



**JOHN  
MOFFAT**

**DARK MATTER  
DOESN'T EXIST**

1  
00:00:03,030 --> 00:00:01,670  
my opinion they're not going to detect

2  
00:00:05,110 --> 00:00:03,040  
the dark matter

3  
00:00:11,190 --> 00:00:05,120  
because it doesn't exist

4  
00:00:15,190 --> 00:00:13,190  
i'm here with professor john moffett

5  
00:00:17,910 --> 00:00:15,200  
part of what i'm doing with this channel

6  
00:00:19,990 --> 00:00:17,920  
as well as this documentary is to

7  
00:00:22,150 --> 00:00:20,000  
place people who i think

8  
00:00:23,029 --> 00:00:22,160  
have gotten not as much press as they

9  
00:00:24,470 --> 00:00:23,039  
should

10  
00:00:25,590 --> 00:00:24,480  
you've heard of lee smallin you heard

11  
00:00:27,189 --> 00:00:25,600  
you've heard of eric weinstein

12  
00:00:28,950 --> 00:00:27,199  
especially from the intellectual dark

13  
00:00:30,870 --> 00:00:28,960

web you've heard of sabine hostenfelder

14

00:00:32,549 --> 00:00:30,880

because of her youtube channel but not

15

00:00:34,470 --> 00:00:32,559

many people have heard at least in the

16

00:00:35,830 --> 00:00:34,480

public have heard of john moffitt and he

17

00:00:38,229 --> 00:00:35,840

deserves

18

00:00:40,869 --> 00:00:38,239

just as much credit he's

19

00:00:42,709 --> 00:00:40,879

put out quite a few theories and not

20

00:00:45,030 --> 00:00:42,719

many people put out even one theory they

21

00:00:47,270 --> 00:00:45,040

usually develop an existing theory

22

00:00:48,709 --> 00:00:47,280

so i'm super excited to meet with john

23

00:00:50,150 --> 00:00:48,719

in person

24

00:00:51,910 --> 00:00:50,160

john how are you doing

25

00:00:53,590 --> 00:00:51,920

very good thank you

26  
00:00:54,790 --> 00:00:53,600  
let's hear about your modified theory of

27  
00:00:58,069 --> 00:00:54,800  
gravity

28  
00:01:01,349 --> 00:00:58,950  
this

29  
00:01:02,950 --> 00:01:01,359  
non-symmetric theory which i

30  
00:01:05,350 --> 00:01:02,960  
worked on

31  
00:01:06,469 --> 00:01:05,360  
uh i decided that the anti-symmetric

32  
00:01:08,149 --> 00:01:06,479  
part

33  
00:01:10,950 --> 00:01:08,159  
of this

34  
00:01:13,270 --> 00:01:10,960  
metric sensor

35  
00:01:14,630 --> 00:01:13,280  
was not the electrolytic field

36  
00:01:16,390 --> 00:01:14,640  
it was

37  
00:01:18,550 --> 00:01:16,400  
additional degrees of

38  
00:01:20,950 --> 00:01:18,560

freedom for gravity

39

00:01:23,429 --> 00:01:20,960

it was part of the gravitational

40

00:01:24,230 --> 00:01:23,439

field okay

41

00:01:26,710 --> 00:01:24,240

and

42

00:01:28,710 --> 00:01:26,720

so i called it the non-symmetric

43

00:01:31,910 --> 00:01:28,720

gravitational theory

44

00:01:33,190 --> 00:01:31,920

now comes the first acronym ngt

45

00:01:34,950 --> 00:01:33,200

let me just break this down for the

46

00:01:37,030 --> 00:01:34,960

audience quickly so in general

47

00:01:38,310 --> 00:01:37,040

relativity of the two tensor as i was

48

00:01:41,270 --> 00:01:38,320

saying before then you have the

49

00:01:42,950 --> 00:01:41,280

symmetric it's it's a symmetric tensor

50

00:01:44,789 --> 00:01:42,960

but any tensor can be broken up into

51  
00:01:46,630 --> 00:01:44,799  
symmetric and an anti-symmetric part you

52  
00:01:48,630 --> 00:01:46,640  
can decompose it much like you can with

53  
00:01:50,630 --> 00:01:48,640  
coordinates there's an x and y

54  
00:01:52,310 --> 00:01:50,640  
or if you know about principal bundles

55  
00:01:53,990 --> 00:01:52,320  
there's a horizontal vertical part so

56  
00:01:55,190 --> 00:01:54,000  
you can decompose so you can decompose

57  
00:01:57,109 --> 00:01:55,200  
and tensor into symmetric and

58  
00:01:58,870 --> 00:01:57,119  
anti-symmetric part anti-symmetric part

59  
00:02:00,709 --> 00:01:58,880  
is just zero in the einstein field

60  
00:02:02,550 --> 00:02:00,719  
equations

61  
00:02:04,550 --> 00:02:02,560  
typically

62  
00:02:06,230 --> 00:02:04,560  
and what moffitt is working on or was

63  
00:02:07,910 --> 00:02:06,240

working on was realizing that this

64

00:02:09,109 --> 00:02:07,920

anti-symmetric part which einstein also

65

00:02:10,070 --> 00:02:09,119

tried to work on

66

00:02:12,869 --> 00:02:10,080

is not

67

00:02:14,309 --> 00:02:12,879

doesn't represent electromagnetism which

68

00:02:15,990 --> 00:02:14,319

is why i signed through it out because

69

00:02:17,430 --> 00:02:16,000

he was trying to make it fit

70

00:02:20,390 --> 00:02:17,440

you're like wait maybe it's not

71

00:02:21,190 --> 00:02:20,400

electromagnetism but it's something else

72

00:02:24,309 --> 00:02:21,200

okay

73

00:02:26,790 --> 00:02:24,319

and you can correct me if i'm incorrect

74

00:02:27,670 --> 00:02:26,800

very good perfect perfect

75

00:02:30,550 --> 00:02:27,680

um

76

00:02:32,070 --> 00:02:30,560

that's a succinct description

77

00:02:33,190 --> 00:02:32,080

um

78

00:02:35,430 --> 00:02:33,200

so

79

00:02:37,670 --> 00:02:35,440

i publish the paper

80

00:02:39,830 --> 00:02:37,680

in physical review

81

00:02:42,150 --> 00:02:39,840

1979

82

00:02:44,790 --> 00:02:42,160

called the new theory of gravitation

83

00:02:47,030 --> 00:02:44,800

what you do is in theoretical physics is

84

00:02:50,630 --> 00:02:47,040

the following

85

00:02:52,229 --> 00:02:50,640

you have an idea

86

00:02:55,910 --> 00:02:52,239

as

87

00:02:57,750 --> 00:02:55,920

richard feynman said you guessed an idea

88

00:02:59,910 --> 00:02:57,760

now i'm going to discuss how we would

89

00:03:01,589 --> 00:02:59,920

look for a new law

90

00:03:05,350 --> 00:03:01,599

in general we look for new law by the

91

00:03:07,670 --> 00:03:05,360

following process first we guess it

92

00:03:10,229 --> 00:03:07,680

then we can well don't let that's really

93

00:03:13,030 --> 00:03:10,239

true and okay you have this idea it

94

00:03:15,030 --> 00:03:13,040

takes seconds to have the idea okay

95

00:03:16,710 --> 00:03:15,040

but then you

96

00:03:19,030 --> 00:03:16,720

have to formulate it

97

00:03:21,670 --> 00:03:19,040

in terms of a mathematical

98

00:03:24,149 --> 00:03:21,680

system mathematical equations

99

00:03:26,229 --> 00:03:24,159

okay so you do that and you have to be

100

00:03:27,990 --> 00:03:26,239

self-consistent

101  
00:03:30,390 --> 00:03:28,000  
and then

102  
00:03:33,750 --> 00:03:30,400  
you have to

103  
00:03:36,789 --> 00:03:33,760  
test it against experiment

104  
00:03:37,670 --> 00:03:36,799  
and it's three phases

105  
00:03:39,910 --> 00:03:37,680  
and

106  
00:03:41,830 --> 00:03:39,920  
the latter part the third phase is very

107  
00:03:43,589 --> 00:03:41,840  
important

108  
00:03:45,910 --> 00:03:43,599  
because you have to know whether it's

109  
00:03:47,990 --> 00:03:45,920  
correct or not experimentally it's

110  
00:03:50,630 --> 00:03:48,000  
physics you're doing physics not just

111  
00:03:53,190 --> 00:03:50,640  
mathematics

112  
00:03:57,509 --> 00:03:56,550  
if it's not doesn't fit the data

113  
00:04:00,390 --> 00:03:57,519

then

114

00:04:02,070 --> 00:04:00,400

you throw away that guess that idea

115

00:04:04,390 --> 00:04:02,080

and you

116

00:04:05,429 --> 00:04:04,400

start some other idea

117

00:04:07,190 --> 00:04:05,439

or you

118

00:04:09,750 --> 00:04:07,200

quit

119

00:04:10,789 --> 00:04:09,760

and this is how physics is done

120

00:04:11,990 --> 00:04:10,799

so

121

00:04:16,710 --> 00:04:12,000

uh

122

00:04:20,150 --> 00:04:18,789

verifying this non-symmetric gravity

123

00:04:23,189 --> 00:04:20,160

it's not easy

124

00:04:24,710 --> 00:04:23,199

doing experimental gravity physics is is

125

00:04:26,550 --> 00:04:24,720

difficult

126  
00:04:30,950 --> 00:04:26,560  
of course i had to agree with einstein's

127  
00:04:32,710 --> 00:04:30,960  
two of gravity that's the first

128  
00:04:34,629 --> 00:04:32,720  
necessary

129  
00:04:35,749 --> 00:04:34,639  
thing to find

130  
00:04:38,230 --> 00:04:35,759  
is correct

131  
00:04:40,710 --> 00:04:38,240  
if it doesn't agree with it presently

132  
00:04:43,749 --> 00:04:40,720  
solar experimental data for example

133  
00:04:44,870 --> 00:04:43,759  
then this the whole thing is off

134  
00:04:50,870 --> 00:04:44,880  
so

135  
00:04:53,270 --> 00:04:50,880  
um

136  
00:04:55,270 --> 00:04:53,280  
people criticized it too just you have

137  
00:04:56,950 --> 00:04:55,280  
to have criticism physics is a very

138  
00:04:59,030 --> 00:04:56,960

conservative business

139

00:05:03,590 --> 00:04:59,040

you do not change the paradigm in

140

00:05:08,310 --> 00:05:05,749

and it's the paradigm shift is usually

141

00:05:10,710 --> 00:05:08,320

driven by experimental physics

142

00:05:12,950 --> 00:05:10,720

some the presence theory

143

00:05:14,390 --> 00:05:12,960

so-called standard theory by the way i

144

00:05:16,950 --> 00:05:14,400

don't like that i won't stand it but

145

00:05:20,310 --> 00:05:16,960

anyway standard theory

146

00:05:22,710 --> 00:05:20,320

uh doesn't agree with some data

147

00:05:25,029 --> 00:05:22,720

or a theory comes forward that predicts

148

00:05:27,350 --> 00:05:25,039

makes a prediction

149

00:05:30,710 --> 00:05:28,870

your theory

150

00:05:32,390 --> 00:05:30,720

fits the data that prediction fits but

151  
00:05:36,230 --> 00:05:32,400  
the older theory doesn't

152  
00:05:39,029 --> 00:05:37,670  
and

153  
00:05:50,550 --> 00:05:39,039  
so

154  
00:05:53,909 --> 00:05:50,560  
1980s i had students working on

155  
00:05:55,670 --> 00:05:53,919  
and uh for example i had neil cornish

156  
00:05:56,950 --> 00:05:55,680  
graduation

157  
00:05:59,110 --> 00:05:56,960  
who um

158  
00:06:00,390 --> 00:05:59,120  
was from australia

159  
00:06:03,430 --> 00:06:00,400  
and uh

160  
00:06:07,350 --> 00:06:03,440  
he's now professor

161  
00:06:11,350 --> 00:06:08,710  
he's found

162  
00:06:12,710 --> 00:06:11,360  
curry senior professor the

163  
00:06:15,189 --> 00:06:12,720

head of a

164

00:06:17,029 --> 00:06:15,199

gravity gravitational

165

00:06:20,790 --> 00:06:17,039

physics group

166

00:06:25,670 --> 00:06:23,270

so we we worked on this and

167

00:06:27,350 --> 00:06:25,680

i had a potential solution

168

00:06:28,629 --> 00:06:27,360

for a black hole which did not have a

169

00:06:31,110 --> 00:06:28,639

horizon

170

00:06:35,909 --> 00:06:33,270

and uh

171

00:06:38,070 --> 00:06:35,919

using your modifier using this modified

172

00:06:40,710 --> 00:06:38,080

theory a black hole with no horizon

173

00:06:42,790 --> 00:06:40,720

that's right uh cornish applied for a

174

00:06:43,990 --> 00:06:42,800

position at cambridge university

175

00:06:45,749 --> 00:06:44,000

to be a

176  
00:06:49,990 --> 00:06:45,759  
hawking's assistant stephen hawking's

177  
00:06:53,670 --> 00:06:50,000  
assistant and he became his assistant

178  
00:06:55,749 --> 00:06:53,680  
it's quite funny story because uh

179  
00:06:57,670 --> 00:06:55,759  
as neil told me later

180  
00:06:59,589 --> 00:06:57,680  
he was sitting in

181  
00:07:02,629 --> 00:06:59,599  
one of the rooms of the

182  
00:07:04,710 --> 00:07:02,639  
department of applied mathematics

183  
00:07:05,990 --> 00:07:04,720  
a silver street cambridge where hawking

184  
00:07:09,110 --> 00:07:06,000  
was

185  
00:07:10,550 --> 00:07:09,120  
and uh he's looking at the blackboard at

186  
00:07:13,270 --> 00:07:10,560  
a blackboard

187  
00:07:15,749 --> 00:07:13,280  
and he suddenly hears this voice

188  
00:07:18,150 --> 00:07:15,759

computer voice

189

00:07:20,710 --> 00:07:18,160

ah so you're neil cornish

190

00:07:22,230 --> 00:07:20,720

so you don't believe in black holes i

191

00:07:25,589 --> 00:07:22,240

believe

192

00:07:35,510 --> 00:07:27,029

so

193

00:07:38,070 --> 00:07:35,520

i started that then i started doing in

194

00:07:39,510 --> 00:07:38,080

particle physics again and left it for a

195

00:07:42,309 --> 00:07:39,520

while

196

00:07:45,270 --> 00:07:42,319

i worked on unified theory again and

197

00:07:47,909 --> 00:07:45,280

with another graduate student david ball

198

00:07:50,469 --> 00:07:47,919

who ended up as a professor simon

199

00:07:52,390 --> 00:07:50,479

friends university british columbia he

200

00:07:55,830 --> 00:07:52,400

was chair actually of the department at

201

00:07:58,469 --> 00:07:55,840

one point david ball b-o-l

202

00:08:01,029 --> 00:07:58,479

and also with gabor constanta

203

00:08:03,110 --> 00:08:01,039

who became professor and dean

204

00:08:05,909 --> 00:08:03,120

of science at the

205

00:08:07,430 --> 00:08:05,919

university of winnipeg in manitoba

206

00:08:10,070 --> 00:08:07,440

uh we worked on

207

00:08:12,150 --> 00:08:10,080

that stuff and but uh there was no clear

208

00:08:13,029 --> 00:08:12,160

experimental evidence that could prove

209

00:08:15,350 --> 00:08:13,039

it

210

00:08:18,150 --> 00:08:15,360

you have to have one piece of experiment

211

00:08:20,070 --> 00:08:18,160

of some some prediction

212

00:08:21,510 --> 00:08:20,080

something that you have in your theory

213

00:08:24,150 --> 00:08:21,520

that cannot be

214

00:08:26,550 --> 00:08:24,160  
fitted by the other theories

215

00:08:29,189 --> 00:08:26,560  
this is very difficult this doesn't

216

00:08:31,830 --> 00:08:29,199  
happen often in physics

217

00:08:33,190 --> 00:08:31,840  
um maxwell's prediction

218

00:08:34,550 --> 00:08:33,200  
that light has to move as an

219

00:08:36,469 --> 00:08:34,560  
electrically wave

220

00:08:38,829 --> 00:08:36,479  
with the speed of light

221

00:08:41,269 --> 00:08:38,839  
is a prediction

222

00:08:42,630 --> 00:08:41,279  
which hurts

223

00:08:44,630 --> 00:08:42,640  
perhaps the

224

00:08:46,949 --> 00:08:44,640  
physicist brought

225

00:08:49,990 --> 00:08:46,959  
experimentally to be correct this is a

226

00:08:51,350 --> 00:08:50,000

remarkable result the iraq is dirac

227

00:08:54,630 --> 00:08:51,360

equation

228

00:08:58,949 --> 00:08:54,640

quantum field theory and quantum

229

00:09:01,350 --> 00:08:58,959

mechanics relativistic quantum physics

230

00:09:03,829 --> 00:09:01,360

and predicted antimatter

231

00:09:07,509 --> 00:09:03,839

when they went and looked for antimatter

232

00:09:10,550 --> 00:09:07,519

and anderson caltech found in 1932 this

233

00:09:11,509 --> 00:09:10,560

is a an amazing prediction see

234

00:09:13,750 --> 00:09:11,519

so

235

00:09:15,829 --> 00:09:13,760

theref this happens a few times in

236

00:09:19,269 --> 00:09:15,839

physics

237

00:09:23,430 --> 00:09:19,279

einstein's theory of general relativity

238

00:09:26,710 --> 00:09:23,440

had to pass the solar system experiments

239

00:09:29,190 --> 00:09:26,720

and then bending light of course 1.57

240

00:09:30,230 --> 00:09:29,200

or five arc seconds

241

00:09:32,790 --> 00:09:30,240

uh

242

00:09:34,470 --> 00:09:32,800

bending of light by the sun

243

00:09:36,630 --> 00:09:34,480

um

244

00:09:38,550 --> 00:09:36,640

the first two eclipse experiments were

245

00:09:41,350 --> 00:09:38,560

not all that great actually

246

00:09:43,990 --> 00:09:41,360

and time had to go on before we had a

247

00:09:47,030 --> 00:09:44,000

really confirmation of the bending of

248

00:09:49,670 --> 00:09:47,040

light prediction by einstein

249

00:09:51,430 --> 00:09:49,680

and uh the period advance of mercury

250

00:09:52,550 --> 00:09:51,440

this is the

251

00:09:55,030 --> 00:09:52,560

uh

252

00:09:56,790 --> 00:09:55,040

the rosetta precession

253

00:09:59,430 --> 00:09:56,800

of mercury's orbit

254

00:10:01,430 --> 00:09:59,440

mercury is the planet closest to the sun

255

00:10:03,509 --> 00:10:01,440

and it presets into the written shape

256

00:10:04,949 --> 00:10:03,519

some set of shape

257

00:10:07,829 --> 00:10:04,959

which

258

00:10:09,590 --> 00:10:07,839

confounded newtonian gravity

259

00:10:11,590 --> 00:10:09,600

where does your modified theory come in

260

00:10:13,430 --> 00:10:11,600

so i had to fit all this

261

00:10:16,150 --> 00:10:13,440

with my modified theory

262

00:10:20,870 --> 00:10:19,670

i got interested in dark matter

263

00:10:22,550 --> 00:10:20,880

because

264

00:10:23,430 --> 00:10:22,560

there was beginning to be interest in

265

00:10:27,990 --> 00:10:23,440

the

266

00:10:29,509 --> 00:10:28,000

very reuben astronomers of women

267

00:10:30,829 --> 00:10:29,519

astronomer

268

00:10:33,190 --> 00:10:30,839

and

269

00:10:35,990 --> 00:10:33,200

fought colleague

270

00:10:38,389 --> 00:10:36,000

did exp observations of uh

271

00:10:41,670 --> 00:10:38,399

rotation curves of galaxies

272

00:10:44,150 --> 00:10:41,680

if you observe doppler shifts

273

00:10:45,190 --> 00:10:44,160

uh light coming and going blue shifting

274

00:10:46,870 --> 00:10:45,200

richard

275

00:10:49,430 --> 00:10:46,880

and from these observations you can

276

00:10:50,710 --> 00:10:49,440

determine

277

00:10:53,750 --> 00:10:50,720

how fast

278

00:10:56,470 --> 00:10:53,760

stars are moving around in the galaxy

279

00:10:58,470 --> 00:10:56,480

in a galaxy

280

00:11:00,630 --> 00:10:58,480

and they found

281

00:11:02,790 --> 00:11:00,640

with great surprise that the

282

00:11:05,750 --> 00:11:02,800

stars were moving faster than could be

283

00:11:09,590 --> 00:11:05,760

accounted for by newtonian gravity

284

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

the if you plot the rotation curve

285

00:11:12,790 --> 00:11:11,200

of the speed

286

00:11:16,550 --> 00:11:12,800

velocity

287

00:11:19,190 --> 00:11:16,560

vertical axis versus the distance

288

00:11:21,910 --> 00:11:19,200

of the size of the star from the center

289

00:11:25,910 --> 00:11:21,920

are equal to zero radially

290

00:11:27,670 --> 00:11:25,920

then the curve comes up and flattens out

291

00:11:28,870 --> 00:11:27,680

whereas you're touring gravity predicts

292

00:11:31,430 --> 00:11:28,880

that it

293

00:11:33,509 --> 00:11:31,440

should fall off okay and it's quite a

294

00:11:34,870 --> 00:11:33,519

six times

295

00:11:37,030 --> 00:11:34,880

the difference the difference between

296

00:11:38,790 --> 00:11:37,040

the touring gravity and this flat

297

00:11:40,870 --> 00:11:38,800

rotation curve experimentally

298

00:11:44,550 --> 00:11:40,880

observationally it's it's a factor of

299

00:11:46,710 --> 00:11:44,560

six and that's confined to a galaxy

300

00:11:48,069 --> 00:11:46,720

that's what happens in our galaxy

301  
00:11:49,509 --> 00:11:48,079  
and

302  
00:11:51,269 --> 00:11:49,519  
well the reason i'm saying that is

303  
00:11:53,670 --> 00:11:51,279  
because we're gravitationally pulled by

304  
00:11:55,190 --> 00:11:53,680  
some other galaxy so if that curve

305  
00:11:57,269 --> 00:11:55,200  
extended out

306  
00:11:59,350 --> 00:11:57,279  
extremely far then we should be spinning

307  
00:12:01,590 --> 00:11:59,360  
you get back to your toeing gravity you

308  
00:12:03,750 --> 00:12:01,600  
must do it go as you go out towards

309  
00:12:05,590 --> 00:12:03,760  
infinity

310  
00:12:07,190 --> 00:12:05,600  
so so it flattens out and then comes

311  
00:12:09,590 --> 00:12:07,200  
back down again

312  
00:12:11,350 --> 00:12:09,600  
so this intrigued me because

313  
00:12:13,590 --> 00:12:11,360

einstein gravity

314

00:12:16,710 --> 00:12:13,600

contains newtonian gravity and we

315

00:12:18,310 --> 00:12:16,720

effectively use newtonian gravity for

316

00:12:20,710 --> 00:12:18,320

galaxies because the gravitational field

317

00:12:22,829 --> 00:12:20,720

is weak

318

00:12:25,030 --> 00:12:22,839

all

319

00:12:27,750 --> 00:12:25,040

experiments um

320

00:12:30,150 --> 00:12:27,760

on gravity after weak gravitational

321

00:12:32,150 --> 00:12:30,160

fields the solar system

322

00:12:33,509 --> 00:12:32,160

is weak gravity

323

00:12:35,350 --> 00:12:33,519

except for

324

00:12:39,990 --> 00:12:35,360

neutron stars

325

00:12:42,389 --> 00:12:40,000

einstein newton doesn't work dark matter

326

00:12:44,310 --> 00:12:42,399

what is this so

327

00:12:46,470 --> 00:12:44,320

in the 70s

328

00:12:48,470 --> 00:12:46,480

that the first

329

00:12:50,710 --> 00:12:48,480

astronomer to

330

00:12:52,710 --> 00:12:50,720

to note this problem was

331

00:12:54,550 --> 00:12:52,720

she it's ricky

332

00:12:57,110 --> 00:12:54,560

in 1933

333

00:12:58,949 --> 00:12:57,120

swiss astronomer rather eccentric

334

00:13:01,590 --> 00:12:58,959

character he has his name on virtually

335

00:13:03,509 --> 00:13:01,600

every aspect of physics he

336

00:13:05,350 --> 00:13:03,519

did some calculations for

337

00:13:08,550 --> 00:13:05,360

what are called clusters these are

338

00:13:10,790 --> 00:13:08,560

clutters of galaxies not stars

339

00:13:12,949 --> 00:13:10,800

galaxies containing stars and these

340

00:13:15,509 --> 00:13:12,959

clusters are huge

341

00:13:17,269 --> 00:13:15,519

and uh he found that what's by what's

342

00:13:18,150 --> 00:13:17,279

called the variable theorem

343

00:13:20,629 --> 00:13:18,160

that they

344

00:13:23,269 --> 00:13:20,639

if you use newtonian gravity

345

00:13:24,710 --> 00:13:23,279

they can't be stable they have to

346

00:13:27,750 --> 00:13:24,720

blow apart

347

00:13:29,350 --> 00:13:27,760

gravity is not sufficiently strong to

348

00:13:30,389 --> 00:13:29,360

maintain

349

00:13:33,030 --> 00:13:30,399

uh

350

00:13:34,629 --> 00:13:33,040

equilibrium stability

351  
00:13:36,949 --> 00:13:34,639  
so he said well there's got to be extra

352  
00:13:40,230 --> 00:13:36,959  
better dark matter

353  
00:13:41,430 --> 00:13:40,240  
and that's it already 1933

354  
00:13:44,230 --> 00:13:41,440  
and so on

355  
00:13:46,629 --> 00:13:44,240  
but no one paid much attention to it

356  
00:13:48,949 --> 00:13:46,639  
but that because of vera ruben and the

357  
00:13:50,949 --> 00:13:48,959  
problem with the galaxies now things

358  
00:13:53,750 --> 00:13:50,959  
became serious

359  
00:13:55,110 --> 00:13:53,760  
and uh more and more attention was paid

360  
00:13:59,030 --> 00:13:55,120  
to

361  
00:14:01,030 --> 00:13:59,990  
it's

362  
00:14:02,870 --> 00:14:01,040  
to me

363  
00:14:04,310 --> 00:14:02,880

in my opinion one of the major problems

364

00:14:05,990 --> 00:14:04,320

of modern physics

365

00:14:09,430 --> 00:14:06,000

because due to the

366

00:14:13,110 --> 00:14:09,440

standard cosmology which i will get into

367

00:14:16,389 --> 00:14:13,120

the standard cosmological model

368

00:14:19,829 --> 00:14:16,399

dark matter plays an essential role 85

369

00:14:22,389 --> 00:14:19,839

86 percent of all matter

370

00:14:23,990 --> 00:14:22,399

is dark matter according to

371

00:14:26,949 --> 00:14:24,000

fitting the data

372

00:14:28,790 --> 00:14:26,959

cosmological data

373

00:14:30,870 --> 00:14:28,800

um

374

00:14:31,750 --> 00:14:30,880

so

375

00:14:35,189 --> 00:14:31,760

after

376

00:14:38,069 --> 00:14:35,199

decades of effort

377

00:14:40,629 --> 00:14:38,079

and large sums of money

378

00:14:42,790 --> 00:14:40,639

millions billions of dollars

379

00:14:44,310 --> 00:14:42,800

one experiment after another

380

00:14:45,829 --> 00:14:44,320

they've been looking for dark matter

381

00:14:47,829 --> 00:14:45,839

particles

382

00:14:50,310 --> 00:14:47,839

and no one can detect them no one has

383

00:14:53,350 --> 00:14:50,320

detected them

384

00:14:54,710 --> 00:14:53,360

so what does this mean

385

00:14:57,829 --> 00:14:54,720

um

386

00:14:59,590 --> 00:14:57,839

it i tend i'd call it potentially the

387

00:15:02,790 --> 00:14:59,600

modern ether

388

00:15:04,310 --> 00:15:02,800

because ether was accepted as being

389

00:15:05,829 --> 00:15:04,320

a fact

390

00:15:07,750 --> 00:15:05,839

at the end of the

391

00:15:09,990 --> 00:15:07,760

19th century

392

00:15:12,230 --> 00:15:10,000

beginning of the 20th century it was a

393

00:15:13,509 --> 00:15:12,240

fact because you had to have electronic

394

00:15:15,750 --> 00:15:13,519

waves

395

00:15:17,509 --> 00:15:15,760

move some through some medium

396

00:15:19,430 --> 00:15:17,519

like sound moves through

397

00:15:22,310 --> 00:15:19,440

air as a medium

398

00:15:23,910 --> 00:15:22,320

maximum believed in ether

399

00:15:25,590 --> 00:15:23,920

and

400

00:15:28,710 --> 00:15:25,600

so what does your modified theory of

401  
00:15:31,509 --> 00:15:28,720  
gravity say about dark matter so i

402  
00:15:33,110 --> 00:15:31,519  
decided to

403  
00:15:34,949 --> 00:15:33,120  
say that um

404  
00:15:38,949 --> 00:15:34,959  
that they like this mark of the

405  
00:15:42,389 --> 00:15:38,959  
anti-symmetric part of my gravity theory

406  
00:15:45,110 --> 00:15:42,399  
what's the part of gravity

407  
00:15:47,910 --> 00:15:45,120  
that modifies gravity

408  
00:15:49,590 --> 00:15:47,920  
without matter you see

409  
00:15:50,949 --> 00:15:49,600  
because the first modification of

410  
00:15:53,670 --> 00:15:50,959  
gravity

411  
00:15:57,030 --> 00:15:53,680  
a serious modification

412  
00:15:58,870 --> 00:15:57,040  
was isaac newton was uh albert einstein

413  
00:16:02,470 --> 00:15:58,880

who modified isaac newton's

414

00:16:05,910 --> 00:16:02,480

gravitational theory published in 18

415

00:16:07,189 --> 00:16:05,920

in 1687 in the pricipia

416

00:16:09,430 --> 00:16:07,199

and

417

00:16:11,030 --> 00:16:09,440

so i'm modifying einstein okay i mean

418

00:16:13,350 --> 00:16:11,040

that's

419

00:16:15,269 --> 00:16:13,360

einstein is failing

420

00:16:18,069 --> 00:16:15,279

newtonian and einstein crowd are failing

421

00:16:20,389 --> 00:16:18,870

describe this

422

00:16:26,310 --> 00:16:20,399

[Applause]

423

00:16:31,350 --> 00:16:28,069

but

424

00:16:34,790 --> 00:16:31,360

one is always agnostic in physics

425

00:16:38,230 --> 00:16:34,800

if you can find the dark matter

426  
00:16:40,470 --> 00:16:38,240  
next month these huge experiments

427  
00:16:42,470 --> 00:16:40,480  
that are still ongoing

428  
00:16:46,310 --> 00:16:42,480  
trying to detect what's called whims

429  
00:16:48,150 --> 00:16:46,320  
weakly interacting massive particles

430  
00:16:49,910 --> 00:16:48,160  
if they find that it fits in and they

431  
00:16:51,350 --> 00:16:49,920  
can explain the rotation curves of the

432  
00:16:54,310 --> 00:16:51,360  
galaxies

433  
00:16:56,230 --> 00:16:54,320  
then forget about modified gravity

434  
00:16:57,269 --> 00:16:56,240  
einstein's theory gravity is a beautiful

435  
00:16:58,310 --> 00:16:57,279  
theory

436  
00:16:59,749 --> 00:16:58,320  
it fits

437  
00:17:01,910 --> 00:16:59,759  
the data

438  
00:17:03,829 --> 00:17:01,920

and that's it

439

00:17:05,669 --> 00:17:03,839

but in my opinion they're not going to

440

00:17:07,750 --> 00:17:05,679

detect the dark matter

441

00:17:12,069 --> 00:17:07,760

because it doesn't exist

442

00:17:14,309 --> 00:17:13,270

so

443

00:17:16,829 --> 00:17:14,319

uh

444

00:17:20,309 --> 00:17:16,839

so i published papers

445

00:17:22,069 --> 00:17:20,319

uh doing this identifying this

446

00:17:23,750 --> 00:17:22,079

anti-symmetric

447

00:17:27,429 --> 00:17:23,760

part with

448

00:17:29,510 --> 00:17:27,439

as a new degree of freedom and gravity

449

00:17:31,430 --> 00:17:29,520

so that i could fit the galaxy rotation

450

00:17:36,070 --> 00:17:31,440

curves the flattening of the curves

451  
00:17:39,430 --> 00:17:36,080  
without dark matter and i did okay

452  
00:17:41,110 --> 00:17:39,440  
and i published a paper in 1995

453  
00:17:42,310 --> 00:17:41,120  
physics letters b

454  
00:17:45,110 --> 00:17:42,320  
doing this

455  
00:17:48,950 --> 00:17:47,190  
astronomers complain because

456  
00:17:50,710 --> 00:17:48,960  
non-symmetric gravity theory is

457  
00:17:52,870 --> 00:17:50,720  
complicated

458  
00:17:54,710 --> 00:17:52,880  
and they don't astronomers don't like

459  
00:17:56,310 --> 00:17:54,720  
this complication

460  
00:17:57,750 --> 00:17:56,320  
so i said all right i'll produce a

461  
00:18:01,350 --> 00:17:57,760  
simpler version

462  
00:18:03,190 --> 00:18:01,360  
so i produce what's called

463  
00:18:05,990 --> 00:18:03,200

mstg

464

00:18:07,669 --> 00:18:06,000

magic skew symmetry gravity than your

465

00:18:09,190 --> 00:18:07,679

previous version and so taking the

466

00:18:13,590 --> 00:18:09,200

previous version

467

00:18:17,669 --> 00:18:15,750

and when you say it's simpler

468

00:18:19,029 --> 00:18:17,679

well it's it's

469

00:18:20,310 --> 00:18:19,039

what are you sacrificing for the

470

00:18:22,630 --> 00:18:20,320

simplicity

471

00:18:25,110 --> 00:18:22,640

i'm sacrificing a lot of the

472

00:18:28,549 --> 00:18:25,120

mathematical mathematics

473

00:18:30,870 --> 00:18:28,559

i made it into a simpler version

474

00:18:34,549 --> 00:18:30,880

by means of uh throwing out a lot of the

475

00:18:35,430 --> 00:18:34,559

complicated non-linear mathematics okay

476

00:18:38,070 --> 00:18:35,440

so

477

00:18:39,350 --> 00:18:38,080

the way that i'm imagining it is like a

478

00:18:41,430 --> 00:18:39,360

taylor expansion you just take the

479

00:18:43,110 --> 00:18:41,440

linear part and just remove that exactly

480

00:18:44,630 --> 00:18:43,120

right okay

481

00:18:46,950 --> 00:18:44,640

so then

482

00:18:49,669 --> 00:18:46,960

i've published papers with this on top

483

00:18:51,350 --> 00:18:49,679

meta i simplified it again because this

484

00:18:52,789 --> 00:18:51,360

drawing book started with still

485

00:18:55,750 --> 00:18:52,799

completing it

486

00:18:57,909 --> 00:18:55,760

so i'll say okay i'll make it simpler

487

00:19:01,029 --> 00:18:57,919

so now we're down to scalar tensor

488

00:19:02,230 --> 00:19:01,039

vector gravity as tvg

489

00:19:04,310 --> 00:19:02,240

and uh

490

00:19:05,990 --> 00:19:04,320

this consisted of taking einstein's

491

00:19:08,070 --> 00:19:06,000

theory you've got to have einstein's

492

00:19:10,870 --> 00:19:08,080

theory as a base

493

00:19:12,230 --> 00:19:10,880

otherwise it's just not going to work

494

00:19:14,470 --> 00:19:12,240

when you say you have it as a base you

495

00:19:17,029 --> 00:19:14,480

mean you derive it in a limit like

496

00:19:19,110 --> 00:19:17,039

newton's driving exactly you have to do

497

00:19:20,549 --> 00:19:19,120

that einstein was

498

00:19:21,909 --> 00:19:20,559

confounded

499

00:19:25,029 --> 00:19:21,919

by the fact that he couldn't get

500

00:19:27,510 --> 00:19:25,039

newtonian gravity over a period of a

501  
00:19:29,669 --> 00:19:27,520  
year or two and he gave up at one point

502  
00:19:31,270 --> 00:19:29,679  
but then he went back in with with

503  
00:19:33,590 --> 00:19:31,280  
grossmont and

504  
00:19:35,270 --> 00:19:33,600  
and uh eventually they got around to

505  
00:19:38,950 --> 00:19:35,280  
getting what's called the poisson

506  
00:19:41,270 --> 00:19:38,960  
equation and utorine gravity has a limit

507  
00:19:42,789 --> 00:19:41,280  
natural limit of ice dichroid so i had

508  
00:19:43,750 --> 00:19:42,799  
to have this

509  
00:19:48,630 --> 00:19:43,760  
so

510  
00:19:51,029 --> 00:19:48,640  
theory where

511  
00:19:54,789 --> 00:19:51,039  
i need a stronger gravity

512  
00:19:57,510 --> 00:19:54,799  
so i made big g i call it big g

513  
00:20:00,390 --> 00:19:57,520

newton's constant  $i$  made it a variable

514

00:20:05,270 --> 00:20:00,400

constant interesting and

515

00:20:08,549 --> 00:20:05,280

following what paul directed in 1938

516

00:20:11,430 --> 00:20:08,559

proceeds are all society

517

00:20:13,350 --> 00:20:11,440

in nature about nature article you also

518

00:20:14,950 --> 00:20:13,360

have a variable speed of light is that

519

00:20:16,470 --> 00:20:14,960

tied to the variables that's another

520

00:20:18,549 --> 00:20:16,480

theory

521

00:20:21,830 --> 00:20:18,559

so um

522

00:20:23,510 --> 00:20:21,840

by the way the photon of gravity the

523

00:20:25,830 --> 00:20:23,520

quantum

524

00:20:28,549 --> 00:20:25,840

the photons he quotes

525

00:20:31,510 --> 00:20:28,559

is the graviton

526

00:20:33,430 --> 00:20:31,520

the graviton is is the

527

00:20:36,149 --> 00:20:33,440

quantum particle that

528

00:20:39,270 --> 00:20:36,159

is exchanged between

529

00:20:42,710 --> 00:20:39,280

particles meta particles and produces

530

00:20:45,510 --> 00:20:42,720

newtonian gravity or einstein gravity

531

00:20:47,669 --> 00:20:45,520

okay in electrodynamics

532

00:20:50,070 --> 00:20:47,679

maxwell's electrode is a relativistic

533

00:20:52,070 --> 00:20:50,080

inversion of masochera

534

00:20:55,029 --> 00:20:52,080

the photon is exchanged between

535

00:20:56,149 --> 00:20:55,039

electrons to produce the coulomb force

536

00:20:58,470 --> 00:20:56,159

okay

537

00:21:00,710 --> 00:20:58,480

so therefore graviton is a photon no

538

00:21:02,470 --> 00:21:00,720

one's ever detected a graviton and

539

00:21:05,990 --> 00:21:02,480

probably no one ever will

540

00:21:11,350 --> 00:21:08,149

he would take the whole galaxy as an

541

00:21:14,310 --> 00:21:11,360

accelerator to detect a graviton as

542

00:21:17,190 --> 00:21:14,320

freeman tyson said

543

00:21:18,870 --> 00:21:17,200

if you have a big enough mass

544

00:21:20,789 --> 00:21:18,880

to to uh

545

00:21:23,350 --> 00:21:20,799

detect the graviton that mass would

546

00:21:25,830 --> 00:21:23,360

collapse to apply

547

00:21:27,590 --> 00:21:25,840

anyway that's the theory okay the crappy

548

00:21:29,190 --> 00:21:27,600

time so

549

00:21:32,870 --> 00:21:29,200

so here i have

550

00:21:34,950 --> 00:21:32,880

the metric tensor field of einstein

551  
00:21:37,190 --> 00:21:34,960  
and then i have a new degree of frame

552  
00:21:42,870 --> 00:21:37,200  
the vector field

553  
00:21:45,750 --> 00:21:42,880  
spin one graviton or a symmetric tensor

554  
00:21:47,190 --> 00:21:45,760  
t u corresponds to a spent spin two

555  
00:21:49,270 --> 00:21:47,200  
graviton

556  
00:21:51,990 --> 00:21:49,280  
so i complete

557  
00:21:53,750 --> 00:21:52,000  
gravity with an extra graviton it's been

558  
00:21:56,630 --> 00:21:53,760  
one graviton

559  
00:21:58,390 --> 00:21:56,640  
and this vector fear is sourced by meta

560  
00:21:59,830 --> 00:21:58,400  
by mass

561  
00:22:02,950 --> 00:21:59,840  
okay

562  
00:22:05,830 --> 00:22:02,960  
so the electromagnetic potential

563  
00:22:07,270 --> 00:22:05,840

amu of maxwell's equations is sourced by

564

00:22:10,070 --> 00:22:07,280

electric charge

565

00:22:11,669 --> 00:22:10,080

my vector field is sourced by mass

566

00:22:13,029 --> 00:22:11,679

to slight

567

00:22:16,070 --> 00:22:13,039

einstein's

568

00:22:19,750 --> 00:22:16,080

metric theory field theories field is

569

00:22:22,789 --> 00:22:19,760

sourced by meta by density of matter

570

00:22:25,990 --> 00:22:22,799

so that's affected to the theory and

571

00:22:29,510 --> 00:22:26,000

i wrote it up and uh

572

00:22:31,990 --> 00:22:29,520

obviously in 2006

573

00:22:36,070 --> 00:22:33,669

eventually

574

00:22:39,590 --> 00:22:36,080

i started calling it mog modified

575

00:22:41,029 --> 00:22:39,600

clarity because it's

576  
00:22:42,310 --> 00:22:41,039  
moored at morikai

577  
00:22:44,070 --> 00:22:42,320  
milkrim

578  
00:22:47,909 --> 00:22:44,080  
in israel

579  
00:22:52,070 --> 00:22:47,919  
he was the first to publish a

580  
00:22:55,270 --> 00:22:52,080  
modification of newtonian gravity

581  
00:22:57,750 --> 00:22:55,280  
called mond modify newtonian dynamics

582  
00:22:58,950 --> 00:22:57,760  
right in 1983

583  
00:23:02,710 --> 00:22:58,960  
and he

584  
00:23:04,870 --> 00:23:02,720  
he's a pioneer i mean to do this because

585  
00:23:08,310 --> 00:23:04,880  
people were critical i mean you know

586  
00:23:10,149 --> 00:23:08,320  
modify einstein gravity

587  
00:23:11,669 --> 00:23:10,159  
so um

588  
00:23:14,789 --> 00:23:11,679

this is month

589

00:23:17,669 --> 00:23:14,799

but mine is a non-relativistic

590

00:23:19,029 --> 00:23:17,679

formula it's not relativistic it's just

591

00:23:22,149 --> 00:23:19,039

a modification it's a modification

592

00:23:27,029 --> 00:23:22,159

newtonian gravity and it's based on

593

00:23:33,270 --> 00:23:30,549

a sub zero a for acceleration

594

00:23:37,110 --> 00:23:33,280

and a zero a sub zero it makes it

595

00:23:38,549 --> 00:23:37,120

special with as rotation and this is a

596

00:23:41,750 --> 00:23:38,559

number list

597

00:23:44,789 --> 00:23:41,760

it's uh one point two times ten to the

598

00:23:46,870 --> 00:23:44,799

minus power tends to the power minus ten

599

00:23:49,350 --> 00:23:46,880

meters per second squared this is the

600

00:23:50,950 --> 00:23:49,360

unit of acceleration that's mind even if

601  
00:23:53,190 --> 00:23:50,960  
mont had correct predictions it would

602  
00:23:54,789 --> 00:23:53,200  
still be incomplete because how does it

603  
00:23:56,630 --> 00:23:54,799  
comport with the general relativity

604  
00:23:58,149 --> 00:23:56,640  
would be the open question

605  
00:24:00,549 --> 00:23:58,159  
because

606  
00:24:01,950 --> 00:24:00,559  
people attempted to

607  
00:24:05,110 --> 00:24:01,960  
generalize this

608  
00:24:07,110 --> 00:24:05,120  
non-relativistic phenological formula

609  
00:24:11,510 --> 00:24:07,120  
a simple formula by the way astronomers

610  
00:24:18,149 --> 00:24:13,990  
astronomers like the simple matter yeah

611  
00:24:21,510 --> 00:24:18,159  
so it's a high score level formula okay

612  
00:24:25,269 --> 00:24:23,190  
i don't want it's not a sense i mean my

613  
00:24:27,029 --> 00:24:25,279

sense of humor is

614

00:24:29,990 --> 00:24:27,039

but hey i've

615

00:24:35,190 --> 00:24:30,000

i call it marx you sort of mind them

616

00:24:40,789 --> 00:24:39,029

but uh this is silly but um

617

00:24:44,070 --> 00:24:40,799

mark it's it's important it's called

618

00:24:46,390 --> 00:24:44,080

mark because it's modified gravity

619

00:24:49,029 --> 00:24:46,400

right as opposed to modifying newtonian

620

00:24:51,029 --> 00:24:49,039

dynamics

621

00:24:53,510 --> 00:24:51,039

so you've got to have general route

622

00:24:55,269 --> 00:24:53,520

you've got to have general relativity

623

00:24:57,029 --> 00:24:55,279

okay so the big question everyone wants

624

00:24:58,470 --> 00:24:57,039

to know and the experimentalists who are

625

00:24:59,669 --> 00:24:58,480

watching this is do you make predictions

626  
00:25:01,430 --> 00:24:59,679  
that agree

627  
00:25:05,430 --> 00:25:01,440  
with the data okay

628  
00:25:08,470 --> 00:25:05,440  
so back to this three phases of physics

629  
00:25:11,909 --> 00:25:08,480  
have an idea guess it

630  
00:25:13,669 --> 00:25:11,919  
mathematical formulation http

631  
00:25:16,070 --> 00:25:13,679  
you publish it

632  
00:25:18,870 --> 00:25:16,080  
now comes what i call

633  
00:25:20,710 --> 00:25:18,880  
i call it physics his imagination in a

634  
00:25:22,630 --> 00:25:20,720  
straight jacket

635  
00:25:24,870 --> 00:25:22,640  
imagination the idea

636  
00:25:27,590 --> 00:25:24,880  
the straight jacket is experimental

637  
00:25:30,149 --> 00:25:27,600  
physics can you agree with experimental

638  
00:25:33,590 --> 00:25:30,159

physics can you predict something that

639

00:25:37,110 --> 00:25:33,600

the other people can't fit

640

00:25:39,269 --> 00:25:37,120

it's hard that's why physics is so hard

641

00:25:40,149 --> 00:25:39,279

because

642

00:25:44,390 --> 00:25:40,159

it

643

00:25:46,789 --> 00:25:44,400

when i paint uh i still paint

644

00:25:49,909 --> 00:25:46,799

um there's no criteria you have to match

645

00:25:51,269 --> 00:25:49,919

no i you i paint my i don't think

646

00:25:53,510 --> 00:25:51,279

it's all left

647

00:25:54,630 --> 00:25:53,520

it's all right brain more or less your

648

00:25:56,549 --> 00:25:54,640

feelings

649

00:25:57,909 --> 00:25:56,559

color composition

650

00:26:00,070 --> 00:25:57,919

so i finish

651

00:26:01,830 --> 00:26:00,080

put it up on the wall

652

00:26:03,350 --> 00:26:01,840

and you either like it or you don't like

653

00:26:05,110 --> 00:26:03,360

it you know i don't have to prove

654

00:26:06,390 --> 00:26:05,120

anything i don't have to prove the

655

00:26:07,750 --> 00:26:06,400

painting

656

00:26:09,430 --> 00:26:07,760

you see

657

00:26:12,149 --> 00:26:09,440

it's not physiological i don't want to

658

00:26:13,590 --> 00:26:12,159

prove it just if you don't like it well

659

00:26:15,430 --> 00:26:13,600

okay

660

00:26:16,390 --> 00:26:15,440

maybe you like this painting

661

00:26:20,070 --> 00:26:16,400

but

662

00:26:22,230 --> 00:26:20,080

in physics the test is to experiment

663

00:26:24,070 --> 00:26:22,240

and this is what makes physics so hard

664

00:26:25,750 --> 00:26:24,080

it's very challenging that's why i like

665

00:26:26,789 --> 00:26:25,760

it okay

666

00:26:29,750 --> 00:26:26,799

so

667

00:26:30,950 --> 00:26:29,760

uh okay moving forward

668

00:26:33,269 --> 00:26:30,960

um

669

00:26:35,750 --> 00:26:33,279

one paper after another

670

00:26:39,350 --> 00:26:35,760

i've been publishing papers now

671

00:26:41,750 --> 00:26:39,360

for 14 years htt stvg was published in

672

00:26:45,510 --> 00:26:41,760

2006.

673

00:26:50,070 --> 00:26:49,029

i published a pair long paper

674

00:26:52,630 --> 00:26:50,080

on

675

00:26:55,669 --> 00:26:52,640

mark black holes because i found a buy

676  
00:26:58,230 --> 00:26:55,679  
all solution okay

677  
00:26:59,590 --> 00:26:58,240  
and i call them marked black holes i

678  
00:27:00,789 --> 00:26:59,600  
call them

679  
00:27:04,870 --> 00:27:00,799  
schwarzschild

680  
00:27:07,830 --> 00:27:04,880  
mog fly holes or car multiply holder my

681  
00:27:09,430 --> 00:27:07,840  
former collaborator and friend

682  
00:27:11,190 --> 00:27:09,440  
from trinity

683  
00:27:14,310 --> 00:27:11,200  
and uh

684  
00:27:16,710 --> 00:27:14,320  
there's been a lot of i've lost track

685  
00:27:18,710 --> 00:27:16,720  
how many papers are published on more

686  
00:27:20,630 --> 00:27:18,720  
play halls oh okay great because one of

687  
00:27:22,789 --> 00:27:20,640  
my questions was what's the reception

688  
00:27:25,430 --> 00:27:22,799

like from the physics community

689

00:27:28,149 --> 00:27:25,440

i i've there must be i don't know i'm

690

00:27:30,470 --> 00:27:28,159

guessing 50 60 papers

691

00:27:34,549 --> 00:27:30,480

that's a lot of citations

692

00:27:40,870 --> 00:27:37,750

i'm up to something like 6000 seven

693

00:27:43,750 --> 00:27:40,880

thousand citations holy moly yeah

694

00:27:46,070 --> 00:27:43,760

there's something called research gate

695

00:27:48,230 --> 00:27:46,080

which is a portal

696

00:27:50,710 --> 00:27:48,240

he was right on that so i'm up to

697

00:27:53,029 --> 00:27:50,720

something like eleven thousand uh

698

00:27:53,990 --> 00:27:53,039

readerships holy moly

699

00:27:55,029 --> 00:27:54,000

yeah

700

00:27:58,149 --> 00:27:55,039

so

701  
00:28:01,029 --> 00:27:58,159  
a lot of people know me from my physics

702  
00:28:05,990 --> 00:28:03,269  
this paper i just sent you just from

703  
00:28:08,149 --> 00:28:06,000  
chinese from china published yesterday

704  
00:28:10,389 --> 00:28:08,159  
it's owned on the archive it'll be

705  
00:28:12,389 --> 00:28:10,399  
published eventually it's a very

706  
00:28:16,310 --> 00:28:12,399  
very good paper

707  
00:28:18,310 --> 00:28:16,320  
because i published in my big paper on

708  
00:28:20,870 --> 00:28:18,320  
mark black halls

709  
00:28:21,990 --> 00:28:20,880  
published the european physical journal

710  
00:28:25,510 --> 00:28:22,000  
c

711  
00:28:26,190 --> 00:28:25,520  
and this is a major european journal

712  
00:28:27,750 --> 00:28:26,200  
in

713  
00:28:31,350 --> 00:28:27,760

2016

714

00:28:32,310 --> 00:28:31,360  
and subsequent papers

715

00:28:40,549 --> 00:28:32,320  
i

716

00:28:43,269 --> 00:28:40,559  
for an object

717

00:28:45,510 --> 00:28:43,279  
which may not have horizons

718

00:28:48,389 --> 00:28:45,520  
and it's regular it does not have any

719

00:28:51,190 --> 00:28:48,399  
singularity at the center

720

00:28:52,870 --> 00:28:51,200  
it's completely regular

721

00:28:55,190 --> 00:28:52,880  
interesting

722

00:28:57,029 --> 00:28:55,200  
but it's close to having a horizon

723

00:28:59,029 --> 00:28:57,039  
because there's a critical

724

00:29:02,470 --> 00:28:59,039  
in in the development there's a free

725

00:29:06,389 --> 00:29:04,789  
in the mathematics of the

726

00:29:10,070 --> 00:29:06,399

the metric

727

00:29:13,029 --> 00:29:10,080

describing my marked black hole

728

00:29:14,470 --> 00:29:13,039

and this offers a deviation parameter it

729

00:29:16,549 --> 00:29:14,480

deviates

730

00:29:17,830 --> 00:29:16,559

the theory from einstein

731

00:29:21,590 --> 00:29:17,840

black holes

732

00:29:22,710 --> 00:29:21,600

the size of alpha when alpha zero

733

00:29:25,510 --> 00:29:22,720

you get

734

00:29:28,230 --> 00:29:25,520

einstein by holes

735

00:29:31,750 --> 00:29:28,240

when half is not zero you don't okay

736

00:29:35,269 --> 00:29:33,990

black hole with a horizon

737

00:29:37,909 --> 00:29:35,279

actually

738

00:29:40,710 --> 00:29:37,919

my solution mock player always has two

739

00:29:42,870 --> 00:29:40,720

horizons

740

00:29:43,990 --> 00:29:42,880

and the parameters are just mass and

741

00:29:47,750 --> 00:29:44,000

spin

742

00:29:51,909 --> 00:29:47,760

and alpha three parameters that's it

743

00:29:56,149 --> 00:29:54,389

i published a

744

00:29:58,710 --> 00:29:56,159

no charge

745

00:30:00,070 --> 00:29:58,720

mass spin and alpha

746

00:30:02,630 --> 00:30:00,080

no charge

747

00:30:04,230 --> 00:30:02,640

no electric char by the way blind host

748

00:30:05,830 --> 00:30:04,240

astrophysical bodies do not have

749

00:30:09,590 --> 00:30:05,840

electric charge

750

00:30:12,230 --> 00:30:09,600

the electrical neutral because

751

00:30:13,669 --> 00:30:12,240

you have positive charge

752

00:30:16,149 --> 00:30:13,679

electrons and

753

00:30:18,230 --> 00:30:16,159

you have positive and negative charge

754

00:30:20,630 --> 00:30:18,240

clumps of charge right

755

00:30:23,430 --> 00:30:20,640

and they neutralize one another i mean

756

00:30:25,669 --> 00:30:23,440

this is this is electrically neutral all

757

00:30:27,510 --> 00:30:25,679

astrophysical borders are bodies are

758

00:30:29,990 --> 00:30:27,520

electrically neutral the sun is

759

00:30:33,110 --> 00:30:30,000

electrically neutral there may be a tiny

760

00:30:33,909 --> 00:30:33,120

amount of charge but it's negligible so

761

00:30:36,710 --> 00:30:33,919

has

762

00:30:38,470 --> 00:30:36,720

very little of any effect on the

763

00:30:40,470 --> 00:30:38,480

on space-time

764

00:30:43,029 --> 00:30:40,480

metric

765

00:30:45,590 --> 00:30:43,039

through max-einstein equations

766

00:30:46,870 --> 00:30:45,600

okay this is for astrophysics so black

767

00:30:48,470 --> 00:30:46,880

holes

768

00:30:51,029 --> 00:30:48,480

should be electrically neutral papers

769

00:30:54,310 --> 00:30:51,039

are published showing this is the case

770

00:30:59,029 --> 00:30:55,750

so

771

00:31:00,630 --> 00:30:59,039

they discharge their charge

772

00:31:03,190 --> 00:31:00,640

so

773

00:31:05,990 --> 00:31:03,200

this theory is just mass

774

00:31:09,110 --> 00:31:06,000

but mass is positive it doesn't have a

775

00:31:10,230 --> 00:31:09,120

negative counterpart there's no negative

776  
00:31:11,990 --> 00:31:10,240  
mass

777  
00:31:13,830 --> 00:31:12,000  
so there's no electric so-called

778  
00:31:16,149 --> 00:31:13,840  
equivalent of a dipole

779  
00:31:19,029 --> 00:31:16,159  
there's no mass dipole okay because you

780  
00:31:21,510 --> 00:31:19,039  
can't have a positive negative mass

781  
00:31:22,870 --> 00:31:21,520  
at two poles

782  
00:31:25,510 --> 00:31:22,880  
so um

783  
00:31:27,110 --> 00:31:25,520  
anyway so

784  
00:31:28,710 --> 00:31:27,120  
by the way if someone is interested and

785  
00:31:30,549 --> 00:31:28,720  
they have a pension for mathematics as

786  
00:31:32,070 --> 00:31:30,559  
well as physics and they want to learn

787  
00:31:33,990 --> 00:31:32,080  
about your theory do they just read the

788  
00:31:35,669 --> 00:31:34,000

papers or do you have a book that you

789

00:31:37,350 --> 00:31:35,679

published much like there are books that

790

00:31:39,430 --> 00:31:37,360

introduce someone to general relativity

791

00:31:42,549 --> 00:31:39,440

from nothing no i haven't actually

792

00:31:47,029 --> 00:31:44,549

a text book on this

793

00:31:50,070 --> 00:31:47,039

i'm too busy working out the theory

794

00:31:52,870 --> 00:31:50,080

probably i i do these but this i just

795

00:31:54,630 --> 00:31:52,880

dictate them but doing a textbook is

796

00:31:55,830 --> 00:31:54,640

much more complicated

797

00:31:57,430 --> 00:31:55,840

because you have to deal with all the

798

00:32:00,549 --> 00:31:57,440

equations and this

799

00:32:01,350 --> 00:32:00,559

but eventually i hope to get a review

800

00:32:04,470 --> 00:32:01,360

but

801  
00:32:05,669 --> 00:32:04,480  
there was a review published by

802  
00:32:07,909 --> 00:32:05,679  
um

803  
00:32:09,110 --> 00:32:07,919  
daniela perez

804  
00:32:11,430 --> 00:32:09,120  
and

805  
00:32:13,750 --> 00:32:11,440  
gustaf romero

806  
00:32:15,830 --> 00:32:13,760  
there at the institute for physics in

807  
00:32:17,590 --> 00:32:15,840  
argentina

808  
00:32:22,149 --> 00:32:17,600  
and

809  
00:32:27,110 --> 00:32:25,430  
big review of what is my mod in a book

810  
00:32:29,029 --> 00:32:27,120  
what do you think of current theories of

811  
00:32:30,549 --> 00:32:29,039  
everything are they missing some key

812  
00:32:32,389 --> 00:32:30,559  
ingredient are they missing that they're

813  
00:32:35,590 --> 00:32:32,399

trying to unify gr as it is and they're

814

00:32:37,990 --> 00:32:35,600

not unifying mog or is there something

815

00:32:40,549 --> 00:32:38,000

else that you feel like they're lacking

816

00:32:43,110 --> 00:32:40,559

okay well there's a long history to this

817

00:32:46,549 --> 00:32:43,120

we just talked about unified theory

818

00:32:48,070 --> 00:32:46,559

way back harman weil and albert einstein

819

00:32:50,389 --> 00:32:48,080

1918

820

00:32:51,509 --> 00:32:50,399

but um

821

00:32:53,269 --> 00:32:51,519

um

822

00:32:55,750 --> 00:32:53,279

yeah it's it's

823

00:32:57,750 --> 00:32:55,760

i don't i think there's loop there's m

824

00:32:59,590 --> 00:32:57,760

theory i'm happy with this

825

00:33:00,870 --> 00:32:59,600

this um

826

00:33:03,830 --> 00:33:00,880

toe

827

00:33:05,110 --> 00:33:03,840

the uh acronym tone yeah because

828

00:33:06,549 --> 00:33:05,120

what does it mean to have a theory of

829

00:33:10,630 --> 00:33:06,559

everything i mean

830

00:33:14,549 --> 00:33:10,640

university

831

00:33:15,590 --> 00:33:14,559

biochemistry chemistry consciousness

832

00:33:17,509 --> 00:33:15,600

i don't know

833

00:33:19,350 --> 00:33:17,519

what does it mean to have a theory every

834

00:33:21,029 --> 00:33:19,360

i don't understand what that means so

835

00:33:24,230 --> 00:33:21,039

you much prefer grand unified theory

836

00:33:26,549 --> 00:33:24,240

than told that's quran unified theory of

837

00:33:28,470 --> 00:33:26,559

grand unified theory

838

00:33:30,389 --> 00:33:28,480

somehow

839

00:33:31,669 --> 00:33:30,399

tied in with

840

00:33:33,110 --> 00:33:31,679

gravity

841

00:33:35,430 --> 00:33:33,120

have you had a chance to look at the

842

00:33:38,870 --> 00:33:35,440

eric weinstein video that i sent you

843

00:33:40,950 --> 00:33:38,880

yeah i didn't understand it

844

00:33:42,549 --> 00:33:40,960

you have to ask him about that what

845

00:33:46,549 --> 00:33:42,559

about stephen wolfram have you heard of

846

00:33:52,070 --> 00:33:48,950

i appreciate that they

847

00:33:53,909 --> 00:33:52,080

they both made a lot of money

848

00:33:56,149 --> 00:33:53,919

apparently

849

00:33:57,509 --> 00:33:56,159

eric einstein is

850

00:34:01,590 --> 00:33:57,519

manager of a

851

00:34:03,190 --> 00:34:01,600

ph fund net electron fund in new york

852

00:34:09,109 --> 00:34:03,200

so

853

00:34:11,909 --> 00:34:09,119

he has has fun with it

854

00:34:11,919 --> 00:34:14,149

but

855

00:34:18,950 --> 00:34:17,349

these theories have not been successful

856

00:34:20,790 --> 00:34:18,960

quantum gravity let's talk about that

857

00:34:22,869 --> 00:34:20,800

for a minute i thought because i

858

00:34:24,310 --> 00:34:22,879

published papers in corn and crevice

859

00:34:25,430 --> 00:34:24,320

i tried to publish in all of these

860

00:34:27,589 --> 00:34:25,440

things

861

00:34:28,550 --> 00:34:27,599

and so several papers actually over the

862

00:34:30,069 --> 00:34:28,560

years

863

00:34:31,510 --> 00:34:30,079

quite quite well

864

00:34:34,149 --> 00:34:31,520

cited actually

865

00:34:36,389 --> 00:34:34,159

i published one paper in 2000 called

866

00:34:38,389 --> 00:34:36,399

non-commutative content gravity which

867

00:34:40,869 --> 00:34:38,399

has many citations

868

00:34:43,510 --> 00:34:40,879

so you have the coordinates of space

869

00:34:46,389 --> 00:34:43,520

time not commuting by

870

00:34:47,750 --> 00:34:46,399

momentum and precision between quantum

871

00:34:49,190 --> 00:34:47,760

mechanics

872

00:34:51,589 --> 00:34:49,200

non-communicative

873

00:34:55,190 --> 00:34:51,599

non-commutative gravity yeah moffitt

874

00:34:59,589 --> 00:34:55,200

okay the problem with point of gravity

875

00:35:05,910 --> 00:35:02,710

okay let me repeat that there are no

876

00:35:08,710 --> 00:35:05,920

quantum gravity data

877

00:35:10,950 --> 00:35:08,720

and you can't do physics without data

878

00:35:12,390 --> 00:35:10,960

that is my main criticism

879

00:35:14,550 --> 00:35:12,400

there may be

880

00:35:16,630 --> 00:35:14,560

i mean i'm not saying there won't be

881

00:35:19,430 --> 00:35:16,640

perhaps of

882

00:35:20,630 --> 00:35:19,440

august 2020

883

00:35:22,710 --> 00:35:20,640

there are no

884

00:35:25,109 --> 00:35:22,720

let's put it this way

885

00:35:27,109 --> 00:35:25,119

the quantum field theory

886

00:35:30,630 --> 00:35:27,119

the feynman graphs

887

00:35:31,990 --> 00:35:30,640

describe what's going on relativistic

888

00:35:35,109 --> 00:35:32,000

cornfield theory

889

00:35:38,390 --> 00:35:35,119

so you have what's called tree graphs

890

00:35:39,270 --> 00:35:38,400

these are trees okay so you have a line

891

00:35:42,790 --> 00:35:39,280

here

892

00:35:44,710 --> 00:35:42,800

electrons and they

893

00:35:46,069 --> 00:35:44,720

interchange the photon which is a

894

00:35:48,470 --> 00:35:46,079

quickly line

895

00:35:50,710 --> 00:35:48,480

and it's just trees

896

00:35:52,390 --> 00:35:50,720

but that's classical

897

00:35:55,750 --> 00:35:52,400

electromagnetism is classical

898

00:35:58,390 --> 00:35:55,760

electrodynamics tree graphs

899

00:36:00,150 --> 00:35:58,400

so the quantum comes in with what's

900

00:36:03,109 --> 00:36:00,160

called loose

901  
00:36:06,069 --> 00:36:03,119  
so now you begin to take the lines and

902  
00:36:07,750 --> 00:36:06,079  
make them into loops close in on loops

903  
00:36:09,910 --> 00:36:07,760  
okay

904  
00:36:13,109 --> 00:36:09,920  
and these loops are the quantum

905  
00:36:14,630 --> 00:36:13,119  
corrections to the classical tree grass

906  
00:36:20,310 --> 00:36:14,640  
okay

907  
00:36:23,190 --> 00:36:21,670  
you have a

908  
00:36:28,310 --> 00:36:23,200  
neutron

909  
00:36:30,470 --> 00:36:28,320  
and they have mass

910  
00:36:32,630 --> 00:36:30,480  
so the mass

911  
00:36:34,310 --> 00:36:32,640  
uh causes the graviton to be

912  
00:36:35,750 --> 00:36:34,320  
interchanged

913  
00:36:40,310 --> 00:36:35,760

between the two

914

00:36:42,390 --> 00:36:40,320

massive electrons or protons whatever

915

00:36:44,870 --> 00:36:42,400

and

916

00:36:47,829 --> 00:36:44,880

that's classical yeah i can then derive

917

00:36:49,510 --> 00:36:47,839

from that tree graph

918

00:36:51,750 --> 00:36:49,520

or graviton and

919

00:36:53,750 --> 00:36:51,760

two protons

920

00:36:57,910 --> 00:36:53,760

i can derive

921

00:37:00,150 --> 00:36:57,920

law of gravity one over square law

922

00:37:03,190 --> 00:37:00,160

dealing with getting general activities

923

00:37:08,069 --> 00:37:04,950

and

924

00:37:09,990 --> 00:37:08,079

the loops quantum gravity comes in when

925

00:37:11,910 --> 00:37:10,000

i form these loops

926  
00:37:14,870 --> 00:37:11,920  
which are proportional to planck's

927  
00:37:16,310 --> 00:37:14,880  
constant now now place constant comes in

928  
00:37:18,790 --> 00:37:16,320  
to the game

929  
00:37:21,030 --> 00:37:18,800  
and these are called self-energy loops

930  
00:37:23,750 --> 00:37:21,040  
so yeah they look graphs

931  
00:37:26,630 --> 00:37:23,760  
and there's no experiment

932  
00:37:28,470 --> 00:37:26,640  
that can determine these loop graphs

933  
00:37:30,150 --> 00:37:28,480  
none

934  
00:37:31,349 --> 00:37:30,160  
this is where the quantum gravity comes

935  
00:37:33,349 --> 00:37:31,359  
in

936  
00:37:36,470 --> 00:37:33,359  
so

937  
00:37:38,550 --> 00:37:36,480  
you construct a theory of gravity uh

938  
00:37:39,349 --> 00:37:38,560

quantum gravity you know there are lots

939

00:37:43,750 --> 00:37:39,359

of

940

00:37:48,870 --> 00:37:46,950

take space time and make it into

941

00:37:51,670 --> 00:37:48,880

little pieces of atomic

942

00:37:52,630 --> 00:37:51,680

pieces lattices

943

00:37:54,310 --> 00:37:52,640

and

944

00:37:56,550 --> 00:37:54,320

you then try to

945

00:37:58,390 --> 00:37:56,560

get general relativity coming up

946

00:38:01,270 --> 00:37:58,400

emerging out of this

947

00:38:03,190 --> 00:38:01,280

spin that work and all that

948

00:38:05,030 --> 00:38:03,200

there's a

949

00:38:07,589 --> 00:38:05,040

string theory

950

00:38:10,550 --> 00:38:07,599

where you have these strings

951  
00:38:12,470 --> 00:38:10,560  
like uh violin strings

952  
00:38:14,230 --> 00:38:12,480  
and one of the strings is i spent two

953  
00:38:15,589 --> 00:38:14,240  
graviton

954  
00:38:16,470 --> 00:38:15,599  
so i did

955  
00:38:18,550 --> 00:38:16,480  
these

956  
00:38:20,870 --> 00:38:18,560  
strings fascinate

957  
00:38:22,390 --> 00:38:20,880  
and they're strings they're not points

958  
00:38:24,230 --> 00:38:22,400  
in space-time

959  
00:38:25,829 --> 00:38:24,240  
so your issue is that they're theorizing

960  
00:38:27,670 --> 00:38:25,839  
with no constraints because there's not

961  
00:38:29,829 --> 00:38:27,680  
much data yeah so

962  
00:38:32,230 --> 00:38:29,839  
strings there has to be formulated in 10

963  
00:38:34,470 --> 00:38:32,240

dimensions or 11 otherwise it's not

964

00:38:37,829 --> 00:38:34,480

self-consistent

965

00:38:39,589 --> 00:38:37,839

and uh you have to have supersymmetry

966

00:38:41,829 --> 00:38:39,599

superpersonity has to come in otherwise

967

00:38:43,190 --> 00:38:41,839

it's not self-consistent physically

968

00:38:44,470 --> 00:38:43,200

speaking what's the difference between

969

00:38:45,670 --> 00:38:44,480

being self-consistent and being

970

00:38:48,310 --> 00:38:45,680

consistent

971

00:38:49,829 --> 00:38:48,320

well for example you need

972

00:38:52,150 --> 00:38:49,839

more dimensions

973

00:38:54,790 --> 00:38:52,160

and strength theory otherwise the

974

00:38:57,109 --> 00:38:54,800

lorentz algebra doesn't close it's not

975

00:39:00,150 --> 00:38:57,119

lawrence invarian

976  
00:39:03,109 --> 00:39:00,160  
um it's because the string is a a

977  
00:39:04,230 --> 00:39:03,119  
surface it's not a point

978  
00:39:06,790 --> 00:39:04,240  
and

979  
00:39:07,670 --> 00:39:06,800  
so then i worked in string theory i once

980  
00:39:10,069 --> 00:39:07,680  
gave a

981  
00:39:12,069 --> 00:39:10,079  
course of summer lectures

982  
00:39:14,870 --> 00:39:12,079  
at the university of western ontario in

983  
00:39:15,990 --> 00:39:14,880  
london but for students and i published

984  
00:39:18,310 --> 00:39:16,000  
it actually

985  
00:39:20,150 --> 00:39:18,320  
and that turned me off straight theory

986  
00:39:22,630 --> 00:39:20,160  
in fact

987  
00:39:25,190 --> 00:39:22,640  
the claim is the string theory is finite

988  
00:39:28,230 --> 00:39:25,200

to all orders of perturbation theory so

989

00:39:30,310 --> 00:39:28,240

you take my three grams and my loops you

990

00:39:32,710 --> 00:39:30,320

do what's called perturbation theory the

991

00:39:34,790 --> 00:39:32,720

loops have perturbations on the string

992

00:39:36,790 --> 00:39:34,800

on the tree graphs

993

00:39:38,790 --> 00:39:36,800

and the strength theory these loops are

994

00:39:39,910 --> 00:39:38,800

supposed to be finite

995

00:39:43,349 --> 00:39:39,920

whereas in

996

00:39:45,190 --> 00:39:43,359

standard quantum electronics are quite

997

00:39:47,190 --> 00:39:45,200

difficult they

998

00:39:49,589 --> 00:39:47,200

they lead to divergences so you have to

999

00:39:51,750 --> 00:39:49,599

re-normalize the loops

1000

00:39:53,829 --> 00:39:51,760

you know you have to take one

1001  
00:39:59,910 --> 00:39:53,839  
infinity and subtract it from another to

1002  
00:40:05,349 --> 00:40:02,870  
so these to gravities by the way gravity

1003  
00:40:07,750 --> 00:40:05,359  
is not only normalizable

1004  
00:40:09,510 --> 00:40:07,760  
this was proved by tuft

1005  
00:40:10,630 --> 00:40:09,520  
and development

1006  
00:40:12,390 --> 00:40:10,640  
and others

1007  
00:40:14,870 --> 00:40:12,400  
in the 70s

1008  
00:40:17,109 --> 00:40:14,880  
and this was a big problem

1009  
00:40:18,230 --> 00:40:17,119  
and so it doesn't behave like

1010  
00:40:19,270 --> 00:40:18,240  
other

1011  
00:40:20,790 --> 00:40:19,280  
standard

1012  
00:40:22,550 --> 00:40:20,800  
quantum field theories and particle

1013  
00:40:24,470 --> 00:40:22,560

physics

1014

00:40:27,750 --> 00:40:24,480

and so it's not running on my

1015

00:40:29,109 --> 00:40:27,760

divergences you can't get rid of them

1016

00:40:29,990 --> 00:40:29,119

so

1017

00:40:31,430 --> 00:40:30,000

um

1018

00:40:32,870 --> 00:40:31,440

this is what loop current gravity's

1019

00:40:34,230 --> 00:40:32,880

supposed to deal with

1020

00:40:36,790 --> 00:40:34,240

and string theory is supposed to be

1021

00:40:38,310 --> 00:40:36,800

finite but i discovered that i wasn't

1022

00:40:39,750 --> 00:40:38,320

convinced that the string theory is

1023

00:40:41,589 --> 00:40:39,760

finite

1024

00:40:43,589 --> 00:40:41,599

i'm not there was never any rigorous

1025

00:40:44,950 --> 00:40:43,599

proof the street theory is finite still

1026

00:40:48,310 --> 00:40:44,960

it's mistake yeah

1027

00:40:51,430 --> 00:40:48,320

and so let's get to the phase three

1028

00:40:52,390 --> 00:40:51,440

what about testing these theories

1029

00:40:55,349 --> 00:40:52,400

well

1030

00:40:57,510 --> 00:40:55,359

strength is was a theory of everything's

1031

00:40:59,349 --> 00:40:57,520

supposedly a toe okay that's where the

1032

00:41:03,510 --> 00:40:59,359

acronym came from

1033

00:41:09,430 --> 00:41:06,870

it would written and so forth

1034

00:41:12,230 --> 00:41:09,440

and the 80s claim that this is the

1035

00:41:16,069 --> 00:41:12,240

the theory okay of everything

1036

00:41:16,079 --> 00:41:19,349

so

1037

00:41:22,950 --> 00:41:21,349

well

1038

00:41:24,069 --> 00:41:22,960

no one's ever detected a higher

1039

00:41:33,670 --> 00:41:24,079

dimension

1040

00:41:35,030 --> 00:41:33,680

just space-time clocks versus rights

1041

00:41:36,630 --> 00:41:35,040

and uh

1042

00:41:38,069 --> 00:41:36,640

okay so we've never seen our

1043

00:41:38,870 --> 00:41:38,079

identification

1044

00:41:40,630 --> 00:41:38,880

the

1045

00:41:41,510 --> 00:41:40,640

large hadron collider has looked for

1046

00:41:44,230 --> 00:41:41,520

them

1047

00:41:46,230 --> 00:41:44,240

for years and not find nothing

1048

00:41:49,190 --> 00:41:46,240

no experimental data

1049

00:41:51,670 --> 00:41:49,200

okay supersymmetry we need supersymmetry

1050

00:41:53,670 --> 00:41:51,680

to make the fermion sector our string

1051  
00:41:55,190 --> 00:41:53,680  
theory consistent

1052  
00:41:57,430 --> 00:41:55,200  
there are reasons why i'm saying

1053  
00:41:58,630 --> 00:41:57,440  
consistent but let's go on

1054  
00:42:02,230 --> 00:41:58,640  
um

1055  
00:42:05,990 --> 00:42:02,240  
so they've tested

1056  
00:42:09,190 --> 00:42:06,000  
for super symmetry for years let's see

1057  
00:42:10,550 --> 00:42:09,200  
we know super 70 doesn't exist

1058  
00:42:14,069 --> 00:42:10,560  
up to about

1059  
00:42:18,150 --> 00:42:14,079  
three tv three or four tv

1060  
00:42:21,030 --> 00:42:18,160  
and so it's got to exist below

1061  
00:42:23,510 --> 00:42:21,040  
one tv to really

1062  
00:42:25,670 --> 00:42:23,520  
solve a lot of supersymmetric problems

1063  
00:42:28,870 --> 00:42:25,680

so that's all gone okay

1064

00:42:33,349 --> 00:42:28,880

there's no evidence for supersymmetry

1065

00:42:37,990 --> 00:42:33,359

so the large hadron collider is at 14 tv

1066

00:42:41,030 --> 00:42:38,000

uh well it's been working at 13 14 13 ta

1067

00:42:43,750 --> 00:42:41,040

and they hope to get it up to 14 tv with

1068

00:42:45,589 --> 00:42:43,760

i'm even beyond that

1069

00:42:47,190 --> 00:42:45,599

but you know it's a supersymmetric

1070

00:42:49,910 --> 00:42:47,200

particles keep getting heavier and

1071

00:42:52,309 --> 00:42:49,920

heavier and we can't detect them

1072

00:42:53,990 --> 00:42:52,319

so that's gone so what's left of string

1073

00:42:56,069 --> 00:42:54,000

theory okay

1074

00:42:57,430 --> 00:42:56,079

there's no experimental test of string

1075

00:42:59,589 --> 00:42:57,440

theory

1076

00:43:01,990 --> 00:42:59,599

that you could say well

1077

00:43:05,109 --> 00:43:02,000

this experiment's done

1078

00:43:06,870 --> 00:43:05,119

and it passes this test and no other

1079

00:43:07,750 --> 00:43:06,880

theory

1080

00:43:09,829 --> 00:43:07,760

no

1081

00:43:11,349 --> 00:43:09,839

theory without supersymmetry can fit

1082

00:43:13,190 --> 00:43:11,359

that data

1083

00:43:14,630 --> 00:43:13,200

doesn't exist

1084

00:43:16,710 --> 00:43:14,640

you modified gravity have you worked on

1085

00:43:19,190 --> 00:43:16,720

modifying qft

1086

00:43:19,990 --> 00:43:19,200

okay so another

1087

00:43:21,910 --> 00:43:20,000

i

1088

00:43:22,950 --> 00:43:21,920

understand the model

1089

00:43:25,510 --> 00:43:22,960

what i

1090

00:43:27,349 --> 00:43:25,520

why i formula alternatives it's not

1091

00:43:29,990 --> 00:43:27,359

because i'm trying to be a difficult

1092

00:43:31,589 --> 00:43:30,000

person i'm just curious about

1093

00:43:33,190 --> 00:43:31,599

how

1094

00:43:35,109 --> 00:43:33,200

um

1095

00:43:36,790 --> 00:43:35,119

stable how

1096

00:43:38,630 --> 00:43:36,800

true

1097

00:43:40,950 --> 00:43:38,640

the so-called standard model is how

1098

00:43:42,470 --> 00:43:40,960

robust is it

1099

00:43:44,390 --> 00:43:42,480

so that's why i

1100

00:43:45,430 --> 00:43:44,400

and also i'm

1101  
00:43:47,670 --> 00:43:45,440  
mentally

1102  
00:43:49,829 --> 00:43:47,680  
somewhat lazy i i can't just sit and

1103  
00:43:52,230 --> 00:43:49,839  
read someone's textbook

1104  
00:43:53,030 --> 00:43:52,240  
so in order to learn a theory

1105  
00:43:54,950 --> 00:43:53,040  
i

1106  
00:43:57,270 --> 00:43:54,960  
produce another theory

1107  
00:43:59,910 --> 00:43:57,280  
and through this i can't produce another

1108  
00:44:02,309 --> 00:43:59,920  
theory unless i really understand the

1109  
00:44:04,950 --> 00:44:02,319  
so-called standard model theory and that

1110  
00:44:06,470 --> 00:44:04,960  
makes me forces me to understand it so

1111  
00:44:08,550 --> 00:44:06,480  
this is a strange mental way of

1112  
00:44:11,109 --> 00:44:08,560  
proceeding but that's that's why that's

1113  
00:44:12,790 --> 00:44:11,119

why all these alternatives come out

1114

00:44:16,950 --> 00:44:12,800

because i went trying to understand the

1115

00:44:20,630 --> 00:44:16,960

standard model by producing another one

1116

00:44:22,790 --> 00:44:20,640

and uh so the other moral is also strong

1117

00:44:26,550 --> 00:44:22,800

strong man woman so to speak you know i

1118

00:44:27,430 --> 00:44:26,560

can knock it down or make it look true

1119

00:44:29,109 --> 00:44:27,440

so

1120

00:44:31,190 --> 00:44:29,119

the way that i analogize it is that it

1121

00:44:32,309 --> 00:44:31,200

would be if as if someone can't watch

1122

00:44:35,990 --> 00:44:32,319

movies

1123

00:44:37,270 --> 00:44:36,000

like let me make my own movie and then i

1124

00:44:38,790 --> 00:44:37,280

gotta watch this movie and understand

1125

00:44:40,710 --> 00:44:38,800

how this director made it in order for

1126  
00:44:42,710 --> 00:44:40,720  
me to make mine and that's my actual

1127  
00:44:43,829 --> 00:44:42,720  
goal is to understand this director yes

1128  
00:44:45,109 --> 00:44:43,839  
that's right

1129  
00:44:45,990 --> 00:44:45,119  
exactly

1130  
00:44:54,309 --> 00:44:46,000  
so

1131  
00:44:55,990 --> 00:44:54,319  
i got

1132  
00:44:57,750 --> 00:44:56,000  
interested in the fact of the

1133  
00:45:00,390 --> 00:44:57,760  
normalization theory

1134  
00:45:02,950 --> 00:45:00,400  
so i mean i published papers on

1135  
00:45:05,510 --> 00:45:02,960  
on particle physics from the

1136  
00:45:07,190 --> 00:45:05,520  
after doing my phd

1137  
00:45:09,430 --> 00:45:07,200  
so i've been doing this for years i have

1138  
00:45:12,230 --> 00:45:09,440

phd students working on just on particle

1139

00:45:15,030 --> 00:45:12,240

physics quark physics and everything

1140

00:45:17,190 --> 00:45:15,040

lots of i had 38 graduate students by

1141

00:45:19,430 --> 00:45:17,200

the way who did phds

1142

00:45:20,230 --> 00:45:19,440

that's quite a lot

1143

00:45:26,870 --> 00:45:20,240

so

1144

00:45:29,990 --> 00:45:26,880

can you develop

1145

00:45:33,670 --> 00:45:30,000

a theory which is ultra out of

1146

00:45:35,109 --> 00:45:33,680

ultraviolet complete uv complete

1147

00:45:37,190 --> 00:45:35,119

in other words

1148

00:45:39,829 --> 00:45:37,200

in standard core and filter these loops

1149

00:45:41,510 --> 00:45:39,839

i was talking about

1150

00:45:44,870 --> 00:45:41,520

they have divergences they're called

1151  
00:45:46,710 --> 00:45:44,880  
ultra to violet ultraviolet divergences

1152  
00:45:48,870 --> 00:45:46,720  
and they have to be cancelled using

1153  
00:45:50,470 --> 00:45:48,880  
renormalization theory

1154  
00:45:52,550 --> 00:45:50,480  
so you do what's called charge and

1155  
00:45:55,109 --> 00:45:52,560  
mastery normalization

1156  
00:46:01,510 --> 00:45:57,829  
iraq never liked renormalization theory

1157  
00:46:03,990 --> 00:46:01,520  
he thought it was it was unsatisfactory

1158  
00:46:06,150 --> 00:46:04,000  
it's rather artificial

1159  
00:46:07,990 --> 00:46:06,160  
you take one set of infinities and it

1160  
00:46:09,510 --> 00:46:08,000  
subtracts it from another

1161  
00:46:11,670 --> 00:46:09,520  
you know why do you have these

1162  
00:46:12,950 --> 00:46:11,680  
infinities in the first place

1163  
00:46:15,270 --> 00:46:12,960

the firing

1164

00:46:17,670 --> 00:46:15,280

feynman and that in the 80s he was

1165

00:46:20,069 --> 00:46:17,680

interviewed he said he

1166

00:46:22,230 --> 00:46:20,079

he wasn't satisfied with normalization

1167

00:46:23,829 --> 00:46:22,240

theory even though he was one of the

1168

00:46:26,390 --> 00:46:23,839

inventors

1169

00:46:27,990 --> 00:46:26,400

with his uh nobel prize in coronary

1170

00:46:29,109 --> 00:46:28,000

arteries

1171

00:46:30,230 --> 00:46:29,119

and

1172

00:46:31,990 --> 00:46:30,240

so i

1173

00:46:32,950 --> 00:46:32,000

constructed a different quantum field

1174

00:46:36,309 --> 00:46:32,960

theory

1175

00:46:38,630 --> 00:46:36,319

and i use what's so instead of having

1176

00:46:40,470 --> 00:46:38,640

in in these graphs

1177

00:46:43,270 --> 00:46:40,480

you have

1178

00:46:46,069 --> 00:46:43,280

two graphs two lines

1179

00:46:49,109 --> 00:46:46,079

or three lines meeting at a point

1180

00:46:51,349 --> 00:46:49,119

it's called a vertex okay and that's

1181

00:46:53,349 --> 00:46:51,359

that's where these three particles

1182

00:46:55,750 --> 00:46:53,359

interact at the point

1183

00:46:59,430 --> 00:46:55,760

so in local corner field theory

1184

00:47:04,950 --> 00:47:01,109

and this point is

1185

00:47:07,829 --> 00:47:04,960

effectively described by delta function

1186

00:47:11,349 --> 00:47:07,839

that are invented by dirac by the way

1187

00:47:13,670 --> 00:47:11,359

we didn't like renormalization

1188

00:47:14,550 --> 00:47:13,680

and i as feyman already understood in

1189

00:47:18,550 --> 00:47:14,560

his

1190

00:47:19,510 --> 00:47:18,560

papers from 1947 1950

1191

00:47:21,750 --> 00:47:19,520

uh

1192

00:47:23,829 --> 00:47:21,760

this already there you already have a

1193

00:47:26,870 --> 00:47:23,839

problem as soon as you introduce the

1194

00:47:30,069 --> 00:47:26,880

delta function and the point

1195

00:47:32,230 --> 00:47:30,079

uh for the vitamin graphs

1196

00:47:33,510 --> 00:47:32,240

you get you get subversions

1197

00:47:34,710 --> 00:47:33,520

immediately

1198

00:47:36,470 --> 00:47:34,720

so

1199

00:47:38,550 --> 00:47:36,480

celtic function in mathematics is what's

1200

00:47:40,550 --> 00:47:38,560

called a distribution you know you get

1201  
00:47:43,270 --> 00:47:40,560  
into distribution theory

1202  
00:47:44,950 --> 00:47:43,280  
so i thought well

1203  
00:47:47,750 --> 00:47:44,960  
i'm going to give a different

1204  
00:47:49,990 --> 00:47:47,760  
distribution at a point so i use what's

1205  
00:47:52,550 --> 00:47:50,000  
called an entire function

1206  
00:47:53,510 --> 00:47:52,560  
in time functional mathematics entire

1207  
00:47:57,349 --> 00:47:53,520  
function

1208  
00:47:59,190 --> 00:47:57,359  
distribution has an infinite number of

1209  
00:48:00,950 --> 00:47:59,200  
derivatives

1210  
00:48:05,190 --> 00:48:00,960  
uh it has

1211  
00:48:07,030 --> 00:48:05,200  
in the complex momentum squared plane

1212  
00:48:08,550 --> 00:48:07,040  
it's different there are no waves there

1213  
00:48:10,470 --> 00:48:08,560

are no poles

1214

00:48:13,670 --> 00:48:10,480

but there's a sensual singularity of

1215

00:48:15,910 --> 00:48:13,680

infinity that's the only singularity

1216

00:48:19,349 --> 00:48:15,920

so it's an infinite taylor series of

1217

00:48:22,630 --> 00:48:19,359

terrific taylor series of derivatives so

1218

00:48:25,990 --> 00:48:22,640

it's infinite derivative theory okay

1219

00:48:28,390 --> 00:48:26,000

and so i it becomes non-local

1220

00:48:31,109 --> 00:48:28,400

the operators become non-local

1221

00:48:33,910 --> 00:48:31,119

so i have a non-local field theory

1222

00:48:35,829 --> 00:48:33,920

but i stress that i've published this

1223

00:48:39,030 --> 00:48:35,839

that i proved that even though the

1224

00:48:41,349 --> 00:48:39,040

operator fields over here is non-local

1225

00:48:43,270 --> 00:48:41,359

the theory does not violate micro

1226  
00:48:50,630 --> 00:48:43,280  
causality

1227  
00:48:51,430 --> 00:48:50,640  
of um

1228  
00:48:56,870 --> 00:48:51,440  
two

1229  
00:48:59,990 --> 00:48:56,880  
and it's supposed to vanish with space

1230  
00:49:02,069 --> 00:49:00,000  
like separation outside the light column

1231  
00:49:02,790 --> 00:49:02,079  
and i proved that this is even though

1232  
00:49:05,270 --> 00:49:02,800  
the

1233  
00:49:07,670 --> 00:49:05,280  
field operators are non-local

1234  
00:49:10,069 --> 00:49:07,680  
they still have these vanishing

1235  
00:49:12,710 --> 00:49:10,079  
communities outside they like cone so

1236  
00:49:14,150 --> 00:49:12,720  
the theory is local is local even though

1237  
00:49:17,030 --> 00:49:14,160  
it's

1238  
00:49:19,030 --> 00:49:17,040

called non-local

1239

00:49:20,950 --> 00:49:19,040

the actual result in the end is local

1240

00:49:23,910 --> 00:49:20,960

that's interesting so

1241

00:49:26,630 --> 00:49:23,920

i published a paper in 1989 physical

1242

00:49:28,470 --> 00:49:26,640

review long paper

1243

00:49:30,230 --> 00:49:28,480

doing this

1244

00:49:33,190 --> 00:49:30,240

and uh what's the reception from it

1245

00:49:35,829 --> 00:49:33,200

proved that it was finite to all others

1246

00:49:37,750 --> 00:49:35,839

it was unique true to all orders

1247

00:49:39,910 --> 00:49:37,760

and what's the reception been like okay

1248

00:49:42,829 --> 00:49:39,920

so richard wooden

1249

00:49:44,309 --> 00:49:42,839

uh i got to know him he's professor

1250

00:49:45,589 --> 00:49:44,319

university of

1251  
00:49:47,270 --> 00:49:45,599  
florida

1252  
00:49:50,390 --> 00:49:47,280  
at gainesville

1253  
00:49:51,910 --> 00:49:50,400  
uh this was 1990. so he came up to

1254  
00:49:54,470 --> 00:49:51,920  
toronto

1255  
00:49:55,910 --> 00:49:54,480  
to give some lectures i invited him up

1256  
00:49:58,549 --> 00:49:55,920  
he said what are you doing i said

1257  
00:50:00,870 --> 00:49:58,559  
non-local field theory what

1258  
00:50:02,710 --> 00:50:00,880  
he said well that can't work

1259  
00:50:05,589 --> 00:50:02,720  
i said well

1260  
00:50:06,710 --> 00:50:05,599  
i'm publishing this paper so

1261  
00:50:08,230 --> 00:50:06,720  
so uh

1262  
00:50:09,910 --> 00:50:08,240  
six weeks later

1263  
00:50:14,230 --> 00:50:09,920

in comes

1264

00:50:17,670 --> 00:50:16,470

saying i've had epiphany

1265

00:50:19,030 --> 00:50:17,680

epiphany

1266

00:50:21,990 --> 00:50:19,040

i think this is

1267

00:50:24,790 --> 00:50:22,000

really interesting let's collaborate so

1268

00:50:27,109 --> 00:50:24,800

we collaborated with uh myself

1269

00:50:27,829 --> 00:50:27,119

and his student

1270

00:50:30,549 --> 00:50:27,839

and

1271

00:50:32,790 --> 00:50:30,559

my student my postdoc

1272

00:50:36,309 --> 00:50:32,800

and

1273

00:50:38,549 --> 00:50:36,319

review

1274

00:50:40,950 --> 00:50:38,559

where we did coin related dynamics from

1275

00:50:42,710 --> 00:50:40,960

start to finish

1276

00:50:43,910 --> 00:50:42,720

everything

1277

00:50:46,069 --> 00:50:43,920

and

1278

00:50:50,069 --> 00:50:46,079

proved that the theory is unitary to all

1279

00:50:52,829 --> 00:50:50,079

these s matrix its units of orders

1280

00:50:56,710 --> 00:50:52,839

all the perturbation loops of finite

1281

00:50:59,030 --> 00:50:56,720

orders and the tree crafts work and

1282

00:51:03,030 --> 00:50:59,040

so we really want to turn on this so

1283

00:51:04,309 --> 00:51:03,040

that papers had many citations okay

1284

00:51:05,430 --> 00:51:04,319

right

1285

00:51:08,150 --> 00:51:05,440

so

1286

00:51:10,069 --> 00:51:08,160

people are publishing piano

1287

00:51:11,829 --> 00:51:10,079

just the other day with paper came

1288

00:51:14,390 --> 00:51:11,839

either coming out

1289

00:51:16,710 --> 00:51:14,400

exciting my papers

1290

00:51:18,790 --> 00:51:16,720

on not look i've had hundreds of

1291

00:51:20,870 --> 00:51:18,800

citations on this

1292

00:51:24,710 --> 00:51:20,880

so um

1293

00:51:26,470 --> 00:51:24,720

i got back into this recently

1294

00:51:27,910 --> 00:51:26,480

because i switched i thought i'd be

1295

00:51:29,829 --> 00:51:27,920

being done enough

1296

00:51:32,230 --> 00:51:29,839

black holes and gravity let's do some

1297

00:51:33,910 --> 00:51:32,240

particle physics for a change

1298

00:51:37,030 --> 00:51:33,920

so i

1299

00:51:39,829 --> 00:51:37,040

looked back into the standard model

1300

00:51:42,390 --> 00:51:39,839

and his particle has been discovered the

1301  
00:51:44,390 --> 00:51:42,400  
discovery of the higgs particle is this

1302  
00:51:45,589 --> 00:51:44,400  
the narrative for those in my

1303  
00:51:47,030 --> 00:51:45,599  
pocket

1304  
00:51:48,790 --> 00:51:47,040  
cracking the particle court of the

1305  
00:51:50,630 --> 00:51:48,800  
universe

1306  
00:51:53,270 --> 00:51:50,640  
oxford university press

1307  
00:51:57,109 --> 00:51:55,270  
collins harper collins this is that's

1308  
00:51:57,829 --> 00:51:57,119  
romantic yeah yeah

1309  
00:51:59,750 --> 00:51:57,839  
so

1310  
00:52:02,470 --> 00:51:59,760  
um

1311  
00:52:04,710 --> 00:52:02,480  
so they're the steiner model

1312  
00:52:07,589 --> 00:52:04,720  
so what you do is you have

1313  
00:52:09,670 --> 00:52:07,599

the strong nuclear force is called

1314

00:52:11,510 --> 00:52:09,680

quantum chromodynamics

1315

00:52:12,950 --> 00:52:11,520

and you have quarks

1316

00:52:14,630 --> 00:52:12,960

all the quarks

1317

00:52:16,950 --> 00:52:14,640

and they the

1318

00:52:18,549 --> 00:52:16,960

the photon in this case the quantum is

1319

00:52:20,150 --> 00:52:18,559

the gluon

1320

00:52:22,150 --> 00:52:20,160

and the clone is colored and when you

1321

00:52:22,870 --> 00:52:22,160

say quote photon in quotations you mean

1322

00:52:24,069 --> 00:52:22,880

the

1323

00:52:26,470 --> 00:52:24,079

particle that

1324

00:52:28,069 --> 00:52:26,480

mediates the force it's the medium of

1325

00:52:34,950 --> 00:52:28,079

the force

1326  
00:52:36,630 --> 00:52:34,960  
and then you have uh

1327  
00:52:39,910 --> 00:52:36,640  
electromagnetism

1328  
00:52:43,270 --> 00:52:39,920  
electrodynamics what is called

1329  
00:52:45,589 --> 00:52:43,280  
and you have uh electro weak

1330  
00:52:47,430 --> 00:52:45,599  
and these are put together or put

1331  
00:52:49,990 --> 00:52:47,440  
together by

1332  
00:52:53,190 --> 00:52:50,000  
uh glashow and

1333  
00:52:57,910 --> 00:52:54,710  
basically

1334  
00:53:01,349 --> 00:52:57,920  
as su 3 consists you two cause you one

1335  
00:53:04,230 --> 00:53:01,359  
issue three is the color nuclear force

1336  
00:53:06,309 --> 00:53:04,240  
strong force group

1337  
00:53:09,829 --> 00:53:06,319  
uh2 is the um

1338  
00:53:11,589 --> 00:53:09,839

hu2 cross u1 is the electromagnetic weak

1339

00:53:13,750 --> 00:53:11,599

and the u1 is the

1340

00:53:16,549 --> 00:53:13,760

electromagnetism so these are the three

1341

00:53:18,309 --> 00:53:16,559

forces of niche protocol and this it's

1342

00:53:19,750 --> 00:53:18,319

called simple group

1343

00:53:21,670 --> 00:53:19,760

and

1344

00:53:24,230 --> 00:53:21,680

why is it an issue sequence issued to

1345

00:53:25,829 --> 00:53:24,240

review one

1346

00:53:32,790 --> 00:53:25,839

so

1347

00:53:35,510 --> 00:53:32,800

in order to get a renormalizable theory

1348

00:53:38,309 --> 00:53:35,520

we use a delta function for the tree to

1349

00:53:41,670 --> 00:53:38,319

craft firemen graphs at the point local

1350

00:53:46,309 --> 00:53:44,230

you um

1351  
00:53:48,870 --> 00:53:46,319  
you need a gauge theory the three has to

1352  
00:53:51,030 --> 00:53:48,880  
be gauging variant

1353  
00:53:53,670 --> 00:53:51,040  
and corner electronics is gazing variant

1354  
00:53:56,470 --> 00:53:53,680  
because the photon is massless

1355  
00:54:00,390 --> 00:53:56,480  
so massive series are cajun grain and

1356  
00:54:03,349 --> 00:54:00,400  
changing theories are very normalizable

1357  
00:54:07,510 --> 00:54:04,790  
now the

1358  
00:54:09,910 --> 00:54:07,520  
quantum chromodynamics hu3 the gluons

1359  
00:54:11,030 --> 00:54:09,920  
are massless hooray we have a cage

1360  
00:54:12,549 --> 00:54:11,040  
theory

1361  
00:54:15,750 --> 00:54:12,559  
all right and it's it's really

1362  
00:54:17,829 --> 00:54:15,760  
normalizable it's called qcd

1363  
00:54:19,349 --> 00:54:17,839

quantum chromodynamics

1364

00:54:21,270 --> 00:54:19,359

what about the

1365

00:54:22,470 --> 00:54:21,280

the weak force so there's always been a

1366

00:54:24,870 --> 00:54:22,480

problem

1367

00:54:27,190 --> 00:54:24,880

so the weak force with these forces are

1368

00:54:29,030 --> 00:54:27,200

described by fields are described by

1369

00:54:30,710 --> 00:54:29,040

yangno's theory

1370

00:54:33,190 --> 00:54:30,720

a young male says what's called name

1371

00:54:35,510 --> 00:54:33,200

mathematics or non-abelian gay theory

1372

00:54:36,710 --> 00:54:35,520

it's gage theory

1373

00:54:38,790 --> 00:54:36,720

the

1374

00:54:40,790 --> 00:54:38,800

particle mediating particles are

1375

00:54:41,990 --> 00:54:40,800

meshless

1376  
00:54:44,630 --> 00:54:42,000  
okay so

1377  
00:54:47,270 --> 00:54:44,640  
for a long time

1378  
00:54:49,990 --> 00:54:47,280  
the the problem was that

1379  
00:54:51,349 --> 00:54:50,000  
that like the electro weak is not

1380  
00:54:53,990 --> 00:54:51,359  
matchless

1381  
00:54:56,309 --> 00:54:54,000  
because the mediating particles are that

1382  
00:54:58,549 --> 00:54:56,319  
the z of the z

1383  
00:55:01,190 --> 00:54:58,559  
posing on and the w botons there are

1384  
00:55:04,549 --> 00:55:01,200  
three of them two w charge and one

1385  
00:55:07,190 --> 00:55:04,559  
neutral that's it they're not messless

1386  
00:55:10,069 --> 00:55:07,200  
in fact earth fake masses

1387  
00:55:13,109 --> 00:55:10,079  
and the fermions are not messless

1388  
00:55:14,710 --> 00:55:13,119

the electrons and quartz

1389

00:55:19,670 --> 00:55:14,720

the top cork

1390

00:55:23,109 --> 00:55:21,829

compared to the electron which has a

1391

00:55:24,710 --> 00:55:23,119

mass of a half

1392

00:55:25,670 --> 00:55:24,720

$\mu$ e

1393

00:55:26,790 --> 00:55:25,680

so

1394

00:55:28,790 --> 00:55:26,800

uh

1395

00:55:31,349 --> 00:55:28,800

okay so

1396

00:55:33,270 --> 00:55:31,359

sg2 creation one on one is not engaging

1397

00:55:36,549 --> 00:55:33,280

very

1398

00:55:39,430 --> 00:55:36,559

so it can't be renormalized

1399

00:55:41,270 --> 00:55:39,440

you can prove this

1400

00:55:44,230 --> 00:55:41,280

what to do

1401

00:55:47,190 --> 00:55:44,240

this took a long time

1402

00:55:50,870 --> 00:55:49,910

the scalar field was invented the higgs

1403

00:55:52,870 --> 00:55:50,880

field

1404

00:55:55,349 --> 00:55:52,880

which had some quantum numbers of the

1405

00:55:55,359 --> 00:55:58,069

so

1406

00:56:02,390 --> 00:56:00,230

what they had to do was to say

1407

00:56:06,470 --> 00:56:02,400

that the electro weak starts with zero

1408

00:56:09,589 --> 00:56:06,480

mass so we put all the masses to zero

1409

00:56:14,390 --> 00:56:09,599

that w the z and the photons

1410

00:56:19,829 --> 00:56:16,789

okay well you know

1411

00:56:22,230 --> 00:56:19,839

173 tv is put to zero okay

1412

00:56:25,190 --> 00:56:22,240

and the

1413

00:56:27,430 --> 00:56:25,200

so yeah w mouse is that match

1414

00:56:28,630 --> 00:56:27,440

was 90 gb or so

1415

00:56:31,349 --> 00:56:28,640

zero

1416

00:56:33,349 --> 00:56:31,359

okay well everything is fine

1417

00:56:35,030 --> 00:56:33,359

so then what they said was that the

1418

00:56:37,829 --> 00:56:35,040

higgs field

1419

00:56:38,630 --> 00:56:37,839

it's a so-called x mechanism

1420

00:56:42,870 --> 00:56:38,640

um

1421

00:56:44,309 --> 00:56:42,880

breaks  $su_2$  cross  $u_1$  turned to  $u_1$  so you

1422

00:56:45,910 --> 00:56:44,319

break the electro weak turn to the

1423

00:56:49,109 --> 00:56:45,920

electromagnetic

1424

00:56:51,030 --> 00:56:49,119

and during this process

1425

00:56:55,270 --> 00:56:51,040

um

1426

00:57:00,549 --> 00:56:57,670

magic okay

1427

00:57:05,270 --> 00:57:03,349

great now that's usually normalizable so

1428

00:57:06,870 --> 00:57:05,280

this hex field has what's called a

1429

00:57:13,589 --> 00:57:06,880

potential

1430

00:57:16,309 --> 00:57:13,599

and it's equal to

1431

00:57:19,030 --> 00:57:16,319

$v$  of  $\phi$  equals  $\lambda \phi$  to the fourth

1432

00:57:20,390 --> 00:57:19,040

or five to four fourth power of the

1433

00:57:23,349 --> 00:57:20,400

scalar

1434

00:57:29,430 --> 00:57:25,430

assume that

1435

00:57:31,750 --> 00:57:29,440

what's called higgs

1436

00:57:33,990 --> 00:57:31,760

mechanism it's the

1437

00:57:35,030 --> 00:57:34,000

breaking of the hex symmetry  $sg_2$  cross

1438

00:57:36,390 --> 00:57:35,040

u1

1439

00:57:38,309 --> 00:57:36,400

okay

1440

00:57:39,750 --> 00:57:38,319

which is supposed to produce the masses

1441

00:57:41,589 --> 00:57:39,760

you keep drawing this because the

1442

00:57:43,510 --> 00:57:41,599

mexican hat or this is referring to

1443

00:57:45,670 --> 00:57:43,520

something else that's right

1444

00:57:48,549 --> 00:57:45,680

so

1445

00:57:52,630 --> 00:57:50,549

this is all done at the classical level

1446

00:57:56,470 --> 00:57:52,640

the higgs mechanism

1447

00:57:57,670 --> 00:57:56,480

not the quantum level it's classical

1448

00:58:00,069 --> 00:57:57,680

but then there's something called the

1449

00:58:02,549 --> 00:58:00,079

yukawa

1450

00:58:03,589 --> 00:58:02,559

lagrangian they look look you call the

1451  
00:58:05,829 --> 00:58:03,599  
chryson

1452  
00:58:08,870 --> 00:58:05,839  
where you have coupling of

1453  
00:58:11,510 --> 00:58:08,880  
massive particles with the hex field

1454  
00:58:13,270 --> 00:58:11,520  
you multiply them together

1455  
00:58:15,270 --> 00:58:13,280  
to interact

1456  
00:58:17,589 --> 00:58:15,280  
and

1457  
00:58:20,150 --> 00:58:17,599  
for example the electron field

1458  
00:58:22,789 --> 00:58:20,160  
multiplies the spinner electron direct

1459  
00:58:25,750 --> 00:58:22,799  
field multiplies the high scalar field

1460  
00:58:26,870 --> 00:58:25,760  
stuff and they have a coupling constant

1461  
00:58:31,270 --> 00:58:26,880  
g

1462  
00:58:34,470 --> 00:58:31,280  
so

1463  
00:58:35,829 --> 00:58:34,480

where did the masses come from

1464

00:58:37,670 --> 00:58:35,839

well

1465

00:58:40,309 --> 00:58:37,680

it turns out that the

1466

00:58:43,030 --> 00:58:40,319

cemetery breaking can sort of produce

1467

00:58:44,309 --> 00:58:43,040

the tubby in the z-mass you can get a

1468

00:58:47,190 --> 00:58:44,319

prediction

1469

00:58:50,309 --> 00:58:47,200

for the w in the z-mass which looks

1470

00:58:52,870 --> 00:58:50,319

looks reasonably good

1471

00:58:54,150 --> 00:58:52,880

but the fermion masses all the quarks

1472

00:59:10,390 --> 00:58:54,160

and

1473

00:59:13,030 --> 00:59:10,400

so you endeavor

1474

00:59:15,910 --> 00:59:13,040

calculate the matters

1475

00:59:17,430 --> 00:59:15,920

it's put in by hand as a free parameter

1476

00:59:18,710 --> 00:59:17,440

that's why the standard world has

1477

00:59:21,670 --> 00:59:18,720

something like

1478

00:59:25,109 --> 00:59:21,680

21 or 26 free parameters depending on

1479

00:59:26,309 --> 00:59:25,119

how you count it's lots of parameters

1480

00:59:28,069 --> 00:59:26,319

so

1481

00:59:30,710 --> 00:59:28,079

i looked at this and i thought okay well

1482

00:59:32,470 --> 00:59:30,720

let me do my finite quantum field theory

1483

00:59:35,190 --> 00:59:32,480

as i call it

1484

00:59:36,470 --> 00:59:35,200

and it works whether you have masses or

1485

00:59:40,230 --> 00:59:36,480

not

1486

00:59:42,630 --> 00:59:40,240

renormalization but it's a finite

1487

00:59:44,630 --> 00:59:42,640

granular there are no infinities

1488

00:59:46,549 --> 00:59:44,640

so i don't have to worry about putting

1489

00:59:49,270 --> 00:59:46,559

the master to zero

1490

00:59:51,349 --> 00:59:49,280

so i rewrote the standard model

1491

00:59:54,309 --> 00:59:51,359

assuming that the masses are not zero

1492

00:59:57,030 --> 00:59:54,319

that the symmetry is what it is

1493

00:59:58,630 --> 00:59:57,040

uh  $s_u^3 = s_u^2 \times s_u^1$

1494

01:00:00,390 --> 00:59:58,640

it's not broken

1495

01:00:01,990 --> 01:00:00,400

actually two cause you want it's not

1496

01:00:04,549 --> 01:00:02,000

broken and when you came up with this

1497

01:00:06,470 --> 01:00:04,559

this was before the higgs was discovered

1498

01:00:09,510 --> 01:00:06,480

yeah well i did that i was doing this

1499

01:00:12,390 --> 01:00:09,520

before the higgs but then when

1500

01:00:16,950 --> 01:00:12,400

the higgs was found i had to put this in

1501

01:00:19,349 --> 01:00:16,960

as a particle field which i did

1502

01:00:20,230 --> 01:00:19,359

and by the way you need the hex field

1503

01:00:23,190 --> 01:00:20,240

still

1504

01:00:24,630 --> 01:00:23,200

i don't need it for renormalization

1505

01:00:29,990 --> 01:00:24,640

and

1506

01:00:31,910 --> 01:00:30,000

masses okay but you do need it because

1507

01:00:33,190 --> 01:00:31,920

without the higgs

1508

01:00:36,710 --> 01:00:33,200

exchange

1509

01:00:40,630 --> 01:00:37,910

corks

1510

01:00:42,470 --> 01:00:40,640

you violate what's called unitarity at a

1511

01:00:45,430 --> 01:00:42,480

participation level

1512

01:00:50,950 --> 01:00:48,390

600 tv this is bad

1513

01:00:54,069 --> 01:00:50,960

so then when you put in the higgs field

1514

01:00:56,390 --> 01:00:54,079

and to redo the calculation it cancels

1515

01:00:58,069 --> 01:00:56,400

all the unitary violations

1516

01:01:00,309 --> 01:00:58,079

so this means you get unity you have to

1517

01:01:01,990 --> 01:01:00,319

have unit turrent probability has to be

1518

01:01:04,710 --> 01:01:02,000

conserved

1519

01:01:06,309 --> 01:01:04,720

so you still need the x okay so i redid

1520

01:01:08,870 --> 01:01:06,319

the whole thing

1521

01:01:11,349 --> 01:01:08,880

and made everything finite work did all

1522

01:01:13,589 --> 01:01:11,359

the calculations prove that i get all

1523

01:01:15,670 --> 01:01:13,599

the low energy experiments of the hatred

1524

01:01:17,430 --> 01:01:15,680

collider

1525

01:01:18,309 --> 01:01:17,440

and um

1526

01:01:21,670 --> 01:01:18,319

and

1527

01:01:27,589 --> 01:01:24,630

how do i calculate the masses

1528

01:01:29,510 --> 01:01:27,599

no one's ever been able to do it

1529

01:01:31,990 --> 01:01:29,520

the feminine masses

1530

01:01:34,150 --> 01:01:32,000

so i work on this occasionally and i

1531

01:01:36,069 --> 01:01:34,160

have a way of doing it so stephen

1532

01:01:38,549 --> 01:01:36,079

weinberg who

1533

01:01:40,630 --> 01:01:38,559

won a nobel price

1534

01:01:41,829 --> 01:01:40,640

for

1535

01:01:43,670 --> 01:01:41,839

the uh

1536

01:01:45,030 --> 01:01:43,680

initiating this idea of the higgs

1537

01:01:46,710 --> 01:01:45,040

mechanism

1538

01:01:48,950 --> 01:01:46,720

and putting all masses to zero for

1539

01:01:51,510 --> 01:01:48,960

leptons it's called the lepton model

1540

01:01:56,309 --> 01:01:54,630

he has recently published a paper

1541

01:01:57,829 --> 01:01:56,319

trying to solve the problem of the

1542

01:01:58,870 --> 01:01:57,839

masses

1543

01:02:01,270 --> 01:01:58,880

and

1544

01:02:05,190 --> 01:02:01,280

stephen i was very clever by the way

1545

01:02:06,950 --> 01:02:05,200

still why yes he's about my age

1546

01:02:07,990 --> 01:02:06,960

and uh

1547

01:02:13,990 --> 01:02:08,000

he's

1548

01:02:16,390 --> 01:02:14,000

so but he failed to do it

1549

01:02:19,030 --> 01:02:16,400

by his own admission yeah was he using

1550

01:02:21,270 --> 01:02:19,040

your modified quantum field theory no he

1551  
01:02:22,069 --> 01:02:21,280  
just doing the standard

1552  
01:02:24,549 --> 01:02:22,079  
so

1553  
01:02:26,710 --> 01:02:24,559  
another criticism is

1554  
01:02:28,470 --> 01:02:26,720  
there's no experimental

1555  
01:02:31,510 --> 01:02:28,480  
data that shows

1556  
01:02:33,750 --> 01:02:31,520  
that this pig's potential is  $\lambda$

1557  
01:02:37,109 --> 01:02:33,760  
which the company constant  $\lambda$  times

1558  
01:02:39,829 --> 01:02:37,119  
 $\phi$  to the fourth because in order to

1559  
01:02:40,789 --> 01:02:39,839  
to do the experimental verification you

1560  
01:02:41,990 --> 01:02:40,799  
need

1561  
01:02:44,710 --> 01:02:42,000  
a hex

1562  
01:02:46,150 --> 01:02:44,720  
decaying into two other hexes

1563  
01:02:47,270 --> 01:02:46,160

or three

1564

01:02:49,510 --> 01:02:47,280

and this is

1565

01:02:52,630 --> 01:02:49,520

the amplitude for this

1566

01:02:54,230 --> 01:02:52,640

decay product is it tiniest

1567

01:02:55,589 --> 01:02:54,240

so there's no evidence for this

1568

01:02:57,589 --> 01:02:55,599

potential

1569

01:02:59,349 --> 01:02:57,599

that's the standard tail that i've heard

1570

01:03:01,190 --> 01:02:59,359

and that everyone has heard yeah it is

1571

01:03:03,109 --> 01:03:01,200

the i statement is

1572

01:03:04,390 --> 01:03:03,119

the clocks and the electrons move

1573

01:03:06,630 --> 01:03:04,400

through this

1574

01:03:09,670 --> 01:03:06,640

hex field vacuum

1575

01:03:11,829 --> 01:03:09,680

molasses and they're moving very slowly

1576

01:03:14,309 --> 01:03:11,839

and the heavier particles move and the

1577

01:03:17,990 --> 01:03:14,319

glass is slower than the faster ones

1578

01:03:22,630 --> 01:03:20,309

okay i mean

1579

01:03:24,470 --> 01:03:22,640

it's a hypothesis ethereum i don't

1580

01:03:26,390 --> 01:03:24,480

necessarily believe in it imagine this

1581

01:03:27,910 --> 01:03:26,400

case this is a completely hypothetical

1582

01:03:29,829 --> 01:03:27,920

but imagine we see two electrons and

1583

01:03:31,270 --> 01:03:29,839

they repel now we see them but we see

1584

01:03:32,789 --> 01:03:31,280

them without photon we didn't discover

1585

01:03:35,270 --> 01:03:32,799

the photon then later we discover the

1586

01:03:36,789 --> 01:03:35,280

photon and then we say oh okay that

1587

01:03:38,390 --> 01:03:36,799

makes sense because we thought that

1588

01:03:39,829 --> 01:03:38,400

there must be a mediator an exchange

1589

01:03:41,910 --> 01:03:39,839

particle between these two but we've

1590

01:03:44,230 --> 01:03:41,920

never seen them exchange so it would be

1591

01:03:45,589 --> 01:03:44,240

like that we see the photon we think

1592

01:03:47,430 --> 01:03:45,599

they're supposed to be a particle and

1593

01:03:49,349 --> 01:03:47,440

that's why we predicted the photon but

1594

01:03:51,589 --> 01:03:49,359

you're saying we just found the photon

1595

01:03:53,109 --> 01:03:51,599

in this case the higgs but we don't see

1596

01:03:55,510 --> 01:03:53,119

its mechanism in the way that you're

1597

01:03:57,270 --> 01:03:55,520

saying the mechanism exists we just see

1598

01:03:58,789 --> 01:03:57,280

the hicks and the hicks can be explained

1599

01:04:01,029 --> 01:03:58,799

alternatively

1600

01:04:02,870 --> 01:04:01,039

via your theory at least right

1601  
01:04:04,549 --> 01:04:02,880  
the point is that

1602  
01:04:06,870 --> 01:04:04,559  
all experiments

1603  
01:04:08,630 --> 01:04:06,880  
with hex particles

1604  
01:04:10,549 --> 01:04:08,640  
that all you ever

1605  
01:04:12,870 --> 01:04:10,559  
do experimentally is to look at the

1606  
01:04:16,870 --> 01:04:12,880  
what's called the decay products

1607  
01:04:22,069 --> 01:04:19,510  
short-lived they only live

1608  
01:04:23,349 --> 01:04:22,079  
10 to the power minus 20 10 to the minus

1609  
01:04:26,470 --> 01:04:23,359  
22

1610  
01:04:28,950 --> 01:04:26,480  
10 to the minus 23 seconds

1611  
01:04:31,349 --> 01:04:28,960  
so you can't scatter the higgs off one

1612  
01:04:33,990 --> 01:04:31,359  
another like you scatter off electrons

1613  
01:04:36,630 --> 01:04:34,000

electrons are stable particles

1614

01:04:39,109 --> 01:04:36,640

and protons are stable you can scatter

1615

01:04:41,670 --> 01:04:39,119

them but these things

1616

01:04:44,549 --> 01:04:41,680

so what you do is discuss it you

1617

01:04:46,950 --> 01:04:44,559

you do experiments on the decay products

1618

01:04:47,990 --> 01:04:46,960

how does this heavy particle decay into

1619

01:04:51,990 --> 01:04:48,000

the

1620

01:04:57,990 --> 01:04:52,000

extract

1621

01:05:01,349 --> 01:04:59,510

it's an arrow time

1622

01:05:02,630 --> 01:05:01,359

i published papers

1623

01:05:04,710 --> 01:05:02,640

um

1624

01:05:06,230 --> 01:05:04,720

where i did way back after some years

1625

01:05:09,990 --> 01:05:06,240

ago

1626  
01:05:11,670 --> 01:05:10,000  
mexican hat and but now we're

1627  
01:05:13,510 --> 01:05:11,680  
violating

1628  
01:05:14,789 --> 01:05:13,520  
special relative lawrence invariants

1629  
01:05:17,349 --> 01:05:14,799  
okay

1630  
01:05:20,829 --> 01:05:17,359  
and so we highlight so

1631  
01:05:22,390 --> 01:05:20,839  
three column one down to it so

1632  
01:05:25,270 --> 01:05:22,400  
two

1633  
01:05:29,750 --> 01:05:27,750  
so the mexican hat as you remember you

1634  
01:05:31,270 --> 01:05:29,760  
go around the rim and you have different

1635  
01:05:32,630 --> 01:05:31,280  
arrows

1636  
01:05:34,950 --> 01:05:32,640  
so i choose

1637  
01:05:40,069 --> 01:05:34,960  
to break the arrow

1638  
01:05:44,470 --> 01:05:41,670

and so

1639

01:05:47,029 --> 01:05:44,480

i start with a very low entropy

1640

01:05:49,349 --> 01:05:47,039

and the age of p increases as

1641

01:05:50,470 --> 01:05:49,359

the universe expands

1642

01:05:53,430 --> 01:05:50,480

that's the

1643

01:05:56,150 --> 01:05:53,440

explanation for the error of time

1644

01:05:58,390 --> 01:05:56,160

to avoid through violation of lawrencium

1645

01:06:01,510 --> 01:05:58,400

variance but this happens

1646

01:06:02,549 --> 01:06:01,520

fractions of seconds after the big bang

1647

01:06:06,470 --> 01:06:02,559

okay

1648

01:06:09,029 --> 01:06:06,480

the violation or inconvenience

1649

01:06:12,069 --> 01:06:09,039

in experiment experiments today is

1650

01:06:14,789 --> 01:06:12,079

it's forget it there is no for me the

1651

01:06:17,349 --> 01:06:14,799

violation occurs seconds or fractions

1652

01:06:18,950 --> 01:06:17,359

practice the seconds after the big bang

1653

01:06:21,910 --> 01:06:18,960

and then it immediate through a phase

1654

01:06:25,349 --> 01:06:21,920

transition goes directly to the speed of

1655

01:06:27,510 --> 01:06:25,359

light that we know measure today

1656

01:06:28,950 --> 01:06:27,520

that's important

1657

01:06:31,109 --> 01:06:28,960

and whereas in

1658

01:06:33,589 --> 01:06:31,119

in the if your violin or instant

1659

01:06:34,870 --> 01:06:33,599

variants to where pakistan did with

1660

01:06:37,510 --> 01:06:34,880

milgram's

1661

01:06:39,270 --> 01:06:37,520

external relativistic extensions you get

1662

01:06:40,789 --> 01:06:39,280

into trouble

1663

01:06:46,309 --> 01:06:40,799

and uh

1664

01:06:51,910 --> 01:06:49,349

i've met firemen here if i hadn't dinner

1665

01:06:53,589 --> 01:06:51,920

with him in hungary once at a conference

1666

01:06:54,950 --> 01:06:53,599

he and his very interesting story was

1667

01:06:55,829 --> 01:06:54,960

great

1668

01:06:57,670 --> 01:06:55,839

um

1669

01:06:59,190 --> 01:06:57,680

i went to one of his lectures at cal

1670

01:07:01,589 --> 01:06:59,200

tech

1671

01:07:05,029 --> 01:07:01,599

and he was he gave lectures in quantum

1672

01:07:06,470 --> 01:07:05,039

field theory and i sat in the audience

1673

01:07:08,710 --> 01:07:06,480

and um

1674

01:07:11,109 --> 01:07:08,720

he was lecturing away and i put my hand

1675

01:07:13,510 --> 01:07:11,119

up to scratch my head and he looked at

1676

01:07:15,829 --> 01:07:13,520

me yes do you have a question

1677

01:07:17,750 --> 01:07:15,839

i said i'm just crashing my head he said

1678

01:07:19,109 --> 01:07:17,760

well that's legitimate you're allowed to

1679

01:07:23,190 --> 01:07:19,119

do that

1680

01:07:28,470 --> 01:07:25,670

i also met young man of course i knew

1681

01:07:29,510 --> 01:07:28,480

german quite well murray gilman it's in

1682

01:07:30,549 --> 01:07:29,520

my

1683

01:07:31,750 --> 01:07:30,559

this

1684

01:07:34,069 --> 01:07:31,760

so

1685

01:07:36,069 --> 01:07:34,079

funny stories anecdotes

1686

01:07:38,309 --> 01:07:36,079

by the way i wouldn't interject the

1687

01:07:41,589 --> 01:07:38,319

following

1688

01:07:42,390 --> 01:07:41,599

so when you modify gravity today

1689

01:07:44,549 --> 01:07:42,400

okay

1690

01:07:46,069 --> 01:07:44,559

and you think you can do without dark

1691

01:07:48,710 --> 01:07:46,079

matter

1692

01:07:52,069 --> 01:07:48,720

or dark energy or explain dark energy

1693

01:07:55,510 --> 01:07:52,079

that's another dark issue

1694

01:07:58,150 --> 01:07:55,520

you have to fit all the data

1695

01:08:01,910 --> 01:07:58,160

you can't cherry pick the data

1696

01:08:04,630 --> 01:08:01,920

so mon does okay for galaxies it doesn't

1697

01:08:06,549 --> 01:08:04,640

do well for clusters this is well known

1698

01:08:09,589 --> 01:08:06,559

okay

1699

01:08:11,910 --> 01:08:09,599

so i have to fit mark has to fit

1700

01:08:13,910 --> 01:08:11,920

galaxy data it has to fit what's called

1701

01:08:17,590 --> 01:08:13,920

the lensing data i just published a

1702

01:08:20,309 --> 01:08:17,600

paper on that another one so

1703

01:08:23,269 --> 01:08:20,319

it has to fit all the cosmological data

1704

01:08:26,070 --> 01:08:23,279

it's it's a huge amount of data

1705

01:08:28,229 --> 01:08:26,080

so life has become very difficult for

1706

01:08:30,070 --> 01:08:28,239

those people who think they can modify

1707

01:08:32,550 --> 01:08:30,080

gravity okay

1708

01:08:34,950 --> 01:08:32,560

is you have to fit all the data

1709

01:08:37,269 --> 01:08:34,960

otherwise someone comes along and says

1710

01:08:40,070 --> 01:08:37,279

hey okay you fit the galaxies or you

1711

01:08:42,309 --> 01:08:40,080

fitted that but what about the cosmology

1712

01:08:43,669 --> 01:08:42,319

what about the do you fit the acoustical

1713

01:08:46,470 --> 01:08:43,679

power spectrum

1714

01:08:49,510 --> 01:08:46,480

at this the cosmic microwave background

1715

01:08:51,030 --> 01:08:49,520

do you fit the amount of power spectrum

1716

01:08:52,550 --> 01:08:51,040

that's the uh

1717

01:08:54,070 --> 01:08:52,560

spectrum for

1718

01:08:58,229 --> 01:08:54,080

statistical

1719

01:09:02,789 --> 01:09:00,470

and to fit the structure growth of

1720

01:09:03,669 --> 01:09:02,799

cosmology

1721

01:09:06,630 --> 01:09:03,679

so

1722

01:09:07,910 --> 01:09:06,640

all of this has to be fitted

1723

01:09:10,070 --> 01:09:07,920

so i

1724

01:09:12,630 --> 01:09:10,080

had to learn all of this

1725

01:09:15,189 --> 01:09:12,640

you have to do all the astronomy

1726

01:09:17,269 --> 01:09:15,199

and you have to do all the cosmology

1727

01:09:18,950 --> 01:09:17,279

solar system there everything has to be

1728

01:09:21,910 --> 01:09:18,960

fitted

1729

01:09:23,990 --> 01:09:21,920

and so far monkeys

1730

01:09:25,590 --> 01:09:24,000

is successful

1731

01:09:28,070 --> 01:09:25,600

there are issues

1732

01:09:30,550 --> 01:09:28,080

to do with what's called dwarf galaxies

1733

01:09:31,669 --> 01:09:30,560

by the way it was just a big review put

1734

01:09:32,470 --> 01:09:31,679

out

1735

01:09:35,110 --> 01:09:32,480

by

1736

01:09:36,309 --> 01:09:35,120

ivante martino

1737

01:09:39,349 --> 01:09:36,319

uh

1738

01:09:43,189 --> 01:09:39,359

published in a journal

1739

01:09:46,550 --> 01:09:43,199

just recently where he reviews my monk

1740

01:09:47,749 --> 01:09:46,560

he reviews mind and mog

1741

01:09:50,950 --> 01:09:47,759

as the two

1742

01:09:55,910 --> 01:09:53,910

gravity without dark matter okay

1743

01:09:58,149 --> 01:09:55,920

and uh

1744

01:09:59,350 --> 01:09:58,159

the galaxy fits are very good and so why

1745

01:10:02,709 --> 01:09:59,360

they're like

1746

01:10:04,550 --> 01:10:02,719

nice to fit some data cosmology

1747

01:10:05,910 --> 01:10:04,560

but uh there's something called dwarf

1748

01:10:14,229 --> 01:10:05,920

galaxies

1749

01:10:19,669 --> 01:10:16,310

they have what's called very large mesh

1750

01:10:20,790 --> 01:10:19,679

to light ratios and over hell

1751

01:10:22,070 --> 01:10:20,800

which are

1752

01:10:24,149 --> 01:10:22,080

huge

1753

01:10:25,990 --> 01:10:24,159

so the idea is that the dark matter

1754

01:10:27,430 --> 01:10:26,000

dominates them

1755

01:10:29,189 --> 01:10:27,440

but um

1756

01:10:31,669 --> 01:10:29,199

the problem is that they're probably not

1757

01:10:33,110 --> 01:10:31,679

realized some of these 12 calories that

1758

01:10:35,990 --> 01:10:33,120

are not stable

1759

01:10:38,070 --> 01:10:36,000

tidal deformation

1760

01:10:39,590 --> 01:10:38,080

destroys the stability

1761

01:10:41,750 --> 01:10:39,600

realization

1762

01:10:42,470 --> 01:10:41,760

and so you can't use them as data so i

1763

01:10:43,750 --> 01:10:42,480

mean

1764

01:10:57,990 --> 01:10:43,760

so

1765

01:11:01,750 --> 01:10:59,750

what are you working on these days uh

1766

01:11:04,709 --> 01:11:01,760

well let's see

1767

01:11:06,550 --> 01:11:04,719

i've been working on my modified gravity

1768

01:11:08,790 --> 01:11:06,560

which i call

1769

01:11:11,110 --> 01:11:08,800

my acronym is mug

1770

01:11:14,870 --> 01:11:11,120

which stands for modified gravity but

1771

01:11:16,790 --> 01:11:14,880

privately modified morphic gravity but

1772

01:11:19,270 --> 01:11:16,800

nothing gravity but that's not public

1773

01:11:22,709 --> 01:11:19,280

that's private

1774

01:11:24,870 --> 01:11:22,719

um yes and um

1775

01:11:29,030 --> 01:11:24,880

the various issues

1776

01:11:33,270 --> 01:11:30,630

generalizations of

1777

01:11:36,550 --> 01:11:33,280

einstein's gravity theory

1778

01:11:39,750 --> 01:11:36,560

already at the phd level

1779

01:11:41,990 --> 01:11:39,760

in cambridge attorney college cambridge

1780

01:11:44,229 --> 01:11:42,000

and uh over the years but i've worked on

1781

01:11:45,270 --> 01:11:44,239

many other subjects

1782

01:11:47,110 --> 01:11:45,280

um

1783

01:11:50,149 --> 01:11:47,120

yes so

1784

01:11:53,110 --> 01:11:50,159

uh it's developing this theory

1785

01:11:54,950 --> 01:11:53,120

i also work on quantum field theory and

1786

01:11:57,350 --> 01:11:54,960

particle physics

1787

01:12:01,350 --> 01:11:57,360

and cosmology

1788

01:12:02,630 --> 01:12:01,360

and those are my three main areas

1789

01:12:04,390 --> 01:12:02,640

why don't you tell the audience a bit

1790

01:12:08,229 --> 01:12:04,400

about your books

1791

01:12:10,950 --> 01:12:08,239

yeah so this is my latest book

1792

01:12:13,669 --> 01:12:10,960

the shadow of the black hole

1793

01:12:15,350 --> 01:12:13,679

the oxford university press publication

1794

01:12:17,590 --> 01:12:15,360

just came out

1795

01:12:20,310 --> 01:12:17,600

uh it's a history of uh

1796

01:12:21,669 --> 01:12:20,320

the gravitational waves their detection

1797

01:12:23,669 --> 01:12:21,679

by ligo

1798

01:12:25,910 --> 01:12:23,679

observatory

1799

01:12:28,709 --> 01:12:25,920

and uh

1800

01:12:29,830 --> 01:12:28,719

the history of black holes

1801  
01:12:33,430 --> 01:12:29,840  
and uh

1802  
01:12:35,910 --> 01:12:33,440  
so the book has a narrative

1803  
01:12:38,070 --> 01:12:35,920  
description of ligo detection of

1804  
01:12:40,630 --> 01:12:38,080  
gravitational waves

1805  
01:12:40,640 --> 01:12:44,229  
also the uh

1806  
01:12:47,430 --> 01:12:46,149  
observation of the first image of a

1807  
01:12:50,229 --> 01:12:47,440  
black hole

1808  
01:12:52,550 --> 01:12:50,239  
and the galaxy aim emit

1809  
01:12:54,550 --> 01:12:52,560  
m31

1810  
01:12:56,870 --> 01:12:54,560  
and

1811  
01:12:59,910 --> 01:12:56,880  
so that's the book

1812  
01:13:01,110 --> 01:12:59,920  
um i also

1813  
01:13:02,630 --> 01:13:01,120

published a

1814

01:13:04,950 --> 01:13:02,640

memoir

1815

01:13:06,630 --> 01:13:04,960

einstein wrote back

1816

01:13:07,910 --> 01:13:06,640

some musical

1817

01:13:09,750 --> 01:13:07,920

and uh

1818

01:13:12,229 --> 01:13:09,760

this is my first book

1819

01:13:15,110 --> 01:13:12,239

reinventing gravity which has

1820

01:13:18,709 --> 01:13:15,120

a history of privacy

1821

01:13:23,350 --> 01:13:21,110

uh prehistoric times

1822

01:13:26,149 --> 01:13:23,360

and through the greeks and uh the

1823

01:13:27,510 --> 01:13:26,159

history of how gravity developed through

1824

01:13:29,990 --> 01:13:27,520

isaac newton

1825

01:13:33,189 --> 01:13:30,000

and albert einstein

1826  
01:13:35,110 --> 01:13:33,199  
and uh

1827  
01:13:37,750 --> 01:13:35,120  
and then uh

1828  
01:13:39,350 --> 01:13:37,760  
this is the book before

1829  
01:13:41,750 --> 01:13:39,360  
my latest

1830  
01:13:44,830 --> 01:13:41,760  
uh cracking the particle cord of the

1831  
01:13:47,510 --> 01:13:44,840  
universe is the history of uh particle

1832  
01:13:50,630 --> 01:13:47,520  
physics and uh

1833  
01:13:52,790 --> 01:13:50,640  
the uh ramifications of quantum field

1834  
01:13:55,350 --> 01:13:52,800  
theory and that development

1835  
01:13:57,270 --> 01:13:55,360  
and now had the description of the large

1836  
01:14:05,830 --> 01:13:57,280  
hatred collider

1837  
01:14:09,830 --> 01:14:06,790  
when you were mentioning the

1838  
01:14:11,430 --> 01:14:09,840

schwarzschild radius and the equations

1839

01:14:13,350 --> 01:14:11,440

you said that it's dependent on the

1840

01:14:14,950 --> 01:14:13,360

choice of coordinates the singularity

1841

01:14:16,709 --> 01:14:14,960

can you explain to the audience because

1842

01:14:18,310 --> 01:14:16,719

to them they might think well what do

1843

01:14:19,590 --> 01:14:18,320

you mean dependent on a choice of

1844

01:14:21,350 --> 01:14:19,600

coordinate system first of all what the

1845

01:14:23,270 --> 01:14:21,360

heck is a coordinate system and why does

1846

01:14:25,350 --> 01:14:23,280

the singularity depend on that

1847

01:14:27,669 --> 01:14:25,360

yes well the original solution the

1848

01:14:30,709 --> 01:14:27,679

slideshow solution

1849

01:14:33,110 --> 01:14:30,719

published by schwarzschild

1850

01:14:34,390 --> 01:14:33,120

who was astronomer

1851

01:14:36,950 --> 01:14:34,400

and uh

1852

01:14:38,870 --> 01:14:36,960

by the way he did the work

1853

01:14:40,870 --> 01:14:38,880

in the trenches of the first world war

1854

01:14:42,709 --> 01:14:40,880

he was in the military

1855

01:14:44,310 --> 01:14:42,719

german military

1856

01:14:46,390 --> 01:14:44,320

in the artillery

1857

01:14:47,990 --> 01:14:46,400

and einstein thought that his equation

1858

01:14:50,310 --> 01:14:48,000

was so complex that

1859

01:14:51,990 --> 01:14:50,320

finding an exact solution would be near

1860

01:14:53,910 --> 01:14:52,000

impossible and then one year later

1861

01:14:54,830 --> 01:14:53,920

schwarzschild while in the trenches came

1862

01:14:57,910 --> 01:14:54,840

up with the

1863

01:15:01,750 --> 01:14:57,920

solution went back to berlin and wrote

1864

01:15:04,870 --> 01:15:01,760

it up there but then he developed a new

1865

01:15:06,470 --> 01:15:04,880

autoimmune disease and immune disease

1866

01:15:09,430 --> 01:15:06,480

which uh

1867

01:15:12,790 --> 01:15:09,440

killed him he died

1868

01:15:13,669 --> 01:15:12,800

not soon after publishing the paper

1869

01:15:20,149 --> 01:15:13,679

so

1870

01:15:22,310 --> 01:15:20,159

uh

1871

01:15:25,270 --> 01:15:22,320

that one uses what's called schweichel

1872

01:15:26,630 --> 01:15:25,280

coordinates chord is x y said three

1873

01:15:29,510 --> 01:15:26,640

dimensional

1874

01:15:33,189 --> 01:15:29,520

and time is the fourth dimension

1875

01:15:34,070 --> 01:15:33,199

so that produces space time

1876

01:15:37,990 --> 01:15:34,080

and

1877

01:15:39,430 --> 01:15:38,000

you can choose other coordinates

1878

01:15:41,110 --> 01:15:39,440

example

1879

01:15:43,110 --> 01:15:41,120

if you

1880

01:15:46,070 --> 01:15:43,120

do a

1881

01:15:48,390 --> 01:15:46,080

a picture of the the earth the planet

1882

01:15:53,430 --> 01:15:48,400

you can use polar coordinates or other

1883

01:15:56,229 --> 01:15:53,440

kinds of coordinates to determine the uh

1884

01:15:57,910 --> 01:15:56,239

the structure of the of of earth

1885

01:16:01,510 --> 01:15:57,920

so if you use polar corners you get a

1886

01:16:03,110 --> 01:16:01,520

singularity on the north and south pole

1887

01:16:04,709 --> 01:16:03,120

and similarly in the schwarzschild

1888

01:16:08,229 --> 01:16:04,719

solution

1889

01:16:10,470 --> 01:16:08,239

the the horizon the schweitzer radius

1890

01:16:12,950 --> 01:16:10,480

is singular in schwarzschild corners but

1891

01:16:15,350 --> 01:16:12,960

you choose other coordinates

1892

01:16:17,270 --> 01:16:15,360

uh for example

1893

01:16:20,310 --> 01:16:17,280

it was the

1894

01:16:21,510 --> 01:16:20,320

mathematicians from princeton published

1895

01:16:22,790 --> 01:16:21,520

a paper

1896

01:16:25,510 --> 01:16:22,800

where they

1897

01:16:28,149 --> 01:16:25,520

did what's called a little continuation

1898

01:16:30,310 --> 01:16:28,159

of the social corners

1899

01:16:32,390 --> 01:16:30,320

space to

1900

01:16:35,030 --> 01:16:32,400

a much bigger space

1901

01:16:37,669 --> 01:16:35,040

in which the uh

1902

01:16:40,310 --> 01:16:37,679

the actual membrane of the horizon was

1903

01:16:43,430 --> 01:16:40,320

not singular so

1904

01:16:45,669 --> 01:16:43,440

so this was a problem because uh

1905

01:16:47,110 --> 01:16:45,679

einstein did wasn't aware of this issue

1906

01:16:49,830 --> 01:16:47,120

of courtness

1907

01:16:54,709 --> 01:16:50,790

he

1908

01:16:57,110 --> 01:16:54,719

because it was singular einstein didn't

1909

01:16:59,189 --> 01:16:57,120

like singularities in his theory he

1910

01:17:01,189 --> 01:16:59,199

always tried to avoid them

1911

01:17:02,870 --> 01:17:01,199

and

1912

01:17:05,189 --> 01:17:02,880

this prevented them

1913

01:17:07,110 --> 01:17:05,199

this ratio of the singular surface

1914

01:17:08,550 --> 01:17:07,120

horizon prevented them from from

1915

01:17:10,950 --> 01:17:08,560

believing

1916

01:17:12,550 --> 01:17:10,960

in these black holes

1917

01:17:14,229 --> 01:17:12,560

um

1918

01:17:16,550 --> 01:17:14,239

but eventually i was cleared up in the

1919

01:17:18,470 --> 01:17:16,560

early 60s

1920

01:17:20,070 --> 01:17:18,480

and uh

1921

01:17:21,990 --> 01:17:20,080

so then

1922

01:17:24,310 --> 01:17:22,000

from that understanding of

1923

01:17:25,910 --> 01:17:24,320

not having a singular membrane surface

1924

01:17:28,229 --> 01:17:25,920

horizon surface

1925

01:17:30,709 --> 01:17:28,239

someone could begin to believe that

1926

01:17:31,830 --> 01:17:30,719

these black holes made mathematical

1927

01:17:33,189 --> 01:17:31,840

sense

1928

01:17:34,950 --> 01:17:33,199

and by the way there's another

1929

01:17:37,270 --> 01:17:34,960

singularity

1930

01:17:39,510 --> 01:17:37,280

for the black hole

1931

01:17:41,030 --> 01:17:39,520

when the star collapses because it has a

1932

01:17:42,630 --> 01:17:41,040

large mass

1933

01:17:45,510 --> 01:17:42,640

too massive

1934

01:17:47,590 --> 01:17:45,520

to sustain itself

1935

01:17:48,709 --> 01:17:47,600

it collapses because the

1936

01:17:50,470 --> 01:17:48,719

pressure

1937

01:17:52,950 --> 01:17:50,480

due to uh

1938

01:17:54,470 --> 01:17:52,960

what's called degenerate gas neutron gas

1939

01:17:57,830 --> 01:17:54,480

for example

1940

01:17:59,669 --> 01:17:57,840

a neutron particle gas

1941

01:18:01,189 --> 01:17:59,679

the pressure there is not big enough to

1942

01:18:03,189 --> 01:18:01,199

balance

1943

01:18:05,990 --> 01:18:03,199

due to the attraction of gravity so the

1944

01:18:08,070 --> 01:18:06,000

star collapses and it collapses in

1945

01:18:10,790 --> 01:18:08,080

einstein's classical theory

1946

01:18:12,870 --> 01:18:10,800

to a singularity at the center

1947

01:18:15,590 --> 01:18:12,880

at the coordinate center which is

1948

01:18:18,870 --> 01:18:15,600

radially the distance

1949

01:18:20,870 --> 01:18:18,880

radially is zero at the center

1950

01:18:24,870 --> 01:18:20,880

and this singularity

1951

01:18:26,870 --> 01:18:24,880

has bothered bother physicists

1952

01:18:30,070 --> 01:18:26,880

from the beginning and this year

1953

01:18:32,149 --> 01:18:30,080

and uh this this is an issue which i can

1954

01:18:34,709 --> 01:18:32,159

get to eventually

1955

01:18:37,189 --> 01:18:34,719

so these are the two possible singulars

1956

01:18:39,430 --> 01:18:37,199

the singular singularities at the center

1957

01:18:42,950 --> 01:18:39,440

and einstein's classical theory

1958

01:18:44,950 --> 01:18:42,960

is there you can't avoid avoid it

1959

01:18:47,430 --> 01:18:44,960

by choosing another coordinate system

1960

01:18:50,310 --> 01:18:47,440

it's called an essential singularity

1961

01:18:52,310 --> 01:18:50,320

whereas as i explained for the horizon

1962

01:18:54,550 --> 01:18:52,320

you can choose different coordinates

1963

01:18:56,550 --> 01:18:54,560

and not have a singular surface

1964

01:18:58,790 --> 01:18:56,560

so the coordinate singularities are more

1965

01:19:00,790 --> 01:18:58,800

like figments of your coordinate choice

1966

01:19:02,229 --> 01:19:00,800

and the essential singularity is one

1967

01:19:03,830 --> 01:19:02,239

that is truer

1968

01:19:06,229 --> 01:19:03,840

that's right it's always there and the

1969

01:19:07,590 --> 01:19:06,239

classical theory of gravity einstein's

1970

01:19:09,669 --> 01:19:07,600

theory you

1971

01:19:11,270 --> 01:19:09,679

started studying physics around the time

1972

01:19:13,830 --> 01:19:11,280

you were 16 you had a correspondence

1973

01:19:14,630 --> 01:19:13,840

with einstein directly 20.

1974

01:19:17,669 --> 01:19:14,640

when you were 20 you had the

1975

01:19:19,430 --> 01:19:17,679

correspondence with einstein and then

1976

01:19:21,270 --> 01:19:19,440

you started developing

1977

01:19:24,390 --> 01:19:21,280

your own theory

1978

01:19:25,430 --> 01:19:24,400

an extension of general relativity

1979

01:19:27,510 --> 01:19:25,440

okay

1980

01:19:29,270 --> 01:19:27,520

well i've come i had an unusual

1981

01:19:30,390 --> 01:19:29,280

background

1982

01:19:33,510 --> 01:19:30,400

um

1983

01:19:35,750 --> 01:19:33,520

i left school when i was 15 because i

1984

01:19:38,390 --> 01:19:35,760

wanted to be an artist

1985

01:19:39,590 --> 01:19:38,400

what kind of artist i paint i still

1986

01:19:40,870 --> 01:19:39,600

paint

1987

01:19:42,790 --> 01:19:40,880

um

1988

01:19:44,310 --> 01:19:42,800

an abstract painting

1989

01:19:45,110 --> 01:19:44,320

so i joined

1990

01:19:48,830 --> 01:19:45,120

i

1991

01:19:51,270 --> 01:19:48,840

just turned

1992

01:19:53,189 --> 01:19:51,280

17. and uh

1993

01:19:56,630 --> 01:19:53,199

i had learned about

1994

01:19:59,430 --> 01:19:56,640

a size polyakov abstract painter who was

1995

01:20:02,470 --> 01:19:59,440

exhibited paintings in copenhagen

1996

01:20:04,390 --> 01:20:02,480

uh before i left for paris and i was

1997

01:20:07,189 --> 01:20:04,400

very impressed with his work

1998

01:20:08,550 --> 01:20:07,199

so i looked him up he lived in autism

1999

01:20:10,630 --> 01:20:08,560

how do you look him up this is before

2000

01:20:13,750 --> 01:20:10,640

the internet

2001

01:20:16,229 --> 01:20:13,760

well i looked him up in the sense of

2002

01:20:18,950 --> 01:20:16,239

not the internet i went to his house

2003

01:20:20,870 --> 01:20:18,960

because he had a little apartment and he

2004

01:20:22,310 --> 01:20:20,880

lives there with his wife

2005

01:20:23,990 --> 01:20:22,320

um

2006

01:20:27,110 --> 01:20:24,000

madame pollock he just showed up at his

2007

01:20:29,669 --> 01:20:27,120

house a 17 year old kid 17 year old kid

2008

01:20:30,550 --> 01:20:29,679

and he had his little boy alex body a

2009

01:20:33,910 --> 01:20:30,560

cup

2010

01:20:35,910 --> 01:20:33,920

and that's where he painted this room

2011

01:20:38,310 --> 01:20:35,920

and uh

2012

01:20:41,590 --> 01:20:38,320

he played the guitar at night because he

2013

01:20:44,310 --> 01:20:41,600

wasn't more well-known at all

2014

01:20:45,270 --> 01:20:44,320

then he became famous and uh i was there

2015

01:20:47,270 --> 01:20:45,280

with him

2016

01:20:48,870 --> 01:20:47,280

for a for about a year

2017

01:20:51,830 --> 01:20:48,880

to show up at his house he stayed for a

2018

01:20:54,390 --> 01:20:51,840

year no no i i had a room

2019

01:20:56,149 --> 01:20:54,400

in porter leon outside near in the

2020

01:20:59,270 --> 01:20:56,159

suburbs of paris

2021

01:21:01,750 --> 01:20:59,280

just one room but uh

2022

01:21:04,550 --> 01:21:01,760

i had saved up some money to to be in

2023

01:21:07,430 --> 01:21:04,560

paris but the money was running out

2024

01:21:08,790 --> 01:21:07,440

and i couldn't find any employment

2025

01:21:11,270 --> 01:21:08,800

because i was

2026  
01:21:13,110 --> 01:21:11,280  
british danish

2027  
01:21:14,950 --> 01:21:13,120  
i was a british citizen

2028  
01:21:17,030 --> 01:21:14,960  
because of my father

2029  
01:21:19,350 --> 01:21:17,040  
and

2030  
01:21:20,470 --> 01:21:19,360  
so i

2031  
01:21:22,870 --> 01:21:20,480  
painted

2032  
01:21:25,669 --> 01:21:22,880  
so he one day he said bring some

2033  
01:21:29,110 --> 01:21:25,679  
paintings along to the studio

2034  
01:21:31,830 --> 01:21:29,120  
and we're going to show you in a show

2035  
01:21:33,830 --> 01:21:31,840  
at the at the museum

2036  
01:21:36,870 --> 01:21:33,840  
with dartmouth

2037  
01:21:39,110 --> 01:21:36,880  
avenue wilson in paris

2038  
01:21:41,270 --> 01:21:39,120

so all of a sudden i have four paintings

2039

01:21:45,669 --> 01:21:41,280

up four or five

2040

01:21:46,790 --> 01:21:45,679

and this big museum modern art museum

2041

01:21:49,270 --> 01:21:46,800

and uh

2042

01:21:51,350 --> 01:21:49,280

i was surrounded by

2043

01:21:53,669 --> 01:21:51,360

these abstract painters

2044

01:21:57,030 --> 01:21:53,679

by cerrelli modiani

2045

01:21:58,390 --> 01:21:57,040

polyakov who are now famous names and

2046

01:22:00,149 --> 01:21:58,400

not

2047

01:22:03,510 --> 01:22:00,159

so you were there before it was cool

2048

01:22:06,550 --> 01:22:03,520

before it was famous before i was and

2049

01:22:11,270 --> 01:22:08,950

interviewed by

2050

01:22:12,709 --> 01:22:11,280

by um

2051  
01:22:14,390 --> 01:22:12,719  
journalists

2052  
01:22:16,390 --> 01:22:14,400  
from the mall

2053  
01:22:20,229 --> 01:22:16,400  
and other figaro

2054  
01:22:24,470 --> 01:22:21,030  
young

2055  
01:22:26,149 --> 01:22:24,480  
but to be exhibited at such a famous

2056  
01:22:26,870 --> 01:22:26,159  
installation

2057  
01:22:29,030 --> 01:22:26,880  
the

2058  
01:22:31,430 --> 01:22:29,040  
exhibition was called royalty novel

2059  
01:22:36,229 --> 01:22:31,440  
actually there was a a

2060  
01:22:38,390 --> 01:22:36,239  
spring exhibition every spring in paris

2061  
01:22:39,590 --> 01:22:38,400  
so i got to know these famous artists

2062  
01:22:41,189 --> 01:22:39,600  
and uh

2063  
01:22:44,470 --> 01:22:41,199

uh

2064

01:22:46,470 --> 01:22:44,480

i was with them for a year

2065

01:22:48,550 --> 01:22:46,480

and uh

2066

01:22:51,189 --> 01:22:48,560

then i ran out of money i had to go back

2067

01:22:54,550 --> 01:22:51,199

to power to copenhagen

2068

01:23:00,229 --> 01:22:57,030

go back living with my parents again

2069

01:23:00,239 --> 01:23:02,790

and

2070

01:23:08,149 --> 01:23:05,350

i got interested in

2071

01:23:10,229 --> 01:23:08,159

i started reading voraciously

2072

01:23:11,910 --> 01:23:10,239

everything classics

2073

01:23:13,590 --> 01:23:11,920

are you a quick reader

2074

01:23:15,030 --> 01:23:13,600

no

2075

01:23:17,270 --> 01:23:15,040

i'm slowly

2076

01:23:18,390 --> 01:23:17,280

i absorb everything

2077

01:23:20,550 --> 01:23:18,400

carefully

2078

01:23:23,189 --> 01:23:20,560

that tends to be true of mathematicians

2079

01:23:24,870 --> 01:23:23,199

it turns out that if you study iq and iq

2080

01:23:26,229 --> 01:23:24,880

can fractionate into mathematical and

2081

01:23:30,629 --> 01:23:26,239

verbal iq

2082

01:23:32,790 --> 01:23:30,639

to mathematical so the more highly

2083

01:23:35,030 --> 01:23:32,800

gifted you are mathematically the less

2084

01:23:37,669 --> 01:23:35,040

verbally and then the reverse tends to

2085

01:23:39,590 --> 01:23:37,679

be true i must say that school i was not

2086

01:23:43,669 --> 01:23:39,600

a very good student

2087

01:23:47,350 --> 01:23:45,430

i was

2088

01:23:50,629 --> 01:23:47,360

the only sappy i did well and it was

2089

01:23:53,030 --> 01:23:50,639

chemistry for some reason i was

2090

01:23:55,590 --> 01:23:53,040

fascinated by chemistry but not physics

2091

01:23:57,189 --> 01:23:55,600

no if i was poor physics or math you

2092

01:23:59,510 --> 01:23:57,199

didn't care too much about i didn't care

2093

01:24:01,510 --> 01:23:59,520

about it i didn't find it interesting

2094

01:24:04,470 --> 01:24:01,520

and this is around 15

2095

01:24:05,990 --> 01:24:04,480

uh no this is around

2096

01:24:08,870 --> 01:24:06,000

10 11

2097

01:24:10,550 --> 01:24:08,880

okay 12 10 yeah

2098

01:24:11,910 --> 01:24:10,560

we were living in glasgow at the time

2099

01:24:15,030 --> 01:24:11,920

what year is this

2100

01:24:18,229 --> 01:24:15,040

uh this would be 1942-43

2101

01:24:19,750 --> 01:24:18,239

so this is during the war do you know

2102

01:24:21,910 --> 01:24:19,760

anyway uh

2103

01:24:23,990 --> 01:24:21,920

so when actually when i left school

2104

01:24:27,990 --> 01:24:24,000

and come hang

2105

01:24:32,229 --> 01:24:28,000

i did try to get into university and uh

2106

01:24:34,070 --> 01:24:32,239

i went in those days in copenhagen

2107

01:24:36,390 --> 01:24:34,080

you uh

2108

01:24:37,669 --> 01:24:36,400

went to what's called gymnasium more

2109

01:24:39,990 --> 01:24:37,679

like it's

2110

01:24:43,270 --> 01:24:40,000

something like the oil german system

2111

01:24:45,110 --> 01:24:43,280

educational system and then you

2112

01:24:48,310 --> 01:24:45,120

went into the university

2113

01:24:50,470 --> 01:24:48,320

so i was interviewed by this

2114

01:24:53,110 --> 01:24:50,480

teacher school teacher to see why i

2115

01:24:55,750 --> 01:24:53,120

should be admitted admitted to

2116

01:24:58,390 --> 01:24:55,760

the gymnasium which is the

2117

01:25:01,270 --> 01:24:58,400

portal for university

2118

01:25:03,030 --> 01:25:01,280

and uh he asked me that i i should say

2119

01:25:04,310 --> 01:25:03,040

by the way that

2120

01:25:06,229 --> 01:25:04,320

um

2121

01:25:09,669 --> 01:25:06,239

during the war

2122

01:25:11,270 --> 01:25:09,679

in brisbane bristol this was 1942 in the

2123

01:25:14,070 --> 01:25:11,280

battle of britain

2124

01:25:15,669 --> 01:25:14,080

july august 1940

2125

01:25:16,870 --> 01:25:15,679

there were bombings

2126  
01:25:18,310 --> 01:25:16,880  
day and night

2127  
01:25:20,870 --> 01:25:18,320  
and

2128  
01:25:22,390 --> 01:25:20,880  
i did schooling on the crown

2129  
01:25:24,229 --> 01:25:22,400  
way underground

2130  
01:25:25,750 --> 01:25:24,239  
with sandbags

2131  
01:25:27,830 --> 01:25:25,760  
it was terrible

2132  
01:25:28,709 --> 01:25:27,840  
and the teaching was really

2133  
01:25:30,390 --> 01:25:28,719  
quite

2134  
01:25:32,070 --> 01:25:30,400  
not very good

2135  
01:25:35,030 --> 01:25:32,080  
and uh anyway

2136  
01:25:37,030 --> 01:25:35,040  
so we went on a vacation to

2137  
01:25:39,030 --> 01:25:37,040  
western supermare a little

2138  
01:25:41,350 --> 01:25:39,040

seaside resort

2139

01:25:43,669 --> 01:25:41,360

coast of england

2140

01:25:45,030 --> 01:25:43,679

we were walking along the beach road

2141

01:25:47,189 --> 01:25:45,040

promenade

2142

01:25:49,510 --> 01:25:47,199

and suddenly these two viciousness

2143

01:25:52,470 --> 01:25:49,520

bombers came up okay by

2144

01:25:55,110 --> 01:25:52,480

i looked at i could see the

2145

01:25:58,390 --> 01:25:55,120

pilots and the plane planes

2146

01:26:01,030 --> 01:25:58,400

and they dropped six bombs

2147

01:26:03,510 --> 01:26:01,040

and uh they fell on the beach

2148

01:26:04,629 --> 01:26:03,520

which is way this is to that tennis

2149

01:26:06,149 --> 01:26:04,639

court

2150

01:26:09,350 --> 01:26:06,159

down there

2151  
01:26:12,070 --> 01:26:09,360  
and uh

2152  
01:26:14,390 --> 01:26:12,080  
that's not too far not too far

2153  
01:26:16,470 --> 01:26:14,400  
so they went into the sand which

2154  
01:26:19,590 --> 01:26:16,480  
somewhat muffled the blast

2155  
01:26:22,550 --> 01:26:19,600  
but we were blown across the street

2156  
01:26:26,070 --> 01:26:22,560  
so i i suffer from ptsd

2157  
01:26:28,470 --> 01:26:26,080  
i still do actually to some extent

2158  
01:26:30,709 --> 01:26:28,480  
and uh did you suffer any physical

2159  
01:26:34,149 --> 01:26:30,719  
injuries yeah

2160  
01:26:38,149 --> 01:26:34,159  
i was suffered a concussion

2161  
01:26:40,870 --> 01:26:38,159  
so uh this had an effect on me back to

2162  
01:26:43,430 --> 01:26:40,880  
the interview by the school teacher and

2163  
01:26:45,910 --> 01:26:43,440

flashing back and forward right he asked

2164

01:26:47,590 --> 01:26:45,920

me these questions at the blackboard

2165

01:26:50,390 --> 01:26:47,600

mathematics

2166

01:26:53,590 --> 01:26:50,400

and because of my

2167

01:26:55,990 --> 01:26:53,600

what we now call PTSD

2168

01:27:00,149 --> 01:26:56,000

poster marries trust disorder i just

2169

01:27:05,189 --> 01:27:02,470

and uh i couldn't answer any questions

2170

01:27:07,030 --> 01:27:05,199

so he said he said i can tell you

2171

01:27:08,790 --> 01:27:07,040

moffitt

2172

01:27:11,350 --> 01:27:08,800

actually sure you'll never become a

2173

01:27:14,629 --> 01:27:11,360

mathematician

2174

01:27:16,709 --> 01:27:14,639

and they rejected me i was rejected

2175

01:27:18,790 --> 01:27:16,719

from going to the gymnasium that was the

2176

01:27:21,910 --> 01:27:18,800

end of the possibility of attending

2177

01:27:27,110 --> 01:27:26,229

in denmark so anyway back to uh

2178

01:27:30,390 --> 01:27:27,120

so

2179

01:27:31,750 --> 01:27:30,400

yeah paris copenhagen again i got

2180

01:27:33,750 --> 01:27:31,760

interested in

2181

01:27:35,910 --> 01:27:33,760

and uh did a lot of reading so i read

2182

01:27:38,229 --> 01:27:35,920

arthur eddington's books

2183

01:27:39,110 --> 01:27:38,239

popular books i got very interested in

2184

01:27:41,990 --> 01:27:39,120

that

2185

01:27:43,669 --> 01:27:42,000

in the end of physics and astronomy

2186

01:27:46,790 --> 01:27:43,679

and uh

2187

01:27:49,030 --> 01:27:46,800

i started getting excited about that

2188

01:27:51,270 --> 01:27:49,040

so i decided this was something to

2189

01:27:53,030 --> 01:27:51,280

pursue so i started learning math and

2190

01:27:55,030 --> 01:27:53,040

physique so it turned out that i could

2191

01:27:56,950 --> 01:27:55,040

attend

2192

01:27:58,870 --> 01:27:56,960

the library university live in the

2193

01:28:01,510 --> 01:27:58,880

university library

2194

01:28:03,910 --> 01:28:01,520

like university copenhagen library

2195

01:28:05,430 --> 01:28:03,920

and get books from physics and mass

2196

01:28:07,669 --> 01:28:05,440

which is

2197

01:28:09,030 --> 01:28:07,679

unusual for cities

2198

01:28:10,310 --> 01:28:09,040

you can't do that in the university of

2199

01:28:12,870 --> 01:28:10,320

toronto

2200

01:28:15,510 --> 01:28:12,880

the robust library you have to

2201

01:28:17,510 --> 01:28:15,520

be a member of the university

2202

01:28:18,629 --> 01:28:17,520

so but back then any member of the

2203

01:28:19,750 --> 01:28:18,639

public could take out the universe

2204

01:28:22,149 --> 01:28:19,760

publicly

2205

01:28:24,070 --> 01:28:22,159

and uh so i took out these books from

2206

01:28:27,189 --> 01:28:24,080

maths and physics

2207

01:28:27,199 --> 01:28:29,910

it just suddenly

2208

01:28:33,110 --> 01:28:31,030

clicked

2209

01:28:34,470 --> 01:28:33,120

and within about a week or two i learned

2210

01:28:36,709 --> 01:28:34,480

calculus

2211

01:28:38,310 --> 01:28:36,719

trigonometry

2212

01:28:39,750 --> 01:28:38,320

uh within

2213

01:28:44,390 --> 01:28:39,760

so you found that you had a natural

2214

01:28:49,350 --> 01:28:46,550

i have to tell you

2215

01:28:50,709 --> 01:28:49,360

i never understood how i did this

2216

01:28:53,030 --> 01:28:50,719

to this day you know

2217

01:28:55,189 --> 01:28:53,040

i still don't understand it

2218

01:28:58,310 --> 01:28:55,199

and uh

2219

01:29:00,709 --> 01:28:58,320

within a couple of months i was

2220

01:29:02,390 --> 01:29:00,719

moving fast okay i was going through all

2221

01:29:04,950 --> 01:29:02,400

our mathematics

2222

01:29:07,510 --> 01:29:04,960

and physics and uh you must have had

2223

01:29:10,950 --> 01:29:07,520

some great books too yeah i had i

2224

01:29:14,550 --> 01:29:10,960

somehow understood as i moved forward

2225

01:29:15,830 --> 01:29:14,560

what to look for what books to look for

2226

01:29:19,110 --> 01:29:15,840

and

2227

01:29:21,910 --> 01:29:19,120

so within six months

2228

01:29:24,070 --> 01:29:21,920

i got up to general relativity

2229

01:29:26,470 --> 01:29:24,080

and

2230

01:29:27,830 --> 01:29:26,480

then i did general relativity within a

2231

01:29:29,830 --> 01:29:27,840

month

2232

01:29:31,110 --> 01:29:29,840

okay for people listening you went from

2233

01:29:32,950 --> 01:29:31,120

a teacher saying that you're never going

2234

01:29:34,629 --> 01:29:32,960

to learn mathematics to you also not

2235

01:29:36,390 --> 01:29:34,639

knowing much of mathematics at that time

2236

01:29:37,910 --> 01:29:36,400

to then you picking up your first book

2237

01:29:39,830 --> 01:29:37,920

in the library for whatever reason you

2238

01:29:41,910 --> 01:29:39,840

were curious about it to then learning

2239

01:29:44,470 --> 01:29:41,920

general relativity in the span of six

2240

01:29:45,830 --> 01:29:44,480

months when you were around 15 or so

2241

01:29:47,430 --> 01:29:45,840

uh no

2242

01:29:49,189 --> 01:29:47,440

19 20

2243

01:29:50,709 --> 01:29:49,199

20.

2244

01:29:53,669 --> 01:29:50,719

yeah um

2245

01:29:57,990 --> 01:29:53,679

after that i had no interest in the

2246

01:30:00,229 --> 01:29:58,000

in science in general but uh

2247

01:30:02,709 --> 01:30:00,239

but then i suddenly

2248

01:30:04,830 --> 01:30:02,719

something lit up

2249

01:30:07,910 --> 01:30:04,840

and

2250

01:30:09,990 --> 01:30:07,920

so i then i ran into einstein's unified

2251  
01:30:12,790 --> 01:30:10,000  
field theory

2252  
01:30:15,430 --> 01:30:12,800  
and uh studied that and

2253  
01:30:17,110 --> 01:30:15,440  
found a problem with it

2254  
01:30:19,270 --> 01:30:17,120  
when you say einstein's unified field

2255  
01:30:21,990 --> 01:30:19,280  
theory you're not referring to general

2256  
01:30:25,110 --> 01:30:22,000  
relativity no this is uh what he called

2257  
01:30:27,350 --> 01:30:25,120  
a non-symmetric theory of gravitation he

2258  
01:30:29,830 --> 01:30:27,360  
called a generalization of gravitation

2259  
01:30:30,709 --> 01:30:29,840  
to it he didn't call it unified field

2260  
01:30:32,870 --> 01:30:30,719  
theory

2261  
01:30:34,149 --> 01:30:32,880  
generalization of gravity uh okay

2262  
01:30:36,629 --> 01:30:34,159  
because this was around the time when

2263  
01:30:39,350 --> 01:30:36,639

einstein was publishing

2264

01:30:41,030 --> 01:30:39,360

people like for example me we don't know

2265

01:30:42,390 --> 01:30:41,040

much about what einstein published that

2266

01:30:44,149 --> 01:30:42,400

didn't work we were only taught what

2267

01:30:46,070 --> 01:30:44,159

worked which is gr and the special

2268

01:30:48,229 --> 01:30:46,080

relativity first so i don't i actually

2269

01:30:50,709 --> 01:30:48,239

don't know about the specifics of his

2270

01:30:52,310 --> 01:30:50,719

unified field theory attempts yeah now

2271

01:30:56,709 --> 01:30:52,320

he

2272

01:30:59,110 --> 01:30:56,719

this is a a lot of this is described in

2273

01:31:00,870 --> 01:30:59,120

my book reinventing gravity i go through

2274

01:31:01,910 --> 01:31:00,880

the whole history of this

2275

01:31:05,030 --> 01:31:01,920

um

2276  
01:31:07,350 --> 01:31:05,040  
after the 1915-16 publication of general

2277  
01:31:09,750 --> 01:31:07,360  
relativity

2278  
01:31:12,390 --> 01:31:09,760  
einstein kept publishing applications

2279  
01:31:14,550 --> 01:31:12,400  
like detection of gravitational waves

2280  
01:31:18,550 --> 01:31:14,560  
his famous book on the cosmology and so

2281  
01:31:21,790 --> 01:31:18,560  
on his famous article and cosmology

2282  
01:31:24,070 --> 01:31:21,800  
but he was more interested in unifying

2283  
01:31:27,110 --> 01:31:24,080  
electromagnetism with gravity

2284  
01:31:28,310 --> 01:31:27,120  
and making the one geometrical theory

2285  
01:31:32,070 --> 01:31:28,320  
okay

2286  
01:31:32,080 --> 01:31:34,950  
uh

2287  
01:31:39,830 --> 01:31:36,390  
about 19

2288  
01:31:41,430 --> 01:31:39,840

18 19 19.

2289

01:31:44,390 --> 01:31:41,440

isn't general relativity already

2290

01:31:45,830 --> 01:31:44,400

compatible with electromagnetism it was

2291

01:31:48,149 --> 01:31:45,840

because you can

2292

01:31:50,229 --> 01:31:48,159

incorporate maxwell's

2293

01:31:51,990 --> 01:31:50,239

equations of electromagnetism into

2294

01:31:54,550 --> 01:31:52,000

general relativity

2295

01:31:56,870 --> 01:31:54,560

in what's called a covariant way a way

2296

01:31:58,950 --> 01:31:56,880

of of not being dependent on any

2297

01:32:01,350 --> 01:31:58,960

particular coordinate system it's called

2298

01:32:02,870 --> 01:32:01,360

the einstein maxwell theory

2299

01:32:05,030 --> 01:32:02,880

and it is

2300

01:32:07,510 --> 01:32:05,040

just but maxwell's equations are not

2301  
01:32:09,430 --> 01:32:07,520  
unified with gravity so to speak in a

2302  
01:32:11,590 --> 01:32:09,440  
geometrical structure

2303  
01:32:14,310 --> 01:32:11,600  
ah okay

2304  
01:32:16,870 --> 01:32:14,320  
um so

2305  
01:32:18,470 --> 01:32:16,880  
he worked on and off on his unified

2306  
01:32:21,110 --> 01:32:18,480  
theories his generalization of

2307  
01:32:23,669 --> 01:32:21,120  
gravitation theory his theory

2308  
01:32:25,430 --> 01:32:23,679  
and in 1925

2309  
01:32:26,470 --> 01:32:25,440  
for example

2310  
01:32:28,870 --> 01:32:26,480  
he

2311  
01:32:31,590 --> 01:32:28,880  
followed collusion and worked on high

2312  
01:32:33,830 --> 01:32:31,600  
dimensional gravity to include the

2313  
01:32:35,750 --> 01:32:33,840

electromagnetic field

2314

01:32:39,510 --> 01:32:35,760

maxwell's equations

2315

01:32:41,189 --> 01:32:39,520

and he wasn't happy with that

2316

01:32:42,149 --> 01:32:41,199

and uh

2317

01:32:44,550 --> 01:32:42,159

then he

2318

01:32:46,310 --> 01:32:44,560

vile herman weil the famous german

2319

01:32:49,430 --> 01:32:46,320

mathematician

2320

01:32:52,310 --> 01:32:49,440

who published a book famous book on uh

2321

01:32:53,669 --> 01:32:52,320

einstein's theory gravity called mata

2322

01:32:57,189 --> 01:32:53,679

and space time space space-time and

2323

01:33:14,470 --> 01:32:58,229

he

2324

01:33:16,870 --> 01:33:14,480

but that failed because

2325

01:33:19,350 --> 01:33:16,880

einstein criticized that there was a

2326

01:33:21,270 --> 01:33:19,360

problem with

2327

01:33:23,110 --> 01:33:21,280

understanding how clocks work in the

2328

01:33:24,790 --> 01:33:23,120

theory because of the so-called gauge

2329

01:33:29,430 --> 01:33:24,800

theory

2330

01:33:31,350 --> 01:33:29,440

and but then in 1925 einstein

2331

01:33:34,830 --> 01:33:31,360

journalized his

2332

01:33:37,510 --> 01:33:34,840

general relativity theory by saying the

2333

01:33:39,910 --> 01:33:37,520

following generality is based on a

2334

01:33:41,030 --> 01:33:39,920

space-time metric

2335

01:33:43,590 --> 01:33:41,040

which is

2336

01:33:46,950 --> 01:33:43,600

what it says a symmetric

2337

01:33:48,470 --> 01:33:46,960

metric it's a symmetric tensor

2338

01:33:50,790 --> 01:33:48,480

okay

2339

01:33:53,270 --> 01:33:50,800

g mu u it's called

2340

01:33:55,990 --> 01:33:53,280

we're mu and you run over space-time

2341

01:34:00,229 --> 01:33:56,000

coordinates one to four

2342

01:34:05,669 --> 01:34:03,110

so he said well why should this

2343

01:34:07,350 --> 01:34:05,679

metric this tends to be symmetric it can

2344

01:34:09,750 --> 01:34:07,360

be

2345

01:34:11,669 --> 01:34:09,760

non-symmetric you have a symmetric plus

2346

01:34:13,189 --> 01:34:11,679

an anti-symmetric part

2347

01:34:14,870 --> 01:34:13,199

added together

2348

01:34:16,790 --> 01:34:14,880

just let me explain this a bit to the

2349

01:34:19,270 --> 01:34:16,800

audience so there's

2350

01:34:20,310 --> 01:34:19,280

a metric which is a two tensor and a

2351

01:34:22,790 --> 01:34:20,320

tensor

2352

01:34:24,550 --> 01:34:22,800

is what you can think of as taking two

2353

01:34:25,830 --> 01:34:24,560

vectors you know what a vector is and

2354

01:34:27,590 --> 01:34:25,840

then outputting

2355

01:34:29,270 --> 01:34:27,600

what your underlying field is which in

2356

01:34:31,590 --> 01:34:29,280

most of the cases it's the real numbers

2357

01:34:33,030 --> 01:34:31,600

so that is you eat two vectors give me

2358

01:34:34,629 --> 01:34:33,040

two vectors and i'll give you a real

2359

01:34:38,550 --> 01:34:34,639

number and you have to satisfy some

2360

01:34:40,229 --> 01:34:38,560

conditions like linearity and so on

2361

01:34:41,910 --> 01:34:40,239

you can also switch those two vectors so

2362

01:34:43,910 --> 01:34:41,920

you can say give me a vector a give me

2363

01:34:45,669 --> 01:34:43,920

one vector then give me another one

2364

01:34:47,350 --> 01:34:45,679

or give me that one and then give me the

2365

01:34:49,830 --> 01:34:47,360

other one so give me a and b or give me

2366

01:34:50,950 --> 01:34:49,840

b and a and then if the result is the

2367

01:34:52,709 --> 01:34:50,960

same

2368

01:34:54,550 --> 01:34:52,719

in your calculation then you call it

2369

01:34:56,550 --> 01:34:54,560

symmetric

2370

01:34:58,790 --> 01:34:56,560

okay that's right

2371

01:35:01,189 --> 01:34:58,800

so yes so um

2372

01:35:02,629 --> 01:35:01,199

anyway he developed the mathematics for

2373

01:35:04,310 --> 01:35:02,639

this

2374

01:35:06,629 --> 01:35:04,320

and

2375

01:35:08,870 --> 01:35:06,639

published it as a paper

2376

01:35:10,229 --> 01:35:08,880

in 1925 there was a lot of excitement

2377

01:35:12,870 --> 01:35:10,239

about

2378

01:35:18,870 --> 01:35:12,880

any publication that he produced because

2379

01:35:23,910 --> 01:35:22,149

verified general relativity in 1919

2380

01:35:25,270 --> 01:35:23,920

arthur eddington's

2381

01:35:27,270 --> 01:35:25,280

uh

2382

01:35:30,229 --> 01:35:27,280

expedition

2383

01:35:32,550 --> 01:35:30,239

uh to to africa and uh

2384

01:35:36,550 --> 01:35:32,560

solar eclipse and so on

2385

01:35:38,790 --> 01:35:36,560

and uh anyway so the anyway so

2386

01:35:42,709 --> 01:35:38,800

back to the non-geometric theory

2387

01:35:44,790 --> 01:35:42,719

uh then he left it and tried other

2388

01:35:46,229 --> 01:35:44,800

made other attempts to have a unified

2389

01:35:49,270 --> 01:35:46,239

theory he

2390

01:35:55,270 --> 01:35:50,550

so

2391

01:36:00,629 --> 01:35:57,590

in collaboration with

2392

01:36:02,550 --> 01:36:00,639

strauss he was einstein's assistant at

2393

01:36:05,590 --> 01:36:02,560

the institute for one study in princeton

2394

01:36:08,390 --> 01:36:05,600

where he now is okay 1945

2395

01:36:10,310 --> 01:36:08,400

professor there in institute

2396

01:36:11,270 --> 01:36:10,320

um

2397

01:36:20,790 --> 01:36:11,280

he

2398

01:36:22,709 --> 01:36:20,800

was a problem

2399

01:36:26,070 --> 01:36:22,719

because the field equations of the

2400

01:36:29,910 --> 01:36:28,950

attracts a beautiful looking

2401

01:36:31,990 --> 01:36:29,920

uh

2402

01:36:35,189 --> 01:36:32,000

it's quite natural to generalize

2403

01:36:37,350 --> 01:36:35,199

einstein's theory there's no reason why

2404

01:36:40,470 --> 01:36:37,360

this tensor should be symmetric

2405

01:36:41,830 --> 01:36:40,480

and some what's called the connection

2406

01:36:43,990 --> 01:36:41,840

uh

2407

01:36:45,430 --> 01:36:44,000

to which is associated with the metric

2408

01:36:47,910 --> 01:36:45,440

tensor

2409

01:36:50,950 --> 01:36:47,920

uh at the i find connection

2410

01:36:52,870 --> 01:36:50,960

is also non-symmetric in this theory

2411

01:36:54,790 --> 01:36:52,880

and it has a symmetric power which is

2412

01:36:57,590 --> 01:36:54,800

the i find connection which is not a

2413

01:36:59,350 --> 01:36:57,600

tensor and the skew and anti-symmetric

2414

01:37:01,830 --> 01:36:59,360

part the skew part

2415

01:37:02,629 --> 01:37:01,840

which is is a tensor anyway

2416

01:37:04,390 --> 01:37:02,639

so

2417

01:37:06,550 --> 01:37:04,400

uh

2418

01:37:09,189 --> 01:37:06,560

it turned out that the field equations

2419

01:37:11,510 --> 01:37:09,199

which are supposed to describe maxwell's

2420

01:37:15,669 --> 01:37:11,520

equations

2421

01:37:17,990 --> 01:37:15,679

and he couldn't get the equation of

2422

01:37:20,310 --> 01:37:18,000

motion for a charged particle what's

2423

01:37:23,350 --> 01:37:20,320

called the the release lawrence lawrence

2424

01:37:25,510 --> 01:37:23,360

ford's law hendrick lawrence the

2425

01:37:29,350 --> 01:37:25,520

physicist

2426

01:37:34,229 --> 01:37:31,510

the turn of the uh

2427

01:37:36,709 --> 01:37:34,239

20th century

2428

01:37:37,830 --> 01:37:36,719

the lorenz force on on the charged

2429

01:37:40,070 --> 01:37:37,840

particle

2430

01:37:43,990 --> 01:37:40,080

didn't come out of the theory

2431

01:37:59,510 --> 01:37:44,790

so

2432

01:38:02,550 --> 01:37:59,520

he did at that time he had what's called

2433

01:38:04,629 --> 01:38:02,560

her mission metric tensor so we had the

2434

01:38:07,030 --> 01:38:04,639

symmetric power was real and the

2435

01:38:10,149 --> 01:38:07,040

anti-symmetric part was

2436

01:38:12,070 --> 01:38:10,159

it was an imaginary quantity measuring

2437

01:38:13,750 --> 01:38:12,080

square root of minus one times the

2438

01:38:17,109 --> 01:38:13,760

measuring part

2439

01:38:19,030 --> 01:38:17,119

and i found the problem with the

2440

01:38:21,109 --> 01:38:19,040

the lagrangian what's called the action

2441

01:38:22,870 --> 01:38:21,119

principle from which you get the filthy

2442

01:38:25,189 --> 01:38:22,880

questions

2443

01:38:27,270 --> 01:38:25,199

so i wrote him a letter and i wrote two

2444

01:38:28,790 --> 01:38:27,280

papers actually but that is to say you

2445

01:38:30,950 --> 01:38:28,800

found a problem with the lagrangian or

2446

01:38:32,149 --> 01:38:30,960

the action that the idea the structure

2447

01:38:35,189 --> 01:38:32,159

of the action

2448

01:38:37,270 --> 01:38:35,199

as to whether it was real or not

2449

01:38:40,149 --> 01:38:37,280

the action that lagrangian has to be

2450

01:38:42,229 --> 01:38:40,159

real okay otherwise you get into trouble

2451

01:38:44,149 --> 01:38:42,239

with uh

2452

01:38:46,310 --> 01:38:44,159

the development of the theories looked

2453

01:38:47,830 --> 01:38:46,320

self-consistent

2454

01:38:50,470 --> 01:38:47,840

so i

2455

01:38:52,950 --> 01:38:50,480

wrote these two papers i

2456

01:38:55,030 --> 01:38:52,960

typed on an old typewriter

2457

01:38:58,390 --> 01:38:55,040

and uh with the math symbols on the old

2458

01:39:01,270 --> 01:38:58,400

typewriter too no i had to put them in

2459

01:39:03,430 --> 01:39:01,280

by a pen okay it's all very primitive

2460

01:39:04,709 --> 01:39:03,440

compared to what we do today

2461

01:39:07,189 --> 01:39:04,719

and uh

2462

01:39:09,350 --> 01:39:07,199

sent them

2463

01:39:11,030 --> 01:39:09,360

these manuscripts and the letter i never

2464

01:39:12,550 --> 01:39:11,040

expected to hear from them because i

2465

01:39:15,189 --> 01:39:12,560

mean

2466

01:39:16,629 --> 01:39:15,199

famous einstein

2467

01:39:18,390 --> 01:39:16,639

people were writing to him all the time

2468

01:39:20,470 --> 01:39:18,400

be like writing obama and then obama

2469

01:39:21,750 --> 01:39:20,480

replying to exactly so

2470

01:39:24,550 --> 01:39:21,760

however

2471

01:39:26,790 --> 01:39:24,560

my prison was

2472

01:39:27,510 --> 01:39:26,800

was correct

2473

01:39:30,790 --> 01:39:27,520

so

2474

01:39:34,390 --> 01:39:30,800

20 or 22 or 20

2475

01:39:37,669 --> 01:39:34,400

92 i was 20 yeah

2476

01:39:42,070 --> 01:39:39,510

so

2477

01:39:45,030 --> 01:39:42,080

right looked at the manuscript and

2478

01:39:47,830 --> 01:39:45,040

um okay so you corrected einstein

2479

01:39:49,590 --> 01:39:47,840

yeah so i'm not correct i'm i questioned

2480

01:39:52,390 --> 01:39:49,600

what he was doing

2481

01:39:56,229 --> 01:39:52,400

and uh so he

2482

01:39:58,950 --> 01:39:56,239

amazingly and um a letter comes in

2483

01:40:00,550 --> 01:39:58,960

from from princeton from mercer street

2484

01:40:02,390 --> 01:40:00,560

where he

2485

01:40:04,629 --> 01:40:02,400

had his house

2486

01:40:07,030 --> 01:40:04,639

and uh

2487

01:40:08,790 --> 01:40:07,040

discussing my paper

2488

01:40:10,870 --> 01:40:08,800

papers and

2489

01:40:12,790 --> 01:40:10,880

and uh

2490

01:40:13,750 --> 01:40:12,800

just caching this issue i raised and so

2491

01:40:21,590 --> 01:40:13,760

on

2492

01:40:22,950 --> 01:40:21,600

i also criticized the fact that he was

2493

01:40:26,149 --> 01:40:22,960

only

2494

01:40:27,990 --> 01:40:26,159

unifying gravity with electromagnetism

2495

01:40:29,350 --> 01:40:28,000

and that that we knew about the nuclear

2496

01:40:32,070 --> 01:40:29,360

force

2497

01:40:33,910 --> 01:40:32,080

i mean there was already nuclear what we

2498

01:40:36,550 --> 01:40:33,920

call nuclear physics

2499

01:40:39,750 --> 01:40:36,560

so how can you leave that out okay and

2500

01:40:40,709 --> 01:40:39,760

he responded to that

2501

01:40:43,109 --> 01:40:40,719

so

2502

01:40:43,119 --> 01:40:47,430

then um

2503

01:40:52,790 --> 01:40:50,629

we have we had a friend my father

2504

01:40:54,870 --> 01:40:52,800

had a friend who was a

2505

01:40:55,910 --> 01:40:54,880

chemist

2506

01:40:58,310 --> 01:40:55,920

and

2507

01:40:59,830 --> 01:40:58,320

living he called me an american

2508

01:41:02,149 --> 01:40:59,840

and

2509

01:41:05,590 --> 01:41:02,159

he got to hear about me

2510

01:41:07,750 --> 01:41:05,600

and uh then he

2511

01:41:09,109 --> 01:41:07,760

somehow got about niels bohr at the

2512

01:41:11,350 --> 01:41:09,119

point if he should

2513

01:41:13,189 --> 01:41:11,360

cut to hear about me

2514

01:41:14,310 --> 01:41:13,199

and so i was invited to the board

2515

01:41:16,229 --> 01:41:14,320

institute

2516

01:41:19,910 --> 01:41:16,239

and i was interviewed by niels paul for

2517

01:41:21,109 --> 01:41:19,920

two hours he criticized einstein because

2518

01:41:23,430 --> 01:41:21,119

people

2519

01:41:26,790 --> 01:41:23,440

felt einstein was wasting his time

2520

01:41:31,590 --> 01:41:26,800

more criticized einstein yeah and said

2521

01:41:36,149 --> 01:41:34,470

albert was wasting his time and

2522

01:41:39,350 --> 01:41:36,159

he he said

2523

01:41:42,149 --> 01:41:39,360

i was like an alchemist

2524

01:41:44,830 --> 01:41:42,159

trying to turn lead into gold and

2525

01:41:48,790 --> 01:41:44,840

so on and so on i just sat

2526

01:41:51,350 --> 01:41:48,800

there famous nobel prize winner

2527

01:41:52,950 --> 01:41:51,360

thinks another famous nobel prize winner

2528

01:41:55,109 --> 01:41:52,960

is wasting his time

2529

01:41:57,189 --> 01:41:55,119

okay or i didn't think einstein was

2530

01:41:59,030 --> 01:41:57,199

wasting his time but

2531

01:42:01,990 --> 01:41:59,040

he was doing unified theory

2532

01:42:03,910 --> 01:42:02,000

before it ever became popular

2533

01:42:05,669 --> 01:42:03,920

at all okay

2534

01:42:07,990 --> 01:42:05,679

and he was actually ignoring the

2535

01:42:10,390 --> 01:42:08,000

institute

2536

01:42:11,270 --> 01:42:10,400

by physicists

2537

01:42:14,470 --> 01:42:11,280

because

2538

01:42:15,510 --> 01:42:14,480

all of his work was just wasting time

2539

01:42:20,149 --> 01:42:15,520

so

2540

01:42:22,470 --> 01:42:20,159

i was a british citizen that you see

2541

01:42:24,950 --> 01:42:22,480

because i never became a danish citizen

2542

01:42:26,830 --> 01:42:24,960

because i was born in copenhagen but i

2543

01:42:29,030 --> 01:42:26,840

took my father's

2544

01:42:31,830 --> 01:42:29,040

citizenship so

2545

01:42:33,990 --> 01:42:31,840

paul got in touch with uh the

2546

01:42:37,510 --> 01:42:34,000

the uh consulate british council in

2547

01:42:41,510 --> 01:42:39,990

uh who got in touch with the

2548

01:42:42,870 --> 01:42:41,520

department of scientific industrial

2549

01:42:44,709 --> 01:42:42,880

association

2550

01:42:49,510 --> 01:42:44,719

in london

2551  
01:42:49,520 --> 01:42:51,990  
and

2552  
01:42:54,830 --> 01:42:53,510  
so i went there

2553  
01:42:58,470 --> 01:42:54,840  
but

2554  
01:43:00,390 --> 01:42:58,480  
uh they arranged me for me to be

2555  
01:43:02,470 --> 01:43:00,400  
interviewed by professors

2556  
01:43:04,790 --> 01:43:02,480  
to see whether i was

2557  
01:43:06,709 --> 01:43:04,800  
the real article or

2558  
01:43:10,709 --> 01:43:06,719  
some

2559  
01:43:11,990 --> 01:43:10,719  
including my own

2560  
01:43:14,310 --> 01:43:12,000  
and

2561  
01:43:17,350 --> 01:43:14,320  
i was interviewed by

2562  
01:43:19,350 --> 01:43:17,360  
william mcrae professor in london

2563  
01:43:23,270 --> 01:43:19,360

university

2564

01:43:28,070 --> 01:43:25,910

then i was sent to

2565

01:43:30,149 --> 01:43:28,080

william bonner who professor liverpool

2566

01:43:32,149 --> 01:43:30,159

university who was working on united

2567

01:43:34,870 --> 01:43:32,159

states unified field theory he was one

2568

01:43:36,709 --> 01:43:34,880

of the people who criticized einstein's

2569

01:43:38,390 --> 01:43:36,719

theory for the fact that you couldn't

2570

01:43:40,709 --> 01:43:38,400

get the equation of motion for a charged

2571

01:43:42,709 --> 01:43:40,719

particle from the theory

2572

01:43:44,870 --> 01:43:42,719

and also that maxwell's equation it

2573

01:43:46,149 --> 01:43:44,880

didn't look like maxwell's equations as

2574

01:43:49,189 --> 01:43:46,159

they should

2575

01:43:53,669 --> 01:43:50,950

so then i was

2576

01:43:55,990 --> 01:43:53,679

sent to dublin

2577

01:43:57,590 --> 01:43:56,000

to h201 study

2578

01:43:59,830 --> 01:43:57,600

in dublin

2579

01:44:01,430 --> 01:43:59,840

and i've been showing other famous iron

2580

01:44:04,070 --> 01:44:01,440

showing uh one of the founders of

2581

01:44:06,709 --> 01:44:04,080

calling me kelly's the shorting equation

2582

01:44:09,350 --> 01:44:06,719

was director of the institute

2583

01:44:11,669 --> 01:44:09,360

so i went there and i went up and we

2584

01:44:13,910 --> 01:44:11,679

always interviewed by showing a saddle

2585

01:44:15,510 --> 01:44:13,920

on his bed with the whole cap on his

2586

01:44:19,510 --> 01:44:15,520

head

2587

01:44:19,520 --> 01:44:23,590

and uh he had my papers

2588

01:44:28,310 --> 01:44:27,030

which uh i sent a height today

2589

01:44:31,270 --> 01:44:28,320

and uh

2590

01:44:36,149 --> 01:44:31,280

science i sent it to him no i

2591

01:44:38,629 --> 01:44:36,159

sort of had copies and i had just

2592

01:44:39,350 --> 01:44:38,639

given them to bohr and

2593

01:44:41,109 --> 01:44:39,360

at

2594

01:44:43,350 --> 01:44:41,119

the palm of

2595

01:44:44,870 --> 01:44:43,360

uh that i was invited to in london and

2596

01:44:47,430 --> 01:44:44,880

so on people

2597

01:44:49,910 --> 01:44:47,440

and they sent it to schrodinger

2598

01:44:51,109 --> 01:44:49,920

so then he got angry and said why are

2599

01:44:53,510 --> 01:44:51,119

you using

2600

01:44:55,109 --> 01:44:53,520

albert's methods to do this theory

2601  
01:44:57,109 --> 01:44:55,119  
because shredding was working on the

2602  
01:44:58,629 --> 01:44:57,119  
non-symmetric theory he published

2603  
01:45:00,830 --> 01:44:58,639  
several papers

2604  
01:45:02,390 --> 01:45:00,840  
i was in the in the

2605  
01:45:03,910 --> 01:45:02,400  
um

2606  
01:45:08,950 --> 01:45:03,920  
i've

2607  
01:45:14,950 --> 01:45:11,750  
which published papers on

2608  
01:45:17,109 --> 01:45:14,960  
greek philosophy and all sorts of issues

2609  
01:45:20,229 --> 01:45:17,119  
and um

2610  
01:45:22,790 --> 01:45:20,239  
there was a dispute between einstein and

2611  
01:45:24,550 --> 01:45:22,800  
schweinger it turned out

2612  
01:45:26,709 --> 01:45:24,560  
uh because

2613  
01:45:28,229 --> 01:45:26,719

schroedinger

2614

01:45:31,669 --> 01:45:28,239

was interviewed by

2615

01:45:36,070 --> 01:45:33,910

because of his uh publication for

2616

01:45:37,669 --> 01:45:36,080

unified field theory

2617

01:45:39,590 --> 01:45:37,679

and uh claimed that he had solved the

2618

01:45:41,590 --> 01:45:39,600

problem

2619

01:45:43,189 --> 01:45:41,600

uh but wasn't happy about this because

2620

01:45:45,750 --> 01:45:43,199

he had solved the problem

2621

01:45:48,070 --> 01:45:45,760

so they had this personal dispute

2622

01:45:53,590 --> 01:45:48,080

and paulie had to intervene because they

2623

01:45:59,270 --> 01:45:55,750

poor albert threatened to sue

2624

01:46:00,629 --> 01:45:59,280

schweringer oh yeah

2625

01:46:03,189 --> 01:46:00,639

anyway so

2626  
01:46:04,229 --> 01:46:03,199  
uh paulie damned things out of kang

2627  
01:46:05,270 --> 01:46:04,239  
paulie

2628  
01:46:06,629 --> 01:46:05,280  
famous

2629  
01:46:09,830 --> 01:46:06,639  
physicist

2630  
01:46:12,629 --> 01:46:09,840  
uh nobel prize winner and um

2631  
01:46:14,790 --> 01:46:12,639  
anyway so i saw the atmosphere

2632  
01:46:16,470 --> 01:46:14,800  
i was interviewed

2633  
01:46:19,590 --> 01:46:16,480  
in and uh

2634  
01:46:21,510 --> 01:46:19,600  
so sharing had his way of deriving

2635  
01:46:23,990 --> 01:46:21,520  
the non-symmetric theory and

2636  
01:46:25,350 --> 01:46:24,000  
einstein had his way

2637  
01:46:27,669 --> 01:46:25,360  
doing it

2638  
01:46:29,990 --> 01:46:27,679

so training was anxious i wasn't using

2639

01:46:33,510 --> 01:46:30,000

heroin schrodinger's away okay why are

2640

01:46:39,030 --> 01:46:38,149

i i said i i i will do that in future

2641

01:46:41,590 --> 01:46:39,040

and

2642

01:46:44,950 --> 01:46:41,600

i had to be diplomatic

2643

01:46:46,790 --> 01:46:44,960

anyway so back to london

2644

01:46:48,390 --> 01:46:46,800

so the next thing is that schrodinger

2645

01:46:50,629 --> 01:46:48,400

sent a letter

2646

01:46:52,070 --> 01:46:50,639

to the

2647

01:46:54,470 --> 01:46:52,080

people

2648

01:46:55,669 --> 01:46:54,480

in london this department of

2649

01:46:57,990 --> 01:46:55,679

scientific

2650

01:47:00,229 --> 01:46:58,000

research in london

2651  
01:47:01,990 --> 01:47:00,239  
and uh

2652  
01:47:03,430 --> 01:47:02,000  
the latter argumentation must have been

2653  
01:47:05,990 --> 01:47:03,440  
something

2654  
01:47:08,390 --> 01:47:06,000  
because uh the next thing is i'm sent to

2655  
01:47:11,430 --> 01:47:08,400  
transit college cambridge to be

2656  
01:47:13,270 --> 01:47:11,440  
interviewed by dennis sharma

2657  
01:47:16,310 --> 01:47:13,280  
who was a

2658  
01:47:17,590 --> 01:47:16,320  
student of paul de iraq

2659  
01:47:20,950 --> 01:47:17,600  
and uh

2660  
01:47:22,709 --> 01:47:20,960  
he was a gone fellow of trinity college

2661  
01:47:24,709 --> 01:47:22,719  
and he was always

2662  
01:47:26,550 --> 01:47:24,719  
a lecturer at the time at cambridge

2663  
01:47:28,070 --> 01:47:26,560

university

2664

01:47:29,270 --> 01:47:28,080

and uh

2665

01:47:31,109 --> 01:47:29,280

so

2666

01:47:33,750 --> 01:47:31,119

i was interviewed by

2667

01:47:36,149 --> 01:47:33,760

sharma in his rooms at trinity

2668

01:47:37,189 --> 01:47:36,159

and after about 20 minutes she said come

2669

01:47:39,350 --> 01:47:37,199

with me

2670

01:47:42,390 --> 01:47:39,360

so we walk across

2671

01:47:45,030 --> 01:47:42,400

the trinity great court in lawrence

2672

01:47:47,510 --> 01:47:45,040

only a dawn can walk on the lawns but i

2673

01:47:49,669 --> 01:47:47,520

was with him i can't eat him

2674

01:47:50,790 --> 01:47:49,679

and otherwise you to walk on the gravel

2675

01:47:53,750 --> 01:47:50,800

path

2676  
01:47:55,270 --> 01:47:53,760  
and uh taken to the browser's office the

2677  
01:47:57,189 --> 01:47:55,280  
trinity and

2678  
01:47:59,990 --> 01:47:57,199  
dennis said this

2679  
01:48:02,470 --> 01:48:00,000  
gentleman john moffett has to be

2680  
01:48:05,669 --> 01:48:02,480  
matriculated as a

2681  
01:48:07,350 --> 01:48:05,679  
phd student at that take

2682  
01:48:09,510 --> 01:48:07,360  
and this is without an undergraduate

2683  
01:48:11,270 --> 01:48:09,520  
degree nor master so they looked into

2684  
01:48:12,550 --> 01:48:11,280  
this person he said he doesn't have any

2685  
01:48:15,830 --> 01:48:12,560  
degree

2686  
01:48:19,030 --> 01:48:15,840  
it doesn't matter doesn't matter no okay

2687  
01:48:20,709 --> 01:48:19,040  
so we're meticulous him and

2688  
01:48:23,109 --> 01:48:20,719

yes okay

2689

01:48:23,910 --> 01:48:23,119

all right so that

2690

01:48:26,550 --> 01:48:23,920

so

2691

01:48:28,470 --> 01:48:26,560

i was given the

2692

01:48:36,149 --> 01:48:28,480

supervisor

2693

01:48:37,669 --> 01:48:36,159

and uh i went to see him at st george

2694

01:48:39,270 --> 01:48:37,679

college

2695

01:48:40,790 --> 01:48:39,280

in his rooms

2696

01:48:42,790 --> 01:48:40,800

and he said well you don't have an

2697

01:48:44,790 --> 01:48:42,800

undergraduate degree

2698

01:48:46,390 --> 01:48:44,800

no

2699

01:48:49,030 --> 01:48:46,400

well maybe you should think about taking

2700

01:48:52,149 --> 01:48:49,040

the tripod exams these are the famous

2701  
01:48:53,750 --> 01:48:52,159  
exams antichrist exams like cambridge

2702  
01:48:55,510 --> 01:48:53,760  
and something called the mathematics

2703  
01:48:58,790 --> 01:48:55,520  
tripos

2704  
01:49:00,790 --> 01:48:58,800  
first part and second part and so on

2705  
01:49:01,910 --> 01:49:00,800  
and uh

2706  
01:49:06,950 --> 01:49:01,920  
well i

2707  
01:49:14,070 --> 01:49:08,550  
somewhat arrogant i should say as a

2708  
01:49:15,750 --> 01:49:14,080  
young man i fell in like so i said well

2709  
01:49:18,070 --> 01:49:15,760  
uh

2710  
01:49:19,669 --> 01:49:18,080  
professor ohio is just

2711  
01:49:22,550 --> 01:49:19,679  
this is just going to waste my time

2712  
01:49:23,590 --> 01:49:22,560  
because i know all this okay

2713  
01:49:25,830 --> 01:49:23,600

so he

2714

01:49:27,750 --> 01:49:25,840

he looked at me dubiously he went

2715

01:49:30,550 --> 01:49:27,760

through

2716

01:49:32,390 --> 01:49:30,560

the tripos himself he's in his biography

2717

01:49:33,430 --> 01:49:32,400

carl's biography

2718

01:49:36,070 --> 01:49:33,440

he

2719

01:49:38,229 --> 01:49:36,080

had problems with that

2720

01:49:39,350 --> 01:49:38,239

getting through and it was brilliant of

2721

01:49:41,510 --> 01:49:39,360

course but

2722

01:49:42,390 --> 01:49:41,520

there were very hard exams

2723

01:49:44,550 --> 01:49:42,400

and

2724

01:49:46,470 --> 01:49:44,560

so he's probably thought well if i

2725

01:49:48,550 --> 01:49:46,480

entered two of his wises

2726  
01:49:49,750 --> 01:49:48,560  
this person

2727  
01:49:52,229 --> 01:49:49,760  
with those

2728  
01:49:53,430 --> 01:49:52,239  
20 20 21 year old

2729  
01:49:56,629 --> 01:49:53,440  
you know

2730  
01:49:58,550 --> 01:49:56,639  
so i can understand his attitude so i

2731  
01:50:00,790 --> 01:49:58,560  
decided that something should be done

2732  
01:50:03,990 --> 01:50:00,800  
about this

2733  
01:50:05,750 --> 01:50:04,000  
so i wrote three papers okay within two

2734  
01:50:08,149 --> 01:50:05,760  
or three months

2735  
01:50:09,750 --> 01:50:08,159  
and uh

2736  
01:50:12,790 --> 01:50:09,760  
submitted it to the presidential

2737  
01:50:15,430 --> 01:50:12,800  
cambridge philosophical society

2738  
01:50:17,350 --> 01:50:15,440

and the first paper was

2739

01:50:20,390 --> 01:50:17,360

very mathematical was a generalization

2740

01:50:21,270 --> 01:50:20,400

of romanian geometry

2741

01:50:23,990 --> 01:50:21,280

and

2742

01:50:25,990 --> 01:50:24,000

the other two were my first modified

2743

01:50:30,149 --> 01:50:26,000

gravity theory

2744

01:50:36,149 --> 01:50:31,189

the

2745

01:50:39,189 --> 01:50:36,159

gravity and electromagnetism

2746

01:50:39,910 --> 01:50:39,199

in my own way okay so i invented this

2747

01:50:41,510 --> 01:50:39,920

way

2748

01:50:43,590 --> 01:50:41,520

no showing a new heinz this is a

2749

01:50:45,189 --> 01:50:43,600

different way of doing it

2750

01:50:46,790 --> 01:50:45,199

and

2751  
01:50:49,590 --> 01:50:46,800  
they accepted them

2752  
01:50:53,750 --> 01:50:51,030  
so i mean

2753  
01:50:56,550 --> 01:50:53,760  
cambridge proceedings as an ancient

2754  
01:50:58,310 --> 01:50:56,560  
history i mean famous mathematicians and

2755  
01:51:01,270 --> 01:50:58,320  
my officers were published there

2756  
01:51:03,189 --> 01:51:01,280  
schrodinger published papers there

2757  
01:51:04,390 --> 01:51:03,199  
economic act

2758  
01:51:07,830 --> 01:51:04,400  
so

2759  
01:51:09,750 --> 01:51:07,840  
i went back to to fred hoyle

2760  
01:51:12,070 --> 01:51:09,760  
and uh

2761  
01:51:13,270 --> 01:51:12,080  
i gave him the papers when he sat and

2762  
01:51:14,790 --> 01:51:13,280  
looked at them

2763  
01:51:17,270 --> 01:51:14,800

and he said well

2764

01:51:20,470 --> 01:51:17,280

forget about the tripods exam just

2765

01:51:22,310 --> 01:51:20,480

continue with what you took me

2766

01:51:24,310 --> 01:51:22,320

that was it

2767

01:51:26,870 --> 01:51:24,320

so i

2768

01:51:29,910 --> 01:51:26,880

did my own research

2769

01:51:31,750 --> 01:51:29,920

i went had to go to um

2770

01:51:34,310 --> 01:51:31,760

california

2771

01:51:37,270 --> 01:51:34,320

to do his steady state theory and work

2772

01:51:38,629 --> 01:51:37,280

with fowler william fowler at the

2773

01:51:40,470 --> 01:51:38,639

caltech

2774

01:51:43,669 --> 01:51:40,480

in pasadena

2775

01:51:45,750 --> 01:51:43,679

and uh visit other institutions so i had

2776

01:51:47,589 --> 01:51:45,760

to get another supervisor so i got up to

2777

01:51:49,589 --> 01:51:47,599

salam

2778

01:51:52,390 --> 01:51:49,599

who was

2779

01:51:53,669 --> 01:51:52,400

at that time a lecturer at st john's

2780

01:51:55,750 --> 01:51:53,679

college

2781

01:51:57,990 --> 01:51:55,760

where direct was

2782

01:52:00,310 --> 01:51:58,000

and uh

2783

01:52:03,109 --> 01:52:00,320

i just did my own thing

2784

01:52:04,950 --> 01:52:03,119

i attended two courses i never took any

2785

01:52:06,709 --> 01:52:04,960

exams

2786

01:52:08,950 --> 01:52:06,719

i didn't bother with that

2787

01:52:11,270 --> 01:52:08,960

but i attended a couple of i attended

2788

01:52:13,830 --> 01:52:11,280

your acts course twice

2789

01:52:16,310 --> 01:52:13,840

because it was brilliant and i just

2790

01:52:18,390 --> 01:52:16,320

called him curious i was fascinated by

2791

01:52:20,629 --> 01:52:18,400

my quantum character myself how was

2792

01:52:22,870 --> 01:52:20,639

direct as a teacher as a lecturer very

2793

01:52:24,550 --> 01:52:22,880

good very clear

2794

01:52:26,390 --> 01:52:24,560

excellent

2795

01:52:30,070 --> 01:52:26,400

did he speak much he has a reputation he

2796

01:52:33,750 --> 01:52:30,080

started off with a loud voice

2797

01:52:37,669 --> 01:52:35,510

to make sure that

2798

01:52:39,910 --> 01:52:37,679

he was being heard

2799

01:52:41,430 --> 01:52:39,920

and then even especially in the back of

2800

01:52:43,350 --> 01:52:41,440

the classroom

2801

01:52:45,350 --> 01:52:43,360

a lot of the students attended

2802

01:52:48,390 --> 01:52:45,360

all the graduate students

2803

01:52:50,229 --> 01:52:48,400

research students attended in physics

2804

01:52:53,510 --> 01:52:50,239

because they were famous

2805

01:52:55,910 --> 01:52:53,520

it's based on his book on coin because

2806

01:52:56,950 --> 01:52:55,920

and then his voice would be so more

2807

01:52:59,109 --> 01:52:56,960

muted

2808

01:53:01,109 --> 01:52:59,119

because he realized that

2809

01:53:05,030 --> 01:53:01,119

people were beginning to that the people

2810

01:53:06,629 --> 01:53:05,040

were able to understand his speech

2811

01:53:08,950 --> 01:53:06,639

anyway uh

2812

01:53:14,149 --> 01:53:12,310

i continued my work on general

2813

01:53:15,270 --> 01:53:14,159

relativity i worked on the equations of

2814

01:53:17,430 --> 01:53:15,280

motion

2815

01:53:19,750 --> 01:53:17,440

general relativity it's what's called

2816

01:53:22,229 --> 01:53:19,760

the einstein for hoffman method

2817

01:53:24,629 --> 01:53:22,239

and i wrote in my unified theory

2818

01:53:26,709 --> 01:53:24,639

this was going to be my thesis

2819

01:53:29,830 --> 01:53:26,719

and then i switched

2820

01:53:34,870 --> 01:53:29,840

to particle physics

2821

01:53:36,390 --> 01:53:34,880

because i was already well ahead with uh

2822

01:53:38,149 --> 01:53:36,400

my

2823

01:53:39,669 --> 01:53:38,159

gravity work

2824

01:53:41,270 --> 01:53:39,679

but i started becoming interested in

2825

01:53:42,229 --> 01:53:41,280

particle physics and quantum field

2826  
01:53:44,149 --> 01:53:42,239  
theory

2827  
01:53:45,830 --> 01:53:44,159  
so i started going to be quantified

2828  
01:53:47,589 --> 01:53:45,840  
theory and

2829  
01:53:50,070 --> 01:53:47,599  
and uh

2830  
01:53:51,910 --> 01:53:50,080  
by the way in the first year

2831  
01:53:54,870 --> 01:53:51,920  
as a student there are about six or

2832  
01:53:57,109 --> 01:53:54,880  
seven of us

2833  
01:53:59,510 --> 01:53:57,119  
in the math department and got what's

2834  
01:54:01,430 --> 01:53:59,520  
called bennett street cambridge

2835  
01:54:04,070 --> 01:54:01,440  
and um

2836  
01:54:06,390 --> 01:54:04,080  
we had a room where we kind of could

2837  
01:54:08,709 --> 01:54:06,400  
beat that big room

2838  
01:54:11,030 --> 01:54:08,719

and uh

2839

01:54:13,109 --> 01:54:11,040

so after a year we were told to

2840

01:54:15,030 --> 01:54:13,119

give a lecture we had seminars every

2841

01:54:16,550 --> 01:54:15,040

thursday

2842

01:54:17,510 --> 01:54:16,560

and uh

2843

01:54:19,830 --> 01:54:17,520

i had to

2844

01:54:21,830 --> 01:54:19,840

give a seminar on my work which was on

2845

01:54:23,750 --> 01:54:21,840

quantum field theory

2846

01:54:25,669 --> 01:54:23,760

not gravity

2847

01:54:27,589 --> 01:54:25,679

and uh

2848

01:54:28,870 --> 01:54:27,599

i worked on the actual matrix of quantum

2849

01:54:31,910 --> 01:54:28,880

field theory

2850

01:54:33,350 --> 01:54:31,920

and what's called hagg's theorem

2851  
01:54:40,070 --> 01:54:33,360  
developed by

2852  
01:54:42,870 --> 01:54:40,080  
a german physicist called hag rudolf hi

2853  
01:54:45,750 --> 01:54:42,880  
and paulie worked on this

2854  
01:54:48,149 --> 01:54:45,760  
hack serum at the time of king park

2855  
01:54:51,430 --> 01:54:48,159  
so i gave this lecture

2856  
01:54:54,149 --> 01:54:51,440  
and it was fairly original work

2857  
01:55:00,390 --> 01:54:56,629  
i used um

2858  
01:55:01,990 --> 01:55:00,400  
notation of freight freight treatment

2859  
01:55:03,589 --> 01:55:02,000  
um

2860  
01:55:05,910 --> 01:55:03,599  
american

2861  
01:55:07,910 --> 01:55:05,920  
quantum field theorist

2862  
01:55:09,270 --> 01:55:07,920  
in new york university

2863  
01:55:11,910 --> 01:55:09,280

published a book

2864

01:55:13,990 --> 01:55:11,920

so i direct and said to me

2865

01:55:16,629 --> 01:55:14,000

asked a question he said what are those

2866

01:55:18,709 --> 01:55:16,639

around brackets

2867

01:55:20,229 --> 01:55:18,719

i said this is what you call bras and

2868

01:55:22,870 --> 01:55:20,239

kits

2869

01:55:23,830 --> 01:55:22,880

the triangular brackets and he said well

2870

01:55:26,149 --> 01:55:23,840

that's

2871

01:55:27,750 --> 01:55:26,159

very interesting he was fascinated by

2872

01:55:32,629 --> 01:55:27,760

this

2873

01:55:33,350 --> 01:55:32,639

professor friedman anyway so

2874

01:55:35,430 --> 01:55:33,360

so

2875

01:55:37,589 --> 01:55:35,440

uh

2876

01:55:39,030 --> 01:55:37,599

three or three of them were

2877

01:55:41,430 --> 01:55:39,040

failed

2878

01:55:43,189 --> 01:55:41,440

it was pretty brutal

2879

01:55:44,870 --> 01:55:43,199

there was no exam we were just to give

2880

01:55:47,189 --> 01:55:44,880

this lecture on original physics

2881

01:55:51,189 --> 01:55:47,199

research and if you didn't make it you

2882

01:55:56,310 --> 01:55:51,199

were out he was sent down from cambridge

2883

01:56:00,950 --> 01:55:57,589

so

2884

01:56:04,149 --> 01:56:00,960

phd in 1958

2885

01:56:06,790 --> 01:56:04,159

during the course of my work

2886

01:56:08,790 --> 01:56:06,800

i met roy carr

2887

01:56:10,709 --> 01:56:08,800

the current metric

2888

01:56:13,510 --> 01:56:10,719

he came in from new zealand

2889

01:56:15,350 --> 01:56:13,520

to be a trinity college where we would

2890

01:56:17,270 --> 01:56:15,360

became friends

2891

01:56:18,950 --> 01:56:17,280

and so he said what should i do i said

2892

01:56:21,910 --> 01:56:18,960

well

2893

01:56:23,990 --> 01:56:21,920

i said what about physics you know

2894

01:56:25,430 --> 01:56:24,000

he was a brilliant mathematician

2895

01:56:28,310 --> 01:56:25,440

i said well do

2896

01:56:29,990 --> 01:56:28,320

gravity general relativity you don't

2897

01:56:31,430 --> 01:56:30,000

have to worry too much about the physics

2898

01:56:33,430 --> 01:56:31,440

at the moment

2899

01:56:35,270 --> 01:56:33,440

because generality was not that well

2900

01:56:38,709 --> 01:56:35,280

developed at this point we're talking

2901

01:56:43,030 --> 01:56:40,870

so even after einstein died general

2902

01:56:45,030 --> 01:56:43,040

relativity wasn't completely developed

2903

01:56:47,109 --> 01:56:45,040

no so the general relativity that we

2904

01:56:49,109 --> 01:56:47,119

learned in university is the fully

2905

01:56:51,430 --> 01:56:49,119

articulated form that einstein didn't

2906

01:56:53,990 --> 01:56:51,440

even put yeah it was being developed

2907

01:56:55,510 --> 01:56:54,000

still being developed and so

2908

01:56:57,350 --> 01:56:55,520

at the time

2909

01:57:00,870 --> 01:56:57,360

and mathematically speaking and there

2910

01:57:03,270 --> 01:57:00,880

was not enough experimental data you see

2911

01:57:06,629 --> 01:57:03,280

uh it was not that cosmology was an

2912

01:57:08,470 --> 01:57:06,639

infancy during my work i wrote a paper

2913

01:57:11,189 --> 01:57:08,480

by einstein an info

2914

01:57:14,070 --> 01:57:11,199

published in 1949

2915

01:57:15,750 --> 01:57:14,080

and uh infel was a police physicist

2916

01:57:19,189 --> 01:57:15,760

more so

2917

01:57:27,990 --> 01:57:23,189

i found a mistake it was wrong

2918

01:57:30,149 --> 01:57:28,000

so i got all the right gripe and i said

2919

01:57:32,070 --> 01:57:30,159

have a look at this i did the

2920

01:57:34,790 --> 01:57:32,080

calculations

2921

01:57:36,790 --> 01:57:34,800

and uh he looked at he said yeah

2922

01:57:37,669 --> 01:57:36,800

you're right it's wrong

2923

01:57:38,470 --> 01:57:37,679

so

2924

01:57:42,470 --> 01:57:38,480

we

2925

01:57:45,030 --> 01:57:42,480

should do something about this

2926  
01:57:47,669 --> 01:57:45,040  
and because there was a famous paper

2927  
01:57:50,390 --> 01:57:47,679  
there was a famous photograph of albert

2928  
01:57:52,709 --> 01:57:50,400  
einstein at the front of the

2929  
01:57:53,990 --> 01:57:52,719  
in the front of the paper

2930  
01:57:55,990 --> 01:57:54,000  
that this was it was the canadian

2931  
01:57:57,109 --> 01:57:56,000  
journal of mathematics to publish the

2932  
01:57:59,669 --> 01:57:57,119  
paper

2933  
01:58:02,070 --> 01:57:59,679  
and this photograph was by kash famous

2934  
01:58:06,070 --> 01:58:02,080  
photographer called kash

2935  
01:58:07,910 --> 01:58:06,080  
and uh anyway so uh

2936  
01:58:09,830 --> 01:58:07,920  
we wrote up this paper and sent it to

2937  
01:58:10,950 --> 01:58:09,840  
physical review

2938  
01:58:12,310 --> 01:58:10,960

it was into

2939

01:58:16,070 --> 01:58:12,320

it was uh

2940

01:58:20,629 --> 01:58:17,910

who was one of einstein's assistants

2941

01:58:22,790 --> 01:58:20,639

that needs to do it at one point

2942

01:58:24,310 --> 01:58:22,800

uh he was editor one of the editors of

2943

01:58:26,070 --> 01:58:24,320

physical review

2944

01:58:28,070 --> 01:58:26,080

and he wrote back saying you can't we

2945

01:58:29,430 --> 01:58:28,080

can't publish this paper

2946

01:58:30,790 --> 01:58:29,440

because it's uh

2947

01:58:32,830 --> 01:58:30,800

best marks

2948

01:58:37,350 --> 01:58:32,840

the reputation of

2949

01:58:40,790 --> 01:58:37,360

famous physicist albert einstein

2950

01:58:43,669 --> 01:58:40,800

so i got upset about that

2951

01:58:47,830 --> 01:58:46,390

i i was kind of angry about that i i was

2952

01:58:50,310 --> 01:58:47,840

at the version of leaving physics like

2953

01:58:53,350 --> 01:58:50,320

that i can't deal with this you know

2954

01:58:55,430 --> 01:58:53,360

so because you have

2955

01:58:56,950 --> 01:58:55,440

responsibility for posterity younger

2956

01:58:59,589 --> 01:58:56,960

physicists who

2957

01:59:01,589 --> 01:58:59,599

can use this work

2958

01:59:04,390 --> 01:59:01,599

so

2959

01:59:07,910 --> 01:59:04,400

i got my phd

2960

01:59:08,629 --> 01:59:07,920

uh they were not happy if i'm i put this

2961

01:59:14,310 --> 01:59:08,639

i

2962

01:59:17,030 --> 01:59:14,320

okay

2963

01:59:18,550 --> 01:59:17,040

and wrote a paper and i put it into my

2964

01:59:20,310 --> 01:59:18,560

phd thesis

2965

01:59:23,109 --> 01:59:20,320

and my examiners were

2966

01:59:24,950 --> 01:59:23,119

not entirely happy about this

2967

01:59:26,950 --> 01:59:24,960

and uh but there wasn't anything they

2968

01:59:28,470 --> 01:59:26,960

could do about it

2969

01:59:31,109 --> 01:59:28,480

so

2970

01:59:35,510 --> 01:59:31,119

uh

2971

01:59:38,229 --> 01:59:35,520

eventually i got my phd without an

2972

01:59:40,310 --> 01:59:38,239

undergraduate degree by the way i was

2973

01:59:42,149 --> 01:59:40,320

i think the one at that time

2974

01:59:43,669 --> 01:59:42,159

maybe still

2975

01:59:46,550 --> 01:59:43,679

the only

2976

01:59:50,390 --> 01:59:46,560

student at trinity to get a phd

2977

01:59:55,270 --> 01:59:51,669

i think

2978

01:59:58,950 --> 01:59:55,280

in theoretical physics anyway i know

2979

02:00:01,910 --> 01:59:58,960

maybe that's still true i don't but um

2980

02:00:04,229 --> 02:00:01,920

um it's always fairly unique

2981

02:00:05,750 --> 02:00:04,239

these examples weren't happy about that

2982

02:00:09,750 --> 02:00:05,760

either of course

2983

02:00:11,990 --> 02:00:09,760

because they had this guinea pig okay

2984

02:00:13,990 --> 02:00:12,000

so to speak who was going through this

2985

02:00:18,149 --> 02:00:14,000

system in cambridge

2986

02:00:20,390 --> 02:00:18,159

it is impossible to do this okay well

2987

02:00:21,270 --> 02:00:20,400

i did it

2988

02:00:22,950 --> 02:00:21,280

so

2989

02:00:26,229 --> 02:00:22,960

uh

2990

02:00:28,070 --> 02:00:26,239

then i got a fellowship from the same

2991

02:00:29,510 --> 02:00:28,080

department industrial scientific

2992

02:00:33,830 --> 02:00:29,520

industrial research

2993

02:00:38,070 --> 02:00:35,669

to a two-year fellowship

2994

02:00:40,390 --> 02:00:38,080

that's why i went to imperial college

2995

02:00:42,149 --> 02:00:40,400

in the meantime after salaam

2996

02:00:43,750 --> 02:00:42,159

was made professor at imperial college

2997

02:00:46,149 --> 02:00:43,760

london

2998

02:00:48,149 --> 02:00:46,159

and here i was i was putting an office

2999

02:00:51,189 --> 02:00:48,159

meet to his office

3000

02:00:52,310 --> 02:00:51,199

i was his first postdoctoral fellow

3001  
02:00:56,229 --> 02:00:52,320  
and

3002  
02:00:57,350 --> 02:00:56,239  
field theory

3003  
02:00:59,830 --> 02:00:57,360  
and uh

3004  
02:01:01,189 --> 02:00:59,840  
but uh i was worrying about getting a

3005  
02:01:04,629 --> 02:01:01,199  
job

3006  
02:01:07,589 --> 02:01:04,639  
at this point i was married

3007  
02:01:10,629 --> 02:01:09,270  
so i i

3008  
02:01:11,589 --> 02:01:10,639  
got ahold of

3009  
02:01:14,229 --> 02:01:11,599  
my um

3010  
02:01:17,430 --> 02:01:14,239  
correspondent john wheeler prince

3011  
02:01:19,750 --> 02:01:17,440  
and he suggested apply for childhood an

3012  
02:01:22,310 --> 02:01:19,760  
institute for research in baltimore

3013  
02:01:23,589 --> 02:01:22,320

maryland which i did they offered me a

3014

02:01:26,470 --> 02:01:23,599

job

3015

02:01:28,629 --> 02:01:26,480

so i went there in 1959

3016

02:01:30,470 --> 02:01:28,639

and

3017

02:01:32,950 --> 02:01:30,480

was at this institute

3018

02:01:34,709 --> 02:01:32,960

i was a senior researcher there

3019

02:01:38,149 --> 02:01:34,719

i was doing particle physics and field

3020

02:01:40,149 --> 02:01:38,159

theory they also had a math department

3021

02:01:43,109 --> 02:01:40,159

and uh

3022

02:01:44,870 --> 02:01:43,119

salmonella schliches was the director of

3023

02:01:46,790 --> 02:01:44,880

the mass the famous night's most

3024

02:01:49,589 --> 02:01:46,800

institute there

3025

02:01:54,629 --> 02:01:51,510

then uh

3026

02:02:00,229 --> 02:01:58,310

i published papers in particle physics

3027

02:02:02,149 --> 02:02:00,239

um

3028

02:02:05,830 --> 02:02:02,159

published a lot of papers rapidly in

3029

02:02:06,790 --> 02:02:05,840

physics particle physics

3030

02:02:08,870 --> 02:02:06,800

then i

3031

02:02:10,629 --> 02:02:08,880

was offered a job at university of

3032

02:02:14,229 --> 02:02:10,639

toronto

3033

02:02:16,229 --> 02:02:14,239

as an associate professor already

3034

02:02:19,030 --> 02:02:16,239

with the promise of being my full

3035

02:02:21,430 --> 02:02:19,040

professor within a couple of years which

3036

02:02:23,189 --> 02:02:21,440

again is very unusual

3037

02:02:24,860 --> 02:02:23,199

and

3038

02:02:27,030 --> 02:02:24,870

i got a job there

3039

02:02:30,070 --> 02:02:27,040

[Music]

3040

02:02:32,390 --> 02:02:30,080

had to do teaching full-time teaching

3041

02:02:33,669 --> 02:02:32,400

so i started teaching undergraduate

3042

02:02:35,270 --> 02:02:33,679

courses

3043

02:02:37,350 --> 02:02:35,280

and i'd never i'd never attended

3044

02:02:39,990 --> 02:02:37,360

undergraduate courses

3045

02:02:40,950 --> 02:02:40,000

but i did okay

3046

02:02:45,510 --> 02:02:40,960

and

3047

02:02:55,510 --> 02:02:45,520

[Music]

3048

02:02:58,830 --> 02:02:57,589

do you know who ryan keating is he's an

3049

02:03:00,709 --> 02:02:58,840

experimental

3050

02:03:03,510 --> 02:03:00,719

physicist uh

3051

02:03:04,870 --> 02:03:03,520

yeah i read his book oh how to lose

3052

02:03:05,910 --> 02:03:04,880

nobel prize