



**AVI
LOEB**

**WORMHOLES &
MANY WORLDS**

1
00:00:03,590 --> 00:00:01,510
this is a conversation with the

2
00:00:07,269 --> 00:00:03,600
inimitable avi loeb

3
00:00:09,509 --> 00:00:07,279
we talk about well i was struggling

4
00:00:10,950 --> 00:00:09,519
what can i talk to avi about that he

5
00:00:11,270 --> 00:00:10,960
hasn't covered before because he's been

6
00:00:13,910 --> 00:00:11,280
on

7
00:00:14,470 --> 00:00:13,920
over 400 podcasts he tends to give the

8
00:00:18,150 --> 00:00:14,480
same

9
00:00:19,750 --> 00:00:18,160
it took quite some time but

10
00:00:21,269 --> 00:00:19,760
along with the community we managed to

11
00:00:21,990 --> 00:00:21,279
conceive of questions that he hasn't

12
00:00:24,390 --> 00:00:22,000
been asked

13
00:00:26,230 --> 00:00:24,400

at least not in the public forum such as

14

00:00:28,390 --> 00:00:26,240

what are his opinions on bob lazar

15

00:00:30,070 --> 00:00:28,400

morality purpose a finality to the

16

00:00:32,069 --> 00:00:30,080

universe the beginning of the universe

17

00:00:33,750 --> 00:00:32,079

some technical questions about manifolds

18

00:00:35,990 --> 00:00:33,760

and the lower bound on the mass of

19

00:00:37,510 --> 00:00:36,000

elementary particles and astrophysical

20

00:00:39,350 --> 00:00:37,520

data god

21

00:00:41,190 --> 00:00:39,360

quite a few topics if you'd like to see

22

00:00:42,790 --> 00:00:41,200

more conversations like this or hear

23

00:00:43,590 --> 00:00:42,800

more conversations like this then please

24

00:00:46,069 --> 00:00:43,600

consider

25

00:00:47,950 --> 00:00:46,079

supporting donating whatever you would

26

00:00:50,470 --> 00:00:47,960

like at

27

00:00:52,310 --> 00:00:50,480

patreon.com literally every single

28

00:00:53,990 --> 00:00:52,320

one of the patrons helps a tremendous

29

00:00:55,590 --> 00:00:54,000

tremendous tremendous amount

30

00:00:57,510 --> 00:00:55,600

thank you so much for all the people who

31

00:00:59,830 --> 00:00:57,520

have continued to donate

32

00:01:01,510 --> 00:00:59,840

and thank you for those of you who are

33

00:01:03,270 --> 00:01:01,520

going to just so you know soon i'll be

34

00:01:04,149 --> 00:01:03,280

hosting a three-way conversation between

35

00:01:06,550 --> 00:01:04,159

myself

36

00:01:08,230 --> 00:01:06,560

donald hoffman and bernardo castro it

37

00:01:10,550 --> 00:01:08,240

may be a four-way conversation

38

00:01:11,670 --> 00:01:10,560

if we can get jonathan verveiki in as

39

00:01:14,070 --> 00:01:11,680

well although

40

00:01:15,350 --> 00:01:14,080

i'm unsure if he's available however

41

00:01:15,910 --> 00:01:15,360

it's at least going to be bernardo

42

00:01:17,910 --> 00:01:15,920

castro

43

00:01:19,990 --> 00:01:17,920

and donald hoffman that's coming shortly

44

00:01:21,510 --> 00:01:20,000

we're looking to hit 50 patrons and then

45

00:01:23,670 --> 00:01:21,520

i'll be able to conduct that

46

00:01:28,310 --> 00:01:23,680

thank you thank you so much i appreciate

47

00:01:31,670 --> 00:01:29,910

i want to know how much did writing your

48

00:01:33,590 --> 00:01:31,680

book or writing books in general or

49

00:01:34,950 --> 00:01:33,600

articles how much does that clarify your

50

00:01:37,270 --> 00:01:34,960

thinking

51
00:01:41,670 --> 00:01:37,280
oh the main purpose for writing the book

52
00:01:43,670 --> 00:01:41,680
as i told the publisher was to

53
00:01:44,870 --> 00:01:43,680
broadcast that excitement that we can

54
00:01:46,950 --> 00:01:44,880
have in science

55
00:01:48,469 --> 00:01:46,960
discovering important things that do

56
00:01:50,149 --> 00:01:48,479
affect our daily lives

57
00:01:51,910 --> 00:01:50,159
and i told the publisher that if one

58
00:01:54,230 --> 00:01:51,920
person around the world will decide to

59
00:01:57,350 --> 00:01:54,240
become a scientist after reading my book

60
00:01:59,429 --> 00:01:57,360
i will be satisfied and as it turns out

61
00:02:00,950 --> 00:01:59,439
a few a few weeks ago i got an email

62
00:02:03,590 --> 00:02:00,960
from malawi

63
00:02:04,550 --> 00:02:03,600

from a woman who wrote the the book is

64

00:02:06,789 --> 00:02:04,560

great

65

00:02:09,270 --> 00:02:06,799

and i'm thinking of becoming an

66

00:02:11,430 --> 00:02:09,280

astronomer so i told her the story about

67

00:02:13,270 --> 00:02:11,440

the publisher and i asked her are you

68

00:02:14,470 --> 00:02:13,280

the one are you that person that will

69

00:02:17,110 --> 00:02:14,480

become a scientist

70

00:02:18,150 --> 00:02:17,120

thanks to reading my book and she said

71

00:02:21,190 --> 00:02:18,160

maybe

72

00:02:23,270 --> 00:02:21,200

so i invited her to apply

73

00:02:24,390 --> 00:02:23,280

to graduate school and at harvard in

74

00:02:26,309 --> 00:02:24,400

astronomy

75

00:02:28,070 --> 00:02:26,319

and i very much hope that she will do so

76

00:02:30,309 --> 00:02:28,080

and then i can work with her

77

00:02:31,110 --> 00:02:30,319

uh there was another undergraduate

78

00:02:33,030 --> 00:02:31,120

student from

79

00:02:34,630 --> 00:02:33,040

colombia that they wrote to me and said

80

00:02:37,509 --> 00:02:34,640

the reading about your work

81

00:02:38,070 --> 00:02:37,519

changed my life and so i get about a

82

00:02:42,150 --> 00:02:38,080

dozen

83

00:02:45,190 --> 00:02:42,160

emails of this type every day now and

84

00:02:45,750 --> 00:02:45,200

i am really satisfied about writing my

85

00:02:49,509 --> 00:02:45,760

book

86

00:02:52,390 --> 00:02:49,519

it wasn't so much for me to clarify

87

00:02:54,550 --> 00:02:52,400

my thinking as to communicate my

88

00:02:57,030 --> 00:02:54,560

excitement about doing science and

89

00:02:58,869 --> 00:02:57,040

you know the fact that we can maintain

90

00:03:00,390 --> 00:02:58,879

our childhood curiosity we can be

91

00:03:03,190 --> 00:03:00,400

excited about doing it

92

00:03:05,190 --> 00:03:03,200

it's not a job like being in the

93

00:03:07,589 --> 00:03:05,200

business world the commercial world

94

00:03:08,630 --> 00:03:07,599

where you get paid and then you use the

95

00:03:11,430 --> 00:03:08,640

money for what you

96

00:03:13,270 --> 00:03:11,440

really enjoy uh in fact you know i would

97

00:03:13,990 --> 00:03:13,280

enjoy doing what i'm doing irrespective

98

00:03:17,750 --> 00:03:14,000

whether i get

99

00:03:17,990 --> 00:03:17,760

money for it there were no problems that

100

00:03:23,030 --> 00:03:18,000

you

101

00:03:24,390 --> 00:03:23,040

elaborate it or cultivate it or

102

00:03:25,990 --> 00:03:24,400

disambiguate it

103

00:03:28,070 --> 00:03:26,000

it was already somewhat formed in your

104

00:03:31,509 --> 00:03:28,080

mind now you just got to put it on paper

105

00:03:32,309 --> 00:03:31,519

yeah i mean it's all in my my head to

106

00:03:34,229 --> 00:03:32,319

start with

107

00:03:35,750 --> 00:03:34,239

and it's just a question of putting it

108

00:03:38,309 --> 00:03:35,760

in a way that is compelling

109

00:03:40,710 --> 00:03:38,319

and you know it's very much the same

110

00:03:42,630 --> 00:03:40,720

when i do my science very often someone

111

00:03:44,710 --> 00:03:42,640

comes to my office and says

112

00:03:46,470 --> 00:03:44,720

this is what i'm working on sort of

113

00:03:48,869 --> 00:03:46,480

immediately i come up with

114

00:03:49,509 --> 00:03:48,879

suggestions for ideas and how to proceed

115

00:03:52,630 --> 00:03:49,519

and

116

00:03:54,869 --> 00:03:52,640

very often that person says oh wow i

117

00:03:57,030 --> 00:03:54,879

how did you come up with that i i didn't

118

00:03:59,110 --> 00:03:57,040

really think about it and

119

00:04:00,710 --> 00:03:59,120

it's not as if it takes me a great

120

00:04:04,070 --> 00:04:00,720

effort to do that it's sort of

121

00:04:07,110 --> 00:04:04,080

in my head to start with and i'm just

122

00:04:10,630 --> 00:04:07,120

explaining it and there is not much

123

00:04:13,670 --> 00:04:10,640

distance between putting it on paper and

124

00:04:14,470 --> 00:04:13,680

having it in my head the only difference

125

00:04:18,949 --> 00:04:14,480

is

126

00:04:19,509 --> 00:04:18,959

okay talking about communicating ideas

127

00:04:21,270 --> 00:04:19,519

to

128

00:04:22,950 --> 00:04:21,280

other scientists i recall you saying

129

00:04:26,150 --> 00:04:22,960

that when you were in your younger years

130

00:04:27,590 --> 00:04:26,160

you would speak about ideas and then

131

00:04:29,189 --> 00:04:27,600

they would get rebuffed but then someone

132

00:04:31,350 --> 00:04:29,199

who is on the periphery listening in

133

00:04:33,110 --> 00:04:31,360

would then advance those ideas and maybe

134

00:04:34,870 --> 00:04:33,120

they would be advanced to the level of

135

00:04:39,030 --> 00:04:34,880

becoming new fields in physics or

136

00:04:40,870 --> 00:04:39,040

insights or or inventions and so on

137

00:04:42,070 --> 00:04:40,880

can you give me some examples of that

138

00:04:44,790 --> 00:04:42,080

yeah it happened several

139

00:04:45,430 --> 00:04:44,800

times and you know early on in my career

140

00:04:54,070 --> 00:04:45,440

i

141

00:04:57,270 --> 00:04:54,080

proposed before

142

00:04:59,350 --> 00:04:57,280

i would advocate for it and uh very

143

00:05:02,950 --> 00:04:59,360

often i was disappointed because

144

00:05:04,230 --> 00:05:02,960

i'll give you an example um 21 years ago

145

00:05:15,670 --> 00:05:04,240

i

146

00:05:17,749 --> 00:05:15,680

and the the the depth

147

00:05:19,749 --> 00:05:17,759

of the gravitational potential well that

148

00:05:22,469 --> 00:05:19,759

they're embedded in so in other words

149

00:05:24,469 --> 00:05:22,479

if black holes grow they behave like

150

00:05:27,270 --> 00:05:24,479

kids you know they

151
00:05:29,590 --> 00:05:27,280
eat as much food as they can from the

152
00:05:31,830 --> 00:05:29,600
table until they become too energetic

153
00:05:32,950 --> 00:05:31,840
and then they throw off the food from

154
00:05:35,590 --> 00:05:32,960
the table and

155
00:05:36,230 --> 00:05:35,600
so if that's the case then black holes

156
00:05:39,590 --> 00:05:36,240
would grow

157
00:05:41,270 --> 00:05:39,600
up to a certain mass at which point they

158
00:05:43,510 --> 00:05:41,280
release so much energy they become so

159
00:05:46,070 --> 00:05:43,520
energetic that they clean off

160
00:05:47,670 --> 00:05:46,080
the food that allows them to continue to

161
00:05:50,310 --> 00:05:47,680
grow and

162
00:05:52,550 --> 00:05:50,320
so i suggested let's check if black hole

163
00:05:54,950 --> 00:05:52,560

masses are correlated with

164

00:05:56,870 --> 00:05:54,960

the depth of the gravitational potential

165

00:05:59,350 --> 00:05:56,880

well of the galaxy that hosts them

166

00:06:01,350 --> 00:05:59,360

and the way to measure that is by the

167

00:06:02,469 --> 00:06:01,360

speed by which stars are moving within

168

00:06:04,870 --> 00:06:02,479

that galaxy

169

00:06:06,390 --> 00:06:04,880

near the core of the galaxy and when i

170

00:06:08,550 --> 00:06:06,400

suggest that people said no

171

00:06:10,629 --> 00:06:08,560

that's not interesting it's it's

172

00:06:11,110 --> 00:06:10,639

probably there is nothing interesting in

173

00:06:14,309 --> 00:06:11,120

that

174

00:06:14,950 --> 00:06:14,319

relation and uh i remember mentioning it

175

00:06:17,029 --> 00:06:14,960

at the

176

00:06:18,230 --> 00:06:17,039

conference and it was completely

177

00:06:20,309 --> 00:06:18,240

rebuffed and then

178

00:06:21,670 --> 00:06:20,319

we had a junior faculty search at the

179

00:06:23,350 --> 00:06:21,680

astronomy department and

180

00:06:25,909 --> 00:06:23,360

as it happens in the short list there

181

00:06:27,990 --> 00:06:25,919

were two people working exactly on

182

00:06:29,270 --> 00:06:28,000

on the central black holes in galaxies

183

00:06:30,309 --> 00:06:29,280

and i suggested to both of them

184

00:06:33,029 --> 00:06:30,319

independently

185

00:06:35,590 --> 00:06:33,039

to check that then uh since they were

186

00:06:36,950 --> 00:06:35,600

young people they decided to do that and

187

00:06:38,550 --> 00:06:36,960

they had all the data

188

00:06:41,110 --> 00:06:38,560

in principle i could have done it as

189

00:06:43,029 --> 00:06:41,120

well anyway they did it and each of them

190

00:06:43,670 --> 00:06:43,039

got so excited a few months later they

191

00:06:45,909 --> 00:06:43,680

said

192

00:06:47,430 --> 00:06:45,919

wow there is a very tight correlation

193

00:06:50,390 --> 00:06:47,440

between the black hole mass and

194

00:06:52,309 --> 00:06:50,400

the characteristic speed of stars in in

195

00:06:55,430 --> 00:06:52,319

the galaxy that hosts it

196

00:06:57,350 --> 00:06:55,440

uh and then they decided to publish and

197

00:06:58,550 --> 00:06:57,360

they published exactly the same time the

198

00:07:00,550 --> 00:06:58,560

two teams

199

00:07:02,070 --> 00:07:00,560

and then they started fighting with each

200

00:07:04,469 --> 00:07:02,080

other for the credit because it becomes

201
00:07:07,670 --> 00:07:04,479
the hot the hottest thing in the field

202
00:07:09,670 --> 00:07:07,680
and then for for a decade it became the

203
00:07:12,150 --> 00:07:09,680
thing that everyone talks about and

204
00:07:14,230 --> 00:07:12,160
that was the first indication and then a

205
00:07:17,589 --> 00:07:14,240
couple of years later i

206
00:07:19,110 --> 00:07:17,599
uh suggested the to call i had a

207
00:07:21,110 --> 00:07:19,120
sabbatical

208
00:07:23,909 --> 00:07:21,120
at princeton and i suggested to a few

209
00:07:26,390 --> 00:07:23,919
people that were experts in

210
00:07:27,909 --> 00:07:26,400
black holes and and the info of gas onto

211
00:07:29,670 --> 00:07:27,919
black holes i suggested

212
00:07:31,830 --> 00:07:29,680
uh perhaps we should calculate what

213
00:07:33,749 --> 00:07:31,840

happens when there is a hot spot a

214

00:07:35,589 --> 00:07:33,759

region that is very bright orbiting a

215

00:07:37,909 --> 00:07:35,599

black hole very closely

216

00:07:39,990 --> 00:07:37,919

so that you can perhaps map the space

217

00:07:41,670 --> 00:07:40,000

and time around the black hole this way

218

00:07:43,270 --> 00:07:41,680

and they completely dismissed it and

219

00:07:45,670 --> 00:07:43,280

said well there would never be a hot

220

00:07:48,629 --> 00:07:45,680

spot that maintains its integrity that

221

00:07:49,270 --> 00:07:48,639

this is not worth doing uh and so i came

222

00:07:51,110 --> 00:07:49,280

back to

223

00:07:52,790 --> 00:07:51,120

to harvard after the sabbatical and i

224

00:07:54,550 --> 00:07:52,800

suggested it to a postdoc

225

00:07:55,909 --> 00:07:54,560

of mine and we did the calculation we

226

00:07:59,510 --> 00:07:55,919

wrote a few papers

227

00:08:00,950 --> 00:07:59,520

and then just a year and a half ago two

228

00:08:03,830 --> 00:08:00,960

years ago

229

00:08:04,869 --> 00:08:03,840

a group in germany uh discovered exactly

230

00:08:08,390 --> 00:08:04,879

that phenomena

231

00:08:09,589 --> 00:08:08,400

they found a hot spot moving around

232

00:08:12,150 --> 00:08:09,599

the black hole at the center of the

233

00:08:15,670 --> 00:08:12,160

milky way galaxy just in the way that we

234

00:08:17,589 --> 00:08:15,680

that i envisioned and they it was

235

00:08:18,950 --> 00:08:17,599

the hotspot was orbiting very close to

236

00:08:22,790 --> 00:08:18,960

the black hole and

237

00:08:24,469 --> 00:08:22,800

so once again um and then uh

238

00:08:26,790 --> 00:08:24,479

i can give you many more examples you

239

00:08:28,950 --> 00:08:26,800

know i gave for example a lecture on

240

00:08:30,150 --> 00:08:28,960

gravitational wave astrophysics which is

241

00:08:32,230 --> 00:08:30,160

a new way of

242

00:08:33,990 --> 00:08:32,240

doing astrophysics astrophysics

243

00:08:35,670 --> 00:08:34,000

traditionally astronomy was based on

244

00:08:37,750 --> 00:08:35,680

light collecting light

245

00:08:39,750 --> 00:08:37,760

but then according to einstein's theory

246

00:08:41,509 --> 00:08:39,760

of gravity when you have massive

247

00:08:44,070 --> 00:08:41,519

objects like black holes that are very

248

00:08:45,030 --> 00:08:44,080

compact they distort space and time

249

00:08:47,190 --> 00:08:45,040

around them and

250

00:08:48,070 --> 00:08:47,200

when they move close to each other they

251
00:08:49,670 --> 00:08:48,080
can send out

252
00:08:52,949 --> 00:08:49,680
waves and these are called gravitational

253
00:08:55,829 --> 00:08:52,959
waves and at the time it was 2013

254
00:08:57,269 --> 00:08:55,839
i thought it's an important subject for

255
00:08:59,110 --> 00:08:57,279
the coming years and

256
00:09:00,870 --> 00:08:59,120
i decided to give a lecture about it in

257
00:09:03,670 --> 00:09:00,880
a winter school for students

258
00:09:04,070 --> 00:09:03,680
and then 10 minutes into my talk one of

259
00:09:07,110 --> 00:09:04,080
the

260
00:09:09,430 --> 00:09:07,120
still

261
00:09:11,030 --> 00:09:09,440
is 20 years younger than me so it has

262
00:09:14,070 --> 00:09:11,040
nothing to do with age

263
00:09:17,110 --> 00:09:14,080

but he he's very conservative he's

264

00:09:18,150 --> 00:09:17,120

how long ago was this this was 2013

265

00:09:21,990 --> 00:09:18,160

january

266

00:09:23,750 --> 00:09:22,000

and he stood up and said

267

00:09:25,829 --> 00:09:23,760

why are you wasting the time of these

268

00:09:27,750 --> 00:09:25,839

graduate students on a subject that will

269

00:09:29,110 --> 00:09:27,760

clearly not be important during their

270

00:09:31,990 --> 00:09:29,120

lifetime

271

00:09:33,269 --> 00:09:32,000

for their careers uh and just two years

272

00:09:33,910 --> 00:09:33,279

later that's allowed in front of

273

00:09:35,990 --> 00:09:33,920

everyone

274

00:09:36,949 --> 00:09:36,000

in front of it yeah that's on video you

275

00:09:40,389 --> 00:09:36,959

can we can

276

00:09:43,430 --> 00:09:40,399

find it uh and you know he was uh

277

00:09:45,829 --> 00:09:43,440

much younger than i am working on

278

00:09:47,509 --> 00:09:45,839

uh star formation and so forth a

279

00:09:50,230 --> 00:09:47,519

conservative

280

00:09:51,350 --> 00:09:50,240

astronomer so to speak but young

281

00:09:53,750 --> 00:09:51,360

relatively young

282

00:09:55,350 --> 00:09:53,760

and so um two years later the ligo

283

00:09:58,630 --> 00:09:55,360

collaboration announced

284

00:10:03,269 --> 00:09:58,640

or discovered the announcement came

285

00:10:07,110 --> 00:10:03,279

uh six months later but then you know in

286

00:10:08,949 --> 00:10:07,120

in august 2015 it was discovered that

287

00:10:10,790 --> 00:10:08,959

there was an event a gravitational wave

288

00:10:13,590 --> 00:10:10,800

event discovered by ligo and that

289

00:10:15,509 --> 00:10:13,600

ushered a new era in astrophysics where

290

00:10:16,630 --> 00:10:15,519

gravitational waves are being used to

291

00:10:18,710 --> 00:10:16,640

discover

292

00:10:20,310 --> 00:10:18,720

objects that otherwise do not emit any

293

00:10:23,670 --> 00:10:20,320

light black holes that

294

00:10:26,310 --> 00:10:23,680

come together uh and the nobel prize was

295

00:10:28,870 --> 00:10:26,320

awarded for that a few years ago

296

00:10:31,190 --> 00:10:28,880

and clearly you know these the same

297

00:10:33,509 --> 00:10:31,200

students that were in the audience

298

00:10:35,110 --> 00:10:33,519

were still doing their phds where this

299

00:10:37,829 --> 00:10:35,120

discovery was made

300

00:10:39,430 --> 00:10:37,839

and so saying why are you wasting the

301
00:10:40,870 --> 00:10:39,440
time of these students on a subject that

302
00:10:42,470 --> 00:10:40,880
would never be important was clearly

303
00:10:44,470 --> 00:10:42,480
invalid

304
00:10:46,230 --> 00:10:44,480
and you know it happened to me many

305
00:10:47,829 --> 00:10:46,240
times and at some point like five years

306
00:10:50,069 --> 00:10:47,839
ago i said to myself

307
00:10:51,829 --> 00:10:50,079
the hell with it i i don't need

308
00:10:52,710 --> 00:10:51,839
confirmation from other people you know

309
00:10:54,550 --> 00:10:52,720
it's just

310
00:10:55,910 --> 00:10:54,560
well it makes you know it makes me

311
00:10:59,509 --> 00:10:55,920
depressed that to to

312
00:11:01,829 --> 00:10:59,519
listen to the criticism and then realize

313
00:11:03,829 --> 00:11:01,839

that the this is the the you know the

314

00:11:05,670 --> 00:11:03,839

hottest thing in in in the field later

315

00:11:07,910 --> 00:11:05,680

on a few years later so

316

00:11:09,350 --> 00:11:07,920

how is that possible well it is possible

317

00:11:11,269 --> 00:11:09,360

because uh

318

00:11:13,350 --> 00:11:11,279

people are not do not have the vision

319

00:11:15,829 --> 00:11:13,360

about the future and they're very

320

00:11:16,389 --> 00:11:15,839

they they prefer to dismiss a new you

321

00:11:19,509 --> 00:11:16,399

know

322

00:11:20,870 --> 00:11:19,519

forth just

323

00:11:22,310 --> 00:11:20,880

because it takes them out of their

324

00:11:24,069 --> 00:11:22,320

comfort zone they're used to doing

325

00:11:26,790 --> 00:11:24,079

business as usual and

326

00:11:27,190 --> 00:11:26,800

and so five years ago as or so i decided

327

00:11:29,590 --> 00:11:27,200

to

328

00:11:31,750 --> 00:11:29,600

basically not listen and just do what i

329

00:11:34,949 --> 00:11:31,760

think is right based on

330

00:11:35,430 --> 00:11:34,959

my inner compass and you can see that

331

00:11:39,350 --> 00:11:35,440

that

332

00:11:41,269 --> 00:11:39,360

nowadays you know as a young

333

00:11:43,670 --> 00:11:41,279

scientist i would never be able to

334

00:11:45,590 --> 00:11:43,680

sustain the pressure the the

335

00:11:47,190 --> 00:11:45,600

social pressure that exists around me

336

00:11:49,829 --> 00:11:47,200

right now but um

337

00:11:51,430 --> 00:11:49,839

i'm sort of immune to it by now what

338

00:11:52,550 --> 00:11:51,440

social pressure exists around you right

339

00:11:55,350 --> 00:11:52,560

now what are you referring to

340

00:11:56,310 --> 00:11:55,360

also why did it take you i don't know

341

00:11:58,870 --> 00:11:56,320

how old you are

342

00:11:59,670 --> 00:11:58,880

but why did it take you 59. uh so yeah

343

00:12:01,910 --> 00:11:59,680

it takes me

344

00:12:03,829 --> 00:12:01,920

54. yeah why did it take you until

345

00:12:05,030 --> 00:12:03,839

you're 54. i imagine that

346

00:12:07,190 --> 00:12:05,040

if this occurred to you when you were in

347

00:12:09,190 --> 00:12:07,200

your late 20s maybe three times then by

348

00:12:09,990 --> 00:12:09,200

the time you're 33 or 35 you would say

349

00:12:11,990 --> 00:12:10,000

okay to heck

350

00:12:13,990 --> 00:12:12,000

with it forget what other people think

351
00:12:14,550 --> 00:12:14,000
well maybe i'm a slow learner maybe i'm

352
00:12:16,949 --> 00:12:14,560
also

353
00:12:19,110 --> 00:12:16,959
um you know i do care about what people

354
00:12:20,150 --> 00:12:19,120
i did care about what people think early

355
00:12:22,710 --> 00:12:20,160
on and

356
00:12:24,230 --> 00:12:22,720
you have to understand the entire um

357
00:12:27,030 --> 00:12:24,240
structure of academia

358
00:12:28,790 --> 00:12:27,040
uh relies on other people evaluating

359
00:12:31,910 --> 00:12:28,800
your you throughout

360
00:12:33,430 --> 00:12:31,920
the various stages in order to get

361
00:12:35,269 --> 00:12:33,440
tenure you need a

362
00:12:36,949 --> 00:12:35,279
tenure committee to recommend and that

363
00:12:38,870 --> 00:12:36,959

is based on letters that are obtained

364

00:12:41,590 --> 00:12:38,880
from the community at large so

365

00:12:42,150 --> 00:12:41,600
you need to dance to the music of a lot

366

00:12:45,350 --> 00:12:42,160
of people

367

00:12:47,750 --> 00:12:45,360
in order to be sort of tenured

368

00:12:48,790 --> 00:12:47,760
uh and then the same is true about

369

00:12:51,269 --> 00:12:48,800
getting grants

370

00:12:51,990 --> 00:12:51,279
grant support is you know the selection

371

00:12:55,030 --> 00:12:52,000
committee

372

00:12:56,629 --> 00:12:55,040
that are

373

00:12:58,150 --> 00:12:56,639
mainstream and they have their own

374

00:13:01,350 --> 00:12:58,160
agenda and

375

00:13:04,310 --> 00:13:01,360
they don't welcome innovation as much

376

00:13:06,230 --> 00:13:04,320

uh and to me it's still a miracle that

377

00:13:08,310 --> 00:13:06,240

the ligo experiment was funded in the

378

00:13:10,150 --> 00:13:08,320

first place i was told by

379

00:13:12,069 --> 00:13:10,160

uh important people at the national

380

00:13:15,670 --> 00:13:12,079

science foundation that

381

00:13:17,269 --> 00:13:15,680

nowadays at present time the likelihood

382

00:13:18,389 --> 00:13:17,279

of it being funded would have been very

383

00:13:21,190 --> 00:13:18,399

small it was

384

00:13:23,030 --> 00:13:21,200

the vision of a few people a couple of

385

00:13:25,269 --> 00:13:23,040

decades ago that pushed it through

386

00:13:26,389 --> 00:13:25,279

um it's really hard to imagine that

387

00:13:28,310 --> 00:13:26,399

nowadays

388

00:13:30,870 --> 00:13:28,320

uh the national science foundation or

389

00:13:33,430 --> 00:13:30,880

other federal agencies would

390

00:13:33,990 --> 00:13:33,440

receive an advice from the scientific

391

00:13:37,269 --> 00:13:34,000

community

392

00:13:37,670 --> 00:13:37,279

to embark on a risky project of this

393

00:13:39,430 --> 00:13:37,680

type

394

00:13:41,670 --> 00:13:39,440

and it was not at all clear that it will

395

00:13:43,910 --> 00:13:41,680

reach the sensitivity necessary

396

00:13:46,550 --> 00:13:43,920

and so you know you're you're dependent

397

00:13:50,389 --> 00:13:46,560

throughout your career on many people

398

00:13:50,949 --> 00:13:50,399

that will approve uh your your agenda

399

00:13:52,949 --> 00:13:50,959

and

400

00:13:53,990 --> 00:13:52,959

uh as a result you develop the mentality

401
00:13:55,829 --> 00:13:54,000
of um

402
00:13:57,829 --> 00:13:55,839
listening and and paying attention and

403
00:13:58,310 --> 00:13:57,839
not not deviating too much from the

404
00:14:01,509 --> 00:13:58,320
beaten

405
00:14:04,069 --> 00:14:01,519
path and then that that is

406
00:14:05,509 --> 00:14:04,079
quite common what is not common is

407
00:14:07,990 --> 00:14:05,519
someone like me that

408
00:14:08,710 --> 00:14:08,000
reaches leadership positions you know i

409
00:14:10,069 --> 00:14:08,720
i've been

410
00:14:11,829 --> 00:14:10,079
chair of the astronomy department at

411
00:14:14,550 --> 00:14:11,839
harvard for nine years and

412
00:14:16,230 --> 00:14:14,560
i've chaired many important committees

413
00:14:19,670 --> 00:14:16,240

someone at that level often

414

00:14:23,189 --> 00:14:19,680

um you know behaves

415

00:14:26,230 --> 00:14:23,199

even more as a conformist because

416

00:14:28,470 --> 00:14:26,240

uh because of political consideration

417

00:14:29,750 --> 00:14:28,480

um you have to understand it's just like

418

00:14:31,990 --> 00:14:29,760

looking at the

419

00:14:33,189 --> 00:14:32,000

seashells on the beach you know when a

420

00:14:35,430 --> 00:14:33,199

seashell

421

00:14:37,670 --> 00:14:35,440

first arrives at the beach it looks

422

00:14:40,470 --> 00:14:37,680

special and unique it has special color

423

00:14:42,310 --> 00:14:40,480

special shape but as time goes on you

424

00:14:44,949 --> 00:14:42,320

know the waves

425

00:14:46,310 --> 00:14:44,959

rub seashells against each other and

426
00:14:48,870 --> 00:14:46,320
then they start

427
00:14:49,990 --> 00:14:48,880
to lose their identity and they start to

428
00:14:53,110 --> 00:14:50,000
look like each other

429
00:14:56,030 --> 00:14:53,120
and eventually you end up with sea sand

430
00:14:58,310 --> 00:14:56,040
basically pieces of seashells that are

431
00:15:00,870 --> 00:14:58,320
indistinguishable from each other

432
00:15:01,509 --> 00:15:00,880
and that's what happens in academia you

433
00:15:03,910 --> 00:15:01,519
know each

434
00:15:05,030 --> 00:15:03,920
in the each individual researcher starts

435
00:15:07,750 --> 00:15:05,040
different

436
00:15:09,829 --> 00:15:07,760
but then you rub against many others and

437
00:15:11,350 --> 00:15:09,839
you end up being indistinguishable from

438
00:15:12,790 --> 00:15:11,360

them

439

00:15:15,030 --> 00:15:12,800

okay when i hear that here's what i'm

440

00:15:16,710 --> 00:15:15,040

thinking there's this it's not a quote

441

00:15:17,189 --> 00:15:16,720

but it's a story from steve jobs and he

442

00:15:18,710 --> 00:15:17,199

said

443

00:15:20,470 --> 00:15:18,720

almost the opposite so there it's

444

00:15:21,990 --> 00:15:20,480

obviously a happy middle he said

445

00:15:23,750 --> 00:15:22,000

what you want to do is take people who

446

00:15:25,269 --> 00:15:23,760

are like rocks that are unpolished

447

00:15:26,790 --> 00:15:25,279

and then put them into a rock tumbler

448

00:15:29,749 --> 00:15:26,800

because afterwards they come out like

449

00:15:31,990 --> 00:15:29,759

diamonds so you want to take intelligent

450

00:15:34,150 --> 00:15:32,000

smart people and have them argue

451

00:15:36,150 --> 00:15:34,160

i can see this well as long as the

452

00:15:37,030 --> 00:15:36,160

argument is accepted you know as long as

453

00:15:39,910 --> 00:15:37,040

it's a la

454

00:15:40,629 --> 00:15:39,920

so if you create an environment where

455

00:15:42,470 --> 00:15:40,639

people are

456

00:15:45,110 --> 00:15:42,480

encouraged to challenge each other to

457

00:15:48,470 --> 00:15:45,120

come up with original ideas

458

00:15:50,790 --> 00:15:48,480

to be different then that is

459

00:15:51,590 --> 00:15:50,800

i completely agree that that experience

460

00:15:55,430 --> 00:15:51,600

of

461

00:15:58,150 --> 00:15:55,440

argument and exchanges is helpful but

462

00:15:59,350 --> 00:15:58,160

but if on the other hand you create an

463

00:16:02,069 --> 00:15:59,360

environment where

464

00:16:02,550 --> 00:16:02,079

you know the dominant view where there

465

00:16:05,590 --> 00:16:02,560

is

466

00:16:09,189 --> 00:16:05,600

a group thing where the uh the

467

00:16:10,790 --> 00:16:09,199

folklore of a field dominates and anyone

468

00:16:12,310 --> 00:16:10,800

that suggests something different is

469

00:16:13,829 --> 00:16:12,320

pushed aside

470

00:16:15,670 --> 00:16:13,839

that is bad and that's what i was

471

00:16:17,749 --> 00:16:15,680

referring to uh-huh

472

00:16:18,710 --> 00:16:17,759

uh-huh so if it's geared toward

473

00:16:21,110 --> 00:16:18,720

constructing

474

00:16:22,949 --> 00:16:21,120

and also if it's geared toward some goal

475

00:16:24,870 --> 00:16:22,959

yeah if you look for example

476
00:16:27,509 --> 00:16:24,880
if you look for example i mean the ideal

477
00:16:30,550 --> 00:16:27,519
example is the corridor of bellaps

478
00:16:31,829 --> 00:16:30,560
you know bellaps was established by a

479
00:16:34,949 --> 00:16:31,839
corporation

480
00:16:36,949 --> 00:16:34,959
that has a profit in mind but then in

481
00:16:37,990 --> 00:16:36,959
that corridor they put very creative

482
00:16:39,910 --> 00:16:38,000
people

483
00:16:41,350 --> 00:16:39,920
uh and you know some of them ended up

484
00:16:42,870 --> 00:16:41,360
winning the nobel prize there were lots

485
00:16:44,629 --> 00:16:42,880
of inventions that came out of the

486
00:16:48,230 --> 00:16:44,639
corridor of bellaps

487
00:16:50,230 --> 00:16:48,240
and so putting a lot of creative people

488
00:16:51,350 --> 00:16:50,240

in the same environment and allowing

489

00:16:54,470 --> 00:16:51,360

them

490

00:16:56,710 --> 00:16:54,480

to innovate

491

00:16:58,710 --> 00:16:56,720

that is the right right right and so i

492

00:16:59,509 --> 00:16:58,720

in that sense i would agree with jobs

493

00:17:01,030 --> 00:16:59,519

that

494

00:17:02,629 --> 00:17:01,040

you know putting them next to each other

495

00:17:05,270 --> 00:17:02,639

is beneficial

496

00:17:06,789 --> 00:17:05,280

but if you on the other hand you put

497

00:17:09,189 --> 00:17:06,799

people together and exert

498

00:17:10,390 --> 00:17:09,199

pressure so that you know they do not

499

00:17:11,990 --> 00:17:10,400

deviate

500

00:17:13,829 --> 00:17:12,000

from what everyone else is thinking

501
00:17:15,429 --> 00:17:13,839
that's bad

502
00:17:16,870 --> 00:17:15,439
so right now the incentives are geared

503
00:17:19,270 --> 00:17:16,880
towards self-preservation or

504
00:17:20,230 --> 00:17:19,280
idea preservation yeah and what can be

505
00:17:21,429 --> 00:17:20,240
done to fix this

506
00:17:22,789 --> 00:17:21,439
one of the questions that i had from the

507
00:17:23,909 --> 00:17:22,799
audience was let's imagine there are

508
00:17:25,829 --> 00:17:23,919
some wacky ideas

509
00:17:27,909 --> 00:17:25,839
obviously you don't want to let in just

510
00:17:29,750 --> 00:17:27,919
any idea there is something

511
00:17:31,110 --> 00:17:29,760
to be said about being too fringe but

512
00:17:31,990 --> 00:17:31,120
then there is something to be said about

513
00:17:35,110 --> 00:17:32,000

having permeable

514

00:17:36,070 --> 00:17:35,120

walls right how do you fix this system

515

00:17:39,110 --> 00:17:36,080

quote unquote

516

00:17:41,669 --> 00:17:39,120

well very very very easily um you

517

00:17:42,310 --> 00:17:41,679

basically evaluate each idea on its

518

00:17:46,230 --> 00:17:42,320

merit

519

00:17:48,870 --> 00:17:46,240

um so the the point is you are not

520

00:17:49,430 --> 00:17:48,880

evaluating the person that mentioned

521

00:17:52,710 --> 00:17:49,440

that

522

00:17:57,029 --> 00:17:52,720

you you're not uh using

523

00:17:59,990 --> 00:17:57,039

uh you know uh the personal traits as a

524

00:18:00,870 --> 00:18:00,000

a way of dismissing an idea which is

525

00:18:02,789 --> 00:18:00,880

very often done

526

00:18:04,870 --> 00:18:02,799

very often the attacks are personal if

527

00:18:05,590 --> 00:18:04,880

you if you see in politics it's very

528

00:18:07,350 --> 00:18:05,600

common

529

00:18:09,029 --> 00:18:07,360

in science it should not be the case in

530

00:18:09,590 --> 00:18:09,039

science we should argue about the ideas

531

00:18:11,190 --> 00:18:09,600

about

532

00:18:12,870 --> 00:18:11,200

and if an idea doesn't make sense you

533

00:18:15,669 --> 00:18:12,880

can easily prove that

534

00:18:17,029 --> 00:18:15,679

um so let me give you a counter you know

535

00:18:20,150 --> 00:18:17,039

like an example

536

00:18:23,590 --> 00:18:20,160

that comes from the opposite side so um

537

00:18:26,070 --> 00:18:23,600

for example with respect to a muammua um

538

00:18:28,549 --> 00:18:26,080

i suggested that it may be of artificial

539

00:18:30,789 --> 00:18:28,559

origin as a possibility and that was

540

00:18:32,150 --> 00:18:30,799

that encountered a lot of opposition now

541

00:18:35,270 --> 00:18:32,160

the latest

542

00:18:38,310 --> 00:18:35,280

alternative to that was that maybe it so

543

00:18:39,510 --> 00:18:38,320

maybe it is a nitrogen iceberg that was

544

00:18:41,909 --> 00:18:39,520

a suggestion and

545

00:18:42,630 --> 00:18:41,919

uh for you can find nitrogen pure

546

00:18:45,190 --> 00:18:42,640

nitrogen

547

00:18:46,549 --> 00:18:45,200

as you need in this case uh in order to

548

00:18:47,990 --> 00:18:46,559

explain the fact we haven't seen a

549

00:18:50,710 --> 00:18:48,000

cometary tail around the

550

00:18:52,230 --> 00:18:50,720

moa and also that it's flat and that is

551
00:18:54,230 --> 00:18:52,240
it was pushed from the

552
00:18:56,390 --> 00:18:54,240
away from the sun all of these facts

553
00:18:58,310 --> 00:18:56,400
will come into uh

554
00:18:59,510 --> 00:18:58,320
we could be explained if it was made of

555
00:19:01,350 --> 00:18:59,520
pure nitrogen and

556
00:19:02,630 --> 00:19:01,360
pure nitrogen for example exists on the

557
00:19:04,870 --> 00:19:02,640
surface of pluto

558
00:19:07,350 --> 00:19:04,880
so the suggestion was let's imagine a

559
00:19:10,150 --> 00:19:07,360
lot of pluto's around other stars

560
00:19:12,470 --> 00:19:10,160
and you chip off their surface with a

561
00:19:14,950 --> 00:19:12,480
high efficiency more than ten percent

562
00:19:16,070 --> 00:19:14,960
uh of all the pluto's are being chipped

563
00:19:18,470 --> 00:19:16,080

off the

564

00:19:20,230 --> 00:19:18,480

and then you send out these rocks and

565

00:19:23,430 --> 00:19:20,240

one of them is

566

00:19:26,789 --> 00:19:23,440

and okay i said they're fine

567

00:19:27,990 --> 00:19:26,799

and then i wrote a paper just a week and

568

00:19:30,070 --> 00:19:28,000

a half ago saying

569

00:19:31,430 --> 00:19:30,080

well if you imagine that to be the case

570

00:19:35,029 --> 00:19:31,440

and it you end up

571

00:19:36,630 --> 00:19:35,039

needing more mass than you have in stars

572

00:19:39,029 --> 00:19:36,640

in the milky way galaxy

573

00:19:39,909 --> 00:19:39,039

by a factor of a hundred actually turns

574

00:19:42,630 --> 00:19:39,919

out

575

00:19:43,909 --> 00:19:42,640

uh and so um what do you mean by that

576

00:19:45,909 --> 00:19:43,919

sorry what do you mean by that and

577

00:19:47,669 --> 00:19:45,919

are you referring to the work by desk

578

00:19:51,029 --> 00:19:47,679

and jackson i believe

579

00:19:53,669 --> 00:19:51,039

dash and jackson yes exactly um

580

00:19:54,549 --> 00:19:53,679

and the reason for that is you know the

581

00:19:57,350 --> 00:19:54,559

the layer

582

00:19:57,990 --> 00:19:57,360

of pure nitrogen on the surface of pluto

583

00:20:01,029 --> 00:19:58,000

is

584

00:20:03,350 --> 00:20:01,039

relatively thin uh so it just makes

585

00:20:04,789 --> 00:20:03,360

a few percent of the mass of pluto most

586

00:20:08,870 --> 00:20:04,799

of most of the mass

587

00:20:12,470 --> 00:20:08,880

is uh you know in in in rock and water

588

00:20:15,669 --> 00:20:12,480

ice and so forth um so

589

00:20:17,909 --> 00:20:15,679

you lose by that and then

590

00:20:20,310 --> 00:20:17,919

so for every bit of nitrogen that you

591

00:20:23,110 --> 00:20:20,320

produce you need much more rock and and

592

00:20:23,830 --> 00:20:23,120

water ice to exist and then on top of

593

00:20:26,070 --> 00:20:23,840

that you need

594

00:20:27,750 --> 00:20:26,080

hydrogen and helium that are much more

595

00:20:29,350 --> 00:20:27,760

abundant than rock so if you do that

596

00:20:32,390 --> 00:20:29,360

just a must budget

597

00:20:33,510 --> 00:20:32,400

how much mass do you need to process in

598

00:20:35,750 --> 00:20:33,520

order to make

599

00:20:37,350 --> 00:20:35,760

enough objects so that you would see one

600

00:20:39,430 --> 00:20:37,360

of them

601
00:20:41,190 --> 00:20:39,440
and we know that you need to produce a

602
00:20:43,669 --> 00:20:41,200
certain you know

603
00:20:45,270 --> 00:20:43,679
uh number of such objects per unit

604
00:20:46,950 --> 00:20:45,280
volume so that we would see one of them

605
00:20:48,870 --> 00:20:46,960
coming within a few years of

606
00:20:50,470 --> 00:20:48,880
the time that we were observing the sky

607
00:20:51,909 --> 00:20:50,480
you know with pan stars

608
00:20:53,270 --> 00:20:51,919
so basically if you just go through the

609
00:20:54,710 --> 00:20:53,280
math which is really simple

610
00:20:56,870 --> 00:20:54,720
straightforward

611
00:20:58,549 --> 00:20:56,880
and also they required that it would

612
00:21:00,789 --> 00:20:58,559
then you know

613
00:21:02,549 --> 00:21:00,799

this object would be just half a billion

614

00:21:05,029 --> 00:21:02,559

years old because otherwise it

615

00:21:06,470 --> 00:21:05,039

would get completely evaporated so if

616

00:21:07,750 --> 00:21:06,480

you put all of these considerations

617

00:21:09,830 --> 00:21:07,760

together you find that

618

00:21:11,669 --> 00:21:09,840

you need a hundred times more mass than

619

00:21:13,270 --> 00:21:11,679

you have available in stars

620

00:21:15,190 --> 00:21:13,280

so even if you take all the mass in

621

00:21:16,630 --> 00:21:15,200

stars multiply by a hundred only then

622

00:21:20,390 --> 00:21:16,640

you will have enough

623

00:21:24,470 --> 00:21:20,400

surface layers of exoplutos

624

00:21:27,430 --> 00:21:24,480

or or pluto like planets around other

625

00:21:30,149 --> 00:21:27,440

stars to make enough objects like a momo

626
00:21:33,190 --> 00:21:30,159
so that you would see one of them during

627
00:21:35,110 --> 00:21:33,200
that mode of observations and then so to

628
00:21:35,590 --> 00:21:35,120
me it makes this scenario very unlikely

629
00:21:37,990 --> 00:21:35,600
so

630
00:21:40,390 --> 00:21:38,000
i just mentioned that you know as an

631
00:21:43,350 --> 00:21:40,400
example of how a scientific debate

632
00:21:44,070 --> 00:21:43,360
should should go uh someone proposes an

633
00:21:47,350 --> 00:21:44,080
idea

634
00:21:49,029 --> 00:21:47,360
merit and you know if they

635
00:21:51,190 --> 00:21:49,039
if you do a calculation that shows that

636
00:21:53,270 --> 00:21:51,200
something is problematic with that

637
00:21:54,310 --> 00:21:53,280
you know that that is a a reason for

638
00:21:57,110 --> 00:21:54,320

concern and

639

00:21:57,990 --> 00:21:57,120

for working on something else so that is

640

00:22:00,149 --> 00:21:58,000

a scientific debate

641

00:22:02,310 --> 00:22:00,159

on the other hand if someone goes to

642

00:22:02,870 --> 00:22:02,320

twitter and says something negative

643

00:22:06,390 --> 00:22:02,880

about

644

00:22:08,390 --> 00:22:06,400

a paper and just doesn't even read it

645

00:22:09,590 --> 00:22:08,400

or or says something negative about a

646

00:22:11,510 --> 00:22:09,600

person

647

00:22:13,190 --> 00:22:11,520

without referring to the details of the

648

00:22:14,950 --> 00:22:13,200

idea or says something negative about

649

00:22:16,789 --> 00:22:14,960

the reference list of a paper rather

650

00:22:18,950 --> 00:22:16,799

than the content of the paper

651
00:22:20,710 --> 00:22:18,960
you know that that is not a viable

652
00:22:24,470 --> 00:22:20,720
scientific discussion so

653
00:22:27,270 --> 00:22:24,480
my point is we can maintain a high level

654
00:22:29,350 --> 00:22:27,280
of integrity in the scientific process

655
00:22:29,909 --> 00:22:29,360
if we just refer to the ideas rather

656
00:22:32,310 --> 00:22:29,919
than

657
00:22:33,909 --> 00:22:32,320
attack people personally and that's the

658
00:22:36,470 --> 00:22:33,919
way we should proceed and

659
00:22:37,990 --> 00:22:36,480
you know most of the time in science you

660
00:22:39,909 --> 00:22:38,000
have to understand most of the time

661
00:22:41,430 --> 00:22:39,919
things are uncertain we just don't have

662
00:22:43,270 --> 00:22:41,440
enough evidence

663
00:22:45,350 --> 00:22:43,280

and therefore we should contemplate

664

00:22:47,190 --> 00:22:45,360

possibilities and that's legitimate

665

00:22:50,230 --> 00:22:47,200

that's part of the scientific process

666

00:22:52,390 --> 00:22:50,240

you can't skip that step you can't say

667

00:22:54,149 --> 00:22:52,400

i know the answer and i don't want to

668

00:22:55,990 --> 00:22:54,159

dismiss other possibilities

669

00:22:58,870 --> 00:22:56,000

even though there is not enough evidence

670

00:23:03,350 --> 00:22:58,880

for your answer to be right

671

00:23:05,430 --> 00:23:03,360

so i think it's good to have

672

00:23:07,029 --> 00:23:05,440

ideas on the table that are viable

673

00:23:09,669 --> 00:23:07,039

scientifically

674

00:23:10,789 --> 00:23:09,679

because then we are exploring exploring

675

00:23:12,789 --> 00:23:10,799

all possibilities and

676

00:23:13,909 --> 00:23:12,799

by the way imagination is extremely

677

00:23:15,590 --> 00:23:13,919

important because

678

00:23:17,190 --> 00:23:15,600

we can't just always restrict our

679

00:23:18,230 --> 00:23:17,200

attention to things that we know from

680

00:23:20,230 --> 00:23:18,240

the past

681

00:23:21,590 --> 00:23:20,240

we will never discover new things that

682

00:23:23,590 --> 00:23:21,600

way

683

00:23:25,270 --> 00:23:23,600

what's jackson's and dash's response to

684

00:23:28,070 --> 00:23:25,280

this i don't know

685

00:23:28,870 --> 00:23:28,080

haven't i all i have seen are personal

686

00:23:30,470 --> 00:23:28,880

attacks

687

00:23:31,990 --> 00:23:30,480

uh not necessarily from them but from

688

00:23:33,590 --> 00:23:32,000

other people

689

00:23:35,510 --> 00:23:33,600

and is that the social pressure that you

690

00:23:36,470 --> 00:23:35,520

were referring to before that previously

691

00:23:37,990 --> 00:23:36,480

let's say five years

692

00:23:40,230 --> 00:23:38,000

younger you wouldn't have been able to

693

00:23:40,549 --> 00:23:40,240

withstand that's a low level you know

694

00:23:43,350 --> 00:23:40,559

that

695

00:23:44,870 --> 00:23:43,360

what you find on on social media which i

696

00:23:46,710 --> 00:23:44,880

you know i don't have any account on

697

00:23:47,190 --> 00:23:46,720

social media so i'm less exposed to that

698

00:23:49,029 --> 00:23:47,200

but

699

00:23:50,230 --> 00:23:49,039

and i'm very grateful for that um you

700

00:23:52,470 --> 00:23:50,240

know i decided

701
00:23:54,789 --> 00:23:52,480
not to have any account when i married

702
00:23:57,269 --> 00:23:54,799
my wife she asked me not to do that

703
00:23:58,390 --> 00:23:57,279
and so i uh agreed not to do that and

704
00:24:00,710 --> 00:23:58,400
i'm and that was

705
00:24:02,390 --> 00:24:00,720
more than 20 years ago and i'm very glad

706
00:24:03,590 --> 00:24:02,400
that i i don't have an account on social

707
00:24:06,549 --> 00:24:03,600
media because

708
00:24:08,390 --> 00:24:06,559
um then i can think creatively and not

709
00:24:09,590 --> 00:24:08,400
be affected i mean of course i'm losing

710
00:24:11,590 --> 00:24:09,600
on some

711
00:24:13,269 --> 00:24:11,600
bits of information that are floating

712
00:24:14,070 --> 00:24:13,279
around on social media but i benefit

713
00:24:17,510 --> 00:24:14,080

much more

714

00:24:19,110 --> 00:24:17,520

by not listening to you know low level

715

00:24:21,029 --> 00:24:19,120

discussions i'm i'm

716

00:24:22,710 --> 00:24:21,039

keeping my eyes on the ball so to speak

717

00:24:25,990 --> 00:24:22,720

not on the audience

718

00:24:28,070 --> 00:24:26,000

uh and so um

719

00:24:30,149 --> 00:24:28,080

so that's one kind of pressure that you

720

00:24:32,789 --> 00:24:30,159

find them on social media but

721

00:24:34,470 --> 00:24:32,799

um i'm sort of resilient to that because

722

00:24:37,669 --> 00:24:34,480

i i don't

723

00:24:38,070 --> 00:24:37,679

monitor it uh but then there are of

724

00:24:41,110 --> 00:24:38,080

course

725

00:24:41,510 --> 00:24:41,120

um you know there are other ways that

726
00:24:43,190 --> 00:24:41,520
people

727
00:24:44,630 --> 00:24:43,200
exert pressure through students and

728
00:24:47,269 --> 00:24:44,640
postdocs you know they are much more

729
00:24:50,630 --> 00:24:47,279
vulnerable they they don't have

730
00:24:53,029 --> 00:24:50,640
uh secure positions so

731
00:24:55,269 --> 00:24:53,039
uh if you create an atmosphere where

732
00:24:56,230 --> 00:24:55,279
some ideas are ridiculed and postdocs

733
00:24:58,789 --> 00:24:56,240
and students

734
00:25:01,110 --> 00:24:58,799
are simply afraid of pursuing them

735
00:25:01,590 --> 00:25:01,120
because of their future careers you know

736
00:25:03,990 --> 00:25:01,600
and

737
00:25:06,149 --> 00:25:04,000
i got a lot of emails from people saying

738
00:25:08,390 --> 00:25:06,159

you know i completely agree with you

739

00:25:10,310 --> 00:25:08,400

uh but i cannot express myself because i

740

00:25:11,669 --> 00:25:10,320

worry about my job prospects and

741

00:25:13,669 --> 00:25:11,679

and that comes from people that are

742

00:25:15,029 --> 00:25:13,679

reality not necessarily at the lowest

743

00:25:17,110 --> 00:25:15,039

level of academia

744

00:25:19,830 --> 00:25:17,120

even people that are you know have

745

00:25:22,870 --> 00:25:19,840

secure positions are worried about that

746

00:25:27,510 --> 00:25:22,880

and then you know this this is unhealthy

747

00:25:30,950 --> 00:25:27,520

um because we want uh an open discussion

748

00:25:32,310 --> 00:25:30,960

uh and scientific discussions a

749

00:25:35,350 --> 00:25:32,320

discussion based on

750

00:25:39,430 --> 00:25:35,360

content not on on the way things

751
00:25:40,710 --> 00:25:39,440
look like or on personal attacks

752
00:25:43,029 --> 00:25:40,720
why is it you think aliens are

753
00:25:44,470 --> 00:25:43,039
considered to be unconventional or so

754
00:25:46,630 --> 00:25:44,480
unconventional that they don't merit

755
00:25:47,510 --> 00:25:46,640
an academic response or an academic

756
00:25:49,669 --> 00:25:47,520
investigation

757
00:25:52,230 --> 00:25:49,679
well there are several aspects first of

758
00:25:54,950 --> 00:25:52,240
all as we discussed before

759
00:25:55,430 --> 00:25:54,960
many ideas are ridiculed for no good

760
00:25:57,430 --> 00:25:55,440
reason

761
00:25:58,549 --> 00:25:57,440
even in the context of black holes or

762
00:26:01,269 --> 00:25:58,559
gravitational waves

763
00:26:02,630 --> 00:26:01,279

as i mentioned to you i remember when i

764

00:26:05,830 --> 00:26:02,640
started

765

00:26:07,909 --> 00:26:05,840
as a postdoc the idea of inflation

766

00:26:08,870 --> 00:26:07,919
cosmic inflation was ridiculed in some

767

00:26:11,669 --> 00:26:08,880
circles of

768

00:26:12,470 --> 00:26:11,679
astronomy so that happens all the time

769

00:26:14,950 --> 00:26:12,480
except

770

00:26:16,950 --> 00:26:14,960
in the and and of course the the search

771

00:26:19,510 --> 00:26:16,960
for extraterrestrial intelligence

772

00:26:20,950 --> 00:26:19,520
you know started 70 years ago so it has

773

00:26:23,350 --> 00:26:20,960
a long history

774

00:26:24,789 --> 00:26:23,360
in the early days it wasn't ridiculed as

775

00:26:27,590 --> 00:26:24,799
much but

776

00:26:29,269 --> 00:26:27,600

but every now and then you know there

777

00:26:30,470 --> 00:26:29,279

was a very negative response of the

778

00:26:33,190 --> 00:26:30,480

community and

779

00:26:34,870 --> 00:26:33,200

since 93 there is no significant federal

780

00:26:36,789 --> 00:26:34,880

funding for this

781

00:26:37,990 --> 00:26:36,799

subject and as a result it was pushed

782

00:26:41,510 --> 00:26:38,000

aside now

783

00:26:45,110 --> 00:26:41,520

the strange thing is that um

784

00:26:47,269 --> 00:26:45,120

for example in in particle physics

785

00:26:48,549 --> 00:26:47,279

uh there was the super conducting super

786

00:26:52,070 --> 00:26:48,559

collider a very big

787

00:26:55,029 --> 00:26:52,080

experimental project that uh

788

00:26:56,630 --> 00:26:55,039

at some point you know the funding for

789

00:26:58,310 --> 00:26:56,640

it stopped and

790

00:26:59,669 --> 00:26:58,320

and then what happened in theoretical

791

00:27:01,750 --> 00:26:59,679

physics is that

792

00:27:03,669 --> 00:27:01,760

that there was a whole culture that

793

00:27:06,710 --> 00:27:03,679

developed after that

794

00:27:07,750 --> 00:27:06,720

that is divorced from feedback from

795

00:27:10,710 --> 00:27:07,760

experiments

796

00:27:11,669 --> 00:27:10,720

and it uh this culture of theoretical

797

00:27:14,470 --> 00:27:11,679

physics became

798

00:27:15,669 --> 00:27:14,480

string theory and the discussions of the

799

00:27:17,990 --> 00:27:15,679

multiverse

800

00:27:20,389 --> 00:27:18,000

and and the extra dimensions and so

801
00:27:23,909 --> 00:27:20,399
forth ideas that have no

802
00:27:24,549 --> 00:27:23,919
evidence to support them so on the one

803
00:27:26,549 --> 00:27:24,559
hand

804
00:27:27,669 --> 00:27:26,559
you have a situation where the

805
00:27:30,470 --> 00:27:27,679
mainstream in

806
00:27:31,669 --> 00:27:30,480
theoretical physics discusses concepts

807
00:27:35,029 --> 00:27:31,679
that have

808
00:27:38,070 --> 00:27:35,039
no foundation in experimental

809
00:27:40,389 --> 00:27:38,080
data and that is accepted

810
00:27:42,070 --> 00:27:40,399
and you know the there are big

811
00:27:43,190 --> 00:27:42,080
communities of people working on these

812
00:27:46,230 --> 00:27:43,200
ideas with

813
00:27:47,590 --> 00:27:46,240

and and they are not even interested in

814

00:27:48,950 --> 00:27:47,600

testing the idea so so

815

00:27:50,950 --> 00:27:48,960

most of the papers are about

816

00:27:53,029 --> 00:27:50,960

mathematical details not about how to

817

00:27:55,430 --> 00:27:53,039

test one idea versus another

818

00:27:57,029 --> 00:27:55,440

and if you suggest the test they shy

819

00:27:58,789 --> 00:27:57,039

away from it and try to

820

00:28:02,070 --> 00:27:58,799

sort of raise enough dust so that you

821

00:28:04,710 --> 00:28:02,080

won't be able to to rule out the theory

822

00:28:06,230 --> 00:28:04,720

and so that's one culture and at the

823

00:28:07,590 --> 00:28:06,240

same time you have in astronomy a

824

00:28:09,669 --> 00:28:07,600

culture that

825

00:28:11,269 --> 00:28:09,679

also as a result of not funding a

826

00:28:14,789 --> 00:28:11,279

research area

827

00:28:15,990 --> 00:28:14,799

is completely negative about something

828

00:28:17,669 --> 00:28:16,000

that is down to earth

829

00:28:19,990 --> 00:28:17,679

so to speak we have it on earth it's

830

00:28:22,389 --> 00:28:20,000

intelligent life technological life

831

00:28:25,269 --> 00:28:22,399

so and we now the one thing that we know

832

00:28:28,630 --> 00:28:25,279

now that wasn't true 20 years ago is

833

00:28:31,510 --> 00:28:28,640

we now know that uh half of

834

00:28:32,710 --> 00:28:31,520

a big fraction of all the sun-like stars

835

00:28:34,630 --> 00:28:32,720

have a

836

00:28:36,149 --> 00:28:34,640

planet the size of the earth roughly the

837

00:28:39,190 --> 00:28:36,159

same separation and

838

00:28:39,669 --> 00:28:39,200

so the earth's sun system is not unusual

839

00:28:41,590 --> 00:28:39,679

and

840

00:28:43,190 --> 00:28:41,600

as a result if you arrange for similar

841

00:28:44,470 --> 00:28:43,200

circumstances you might as well get

842

00:28:46,470 --> 00:28:44,480

similar outcomes

843

00:28:48,149 --> 00:28:46,480

and rather than argue about whether it's

844

00:28:48,789 --> 00:28:48,159

likely or not likely whether we are

845

00:28:51,190 --> 00:28:48,799

unique

846

00:28:51,990 --> 00:28:51,200

special or whether we are very common as

847

00:28:54,070 --> 00:28:52,000

common as

848

00:28:55,029 --> 00:28:54,080

ants are on a sidewalk rather than argue

849

00:28:56,710 --> 00:28:55,039

about that

850

00:28:58,389 --> 00:28:56,720

and by the way i believe in the latter

851

00:29:01,190 --> 00:28:58,399

options you know

852

00:29:02,789 --> 00:29:01,200

we should just search and of course we

853

00:29:03,510 --> 00:29:02,799

will never find the truth if we don't

854

00:29:05,029 --> 00:29:03,520

search and

855

00:29:06,630 --> 00:29:05,039

the strange thing is the current

856

00:29:07,350 --> 00:29:06,640

situation is there is very little

857

00:29:10,950 --> 00:29:07,360

funding

858

00:29:12,870 --> 00:29:10,960

search for technological signatures

859

00:29:14,710 --> 00:29:12,880

than there is for the search for dark

860

00:29:17,269 --> 00:29:14,720

matter and frankly

861

00:29:19,269 --> 00:29:17,279

the nature of dark matter will have zero

862

00:29:22,470 --> 00:29:19,279

impact on our daily lives

863

00:29:24,789 --> 00:29:22,480

if um was a technological rally or if we

864

00:29:27,590 --> 00:29:24,799

find other technological relics in space

865

00:29:27,990 --> 00:29:27,600

that would have a huge impact on society

866

00:29:31,029 --> 00:29:28,000

and

867

00:29:33,269 --> 00:29:31,039

society the public is very interested in

868

00:29:35,029 --> 00:29:33,279

this subject and it funds science

869

00:29:37,029 --> 00:29:35,039

so i find the current situation

870

00:29:38,630 --> 00:29:37,039

unacceptable

871

00:29:40,789 --> 00:29:38,640

it would have an impact on society in

872

00:29:43,190 --> 00:29:40,799

the sense of how we view ourselves

873

00:29:43,990 --> 00:29:43,200

yeah there are many different aspects

874

00:29:46,870 --> 00:29:44,000

how we

875

00:29:47,590 --> 00:29:46,880

view our place in the universe you know

876

00:29:50,470 --> 00:29:47,600

and

877

00:29:51,590 --> 00:29:50,480

our aspirations for space if there are

878

00:29:54,070 --> 00:29:51,600

others out there

879

00:29:55,669 --> 00:29:54,080

if there is a smarter kid on the block

880

00:29:58,230 --> 00:29:55,679

and by the way most stars

881

00:29:59,510 --> 00:29:58,240

formed billions of years before the sun

882

00:30:00,710 --> 00:29:59,520

and therefore they may have had

883

00:30:03,909 --> 00:30:00,720

civilizations like

884

00:30:05,990 --> 00:30:03,919

us billions of years before us so we're

885

00:30:08,389 --> 00:30:06,000

arriving relatively late to the game you

886

00:30:10,389 --> 00:30:08,399

know the way i see it is you know we are

887

00:30:12,950 --> 00:30:10,399

born into this world

888

00:30:13,669 --> 00:30:12,960

uh just like actors that are put on a

889

00:30:15,830 --> 00:30:13,679

stage

890

00:30:17,350 --> 00:30:15,840

without a script we don't know what the

891

00:30:18,870 --> 00:30:17,360

play is about

892

00:30:20,950 --> 00:30:18,880

so the first thing to check is whether

893

00:30:22,630 --> 00:30:20,960

there are other actors out there perhaps

894

00:30:24,549 --> 00:30:22,640

they know what's going on because they

895

00:30:26,070 --> 00:30:24,559

have been around for a while

896

00:30:27,830 --> 00:30:26,080

so that's what like searching for

897

00:30:29,269 --> 00:30:27,840

another kid on the block

898

00:30:31,350 --> 00:30:29,279

finding whether there are smarter kids

899

00:30:33,590 --> 00:30:31,360

on you know most likely there were

900

00:30:35,990 --> 00:30:33,600

civilizations that died by now

901
00:30:37,909 --> 00:30:36,000
but we can find relics technological

902
00:30:39,029 --> 00:30:37,919
relics they sent out to space just like

903
00:30:41,590 --> 00:30:39,039
we send

904
00:30:42,149 --> 00:30:41,600
voyager 1 voyager 2 no horizons and so

905
00:30:44,389 --> 00:30:42,159
forth

906
00:30:45,830 --> 00:30:44,399
so it's a very natural to me again it's

907
00:30:50,149 --> 00:30:45,840
a common sense

908
00:30:52,630 --> 00:30:50,159
to invest in the search for such things

909
00:30:55,029 --> 00:30:52,640
i call it space archaeology you know

910
00:30:57,590 --> 00:30:55,039
monitoring for example with the camera

911
00:30:58,870 --> 00:30:57,600
every object that comes into the solar

912
00:31:00,789 --> 00:30:58,880
system from outside

913
00:31:02,149 --> 00:31:00,799

that gets close to earth and and

914

00:31:03,669 --> 00:31:02,159

checking it you know

915

00:31:06,389 --> 00:31:03,679

checking whether it's artificial or

916

00:31:08,149 --> 00:31:06,399

natural by a close-up photograph

917

00:31:10,149 --> 00:31:08,159

because a picture is worth a thousand

918

00:31:10,870 --> 00:31:10,159

words and in my case a picture is worth

919

00:31:13,430 --> 00:31:10,880

66

920

00:31:13,909 --> 00:31:13,440

000 words the number of words in my book

921

00:31:15,750 --> 00:31:13,919

so

922

00:31:17,430 --> 00:31:15,760

i think it's very natural to do this

923

00:31:19,110 --> 00:31:17,440

search and invest

924

00:31:21,029 --> 00:31:19,120

at least the same amount of money we

925

00:31:22,789 --> 00:31:21,039

invest in the search for dark matter

926

00:31:24,070 --> 00:31:22,799

which is also a search in the dark you

927

00:31:24,710 --> 00:31:24,080

know we don't know what the dark matter

928

00:31:26,870 --> 00:31:24,720

is

929

00:31:28,230 --> 00:31:26,880

why not invest hundreds of millions of

930

00:31:29,830 --> 00:31:28,240

dollars or

931

00:31:33,029 --> 00:31:29,840

even a billion dollars that's what we

932

00:31:34,710 --> 00:31:33,039

invested in in ligo to me it sounds like

933

00:31:36,789 --> 00:31:34,720

a straightforward

934

00:31:37,750 --> 00:31:36,799

thing to do a very common sensical thing

935

00:31:40,950 --> 00:31:37,760

to do

936

00:31:44,149 --> 00:31:40,960

but somehow my view is not

937

00:31:47,590 --> 00:31:44,159

dominant they say not only that but

938

00:31:50,549 --> 00:31:47,600

the discussion is being ridiculed and

939

00:31:52,310 --> 00:31:50,559

moreover the community doesn't like me

940

00:31:54,070 --> 00:31:52,320

saying that

941

00:31:55,590 --> 00:31:54,080

uh even though that's the reality of the

942

00:31:56,950 --> 00:31:55,600

situation

943

00:31:58,389 --> 00:31:56,960

when i hear that what i'm wondering is

944

00:31:59,430 --> 00:31:58,399

is there a way to monetize the search

945

00:32:00,950 --> 00:31:59,440

for aliens

946

00:32:02,870 --> 00:32:00,960

because then you can get the private

947

00:32:04,310 --> 00:32:02,880

industry the private sector definitely

948

00:32:05,750 --> 00:32:04,320

definitely and then number two what do

949

00:32:07,029 --> 00:32:05,760

you think about elon musk's mission to

950

00:32:08,710 --> 00:32:07,039

mars okay so those are two questions

951
00:32:09,430 --> 00:32:08,720
privatizing the search for aliens and

952
00:32:12,789 --> 00:32:09,440
then

953
00:32:14,549 --> 00:32:12,799
elon musk definitely i think um if

954
00:32:16,870 --> 00:32:14,559
there are individuals interested in the

955
00:32:19,190 --> 00:32:16,880
search i have some

956
00:32:21,509 --> 00:32:19,200
good ideas about how to do space

957
00:32:23,750 --> 00:32:21,519
archaeology how to examine

958
00:32:25,430 --> 00:32:23,760
interstellar objects that enter the

959
00:32:27,110 --> 00:32:25,440
solar system and come close to earth and

960
00:32:29,909 --> 00:32:27,120
take a photograph of them and

961
00:32:30,710 --> 00:32:29,919
you know that that could be a a new

962
00:32:33,029 --> 00:32:30,720
frontier

963
00:32:33,990 --> 00:32:33,039

in in astronomy that there was never

964

00:32:37,430 --> 00:32:34,000

pursued and

965

00:32:39,430 --> 00:32:37,440

it's um simply because

966

00:32:41,669 --> 00:32:39,440

just a few years ago we discovered the

967

00:32:44,549 --> 00:32:41,679

first intestinal object

968

00:32:46,070 --> 00:32:44,559

so right now you know we have our eyes

969

00:32:48,549 --> 00:32:46,080

open it's

970

00:32:49,750 --> 00:32:48,559

it's a wake-up call for us and uh i

971

00:32:52,470 --> 00:32:49,760

would be glad

972

00:32:53,750 --> 00:32:52,480

to discuss with a wealthy individuals

973

00:32:55,750 --> 00:32:53,760

what can be done to

974

00:32:57,590 --> 00:32:55,760

to advance this frontier i think it

975

00:32:59,190 --> 00:32:57,600

would be a very exciting frontier

976
00:33:00,870 --> 00:32:59,200
even more exciting than gravitational

977
00:33:03,350 --> 00:33:00,880
wave astrophysics

978
00:33:03,909 --> 00:33:03,360
uh or the search for dark matter and

979
00:33:06,870 --> 00:33:03,919
then

980
00:33:08,710 --> 00:33:06,880
it could be you know it could be the

981
00:33:11,509 --> 00:33:08,720
most important

982
00:33:13,110 --> 00:33:11,519
discovery that humanity ever made if we

983
00:33:15,909 --> 00:33:13,120
find conclusive evidence

984
00:33:17,029 --> 00:33:15,919
uh for uh alien technology floating in

985
00:33:19,029 --> 00:33:17,039
space

986
00:33:20,310 --> 00:33:19,039
so given that i think we should

987
00:33:23,750 --> 00:33:20,320
definitely

988
00:33:24,310 --> 00:33:23,760

pursue it uh with the private sector

989

00:33:26,230 --> 00:33:24,320

because

990

00:33:27,590 --> 00:33:26,240

that is completely independent and is

991

00:33:31,029 --> 00:33:27,600

known for its innovation

992

00:33:32,149 --> 00:33:31,039

you know because there are very wealthy

993

00:33:34,950 --> 00:33:32,159

individuals that

994

00:33:35,830 --> 00:33:34,960

became wealthy as a result of taking

995

00:33:38,310 --> 00:33:35,840

risks and

996

00:33:39,750 --> 00:33:38,320

you know innovating in the technological

997

00:33:42,470 --> 00:33:39,760

sector so i think

998

00:33:44,230 --> 00:33:42,480

it would be fantastic to open up new

999

00:33:47,110 --> 00:33:44,240

scientific frontiers

1000

00:33:48,070 --> 00:33:47,120

uh that they they can pursue with their

1001
00:33:51,350 --> 00:33:48,080
wealth

1002
00:33:53,669 --> 00:33:51,360
um the second question about going to

1003
00:33:55,590 --> 00:33:53,679
mars i think one aspect of that that was

1004
00:33:58,870 --> 00:33:55,600
not explored enough and should

1005
00:34:01,029 --> 00:33:58,880
should be explored before we go on that

1006
00:34:04,310 --> 00:34:01,039
ship that brings us to mars

1007
00:34:07,029 --> 00:34:04,320
is um the health concern you know they

1008
00:34:09,030 --> 00:34:07,039
if um down here on earth we are

1009
00:34:09,589 --> 00:34:09,040
protected by the earth's magnetic field

1010
00:34:12,710 --> 00:34:09,599
from

1011
00:34:15,109 --> 00:34:12,720
very energetic particles cosmic rays and

1012
00:34:19,510 --> 00:34:15,119
by the atmosphere of the earth

1013
00:34:21,750 --> 00:34:19,520

and the environment of the space station

1014

00:34:23,589 --> 00:34:21,760

floating just hovering above earth is

1015

00:34:26,230 --> 00:34:23,599

also relatively protected but

1016

00:34:28,389 --> 00:34:26,240

if you go to mars and you spend a year

1017

00:34:31,510 --> 00:34:28,399

actually a significant fraction of

1018

00:34:34,069 --> 00:34:31,520

your brain cells can be damaged as a

1019

00:34:36,310 --> 00:34:34,079

result of energetic particles

1020

00:34:37,669 --> 00:34:36,320

going through the helmet i mean you

1021

00:34:41,510 --> 00:34:37,679

can't

1022

00:34:44,950 --> 00:34:41,520

you have to be in a cave underground

1023

00:34:47,589 --> 00:34:44,960

or to have some special shielding

1024

00:34:48,470 --> 00:34:47,599

around you to be protected and there was

1025

00:34:50,790 --> 00:34:48,480

not enough

1026
00:34:51,909 --> 00:34:50,800
attention given to that and i think that

1027
00:34:54,470 --> 00:34:51,919
should be addressed

1028
00:34:55,270 --> 00:34:54,480
because we don't want them it to be a

1029
00:34:57,030 --> 00:34:55,280
one-way

1030
00:34:58,310 --> 00:34:57,040
trip where after a year everyone that

1031
00:34:59,750 --> 00:34:58,320
goes there dies

1032
00:35:01,990 --> 00:34:59,760
so there's too much of a focus on

1033
00:35:04,710 --> 00:35:02,000
building the atmosphere not much of

1034
00:35:05,030 --> 00:35:04,720
the lack of a magnetic well yeah so i

1035
00:35:07,109 --> 00:35:05,040
mean

1036
00:35:08,150 --> 00:35:07,119
one thing is of course to create a

1037
00:35:10,069 --> 00:35:08,160
habitat that

1038
00:35:11,750 --> 00:35:10,079

allows people to breathe and you don't

1039

00:35:14,150 --> 00:35:11,760

need to build a

1040

00:35:17,190 --> 00:35:14,160

a whole atmosphere to terraform mars you

1041

00:35:19,670 --> 00:35:17,200

can just do it inside a closed vessel

1042

00:35:21,990 --> 00:35:19,680

you know and and but at the same time

1043

00:35:25,190 --> 00:35:22,000

worrying about the

1044

00:35:27,270 --> 00:35:25,200

how to protect humans so that they can

1045

00:35:28,950 --> 00:35:27,280

live there for more than a year is i

1046

00:35:30,470 --> 00:35:28,960

think a major challenge that was not

1047

00:35:32,550 --> 00:35:30,480

addressed enough

1048

00:35:34,790 --> 00:35:32,560

and of course you can do it in steps you

1049

00:35:36,630 --> 00:35:34,800

can go first to the moon

1050

00:35:38,310 --> 00:35:36,640

and then because the moon is closer to

1051

00:35:41,349 --> 00:35:38,320

us and we can ship

1052

00:35:43,030 --> 00:35:41,359

people back and forth more easily

1053

00:35:45,990 --> 00:35:43,040

and that could be a stepping stone to

1054

00:35:47,990 --> 00:35:46,000

mars what do you think of sean carroll's

1055

00:35:50,390 --> 00:35:48,000

many worlds well it's not his many

1056

00:35:52,150 --> 00:35:50,400

worlds interpretation but

1057

00:35:54,150 --> 00:35:52,160

he seems to think it's the only game in

1058

00:35:56,390 --> 00:35:54,160

town with regard to

1059

00:35:57,990 --> 00:35:56,400

quantum mechanical interpretations and

1060

00:35:59,990 --> 00:35:58,000

he seems to think it's not as arbitrary

1061

00:36:01,030 --> 00:36:00,000

as people say and that maybe there's

1062

00:36:02,550 --> 00:36:01,040

some evidence for it

1063

00:36:04,069 --> 00:36:02,560

at least if you quote unquote follow the

1064

00:36:05,030 --> 00:36:04,079

math so what do you make of that

1065

00:36:07,990 --> 00:36:05,040

argument um

1066

00:36:09,670 --> 00:36:08,000

well so quantum mechanics was discovered

1067

00:36:12,790 --> 00:36:09,680

experimentally and

1068

00:36:13,349 --> 00:36:12,800

that's an important lesson for us to

1069

00:36:17,030 --> 00:36:13,359

maintain

1070

00:36:19,910 --> 00:36:17,040

our humility as scientists you know

1071

00:36:21,910 --> 00:36:19,920

sometimes we need the experiments to to

1072

00:36:23,750 --> 00:36:21,920

to give us an insight about nature that

1073

00:36:26,950 --> 00:36:23,760

we haven't expected

1074

00:36:29,190 --> 00:36:26,960

and it takes us out of our comfort zone

1075

00:36:31,510 --> 00:36:29,200

and he took albert einstein out of his

1076

00:36:33,829 --> 00:36:31,520

comfort zone because he thought

1077

00:36:35,589 --> 00:36:33,839

you can't have quantum mechanics with

1078

00:36:38,710 --> 00:36:35,599

spooky action at the distance

1079

00:36:41,510 --> 00:36:38,720

it makes no sense to him

1080

00:36:43,750 --> 00:36:41,520

and so he wrote a paper about it the the

1081

00:36:45,430 --> 00:36:43,760

einstein podolski rosen paper

1082

00:36:47,829 --> 00:36:45,440

trying to propose an experiment that

1083

00:36:50,470 --> 00:36:47,839

will demonstrate that spooky action

1084

00:36:52,230 --> 00:36:50,480

at the distance does not exist versions

1085

00:36:55,829 --> 00:36:52,240

of that experiment were done and

1086

00:36:58,390 --> 00:36:55,839

he was proven wrong and indeed we are

1087

00:36:59,589 --> 00:36:58,400

a century later after quantum mechanics

1088

00:37:02,390 --> 00:36:59,599

was discovered

1089

00:37:03,750 --> 00:37:02,400

still uh feeling uneasy about how to

1090

00:37:07,109 --> 00:37:03,760

interpret it

1091

00:37:09,670 --> 00:37:07,119

um and this is an excellent example for

1092

00:37:13,190 --> 00:37:09,680

why we need experiments because

1093

00:37:16,630 --> 00:37:13,200

uh very often uh experiments open us

1094

00:37:18,870 --> 00:37:16,640

our eyes to facts that we

1095

00:37:19,910 --> 00:37:18,880

you know we haven't anticipated but our

1096

00:37:23,349 --> 00:37:19,920

imagination

1097

00:37:26,550 --> 00:37:23,359

is limited the more limited than

1098

00:37:31,030 --> 00:37:26,560

nature's imagination in a way and we

1099

00:37:34,710 --> 00:37:34,150

just being a student for life as a

1100

00:37:37,190 --> 00:37:34,720

scientist

1101

00:37:37,910 --> 00:37:37,200

you are you have to be humble and modest

1102

00:37:41,670 --> 00:37:37,920

enough to

1103

00:37:44,230 --> 00:37:41,680

admit that you know that perhaps nature

1104

00:37:44,870 --> 00:37:44,240

uh is different than your preconceptions

1105

00:37:47,030 --> 00:37:44,880

and

1106

00:37:49,910 --> 00:37:47,040

if you were to say i don't need

1107

00:37:51,829 --> 00:37:49,920

verification i know the truth in advance

1108

00:37:55,030 --> 00:37:51,839

i know that there are extra dimensions

1109

00:37:57,030 --> 00:37:55,040

or i know that um a rock

1110

00:37:59,190 --> 00:37:57,040

or i know that this and that without

1111

00:38:00,069 --> 00:37:59,200

even checking then you are just like the

1112

00:38:01,829 --> 00:38:00,079

philosophers

1113

00:38:03,589 --> 00:38:01,839

during the days of galileo that didn't

1114

00:38:05,349 --> 00:38:03,599

want to look through his telescope

1115

00:38:06,790 --> 00:38:05,359

because they knew that the sun moves

1116

00:38:09,270 --> 00:38:06,800

around the earth

1117

00:38:10,150 --> 00:38:09,280

so just i just wanted to to make that

1118

00:38:12,870 --> 00:38:10,160

point that the

1119

00:38:14,790 --> 00:38:12,880

quantum mechanics is really a an

1120

00:38:17,829 --> 00:38:14,800

excellent example for why

1121

00:38:18,790 --> 00:38:17,839

a scientist we should always regard

1122

00:38:22,550 --> 00:38:18,800

ourselves as

1123

00:38:25,270 --> 00:38:22,560

students of nature uh but coming back to

1124

00:38:26,710 --> 00:38:25,280

so to the question of what's the meaning

1125

00:38:28,630 --> 00:38:26,720

of quantum mechanics that

1126
00:38:30,710 --> 00:38:28,640
as you mentioned that the there was the

1127
00:38:32,950 --> 00:38:30,720
many world interpretation and

1128
00:38:35,430 --> 00:38:32,960
uh sean carroll puts it in a modern

1129
00:38:39,030 --> 00:38:35,440
context um

1130
00:38:40,550 --> 00:38:39,040
and uh obviously does sean carroll add

1131
00:38:42,150 --> 00:38:40,560
anything that hasn't been said before on

1132
00:38:46,310 --> 00:38:42,160
the many worlds interpretation

1133
00:38:47,670 --> 00:38:46,320
from everett um yeah i mean there are

1134
00:38:51,349 --> 00:38:47,680
some new nuances

1135
00:38:53,990 --> 00:38:51,359
uh now um that relate

1136
00:38:54,550 --> 00:38:54,000
to how to to define the wave function

1137
00:38:56,870 --> 00:38:54,560
and

1138
00:38:57,990 --> 00:38:56,880

the possible existence of the multiverse

1139

00:39:02,230 --> 00:38:58,000

that some people

1140

00:39:05,349 --> 00:39:02,240

contemplate as you know that the actual

1141

00:39:08,390 --> 00:39:05,359

reality is much uh

1142

00:39:11,030 --> 00:39:08,400

bigger than what we can experiment with

1143

00:39:12,870 --> 00:39:11,040

within the observable universe that we

1144

00:39:15,190 --> 00:39:12,880

see

1145

00:39:15,910 --> 00:39:15,200

but um i would say that the verdict is

1146

00:39:19,270 --> 00:39:15,920

still out

1147

00:39:22,310 --> 00:39:19,280

i mean um every year or two i read the

1148

00:39:24,310 --> 00:39:22,320

an interesting essay that uh offers new

1149

00:39:25,750 --> 00:39:24,320

insights to quantum mechanics the

1150

00:39:27,510 --> 00:39:25,760

interpretation of quantum mechanics but

1151

00:39:29,109 --> 00:39:27,520

we are not there yet we we haven't

1152

00:39:30,230 --> 00:39:29,119

converged on something that everyone

1153

00:39:32,550 --> 00:39:30,240

agrees on

1154

00:39:33,349 --> 00:39:32,560

and again i think the way to converge

1155

00:39:35,430 --> 00:39:33,359

would be

1156

00:39:36,950 --> 00:39:35,440

to be guided by experience and and it's

1157

00:39:38,150 --> 00:39:36,960

quite possible you know that the one

1158

00:39:40,230 --> 00:39:38,160

thing we're missing

1159

00:39:42,470 --> 00:39:40,240

is the connection with gravity that we

1160

00:39:44,150 --> 00:39:42,480

don't have a quantum theory of gravity

1161

00:39:45,109 --> 00:39:44,160

that was tested experimentally and

1162

00:39:48,550 --> 00:39:45,119

perhaps

1163

00:39:50,710 --> 00:39:48,560

in the context of such a theory the

1164

00:39:52,470 --> 00:39:50,720

the concerns we have we will go away

1165

00:39:54,470 --> 00:39:52,480

because one thing that

1166

00:39:55,829 --> 00:39:54,480

you recognize in quantum mechanics at

1167

00:39:57,190 --> 00:39:55,839

least the traditional way it was

1168

00:39:59,510 --> 00:39:57,200

formulated in

1169

00:40:01,349 --> 00:39:59,520

is that time plays a special role

1170

00:40:04,950 --> 00:40:01,359

relative to space and

1171

00:40:06,870 --> 00:40:04,960

um whereas in in the general theory of

1172

00:40:07,589 --> 00:40:06,880

relativity time and space are just

1173

00:40:11,430 --> 00:40:07,599

dimensions

1174

00:40:15,990 --> 00:40:11,440

of space time and they can be curved by

1175

00:40:18,550 --> 00:40:16,000

objects and so forth so perhaps once we

1176

00:40:20,069 --> 00:40:18,560

identify a winning theory that unifies

1177

00:40:21,670 --> 00:40:20,079

quantum mechanics and gravity many of

1178

00:40:23,430 --> 00:40:21,680

the

1179

00:40:25,270 --> 00:40:23,440

ambiguities that we have right now in

1180

00:40:26,870 --> 00:40:25,280

physics and by the way there are many

1181

00:40:28,630 --> 00:40:26,880

not just not just the interpretation of

1182

00:40:30,710 --> 00:40:28,640

quantum mechanics the

1183

00:40:32,710 --> 00:40:30,720

there is the information paradox in the

1184

00:40:35,190 --> 00:40:32,720

context of black holes and

1185

00:40:37,589 --> 00:40:35,200

we don't know what happens to

1186

00:40:41,270 --> 00:40:37,599

information that falls into a black hole

1187

00:40:42,710 --> 00:40:41,280

um stephen hawking demonstrated that

1188

00:40:44,870 --> 00:40:42,720

black holes evaporate

1189

00:40:46,950 --> 00:40:44,880

eventually into thermal radiation that

1190

00:40:47,829 --> 00:40:46,960

doesn't carry that information so the

1191

00:40:50,150 --> 00:40:47,839

question is

1192

00:40:51,190 --> 00:40:50,160

if the black hole goes away where where

1193

00:40:52,550 --> 00:40:51,200

are all

1194

00:40:55,109 --> 00:40:52,560

where is all the information that we

1195

00:40:56,710 --> 00:40:55,119

threw into it when we made it

1196

00:40:58,630 --> 00:40:56,720

uh and that's a fundamental question

1197

00:41:00,150 --> 00:40:58,640

because quantum mechanics

1198

00:41:01,990 --> 00:41:00,160

argues that information cannot be

1199

00:41:05,190 --> 00:41:02,000

destroyed and so

1200

00:41:07,430 --> 00:41:05,200

this is one puzzle that is also unsolved

1201
00:41:08,550 --> 00:41:07,440
in modern physics then there is a

1202
00:41:10,950 --> 00:41:08,560
question of what

1203
00:41:12,550 --> 00:41:10,960
happens in the singularities of either

1204
00:41:14,630 --> 00:41:12,560
the singularity of a black hole where

1205
00:41:17,510 --> 00:41:14,640
the curvature of space and time

1206
00:41:19,750 --> 00:41:17,520
diverges or the singularity of the big

1207
00:41:20,710 --> 00:41:19,760
bang what happened before the big bang

1208
00:41:21,750 --> 00:41:20,720
do you believe that there are

1209
00:41:24,069 --> 00:41:21,760
singularities within

1210
00:41:24,790 --> 00:41:24,079
no it's clear that singularities are

1211
00:41:26,230 --> 00:41:24,800
just

1212
00:41:28,230 --> 00:41:26,240
appearing in einstein's theory of

1213
00:41:30,550 --> 00:41:28,240

gravity because it doesn't it's not

1214

00:41:32,150 --> 00:41:30,560

unified with quantum mechanics

1215

00:41:34,390 --> 00:41:32,160

because once you get to very large

1216

00:41:36,069 --> 00:41:34,400

curvatures of space and time

1217

00:41:37,670 --> 00:41:36,079

you have to correct the equations that

1218

00:41:39,430 --> 00:41:37,680

einstein wrote

1219

00:41:40,870 --> 00:41:39,440

because quantum mechanics comes into

1220

00:41:43,270 --> 00:41:40,880

play

1221

00:41:44,470 --> 00:41:43,280

so again the singularities are just

1222

00:41:47,430 --> 00:41:44,480

symptoms

1223

00:41:47,990 --> 00:41:47,440

of us having an incomplete theory and

1224

00:41:51,670 --> 00:41:48,000

what we need

1225

00:41:53,190 --> 00:41:51,680

is to unified quantum mechanics with uh

1226

00:41:55,510 --> 00:41:53,200

the general theory of relativity of

1227

00:41:57,829 --> 00:41:55,520

einstein and of course string theory is

1228

00:41:59,270 --> 00:41:57,839

a very popular contender but

1229

00:42:01,030 --> 00:41:59,280

when you ask string theories can you

1230

00:42:03,030 --> 00:42:01,040

tell me what what happens in the

1231

00:42:04,870 --> 00:42:03,040

singularity of a black hole they say

1232

00:42:06,790 --> 00:42:04,880

oh that's the too difficult question we

1233

00:42:09,589 --> 00:42:06,800

can't really address it at this point

1234

00:42:11,430 --> 00:42:09,599

when you ask them what happens at the

1235

00:42:13,109 --> 00:42:11,440

big bang just before the big bang

1236

00:42:14,790 --> 00:42:13,119

they say oh that's too difficult we

1237

00:42:16,630 --> 00:42:14,800

can't really and then there are people

1238

00:42:19,030 --> 00:42:16,640

that try to formulate some

1239

00:42:19,910 --> 00:42:19,040

guesses as to how string theory would

1240

00:42:23,030 --> 00:42:19,920

behave

1241

00:42:25,510 --> 00:42:23,040

but um so first of all there is not

1242

00:42:26,390 --> 00:42:25,520

a unique answer from string theory right

1243

00:42:28,470 --> 00:42:26,400

now

1244

00:42:29,670 --> 00:42:28,480

and the theory is not unique in its

1245

00:42:33,109 --> 00:42:29,680

predictions

1246

00:42:35,589 --> 00:42:33,119

and second uh on the issues that matter

1247

00:42:37,190 --> 00:42:35,599

it doesn't put any skin in the game it

1248

00:42:38,069 --> 00:42:37,200

doesn't say here is a prediction that

1249

00:42:40,470 --> 00:42:38,079

you can test

1250

00:42:42,069 --> 00:42:40,480

experimentally and if if you find one

1251

00:42:44,309 --> 00:42:42,079

answer then string theory is right if

1252

00:42:46,069 --> 00:42:44,319

you find another answer then it's wrong

1253

00:42:48,309 --> 00:42:46,079

no they prefer not to put skin in the

1254

00:42:49,510 --> 00:42:48,319

game so that it will still be right

1255

00:42:52,230 --> 00:42:49,520

forever

1256

00:42:52,710 --> 00:42:52,240

and there is even the claim that if by

1257

00:42:54,870 --> 00:42:52,720

some

1258

00:42:57,829 --> 00:42:54,880

philosophers that if physicists agree on

1259

00:42:59,589 --> 00:42:57,839

something for a decade it must be right

1260

00:43:01,990 --> 00:42:59,599

and i find that

1261

00:43:02,710 --> 00:43:02,000

really embarrassing that people argue

1262

00:43:06,150 --> 00:43:02,720

that uh

1263

00:43:09,910 --> 00:43:06,160

which philosophers oh there is uh

1264

00:43:12,630 --> 00:43:09,920

there is the weed no um

1265

00:43:13,430 --> 00:43:12,640

there is a philosopher with uh that that

1266

00:43:15,430 --> 00:43:13,440

wrote a book

1267

00:43:16,630 --> 00:43:15,440

about string theory and suggesting that

1268

00:43:20,230 --> 00:43:16,640

you know we should

1269

00:43:23,030 --> 00:43:20,240

adjust our conception of what physics is

1270

00:43:24,710 --> 00:43:23,040

supposed to mean that uh experiments may

1271

00:43:28,550 --> 00:43:24,720

not be needed and that

1272

00:43:31,510 --> 00:43:28,560

in fact physics is what physicists do

1273

00:43:33,349 --> 00:43:31,520

and once again from my perspective i

1274

00:43:34,230 --> 00:43:33,359

hold exactly the opposite view i think

1275

00:43:36,630 --> 00:43:34,240

that

1276

00:43:38,309 --> 00:43:36,640

you know nature educates us we are just

1277

00:43:40,150 --> 00:43:38,319

students of nature so

1278

00:43:41,430 --> 00:43:40,160

we should be modest and learn from

1279

00:43:43,270 --> 00:43:41,440

experiments we can't

1280

00:43:44,710 --> 00:43:43,280

imagine that we will know the truth in

1281

00:43:47,750 --> 00:43:44,720

advance you know it

1282

00:43:49,430 --> 00:43:47,760

to me it sounds like hallucinations like

1283

00:43:51,109 --> 00:43:49,440

you are high on drugs if you believe

1284

00:43:53,270 --> 00:43:51,119

that you can that reality always

1285

00:43:55,430 --> 00:43:53,280

reflects what you think it is

1286

00:43:57,589 --> 00:43:55,440

uh that's what people that are you know

1287

00:43:59,349 --> 00:43:57,599

that hallucinating

1288

00:44:01,670 --> 00:43:59,359

but you can think that you're the the

1289

00:44:03,910 --> 00:44:01,680

wealthiest person in the world and

1290

00:44:05,589 --> 00:44:03,920

when you go to the bank and check how

1291

00:44:06,790 --> 00:44:05,599

much money you have in your checking

1292

00:44:08,309 --> 00:44:06,800

account

1293

00:44:10,390 --> 00:44:08,319

you realize that you know that's an

1294

00:44:13,190 --> 00:44:10,400

experiment and you realize that

1295

00:44:14,870 --> 00:44:13,200

you cannot cash it uh so i mean of

1296

00:44:16,790 --> 00:44:14,880

course people can feel happy

1297

00:44:18,870 --> 00:44:16,800

i have nothing against that they can do

1298

00:44:19,670 --> 00:44:18,880

mathematical gymnastics and feel happy i

1299

00:44:21,829 --> 00:44:19,680

just have

1300

00:44:24,230 --> 00:44:21,839

the objection i have is about that

1301
00:44:25,910 --> 00:44:24,240
applying to reality

1302
00:44:27,510 --> 00:44:25,920
a reality check needs to happen at some

1303
00:44:30,150 --> 00:44:27,520
point right exactly

1304
00:44:32,710 --> 00:44:30,160
otherwise i mean you can just celebrate

1305
00:44:35,190 --> 00:44:32,720
something that is not real

1306
00:44:36,550 --> 00:44:35,200
okay let's talk about bob lazar i sent

1307
00:44:38,150 --> 00:44:36,560
you an email and i asked you

1308
00:44:40,069 --> 00:44:38,160
if you had the time to please watch this

1309
00:44:41,829 --> 00:44:40,079
video was a technical explanation of bob

1310
00:44:43,910 --> 00:44:41,839
lazar in his younger years

1311
00:44:45,910 --> 00:44:43,920
did you have a chance to even skim it

1312
00:44:49,990 --> 00:44:45,920
yeah i skimmed it and then

1313
00:44:52,230 --> 00:44:50,000

i what i found on on the web is that um

1314

00:44:54,230 --> 00:44:52,240

he made a lot of statements without ev

1315

00:44:56,230 --> 00:44:54,240

showing any evidence and

1316

00:44:57,750 --> 00:44:56,240

you know here i give usually the example

1317

00:44:59,190 --> 00:44:57,760

of napoleon

1318

00:45:00,790 --> 00:44:59,200

you know there were many people over the

1319

00:45:04,790 --> 00:45:00,800

years that claimed that they are

1320

00:45:06,550 --> 00:45:04,800

napoleon and how do you check that

1321

00:45:08,309 --> 00:45:06,560

once again experimentally you ask them

1322

00:45:10,550 --> 00:45:08,319

show me your id

1323

00:45:13,030 --> 00:45:10,560

and if they can't show you the idea that

1324

00:45:14,950 --> 00:45:13,040

says that they are napoleon

1325

00:45:17,030 --> 00:45:14,960

and if they keep insisting that they are

1326
00:45:18,150 --> 00:45:17,040
napoleon without showing you evidence

1327
00:45:20,309 --> 00:45:18,160
for that

1328
00:45:21,750 --> 00:45:20,319
you know there are places where you can

1329
00:45:25,750 --> 00:45:21,760
put them

1330
00:45:28,950 --> 00:45:25,760
and my point is evidence is the key

1331
00:45:31,510 --> 00:45:28,960
that's the way that uh science

1332
00:45:33,109 --> 00:45:31,520
gets credibility that that that's the

1333
00:45:35,030 --> 00:45:33,119
way for us to make progress as i

1334
00:45:35,589 --> 00:45:35,040
discussed before for us to learn new

1335
00:45:38,069 --> 00:45:35,599
things

1336
00:45:38,870 --> 00:45:38,079
through experiments through evidence and

1337
00:45:41,750 --> 00:45:38,880
it's just

1338
00:45:43,430 --> 00:45:41,760

it's not just a nuance uh looking for

1339

00:45:43,910 --> 00:45:43,440

evidence is not just something that you

1340

00:45:48,069 --> 00:45:43,920

can

1341

00:45:50,630 --> 00:45:48,079

give up on it's a necessity

1342

00:45:51,349 --> 00:45:50,640

that's the only thing that will keep you

1343

00:45:55,030 --> 00:45:51,359

sane

1344

00:45:56,870 --> 00:45:55,040

and making relevant statements and

1345

00:45:58,630 --> 00:45:56,880

you can make a lot of statements that

1346

00:46:01,990 --> 00:45:58,640

look bizarre

1347

00:46:03,910 --> 00:46:02,000

interesting intriguing emotionally

1348

00:46:04,870 --> 00:46:03,920

appealing

1349

00:46:07,190 --> 00:46:04,880

you know you can make a lot of

1350

00:46:08,790 --> 00:46:07,200

statements like that and in fact our

1351

00:46:10,790 --> 00:46:08,800

culture is full of that

1352

00:46:11,990 --> 00:46:10,800

you have all kinds of myths in our

1353

00:46:15,190 --> 00:46:12,000

culture

1354

00:46:15,829 --> 00:46:15,200

you know if you can think about lots of

1355

00:46:18,870 --> 00:46:15,839

them i mean

1356

00:46:20,630 --> 00:46:18,880

santa claus i mean there are lots of

1357

00:46:23,270 --> 00:46:20,640

myths that are accepted

1358

00:46:24,790 --> 00:46:23,280

uh and they're part of our culture but

1359

00:46:26,069 --> 00:46:24,800

they're not regarded as possible you're

1360

00:46:28,790 --> 00:46:26,079

crushing me right now i thought santa

1361

00:46:31,430 --> 00:46:28,800

claus is real

1362

00:46:33,510 --> 00:46:31,440

oh man summarize my point is uh when i

1363

00:46:36,710 --> 00:46:33,520

checked a lot of the things he said

1364

00:46:37,829 --> 00:46:36,720

he didn't bring um credible evidence to

1365

00:46:40,630 --> 00:46:37,839

support them and

1366

00:46:41,510 --> 00:46:40,640

that's what makes me worried that you

1367

00:46:44,870 --> 00:46:41,520

know and

1368

00:46:46,950 --> 00:46:44,880

that he he's not real

1369

00:46:48,870 --> 00:46:46,960

ah ah i see i see did you take a look at

1370

00:46:49,829 --> 00:46:48,880

any of his explanations as to how the

1371

00:46:51,750 --> 00:46:49,839

spacecraft

1372

00:46:54,630 --> 00:46:51,760

would work and is it feasible in your

1373

00:46:58,069 --> 00:46:54,640

mind is it

1374

00:46:59,910 --> 00:46:58,079

untenable is it ridiculous no i mean

1375

00:47:01,670 --> 00:46:59,920

once again suppose he had a good idea

1376

00:47:04,710 --> 00:47:01,680

for making a spacecraft that

1377

00:47:06,470 --> 00:47:04,720

we currently do not do not have okay

1378

00:47:08,710 --> 00:47:06,480

that nasa is not developing

1379

00:47:09,589 --> 00:47:08,720

he could have made a fortune out of it

1380

00:47:11,910 --> 00:47:09,599

how

1381

00:47:13,990 --> 00:47:11,920

very simply instead of talking about it

1382

00:47:17,430 --> 00:47:14,000

he could have built it

1383

00:47:19,430 --> 00:47:17,440

and then it would fly what's the problem

1384

00:47:21,270 --> 00:47:19,440

i mean that's a straightforward i don't

1385

00:47:21,910 --> 00:47:21,280

understand why we need to talk about it

1386

00:47:24,549 --> 00:47:21,920

even

1387

00:47:26,710 --> 00:47:24,559

i mean any reasonable person that has an

1388

00:47:29,190 --> 00:47:26,720

idea that is not being used

1389

00:47:29,829 --> 00:47:29,200

and that could make millions or even

1390

00:47:32,069 --> 00:47:29,839

billions

1391

00:47:34,150 --> 00:47:32,079

of dollars you know first of all

1392

00:47:36,230 --> 00:47:34,160

establishes a patent on that

1393

00:47:37,349 --> 00:47:36,240

and secondly you know tries to build

1394

00:47:40,230 --> 00:47:37,359

this thing

1395

00:47:41,430 --> 00:47:40,240

and if it's real he will make that

1396

00:47:43,430 --> 00:47:41,440

profit you know

1397

00:47:45,190 --> 00:47:43,440

it would be bigger than tesla it would

1398

00:47:46,790 --> 00:47:45,200

be bigger than spacex

1399

00:47:48,549 --> 00:47:46,800

because you would find a technology that

1400

00:47:51,589 --> 00:47:48,559

nasa can use

1401
00:47:51,990 --> 00:47:51,599
that nobody thought about so you know it

1402
00:47:54,309 --> 00:47:52,000
makes

1403
00:47:55,270 --> 00:47:54,319
zero sense to say i know how to do

1404
00:47:57,670 --> 00:47:55,280
something

1405
00:47:58,630 --> 00:47:57,680
and not reveal the details and not build

1406
00:48:02,549 --> 00:47:58,640
it

1407
00:48:05,270 --> 00:48:02,559
that's what i tell kids when they come

1408
00:48:07,109 --> 00:48:05,280
to me with ideas

1409
00:48:08,950 --> 00:48:07,119
okay i believe what he was saying is

1410
00:48:11,750 --> 00:48:08,960
that he doesn't know how it works

1411
00:48:13,270 --> 00:48:11,760
what happened was he was told to work on

1412
00:48:15,430 --> 00:48:13,280
some craft and he believes they're of

1413
00:48:17,109 --> 00:48:15,440

alien or extraterrestrial origin

1414

00:48:18,710 --> 00:48:17,119

and that the us government knows how to

1415

00:48:20,069 --> 00:48:18,720

pilot them to some degree

1416

00:48:22,150 --> 00:48:20,079

in the same way that you can learn how

1417

00:48:24,230 --> 00:48:22,160

to use a phone or a tablet like

1418

00:48:25,910 --> 00:48:24,240

they've dropped phones and tribes and

1419

00:48:28,069 --> 00:48:25,920

they know how to turn it on

1420

00:48:29,910 --> 00:48:28,079

but they don't know how it works and he

1421

00:48:30,230 --> 00:48:29,920

said possibly the way that it works is

1422

00:48:32,950 --> 00:48:30,240

with

1423

00:48:34,069 --> 00:48:32,960

this element called element 115 and

1424

00:48:35,670 --> 00:48:34,079

there's a strong nuclear

1425

00:48:37,910 --> 00:48:35,680

force which turns into a gravitational

1426

00:48:39,270 --> 00:48:37,920

force now that i find interesting i

1427

00:48:41,030 --> 00:48:39,280

don't know how it works but to me if

1428

00:48:42,549 --> 00:48:41,040

that's true that's

1429

00:48:44,230 --> 00:48:42,559

that's one way of unifying quantum field

1430

00:48:46,950 --> 00:48:44,240

theory with gravity

1431

00:48:48,390 --> 00:48:46,960

either way what do you think about that

1432

00:48:51,030 --> 00:48:48,400

from the point of view of a physicist

1433

00:48:52,790 --> 00:48:51,040

this is just nonsense

1434

00:48:54,549 --> 00:48:52,800

i mean it makes more sense i i've never

1435

00:48:56,230 --> 00:48:54,559

heard about how you turn

1436

00:48:57,990 --> 00:48:56,240

the nuclear force into a gravitational

1437

00:49:00,549 --> 00:48:58,000

force in any

1438

00:49:01,990 --> 00:49:00,559

piece of equipment of course if you

1439

00:49:04,790 --> 00:49:02,000

reach the planck scale you might

1440

00:49:06,069 --> 00:49:04,800

be able to do something but you know no

1441

00:49:09,030 --> 00:49:06,079

accelerator

1442

00:49:10,790 --> 00:49:09,040

gets even closer the only time when we

1443

00:49:11,990 --> 00:49:10,800

reach that scale perhaps was at the big

1444

00:49:13,990 --> 00:49:12,000

bang

1445

00:49:15,829 --> 00:49:14,000

or near a singularity of a black hole

1446

00:49:18,150 --> 00:49:15,839

but so i i would say

1447

00:49:19,829 --> 00:49:18,160

this is just not i mean it makes no

1448

00:49:23,510 --> 00:49:19,839

scientific sense to me

1449

00:49:25,510 --> 00:49:23,520

and uh moreover let's imagine that he

1450

00:49:27,910 --> 00:49:25,520

did not know the details but someone

1451

00:49:29,349 --> 00:49:27,920

else has that equipment

1452

00:49:31,109 --> 00:49:29,359

why do you think that someone else will

1453

00:49:34,470 --> 00:49:31,119

keep it secret why won't they

1454

00:49:37,270 --> 00:49:34,480

just use it or develop it and and

1455

00:49:38,150 --> 00:49:37,280

you know get a great advantage relative

1456

00:49:41,190 --> 00:49:38,160

to others

1457

00:49:41,829 --> 00:49:41,200

by using it i was listening to one of

1458

00:49:43,670 --> 00:49:41,839

you actually

1459

00:49:44,870 --> 00:49:43,680

i believe you said this plenty of times

1460

00:49:46,710 --> 00:49:44,880

that

1461

00:49:48,150 --> 00:49:46,720

someone said to you deflation is not

1462

00:49:51,589 --> 00:49:48,160

disprovable

1463

00:49:54,710 --> 00:49:51,599

yeah okay

1464

00:49:55,270 --> 00:49:54,720

do you mind explaining why okay so here

1465

00:49:58,870 --> 00:49:55,280

is the

1466

00:50:01,589 --> 00:49:58,880

thing that cosmic inflation

1467

00:50:02,790 --> 00:50:01,599

is a theory that was proposed um about

1468

00:50:06,950 --> 00:50:02,800

um

1469

00:50:08,790 --> 00:50:06,960

40 years ago and it was meant to explain

1470

00:50:10,069 --> 00:50:08,800

some very peculiar facts about the

1471

00:50:12,390 --> 00:50:10,079

universe

1472

00:50:13,510 --> 00:50:12,400

one of which let me just mention because

1473

00:50:15,829 --> 00:50:13,520

it's really simple to

1474

00:50:16,710 --> 00:50:15,839

to follow uh when we look in one

1475

00:50:20,150 --> 00:50:16,720

direction

1476

00:50:22,230 --> 00:50:20,160

uh in the on the sky we find the cosmic

1477

00:50:25,349 --> 00:50:22,240

microwave background relic from the

1478

00:50:25,990 --> 00:50:25,359

big bang with some temperature okay then

1479

00:50:28,230 --> 00:50:26,000

we look at the

1480

00:50:29,750 --> 00:50:28,240

opposite direction on the sky and we

1481

00:50:32,790 --> 00:50:29,760

find the cosmic microwave background

1482

00:50:35,430 --> 00:50:32,800

having exactly the same temperature

1483

00:50:36,470 --> 00:50:35,440

now how is that possible it took the age

1484

00:50:39,910 --> 00:50:36,480

of the universe

1485

00:50:42,150 --> 00:50:39,920

for the this light to arrive to us from

1486

00:50:45,510 --> 00:50:42,160

these two points on the sky

1487

00:50:47,190 --> 00:50:45,520

and these two points on on the sky did

1488

00:50:48,390 --> 00:50:47,200

not have time to communicate with each

1489

00:50:51,270 --> 00:50:48,400

other because it would take

1490

00:50:51,910 --> 00:50:51,280

twice as long at least or more than that

1491

00:50:53,990 --> 00:50:51,920

for the

1492

00:50:55,589 --> 00:50:54,000

light to arrive from one point to

1493

00:50:58,309 --> 00:50:55,599

another to the other

1494

00:50:59,270 --> 00:50:58,319

so how come the universe was arranged in

1495

00:51:02,630 --> 00:50:59,280

a way

1496

00:51:05,589 --> 00:51:02,640

such that conditions are the same

1497

00:51:07,030 --> 00:51:05,599

or throughout the entire sky in terms of

1498

00:51:08,150 --> 00:51:07,040

the cosmic microwave background

1499

00:51:10,069 --> 00:51:08,160

temperature for example

1500

00:51:12,549 --> 00:51:10,079

so we know the universe had similar

1501
00:51:15,750 --> 00:51:12,559
initial conditions

1502
00:51:19,030 --> 00:51:15,760
uh to one part in a hundred thousand

1503
00:51:20,470 --> 00:51:19,040
uh throughout the region that we can see

1504
00:51:22,069 --> 00:51:20,480
meaning that in one part in a hundred

1505
00:51:22,470 --> 00:51:22,079
thousand it's the same temperature or

1506
00:51:25,510 --> 00:51:22,480
what

1507
00:51:28,790 --> 00:51:25,520
yes yes uh and how

1508
00:51:30,150 --> 00:51:28,800
how come it was prepared in such a state

1509
00:51:33,589 --> 00:51:30,160
which is very

1510
00:51:34,549 --> 00:51:33,599
special you know if you had if you would

1511
00:51:36,309 --> 00:51:34,559
imagine a

1512
00:51:38,309 --> 00:51:36,319
just a random state you would have very

1513
00:51:40,470 --> 00:51:38,319

different temperatures in different

1514

00:51:42,950 --> 00:51:40,480

places

1515

00:51:44,870 --> 00:51:42,960

so inflation attempts to explain that

1516

00:51:46,870 --> 00:51:44,880

the idea is that

1517

00:51:49,109 --> 00:51:46,880

uh everything that we see came from a

1518

00:51:52,309 --> 00:51:49,119

very small patch

1519

00:51:53,750 --> 00:51:52,319

that was stretched exponentially in time

1520

00:51:55,910 --> 00:51:53,760

very quickly

1521

00:51:58,870 --> 00:51:55,920

uh so points that were in contact with

1522

00:52:01,589 --> 00:51:58,880

each other were separated

1523

00:52:03,190 --> 00:52:01,599

very fast faster than light from each

1524

00:52:04,630 --> 00:52:03,200

other and that is possible based on

1525

00:52:05,510 --> 00:52:04,640

einstein's theory of gravity you can

1526

00:52:07,990 --> 00:52:05,520

separate

1527

00:52:08,630 --> 00:52:08,000

points exponentially away from each

1528

00:52:12,710 --> 00:52:08,640

other

1529

00:52:14,309 --> 00:52:12,720

if the vacuum itself dominates gravity

1530

00:52:16,069 --> 00:52:14,319

which by the way is what is happening

1531

00:52:17,270 --> 00:52:16,079

right now in the universe the

1532

00:52:19,750 --> 00:52:17,280

expansion of the universe is

1533

00:52:22,790 --> 00:52:19,760

accelerating as of recently

1534

00:52:24,710 --> 00:52:22,800

over the past half of the history of the

1535

00:52:27,589 --> 00:52:24,720

universe the the expansion is

1536

00:52:29,190 --> 00:52:27,599

speeding up rather than slowing down and

1537

00:52:30,470 --> 00:52:29,200

the idea is that the same thing happened

1538

00:52:33,829 --> 00:52:30,480

at a very early

1539

00:52:36,630 --> 00:52:33,839

time and then that

1540

00:52:38,390 --> 00:52:36,640

took a small region of space that where

1541

00:52:40,150 --> 00:52:38,400

points were connected to each other had

1542

00:52:42,790 --> 00:52:40,160

the same conditions

1543

00:52:44,630 --> 00:52:42,800

and spread them apart sorry just i want

1544

00:52:46,150 --> 00:52:44,640

to make sure i'm understanding is this

1545

00:52:47,670 --> 00:52:46,160

just a change of the metric with the

1546

00:52:49,270 --> 00:52:47,680

cosmological constant

1547

00:52:50,710 --> 00:52:49,280

and so there so inflation is just saying

1548

00:52:52,230 --> 00:52:50,720

the cosmological constant was large in

1549

00:52:55,670 --> 00:52:52,240

the early universe and then somehow

1550

00:52:57,670 --> 00:52:55,680

became smaller yeah exactly and

1551
00:52:58,790 --> 00:52:57,680
the cosmological constant is equivalent

1552
00:53:01,510 --> 00:52:58,800
to the vacuum

1553
00:53:02,470 --> 00:53:01,520
having some mass density some energy

1554
00:53:04,470 --> 00:53:02,480
density

1555
00:53:06,069 --> 00:53:04,480
which by the way today is called dark

1556
00:53:07,750 --> 00:53:06,079
energy i mean it's basically the energy

1557
00:53:10,390 --> 00:53:07,760
of the back

1558
00:53:11,270 --> 00:53:10,400
so by the vacuum i mean if you clean up

1559
00:53:13,670 --> 00:53:11,280
all the matter

1560
00:53:15,430 --> 00:53:13,680
whatever you have left is the backing

1561
00:53:18,549 --> 00:53:15,440
and the vacuum could have

1562
00:53:19,430 --> 00:53:18,559
a uniform energy density the same energy

1563
00:53:22,150 --> 00:53:19,440

density

1564

00:53:23,910 --> 00:53:22,160

everywhere uh because it's the vacuum

1565

00:53:26,390 --> 00:53:23,920

it's the ground state

1566

00:53:27,990 --> 00:53:26,400

so if you just imagine at the early

1567

00:53:30,390 --> 00:53:28,000

cosmic time the vacuum had

1568

00:53:31,109 --> 00:53:30,400

a large energy density and that went

1569

00:53:33,190 --> 00:53:31,119

away

1570

00:53:36,470 --> 00:53:33,200

it was sort of a false vacuum the vacuum

1571

00:53:38,309 --> 00:53:36,480

was excited to some higher state

1572

00:53:39,589 --> 00:53:38,319

and then it decayed into the vacuum we

1573

00:53:41,349 --> 00:53:39,599

have today

1574

00:53:43,030 --> 00:53:41,359

then that will create an exponential

1575

00:53:45,430 --> 00:53:43,040

expansion that is called

1576

00:53:47,670 --> 00:53:45,440

a cosmic inflation early on and would

1577

00:53:50,870 --> 00:53:47,680

explain some facts about the universe

1578

00:53:51,910 --> 00:53:50,880

it could also generate it will make the

1579

00:53:53,589 --> 00:53:51,920

universe

1580

00:53:55,190 --> 00:53:53,599

have the same conditions everywhere but

1581

00:53:57,270 --> 00:53:55,200

it also through quantum mechanics

1582

00:54:00,870 --> 00:53:57,280

generates small

1583

00:54:03,430 --> 00:54:00,880

ripples in the the density of matter

1584

00:54:04,870 --> 00:54:03,440

one percent ripples yeah small

1585

00:54:08,309 --> 00:54:04,880

fluctuations

1586

00:54:10,549 --> 00:54:08,319

quantum mechanics

1587

00:54:11,829 --> 00:54:10,559

that later grow and become the galaxies

1588

00:54:13,990 --> 00:54:11,839

that we see today or

1589

00:54:15,430 --> 00:54:14,000

the objects that we see today so so

1590

00:54:17,910 --> 00:54:15,440

that's that's the nice

1591

00:54:19,589 --> 00:54:17,920

the beauty of the concept of cosmic

1592

00:54:21,510 --> 00:54:19,599

inflation that it explains

1593

00:54:23,190 --> 00:54:21,520

a lot of things and that's why it was

1594

00:54:24,549 --> 00:54:23,200

widely accepted after

1595

00:54:27,030 --> 00:54:24,559

after a while in the scientific

1596

00:54:28,390 --> 00:54:27,040

community uh

1597

00:54:29,910 --> 00:54:28,400

sorry i just want to make sure i'm

1598

00:54:31,190 --> 00:54:29,920

understanding this correctly so is the

1599

00:54:33,990 --> 00:54:31,200

way that they put a

1600

00:54:34,790 --> 00:54:34,000

bound on the time that the cosmological

1601
00:54:37,829 --> 00:54:34,800
constant was

1602
00:54:38,309 --> 00:54:37,839
extremely high is it with by observing

1603
00:54:40,069 --> 00:54:38,319
the

1604
00:54:41,589 --> 00:54:40,079
cosmic background radiation and saying

1605
00:54:43,430 --> 00:54:41,599
okay there's a one percent difference

1606
00:54:44,710 --> 00:54:43,440
about one in a hundred you said right no

1607
00:54:47,990 --> 00:54:44,720
one in a hundred thousand

1608
00:54:50,069 --> 00:54:48,000
then that means that there's a

1609
00:54:51,750 --> 00:54:50,079
a bound as to how long that could go on

1610
00:54:52,950 --> 00:54:51,760
for because otherwise the fluctuations

1611
00:54:53,750 --> 00:54:52,960
would be so large that we would see

1612
00:54:55,750 --> 00:54:53,760
larger gaps

1613
00:54:58,630 --> 00:54:55,760

i mean larger variations so that there

1614

00:55:00,230 --> 00:54:58,640

is there is a lower limit on how long it

1615

00:55:03,750 --> 00:55:00,240

persisted which is

1616

00:55:06,309 --> 00:55:03,760

you need to inflate enough so that

1617

00:55:08,390 --> 00:55:06,319

the small patch would become as big as

1618

00:55:11,349 --> 00:55:08,400

the universe today

1619

00:55:12,309 --> 00:55:11,359

okay that's uh that's the minimum you

1620

00:55:13,829 --> 00:55:12,319

need to expand by

1621

00:55:15,430 --> 00:55:13,839

but it could have expanded much more

1622

00:55:18,710 --> 00:55:15,440

than that we just don't know

1623

00:55:20,549 --> 00:55:18,720

so inflation could have lasted much more

1624

00:55:22,630 --> 00:55:20,559

you know we we have no upper limit on

1625

00:55:26,069 --> 00:55:22,640

how long it lasted

1626
00:55:27,750 --> 00:55:26,079
but we have a lower limit uh and and we

1627
00:55:28,390 --> 00:55:27,760
know that it should have ended so that

1628
00:55:31,430 --> 00:55:28,400
we will

1629
00:55:33,349 --> 00:55:31,440
end up with universe full of matter

1630
00:55:35,430 --> 00:55:33,359
that made every all the objects we see

1631
00:55:37,829 --> 00:55:35,440
now so the vacuum could not have con

1632
00:55:40,230 --> 00:55:37,839
continued to dominate the expansion

1633
00:55:43,030 --> 00:55:40,240
forever because then we wouldn't exist

1634
00:55:44,309 --> 00:55:43,040
so the vacuum dominated for a while and

1635
00:55:47,670 --> 00:55:44,319
that while

1636
00:55:49,589 --> 00:55:47,680
lasted at least 60

1637
00:55:50,789 --> 00:55:49,599
periods of exponential expansion at

1638
00:55:52,789 --> 00:55:50,799

least 60

1639

00:55:54,150 --> 00:55:52,799

and then after that it you know we don't

1640

00:55:56,789 --> 00:55:54,160

know how much more but

1641

00:55:58,150 --> 00:55:56,799

eventually it decayed and became the

1642

00:56:00,309 --> 00:55:58,160

matter that we have

1643

00:56:02,789 --> 00:56:00,319

today and and the universe entered into

1644

00:56:06,150 --> 00:56:02,799

its expansion the way we see it

1645

00:56:09,430 --> 00:56:06,160

um so anyway unfalsifiable because

1646

00:56:11,589 --> 00:56:09,440

okay no so that idea

1647

00:56:13,109 --> 00:56:11,599

as it was formulated initially was a

1648

00:56:13,750 --> 00:56:13,119

very interesting idea because you can

1649

00:56:16,390 --> 00:56:13,760

test it

1650

00:56:17,270 --> 00:56:16,400

there are various predictions uh one of

1651
00:56:18,789 --> 00:56:17,280
them is that

1652
00:56:21,190 --> 00:56:18,799
the geometry of the universe would be

1653
00:56:23,750 --> 00:56:21,200
flat and

1654
00:56:25,349 --> 00:56:23,760
and so forth and and by the way it was

1655
00:56:27,349 --> 00:56:25,359
confirmed the the

1656
00:56:29,430 --> 00:56:27,359
the universe is flat you know if you

1657
00:56:31,589 --> 00:56:29,440
draw a triangle the sum of the angles is

1658
00:56:35,030 --> 00:56:31,599
180 degrees and so forth

1659
00:56:35,910 --> 00:56:35,040
but at some point uh it became clear

1660
00:56:38,950 --> 00:56:35,920
that

1661
00:56:40,390 --> 00:56:38,960
to account for inflation you actually

1662
00:56:44,950 --> 00:56:40,400
come up with

1663
00:56:47,109 --> 00:56:44,960

uh the multiverse uh

1664

00:56:48,150 --> 00:56:47,119

there are lots of other regions in

1665

00:56:49,910 --> 00:56:48,160

inside of which

1666

00:56:52,069 --> 00:56:49,920

conditions could be very different so

1667

00:56:55,990 --> 00:56:52,079

anything that is possible

1668

00:56:58,710 --> 00:56:56,000

happens an infinite number of times

1669

00:56:59,270 --> 00:56:58,720

in such a theory of cosmic inflation so

1670

00:57:02,710 --> 00:56:59,280

once you

1671

00:57:03,430 --> 00:57:02,720

allow for not just our reality to exist

1672

00:57:05,589 --> 00:57:03,440

but you have

1673

00:57:07,270 --> 00:57:05,599

all kinds of regions where things

1674

00:57:09,829 --> 00:57:07,280

everything that can happen happens

1675

00:57:11,990 --> 00:57:09,839

an infinite number of times then it

1676
00:57:13,430 --> 00:57:12,000
starts losing its predictability because

1677
00:57:15,750 --> 00:57:13,440
anything that you find about our

1678
00:57:19,030 --> 00:57:15,760
universe could you could

1679
00:57:21,190 --> 00:57:19,040
it's a very flexible theory now that

1680
00:57:23,190 --> 00:57:21,200
can explain anything and so i had a

1681
00:57:25,349 --> 00:57:23,200
panel discussion with alan guth

1682
00:57:26,549 --> 00:57:25,359
that is one of the pioneers of inflation

1683
00:57:28,950 --> 00:57:26,559
and in which

1684
00:57:29,589 --> 00:57:28,960
i asked him a simple question i said and

1685
00:57:31,990 --> 00:57:29,599
that was

1686
00:57:33,990 --> 00:57:32,000
about five years ago i asked him is

1687
00:57:36,549 --> 00:57:34,000
inflation forsifiable

1688
00:57:37,750 --> 00:57:36,559

is there an experiment by which you will

1689

00:57:39,349 --> 00:57:37,760

detect something

1690

00:57:40,789 --> 00:57:39,359

about the cosmic micro background or

1691

00:57:43,510 --> 00:57:40,799

about the universe

1692

00:57:45,270 --> 00:57:43,520

and that will demonstrate that inflation

1693

00:57:47,349 --> 00:57:45,280

is wrong

1694

00:57:48,950 --> 00:57:47,359

can you envision something i'm not

1695

00:57:51,030 --> 00:57:48,960

saying necessarily that it's wrong i'm

1696

00:57:52,789 --> 00:57:51,040

just saying is there a way to test it

1697

00:57:54,069 --> 00:57:52,799

skin in the game as you would call it

1698

00:57:57,510 --> 00:57:54,079

yeah and he said

1699

00:58:00,150 --> 00:57:57,520

that's a silly question he said uh

1700

00:58:01,270 --> 00:58:00,160

any observational fact uh in the

1701

00:58:03,190 --> 00:58:01,280

universe can be a

1702

00:58:04,630 --> 00:58:03,200

inflation right now as a theory is

1703

00:58:06,710 --> 00:58:04,640

sufficiently flexible

1704

00:58:08,870 --> 00:58:06,720

that it can explain can accommodate any

1705

00:58:11,910 --> 00:58:08,880

fact that you detect

1706

00:58:14,870 --> 00:58:11,920

and to me a theory of everything is not

1707

00:58:16,789 --> 00:58:14,880

very far from being a theory of nothing

1708

00:58:18,150 --> 00:58:16,799

because if you can explain anything that

1709

00:58:20,470 --> 00:58:18,160

you find

1710

00:58:22,069 --> 00:58:20,480

then what's the value of the theory it

1711

00:58:24,870 --> 00:58:22,079

doesn't give you any added

1712

00:58:25,589 --> 00:58:24,880

value because first you find it and then

1713

00:58:27,270 --> 00:58:25,599

the theory says

1714

00:58:28,870 --> 00:58:27,280

yes yes of course a version of the

1715

00:58:31,030 --> 00:58:28,880

theory would make it

1716

00:58:32,309 --> 00:58:31,040

so what did i learn i didn't learn that

1717

00:58:34,390 --> 00:58:32,319

theory is right

1718

00:58:36,630 --> 00:58:34,400

i didn't love the theory i cannot learn

1719

00:58:38,309 --> 00:58:36,640

that theory is wrong

1720

00:58:40,309 --> 00:58:38,319

and therefore it loses its scientific

1721

00:58:43,109 --> 00:58:40,319

value in my view

1722

00:58:43,510 --> 00:58:43,119

not in the view of alan good he thinks

1723

00:58:45,990 --> 00:58:43,520

that

1724

00:58:47,750 --> 00:58:46,000

it makes the theory very robust because

1725

00:58:48,549 --> 00:58:47,760

it can agree with anything that is being

1726
00:58:50,309 --> 00:58:48,559
found

1727
00:58:52,230 --> 00:58:50,319
and you know that is the shift in the

1728
00:58:55,589 --> 00:58:52,240
culture that i'm

1729
00:58:56,630 --> 00:58:55,599
worried about you see this with string

1730
00:58:58,630 --> 00:58:56,640
theory as well

1731
00:58:59,990 --> 00:58:58,640
yes i'm not sure if alan is a string

1732
00:59:03,349 --> 00:59:00,000
theorist

1733
00:59:06,549 --> 00:59:03,359
well no he's not but the two cultures

1734
00:59:09,109 --> 00:59:06,559
uh you know celebrate to get uh the same

1735
00:59:11,589 --> 00:59:09,119
the same view about how physics can be

1736
00:59:13,750 --> 00:59:11,599
done nowadays

1737
00:59:14,630 --> 00:59:13,760
they both i mean also in the context of

1738
00:59:17,349 --> 00:59:14,640

string theory

1739

00:59:18,710 --> 00:59:17,359

you know for example there was a

1740

00:59:22,150 --> 00:59:18,720

suggestion

1741

00:59:23,349 --> 00:59:22,160

that the uh you know some it has a

1742

00:59:25,109 --> 00:59:23,359

landscape and and

1743

00:59:26,950 --> 00:59:25,119

in its landscape the landscape of the

1744

00:59:30,150 --> 00:59:26,960

string theory uh

1745

00:59:33,430 --> 00:59:30,160

accounts for some uh versions of

1746

00:59:36,549 --> 00:59:33,440

inflation and so i asked the person that

1747

00:59:38,549 --> 00:59:36,559

worked on that i said okay so this

1748

00:59:40,870 --> 00:59:38,559

connection that you make between

1749

00:59:41,589 --> 00:59:40,880

the natural incarnation of string theory

1750

00:59:45,910 --> 00:59:41,599

and

1751
00:59:47,670 --> 00:59:45,920
something in the cosmic microwave

1752
00:59:48,630 --> 00:59:47,680
background about inflation and we show

1753
00:59:50,309 --> 00:59:48,640
that the kind of

1754
00:59:51,829 --> 00:59:50,319
inflation that you are advocating is

1755
00:59:54,390 --> 00:59:51,839
wrong would that prove

1756
00:59:54,950 --> 00:59:54,400
string theory wrong and that person said

1757
00:59:57,270 --> 00:59:54,960
no

1758
00:59:58,150 --> 00:59:57,280
string theory will always be right what

1759
00:59:59,990 --> 00:59:58,160
it will

1760
01:00:01,990 --> 01:00:00,000
prove is the connection that i made

1761
01:00:05,829 --> 01:00:02,000
between string theory and inflation

1762
01:00:08,150 --> 01:00:05,839
that connection is wrong so you see

1763
01:00:09,430 --> 01:00:08,160

there are the psychology is always to

1764

01:00:12,710 --> 01:00:09,440

retreat

1765

01:00:16,630 --> 01:00:12,720

uh to a place that cannot be

1766

01:00:17,910 --> 01:00:16,640

shown wrong and although it sounds very

1767

01:00:22,549 --> 01:00:17,920

appealing and comfortable

1768

01:00:25,349 --> 01:00:22,559

because you can maintain your image as

1769

01:00:25,910 --> 01:00:25,359

you know being always right and you

1770

01:00:28,549 --> 01:00:25,920

don't

1771

01:00:30,950 --> 01:00:28,559

put any skin in the game it's not really

1772

01:00:32,390 --> 01:00:30,960

what physics is about

1773

01:00:34,870 --> 01:00:32,400

this flatness that you mentioned of

1774

01:00:36,789 --> 01:00:34,880

space-time is this why we can say that a

1775

01:00:38,069 --> 01:00:36,799

galaxy is moving away from us at a

1776

01:00:39,510 --> 01:00:38,079

certain speed and the reason why i say

1777

01:00:41,990 --> 01:00:39,520

that is

1778

01:00:43,589 --> 01:00:42,000

in a manifold you can't technically to

1779

01:00:45,109 --> 01:00:43,599

get a bit technical can't technically

1780

01:00:46,390 --> 01:00:45,119

compare two different velocities unless

1781

01:00:47,109 --> 01:00:46,400

they're brought at the same point unless

1782

01:00:49,109 --> 01:00:47,119

you have

1783

01:00:50,950 --> 01:00:49,119

a horizontal or vertical subspace given

1784

01:00:53,030 --> 01:00:50,960

by a connection and so on

1785

01:00:54,309 --> 01:00:53,040

so how can you compare different

1786

01:00:55,510 --> 01:00:54,319

velocities when you're at different

1787

01:00:56,470 --> 01:00:55,520

points in a manifold that's what i'm

1788

01:00:59,670 --> 01:00:56,480

wondering

1789

01:01:02,630 --> 01:00:59,680

no so first of all i should say that in

1790

01:01:05,750 --> 01:01:02,640

einstein's theory of gravity you can get

1791

01:01:05,990 --> 01:01:05,760

a very distant galaxy to move away from

1792

01:01:10,630 --> 01:01:06,000

us

1793

01:01:13,190 --> 01:01:10,640

it's far away

1794

01:01:13,670 --> 01:01:13,200

so space and time can expand faster than

1795

01:01:15,030 --> 01:01:13,680

light

1796

01:01:16,950 --> 01:01:15,040

when you're dealing with points that are

1797

01:01:19,670 --> 01:01:16,960

separated by a large distance

1798

01:01:20,390 --> 01:01:19,680

that's allowed by einstein's theory and

1799

01:01:22,950 --> 01:01:20,400

that's why

1800

01:01:24,789 --> 01:01:22,960

we lose contact with galaxies once they

1801
01:01:25,589 --> 01:01:24,799
start moving faster than light relative

1802
01:01:28,470 --> 01:01:25,599
to us

1803
01:01:30,150 --> 01:01:28,480
and so in an accelerating universe two

1804
01:01:31,990 --> 01:01:30,160
points that were in contact

1805
01:01:34,950 --> 01:01:32,000
are separated eventually so that they

1806
01:01:38,069 --> 01:01:34,960
are not in contact anymore after a while

1807
01:01:39,750 --> 01:01:38,079
and of course that time that it takes is

1808
01:01:41,910 --> 01:01:39,760
the time that it takes them to reach the

1809
01:01:43,510 --> 01:01:41,920
speed of light basically that's the time

1810
01:01:45,109 --> 01:01:43,520
that they're still in contact and after

1811
01:01:48,390 --> 01:01:45,119
that they're not in cont

1812
01:01:51,430 --> 01:01:48,400
that they cannot communicate um but

1813
01:01:51,990 --> 01:01:51,440

to your second question that has to do

1814

01:01:54,710 --> 01:01:52,000

with how

1815

01:01:56,710 --> 01:01:54,720

can we measure that the universe is flat

1816

01:02:00,309 --> 01:01:56,720

and that is simply just like

1817

01:02:03,510 --> 01:02:00,319

um you check if a piece of paper is flat

1818

01:02:04,710 --> 01:02:03,520

you draw a triangle and you check the

1819

01:02:09,750 --> 01:02:04,720

sum of the angles

1820

01:02:11,190 --> 01:02:09,760

you know that this piece of paper is

1821

01:02:13,430 --> 01:02:11,200

flat

1822

01:02:14,470 --> 01:02:13,440

but if it sits on top of a ball for

1823

01:02:17,270 --> 01:02:14,480

example

1824

01:02:17,910 --> 01:02:17,280

then the sum of the angle can be bigger

1825

01:02:20,470 --> 01:02:17,920

than

1826
01:02:21,990 --> 01:02:20,480
180 degrees you can take a line from the

1827
01:02:24,230 --> 01:02:22,000
pole to the equator

1828
01:02:25,109 --> 01:02:24,240
go along the equator and go back to the

1829
01:02:27,750 --> 01:02:25,119
pole

1830
01:02:29,190 --> 01:02:27,760
and each of these angles would be 90

1831
01:02:33,670 --> 01:02:29,200
degrees

1832
01:02:37,670 --> 01:02:33,680
so 90 plus 90 plus 90 if you're doing it

1833
01:02:39,109 --> 01:02:37,680
that would be 270 it's more than 180

1834
01:02:42,309 --> 01:02:39,119
degrees then you know that

1835
01:02:42,870 --> 01:02:42,319
the surface is not flat it's actually

1836
01:02:46,470 --> 01:02:42,880
curved

1837
01:02:48,710 --> 01:02:46,480
like a ball positive so

1838
01:02:49,670 --> 01:02:48,720

how do we check the sums of the angles

1839

01:02:52,230 --> 01:02:49,680

of a triangle

1840

01:02:53,349 --> 01:02:52,240

in the universe well we just need a

1841

01:02:55,190 --> 01:02:53,359

standard ruler

1842

01:02:56,710 --> 01:02:55,200

and we have that uh in the early

1843

01:02:59,109 --> 01:02:56,720

universe you know

1844

01:02:59,829 --> 01:02:59,119

a sound wave would propagate a certain

1845

01:03:01,750 --> 01:02:59,839

distance

1846

01:03:03,910 --> 01:03:01,760

that we can calculate so at a given time

1847

01:03:06,549 --> 01:03:03,920

after the big bang we know how far

1848

01:03:08,069 --> 01:03:06,559

a sound wave can propagate and it turns

1849

01:03:09,109 --> 01:03:08,079

out that this is the distance where you

1850

01:03:12,150 --> 01:03:09,119

can have

1851
01:03:13,829 --> 01:03:12,160
correlations between the temperature

1852
01:03:15,270 --> 01:03:13,839
of the microwave background because

1853
01:03:17,670 --> 01:03:15,280
sound waves

1854
01:03:19,109 --> 01:03:17,680
correlate different points in the sky

1855
01:03:20,230 --> 01:03:19,119
where the temperature of the micro

1856
01:03:23,109 --> 01:03:20,240
background

1857
01:03:24,630 --> 01:03:23,119
knows about another point sorry why are

1858
01:03:27,029 --> 01:03:24,640
you using sound waves because

1859
01:03:28,789 --> 01:03:27,039
sound waves require a medium yes there

1860
01:03:30,470 --> 01:03:28,799
is a medium the matter in the universe

1861
01:03:32,950 --> 01:03:30,480
is the medium i mean there is

1862
01:03:33,910 --> 01:03:32,960
ordinary matter and there is light and

1863
01:03:36,390 --> 01:03:33,920

there is dark matter

1864

01:03:36,950 --> 01:03:36,400

so there is matter uh and and the sound

1865

01:03:38,710 --> 01:03:36,960

waves

1866

01:03:40,870 --> 01:03:38,720

we can calculate the speed by which they

1867

01:03:42,230 --> 01:03:40,880

move and so if we look at a certain time

1868

01:03:44,150 --> 01:03:42,240

after the big bang

1869

01:03:45,990 --> 01:03:44,160

we can tell how far sound waves could

1870

01:03:46,789 --> 01:03:46,000

propagate and that defines the standard

1871

01:03:49,750 --> 01:03:46,799

ruler

1872

01:03:51,430 --> 01:03:49,760

that's the distance over which different

1873

01:03:53,589 --> 01:03:51,440

points in the sky would be correlated

1874

01:03:55,910 --> 01:03:53,599

with each other because they could speak

1875

01:03:57,589 --> 01:03:55,920

via sound with each other and so when we

1876

01:03:59,910 --> 01:03:57,599

look at the micro background

1877

01:04:00,789 --> 01:03:59,920

we can measure the angle that that

1878

01:04:03,270 --> 01:04:00,799

yardstick

1879

01:04:04,470 --> 01:04:03,280

occupies and we can figure out whether

1880

01:04:07,029 --> 01:04:04,480

the sums

1881

01:04:07,990 --> 01:04:07,039

of the angles in that triangle the base

1882

01:04:11,109 --> 01:04:08,000

of the triangle

1883

01:04:12,789 --> 01:04:11,119

is the yardstick the distance that sound

1884

01:04:14,870 --> 01:04:12,799

traveled at that time

1885

01:04:16,710 --> 01:04:14,880

and then the the other sides of the

1886

01:04:18,870 --> 01:04:16,720

triangle bring

1887

01:04:20,309 --> 01:04:18,880

go to the observer so the observer looks

1888

01:04:23,029 --> 01:04:20,319

at this yardstick

1889

01:04:25,029 --> 01:04:23,039

and we can look at how what is the angle

1890

01:04:27,029 --> 01:04:25,039

that this yardstick occupies

1891

01:04:28,870 --> 01:04:27,039

and from that we can figure out that

1892

01:04:30,789 --> 01:04:28,880

whether the universe is flat or not and

1893

01:04:31,990 --> 01:04:30,799

this experiment was done in in the year

1894

01:04:34,150 --> 01:04:32,000

2000

1895

01:04:35,109 --> 01:04:34,160

uh we already knew that the universe is

1896

01:04:37,270 --> 01:04:35,119

flat

1897

01:04:38,710 --> 01:04:37,280

that it's the simplest geometry you can

1898

01:04:41,589 --> 01:04:38,720

think of that's absolutely

1899

01:04:43,270 --> 01:04:41,599

interesting of a flat space a priori is

1900

01:04:45,829 --> 01:04:43,280

there a reason why it should be flat

1901

01:04:47,270 --> 01:04:45,839

i see it's as simple but and also is

1902

01:04:48,870 --> 01:04:47,280

there a margin of error with this

1903

01:04:51,829 --> 01:04:48,880

well there should be a margin of error

1904

01:04:54,630 --> 01:04:51,839

there is a margin of error all right

1905

01:04:55,190 --> 01:04:54,640

the precision right now is a few percent

1906

01:04:59,349 --> 01:04:55,200

uh

1907

01:05:01,109 --> 01:04:59,359

but um cosmic inflation naturally

1908

01:05:03,349 --> 01:05:01,119

you know in the all the incarnation of

1909

01:05:06,829 --> 01:05:03,359

it where not everything was possible but

1910

01:05:09,589 --> 01:05:06,839

if you were to take the models from 1980

1911

01:05:10,630 --> 01:05:09,599

um they would expect the universe to be

1912

01:05:12,549 --> 01:05:10,640

flat because

1913

01:05:14,230 --> 01:05:12,559

you take a small patch of space you

1914

01:05:15,510 --> 01:05:14,240

might have some curvature of space and

1915

01:05:17,750 --> 01:05:15,520

time in that patch

1916

01:05:19,589 --> 01:05:17,760

but then you inflate it and when you

1917

01:05:21,589 --> 01:05:19,599

inflate it you stretch it

1918

01:05:23,190 --> 01:05:21,599

to huge dimensions so all the curvature

1919

01:05:26,309 --> 01:05:23,200

that you had on small scales

1920

01:05:28,630 --> 01:05:26,319

is now being ironed out and

1921

01:05:30,309 --> 01:05:28,640

you can think of it as a cosmic iron you

1922

01:05:33,589 --> 01:05:30,319

basically iron out by

1923

01:05:34,069 --> 01:05:33,599

expansion you do you make the universe

1924

01:05:39,910 --> 01:05:34,079

flat

1925

01:05:41,510 --> 01:05:39,920

indeed

1926

01:05:43,349 --> 01:05:41,520

that seems to me to be evidence for the

1927

01:05:45,750 --> 01:05:43,359

inflation yes it is

1928

01:05:46,950 --> 01:05:45,760

but in the original incarnation of the

1929

01:05:49,109 --> 01:05:46,960

1980s

1930

01:05:50,710 --> 01:05:49,119

uh what happened afterwards is that the

1931

01:05:53,510 --> 01:05:50,720

theory was

1932

01:05:54,470 --> 01:05:53,520

appended supplemented by ingredients

1933

01:05:57,029 --> 01:05:54,480

that make it

1934

01:05:58,390 --> 01:05:57,039

much less predictive that it can

1935

01:06:01,029 --> 01:05:58,400

accommodate anything

1936

01:06:01,589 --> 01:06:01,039

that's the part that they resist i see i

1937

01:06:03,510 --> 01:06:01,599

see

1938

01:06:04,870 --> 01:06:03,520

let's imagine i think wolfram predicts

1939

01:06:06,870 --> 01:06:04,880

that there's a lower bound to the

1940

01:06:08,789 --> 01:06:06,880

elementary particle masses or at least

1941

01:06:10,390 --> 01:06:08,799

he says he can get to that

1942

01:06:12,870 --> 01:06:10,400

i think you mentioned that astrophysical

1943

01:06:17,029 --> 01:06:12,880

data can validate this

1944

01:06:21,510 --> 01:06:17,039

how well wolfram has a different

1945

01:06:24,630 --> 01:06:21,520

way of looking at physics uh

1946

01:06:25,750 --> 01:06:24,640

which is related to um something he

1947

01:06:29,430 --> 01:06:25,760

worked on

1948

01:06:31,510 --> 01:06:29,440

for a while it's diagrams of

1949

01:06:33,750 --> 01:06:31,520

hyper graphs and so on yeah temperatures

1950

01:06:34,390 --> 01:06:33,760

and he has a group of people working

1951

01:06:37,750 --> 01:06:34,400

with him and

1952

01:06:41,270 --> 01:06:37,760

it's a very ambitious process project

1953

01:06:44,390 --> 01:06:41,280

he is very bright i

1954

01:06:46,630 --> 01:06:44,400

i haven't seen yet that the effort

1955

01:06:47,430 --> 01:06:46,640

yield predictions that we can test

1956

01:06:49,349 --> 01:06:47,440

experimentally

1957

01:06:51,029 --> 01:06:49,359

so far he's trying to reproduce things

1958

01:06:55,190 --> 01:06:51,039

we know about

1959

01:06:58,950 --> 01:06:57,109

not far from where i live and he's

1960

01:07:02,069 --> 01:06:58,960

relatively local

1961

01:07:05,270 --> 01:07:02,079

how many minutes am i driving

1962

01:07:07,349 --> 01:07:05,280

yeah at some point i i hope to to have a

1963

01:07:08,870 --> 01:07:07,359

conversation with him walking together

1964

01:07:12,150 --> 01:07:08,880

in the woods and

1965

01:07:14,549 --> 01:07:12,160

trying to get the latest on his work

1966

01:07:15,670 --> 01:07:14,559

but as far as i know it's not yet at the

1967

01:07:17,750 --> 01:07:15,680

point where

1968

01:07:20,549 --> 01:07:17,760

the theory predicts new things that we

1969

01:07:22,950 --> 01:07:20,559

can test beyond what we already know

1970

01:07:24,630 --> 01:07:22,960

i see i see so what do you think of his

1971

01:07:26,630 --> 01:07:24,640

model

1972

01:07:27,910 --> 01:07:26,640

i think it's too preliminary it's it's

1973

01:07:29,670 --> 01:07:27,920

nice to have people thinking

1974

01:07:32,789 --> 01:07:29,680

independently you know and

1975

01:07:34,789 --> 01:07:32,799

um i i very much i i salute his

1976

01:07:36,309 --> 01:07:34,799

effort intellectually because it's very

1977

01:07:40,150 --> 01:07:36,319

ambitious you know to come up with a

1978

01:07:42,870 --> 01:07:40,160

completely new way of looking at physics

1979

01:07:43,910 --> 01:07:42,880

and his courage for do taking on this

1980

01:07:46,309 --> 01:07:43,920

task

1981

01:07:47,190 --> 01:07:46,319

uh and his intellect i mean he's he's

1982

01:07:49,589 --> 01:07:47,200

brilliant

1983

01:07:51,430 --> 01:07:49,599

when you listen to him have you heard of

1984

01:07:53,109 --> 01:07:51,440

eric weinstein's geometric unity

1985

01:07:54,950 --> 01:07:53,119

have you researched into it and what do

1986

01:07:58,549 --> 01:07:54,960

you think about it i did not

1987

01:08:00,870 --> 01:07:58,559

look into it in detail no

1988

01:08:01,829 --> 01:08:00,880

so i cannot comment but i know that he's

1989

01:08:03,430 --> 01:08:01,839

very bright

1990

01:08:05,109 --> 01:08:03,440

yeah do you think that innovation in

1991

01:08:06,710 --> 01:08:05,119

physics is going to necessarily come

1992

01:08:08,150 --> 01:08:06,720

from the outside because of these

1993

01:08:10,390 --> 01:08:08,160

selective pressures that you mentioned

1994

01:08:13,670 --> 01:08:10,400

in the

1995

01:08:16,149 --> 01:08:13,680

in academia yeah well i think uh

1996

01:08:16,910 --> 01:08:16,159

what it what happens is that this

1997

01:08:20,470 --> 01:08:16,920

pressure

1998

01:08:21,189 --> 01:08:20,480

is is reducing the efficiency of science

1999

01:08:23,669 --> 01:08:21,199

that

2000

01:08:25,510 --> 01:08:23,679

fewer people are attempting to deviate

2001

01:08:27,269 --> 01:08:25,520

from the beaten path

2002

01:08:29,430 --> 01:08:27,279

and especially the young people you know

2003

01:08:30,709 --> 01:08:29,440

if you think about albert einstein he

2004

01:08:33,749 --> 01:08:30,719

was not deterred by

2005

01:08:36,789 --> 01:08:33,759

oppression he in one year had five

2006

01:08:38,630 --> 01:08:36,799

seminal papers and i very much hope that

2007

01:08:41,030 --> 01:08:38,640

this tradition will come back

2008

01:08:42,229 --> 01:08:41,040

where young people will not be afraid to

2009

01:08:45,510 --> 01:08:42,239

innovate

2010

01:08:47,910 --> 01:08:45,520

uh and uh i think

2011

01:08:49,590 --> 01:08:47,920

even with social pressure as long as we

2012

01:08:50,870 --> 01:08:49,600

continue to do experiments you know

2013

01:08:52,630 --> 01:08:50,880

that's the key

2014

01:08:54,070 --> 01:08:52,640

because experiments and collecting

2015

01:08:56,709 --> 01:08:54,080

evidence will eventually

2016

01:08:57,590 --> 01:08:56,719

tell us that we are wrong it takes more

2017

01:08:59,430 --> 01:08:57,600

time

2018

01:09:00,709 --> 01:08:59,440

if we are not open-minded and if you

2019

01:09:03,990 --> 01:09:00,719

look for example

2020

01:09:04,229 --> 01:09:04,000

the perfect example is the mayan culture

2021

01:09:16,149 --> 01:09:04,239

i

2022

01:09:18,309 --> 01:09:16,159

culture were held

2023

01:09:20,149 --> 01:09:18,319

at a very high regard they were

2024

01:09:23,189 --> 01:09:20,159

considered astronomer priests

2025

01:09:24,709 --> 01:09:23,199

the highest level in society and i was

2026

01:09:27,990 --> 01:09:24,719

wondering why and

2027

01:09:30,789 --> 01:09:28,000

turns out that uh politicians

2028

01:09:31,349 --> 01:09:30,799

the rulers of the mayans they thought

2029

01:09:33,110 --> 01:09:31,359

that

2030

01:09:34,390 --> 01:09:33,120

by knowing the positions of planets and

2031

01:09:36,709 --> 01:09:34,400

stars on the sky

2032

01:09:38,789 --> 01:09:36,719

you can forecast the future so you can

2033

01:09:40,390 --> 01:09:38,799

tell the outcome of a war you can decide

2034

01:09:42,229 --> 01:09:40,400

when to go out to a war

2035

01:09:45,110 --> 01:09:42,239

so that it will be successful so that

2036

01:09:48,309 --> 01:09:45,120

you would win based on the locations of

2037

01:09:50,149 --> 01:09:48,319

planets and so they put astronomers

2038

01:09:51,990 --> 01:09:50,159

that monitor the sky the planets where

2039

01:09:53,910 --> 01:09:52,000

did they get that idea from

2040

01:09:56,310 --> 01:09:53,920

just from the predictive powers of the

2041

01:09:59,350 --> 01:09:56,320

weather and then extrapolating that

2042

01:10:02,229 --> 01:09:59,360

no it's just a it's um it's sort of like

2043

01:10:04,470 --> 01:10:02,239

horoscopes nowadays you know astrology

2044

01:10:05,350 --> 01:10:04,480

uh it's a natural tendency of people to

2045

01:10:07,669 --> 01:10:05,360

believe that

2046

01:10:09,189 --> 01:10:07,679

there are powers that extend way beyond

2047

01:10:12,229 --> 01:10:09,199

what reality is

2048

01:10:13,669 --> 01:10:12,239

you know and alchemy was one example

2049

01:10:16,950 --> 01:10:13,679

where people thought that their

2050

01:10:20,550 --> 01:10:16,960

beliefs or emotions affect you know

2051

01:10:23,669 --> 01:10:20,560

materials the nature of materials

2052

01:10:26,470 --> 01:10:23,679

so anyway they thought that

2053

01:10:28,149 --> 01:10:26,480

the motion of stars and planets affect

2054

01:10:31,350 --> 01:10:28,159

human history and that's

2055

01:10:34,709 --> 01:10:31,360

astrology fundamentally so but

2056

01:10:36,550 --> 01:10:34,719

that was their belief system and then

2057

01:10:38,229 --> 01:10:36,560

and then the astronomers collected huge

2058

01:10:42,709 --> 01:10:38,239

amounts of data over

2059

01:10:44,790 --> 01:10:42,719

thousands of years and uh amazing data

2060

01:10:45,750 --> 01:10:44,800

but it was not used for the purpose of

2061

01:10:49,110 --> 01:10:45,760

finding

2062

01:10:50,870 --> 01:10:49,120

uh newton's law of gravity it was for

2063

01:10:52,709 --> 01:10:50,880

the purp for the political purpose of

2064

01:10:54,550 --> 01:10:52,719

winning a war

2065

01:10:56,470 --> 01:10:54,560

and if you think about it from a modern

2066

01:10:59,430 --> 01:10:56,480

perspective

2067

01:10:59,830 --> 01:10:59,440

we now know that the motion of mars or

2068

01:11:02,310 --> 01:10:59,840

or

2069

01:11:04,310 --> 01:11:02,320

venus have nothing to do with whether

2070

01:11:05,669 --> 01:11:04,320

the gulf war was successful or a

2071

01:11:08,149 --> 01:11:05,679

disaster

2072

01:11:09,189 --> 01:11:08,159

and so we nowadays have a different view

2073

01:11:12,070 --> 01:11:09,199

about planets

2074

01:11:14,709 --> 01:11:12,080

and stars and collecting all this

2075

01:11:17,350 --> 01:11:14,719

exquisite data was not enough

2076

01:11:17,830 --> 01:11:17,360

if you have the wrong conception good

2077

01:11:20,390 --> 01:11:17,840

data

2078

01:11:22,070 --> 01:11:20,400

is not enough so you need to be

2079

01:11:24,070 --> 01:11:22,080

open-minded

2080

01:11:26,149 --> 01:11:24,080

for other interpretations and to think

2081

01:11:27,990 --> 01:11:26,159

about the data that you get in ways that

2082

01:11:30,310 --> 01:11:28,000

are not traditional

2083

01:11:31,990 --> 01:11:30,320

and i bring this up because if you

2084

01:11:32,870 --> 01:11:32,000

always think that you know the answer in

2085

01:11:35,270 --> 01:11:32,880

advance

2086

01:11:36,950 --> 01:11:35,280

you might not even collect the data

2087

01:11:39,750 --> 01:11:36,960

that's even more dangerous

2088

01:11:40,149 --> 01:11:39,760

the mayans were in a way more advanced

2089

01:11:41,990 --> 01:11:40,159

than

2090

01:11:43,669 --> 01:11:42,000

those people that say we don't need data

2091

01:11:45,510 --> 01:11:43,679

we know the answer without it

2092

01:11:47,030 --> 01:11:45,520

you know those philosophers let's say if

2093

01:11:47,750 --> 01:11:47,040

physicists agree on something that's

2094

01:11:49,830 --> 01:11:47,760

enough

2095

01:11:51,110 --> 01:11:49,840

that's that's much more primitive than

2096

01:11:53,910 --> 01:11:51,120

the mayans

2097

01:11:55,910 --> 01:11:53,920

uh belief system because the minds were

2098

01:11:59,030 --> 01:11:55,920

collecting data about the sky

2099

01:12:01,110 --> 01:11:59,040

at least and and you know the

2100

01:12:02,870 --> 01:12:01,120

i think that's the most important thing

2101

01:12:04,709 --> 01:12:02,880

that we can

2102

01:12:07,669 --> 01:12:04,719

maintain in terms of the integrity of

2103

01:12:10,790 --> 01:12:07,679

science is its reliance on evidence

2104

01:12:13,830 --> 01:12:10,800

rather than on what people say

2105

01:12:16,310 --> 01:12:13,840

and i hope if that stays

2106

01:12:18,070 --> 01:12:16,320

even if some ideas are ridiculed now

2107

01:12:19,669 --> 01:12:18,080

eventually there would be data and

2108

01:12:20,870 --> 01:12:19,679

evidence that would

2109

01:12:22,310 --> 01:12:20,880

demonstrate that they're right and

2110

01:12:23,669 --> 01:12:22,320

that's what happened to me you know in

2111

01:12:24,950 --> 01:12:23,679

the examples that we

2112

01:12:27,510 --> 01:12:24,960

discussed at the beginning of our

2113

01:12:29,590 --> 01:12:27,520

conversation you know that eventually

2114

01:12:31,270 --> 01:12:29,600

data came along and demonstrated that

2115

01:12:33,669 --> 01:12:31,280

what i'm saying is correct

2116

01:12:34,709 --> 01:12:33,679

and so that that is you know great i

2117

01:12:36,390 --> 01:12:34,719

mean

2118

01:12:38,470 --> 01:12:36,400

and by the way it's not about me being

2119

01:12:40,229 --> 01:12:38,480

right it's not about us it's about

2120

01:12:42,229 --> 01:12:40,239

right it's about the dialogue we have

2121

01:12:43,910 --> 01:12:42,239

with nature i recall reading one of your

2122

01:12:45,750 --> 01:12:43,920

scientific american articles about the

2123

01:12:47,350 --> 01:12:45,760

limitations of knowing a theory of

2124

01:12:48,630 --> 01:12:47,360

everything and you cited girdle

2125

01:12:50,070 --> 01:12:48,640

i'm not sure if you were citing girdle

2126
01:12:51,189 --> 01:12:50,080
to say that what girdles incompleteness

2127
01:12:53,350 --> 01:12:51,199
theorem has to say

2128
01:12:55,189 --> 01:12:53,360
is something about whether or not we can

2129
01:12:57,270 --> 01:12:55,199
ultimately find the laws that govern us

2130
01:12:58,790 --> 01:12:57,280
or you're using that to say well look

2131
01:12:59,590 --> 01:12:58,800
there are limitations so let's be a bit

2132
01:13:01,270 --> 01:12:59,600
more humble

2133
01:13:02,630 --> 01:13:01,280
which one was it does girdle's theorem

2134
01:13:04,229 --> 01:13:02,640
have anything to do

2135
01:13:06,149 --> 01:13:04,239
it was the second one i think we should

2136
01:13:08,790 --> 01:13:06,159
be humble because

2137
01:13:09,510 --> 01:13:08,800
we will never have a complete theory of

2138
01:13:12,310 --> 01:13:09,520

everything

2139

01:13:13,430 --> 01:13:12,320

uh logically that was demonstrated by

2140

01:13:16,550 --> 01:13:13,440

ghetto but

2141

01:13:19,350 --> 01:13:16,560

but also you know the scientific process

2142

01:13:21,270 --> 01:13:19,360

is working progress you know we

2143

01:13:23,590 --> 01:13:21,280

it turns out that when we discover new

2144

01:13:25,990 --> 01:13:23,600

things uh we can ask more questions

2145

01:13:27,830 --> 01:13:26,000

it's not that we ask less questions so

2146

01:13:28,550 --> 01:13:27,840

the the illusion that you know physics

2147

01:13:30,830 --> 01:13:28,560

will get to an

2148

01:13:32,390 --> 01:13:30,840

end and that would be it you know that

2149

01:13:34,950 --> 01:13:32,400

was uh

2150

01:13:35,590 --> 01:13:34,960

advocated that a hundred years ago

2151
01:13:38,070 --> 01:13:35,600
before

2152
01:13:38,950 --> 01:13:38,080
uh einstein came more than a hundred

2153
01:13:41,270 --> 01:13:38,960
years 100

2154
01:13:42,950 --> 01:13:41,280
yeah 20 years ago before einstein came

2155
01:13:44,550 --> 01:13:42,960
with special relativity and quantum

2156
01:13:47,350 --> 01:13:44,560
mechanics was discovered

2157
01:13:48,470 --> 01:13:47,360
and clearly physics was revolutionized

2158
01:13:50,709 --> 01:13:48,480
and it's being

2159
01:13:51,590 --> 01:13:50,719
it was said the in recent decades by

2160
01:13:53,270 --> 01:13:51,600
some people and

2161
01:13:54,870 --> 01:13:53,280
again i i think they are completely

2162
01:13:57,590 --> 01:13:54,880
misguided because

2163
01:14:00,149 --> 01:13:57,600

uh you know knowledge is just an island

2164

01:14:00,630 --> 01:14:00,159

in an ocean of ignorance we we know so

2165

01:14:04,149 --> 01:14:00,640

little

2166

01:14:05,830 --> 01:14:04,159

and the way to for us to maintain

2167

01:14:07,910 --> 01:14:05,840

the integrity of science is to stay

2168

01:14:08,709 --> 01:14:07,920

modest and say look we we don't know so

2169

01:14:10,310 --> 01:14:08,719

much

2170

01:14:12,070 --> 01:14:10,320

and and it's work in progress and

2171

01:14:14,390 --> 01:14:12,080

sometimes we may be wrong so let's be

2172

01:14:17,110 --> 01:14:14,400

open-minded and let's continue to

2173

01:14:17,910 --> 01:14:17,120

collect evidence and and make progress

2174

01:14:19,350 --> 01:14:17,920

through that

2175

01:14:20,950 --> 01:14:19,360

why does girls in completeness theorem

2176

01:14:22,229 --> 01:14:20,960

have anything to do with

2177

01:14:24,550 --> 01:14:22,239

whether or not we can learn uh

2178

01:14:26,390 --> 01:14:24,560

fundamental laws because

2179

01:14:28,070 --> 01:14:26,400

what ghetto demonstrated is that you

2180

01:14:31,669 --> 01:14:28,080

cannot build a

2181

01:14:35,669 --> 01:14:31,679

a self-consistent logical

2182

01:14:38,470 --> 01:14:35,679

system that uh that that

2183

01:14:40,229 --> 01:14:38,480

can be proven uh and and and be

2184

01:14:41,830 --> 01:14:40,239

self-contained so to speak

2185

01:14:43,270 --> 01:14:41,840

i see i see you you're talking about

2186

01:14:44,950 --> 01:14:43,280

whether or not we can prove that

2187

01:14:46,790 --> 01:14:44,960

our theory of everything is the theory

2188

01:14:49,669 --> 01:14:46,800

of everything so there will always be

2189

01:14:53,430 --> 01:14:49,679

some loopholes even at the logical level

2190

01:14:55,990 --> 01:14:53,440

uh but what i'm referring to in addition

2191

01:14:59,830 --> 01:14:56,000

to that is the fact that uh

2192

01:15:01,590 --> 01:14:59,840

reality you know it will take us a long

2193

01:15:03,750 --> 01:15:01,600

while before we figure out all the

2194

01:15:06,550 --> 01:15:03,760

details of reality through experiments

2195

01:15:07,830 --> 01:15:06,560

in addition to the logical issues i

2196

01:15:09,590 --> 01:15:07,840

recall you mentioned

2197

01:15:11,189 --> 01:15:09,600

that science sorry that religion can

2198

01:15:12,470 --> 01:15:11,199

learn from science obviously in the

2199

01:15:13,830 --> 01:15:12,480

sense that we investigate nature it

2200

01:15:15,830 --> 01:15:13,840

tells us more about

2201

01:15:17,750 --> 01:15:15,840

god as well as it allows us a deeper

2202

01:15:20,149 --> 01:15:17,760

appreciation of that nature

2203

01:15:21,669 --> 01:15:20,159

and this is an old view actually which

2204

01:15:22,630 --> 01:15:21,679

says that if you have an interpretation

2205

01:15:25,669 --> 01:15:22,640

of the bible

2206

01:15:26,070 --> 01:15:25,679

the christian bible and you find that

2207

01:15:27,510 --> 01:15:26,080

nature

2208

01:15:28,630 --> 01:15:27,520

contradicts that then it's not that

2209

01:15:30,149 --> 01:15:28,640

nature is wrong is that your

2210

01:15:31,669 --> 01:15:30,159

interpretation of the bible is wrong

2211

01:15:33,430 --> 01:15:31,679

nature is always right because nature is

2212

01:15:35,830 --> 01:15:33,440

what god made

2213

01:15:36,550 --> 01:15:35,840

nature is god in some way actually so

2214

01:15:37,830 --> 01:15:36,560

then i'm wondering

2215

01:15:39,910 --> 01:15:37,840

that means that religion can learn from

2216

01:15:43,430 --> 01:15:39,920

science okay can science

2217

01:15:47,030 --> 01:15:43,440

learn from religion and if so how

2218

01:15:49,030 --> 01:15:47,040

well yeah so you know

2219

01:15:50,229 --> 01:15:49,040

being a physicist is just like trying to

2220

01:15:52,630 --> 01:15:50,239

figure out

2221

01:15:54,070 --> 01:15:52,640

what a building is is made of you know

2222

01:15:56,070 --> 01:15:54,080

you're trying to figure out

2223

01:15:57,669 --> 01:15:56,080

the bricks and mortar that make the

2224

01:15:59,110 --> 01:15:57,679

building that's the fundamental laws of

2225

01:16:00,630 --> 01:15:59,120

physics and

2226

01:16:02,310 --> 01:16:00,640

uh when we look at the universe we're

2227

01:16:03,750 --> 01:16:02,320

trying to figure out what it's made of

2228

01:16:06,149 --> 01:16:03,760

what the composition of the universe

2229

01:16:08,630 --> 01:16:06,159

what are the laws that are governing it

2230

01:16:10,390 --> 01:16:08,640

and then lo and behold we find that the

2231

01:16:13,510 --> 01:16:10,400

most most of the matter in the universe

2232

01:16:16,390 --> 01:16:13,520

is in some form that we don't know what

2233

01:16:18,390 --> 01:16:16,400

what what it is and we are not made of

2234

01:16:20,550 --> 01:16:18,400

it it's called dark matter so we still

2235

01:16:22,229 --> 01:16:20,560

have to figure it out

2236

01:16:23,990 --> 01:16:22,239

you know it's a puzzle and we're trying

2237

01:16:26,870 --> 01:16:24,000

to figure out uh

2238

01:16:28,470 --> 01:16:26,880

also the laws that govern the behavior

2239

01:16:31,590 --> 01:16:28,480
of the universe

2240

01:16:33,830 --> 01:16:31,600
but if you look at the building

2241

01:16:36,149 --> 01:16:33,840
there is more to it than the bricks and

2242

01:16:39,270 --> 01:16:36,159
mortar that make the building

2243

01:16:42,310 --> 01:16:39,280
the there is the design and there is the

2244

01:16:43,830 --> 01:16:42,320
uh purpose of the building and there is

2245

01:16:46,229 --> 01:16:43,840
the meaning of the building

2246

01:16:48,630 --> 01:16:46,239
you know and that goes beyond physics

2247

01:16:50,709 --> 01:16:48,640
that's the metaphysics now a physicist

2248

01:16:52,229 --> 01:16:50,719
can take a practical approach and say i

2249

01:16:53,910 --> 01:16:52,239
don't really care about that

2250

01:16:55,270 --> 01:16:53,920
i want to figure out how reality

2251

01:16:57,270 --> 01:16:55,280

operates because that's the only

2252

01:16:59,189 --> 01:16:57,280

tangible thing that i can later use in

2253

01:17:01,750 --> 01:16:59,199

developing technology

2254

01:17:02,310 --> 01:17:01,760

uh you know i i don't want to think

2255

01:17:04,550 --> 01:17:02,320

about

2256

01:17:05,430 --> 01:17:04,560

things that i cannot test empirically

2257

01:17:08,870 --> 01:17:05,440

like

2258

01:17:10,709 --> 01:17:08,880

you know that involve beauty

2259

01:17:12,630 --> 01:17:10,719

is the building beautiful is the

2260

01:17:13,669 --> 01:17:12,640

building serving a bigger purpose that's

2261

01:17:16,870 --> 01:17:13,679

that's not of my

2262

01:17:18,630 --> 01:17:16,880

interest but if you're an architect

2263

01:17:20,310 --> 01:17:18,640

right and you care mostly about that you

2264

01:17:23,669 --> 01:17:20,320

don't care about the bricks and mortar

2265

01:17:26,470 --> 01:17:23,679

uh as an architect you you draw a blue

2266

01:17:27,510 --> 01:17:26,480

blueprint of a building and you know in

2267

01:17:30,310 --> 01:17:27,520

principle

2268

01:17:30,870 --> 01:17:30,320

the con construction workers could use

2269

01:17:33,910 --> 01:17:30,880

different

2270

01:17:35,750 --> 01:17:33,920

materials to to make that

2271

01:17:37,350 --> 01:17:35,760

uh of course the materials affect the

2272

01:17:38,070 --> 01:17:37,360

durability of the building and so forth

2273

01:17:45,030 --> 01:17:38,080

but

2274

01:17:46,550 --> 01:17:45,040

it appears and and functions and uh so

2275

01:17:48,149 --> 01:17:46,560

from the point of view of an architect

2276

01:17:48,390 --> 01:17:48,159

it's a completely different question you

2277

01:17:51,189 --> 01:17:48,400

know

2278

01:17:53,270 --> 01:17:51,199

than from the point of construction work

2279

01:17:57,110 --> 01:17:53,280

what the building represents and

2280

01:17:57,669 --> 01:17:57,120

so the way i i see that is that reality

2281

01:18:00,709 --> 01:17:57,679

you know it

2282

01:18:02,630 --> 01:18:00,719

has many facets to it and

2283

01:18:04,390 --> 01:18:02,640

one of the facets is indeed what the

2284

01:18:06,870 --> 01:18:04,400

physics is dealing with

2285

01:18:07,990 --> 01:18:06,880

but another facet is what the humanities

2286

01:18:09,990 --> 01:18:08,000

are dealing with and

2287

01:18:11,270 --> 01:18:10,000

and that include includes philosophy and

2288

01:18:15,270 --> 01:18:11,280

theology and

2289

01:18:17,270 --> 01:18:15,280

religion and then you know as a human

2290

01:18:19,110 --> 01:18:17,280

you are incomplete if you were not to

2291

01:18:21,270 --> 01:18:19,120

consider all the facets

2292

01:18:23,110 --> 01:18:21,280

i mean you can of course narrow yourself

2293

01:18:24,950 --> 01:18:23,120

to one of them and just say i don't care

2294

01:18:27,110 --> 01:18:24,960

about anything else

2295

01:18:28,550 --> 01:18:27,120

that's fine but that's uh in a way

2296

01:18:30,709 --> 01:18:28,560

narrow-minded you know

2297

01:18:32,550 --> 01:18:30,719

it's just like looking at a small piece

2298

01:18:33,669 --> 01:18:32,560

of the of the big picture and i think

2299

01:18:36,470 --> 01:18:33,679

you're not

2300

01:18:38,390 --> 01:18:36,480

um fully satisfied living like that i

2301

01:18:41,510 --> 01:18:38,400

mean i don't think

2302

01:18:43,350 --> 01:18:41,520

uh that ignoring the humanities is a

2303

01:18:45,669 --> 01:18:43,360

good practice

2304

01:18:47,669 --> 01:18:45,679

i'm reminded by aristotle who had a

2305

01:18:48,630 --> 01:18:47,679

concept of causation which unified what

2306

01:18:50,790 --> 01:18:48,640

you're referring to

2307

01:18:52,709 --> 01:18:50,800

so material cause efficient cause formal

2308

01:18:54,149 --> 01:18:52,719

and final so the material is what you

2309

01:18:55,990 --> 01:18:54,159

bring some order and then the efficient

2310

01:18:57,750 --> 01:18:56,000

is essentially causation as we

2311

01:18:59,510 --> 01:18:57,760

understand it as physicists and the

2312

01:19:01,189 --> 01:18:59,520

formal is okay the

2313

01:19:02,870 --> 01:19:01,199

architecture and then the final is the

2314

01:19:04,630 --> 01:19:02,880

purpose of it so you're saying we've

2315

01:19:06,149 --> 01:19:04,640

forgotten about formal and final as

2316

01:19:08,470 --> 01:19:06,159

physicists or as

2317

01:19:10,630 --> 01:19:08,480

materialists in some way but then

2318

01:19:12,310 --> 01:19:10,640

aristotle's causation was secular

2319

01:19:13,910 --> 01:19:12,320

and what i was wondering is how can

2320

01:19:16,149 --> 01:19:13,920

science learn from religion

2321

01:19:17,110 --> 01:19:16,159

and that to me doesn't unless you want

2322

01:19:19,830 --> 01:19:17,120

to call what

2323

01:19:21,189 --> 01:19:19,840

aristotle was doing as religious where's

2324

01:19:23,430 --> 01:19:21,199

traditional religion in that

2325

01:19:24,470 --> 01:19:23,440

in your answer okay so traditional

2326

01:19:26,550 --> 01:19:24,480

religion that

2327

01:19:28,470 --> 01:19:26,560

has a god that looks over your shoulder

2328

01:19:31,590 --> 01:19:28,480

and affects what happens to you

2329

01:19:32,790 --> 01:19:31,600

you know that is you know that you can

2330

01:19:35,430 --> 01:19:32,800

falsify if you

2331

01:19:35,990 --> 01:19:35,440

you know in principle bad things happen

2332

01:19:39,270 --> 01:19:36,000

to good

2333

01:19:43,350 --> 01:19:39,280

people and vice versa and uh

2334

01:19:45,590 --> 01:19:43,360

and you know you can operate

2335

01:19:47,110 --> 01:19:45,600

if you are using the scientific method

2336

01:19:49,110 --> 01:19:47,120

uh you can test

2337

01:19:50,870 --> 01:19:49,120

those predictions you know if if there

2338

01:19:52,310 --> 01:19:50,880

is a way by which you can forecast what

2339

01:19:54,310 --> 01:19:52,320

will happen

2340

01:19:55,750 --> 01:19:54,320

and you see that that not happening that

2341

01:19:58,790 --> 01:19:55,760

that

2342

01:20:00,229 --> 01:19:58,800

or you know if the biblical story of

2343

01:20:02,390 --> 01:20:00,239

abraham in the bible if

2344

01:20:04,709 --> 01:20:02,400

abraham heard the voice of god and he

2345

01:20:06,629 --> 01:20:04,719

had a cell phone where he had a

2346

01:20:08,310 --> 01:20:06,639

voice memo app and he would have pressed

2347

01:20:09,590 --> 01:20:08,320

the button he could have recorded the

2348

01:20:11,669 --> 01:20:09,600

voice of god so

2349

01:20:13,270 --> 01:20:11,679

you know it in principle it's possible

2350

01:20:16,390 --> 01:20:13,280

to test some of these

2351
01:20:17,510 --> 01:20:16,400
direct interactions uh between a divine

2352
01:20:19,830 --> 01:20:17,520
entity

2353
01:20:21,669 --> 01:20:19,840
and and the human but if you believe

2354
01:20:22,229 --> 01:20:21,679
more in the concept the philosophical

2355
01:20:25,990 --> 01:20:22,239
concept

2356
01:20:29,270 --> 01:20:26,000
like spinoza did where he identified

2357
01:20:30,870 --> 01:20:29,280
god with nature and

2358
01:20:32,950 --> 01:20:30,880
you know there is something to it

2359
01:20:34,870 --> 01:20:32,960
because nature itself is not completely

2360
01:20:36,709 --> 01:20:34,880
random you know it's organized and

2361
01:20:38,470 --> 01:20:36,719
that's quite striking that the laws of

2362
01:20:40,470 --> 01:20:38,480
physics create

2363
01:20:42,470 --> 01:20:40,480

some order in the universe that

2364

01:20:44,149 --> 01:20:42,480

otherwise would not exist and

2365

01:20:46,070 --> 01:20:44,159

the fact that the same laws of physics

2366

01:20:49,590 --> 01:20:46,080

that we find here on earth apply

2367

01:20:51,270 --> 01:20:49,600

everywhere is remarkable in my view

2368

01:20:53,030 --> 01:20:51,280

and you know discovering the laws of

2369

01:20:56,070 --> 01:20:53,040

physics gives you a sense of

2370

01:20:57,910 --> 01:20:56,080

oh of the type that a religious person

2371

01:21:00,470 --> 01:20:57,920

may feel

2372

01:21:02,149 --> 01:21:00,480

you know because you are feeling

2373

01:21:03,110 --> 01:21:02,159

something about nature that you

2374

01:21:05,430 --> 01:21:03,120

uncovered that

2375

01:21:07,750 --> 01:21:05,440

is remarkable that applies everywhere

2376

01:21:11,030 --> 01:21:07,760

and it's much greater than we are

2377

01:21:13,510 --> 01:21:11,040

because it applies everywhere so um

2378

01:21:14,149 --> 01:21:13,520

you can call it a religious sense a

2379

01:21:16,470 --> 01:21:14,159

sense of

2380

01:21:17,590 --> 01:21:16,480

oh but you're doing it through a

2381

01:21:19,910 --> 01:21:17,600

scientific lens

2382

01:21:22,310 --> 01:21:19,920

and frankly it's not obvious to me that

2383

01:21:24,629 --> 01:21:22,320

there is a bigger meaning to life

2384

01:21:26,470 --> 01:21:24,639

uh you know like the because if you

2385

01:21:27,830 --> 01:21:26,480

think about the meanings that we assign

2386

01:21:31,750 --> 01:21:27,840

to life

2387

01:21:34,709 --> 01:21:31,760

they're usually confined to earth

2388

01:21:35,590 --> 01:21:34,719

all of our ambitions are confined to

2389

01:21:38,229 --> 01:21:35,600

earth

2390

01:21:39,030 --> 01:21:38,239

and within a billion years the sun will

2391

01:21:42,229 --> 01:21:39,040

boil off

2392

01:21:43,270 --> 01:21:42,239

all the oceans on earth so nothing that

2393

01:21:46,550 --> 01:21:43,280

we care about

2394

01:21:49,030 --> 01:21:46,560

that that is dear to our heart will stay

2395

01:21:50,070 --> 01:21:49,040

around for more than a billion years so

2396

01:21:54,550 --> 01:21:50,080

then you ask yourself

2397

01:21:56,229 --> 01:21:54,560

is that really a valuable meaning

2398

01:21:58,310 --> 01:21:56,239

something that will go away okay it will

2399

01:22:00,229 --> 01:21:58,320

go away in a billion years not in a

2400

01:22:01,750 --> 01:22:00,239

in a hundred years but qualitatively

2401

01:22:03,990 --> 01:22:01,760

speaking

2402

01:22:05,830 --> 01:22:04,000

it will go away it's just like something

2403

01:22:07,750 --> 01:22:05,840

that goes away in a week

2404

01:22:10,070 --> 01:22:07,760

i mean it may be meaningful for a while

2405

01:22:13,030 --> 01:22:10,080

but then it's not anymore so

2406

01:22:14,709 --> 01:22:13,040

there is no absolute meaning to our

2407

01:22:15,830 --> 01:22:14,719

existence if you think about the big

2408

01:22:19,270 --> 01:22:15,840

picture

2409

01:22:20,790 --> 01:22:19,280

and you know one thing that people ask

2410

01:22:23,590 --> 01:22:20,800

me what is the one thing you would

2411

01:22:25,350 --> 01:22:23,600

like to ask an alien if you were to be

2412

01:22:27,430 --> 01:22:25,360

in contact that is the question i would

2413

01:22:29,270 --> 01:22:27,440

like to ask is there a meaning to this

2414

01:22:31,750 --> 01:22:29,280

or what is the what is the meaning of

2415

01:22:33,910 --> 01:22:31,760

this play and as i said at the beginning

2416

01:22:35,750 --> 01:22:33,920

we are put on the stage like actors

2417

01:22:38,149 --> 01:22:35,760

without a script

2418

01:22:39,270 --> 01:22:38,159

what's the play about i would like to

2419

01:22:41,590 --> 01:22:39,280

know that

2420

01:22:43,270 --> 01:22:41,600

do you think that because we can zoom

2421

01:22:44,470 --> 01:22:43,280

out and say that over across a billion

2422

01:22:46,470 --> 01:22:44,480

years let's say that

2423

01:22:48,149 --> 01:22:46,480

will no longer be here therefore it's

2424

01:22:49,510 --> 01:22:48,159

meaningless do you think that

2425

01:22:51,189 --> 01:22:49,520

that means it's meaningless or do you

2426

01:22:51,990 --> 01:22:51,199

think that means that that view that we

2427

01:22:54,390 --> 01:22:52,000

zoom out and look

2428

01:22:56,629 --> 01:22:54,400

at our lives across a billion years that

2429

01:22:59,270 --> 01:22:56,639

that is not a way that we should view

2430

01:23:01,910 --> 01:22:59,280

ourselves the reason i'm saying that is

2431

01:23:04,629 --> 01:23:01,920

if we say that it's meaningless because

2432

01:23:05,990 --> 01:23:04,639

there's a there's an end to it then why

2433

01:23:07,750 --> 01:23:06,000

can't we just go

2434

01:23:09,110 --> 01:23:07,760

to a holocaust museum and say well their

2435

01:23:11,030 --> 01:23:09,120

suffering didn't matter because there

2436

01:23:12,550 --> 01:23:11,040

was an end to it anyway

2437

01:23:14,550 --> 01:23:12,560

like why can't we just apply that even

2438

01:23:18,070 --> 01:23:14,560

more locally and there is a meaning

2439

01:23:20,629 --> 01:23:18,080

but it's a temporary of course and um

2440

01:23:21,270 --> 01:23:20,639

and of course it it you know it means uh

2441

01:23:23,590 --> 01:23:21,280

the world

2442

01:23:25,430 --> 01:23:23,600

to us because we are also short-lived

2443

01:23:28,390 --> 01:23:25,440

you know we we live just

2444

01:23:29,270 --> 01:23:28,400

for decades and you know 100 years or so

2445

01:23:32,550 --> 01:23:29,280

uh

2446

01:23:33,990 --> 01:23:32,560

and um so during that time you know

2447

01:23:35,590 --> 01:23:34,000

that's what matters to us

2448

01:23:37,510 --> 01:23:35,600

what happens during that time and that's

2449

01:23:39,030 --> 01:23:37,520

extreme but when i was referring to

2450

01:23:40,550 --> 01:23:39,040

meaning i was referring to something

2451
01:23:43,350 --> 01:23:40,560
bigger that is

2452
01:23:44,870 --> 01:23:43,360
that is not going to go away you know

2453
01:23:47,590 --> 01:23:44,880
something that stays forever

2454
01:23:49,669 --> 01:23:47,600
and that's the thing that we need to

2455
01:23:52,790 --> 01:23:49,679
give up on i think

2456
01:23:54,070 --> 01:23:52,800
and and again uh staying modest you know

2457
01:23:58,070 --> 01:23:54,080
i think

2458
01:24:00,550 --> 01:23:58,080
it allows you not to want too much

2459
01:24:02,550 --> 01:24:00,560
you know not to think that oh there you

2460
01:24:03,510 --> 01:24:02,560
know i really want something that will

2461
01:24:05,189 --> 01:24:03,520
stay forever

2462
01:24:07,110 --> 01:24:05,199
perhaps we should yeah as you say

2463
01:24:08,790 --> 01:24:07,120

perhaps we should admit that

2464

01:24:10,470 --> 01:24:08,800

everything is temporary everything

2465

01:24:12,310 --> 01:24:10,480

changes all the time

2466

01:24:14,149 --> 01:24:12,320

we should just adapt to changing

2467

01:24:15,189 --> 01:24:14,159

circumstances and the meaning that we

2468

01:24:16,950 --> 01:24:15,199

have is

2469

01:24:18,709 --> 01:24:16,960

always short-lived and we should be

2470

01:24:20,629 --> 01:24:18,719

happy about that you know we can enjoy

2471

01:24:22,709 --> 01:24:20,639

good food when we eat it

2472

01:24:24,629 --> 01:24:22,719

we can enjoy the company of friends when

2473

01:24:27,350 --> 01:24:24,639

we have them around

2474

01:24:28,790 --> 01:24:27,360

uh and after a while it goes away that's

2475

01:24:31,750 --> 01:24:28,800

okay that's that's the way

2476

01:24:33,669 --> 01:24:31,760

life is and if we we don't aspire for a

2477

01:24:36,950 --> 01:24:33,679

meaning that is beyond that

2478

01:24:41,110 --> 01:24:39,510

something i was toying with was i wonder

2479

01:24:42,950 --> 01:24:41,120

if there's a way that the world of

2480

01:24:44,629 --> 01:24:42,960

experience can last forever

2481

01:24:46,550 --> 01:24:44,639

and the reason is let's say in general

2482

01:24:49,110 --> 01:24:46,560

relativity right beside a black hole

2483

01:24:50,470 --> 01:24:49,120

you can watch your person your friend

2484

01:24:51,510 --> 01:24:50,480

enter the black hole infinitely for the

2485

01:24:52,870 --> 01:24:51,520

rest of time

2486

01:24:54,629 --> 01:24:52,880

obviously they'd have to send photons

2487

01:24:56,229 --> 01:24:54,639

back to you but you can watch them it's

2488

01:24:57,030 --> 01:24:56,239

almost as if they're frozen right at the

2489

01:24:58,870 --> 01:24:57,040

event horizon

2490

01:25:00,790 --> 01:24:58,880

but then for them it's as if they passed

2491

01:25:03,189 --> 01:25:00,800

into the black hole now let's imagine in

2492

01:25:05,510 --> 01:25:03,199

reverse right before you're about to die

2493

01:25:06,790 --> 01:25:05,520

your experience of life gets stretched

2494

01:25:09,590 --> 01:25:06,800

infinitely

2495

01:25:09,910 --> 01:25:09,600

to everyone else it's as if it ended but

2496

01:25:11,350 --> 01:25:09,920

then

2497

01:25:13,350 --> 01:25:11,360

in just like in general relativity you

2498

01:25:14,870 --> 01:25:13,360

can't say that your frame of reference

2499

01:25:16,310 --> 01:25:14,880

is the correct one that they're your

2500

01:25:17,030 --> 01:25:16,320

friends is just as valid so i'm

2501

01:25:19,350 --> 01:25:17,040

wondering

2502

01:25:20,790 --> 01:25:19,360

does your experience it's not something

2503

01:25:22,229 --> 01:25:20,800

we can test but i'm wondering if right

2504

01:25:23,750 --> 01:25:22,239

before you die

2505

01:25:25,030 --> 01:25:23,760

does it get stretched infinitely and

2506

01:25:26,629 --> 01:25:25,040

that's one of the reasons why they say

2507

01:25:30,709 --> 01:25:26,639

heaven and hell

2508

01:25:31,990 --> 01:25:30,719

is dependent on how you live your life

2509

01:25:33,830 --> 01:25:32,000

right now because if you live

2510

01:25:35,430 --> 01:25:33,840

as if you're in heaven or you live

2511

01:25:36,629 --> 01:25:35,440

properly or you live as if you're in

2512

01:25:38,550 --> 01:25:36,639

hell and you hate everyone

2513

01:25:40,149 --> 01:25:38,560

if you were to die you're going to feel

2514

01:25:41,910 --> 01:25:40,159

that stretched out for the rest of

2515

01:25:43,030 --> 01:25:41,920

your life now you won't be able to see

2516

01:25:45,110 --> 01:25:43,040

other people but somehow

2517

01:25:47,189 --> 01:25:45,120

phenomenologically or experientially

2518

01:25:48,390 --> 01:25:47,199

it will get stretched and that's a huge

2519

01:25:49,910 --> 01:25:48,400

speculative jump

2520

01:25:52,550 --> 01:25:49,920

well that's that's an interesting

2521

01:25:55,350 --> 01:25:52,560

thought but if you ask me for my opinion

2522

01:25:56,070 --> 01:25:55,360

i think that we are just our body is

2523

01:25:58,550 --> 01:25:56,080

just like

2524

01:26:00,870 --> 01:25:58,560

a computer and when you unplug it from

2525

01:26:03,189 --> 01:26:00,880

the wall it shuts off all the systems

2526

01:26:04,070 --> 01:26:03,199

shut off and that's the experience of

2527

01:26:07,110 --> 01:26:04,080

death

2528

01:26:08,070 --> 01:26:07,120

basically your you know your your cord

2529

01:26:11,110 --> 01:26:08,080

is taken out of the

2530

01:26:12,390 --> 01:26:11,120

outlet do you have any ideas as to

2531

01:26:14,629 --> 01:26:12,400

consciousness or

2532

01:26:16,470 --> 01:26:14,639

its origins is it emerged is

2533

01:26:18,950 --> 01:26:16,480

consciousness emergent

2534

01:26:20,830 --> 01:26:18,960

yeah that's what i think i think um that

2535

01:26:24,149 --> 01:26:20,840

we are very complex

2536

01:26:27,910 --> 01:26:24,159

systems and we are subject

2537

01:26:30,229 --> 01:26:27,920

to a lot of uh inputs

2538

01:26:31,270 --> 01:26:30,239

you know from our environment and that's

2539

01:26:33,510 --> 01:26:31,280

what makes us

2540

01:26:34,790 --> 01:26:33,520

unpredictable so when people talk about

2541

01:26:37,110 --> 01:26:34,800

free will it's

2542

01:26:38,709 --> 01:26:37,120

sort of the confluence of a lot of

2543

01:26:40,550 --> 01:26:38,719

ingredients

2544

01:26:42,229 --> 01:26:40,560

each of which you know can change the

2545

01:26:44,709 --> 01:26:42,239

outcome and

2546

01:26:45,270 --> 01:26:44,719

as a result we are not that predictable

2547

01:26:47,030 --> 01:26:45,280

and

2548

01:26:48,870 --> 01:26:47,040

of course according to quantum mechanics

2549

01:26:52,149 --> 01:26:48,880

things are not predictable

2550

01:26:55,750 --> 01:26:52,159

there is a probabilistic outcome

2551

01:26:59,990 --> 01:26:55,760

but in general you know i think

2552

01:27:02,149 --> 01:27:00,000

both free will and consciousness are

2553

01:27:03,110 --> 01:27:02,159

incarnations of very complex systems so

2554

01:27:06,229 --> 01:27:03,120

it's it's the way that

2555

01:27:07,830 --> 01:27:06,239

a complex system the human appears uh

2556

01:27:09,590 --> 01:27:07,840

but it doesn't mean that the building

2557

01:27:12,470 --> 01:27:09,600

blocks of making a human

2558

01:27:13,830 --> 01:27:12,480

are anything different than you know the

2559

01:27:15,910 --> 01:27:13,840

physical elements

2560

01:27:17,189 --> 01:27:15,920

that we know about you just put them

2561

01:27:19,270 --> 01:27:17,199

together in some way

2562

01:27:20,550 --> 01:27:19,280

and you get phenomenal like

2563

01:27:23,510 --> 01:27:20,560

consciousness

2564

01:27:26,870 --> 01:27:23,520

which by which we mean that the the

2565

01:27:29,590 --> 01:27:26,880

system itself recognizes that it exists

2566

01:27:32,470 --> 01:27:29,600

uh and acts based on the feedback that

2567

01:27:35,510 --> 01:27:32,480

it gets from reality

2568

01:27:37,669 --> 01:27:35,520

but in principle i can imagine

2569

01:27:39,350 --> 01:27:37,679

us constructing entities that will

2570

01:27:41,350 --> 01:27:39,360

behave the same way

2571

01:27:42,870 --> 01:27:41,360

in the future you know robots that are

2572

01:27:46,470 --> 01:27:42,880

sufficiently advanced with

2573

01:27:50,229 --> 01:27:46,480

ai and so forth i don't see a

2574

01:27:50,870 --> 01:27:50,239

qualitative difference between the human

2575

01:27:53,830 --> 01:27:50,880

body

2576

01:27:55,110 --> 01:27:53,840

and and the materials that that it's

2577

01:27:56,709 --> 01:27:55,120

made of it's just that there are

2578

01:27:58,629 --> 01:27:56,719

the materials are organized in a way

2579

01:27:59,669 --> 01:27:58,639

that gives the human body special

2580

01:28:03,350 --> 01:27:59,679

qualities

2581

01:28:06,390 --> 01:28:03,360

and abilities but

2582

01:28:09,510 --> 01:28:06,400

when we die it's just like taking the

2583

01:28:11,110 --> 01:28:09,520

computer chord out of the outlet i'm

2584

01:28:12,149 --> 01:28:11,120

sure you've heard of the hard problem of

2585

01:28:14,870 --> 01:28:12,159

consciousness

2586

01:28:15,830 --> 01:28:14,880

that is how can we get experience from

2587

01:28:18,709 --> 01:28:15,840

what's

2588

01:28:20,229 --> 01:28:18,719

fundamentally not experiencing do you

2589

01:28:21,430 --> 01:28:20,239

have any ideas as to that

2590

01:28:22,709 --> 01:28:21,440

you mentioned well when you have a

2591

01:28:23,430 --> 01:28:22,719

feedback when you have a system looking

2592

01:28:25,590 --> 01:28:23,440

at itself but then that's

2593

01:28:27,990 --> 01:28:25,600

self-consciousness i'm just referring to

2594

01:28:29,590 --> 01:28:28,000

experience in and of itself yeah because

2595

01:28:33,189 --> 01:28:29,600

the experience is being

2596

01:28:33,590 --> 01:28:33,199

sensed by our body and you know our body

2597

01:28:37,030 --> 01:28:33,600

can

2598

01:28:39,350 --> 01:28:37,040

that

2599

01:28:40,830 --> 01:28:39,360

do not really exist outside of the body

2600

01:28:44,310 --> 01:28:40,840

and they are just

2601
01:28:46,790 --> 01:28:44,320
self-created so you can you can imagine

2602
01:28:49,750 --> 01:28:46,800
phenomena like that

2603
01:28:53,350 --> 01:28:49,760
but it's all related to physical

2604
01:28:56,709 --> 01:28:55,189
do you believe that there are wormholes

2605
01:28:59,510 --> 01:28:56,719
or stable wormholes

2606
01:29:00,790 --> 01:28:59,520
possibly aliens are using them no i at

2607
01:29:02,709 --> 01:29:00,800
the moment

2608
01:29:05,510 --> 01:29:02,719
you know there are people suggesting how

2609
01:29:08,070 --> 01:29:05,520
to construct wormholes how to

2610
01:29:09,270 --> 01:29:08,080
perhaps build time machines and but all

2611
01:29:12,470 --> 01:29:09,280
of these suggestions

2612
01:29:14,709 --> 01:29:12,480
again are highly speculative because we

2613
01:29:15,030 --> 01:29:14,719

don't have a quantum mechanical theory

2614

01:29:18,070 --> 01:29:15,040

of

2615

01:29:19,110 --> 01:29:18,080

gravity and without it um you know these

2616

01:29:22,390 --> 01:29:19,120

ideas may not

2617

01:29:25,030 --> 01:29:22,400

hold water you know so let's put it this

2618

01:29:27,189 --> 01:29:25,040

way we have no way of designing an

2619

01:29:28,870 --> 01:29:27,199

engineering project to build either a

2620

01:29:29,830 --> 01:29:28,880

time machine or a wormhole the current

2621

01:29:32,870 --> 01:29:29,840

knowledge is

2622

01:29:33,270 --> 01:29:32,880

very sketchy and the proposal that we

2623

01:29:35,510 --> 01:29:33,280

have

2624

01:29:37,110 --> 01:29:35,520

in various papers are all very

2625

01:29:38,790 --> 01:29:37,120

speculative

2626

01:29:41,110 --> 01:29:38,800

as for the fine-tuning of the universe

2627

01:29:42,790 --> 01:29:41,120

do you have any inklings as to why

2628

01:29:46,070 --> 01:29:42,800

it is the way that it is do you take lee

2629

01:29:49,830 --> 01:29:46,080

smullin's evolutionary black hole model

2630

01:29:51,430 --> 01:29:49,840

no um i you know i think that the

2631

01:29:53,430 --> 01:29:51,440

conditions we have in the universe were

2632

01:29:55,750 --> 01:29:53,440

dictated by

2633

01:29:56,709 --> 01:29:55,760

how it started uh you know around the

2634

01:29:58,629 --> 01:29:56,719

big bang

2635

01:30:00,709 --> 01:29:58,639

and so you know just like cosmic

2636

01:30:01,750 --> 01:30:00,719

inflation tries to explain various facts

2637

01:30:03,510 --> 01:30:01,760

and

2638

01:30:05,590 --> 01:30:03,520

uh once we have a quantum theory of

2639

01:30:06,070 --> 01:30:05,600

gravity we figure out where the universe

2640

01:30:07,990 --> 01:30:06,080

came from

2641

01:30:09,910 --> 01:30:08,000

you know what is the womb that the

2642

01:30:11,189 --> 01:30:09,920

umbilical cord of the universe was

2643

01:30:13,350 --> 01:30:11,199

connected to

2644

01:30:15,110 --> 01:30:13,360

and that would explain to us why it has

2645

01:30:17,430 --> 01:30:15,120

the properties that it has

2646

01:30:19,350 --> 01:30:17,440

so rather than guess it i would rather

2647

01:30:19,990 --> 01:30:19,360

go to that womb that created the

2648

01:30:22,149 --> 01:30:20,000

universe and

2649

01:30:23,590 --> 01:30:22,159

asked what are the reasons that we have

2650

01:30:24,950 --> 01:30:23,600

the conditions we have

2651
01:30:26,950 --> 01:30:24,960
so you believe that we can derive the

2652
01:30:29,510 --> 01:30:26,960
fundamental constants in some way

2653
01:30:30,310 --> 01:30:29,520
potentially yeah if we figure out what

2654
01:30:32,229 --> 01:30:30,320
happened

2655
01:30:35,350 --> 01:30:32,239
before the big bang using a quantum

2656
01:30:37,110 --> 01:30:35,360
theory of gravity perhaps

2657
01:30:38,950 --> 01:30:37,120
once again what we find in the universe

2658
01:30:40,629 --> 01:30:38,960
will be emerging out of those

2659
01:30:42,629 --> 01:30:40,639
conditions early conditions and the

2660
01:30:43,910 --> 01:30:42,639
theory and the you know the unifying

2661
01:30:46,229 --> 01:30:43,920
theory

2662
01:30:47,510 --> 01:30:46,239
which we don't have at the moment before

2663
01:30:49,910 --> 01:30:47,520

i get to audience questions

2664

01:30:50,950 --> 01:30:49,920

the last question i have well two i want

2665

01:30:52,390 --> 01:30:50,960

to know what you think is

2666

01:30:54,310 --> 01:30:52,400

the difference between wisdom and

2667

01:30:55,669 --> 01:30:54,320

intelligence and then i wanted to know

2668

01:30:57,510 --> 01:30:55,679

what you thought of wigner's

2669

01:30:59,030 --> 01:30:57,520

friends fingers friends thought

2670

01:31:00,390 --> 01:30:59,040

experiment or the thought experiment of

2671

01:31:00,709 --> 01:31:00,400

vigner's friend i'm sure you've heard of

2672

01:31:02,870 --> 01:31:00,719

it

2673

01:31:04,070 --> 01:31:02,880

about the collapse of the wave function

2674

01:31:06,149 --> 01:31:04,080

yeah so uh

2675

01:31:07,990 --> 01:31:06,159

first with respect to intelligence and

2676

01:31:12,550 --> 01:31:08,000

wisdom there is a very

2677

01:31:15,110 --> 01:31:12,560

uh big difference between them wisdom

2678

01:31:16,470 --> 01:31:15,120

is the ability to to identify the

2679

01:31:19,750 --> 01:31:16,480

essential

2680

01:31:21,590 --> 01:31:19,760

elements necessary to to answer

2681

01:31:24,950 --> 01:31:21,600

questions and and learn about

2682

01:31:27,590 --> 01:31:24,960

about the world so

2683

01:31:28,629 --> 01:31:27,600

it's a way of improving the efficiency

2684

01:31:31,350 --> 01:31:28,639

of us

2685

01:31:32,550 --> 01:31:31,360

figuring out the truth you know and

2686

01:31:37,110 --> 01:31:32,560

someone

2687

01:31:39,270 --> 01:31:37,120

that is wise gives you a shortcut

2688

01:31:42,950 --> 01:31:39,280

you can be very intelligent and just

2689

01:31:45,030 --> 01:31:42,960

examine all the exits from the highway

2690

01:31:47,189 --> 01:31:45,040

uh many of them would lead you into bad

2691

01:31:49,669 --> 01:31:47,199

neighborhoods

2692

01:31:50,550 --> 01:31:49,679

uh but if you are wise you will try to

2693

01:31:53,590 --> 01:31:50,560

figure out

2694

01:31:56,870 --> 01:31:53,600

which exit is the right one

2695

01:32:00,070 --> 01:31:56,880

and um so

2696

01:32:03,669 --> 01:32:00,080

so intelligence

2697

01:32:05,430 --> 01:32:03,679

may be an essential skill in pursuing

2698

01:32:07,669 --> 01:32:05,440

science

2699

01:32:09,510 --> 01:32:07,679

and you can become a world expert in a

2700

01:32:11,110 --> 01:32:09,520

particular niche

2701
01:32:14,149 --> 01:32:11,120
just like taking an exit from the

2702
01:32:16,790 --> 01:32:14,159
highway and that exit you can become

2703
01:32:18,950 --> 01:32:16,800
the world expert but it's not

2704
01:32:20,550 --> 01:32:18,960
necessarily the niche that matters the

2705
01:32:23,830 --> 01:32:20,560
most

2706
01:32:26,550 --> 01:32:23,840
and if you are wise you can figure out

2707
01:32:28,149 --> 01:32:26,560
which niche matters the most

2708
01:32:29,910 --> 01:32:28,159
if you're wise how do you determine

2709
01:32:31,270 --> 01:32:29,920
which one matters

2710
01:32:32,550 --> 01:32:31,280
which one is the right one i imagine

2711
01:32:33,189 --> 01:32:32,560
that depends on the goal but then i'm

2712
01:32:34,870 --> 01:32:33,199
wondering

2713
01:32:36,709 --> 01:32:34,880

well how do you decide on the goal you

2714

01:32:38,229 --> 01:32:36,719

have just what allows you to survive

2715

01:32:40,950 --> 01:32:38,239

you have to decide about the guiding

2716

01:32:43,830 --> 01:32:40,960

principles first so

2717

01:32:45,510 --> 01:32:43,840

for example to some people what matters

2718

01:32:48,550 --> 01:32:45,520

the most are

2719

01:32:51,669 --> 01:32:48,560

subjects of relevance to society

2720

01:32:53,510 --> 01:32:51,679

you know if it has an impact on society

2721

01:32:55,350 --> 01:32:53,520

because after all we live in a society

2722

01:32:58,229 --> 01:32:55,360

you know and whether we

2723

01:32:59,270 --> 01:32:58,239

address um how many extra dimensions

2724

01:33:01,910 --> 01:32:59,280

exist or

2725

01:33:03,110 --> 01:33:01,920

whether we address how to find a vaccine

2726
01:33:06,070 --> 01:33:03,120
to covet 19

2727
01:33:08,390 --> 01:33:06,080
or you know these are two different

2728
01:33:11,510 --> 01:33:08,400
questions with very different

2729
01:33:14,310 --> 01:33:11,520
impacts on society

2730
01:33:15,430 --> 01:33:14,320
so you might use that when you evaluate

2731
01:33:18,229 --> 01:33:15,440
what you want to do

2732
01:33:19,590 --> 01:33:18,239
if you want to help people then you work

2733
01:33:21,510 --> 01:33:19,600
on some

2734
01:33:23,270 --> 01:33:21,520
questions that matter to them now it

2735
01:33:24,390 --> 01:33:23,280
doesn't mean that they all have to be

2736
01:33:26,310 --> 01:33:24,400
medical

2737
01:33:27,750 --> 01:33:26,320
they could be questions that people care

2738
01:33:31,910 --> 01:33:27,760

about

2739

01:33:35,030 --> 01:33:31,920

right right so um in that way

2740

01:33:36,070 --> 01:33:35,040

since the public is funding science you

2741

01:33:38,870 --> 01:33:36,080

are paying respect

2742

01:33:41,110 --> 01:33:38,880

to the public if on the other hand you

2743

01:33:42,790 --> 01:33:41,120

ask yourself how many angels can sit on

2744

01:33:45,350 --> 01:33:42,800

the tip of a pin

2745

01:33:46,709 --> 01:33:45,360

and you get funded by the public and

2746

01:33:48,310 --> 01:33:46,719

then you say i don't care what the

2747

01:33:50,870 --> 01:33:48,320

public says and i don't care if i have

2748

01:33:52,870 --> 01:33:50,880

experiments to test my ideas

2749

01:33:55,910 --> 01:33:52,880

then that's a betrayal of the trust that

2750

01:33:58,470 --> 01:33:55,920

the society has in academia

2751
01:33:59,750 --> 01:33:58,480
and that is a good reason for the public

2752
01:34:02,950 --> 01:33:59,760
to say

2753
01:34:04,070 --> 01:34:02,960
that you know academia is part of the

2754
01:34:06,229 --> 01:34:04,080
elite

2755
01:34:08,870 --> 01:34:06,239
because because it's divorcing itself

2756
01:34:12,709 --> 01:34:08,880
from the interests of the public

2757
01:34:15,270 --> 01:34:12,719
so being wise is attending

2758
01:34:16,870 --> 01:34:15,280
to the interests of those who found fund

2759
01:34:20,470 --> 01:34:16,880
you

2760
01:34:22,070 --> 01:34:20,480
and that's an example okay what about if

2761
01:34:22,390 --> 01:34:22,080
there's no capitalism there's no funding

2762
01:34:23,910 --> 01:34:22,400
well

2763
01:34:25,110 --> 01:34:23,920

sorry in socialism you're also funded

2764

01:34:27,590 --> 01:34:25,120

there's no money we're hunt

2765

01:34:29,510 --> 01:34:27,600

hunter-gatherers can you be wise

2766

01:34:31,189 --> 01:34:29,520

yeah if you're a hunter and guard you

2767

01:34:32,790 --> 01:34:31,199

still have a purpose right you're trying

2768

01:34:34,870 --> 01:34:32,800

to hunt

2769

01:34:36,790 --> 01:34:34,880

so you're so for that purpose you

2770

01:34:38,550 --> 01:34:36,800

develop tools that are relevant

2771

01:34:41,109 --> 01:34:38,560

so instead of the relevance being to

2772

01:34:45,270 --> 01:34:41,119

society to the people that fund you

2773

01:34:48,149 --> 01:34:45,280

here the relevance is to your objectives

2774

01:34:49,830 --> 01:34:48,159

sorry what i'm trying to get at is how

2775

01:34:51,750 --> 01:34:49,840

do you know which goals

2776
01:34:52,950 --> 01:34:51,760
you're you're presuming a goal already

2777
01:34:54,870 --> 01:34:52,960
so what i'm wondering is

2778
01:34:57,109 --> 01:34:54,880
how do you determine which goal you

2779
01:34:59,590 --> 01:34:57,119
should follow oh okay i think well

2780
01:35:00,550 --> 01:34:59,600
the way i determine is personally that

2781
01:35:03,990 --> 01:35:00,560
doesn't mean that

2782
01:35:07,030 --> 01:35:04,000
everyone should operate this way but i i

2783
01:35:08,950 --> 01:35:07,040
um pay attention to the goals

2784
01:35:10,070 --> 01:35:08,960
that are most important you know that

2785
01:35:12,070 --> 01:35:10,080
are

2786
01:35:13,430 --> 01:35:12,080
that will make the biggest difference

2787
01:35:15,189 --> 01:35:13,440
you see uh

2788
01:35:16,790 --> 01:35:15,199

you can always work on on something in

2789

01:35:18,790 --> 01:35:16,800

the periphery that makes very little

2790

01:35:21,189 --> 01:35:18,800

difference to anyone

2791

01:35:22,950 --> 01:35:21,199

and nobody would bother you and you will

2792

01:35:24,870 --> 01:35:22,960

be happy you'll earn your living you go

2793

01:35:26,550 --> 01:35:24,880

to work you will smile

2794

01:35:28,950 --> 01:35:26,560

and people will smile at you and that's

2795

01:35:31,990 --> 01:35:28,960

it but the question is

2796

01:35:34,709 --> 01:35:32,000

does it matter to anyone or to yourself

2797

01:35:37,830 --> 01:35:34,719

do you feel will you feel at the age of

2798

01:35:42,790 --> 01:35:37,840

90 that you actually fulfilled your

2799

01:35:43,430 --> 01:35:42,800

uh life uh interests and the answer may

2800

01:35:45,270 --> 01:35:43,440

be no

2801
01:35:46,709 --> 01:35:45,280
you should have been more daring more

2802
01:35:48,470 --> 01:35:46,719
risk-taking

2803
01:35:50,149 --> 01:35:48,480
more willing to embark on things that

2804
01:35:51,030 --> 01:35:50,159
are difficult that will take a while to

2805
01:35:55,030 --> 01:35:51,040
figure out

2806
01:35:57,750 --> 01:35:55,040
but matter more so i look at myself

2807
01:35:58,070 --> 01:35:57,760
at that stage you know at a late age and

2808
01:36:02,310 --> 01:35:58,080
ask

2809
01:36:04,070 --> 01:36:02,320
what would i advise myself now to do

2810
01:36:06,470 --> 01:36:04,080
that would matter that will make a

2811
01:36:08,629 --> 01:36:06,480
difference and that's what i do

2812
01:36:10,470 --> 01:36:08,639
okay well let's get to some audience

2813
01:36:12,229 --> 01:36:10,480

questions steve scully here says is it

2814

01:36:13,189 --> 01:36:12,239

possible that the universe is infinite

2815

01:36:15,669 --> 01:36:13,199

that there is no

2816

01:36:16,310 --> 01:36:15,679

end to how large or small objects in the

2817

01:36:18,709 --> 01:36:16,320

universe

2818

01:36:20,229 --> 01:36:18,719

can be relative to one another and that

2819

01:36:23,030 --> 01:36:20,239

if the overall system

2820

01:36:23,990 --> 01:36:23,040

is to be comprehensible it is only by us

2821

01:36:25,750 --> 01:36:24,000

recognizing how

2822

01:36:28,149 --> 01:36:25,760

all of these apparently separate and

2823

01:36:30,390 --> 01:36:28,159

distinct different systems

2824

01:36:33,189 --> 01:36:30,400

actually share the same underlying

2825

01:36:36,629 --> 01:36:34,870

yes read the question you understood the

2826

01:36:38,790 --> 01:36:36,639

question yeah i understood that

2827

01:36:40,790 --> 01:36:38,800

okay well most of the the answer to most

2828

01:36:43,750 --> 01:36:40,800

of the question is yes

2829

01:36:45,350 --> 01:36:43,760

it's quite possible that um in each

2830

01:36:46,629 --> 01:36:45,360

direction you know it's an infinite

2831

01:36:49,669 --> 01:36:46,639

series of sizes

2832

01:36:52,870 --> 01:36:49,679

and scales and uh but to me the most

2833

01:36:55,270 --> 01:36:52,880

interesting part of the question is

2834

01:36:57,669 --> 01:36:55,280

will the laws of physics apply

2835

01:37:01,669 --> 01:36:57,679

everywhere the same way

2836

01:37:03,669 --> 01:37:01,679

or will you have and then so far

2837

01:37:06,950 --> 01:37:03,679

the amazing thing is that in the region

2838

01:37:08,790 --> 01:37:06,960

that we can see that we can observe

2839

01:37:11,910 --> 01:37:08,800

it appears like the laws of physics

2840

01:37:14,470 --> 01:37:11,920

apply everywhere the same way

2841

01:37:16,629 --> 01:37:14,480

and that that's remarkable but it may

2842

01:37:18,149 --> 01:37:16,639

it's not guaranteed by any means

2843

01:37:19,669 --> 01:37:18,159

and of course people are searching for

2844

01:37:21,430 --> 01:37:19,679

deviations

2845

01:37:22,950 --> 01:37:21,440

because if you find a deviation you get

2846

01:37:24,709 --> 01:37:22,960

an overcross right

2847

01:37:25,990 --> 01:37:24,719

right that brings me to a question that

2848

01:37:26,950 --> 01:37:26,000

i have for you but it's more for an

2849

01:37:29,430 --> 01:37:26,960

experimentalist

2850

01:37:30,950 --> 01:37:29,440

do you always need a theory to interpret

2851

01:37:33,030 --> 01:37:30,960

the data or can you just interpret the

2852

01:37:34,629 --> 01:37:33,040

data without a theory so for example

2853

01:37:36,470 --> 01:37:34,639

collecting astronomical data we're

2854

01:37:38,070 --> 01:37:36,480

assuming that we're at no special

2855

01:37:39,750 --> 01:37:38,080

place in the universe and that the laws

2856

01:37:42,870 --> 01:37:39,760

are pretty much the same

2857

01:37:47,990 --> 01:37:46,950

so can you interpret the data without a

2858

01:37:50,070 --> 01:37:48,000

theory can you even

2859

01:37:51,590 --> 01:37:50,080

make sense of the data without a theory

2860

01:37:53,270 --> 01:37:51,600

i don't think so i think

2861

01:37:55,189 --> 01:37:53,280

you always have to have something in the

2862

01:37:59,030 --> 01:37:55,199

back of your mind

2863

01:38:01,990 --> 01:37:59,040

because otherwise the data

2864

01:38:02,629 --> 01:38:02,000

is not telling you anything you have to

2865

01:38:05,109 --> 01:38:02,639

put it in

2866

01:38:07,510 --> 01:38:05,119

in a context so just to give you an

2867

01:38:12,310 --> 01:38:07,520

example

2868

01:38:16,470 --> 01:38:15,910

astrophysical journals used to come in

2869

01:38:20,070 --> 01:38:16,480

print

2870

01:38:22,550 --> 01:38:20,080

it was not on the internet and so i went

2871

01:38:23,750 --> 01:38:22,560

to the library

2872

01:38:25,830 --> 01:38:23,760

at the institute for advanced study at

2873

01:38:29,669 --> 01:38:25,840

princeton and i saw that

2874

01:38:33,750 --> 01:38:29,679

before the 1980s there were photographs

2875

01:38:37,430 --> 01:38:33,760

published in print where you can see

2876
01:38:38,390 --> 01:38:37,440
giant arcs of light surrounding clusters

2877
01:38:40,870 --> 01:38:38,400
of galaxies and

2878
01:38:42,390 --> 01:38:40,880
people just ignored them the data was

2879
01:38:45,350 --> 01:38:42,400
there it was

2880
01:38:46,709 --> 01:38:45,360
it was printed uh you know in images

2881
01:38:50,390 --> 01:38:46,719
that were put on paper

2882
01:38:53,030 --> 01:38:50,400
in papers and nobody asked anything

2883
01:38:54,550 --> 01:38:53,040
about those arcs why are there arcs

2884
01:38:57,590 --> 01:38:54,560
you know like lightning strikes between

2885
01:38:59,990 --> 01:38:57,600
galaxies like sparks almost

2886
01:39:01,830 --> 01:39:00,000
well they look like arcs and then then

2887
01:39:03,350 --> 01:39:01,840
in the 1980s the subject of

2888
01:39:05,910 --> 01:39:03,360

gravitational lensing

2889

01:39:08,390 --> 01:39:05,920

uh became singular and then people

2890

01:39:10,390 --> 01:39:08,400

explained those arcs as

2891

01:39:12,390 --> 01:39:10,400

focusing of light by the force of

2892

01:39:14,550 --> 01:39:12,400

gravity you know so you have a cluster

2893

01:39:16,550 --> 01:39:14,560

of galaxies that acts on light

2894

01:39:17,590 --> 01:39:16,560

from a background source behind it let's

2895

01:39:19,510 --> 01:39:17,600

say a galaxy

2896

01:39:20,950 --> 01:39:19,520

sits far away behind the cluster and

2897

01:39:21,830 --> 01:39:20,960

then the light that comes from that

2898

01:39:24,470 --> 01:39:21,840

galaxy

2899

01:39:25,189 --> 01:39:24,480

is being gravitationally bent and

2900

01:39:28,310 --> 01:39:25,199

focused

2901
01:39:29,270 --> 01:39:28,320
at the observer and you end up with what

2902
01:39:31,189 --> 01:39:29,280
is called

2903
01:39:32,790 --> 01:39:31,199
an einstein ring einstein already

2904
01:39:36,470 --> 01:39:32,800
thought that this could happen

2905
01:39:39,990 --> 01:39:36,480
in 1940 so you can get a giant

2906
01:39:43,030 --> 01:39:40,000
arc of a background source that is

2907
01:39:45,430 --> 01:39:43,040
part of sort of a ring of

2908
01:39:46,229 --> 01:39:45,440
uh light that comes from gravitational

2909
01:39:48,390 --> 01:39:46,239
lensing and

2910
01:39:50,229 --> 01:39:48,400
once they realized that they said oh

2911
01:39:51,109 --> 01:39:50,239
that that's a good explanation for those

2912
01:39:54,229 --> 01:39:51,119
arcs

2913
01:39:56,390 --> 01:39:54,239

before

2914

01:39:58,550 --> 01:39:56,400

and people just didn't think about it in

2915

01:40:00,070 --> 01:39:58,560

that context so you can have data it's

2916

01:40:03,189 --> 01:40:00,080

just without

2917

01:40:04,070 --> 01:40:03,199

a sense of what the data may mean you

2918

01:40:10,149 --> 01:40:04,080

might actually

2919

01:40:14,390 --> 01:40:13,030

362 asks do you still learn math and

2920

01:40:17,189 --> 01:40:14,400

physics in the same way you did

2921

01:40:18,629 --> 01:40:17,199

as you were when you were younger and if

2922

01:40:20,830 --> 01:40:18,639

not how has aging

2923

01:40:22,790 --> 01:40:20,840

and experience changed your learning

2924

01:40:25,990 --> 01:40:22,800

process right so

2925

01:40:26,790 --> 01:40:26,000

um i was always i'm not a good example

2926
01:40:29,350 --> 01:40:26,800
because

2927
01:40:30,149 --> 01:40:29,360
from a young age i was always most

2928
01:40:35,189 --> 01:40:30,159
interested in

2929
01:40:38,629 --> 01:40:36,950
the mathematical techniques that are

2930
01:40:41,910 --> 01:40:38,639
used to to

2931
01:40:45,270 --> 01:40:41,920
uh perfect them or

2932
01:40:46,470 --> 01:40:45,280
or demonstrate them uh and so um in that

2933
01:40:48,870 --> 01:40:46,480
sense

2934
01:40:51,430 --> 01:40:48,880
uh i'm actually more efficient now than

2935
01:40:54,870 --> 01:40:51,440
i was because

2936
01:40:58,629 --> 01:40:54,880
you know i i i i know the field

2937
01:41:00,790 --> 01:40:58,639
much better and so

2938
01:41:01,750 --> 01:41:00,800

if i were to meet a young version of

2939

01:41:07,270 --> 01:41:01,760

myself

2940

01:41:08,950 --> 01:41:07,280

so i feel that i'm much stronger now

2941

01:41:12,390 --> 01:41:08,960

than i was at a younger age

2942

01:41:14,149 --> 01:41:12,400

uh because i i don't i don't waste as

2943

01:41:15,189 --> 01:41:14,159

much time in directions that would not

2944

01:41:18,229 --> 01:41:15,199

prove

2945

01:41:21,350 --> 01:41:18,239

use fruitful but

2946

01:41:23,270 --> 01:41:21,360

in terms of the techniques

2947

01:41:24,390 --> 01:41:23,280

it's true that after a certain age you

2948

01:41:27,510 --> 01:41:24,400

stop

2949

01:41:29,910 --> 01:41:27,520

learning new techniques most people

2950

01:41:30,790 --> 01:41:29,920

and so you continue to use what you've

2951

01:41:33,430 --> 01:41:30,800

learned then

2952

01:41:36,070 --> 01:41:33,440

during your studies in you know during

2953

01:41:38,790 --> 01:41:36,080

your phd and you continue to use that

2954

01:41:39,990 --> 01:41:38,800

uh but you use it on on subjects that

2955

01:41:43,109 --> 01:41:40,000

are new

2956

01:41:44,550 --> 01:41:43,119

um very few people do learn new

2957

01:41:47,590 --> 01:41:44,560

techniques and and

2958

01:41:48,790 --> 01:41:47,600

by that rejuvenate their skills people

2959

01:41:51,750 --> 01:41:48,800

do that

2960

01:41:52,709 --> 01:41:51,760

but since i was always about ideas uh

2961

01:41:54,790 --> 01:41:52,719

about thinking

2962

01:41:55,750 --> 01:41:54,800

on things that other people do not think

2963

01:41:57,910 --> 01:41:55,760

about

2964

01:41:59,510 --> 01:41:57,920

then the techniques were not

2965

01:42:02,070 --> 01:41:59,520

particularly

2966

01:42:05,270 --> 01:42:02,080

important for me and i remember when i

2967

01:42:07,510 --> 01:42:05,280

came as a postdoc i was asked

2968

01:42:09,270 --> 01:42:07,520

what kind of computer skills you have

2969

01:42:11,189 --> 01:42:09,280

and i said very minimal

2970

01:42:13,189 --> 01:42:11,199

during my phd i just used whatever i

2971

01:42:15,109 --> 01:42:13,199

needed in order to solve

2972

01:42:16,709 --> 01:42:15,119

uh the differential equations that i had

2973

01:42:18,950 --> 01:42:16,719

i didn't

2974

01:42:20,709 --> 01:42:18,960

master anything beyond that and the

2975

01:42:23,590 --> 01:42:20,719

person who hired me was

2976

01:42:24,629 --> 01:42:23,600

stunned he said how how come you didn't

2977

01:42:28,310 --> 01:42:24,639

learn

2978

01:42:28,790 --> 01:42:28,320

you know and um i should say that i had

2979

01:42:31,270 --> 01:42:28,800

a very

2980

01:42:32,550 --> 01:42:31,280

rather productive career even though i

2981

01:42:34,790 --> 01:42:32,560

didn't

2982

01:42:36,550 --> 01:42:34,800

learn much more computer skills since

2983

01:42:39,830 --> 01:42:36,560

then even so

2984

01:42:41,430 --> 01:42:39,840

it's possible yeah because

2985

01:42:43,109 --> 01:42:41,440

a lot of people have the technical

2986

01:42:46,709 --> 01:42:43,119

skills but they lack

2987

01:42:48,709 --> 01:42:46,719

the the imagination of the the ideas

2988

01:42:50,550 --> 01:42:48,719

so you play more in the realm of

2989

01:42:52,470 --> 01:42:50,560

concepts and ideas and how they relate

2990

01:42:55,669 --> 01:42:52,480

than you do with the mathematical

2991

01:42:58,870 --> 01:42:55,679

pedantry yeah so it's sort of like

2992

01:43:01,910 --> 01:42:58,880

you know sketching a blueprint of

2993

01:43:03,350 --> 01:43:01,920

a building rather than building it so

2994

01:43:05,189 --> 01:43:03,360

then who does the mathematical work you

2995

01:43:07,109 --> 01:43:05,199

just give it to a graduate student

2996

01:43:10,229 --> 01:43:07,119

a lot yeah students postdocs a lot of

2997

01:43:11,750 --> 01:43:10,239

people that i collaborate with

2998

01:43:13,030 --> 01:43:11,760

and with regard to learning new

2999

01:43:14,550 --> 01:43:13,040

techniques and constantly staying

3000

01:43:17,270 --> 01:43:14,560

updated

3001
01:43:18,149 --> 01:43:17,280
you said that some people do but

3002
01:43:21,350 --> 01:43:18,159
generally

3003
01:43:21,990 --> 01:43:21,360
let's say past the age of 30 or 40 i

3004
01:43:23,590 --> 01:43:22,000
don't know which

3005
01:43:25,669 --> 01:43:23,600
i'm asking you what time do you stop

3006
01:43:27,910 --> 01:43:25,679
doing it and it's it's not this

3007
01:43:29,750 --> 01:43:27,920
i know of people that are in their 50s

3008
01:43:30,390 --> 01:43:29,760
that are learning machine learning now

3009
01:43:36,709 --> 01:43:30,400
and

3010
01:43:39,350 --> 01:43:36,719
you know it really is a matter of

3011
01:43:41,510 --> 01:43:39,360
people that enjoy the the you know the

3012
01:43:43,189 --> 01:43:41,520
technical gymnastics and there are some

3013
01:43:45,750 --> 01:43:43,199

people that enjoy that and they're

3014

01:43:47,350 --> 01:43:45,760

they're not not many but i mean they're

3015

01:43:49,350 --> 01:43:47,360

a minority

3016

01:43:50,550 --> 01:43:49,360

do you think that instead of focusing on

3017

01:43:51,990 --> 01:43:50,560

artificial intelligence like you

3018

01:43:54,950 --> 01:43:52,000

mentioned we should focus on wisdom

3019

01:43:55,990 --> 01:43:54,960

so artificial wisdom so ah instead of ai

3020

01:43:57,669 --> 01:43:56,000

do you think that that's something we

3021

01:43:59,189 --> 01:43:57,679

should be focusing on or do you see like

3022

01:43:59,830 --> 01:43:59,199

how the heck would we even start that

3023

01:44:02,310 --> 01:43:59,840

project

3024

01:44:03,910 --> 01:44:02,320

oh i do think that it's interes a very

3025

01:44:06,229 --> 01:44:03,920

interesting idea i i haven't thought

3026

01:44:08,550 --> 01:44:06,239

about it before but

3027

01:44:10,950 --> 01:44:08,560

yeah you can think about designing a

3028

01:44:14,149 --> 01:44:10,960

system that will be wise

3029

01:44:18,390 --> 01:44:15,510

rather than go and explore all

3030

01:44:22,390 --> 01:44:21,030

brian keating asks our mutual friend

3031

01:44:23,590 --> 01:44:22,400

brian keating and by the way for those

3032

01:44:25,750 --> 01:44:23,600

listening brian keating

3033

01:44:27,270 --> 01:44:25,760

a link to his youtube channel be below

3034

01:44:28,790 --> 01:44:27,280

he said i'd love to know what his daily

3035

01:44:31,030 --> 01:44:28,800

routine is so that is you

3036

01:44:32,950 --> 01:44:31,040

and whether you've expected and even

3037

01:44:35,030 --> 01:44:32,960

regret the backlash

3038

01:44:36,709 --> 01:44:35,040

to your new fame so daily routine and

3039

01:44:37,270 --> 01:44:36,719

the backlash and how you feel about it

3040

01:44:40,070 --> 01:44:37,280

yeah well

3041

01:44:40,470 --> 01:44:40,080

um every since the pandemic started um

3042

01:44:43,669 --> 01:44:40,480

since

3043

01:44:45,030 --> 01:44:43,679

uh it's more than a year now uh every

3044

01:44:48,310 --> 01:44:45,040

morning at 5am

3045

01:44:51,270 --> 01:44:48,320

i go out and jog in the company of birds

3046

01:44:52,470 --> 01:44:51,280

ducks and rabbits and wild turkeys they

3047

01:44:54,790 --> 01:44:52,480

are they are very loud i

3048

01:44:56,629 --> 01:44:54,800

i see the same wild turkeys for a year

3049

01:44:59,109 --> 01:44:56,639

now along my path

3050

01:45:00,950 --> 01:44:59,119

what city are you in i'm a on a in a

3051

01:45:04,950 --> 01:45:00,960

suburb near boston

3052

01:45:06,709 --> 01:45:04,960

okay so it's cold oh yeah i go out

3053

01:45:10,070 --> 01:45:06,719

in any weather whether it's snows

3054

01:45:15,030 --> 01:45:13,109

whether it's freezing i you know i it's

3055

01:45:16,229 --> 01:45:15,040

just an aspect of nature that i enjoy i

3056

01:45:17,830 --> 01:45:16,239

enjoy going i i

3057

01:45:20,070 --> 01:45:17,840

enjoy very much being in the company of

3058

01:45:22,070 --> 01:45:20,080

nature rather than and i don't regard

3059

01:45:23,830 --> 01:45:22,080

people or my colleagues in particular as

3060

01:45:25,910 --> 01:45:23,840

part of nature because

3061

01:45:27,990 --> 01:45:25,920

nature is always gracious you know you

3062

01:45:30,470 --> 01:45:28,000

always learn something it's

3063

01:45:31,990 --> 01:45:30,480

i always enjoy nature i grew up on a

3064

01:45:34,790 --> 01:45:32,000

farm

3065

01:45:36,149 --> 01:45:34,800

so that my day starts at 5am and i

3066

01:45:39,830 --> 01:45:36,159

should say over

3067

01:45:42,070 --> 01:45:39,840

the the months of january february and

3068

01:45:44,070 --> 01:45:42,080

half of march

3069

01:45:45,350 --> 01:45:44,080

i would have back-to-back interviews

3070

01:45:48,790 --> 01:45:45,360

from 8 a.m until

3071

01:45:49,590 --> 01:45:48,800

7 00 p.m there were about 450 of them

3072

01:45:52,870 --> 01:45:49,600

all together

3073

01:45:55,430 --> 01:45:52,880

it was a huge huge uh

3074

01:45:57,189 --> 01:45:55,440

exhausting marathon that i had to be

3075

01:45:58,149 --> 01:45:57,199

engaged in just because of the interest

3076

01:46:01,270 --> 01:45:58,159

in my book

3077

01:46:01,990 --> 01:46:01,280

but that's very untypical because by now

3078

01:46:03,910 --> 01:46:02,000

it sort of

3079

01:46:06,070 --> 01:46:03,920

is fading away i mean the book is

3080

01:46:10,070 --> 01:46:06,080

already out for two months now

3081

01:46:11,109 --> 01:46:10,080

um and then uh by now i'm getting back

3082

01:46:13,109 --> 01:46:11,119

to my

3083

01:46:15,189 --> 01:46:13,119

regular routine which is writing papers

3084

01:46:17,910 --> 01:46:15,199

and and commentaries so

3085

01:46:19,030 --> 01:46:17,920

i should say the past 12 months were the

3086

01:46:21,669 --> 01:46:19,040

most productive

3087

01:46:23,030 --> 01:46:21,679

in my scientific career because i didn't

3088

01:46:25,669 --> 01:46:23,040

have to drive to work

3089

01:46:26,070 --> 01:46:25,679

i didn't have people getting into my

3090

01:46:29,189 --> 01:46:26,080

office

3091

01:46:32,390 --> 01:46:29,199

uninvited i didn't have the

3092

01:46:33,510 --> 01:46:32,400

administrative uh distractions that i

3093

01:46:35,510 --> 01:46:33,520

usually have

3094

01:46:37,430 --> 01:46:35,520

and so i could focus on creative work

3095

01:46:41,109 --> 01:46:37,440

and i wrote of the order of

3096

01:46:41,840 --> 01:46:41,119

46 scientific papers and

3097

01:46:44,550 --> 01:46:41,850

52

3098

01:46:46,229 --> 01:46:44,560

[Music]

3099

01:46:48,149 --> 01:46:46,239

commentaries mostly in scientific

3100

01:46:50,229 --> 01:46:48,159

american and then

3101

01:46:51,510 --> 01:46:50,239

a couple of books one of them is the one

3102

01:46:53,189 --> 01:46:51,520

that was published two months ago and

3103

01:46:53,669 --> 01:46:53,199

there is another one a textbook coming

3104

01:46:57,109 --> 01:46:53,679

out

3105

01:46:59,350 --> 01:46:57,119

cosmos

3106

01:47:01,590 --> 01:46:59,360

so it has been a very productive time

3107

01:47:01,990 --> 01:47:01,600

and you know frankly i can continue like

3108

01:47:05,109 --> 01:47:02,000

that

3109

01:47:06,470 --> 01:47:05,119

um you know for the next for the next

3110

01:47:08,550 --> 01:47:06,480

few years

3111

01:47:10,629 --> 01:47:08,560

uh without the problem that there is

3112

01:47:14,070 --> 01:47:10,639

always something interesting to work on

3113

01:47:16,229 --> 01:47:14,080

um and i enjoy the creative work for

3114

01:47:18,149 --> 01:47:16,239

i used to do leadership positions just

3115

01:47:18,950 --> 01:47:18,159

as a service to the community because at

3116

01:47:20,790 --> 01:47:18,960

some point i

3117

01:47:22,709 --> 01:47:20,800

realized that other people are not doing

3118

01:47:24,950 --> 01:47:22,719

their job properly when they are leading

3119

01:47:26,070 --> 01:47:24,960

a department or doing something else

3120

01:47:27,830 --> 01:47:26,080

sharing a committee

3121

01:47:29,990 --> 01:47:27,840

so i thought you know i should do it

3122

01:47:31,669 --> 01:47:30,000

just to make sure that things are done

3123

01:47:33,270 --> 01:47:31,679

according to the government the the

3124

01:47:33,830 --> 01:47:33,280

proper guiding principles what were they

3125

01:47:36,149 --> 01:47:33,840

doing

3126

01:47:38,070 --> 01:47:36,159

and what did you do that corrected it

3127

01:47:41,350 --> 01:47:38,080

many times they would they state

3128

01:47:43,590 --> 01:47:41,360

that you know the right ideas but

3129

01:47:44,790 --> 01:47:43,600

they would not really accomplish them in

3130

01:47:46,790 --> 01:47:44,800

practice and

3131

01:47:48,390 --> 01:47:46,800

that was a puzzle to me because i could

3132

01:47:49,030 --> 01:47:48,400

always see what needs to be done you

3133

01:47:51,510 --> 01:47:49,040

know in order

3134

01:47:52,149 --> 01:47:51,520

i giving a specific example no because

3135

01:47:54,790 --> 01:47:52,159

that was of

3136

01:47:55,510 --> 01:47:54,800

that will offend some people uh okay you

3137

01:47:57,590 --> 01:47:55,520

can be vegan

3138

01:47:58,790 --> 01:47:57,600

sorry give an example you can just

3139

01:47:59,590 --> 01:47:58,800

change it because i don't understand

3140

01:48:02,070 --> 01:47:59,600

what you mean by

3141

01:48:03,750 --> 01:48:02,080

what i mean you know like for example

3142

01:48:07,350 --> 01:48:03,760

when i became department chair

3143

01:48:08,870 --> 01:48:07,360

in 2011 i i continued three terms

3144

01:48:10,470 --> 01:48:08,880

that was the longest service in the

3145

01:48:11,990 --> 01:48:10,480

history of the department

3146

01:48:14,310 --> 01:48:12,000

i was the longest-serving department

3147

01:48:17,030 --> 01:48:14,320

chair um and then

3148

01:48:18,709 --> 01:48:17,040

one thing from the beginning was that i

3149

01:48:19,910 --> 01:48:18,719

was always straightforward with people i

3150

01:48:22,070 --> 01:48:19,920

would tell them

3151

01:48:24,149 --> 01:48:22,080

the situation as is right i never

3152

01:48:25,350 --> 01:48:24,159

manipulate people i never hide things

3153

01:48:26,950 --> 01:48:25,360

from them

3154

01:48:29,189 --> 01:48:26,960

and you might think that that's a

3155

01:48:30,950 --> 01:48:29,199

negative politically because

3156

01:48:32,870 --> 01:48:30,960

very often in politics you have to

3157

01:48:35,030 --> 01:48:32,880

maneuver in a way that would

3158

01:48:36,310 --> 01:48:35,040

people would not know exactly what is

3159

01:48:39,430 --> 01:48:36,320

going on

3160

01:48:41,350 --> 01:48:39,440

but i found it to be a i didn't

3161

01:48:43,350 --> 01:48:41,360

care so much because i said you know if

3162

01:48:45,990 --> 01:48:43,360

if i give up on my

3163

01:48:47,590 --> 01:48:46,000

service i would go back to to research

3164

01:48:48,709 --> 01:48:47,600

and i'll be happy at that i'm doing the

3165

01:48:50,629 --> 01:48:48,719

service

3166

01:48:51,750 --> 01:48:50,639

uh you know just in order to serve the

3167

01:48:53,270 --> 01:48:51,760

community and

3168

01:48:55,270 --> 01:48:53,280

uh so i was straightforward and it

3169

01:48:58,149 --> 01:48:55,280

turned out to be a great

3170

01:49:00,149 --> 01:48:58,159

asset because people never suspected me

3171

01:49:02,950 --> 01:49:00,159

doing things behind their back and

3172

01:49:03,750 --> 01:49:02,960

they always trusted my dealings with

3173

01:49:05,750 --> 01:49:03,760

things and

3174

01:49:07,430 --> 01:49:05,760

and then i i put an important item to

3175

01:49:09,510 --> 01:49:07,440

promote

3176
01:49:11,510 --> 01:49:09,520
minorities and women in the department

3177
01:49:13,910 --> 01:49:11,520
and you know i hired

3178
01:49:14,870 --> 01:49:13,920
in that direction and there was not much

3179
01:49:17,990 --> 01:49:14,880
resistance

3180
01:49:18,550 --> 01:49:18,000
uh from my colleagues to that and uh so

3181
01:49:26,390 --> 01:49:18,560
i

3182
01:49:29,830 --> 01:49:26,400
uh so you know transparency

3183
01:49:33,189 --> 01:49:29,840
uh people from underprivileged

3184
01:49:36,870 --> 01:49:35,350
have the proper training so that they

3185
01:49:38,149 --> 01:49:36,880
can become leaders

3186
01:49:40,070 --> 01:49:38,159
you know these are the kinds of

3187
01:49:40,629 --> 01:49:40,080
principles that i felt strongly about

3188
01:49:45,030 --> 01:49:40,639

and

3189

01:49:47,669 --> 01:49:45,040

didn't feel were promoted enough

3190

01:49:49,189 --> 01:49:47,679

uh but now you know that i finished my

3191

01:49:53,510 --> 01:49:49,199

third term and

3192

01:49:56,550 --> 01:49:53,520

just um you know in july 2020

3193

01:49:57,589 --> 01:49:56,560

then i can go back to doing creative

3194

01:50:00,709 --> 01:49:57,599

work and

3195

01:50:03,189 --> 01:50:00,719

that's what i enjoy the most you wrote

3196

01:50:07,030 --> 01:50:03,199

this book while you were the chair

3197

01:50:10,070 --> 01:50:07,040

the book was yes um that's right

3198

01:50:14,629 --> 01:50:10,080

you were a productive man well i

3199

01:50:16,550 --> 01:50:14,639

i i i i'm a no-nonsense kind of

3200

01:50:20,790 --> 01:50:16,560

person in the sense that you know when i

3201

01:50:23,990 --> 01:50:22,950

i work most of the day how do you

3202

01:50:25,430 --> 01:50:24,000

balance that with

3203

01:50:26,790 --> 01:50:25,440

spending time with your wife and i'm not

3204

01:50:27,669 --> 01:50:26,800

sure if you have kids but whatever your

3205

01:50:31,189 --> 01:50:27,679

personal life

3206

01:50:33,589 --> 01:50:31,199

i have two daughters uh yeah i mean

3207

01:50:36,310 --> 01:50:33,599

uh i do spend time with them but but one

3208

01:50:38,629 --> 01:50:36,320

of them is 15 the other one is 19 and

3209

01:50:39,589 --> 01:50:38,639

um they are sort of independent by now

3210

01:50:42,229 --> 01:50:39,599

the the two

3211

01:50:44,629 --> 01:50:42,239

i'm surrounded by uh three wonderful

3212

01:50:47,910 --> 01:50:44,639

women that were the muses for my

3213

01:50:50,390 --> 01:50:47,920

book uh and they support me

3214

01:50:52,390 --> 01:50:50,400

in a lot of different ways provide the

3215

01:50:55,830 --> 01:50:52,400

right balance for my life so

3216

01:50:59,510 --> 01:50:55,840

i'm sort of at this point in my life i'm

3217

01:51:00,870 --> 01:50:59,520

self-sustained and can do creative work

3218

01:51:03,589 --> 01:51:00,880

you know that's the the

3219

01:51:04,550 --> 01:51:03,599

the best you can hope for that you don't

3220

01:51:08,310 --> 01:51:04,560

depend on

3221

01:51:09,910 --> 01:51:08,320

other people that have agendas that are

3222

01:51:11,270 --> 01:51:09,920

not necessarily aligned with your

3223

01:51:14,070 --> 01:51:11,280

principles

3224

01:51:16,390 --> 01:51:14,080

um so that that's a good place to be in

3225

01:51:18,229 --> 01:51:16,400

and i'm very happy to be in that place

3226

01:51:20,149 --> 01:51:18,239

when you were doing podcasts for 11

3227

01:51:22,709 --> 01:51:20,159

hours a day back

3228

01:51:24,310 --> 01:51:22,719

a couple months ago including now even

3229

01:51:25,669 --> 01:51:24,320

why do you say that you had to do it

3230

01:51:26,790 --> 01:51:25,679

your publisher pushed you to do it or

3231

01:51:29,189 --> 01:51:26,800

you wanted no no

3232

01:51:31,189 --> 01:51:29,199

i felt that it's a platform that allows

3233

01:51:33,669 --> 01:51:31,199

me to communicate what i believe in

3234

01:51:34,709 --> 01:51:33,679

to the public had nothing to do some

3235

01:51:37,669 --> 01:51:34,719

people argue that

3236

01:51:38,390 --> 01:51:37,679

maybe i'm doing it to sell my book i

3237

01:51:40,550 --> 01:51:38,400

told my

3238

01:51:41,669 --> 01:51:40,560

my publicist that it's not for that

3239

01:51:43,430 --> 01:51:41,679

purpose that i'm

3240

01:51:45,510 --> 01:51:43,440

doing it to convey a message the

3241

01:51:46,149 --> 01:51:45,520

publicist was saying good job avi and i

3242

01:51:48,229 --> 01:51:46,159

said

3243

01:51:50,070 --> 01:51:48,239

i'm not trying to sell my book even so

3244

01:51:51,910 --> 01:51:50,080

when the book became a bestseller that

3245

01:51:53,830 --> 01:51:51,920

was not my objective at all i

3246

01:51:55,669 --> 01:51:53,840

i wouldn't care less if you know if it

3247

01:51:56,790 --> 01:51:55,679

sold just a few hundred copies and

3248

01:51:59,189 --> 01:51:56,800

that's it and

3249

01:52:01,750 --> 01:51:59,199

what i would like to communicate is a

3250

01:52:04,470 --> 01:52:01,760

message to the public and i communicate

3251
01:52:05,830 --> 01:52:04,480
through my book and through these

3252
01:52:08,950 --> 01:52:05,840
appearances and

3253
01:52:10,790 --> 01:52:08,960
and it got them huge attention from from

3254
01:52:13,910 --> 01:52:10,800
the public i should say you know like

3255
01:52:16,950 --> 01:52:13,920
there was a advice

3256
01:52:18,229 --> 01:52:16,960
video that received the one and a half

3257
01:52:21,350 --> 01:52:18,239
million views within

3258
01:52:24,950 --> 01:52:21,360
a week and a half and you know

3259
01:52:29,189 --> 01:52:24,960
there was of course the interviews with

3260
01:52:36,709 --> 01:52:33,270
uh and some other people got a huge um

3261
01:52:39,350 --> 01:52:36,719
amount of attention so so in that sense

3262
01:52:40,070 --> 01:52:39,360
i i did bring my message to the public

3263
01:52:42,070 --> 01:52:40,080

um

3264

01:52:43,430 --> 01:52:42,080

and that's what i wanted and then now i

3265

01:52:46,310 --> 01:52:43,440

can move on and

3266

01:52:47,830 --> 01:52:46,320

and you know write additional books do

3267

01:52:49,350 --> 01:52:47,840

the views make you feel happy do you

3268

01:52:50,790 --> 01:52:49,360

feel giddy do you share the news with

3269

01:52:52,390 --> 01:52:50,800

your wife like look this got a million

3270

01:52:56,070 --> 01:52:52,400

views or do you read the comments

3271

01:52:59,350 --> 01:52:56,080

how do you view your own appearances um

3272

01:53:00,709 --> 01:52:59,360

i i let the publicist look into that um

3273

01:53:02,470 --> 01:53:00,719

and and there were of course other

3274

01:53:06,790 --> 01:53:02,480

opportunities that were opened up

3275

01:53:10,830 --> 01:53:06,800

um that involved uh documentaries or

3276

01:53:15,189 --> 01:53:10,840

or films and there were of other

3277

01:53:19,109 --> 01:53:15,199

25 filmmakers and producers that

3278

01:53:22,870 --> 01:53:19,119

approached us as a result

3279

01:53:24,390 --> 01:53:22,880

but we should see if anything comes out

3280

01:53:25,990 --> 01:53:24,400

congratulations that's not easy as a

3281

01:53:28,709 --> 01:53:26,000

filmmaker i know that that's not

3282

01:53:31,750 --> 01:53:28,719

a that's not something to be sneezed at

3283

01:53:33,350 --> 01:53:31,760

so 20 years ago 2001 you were married

3284

01:53:34,790 --> 01:53:33,360

and your wife said don't go on social

3285

01:53:37,430 --> 01:53:34,800

media how the heck does she know about

3286

01:53:40,149 --> 01:53:37,440

social media in 2001

3287

01:53:41,669 --> 01:53:40,159

yeah because well back then um there

3288

01:53:45,189 --> 01:53:41,679

were some versions of it

3289

01:53:48,470 --> 01:53:45,199

and then uh myspace i'm assuming

3290

01:53:52,149 --> 01:53:48,480

yeah yeah myspace i i forgot but

3291

01:53:54,950 --> 01:53:52,159

you know i usually i do not deviate if i

3292

01:53:55,750 --> 01:53:54,960

agree to something and i maintained the

3293

01:53:58,470 --> 01:53:55,760

course and

3294

01:53:59,669 --> 01:53:58,480

when facebook appeared and twitter and

3295

01:54:02,870 --> 01:53:59,679

so forth i

3296

01:54:04,870 --> 01:54:02,880

kept my promise to her and

3297

01:54:07,510 --> 01:54:04,880

how attractive you were and how much

3298

01:54:10,149 --> 01:54:07,520

girls will be messaging you wasn't about

3299

01:54:12,310 --> 01:54:10,159

keeping you that car that's an

3300

01:54:14,709 --> 01:54:12,320

interesting insight i i wouldn't um

3301
01:54:17,750 --> 01:54:14,719
yeah perhaps she was thinking about that

3302
01:54:19,910 --> 01:54:17,760
yeah i i don't know exactly why but then

3303
01:54:20,950 --> 01:54:19,920
i'm grateful for working out it worked

3304
01:54:24,709 --> 01:54:20,960
out in the sense that

3305
01:54:25,750 --> 01:54:24,719
it kept me honest and uh independent of

3306
01:54:27,910 --> 01:54:25,760
others

3307
01:54:29,510 --> 01:54:27,920
okay barfi man again his also his name

3308
01:54:31,189 --> 01:54:29,520
is also ryan collins he said

3309
01:54:33,189 --> 01:54:31,199
can you ask him about virtual black

3310
01:54:34,870 --> 01:54:33,199
holes and spin network evolution

3311
01:54:37,109 --> 01:54:34,880
how might a superposition of spin

3312
01:54:40,470 --> 01:54:37,119
network evolutions brackets spin foams

3313
01:54:40,480 --> 01:54:43,910

um

3314

01:54:49,430 --> 01:54:47,109

well we so again the structure of space

3315

01:54:53,189 --> 01:54:49,440

and time you know is a matter of

3316

01:54:54,550 --> 01:54:53,199

the the unified theory of quantum

3317

01:54:56,229 --> 01:54:54,560

gravity which we don't have at the

3318

01:54:58,229 --> 01:54:56,239

moment so

3319

01:55:00,310 --> 01:54:58,239

john wheeler was a physicist who thought

3320

01:55:03,750 --> 01:55:00,320

about the space-time foam

3321

01:55:06,149 --> 01:55:03,760

as the way that space and time appear

3322

01:55:07,510 --> 01:55:06,159

on very tiny scales that's not the way

3323

01:55:10,709 --> 01:55:07,520

that string theory thinks

3324

01:55:12,790 --> 01:55:10,719

of it right now and um there are all

3325

01:55:16,229 --> 01:55:12,800

these extra dimensions and

3326

01:55:17,830 --> 01:55:16,239

uh so i would say the verdict is still

3327

01:55:21,189 --> 01:55:17,840

out as to what's going on

3328

01:55:24,310 --> 01:55:21,199

with space and time and let's just

3329

01:55:26,629 --> 01:55:24,320

keep an open mind jeff b says

3330

01:55:29,430 --> 01:55:26,639

number one have they confirmed yet if

3331

01:55:31,750 --> 01:55:29,440

blc1 narrow band radio signal

3332

01:55:32,870 --> 01:55:31,760

detected in december 2020 by the parks

3333

01:55:35,430 --> 01:55:32,880

radio telescope

3334

01:55:36,790 --> 01:55:35,440

hopefully you know about this came from

3335

01:55:39,030 --> 01:55:36,800

proxima centauri

3336

01:55:41,990 --> 01:55:39,040

or was it just earth-based local

3337

01:55:46,870 --> 01:55:44,310

that's an excellent question and most

3338

01:55:49,910 --> 01:55:46,880

likely it's earth-based

3339

01:55:51,669 --> 01:55:49,920

the reason i say that is because the

3340

01:55:53,990 --> 01:55:51,679

frequency was very steady

3341

01:55:56,310 --> 01:55:54,000

didn't really drift much and it was a

3342

01:55:59,030 --> 01:55:56,320

very narrow band of frequencies that was

3343

01:56:00,950 --> 01:55:59,040

detected and

3344

01:56:02,149 --> 01:56:00,960

if it came if it were to come from a

3345

01:56:04,950 --> 01:56:02,159

habitable

3346

01:56:06,390 --> 01:56:04,960

uh planet around proxima centauri then

3347

01:56:08,149 --> 01:56:06,400

you would see some drift in the

3348

01:56:09,030 --> 01:56:08,159

frequency because of the motion of that

3349

01:56:12,149 --> 01:56:09,040

planet

3350

01:56:13,669 --> 01:56:12,159

well beyond the the limits uh

3351

01:56:16,229 --> 01:56:13,679

but of course it could have come from a

3352

01:56:20,229 --> 01:56:16,239

planet not in the habitable zone

3353

01:56:22,950 --> 01:56:20,239

um based on the

3354

01:56:24,310 --> 01:56:22,960

the fact that it was one telescope in

3355

01:56:26,550 --> 01:56:24,320

australia i think we should be very

3356

01:56:29,350 --> 01:56:26,560

suspicious because the same telescope

3357

01:56:30,709 --> 01:56:29,360

reported the fast radio burst repeating

3358

01:56:33,990 --> 01:56:30,719

fast radio burst

3359

01:56:36,149 --> 01:56:34,000

a few years ago that ended up being the

3360

01:56:37,750 --> 01:56:36,159

uh that they found that it comes only

3361

01:56:42,149 --> 01:56:37,760

during lunch time and

3362

01:56:43,910 --> 01:56:42,159

uh then realized that it's the door of a

3363

01:56:46,470 --> 01:56:43,920

microwave oven that was opened

3364

01:56:49,030 --> 01:56:46,480

prematurely right right

3365

01:56:50,470 --> 01:56:49,040

so i would say there is a like high

3366

01:56:52,950 --> 01:56:50,480

likelihood that

3367

01:56:54,550 --> 01:56:52,960

it's it's local um and the only way to

3368

01:56:56,070 --> 01:56:54,560

find out is to have

3369

01:56:58,310 --> 01:56:56,080

another observatory at a different

3370

01:57:00,310 --> 01:56:58,320

location finding the same source so

3371

01:57:02,709 --> 01:57:00,320

we really need the confirmation before

3372

01:57:06,229 --> 01:57:02,719

we assume that it is

3373

01:57:08,070 --> 01:57:06,239

uh associated with proxima centauri

3374

01:57:09,430 --> 01:57:08,080

rabbit skywalker says i really would

3375

01:57:10,070 --> 01:57:09,440

like to hear his opinion about the

3376

01:57:12,149 --> 01:57:10,080

claims

3377

01:57:13,189 --> 01:57:12,159

from former israeli director of the

3378

01:57:15,990 --> 01:57:13,199

space program

3379

01:57:17,270 --> 01:57:16,000

ham ashad brought forward you must have

3380

01:57:18,629 --> 01:57:17,280

heard about it he must have heard about

3381

01:57:21,350 --> 01:57:18,639

it referring to

3382

01:57:22,629 --> 01:57:21,360

you and i wonder what avi thinks about

3383

01:57:25,350 --> 01:57:22,639

this story

3384

01:57:27,430 --> 01:57:25,360

yeah so my reply to that is he didn't

3385

01:57:29,350 --> 01:57:27,440

really provide any evidence and that

3386

01:57:30,870 --> 01:57:29,360

goes back to what we discussed before

3387

01:57:33,910 --> 01:57:30,880

that uh

3388

01:57:36,790 --> 01:57:33,920

if you don't have a document supporting

3389

01:57:38,950 --> 01:57:36,800

uh your claim or or some other type of

3390

01:57:41,510 --> 01:57:38,960

evidence then

3391

01:57:43,510 --> 01:57:41,520

to me it sounds like no journalist

3392

01:57:45,189 --> 01:57:43,520

should cover that story because

3393

01:57:47,270 --> 01:57:45,199

otherwise you create a lot of noise in

3394

01:57:48,470 --> 01:57:47,280

the system without much signal

3395

01:57:50,310 --> 01:57:48,480

about there being evidence there's

3396

01:57:52,070 --> 01:57:50,320

someone named kevin knuth i don't

3397

01:57:53,350 --> 01:57:52,080

or kevin knuth i don't know if you've

3398

01:57:54,149 --> 01:57:53,360

heard of him he's a physicist from

3399

01:57:55,669 --> 01:57:54,159

albany

3400

01:57:57,189 --> 01:57:55,679

you've heard of him yes definitely okay

3401
01:57:58,390 --> 01:57:57,199
well i'm speaking to him in a few hours

3402
01:57:59,669 --> 01:57:58,400
just for the people listening to i'm

3403
01:58:01,510 --> 01:57:59,679
speaking to him in a few hours

3404
01:58:02,709 --> 01:58:01,520
he says that he's analyzed some of the

3405
01:58:04,550 --> 01:58:02,719
data of the

3406
01:58:06,470 --> 01:58:04,560
ufos or uaps i believe they're called

3407
01:58:08,550 --> 01:58:06,480
now and he has showed that

3408
01:58:09,830 --> 01:58:08,560
through analysis the amount of

3409
01:58:11,350 --> 01:58:09,840
acceleration is

3410
01:58:13,109 --> 01:58:11,360
incomparable to anything that we can

3411
01:58:14,790 --> 01:58:13,119
produce and it's

3412
01:58:16,790 --> 01:58:14,800
well i guess you can take that as

3413
01:58:17,830 --> 01:58:16,800

evidence

3414

01:58:20,390 --> 01:58:17,840

what do you think about that have you

3415

01:58:22,870 --> 01:58:20,400

seen that paper of his so

3416

01:58:23,669 --> 01:58:22,880

anything to do with unidentifying flying

3417

01:58:27,189 --> 01:58:23,679

objects

3418

01:58:30,790 --> 01:58:27,199

or aerial phenomena my take on those

3419

01:58:34,149 --> 01:58:30,800

is simple that we should deploy

3420

01:58:36,470 --> 01:58:34,159

state-of-the-art instruments cameras or

3421

01:58:37,830 --> 01:58:36,480

audio sensors in the same locations and

3422

01:58:39,750 --> 01:58:37,840

try to collect data just like a

3423

01:58:41,669 --> 01:58:39,760

scientific experiment

3424

01:58:43,910 --> 01:58:41,679

rather than rely on instruments that

3425

01:58:47,030 --> 01:58:43,920

were not optimized for that purpose that

3426

01:58:49,430 --> 01:58:47,040

you know pilots have access to and

3427

01:58:50,390 --> 01:58:49,440

or rely on reports that came from many

3428

01:58:53,910 --> 01:58:50,400

years ago that

3429

01:58:54,790 --> 01:58:53,920

we cannot really check um and so i think

3430

01:58:58,149 --> 01:58:54,800

that

3431

01:59:01,589 --> 01:58:58,159

all the ufo and uap supporters

3432

01:59:04,709 --> 01:59:01,599

should fund a scientific mission

3433

01:59:06,550 --> 01:59:04,719

experiment to monitor the earth

3434

01:59:08,390 --> 01:59:06,560

yeah monitor those locations if you

3435

01:59:10,070 --> 01:59:08,400

think that they are and basically if we

3436

01:59:11,510 --> 01:59:10,080

see anything unusual

3437

01:59:14,070 --> 01:59:11,520

it will be documented in a

3438

01:59:17,669 --> 01:59:14,080

scientifically credible way

3439

01:59:19,589 --> 01:59:17,679

rather than rely on those unoptimized

3440

01:59:21,189 --> 01:59:19,599

reports that you know the images are

3441

01:59:22,950 --> 01:59:21,199

always fuzzy it could be something in

3442

01:59:25,109 --> 01:59:22,960

the instrument it could be

3443

01:59:26,390 --> 01:59:25,119

something else in the sky that is an

3444

01:59:29,589 --> 01:59:26,400

optical illusion

3445

01:59:31,270 --> 01:59:29,599

could be many things so um i would

3446

01:59:32,390 --> 01:59:31,280

highly recommend doing a scientific

3447

01:59:34,070 --> 01:59:32,400

credible scientific

3448

01:59:36,470 --> 01:59:34,080

experiment and you know it shouldn't be

3449

01:59:39,030 --> 01:59:36,480

too expensive and it would save us

3450

01:59:39,589 --> 01:59:39,040

a lot of time instead of discussing it

3451

01:59:42,709 --> 01:59:39,599

let's just

3452

01:59:45,030 --> 01:59:42,719

let we should let the evidence

3453

01:59:46,709 --> 01:59:45,040

dictate yes of course of course i know

3454

01:59:48,390 --> 01:59:46,719

you got to go how did but how can we do

3455

01:59:50,149 --> 01:59:48,400

that because i imagine that the ufos are

3456

01:59:52,310 --> 01:59:50,159

so small and they're so sporadic

3457

01:59:53,830 --> 01:59:52,320

that to monitor the entire earth is not

3458

01:59:55,510 --> 01:59:53,840

cheap so how can

3459

01:59:57,510 --> 01:59:55,520

conceivably that be done you don't need

3460

01:59:59,910 --> 01:59:57,520

the entire earth you can just do it

3461

02:00:01,910 --> 01:59:59,920

in the spots where detections were

3462

02:00:03,589 --> 02:00:01,920

reported and

3463

02:00:05,830 --> 02:00:03,599

nowadays we have technologies that

3464

02:00:09,109 --> 02:00:05,840

didn't exist decades ago and

3465

02:00:10,790 --> 02:00:09,119

uh we should you know it's it should not

3466

02:00:12,709 --> 02:00:10,800

be too expensive that

3467

02:00:13,910 --> 02:00:12,719

i'm sure that at the level of tens of

3468

02:00:16,149 --> 02:00:13,920

millions of dollars

3469

02:00:18,070 --> 02:00:16,159

one can do a state-of-the-art experiment

3470

02:00:21,589 --> 02:00:18,080

to check if there is anything unusual

3471

02:00:24,070 --> 02:00:21,599

if we don't see anything unusual then uh

3472

02:00:24,709 --> 02:00:24,080

it must mean that these were artifacts

3473

02:00:28,070 --> 02:00:24,719

of the

3474

02:00:29,669 --> 02:00:28,080

instruments or some illusions amjad

3475

02:00:31,030 --> 02:00:29,679

hussain had a couple questions that i

3476

02:00:32,629 --> 02:00:31,040

wasn't able to get to during the

3477

02:00:34,629 --> 02:00:32,639

interview but i emailed avi

3478

02:00:37,030 --> 02:00:34,639

directly and here's the exchange

3479

02:00:39,790 --> 02:00:37,040

professor avi are there aliens on earth

3480

02:00:41,750 --> 02:00:39,800

living sharing the planet with us in a

3481

02:00:44,070 --> 02:00:41,760

non-electromagnetic realm dimension

3482

02:00:46,629 --> 02:00:44,080

consciousness like dark matter energy

3483

02:00:48,070 --> 02:00:46,639

where we don't know their existence

3484

02:00:50,550 --> 02:00:48,080

and then he had another question number

3485

02:00:52,149 --> 02:00:50,560

two do fundamental particles in nature

3486

02:00:54,149 --> 02:00:52,159

have proto-consciousness

3487

02:00:55,189 --> 02:00:54,159

meaning that an electron feels its own

3488

02:00:57,669 --> 02:00:55,199

intrinsic state

3489

02:00:58,950 --> 02:00:57,679

of charge spin etc does consciousness

3490

02:01:00,870 --> 02:00:58,960

equal existence

3491

02:01:02,070 --> 02:01:00,880

avi replied saying the answers to both

3492

02:01:06,629 --> 02:01:02,080

questions are no

3493

02:01:10,550 --> 02:01:08,950

avi you gotta go thank you so much i

3494

02:01:11,910 --> 02:01:10,560

appreciate your time it was a pleasure

3495

02:01:14,070 --> 02:01:11,920

talking to you

3496

02:01:16,550 --> 02:01:14,080

it was a pleasure to to answer all these

3497

02:01:17,990 --> 02:01:16,560

questions and there were