

584

00:24:45,409 --> 00:24:41,520

good question you know certainly there

585

00:24:47,330 --> 00:24:45,419

was a a time in my 40s that I can that I

586

00:24:50,149 --> 00:24:47,340

can point to

587

00:24:52,789 --> 00:24:50,159

um there were episodes earlier like

588

00:24:55,310 --> 00:24:52,799

right after college I went through a

589

00:24:59,570 --> 00:24:55,320

kind of a rough spell there but it was

590

00:25:03,010 --> 00:24:59,580

thankfully relatively short-lived

591

00:25:05,990 --> 00:25:03,020

um and so it's been it's been periodic

592

00:25:09,470 --> 00:25:06,000

but it hasn't been debilitating

593

00:25:11,570 --> 00:25:09,480

and when I look at the things that I've

594

00:25:14,210 --> 00:25:11,580

done that I value most

595

00:25:17,390 --> 00:25:14,220

I can't help but think that those

596

00:25:20,270 --> 00:25:17,400

periods were pretty vital toward being

597

00:25:22,909 --> 00:25:20,280

able to do the things that I did so look

598

00:25:26,750 --> 00:25:22,919

it's a life is a is a whole package

599

00:25:28,610 --> 00:25:26,760

right and and that whole package for

600

00:25:29,990 --> 00:25:28,620

some will involve periods that are less

601  
00:25:32,630 --> 00:25:30,000  
comfortable than others from this

602  
00:25:34,730 --> 00:25:32,640  
perspective was it mainly the paltryness

603  
00:25:37,310 --> 00:25:34,740  
of existence or did you feel worthless

604  
00:25:39,110 --> 00:25:37,320  
as a result or for some other reason an

605  
00:25:40,789 --> 00:25:39,120  
apologies if it's getting personal but

606  
00:25:42,890 --> 00:25:40,799  
it's just that many people including

607  
00:25:45,350 --> 00:25:42,900  
myself like it's super helpful to see

608  
00:25:47,390 --> 00:25:45,360  
people that you look up to as a hero

609  
00:25:50,690 --> 00:25:47,400  
intellectually especially going through

610  
00:25:53,210 --> 00:25:50,700  
what is common and emotional

611  
00:25:56,390 --> 00:25:53,220  
yeah you know it definitely wasn't

612  
00:26:00,710 --> 00:25:56,400  
feelings of worthlessness

613  
00:26:03,289 --> 00:26:00,720

in a sense it wasn't quite that personal

614

00:26:05,510 --> 00:26:03,299

I mean obviously it was a a very

615

00:26:09,769 --> 00:26:05,520

personal sensation and and a personal

616

00:26:12,710 --> 00:26:09,779

challenge to um to overcome certain

617

00:26:15,649 --> 00:26:12,720

things that made it difficult to feel to

618

00:26:18,890 --> 00:26:15,659

feel happy and to feel alive

619

00:26:21,590 --> 00:26:18,900

but it was never a sense of I Brian

620

00:26:23,029 --> 00:26:21,600

Green I'm worthless it was more a sense

621

00:26:24,769 --> 00:26:23,039

of

622

00:26:28,310 --> 00:26:24,779

oh my God

623

00:26:31,909 --> 00:26:28,320

like how does one live with the

624

00:26:35,810 --> 00:26:31,919

understanding of

625

00:26:37,730 --> 00:26:35,820

the fact that apparently we are just the

626  
00:26:42,289 --> 00:26:37,740  
random output

627  
00:26:45,470 --> 00:26:42,299  
of random conditions being Guided by a

628  
00:26:47,090 --> 00:26:45,480  
particular set of rigid mathematical

629  
00:26:49,669 --> 00:26:47,100  
rules

630  
00:26:52,430 --> 00:26:49,679  
and if you think about that cognitively

631  
00:26:55,190 --> 00:26:52,440  
it's kind of interesting and quirky but

632  
00:26:58,070 --> 00:26:55,200  
if you think about it emotionally

633  
00:26:59,090 --> 00:26:58,080  
it can really take you to a different

634  
00:27:03,350 --> 00:26:59,100  
place

635  
00:27:07,250 --> 00:27:03,360  
and and for me as I was saying before I

636  
00:27:10,190 --> 00:27:07,260  
think the key to going forward was to

637  
00:27:14,230 --> 00:27:10,200  
not be terrorized by those realizations

638  
00:27:19,430 --> 00:27:14,240

but find a way within those realizations

639

00:27:22,250 --> 00:27:19,440

to feel a deep gratification and that's

640

00:27:24,470 --> 00:27:22,260

a place that I've been able to get to

641

00:27:27,110 --> 00:27:24,480

but it's relatively recent getting to

642

00:27:29,510 --> 00:27:27,120

that place it's not as though as the 19

643

00:27:33,230 --> 00:27:29,520

year old or a 20 year old this was

644

00:27:35,510 --> 00:27:33,240

something that was right there and so it

645

00:27:39,769 --> 00:27:35,520

really is tying together the emotional

646

00:27:42,049 --> 00:27:39,779

and the cognitive into a narrative a

647

00:27:45,529 --> 00:27:42,059

story that at least for me is an

648

00:27:50,810 --> 00:27:45,539

individual leaves me feeling deeply

649

00:27:53,870 --> 00:27:50,820

connected to a wider reality and no

650

00:27:57,130 --> 00:27:53,880

longer feeling that sense of foreboding

651  
00:27:59,750 --> 00:27:57,140  
at the apparent

652  
00:28:01,669 --> 00:27:59,760  
randomness of it all

653  
00:28:03,669 --> 00:28:01,679  
is it possible to find meaning and

654  
00:28:05,630 --> 00:28:03,679  
disconnectedness I often hear that

655  
00:28:08,390 --> 00:28:05,640  
connectedness is associated with meaning

656  
00:28:10,130 --> 00:28:08,400  
but is it possible do you see a way that

657  
00:28:12,289 --> 00:28:10,140  
you could be too connected and you feel

658  
00:28:13,730 --> 00:28:12,299  
like okay let me just back off a bit

659  
00:28:16,190 --> 00:28:13,740  
well it's a funny thing that you frame

660  
00:28:18,230 --> 00:28:16,200  
it that way because anybody who knows me

661  
00:28:22,970 --> 00:28:18,240  
who personally would not consider me

662  
00:28:26,630 --> 00:28:22,980  
connected in the usual sense I don't

663  
00:28:28,010 --> 00:28:26,640

spend an enormous amount of time with uh

664

00:28:31,549 --> 00:28:28,020

human beings

665

00:28:35,269 --> 00:28:31,559

outside of my most immediate family you

666

00:28:38,090 --> 00:28:35,279

know my my kids and wife like to joke of

667

00:28:41,210 --> 00:28:38,100

the uh you know the lack of human

668

00:28:44,330 --> 00:28:41,220

contact that I have Beyond a fairly

669

00:28:47,750 --> 00:28:44,340

small group so I'm not talking about

670

00:28:50,390 --> 00:28:47,760

Connection in that sense although for

671

00:28:54,289 --> 00:28:50,400

some people that connection is utterly

672

00:28:57,350 --> 00:28:54,299

vital and utterly Central to their being

673

00:29:01,190 --> 00:28:57,360

I'm talking more of a kind of cosmic

674

00:29:04,190 --> 00:29:01,200

connection a feeling of being integrated

675

00:29:06,710 --> 00:29:04,200

into a wider reality because we're made

676  
00:29:09,529 --> 00:29:06,720  
of the very same stuff as everything

677  
00:29:13,370 --> 00:29:09,539  
else in reality we're Guided by the

678  
00:29:16,549 --> 00:29:13,380  
various same laws as everything else in

679  
00:29:18,710 --> 00:29:16,559  
reality we emerged by processes that

680  
00:29:22,430 --> 00:29:18,720  
stretch from the beginning until today

681  
00:29:24,409 --> 00:29:22,440  
as every other structure in the cosmos

682  
00:29:26,930 --> 00:29:24,419  
has as well

683  
00:29:30,110 --> 00:29:26,940  
and so if you take that in fully enough

684  
00:29:32,630 --> 00:29:30,120  
and in the right light it makes you feel

685  
00:29:35,630 --> 00:29:32,640  
part of the fabric of reality

686  
00:29:38,570 --> 00:29:35,640  
and I think that's the connection that

687  
00:29:40,549 --> 00:29:38,580  
to me is the one that has proven to be

688  
00:29:42,470 --> 00:29:40,559

the most important

689

00:29:45,230 --> 00:29:42,480

have psychedelics informed either your

690

00:29:47,570 --> 00:29:45,240

physics or your metaphysics

691

00:29:49,669 --> 00:29:47,580

I can't really say in fact it's not

692

00:29:52,250 --> 00:29:49,679

completely clear to me whether or not

693

00:29:55,250 --> 00:29:52,260

I've actually ever had a psychedelic

694

00:29:57,289 --> 00:29:55,260

experience no doubt you're referring to

695

00:30:00,590 --> 00:29:57,299

the fact that on in some more recent

696

00:30:04,909 --> 00:30:00,600

interviews I've opened up about certain

697

00:30:08,389 --> 00:30:04,919

experiences uh that um at the time were

698

00:30:11,210 --> 00:30:08,399

absolutely terrifying and in

699

00:30:15,350 --> 00:30:11,220

conversation with people who know far

700

00:30:17,810 --> 00:30:15,360

more about this Arena than I do

701  
00:30:19,430 --> 00:30:17,820  
um their view is you know anything that

702  
00:30:22,130 --> 00:30:19,440  
takes your mind to a different place

703  
00:30:26,389 --> 00:30:22,140  
that ultimately you learn something from

704  
00:30:28,010 --> 00:30:26,399  
fits within the genre of exploration of

705  
00:30:30,409 --> 00:30:28,020  
Altered States Of Consciousness so

706  
00:30:32,510 --> 00:30:30,419  
framing it in that way

707  
00:30:34,909 --> 00:30:32,520  
um yeah I would say that

708  
00:30:39,289 --> 00:30:34,919  
um I have not had many such experiences

709  
00:30:42,409 --> 00:30:39,299  
but the the few that I have had

710  
00:30:47,750 --> 00:30:42,419  
um I guess gave me the deepest sense of

711  
00:30:50,090 --> 00:30:47,760  
how fragile ordinary cognition and

712  
00:30:52,789 --> 00:30:50,100  
ordinary experiences you introduce a few

713  
00:30:56,889 --> 00:30:52,799

little molecules into the mind

714

00:30:59,930 --> 00:30:56,899

and these molecules radically change

715

00:31:02,750 --> 00:30:59,940

your experience I mean that's

716

00:31:04,850 --> 00:31:02,760

mind-blowing isn't it I mean you know

717

00:31:06,649 --> 00:31:04,860

cognitively we all know that what's

718

00:31:09,049 --> 00:31:06,659

happening inside of our head is just the

719

00:31:12,049 --> 00:31:09,059

cascading motion of particles going

720

00:31:14,450 --> 00:31:12,059

through our brains neurons firing it's

721

00:31:16,490 --> 00:31:14,460

all describable at the level of

722

00:31:19,250 --> 00:31:16,500

particulate motion inside of our heads

723

00:31:20,870 --> 00:31:19,260

okay good I got that cognitively now let

724

00:31:23,990 --> 00:31:20,880

me just throw in a few more molecules

725

00:31:25,730 --> 00:31:24,000

and all of a sudden the experience

726

00:31:29,269 --> 00:31:25,740

changes radically

727

00:31:31,190 --> 00:31:29,279

and so everything that that we you

728

00:31:34,669 --> 00:31:31,200

usually think of as defining reality

729

00:31:38,230 --> 00:31:34,679

which is our experience in an intuitive

730

00:31:41,990 --> 00:31:38,240

level can be not completely off kilter

731

00:31:45,110 --> 00:31:42,000

through some molecules and that's a

732

00:31:48,409 --> 00:31:45,120

beautiful recognition and it opens you

733

00:31:50,690 --> 00:31:48,419

up to the realization that our

734

00:31:52,010 --> 00:31:50,700

experience is not tapping into the

735

00:31:59,210 --> 00:31:52,020

reality

736

00:32:02,690 --> 00:31:59,220

interpreting it and molding it and

737

00:32:04,310 --> 00:32:02,700

shaping it in a manner that our brains

738

00:32:06,470 --> 00:32:04,320

do because of how they form through

739

00:32:09,649 --> 00:32:06,480

evolution by natural selection across

740

00:32:13,010 --> 00:32:09,659

the eons right our brains are the way

741

00:32:15,710 --> 00:32:13,020

they are because our forebears survive

742

00:32:17,570 --> 00:32:15,720

and they survive because their brains

743

00:32:19,970 --> 00:32:17,580

were in a particular configuration and

744

00:32:22,430 --> 00:32:19,980

allowed them to better navigate the

745

00:32:26,149 --> 00:32:22,440

environment than their competitors

746

00:32:28,909 --> 00:32:26,159

and that brain interprets the world

747

00:32:32,690 --> 00:32:28,919

we can change that interpretation by

748

00:32:33,590 --> 00:32:32,700

introducing new molecules and that is a

749

00:32:37,250 --> 00:32:33,600

deeply

750

00:32:38,930 --> 00:32:37,260

profound and eye-opening experience

751  
00:32:41,149 --> 00:32:38,940  
if you could solve one problem an

752  
00:32:43,909 --> 00:32:41,159  
academic one so not let's take off the

753  
00:32:45,289 --> 00:32:43,919  
table world hunger or peace and so on

754  
00:32:47,149 --> 00:32:45,299  
which one

755  
00:32:48,769 --> 00:32:47,159  
and so this includes the hard problem of

756  
00:32:51,889 --> 00:32:48,779  
Consciousness or philosophical problems

757  
00:32:55,250 --> 00:32:51,899  
as well as physics ones which one do you

758  
00:32:58,370 --> 00:32:55,260  
most want solved by you

759  
00:33:02,570 --> 00:32:58,380  
uh well it's interesting and part of my

760  
00:33:05,690 --> 00:33:02,580  
answer will depend on what the answer is

761  
00:33:08,330 --> 00:33:05,700  
so I think that the solution to the hard

762  
00:33:10,789 --> 00:33:08,340  
problem of Consciousness I suspect it's

763  
00:33:12,950 --> 00:33:10,799

not going to be very interesting

764

00:33:15,070 --> 00:33:12,960

I suspect that the solution to the hard

765

00:33:18,889 --> 00:33:15,080

problem of Consciousness will be

766

00:33:22,130 --> 00:33:18,899

Consciousness just is it's a quality

767

00:33:25,310 --> 00:33:22,140

that emerges when matter takes on a

768

00:33:28,370 --> 00:33:25,320

particular organized form and undergoes

769

00:33:30,590 --> 00:33:28,380

certain very orderly and organized

770

00:33:32,330 --> 00:33:30,600

procedures and phenomena

771

00:33:35,210 --> 00:33:32,340

and if that's the answer and I think

772

00:33:37,250 --> 00:33:35,220

that is likely to be the answer then

773

00:33:38,389 --> 00:33:37,260

count me out in terms of wanting to

774

00:33:39,830 --> 00:33:38,399

solve it I think that may be the

775

00:33:42,710 --> 00:33:39,840

solution if it's more interesting than

776

00:33:45,350 --> 00:33:42,720

that if there's some Consciousness feel

777

00:33:48,049 --> 00:33:45,360

that you know various religions talk

778

00:33:50,630 --> 00:33:48,059

about or or something that we can't even

779

00:33:53,630 --> 00:33:50,640

imagine and that's the root of

780

00:33:55,549 --> 00:33:53,640

Consciousness yes then I'd love I'd love

781

00:33:57,470 --> 00:33:55,559

to be part of the journey to solve it

782

00:34:00,409 --> 00:33:57,480

that way but assuming that it's the more

783

00:34:02,930 --> 00:34:00,419

boring but nevertheless you know

784

00:34:04,789 --> 00:34:02,940

profoundly important Solution on what

785

00:34:07,490 --> 00:34:04,799

the hard problem is then the other

786

00:34:11,030 --> 00:34:07,500

questions that I would really love to be

787

00:34:13,129 --> 00:34:11,040

part of finding the solution of is

788

00:34:16,190 --> 00:34:13,139

what is time

789

00:34:18,770 --> 00:34:16,200

is it just a secondary feature of the

790

00:34:21,050 --> 00:34:18,780

world that we human beings find useful

791

00:34:24,169 --> 00:34:21,060

in order to organize our perceptions of

792

00:34:27,230 --> 00:34:24,179

the world or is time more fundamentally

793

00:34:29,690 --> 00:34:27,240

woven into the fabric of reality you

794

00:34:31,810 --> 00:34:29,700

know is there a realm of reality in

795

00:34:35,570 --> 00:34:31,820

which there's no conception of time

796

00:34:38,869 --> 00:34:35,580

because the conditions simply have not

797

00:34:42,050 --> 00:34:38,879

gelled to the point where the conception

798

00:34:44,570 --> 00:34:42,060

of time can even emerge or is there

799

00:34:46,849 --> 00:34:44,580

always a notion of time because it's

800

00:34:49,369 --> 00:34:46,859

just fundamentally part of how reality

801  
00:34:53,270 --> 00:34:49,379  
is constructed I'd say that would be the

802  
00:34:56,450 --> 00:34:53,280  
the one big one and then a lot allied

803  
00:34:58,910 --> 00:34:56,460  
with that you know look I'd love to know

804  
00:35:02,089 --> 00:34:58,920  
what the unified theory is Right I'd

805  
00:35:04,510 --> 00:35:02,099  
love to know what

806  
00:35:07,070 --> 00:35:04,520  
a thousand years from now

807  
00:35:09,650 --> 00:35:07,080  
kindergarteners are going to learn in

808  
00:35:12,230 --> 00:35:09,660  
their course on unified field theory if

809  
00:35:15,230 --> 00:35:12,240  
that's the answer you know what is it

810  
00:35:17,930 --> 00:35:15,240  
and where does it come from

811  
00:35:20,089 --> 00:35:17,940  
we can have a final Theory whatever it

812  
00:35:21,290 --> 00:35:20,099  
is general relativity plus Quantum and

813  
00:35:23,329 --> 00:35:21,300

can't what or maybe it's radically

814

00:35:24,890 --> 00:35:23,339

different but whatever that ultimate

815

00:35:27,230 --> 00:35:24,900

theory is

816

00:35:31,370 --> 00:35:27,240

where did it come from

817

00:35:33,890 --> 00:35:31,380

did someone in some super simulation

818

00:35:36,910 --> 00:35:33,900

dream it up and we were just living out

819

00:35:39,950 --> 00:35:36,920

or where in the world do these

820

00:35:42,829 --> 00:35:39,960

fundamental laws and regularities and

821

00:35:45,290 --> 00:35:42,839

patterns come from in essence really why

822

00:35:47,089 --> 00:35:45,300

is there something rather than nothing I

823

00:35:49,550 --> 00:35:47,099

mean it can't really get deeper than

824

00:35:52,609 --> 00:35:49,560

that and by nothing I don't mean you

825

00:35:54,650 --> 00:35:52,619

know empty space I don't mean nothing in

826

00:35:58,310 --> 00:35:54,660

the sense of a void

827

00:36:01,370 --> 00:35:58,320

I mean truly nothing no space no time no

828

00:36:04,310 --> 00:36:01,380

quantum mechanics no mathematics no

829

00:36:06,890 --> 00:36:04,320

platonic realm like why isn't there

830

00:36:11,450 --> 00:36:06,900

nothing it seems that there could be

831

00:36:13,010 --> 00:36:11,460

nothing so how did it transpire that

832

00:36:15,470 --> 00:36:13,020

there is a something

833

00:36:17,930 --> 00:36:15,480

that's the big one

834

00:36:21,530 --> 00:36:17,940

do you think that a true toe or a good

835

00:36:23,210 --> 00:36:21,540

toe is one that explains itself

836

00:36:26,270 --> 00:36:23,220

well

837

00:36:27,890 --> 00:36:26,280

whenever you talk about a theory of

838

00:36:29,870 --> 00:36:27,900

everything and let me I will frame it

839

00:36:31,910 --> 00:36:29,880

that way I never use the word toe myself

840

00:36:33,650 --> 00:36:31,920

but you know whenever you talk about a

841

00:36:36,950 --> 00:36:33,660

Theory of Everything

842

00:36:39,470 --> 00:36:36,960

you have to say to yourself what is

843

00:36:42,410 --> 00:36:39,480

embraced by everything

844

00:36:44,329 --> 00:36:42,420

usually when we physicists throw it away

845

00:36:45,829 --> 00:36:44,339

throw around not throw away when we

846

00:36:48,530 --> 00:36:45,839

throw around the term Theory of

847

00:36:51,349 --> 00:36:48,540

Everything we usually mean it in a very

848

00:36:53,450 --> 00:36:51,359

limited everything we usually mean you

849

00:36:56,210 --> 00:36:53,460

know the particles and the laws you know

850

00:36:58,849 --> 00:36:56,220

the ingredients and the rules that's

851

00:37:01,730 --> 00:36:58,859

what we mean by everything but given

852

00:37:05,630 --> 00:37:01,740

that one can say but why are there any

853

00:37:08,089 --> 00:37:05,640

particles why are there any rules and so

854

00:37:10,069 --> 00:37:08,099

yeah your way of framing it that if that

855

00:37:13,430 --> 00:37:10,079

Theory of Everything could somehow

856

00:37:16,130 --> 00:37:13,440

establish its own inevitability

857

00:37:19,370 --> 00:37:16,140

if that Theory of Everything somehow has

858

00:37:21,530 --> 00:37:19,380

built within it that the lack of

859

00:37:24,890 --> 00:37:21,540

existence of that theory of everything

860

00:37:27,290 --> 00:37:24,900

would somehow be itself a logical

861

00:37:29,810 --> 00:37:27,300

inconsistency

862

00:37:32,089 --> 00:37:29,820

so that reality could not have this

863

00:37:36,170 --> 00:37:32,099

Theory of Everything because reality is

864

00:37:39,670 --> 00:37:36,180

we believe in some sense consistent that

865

00:37:42,890 --> 00:37:39,680

would that would be deeply compelling

866

00:37:44,329 --> 00:37:42,900

Dyson conjectured that the girdle

867

00:37:46,310 --> 00:37:44,339

incompleteness theorem or one of them

868

00:37:48,170 --> 00:37:46,320

applied to physics and so we may never

869

00:37:49,790 --> 00:37:48,180

know at all I don't recall his argument

870

00:37:51,950 --> 00:37:49,800

but I'm sure you've heard an argument

871

00:37:53,210 --> 00:37:51,960

akin to this can you spell it out for

872

00:37:56,690 --> 00:37:53,220

the audience and then where do you stand

873

00:37:58,190 --> 00:37:56,700

on it you know I have to say I have

874

00:38:01,609 --> 00:37:58,200

struggled myself

875

00:38:05,630 --> 00:38:01,619

for a long time

876

00:38:08,930 --> 00:38:05,640

to really know or at least have a feel

877

00:38:12,109 --> 00:38:08,940

for the relevance of girdle's ideas

878

00:38:13,790 --> 00:38:12,119

when it comes to the laws of physics

879

00:38:16,609 --> 00:38:13,800

and um

880

00:38:19,310 --> 00:38:16,619

there was a time when I tried to

881

00:38:20,829 --> 00:38:19,320

convince myself that

882

00:38:24,470 --> 00:38:20,839

because

883

00:38:28,069 --> 00:38:24,480

girdles theorem itself relies upon

884

00:38:31,130 --> 00:38:28,079

assumptions could we modify the

885

00:38:33,770 --> 00:38:31,140

assumptions in such a way that

886

00:38:36,109 --> 00:38:33,780

the new assumptions could be relevant to

887

00:38:38,030 --> 00:38:36,119

the universe but the conclusion that

888

00:38:39,589 --> 00:38:38,040

girdle came to would no longer be

889

00:38:41,150 --> 00:38:39,599

relevant because the assumptions had

890

00:38:44,770 --> 00:38:41,160

changed

891

00:38:49,130 --> 00:38:44,780

and there are a handful of relatively

892

00:38:50,870 --> 00:38:49,140

straightforward ways to do that

893

00:38:53,150 --> 00:38:50,880

um and frankly I don't even haven't

894

00:38:55,310 --> 00:38:53,160

thought about it in detail in quite some

895

00:38:58,569 --> 00:38:55,320

time but I I remember going through and

896

00:39:02,630 --> 00:38:58,579

saying aha all we have to do is imagine

897

00:39:04,670 --> 00:39:02,640

a universe in which this is not true and

898

00:39:07,250 --> 00:39:04,680

that Universe could be our unit like

899

00:39:10,370 --> 00:39:07,260

para compact logic or I mean there are

900

00:39:13,730 --> 00:39:10,380

ways in which you can go beyond the

901  
00:39:16,490 --> 00:39:13,740  
limited set of assumptions that girdle

902  
00:39:20,150 --> 00:39:16,500  
had and so I

903  
00:39:24,530 --> 00:39:20,160  
more or less have convinced myself that

904  
00:39:28,370 --> 00:39:24,540  
girdle's ideas need not imply that we

905  
00:39:30,770 --> 00:39:28,380  
will somehow fundamentally be in an

906  
00:39:33,290 --> 00:39:30,780  
undecidable situation when it comes to

907  
00:39:37,550 --> 00:39:33,300  
understanding the Deep laws of the

908  
00:39:40,190 --> 00:39:37,560  
universe it doesn't mean that girdle's

909  
00:39:41,630 --> 00:39:40,200  
ideas might not apply they could but

910  
00:39:44,750 --> 00:39:41,640  
they don't have to

911  
00:39:48,230 --> 00:39:44,760  
and without realization I became less

912  
00:39:51,770 --> 00:39:48,240  
interested in in really puzzling because

913  
00:39:54,230 --> 00:39:51,780

now we're in a realm that's so esoteric

914

00:39:56,630 --> 00:39:54,240

and Abstract relative to the kind of

915

00:39:59,390 --> 00:39:56,640

concrete problems like what's the dark

916

00:40:02,810 --> 00:39:59,400

matter and what's the dark energy and

917

00:40:05,450 --> 00:40:02,820

you know is there just a unified theory

918

00:40:08,270 --> 00:40:05,460

of the particles of matter that we have

919

00:40:12,650 --> 00:40:08,280

discovered it just felt

920

00:40:14,750 --> 00:40:12,660

20 steps removed from those kind of deep

921

00:40:15,890 --> 00:40:14,760

but really Hands-On questions that I

922

00:40:19,490 --> 00:40:15,900

haven't spent a whole lot of time

923

00:40:21,950 --> 00:40:19,500

thinking about it since speaking of time

924

00:40:23,990 --> 00:40:21,960

do you believe time to be well maybe you

925

00:40:26,990 --> 00:40:24,000

don't let's not say believe when you

926  
00:40:28,490 --> 00:40:27,000  
were playing with some ideas earlier and

927  
00:40:30,050 --> 00:40:28,500  
you're saying well time may be emergent

928  
00:40:31,430 --> 00:40:30,060  
do you also believe space to be emergent

929  
00:40:32,750 --> 00:40:31,440  
do you believe space time itself is

930  
00:40:37,310 --> 00:40:32,760  
emergent

931  
00:40:39,410 --> 00:40:37,320  
it's hard for me to imagine that space

932  
00:40:41,990 --> 00:40:39,420  
is not emerging too

933  
00:40:44,810 --> 00:40:42,000  
again anybody who's uh spent a little

934  
00:40:46,510 --> 00:40:44,820  
time thinking about the insights from

935  
00:40:49,750 --> 00:40:46,520  
Einstein on

936  
00:40:53,569 --> 00:40:49,760  
recognizes that space and time are so

937  
00:40:56,690 --> 00:40:53,579  
deeply and intricately interwoven into

938  
00:40:59,270 --> 00:40:56,700

the fabric of space-time that sort of

939

00:41:01,910 --> 00:40:59,280

pulling one apart and imagining it has

940

00:41:04,069 --> 00:41:01,920

different properties space and time have

941

00:41:06,710 --> 00:41:04,079

different properties it's not impossible

942

00:41:08,150 --> 00:41:06,720

but it does fly in the face of pretty

943

00:41:09,829 --> 00:41:08,160

much everything we've learned in the

944

00:41:13,010 --> 00:41:09,839

last hundred years so

945

00:41:16,310 --> 00:41:13,020

I certainly do Envision that if there's

946

00:41:18,349 --> 00:41:16,320

a realm of reality in which time does

947

00:41:21,710 --> 00:41:18,359

not apply because as we're saying before

948

00:41:23,810 --> 00:41:21,720

the conditions haven't yet allowed for a

949

00:41:26,650 --> 00:41:23,820

conception of time to emerge the same

950

00:41:30,410 --> 00:41:26,660

would almost certainly be true of space

951  
00:41:32,150 --> 00:41:30,420  
so the real way of saying it is is there

952  
00:41:34,250 --> 00:41:32,160  
a realm of reality in which there's no

953  
00:41:37,790 --> 00:41:34,260  
conception of space-time

954  
00:41:40,010 --> 00:41:37,800  
and and it's hard for me to imagine what

955  
00:41:44,750 --> 00:41:40,020  
that is but that's because I've got this

956  
00:41:49,130 --> 00:41:44,760  
brain that is constrained by what my

957  
00:41:53,270 --> 00:41:49,140  
ancestors did and that brain is one that

958  
00:41:55,910 --> 00:41:53,280  
is so tied to a conception of reality in

959  
00:41:58,250 --> 00:41:55,920  
which space and time are the

960  
00:42:01,190 --> 00:41:58,260  
architecture within which

961  
00:42:04,310 --> 00:42:01,200  
events take place that it's really hard

962  
00:42:08,150 --> 00:42:04,320  
for us to think about a reality in which

963  
00:42:10,370 --> 00:42:08,160

there isn't space time and so I I wish I

964

00:42:13,910 --> 00:42:10,380

could give some really good uh example

965

00:42:17,450 --> 00:42:13,920

or insight into what that would be like

966

00:42:19,670 --> 00:42:17,460

but it would be some kind of reality in

967

00:42:22,310 --> 00:42:19,680

which the language that we use would not

968

00:42:23,990 --> 00:42:22,320

talk about when things are happening and

969

00:42:26,750 --> 00:42:24,000

the language that we use would not talk

970

00:42:29,150 --> 00:42:26,760

about where things are happening the

971

00:42:32,569 --> 00:42:29,160

language would somehow be

972

00:42:34,609 --> 00:42:32,579

beneath that more fundamental than that

973

00:42:37,490 --> 00:42:34,619

and it's not that scientists don't have

974

00:42:40,430 --> 00:42:37,500

some ideas for what this might be like

975

00:42:43,790 --> 00:42:40,440

but I'd say that we do lack

976

00:42:47,750 --> 00:42:43,800

the Deep picture and the Deep story of

977

00:42:51,770 --> 00:42:47,760

how we would really articulate and

978

00:42:53,150 --> 00:42:51,780

navigate a reality absent space-time

979

00:42:56,690 --> 00:42:53,160

have you had a chance to go through

980

00:42:59,809 --> 00:42:56,700

wolfram's Theory his project on physics

981

00:43:00,770 --> 00:42:59,819

I wish I had you know yeah I mean you

982

00:43:06,290 --> 00:43:00,780

know

983

00:43:10,250 --> 00:43:06,300

and he's a friend and um

984

00:43:13,190 --> 00:43:10,260

we talk about things on occasion

985

00:43:14,510 --> 00:43:13,200

and um I wish I had more time to to

986

00:43:16,550 --> 00:43:14,520

spend with him because it's always

987

00:43:17,990 --> 00:43:16,560

illuminating when we do spend some time

988

00:43:20,630 --> 00:43:18,000

together

989

00:43:24,890 --> 00:43:20,640

but I've I've not

990

00:43:28,309 --> 00:43:24,900

I don't feel like I fully grasp the

991

00:43:32,510 --> 00:43:28,319

approach that he's taking

992

00:43:34,130 --> 00:43:32,520

um and why I oh well well I can aptly

993

00:43:37,069 --> 00:43:34,140

throw this on myself

994

00:43:39,290 --> 00:43:37,079

um so it could well be limitations in my

995

00:43:41,390 --> 00:43:39,300

own thinking and limitations the amount

996

00:43:46,430 --> 00:43:41,400

of energy and effort that I've expended

997

00:43:49,670 --> 00:43:46,440

to understand his approach more fully

998

00:43:53,510 --> 00:43:49,680

um but I get stuck on trying to really

999

00:43:54,950 --> 00:43:53,520

understand whether the formalism as he

1000

00:43:57,550 --> 00:43:54,960

envisions it

1001  
00:44:01,130 --> 00:43:57,560  
is it actually fundamentally different

1002  
00:44:04,250 --> 00:44:01,140  
from the more traditional formalism he

1003  
00:44:07,670 --> 00:44:04,260  
would say yes as far as I can tell but

1004  
00:44:10,190 --> 00:44:07,680  
as I have looked at it on occasion it

1005  
00:44:12,650 --> 00:44:10,200  
has struck me that it's not obvious to

1006  
00:44:14,870 --> 00:44:12,660  
me that it is as different as He

1007  
00:44:17,030 --> 00:44:14,880  
suggests and again I could be wrong on

1008  
00:44:21,050 --> 00:44:17,040  
this and it could be that I just haven't

1009  
00:44:24,609 --> 00:44:21,060  
put enough effort or energy into it I'm

1010  
00:44:28,690 --> 00:44:24,619  
glad that he's pursuing his approach

1011  
00:44:31,730 --> 00:44:28,700  
it's not within the confines of the

1012  
00:44:33,349 --> 00:44:31,740  
traditional established environment is

1013  
00:44:35,750 --> 00:44:33,359

not doing it inside of a physics

1014

00:44:38,750 --> 00:44:35,760

department or math department you know

1015

00:44:41,809 --> 00:44:38,760

he has the resources and and and the

1016

00:44:43,849 --> 00:44:41,819

creative energies to make his own

1017

00:44:47,690 --> 00:44:43,859

environment and find his own

1018

00:44:51,170 --> 00:44:47,700

collaborators and and more power to

1019

00:44:53,329 --> 00:44:51,180

anybody who who has the capacity to do

1020

00:44:57,710 --> 00:44:53,339

that whether it's going to Bear the

1021

00:45:00,290 --> 00:44:57,720

fruit that he envisions I don't know but

1022

00:45:02,809 --> 00:45:00,300

I'd say the same thing about what we're

1023

00:45:06,130 --> 00:45:02,819

doing here like we've been beating down

1024

00:45:09,589 --> 00:45:06,140

on string theory you know since you know

1025

00:45:12,829 --> 00:45:09,599

1984 at least you know the the big first

1026  
00:45:14,990 --> 00:45:12,839  
Revolution but since 1968 if you want to

1027  
00:45:18,109 --> 00:45:15,000  
go further back to the first glimmers of

1028  
00:45:20,870 --> 00:45:18,119  
string theory and where are we now 2023

1029  
00:45:23,690 --> 00:45:20,880  
that's a lot of years right so you can

1030  
00:45:27,349 --> 00:45:23,700  
say the same thing you know so so I

1031  
00:45:30,230 --> 00:45:27,359  
don't feel qualified to really judge the

1032  
00:45:33,109 --> 00:45:30,240  
approach but I I just feel that I

1033  
00:45:35,630 --> 00:45:33,119  
haven't fully wrapped my head around

1034  
00:45:38,569 --> 00:45:35,640  
whether or not it's fundamentally

1035  
00:45:41,210 --> 00:45:38,579  
different from what we do

1036  
00:45:43,309 --> 00:45:41,220  
quite a few thoughts firstly what

1037  
00:45:47,150 --> 00:45:43,319  
progress has been made in string theory

1038  
00:45:50,870 --> 00:45:47,160

in the past say two decades

1039

00:45:53,569 --> 00:45:50,880

yeah well that's a a nice big chunk of

1040

00:45:57,589 --> 00:45:53,579

time and I'd say you know the the big

1041

00:46:00,410 --> 00:45:57,599

thing in the last two decades has been

1042

00:46:02,569 --> 00:46:00,420

the the recognition

1043

00:46:06,530 --> 00:46:02,579

that

1044

00:46:08,329 --> 00:46:06,540

there's a connection between gravity and

1045

00:46:10,790 --> 00:46:08,339

quantum mechanics

1046

00:46:15,589 --> 00:46:10,800

that I don't think we sufficiently

1047

00:46:18,349 --> 00:46:15,599

appreciated 20 25 years ago I mean I

1048

00:46:20,510 --> 00:46:18,359

mean take my book just as As One Moment

1049

00:46:23,750 --> 00:46:20,520

In Time a snapshot in the elegant

1050

00:46:27,470 --> 00:46:23,760

Universe I was published in 1999.

1051

00:46:29,030 --> 00:46:27,480

and in that book I I very clearly lay

1052

00:46:31,849 --> 00:46:29,040

out there's this Theory called general

1053

00:46:32,809 --> 00:46:31,859

relativity describing Gravity the big

1054

00:46:35,630 --> 00:46:32,819

stuff

1055

00:46:37,730 --> 00:46:35,640

I lay out how there is this other Theory

1056

00:46:40,490 --> 00:46:37,740

called quantum mechanics describing the

1057

00:46:42,890 --> 00:46:40,500

small stuff and we want to put them all

1058

00:46:44,990 --> 00:46:42,900

together to have a unified theory of the

1059

00:46:47,750 --> 00:46:45,000

big n the small but we're having trouble

1060

00:46:49,550 --> 00:46:47,760

doing that and then I go into the book

1061

00:46:51,890 --> 00:46:49,560

and how String Theory seems to be making

1062

00:46:54,890 --> 00:46:51,900

progress and putting the big and the

1063

00:46:56,569 --> 00:46:54,900

small together if I was writing that

1064

00:46:59,569 --> 00:46:56,579

book today and in some sense I am

1065

00:47:02,329 --> 00:46:59,579

because I'm adding a chapter for the

1066

00:47:04,370 --> 00:47:02,339

25th anniversary of the elegant universe

1067

00:47:06,530 --> 00:47:04,380

and and one of the things that I'm

1068

00:47:09,109 --> 00:47:06,540

emphasizing is

1069

00:47:11,809 --> 00:47:09,119

there's now a lot of evidence

1070

00:47:13,790 --> 00:47:11,819

that gravity and quantum mechanics in

1071

00:47:17,329 --> 00:47:13,800

some sense

1072

00:47:21,170 --> 00:47:17,339

are kind of the same Theory they

1073

00:47:22,970 --> 00:47:21,180

are already in some strange sense

1074

00:47:26,750 --> 00:47:22,980

combined

1075

00:47:31,069 --> 00:47:26,760

and this was completely unexpected based

1076

00:47:34,069 --> 00:47:31,079

on anything that we knew 20 or so 20

1077

00:47:37,069 --> 00:47:34,079

plus years ago so within for instance

1078

00:47:39,170 --> 00:47:37,079

general relativity there are these

1079

00:47:41,690 --> 00:47:39,180

structures you made reference to one of

1080

00:47:44,030 --> 00:47:41,700

them earlier called wormholes which are

1081

00:47:47,270 --> 00:47:44,040

tunnels in the fabric of space going

1082

00:47:49,490 --> 00:47:47,280

from one space-time location to another

1083

00:47:52,130 --> 00:47:49,500

through a kind of shortcut that's

1084

00:47:53,809 --> 00:47:52,140

general relativity and quantum mechanics

1085

00:47:57,170 --> 00:47:53,819

there's this weird thing called quantum

1086

00:47:59,270 --> 00:47:57,180

entanglement where two widely separated

1087

00:48:00,710 --> 00:47:59,280

particles can act as though they're

1088

00:48:02,270 --> 00:48:00,720

right next to each other even though

1089

00:48:03,890 --> 00:48:02,280

they can be on opposite ends of the

1090

00:48:06,829 --> 00:48:03,900

universe

1091

00:48:09,589 --> 00:48:06,839

and really nobody thought there was a

1092

00:48:12,710 --> 00:48:09,599

connection between these two ideas until

1093

00:48:15,290 --> 00:48:12,720

people like Lenny suskind and Juan Mall

1094

00:48:17,690 --> 00:48:15,300

the Cena and and a variety of other

1095

00:48:19,069 --> 00:48:17,700

influential scientists too many to name

1096

00:48:21,790 --> 00:48:19,079

them all

1097

00:48:24,170 --> 00:48:21,800

gave evidence that in some sense

1098

00:48:25,849 --> 00:48:24,180

wormholes and entanglement are kind of

1099

00:48:27,890 --> 00:48:25,859

the same thing they kind of feel the

1100

00:48:30,410 --> 00:48:27,900

same if you think about it

1101

00:48:31,790 --> 00:48:30,420

Wormhole it's connecting one point in

1102

00:48:34,250 --> 00:48:31,800

space time with another through a

1103

00:48:35,690 --> 00:48:34,260

shortcut entanglement is connecting one

1104

00:48:37,550 --> 00:48:35,700

particle in space time with another

1105

00:48:39,050 --> 00:48:37,560

particle in some sense through a

1106

00:48:40,190 --> 00:48:39,060

shortcut because they're acting as

1107

00:48:42,890 --> 00:48:40,200

though they're right next to each other

1108

00:48:45,410 --> 00:48:42,900

and so this is the beginning the tip of

1109

00:48:48,349 --> 00:48:45,420

an iceberg of a deep and and very

1110

00:48:49,970 --> 00:48:48,359

powerful story which is showing that

1111

00:48:52,190 --> 00:48:49,980

structures and general relativity and

1112

00:48:55,010 --> 00:48:52,200

structures and quantum mechanics are

1113

00:48:58,870 --> 00:48:55,020

already deeply connected and deeply

1114

00:49:02,510 --> 00:48:58,880

entwined and so the unification program

1115

00:49:04,130 --> 00:49:02,520

May ultimately not be described in terms

1116

00:49:06,290 --> 00:49:04,140

of putting gravity and quantum mechanics

1117

00:49:09,410 --> 00:49:06,300

together the way I described it and many

1118

00:49:12,650 --> 00:49:09,420

did of course in the earlier days but it

1119

00:49:14,450 --> 00:49:12,660

may be more deeply understanding general

1120

00:49:16,010 --> 00:49:14,460

relativity more deeply understanding

1121

00:49:18,410 --> 00:49:16,020

quantum mechanics and more deeply

1122

00:49:22,069 --> 00:49:18,420

understanding how they are part and

1123

00:49:24,589 --> 00:49:22,079

parcel of the same theoretical structure

1124

00:49:28,069 --> 00:49:24,599

so the recent results by Google of the

1125

00:49:30,770 --> 00:49:28,079

ER equals epr is that over hyped

1126

00:49:33,290 --> 00:49:30,780

is that under hyped I also can you

1127

00:49:35,650 --> 00:49:33,300

explain the results to the audience

1128

00:49:39,470 --> 00:49:35,660

yeah so this is a little bit

1129

00:49:43,609 --> 00:49:39,480

controversial there there have been some

1130

00:49:47,390 --> 00:49:43,619

um feathers ruffled by uh some some

1131

00:49:50,450 --> 00:49:47,400

recent activity and what the idea is

1132

00:49:53,809 --> 00:49:50,460

that if for instance what I said a

1133

00:49:55,270 --> 00:49:53,819

moment ago is true that there's a deep

1134

00:49:57,589 --> 00:49:55,280

connection between

1135

00:50:00,770 --> 00:49:57,599

wormholes and general relativity and

1136

00:50:03,530 --> 00:50:00,780

entanglement in quantum physics then a

1137

00:50:06,530 --> 00:50:03,540

number of influential physicists pointed

1138

00:50:10,730 --> 00:50:06,540

out that by doing certain calculations

1139

00:50:11,650 --> 00:50:10,740

on a quantum computer you would in some

1140

00:50:15,410 --> 00:50:11,660

sense

1141

00:50:18,410 --> 00:50:15,420

be simulating

1142

00:50:20,990 --> 00:50:18,420

a wormhole in general relativity because

1143

00:50:23,510 --> 00:50:21,000

Quantum Computing is all about

1144

00:50:25,010 --> 00:50:23,520

leveraging quantum entanglement between

1145

00:50:29,450 --> 00:50:25,020

qubits

1146

00:50:32,030 --> 00:50:29,460

and so there was a recent paper and it

1147

00:50:35,990 --> 00:50:32,040

was making use of the quantum

1148

00:50:38,870 --> 00:50:36,000

computational capacities at Google

1149

00:50:41,870 --> 00:50:38,880

and I think the I think the

1150

00:50:44,390 --> 00:50:41,880

um the kerfuffle is more about language

1151  
00:50:47,390 --> 00:50:44,400  
than anything else because some of the

1152  
00:50:50,390 --> 00:50:47,400  
folks who were carrying out this work

1153  
00:50:54,950 --> 00:50:50,400  
this is like Maria spirapalu and and Joe

1154  
00:50:57,170 --> 00:50:54,960  
Lickin and Daniel Jefferson so on there

1155  
00:50:59,809 --> 00:50:57,180  
was at least some part of the

1156  
00:51:04,150 --> 00:50:59,819  
description which made it sound like

1157  
00:51:07,250 --> 00:51:04,160  
they claimed to have created a wormhole

1158  
00:51:09,230 --> 00:51:07,260  
in the quantum computer at Google that

1159  
00:51:13,069 --> 00:51:09,240  
actually created a wormhole by carrying

1160  
00:51:15,230 --> 00:51:13,079  
out this Quantum computation and and I

1161  
00:51:18,109 --> 00:51:15,240  
guess some people would be more

1162  
00:51:20,750 --> 00:51:18,119  
comfortable by saying they were modeling

1163  
00:51:23,270 --> 00:51:20,760

a wormhole or kind of simulating a

1164

00:51:26,870 --> 00:51:23,280

wormhole as opposed to actually creating

1165

00:51:31,309 --> 00:51:26,880

a wormhole you know one comment I saw by

1166

00:51:34,549 --> 00:51:31,319

the the really deeply insightful

1167

00:51:37,250 --> 00:51:34,559

um Quantum computational physicist Scott

1168

00:51:40,270 --> 00:51:37,260

Aronson was saying to say that you

1169

00:51:42,950 --> 00:51:40,280

created a wormhole in in

1170

00:51:45,650 --> 00:51:42,960

undertaking this quantum computer

1171

00:51:47,390 --> 00:51:45,660

simulation would be tantamount to saying

1172

00:51:49,010 --> 00:51:47,400

that every time you drew a worm on a

1173

00:51:51,010 --> 00:51:49,020

piece of paper you created or almost

1174

00:51:54,530 --> 00:51:51,020

like how do you distinguish between

1175

00:51:57,890 --> 00:51:54,540

modeling something and the something

1176

00:52:01,370 --> 00:51:57,900

and I think that distinction perhaps

1177

00:52:02,150 --> 00:52:01,380

According to some was lost in some of

1178

00:52:05,510 --> 00:52:02,160

the

1179

00:52:08,150 --> 00:52:05,520

articulated

1180

00:52:12,650 --> 00:52:08,160

um but putting the the the controversy

1181

00:52:15,049 --> 00:52:12,660

or the bit of uh uh kerfuffle to the

1182

00:52:19,609 --> 00:52:15,059

side it's a very very interesting piece

1183

00:52:22,130 --> 00:52:19,619

of work in which doing a Quantum

1184

00:52:24,230 --> 00:52:22,140

computation and appropriately

1185

00:52:27,829 --> 00:52:24,240

interpreting it you could see within

1186

00:52:31,490 --> 00:52:27,839

that computation the kinds of phenomenon

1187

00:52:34,670 --> 00:52:31,500

that you would associate with a wormhole

1188

00:52:37,069 --> 00:52:34,680

and that's a beautiful thing because it

1189

00:52:39,710 --> 00:52:37,079

now is a very concrete realization of

1190

00:52:41,150 --> 00:52:39,720

what I was saying before an answer to a

1191

00:52:44,150 --> 00:52:41,160

question of what's new in the last 20

1192

00:52:46,130 --> 00:52:44,160

years what's new is here you're doing

1193

00:52:48,410 --> 00:52:46,140

something that's purely quantum

1194

00:52:51,170 --> 00:52:48,420

mechanical you're carrying out a Quantum

1195

00:52:52,910 --> 00:52:51,180

computation on a quantum computer and

1196

00:52:55,730 --> 00:52:52,920

then by analyzing it appropriately

1197

00:52:59,089 --> 00:52:55,740

you're saying oh my god look in there

1198

00:53:01,069 --> 00:52:59,099

we're seeing exactly what we'd expect in

1199

00:53:03,170 --> 00:53:01,079

a particular kind of wormhole

1200

00:53:05,329 --> 00:53:03,180

and so the connection between general

1201

00:53:07,910 --> 00:53:05,339

relativity and quantum mechanics becomes

1202

00:53:09,650 --> 00:53:07,920

that much more apparent

1203

00:53:11,390 --> 00:53:09,660

the uncontroversial statement is that

1204

00:53:12,829 --> 00:53:11,400

they've simulated a wormhole or modeled

1205

00:53:15,530 --> 00:53:12,839

a wormhole

1206

00:53:19,190 --> 00:53:15,540

I don't want to speak at a turn because

1207

00:53:22,370 --> 00:53:19,200

I want to speak for either side of this

1208

00:53:25,910 --> 00:53:22,380

debate but I would say that I think

1209

00:53:29,030 --> 00:53:25,920

that's the linchpin of some of the

1210

00:53:30,650 --> 00:53:29,040

controversy and so it feels less

1211

00:53:34,309 --> 00:53:30,660

important to me

1212

00:53:37,010 --> 00:53:34,319

when thought of in that light I'm just

1213

00:53:39,650 --> 00:53:37,020

interested in how curious and wonderful

1214

00:53:42,890 --> 00:53:39,660

it is that general relativity and

1215

00:53:45,950 --> 00:53:42,900

quantum mechanics are brushing up

1216

00:53:48,470 --> 00:53:45,960

against each other in a manner that we

1217

00:53:50,089 --> 00:53:48,480

really wouldn't have anticipated with

1218

00:53:51,470 --> 00:53:50,099

the level of our understanding 20 25

1219

00:53:53,510 --> 00:53:51,480

years ago

1220

00:53:55,309 --> 00:53:53,520

okay now speaking about what's overhyped

1221

00:53:56,990 --> 00:53:55,319

or potentially under hyped what are some

1222

00:54:00,410 --> 00:53:57,000

of the applications of category Theory

1223

00:54:04,490 --> 00:54:02,690

oh goodness gracious wrong person to

1224

00:54:07,190 --> 00:54:04,500

talk about you know I've read some of

1225

00:54:09,349 --> 00:54:07,200

the uh the papers on this stuff but I

1226

00:54:12,470 --> 00:54:09,359

don't feel sufficiently expert to weigh

1227

00:54:15,829 --> 00:54:12,480

in on that at all so sorry all right no

1228

00:54:18,530 --> 00:54:15,839

problem so there are different toes like

1229

00:54:21,290 --> 00:54:18,540

Garrett lisi's like Eric Weinstein from

1230

00:54:23,089 --> 00:54:21,300

Peter white and I'm curious

1231

00:54:25,549 --> 00:54:23,099

have you had a chance to look into any

1232

00:54:28,490 --> 00:54:25,559

of those like lisi's E8 or or Eric

1233

00:54:30,910 --> 00:54:28,500

Weinstein's geometric Unity or Peter

1234

00:54:33,290 --> 00:54:30,920

White's euclidean twister

1235

00:54:34,430 --> 00:54:33,300

I didn't even know that Peter Boyd had

1236

00:54:36,410 --> 00:54:34,440

put forward

1237

00:54:39,829 --> 00:54:36,420

um a particular idea so again I'll have

1238

00:54:41,870 --> 00:54:39,839

to uh claim ignorance on that front but

1239

00:54:43,309 --> 00:54:41,880

um the Garrett leasy stuff unless

1240

00:54:46,430 --> 00:54:43,319

there's something radically new in

1241

00:54:49,130 --> 00:54:46,440

recent years certainly when he first

1242

00:54:52,250 --> 00:54:49,140

gained a little bit of attention for the

1243

00:54:55,430 --> 00:54:52,260

ideas he was put forward

1244

00:54:59,510 --> 00:54:55,440

um you know I I have to say I relied

1245

00:55:01,430 --> 00:54:59,520

upon a good friend who I've known for 40

1246

00:55:04,190 --> 00:55:01,440

years perhaps

1247

00:55:07,430 --> 00:55:04,200

um Jacques disler at a University of

1248

00:55:11,990 --> 00:55:07,440

Texas who did a wonderful series of blog

1249

00:55:14,510 --> 00:55:12,000

posts that analyze the claims and made

1250

00:55:16,549 --> 00:55:14,520

it quite clear that there wasn't a whole

1251

00:55:18,530 --> 00:55:16,559

lot there there when it came to the

1252

00:55:20,690 --> 00:55:18,540

Gareth leasy stuff and that that

1253

00:55:23,329 --> 00:55:20,700

certainly convinced me that it really

1254

00:55:25,130 --> 00:55:23,339

wasn't worth my time to delve into it

1255

00:55:28,250 --> 00:55:25,140

you know life is short if you chase

1256

00:55:30,770 --> 00:55:28,260

every idea that someone raises the flag

1257

00:55:33,109 --> 00:55:30,780

on and says here it is you wind up never

1258

00:55:35,270 --> 00:55:33,119

being able to do any of your own work

1259

00:55:36,650 --> 00:55:35,280

um and what was the other one oh oh the

1260

00:55:39,890 --> 00:55:36,660

wine shark Weinstein I don't know much

1261

00:55:43,309 --> 00:55:39,900

yeah I don't know much about again in

1262

00:55:45,230 --> 00:55:43,319

any detail so I I can't comment but I

1263

00:55:48,890 --> 00:55:45,240

guess you know I've not I've not

1264

00:55:51,230 --> 00:55:48,900

encountered uh anything beyond quantum

1265

00:55:55,130 --> 00:55:51,240

gravity which I don't work on I don't I

1266

00:55:57,829 --> 00:55:55,140

don't study but I certainly respect

1267

00:56:00,710 --> 00:55:57,839

um the results that that Community has

1268

00:56:03,470 --> 00:56:00,720

put forward and you know

1269

00:56:06,170 --> 00:56:03,480

um while some people take exception with

1270

00:56:09,049 --> 00:56:06,180

certain things that Lee smullen one of

1271

00:56:11,450 --> 00:56:09,059

the leaders of that field has said about

1272

00:56:14,150 --> 00:56:11,460

String Theory I I sort of don't take

1273

00:56:17,990 --> 00:56:14,160

those things personally and I focus more

1274

00:56:20,450 --> 00:56:18,000

on on the ideas and I think they've done

1275

00:56:22,490 --> 00:56:20,460

some some wonderful work in

1276

00:56:25,609 --> 00:56:22,500

understanding connections between

1277

00:56:28,549 --> 00:56:25,619

General activity and and quantum

1278

00:56:30,710 --> 00:56:28,559

mechanics but you know one would say

1279

00:56:33,170 --> 00:56:30,720

that I'm biased I don't see anything

1280

00:56:36,710 --> 00:56:33,180

that's achieved the level of refinement

1281

00:56:40,549 --> 00:56:36,720

and sophistication and insight that

1282

00:56:44,329 --> 00:56:40,559

string theory has provided nothing that

1283

00:56:47,030 --> 00:56:44,339

I've seen remotely holds a candle to the

1284

00:56:49,490 --> 00:56:47,040

kinds of insights especially the ones

1285

00:56:51,410 --> 00:56:49,500

that we were just talking about a moment

1286

00:56:54,230 --> 00:56:51,420

ago which are which are both deep and

1287

00:56:58,069 --> 00:56:54,240

surprising but you know even before that

1288

00:57:00,670 --> 00:56:58,079

you know the capacity to have a theory

1289

00:57:03,349 --> 00:57:00,680

that is

1290

00:57:05,030 --> 00:57:03,359

quantum mechanical and has general

1291

00:57:07,790 --> 00:57:05,040

relativity embedded

1292

00:57:10,370 --> 00:57:07,800

and is able to have within it the

1293

00:57:12,230 --> 00:57:10,380

symmetries of the standard model of

1294

00:57:14,630 --> 00:57:12,240

particle physics and the particles in

1295

00:57:16,970 --> 00:57:14,640

the standard model and naturally is

1296

00:57:19,970 --> 00:57:16,980

within their Theory that's able to give

1297

00:57:22,670 --> 00:57:19,980

us insight into

1298

00:57:25,190 --> 00:57:22,680

things like the entropy of black holes

1299

00:57:27,650 --> 00:57:25,200

which again you know Loop quantum

1300

00:57:31,089 --> 00:57:27,660

gravity has its own insights but I think

1301

00:57:34,609 --> 00:57:31,099

the string theoretic ones are are deeply

1302

00:57:37,910 --> 00:57:34,619

impressive and so there have been so

1303

00:57:40,790 --> 00:57:37,920

many small achievements along the way

1304

00:57:43,069 --> 00:57:40,800

yeah we haven't gotten the big one which

1305

00:57:46,670 --> 00:57:43,079

would be an experiment that somehow

1306

00:57:48,530 --> 00:57:46,680

reveals that this Approach To Nature is

1307

00:57:51,230 --> 00:57:48,540

the right approach but there have been

1308

00:57:54,950 --> 00:57:51,240

so many achievements over the course of

1309

00:57:58,069 --> 00:57:54,960

the last 50 years that I haven't feel

1310

00:58:01,910 --> 00:57:58,079

compelled to look for another approach

1311

00:58:04,190 --> 00:58:01,920

because we've got a rich wondrous deep

1312

00:58:05,870 --> 00:58:04,200

compelling theory that we're in the

1313

00:58:10,670 --> 00:58:05,880

midst of unraveling

1314

00:58:13,609 --> 00:58:10,680

and so that feels to me a very strong

1315

00:58:16,190 --> 00:58:13,619

pull relative to you know somebody comes

1316

00:58:18,410 --> 00:58:16,200

up with some idea raises their hand and

1317

00:58:20,510 --> 00:58:18,420

said now look at what I have got and

1318

00:58:22,670 --> 00:58:20,520

that to me I'm glad there are people who

1319

00:58:24,849 --> 00:58:22,680

are doing it but it's typically not the

1320

00:58:27,770 --> 00:58:24,859

thing will grab my attention away from

1321

00:58:30,470 --> 00:58:27,780

the focus work that that I'm doing that

1322

00:58:33,290 --> 00:58:30,480

we're doing as a community what would be

1323

00:58:35,569 --> 00:58:33,300

the other people in the ring that you

1324

00:58:37,970 --> 00:58:35,579

see as competent boxers that are

1325

00:58:40,190 --> 00:58:37,980

opponents to string theory or or perhaps

1326

00:58:41,390 --> 00:58:40,200

it's not a competition they're all

1327

00:58:43,190 --> 00:58:41,400

clearing for the same they're all

1328

00:58:45,109 --> 00:58:43,200

fighting toward the same goal so what

1329

00:58:46,910 --> 00:58:45,119

else is there so there's Loop but again

1330

00:58:49,069 --> 00:58:46,920

that's not a toll per se it's quantum

1331

00:58:50,510 --> 00:58:49,079

gravity approach unless there's some

1332

00:58:51,710 --> 00:58:50,520

other development I'm unaware of do you

1333

00:58:54,049 --> 00:58:51,720

mind listing some

1334

00:58:56,150 --> 00:58:54,059

no I wouldn't I I guess people say to

1335

00:58:58,670 --> 00:58:56,160

this first of all like I said before I I

1336

00:59:00,470 --> 00:58:58,680

typically don't use the language

1337

00:59:03,049 --> 00:59:00,480

toe or Theory of Everything and it's not

1338

00:59:05,750 --> 00:59:03,059

because of the um the abbreviation of

1339

00:59:09,049 --> 00:59:05,760

the acronym I think that the whole

1340

00:59:12,289 --> 00:59:09,059

conception of everything is an odd one

1341

00:59:15,289 --> 00:59:12,299

so when you talk about Loop quantum

1342

00:59:18,589 --> 00:59:15,299

gravity you know if you have a theory

1343

00:59:21,170 --> 00:59:18,599

that is able to embrace general

1344

00:59:24,170 --> 00:59:21,180

relativity and quantum mechanics in some

1345

00:59:25,309 --> 00:59:24,180

calculable and coherent mathematical

1346

00:59:27,710 --> 00:59:25,319

form

1347

00:59:30,890 --> 00:59:27,720

that's huge right I wouldn't say that it

1348

00:59:33,530 --> 00:59:30,900

somehow is subordinate to string theory

1349

00:59:35,870 --> 00:59:33,540

because within String Theory you know

1350

00:59:37,849 --> 00:59:35,880

perhaps you can also put the standard

1351  
00:59:40,490 --> 00:59:37,859  
model particle physics most direct you

1352  
00:59:43,849 --> 00:59:40,500  
know if Loop quantum gravity works you

1353  
00:59:46,609 --> 00:59:43,859  
will be able to use it as an overarching

1354  
00:59:49,010 --> 00:59:46,619  
framework and then put in quote unquote

1355  
00:59:53,390 --> 00:59:49,020  
everything else put in matter I have no

1356  
00:59:57,049 --> 00:59:53,400  
doubt that that this is a a potential

1357  
00:59:58,190 --> 00:59:57,059  
future if indeed Loop quantum gravity is

1358  
01:00:00,349 --> 00:59:58,200  
the right way to go so I wouldn't

1359  
01:00:01,849 --> 01:00:00,359  
somehow diminish it and say well string

1360  
01:00:03,109 --> 01:00:01,859  
theory is a theory of everything and

1361  
01:00:05,930 --> 01:00:03,119  
loop quantum gravity is not I don't I

1362  
01:00:08,990 --> 01:00:05,940  
don't think that way sure at all I mean

1363  
01:00:10,730 --> 01:00:09,000

to me the big question is you know what

1364

01:00:12,170 --> 01:00:10,740

do we do about general relativity and

1365

01:00:14,270 --> 01:00:12,180

quantum mechanics and what's becoming

1366

01:00:17,150 --> 01:00:14,280

clear as I mentioned before

1367

01:00:19,430 --> 01:00:17,160

is that the idea of trying to meld them

1368

01:00:22,069 --> 01:00:19,440

together May itself have been somewhat

1369

01:00:25,270 --> 01:00:22,079

wrong-headed they may already be melded

1370

01:00:29,150 --> 01:00:25,280

together and it's up to us to understand

1371

01:00:32,510 --> 01:00:29,160

how that melding actually works I mean

1372

01:00:35,329 --> 01:00:32,520

as you know well once quantum mechanics

1373

01:00:37,670 --> 01:00:35,339

came on the scene in the 1920s

1374

01:00:39,530 --> 01:00:37,680

there was this approach developed called

1375

01:00:42,109 --> 01:00:39,540

quantization

1376

01:00:44,930 --> 01:00:42,119

where you took ideas from the

1377

01:00:47,630 --> 01:00:44,940

pre-quantum world classical physics and

1378

01:00:49,910 --> 01:00:47,640

you found a kind of algorithm

1379

01:00:51,650 --> 01:00:49,920

for making them quantum mechanical and

1380

01:00:54,230 --> 01:00:51,660

that algorithm is called quantization

1381

01:00:57,289 --> 01:00:54,240

take Newton's ideas make them quantum

1382

01:00:59,510 --> 01:00:57,299

mechanical you know and and and that was

1383

01:01:01,730 --> 01:00:59,520

the Rhythm that was the approach that we

1384

01:01:03,430 --> 01:01:01,740

took for a long time that may not be the

1385

01:01:06,349 --> 01:01:03,440

right approach it may not be you take

1386

01:01:09,530 --> 01:01:06,359

Einstein's ideas of General activity and

1387

01:01:12,109 --> 01:01:09,540

you quantize them they may already have

1388

01:01:15,770 --> 01:01:12,119

quantum mechanics within them and that

1389

01:01:18,049 --> 01:01:15,780

that's the Deep new and exciting Insight

1390

01:01:21,049 --> 01:01:18,059

so he asked me sort of what are the sort

1391

01:01:23,630 --> 01:01:21,059

of competitors or candidates

1392

01:01:26,210 --> 01:01:23,640

you know we'll we'll certainly

1393

01:01:29,329 --> 01:01:26,220

I consider as I mentioned before the

1394

01:01:32,690 --> 01:01:29,339

Luke quantum gravity community

1395

01:01:36,470 --> 01:01:32,700

many colleagues many friends in that

1396

01:01:38,690 --> 01:01:36,480

world and I respect what they are doing

1397

01:01:41,990 --> 01:01:38,700

I think as I mentioned that this string

1398

01:01:44,390 --> 01:01:42,000

theoretic approach has achieved more and

1399

01:01:47,990 --> 01:01:44,400

it feels like it's giving us more

1400

01:01:51,170 --> 01:01:48,000

surprising and and detailed insights but

1401  
01:01:53,809 --> 01:01:51,180  
no doubt people would say partly your

1402  
01:01:55,549 --> 01:01:53,819  
view is colored by the fact that you

1403  
01:01:58,010 --> 01:01:55,559  
know since I was a graduate student

1404  
01:02:00,950 --> 01:01:58,020  
that's been more or less the domain

1405  
01:02:05,510 --> 01:02:00,960  
within which I've walked none of the

1406  
01:02:07,549 --> 01:02:05,520  
other ideas that I've seen described and

1407  
01:02:09,109 --> 01:02:07,559  
again I full well say I do not

1408  
01:02:10,970 --> 01:02:09,119  
investigate them all because I don't

1409  
01:02:14,150 --> 01:02:10,980  
have the time but I have not seen

1410  
01:02:17,030 --> 01:02:14,160  
anything else that rises to that level

1411  
01:02:19,130 --> 01:02:17,040  
of achievement or sophistication the

1412  
01:02:21,230 --> 01:02:19,140  
reason behind my question is that I'm

1413  
01:02:23,870 --> 01:02:21,240

working on a paper with a colleague

1414

01:02:25,910 --> 01:02:23,880

Carlos zapeda where we're going to do an

1415

01:02:27,950 --> 01:02:25,920

inventory of the candidates for

1416

01:02:29,870 --> 01:02:27,960

unification attempts between gravity and

1417

01:02:31,329 --> 01:02:29,880

quantum mechanics so maybe don't you

1418

01:02:33,410 --> 01:02:31,339

don't want to call it tells whatever

1419

01:02:35,870 --> 01:02:33,420

let's just call the tolls for the sake

1420

01:02:39,109 --> 01:02:35,880

of this and then also some deciderata on

1421

01:02:40,549 --> 01:02:39,119

the side like does it explain so and so

1422

01:02:42,589 --> 01:02:40,559

on and there's some uncontroversial list

1423

01:02:44,210 --> 01:02:42,599

on Wikipedia of the outstanding problems

1424

01:02:46,250 --> 01:02:44,220

in physics and putting a check mark like

1425

01:02:47,390 --> 01:02:46,260

a matrix with one on the x-axis one on

1426

01:02:50,150 --> 01:02:47,400

the y-axis

1427

01:02:52,370 --> 01:02:50,160

and so I wanted to know well I'm asking

1428

01:02:54,710 --> 01:02:52,380

different physicists and also

1429

01:02:55,670 --> 01:02:54,720

mathematicians who work in physics what

1430

01:02:57,770 --> 01:02:55,680

are the

1431

01:02:59,510 --> 01:02:57,780

different candidates that should go

1432

01:03:00,829 --> 01:02:59,520

there and I know that you mentioned that

1433

01:03:02,210 --> 01:03:00,839

there are several people who raised a

1434

01:03:04,549 --> 01:03:02,220

hand as difficulty can't follow every

1435

01:03:07,250 --> 01:03:04,559

single one who says I have a toe the toe

1436

01:03:09,289 --> 01:03:07,260

by Lisi and and Weinstein and Eric

1437

01:03:11,270 --> 01:03:09,299

Wolfram they're of a different quality

1438

01:03:13,190 --> 01:03:11,280

than the average person who emails and

1439

01:03:14,930 --> 01:03:13,200

says that they have a toe that is in

1440

01:03:17,809 --> 01:03:14,940

mathematical sophistication maybe not

1441

01:03:19,430 --> 01:03:17,819

rigor but hey the elements of a toll

1442

01:03:22,069 --> 01:03:19,440

even Quantum field theory is not

1443

01:03:23,569 --> 01:03:22,079

entirely rigorous but the the point is

1444

01:03:26,210 --> 01:03:23,579

in terms of mathematical sophistication

1445

01:03:28,190 --> 01:03:26,220

they're in a different League so I'm

1446

01:03:31,130 --> 01:03:28,200

curious what else goes there and then I

1447

01:03:34,609 --> 01:03:31,140

wanted to do a waiting like it's it's a

1448

01:03:35,690 --> 01:03:34,619

bit unfair to say s032 solves 7 out of

1449

01:03:38,030 --> 01:03:35,700

the 15.

1450

01:03:40,370 --> 01:03:38,040

but wolf runs only solves 5 out of the

1451

01:03:42,230 --> 01:03:40,380

15. however wolfram's working on it in a

1452

01:03:44,750 --> 01:03:42,240

basement maybe a basement in a lovely

1453

01:03:46,130 --> 01:03:44,760

house but like in a basement and and

1454

01:03:48,530 --> 01:03:46,140

there's let's say a thousand people

1455

01:03:50,809 --> 01:03:48,540

working on sl32 across decades or

1456

01:03:52,549 --> 01:03:50,819

heterotic eight or whatever it may be so

1457

01:03:54,530 --> 01:03:52,559

then I was like how do I do that waiting

1458

01:03:55,549 --> 01:03:54,540

and then but anyway so it's a fun

1459

01:03:57,770 --> 01:03:55,559

project

1460

01:03:59,630 --> 01:03:57,780

and I just wanted some some help with it

1461

01:04:01,010 --> 01:03:59,640

and I wanted to hear what your thoughts

1462

01:04:02,990 --> 01:04:01,020

were and what else do you think I should

1463

01:04:04,210 --> 01:04:03,000

consider putting in it or not putting in

1464

01:04:14,450 --> 01:04:04,220

it

1465

01:04:18,190 --> 01:04:14,460

out but the but the interesting thing is

1466

01:04:23,750 --> 01:04:18,200

to most researchers in the field

1467

01:04:27,710 --> 01:04:23,760

the work is all about the details

1468

01:04:29,089 --> 01:04:27,720

and and you're right that we all receive

1469

01:04:32,390 --> 01:04:29,099

these letters

1470

01:04:33,770 --> 01:04:32,400

in the mail and sometimes they're

1471

01:04:36,109 --> 01:04:33,780

actually kind of heartbreaking I've

1472

01:04:37,970 --> 01:04:36,119

gotten letters from people who have been

1473

01:04:39,890 --> 01:04:37,980

in that basement that you just made

1474

01:04:42,470 --> 01:04:39,900

reference to not a particularly nice one

1475

01:04:45,190 --> 01:04:42,480

I would imagine working out the final

1476

01:04:49,130 --> 01:04:45,200

Theory of Everything I remember one

1477

01:04:50,870 --> 01:04:49,140

gentleman wrote to me and I'm I think he

1478

01:04:54,349 --> 01:04:50,880

was on the level he was saying how he's

1479

01:04:56,930 --> 01:04:54,359

been working on this for 20 25 years his

1480

01:04:58,970 --> 01:04:56,940

wife left him his kids left him because

1481

01:05:01,010 --> 01:04:58,980

the only thing he cared about was

1482

01:05:03,950 --> 01:05:01,020

working out this Theory and he finally

1483

01:05:07,609 --> 01:05:03,960

had the theory and it sent it to me and

1484

01:05:10,970 --> 01:05:07,619

it looked like every other theory that I

1485

01:05:13,370 --> 01:05:10,980

get through that particular medium all

1486

01:05:15,710 --> 01:05:13,380

sorts of graphs and lines and

1487

01:05:19,250 --> 01:05:15,720

interconnected shapes and you're like oh

1488

01:05:22,309 --> 01:05:19,260

my God you know this is probably insane

1489

01:05:25,030 --> 01:05:22,319

I mean not insane in some medically

1490

01:05:27,890 --> 01:05:25,040

verifiable sense but it's deeply sad

1491

01:05:30,589 --> 01:05:27,900

that someone

1492

01:05:33,410 --> 01:05:30,599

um who has the same urge that we have

1493

01:05:38,150 --> 01:05:33,420

right and wants to figure it all out is

1494

01:05:41,150 --> 01:05:38,160

somehow likely being misled by certain

1495

01:05:43,370 --> 01:05:41,160

kinds of patterns or certain kinds of

1496

01:05:45,710 --> 01:05:43,380

geometrical shapes that really have no

1497

01:05:48,950 --> 01:05:45,720

bearing on the final answer the number

1498

01:05:51,849 --> 01:05:48,960

of times you get Communications of the

1499

01:05:55,789 --> 01:05:51,859

sort where it's all about working out

1500

01:05:58,849 --> 01:05:55,799

ratios of like pi to the ninth divided

1501  
01:06:01,370 --> 01:05:58,859  
by e to the seventh you know time you

1502  
01:06:03,770 --> 01:06:01,380  
know and and they work out to like 12 or

1503  
01:06:06,589 --> 01:06:03,780  
15 decimal places and they find some

1504  
01:06:08,569 --> 01:06:06,599  
pattern in the numbers and yeah it hurts

1505  
01:06:10,849 --> 01:06:08,579  
inside to imagine someone spending their

1506  
01:06:12,710 --> 01:06:10,859  
life doing something like that which is

1507  
01:06:16,430 --> 01:06:12,720  
meaningless

1508  
01:06:17,809 --> 01:06:16,440  
and so yes that category of work is

1509  
01:06:20,630 --> 01:06:17,819  
quite different

1510  
01:06:22,609 --> 01:06:20,640  
from any of the other ideas that you've

1511  
01:06:24,650 --> 01:06:22,619  
put forward

1512  
01:06:30,049 --> 01:06:24,660  
um but in the end of the day you know

1513  
01:06:33,829 --> 01:06:30,059

people vote with what they work on and

1514

01:06:35,809 --> 01:06:33,839

string theory has attracted a great deal

1515

01:06:38,329 --> 01:06:35,819

of people to work on and by strength

1516

01:06:41,210 --> 01:06:38,339

year I mean now something broader than

1517

01:06:46,430 --> 01:06:41,220

what I would have meant say in 1990 or

1518

01:06:50,029 --> 01:06:46,440

2000 now String Theory now is any work

1519

01:06:53,589 --> 01:06:50,039

that uses the ingredients or the

1520

01:06:56,270 --> 01:06:53,599

insights or the mathematical formalism

1521

01:06:58,730 --> 01:06:56,280

that was part of the early development

1522

01:07:00,549 --> 01:06:58,740

of string theory so now you know people

1523

01:07:03,049 --> 01:07:00,559

who are working on connections between

1524

01:07:04,730 --> 01:07:03,059

gravity general relativity and quantum

1525

01:07:08,089 --> 01:07:04,740

mechanics entanglement as we described

1526

01:07:11,029 --> 01:07:08,099

before would I call that string theory

1527

01:07:14,569 --> 01:07:11,039

per se I don't know it would have been

1528

01:07:17,750 --> 01:07:14,579

very unfamiliar to a string theorist say

1529

01:07:20,870 --> 01:07:17,760

from 1980 but that's what progress is

1530

01:07:22,609 --> 01:07:20,880

it's it's wherever the ideas Lead You So

1531

01:07:25,789 --> 01:07:22,619

as a community

1532

01:07:29,029 --> 01:07:25,799

it's hard for me to compare anything to

1533

01:07:31,789 --> 01:07:29,039

the string theory Community for the

1534

01:07:34,670 --> 01:07:31,799

level of insight and and the level of

1535

01:07:37,490 --> 01:07:34,680

achievement so sure I mean it's nice to

1536

01:07:40,010 --> 01:07:37,500

lay out like in a matrix in a chart you

1537

01:07:42,890 --> 01:07:40,020

know the various approaches that that

1538

01:07:46,130 --> 01:07:42,900

serious scientists as opposed to perhaps

1539

01:07:47,870 --> 01:07:46,140

untrained folks in basements

1540

01:07:50,809 --> 01:07:47,880

um what serious scientists have been

1541

01:07:53,210 --> 01:07:50,819

focusing their attention on but I I

1542

01:07:56,150 --> 01:07:53,220

really don't think anything comes close

1543

01:07:58,849 --> 01:07:56,160

to what the string theory Community

1544

01:08:00,829 --> 01:07:58,859

broadly defined has achieved and again I

1545

01:08:02,210 --> 01:08:00,839

do have great respects as I mentioned

1546

01:08:05,510 --> 01:08:02,220

for the loop quantum gravity Community

1547

01:08:09,349 --> 01:08:05,520

but none of the others for me really are

1548

01:08:11,630 --> 01:08:09,359

are developed to a point that are worthy

1549

01:08:12,529 --> 01:08:11,640

of exploration and tension at least not

1550

01:08:14,329 --> 01:08:12,539

yet

1551

01:08:16,249 --> 01:08:14,339

what advice do you have for people who

1552

01:08:17,749 --> 01:08:16,259

are interested in physics like seriously

1553

01:08:19,490 --> 01:08:17,759

interested in physics but aren't able to

1554

01:08:21,470 --> 01:08:19,500

go to a university for whatever reason

1555

01:08:22,789 --> 01:08:21,480

maybe they're older now and they feel

1556

01:08:25,130 --> 01:08:22,799

like they don't want to go back they

1557

01:08:27,530 --> 01:08:25,140

have not enough time or they just don't

1558

01:08:29,030 --> 01:08:27,540

have the money or for whatever life

1559

01:08:31,490 --> 01:08:29,040

circumstance

1560

01:08:33,410 --> 01:08:31,500

yeah well look you know I never want to

1561

01:08:37,189 --> 01:08:33,420

discourage people

1562

01:08:40,729 --> 01:08:37,199

there may be a a ramanujan

1563

01:08:45,130 --> 01:08:40,739

in our midst you know someone who's

1564

01:08:47,329 --> 01:08:45,140

level of perspicacity is so off scale

1565

01:08:49,550 --> 01:08:47,339

that they don't need the traditional

1566

01:08:50,809 --> 01:08:49,560

training and they don't need the

1567

01:08:53,630 --> 01:08:50,819

traditional environment and then they

1568

01:08:55,570 --> 01:08:53,640

can produce things that you know I

1569

01:08:58,789 --> 01:08:55,580

forget exactly the quote but

1570

01:09:01,550 --> 01:08:58,799

mathematician GH Hardy when looking at

1571

01:09:05,150 --> 01:09:01,560

some of the theorems that ramanujan had

1572

01:09:07,630 --> 01:09:05,160

sent him said something like you know

1573

01:09:10,370 --> 01:09:07,640

if these are true he's the greatest

1574

01:09:13,010 --> 01:09:10,380

mathematician if these are not true he's

1575

01:09:14,630 --> 01:09:13,020

an even greater mathematician for having

1576

01:09:17,209 --> 01:09:14,640

thought them up when they're not

1577

01:09:21,110 --> 01:09:17,219

actually true I mean you know so so if

1578

01:09:24,050 --> 01:09:21,120

there's somebody like that uh wow more

1579

01:09:26,990 --> 01:09:24,060

power to them and and they can pursue

1580

01:09:28,550 --> 01:09:27,000

these kinds of ideas on their own or

1581

01:09:30,530 --> 01:09:28,560

maybe through brief Communications but

1582

01:09:32,749 --> 01:09:30,540

for the vast majority of people of the

1583

01:09:33,769 --> 01:09:32,759

sort that you're describing it is really

1584

01:09:37,849 --> 01:09:33,779

tough

1585

01:09:40,910 --> 01:09:37,859

to do this outside of a community of

1586

01:09:43,070 --> 01:09:40,920

co-workers I mean the way we physicists

1587

01:09:45,950 --> 01:09:43,080

typically work you know I'm in my office

1588

01:09:48,349 --> 01:09:45,960

at Columbia students and grad students

1589

01:09:50,749 --> 01:09:48,359

and post-docs and seminars and

1590

01:09:52,789 --> 01:09:50,759

informal conversations and you read this

1591

01:09:54,890 --> 01:09:52,799

paper and you hear that idea you talk to

1592

01:09:57,470 --> 01:09:54,900

that person you start to develop this

1593

01:09:59,090 --> 01:09:57,480

collaboration that collaboration it's

1594

01:10:02,870 --> 01:09:59,100

just really hard to do

1595

01:10:05,870 --> 01:10:02,880

physics without that and so if one is

1596

01:10:09,770 --> 01:10:05,880

not in that world and one is somewhat

1597

01:10:11,689 --> 01:10:09,780

older it's really tough to break in and

1598

01:10:13,490 --> 01:10:11,699

for most people they they don't have the

1599

01:10:16,250 --> 01:10:13,500

financial resources to just give up

1600

01:10:19,669 --> 01:10:16,260

their life and go back to school

1601  
01:10:22,250 --> 01:10:19,679  
especially with the fact that I mean you

1602  
01:10:24,830 --> 01:10:22,260  
know maybe things are changing but

1603  
01:10:28,910 --> 01:10:24,840  
you know it's tough to get a faculty job

1604  
01:10:31,130 --> 01:10:28,920  
if you get your PhD at like 70. it's

1605  
01:10:33,770 --> 01:10:31,140  
just unlikely I'm using extreme numbers

1606  
01:10:36,169 --> 01:10:33,780  
to avoid anybody like jumping down my

1607  
01:10:38,209 --> 01:10:36,179  
throat in some ageism because you know

1608  
01:10:41,450 --> 01:10:38,219  
but you know what I'm saying the typical

1609  
01:10:45,290 --> 01:10:41,460  
root the typical root is someone gets

1610  
01:10:47,810 --> 01:10:45,300  
their PHD at a relatively young and

1611  
01:10:50,570 --> 01:10:47,820  
Society views it as more energetic

1612  
01:10:52,790 --> 01:10:50,580  
fertile Age and and and and and then

1613  
01:10:54,470 --> 01:10:52,800

they get a faculty job and and they're

1614

01:10:57,530 --> 01:10:54,480

often running as part of the community

1615

01:11:01,310 --> 01:10:57,540

and when you when you delay that it's

1616

01:11:04,070 --> 01:11:01,320

really really hard I mean I have known

1617

01:11:05,390 --> 01:11:04,080

and you know individuals who loved I

1618

01:11:07,669 --> 01:11:05,400

remember I'm thinking of one guy in

1619

01:11:11,050 --> 01:11:07,679

particular love mathematics and he went

1620

01:11:13,370 --> 01:11:11,060

back and got his PhD at a relatively

1621

01:11:15,189 --> 01:11:13,380

Advanced age which wasn't old but

1622

01:11:18,890 --> 01:11:15,199

relative Advantage compared to the norm

1623

01:11:20,990 --> 01:11:18,900

and got himself a really nice teaching

1624

01:11:22,610 --> 01:11:21,000

job at a university

1625

01:11:25,130 --> 01:11:22,620

and as far as I can tell I haven't

1626

01:11:28,250 --> 01:11:25,140

spoken to one is quite happy

1627

01:11:30,649 --> 01:11:28,260

because he's spending time in the

1628

01:11:33,050 --> 01:11:30,659

community of ideas that he finds most

1629

01:11:35,990 --> 01:11:33,060

exciting but

1630

01:11:39,290 --> 01:11:36,000

um it's tough that's rare that's really

1631

01:11:40,430 --> 01:11:39,300

tough so you know I guess the advice

1632

01:11:42,830 --> 01:11:40,440

would be

1633

01:11:46,490 --> 01:11:42,840

maybe you can find enough gratification

1634

01:11:48,590 --> 01:11:46,500

from reading about the ideas and maybe

1635

01:11:50,450 --> 01:11:48,600

going to a local University when they

1636

01:11:53,209 --> 01:11:50,460

have a seminar series maybe you can you

1637

01:11:56,149 --> 01:11:53,219

know and maybe through that you can find

1638

01:11:58,130 --> 01:11:56,159

inroads into your local community at a

1639

01:12:00,890 --> 01:11:58,140

local University and maybe even begin

1640

01:12:01,790 --> 01:12:00,900

some collaboration on on some kind of

1641

01:12:05,149 --> 01:12:01,800

project

1642

01:12:07,250 --> 01:12:05,159

but it's it's not an easy path and

1643

01:12:08,390 --> 01:12:07,260

certainly not if one wants to make it

1644

01:12:11,870 --> 01:12:08,400

there

1645

01:12:14,510 --> 01:12:11,880

sort of career and and for them to make

1646

01:12:17,570 --> 01:12:14,520

a living from it that's really tough if

1647

01:12:19,790 --> 01:12:17,580

you're not in a traditional trajectory

1648

01:12:21,770 --> 01:12:19,800

would an analogy be if someone wants to

1649

01:12:23,090 --> 01:12:21,780

learn martial arts sure you could do so

1650

01:12:25,310 --> 01:12:23,100

on your own you can watch YouTube videos

1651  
01:12:27,410 --> 01:12:25,320  
but there is something about grappling

1652  
01:12:29,030 --> 01:12:27,420  
with other people using your body with

1653  
01:12:30,890 --> 01:12:29,040  
someone who's living rather than a

1654  
01:12:32,149 --> 01:12:30,900  
wooden machine

1655  
01:12:35,149 --> 01:12:32,159  
there's something about the group

1656  
01:12:37,850 --> 01:12:35,159  
dynamic or does that an analogy fail no

1657  
01:12:39,649 --> 01:12:37,860  
I think it's a really good analogy and I

1658  
01:12:41,689 --> 01:12:39,659  
think I may use it going forward so

1659  
01:12:43,850 --> 01:12:41,699  
thank you on that one but because

1660  
01:12:45,470 --> 01:12:43,860  
um but the number of times

1661  
01:12:47,810 --> 01:12:45,480  
you know I'm reasonably well

1662  
01:12:49,910 --> 01:12:47,820  
accomplished right the number of times

1663  
01:12:52,610 --> 01:12:49,920

when I've been working on something I'm

1664

01:12:54,950 --> 01:12:52,620

completely stuck I try this I try that

1665

01:12:57,410 --> 01:12:54,960

it's just not just not happening right

1666

01:12:59,330 --> 01:12:57,420

then I'll meet with a few people you

1667

01:13:02,030 --> 01:12:59,340

know here Colombia collaboration we Chit

1668

01:13:05,209 --> 01:13:02,040

Chat talk about oh boom now we know

1669

01:13:07,970 --> 01:13:05,219

where to go where did the idea come from

1670

01:13:11,689 --> 01:13:07,980

none of us had the idea going in to that

1671

01:13:14,450 --> 01:13:11,699

exchange but yet somehow in the midst of

1672

01:13:17,630 --> 01:13:14,460

that grappling if I go back to your

1673

01:13:21,950 --> 01:13:17,640

metaphor the the the potential idea

1674

01:13:24,950 --> 01:13:21,960

emerged and and so without that

1675

01:13:26,689 --> 01:13:24,960

um it's very hard to make progress

1676

01:13:28,910 --> 01:13:26,699

have you ever collaborated with Ed

1677

01:13:32,870 --> 01:13:28,920

Whitton

1678

01:13:37,910 --> 01:13:32,880

collaborated no but worked

1679

01:13:41,450 --> 01:13:37,920

um uh uh right next to him yes in the

1680

01:13:44,090 --> 01:13:41,460

sense of back in the 1990s oh my God I'm

1681

01:13:47,270 --> 01:13:44,100

getting old but back in the 1990s I was

1682

01:13:50,330 --> 01:13:47,280

at the institute for advanced study and

1683

01:13:52,189 --> 01:13:50,340

um we had an idea I had a particular

1684

01:13:55,370 --> 01:13:52,199

idea of something I wanted to prove that

1685

01:13:56,930 --> 01:13:55,380

the fabric of space could rip and uh Ed

1686

01:13:58,850 --> 01:13:56,940

is at the institute for Advantage so I

1687

01:14:00,169 --> 01:13:58,860

told him about this idea and thought it

1688

01:14:03,229 --> 01:14:00,179

was exciting I was working with a couple

1689

01:14:06,830 --> 01:14:03,239

other people Paul asmold Dave Morrison

1690

01:14:08,090 --> 01:14:06,840

and Edward started to work on his own

1691

01:14:09,830 --> 01:14:08,100

version

1692

01:14:10,850 --> 01:14:09,840

didn't take anything from us he was just

1693

01:14:14,030 --> 01:14:10,860

went a completely different direction

1694

01:14:15,770 --> 01:14:14,040

but yet converged on exactly the same

1695

01:14:17,990 --> 01:14:15,780

question and it was among the most

1696

01:14:21,050 --> 01:14:18,000

exciting times that I've had in physics

1697

01:14:23,750 --> 01:14:21,060

because like we knew he was closing in

1698

01:14:26,750 --> 01:14:23,760

on it we were closing in on it we knew

1699

01:14:28,790 --> 01:14:26,760

that he's a million times smarter than

1700

01:14:31,430 --> 01:14:28,800

we are so we had to work the million

1701

01:14:33,590 --> 01:14:31,440

times harder and faster to try to get

1702

01:14:36,169 --> 01:14:33,600

there and not be completely scooped and

1703

01:14:40,010 --> 01:14:36,179

basically at the same time late in the

1704

01:14:42,830 --> 01:14:40,020

fall I guess of 1992 it was we within

1705

01:14:45,709 --> 01:14:42,840

days came to the same conclusion from

1706

01:14:49,010 --> 01:14:45,719

completely different approaches and so

1707

01:14:51,050 --> 01:14:49,020

we were right right there you know Head

1708

01:14:54,050 --> 01:14:51,060

to Head it was an incredibly exciting

1709

01:14:56,750 --> 01:14:54,060

time uh but yeah he's again

1710

01:15:00,110 --> 01:14:56,760

you know one of those figures whose

1711

01:15:01,910 --> 01:15:00,120

intellect is just hard to fathom I was

1712

01:15:04,130 --> 01:15:01,920

speaking to Richard Orchards and he said

1713

01:15:07,130 --> 01:15:04,140

Ed Whitton is terrifying

1714

01:15:10,669 --> 01:15:07,140

that I said well why and he said that he

1715

01:15:12,410 --> 01:15:10,679

puts out as side effects whole other

1716

01:15:14,870 --> 01:15:12,420

fields like the Witten invariance like

1717

01:15:16,310 --> 01:15:14,880

cyborg yeah

1718

01:15:18,470 --> 01:15:16,320

you have to tell you you know it's funny

1719

01:15:21,590 --> 01:15:18,480

a friend of mine was at the institute

1720

01:15:23,870 --> 01:15:21,600

for advanced study over a summer and the

1721

01:15:25,850 --> 01:15:23,880

place that kind of cleared out and and I

1722

01:15:27,950 --> 01:15:25,860

think Edward was there and this friend

1723

01:15:29,870 --> 01:15:27,960

of mine was there I won't give his name

1724

01:15:32,390 --> 01:15:29,880

in case he wouldn't want me to share it

1725

01:15:34,130 --> 01:15:32,400

but they were kind of sharing a wall

1726

01:15:36,530 --> 01:15:34,140

their offices were right next to each

1727

01:15:39,290 --> 01:15:36,540

other and so my friend was slogging away

1728

01:15:41,750 --> 01:15:39,300

doing his calculations you know hitting

1729

01:15:44,330 --> 01:15:41,760

dead ends and all through the summer he

1730

01:15:47,930 --> 01:15:44,340

kept hearing tap tap tap tap as Ed was

1731

01:15:49,669 --> 01:15:47,940

typing out paper after paper after paper

1732

01:15:52,130 --> 01:15:49,679

as if he was just sort of sitting there

1733

01:15:53,570 --> 01:15:52,140

and the ideas were sufficiently formed

1734

01:15:56,270 --> 01:15:53,580

they didn't even have to write anything

1735

01:15:59,149 --> 01:15:56,280

out he could go right from brain to

1736

01:16:01,010 --> 01:15:59,159

finished paper and my friend was like

1737

01:16:02,930 --> 01:16:01,020

you sit there and you're like what am I

1738

01:16:05,390 --> 01:16:02,940

doing why am I in this field

1739

01:16:07,970 --> 01:16:05,400

you know I can't you I can't but but but

1740

01:16:10,790 --> 01:16:07,980

that's actually an important thing

1741

01:16:12,770 --> 01:16:10,800

there is a place where so many people

1742

01:16:14,450 --> 01:16:12,780

can contribute sort of back to the

1743

01:16:16,790 --> 01:16:14,460

question we had before

1744

01:16:18,470 --> 01:16:16,800

while it's harder for the person who's

1745

01:16:20,330 --> 01:16:18,480

not gone to graduate school or is

1746

01:16:22,729 --> 01:16:20,340

working in the basement to really make

1747

01:16:25,550 --> 01:16:22,739

that contribution

1748

01:16:28,490 --> 01:16:25,560

kids who go to undergraduate then go to

1749

01:16:29,870 --> 01:16:28,500

graduate there's so many ways for so

1750

01:16:31,209 --> 01:16:29,880

many different people with so many

1751

01:16:35,209 --> 01:16:31,219

different

1752

01:16:37,790 --> 01:16:35,219

levels of intellectual capacity and

1753

01:16:40,490 --> 01:16:37,800

level of insight to contribute and to

1754

01:16:42,290 --> 01:16:40,500

contribute in vital ways and so you

1755

01:16:46,189 --> 01:16:42,300

don't have to only be an Edward Whitten

1756

01:16:48,890 --> 01:16:46,199

in order that you advance the field and

1757

01:16:50,930 --> 01:16:48,900

and so it's absolutely the case

1758

01:16:52,910 --> 01:16:50,940

yeah how do you not feel demoralized if

1759

01:16:55,370 --> 01:16:52,920

you're working on the same problem as Ed

1760

01:16:57,530 --> 01:16:55,380

Whitton or synonym for Ed Whitton

1761

01:16:59,510 --> 01:16:57,540

so you work on a different problem or or

1762

01:17:00,470 --> 01:16:59,520

what or you try to collaborate look I

1763

01:17:03,530 --> 01:17:00,480

mean

1764

01:17:05,510 --> 01:17:03,540

it is so I you know I gave you one

1765

01:17:07,430 --> 01:17:05,520

example where we were working on the

1766

01:17:09,950 --> 01:17:07,440

same problem in a sense as Edward

1767

01:17:11,750 --> 01:17:09,960

Whitton and and the fact that we got to

1768

01:17:13,189 --> 01:17:11,760

the Finish Line at the same time was

1769

01:17:15,709 --> 01:17:13,199

again you know one of those great

1770

01:17:18,290 --> 01:17:15,719

achievements that that I will always

1771

01:17:21,050 --> 01:17:18,300

remember for Edward it was just another

1772

01:17:23,090 --> 01:17:21,060

day at the office you know

1773

01:17:25,250 --> 01:17:23,100

um but having said that

1774

01:17:27,709 --> 01:17:25,260

I think it's very important that you

1775

01:17:30,709 --> 01:17:27,719

pick your problems carefully

1776

01:17:32,930 --> 01:17:30,719

you don't want to take I don't like to

1777

01:17:35,450 --> 01:17:32,940

take a problem that every other

1778

01:17:36,890 --> 01:17:35,460

physicist deems as the most important

1779

01:17:40,250 --> 01:17:36,900

and they're all working on it that's

1780

01:17:43,130 --> 01:17:40,260

never been my Approach my Approach has

1781

01:17:46,610 --> 01:17:43,140

always been I'm gonna find that corner

1782

01:17:49,850 --> 01:17:46,620

that appeals to me that corner that I

1783

01:17:51,950 --> 01:17:49,860

feel like I can at my own pace I'll work

1784

01:17:54,830 --> 01:17:51,960

hard but at my own pace I can make

1785

01:17:56,689 --> 01:17:54,840

Headway make progress and contribute

1786

01:17:59,570 --> 01:17:56,699

something bring it out to the world and

1787

01:18:01,910 --> 01:17:59,580

then maybe excite people to work on that

1788

01:18:03,649 --> 01:18:01,920

I mean that's you know I I one of the

1789

01:18:06,470 --> 01:18:03,659

big things that I did some years ago is

1790

01:18:09,470 --> 01:18:06,480

called mirror symmetry which was uh

1791

01:18:12,470 --> 01:18:09,480

developing certain properties of higher

1792

01:18:15,169 --> 01:18:12,480

dimensional spaces that are relevant for

1793

01:18:17,750 --> 01:18:15,179

string theory and when we were working

1794

01:18:19,910 --> 01:18:17,760

on this it was a really small community

1795

01:18:21,770 --> 01:18:19,920

that was working it was really us and

1796

01:18:23,470 --> 01:18:21,780

one other group in Texas Philip

1797

01:18:26,209 --> 01:18:23,480

candelison who is grouped down in Texas

1798

01:18:28,430 --> 01:18:26,219

and so it was really exciting we were

1799

01:18:31,490 --> 01:18:28,440

competing against each other there but

1800

01:18:32,930 --> 01:18:31,500

we were in close communication but it

1801

01:18:34,729 --> 01:18:32,940

wasn't like a thousand other groups

1802

01:18:37,550 --> 01:18:34,739

around the world were all battered and

1803

01:18:39,830 --> 01:18:37,560

it's just us and so you know we got

1804

01:18:41,689 --> 01:18:39,840

hours he got his results our group got

1805

01:18:45,110 --> 01:18:41,699

our results he put people got excited

1806

01:18:47,750 --> 01:18:45,120

and then the field took off and now like

1807

01:18:49,790 --> 01:18:47,760

mirror symmetry has become a whole field

1808

01:18:53,330 --> 01:18:49,800

of mathematics that has developed over

1809

01:18:55,310 --> 01:18:53,340

decades I no longer even recognize the

1810

01:18:58,610 --> 01:18:55,320

things that happen in this field because

1811

01:19:00,709 --> 01:18:58,620

it got so mathematical and so beyond my

1812

01:19:03,830 --> 01:19:00,719

particular interest which is really from

1813

01:19:05,330 --> 01:19:03,840

the physics standpoint but that's a

1814

01:19:07,430 --> 01:19:05,340

great place to be work in your own

1815

01:19:08,870 --> 01:19:07,440

Corner come up with something put it out

1816

01:19:11,090 --> 01:19:08,880

there start a field and then the field

1817

01:19:12,350 --> 01:19:11,100

takes off and God bless everybody who

1818

01:19:14,930 --> 01:19:12,360

works on it

1819

01:19:17,149 --> 01:19:14,940

your current interest is time or one of

1820

01:19:19,610 --> 01:19:17,159

them the emergence of time

1821

01:19:21,950 --> 01:19:19,620

yeah I mean that it's a big question

1822

01:19:23,689 --> 01:19:21,960

though it's not as though you sit down

1823

01:19:25,430 --> 01:19:23,699

at your desk and you're like okay where

1824

01:19:27,890 --> 01:19:25,440

where does time begin you know I it's

1825

01:19:30,290 --> 01:19:27,900

not a question you hit head on I think

1826

01:19:31,850 --> 01:19:30,300

it's the kind of question that you hit

1827

01:19:34,010 --> 01:19:31,860

obliquely

1828

01:19:36,350 --> 01:19:34,020

and for instance I would imagine that

1829

01:19:38,149 --> 01:19:36,360

this work being done on wormholes and

1830

01:19:40,370 --> 01:19:38,159

quantum entanglement

1831

01:19:42,590 --> 01:19:40,380

taking general relativity and

1832

01:19:46,370 --> 01:19:42,600

understanding its inherent quantum

1833

01:19:48,830 --> 01:19:46,380

mechanical aspects I anticipate that

1834

01:19:50,750 --> 01:19:48,840

insight into a deep question such as the

1835

01:19:53,530 --> 01:19:50,760

origin of time will ultimately emerge

1836

01:19:56,149 --> 01:19:53,540

from that but not from a head-on

1837

01:19:58,790 --> 01:19:56,159

approach but rather from a more indirect

1838

01:20:01,490 --> 01:19:58,800

approach do you agree with or find

1839

01:20:02,930 --> 01:20:01,500

interesting Carlo ravelli's views on

1840

01:20:04,610 --> 01:20:02,940

time he has this book the order of time

1841

01:20:06,530 --> 01:20:04,620

and Lisa Mullen has his own views too

1842

01:20:08,450 --> 01:20:06,540

which I believe is a realist and then

1843

01:20:09,950 --> 01:20:08,460

Carlo believes it's more relational or

1844

01:20:11,990 --> 01:20:09,960

an emergent

1845

01:20:14,270 --> 01:20:12,000

and then Julian Barber

1846

01:20:16,189 --> 01:20:14,280

yeah so I think they're all interesting

1847

01:20:18,350 --> 01:20:16,199

yeah I think they're all interesting

1848

01:20:19,370 --> 01:20:18,360

ideas you know

1849

01:20:21,229 --> 01:20:19,380

um

1850

01:20:22,630 --> 01:20:21,239

I think that

1851

01:20:25,610 --> 01:20:22,640

ultimately

1852

01:20:29,390 --> 01:20:25,620

the the question of the the fundamental

1853

01:20:31,790 --> 01:20:29,400

nature of time is going to require

1854

01:20:34,209 --> 01:20:31,800

scientific insights Beyond those that we

1855

01:20:36,530 --> 01:20:34,219

currently have so I'm always interested

1856

01:20:39,350 --> 01:20:36,540

to hear

1857

01:20:42,169 --> 01:20:39,360

thoughts on the nature of time and so

1858

01:20:44,930 --> 01:20:42,179

Rebellion the relational quality of

1859

01:20:48,050 --> 01:20:44,940

space-time that resonates with me I

1860

01:20:51,830 --> 01:20:48,060

think there's definite powerful truth in

1861

01:20:56,590 --> 01:20:51,840

there uh I've seen papers of Lee's

1862

01:21:01,490 --> 01:20:56,600

talking about the way in which time can

1863

01:21:05,270 --> 01:21:01,500

emerge from an earlier temporal quality

1864

01:21:07,310 --> 01:21:05,280

a kind of way in which the future is

1865

01:21:09,890 --> 01:21:07,320

built from the present as opposed to

1866

01:21:11,570 --> 01:21:09,900

already in some sense a temporal

1867

01:21:15,709 --> 01:21:11,580

Dimension being out there I think it's

1868

01:21:18,890 --> 01:21:15,719

quite interesting Julian Barber

1869

01:21:21,350 --> 01:21:18,900

um I I remember being very excited about

1870

01:21:24,169 --> 01:21:21,360

the initial ideas and then I read his

1871

01:21:26,090 --> 01:21:24,179

book and there was one paragraph where I

1872

01:21:27,110 --> 01:21:26,100

felt the heart of the idea was put

1873

01:21:29,930 --> 01:21:27,120

forward

1874

01:21:32,330 --> 01:21:29,940

and it felt to me that he'd redefined

1875

01:21:34,189 --> 01:21:32,340

the problem for me in a way that didn't

1876

01:21:36,350 --> 01:21:34,199

feel as interesting any longer I don't

1877

01:21:39,590 --> 01:21:36,360

know if there's been developments since

1878

01:21:42,169 --> 01:21:39,600

then so it's all just to say that yeah

1879

01:21:45,169 --> 01:21:42,179

there time is a big mystery

1880

01:21:47,870 --> 01:21:45,179

always interested to hear people's take

1881

01:21:50,030 --> 01:21:47,880

on it but in the end of the day I think

1882

01:21:53,630 --> 01:21:50,040

it's going to take deeper scientific

1883

01:21:56,149 --> 01:21:53,640

insight and what's happening now in

1884

01:21:57,830 --> 01:21:56,159

string theory broadly defined in

1885

01:21:59,750 --> 01:21:57,840

understanding the quantum mechanical

1886

01:22:02,209 --> 01:21:59,760

qualities of general relativity the

1887

01:22:04,850 --> 01:22:02,219

intrinsic quantum mechanical qualities

1888

01:22:06,649 --> 01:22:04,860

of general relativity I think that's

1889

01:22:09,950 --> 01:22:06,659

where the new ideas are going to come

1890

01:22:11,689 --> 01:22:09,960

from before we wrap I have a choice for

1891

01:22:13,310 --> 01:22:11,699

you we can I have a couple physics

1892

01:22:15,890 --> 01:22:13,320

questions or a couple more philosophical

1893

01:22:17,450 --> 01:22:15,900

questions do you have a preference uh

1894

01:22:19,790 --> 01:22:17,460

you can do a blend whatever you whatever

1895

01:22:21,590 --> 01:22:19,800

you think is good all right all right so

1896

01:22:23,270 --> 01:22:21,600

I know that you have an explored

1897

01:22:25,490 --> 01:22:23,280

category Theory much but have you

1898

01:22:27,050 --> 01:22:25,500

explored geometric algebra or geometric

1899

01:22:30,350 --> 01:22:27,060

calculus

1900

01:22:34,370 --> 01:22:30,360

you know I have dabbled but not enough

1901

01:22:35,990 --> 01:22:34,380

to feel like I can provide any insight

1902

01:22:37,910 --> 01:22:36,000

compared to the people who really know

1903

01:22:40,010 --> 01:22:37,920

the subjects that I probably would save

1904

01:22:42,770 --> 01:22:40,020

those questions for subsequent guests

1905

01:22:45,649 --> 01:22:42,780

who are more in that space sure sure

1906

01:22:47,030 --> 01:22:45,659

what is the swampland the swampland

1907

01:22:52,850 --> 01:22:47,040

conjectures

1908

01:22:54,850 --> 01:22:52,860

have to do with the following

1909

01:22:58,669 --> 01:22:54,860

question

1910

01:23:01,370 --> 01:22:58,679

when you have a theory that does a

1911

01:23:03,290 --> 01:23:01,380

really good job at describing say the

1912

01:23:06,370 --> 01:23:03,300

physics that we can see low energy

1913

01:23:10,370 --> 01:23:06,380

physics is the physics that we can see

1914

01:23:12,410 --> 01:23:10,380

does that theoretical description have

1915

01:23:15,530 --> 01:23:12,420

what's known as an UltraViolet

1916

01:23:20,030 --> 01:23:15,540

completion that is can that low energy

1917

01:23:21,890 --> 01:23:20,040

physics be augmented into a theory that

1918

01:23:26,209 --> 01:23:21,900

will agree with that low energy physics

1919

01:23:29,330 --> 01:23:26,219

but work at arbitrarily High energies or

1920

01:23:32,030 --> 01:23:29,340

is this just kind of an approximate

1921

01:23:34,070 --> 01:23:32,040

theory that works at low energies but

1922

01:23:36,229 --> 01:23:34,080

doesn't admit

1923

01:23:37,729 --> 01:23:36,239

an UltraViolet completed ultra high

1924

01:23:39,890 --> 01:23:37,739

energy doesn't emit the high energy

1925

01:23:42,169 --> 01:23:39,900

completion that is it cannot be extended

1926

01:23:46,130 --> 01:23:42,179

to arbitrarily High energies and the

1927

01:23:49,430 --> 01:23:46,140

swamp playing idea is to delineate

1928

01:23:53,149 --> 01:23:49,440

theories that may have a low energy

1929

01:23:56,590 --> 01:23:53,159

Incarnation but don't admit a full

1930

01:23:59,870 --> 01:23:56,600

completion to the entire energy spectrum

1931

01:24:03,110 --> 01:23:59,880

and and the the thought According to

1932

01:24:06,110 --> 01:24:03,120

some of the swamp limit ideas is that

1933

01:24:08,870 --> 01:24:06,120

the swamp plant is pretty big many many

1934

01:24:11,390 --> 01:24:08,880

of the theories that perhaps look like

1935

01:24:13,130 --> 01:24:11,400

they may be candidates for theories that

1936

01:24:16,490 --> 01:24:13,140

could be extended to arbitrarily High

1937

01:24:19,550 --> 01:24:16,500

energies they can't that they are

1938

01:24:22,430 --> 01:24:19,560

fundamentally inconsistent

1939

01:24:26,030 --> 01:24:22,440

and and that would be a that's a

1940

01:24:29,570 --> 01:24:26,040

potentially powerful idea because after

1941

01:24:30,729 --> 01:24:29,580

all our goal is to winnow down the

1942

01:24:34,130 --> 01:24:30,739

number of

1943

01:24:36,649 --> 01:24:34,140

candidate theories for the final Theory

1944

01:24:39,290 --> 01:24:36,659

and a final Theory would work at any

1945

01:24:41,750 --> 01:24:39,300

energy scale and if it can establish

1946

01:24:43,430 --> 01:24:41,760

that a great many theories that look

1947

01:24:46,850 --> 01:24:43,440

like they were contenders at low

1948

01:24:48,649 --> 01:24:46,860

energies that they don't admit an

1949

01:24:50,209 --> 01:24:48,659

extension to arbitrarily High energies

1950

01:24:51,350 --> 01:24:50,219

then they get eliminated from the

1951

01:24:54,169 --> 01:24:51,360

competition

1952

01:24:56,810 --> 01:24:54,179

and so you get to winnow out a whole

1953

01:25:00,050 --> 01:24:56,820

class of theories that don't

1954

01:25:02,030 --> 01:25:00,060

stand this test of completion to

1955

01:25:04,490 --> 01:25:02,040

arbitrarily High Energies

1956

01:25:06,709 --> 01:25:04,500

so what's meant by you can take a low

1957

01:25:08,630 --> 01:25:06,719

effect sorry a low energy Theory and it

1958

01:25:10,490 --> 01:25:08,640

works at the low energy but then for

1959

01:25:12,169 --> 01:25:10,500

some you may be able to augment them and

1960

01:25:14,990 --> 01:25:12,179

then their UV complete what's meant by

1961

01:25:16,550 --> 01:25:15,000

augment what's a valid augmenting so

1962

01:25:18,290 --> 01:25:16,560

that what I mean is you can augment

1963

01:25:19,370 --> 01:25:18,300

Newtonian Theory to get special relative

1964

01:25:20,630 --> 01:25:19,380

video I don't know if like does that

1965

01:25:25,910 --> 01:25:20,640

mean Newtonian like I don't know what

1966

01:25:29,149 --> 01:25:25,920

augment means yeah so so usually these

1967

01:25:31,930 --> 01:25:29,159

ideas are formulated where you've

1968

01:25:35,149 --> 01:25:31,940

actually got a mathematical formulation

1969

01:25:38,750 --> 01:25:35,159

of a given Theory say perhaps even

1970

01:25:42,169 --> 01:25:38,760

within String Theory itself and then you

1971

01:25:45,169 --> 01:25:42,179

can simply ask is this a self-consistent

1972

01:25:46,970 --> 01:25:45,179

theory in the sense that you can use it

1973

01:25:49,310 --> 01:25:46,980

that Matt that very mathematical

1974

01:25:54,229 --> 01:25:49,320

formulation at arbitrarily High Energies

1975

01:25:55,209 --> 01:25:54,239

and if you can't then it properly should

1976

01:26:02,330 --> 01:25:55,219

be

1977

01:26:03,950 --> 01:26:02,340

doesn't admit an extension to or an

1978

01:26:05,450 --> 01:26:03,960

application perhaps would be a better

1979

01:26:06,950 --> 01:26:05,460

way of saying it to arbitrarily High

1980

01:26:09,110 --> 01:26:06,960

energies

1981

01:26:12,050 --> 01:26:09,120

um and so you know this is an idea that

1982

01:26:15,770 --> 01:26:12,060

cumren vaffa and collaborators was You

1983

01:26:18,830 --> 01:26:15,780

Know instrumental in developing

1984

01:26:20,390 --> 01:26:18,840

um and it it you know I wouldn't say

1985

01:26:21,229 --> 01:26:20,400

that it has

1986

01:26:28,490 --> 01:26:21,239

um

1987

01:26:31,629 --> 01:26:28,500

when it comes to theories like string

1988

01:26:34,970 --> 01:26:31,639

theory but it has sharpened them because

1989

01:26:38,990 --> 01:26:34,980

anytime you have a test in some sense

1990

01:26:42,169 --> 01:26:39,000

for whether or not a theory is fully

1991

01:26:44,149 --> 01:26:42,179

consistent works at arbitrarily High

1992

01:26:46,550 --> 01:26:44,159

energies and I should say high energies

1993

01:26:49,850 --> 01:26:46,560

mean short distances so does the theory

1994

01:26:52,910 --> 01:26:49,860

work at arbitrarily short distances if

1995

01:26:55,550 --> 01:26:52,920

it somehow is inconsistent at

1996

01:26:58,070 --> 01:26:55,560

sufficiently Short distances that's a

1997

01:27:00,050 --> 01:26:58,080

good thing for the project because now

1998

01:27:01,610 --> 01:27:00,060

you can throw that theory away

1999

01:27:03,470 --> 01:27:01,620

is consistency the same as

2000

01:27:06,110 --> 01:27:03,480

self-consistency

2001

01:27:11,750 --> 01:27:06,120

or is are those separate usually well

2002

01:27:14,450 --> 01:27:11,760

usually so unfortunately our ability to

2003

01:27:17,450 --> 01:27:14,460

probe the real physics of the real world

2004

01:27:19,129 --> 01:27:17,460

it arbitrarily short distances is highly

2005

01:27:22,070 --> 01:27:19,139

constrained by the equipment that we

2006

01:27:25,490 --> 01:27:22,080

have and so we'd love it

2007

01:27:27,790 --> 01:27:25,500

if consistency meant sure internal

2008

01:27:31,729 --> 01:27:27,800

consistency but also consistency with

2009

01:27:34,010 --> 01:27:31,739

observations that we might make of you

2010

01:27:37,129 --> 01:27:34,020

know physics down to 10 to the minus 25

2011

01:27:38,990 --> 01:27:37,139

or 10 to the minus 30 centimeters you

2012

01:27:42,169 --> 01:27:39,000

know that would be beautiful but but

2013

01:27:44,390 --> 01:27:42,179

because our ability to probe such Realms

2014

01:27:45,590 --> 01:27:44,400

is limited by our technology for the

2015

01:27:48,290 --> 01:27:45,600

most part yeah we're talking about

2016

01:27:50,629 --> 01:27:48,300

internal self-consistency uh okay

2017

01:27:52,430 --> 01:27:50,639

firstly is internal consistency the same

2018

01:27:53,750 --> 01:27:52,440

as self-consistency just so I can get

2019

01:27:57,470 --> 01:27:53,760

the terminology clear

2020

01:27:59,689 --> 01:27:57,480

yeah I mean it's just a statement of as

2021

01:28:04,129 --> 01:27:59,699

a mathematical structure

2022

01:28:07,810 --> 01:28:04,139

do you find any divergences do you find

2023

01:28:11,390 --> 01:28:07,820

any incurable Infinities or other

2024

01:28:15,229 --> 01:28:11,400

mathematical maladies do they emerge

2025

01:28:16,790 --> 01:28:15,239

when you try to apply this Theory to

2026

01:28:18,770 --> 01:28:16,800

arbitrarily short distance or

2027

01:28:20,570 --> 01:28:18,780

arbitrarily High Energies

2028

01:28:22,669 --> 01:28:20,580

and yeah you're not you're not talking

2029

01:28:25,610 --> 01:28:22,679

about observation at this point because

2030

01:28:27,350 --> 01:28:25,620

you don't have the observations sorry a

2031

01:28:29,390 --> 01:28:27,360

self-consistent theory would be UV

2032

01:28:32,209 --> 01:28:29,400

complete and a UV complete Theory would

2033

01:28:35,629 --> 01:28:32,219

be self-consistent or no like there's oh

2034

01:28:37,990 --> 01:28:35,639

yeah and if you if you have a true UV

2035

01:28:41,149 --> 01:28:38,000

complete Theory almost by definition

2036

01:28:44,090 --> 01:28:41,159

it's consistent because the completion

2037

01:28:46,310 --> 01:28:44,100

means that you've been able to

2038

01:28:47,990 --> 01:28:46,320

formulate the theory in a way that you

2039

01:28:49,610 --> 01:28:48,000

can apply it arbitrarily short distances

2040

01:28:51,709 --> 01:28:49,620

arbitrarily High energies that's what UV

2041

01:28:54,169 --> 01:28:51,719

completed is okay let's end with your

2042

01:28:57,290 --> 01:28:54,179

thoughts on simulation Theory

2043

01:28:58,910 --> 01:28:57,300

or sorry the simulation hypothesis yeah

2044

01:29:00,410 --> 01:28:58,920

uh well

2045

01:29:01,729 --> 01:29:00,420

um look

2046

01:29:04,610 --> 01:29:01,739

um

2047

01:29:07,370 --> 01:29:04,620

it's certainly the case

2048

01:29:10,129 --> 01:29:07,380

that as

2049

01:29:11,870 --> 01:29:10,139

um computational systems have become

2050

01:29:15,610 --> 01:29:11,880

more and more sophisticated their

2051

01:29:19,189 --> 01:29:15,620

ability to simulate the real world

2052

01:29:21,350 --> 01:29:19,199

seemingly is getting better and better

2053

01:29:23,689 --> 01:29:21,360

we see this with you know going from

2054

01:29:26,270 --> 01:29:23,699

video games to the most sophisticated

2055

01:29:29,510 --> 01:29:26,280

you know virtual reality

2056

01:29:31,610 --> 01:29:29,520

and so certainly one can imagine that at

2057

01:29:35,410 --> 01:29:31,620

some point in the future we will have

2058

01:29:38,510 --> 01:29:35,420

computational systems that are so

2059

01:29:44,290 --> 01:29:38,520

sophisticated that

2060

01:29:46,910 --> 01:29:44,300

they are able to have within them

2061

01:29:50,270 --> 01:29:46,920

collections of bits and bytes running

2062

01:29:53,030 --> 01:29:50,280

around that may themselves have

2063

01:29:55,189 --> 01:29:53,040

self-awareness now

2064

01:29:57,649 --> 01:29:55,199

that's the big unknown

2065

01:29:59,570 --> 01:29:57,659

can you have a computational system that

2066

01:30:02,390 --> 01:29:59,580

is itself self-aware that it has you

2067

01:30:03,709 --> 01:30:02,400

know some sort of Consciousness that

2068

01:30:05,750 --> 01:30:03,719

goes back to the question that we

2069

01:30:07,310 --> 01:30:05,760

started with early on I don't know the

2070

01:30:09,169 --> 01:30:07,320

answer to that but let's assume the

2071

01:30:10,370 --> 01:30:09,179

answers yet big assumption let's assume

2072

01:30:11,990 --> 01:30:10,380

the answer is yes

2073

01:30:14,149 --> 01:30:12,000

well then you're in an interesting

2074

01:30:15,770 --> 01:30:14,159

circumstance because

2075

01:30:19,010 --> 01:30:15,780

you can ask yourself

2076  
01:30:22,010 --> 01:30:19,020  
how many real universes in the sense of

2077  
01:30:24,590 --> 01:30:22,020  
solid tables and chairs are there well

2078  
01:30:26,810 --> 01:30:24,600  
we're kind of aware of one

2079  
01:30:28,610 --> 01:30:26,820  
and it's very hard to create new ones if

2080  
01:30:30,830 --> 01:30:28,620  
I challenge you to create a new real

2081  
01:30:33,290 --> 01:30:30,840  
Universe you don't know how to do it

2082  
01:30:35,990 --> 01:30:33,300  
create a new Big Bang nobody really

2083  
01:30:39,050 --> 01:30:36,000  
knows how to do that but if I ask you

2084  
01:30:41,570 --> 01:30:39,060  
how many of these simulated universes

2085  
01:30:43,189 --> 01:30:41,580  
are there again assuming that we've

2086  
01:30:45,709 --> 01:30:43,199  
gotten to the point say in the future

2087  
01:30:47,270 --> 01:30:45,719  
when we're able to simulate worlds of

2088  
01:30:50,629 --> 01:30:47,280

the conscious beings there could be a

2089

01:30:52,370 --> 01:30:50,639

gazillion simulated universes you know

2090

01:30:54,110 --> 01:30:52,380

some kid just comes home late at night

2091

01:30:56,030 --> 01:30:54,120

and flips on the

2092

01:30:57,890 --> 01:30:56,040

computer and says let me just simulate

2093

01:31:00,110 --> 01:30:57,900

one more Universe with these and these

2094

01:31:02,149 --> 01:31:00,120

parameters it just flips it up and the

2095

01:31:03,830 --> 01:31:02,159

computer just simulates it and within

2096

01:31:05,750 --> 01:31:03,840

that simulation our further conscious

2097

01:31:08,330 --> 01:31:05,760

beings so then the question to ask

2098

01:31:10,250 --> 01:31:08,340

yourself is what's the likelihood that

2099

01:31:12,229 --> 01:31:10,260

right now we are in

2100

01:31:14,870 --> 01:31:12,239

the simulation

2101  
01:31:17,510 --> 01:31:14,880  
and if you sort of play the odds in the

2102  
01:31:19,490 --> 01:31:17,520  
most naive way you say well there's only

2103  
01:31:22,070 --> 01:31:19,500  
one real universe

2104  
01:31:25,189 --> 01:31:22,080  
but they're a gazillion gazillion

2105  
01:31:28,010 --> 01:31:25,199  
gazillion of these simulated worlds

2106  
01:31:30,669 --> 01:31:28,020  
and so the odds would seem to suggest

2107  
01:31:33,229 --> 01:31:30,679  
that we are in a simulated world just by

2108  
01:31:34,430 --> 01:31:33,239  
sheer force of the numbers and

2109  
01:31:36,530 --> 01:31:34,440  
probabilities

2110  
01:31:38,270 --> 01:31:36,540  
so do I believe that do I think that we

2111  
01:31:40,790 --> 01:31:38,280  
are in a simulation right now I can't

2112  
01:31:44,510 --> 01:31:40,800  
say that I do if you're to really

2113  
01:31:47,030 --> 01:31:44,520

challenge me why I don't I don't really

2114

01:31:52,189 --> 01:31:47,040

have a good response beyond the fact

2115

01:31:53,689 --> 01:31:52,199

that I've never seen a simulation that

2116

01:31:57,110 --> 01:31:53,699

can do this

2117

01:31:59,510 --> 01:31:57,120

but you know that may simply be that the

2118

01:32:02,629 --> 01:31:59,520

simulator is so good that the simulator

2119

01:32:05,870 --> 01:32:02,639

is hidden from me the fact that I'm in a

2120

01:32:08,629 --> 01:32:05,880

simulation and I agree that if I

2121

01:32:11,330 --> 01:32:08,639

extrapolate from where computation was

2122

01:32:15,470 --> 01:32:11,340

40 years ago it's where it is today sort

2123

01:32:18,890 --> 01:32:15,480

of exponential growth in its ability to

2124

01:32:21,169 --> 01:32:18,900

do things that seem real then you know

2125

01:32:23,930 --> 01:32:21,179

don't go 40 years hence assuming we

2126  
01:32:26,330 --> 01:32:23,940  
don't blow ourselves up go A Thousand

2127  
01:32:29,169 --> 01:32:26,340  
Years hence and now you can really

2128  
01:32:33,530 --> 01:32:29,179  
imagine that there are these simulations

2129  
01:32:35,470 --> 01:32:33,540  
and we could well be in one of them so

2130  
01:32:39,470 --> 01:32:35,480  
I don't feel like I have a strong

2131  
01:32:42,830 --> 01:32:39,480  
refutation of the possibility that I'm

2132  
01:32:45,229 --> 01:32:42,840  
in a simulation but damn I certainly I I

2133  
01:32:46,850 --> 01:32:45,239  
can't say that I think or believe that I

2134  
01:32:50,270 --> 01:32:46,860  
am

2135  
01:32:52,129 --> 01:32:50,280  
man thank you so much for your time it's

2136  
01:32:53,810 --> 01:32:52,139  
been a pleasure I do have a last

2137  
01:32:55,490 --> 01:32:53,820  
question from Charlie from The Institute

2138  
01:32:57,350 --> 01:32:55,500

for arts and ideas he sent this to me

2139

01:32:59,090 --> 01:32:57,360

and he's like Kurt can you please if

2140

01:33:01,070 --> 01:32:59,100

you're speaking to Brian I would love if

2141

01:33:03,530 --> 01:33:01,080

you could mention this so I'll chat it

2142

01:33:06,790 --> 01:33:03,540

here and I can say it aloud if that's

2143

01:33:11,870 --> 01:33:09,410

so it's actually two uh

2144

01:33:14,149 --> 01:33:11,880

I can uh okay okay why don't you read it

2145

01:33:16,490 --> 01:33:14,159

yeah Charlie Barnett from The Institute

2146

01:33:18,950 --> 01:33:16,500

of Arts and ideas says

2147

01:33:20,870 --> 01:33:18,960

hi Brian almost a year ago to this day

2148

01:33:22,610 --> 01:33:20,880

you were featured on a panel at the IAI

2149

01:33:24,590 --> 01:33:22,620

so the institute for arts and ideas with

2150

01:33:27,290 --> 01:33:24,600

Michael Shermer Sabine hostenfelder and

2151  
01:33:28,790 --> 01:33:27,300  
Eric Weinstein Eric Weinstein who is a

2152  
01:33:30,470 --> 01:33:28,800  
mathematical physicist at Harvard said

2153  
01:33:33,229 --> 01:33:30,480  
that string theory had a terrible

2154  
01:33:35,450 --> 01:33:33,239  
culture in the 1980s that was in the

2155  
01:33:37,550 --> 01:33:35,460  
process of resolving itself

2156  
01:33:38,629 --> 01:33:37,560  
in response to this you sympathize and

2157  
01:33:40,669 --> 01:33:38,639  
said that there was a sense of

2158  
01:33:42,110 --> 01:33:40,679  
unreasonable exuberance that many

2159  
01:33:44,870 --> 01:33:42,120  
thought string theory was the final

2160  
01:33:46,370 --> 01:33:44,880  
Theory but it also seemed that Eric was

2161  
01:33:48,169 --> 01:33:46,380  
slightly exaggerating how bad the

2162  
01:33:50,030 --> 01:33:48,179  
culture was what do you think he was

2163  
01:33:54,050 --> 01:33:50,040

referring to and could you maybe comment

2164

01:33:56,030 --> 01:33:54,060

more broadly about how one can ensure

2165

01:33:57,290 --> 01:33:56,040

that bias doesn't creep into scientific

2166

01:34:00,290 --> 01:33:57,300

theories

2167

01:34:01,250 --> 01:34:00,300

yeah I mean you know you know briefly

2168

01:34:04,729 --> 01:34:01,260

put

2169

01:34:07,550 --> 01:34:04,739

there there was a sentiment in the 80s I

2170

01:34:10,250 --> 01:34:07,560

mean I was I was there as in thick of it

2171

01:34:11,870 --> 01:34:10,260

as a graduate student mostly not as a

2172

01:34:15,950 --> 01:34:11,880

faculty member

2173

01:34:18,410 --> 01:34:15,960

and there was a sentiment that we were

2174

01:34:19,970 --> 01:34:18,420

approaching the end of physics

2175

01:34:22,310 --> 01:34:19,980

it was naive

2176  
01:34:25,669 --> 01:34:22,320  
but it was genuine it wasn't as though

2177  
01:34:28,310 --> 01:34:25,679  
people were making it up I mean you

2178  
01:34:29,930 --> 01:34:28,320  
can't imagine well you can but

2179  
01:34:33,350 --> 01:34:29,940  
if you weren't actually part of it

2180  
01:34:37,070 --> 01:34:33,360  
perhaps someone can't really feel the

2181  
01:34:41,030 --> 01:34:37,080  
visceral excitement that had taken hold

2182  
01:34:42,890 --> 01:34:41,040  
of a segment of the physics Community I

2183  
01:34:46,790 --> 01:34:42,900  
mean there I was a graduate student at

2184  
01:34:50,689 --> 01:34:46,800  
Oxford in 1984 1985

2185  
01:34:53,149 --> 01:34:50,699  
and every Wednesday or something like

2186  
01:34:54,590 --> 01:34:53,159  
that when when the free prints were

2187  
01:34:56,990 --> 01:34:54,600  
finally delivered to the physics

2188  
01:34:59,810 --> 01:34:57,000

department The Graduate students two

2189

01:35:02,810 --> 01:34:59,820

others and myself in particular

2190

01:35:05,450 --> 01:35:02,820

we would like tear open the envelopes to

2191

01:35:07,189 --> 01:35:05,460

see the next result and we'd take that

2192

01:35:09,050 --> 01:35:07,199

paper and compare to what we were doing

2193

01:35:11,750 --> 01:35:09,060

we'd go upset and we were working like

2194

01:35:13,550 --> 01:35:11,760

you know 15 hours a day

2195

01:35:15,470 --> 01:35:13,560

you know I go to sleep at two in the

2196

01:35:17,270 --> 01:35:15,480

morning I'd wake up at seven I'd ride my

2197

01:35:20,090 --> 01:35:17,280

bike to the physical because it was just

2198

01:35:21,290 --> 01:35:20,100

like oh my God like it was all coming

2199

01:35:23,390 --> 01:35:21,300

together

2200

01:35:26,030 --> 01:35:23,400

which is all just to say it was genuine

2201

01:35:28,189 --> 01:35:26,040

the excitement was genuine but the

2202

01:35:31,370 --> 01:35:28,199

downside of that kind of excitement is

2203

01:35:34,070 --> 01:35:31,380

if someone's not working on string

2204

01:35:37,010 --> 01:35:34,080

theory at that time I can well imagine

2205

01:35:38,930 --> 01:35:37,020

they feel like a complete Outsider that

2206

01:35:41,510 --> 01:35:38,940

they're completely excluded that nobody

2207

01:35:44,870 --> 01:35:41,520

cares about what they're working on or

2208

01:35:47,450 --> 01:35:44,880

what they are doing and and I know

2209

01:35:49,070 --> 01:35:47,460

people who have described that

2210

01:35:50,990 --> 01:35:49,080

experience to me and I don't know if

2211

01:35:52,850 --> 01:35:51,000

that was Eric's experience or if there

2212

01:35:53,990 --> 01:35:52,860

was something particular that happened I

2213

01:35:55,850 --> 01:35:54,000

just don't know I don't know him

2214

01:35:59,570 --> 01:35:55,860

personally sure I've done that event and

2215

01:36:01,430 --> 01:35:59,580

so forth but I do know people who from a

2216

01:36:04,850 --> 01:36:01,440

more personal perspective have described

2217

01:36:07,129 --> 01:36:04,860

how alienated the excitement and the

2218

01:36:09,470 --> 01:36:07,139

string theory Community made them feel

2219

01:36:13,250 --> 01:36:09,480

back in those days

2220

01:36:15,530 --> 01:36:13,260

and and so I get it and and I wish it

2221

01:36:17,090 --> 01:36:15,540

wasn't that way but I guess the point

2222

01:36:19,250 --> 01:36:17,100

that I was making last year and the

2223

01:36:22,189 --> 01:36:19,260

point that I make again here it wasn't

2224

01:36:24,050 --> 01:36:22,199

malicious it wasn't like folks said

2225

01:36:26,450 --> 01:36:24,060

let's exclude everybody else is not

2226

01:36:28,850 --> 01:36:26,460

working on this sacred it wasn't like

2227

01:36:30,470 --> 01:36:28,860

that it was just that people were so

2228

01:36:33,709 --> 01:36:30,480

wrapped up in what they were doing and

2229

01:36:35,689 --> 01:36:33,719

so excited by what they were doing that

2230

01:36:38,930 --> 01:36:35,699

there wasn't a lot of energy or time

2231

01:36:41,330 --> 01:36:38,940

left in the community to pay attention

2232

01:36:43,910 --> 01:36:41,340

to things that were happening in in in

2233

01:36:46,370 --> 01:36:43,920

the surrounding and when it came to jobs

2234

01:36:48,310 --> 01:36:46,380

there were real implications for this

2235

01:36:51,530 --> 01:36:48,320

you know in those days

2236

01:36:53,870 --> 01:36:51,540

more strength here is got the postdocs

2237

01:36:56,149 --> 01:36:53,880

and got the faculty jobs because of the

2238

01:36:57,709 --> 01:36:56,159

excitement and you can well imagine that

2239

01:37:00,110 --> 01:36:57,719

somebody who is working hard and doing

2240

01:37:03,770 --> 01:37:00,120

really good work but outside of string

2241

01:37:06,470 --> 01:37:03,780

theory maybe said let me in I want a job

2242

01:37:08,030 --> 01:37:06,480

like I want a postdoc I want to I get it

2243

01:37:11,030 --> 01:37:08,040

and I totally

2244

01:37:12,709 --> 01:37:11,040

empathize with that but it's just that

2245

01:37:14,209 --> 01:37:12,719

when it's framed as though string

2246

01:37:16,790 --> 01:37:14,219

theorists were like a malicious

2247

01:37:19,910 --> 01:37:16,800

community that were sort of barring the

2248

01:37:22,970 --> 01:37:19,920

doors against it wasn't like that at all

2249

01:37:25,370 --> 01:37:22,980

it was just coming from whatever Alan

2250

01:37:27,590 --> 01:37:25,380

Green's you know irrational exuberance

2251

01:37:29,750 --> 01:37:27,600

you know it was exuberant and was it

2252

01:37:31,910 --> 01:37:29,760

irrational not irrational but it was

2253

01:37:35,570 --> 01:37:31,920

perhaps a little too much

2254

01:37:39,410 --> 01:37:35,580

because the more seasoned researchers

2255

01:37:42,590 --> 01:37:39,420

and physicists at that time knew that

2256

01:37:45,110 --> 01:37:42,600

ultimately the excitement would die down

2257

01:37:47,450 --> 01:37:45,120

and the theory would need to mature and

2258

01:37:50,570 --> 01:37:47,460

be developed and and that's what we've

2259

01:37:53,330 --> 01:37:50,580

been doing so I think that's sort of my

2260

01:37:56,209 --> 01:37:53,340

best answer that it was coming from a

2261

01:37:58,010 --> 01:37:56,219

good place it wasn't coming from a place

2262

01:37:59,810 --> 01:37:58,020

of exclusion

2263

01:38:02,149 --> 01:37:59,820

thank you Professor thank you for

2264

01:38:03,410 --> 01:38:02,159

spending so much time with me and I want

2265

01:38:05,510 --> 01:38:03,420

to know well people want to know where

2266

01:38:07,850 --> 01:38:05,520

can they find out more about you and

2267

01:38:09,890 --> 01:38:07,860

what you're working on next and what are

2268

01:38:12,770 --> 01:38:09,900

the URLs the social media

2269

01:38:15,169 --> 01:38:12,780

yeah you know I I I need to be a little

2270

01:38:18,110 --> 01:38:15,179

bit more active in that realm you know

2271

01:38:20,270 --> 01:38:18,120

sometimes I use Twitter my kids tell me

2272

01:38:22,490 --> 01:38:20,280

I should use Instagram maybe I'll start

2273

01:38:24,830 --> 01:38:22,500

doing that I don't know Tick Tock maybe

2274

01:38:26,810 --> 01:38:24,840

I think I'm too old for that but you

2275

01:38:29,330 --> 01:38:26,820

know the world Science Festival is

2276

01:38:31,550 --> 01:38:29,340

probably the best place we are creating

2277

01:38:33,229 --> 01:38:31,560

all sorts of I think really interesting

2278

01:38:35,510 --> 01:38:33,239

content and so people should sign up for

2279

01:38:37,490 --> 01:38:35,520

the world science social newsletter and

2280

01:38:40,250 --> 01:38:37,500

that certainly where a lot of my focus

2281

01:38:41,510 --> 01:38:40,260

has been in terms of bringing signs to

2282

01:38:43,370 --> 01:38:41,520

the public

2283

01:38:46,430 --> 01:38:43,380

um and yeah if you happen to be uh in

2284

01:38:47,930 --> 01:38:46,440

the Toronto area on the 26th and you

2285

01:38:50,629 --> 01:38:47,940

said it's next week because relative to

2286

01:38:52,850 --> 01:38:50,639

when this goes out yeah come by to the

2287

01:38:54,290 --> 01:38:52,860

program at Roy Thompson Hall I think

2288

01:38:56,689 --> 01:38:54,300

you'll enjoy it sort of an evening

2289

01:38:59,450 --> 01:38:56,699

exploration of the Universe from sort of

2290

01:39:03,350 --> 01:38:59,460

Soup To Nuts great and just to be clear

2291

01:39:05,450 --> 01:39:03,360

that's January 26 2023 evening time I'm

2292

01:39:08,689 --> 01:39:05,460

assuming when whatever it is I'll put it

2293

01:39:10,669 --> 01:39:08,699

on screen yeah and is that is that being

2294

01:39:12,590 --> 01:39:10,679

repeated that talking it at a different

2295

01:39:14,629 --> 01:39:12,600

city that you can promote

2296

01:39:16,910 --> 01:39:14,639

I don't know not yet I'm just sort of

2297

01:39:19,790 --> 01:39:16,920

trying it out in Toronto see how it goes

2298

01:39:21,350 --> 01:39:19,800

and yeah if the reception is is good

2299

01:39:23,330 --> 01:39:21,360

then I can imagine doing it all right

2300

01:39:24,770 --> 01:39:23,340

we're the testing ground and maybe I'll

2301

01:39:27,830 --> 01:39:24,780

see you there I don't think I'm in town

2302

01:39:29,030 --> 01:39:27,840

then otherwise I I don't think I'm in

2303

01:39:30,770 --> 01:39:29,040

town it would it would have been great

2304

01:39:32,870 --> 01:39:30,780

to shake your hand man

2305

01:39:35,270 --> 01:39:32,880

if for whatever reason my other plans

2306

01:39:36,770 --> 01:39:35,280

cancel then hey if you find yourself in

2307

01:39:38,750 --> 01:39:36,780

New York if you find yourself in New

2308

01:39:40,910 --> 01:39:38,760

York at the end of May we're going to do

2309

01:39:43,729 --> 01:39:40,920

our first live world Science Festival

2310

01:39:45,649 --> 01:39:43,739

since 2019 because of everything you

2311

01:39:48,050 --> 01:39:45,659

know we've gone fully digital but we're

2312

01:39:52,189 --> 01:39:48,060

going to go live again in the end of May

2313

01:39:54,649 --> 01:39:52,199

of 2023 and that's coming up in you know

2314

01:39:56,810 --> 01:39:54,659

five six months so it'll be a fun time

2315

01:39:59,149 --> 01:39:56,820

in New York and I'm going to do this

2316

01:40:01,370 --> 01:39:59,159

program in New York as well

2317

01:40:02,990 --> 01:40:01,380

okay I see I see okay yeah well

2318

01:40:05,330 --> 01:40:03,000

definitely keep me apprised about the

2319

01:40:06,590 --> 01:40:05,340

world Science Festival because as toe

2320

01:40:08,030 --> 01:40:06,600

grows sorry the theories of everything

2321

01:40:10,490 --> 01:40:08,040

Channel girls maybe there's something I

2322

01:40:12,290 --> 01:40:10,500

could do to help promote it and it was

2323

01:40:14,390 --> 01:40:12,300

yeah it was a pleasure man

2324

01:40:16,610 --> 01:40:14,400

my pleasure too it's good talking to you

2325

01:40:18,290 --> 01:40:16,620

the podcast is now concluded thank you

2326  
01:40:20,149 --> 01:40:18,300  
for watching if you haven't subscribed

2327  
01:40:22,189 --> 01:40:20,159  
or clicked on that like button now would

2328  
01:40:24,950 --> 01:40:22,199  
be a great time to do so as each

2329  
01:40:27,050 --> 01:40:24,960  
subscribe and like helps YouTube push

2330  
01:40:28,850 --> 01:40:27,060  
this content to more people also I

2331  
01:40:31,250 --> 01:40:28,860  
recently found out that external links

2332  
01:40:33,709 --> 01:40:31,260  
count plenty toward the algorithm which

2333  
01:40:34,970 --> 01:40:33,719  
means that when you share on Twitter on

2334  
01:40:37,129 --> 01:40:34,980  
Facebook on Reddit

2335  
01:40:38,990 --> 01:40:37,139  
Etc it shows YouTube that people are

2336  
01:40:41,030 --> 01:40:39,000  
talking about this outside of YouTube

2337  
01:40:42,890 --> 01:40:41,040  
which in turn greatly AIDS the

2338  
01:40:44,570 --> 01:40:42,900

Distribution on YouTube as well if you'd

2339

01:40:46,870 --> 01:40:44,580

like to support more conversations like

2340

01:40:48,950 --> 01:40:46,880

this then do consider visiting

2341

01:40:51,169 --> 01:40:48,960

theoriesofeverything.org again it's

2342

01:40:53,629 --> 01:40:51,179

support from the sponsors and you that

2343

01:40:55,250 --> 01:40:53,639

allow me to work on toe full-time you

2344

01:40:57,410 --> 01:40:55,260

get early access to ad-free audio

2345

01:40:59,510 --> 01:40:57,420

episodes there as well every dollar

2346

01:41:01,550 --> 01:40:59,520

helps far more than you may think either