

JULY 9, 2019

7 PM PT / 10 PM ET LIVE BROADCAST



ISAAK ARTHUR
SCIENCE & FUTURISM

Ep. 1074

F2B

with Jimmy Church

ARTHUR C. CLARKE



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1
00:00:13,910 --> 00:00:11,360

[Music]

2
00:00:16,790 --> 00:00:13,920

[Applause]

3
00:00:19,670 --> 00:00:16,800

the smoke radio for the masses headline

4
00:00:21,590 --> 00:00:19,680

edition july 8 1947

5
00:00:24,070 --> 00:00:21,600

the army air forces has announced that a

6
00:00:25,750 --> 00:00:24,080

flying bist has been found and is now in

7
00:00:28,470 --> 00:00:25,760

the possession of the army

8
00:00:30,470 --> 00:00:28,480

if the game is rigged change the game

9
00:00:33,270 --> 00:00:30,480

game changer

10
00:00:35,670 --> 00:00:33,280

i occasionally think how quickly

11
00:00:36,950 --> 00:00:35,680

our differences worldwide

12
00:00:39,670 --> 00:00:36,960

would vanish

13
00:00:45,830 --> 00:00:39,680

if we were facing an alien threat from

14

00:00:51,350 --> 00:00:48,630

this is fade to black with your host

15

00:00:54,549 --> 00:00:51,360

jimmy church on the game changer radio

16

00:00:58,229 --> 00:00:54,559

network and kgra the global radio

17

00:01:03,500 --> 00:01:00,389

i need your help to get to the year

18

00:01:09,270 --> 00:01:07,270

[Music]

19

00:01:12,220 --> 00:01:09,280

you are listening to fate to flag with

20

00:01:19,910 --> 00:01:12,230

jimmy judge on the game changer network

21

00:01:24,070 --> 00:01:21,480

welcome fade to black

22

00:01:28,149 --> 00:01:24,080

[Music]

23

00:01:32,710 --> 00:01:29,190

for

24

00:01:35,190 --> 00:01:33,400

masses

25

00:01:37,270 --> 00:01:35,200

[Music]

26

00:01:40,390 --> 00:01:37,280

yeah

27

00:01:42,870 --> 00:01:40,400

how you doing

28

00:01:45,960 --> 00:01:42,880

how are you doing

29

00:01:50,270 --> 00:01:45,970

today's tuesday july 9 2019

30

00:01:54,310 --> 00:01:50,280

[Music]

31

00:01:57,109 --> 00:01:54,320

189 days into the new year just 176 days

32

00:01:58,469 --> 00:01:57,119

left we are live from a bunker

33

00:02:00,709 --> 00:01:58,479

somewhere in the middle of beautiful

34

00:02:02,389 --> 00:02:00,719

downtown burbank california and i would

35

00:02:03,990 --> 00:02:02,399

like to welcome everybody listening all

36

00:02:08,469 --> 00:02:04,000

around the world

37

00:02:10,550 --> 00:02:08,479

all across the united states

38

00:02:12,949 --> 00:02:10,560

hither and tether

39

00:02:18,150 --> 00:02:12,959

to and fro

40

00:02:23,830 --> 00:02:18,160

back and forth up and down east and west

41

00:02:29,510 --> 00:02:27,430

this is fade to black for kj cr the game

42

00:02:31,430 --> 00:02:29,520

changer network and kg are a the planet

43

00:02:33,270 --> 00:02:31,440

i am your host

44

00:02:36,090 --> 00:02:33,280

jimmy church

45

00:02:39,190 --> 00:02:36,100

what is cracking everybody how you doing

46

00:02:42,229 --> 00:02:39,200

[Music]

47

00:02:44,550 --> 00:02:42,239

so looking forward to tonight's show

48

00:02:47,350 --> 00:02:44,560

isaac arthur is back

49

00:02:48,309 --> 00:02:47,360

and tonight's

50

00:02:50,470 --> 00:02:48,319

tonight

51
00:02:52,710 --> 00:02:50,480
is isaac's job

52
00:02:57,750 --> 00:02:52,720
is to make me look

53
00:03:02,229 --> 00:03:00,150
yeah man he's great

54
00:03:05,750 --> 00:03:02,239
and tonight we're going to discuss clark

55
00:03:10,710 --> 00:03:08,390
isaac's got a whole video series on this

56
00:03:12,710 --> 00:03:10,720
and he discusses

57
00:03:14,390 --> 00:03:12,720
uh quite often a lot of the subjects

58
00:03:16,229 --> 00:03:14,400
we're going to go through tonight

59
00:03:18,470 --> 00:03:16,239
but clark tech technology's

60
00:03:19,830 --> 00:03:18,480
indistinguishable

61
00:03:22,470 --> 00:03:19,840
from magic

62
00:03:25,430 --> 00:03:22,480
so that's tonight a lot to discuss and

63
00:03:28,869 --> 00:03:25,440

i'm i'm really looking forward to this

64

00:03:31,190 --> 00:03:28,879

my my quest is to learn isaac is the

65

00:03:33,910 --> 00:03:31,200

host of science and futurism with isaac

66

00:03:36,390 --> 00:03:33,920

arthur on youtube he's got over 300 000

67

00:03:39,190 --> 00:03:36,400

subscribers nearly 200 episodes covering

68

00:03:41,270 --> 00:03:39,200

topics like colonizing the solar system

69

00:03:43,190 --> 00:03:41,280

interstellar travel the fermi paradox

70

00:03:45,110 --> 00:03:43,200

artificial intelligence other topics

71

00:03:48,869 --> 00:03:45,120

representing the possible future paths

72

00:03:50,949 --> 00:03:48,879

of the challenges for humanity isaac

73

00:03:53,110 --> 00:03:50,959

received his degree in physics from kent

74

00:03:55,509 --> 00:03:53,120

state university graduating top of his

75

00:03:57,509 --> 00:03:55,519

class at the age of 20 and remain there

76
00:03:59,910 --> 00:03:57,519
for graduate studies before joining the

77
00:04:01,190 --> 00:03:59,920
united states army and serving in iraq

78
00:04:03,830 --> 00:04:01,200
he also

79
00:04:06,550 --> 00:04:03,840
ready worked as a civilian researcher at

80
00:04:09,350 --> 00:04:06,560
the air force institute of technology in

81
00:04:11,750 --> 00:04:09,360
dayton ohio that's right and after the

82
00:04:13,429 --> 00:04:11,760
military returned home in ohio and

83
00:04:16,229 --> 00:04:13,439
serves as the chairman of the board of

84
00:04:18,550 --> 00:04:16,239
elections for his area when not working

85
00:04:20,229 --> 00:04:18,560
on his channel the website of course is

86
00:04:21,590 --> 00:04:20,239
isaacarthur.net

87
00:04:23,990 --> 00:04:21,600
i'd like to welcome back to fade to

88
00:04:25,270 --> 00:04:24,000

black isaac arthur isaac good evening

89

00:04:26,710 --> 00:04:25,280

man how are you

90

00:04:28,629 --> 00:04:26,720

i'm doing great jimmy thanks for having

91

00:04:30,870 --> 00:04:28,639

me back on man great to hear your voice

92

00:04:33,110 --> 00:04:30,880

my man great to hear your voice i you

93

00:04:34,070 --> 00:04:33,120

know um

94

00:04:37,749 --> 00:04:34,080

uh

95

00:04:40,790 --> 00:04:37,759

guys like you um isaac

96

00:04:42,790 --> 00:04:40,800

uh sometimes i get a little intimidated

97

00:04:45,430 --> 00:04:42,800

because i don't have that education

98

00:04:48,950 --> 00:04:45,440

behind me and i try

99

00:04:50,790 --> 00:04:48,960

uh to self you know to be self-taught

100

00:04:53,030 --> 00:04:50,800

and learn and acquire

101

00:04:55,830 --> 00:04:53,040

uh these very intimidating things but

102

00:04:58,870 --> 00:04:55,840

but with you i'm totally comfortable and

103

00:05:01,749 --> 00:04:58,880

i think that that resonates through

104

00:05:04,390 --> 00:05:01,759

your uh the popularity that you have uh

105

00:05:06,230 --> 00:05:04,400

achieved on your channel that you break

106

00:05:08,150 --> 00:05:06,240

this down for everybody that is out

107

00:05:10,310 --> 00:05:08,160

there hungry for this knowledge but they

108

00:05:12,469 --> 00:05:10,320

don't know where to get it and and i

109

00:05:15,029 --> 00:05:12,479

just want to thank you for that because

110

00:05:17,909 --> 00:05:15,039

uh you have a very sensible way

111

00:05:20,710 --> 00:05:17,919

of presenting this until

112

00:05:22,430 --> 00:05:20,720

you get down to those crazy

113

00:05:24,550 --> 00:05:22,440

crazy

114

00:05:27,510 --> 00:05:24,560

mathematical symbols

115

00:05:30,230 --> 00:05:27,520

it it and and this is where i want to

116

00:05:31,430 --> 00:05:30,240

start okay when i look at

117

00:05:33,270 --> 00:05:31,440

um

118

00:05:34,710 --> 00:05:33,280

some formula

119

00:05:36,790 --> 00:05:34,720

something that breaks down you got an

120

00:05:39,510 --> 00:05:36,800

equal sign in the middle right

121

00:05:41,990 --> 00:05:39,520

you got these things going on both sides

122

00:05:44,950 --> 00:05:42,000

is that a secret is that a secret

123

00:05:47,350 --> 00:05:44,960

language is that something that prevents

124

00:05:49,830 --> 00:05:47,360

anybody else from looking at it because

125

00:05:52,310 --> 00:05:49,840

honestly you could write anything on

126
00:05:53,670 --> 00:05:52,320
that chalkboard and most people don't

127
00:05:54,870 --> 00:05:53,680
understand it

128
00:05:56,150 --> 00:05:54,880
you know i was about to say that it's

129
00:05:57,830 --> 00:05:56,160
not a secret language but i think

130
00:05:59,350 --> 00:05:57,840
they've actually used geometry and

131
00:06:01,029 --> 00:05:59,360
things like that as secret languages a

132
00:06:02,150 --> 00:06:01,039
few times in the past

133
00:06:02,950 --> 00:06:02,160
um

134
00:06:04,790 --> 00:06:02,960
and

135
00:06:07,189 --> 00:06:04,800
i mean the idea with the math of course

136
00:06:09,670 --> 00:06:07,199
is that these concepts are easier done

137
00:06:11,189 --> 00:06:09,680
and described accurately with math but

138
00:06:12,710 --> 00:06:11,199

usually feel as one of the reasons why

139

00:06:14,710 --> 00:06:12,720

we never put anything up there much more

140

00:06:16,230 --> 00:06:14,720

complex than algebra on the screen at

141

00:06:17,590 --> 00:06:16,240

least um

142

00:06:20,070 --> 00:06:17,600

if you've got to use a lot of math to

143

00:06:21,510 --> 00:06:20,080

explain it as a concept not to work with

144

00:06:23,430 --> 00:06:21,520

it but to explain it

145

00:06:25,350 --> 00:06:23,440

you're probably not understanding as

146

00:06:26,629 --> 00:06:25,360

well as you can yourself so

147

00:06:27,830 --> 00:06:26,639

unfortunately that does tend to break

148

00:06:29,510 --> 00:06:27,840

down for some things like general

149

00:06:31,670 --> 00:06:29,520

relativity and string theory those you

150

00:06:35,350 --> 00:06:31,680

you really do need the math on those

151

00:06:38,550 --> 00:06:35,360

right you know i remember um

152

00:06:41,430 --> 00:06:38,560

he recently talked about this and uh but

153

00:06:43,590 --> 00:06:41,440

i remember uh watching a documentary a

154

00:06:45,430 --> 00:06:43,600

few years ago on

155

00:06:48,870 --> 00:06:45,440

uh radar

156

00:06:50,870 --> 00:06:48,880

and how planes are tracked and how they

157

00:06:53,029 --> 00:06:50,880

do this accurately and they couldn't do

158

00:06:56,870 --> 00:06:53,039

it until they inserted

159

00:06:58,790 --> 00:06:56,880

um a random negative uh uh integer

160

00:07:01,670 --> 00:06:58,800

number in in it

161

00:07:04,230 --> 00:07:01,680

that technically meant nothing but it

162

00:07:07,430 --> 00:07:04,240

was the only way that they could get the

163

00:07:09,830 --> 00:07:07,440

software and the numbers to work

164

00:07:11,990 --> 00:07:09,840

for these very complex radar systems

165

00:07:14,070 --> 00:07:12,000

that are used all around the world

166

00:07:16,390 --> 00:07:14,080

and and i thought to myself that doesn't

167

00:07:17,909 --> 00:07:16,400

make any sense

168

00:07:19,990 --> 00:07:17,919

where does that come from and you

169

00:07:22,309 --> 00:07:20,000

recently addressed this and i remember

170

00:07:24,629 --> 00:07:22,319

you saying something like well okay that

171

00:07:27,589 --> 00:07:24,639

the forget about the negative number

172

00:07:30,870 --> 00:07:27,599

there um but it it needs to be there

173

00:07:32,790 --> 00:07:30,880

again this adds to the mystery for for

174

00:07:35,189 --> 00:07:32,800

most of us that don't understand math

175

00:07:37,430 --> 00:07:35,199

and we get into these equations right

176

00:07:39,270 --> 00:07:37,440

what's the need for something like that

177

00:07:41,270 --> 00:07:39,280

but it adds to

178

00:07:44,070 --> 00:07:41,280

uh the complexity of it where we just

179

00:07:46,070 --> 00:07:44,080

can't wrap our minds around it uh isaac

180

00:07:47,990 --> 00:07:46,080

yeah i mean i get a great example is

181

00:07:49,510 --> 00:07:48,000

those negative numbers so much what we

182

00:07:51,430 --> 00:07:49,520

talk about in in physics we talk about

183

00:07:53,430 --> 00:07:51,440

things like wormholes or time travel or

184

00:07:55,510 --> 00:07:53,440

going faster than light that all relies

185

00:07:57,110 --> 00:07:55,520

on negative numbers and

186

00:07:59,510 --> 00:07:57,120

they work great in math but they're kind

187

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

of like accounting and uh the only real

188

00:08:02,710 --> 00:08:00,960

excuse we have for using them is it does

189

00:08:04,629 --> 00:08:02,720

look like the universe sometimes engages

190

00:08:06,629 --> 00:08:04,639

in accounting itself so you could have a

191

00:08:08,790 --> 00:08:06,639

negative dollar on a sheet of paper but

192

00:08:10,309 --> 00:08:08,800

you can't really have one in your hand

193

00:08:11,670 --> 00:08:10,319

and uh it looks like at the quantum

194

00:08:13,510 --> 00:08:11,680

level at least maybe the universe

195

00:08:15,110 --> 00:08:13,520

actually does let you have negatives for

196

00:08:17,990 --> 00:08:15,120

counting purposes

197

00:08:19,990 --> 00:08:18,000

and uh negative mass now we're going to

198

00:08:23,189 --> 00:08:20,000

get into some real subjects here in a

199

00:08:24,790 --> 00:08:23,199

second everybody but negative mass is

200

00:08:27,189 --> 00:08:24,800

something that we're going to discuss a

201

00:08:29,830 --> 00:08:27,199

few times tonight too as well

202

00:08:32,230 --> 00:08:29,840

and to make some of these very complex

203

00:08:35,430 --> 00:08:32,240

uh theories and ideas work

204

00:08:36,870 --> 00:08:35,440

negative mass comes into play uh explain

205

00:08:38,790 --> 00:08:36,880

that really quick because we're gonna

206

00:08:41,269 --> 00:08:38,800

we're gonna mention this quite a few

207

00:08:43,110 --> 00:08:41,279

times tonight well the one downside with

208

00:08:44,870 --> 00:08:43,120

negative mass is that what we call mass

209

00:08:47,430 --> 00:08:44,880

is actually kind of three correlated

210

00:08:49,110 --> 00:08:47,440

things there's mass or inertial mass how

211

00:08:51,430 --> 00:08:49,120

hard it is to push on something so if it

212

00:08:53,509 --> 00:08:51,440

had a negative um an inertial mass if

213

00:08:55,509 --> 00:08:53,519

you pushed on it would come towards you

214

00:08:57,670 --> 00:08:55,519

that you got negative gravitational mass

215

00:08:59,350 --> 00:08:57,680

in terms of the attractive component uh

216

00:09:00,870 --> 00:08:59,360

which you say would push you away if it

217

00:09:02,310 --> 00:09:00,880

was a planet of negative mass it would

218

00:09:03,269 --> 00:09:02,320

push you away but of course you could

219

00:09:05,430 --> 00:09:03,279

never have such thing because it

220

00:09:06,550 --> 00:09:05,440

couldn't form would push itself apart

221

00:09:07,829 --> 00:09:06,560

and then you've got the other one which

222

00:09:10,150 --> 00:09:07,839

is the responsiveness to it which should

223

00:09:12,630 --> 00:09:10,160

be your anti-gravity example you don't

224

00:09:15,110 --> 00:09:12,640

respond to gravity when it pulls on you

225

00:09:17,350 --> 00:09:15,120

by falling towards things you fall away

226

00:09:18,870 --> 00:09:17,360

and each of these properties and

227

00:09:20,949 --> 00:09:18,880

negative mass could theoretically have

228

00:09:24,870 --> 00:09:20,959

one two or three of those

229

00:09:27,350 --> 00:09:24,880

is incredibly useful if the stuff exists

230

00:09:30,470 --> 00:09:27,360

right and so

231

00:09:33,269 --> 00:09:30,480

um okay now this is where i've got a a

232

00:09:34,230 --> 00:09:33,279

list of a few questions

233

00:09:37,350 --> 00:09:34,240

um

234

00:09:39,190 --> 00:09:37,360

that i want to discuss gravity first and

235

00:09:40,150 --> 00:09:39,200

and try to simplify it

236

00:09:44,870 --> 00:09:40,160

um

237

00:09:46,870 --> 00:09:44,880

you just stated uh that gravity pulls

238

00:09:48,230 --> 00:09:46,880

yes it's the only purely attractive

239

00:09:50,470 --> 00:09:48,240

force we have

240

00:09:51,829 --> 00:09:50,480

but all the others push or pull

241

00:09:55,829 --> 00:09:51,839

but

242

00:09:58,710 --> 00:09:55,839

yet i feel that it pushes too

243

00:10:01,269 --> 00:09:58,720

in other words uh

244

00:10:02,389 --> 00:10:01,279

couldn't it be the same

245

00:10:04,550 --> 00:10:02,399

thing

246

00:10:07,190 --> 00:10:04,560

gravity doesn't change but depends on

247

00:10:08,870 --> 00:10:07,200

what side of it you're on

248

00:10:10,710 --> 00:10:08,880

well it's i mean this is the big problem

249

00:10:12,710 --> 00:10:10,720

with gravity it's the oldest force we

250

00:10:14,389 --> 00:10:12,720

know of but we know so little about it

251
00:10:16,230 --> 00:10:14,399
and it's so much weaker than the others

252
00:10:18,550 --> 00:10:16,240
some folks think that it's probably tied

253
00:10:20,630 --> 00:10:18,560
into dark energy which is expanding

254
00:10:22,470 --> 00:10:20,640
space and time which is what gravity

255
00:10:23,829 --> 00:10:22,480
doesn't do it contracts it right right

256
00:10:25,430 --> 00:10:23,839
and then they'll also say well maybe

257
00:10:27,110 --> 00:10:25,440
gravity's leaking over from other

258
00:10:28,710 --> 00:10:27,120
dimensions so that's why it's so weak

259
00:10:30,710 --> 00:10:28,720
it's trying to do all of our parallel

260
00:10:32,069 --> 00:10:30,720
realities at the same time

261
00:10:33,590 --> 00:10:32,079
and i mean there are so many different

262
00:10:34,949 --> 00:10:33,600
versions of this and and there's there

263
00:10:36,870 --> 00:10:34,959

are great theories for this too and

264

00:10:38,389 --> 00:10:36,880

there's so much good stuff on paper

265

00:10:40,230 --> 00:10:38,399

the problem is it's all on paper we

266

00:10:42,470 --> 00:10:40,240

haven't got any empirical evidence to

267

00:10:44,790 --> 00:10:42,480

support any of these theories yet now

268

00:10:47,509 --> 00:10:44,800

i've i've got a few uh things that i

269

00:10:51,030 --> 00:10:47,519

want to pop out there uh including these

270

00:10:52,230 --> 00:10:51,040

questions but when we discuss gravity

271

00:10:54,630 --> 00:10:52,240

we have

272

00:10:55,509 --> 00:10:54,640

gravity at the quantum level

273

00:10:59,110 --> 00:10:55,519

right

274

00:11:01,110 --> 00:10:59,120

we have gravity of our earth we have the

275

00:11:03,910 --> 00:11:01,120

moon we have what's holding us to the

276

00:11:05,910 --> 00:11:03,920

sun the sun is moving around it's not

277

00:11:08,389 --> 00:11:05,920

the center of our solar system it's

278

00:11:10,790 --> 00:11:08,399

actually in orbit around a central point

279

00:11:12,949 --> 00:11:10,800

too as well so there's gravity there

280

00:11:15,670 --> 00:11:12,959

then we have the gravity of

281

00:11:18,710 --> 00:11:15,680

what is holding our milky way together

282

00:11:21,190 --> 00:11:18,720

and it it just expands expands but

283

00:11:24,470 --> 00:11:21,200

yet out in the

284

00:11:27,030 --> 00:11:24,480

universe things are moving outward and

285

00:11:29,030 --> 00:11:27,040

they're not pulling inward and there

286

00:11:31,990 --> 00:11:29,040

isn't a central spot

287

00:11:33,990 --> 00:11:32,000

of gravity holding everything together

288

00:11:36,790 --> 00:11:34,000

so it doesn't it doesn't really make

289

00:11:38,790 --> 00:11:36,800

sense to me that we have different types

290

00:11:40,230 --> 00:11:38,800

of gravity

291

00:11:41,910 --> 00:11:40,240

well we can make it even worse these are

292

00:11:43,269 --> 00:11:41,920

the same types of gravity in theory but

293

00:11:45,030 --> 00:11:43,279

we always say you can't move anything

294

00:11:47,030 --> 00:11:45,040

faster than speed of light and yet the

295

00:11:48,550 --> 00:11:47,040

super majority of mass we can observe is

296

00:11:50,310 --> 00:11:48,560

actually traveling away from us faster

297

00:11:52,069 --> 00:11:50,320

than lights

298

00:11:53,910 --> 00:11:52,079

um but

299

00:11:55,590 --> 00:11:53,920

the thing is the gravity to the best of

300

00:11:57,110 --> 00:11:55,600

our knowledge acts the same at every

301
00:11:59,030 --> 00:11:57,120
scale it's just whether or not it's

302
00:12:00,949 --> 00:11:59,040
dominant when you're dealing at the

303
00:12:02,470 --> 00:12:00,959
quantum level assuming even functions

304
00:12:04,550 --> 00:12:02,480
right we have no working theory for

305
00:12:06,389 --> 00:12:04,560
quantum gravity at all right now

306
00:12:07,829 --> 00:12:06,399
um there's all those other forces that

307
00:12:09,910 --> 00:12:07,839
are so much stronger but those have a

308
00:12:11,350 --> 00:12:09,920
repulsive and attractive force they tend

309
00:12:12,949 --> 00:12:11,360
to negate out

310
00:12:15,190 --> 00:12:12,959
and the electric charge on this planet

311
00:12:17,269 --> 00:12:15,200
is huge but all cancels out so gravity

312
00:12:20,310 --> 00:12:17,279
dominates and that's what's interesting

313
00:12:22,550 --> 00:12:20,320

to me in that uh the the

314

00:12:24,550 --> 00:12:22,560

the gravity at the atomic level what is

315

00:12:27,750 --> 00:12:24,560

holding atoms together

316

00:12:30,470 --> 00:12:27,760

is so extreme that we can't tear it

317

00:12:32,150 --> 00:12:30,480

apart it appears well we can i mean you

318

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

know with the collider and stuff but

319

00:12:35,190 --> 00:12:33,519

well that's not gravity that's the

320

00:12:38,230 --> 00:12:35,200

strong nuclear force one of the other

321

00:12:40,069 --> 00:12:38,240

three forces one of the three forces but

322

00:12:42,150 --> 00:12:40,079

yet the

323

00:12:45,110 --> 00:12:42,160

the fact that we can jump up and down

324

00:12:46,310 --> 00:12:45,120

and pull away from gravity if we have to

325

00:12:50,949 --> 00:12:46,320

right

326

00:12:52,949 --> 00:12:50,959

but yet it is the glue that is holding

327

00:12:55,590 --> 00:12:52,959

everything together at the same time

328

00:12:57,590 --> 00:12:55,600

sure it takes a trillion trillion times

329

00:12:59,269 --> 00:12:57,600

more mass than a person has to hold your

330

00:13:00,629 --> 00:12:59,279

feet to the ground right now that i mean

331

00:13:02,150 --> 00:13:00,639

that's how much heavier the earth is a

332

00:13:03,030 --> 00:13:02,160

trillion trillion times more mass than

333

00:13:05,590 --> 00:13:03,040

us

334

00:13:06,790 --> 00:13:05,600

and that's all the gravity it generates

335

00:13:07,750 --> 00:13:06,800

and that's very weak when you think

336

00:13:09,590 --> 00:13:07,760

about it

337

00:13:11,910 --> 00:13:09,600

uh but electric charge on the other hand

338

00:13:13,750 --> 00:13:11,920

if you had nothing but a handful of

339

00:13:15,350 --> 00:13:13,760

positively charged particles that would

340

00:13:17,190 --> 00:13:15,360

be real quite able to move like a

341

00:13:19,269 --> 00:13:17,200

building it would just yank it right

342

00:13:21,350 --> 00:13:19,279

that's how big the difference is because

343

00:13:22,710 --> 00:13:21,360

there's much stronger force so it's i

344

00:13:24,870 --> 00:13:22,720

think it's uh

345

00:13:26,790 --> 00:13:24,880

like 10 to the 40th times stronger than

346

00:13:28,550 --> 00:13:26,800

gravity like trillion trillion trillion

347

00:13:30,790 --> 00:13:28,560

times then some change much stronger

348

00:13:32,550 --> 00:13:30,800

force but negates out so you get these

349

00:13:34,470 --> 00:13:32,560

dominant effects the gravity is not

350

00:13:35,990 --> 00:13:34,480

changing as you get to bigger scales

351

00:13:37,670 --> 00:13:36,000

it's how much the other forces are

352

00:13:39,990 --> 00:13:37,680

getting negated out when you get past

353

00:13:41,590 --> 00:13:40,000

the galactic scale that dark energy

354

00:13:43,509 --> 00:13:41,600

starts to kick in now that's always in

355

00:13:45,590 --> 00:13:43,519

place to begin with too we think little

356

00:13:47,110 --> 00:13:45,600

pockets of space-time tinier than an

357

00:13:48,870 --> 00:13:47,120

atom will pop you up everywhere all the

358

00:13:49,910 --> 00:13:48,880

time that's our best guess right now for

359

00:13:51,190 --> 00:13:49,920

dark energy and there's a lot of

360

00:13:53,829 --> 00:13:51,200

guesswork there

361

00:13:55,110 --> 00:13:53,839

but that's such a minor factor that you

362

00:13:56,790 --> 00:13:55,120

know inside you these little things will

363

00:13:58,550 --> 00:13:56,800

pop you up but you won't even notice at

364

00:14:00,310 --> 00:13:58,560

the solar system scale that's still so

365

00:14:01,670 --> 00:14:00,320

minimal you can't really notice

366

00:14:03,910 --> 00:14:01,680

you have to get up to all the way to the

367

00:14:05,189 --> 00:14:03,920

galactic scale where gravity is so weak

368

00:14:08,150 --> 00:14:05,199

pulling between these things before you

369

00:14:10,069 --> 00:14:08,160

can actually see this dark energy effect

370

00:14:13,030 --> 00:14:10,079

so it becomes a dominant factor there

371

00:14:16,550 --> 00:14:13,040

yes yes it's it's fascinating to me and

372

00:14:20,389 --> 00:14:16,560

now let's stay right here

373

00:14:21,990 --> 00:14:20,399

is if you went out is there any part of

374

00:14:25,189 --> 00:14:22,000

space

375

00:14:26,550 --> 00:14:25,199

any part that has nothing in it

376

00:14:29,030 --> 00:14:26,560

empty space

377

00:14:31,110 --> 00:14:29,040

there isn't is there and it that's a

378

00:14:32,150 --> 00:14:31,120

that's a misconception

379

00:14:35,189 --> 00:14:32,160

that

380

00:14:37,189 --> 00:14:35,199

many have had even you know you can say

381

00:14:39,829 --> 00:14:37,199

in the vacuum of space

382

00:14:42,470 --> 00:14:39,839

but there is always something present

383

00:14:43,829 --> 00:14:42,480

correct yeah we've made vacuums in a

384

00:14:45,750 --> 00:14:43,839

laboratory that still aren't perfect

385

00:14:47,269 --> 00:14:45,760

vacuums that are more empty than

386

00:14:48,949 --> 00:14:47,279

anything you'll find in space even in

387

00:14:50,870 --> 00:14:48,959

the voids people talk about those are

388

00:14:53,590 --> 00:14:50,880

voids only in the same way that a desert

389

00:14:54,550 --> 00:14:53,600

is dry they're still oasis

390

00:14:56,629 --> 00:14:54,560

but

391

00:14:58,389 --> 00:14:56,639

you can make a vacuum that has no

392

00:15:00,069 --> 00:14:58,399

particles in it at all and you still

393

00:15:01,350 --> 00:15:00,079

have particles kicking around that pop

394

00:15:02,790 --> 00:15:01,360

in and out of existence as best you can

395

00:15:04,870 --> 00:15:02,800

tell that's that quantum foam and

396

00:15:08,550 --> 00:15:04,880

virtual particle stuff right right right

397

00:15:11,110 --> 00:15:08,560

fascinating okay so that clears up that

398

00:15:12,550 --> 00:15:11,120

let's go to the next uh question that i

399

00:15:13,910 --> 00:15:12,560

have

400

00:15:16,150 --> 00:15:13,920

light

401
00:15:19,269 --> 00:15:16,160

okay now uh

402
00:15:21,430 --> 00:15:19,279

waves or particles

403
00:15:23,030 --> 00:15:21,440

and photons okay but let's talk about

404
00:15:27,430 --> 00:15:23,040

light for a second

405
00:15:29,430 --> 00:15:27,440

does light have a half-life

406
00:15:31,829 --> 00:15:29,440

it might but the problem is that light

407
00:15:34,069 --> 00:15:31,839

doesn't experience any time so if that

408
00:15:36,069 --> 00:15:34,079

half-life could be 5 seconds or 50

409
00:15:37,509 --> 00:15:36,079

trillion years no time is passing for

410
00:15:40,310 --> 00:15:37,519

the photon because it moves at light

411
00:15:41,990 --> 00:15:40,320

speed so if it had a half-life we'd

412
00:15:42,710 --> 00:15:42,000

never be able to tell

413
00:15:44,389 --> 00:15:42,720

so

414

00:15:47,590 --> 00:15:44,399

a photon

415

00:15:48,710 --> 00:15:47,600

the the single you know uh element of

416

00:15:50,710 --> 00:15:48,720

light

417

00:15:52,470 --> 00:15:50,720

you know not from

418

00:15:55,189 --> 00:15:52,480

separated from a wave right where we

419

00:15:59,030 --> 00:15:55,199

break it down to the photon level does a

420

00:16:00,470 --> 00:15:59,040

photon have a half-life

421

00:16:02,150 --> 00:16:00,480

if it does we'd have no way to tell

422

00:16:03,910 --> 00:16:02,160

again that there's no time being

423

00:16:05,350 --> 00:16:03,920

experienced by that object and that

424

00:16:07,030 --> 00:16:05,360

seems like it's traveling through space

425

00:16:08,870 --> 00:16:07,040

but it's really just got this timeline

426

00:16:11,189 --> 00:16:08,880

it's on for where it's trashy in a

427

00:16:13,189 --> 00:16:11,199

straight line it experiences no time if

428

00:16:14,629 --> 00:16:13,199

you're a photon you had a watch i mean

429

00:16:16,230 --> 00:16:14,639

you've never seen any time pass on that

430

00:16:17,110 --> 00:16:16,240

watch

431

00:16:20,550 --> 00:16:17,120

but

432

00:16:23,749 --> 00:16:20,560

this is this is okay so

433

00:16:27,350 --> 00:16:23,759

where does the energy

434

00:16:30,389 --> 00:16:27,360

come from for a photon to technically

435

00:16:32,069 --> 00:16:30,399

exist forever

436

00:16:34,150 --> 00:16:32,079

well nothing's causing it to cease to

437

00:16:35,509 --> 00:16:34,160

exist energy can't be

438

00:16:37,509 --> 00:16:35,519

created or destroyed to the best of our

439

00:16:39,110 --> 00:16:37,519

knowledge and although things like the

440

00:16:41,189 --> 00:16:39,120

big bang and dark energy would kind of

441

00:16:43,590 --> 00:16:41,199

challenge that assumption but in general

442

00:16:45,670 --> 00:16:43,600

energy can't be created or destroyed you

443

00:16:47,829 --> 00:16:45,680

can absorb a photon shine a flashlight

444

00:16:49,110 --> 00:16:47,839

on something black it gets absorbed but

445

00:16:50,710 --> 00:16:49,120

left to itself it would just float

446

00:16:52,470 --> 00:16:50,720

through the void nothing's affecting it

447

00:16:54,870 --> 00:16:52,480

so there's no change that energy just

448

00:16:56,470 --> 00:16:54,880

stays there except it's not really stain

449

00:16:57,590 --> 00:16:56,480

it's moving that straight line of course

450

00:16:59,269 --> 00:16:57,600

towards whatever that photons

451
00:17:01,350 --> 00:16:59,279
destination might be

452
00:17:04,150 --> 00:17:01,360
it it okay so

453
00:17:07,350 --> 00:17:04,160
when uh

454
00:17:11,189 --> 00:17:07,360
when light reaches us from

455
00:17:13,110 --> 00:17:11,199
eight million light years away right

456
00:17:15,270 --> 00:17:13,120
whatever it whatever it is out there

457
00:17:17,429 --> 00:17:15,280
that is reaching us

458
00:17:18,789 --> 00:17:17,439
that will continue

459
00:17:20,069 --> 00:17:18,799
past us

460
00:17:22,230 --> 00:17:20,079
forever

461
00:17:23,669 --> 00:17:22,240
unless we absorb it yeah um cosmic

462
00:17:25,189 --> 00:17:23,679
microwave background radiation

463
00:17:26,630 --> 00:17:25,199

everyone's heard about that that's stuff

464

00:17:29,430 --> 00:17:26,640

that's left over from when the universe

465

00:17:30,630 --> 00:17:29,440

was very young and when it was made this

466

00:17:32,390 --> 00:17:30,640

is you know these microwaves are very

467

00:17:33,510 --> 00:17:32,400

weak energy sources

468

00:17:35,830 --> 00:17:33,520

when it was made it would actually have

469

00:17:37,430 --> 00:17:35,840

been visible light or high infrared it's

470

00:17:39,669 --> 00:17:37,440

redshifted it's gotten weaker what time

471

00:17:42,230 --> 00:17:39,679

is it past that distance right

472

00:17:43,830 --> 00:17:42,240

now a flashlight which you brought up

473

00:17:46,789 --> 00:17:43,840

earlier

474

00:17:48,310 --> 00:17:46,799

why does a flashlight dissipate over

475

00:17:49,990 --> 00:17:48,320

distance

476

00:17:51,590 --> 00:17:50,000

well those are where it's spreading out

477

00:17:53,110 --> 00:17:51,600

and that's that's a common misconception

478

00:17:54,950 --> 00:17:53,120

about laser beams people think it was a

479

00:17:56,789 --> 00:17:54,960

beam that stays tight but it actually

480

00:18:00,230 --> 00:17:56,799

doesn't it's just like a flashlight only

481

00:18:02,070 --> 00:18:00,240

it's way way tighter so it will stay

482

00:18:03,430 --> 00:18:02,080

point like or thin for much longer

483

00:18:05,430 --> 00:18:03,440

period of time but it is spreading out

484

00:18:06,390 --> 00:18:05,440

from the moment it leaves the laser

485

00:18:08,390 --> 00:18:06,400

um

486

00:18:09,909 --> 00:18:08,400

it's same as a flashlight would it just

487

00:18:11,270 --> 00:18:09,919

takes a lot longer to spread out and

488

00:18:13,029 --> 00:18:11,280

that becomes a problem when you're

489

00:18:14,630 --> 00:18:13,039

trying to use lasers over long distances

490

00:18:16,630 --> 00:18:14,640

like pushing spaceships or sending

491

00:18:19,590 --> 00:18:16,640

signals you need a ramp up the power

492

00:18:21,190 --> 00:18:19,600

because it stays a lot tighter but it's

493

00:18:23,430 --> 00:18:21,200

ultimately really just a much more

494

00:18:24,710 --> 00:18:23,440

focused and collimated beam

495

00:18:25,909 --> 00:18:24,720

but uh

496

00:18:27,990 --> 00:18:25,919

again

497

00:18:31,909 --> 00:18:28,000

are the photons

498

00:18:34,150 --> 00:18:31,919

from a flashlight existing forever

499

00:18:36,070 --> 00:18:34,160

yes left themselves they will exist well

500

00:18:37,510 --> 00:18:36,080

they just spread out as they go

501
00:18:38,870 --> 00:18:37,520
the beam gets weaker just like if you

502
00:18:40,630 --> 00:18:38,880
step away from the wall while hoarding

503
00:18:43,350 --> 00:18:40,640
it will get uh you know dimmer on the

504
00:18:44,870 --> 00:18:43,360
wall yeah because it's cone-shaped

505
00:18:47,270 --> 00:18:44,880
mm-hmm the beams there's a laser beam

506
00:18:49,830 --> 00:18:47,280
yeah and the laser beam is too right so

507
00:18:52,390 --> 00:18:49,840
if okay all right

508
00:18:54,950 --> 00:18:52,400
it's still a little it will go

509
00:18:56,950 --> 00:18:54,960
it's it it's still a little confusing to

510
00:18:58,870 --> 00:18:56,960
me in that everything's got a half-life

511
00:19:00,789 --> 00:18:58,880
right that's what we've been told about

512
00:19:02,870 --> 00:19:00,799
that uh we thought the proton did for

513
00:19:04,549 --> 00:19:02,880

the longest time but the problem is that

514

00:19:05,830 --> 00:19:04,559

as best as we can tell

515

00:19:07,190 --> 00:19:05,840

it's half-life because we assumed

516

00:19:09,990 --> 00:19:07,200

everything's got to have a half-life

517

00:19:11,350 --> 00:19:10,000

right um but as best we can tell protons

518

00:19:12,870 --> 00:19:11,360

that they have a half-life would be

519

00:19:15,190 --> 00:19:12,880

trillions and trillions and trillions of

520

00:19:16,549 --> 00:19:15,200

years but you never absorb one decaying

521

00:19:17,990 --> 00:19:16,559

now with a photon it's actually a little

522

00:19:20,230 --> 00:19:18,000

bit more problematic because it could

523

00:19:22,470 --> 00:19:20,240

have any half-life it wants but it's

524

00:19:24,390 --> 00:19:22,480

frozen in time it's the same as you

525

00:19:26,310 --> 00:19:24,400

would say if i put somebody on ice

526
00:19:28,549 --> 00:19:26,320
they should only live 70 years but while

527
00:19:30,310 --> 00:19:28,559
i've got them frozen they're not aging

528
00:19:32,390 --> 00:19:30,320
photons the same way

529
00:19:34,630 --> 00:19:32,400
if it has a half-life it wouldn't be

530
00:19:37,110 --> 00:19:34,640
able to actually ever decay because it

531
00:19:38,990 --> 00:19:37,120
just keeps it's frozen in time

532
00:19:41,270 --> 00:19:39,000
now okay so let's talk about

533
00:19:44,230 --> 00:19:41,280
electromagnetism for a second is there a

534
00:19:46,230 --> 00:19:44,240
half-life involved with that

535
00:19:48,630 --> 00:19:46,240
em is the same thing as photons uh

536
00:19:50,310 --> 00:19:48,640
whether it's a radio wave or a gamma-ray

537
00:19:51,590 --> 00:19:50,320
or some of the really high-energy things

538
00:19:53,830 --> 00:19:51,600

that you know might have been made by

539

00:19:55,430 --> 00:19:53,840

the big bang or by super collider those

540

00:19:57,110 --> 00:19:55,440

are all fundamentally photons they all

541

00:19:58,070 --> 00:19:57,120

act the same that's the electromagnetic

542

00:19:59,909 --> 00:19:58,080

force

543

00:20:02,150 --> 00:19:59,919

and so em

544

00:20:03,990 --> 00:20:02,160

again i i know that i'm bringing you

545

00:20:07,590 --> 00:20:04,000

down to my level and answering these

546

00:20:10,549 --> 00:20:07,600

questions but this is these get to be

547

00:20:15,029 --> 00:20:10,559

confusing subjects for uh for a lot of

548

00:20:18,310 --> 00:20:15,039

people so staying on em for a second em

549

00:20:21,590 --> 00:20:18,320

uh which uh uh you know one of the uh

550

00:20:25,669 --> 00:20:21,600

fundamental forces if it is present it

551

00:20:27,909 --> 00:20:25,679

will never go away it it lasts forever

552

00:20:29,830 --> 00:20:27,919

when it's a photon yeah a magnet or an

553

00:20:31,110 --> 00:20:29,840

electric only thing like a static

554

00:20:33,270 --> 00:20:31,120

electric charge that can obviously

555

00:20:35,029 --> 00:20:33,280

dissipate though the energy there isn't

556

00:20:39,909 --> 00:20:35,039

isn't going away it's just changing what

557

00:20:41,990 --> 00:20:39,919

type it is now will uh em in metal uh

558

00:20:43,270 --> 00:20:42,000

dissipate over time

559

00:20:44,630 --> 00:20:43,280

it will get absorbed by the middle i

560

00:20:46,390 --> 00:20:44,640

mean that's how everyone's listening to

561

00:20:48,630 --> 00:20:46,400

this right now is listen radio those

562

00:20:49,909 --> 00:20:48,640

photons get sucked up or emitted yeah

563

00:20:51,590 --> 00:20:49,919

right right

564

00:20:53,110 --> 00:20:51,600

fascinating the game changes the moment

565

00:20:55,430 --> 00:20:53,120

anything it touches any matter it

566

00:20:58,950 --> 00:20:55,440

changes right right right

567

00:21:01,510 --> 00:20:58,960

okay um i feel a little better i feel

568

00:21:02,710 --> 00:21:01,520

like we can move on okay before we get

569

00:21:06,070 --> 00:21:02,720

to the break

570

00:21:08,470 --> 00:21:06,080

uh i want to uh uh do a couple of things

571

00:21:10,630 --> 00:21:08,480

here and one is uh since we're

572

00:21:12,149 --> 00:21:10,640

discussing clark tech

573

00:21:16,710 --> 00:21:12,159

here's a quote

574

00:21:18,470 --> 00:21:16,720

that arthur c clarke used to use and

575

00:21:22,230 --> 00:21:18,480

it's this

576

00:21:24,549 --> 00:21:22,240

it's attributed to a jbs uh um haldane

577

00:21:26,070 --> 00:21:24,559

but the universe is not only stranger

578

00:21:29,590 --> 00:21:26,080

than we imagine

579

00:21:32,230 --> 00:21:29,600

it's stranger than we can imagine and

580

00:21:35,510 --> 00:21:32,240

clark used to say this quote uh quite

581

00:21:37,590 --> 00:21:35,520

often and and and of course attribute it

582

00:21:41,750 --> 00:21:37,600

and give credit back to uh

583

00:21:44,710 --> 00:21:41,760

haldane but the actual quote is this

584

00:21:46,470 --> 00:21:44,720

quote i have no doubt that in reality

585

00:21:49,669 --> 00:21:46,480

the future will be vastly more

586

00:21:52,149 --> 00:21:49,679

surprising than anything i can imagine

587

00:21:54,870 --> 00:21:52,159

now my own suspicion is that the

588

00:21:59,510 --> 00:21:54,880

universe is not only queerer than we

589

00:22:01,669 --> 00:21:59,520

supposed but queerer than we can suppose

590

00:22:03,789 --> 00:22:01,679

and that is from his paper possible

591

00:22:07,750 --> 00:22:03,799

worlds and other papers published in

592

00:22:10,070 --> 00:22:07,760

1927 that comes from page 286.

593

00:22:12,950 --> 00:22:10,080

that's a pretty fascinating quote isn't

594

00:22:15,190 --> 00:22:12,960

it and i think that uh it is

595

00:22:18,870 --> 00:22:15,200

it it not only applies to this show

596

00:22:20,950 --> 00:22:18,880

tonight but it applies to you doesn't it

597

00:22:22,710 --> 00:22:20,960

oh absolutely i you know we try always

598

00:22:24,230 --> 00:22:22,720

talk about what science tells us about

599

00:22:26,390 --> 00:22:24,240

the universe and what we can do inside

600

00:22:27,830 --> 00:22:26,400

known science but i and everybody else

601
00:22:29,750 --> 00:22:27,840
just takes a given that we're going to

602
00:22:31,990 --> 00:22:29,760
find out the universe is a much stranger

603
00:22:34,470 --> 00:22:32,000
place than we think it is

604
00:22:37,029 --> 00:22:34,480
is there a day that goes by that you you

605
00:22:39,830 --> 00:22:37,039
don't realize that this quote is

606
00:22:41,510 --> 00:22:39,840
is stronger than it was yesterday i

607
00:22:43,350 --> 00:22:41,520
don't know there's always something new

608
00:22:44,549 --> 00:22:43,360
and um a lot of times it's not really so

609
00:22:46,070 --> 00:22:44,559
much new in the sense of something

610
00:22:48,549 --> 00:22:46,080
groundbreaking those tend to come a

611
00:22:49,909 --> 00:22:48,559
little bit less frequently but uh if

612
00:22:51,990 --> 00:22:49,919
there's a day that you don't get

613
00:22:54,310 --> 00:22:52,000

surprised by the universe around you it

614

00:22:57,430 --> 00:22:54,320

probably indicates you're in a grave

615

00:23:00,470 --> 00:22:57,440

which might be surprising too

616

00:23:02,310 --> 00:23:00,480

well then we have clark's three laws and

617

00:23:05,830 --> 00:23:02,320

the first one which

618

00:23:07,909 --> 00:23:05,840

uh it it's funny because uh the uh

619

00:23:10,870 --> 00:23:07,919

the fans of the show post these quotes

620

00:23:13,510 --> 00:23:10,880

up quite often in twitter but

621

00:23:15,669 --> 00:23:13,520

his first of the three laws was

622

00:23:17,909 --> 00:23:15,679

when a distinguished but elderly

623

00:23:21,190 --> 00:23:17,919

scientist states that something is

624

00:23:23,350 --> 00:23:21,200

possible he is almost certainly right

625

00:23:27,830 --> 00:23:23,360

when he states that something is

626

00:23:30,630 --> 00:23:27,840

impossible he is very probably wrong

627

00:23:32,630 --> 00:23:30,640

his second law is the only way of

628

00:23:35,350 --> 00:23:32,640

discovering the limits of the possible

629

00:23:38,470 --> 00:23:35,360

is to venture a little way past them

630

00:23:40,549 --> 00:23:38,480

into the impossible and for us tonight

631

00:23:43,110 --> 00:23:40,559

we're going to be discussing

632

00:23:44,390 --> 00:23:43,120

his third law what is his third law

633

00:23:46,710 --> 00:23:44,400

isaac

634

00:23:48,950 --> 00:23:46,720

any sufficiently advanced technology is

635

00:23:50,549 --> 00:23:48,960

indistinguishable for magic

636

00:23:55,190 --> 00:23:50,559

i love that quote

637

00:23:56,870 --> 00:23:55,200

about it now it's one thing to go into

638

00:23:59,909 --> 00:23:56,880

the future and talk about future tech

639

00:24:01,510 --> 00:23:59,919

and science and physics and quantum and

640

00:24:03,510 --> 00:24:01,520

and go there

641

00:24:06,549 --> 00:24:03,520

you need to just

642

00:24:08,789 --> 00:24:06,559

look into our own past and think about

643

00:24:11,190 --> 00:24:08,799

what these cultures who had never seen a

644

00:24:12,950 --> 00:24:11,200

boat before right and see a boat coming

645

00:24:15,029 --> 00:24:12,960

at him from the ocean

646

00:24:17,990 --> 00:24:15,039

uh that's magic

647

00:24:19,909 --> 00:24:18,000

and that's exactly what isaac is talking

648

00:24:22,470 --> 00:24:19,919

about right isaac

649

00:24:24,630 --> 00:24:22,480

isaac i said

650

00:24:26,580 --> 00:24:24,640

that's exactly what arthur

651

00:24:29,430 --> 00:24:26,590

c clarke is talking about right

652

00:24:31,110 --> 00:24:29,440

[Laughter]

653

00:24:33,110 --> 00:24:31,120

i know that's a great example these

654

00:24:34,549 --> 00:24:33,120

technologies you know that we all expect

655

00:24:35,750 --> 00:24:34,559

to maybe get invented one day it

656

00:24:37,029 --> 00:24:35,760

probably won't be like we're thinking

657

00:24:39,190 --> 00:24:37,039

they're all so we won't be careful

658

00:24:40,950 --> 00:24:39,200

saying what is and isn't possible

659

00:24:42,789 --> 00:24:40,960

uh but at the same time we always have

660

00:24:44,789 --> 00:24:42,799

to kind of look at what we know is

661

00:24:46,789 --> 00:24:44,799

possible first and see if there might be

662

00:24:48,710 --> 00:24:46,799

some way we can approximate these

663

00:24:49,590 --> 00:24:48,720

technologies till we get them if we ever

664

00:24:52,149 --> 00:24:49,600

do

665

00:24:53,990 --> 00:24:52,159

with um arthur c clarke we're not going

666

00:24:57,029 --> 00:24:54,000

to be specifically talking about

667

00:24:57,830 --> 00:24:57,039

arthur's science fiction tonight

668

00:25:00,710 --> 00:24:57,840

but

669

00:25:03,269 --> 00:25:00,720

he he had a vision of the future and if

670

00:25:05,590 --> 00:25:03,279

you go back and and look at some of

671

00:25:08,070 --> 00:25:05,600

these conversations that he's had i've

672

00:25:10,549 --> 00:25:08,080

tried to watch all of them and listen to

673

00:25:12,950 --> 00:25:10,559

all of the interviews that he's done

674

00:25:15,269 --> 00:25:12,960

i literally have

675

00:25:17,990 --> 00:25:15,279

his vision i've read all of his books

676
00:25:19,750 --> 00:25:18,000
his vision of the future turns out to be

677
00:25:22,870 --> 00:25:19,760
so spot-on

678
00:25:25,269 --> 00:25:22,880
how impressed are you uh by that

679
00:25:26,950 --> 00:25:25,279
he's really good at predicting things um

680
00:25:28,470 --> 00:25:26,960
you know i mean some folks have a you

681
00:25:30,310 --> 00:25:28,480
know a tendency to predict stuff and

682
00:25:31,909 --> 00:25:30,320
tend to be a lot wrong i make a point of

683
00:25:33,750 --> 00:25:31,919
almost never trying to protect timelines

684
00:25:35,990 --> 00:25:33,760
on things for that same reason right

685
00:25:37,750 --> 00:25:36,000
clark had a knack for it and i think uh

686
00:25:39,190 --> 00:25:37,760
a rare one because he was a scientist

687
00:25:41,029 --> 00:25:39,200
who wrote fiction

688
00:25:42,950 --> 00:25:41,039

whereas you know that really helps you

689

00:25:45,110 --> 00:25:42,960

get a better idea for what really isn't

690

00:25:46,390 --> 00:25:45,120

too realistic in your settings

691

00:25:48,070 --> 00:25:46,400

and so

692

00:25:50,149 --> 00:25:48,080

he just had a knack for seeing what was

693

00:25:52,230 --> 00:25:50,159

going to happen next a lot of times

694

00:25:54,549 --> 00:25:52,240

and that's a lot of fun of videos

695

00:25:57,190 --> 00:25:54,559

fiction as you can see how he hit the

696

00:25:59,430 --> 00:25:57,200

mark or just barely missed it or in some

697

00:26:01,029 --> 00:25:59,440

cases got it completely wrong which is

698

00:26:03,190 --> 00:26:01,039

no negative on him i mean who's gonna

699

00:26:05,029 --> 00:26:03,200

predict the cell phone and uh texting

700

00:26:06,950 --> 00:26:05,039

you know this is not there

701
00:26:09,110 --> 00:26:06,960
and that's a good model for us to use we

702
00:26:11,110 --> 00:26:09,120
try to predict the future on the show is

703
00:26:13,830 --> 00:26:11,120
always remember those little tiny things

704
00:26:15,750 --> 00:26:13,840
that nobody saw coming that will just

705
00:26:16,630 --> 00:26:15,760
rock the world entirely in some small

706
00:26:19,029 --> 00:26:16,640
way

707
00:26:22,549 --> 00:26:19,039
when uh there's a scene

708
00:26:24,789 --> 00:26:22,559
uh in in 2001 the famous you know video

709
00:26:26,710 --> 00:26:24,799
phone scene right bell telephone and the

710
00:26:28,549 --> 00:26:26,720
the video booth and he steps in the

711
00:26:31,430 --> 00:26:28,559
phone booth but

712
00:26:33,430 --> 00:26:31,440
very nonchalantly takes out a card pops

713
00:26:35,830 --> 00:26:33,440

it in a card reader

714

00:26:37,669 --> 00:26:35,840

right and has a video call with his

715

00:26:40,070 --> 00:26:37,679

daughter who happens to be stanley

716

00:26:44,789 --> 00:26:40,080

kubrick's daughter uh who plays the part

717

00:26:46,390 --> 00:26:44,799

there but that that small scene uh a a

718

00:26:49,029 --> 00:26:46,400

minute long

719

00:26:51,750 --> 00:26:49,039

was a complete vision of the future and

720

00:26:53,990 --> 00:26:51,760

and it was complete and came to pass

721

00:26:56,870 --> 00:26:54,000

when the movie came out it was so

722

00:26:59,909 --> 00:26:56,880

science fiction and so out there today

723

00:27:01,190 --> 00:26:59,919

we watch it and it was just uh it's

724

00:27:02,149 --> 00:27:01,200

normalcy

725

00:27:03,830 --> 00:27:02,159

isn't it

726

00:27:05,190 --> 00:27:03,840

oh yeah there's so much of that that uh

727

00:27:06,710 --> 00:27:05,200

i know there are other parts i wish were

728

00:27:09,110 --> 00:27:06,720

already true like actually being on the

729

00:27:10,789 --> 00:27:09,120

moon by 2001 but uh

730

00:27:12,390 --> 00:27:10,799

you know they uh

731

00:27:14,230 --> 00:27:12,400

he was just so good at nailing those

732

00:27:15,830 --> 00:27:14,240

little things that we just wouldn't even

733

00:27:17,909 --> 00:27:15,840

expect to see

734

00:27:19,269 --> 00:27:17,919

and uh that the movie is full of things

735

00:27:20,390 --> 00:27:19,279

like that and i'll give cooper credit

736

00:27:21,590 --> 00:27:20,400

for that stuff too because he was

737

00:27:22,710 --> 00:27:21,600

actually very good at making those

738

00:27:25,269 --> 00:27:22,720

visuals

739

00:27:27,590 --> 00:27:25,279

resonate with their importance and uh

740

00:27:30,630 --> 00:27:27,600

arthur c clarke uh

741

00:27:32,950 --> 00:27:30,640

very effectively now i i do believe that

742

00:27:34,630 --> 00:27:32,960

he was also a product of his environment

743

00:27:36,710 --> 00:27:34,640

and his friends and

744

00:27:39,350 --> 00:27:36,720

and other scientists and science fiction

745

00:27:41,029 --> 00:27:39,360

writers that he hung out with but he

746

00:27:43,110 --> 00:27:41,039

nailed the internet

747

00:27:45,110 --> 00:27:43,120

you know we can talk about geostationary

748

00:27:48,230 --> 00:27:45,120

satellites that was an obvious thing but

749

00:27:51,510 --> 00:27:48,240

high definition tv uh you just mentioned

750

00:27:55,029 --> 00:27:51,520

uh texting and email but little things

751
00:27:56,630 --> 00:27:55,039
like um booking your online travel right

752
00:27:59,190 --> 00:27:56,640
and shopping

753
00:28:02,630 --> 00:27:59,200
and ebooks and smart

754
00:28:04,630 --> 00:28:02,640
howl as an early form of cereal alexa

755
00:28:07,590 --> 00:28:04,640
it's exactly right

756
00:28:09,669 --> 00:28:07,600
exactly right and and back then we we

757
00:28:12,870 --> 00:28:09,679
looked at all of that as you know like

758
00:28:15,029 --> 00:28:12,880
like magic like it it but we we got to

759
00:28:17,590 --> 00:28:15,039
it and we got to it very quickly he was

760
00:28:21,029 --> 00:28:17,600
just amazing uh the way that he did it

761
00:28:22,950 --> 00:28:21,039
now i want your uh really quick i've got

762
00:28:26,549 --> 00:28:22,960
uh 30 seconds

763
00:28:29,190 --> 00:28:26,559

uh your your definition of clark tech

764

00:28:30,549 --> 00:28:29,200

because you do a series on this what is

765

00:28:32,870 --> 00:28:30,559

clark tech

766

00:28:35,110 --> 00:28:32,880

any technology that we can sufficiently

767

00:28:37,029 --> 00:28:35,120

explain is a concept but for which we

768

00:28:38,710 --> 00:28:37,039

don't have any clear pathway to with

769

00:28:40,549 --> 00:28:38,720

existing science

770

00:28:42,789 --> 00:28:40,559

now we're going to get into all of that

771

00:28:45,510 --> 00:28:42,799

in just a bit well let's take our break

772

00:28:50,870 --> 00:28:45,520

right here our guest tonight is isaac

773

00:28:54,190 --> 00:28:53,190

all of his videos are there his youtube

774

00:28:56,669 --> 00:28:54,200

channel

775

00:28:58,710 --> 00:28:56,679

isaacarthur.net the links are at

776

00:29:00,710 --> 00:28:58,720

jimmychurchradio.com you can also follow

777

00:29:02,630 --> 00:29:00,720

isaac on twitter we've got his links up

778

00:29:04,470 --> 00:29:02,640

right there in the feed this is fade to

779

00:29:05,990 --> 00:29:04,480

black i'm yours jimmy church we'll be

780

00:29:08,510 --> 00:29:06,000

right back after this short break stay

781

00:29:18,070 --> 00:29:08,520

with us

782

00:29:18,080 --> 00:29:22,270

me

783

00:29:31,350 --> 00:29:28,230

[Music]

784

00:29:33,350 --> 00:29:31,360

all right welcome back here we go

785

00:29:36,310 --> 00:29:33,360

isaac arthur is our guest tonight the

786

00:29:37,750 --> 00:29:36,320

subject clark tech

787

00:29:39,590 --> 00:29:37,760

yeah man

788

00:29:42,470 --> 00:29:39,600

i can't wait for this

789

00:29:43,590 --> 00:29:42,480

isaac let's go first step on the block

790

00:29:45,909 --> 00:29:43,600

tonight

791

00:29:53,750 --> 00:29:45,919

force fields

792

00:29:56,310 --> 00:29:53,760

it's uh it's an easy thing to do uh in

793

00:29:58,710 --> 00:29:56,320

science fiction and in movies

794

00:30:01,909 --> 00:29:58,720

uh we've got to get our shields up we've

795

00:30:05,110 --> 00:30:01,919

got to get our shields up but there's

796

00:30:06,470 --> 00:30:05,120

one point with this that i would like to

797

00:30:09,909 --> 00:30:06,480

ask you about

798

00:30:11,750 --> 00:30:09,919

we've got natural force fields

799

00:30:14,789 --> 00:30:11,760

right now that are protecting us this

800

00:30:17,430 --> 00:30:14,799

planet we wouldn't exist if it wasn't

801
00:30:20,070 --> 00:30:17,440
for the force fields that we have

802
00:30:22,789 --> 00:30:20,080
around this planet how can we

803
00:30:23,990 --> 00:30:22,799
how why is it that we we know that they

804
00:30:26,630 --> 00:30:24,000
exist

805
00:30:28,710 --> 00:30:26,640
but we can't apply it to planes and

806
00:30:30,230 --> 00:30:28,720
trains and automobiles

807
00:30:31,990 --> 00:30:30,240
well of course we could make a magnetic

808
00:30:34,549 --> 00:30:32,000
field around the trains that would mess

809
00:30:35,750 --> 00:30:34,559
up every phone reception pretty good um

810
00:30:37,750 --> 00:30:35,760
the problem with a lot of these is it's

811
00:30:39,430 --> 00:30:37,760
very energy consumptive and for

812
00:30:41,269 --> 00:30:39,440
something like a force field

813
00:30:43,190 --> 00:30:41,279

what the force field around earth does

814

00:30:45,269 --> 00:30:43,200

the magnetosphere is mostly cause

815

00:30:47,430 --> 00:30:45,279

ionized particles from the sun to bounce

816

00:30:48,950 --> 00:30:47,440

away and for ionized particles on the

817

00:30:50,549 --> 00:30:48,960

atmosphere to bounce back down so we

818

00:30:51,909 --> 00:30:50,559

don't lose our atmosphere

819

00:30:53,510 --> 00:30:51,919

ionize being anything that's got an

820

00:30:55,269 --> 00:30:53,520

electric charge because it's missing uh

821

00:30:56,789 --> 00:30:55,279

missing one of its electrons right or it

822

00:31:00,070 --> 00:30:56,799

has an extra one

823

00:31:01,990 --> 00:31:00,080

and uh that's very handy for keeping

824

00:31:03,430 --> 00:31:02,000

ionized particles walking so somebody

825

00:31:05,669 --> 00:31:03,440

hits you with like a particle beam like

826

00:31:07,269 --> 00:31:05,679

they have sometimes or a plasma gun a

827

00:31:09,110 --> 00:31:07,279

magnetic shield like that on your belt

828

00:31:11,110 --> 00:31:09,120

which you could conceivably make

829

00:31:12,630 --> 00:31:11,120

behind the power but you could make it

830

00:31:13,750 --> 00:31:12,640

would work you could use something like

831

00:31:15,750 --> 00:31:13,760

that to prevent some from hitting you

832

00:31:16,950 --> 00:31:15,760

with a plasma gun or a particle

833

00:31:18,630 --> 00:31:16,960

projectile

834

00:31:20,149 --> 00:31:18,640

but all it's going to do is affect

835

00:31:22,870 --> 00:31:20,159

anything that's actually got that big

836

00:31:24,630 --> 00:31:22,880

electric charge relative to its mass

837

00:31:26,470 --> 00:31:24,640

a bullet would you go right through that

838

00:31:28,389 --> 00:31:26,480

same as uh the shuttle falls through the

839

00:31:30,789 --> 00:31:28,399

planet's atmosphere

840

00:31:33,190 --> 00:31:30,799

right and uh

841

00:31:36,310 --> 00:31:33,200

in in the movie dune where they've got

842

00:31:38,870 --> 00:31:36,320

the personal force fields right

843

00:31:41,509 --> 00:31:38,880

yeah it's and it's a great scene

844

00:31:42,470 --> 00:31:41,519

in that uh high-speed

845

00:31:43,909 --> 00:31:42,480

stuff

846

00:31:46,950 --> 00:31:43,919

bullets or

847

00:31:47,990 --> 00:31:46,960

or even they demonstrate the knife but

848

00:31:51,909 --> 00:31:48,000

slow

849

00:31:54,389 --> 00:31:51,919

moving objects pass straight through it

850

00:31:57,190 --> 00:31:54,399

um i i kind of want to address that for

851
00:31:58,830 --> 00:31:57,200
a second is that is that reality is that

852
00:32:01,110 --> 00:31:58,840
is that something that is

853
00:32:02,710 --> 00:32:01,120
achievable well i think the idea there

854
00:32:03,909 --> 00:32:02,720
is that uh in order for the folks to be

855
00:32:05,990 --> 00:32:03,919
able to breathe while they're inside

856
00:32:08,389 --> 00:32:06,000
that they have to tune the uh tune the

857
00:32:10,230 --> 00:32:08,399
shield generator so ao can get through

858
00:32:11,750 --> 00:32:10,240
um and of course if you had something to

859
00:32:13,430 --> 00:32:11,760
produce fields like that you might be

860
00:32:15,269 --> 00:32:13,440
able to make it selective

861
00:32:16,549 --> 00:32:15,279
but if you most of the ways we normally

862
00:32:18,630 --> 00:32:16,559
think about making a force feel like

863
00:32:20,149 --> 00:32:18,640

that probably won't let you do that

864

00:32:21,590 --> 00:32:20,159

the trick though is really if you want

865

00:32:23,029 --> 00:32:21,600

to make one of these things with known

866

00:32:25,350 --> 00:32:23,039

signs assuming you know something else

867

00:32:27,190 --> 00:32:25,360

new you kind of have to take a step back

868

00:32:28,789 --> 00:32:27,200

to the more the medieval concept of what

869

00:32:30,950 --> 00:32:28,799

a shield was which is a big chunk of

870

00:32:32,389 --> 00:32:30,960

metal between you and a target and we

871

00:32:34,389 --> 00:32:32,399

were also talking about uh the shield

872

00:32:36,630 --> 00:32:34,399

around the earth the big shield around

873

00:32:38,230 --> 00:32:36,640

the earth is actually the atmosphere

874

00:32:39,269 --> 00:32:38,240

that's what keeps most of these meteors

875

00:32:41,350 --> 00:32:39,279

from hitting us because they go right

876

00:32:43,110 --> 00:32:41,360

through the actual magnetosphere the

877

00:32:44,950 --> 00:32:43,120

magnesium helps hold the atmosphere in

878

00:32:46,470 --> 00:32:44,960

place but it's all those little pockets

879

00:32:49,590 --> 00:32:46,480

of air that actually keep us from

880

00:32:50,950 --> 00:32:49,600

getting hit by micrometeos all the time

881

00:32:52,710 --> 00:32:50,960

so when you're looking at something like

882

00:32:54,389 --> 00:32:52,720

a shield technology that might be

883

00:32:56,310 --> 00:32:54,399

something where you'd say

884

00:32:57,909 --> 00:32:56,320

have a bunch of little tiny drones that

885

00:33:00,149 --> 00:32:57,919

were transparent just like the drones we

886

00:33:01,990 --> 00:33:00,159

have now only smaller that flew around

887

00:33:03,350 --> 00:33:02,000

with radars and would just jump in front

888

00:33:04,549 --> 00:33:03,360

of any object they detected coming

889

00:33:07,430 --> 00:33:04,559

towards you

890

00:33:09,029 --> 00:33:07,440

and that's bang a shield you know that's

891

00:33:10,549 --> 00:33:09,039

all necessarily takes

892

00:33:12,149 --> 00:33:10,559

something like a magnetic field your

893

00:33:14,230 --> 00:33:12,159

ideal shield that's supposed to stop

894

00:33:15,669 --> 00:33:14,240

everything that's probably not too

895

00:33:17,350 --> 00:33:15,679

realistic

896

00:33:19,350 --> 00:33:17,360

but you don't have to necessarily have

897

00:33:20,950 --> 00:33:19,360

only one type of armor on you

898

00:33:22,470 --> 00:33:20,960

so for something like that you might use

899

00:33:24,789 --> 00:33:22,480

a magnetic field to produce you you know

900

00:33:26,950 --> 00:33:24,799

to keep you safe from uh plasma guns and

901
00:33:29,110 --> 00:33:26,960
you might use meal shielding on your own

902
00:33:31,190 --> 00:33:29,120
arm but protect you from lasers and you

903
00:33:32,630 --> 00:33:31,200
might use little drones that flew around

904
00:33:34,549 --> 00:33:32,640
to put you know keep you safe from

905
00:33:36,549 --> 00:33:34,559
bullets they jump out the way or fire

906
00:33:39,350 --> 00:33:36,559
tiny bullets at the bullet so you have

907
00:33:40,950 --> 00:33:39,360
to kind of an overlapping process but

908
00:33:43,430 --> 00:33:40,960
the ultimate idea of a shield which

909
00:33:45,590 --> 00:33:43,440
protects you from damage that's probably

910
00:33:48,549 --> 00:33:45,600
doable you just had to improvise a bit

911
00:33:51,110 --> 00:33:48,559
now okay so now let's talk about our our

912
00:33:53,669 --> 00:33:51,120
starship cruiser

913
00:33:54,549 --> 00:33:53,679

right out there flying across

914

00:33:58,310 --> 00:33:54,559

uh

915

00:34:00,950 --> 00:33:58,320

the galaxy and we encounter another ship

916

00:34:01,669 --> 00:34:00,960

and we put up our shields

917

00:34:04,870 --> 00:34:01,679

now

918

00:34:07,750 --> 00:34:04,880

suggesting something else all together

919

00:34:08,950 --> 00:34:07,760

aren't we oh yes and in this case it

920

00:34:10,550 --> 00:34:08,960

might actually be handy to have that

921

00:34:11,750 --> 00:34:10,560

magnetic shield you might have that on

922

00:34:13,589 --> 00:34:11,760

ship anyway because there's so much

923

00:34:15,430 --> 00:34:13,599

ionized gas just floating around out

924

00:34:19,190 --> 00:34:15,440

there in the void that you're ramming

925

00:34:20,389 --> 00:34:19,200

into at a good portion of speed of light

926
00:34:21,829 --> 00:34:20,399
and of course you might want to have

927
00:34:23,430 --> 00:34:21,839
something there that protects you from

928
00:34:25,589 --> 00:34:23,440
things that weren't really ionized

929
00:34:27,589 --> 00:34:25,599
little tiny dust grains that might hit

930
00:34:29,909 --> 00:34:27,599
you like a nuclear bomb at those speeds

931
00:34:32,149 --> 00:34:29,919
there your shield is really more of an

932
00:34:33,510 --> 00:34:32,159
active shield it's a radar

933
00:34:35,030 --> 00:34:33,520
that's out there looking for everything

934
00:34:37,669 --> 00:34:35,040
you can see and then you shoot the

935
00:34:39,510 --> 00:34:37,679
little things with lasers as you go by

936
00:34:41,030 --> 00:34:39,520
but that's a good example of spaceships

937
00:34:42,950 --> 00:34:41,040
is they're not going to park and shoot

938
00:34:44,310 --> 00:34:42,960

at each other 10 feet away like we often

939

00:34:45,829 --> 00:34:44,320

see in sci-fi

940

00:34:48,310 --> 00:34:45,839

they'll be flying by each other at very

941

00:34:49,909 --> 00:34:48,320

high speeds for very quick moments and

942

00:34:51,669 --> 00:34:49,919

so they probably almost have to use

943

00:34:53,589 --> 00:34:51,679

things like laser beams or particle

944

00:34:54,790 --> 00:34:53,599

projectors so you might be able to get

945

00:34:57,190 --> 00:34:54,800

away with those shields that were

946

00:34:58,630 --> 00:34:57,200

reflective or which were magnetic and

947

00:35:00,550 --> 00:34:58,640

and diverted anything that was charged

948

00:35:02,470 --> 00:35:00,560

like that so you might actually have

949

00:35:05,589 --> 00:35:02,480

shields like that to some degree not

950

00:35:07,910 --> 00:35:05,599

quite the star trek shield but similar

951
00:35:11,510 --> 00:35:07,920
the the problem that i've always had

952
00:35:13,430 --> 00:35:11,520
with those shields is that you know when

953
00:35:15,190 --> 00:35:13,440
they when they bring up something that

954
00:35:18,230 --> 00:35:15,200
surrounds the ship

955
00:35:20,630 --> 00:35:18,240
is that they can see through it

956
00:35:22,310 --> 00:35:20,640
i i've always had a problem with that

957
00:35:24,870 --> 00:35:22,320
because if you can see through it that

958
00:35:27,190 --> 00:35:24,880
means they can see you and they could

959
00:35:29,190 --> 00:35:27,200
shoot through it right

960
00:35:32,950 --> 00:35:29,200
that's uh

961
00:35:36,069 --> 00:35:32,960
ex explain that part of it uh to me uh

962
00:35:38,310 --> 00:35:36,079
is that does that just make that

963
00:35:39,829 --> 00:35:38,320

uh cartoonish that that is complete

964

00:35:41,030 --> 00:35:39,839

fiction and something that would be

965

00:35:43,349 --> 00:35:41,040

impossible

966

00:35:44,950 --> 00:35:43,359

somewhat i mean from a conceptual idea

967

00:35:46,950 --> 00:35:44,960

it's it's the right notion from a

968

00:35:48,310 --> 00:35:46,960

military angle if you've got a weakness

969

00:35:50,630 --> 00:35:48,320

in somebody else's armor that they're

970

00:35:52,870 --> 00:35:50,640

using like a visor on a helmet that's

971

00:35:54,390 --> 00:35:52,880

exactly where you focus your attacks at

972

00:35:55,349 --> 00:35:54,400

seeing for the gate on a city wall

973

00:35:56,870 --> 00:35:55,359

that's where you go bring up your

974

00:35:58,790 --> 00:35:56,880

battery rams

975

00:36:00,310 --> 00:35:58,800

and so that's the right kind of notion

976

00:36:01,829 --> 00:36:00,320

if you've got a shield like that where

977

00:36:03,349 --> 00:36:01,839

it blocks out a certain frequency of

978

00:36:05,670 --> 00:36:03,359

light that you're using to detect things

979

00:36:07,349 --> 00:36:05,680

with you might constantly cycle what

980

00:36:09,109 --> 00:36:07,359

frequency that was on

981

00:36:10,390 --> 00:36:09,119

so the enemy didn't know what it was but

982

00:36:11,750 --> 00:36:10,400

you could still shoot through that well

983

00:36:13,190 --> 00:36:11,760

they're trying to guess which frequency

984

00:36:15,190 --> 00:36:13,200

you're going to use next

985

00:36:16,710 --> 00:36:15,200

and shoot through that themselves you

986

00:36:17,829 --> 00:36:16,720

can still see through that on that one

987

00:36:19,670 --> 00:36:17,839

wavelength

988

00:36:21,030 --> 00:36:19,680

and so with something like a shield we

989

00:36:23,430 --> 00:36:21,040

don't know how we do it yet but we can

990

00:36:24,950 --> 00:36:23,440

still discuss it this way because we

991

00:36:26,870 --> 00:36:24,960

know what it's supposed to be doing and

992

00:36:28,150 --> 00:36:26,880

so we get an idea what the weakness is

993

00:36:30,230 --> 00:36:28,160

something like that you might also have

994

00:36:31,829 --> 00:36:30,240

a tether on a little camera at the end

995

00:36:33,829 --> 00:36:31,839

that was excluded from the shield you

996

00:36:35,030 --> 00:36:33,839

could kind of like let slip out through

997

00:36:36,710 --> 00:36:35,040

the edge of the shield and that was what

998

00:36:37,990 --> 00:36:36,720

you were seeing by

999

00:36:39,510 --> 00:36:38,000

right right how would you go about

1000

00:36:40,310 --> 00:36:39,520

making something like that and usually

1001

00:36:41,589 --> 00:36:40,320

you have to be able to play with

1002

00:36:44,069 --> 00:36:41,599

something like negative matter or

1003

00:36:47,190 --> 00:36:44,079

gravity to be able to pull that off so a

1004

00:36:50,390 --> 00:36:47,200

real force field would actually be the

1005

00:36:52,069 --> 00:36:50,400

the most effective idea from this would

1006

00:36:54,630 --> 00:36:52,079

actually end up being something that you

1007

00:36:57,670 --> 00:36:54,640

probably couldn't see through and then

1008

00:36:58,950 --> 00:36:57,680

that would defeat the purpose of

1009

00:37:00,470 --> 00:36:58,960

the force field because then you

1010

00:37:02,230 --> 00:37:00,480

couldn't see outside of the ship you'd

1011

00:37:04,069 --> 00:37:02,240

look out of the window and you would

1012

00:37:05,349 --> 00:37:04,079

have a solid wall there

1013

00:37:07,829 --> 00:37:05,359

yep the only way you could get around

1014

00:37:10,069 --> 00:37:07,839

that is if it was like a one-way meal or

1015

00:37:11,510 --> 00:37:10,079

which is concealedly possible or if it

1016

00:37:13,190 --> 00:37:11,520

was that it lets you see in certain

1017

00:37:14,550 --> 00:37:13,200

frequencies and of course they'd have to

1018

00:37:16,230 --> 00:37:14,560

be ones you could change because if the

1019

00:37:17,829 --> 00:37:16,240

enemy knows what frequency you see

1020

00:37:19,990 --> 00:37:17,839

through that's the frequency they're

1021

00:37:23,829 --> 00:37:20,000

using for all of their lasers

1022

00:37:27,190 --> 00:37:23,839

right right right and uh let's let's go

1023

00:37:28,710 --> 00:37:27,200

to the other side of this which is

1024

00:37:29,750 --> 00:37:28,720

weapons

1025

00:37:38,390 --> 00:37:29,760

and

1026

00:37:40,230 --> 00:37:38,400

uh weapons is is this clark attack is

1027

00:37:41,990 --> 00:37:40,240

this something that

1028

00:37:43,750 --> 00:37:42,000

because we hear about laser weapons now

1029

00:37:45,589 --> 00:37:43,760

that they're being deployed in our own

1030

00:37:47,510 --> 00:37:45,599

military

1031

00:37:49,670 --> 00:37:47,520

but usually the laser weapons purpose is

1032

00:37:50,630 --> 00:37:49,680

not to actually cause much direct damage

1033

00:37:52,069 --> 00:37:50,640

although sometimes you get like a

1034

00:37:54,390 --> 00:37:52,079

kinetic kill on a missile a really

1035

00:37:56,550 --> 00:37:54,400

powerful laser that just burns it out

1036

00:37:59,190 --> 00:37:56,560

but by and large we use them to you know

1037

00:38:00,790 --> 00:37:59,200

enhance aim things like that the problem

1038

00:38:02,310 --> 00:38:00,800

is that a laser

1039

00:38:04,150 --> 00:38:02,320

doesn't really have that much energy in

1040

00:38:07,190 --> 00:38:04,160

it and anything you can use to actually

1041

00:38:08,630 --> 00:38:07,200

power that is usually very bulky and

1042

00:38:10,550 --> 00:38:08,640

you'd almost always be better off

1043

00:38:11,910 --> 00:38:10,560

instead taking that energy running

1044

00:38:14,230 --> 00:38:11,920

through a magnetic field and shooting

1045

00:38:16,710 --> 00:38:14,240

something out what's called a rail gun

1046

00:38:19,109 --> 00:38:16,720

or on the channel a whale gun

1047

00:38:20,550 --> 00:38:19,119

right right and uh that's usually a

1048

00:38:21,829 --> 00:38:20,560

better bang for your buck in terms of

1049

00:38:23,430 --> 00:38:21,839

energy you throw a chunk of metal

1050

00:38:25,589 --> 00:38:23,440

somebody's way instead that you put that

1051

00:38:27,829 --> 00:38:25,599

same amount of energy in as kinetic

1052

00:38:29,109 --> 00:38:27,839

but a laser weapon that's just there to

1053

00:38:30,790 --> 00:38:29,119

burn a hole through somebody like we

1054

00:38:33,349 --> 00:38:30,800

usually see with a laser rifle a pistol

1055

00:38:34,870 --> 00:38:33,359

and sci-fi that one's probably not on

1056

00:38:36,390 --> 00:38:34,880

the radar what you'd see instead was

1057

00:38:38,310 --> 00:38:36,400

something that did something like suck

1058

00:38:39,589 --> 00:38:38,320

air out solidified and shoot that at

1059

00:38:43,349 --> 00:38:39,599

somebody instead

1060

00:38:45,190 --> 00:38:43,359

no i i've got a laser uh over at the

1061

00:38:48,150 --> 00:38:45,200

house right i've got a crazy

1062

00:38:51,510 --> 00:38:48,160

high-powered laser that i use to uh

1063

00:38:53,829 --> 00:38:51,520

attract ships when we're out doing uh

1064

00:38:55,510 --> 00:38:53,839

sky watches night watches at night with

1065

00:38:58,310 --> 00:38:55,520

night vision goggles

1066

00:39:00,710 --> 00:38:58,320

that laser that i have

1067

00:39:02,390 --> 00:39:00,720

can burn you in a second if you pointed

1068

00:39:05,510 --> 00:39:02,400

that at your skin

1069

00:39:09,109 --> 00:39:05,520

and you hold it on it burns you but

1070

00:39:11,430 --> 00:39:09,119

it's a constant thing as opposed to with

1071

00:39:12,710 --> 00:39:11,440

this future tech where you see these

1072

00:39:13,670 --> 00:39:12,720

lasers

1073

00:39:16,870 --> 00:39:13,680

running

1074

00:39:18,950 --> 00:39:16,880

in slow motion right you see them and

1075

00:39:21,190 --> 00:39:18,960

they're running so slow

1076

00:39:23,109 --> 00:39:21,200

it looks like whoever's being shot at

1077

00:39:25,030 --> 00:39:23,119

can dodge the bullets

1078

00:39:26,150 --> 00:39:25,040

yeah it can dance out of the way

1079

00:39:27,910 --> 00:39:26,160

the funny thing is that might actually

1080

00:39:29,430 --> 00:39:27,920

be appropriate when scaled up a bit

1081

00:39:31,349 --> 00:39:29,440

because if these ships aren't tens of

1082

00:39:33,750 --> 00:39:31,359

meters away or kilometers away but

1083

00:39:35,430 --> 00:39:33,760

rather engage each other light seconds

1084

00:39:36,790 --> 00:39:35,440

away then they might be able to dodge

1085

00:39:38,870 --> 00:39:36,800

just the scales messed up because you

1086

00:39:40,310 --> 00:39:38,880

wouldn't be to see those ships or if you

1087

00:39:42,310 --> 00:39:40,320

were you'd be shooting some ship that

1088

00:39:43,510 --> 00:39:42,320

was several thousand miles across itself

1089

00:39:44,790 --> 00:39:43,520

in which case

1090

00:39:46,390 --> 00:39:44,800

you probably don't want to be fighting

1091

00:39:48,230 --> 00:39:46,400

that thing

1092

00:39:50,870 --> 00:39:48,240

right and so

1093

00:39:51,870 --> 00:39:50,880

with uh a laser weapon

1094

00:39:55,109 --> 00:39:51,880

you wouldn't

1095

00:39:56,550 --> 00:39:55,119

necessarily even see the beam of light

1096

00:40:00,870 --> 00:39:56,560

right

1097

00:40:03,030 --> 00:40:00,880

seeing these you know hand-to-hand

1098

00:40:06,150 --> 00:40:03,040

battles going on with these shoulder

1099

00:40:07,990 --> 00:40:06,160

fired and you know pistols and stuff

1100

00:40:10,069 --> 00:40:08,000

you're seeing the beams of light but in

1101
00:40:10,790 --> 00:40:10,079
reality you wouldn't see anything would

1102
00:40:14,870 --> 00:40:10,800
you

1103
00:40:16,230 --> 00:40:14,880
one high powered enough on the ground to

1104
00:40:18,230 --> 00:40:16,240
shoot somebody and bought a hole through

1105
00:40:20,310 --> 00:40:18,240
them the amount of scatter off of that

1106
00:40:22,390 --> 00:40:20,320
uh would actually probably give you some

1107
00:40:23,670 --> 00:40:22,400
visual effect you could see and then of

1108
00:40:25,190 --> 00:40:23,680
course there's also the augmented

1109
00:40:27,109 --> 00:40:25,200
reality thing which is our biggest

1110
00:40:28,790 --> 00:40:27,119
excuse for video games with sci-fi is

1111
00:40:30,310 --> 00:40:28,800
why you can see the other guys ships is

1112
00:40:32,390 --> 00:40:30,320
you're not actually seeing real space

1113
00:40:33,750 --> 00:40:32,400

you're seeing the computer's version of

1114

00:40:35,270 --> 00:40:33,760

that that shows you so you can pay

1115

00:40:37,190 --> 00:40:35,280

attention properly

1116

00:40:38,470 --> 00:40:37,200

but um and that's kind of handwave we

1117

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

might actually see people use in the

1118

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

future too is all the ships look like

1119

00:40:43,190 --> 00:40:42,320

they're only you know right next door

1120

00:40:45,190 --> 00:40:43,200

even though they are thousands of

1121

00:40:47,670 --> 00:40:45,200

kilometers away just so that the human

1122

00:40:50,150 --> 00:40:47,680

mind can kind of process it properly

1123

00:40:51,270 --> 00:40:50,160

but uh in space there's almost no debris

1124

00:40:52,630 --> 00:40:51,280

now if they're fighting long enough

1125

00:40:53,990 --> 00:40:52,640

there might be enough debris and gas

1126
00:40:55,670 --> 00:40:54,000
around that they could actually see the

1127
00:40:57,430 --> 00:40:55,680
laser beam scatter

1128
00:40:59,109 --> 00:40:57,440
but uh no you don't see one of those

1129
00:41:00,550 --> 00:40:59,119
until it actually hits you

1130
00:41:01,589 --> 00:41:00,560
and you don't really see it at all from

1131
00:41:03,829 --> 00:41:01,599
the side

1132
00:41:06,390 --> 00:41:03,839
and the only way to dodge a laser beam

1133
00:41:07,910 --> 00:41:06,400
is to preemptively dodge it which the

1134
00:41:09,589 --> 00:41:07,920
only way you can do that right now is to

1135
00:41:11,589 --> 00:41:09,599
randomly walk you're constantly

1136
00:41:12,710 --> 00:41:11,599
jittering back and forth right on the

1137
00:41:14,309 --> 00:41:12,720
assumption someone's going to take a

1138
00:41:15,510 --> 00:41:14,319

shot at you so they don't know where

1139

00:41:16,470 --> 00:41:15,520

you're going to be at

1140

00:41:17,829 --> 00:41:16,480

but you don't know when they're going to

1141

00:41:19,750 --> 00:41:17,839

shoot at you until it arrives you have

1142

00:41:21,349 --> 00:41:19,760

to be constantly doing that and that

1143

00:41:24,950 --> 00:41:21,359

takes a lot of energy

1144

00:41:27,510 --> 00:41:24,960

i have uh seen demonstrations of uh

1145

00:41:29,990 --> 00:41:27,520

laser beams you know

1146

00:41:32,950 --> 00:41:30,000

burning up a ship or or what have you in

1147

00:41:36,150 --> 00:41:32,960

target exercises right now i can't see

1148

00:41:37,510 --> 00:41:36,160

those laser beams

1149

00:41:39,670 --> 00:41:37,520

no they're usually not even invisible

1150

00:41:41,349 --> 00:41:39,680

frequencies i mean the spectrum is huge

1151

00:41:43,270 --> 00:41:41,359

and uh typically speaking the visual

1152

00:41:45,349 --> 00:41:43,280

spectrum is not a good one for lasers

1153

00:41:48,230 --> 00:41:45,359

unless you try to use them to use like a

1154

00:41:49,510 --> 00:41:48,240

laser pointer because those frequencies

1155

00:41:51,430 --> 00:41:49,520

are the things that get absorbed by

1156

00:41:53,109 --> 00:41:51,440

almost everything we think of as normal

1157

00:41:54,470 --> 00:41:53,119

chemistry that's why we use them to see

1158

00:41:56,630 --> 00:41:54,480

by

1159

00:41:58,790 --> 00:41:56,640

explain that to me for a second

1160

00:42:01,430 --> 00:41:58,800

well you got the uh the frequency

1161

00:42:03,750 --> 00:42:01,440

of light varies a lot by wavelength and

1162

00:42:05,829 --> 00:42:03,760

by and lowe's the frequency of light its

1163

00:42:07,510 --> 00:42:05,839

wavelength is very similar in size to

1164

00:42:09,829 --> 00:42:07,520

whatever is actually emitting process

1165

00:42:11,430 --> 00:42:09,839

wave like gamma rays very high energy

1166

00:42:13,109 --> 00:42:11,440

things they have a wavelength about the

1167

00:42:14,790 --> 00:42:13,119

size of an atomic nucleus which is

1168

00:42:16,309 --> 00:42:14,800

typically where they come from x-rays

1169

00:42:18,309 --> 00:42:16,319

are about the size of that inner core of

1170

00:42:19,510 --> 00:42:18,319

electrons around most

1171

00:42:21,510 --> 00:42:19,520

uh atoms

1172

00:42:22,710 --> 00:42:21,520

and that's what emits them too

1173

00:42:23,990 --> 00:42:22,720

most of things that we think of as

1174

00:42:25,829 --> 00:42:24,000

visible light or infrared and

1175

00:42:27,030 --> 00:42:25,839

ultraviolet which are those same types

1176

00:42:28,790 --> 00:42:27,040

of light they just have to be on either

1177

00:42:30,309 --> 00:42:28,800

side of the part we can see

1178

00:42:31,670 --> 00:42:30,319

uh these are chemical lights for the

1179

00:42:33,030 --> 00:42:31,680

most part yeah these are the kind of

1180

00:42:34,390 --> 00:42:33,040

things that interact with normal

1181

00:42:36,390 --> 00:42:34,400

chemistry

1182

00:42:38,550 --> 00:42:36,400

and um

1183

00:42:40,069 --> 00:42:38,560

by and large uh that's what makes it

1184

00:42:41,829 --> 00:42:40,079

easier to see ultimately something like

1185

00:42:43,990 --> 00:42:41,839

radio waves you can have a radio wave

1186

00:42:45,430 --> 00:42:44,000

like an elf one such as the subs use the

1187

00:42:46,630 --> 00:42:45,440

photon of that is about the size of a

1188

00:42:48,710 --> 00:42:46,640

planet

1189

00:42:52,069 --> 00:42:48,720
every little tiny individual photon

1190

00:42:54,470 --> 00:42:52,079
right right right and how does it work

1191

00:42:59,270 --> 00:42:54,480
and we're going to move on for uh uh in

1192

00:43:03,510 --> 00:42:59,280
in just a second but when uh uh

1193

00:43:05,510 --> 00:43:03,520
observatories are firing off uh laser

1194

00:43:07,910 --> 00:43:05,520
beams out into

1195

00:43:10,230 --> 00:43:07,920
the milky way to measure the distance of

1196

00:43:11,030 --> 00:43:10,240
stars and and to do these kinds of

1197

00:43:13,349 --> 00:43:11,040
things

1198

00:43:14,950 --> 00:43:13,359
with the dissipation that happens over

1199

00:43:18,550 --> 00:43:14,960
distance

1200

00:43:20,950 --> 00:43:18,560
how do they keep that laser focused uh

1201
00:43:23,109 --> 00:43:20,960
so they can work if they are jumping out

1202
00:43:25,190 --> 00:43:23,119
100 light years away that's a you know

1203
00:43:27,430 --> 00:43:25,200
it's a vast distance i i don't

1204
00:43:30,150 --> 00:43:27,440
understand that part of it it seems like

1205
00:43:32,150 --> 00:43:30,160
at that at that at the receiving end

1206
00:43:34,550 --> 00:43:32,160
that laser beam would be

1207
00:43:36,710 --> 00:43:34,560
you know millions of miles wide wouldn't

1208
00:43:38,710 --> 00:43:36,720
it oh yeah yeah uh and of course usually

1209
00:43:40,309 --> 00:43:38,720
when we're using telescopes or i should

1210
00:43:41,910 --> 00:43:40,319
say middles that are really condensed

1211
00:43:43,910 --> 00:43:41,920
like that that's not to detect things

1212
00:43:45,109 --> 00:43:43,920
ourselves that's to send a message you

1213
00:43:46,790 --> 00:43:45,119

can use a laser on something like the

1214

00:43:48,550 --> 00:43:46,800

moon or mars and get a useful piece of

1215

00:43:50,150 --> 00:43:48,560

data but the others will take you know

1216

00:43:51,430 --> 00:43:50,160

years or centuries for that beam to

1217

00:43:53,589 --> 00:43:51,440

arrive and you're not going to detect it

1218

00:43:55,910 --> 00:43:53,599

when it bounces back be too scattered

1219

00:43:56,790 --> 00:43:55,920

but if you want to talk to somebody uh

1220

00:43:58,630 --> 00:43:56,800

who's

1221

00:44:00,710 --> 00:43:58,640

a radio transmitter that's 50 kilowatts

1222

00:44:02,309 --> 00:44:00,720

you can hear that uh halfway around the

1223

00:44:04,069 --> 00:44:02,319

continent with a good with a good uh

1224

00:44:05,109 --> 00:44:04,079

normal antenna

1225

00:44:06,870 --> 00:44:05,119

um

1226

00:44:08,870 --> 00:44:06,880

but that stuff falls off with the

1227

00:44:11,030 --> 00:44:08,880

invoice square so if it's 10 times

1228

00:44:12,390 --> 00:44:11,040

further away it's 100 times weaker if

1229

00:44:15,109 --> 00:44:12,400

you want to hear people from another

1230

00:44:15,990 --> 00:44:15,119

solar system either a dish you know

1231

00:44:18,069 --> 00:44:16,000

that's

1232

00:44:20,309 --> 00:44:18,079

ginormous or they need to send you a

1233

00:44:22,230 --> 00:44:20,319

really concentrated beam so we try to

1234

00:44:24,470 --> 00:44:22,240

send signals off to other plants to see

1235

00:44:26,630 --> 00:44:24,480

if there's anybody there we concentrate

1236

00:44:28,550 --> 00:44:26,640

as much as possible to save power

1237

00:44:30,390 --> 00:44:28,560

you could do an omnidirectional

1238

00:44:32,150 --> 00:44:30,400

broadcast with that but it needs a lot

1239

00:44:33,829 --> 00:44:32,160

more power and you have problems hearing

1240

00:44:35,670 --> 00:44:33,839

even our best radios with our best

1241

00:44:38,470 --> 00:44:35,680

equipment more than a few light years

1242

00:44:39,589 --> 00:44:38,480

away yeah now that made sense that i

1243

00:44:41,990 --> 00:44:39,599

understood

1244

00:44:44,710 --> 00:44:42,000

and i want to get into communication and

1245

00:44:46,230 --> 00:44:44,720

travel right now uh by jumping into

1246

00:44:47,589 --> 00:44:46,240

wormholes

1247

00:44:50,230 --> 00:44:47,599

and

1248

00:44:51,190 --> 00:44:50,240

the the concept of wormholes has been

1249

00:44:53,109 --> 00:44:51,200

talked

1250

00:44:55,510 --> 00:44:53,119

you know since i was a kid

1251

00:44:58,870 --> 00:44:55,520

uh in the 70s where wormholes started to

1252

00:45:02,950 --> 00:44:58,880

become a subject of conversation

1253

00:45:05,829 --> 00:45:02,960

um has there at this point

1254

00:45:08,150 --> 00:45:05,839

has it gone beyond theory has there been

1255

00:45:08,950 --> 00:45:08,160

any wormholes detected

1256

00:45:12,470 --> 00:45:08,960

no

1257

00:45:14,710 --> 00:45:12,480

they probably can't actually exist at

1258

00:45:16,150 --> 00:45:14,720

least any sort of useful fashion

1259

00:45:18,230 --> 00:45:16,160

um that's one of those examples of

1260

00:45:19,910 --> 00:45:18,240

things where it's predicted by uh by

1261

00:45:21,670 --> 00:45:19,920

general relativity which has been so

1262

00:45:23,510 --> 00:45:21,680

good at predicting things so far

1263

00:45:25,190 --> 00:45:23,520

uh but so are white holes for instance

1264

00:45:28,870 --> 00:45:25,200

as opposed to black holes

1265

00:45:30,710 --> 00:45:28,880

and as best as we can tell they probably

1266

00:45:32,550 --> 00:45:30,720

are never stable if they do happen at

1267

00:45:34,230 --> 00:45:32,560

all though there are some exceptions

1268

00:45:37,670 --> 00:45:34,240

that there's actually a working theory

1269

00:45:39,270 --> 00:45:37,680

called er equals epr by leonard suskind

1270

00:45:41,670 --> 00:45:39,280

that posits that there might actually be

1271

00:45:43,349 --> 00:45:41,680

a wormhole between every electron that

1272

00:45:45,109 --> 00:45:43,359

these things might be you know

1273

00:45:46,550 --> 00:45:45,119

ridiculously common

1274

00:45:49,030 --> 00:45:46,560

but we probably could not use them to

1275

00:45:50,390 --> 00:45:49,040

send information or send mass through

1276

00:45:52,230 --> 00:45:50,400

and there's a problem when you look at

1277

00:45:54,470 --> 00:45:52,240

these things from a math standpoint is

1278

00:45:56,150 --> 00:45:54,480

uh if you ever feed a wormhole more

1279

00:45:57,589 --> 00:45:56,160

matter than it's got making it up if you

1280

00:45:59,589 --> 00:45:57,599

try to put through too many ships at war

1281

00:46:00,710 --> 00:45:59,599

it should collapse even if you're

1282

00:46:02,069 --> 00:46:00,720

actually using all the cheats like

1283

00:46:04,950 --> 00:46:02,079

negative matter that would hold it

1284

00:46:06,230 --> 00:46:04,960

together to let you use it

1285

00:46:15,510 --> 00:46:06,240

the

1286

00:46:17,270 --> 00:46:15,520

if we would have to make our own

1287

00:46:18,710 --> 00:46:17,280

yes almost certainly if we want to use

1288

00:46:20,790 --> 00:46:18,720

them we'd have to make them ourselves

1289

00:46:23,190 --> 00:46:20,800

and we'd probably have to have negative

1290

00:46:25,270 --> 00:46:23,200

matter or energy to do that with

1291

00:46:27,270 --> 00:46:25,280

from a black hole or wormhole standpoint

1292

00:46:30,870 --> 00:46:27,280

energy works as well as matter

1293

00:46:31,990 --> 00:46:30,880

if you were going to uh build a wormhole

1294

00:46:33,109 --> 00:46:32,000

your own

1295

00:46:35,430 --> 00:46:33,119

what would you

1296

00:46:38,550 --> 00:46:35,440

use it for first

1297

00:46:40,150 --> 00:46:38,560

oh um i would probably use to send

1298

00:46:44,790 --> 00:46:40,160

myself a message on how to construct

1299

00:46:48,069 --> 00:46:46,710

so you what happens is you theoretically

1300

00:46:50,230 --> 00:46:48,079

have to make both sides of it you're

1301
00:46:51,910 --> 00:46:50,240
making the two next to each other and if

1302
00:46:53,270 --> 00:46:51,920
you move one of those gates to some

1303
00:46:55,430 --> 00:46:53,280
place that's useful which you have to do

1304
00:46:57,030 --> 00:46:55,440
at sublight speeds and various sublight

1305
00:46:58,390 --> 00:46:57,040
speeds because these things are massive

1306
00:47:00,069 --> 00:46:58,400
these are not things you make in a room

1307
00:47:01,990 --> 00:47:00,079
these are things that are out usually at

1308
00:47:04,150 --> 00:47:02,000
our master solar system

1309
00:47:05,829 --> 00:47:04,160
um you move that point somewhere and

1310
00:47:08,470 --> 00:47:05,839
it's undergone time dilation while you

1311
00:47:09,750 --> 00:47:08,480
did that if you drag it back home after

1312
00:47:11,349 --> 00:47:09,760
you moved it away

1313
00:47:13,670 --> 00:47:11,359

you're going to go in one gate and pop

1314

00:47:16,150 --> 00:47:13,680

out before you left

1315

00:47:20,230 --> 00:47:17,750

okay

1316

00:47:23,030 --> 00:47:20,240

if we built a wormhole

1317

00:47:26,230 --> 00:47:23,040

we built a wormhole from here on earth

1318

00:47:27,109 --> 00:47:26,240

to you know pick something serious be

1319

00:47:29,670 --> 00:47:27,119

right

1320

00:47:31,430 --> 00:47:29,680

okay and and that's where we want to go

1321

00:47:32,470 --> 00:47:31,440

we build that

1322

00:47:33,430 --> 00:47:32,480

could

1323

00:47:35,270 --> 00:47:33,440

that

1324

00:47:38,309 --> 00:47:35,280

be seen

1325

00:47:40,230 --> 00:47:38,319

would we see the wormhole would somebody

1326

00:47:42,309 --> 00:47:40,240

else see the wormhole

1327

00:47:44,309 --> 00:47:42,319

yes uh most of the ways you would

1328

00:47:46,309 --> 00:47:44,319

normally make a wormhole involve so much

1329

00:47:48,309 --> 00:47:46,319

mass going into the thing

1330

00:47:50,230 --> 00:47:48,319

that uh you'd see all the emission i

1331

00:47:51,349 --> 00:47:50,240

like was a gigantic black hole because

1332

00:47:53,109 --> 00:47:51,359

that's basically what they always

1333

00:47:54,550 --> 00:47:53,119

gigantic black holes

1334

00:47:56,309 --> 00:47:54,560

and you would absolutely see that and

1335

00:47:57,670 --> 00:47:56,319

then of course a white hole which

1336

00:47:59,750 --> 00:47:57,680

theoretically might be on the other end

1337

00:48:01,190 --> 00:47:59,760

of these things um which we've also

1338

00:48:03,589 --> 00:48:01,200

never detected

1339

00:48:05,109 --> 00:48:03,599

right um those are i mean the exact

1340

00:48:07,270 --> 00:48:05,119

opposite of black hole all they do is

1341

00:48:08,790 --> 00:48:07,280

shoot metal out you can never get out

1342

00:48:11,430 --> 00:48:08,800

from behind a black hole but you never

1343

00:48:14,150 --> 00:48:11,440

get into a white hole

1344

00:48:16,790 --> 00:48:14,160

and the difference between okay so

1345

00:48:19,270 --> 00:48:16,800

we build our wormhole

1346

00:48:22,309 --> 00:48:19,280

between here and series b

1347

00:48:24,630 --> 00:48:22,319

when we travel through it does anything

1348

00:48:27,349 --> 00:48:24,640

change with us physically we know what

1349

00:48:29,270 --> 00:48:27,359

happens uh down to a singularity with

1350

00:48:31,510 --> 00:48:29,280

with the black hole we're ripped to

1351
00:48:33,349 --> 00:48:31,520
shreds

1352
00:48:34,870 --> 00:48:33,359
what happens when we travel through a

1353
00:48:37,670 --> 00:48:34,880
wormhole

1354
00:48:39,349 --> 00:48:37,680
it should be like just falling down um

1355
00:48:40,710 --> 00:48:39,359
the problem is it's kind of dubious if

1356
00:48:42,950 --> 00:48:40,720
you can actually build up enough speed

1357
00:48:44,630 --> 00:48:42,960
to keep going the idea is to make sure

1358
00:48:46,069 --> 00:48:44,640
you don't fall into that singularity

1359
00:48:47,750 --> 00:48:46,079
which is where the negative matter comes

1360
00:48:49,750 --> 00:48:47,760
to play but imagine if we took the earth

1361
00:48:51,990 --> 00:48:49,760
and we drilled a hole down to it

1362
00:48:53,829 --> 00:48:52,000
uh all the way through and uh right

1363
00:48:55,109 --> 00:48:53,839

through the core if i drop you down

1364

00:48:56,790 --> 00:48:55,119

there people wonder what happens when

1365

00:48:58,710 --> 00:48:56,800

you hit the center at the very center

1366

00:49:00,549 --> 00:48:58,720

there's no gravity of course but you

1367

00:49:02,230 --> 00:49:00,559

just keep falling down but then you'd

1368

00:49:03,750 --> 00:49:02,240

oscillate right back down again you

1369

00:49:06,230 --> 00:49:03,760

never stop falling you'll fall through

1370

00:49:08,390 --> 00:49:06,240

the center rise back up fall back down

1371

00:49:09,910 --> 00:49:08,400

again rise back up and oscillate

1372

00:49:12,549 --> 00:49:09,920

and in order to actually get away from

1373

00:49:14,710 --> 00:49:12,559

that you'd have to apply some more speed

1374

00:49:16,069 --> 00:49:14,720

so in theory while you're traveling down

1375

00:49:17,589 --> 00:49:16,079

one of these wormholes if you gave

1376

00:49:18,710 --> 00:49:17,599

yourself a big kick of speed while

1377

00:49:20,390 --> 00:49:18,720

you're in it

1378

00:49:22,390 --> 00:49:20,400

you should have all that energy you had

1379

00:49:23,750 --> 00:49:22,400

falling down building up and speeding up

1380

00:49:25,589 --> 00:49:23,760

plus that little bit of thrust you gave

1381

00:49:27,910 --> 00:49:25,599

yourself that could let you

1382

00:49:29,270 --> 00:49:27,920

theoretically exit maybe kind of solder

1383

00:49:31,030 --> 00:49:29,280

yeah there's a lot of baby kind of

1384

00:49:32,390 --> 00:49:31,040

swords with horses

1385

00:49:35,109 --> 00:49:32,400

so what would you do at the other end

1386

00:49:37,109 --> 00:49:35,119

like reach up and try to grab the edge

1387

00:49:38,150 --> 00:49:37,119

so you don't fall back

1388

00:49:40,309 --> 00:49:38,160

if you have that kick that would

1389

00:49:41,910 --> 00:49:40,319

actually let you get out from inside the

1390

00:49:43,829 --> 00:49:41,920

event horizon that nothing can escape

1391

00:49:45,430 --> 00:49:43,839

from you should just emerge on your own

1392

00:49:47,430 --> 00:49:45,440

at that point in time

1393

00:49:49,349 --> 00:49:47,440

um that's the problem though is you

1394

00:49:51,270 --> 00:49:49,359

could get through that sink get through

1395

00:49:53,349 --> 00:49:51,280

that one horse the other side but you're

1396

00:49:55,430 --> 00:49:53,359

probably gonna fall right back down into

1397

00:49:58,150 --> 00:49:55,440

the warm wall again so

1398

00:50:00,230 --> 00:49:58,160

what so what does this do with all of

1399

00:50:03,109 --> 00:50:00,240

the science fiction writing out there

1400

00:50:05,270 --> 00:50:03,119

about traveling through a wormhole

1401

00:50:06,870 --> 00:50:05,280

it mostly makes it not work to really

1402

00:50:08,549 --> 00:50:06,880

make something like a wormhole walk at

1403

00:50:11,109 --> 00:50:08,559

all you at least need negative matter or

1404

00:50:13,109 --> 00:50:11,119

energy which is least on the table

1405

00:50:15,030 --> 00:50:13,119

but probably the more

1406

00:50:17,270 --> 00:50:15,040

the more realistic approach you want to

1407

00:50:18,950 --> 00:50:17,280

say realistic would be to have a new bit

1408

00:50:20,870 --> 00:50:18,960

of science let you play with gravity

1409

00:50:21,670 --> 00:50:20,880

directly your anti-gravity or gravity

1410

00:50:22,950 --> 00:50:21,680

things

1411

00:50:24,790 --> 00:50:22,960

at that point in time you don't

1412

00:50:26,950 --> 00:50:24,800

necessarily have to have something like

1413

00:50:29,270 --> 00:50:26,960

negative mass what you could do instead

1414

00:50:30,790 --> 00:50:29,280

is you know make a big long relay of

1415

00:50:33,430 --> 00:50:30,800

gravity generators that just

1416

00:50:35,270 --> 00:50:33,440

concentrated space time down in a line

1417

00:50:36,870 --> 00:50:35,280

and you just run along that line you're

1418

00:50:38,069 --> 00:50:36,880

not technically going faster than light

1419

00:50:40,230 --> 00:50:38,079

it's the same as like with the warp

1420

00:50:41,670 --> 00:50:40,240

drive you're condensing space in front

1421

00:50:43,990 --> 00:50:41,680

of you only in this case it's like a

1422

00:50:46,230 --> 00:50:44,000

highway you'd be driving from one solar

1423

00:50:47,430 --> 00:50:46,240

system to another and it's expressway

1424

00:50:48,790 --> 00:50:47,440

it's a much shorter distance you

1425

00:50:50,069 --> 00:50:48,800

actually have to follow even though it

1426
00:50:51,030 --> 00:50:50,079
looks to everyone else like a longer

1427
00:50:53,270 --> 00:50:51,040
distance

1428
00:50:54,950 --> 00:50:53,280
and that doesn't break the whole fti

1429
00:50:56,710 --> 00:50:54,960
thing but that kind of gravity

1430
00:50:58,870 --> 00:50:56,720
manipulation which is kind of the idea

1431
00:50:59,750 --> 00:50:58,880
behind a wormhole in the first place is

1432
00:51:01,910 --> 00:50:59,760
the sort of thing that would actually

1433
00:51:04,230 --> 00:51:01,920
let you do something like that if we

1434
00:51:05,670 --> 00:51:04,240
could get that to walk so gravity very

1435
00:51:08,230 --> 00:51:05,680
interesting force so we can actually

1436
00:51:10,630 --> 00:51:08,240
control it but we don't know how to yet

1437
00:51:13,190 --> 00:51:10,640
now what about uh

1438
00:51:17,109 --> 00:51:13,200

traveling in something that has got

1439

00:51:20,069 --> 00:51:17,119

energy like a ship that has got thrust

1440

00:51:21,510 --> 00:51:20,079

could that go through a wormhole

1441

00:51:22,950 --> 00:51:21,520

and that's the general idea would be

1442

00:51:24,870 --> 00:51:22,960

that if you're falling into this black

1443

00:51:27,430 --> 00:51:24,880

hole you pick up energy and you can

1444

00:51:28,309 --> 00:51:27,440

apply more energy when you start rising

1445

00:51:30,309 --> 00:51:28,319

up out from the other side of

1446

00:51:32,470 --> 00:51:30,319

singularity which you've managed to

1447

00:51:33,990 --> 00:51:32,480

somehow not encounter right the problem

1448

00:51:34,950 --> 00:51:34,000

with the singularity is we call it that

1449

00:51:36,870 --> 00:51:34,960

because it's what happens when you

1450

00:51:38,470 --> 00:51:36,880

divide by zero

1451

00:51:40,549 --> 00:51:38,480

there is no mathematical solution at

1452

00:51:42,309 --> 00:51:40,559

that point anything starts to break down

1453

00:51:44,069 --> 00:51:42,319

um you know how do you divide half and

1454

00:51:46,309 --> 00:51:44,079

half what's twice infinity those kind of

1455

00:51:47,670 --> 00:51:46,319

math problems it takes an infinite

1456

00:51:50,390 --> 00:51:47,680

amount of energy to get away from a

1457

00:51:52,470 --> 00:51:50,400

singularity if they actually even exist

1458

00:51:53,430 --> 00:51:52,480

um how do you get an infinite amount of

1459

00:51:56,870 --> 00:51:53,440

energy

1460

00:51:58,150 --> 00:51:56,880

passed through it now rising away but

1461

00:51:59,510 --> 00:51:58,160

you still need an infinite amount of

1462

00:52:00,710 --> 00:51:59,520

energy to get away

1463

00:52:02,870 --> 00:52:00,720

and you know that's one of those

1464

00:52:05,030 --> 00:52:02,880

infinity plus one questions we don't

1465

00:52:06,309 --> 00:52:05,040

really know how that works out and

1466

00:52:07,510 --> 00:52:06,319

that's also one reason why we tend to be

1467

00:52:09,270 --> 00:52:07,520

dubious as to whether or not there

1468

00:52:10,790 --> 00:52:09,280

really is a singularity it might just be

1469

00:52:12,309 --> 00:52:10,800

ultra condensed matter down to the

1470

00:52:14,069 --> 00:52:12,319

planck scale

1471

00:52:16,790 --> 00:52:14,079

and and

1472

00:52:18,950 --> 00:52:16,800

i love the word uh playing scale uh you

1473

00:52:22,069 --> 00:52:18,960

just lit up twitter uh we discussed this

1474

00:52:26,309 --> 00:52:22,079

so often on the show but what about the

1475

00:52:28,549 --> 00:52:26,319

other concept of this like uh stargate

1476
00:52:29,589 --> 00:52:28,559
which you love and i love and everybody

1477
00:52:31,430 --> 00:52:29,599
loves

1478
00:52:33,190 --> 00:52:31,440
but they walk

1479
00:52:34,950 --> 00:52:33,200
right they they

1480
00:52:37,349 --> 00:52:34,960
walk through it

1481
00:52:39,349 --> 00:52:37,359
and and then they're they're covering

1482
00:52:42,470 --> 00:52:39,359
these fast distances

1483
00:52:45,349 --> 00:52:42,480
instantly but they're on their feet

1484
00:52:47,190 --> 00:52:45,359
now is that the same concept is that a

1485
00:52:48,549 --> 00:52:47,200
wormhole

1486
00:52:50,549 --> 00:52:48,559
what they discussed is there i think

1487
00:52:52,549 --> 00:52:50,559
they say it's specifically not actually

1488
00:52:53,910 --> 00:52:52,559

a wormhole but basically it's a wormhole

1489

00:52:55,750 --> 00:52:53,920

and that's probably about the right way

1490

00:52:57,430 --> 00:52:55,760

to look at it the wormholes that we see

1491

00:52:59,109 --> 00:52:57,440

that we theorize about

1492

00:53:00,309 --> 00:52:59,119

uh which to be fair is kind of steering

1493

00:53:01,670 --> 00:53:00,319

the name because it more popped up in

1494

00:53:03,510 --> 00:53:01,680

science fiction is something different

1495

00:53:05,589 --> 00:53:03,520

than we said this is what a wormhole is

1496

00:53:07,349 --> 00:53:05,599

right if we got that gateway thing where

1497

00:53:09,109 --> 00:53:07,359

it's just a two-dimensional thing and

1498

00:53:10,470 --> 00:53:09,119

and by the way a wormhole that we'd

1499

00:53:12,470 --> 00:53:10,480

actually have in real space would be

1500

00:53:14,150 --> 00:53:12,480

three-dimensional look like a sphere

1501
00:53:15,829 --> 00:53:14,160
but there's nothing necessarily says

1502
00:53:17,430 --> 00:53:15,839
that if you got gravity manipulation you

1503
00:53:18,309 --> 00:53:17,440
couldn't maybe make something that was

1504
00:53:20,710 --> 00:53:18,319
two-dimensional instead of

1505
00:53:22,230 --> 00:53:20,720
one-dimensional might save you power

1506
00:53:24,390 --> 00:53:22,240
and of course we have no idea how to do

1507
00:53:26,470 --> 00:53:24,400
this but that's the kind of your ideal

1508
00:53:27,750 --> 00:53:26,480
transport system and one thing i liked

1509
00:53:29,910 --> 00:53:27,760
about that franchise they said wait a

1510
00:53:32,870 --> 00:53:29,920
minute why do we even have spaceships if

1511
00:53:34,470 --> 00:53:32,880
we got this gateway you know

1512
00:53:35,510 --> 00:53:34,480
these are just delivery systems and that

1513
00:53:37,270 --> 00:53:35,520

is one of the problems we often have

1514

00:53:39,190 --> 00:53:37,280

with wormholes as you make them and you

1515

00:53:41,270 --> 00:53:39,200

have to take them to the location

1516

00:53:42,950 --> 00:53:41,280

handy for communication travel inside an

1517

00:53:45,349 --> 00:53:42,960

empire but not so handy for traveling to

1518

00:53:47,910 --> 00:53:45,359

new places and

1519

00:53:49,829 --> 00:53:47,920

the speed

1520

00:53:51,510 --> 00:53:49,839

what is okay let's let's talk about

1521

00:53:53,750 --> 00:53:51,520

stargate for a second you can answer

1522

00:53:55,190 --> 00:53:53,760

i've i've got 30 seconds

1523

00:53:58,309 --> 00:53:55,200

what is the speed that they are

1524

00:53:59,589 --> 00:53:58,319

traveling at in it with the example of

1525

00:54:02,390 --> 00:53:59,599

stargate

1526
00:54:04,470 --> 00:54:02,400
because now we're not talking about ftl

1527
00:54:07,430 --> 00:54:04,480
we're talking about redunkulous right

1528
00:54:08,950 --> 00:54:07,440
it's a whole nother speed all together

1529
00:54:10,470 --> 00:54:08,960
they ironically they'd be moving at

1530
00:54:11,750 --> 00:54:10,480
walking speed the whole idea of the

1531
00:54:14,150 --> 00:54:11,760
wormhole is that it's shortening the

1532
00:54:15,990 --> 00:54:14,160
distance between those two points

1533
00:54:17,589 --> 00:54:16,000
so that they aren't actually speeding up

1534
00:54:19,270 --> 00:54:17,599
or exceeding the speed of light that's

1535
00:54:21,190 --> 00:54:19,280
one of the ways that wormholes and warp

1536
00:54:23,910 --> 00:54:21,200
drives get around ftl is that they are

1537
00:54:25,510 --> 00:54:23,920
not actually breaking that rule at all

1538
00:54:27,109 --> 00:54:25,520

they just kind of seem to be from a

1539

00:54:28,870 --> 00:54:27,119

practical standpoint and we're going to

1540

00:54:30,630 --> 00:54:28,880

discuss that when we come back it's a

1541

00:54:34,069 --> 00:54:30,640

very important point that we need to

1542

00:54:37,510 --> 00:54:34,079

address here because time travel and ftl

1543

00:54:39,430 --> 00:54:37,520

uh with these examples uh take things uh

1544

00:54:41,270 --> 00:54:39,440

to a whole nother level we need to get

1545

00:54:43,670 --> 00:54:41,280

through all of that this is fade to

1546

00:54:45,829 --> 00:54:43,680

black our guest tonight isaac arthur

1547

00:54:47,910 --> 00:54:45,839

we're talking clark tech this is fade to

1548

00:54:49,510 --> 00:54:47,920

black i'm your jimmy church we'll be

1549

00:54:51,920 --> 00:54:49,520

right back after this short break stay

1550

00:55:30,710 --> 00:54:51,930

with us

1551
00:55:35,510 --> 00:55:33,510
all right welcome back isaac arthur is

1552
00:55:38,150 --> 00:55:35,520
our guest

1553
00:55:40,470 --> 00:55:38,160
we're talking clark tech now

1554
00:55:42,710 --> 00:55:40,480
you need to go to isaacarthur.net the

1555
00:55:45,030 --> 00:55:42,720
links are over at jimmychurchradio.com

1556
00:55:47,349 --> 00:55:45,040
just click after the show tonight head

1557
00:55:49,670 --> 00:55:47,359
over to his youtube channel and his uh

1558
00:55:51,430 --> 00:55:49,680
website and and get it on it's

1559
00:55:53,910 --> 00:55:51,440
absolutely amazing

1560
00:55:54,710 --> 00:55:53,920
i spend way too much time there isaac

1561
00:55:59,670 --> 00:55:54,720
way

1562
00:56:02,470 --> 00:55:59,680
drives

1563
00:56:05,990 --> 00:56:02,480

and i recently

1564

00:56:08,630 --> 00:56:06,000

uh i'll send you the link to it um

1565

00:56:11,910 --> 00:56:08,640

uh i have it uh somewhere i'll send you

1566

00:56:13,430 --> 00:56:11,920

the link listen to uh an interview uh

1567

00:56:16,549 --> 00:56:13,440

with miguel

1568

00:56:17,430 --> 00:56:16,559

um uh alcup

1569

00:56:23,750 --> 00:56:17,440

uh

1570

00:56:25,510 --> 00:56:23,760

the science to put this all together

1571

00:56:27,510 --> 00:56:25,520

because it has been talked about for a

1572

00:56:29,190 --> 00:56:27,520

very long time it's not like it's a

1573

00:56:32,789 --> 00:56:29,200

brand new concept

1574

00:56:36,390 --> 00:56:32,799

but uh it's pretty incredible

1575

00:56:38,390 --> 00:56:36,400

and to hear nasa's announcement as as

1576

00:56:40,390 --> 00:56:38,400

you well know i think it was last year

1577

00:56:43,109 --> 00:56:40,400

maybe a year and a half ago you know

1578

00:56:44,390 --> 00:56:43,119

talking about the development of a warp

1579

00:56:47,510 --> 00:56:44,400

drive engine

1580

00:56:49,670 --> 00:56:47,520

is pretty exciting stuff and this isn't

1581

00:56:52,069 --> 00:56:49,680

really outside of the realm of physics

1582

00:56:54,630 --> 00:56:52,079

is it this is something that could

1583

00:56:56,950 --> 00:56:54,640

actually be built

1584

00:56:58,870 --> 00:56:56,960

possibly and it's it's got some options

1585

00:57:00,390 --> 00:56:58,880

there it's not forbidden by physics in

1586

00:57:02,390 --> 00:57:00,400

fact it's kind of a consequence of what

1587

00:57:03,750 --> 00:57:02,400

we think the current theory is

1588

00:57:05,270 --> 00:57:03,760

but it's one of those ones where it runs

1589

00:57:06,710 --> 00:57:05,280

that quantum gravity issue where we

1590

00:57:08,069 --> 00:57:06,720

don't really understand what

1591

00:57:09,670 --> 00:57:08,079

happens with the gravity at this super

1592

00:57:11,510 --> 00:57:09,680

tiny scale

1593

00:57:14,470 --> 00:57:11,520

i think when sunny white's talking about

1594

00:57:15,589 --> 00:57:14,480

it as an idea um from nasa

1595

00:57:16,950 --> 00:57:15,599

um

1596

00:57:19,030 --> 00:57:16,960

one of the things winston there is not

1597

00:57:20,950 --> 00:57:19,040

just using this for ftl travel but for

1598

00:57:22,549 --> 00:57:20,960

using it just for its very fast ship

1599

00:57:24,470 --> 00:57:22,559

propellant you know for conventional

1600

00:57:26,630 --> 00:57:24,480

drive but very quick

1601
00:57:28,069 --> 00:57:26,640
and the idea there and that's i was

1602
00:57:29,910 --> 00:57:28,079
funny i was saying white horse don't

1603
00:57:31,670 --> 00:57:29,920
exist earlier on when you're making one

1604
00:57:33,030 --> 00:57:31,680
of these warp drives you're actually not

1605
00:57:34,309 --> 00:57:33,040
dividing between a white hole and a

1606
00:57:36,390 --> 00:57:34,319
black hole

1607
00:57:38,870 --> 00:57:36,400
and it's uh a very

1608
00:57:40,710 --> 00:57:38,880
dangerous motion method

1609
00:57:43,750 --> 00:57:40,720
well yeah and that we're getting ahead

1610
00:57:47,430 --> 00:57:43,760
of our skis here uh the white hole uh

1611
00:57:50,549 --> 00:57:47,440
black hole concept uh has been suggested

1612
00:57:55,670 --> 00:57:50,559
uh but before we get to that

1613
00:57:57,910 --> 00:57:55,680

the idea of how a warp drive works

1614

00:57:59,910 --> 00:57:57,920

let's i'm going to do the simplified

1615

00:58:02,069 --> 00:57:59,920

side of it first

1616

00:58:04,789 --> 00:58:02,079

and then i need you to help me explain

1617

00:58:06,549 --> 00:58:04,799

what they're actually talking about but

1618

00:58:10,630 --> 00:58:06,559

the concept is

1619

00:58:12,870 --> 00:58:10,640

that you are removing space in front of

1620

00:58:16,309 --> 00:58:12,880

you you're cutting it out you're

1621

00:58:17,990 --> 00:58:16,319

replacing the space behind you and

1622

00:58:20,230 --> 00:58:18,000

adding space

1623

00:58:23,829 --> 00:58:20,240

and therefore uh

1624

00:58:27,109 --> 00:58:23,839

cutting the distance between where you

1625

00:58:28,950 --> 00:58:27,119

need to get to you're removing the space

1626
00:58:32,710 --> 00:58:28,960
which essentially

1627
00:58:33,990 --> 00:58:32,720
instantly puts you where you need to go

1628
00:58:36,870 --> 00:58:34,000
that

1629
00:58:39,030 --> 00:58:36,880
it's it's not faster than light it's

1630
00:58:40,950 --> 00:58:39,040
it's it this is a whole other concept

1631
00:58:44,230 --> 00:58:40,960
you you're not traveling at the speed of

1632
00:58:45,190 --> 00:58:44,240
light you're merely cutting out in front

1633
00:58:47,990 --> 00:58:45,200
of you

1634
00:58:49,030 --> 00:58:48,000
the distance now am i explaining that

1635
00:58:51,109 --> 00:58:49,040
correctly

1636
00:58:52,549 --> 00:58:51,119
yes it's interesting though is it's

1637
00:58:54,470 --> 00:58:52,559
probably a bad name for cause we always

1638
00:58:55,910 --> 00:58:54,480

get warped from star trek and that's you

1639

00:58:57,910 --> 00:58:55,920

know that that looks like motion what

1640

00:58:59,750 --> 00:58:57,920

you're really doing is uh it's something

1641

00:59:01,270 --> 00:58:59,760

they have a flawed analogy i think like

1642

00:59:03,670 --> 00:59:01,280

a submarine where it sucks water in the

1643

00:59:05,270 --> 00:59:03,680

front and spits out the back you're kind

1644

00:59:06,710 --> 00:59:05,280

of doing that only with space-time

1645

00:59:08,309 --> 00:59:06,720

you're compressing in front of you and

1646

00:59:10,390 --> 00:59:08,319

expanding behind you

1647

00:59:11,990 --> 00:59:10,400

and what's neat about this idea it

1648

00:59:13,670 --> 00:59:12,000

doesn't violate ftl at all you're not

1649

00:59:16,150 --> 00:59:13,680

even moving yourself

1650

00:59:17,910 --> 00:59:16,160

um but you're covering distance what's

1651

00:59:20,309 --> 00:59:17,920

neat about it is that it is actually

1652

00:59:21,510 --> 00:59:20,319

allowed under what we know about science

1653

00:59:23,750 --> 00:59:21,520

because

1654

00:59:25,670 --> 00:59:23,760

we know that gravity does contract space

1655

00:59:28,390 --> 00:59:25,680

and time and we know from the existence

1656

00:59:29,670 --> 00:59:28,400

of dark energy that you can expand

1657

00:59:31,270 --> 00:59:29,680

space-time

1658

00:59:33,910 --> 00:59:31,280

and we also know from our theory of

1659

00:59:36,710 --> 00:59:33,920

expansion for the universe that you can

1660

00:59:39,030 --> 00:59:36,720

move things faster than light this way

1661

00:59:40,950 --> 00:59:39,040

and then it's a cheat but cheating's

1662

00:59:44,470 --> 00:59:40,960

okay in this case if you can get it to

1663

00:59:46,069 --> 00:59:44,480

walk right and so what does this do

1664

00:59:47,670 --> 00:59:46,079

we'll get back to the warp drive in a

1665

00:59:49,990 --> 00:59:47,680

second but

1666

00:59:53,030 --> 00:59:50,000

jumping back to star trek where

1667

00:59:55,430 --> 00:59:53,040

or the orville or any of these science

1668

00:59:57,190 --> 00:59:55,440

fiction movies and books where they do

1669

00:59:58,069 --> 00:59:57,200

this kind of travel

1670

01:00:00,549 --> 00:59:58,079

so

1671

01:00:02,630 --> 01:00:00,559

europe you know you're in the orville

1672

01:00:04,630 --> 01:00:02,640

right and you're zipping around fat fat

1673

01:00:07,109 --> 01:00:04,640

fat fat and you're you're zigzagging

1674

01:00:09,030 --> 01:00:07,119

across space on a mission

1675

01:00:09,990 --> 01:00:09,040

what does this do

1676

01:00:12,630 --> 01:00:10,000

to

1677

01:00:15,430 --> 01:00:12,640

relative time back on earth

1678

01:00:17,349 --> 01:00:15,440

we all understand the concepts of of

1679

01:00:18,549 --> 01:00:17,359

albert einstein you know traveling at

1680

01:00:20,710 --> 01:00:18,559

the speed of light you and i have

1681

01:00:22,789 --> 01:00:20,720

discussed this many times and then you

1682

01:00:25,349 --> 01:00:22,799

return back to earth and now you're a

1683

01:00:28,230 --> 01:00:25,359

time traveler you're in the future

1684

01:00:32,710 --> 01:00:28,240

if you're out there on the orville doing

1685

01:00:35,109 --> 01:00:32,720

these uh fantastic light speed jumps

1686

01:00:36,789 --> 01:00:35,119

you earth is no longer part of the

1687

01:00:39,990 --> 01:00:36,799

equation i would think

1688

01:00:42,150 --> 01:00:40,000

in that you're bazillions of years in

1689

01:00:43,589 --> 01:00:42,160

the future when you're done with this

1690

01:00:45,030 --> 01:00:43,599

well you'd expect that from the normal

1691

01:00:46,150 --> 01:00:45,040

stuff but this actually is the real

1692

01:00:47,190 --> 01:00:46,160

cheat that we always think of where

1693

01:00:48,870 --> 01:00:47,200

you're just moving faster and light with

1694

01:00:50,150 --> 01:00:48,880

no time consequences because again

1695

01:00:51,750 --> 01:00:50,160

you're not moving you're not

1696

01:00:53,589 --> 01:00:51,760

experiencing relative motion you're just

1697

01:00:55,910 --> 01:00:53,599

sucking space time in and out the back

1698

01:00:57,349 --> 01:00:55,920

as a war so your watch looks the same as

1699

01:00:59,349 --> 01:00:57,359

anybody else's background earth's watch

1700

01:01:01,190 --> 01:00:59,359

unless you're moving yourself normally

1701
01:01:02,390 --> 01:01:01,200
too you could be moving while you turn

1702
01:01:04,549 --> 01:01:02,400
one of these on and still get some of

1703
01:01:06,470 --> 01:01:04,559
that time dilation but this object

1704
01:01:08,230 --> 01:01:06,480
doesn't work by you moving it works by

1705
01:01:08,950 --> 01:01:08,240
moving space underneath you use a wall

1706
01:01:11,589 --> 01:01:08,960
no

1707
01:01:14,390 --> 01:01:11,599
yes yes yes yes yes yes yes but that's

1708
01:01:16,789 --> 01:01:14,400
not what i'm uh actually asking

1709
01:01:20,230 --> 01:01:16,799
what i am what i'm suggesting here is

1710
01:01:23,349 --> 01:01:20,240
that in like a tv show like the orville

1711
01:01:25,510 --> 01:01:23,359
where they jump up uh and and and

1712
01:01:28,150 --> 01:01:25,520
they're they're not using a warp drive

1713
01:01:30,789 --> 01:01:28,160

they're they're using speed

1714

01:01:32,470 --> 01:01:30,799

right and so by doing this time after

1715

01:01:33,829 --> 01:01:32,480

time after time when they come back to

1716

01:01:36,069 --> 01:01:33,839

visit earth

1717

01:01:38,069 --> 01:01:36,079

it's is that a misrepresentation that

1718

01:01:40,069 --> 01:01:38,079

earth is still on the same timeline

1719

01:01:41,750 --> 01:01:40,079

after they're out there running around

1720

01:01:43,589 --> 01:01:41,760

at the speed of light

1721

01:01:44,789 --> 01:01:43,599

uh well if they're moving around the

1722

01:01:46,630 --> 01:01:44,799

speed of light they won't actually be

1723

01:01:47,990 --> 01:01:46,640

experiencing time at all but if they're

1724

01:01:49,589 --> 01:01:48,000

moving really close to speed of light

1725

01:01:51,589 --> 01:01:49,599

that's the usual case where it slows

1726

01:01:53,270 --> 01:01:51,599

down if they're actually moving fast and

1727

01:01:54,309 --> 01:01:53,280

light it's not they're going to come out

1728

01:01:55,990 --> 01:01:54,319

in earth's future they're going to come

1729

01:01:57,750 --> 01:01:56,000

out earth's past that's just how that

1730

01:01:59,349 --> 01:01:57,760

works out anytime you're going faster

1731

01:02:01,589 --> 01:01:59,359

light for real actually going through

1732

01:02:03,510 --> 01:02:01,599

space faster than light as opposed to

1733

01:02:05,030 --> 01:02:03,520

warp drives or wormhole methods you're

1734

01:02:07,510 --> 01:02:05,040

not going forward in time you're going

1735

01:02:09,510 --> 01:02:07,520

backward in time okay so now back to the

1736

01:02:10,950 --> 01:02:09,520

warp drive

1737

01:02:16,470 --> 01:02:10,960

the

1738

01:02:19,589 --> 01:02:16,480

that we are talking here

1739

01:02:21,750 --> 01:02:19,599

with the functional warp drive engine uh

1740

01:02:23,750 --> 01:02:21,760

let's uh let's take sirius b for

1741

01:02:26,150 --> 01:02:23,760

instance right or you know what let's

1742

01:02:29,109 --> 01:02:26,160

even go closer let's go to proxima

1743

01:02:30,870 --> 01:02:29,119

okay let's go to alpha centauri uh four

1744

01:02:32,630 --> 01:02:30,880

and a half light years away and that's

1745

01:02:33,589 --> 01:02:32,640

and we're going to use a warp drive for

1746

01:02:36,230 --> 01:02:33,599

that

1747

01:02:39,589 --> 01:02:36,240

um the speed of light is four and a half

1748

01:02:41,190 --> 01:02:39,599

years right we know this right yep okay

1749

01:02:44,710 --> 01:02:41,200

warp drive

1750

01:02:46,069 --> 01:02:44,720

from earth to alpha centauri

1751

01:02:47,910 --> 01:02:46,079

is how long

1752

01:02:49,349 --> 01:02:47,920

potentially a microsecond i mean it

1753

01:02:50,870 --> 01:02:49,359

depends on what you're looking at with

1754

01:02:52,789 --> 01:02:50,880

the model and how powerful the system

1755

01:02:54,230 --> 01:02:52,799

you're using is you can cross galaxies

1756

01:02:56,470 --> 01:02:54,240

in a second with the thing so you

1757

01:02:59,430 --> 01:02:56,480

wouldn't you wouldn't even know that you

1758

01:03:01,030 --> 01:02:59,440

traveled because the ship itself

1759

01:03:03,829 --> 01:03:01,040

i want to understand

1760

01:03:05,349 --> 01:03:03,839

isn't actually moving right

1761

01:03:07,190 --> 01:03:05,359

nope all you see in front of you is a

1762

01:03:09,030 --> 01:03:07,200

gigantic white field and behind you a

1763

01:03:10,549 --> 01:03:09,040

gigantic black field until it stops and

1764

01:03:13,030 --> 01:03:10,559

you're somewhere else

1765

01:03:19,430 --> 01:03:17,349

the time element the time travel element

1766

01:03:21,670 --> 01:03:19,440

of it does that come into play with a

1767

01:03:22,470 --> 01:03:21,680

warp drive no time travel with a warp

1768

01:03:23,510 --> 01:03:22,480

drive

1769

01:03:25,349 --> 01:03:23,520

although there are some ways you can

1770

01:03:27,190 --> 01:03:25,359

play with it to get a time travel effect

1771

01:03:28,710 --> 01:03:27,200

but by its default nature that's that's

1772

01:03:30,710 --> 01:03:28,720

what let's work is that it's not

1773

01:03:32,390 --> 01:03:30,720

screening out any of that so when we're

1774

01:03:34,470 --> 01:03:32,400

talking almost like a teleportation

1775

01:03:36,470 --> 01:03:34,480

system yes yes yes it's it's

1776

01:03:37,589 --> 01:03:36,480

mind-bending when we think about this in

1777

01:03:39,270 --> 01:03:37,599

concept

1778

01:03:41,829 --> 01:03:39,280

uh now

1779

01:03:44,549 --> 01:03:41,839

et let's talk about et an advanced

1780

01:03:47,750 --> 01:03:44,559

civilization out there if they have warp

1781

01:03:50,150 --> 01:03:47,760

drives and we're talking uh you know uh

1782

01:03:53,349 --> 01:03:50,160

the the size of the milky way which is

1783

01:03:55,910 --> 01:03:53,359

positively ginormous right we think it's

1784

01:03:57,270 --> 01:03:55,920

small it's not it's huge our solar

1785

01:04:00,710 --> 01:03:57,280

system is huge

1786

01:04:02,870 --> 01:04:00,720

but to travel across the milky way

1787

01:04:04,150 --> 01:04:02,880

with a warp drive

1788

01:04:05,670 --> 01:04:04,160

technically

1789

01:04:07,510 --> 01:04:05,680

in concept

1790

01:04:09,349 --> 01:04:07,520

is instant

1791

01:04:11,190 --> 01:04:09,359

close to it yeah but it's not just the

1792

01:04:12,710 --> 01:04:11,200

milky way it would be all the you know

1793

01:04:14,630 --> 01:04:12,720

all the universes see i was going to get

1794

01:04:16,710 --> 01:04:14,640

to that in a second okay that's my next

1795

01:04:18,390 --> 01:04:16,720

question

1796

01:04:21,029 --> 01:04:18,400

in that okay so

1797

01:04:21,910 --> 01:04:21,039

uh uh traveling across the milky way

1798

01:04:25,190 --> 01:04:21,920

would be

1799

01:04:28,230 --> 01:04:25,200

uh at an instant and so that removes any

1800

01:04:30,789 --> 01:04:28,240

of these uh conversations about how long

1801
01:04:32,710 --> 01:04:30,799
it would take and food and necessity you

1802
01:04:34,390 --> 01:04:32,720
know everything's worse than that yeah

1803
01:04:36,549 --> 01:04:34,400
right normally we say you grab every

1804
01:04:38,309 --> 01:04:36,559
stall you can along the way that's even

1805
01:04:40,710 --> 01:04:38,319
vaguely usable to you because it's

1806
01:04:41,829 --> 01:04:40,720
closer but if you've got a helicopter

1807
01:04:43,349 --> 01:04:41,839
over an area you're trying to pick the

1808
01:04:45,349 --> 01:04:43,359
best settlement you don't go for closest

1809
01:04:47,029 --> 01:04:45,359
you go for best right you got the entire

1810
01:04:48,710 --> 01:04:47,039
universe to pick from your colony is now

1811
01:04:50,230 --> 01:04:48,720
so it's not a sphere that expands from

1812
01:04:52,470 --> 01:04:50,240
your homeworld it's

1813
01:04:54,789 --> 01:04:52,480

you know wherever you find best

1814

01:04:59,190 --> 01:04:54,799

so technically

1815

01:05:02,069 --> 01:04:59,200

going from galaxy to galaxy or to the

1816

01:05:04,390 --> 01:05:02,079

fringes of the universe the same concept

1817

01:05:06,069 --> 01:05:04,400

applies instant

1818

01:05:08,230 --> 01:05:06,079

close to it yeah not quite instant but

1819

01:05:09,510 --> 01:05:08,240

very close to it would you have to do it

1820

01:05:11,190 --> 01:05:09,520

in stages

1821

01:05:13,750 --> 01:05:11,200

would you have to would you

1822

01:05:16,870 --> 01:05:13,760

yeah would you have to warp warp warp

1823

01:05:18,390 --> 01:05:16,880

you know uh go from uh uh

1824

01:05:20,230 --> 01:05:18,400

point to point

1825

01:05:21,750 --> 01:05:20,240

there are so many of the uncertainties

1826

01:05:23,349 --> 01:05:21,760

even on the mass side of this like one

1827

01:05:24,870 --> 01:05:23,359

of the versions that we think might work

1828

01:05:25,990 --> 01:05:24,880

would be where you're basically putting

1829

01:05:27,190 --> 01:05:26,000

down um

1830

01:05:28,710 --> 01:05:27,200

a feed line in front of you like a

1831

01:05:30,470 --> 01:05:28,720

railroad track and you actually have to

1832

01:05:31,510 --> 01:05:30,480

build that at sublight speed and that

1833

01:05:33,109 --> 01:05:31,520

might be the only way you could get to

1834

01:05:34,789 --> 01:05:33,119

walk basically building yourself this

1835

01:05:35,589 --> 01:05:34,799

track way of negative matter along the

1836

01:05:37,349 --> 01:05:35,599

way

1837

01:05:38,390 --> 01:05:37,359

in which case that goes right back to

1838

01:05:39,829 --> 01:05:38,400

the same thing it's great for

1839

01:05:41,670 --> 01:05:39,839

communicating like a wormhole it's great

1840

01:05:43,349 --> 01:05:41,680

for keeping an empire across the stars

1841

01:05:45,990 --> 01:05:43,359

intact right but it's not so great for

1842

01:05:48,549 --> 01:05:46,000

building one in the first place so

1843

01:05:50,789 --> 01:05:48,559

now that sounds too good to be true

1844

01:05:53,990 --> 01:05:50,799

right and concept it's it's just too

1845

01:05:56,390 --> 01:05:54,000

good to be true and it probably is

1846

01:05:58,549 --> 01:05:56,400

so there's got to be some some

1847

01:06:00,230 --> 01:05:58,559

you know a downside or two we're going

1848

01:06:01,029 --> 01:06:00,240

to get to that in a second

1849

01:06:03,109 --> 01:06:01,039

but

1850

01:06:05,510 --> 01:06:03,119

let's let's say

1851

01:06:08,230 --> 01:06:05,520

that this is possible

1852

01:06:09,109 --> 01:06:08,240

what about objects that would be in the

1853

01:06:10,950 --> 01:06:09,119

way

1854

01:06:13,589 --> 01:06:10,960

you're removing space but what if

1855

01:06:15,589 --> 01:06:13,599

there's a star in the way uh another

1856

01:06:18,309 --> 01:06:15,599

planet

1857

01:06:21,270 --> 01:06:18,319

you're gonna slam right into it right

1858

01:06:22,870 --> 01:06:21,280

you can't you can't cut that out yeah

1859

01:06:24,230 --> 01:06:22,880

and it's not just that you know those

1860

01:06:25,829 --> 01:06:24,240

things you're running into you've got

1861

01:06:27,589 --> 01:06:25,839

all that gas and other things along the

1862

01:06:29,270 --> 01:06:27,599

way that you're slamming into as well

1863

01:06:31,430 --> 01:06:29,280

although that's kind of least your

1864

01:06:33,430 --> 01:06:31,440

problems in a case like this because the

1865

01:06:37,910 --> 01:06:33,440

ship's engine itself ought to kill you

1866

01:06:39,829 --> 01:06:37,920

the moment you turn it on but okay so

1867

01:06:43,829 --> 01:06:39,839

yeah

1868

01:06:45,670 --> 01:06:43,839

is there a is calling it an engine a

1869

01:06:49,029 --> 01:06:45,680

warp drive engine

1870

01:06:51,109 --> 01:06:49,039

is that a correct use of the term

1871

01:06:52,549 --> 01:06:51,119

well i suppose i mean it's it's kind of

1872

01:06:54,390 --> 01:06:52,559

debatable if you think there's an engine

1873

01:06:56,230 --> 01:06:54,400

for moving space time around then yeah

1874

01:06:58,150 --> 01:06:56,240

but warp drives the usual thing so

1875

01:07:01,270 --> 01:06:58,160

that's probably more accurate right and

1876

01:07:04,230 --> 01:07:01,280

so with with this with a warp drive ship

1877

01:07:06,390 --> 01:07:04,240

you would also have auxiliary engines

1878

01:07:08,230 --> 01:07:06,400

right you would have traditional

1879

01:07:10,390 --> 01:07:08,240

chemical engines because you would have

1880

01:07:11,589 --> 01:07:10,400

to still move you'd have to dock you

1881

01:07:13,430 --> 01:07:11,599

would have to

1882

01:07:15,270 --> 01:07:13,440

you know right

1883

01:07:16,870 --> 01:07:15,280

probably i mean if you were really good

1884

01:07:18,390 --> 01:07:16,880

with it i suppose you could but i'm not

1885

01:07:20,309 --> 01:07:18,400

sure anyone want you document their

1886

01:07:21,990 --> 01:07:20,319

space station by warping space time

1887

01:07:24,069 --> 01:07:22,000

right next to them so probably you need

1888

01:07:26,470 --> 01:07:24,079

conventional engines so what happens at

1889

01:07:28,789 --> 01:07:26,480

the other end

1890

01:07:29,910 --> 01:07:28,799

what happens when you arrive

1891

01:07:31,750 --> 01:07:29,920

assuming you weren't killed in the

1892

01:07:33,589 --> 01:07:31,760

process of using it you should just pop

1893

01:07:35,670 --> 01:07:33,599

out of space no well i shouldn't say pop

1894

01:07:37,589 --> 01:07:35,680

out of space you should just stop moving

1895

01:07:41,990 --> 01:07:37,599

as it were but do you turn it off and

1896

01:07:43,349 --> 01:07:42,000

there you are do you just appear

1897

01:07:44,630 --> 01:07:43,359

you would seem to yeah i mean because

1898

01:07:46,230 --> 01:07:44,640

you're going fast in life from the

1899

01:07:47,349 --> 01:07:46,240

perspective of anyone watching you

1900

01:07:49,670 --> 01:07:47,359

you're just gonna

1901

01:07:52,309 --> 01:07:49,680

pop right out of space at war now

1902

01:07:55,109 --> 01:07:52,319

what happens to you and i when we just

1903

01:07:55,870 --> 01:07:55,119

appear do we slam into the window in

1904

01:07:58,150 --> 01:07:55,880

front of us

1905

01:08:00,230 --> 01:07:58,160

[Laughter]

1906

01:08:01,829 --> 01:08:00,240

not quite now what would happen is all

1907

01:08:03,349 --> 01:08:01,839

that light that you emitted normally

1908

01:08:05,190 --> 01:08:03,359

along the way is going to eventually

1909

01:08:06,870 --> 01:08:05,200

catch back up to you so they'll see a

1910

01:08:08,390 --> 01:08:06,880

ghost image as it were following you in

1911

01:08:10,150 --> 01:08:08,400

when you arrive but they'll see you

1912

01:08:12,309 --> 01:08:10,160

arrive before your light got there so to

1913

01:08:14,150 --> 01:08:12,319

see that first you turn off and all of a

1914

01:08:16,470 --> 01:08:14,160

sudden they'll see you arrive

1915

01:08:17,669 --> 01:08:16,480

um things are more complicated on the

1916

01:08:19,510 --> 01:08:17,679

inside of that and there's also the

1917

01:08:21,430 --> 01:08:19,520

possibility that you might blow up their

1918

01:08:23,910 --> 01:08:21,440

solar system when you arrive too now

1919

01:08:28,070 --> 01:08:23,920

describe what the ship would actually be

1920

01:08:29,510 --> 01:08:28,080

is it is it enveloped is it in a cocoon

1921

01:08:31,430 --> 01:08:29,520

the usual thought is that you go for a

1922

01:08:33,510 --> 01:08:31,440

spherical bubble because the biggest

1923

01:08:35,669 --> 01:08:33,520

problem with these things from a mass

1924

01:08:38,390 --> 01:08:35,679

standpoint is trying to keep this really

1925

01:08:40,470 --> 01:08:38,400

stable perfectly stable field because if

1926

01:08:41,590 --> 01:08:40,480

it's not totally homogeneous you're

1927

01:08:43,030 --> 01:08:41,600

gonna have bits and pieces of yourself

1928

01:08:43,990 --> 01:08:43,040

maybe at different rates that's that's

1929

01:08:45,749 --> 01:08:44,000

not good

1930

01:08:47,829 --> 01:08:45,759

uh so you wanna like a perfect spherical

1931

01:08:50,550 --> 01:08:47,839

bubble if you can or perhaps an

1932

01:08:52,229 --> 01:08:50,560

ellipsoid um

1933

01:08:53,910 --> 01:08:52,239

and so that that does tend to give that

1934

01:08:55,590 --> 01:08:53,920

that shape that we often see when we

1935

01:08:57,829 --> 01:08:55,600

look at uh always rendering these where

1936

01:08:59,030 --> 01:08:57,839

they got the big uh big cylinder around

1937

01:09:00,709 --> 01:08:59,040

that kind of thing

1938

01:09:03,110 --> 01:09:00,719

um on the inside though the ship could

1939

01:09:04,789 --> 01:09:03,120

be shaped however you want um though you

1940

01:09:06,309 --> 01:09:04,799

want to be really sure whatever you're

1941

01:09:07,269 --> 01:09:06,319

building that ship as that's not doing

1942

01:09:09,269 --> 01:09:07,279

anything that's going to mess with the

1943

01:09:11,430 --> 01:09:09,279

geometry of that field anything messed

1944

01:09:12,630 --> 01:09:11,440

with geometry that field you are dead

1945

01:09:16,149 --> 01:09:12,640

assuming you weren't killed again the

1946

01:09:19,749 --> 01:09:16,159

moment you turned it on well okay so

1947

01:09:21,189 --> 01:09:19,759

at that kind of um and and speed is the

1948

01:09:23,829 --> 01:09:21,199

wrong

1949

01:09:24,950 --> 01:09:23,839

description here for the audience but

1950

01:09:28,149 --> 01:09:24,960

let's say

1951

01:09:31,430 --> 01:09:28,159

let's use energy uh uh

1952

01:09:33,829 --> 01:09:31,440

to do that to travel

1953

01:09:36,070 --> 01:09:33,839

that amount of distance i would only

1954

01:09:38,550 --> 01:09:36,080

assume like anything else

1955

01:09:40,950 --> 01:09:38,560

uh physics has to come into play we have

1956

01:09:43,110 --> 01:09:40,960

thermal considerations too

1957

01:09:45,829 --> 01:09:43,120

and if you're inside of a bubble you

1958

01:09:49,269 --> 01:09:45,839

would have to have the most massive air

1959

01:09:50,390 --> 01:09:49,279

conditioner known to man uh-huh

1960

01:09:52,149 --> 01:09:50,400

theoretically you'd need something to

1961

01:09:53,910 --> 01:09:52,159

get rid of that energy as though you

1962

01:09:55,669 --> 01:09:53,920

were inside a stall

1963

01:09:56,950 --> 01:09:55,679

right i mean that's and that's exactly

1964

01:09:58,870 --> 01:09:56,960

the problem with these things is that

1965

01:10:00,870 --> 01:09:58,880

that white hole in front of you is just

1966

01:10:02,709 --> 01:10:00,880

nothing but raw energy coming out you

1967

01:10:05,510 --> 01:10:02,719

and there's no way to block that you're

1968

01:10:07,270 --> 01:10:05,520

compressing space time in front of you

1969

01:10:09,510 --> 01:10:07,280

and that's causing everything in front

1970

01:10:10,709 --> 01:10:09,520

of you to blue shift like crazy

1971

01:10:12,630 --> 01:10:10,719

and so

1972

01:10:14,149 --> 01:10:12,640

much we said like when red shifted light

1973

01:10:15,990 --> 01:10:14,159

for cosmic background radiation keeps

1974

01:10:17,510 --> 01:10:16,000

getting weaker behind you that's kind of

1975

01:10:18,709 --> 01:10:17,520

what's happening in front of you

1976

01:10:20,470 --> 01:10:18,719

everything's going the other way it's

1977

01:10:22,709 --> 01:10:20,480

blue shifting it's getting way more

1978

01:10:24,709 --> 01:10:22,719

potent and powerful and slamming into

1979

01:10:26,070 --> 01:10:24,719

you right all that energy is hitting you

1980

01:10:27,189 --> 01:10:26,080

right now you would have to pass through

1981

01:10:28,790 --> 01:10:27,199

normally

1982

01:10:30,630 --> 01:10:28,800

and that's just one of the many ways

1983

01:10:31,990 --> 01:10:30,640

that thing can kind of cook you

1984

01:10:33,430 --> 01:10:32,000

uh the other problem is that you

1985

01:10:35,030 --> 01:10:33,440

probably need to involve enough energy

1986

01:10:36,470 --> 01:10:35,040

on something like this i mean it's

1987

01:10:37,669 --> 01:10:36,480

debatable we're not really sure how much

1988

01:10:39,910 --> 01:10:37,679

energy you need for this they've been

1989

01:10:41,430 --> 01:10:39,920

debatable models most the original ones

1990

01:10:43,590 --> 01:10:41,440

that looked at this idea because it's

1991

01:10:45,910 --> 01:10:43,600

been kicked around before uh before el

1992

01:10:47,110 --> 01:10:45,920

cubio did it but usually the assumption

1993

01:10:49,669 --> 01:10:47,120

there was that you need to be working

1994

01:10:50,630 --> 01:10:49,679

with at least planetary masses for a

1995

01:10:52,470 --> 01:10:50,640

ship

1996

01:10:53,990 --> 01:10:52,480

uh they've gotten versions of this that

1997

01:10:56,310 --> 01:10:54,000

work on paper that might only require

1998

01:10:58,229 --> 01:10:56,320

maybe a ton of negative matter

1999

01:11:00,310 --> 01:10:58,239

and so that's the other problem there

2000

01:11:01,830 --> 01:11:00,320

all these things very energy-intensive

2001

01:11:03,350 --> 01:11:01,840

and there's usually not a cheat for that

2002

01:11:05,510 --> 01:11:03,360

the universe is

2003

01:11:07,350 --> 01:11:05,520

really touchy about uh violin energy

2004

01:11:08,390 --> 01:11:07,360

conservation except if it's approved of

2005

01:11:12,709 --> 01:11:08,400

ways

2006

01:11:14,950 --> 01:11:12,719

well it's totally and if we which were

2007

01:11:17,030 --> 01:11:14,960

you know when we get into the quantum

2008

01:11:19,189 --> 01:11:17,040

side of this uh

2009

01:11:20,390 --> 01:11:19,199

all of it it not only mechanics and

2010

01:11:22,229 --> 01:11:20,400

theory but

2011

01:11:25,350 --> 01:11:22,239

uh entanglement

2012

01:11:27,030 --> 01:11:25,360

if you're traveling those vast distances

2013

01:11:28,630 --> 01:11:27,040

of of

2014

01:11:30,070 --> 01:11:28,640

space you're covering those fast

2015

01:11:33,030 --> 01:11:30,080

distances

2016

01:11:35,270 --> 01:11:33,040

what happens to the entanglement of

2017

01:11:37,910 --> 01:11:35,280

things that are around you how about the

2018

01:11:40,790 --> 01:11:37,920

entanglement of your own body

2019

01:11:42,310 --> 01:11:40,800

does that come into play do you overheat

2020

01:11:43,590 --> 01:11:42,320

do you dissolve

2021

01:11:44,709 --> 01:11:43,600

i mean what happened absolutely will

2022

01:11:45,990 --> 01:11:44,719

from all the radiation in you but

2023

01:11:48,070 --> 01:11:46,000

remember i said a moment ago the

2024

01:11:50,229 --> 01:11:48,080

geometry that bubble has to be perfect

2025

01:11:52,229 --> 01:11:50,239

right um it's the same kind of idea as

2026

01:11:54,470 --> 01:11:52,239

what happens with a black hole if that

2027

01:11:56,950 --> 01:11:54,480

force on you is not homogeneous uniform

2028

01:11:58,390 --> 01:11:56,960

the same everywhere right um if that

2029

01:12:00,310 --> 01:11:58,400

space time is being warped a little bit

2030

01:12:02,070 --> 01:12:00,320

different by your finger than your head

2031

01:12:03,830 --> 01:12:02,080

when that little difference is

2032

01:12:06,630 --> 01:12:03,840

light years of distance you're gonna get

2033

01:12:08,790 --> 01:12:06,640

obliterated even by the tiniest tiniest

2034

01:12:09,910 --> 01:12:08,800

little lack of homogeneity about that

2035

01:12:13,510 --> 01:12:09,920

field

2036

01:12:16,790 --> 01:12:13,520

did does the entanglement uh

2037

01:12:18,550 --> 01:12:16,800

possibly go away i mean okay

2038

01:12:19,990 --> 01:12:18,560

you can tangle somebody so they actually

2039

01:12:22,149 --> 01:12:20,000

would stay together when you got them

2040

01:12:24,070 --> 01:12:22,159

there um that's kind of a teleportation

2041

01:12:25,990 --> 01:12:24,080

notion but you've got a black hole

2042

01:12:28,790 --> 01:12:26,000

behind you

2043

01:12:30,950 --> 01:12:28,800

well say a black hole because that's

2044

01:12:32,229 --> 01:12:30,960

more or less the same concept but

2045

01:12:33,669 --> 01:12:32,239

you can't see anything behind you

2046

01:12:35,030 --> 01:12:33,679

because the light can't reach you i mean

2047

01:12:36,790 --> 01:12:35,040

you're running away from that light

2048

01:12:39,189 --> 01:12:36,800

fasten that lights covering the distance

2049

01:12:40,390 --> 01:12:39,199

behind you and thus you see nothing when

2050

01:12:42,950 --> 01:12:40,400

you turn one of these on everything

2051
01:12:44,070 --> 01:12:42,960
behind you goes dead black because none

2052
01:12:45,430 --> 01:12:44,080
of the light can reach you from behind

2053
01:12:47,270 --> 01:12:45,440
you anymore you're moving away from it

2054
01:12:49,110 --> 01:12:47,280
too quickly uh and everything in front

2055
01:12:50,550 --> 01:12:49,120
of you gets compressed because all that

2056
01:12:51,990 --> 01:12:50,560
light's ramming into you now that we

2057
01:12:54,149 --> 01:12:52,000
would have taken a much longer time to

2058
01:12:57,189 --> 01:12:54,159
have reached and it's all super super

2059
01:12:59,270 --> 01:12:57,199
blue shifted and what about uh going

2060
01:13:01,750 --> 01:12:59,280
back to entangled if you've got a black

2061
01:13:04,390 --> 01:13:01,760
hole behind you certainly there are

2062
01:13:07,270 --> 01:13:04,400
entangled particles inside of this

2063
01:13:09,030 --> 01:13:07,280

sphere maybe even inside of your body

2064

01:13:10,870 --> 01:13:09,040

that are getting sucked into the black

2065

01:13:12,149 --> 01:13:10,880

hole the other half of these entangled

2066

01:13:14,070 --> 01:13:12,159

particles

2067

01:13:15,350 --> 01:13:14,080

uh with a virtual particle pair wasn't a

2068

01:13:17,750 --> 01:13:15,360

case like that

2069

01:13:20,390 --> 01:13:17,760

yes anytime you have an event horizon

2070

01:13:21,990 --> 01:13:20,400

and it's a tricky thing with uh with the

2071

01:13:23,270 --> 01:13:22,000

hockey radios or things like that folks

2072

01:13:24,790 --> 01:13:23,280

think it's the black hole that's

2073

01:13:26,310 --> 01:13:24,800

producing these that that's not quite

2074

01:13:28,149 --> 01:13:26,320

what's happening these things are

2075

01:13:30,310 --> 01:13:28,159

popping up all the time this insane

2076

01:13:31,990 --> 01:13:30,320

amount of uh virtual particles this is

2077

01:13:33,590 --> 01:13:32,000

normally the pairs that model back into

2078

01:13:35,189 --> 01:13:33,600

each other and self-destruct

2079

01:13:37,510 --> 01:13:35,199

if you have a big enough difference in

2080

01:13:39,350 --> 01:13:37,520

the force in some tiny little atomic

2081

01:13:41,270 --> 01:13:39,360

space like that it can rip those

2082

01:13:42,550 --> 01:13:41,280

particles apart to use the virtual

2083

01:13:44,229 --> 01:13:42,560

particle analogy which is a little

2084

01:13:46,470 --> 01:13:44,239

dubious at times right but it can rip

2085

01:13:47,270 --> 01:13:46,480

those apart so that event horizon behind

2086

01:13:49,110 --> 01:13:47,280

you

2087

01:13:51,750 --> 01:13:49,120

might be spewing out insane amounts of

2088

01:13:54,149 --> 01:13:51,760

radiation as well

2089

01:13:56,070 --> 01:13:54,159

they would have to because they were

2090

01:13:59,510 --> 01:13:56,080

entangled before technically they're

2091

01:14:02,229 --> 01:13:59,520

still entangled if they change then what

2092

01:14:05,189 --> 01:14:02,239

is with you is changing

2093

01:14:07,110 --> 01:14:05,199

right right inside the bubble

2094

01:14:08,550 --> 01:14:07,120

whether you got the um it's always that

2095

01:14:10,630 --> 01:14:08,560

conservation of energy issue with these

2096

01:14:12,070 --> 01:14:10,640

uh going to the to the wormhole example

2097

01:14:13,350 --> 01:14:12,080

a quick common thing that people say

2098

01:14:14,870 --> 01:14:13,360

with the wormhole is well we can use

2099

01:14:16,709 --> 01:14:14,880

that to make a perpetual motion machine

2100

01:14:18,630 --> 01:14:16,719

right i take one end of the wormhole and

2101
01:14:20,310 --> 01:14:18,640
stick it up in the air so an object

2102
01:14:21,669 --> 01:14:20,320
falls down from the one thing follows

2103
01:14:23,189 --> 01:14:21,679
into the other end of the mouth of that

2104
01:14:24,870 --> 01:14:23,199
one hole comes back out the top and

2105
01:14:26,070 --> 01:14:24,880
picks up more speed but when you

2106
01:14:27,270 --> 01:14:26,080
actually run the math on that it

2107
01:14:29,510 --> 01:14:27,280
actually won't

2108
01:14:32,070 --> 01:14:29,520
if you do the math on the wormholes the

2109
01:14:33,830 --> 01:14:32,080
ball falls down hits the bottom and

2110
01:14:35,590 --> 01:14:33,840
slows back on its way up just as though

2111
01:14:37,189 --> 01:14:35,600
you were lifting it back up again

2112
01:14:39,430 --> 01:14:37,199
so there is that conservation of energy

2113
01:14:41,030 --> 01:14:39,440

issue and there's that other problem

2114

01:14:42,550 --> 01:14:41,040

with warp drives almost everything

2115

01:14:44,229 --> 01:14:42,560

involving them would tend to require you

2116

01:14:46,149 --> 01:14:44,239

to have some kind of infinite amount of

2117

01:14:47,669 --> 01:14:46,159

energy it seems like a singularity

2118

01:14:48,709 --> 01:14:47,679

requires an infinite amount of energy to

2119

01:14:51,430 --> 01:14:48,719

escape

2120

01:14:53,590 --> 01:14:51,440

and that's okay on paper although that's

2121

01:14:54,870 --> 01:14:53,600

actually problematic on people too but

2122

01:14:56,390 --> 01:14:54,880

where's that infinite amount of energy

2123

01:14:59,350 --> 01:14:56,400

coming from

2124

01:15:01,590 --> 01:14:59,360

is there a way to overcome all of this

2125

01:15:03,270 --> 01:15:01,600

like i said it's it's just too good to

2126

01:15:07,590 --> 01:15:03,280

be true that you would

2127

01:15:10,390 --> 01:15:07,600

literally flip a switch and you go from

2128

01:15:11,910 --> 01:15:10,400

uh one galaxy to the next in an instant

2129

01:15:14,470 --> 01:15:11,920

you don't have time travel you don't

2130

01:15:16,070 --> 01:15:14,480

have food issues you know

2131

01:15:18,310 --> 01:15:16,080

everything is just taken off the table

2132

01:15:20,390 --> 01:15:18,320

you just arrive instantly

2133

01:15:23,030 --> 01:15:20,400

uh it's too good to be true

2134

01:15:24,550 --> 01:15:23,040

with this other stuff where it looks

2135

01:15:26,790 --> 01:15:24,560

sounds to me

2136

01:15:29,430 --> 01:15:26,800

like if you flip the switch

2137

01:15:31,830 --> 01:15:29,440

you may go but you're going to arrive as

2138

01:15:33,270 --> 01:15:31,840

a piece of charcoal

2139

01:15:34,709 --> 01:15:33,280

you should be completely atomized in the

2140

01:15:36,310 --> 01:15:34,719

past

2141

01:15:37,270 --> 01:15:36,320

i would say i mean we don't we don't

2142

01:15:38,950 --> 01:15:37,280

want to rule it out because it's too

2143

01:15:40,870 --> 01:15:38,960

good to be true many of the technologies

2144

01:15:42,870 --> 01:15:40,880

we've invented to our ancestors would be

2145

01:15:44,470 --> 01:15:42,880

too good to be true and yet we have them

2146

01:15:45,270 --> 01:15:44,480

anyway the ability to talk to someone on

2147

01:15:47,510 --> 01:15:45,280

the other side of the planet

2148

01:15:48,709 --> 01:15:47,520

instantaneously that seems too good to

2149

01:15:51,910 --> 01:15:48,719

be true

2150

01:15:53,669 --> 01:15:51,920

but it is we got it so we can't say it's

2151
01:15:55,430 --> 01:15:53,679
too good to be true so it's impossible

2152
01:15:57,110 --> 01:15:55,440
but at the same time we also have no way

2153
01:15:59,910 --> 01:15:57,120
to figure out how we could do it just

2154
01:16:02,310 --> 01:15:59,920
yet we've got it on paper as an idea we

2155
01:16:04,310 --> 01:16:02,320
might be able to get working but there

2156
01:16:05,350 --> 01:16:04,320
usually has to be something that uh

2157
01:16:07,350 --> 01:16:05,360
there's a couple different ways it could

2158
01:16:09,350 --> 01:16:07,360
be made to work if you can find one of

2159
01:16:10,390 --> 01:16:09,360
these impossible materials or possible

2160
01:16:13,110 --> 01:16:10,400
methods

2161
01:16:16,390 --> 01:16:13,120
but until we actually have one of those

2162
01:16:18,070 --> 01:16:16,400
we can't make it work uh and if we get

2163
01:16:18,870 --> 01:16:18,080

any of those though almost no matter

2164

01:16:20,709 --> 01:16:18,880

what you do you're gonna have a

2165

01:16:23,030 --> 01:16:20,719

technology that's too good to be true

2166

01:16:24,709 --> 01:16:23,040

that actually works it doesn't matter if

2167

01:16:26,149 --> 01:16:24,719

you can get a warp drive to walk almost

2168

01:16:26,950 --> 01:16:26,159

any of the technologies associated to

2169

01:16:29,270 --> 01:16:26,960

that

2170

01:16:30,550 --> 01:16:29,280

are going to be amazingly awesome

2171

01:16:31,910 --> 01:16:30,560

could you

2172

01:16:34,470 --> 01:16:31,920

uh

2173

01:16:36,310 --> 01:16:34,480

in nasa's concepts of this

2174

01:16:37,350 --> 01:16:36,320

are we talking about something that

2175

01:16:40,229 --> 01:16:37,360

could be

2176

01:16:42,630 --> 01:16:40,239

uh you know like a cubesat you know some

2177

01:16:45,189 --> 01:16:42,640

uh small version of this

2178

01:16:48,070 --> 01:16:45,199

that would uh you know be put up by

2179

01:16:50,790 --> 01:16:48,080

spacex or whatever and and and in low

2180

01:16:53,910 --> 01:16:50,800

earth orbit and then turn around and and

2181

01:16:56,790 --> 01:16:53,920

go to alpha centauri and return but it

2182

01:16:57,510 --> 01:16:56,800

would be the size of a toaster

2183

01:17:00,470 --> 01:16:57,520

or

2184

01:17:02,390 --> 01:17:00,480

is that not

2185

01:17:04,390 --> 01:17:02,400

conceptually that couldn't be possible

2186

01:17:07,590 --> 01:17:04,400

because of the energy sources that would

2187

01:17:09,030 --> 01:17:07,600

be needed how would you prove it

2188

01:17:10,709 --> 01:17:09,040

you have to actually make one of things

2189

01:17:12,310 --> 01:17:10,719

work it's i mean maybe you could do it

2190

01:17:13,910 --> 01:17:12,320

inside a lab but just a tiny amount of

2191

01:17:15,750 --> 01:17:13,920

negative matter if you find some and

2192

01:17:17,270 --> 01:17:15,760

just get the thing to move from one side

2193

01:17:18,870 --> 01:17:17,280

of the lab to the other

2194

01:17:20,149 --> 01:17:18,880

um and that's one thing we play around

2195

01:17:21,430 --> 01:17:20,159

with a lot of times when we're doing

2196

01:17:22,950 --> 01:17:21,440

quantum entanglement or other things to

2197

01:17:25,030 --> 01:17:22,960

see whether or not you can actually do

2198

01:17:27,510 --> 01:17:25,040

things fast and light you do a very tiny

2199

01:17:28,390 --> 01:17:27,520

thing that requires versus your energy

2200

01:17:29,750 --> 01:17:28,400

first

2201

01:17:31,830 --> 01:17:29,760

but there's a possibility that there was

2202

01:17:33,110 --> 01:17:31,840

a real minimum size on these and i i

2203

01:17:34,630 --> 01:17:33,120

think i mentioned that we've seen

2204

01:17:37,110 --> 01:17:34,640

versions that might let you be as little

2205

01:17:39,270 --> 01:17:37,120

as a ton which is a not a spaceship to

2206

01:17:40,630 --> 01:17:39,280

make right uh but other ones back in the

2207

01:17:42,709 --> 01:17:40,640

day we always say well you want a warm

2208

01:17:44,310 --> 01:17:42,719

hole you need something that outmasters

2209

01:17:46,390 --> 01:17:44,320

the sun to begin with which makes it

2210

01:17:47,750 --> 01:17:46,400

kind of useless for traveling around

2211

01:17:51,270 --> 01:17:47,760

solar systems

2212

01:17:52,390 --> 01:17:51,280

now if you yeah right exactly um

2213

01:17:53,270 --> 01:17:52,400

so

2214

01:17:57,510 --> 01:17:53,280

we

2215

01:17:59,189 --> 01:17:57,520

centauri it's four and a half light

2216

01:18:02,149 --> 01:17:59,199

years away

2217

01:18:04,870 --> 01:18:02,159

how do we

2218

01:18:06,550 --> 01:18:04,880

let earth know that we arrived because

2219

01:18:08,709 --> 01:18:06,560

communication is a whole different

2220

01:18:11,669 --> 01:18:08,719

matter you can't warp you can't warp

2221

01:18:13,430 --> 01:18:11,679

drive voices or can you

2222

01:18:14,470 --> 01:18:13,440

you can't uh you need that machine it's

2223

01:18:15,910 --> 01:18:14,480

kind of like one of those science

2224

01:18:17,669 --> 01:18:15,920

fiction ones where you can't communicate

2225

01:18:19,750 --> 01:18:17,679

by a beam you gotta go there and talk to

2226

01:18:21,830 --> 01:18:19,760

them the old-fashioned way so you'd warp

2227

01:18:23,669 --> 01:18:21,840

there and then you had to warp back or

2228

01:18:24,790 --> 01:18:23,679

send a signal back to them no your first

2229

01:18:26,149 --> 01:18:24,800

probe might be one of those things where

2230

01:18:27,510 --> 01:18:26,159

you sent it and it's a one-way trip

2231

01:18:29,189 --> 01:18:27,520

because you don't know how to you can't

2232

01:18:30,470 --> 01:18:29,199

automate to come back and you have to

2233

01:18:31,830 --> 01:18:30,480

wait four and a half years to find out

2234

01:18:32,790 --> 01:18:31,840

if it worked

2235

01:18:34,070 --> 01:18:32,800

um

2236

01:18:35,270 --> 01:18:34,080

and it might be a good deal longer than

2237

01:18:37,830 --> 01:18:35,280

that because i'd imagine a prototype

2238

01:18:39,350 --> 01:18:37,840

would be very hard to actually aim

2239

01:18:41,110 --> 01:18:39,360

so that's what you would do you would

2240

01:18:44,070 --> 01:18:41,120

warp drive back

2241

01:18:45,189 --> 01:18:44,080

an iphone with a recording on it we made

2242

01:18:47,110 --> 01:18:45,199

it

2243

01:18:48,870 --> 01:18:47,120

that would be the idea yeah you need a

2244

01:18:50,390 --> 01:18:48,880

smaller secondary drive you could send

2245

01:18:52,149 --> 01:18:50,400

back to let people know you derived or

2246

01:18:54,070 --> 01:18:52,159

you just jump there and jump back and

2247

01:18:56,070 --> 01:18:54,080

say look we succeeded with a recording

2248

01:18:58,070 --> 01:18:56,080

obviously let me know you succeeded if

2249

01:19:01,270 --> 01:18:58,080

uh what's that what's the biggest

2250

01:19:03,830 --> 01:19:01,280

obstacle here is it is it heat is it

2251

01:19:05,750 --> 01:19:03,840

cooking ourselves um and it seems like

2252

01:19:08,149 --> 01:19:05,760

there would be a way around that but for

2253

01:19:10,550 --> 01:19:08,159

you what's the biggest obstacle with the

2254

01:19:12,630 --> 01:19:10,560

reality of warp drive i mean into the

2255

01:19:14,870 --> 01:19:12,640

story for both wormholes and warp drives

2256

01:19:16,709 --> 01:19:14,880

is you need negative matter of energy

2257

01:19:17,990 --> 01:19:16,719

and not not like they often put in tops

2258

01:19:19,350 --> 01:19:18,000

of articles to say we've discovered

2259

01:19:21,590 --> 01:19:19,360

negative energy even though they found

2260

01:19:23,669 --> 01:19:21,600

something that acts like it from a

2261

01:19:24,630 --> 01:19:23,679

chemical point of view it's not actually

2262

01:19:26,630 --> 01:19:24,640

holding any of the properties of

2263

01:19:28,229 --> 01:19:26,640

negative matter or energy

2264

01:19:29,990 --> 01:19:28,239

uh even with things like the cashmere

2265

01:19:32,550 --> 01:19:30,000

effect that's only a relative negative

2266

01:19:34,709 --> 01:19:32,560

it's like on math you'd say well

2267

01:19:36,709 --> 01:19:34,719

i'm at a net loss this year even though

2268

01:19:38,709 --> 01:19:36,719

i brought in a lot of revenue that's an

2269

01:19:40,390 --> 01:19:38,719

accounting negative you still brought in

2270

01:19:42,390 --> 01:19:40,400

a positive amount of revenue

2271

01:19:44,070 --> 01:19:42,400

um a lot of times we say negative energy

2272

01:19:45,910 --> 01:19:44,080

that's what we mean it's negative only

2273

01:19:47,910 --> 01:19:45,920

relative to something else

2274

01:19:50,390 --> 01:19:47,920

if you can get a single particle of

2275

01:19:52,070 --> 01:19:50,400

negative matter just one that would tell

2276

01:19:54,070 --> 01:19:52,080

us that this is probably possible to do

2277

01:19:55,669 --> 01:19:54,080

in some fashion and even if that one

2278

01:19:57,910 --> 01:19:55,679

still turns out not to be possible from

2279

01:20:00,229 --> 01:19:57,920

a pragmatism angle any negative matter

2280

01:20:02,950 --> 01:20:00,239

suddenly becomes insanely useful as

2281

01:20:04,950 --> 01:20:02,960

something we can make if we can make it

2282

01:20:06,630 --> 01:20:04,960

um but that's the big obstacle for

2283

01:20:07,510 --> 01:20:06,640

anything seems to be possible you have

2284

01:20:09,430 --> 01:20:07,520

to have

2285

01:20:13,990 --> 01:20:09,440

negative matter or energy

2286

01:20:17,110 --> 01:20:14,000

the the warping of space uh is is easy

2287

01:20:19,430 --> 01:20:17,120

to visually represent with a planet or a

2288

01:20:21,910 --> 01:20:19,440

star we've all seen the grid that you

2289

01:20:23,910 --> 01:20:21,920

know that bends around it and and that

2290

01:20:27,590 --> 01:20:23,920

example if that's a visual

2291

01:20:28,950 --> 01:20:27,600

but with a warp drive to bend space in

2292

01:20:31,110 --> 01:20:28,960

front of you

2293

01:20:33,990 --> 01:20:31,120

uh that you would have to have that kind

2294

01:20:36,390 --> 01:20:34,000

of mass unless i'm misunderstanding the

2295

01:20:38,149 --> 01:20:36,400

the concept here you would have to have

2296

01:20:40,149 --> 01:20:38,159

something in front of you with a

2297

01:20:42,950 --> 01:20:40,159

suggested mass

2298

01:20:43,750 --> 01:20:42,960

to to bend that space or to remove it

2299

01:20:45,510 --> 01:20:43,760

right

2300

01:20:47,030 --> 01:20:45,520

or that amount of energy fundamentally

2301

01:20:48,870 --> 01:20:47,040

it's energy not mass that's doing the

2302

01:20:51,430 --> 01:20:48,880

compression but yeah and then the mass

2303

01:20:53,189 --> 01:20:51,440

is a very dense form of energy um you

2304

01:20:54,950 --> 01:20:53,199

have to have that all that to pull that

2305

01:20:56,070 --> 01:20:54,960

off and most of the ways around that are

2306

01:20:57,910 --> 01:20:56,080

trying to figure out how you could do it

2307

01:20:59,350 --> 01:20:57,920

just a tiny little bit of it because if

2308

01:21:02,149 --> 01:20:59,360

a little bit can sometimes be just

2309

01:21:03,750 --> 01:21:02,159

enough but if i wanted to warp space in

2310

01:21:04,630 --> 01:21:03,760

a significant fashion normally i need

2311

01:21:06,630 --> 01:21:04,640

something

2312

01:21:09,270 --> 01:21:06,640

much more massive than the star that was

2313

01:21:10,709 --> 01:21:09,280

you know compressing space a lot

2314

01:21:12,470 --> 01:21:10,719

and we can see that compression effect

2315

01:21:14,149 --> 01:21:12,480

all that gravitational lensing we use in

2316

01:21:16,149 --> 01:21:14,159

astronomy that's that's this effect in

2317

01:21:18,070 --> 01:21:16,159

action the warp drive is about you know

2318

01:21:20,310 --> 01:21:18,080

do that uh without having to carry

2319

01:21:21,510 --> 01:21:20,320

around you know a galaxy's worth of

2320

01:21:23,510 --> 01:21:21,520

matter in front of you which doesn't

2321

01:21:25,110 --> 01:21:23,520

make for a good spaceship

2322

01:21:26,790 --> 01:21:25,120

let's take a break right here that's

2323

01:21:28,550 --> 01:21:26,800

actually the best way to put it let's

2324

01:21:30,149 --> 01:21:28,560

take a break right here this is fade to

2325

01:21:32,229 --> 01:21:30,159

black i am your host jimmy church i

2326

01:21:34,630 --> 01:21:32,239

guess tonight isaac arthur we are

2327

01:21:36,630 --> 01:21:34,640

talking a clark tech i'm not done with

2328

01:21:38,229 --> 01:21:36,640

warp drives uh we're gonna have to come

2329

01:21:39,669 --> 01:21:38,239

back and pick up where we're leaving off

2330

01:21:42,070 --> 01:21:39,679

right now this is fade to black i'm

2331

01:21:42,720 --> 01:21:42,080

yours jimmy church stay with us we'll be

2332

01:21:54,870 --> 01:21:42,730

right back

2333

01:21:56,390 --> 01:21:54,880

[Music]

2334

01:21:57,910 --> 01:21:56,400

welcome back fade to block i'm your host

2335

01:22:00,070 --> 01:21:57,920

jimmy church our guest tonight isaac

2336

01:22:04,070 --> 01:22:00,080

arthur tomorrow night

2337

01:22:06,390 --> 01:22:04,080

jason quit with his new drone footage

2338

01:22:07,990 --> 01:22:06,400

from italy we will be discussing that

2339

01:22:09,590 --> 01:22:08,000

tomorrow night thursday night is another

2340

01:22:11,830 --> 01:22:09,600

fader night with open lines all night

2341

01:22:15,189 --> 01:22:11,840

long tonight it's isaac arthur isaac

2342

01:22:17,990 --> 01:22:15,199

discussing uh wormholes and and warp

2343

01:22:20,149 --> 01:22:18,000

drives as i paint these pictures in my

2344

01:22:25,030 --> 01:22:20,159

mind about what we're talking about here

2345

01:22:26,950 --> 01:22:25,040

i see a lot of similarities in that

2346

01:22:29,270 --> 01:22:26,960

with a wormhole you need to construct

2347

01:22:31,350 --> 01:22:29,280

out in front of you with the warp drive

2348

01:22:33,189 --> 01:22:31,360

you are also doing something in front of

2349

01:22:34,950 --> 01:22:33,199

you removing space

2350

01:22:37,110 --> 01:22:34,960

to move forward

2351

01:22:40,629 --> 01:22:37,120

and and you have to do something in back

2352

01:22:41,510 --> 01:22:40,639

of you in both cases as well

2353

01:22:43,750 --> 01:22:41,520

and

2354

01:22:46,709 --> 01:22:43,760

there is uh

2355

01:22:50,950 --> 01:22:46,719

no time travel or time dilation

2356

01:22:53,510 --> 01:22:50,960

or speed of light that is in both cases

2357

01:22:55,990 --> 01:22:53,520

are they that similar are we

2358

01:22:58,950 --> 01:22:56,000

and if you were a betting man

2359

01:23:00,870 --> 01:22:58,960

which one would happen first

2360

01:23:02,149 --> 01:23:00,880

hmm they are actually that similar i

2361

01:23:04,229 --> 01:23:02,159

mean they're not quite the identical

2362

01:23:07,030 --> 01:23:04,239

concept but they run on that same basic

2363

01:23:09,590 --> 01:23:07,040

principle but um i would actually tend

2364

01:23:11,510 --> 01:23:09,600

to favor the wormhole idea but probably

2365

01:23:13,510 --> 01:23:11,520

not a wormhole inside of our universe

2366

01:23:15,189 --> 01:23:13,520

probably one to a different uh different

2367

01:23:17,350 --> 01:23:15,199

universe

2368

01:23:19,270 --> 01:23:17,360

yeah i see my money would be on warp

2369

01:23:25,030 --> 01:23:19,280

drive

2370

01:23:28,470 --> 01:23:25,040

the burn to a crisp aspect of it

2371

01:23:29,189 --> 01:23:28,480

um i see as uh something that we could i

2372

01:23:31,350 --> 01:23:29,199

mean

2373

01:23:32,229 --> 01:23:31,360

that we could overcome that

2374

01:23:36,550 --> 01:23:32,239

and

2375

01:23:38,709 --> 01:23:36,560

the uh

2376

01:23:40,790 --> 01:23:38,719

uh different uh theories that have been

2377

01:23:42,870 --> 01:23:40,800

applied to the warp drive that just

2378

01:23:45,189 --> 01:23:42,880

absolutely makes it impossible and

2379

01:23:47,990 --> 01:23:45,199

there's many we haven't touched upon

2380

01:23:50,709 --> 01:23:48,000

uh other aspects of it but i would say

2381

01:23:52,070 --> 01:23:50,719

that uh the warp drive is is very

2382

01:23:53,750 --> 01:23:52,080

achievable

2383

01:23:55,510 --> 01:23:53,760

it seems like it's magical in terms of

2384

01:23:57,270 --> 01:23:55,520

little bits and pieces each one of which

2385

01:23:58,870 --> 01:23:57,280

is hard to deal with but maybe if you

2386

01:24:00,629 --> 01:23:58,880

just be you know beat that one you can

2387

01:24:02,870 --> 01:24:00,639

beat the next one and so on yeah from

2388

01:24:04,950 --> 01:24:02,880

that perspective that would seem to make

2389

01:24:06,310 --> 01:24:04,960

it more plausible in some ways whereas

2390

01:24:07,350 --> 01:24:06,320

the warm horse seems like something

2391

01:24:09,270 --> 01:24:07,360

where

2392

01:24:10,790 --> 01:24:09,280

you either get to walk or you don't

2393

01:24:13,189 --> 01:24:10,800

now are we

2394

01:24:17,270 --> 01:24:13,199

let's get into the physics aspect of

2395

01:24:19,750 --> 01:24:17,280

this are we violating anything um

2396

01:24:22,310 --> 01:24:19,760

in the natural aspect of things uh

2397

01:24:25,669 --> 01:24:22,320

physically you and i if we were

2398

01:24:28,629 --> 01:24:25,679

traveling in a warp drive equipped ship

2399

01:24:30,149 --> 01:24:28,639

uh would we change physically is there

2400

01:24:32,629 --> 01:24:30,159

something that we're messing with with

2401

01:24:34,709 --> 01:24:32,639

nature or are we staying on the good

2402

01:24:35,830 --> 01:24:34,719

side of the fence in in the laws of

2403

01:24:38,229 --> 01:24:35,840

physics

2404

01:24:40,310 --> 01:24:38,239

as best as we can tell yes that's what's

2405

01:24:42,550 --> 01:24:40,320

cool about the system it doesn't violate

2406

01:24:45,510 --> 01:24:42,560

any known laws of physics other than

2407

01:24:47,270 --> 01:24:45,520

arguably energy conservation and um

2408

01:24:48,470 --> 01:24:47,280

having material that probably doesn't

2409

01:24:50,390 --> 01:24:48,480

exist

2410

01:24:52,709 --> 01:24:50,400

um such as

2411

01:24:53,830 --> 01:24:52,719

the negative matter we have i mean

2412

01:24:55,270 --> 01:24:53,840

we don't know for sure how negative

2413

01:24:56,709 --> 01:24:55,280

metal would act so it might be really

2414

01:24:57,830 --> 01:24:56,719

hard to find the stuff since it's not

2415

01:24:59,510 --> 01:24:57,840

gonna you know it's not going to clump

2416

01:25:01,350 --> 01:24:59,520

up anywhere it permits negative

2417

01:25:03,270 --> 01:25:01,360

gravity's at war but uh

2418

01:25:05,270 --> 01:25:03,280

we don't have any of this stuff and we

2419

01:25:07,430 --> 01:25:05,280

have no real reason to think that we do

2420

01:25:09,669 --> 01:25:07,440

off of math and

2421

01:25:11,510 --> 01:25:09,679

math is great but you always want that

2422

01:25:13,430 --> 01:25:11,520

empirical evidence it's so easy with

2423

01:25:15,270 --> 01:25:13,440

math or logic to predict things and say

2424

01:25:16,950 --> 01:25:15,280

oh that has to be so

2425

01:25:17,990 --> 01:25:16,960

but until you've actually got a chunk of

2426
01:25:19,590 --> 01:25:18,000
the stuff

2427
01:25:20,709 --> 01:25:19,600
it all really is is fundamentally

2428
01:25:23,030 --> 01:25:20,719
speculation

2429
01:25:24,790 --> 01:25:23,040
very well uh you know well calculated

2430
01:25:26,390 --> 01:25:24,800
speculation but that's still what it is

2431
01:25:28,629 --> 01:25:26,400
you need that empirical proof that

2432
01:25:30,629 --> 01:25:28,639
you've got it and so you need that one

2433
01:25:33,270 --> 01:25:30,639
atom of negative matter

2434
01:25:34,629 --> 01:25:33,280
now uh is negative matter the same as

2435
01:25:35,830 --> 01:25:34,639
antimatter

2436
01:25:37,430 --> 01:25:35,840
no no

2437
01:25:38,709 --> 01:25:37,440
antimatter you've got all over the place

2438
01:25:40,229 --> 01:25:38,719

in fact every time you eat a banana

2439

01:25:41,669 --> 01:25:40,239

you've got some antimatter involved

2440

01:25:44,149 --> 01:25:41,679

because that's how that potassium

2441

01:25:45,189 --> 01:25:44,159

radiation is generated as a beta decay

2442

01:25:47,430 --> 01:25:45,199

um

2443

01:25:49,510 --> 01:25:47,440

antimatter is for something for some

2444

01:25:50,709 --> 01:25:49,520

reason we're not sure about was created

2445

01:25:52,709 --> 01:25:50,719

in much smaller amounts when the

2446

01:25:53,990 --> 01:25:52,719

universe was formed or not actually much

2447

01:25:55,590 --> 01:25:54,000

smaller amounts enough that everything

2448

01:25:58,070 --> 01:25:55,600

else got obliterated

2449

01:25:59,430 --> 01:25:58,080

except it left over some uh regular

2450

01:26:01,750 --> 01:25:59,440

matters of war

2451

01:26:03,350 --> 01:26:01,760

and the name antimatters in some ways a

2452

01:26:05,030 --> 01:26:03,360

really bad name because it implies

2453

01:26:07,189 --> 01:26:05,040

something kind of uh negative or

2454

01:26:10,709 --> 01:26:07,199

reversed when it's really just a less

2455

01:26:14,229 --> 01:26:10,719

common type of metal probably locally

2456

01:26:16,229 --> 01:26:14,239

with uh negative mass isn't

2457

01:26:19,510 --> 01:26:16,239

isn't there an equal amount of negative

2458

01:26:21,030 --> 01:26:19,520

mass with regular mass in the universe

2459

01:26:22,550 --> 01:26:21,040

well that would be a thought that's been

2460

01:26:24,790 --> 01:26:22,560

kicked around that the total amount of

2461

01:26:27,270 --> 01:26:24,800

energy in the universe might be exactly

2462

01:26:28,550 --> 01:26:27,280

zero right um and that's actually been

2463

01:26:30,310 --> 01:26:28,560

thought about with things like uh

2464

01:26:32,390 --> 01:26:30,320

anti-matter too that like

2465

01:26:34,390 --> 01:26:32,400

we don't know if the if the universe or

2466

01:26:36,390 --> 01:26:34,400

you know has a net charge if it actually

2467

01:26:38,470 --> 01:26:36,400

has more positive than negative charges

2468

01:26:39,669 --> 01:26:38,480

it might but it looks like it probably

2469

01:26:41,830 --> 01:26:39,679

doesn't and we can always say that

2470

01:26:43,510 --> 01:26:41,840

because we don't see any overt signs

2471

01:26:45,910 --> 01:26:43,520

that there's an imbalance but it could

2472

01:26:47,350 --> 01:26:45,920

be off by a few electrons even and the

2473

01:26:49,669 --> 01:26:47,360

question is why are we assuming that

2474

01:26:51,990 --> 01:26:49,679

it's exactly even and with this example

2475

01:26:53,189 --> 01:26:52,000

of antimatter as best as we can tell

2476
01:26:54,470 --> 01:26:53,199
when the universe formed there should

2477
01:26:57,030 --> 01:26:54,480
have been an equal number of all of

2478
01:26:59,510 --> 01:26:57,040
these particles regular and antimatter

2479
01:27:00,629 --> 01:26:59,520
but uh there wasn't

2480
01:27:02,310 --> 01:27:00,639
maybe there are other chunks of the

2481
01:27:03,590 --> 01:27:02,320
universe we can't see where antimatter

2482
01:27:05,270 --> 01:27:03,600
is the more common and we just got all

2483
01:27:06,470 --> 01:27:05,280
the metal locally that was of that

2484
01:27:08,870 --> 01:27:06,480
variety

2485
01:27:11,430 --> 01:27:08,880
but that's an example of an imbalance

2486
01:27:12,629 --> 01:27:11,440
there was more of this than that when we

2487
01:27:13,590 --> 01:27:12,639
would guess that they'd be the same

2488
01:27:15,270 --> 01:27:13,600

amount

2489

01:27:16,950 --> 01:27:15,280

and so with something like negative

2490

01:27:19,189 --> 01:27:16,960

metal maybe a very tiny amount of it was

2491

01:27:21,030 --> 01:27:19,199

made but we'd like to assume with a lot

2492

01:27:23,590 --> 01:27:21,040

of these ideas that it would be exactly

2493

01:27:25,910 --> 01:27:23,600

equal that they would all negate out

2494

01:27:28,149 --> 01:27:25,920

and that's kind of an example of logic

2495

01:27:30,550 --> 01:27:28,159

preceding evidence we figure it ought to

2496

01:27:32,790 --> 01:27:30,560

be net zero but where's the evidence to

2497

01:27:36,229 --> 01:27:32,800

back that up now

2498

01:27:38,709 --> 01:27:36,239

let's talk about the the concept of uh i

2499

01:27:41,350 --> 01:27:38,719

want to move on to uh time travel and

2500

01:27:45,110 --> 01:27:41,360

teleportation a couple of other subjects

2501

01:27:47,510 --> 01:27:45,120

but uh one of the obstacles that has

2502

01:27:50,950 --> 01:27:47,520

been brought up about the warp drive

2503

01:27:53,750 --> 01:27:50,960

is now we all understand and and i've

2504

01:27:55,910 --> 01:27:53,760

heard of absolute zero right and in the

2505

01:27:58,709 --> 01:27:55,920

vacuum of space and that's really really

2506

01:27:59,430 --> 01:27:58,719

cold right well it's the ultimate cold

2507

01:28:02,629 --> 01:27:59,440

it's

2508

01:28:04,229 --> 01:28:02,639

anyway

2509

01:28:07,830 --> 01:28:04,239

it's really cold

2510

01:28:09,590 --> 01:28:07,840

but then we have the concept of absolute

2511

01:28:10,950 --> 01:28:09,600

hot

2512

01:28:11,750 --> 01:28:10,960

okay

2513

01:28:14,229 --> 01:28:11,760

let's

2514

01:28:18,070 --> 01:28:14,239

what is absolute hot most people haven't

2515

01:28:19,910 --> 01:28:18,080

heard uh uh of this uh before what is

2516

01:28:21,750 --> 01:28:19,920

absolute hot

2517

01:28:23,270 --> 01:28:21,760

well we were talking about plank scale

2518

01:28:24,950 --> 01:28:23,280

which is like the planck time of the

2519

01:28:28,070 --> 01:28:24,960

plank length and these are very tiny

2520

01:28:29,189 --> 01:28:28,080

things and uh not all the plank units uh

2521

01:28:31,990 --> 01:28:29,199

these are fundamental things you put

2522

01:28:33,830 --> 01:28:32,000

together from the physical constants um

2523

01:28:35,270 --> 01:28:33,840

not all of those are actually small like

2524

01:28:37,030 --> 01:28:35,280

a plank mass is actually about a

2525

01:28:39,430 --> 01:28:37,040

microgram some really impressive one way

2526

01:28:42,229 --> 01:28:39,440

or another but a plank temperature

2527

01:28:43,910 --> 01:28:42,239

is the maximum temperature you can have

2528

01:28:46,149 --> 01:28:43,920

and we think above that all the physics

2529

01:28:48,629 --> 01:28:46,159

would break down that we have going on

2530

01:28:51,510 --> 01:28:48,639

a plank temperature is

2531

01:28:53,030 --> 01:28:51,520

like a trillion trillion million degrees

2532

01:28:55,110 --> 01:28:53,040

something along those lines it's it's a

2533

01:28:57,110 --> 01:28:55,120

very very large number even compared to

2534

01:28:58,790 --> 01:28:57,120

the insides of stars

2535

01:29:00,310 --> 01:28:58,800

and we think that that might be the

2536

01:29:02,310 --> 01:29:00,320

temperature of the universe was when it

2537

01:29:03,830 --> 01:29:02,320

first got spawned

2538

01:29:04,950 --> 01:29:03,840

nothing should be able to exceed that

2539

01:29:07,350 --> 01:29:04,960

temperature

2540

01:29:08,310 --> 01:29:07,360

and that's one of those quantum things

2541

01:29:09,189 --> 01:29:08,320

where

2542

01:29:10,870 --> 01:29:09,199

we were saying earlier about

2543

01:29:13,030 --> 01:29:10,880

singularities and you can't divide by

2544

01:29:15,430 --> 01:29:13,040

zero the universe doesn't seem to like

2545

01:29:16,950 --> 01:29:15,440

the number zero or the number infinity

2546

01:29:19,110 --> 01:29:16,960

so it doesn't really seem to present us

2547

01:29:21,189 --> 01:29:19,120

examples of that there are limits to how

2548

01:29:22,550 --> 01:29:21,199

much you can cut things in half

2549

01:29:24,950 --> 01:29:22,560

um you know there are limits to how

2550

01:29:26,310 --> 01:29:24,960

small you can make an object uh and

2551

01:29:29,270 --> 01:29:26,320

indeed that is that planck length or

2552

01:29:30,709 --> 01:29:29,280

that planck time if you make something

2553

01:29:32,229 --> 01:29:30,719

down to the planck length it's pretty

2554

01:29:33,270 --> 01:29:32,239

much automatically going to be a black

2555

01:29:35,189 --> 01:29:33,280

hole

2556

01:29:36,709 --> 01:29:35,199

uh if it's got any energy in it at all

2557

01:29:38,470 --> 01:29:36,719

in terms of like photons anything that

2558

01:29:39,990 --> 01:29:38,480

can be that small

2559

01:29:41,830 --> 01:29:40,000

has to be so energetic it would be a

2560

01:29:43,110 --> 01:29:41,840

black hole at that size plant

2561

01:29:44,870 --> 01:29:43,120

temperature is the exact opposite it's

2562

01:29:46,550 --> 01:29:44,880

one of those maximums that would seem to

2563

01:29:47,910 --> 01:29:46,560

be imposed by nature that you can't

2564

01:29:49,830 --> 01:29:47,920

exceed this temperature that there is no

2565

01:29:51,350 --> 01:29:49,840

infinite temperature but that that's an

2566

01:29:54,070 --> 01:29:51,360

actual maximum

2567

01:29:56,870 --> 01:29:54,080

and one of the dangers of uh

2568

01:29:58,790 --> 01:29:56,880

using a warp drive would be the

2569

01:30:00,229 --> 01:29:58,800

possibility of

2570

01:30:01,430 --> 01:30:00,239

achieving

2571

01:30:03,510 --> 01:30:01,440

uh

2572

01:30:05,590 --> 01:30:03,520

that scale of hot

2573

01:30:06,870 --> 01:30:05,600

right right in front of you probably

2574

01:30:08,550 --> 01:30:06,880

that's one of those problems you have

2575

01:30:10,950 --> 01:30:08,560

with things like white holes that might

2576

01:30:11,830 --> 01:30:10,960

very easily be what temperature they are

2577

01:30:14,470 --> 01:30:11,840

and

2578

01:30:19,430 --> 01:30:14,480

how would you

2579

01:30:21,189 --> 01:30:19,440

i you know how do you overcome standing

2580

01:30:22,149 --> 01:30:21,199

next to a nuclear bomb when it goes off

2581

01:30:23,830 --> 01:30:22,159

right um

2582

01:30:27,030 --> 01:30:23,840

and this is much worse than a nuclear

2583

01:30:28,790 --> 01:30:27,040

bomb i'm much much worse you know

2584

01:30:30,310 --> 01:30:28,800

and so you say well i've got this this

2585

01:30:33,030 --> 01:30:30,320

really powerful energy source in front

2586

01:30:34,870 --> 01:30:33,040

of me i'll just bounce it away

2587

01:30:36,390 --> 01:30:34,880

how i'm not sure how you would do that

2588

01:30:38,149 --> 01:30:36,400

it's it's a it's just like standing in

2589

01:30:39,350 --> 01:30:38,159

the middle of the bag actually it is

2590

01:30:40,310 --> 01:30:39,360

literally standing in the middle of the

2591

01:30:43,669 --> 01:30:40,320

big bang

2592

01:30:47,189 --> 01:30:43,679

right and so absolute hot if if if we

2593

01:30:49,270 --> 01:30:47,199

get to that point then everything ceases

2594

01:30:51,270 --> 01:30:49,280

to exist

2595

01:30:53,350 --> 01:30:51,280

right everything breaks down

2596

01:30:55,590 --> 01:30:53,360

well or something new pops up i mean

2597

01:30:57,990 --> 01:30:55,600

again big bang

2598

01:31:00,830 --> 01:30:58,000

right right right right

2599

01:31:04,149 --> 01:31:00,840

yeah okay all right absolute hot i've

2600

01:31:07,510 --> 01:31:04,159

i've been looking into that lately

2601

01:31:10,390 --> 01:31:07,520

and again it's it's when we talk about

2602

01:31:12,870 --> 01:31:10,400

you know uh the surface of mercury or

2603

01:31:14,870 --> 01:31:12,880

the the surface temperature of the sun

2604

01:31:16,709 --> 01:31:14,880

or you know these extreme things that

2605

01:31:19,750 --> 01:31:16,719

peanuts and companions right right

2606

01:31:23,189 --> 01:31:19,760

because we wrestle with that heat

2607

01:31:25,270 --> 01:31:23,199

right in our mind about how great of a

2608

01:31:27,750 --> 01:31:25,280

temperature that actually is

2609

01:31:30,310 --> 01:31:27,760

well when we go to absolute hot it's

2610

01:31:32,950 --> 01:31:30,320

just like talking about ice cubes and

2611

01:31:36,790 --> 01:31:32,960

then going to absolute zero

2612

01:31:40,310 --> 01:31:36,800

that is uh that is a crazy number of

2613

01:31:42,470 --> 01:31:40,320

cold well we have the same extreme with

2614

01:31:46,550 --> 01:31:42,480

absolute hot

2615

01:31:49,430 --> 01:31:46,560

and it is a mind-numbing number of of of

2616

01:31:50,950 --> 01:31:49,440

heat of degrees my numbing how many how

2617

01:31:53,270 --> 01:31:50,960

many zeros

2618

01:31:54,709 --> 01:31:53,280

like 30 of them i think yeah maybe 32

2619

01:31:57,030 --> 01:31:54,719

it's it's a huge number of zeros

2620

01:31:59,030 --> 01:31:57,040

trillion trillion trillion roughly

2621

01:32:00,709 --> 01:31:59,040

and um you know it's it's interesting

2622

01:32:02,229 --> 01:32:00,719

you can't quite get to absolute zero

2623

01:32:03,750 --> 01:32:02,239

that's what we have as a theory right

2624

01:32:05,590 --> 01:32:03,760

now is there's a minimum temperature you

2625

01:32:06,550 --> 01:32:05,600

can get to it's real close but not quite

2626

01:32:08,070 --> 01:32:06,560

there

2627

01:32:09,430 --> 01:32:08,080

and uh this is the other kind of the

2628

01:32:11,030 --> 01:32:09,440

side thing how close can you get to

2629

01:32:13,189 --> 01:32:11,040

infinity well you can't get really all

2630

01:32:15,350 --> 01:32:13,199

that close because you're never close to

2631

01:32:16,709 --> 01:32:15,360

infinity but this does look like as much

2632

01:32:17,990 --> 01:32:16,719

as you're going to get

2633

01:32:19,669 --> 01:32:18,000

and against one of those problems that

2634

01:32:22,229 --> 01:32:19,679

pops up when we work on these things on

2635

01:32:24,310 --> 01:32:22,239

on paper uh we can see infinities and

2636

01:32:25,110 --> 01:32:24,320

zeros on paper we can calculate around

2637

01:32:27,110 --> 01:32:25,120

them

2638

01:32:29,350 --> 01:32:27,120

but um usually the universe doesn't

2639

01:32:32,709 --> 01:32:29,360

actually let us have those

2640

01:32:35,270 --> 01:32:32,719

is is something like a supernova or some

2641

01:32:37,030 --> 01:32:35,280

extreme explosion out there that you

2642

01:32:39,030 --> 01:32:37,040

know the brightest things that are out

2643

01:32:41,750 --> 01:32:39,040

there in the universe are are those

2644

01:32:44,390 --> 01:32:41,760

achieving absolute hot

2645

01:32:45,910 --> 01:32:44,400

no not even close uh they might be doing

2646

01:32:47,430 --> 01:32:45,920

so afterwards when the supernova

2647

01:32:49,669 --> 01:32:47,440

collapse into a black hole because

2648

01:32:51,750 --> 01:32:49,679

that's probably assuming for the moment

2649

01:32:53,510 --> 01:32:51,760

that there is no singularity no actual

2650

01:32:55,030 --> 01:32:53,520

point-like center of a black hole that

2651
01:32:57,110 --> 01:32:55,040
it just claps into something really

2652
01:32:59,430 --> 01:32:57,120
really tiny at the plank scale that

2653
01:33:02,310 --> 01:32:59,440
matter should be at plank temperature

2654
01:33:05,430 --> 01:33:02,320
incredible incredible i feel smarter

2655
01:33:09,350 --> 01:33:05,440
already okay let's let's move on to uh

2656
01:33:10,790 --> 01:33:09,360
uh let's do time travel and uh

2657
01:33:13,669 --> 01:33:10,800
right now

2658
01:33:15,750 --> 01:33:13,679
uh where is your head at

2659
01:33:18,070 --> 01:33:15,760
when it comes to time travel

2660
01:33:19,669 --> 01:33:18,080
i don't think it will ever be possible

2661
01:33:21,189 --> 01:33:19,679
why

2662
01:33:22,470 --> 01:33:21,199
fundamentally time travel was about

2663
01:33:24,149 --> 01:33:22,480

cause and effect and that that's the

2664

01:33:25,510 --> 01:33:24,159

same problem we have with ftl because it

2665

01:33:28,310 --> 01:33:25,520

always seems to allow you to violate

2666

01:33:30,390 --> 01:33:28,320

causality what causes things to happen

2667

01:33:32,870 --> 01:33:30,400

anytime you have time travel you you get

2668

01:33:34,310 --> 01:33:32,880

the the more obvious logical issues like

2669

01:33:36,070 --> 01:33:34,320

when you know what year is time travel

2670

01:33:38,229 --> 01:33:36,080

discovered every year simultaneously

2671

01:33:40,470 --> 01:33:38,239

because you can go to whatever you want

2672

01:33:41,910 --> 01:33:40,480

um if time travel were possible this

2673

01:33:43,110 --> 01:33:41,920

kind of a deductive back way if you

2674

01:33:44,790 --> 01:33:43,120

could actually make a practical time

2675

01:33:45,990 --> 01:33:44,800

travel somebody should have shown up

2676
01:33:47,910 --> 01:33:46,000
when the universe was brand new and

2677
01:33:48,950 --> 01:33:47,920
colonized the whole thing by now

2678
01:33:50,310 --> 01:33:48,960
um

2679
01:33:51,430 --> 01:33:50,320
but then there's the other aspect of

2680
01:33:53,430 --> 01:33:51,440
that is

2681
01:33:56,070 --> 01:33:53,440
you know either someone invents time

2682
01:33:57,669 --> 01:33:56,080
travel and they uh

2683
01:33:58,950 --> 01:33:57,679
they've only got the only working time

2684
01:34:00,229 --> 01:33:58,960
travel machine because they can go back

2685
01:34:02,070 --> 01:34:00,239
for anybody else would invent it and

2686
01:34:03,990 --> 01:34:02,080
keep them from doing it well you've got

2687
01:34:05,590 --> 01:34:04,000
everybody constantly doing it and then

2688
01:34:07,430 --> 01:34:05,600

there's the other aspect people look is

2689

01:34:09,590 --> 01:34:07,440

that conservation issue

2690

01:34:10,870 --> 01:34:09,600

what happens when i move myself back in

2691

01:34:12,870 --> 01:34:10,880

time

2692

01:34:14,709 --> 01:34:12,880

there's all that matter all those atoms

2693

01:34:18,310 --> 01:34:14,719

in me they're somewhere in the universe

2694

01:34:19,590 --> 01:34:18,320

already now they are there again how

2695

01:34:21,030 --> 01:34:19,600

does that work

2696

01:34:22,790 --> 01:34:21,040

the universe has a finite amount of

2697

01:34:24,790 --> 01:34:22,800

matter in it now it has finite number

2698

01:34:27,430 --> 01:34:24,800

plus some number of 100 kilograms

2699

01:34:29,510 --> 01:34:27,440

whatever it is but aren't you removed

2700

01:34:31,750 --> 01:34:29,520

from the future

2701

01:34:33,430 --> 01:34:31,760

doesn't it stay constant

2702

01:34:35,830 --> 01:34:33,440

well that would be a violation of

2703

01:34:38,470 --> 01:34:35,840

conservation of energy right i uh if i

2704

01:34:40,629 --> 01:34:38,480

jump back 100 years right as a physical

2705

01:34:42,790 --> 01:34:40,639

object i've moved backwards the universe

2706

01:34:45,430 --> 01:34:42,800

100 years ago is now 100 kilograms

2707

01:34:47,510 --> 01:34:45,440

heavier and the universe 100 years now

2708

01:34:48,470 --> 01:34:47,520

is 100 kilograms lighter that mass being

2709

01:34:54,709 --> 01:34:48,480

energy

2710

01:34:55,910 --> 01:34:54,719

and that doesn't necessarily mean that's

2711

01:34:57,590 --> 01:34:55,920

impossible we don't know that

2712

01:34:59,270 --> 01:34:57,600

conservation energy always has to be

2713

01:35:00,629 --> 01:34:59,280

preserved in fact for some reasons think

2714

01:35:02,229 --> 01:35:00,639

it might not be

2715

01:35:04,229 --> 01:35:02,239

but that would be an example of why it

2716

01:35:06,070 --> 01:35:04,239

might be impossible is simply because

2717

01:35:08,149 --> 01:35:06,080

there you go you you've

2718

01:35:11,750 --> 01:35:08,159

created or destroyed energy

2719

01:35:15,350 --> 01:35:11,760

the okay but that's okay that's one

2720

01:35:19,030 --> 01:35:15,360

version of time travel okay and and i

2721

01:35:21,350 --> 01:35:19,040

understand that concept and there is uh

2722

01:35:23,990 --> 01:35:21,360

uh another part of it that you didn't

2723

01:35:26,790 --> 01:35:24,000

touch upon where i talked to you know

2724

01:35:28,790 --> 01:35:26,800

very bright individuals where they're

2725

01:35:30,950 --> 01:35:28,800

uh referring to

2726

01:35:33,270 --> 01:35:30,960

uh you know a time machine aspect of

2727

01:35:35,270 --> 01:35:33,280

this where you're literally choosing the

2728

01:35:37,510 --> 01:35:35,280

time and you're going back

2729

01:35:38,950 --> 01:35:37,520

well then what happens to the rest of

2730

01:35:39,910 --> 01:35:38,960

the universe

2731

01:35:41,830 --> 01:35:39,920

right

2732

01:35:43,990 --> 01:35:41,840

is it that maybe it would get closed off

2733

01:35:45,350 --> 01:35:44,000

as a kind of with these event horizons

2734

01:35:47,110 --> 01:35:45,360

we always talk about with black holes

2735

01:35:48,550 --> 01:35:47,120

there are plenty of other event horizons

2736

01:35:50,709 --> 01:35:48,560

uh like the edge of the universe that's

2737

01:35:52,629 --> 01:35:50,719

absorbable you might find that any place

2738

01:35:54,310 --> 01:35:52,639

you were doing time traveling got its

2739

01:35:56,470 --> 01:35:54,320

own new event horizon around it kind of

2740

01:35:57,270 --> 01:35:56,480

closed itself off right

2741

01:35:59,430 --> 01:35:57,280

well

2742

01:36:01,510 --> 01:35:59,440

and so would the

2743

01:36:03,910 --> 01:36:01,520

okay let's say

2744

01:36:05,750 --> 01:36:03,920

we have a colony on mars i'm going to

2745

01:36:08,790 --> 01:36:05,760

keep this really simple we have a colony

2746

01:36:11,830 --> 01:36:08,800

on mars and you and i jump into our time

2747

01:36:14,470 --> 01:36:11,840

traveling phone booth right and we go

2748

01:36:17,430 --> 01:36:14,480

yes i made that reference i just did it

2749

01:36:20,790 --> 01:36:17,440

and and we jump in our time travel uh

2750

01:36:24,629 --> 01:36:20,800

phone booth and we go back in time

2751

01:36:27,270 --> 01:36:24,639

does mars go back in time are we

2752

01:36:29,030 --> 01:36:27,280

and what kind of energy are we actually

2753

01:36:33,590 --> 01:36:29,040

talking about here where we are

2754

01:36:35,350 --> 01:36:33,600

reversing the gears on everything

2755

01:36:36,950 --> 01:36:35,360

in most versions where you're going back

2756

01:36:38,470 --> 01:36:36,960

in time like that to actually do it

2757

01:36:39,669 --> 01:36:38,480

under known physics would acquire an

2758

01:36:41,350 --> 01:36:39,679

infinite amount of energy so you

2759

01:36:43,350 --> 01:36:41,360

couldn't do it right if you're popping

2760

01:36:44,950 --> 01:36:43,360

back those about mine whatever energy

2761

01:36:46,390 --> 01:36:44,960

you had in your body or whatever you're

2762

01:36:47,990 --> 01:36:46,400

moving back in time that's gonna get

2763

01:36:49,990 --> 01:36:48,000

transplanted which is quite a lot of

2764

01:36:51,669 --> 01:36:50,000

energy so it might be that if you want

2765

01:36:53,990 --> 01:36:51,679

to send somebody back in time you to pay

2766

01:36:55,270 --> 01:36:54,000

that energy bill which would be a very

2767

01:36:56,310 --> 01:36:55,280

large number

2768

01:36:57,830 --> 01:36:56,320

um

2769

01:36:59,830 --> 01:36:57,840

you know that whole equals mc^2

2770

01:37:01,430 --> 01:36:59,840

thing um the other is that you might be

2771

01:37:04,149 --> 01:37:01,440

able to create these kind of closed

2772

01:37:05,830 --> 01:37:04,159

loops um wherever you invented the time

2773

01:37:07,669 --> 01:37:05,840

machine and start that up you could

2774

01:37:09,750 --> 01:37:07,679

travel back in time only to the moment

2775

01:37:12,070 --> 01:37:09,760

when that was created that's kind of how

2776

01:37:14,470 --> 01:37:12,080

that works with wormholes you can make

2777

01:37:16,149 --> 01:37:14,480

two wormholes drag one end away give it

2778

01:37:18,149 --> 01:37:16,159

time dilation bring it back and there

2779

01:37:19,430 --> 01:37:18,159

you have a time machine but only goes

2780

01:37:20,950 --> 01:37:19,440

back to the moment that wormhole was

2781

01:37:22,550 --> 01:37:20,960

created

2782

01:37:23,830 --> 01:37:22,560

and we don't actually know what happened

2783

01:37:25,669 --> 01:37:23,840

at that point in time we just have some

2784

01:37:28,229 --> 01:37:25,679

guesses and one of those is the nokia

2785

01:37:30,709 --> 01:37:28,239

self-consistency principle which is that

2786

01:37:32,709 --> 01:37:30,719

you could change time but you're always

2787

01:37:34,470 --> 01:37:32,719

going to come back to the same

2788

01:37:37,590 --> 01:37:34,480

event to prevent all the things like

2789

01:37:39,189 --> 01:37:37,600

well i went back in time to save jfk but

2790

01:37:41,109 --> 01:37:39,199

then why did i go back and try to save

2791

01:37:43,270 --> 01:37:41,119

jfk if he never been shot

2792

01:37:46,070 --> 01:37:43,280

one way or another by the nokia self

2793

01:37:48,149 --> 01:37:46,080

consistency principle if that's true you

2794

01:37:50,070 --> 01:37:48,159

would always end up back in a moment

2795

01:37:51,430 --> 01:37:50,080

that caused you to do that that closed

2796

01:37:53,109 --> 01:37:51,440

loop is a war

2797

01:37:54,709 --> 01:37:53,119

which is

2798

01:37:56,870 --> 01:37:54,719

more science fiction than science is a

2799

01:37:58,070 --> 01:37:56,880

concept to be honest but it does you

2800

01:37:59,350 --> 01:37:58,080

know that's one of those logical

2801

01:38:00,470 --> 01:37:59,360

extractions

2802

01:38:02,709 --> 01:38:00,480

that doesn't necessarily mean you didn't

2803

01:38:04,149 --> 01:38:02,719

change time though it just means that it

2804

01:38:06,149 --> 01:38:04,159

always proceeds back to something that's

2805

01:38:07,830 --> 01:38:06,159

going to cause you to do that same event

2806

01:38:09,510 --> 01:38:07,840

it might be that

2807

01:38:11,109 --> 01:38:09,520

you went back and saved kenny but

2808

01:38:12,790 --> 01:38:11,119

something happens in your timeline that

2809

01:38:14,709 --> 01:38:12,800

makes you believe that he was actually

2810

01:38:16,470 --> 01:38:14,719

shot even though he wasn't so

2811

01:38:17,910 --> 01:38:16,480

delusionally you jump back in time to

2812

01:38:19,350 --> 01:38:17,920

save him even though he doesn't need

2813

01:38:21,990 --> 01:38:19,360

saving anymore

2814

01:38:25,350 --> 01:38:22,000

the the concept of time travel that i

2815

01:38:26,709 --> 01:38:25,360

that i wrestle with the most is

2816

01:38:31,109 --> 01:38:26,719

the the

2817

01:38:34,229 --> 01:38:31,119

going back in time is the uh is the

2818

01:38:37,270 --> 01:38:34,239

unachievable that's where things get

2819

01:38:40,310 --> 01:38:37,280

complicated that going to the future is

2820

01:38:43,270 --> 01:38:40,320

quite easy and einstein has uh

2821

01:38:45,910 --> 01:38:43,280

clearly said that okay i get that part

2822

01:38:47,590 --> 01:38:45,920

but what i am confused with is that the

2823

01:38:50,229 --> 01:38:47,600

past has happened

2824

01:38:52,149 --> 01:38:50,239

we know we know the past is there the

2825

01:38:56,229 --> 01:38:52,159

future hasn't happened

2826
01:38:58,470 --> 01:38:56,239
so that would be more complicated to me

2827
01:39:00,550 --> 01:38:58,480
uh

2828
01:39:01,910 --> 01:39:00,560
um we assume that there's an infinite

2829
01:39:04,550 --> 01:39:01,920
number of futures this war and that

2830
01:39:06,390 --> 01:39:04,560
there's just that one concrete past

2831
01:39:09,189 --> 01:39:06,400
but the same kind of reason it gives us

2832
01:39:12,390 --> 01:39:09,199
multiverses and multiple futures says

2833
01:39:13,669 --> 01:39:12,400
there's also possibly multiple paths

2834
01:39:15,430 --> 01:39:13,679
that uh you know there are many

2835
01:39:17,669 --> 01:39:15,440
different potential paths that would

2836
01:39:19,750 --> 01:39:17,679
result in this exact moment

2837
01:39:21,109 --> 01:39:19,760
and uh there's the other aspect of time

2838
01:39:23,030 --> 01:39:21,119

travel would say well if i jump back

2839

01:39:24,149 --> 01:39:23,040

there i'm only jumping back to a reality

2840

01:39:26,629 --> 01:39:24,159

that's very

2841

01:39:27,830 --> 01:39:26,639

similar to mine now it's a new universe

2842

01:39:29,189 --> 01:39:27,840

and of course if i just add a bunch of

2843

01:39:30,550 --> 01:39:29,199

energy to it it certainly is a new

2844

01:39:32,070 --> 01:39:30,560

universe it's not the same one it

2845

01:39:34,310 --> 01:39:32,080

doesn't have the same properties it's

2846

01:39:36,070 --> 01:39:34,320

got an extra amount of energy in it

2847

01:39:37,750 --> 01:39:36,080

and on those you're not traveling to a

2848

01:39:39,510 --> 01:39:37,760

different uh different part of your own

2849

01:39:41,590 --> 01:39:39,520

time you're just traveling to a universe

2850

01:39:44,310 --> 01:39:41,600

that's very much like yours

2851
01:39:46,790 --> 01:39:44,320
if you upset the amount of energy or the

2852
01:39:49,270 --> 01:39:46,800
amount of matter

2853
01:39:50,550 --> 01:39:49,280
and you tip that over what what would

2854
01:39:53,750 --> 01:39:50,560
happen

2855
01:39:56,310 --> 01:39:53,760
i mean do we just dissolve i mean do we

2856
01:39:57,830 --> 01:39:56,320
do we have a reversal big bang

2857
01:39:59,109 --> 01:39:57,840
that has been suggested that you might

2858
01:40:00,870 --> 01:39:59,119
actually cause one of those vacuum

2859
01:40:02,229 --> 01:40:00,880
fluctuations they talk about killing

2860
01:40:04,390 --> 01:40:02,239
everybody which is an interesting one

2861
01:40:05,750 --> 01:40:04,400
because that is not instantaneous that

2862
01:40:07,910 --> 01:40:05,760
would spread out what at the speed of

2863
01:40:10,229 --> 01:40:07,920

light we believe so you've you know you

2864

01:40:11,990 --> 01:40:10,239

create this uh doomsday scenario where

2865

01:40:13,990 --> 01:40:12,000

the universe is being destroyed at light

2866

01:40:15,590 --> 01:40:14,000

speed so somebody doing a galaxy right

2867

01:40:16,550 --> 01:40:15,600

now far away from us you know millions

2868

01:40:18,870 --> 01:40:16,560

of years from now the weight would

2869

01:40:20,629 --> 01:40:18,880

finally hit us right um but that's a

2870

01:40:22,470 --> 01:40:20,639

possibility that you might just unravel

2871

01:40:24,950 --> 01:40:22,480

that but then of course if you unravel

2872

01:40:27,030 --> 01:40:24,960

that universe uh by having done that

2873

01:40:28,149 --> 01:40:27,040

then how do you travel back there

2874

01:40:29,510 --> 01:40:28,159

because that universe doesn't exist

2875

01:40:30,550 --> 01:40:29,520

anymore to produce you to make that time

2876
01:40:31,990 --> 01:40:30,560
machine

2877
01:40:33,270 --> 01:40:32,000
and that's one of those

2878
01:40:35,189 --> 01:40:33,280
um

2879
01:40:37,189 --> 01:40:35,199
timey why me things i think to use the

2880
01:40:39,350 --> 01:40:37,199
uh phone box weapons

2881
01:40:41,189 --> 01:40:39,360
well see it doesn't make much sense and

2882
01:40:43,350 --> 01:40:41,199
and if there

2883
01:40:45,430 --> 01:40:43,360
uh is

2884
01:40:48,390 --> 01:40:45,440
the practice of these concepts that are

2885
01:40:51,109 --> 01:40:48,400
going down in another galaxy

2886
01:40:53,990 --> 01:40:51,119
another galaxy pick the number not the

2887
01:40:56,229 --> 01:40:54,000
milky way another galaxy where you've

2888
01:40:59,510 --> 01:40:56,239

got advanced civilizations messing

2889

01:41:02,229 --> 01:40:59,520

around with the fabric of space time

2890

01:41:06,950 --> 01:41:02,239

and our time traveling and dissolving

2891

01:41:09,430 --> 01:41:06,960

energy and and all of that and matter

2892

01:41:11,109 --> 01:41:09,440

would would that be something that would

2893

01:41:12,550 --> 01:41:11,119

affect us here

2894

01:41:13,830 --> 01:41:12,560

and we wouldn't understand what was

2895

01:41:15,510 --> 01:41:13,840

going on

2896

01:41:16,709 --> 01:41:15,520

possibly uh that's one of those things

2897

01:41:18,629 --> 01:41:16,719

where you know it just depends on how

2898

01:41:20,470 --> 01:41:18,639

the universe reacts to this it could be

2899

01:41:21,910 --> 01:41:20,480

that it's entirely possible to engage in

2900

01:41:23,669 --> 01:41:21,920

time travel and indeed there's nothing

2901
01:41:24,870 --> 01:41:23,679
banning under general relativity what's

2902
01:41:26,550 --> 01:41:24,880
violated which are not allowed to

2903
01:41:28,470 --> 01:41:26,560
violate is causality

2904
01:41:30,149 --> 01:41:28,480
uh cause and effect is what can't be

2905
01:41:32,310 --> 01:41:30,159
violated that just usually bans time

2906
01:41:33,669 --> 01:41:32,320
travel but it's possible that if you

2907
01:41:35,430 --> 01:41:33,679
start playing around with these things

2908
01:41:37,430 --> 01:41:35,440
you would create a event horizon around

2909
01:41:39,750 --> 01:41:37,440
yourself that would basically insulate

2910
01:41:40,950 --> 01:41:39,760
everybody else from you and again

2911
01:41:42,229 --> 01:41:40,960
there's not a lot of evidence to back

2912
01:41:43,350 --> 01:41:42,239
that up because there's not a lot of

2913
01:41:44,310 --> 01:41:43,360

evidence back any of the stuff up at

2914

01:41:45,270 --> 01:41:44,320

this time

2915

01:41:47,510 --> 01:41:45,280

but

2916

01:41:50,229 --> 01:41:47,520

um that is one of those situations that

2917

01:41:52,310 --> 01:41:50,239

happens um if you've got a universal

2918

01:41:54,629 --> 01:41:52,320

structure to prevent you from

2919

01:41:55,990 --> 01:41:54,639

filing causality it might be the time

2920

01:41:57,990 --> 01:41:56,000

travel is possible but every time

2921

01:42:00,229 --> 01:41:58,000

somebody's about to discover it they

2922

01:42:01,669 --> 01:42:00,239

essentially edit out that moment that

2923

01:42:03,830 --> 01:42:01,679

never happens they never actually get

2924

01:42:05,750 --> 01:42:03,840

around to discovering it because

2925

01:42:07,030 --> 01:42:05,760

things correct themselves instantly you

2926

01:42:08,470 --> 01:42:07,040

know you've got this thing where he

2927

01:42:10,950 --> 01:42:08,480

invented it went back in time and

2928

01:42:12,390 --> 01:42:10,960

prevented himself from ever inventing it

2929

01:42:14,070 --> 01:42:12,400

so it might be that that's one of the

2930

01:42:16,070 --> 01:42:14,080

things you could never invent if it was

2931

01:42:18,390 --> 01:42:16,080

possible because you never actually get

2932

01:42:19,350 --> 01:42:18,400

a chance to invent it if that makes

2933

01:42:23,590 --> 01:42:19,360

sense

2934

01:42:25,510 --> 01:42:23,600

it does it does and if okay now jumping

2935

01:42:27,270 --> 01:42:25,520

into the future which you know i've

2936

01:42:31,109 --> 01:42:27,280

discussed but let's do this in a very

2937

01:42:34,470 --> 01:42:31,119

simplified way we zip out we go ftl we

2938

01:42:37,510 --> 01:42:34,480

go 99.9 right 999.99999 we're right

2939

01:42:40,390 --> 01:42:37,520

there and we we head out let's let's

2940

01:42:43,030 --> 01:42:40,400

pick a uh an achievable number let's do

2941

01:42:44,310 --> 01:42:43,040

a 20-year round trip 10 years out 10

2942

01:42:47,750 --> 01:42:44,320

years back

2943

01:42:50,629 --> 01:42:47,760

earth is now at 99.999

2944

01:42:52,149 --> 01:42:50,639

earth is a million years in the future

2945

01:42:54,550 --> 01:42:52,159

a million

2946

01:42:58,310 --> 01:42:54,560

and we come back here

2947

01:43:01,350 --> 01:42:58,320

and time travel is now a tourist

2948

01:43:04,950 --> 01:43:01,360

attraction it's a destination

2949

01:43:08,390 --> 01:43:04,960

right now what happens to us

2950

01:43:09,669 --> 01:43:08,400

we come back is it possible uh to

2951

01:43:11,590 --> 01:43:09,679

[Music]

2952

01:43:15,030 --> 01:43:11,600

go from the future

2953

01:43:17,189 --> 01:43:15,040

remove ourselves time travel back to

2954

01:43:19,350 --> 01:43:17,199

2020

2955

01:43:22,070 --> 01:43:19,360

where we can tell everybody that time

2956

01:43:25,270 --> 01:43:22,080

travel is possible now what happens to

2957

01:43:26,709 --> 01:43:25,280

the matter that has been removed and the

2958

01:43:28,390 --> 01:43:26,719

energy

2959

01:43:30,870 --> 01:43:28,400

that has

2960

01:43:32,229 --> 01:43:30,880

disappeared from the future

2961

01:43:33,590 --> 01:43:32,239

we have no idea

2962

01:43:35,510 --> 01:43:33,600

that's one of those problems with time

2963

01:43:36,390 --> 01:43:35,520

travel um i mean from a logical point of

2964

01:43:38,470 --> 01:43:36,400

view when you're dealing with like

2965

01:43:40,550 --> 01:43:38,480

civilizations the fermi paradox

2966

01:43:41,510 --> 01:43:40,560

if i invent time travel a century from

2967

01:43:43,109 --> 01:43:41,520

now

2968

01:43:45,350 --> 01:43:43,119

the first thing i ought to be doing is

2969

01:43:46,790 --> 01:43:45,360

is traveling back in time to modern me

2970

01:43:48,550 --> 01:43:46,800

and handing me the blueprints for all

2971

01:43:50,229 --> 01:43:48,560

the really expensive technologies that

2972

01:43:51,669 --> 01:43:50,239

will make me a trillionaire right that's

2973

01:43:53,189 --> 01:43:51,679

correct

2974

01:43:54,950 --> 01:43:53,199

but i haven't done that it's like with

2975

01:43:56,870 --> 01:43:54,960

the the stephen hawking party for time

2976

01:43:58,310 --> 01:43:56,880

travelers he announced it was the day

2977

01:44:00,390 --> 01:43:58,320

afterwards he announced the party was

2978

01:44:03,270 --> 01:44:00,400

last night and nobody came

2979

01:44:04,950 --> 01:44:03,280

um and uh of course

2980

01:44:07,109 --> 01:44:04,960

they say well

2981

01:44:09,430 --> 01:44:07,119

maybe they have a rule against not

2982

01:44:11,750 --> 01:44:09,440

doing it they can do it but they don't i

2983

01:44:14,390 --> 01:44:11,760

said well yeah you could do that but

2984

01:44:16,790 --> 01:44:14,400

find me a rule that people voluntarily

2985

01:44:19,109 --> 01:44:16,800

follow 100 of the time

2986

01:44:20,709 --> 01:44:19,119

and uh and i would say that that's

2987

01:44:22,229 --> 01:44:20,719

that's probably not gonna i would

2988

01:44:24,149 --> 01:44:22,239

consider that to be more impossible than

2989

01:44:26,149 --> 01:44:24,159

time travel itself

2990

01:44:29,109 --> 01:44:26,159

well and this is the this is the i i

2991

01:44:31,270 --> 01:44:29,119

don't want to get into paradoxes because

2992

01:44:33,109 --> 01:44:31,280

i i don't believe in any of them all

2993

01:44:35,109 --> 01:44:33,119

right because nobody's time traveled

2994

01:44:38,870 --> 01:44:35,119

this is all just theories and ideas

2995

01:44:41,750 --> 01:44:38,880

that's all it is i entertain all of them

2996

01:44:43,990 --> 01:44:41,760

but i have my own concepts too as well

2997

01:44:46,709 --> 01:44:44,000

then let's stay right there

2998

01:44:50,229 --> 01:44:46,719

we go back in time uh

2999

01:44:52,950 --> 01:44:50,239

and we do visit a paradox we we

3000

01:44:55,270 --> 01:44:52,960

literally kill our grandmother i'd say

3001

01:44:57,590 --> 01:44:55,280

let's not say that they don't have sex

3002

01:45:00,629 --> 01:44:57,600

let's just say i take out my grandmother

3003

01:45:03,750 --> 01:45:00,639

right i take her out at that moment

3004

01:45:05,510 --> 01:45:03,760

where i now cease to exist

3005

01:45:07,510 --> 01:45:05,520

what happens to me

3006

01:45:10,470 --> 01:45:07,520

do i disappear

3007

01:45:13,350 --> 01:45:10,480

do i turn into stardust

3008

01:45:16,470 --> 01:45:13,360

do i fall down and die and my physical

3009

01:45:19,030 --> 01:45:16,480

body is still there in the past

3010

01:45:20,870 --> 01:45:19,040

but i just dropped dead

3011

01:45:22,950 --> 01:45:20,880

what happens at that moment

3012

01:45:24,229 --> 01:45:22,960

i mean we don't know for sure if uh back

3013

01:45:25,510 --> 01:45:24,239

to the future scene and go by you'd

3014

01:45:28,229 --> 01:45:25,520

start to kind of fade out and see your

3015

01:45:30,550 --> 01:45:28,239

hand go away but uh from a uh a more

3016

01:45:31,910 --> 01:45:30,560

realistic perspective it could never

3017

01:45:34,229 --> 01:45:31,920

have happened right you went back there

3018

01:45:35,830 --> 01:45:34,239

you shot her and now you never exist to

3019

01:45:37,189 --> 01:45:35,840

go back there and shoot off and that

3020

01:45:38,550 --> 01:45:37,199

again that's where that nokia self

3021

01:45:39,510 --> 01:45:38,560

consistency principle comes in where it

3022

01:45:40,950 --> 01:45:39,520

says

3023

01:45:42,550 --> 01:45:40,960

if you could actually have gone back and

3024

01:45:43,910 --> 01:45:42,560

done that in the first place

3025

01:45:45,590 --> 01:45:43,920

maybe something's going to happen that

3026

01:45:48,149 --> 01:45:45,600

would make you do it anyway like it

3027

01:45:49,750 --> 01:45:48,159

turns out that in this new timeline

3028

01:45:51,270 --> 01:45:49,760

you've really been deluded into thinking

3029

01:45:53,030 --> 01:45:51,280

she was your grandmother

3030

01:45:54,629 --> 01:45:53,040

you were wrong it's not your grandmother

3031

01:45:56,790 --> 01:45:54,639

you went back and shot at all because

3032

01:45:58,229 --> 01:45:56,800

that's a possible timeline right

3033

01:45:59,430 --> 01:45:58,239

or somebody came up to you and lied to

3034

01:46:00,470 --> 01:45:59,440

you before you got in the time machine

3035

01:46:02,310 --> 01:46:00,480

and said

3036

01:46:04,310 --> 01:46:02,320

that that's you know that that was your

3037

01:46:05,270 --> 01:46:04,320

grandmother you're going back to shoot

3038

01:46:07,030 --> 01:46:05,280

um

3039

01:46:09,109 --> 01:46:07,040

and say well that that seems to be kind

3040

01:46:11,750 --> 01:46:09,119

of contrived and it's not the idea that

3041

01:46:14,470 --> 01:46:11,760

the universe is consciously um making

3042

01:46:15,990 --> 01:46:14,480

that happen it's more the idea that of

3043

01:46:17,750 --> 01:46:16,000

all these possible futures that could

3044

01:46:19,109 --> 01:46:17,760

happen that that would that would be

3045

01:46:20,229 --> 01:46:19,119

consistent that would actually have

3046

01:46:21,910 --> 01:46:20,239

allowed that there are an infinite

3047

01:46:23,910 --> 01:46:21,920

number or very nearly infinite number of

3048

01:46:25,830 --> 01:46:23,920

scenarios that could cause you to go

3049

01:46:28,229 --> 01:46:25,840

back and do something like that in a way

3050

01:46:30,550 --> 01:46:28,239

that would not violate uh not create a

3051

01:46:32,390 --> 01:46:30,560

paradox there are very few of these

3052

01:46:34,149 --> 01:46:32,400

relative numbers of normal universes but

3053

01:46:35,350 --> 01:46:34,159

there's still a huge number of them

3054

01:46:37,669 --> 01:46:35,360

and so there would be an alternate

3055

01:46:39,430 --> 01:46:37,679

universe in which you had done that

3056

01:46:40,950 --> 01:46:39,440

mistakenly where you went back in in

3057

01:46:42,629 --> 01:46:40,960

time and shot the person who you thought

3058

01:46:43,430 --> 01:46:42,639

was your grandmother but actually was

3059

01:46:44,310 --> 01:46:43,440

not

3060

01:46:45,669 --> 01:46:44,320

uh

3061

01:46:47,189 --> 01:46:45,679

and now you just end up in one of those

3062

01:46:48,950 --> 01:46:47,199

paths for the same reason that water

3063

01:46:50,070 --> 01:46:48,960

when it falls on a hill

3064

01:46:51,750 --> 01:46:50,080

one way or another it ends up at the

3065

01:46:53,350 --> 01:46:51,760

bottom of that hill and the ocean again

3066

01:46:56,709 --> 01:46:53,360

it can take many different paths to get

3067

01:46:59,590 --> 01:46:56,719

there see this is okay now this is my

3068

01:47:02,229 --> 01:46:59,600

idea are you ready this is this is

3069

01:47:04,550 --> 01:47:02,239

church time travel theory

3070

01:47:10,310 --> 01:47:04,560

nothing happens

3071

01:47:12,629 --> 01:47:10,320

pop a cap in my grandmother i still live

3072

01:47:15,910 --> 01:47:12,639

i time travel to the future back to

3073

01:47:18,149 --> 01:47:15,920

where i was i'm still there there isn't

3074

01:47:20,229 --> 01:47:18,159

an alternate me there isn't a younger me

3075

01:47:21,669 --> 01:47:20,239

there isn't a twin me none of that

3076

01:47:23,830 --> 01:47:21,679

happens

3077

01:47:26,470 --> 01:47:23,840

all of the other stuff all the paradoxes

3078

01:47:28,070 --> 01:47:26,480

the alternate timelines the the infinite

3079

01:47:29,030 --> 01:47:28,080

none of that happens

3080

01:47:33,830 --> 01:47:29,040

it's just

3081

01:47:35,430 --> 01:47:33,840

that that's what i'm saying there it it

3082

01:47:37,750 --> 01:47:35,440

it just wouldn't it was just

3083

01:47:39,109 --> 01:47:37,760

it just life continues well that's

3084

01:47:41,430 --> 01:47:39,119

another one the ones that sometimes

3085

01:47:43,430 --> 01:47:41,440

present is that uh you know the the time

3086

01:47:45,990 --> 01:47:43,440

motion thing that we have here uh you

3087

01:47:47,350 --> 01:47:46,000

went back in time and changed something

3088

01:47:49,030 --> 01:47:47,360

and time continues to just proceed

3089

01:47:50,470 --> 01:47:49,040

normally there's no paradox because you

3090

01:47:52,229 --> 01:47:50,480

still have that one timeline it just

3091

01:47:53,990 --> 01:47:52,239

kind of loops like a string

3092

01:47:55,590 --> 01:47:54,000

you've got a straight string but who

3093

01:47:56,790 --> 01:47:55,600

says you can't take your finger and cord

3094

01:47:58,390 --> 01:47:56,800

around your finger real quick and make a

3095

01:47:59,910 --> 01:47:58,400

loop in the middle of that string you're

3096

01:48:01,510 --> 01:47:59,920

still walking along a straight line with

3097

01:48:03,669 --> 01:48:01,520

that string though yeah it just happens

3098

01:48:06,229 --> 01:48:03,679

to intersect at one point and loop yep i

3099

01:48:10,550 --> 01:48:06,239

i i that's what i i honest

3100

01:48:13,669 --> 01:48:12,229

my whole take on it would be i've got to

3101

01:48:16,070 --> 01:48:13,679

take a break right here i'm already

3102

01:48:18,790 --> 01:48:16,080

running late um is that i would come

3103

01:48:20,950 --> 01:48:18,800

back i'd look at you i tap myself

3104

01:48:23,270 --> 01:48:20,960

wow i'm still here i just killed my

3105

01:48:25,709 --> 01:48:23,280

grandmother i'm back

3106

01:48:27,270 --> 01:48:25,719

life is

3107

01:48:29,109 --> 01:48:27,280

unchanged

3108

01:48:30,550 --> 01:48:29,119

that's that's my take that's my take and

3109

01:48:32,629 --> 01:48:30,560

i'm sticking to it let's take a break

3110

01:48:35,430 --> 01:48:32,639

right here when we come back let's talk

3111

01:48:38,590 --> 01:48:35,440

some teleportation our guest tonight is

3112

01:48:40,390 --> 01:48:38,600

isaac arthur and it's very simple

3113

01:48:41,910 --> 01:48:40,400

isaacarthur.net the links are over at

3114

01:48:44,149 --> 01:48:41,920

jimmychurchradio.com

3115

01:48:46,950 --> 01:48:44,159

if you're enjoying this you need to go

3116

01:48:49,189 --> 01:48:46,960

and check out all of isaac's videos and

3117

01:48:53,730 --> 01:48:49,199

presentations it is fascinating we'll be

3118

01:49:04,709 --> 01:49:00,690

[Music]

3119

01:49:05,790 --> 01:49:04,719

fantastic conversation tonight with

3120

01:49:07,109 --> 01:49:05,800

isaac arthur

3121

01:49:10,229 --> 01:49:07,119

[Music]

3122

01:49:12,950 --> 01:49:10,239

but you know we expected that

3123

01:49:14,550 --> 01:49:12,960

heading into a little overtime and isaac

3124

01:49:17,270 --> 01:49:14,560

you know thank you for this conversation

3125

01:49:19,430 --> 01:49:17,280

tonight it is just incredible and

3126

01:49:21,109 --> 01:49:19,440

the uh these thoughts and concepts for a

3127

01:49:24,870 --> 01:49:21,119

lot of us are

3128

01:49:27,590 --> 01:49:24,880

um uh it's mentally draining because we

3129

01:49:28,709 --> 01:49:27,600

are getting into an uncomfortable zone

3130

01:49:31,109 --> 01:49:28,719

and knowledge

3131

01:49:32,950 --> 01:49:31,119

for you you just rattle this stuff off

3132

01:49:35,590 --> 01:49:32,960

and it's just another day

3133

01:49:37,830 --> 01:49:35,600

uh for you but uh teleportation is

3134

01:49:40,550 --> 01:49:37,840

another complex issue

3135

01:49:43,350 --> 01:49:40,560

and we've been watching this uh magic

3136

01:49:45,590 --> 01:49:43,360

occur uh uh

3137

01:49:48,229 --> 01:49:45,600

going back uh we

3138

01:49:49,669 --> 01:49:48,239

i think most people remember star trek

3139

01:49:52,550 --> 01:49:49,679

but my

3140

01:49:55,590 --> 01:49:52,560

first memory of this is is way before

3141

01:49:57,830 --> 01:49:55,600

that probably by 10 or 12 years in uh

3142

01:50:00,790 --> 01:49:57,840

forbidden planet

3143

01:50:02,149 --> 01:50:00,800

i love that movie yeah love it love it i

3144

01:50:04,310 --> 01:50:02,159

still watch it all the time you know

3145

01:50:07,350 --> 01:50:04,320

it's funny with forbidden planet

3146

01:50:08,709 --> 01:50:07,360

uh it gets shorter and shorter

3147

01:50:11,270 --> 01:50:08,719

um

3148

01:50:14,070 --> 01:50:11,280

if the movie happens very very quickly

3149

01:50:17,590 --> 01:50:14,080

for me now i i it's a time travel

3150

01:50:20,070 --> 01:50:17,600

teleportation thing um in that it it is

3151

01:50:22,870 --> 01:50:20,080

just so well laid out and the vision of

3152

01:50:25,669 --> 01:50:22,880

the future was uh just incredible just

3153

01:50:29,270 --> 01:50:25,679

incredible and also the uh

3154

01:50:31,750 --> 01:50:29,280

uh the gps uh aspect of it where they've

3155

01:50:34,470 --> 01:50:31,760

got the ship in the middle of that dome

3156

01:50:36,870 --> 01:50:34,480

uh and traveling the universe i thought

3157

01:50:39,430 --> 01:50:36,880

was a very interesting uh concept too as

3158

01:50:40,950 --> 01:50:39,440

well well the forbidden planet i mean

3159

01:50:42,550 --> 01:50:40,960

there's a good example of that for

3160

01:50:44,870 --> 01:50:42,560

things like teleportation where you've

3161

01:50:46,390 --> 01:50:44,880

got the uh robbie the robot who's uh

3162

01:50:47,910 --> 01:50:46,400

who's making all this stuff for them out

3163

01:50:49,430 --> 01:50:47,920

of nowhere and i think it was a bunch of

3164

01:50:50,830 --> 01:50:49,440

bottles of whiskey for the cook was the

3165

01:50:53,270 --> 01:50:50,840

example he used

3166

01:50:55,669 --> 01:50:53,280

um that's one of those ways you can do

3167

01:50:57,109 --> 01:50:55,679

teleportation is you obviously you just

3168

01:50:58,870 --> 01:50:57,119

go ahead and print out a copy of a

3169

01:51:00,070 --> 01:50:58,880

person at the destination

3170

01:51:01,350 --> 01:51:00,080

which kind of raises the issue of what

3171

01:51:03,910 --> 01:51:01,360

happens to the original guy is that

3172

01:51:04,950 --> 01:51:03,920

really just long distance cloning

3173

01:51:07,510 --> 01:51:04,960

and when we start looking at

3174

01:51:09,109 --> 01:51:07,520

teleportation what our ideal version is

3175

01:51:10,229 --> 01:51:09,119

is that here you are and now you're

3176

01:51:12,709 --> 01:51:10,239

elsewhere

3177

01:51:14,310 --> 01:51:12,719

and that one seems like we kind of

3178

01:51:15,430 --> 01:51:14,320

problematic to actually ever make work

3179

01:51:17,350 --> 01:51:15,440

but we have a lot of things that come

3180

01:51:19,510 --> 01:51:17,360

real close and one of those would be

3181

01:51:21,830 --> 01:51:19,520

where we scan you in

3182

01:51:23,510 --> 01:51:21,840

and copy you somewhere else

3183

01:51:25,270 --> 01:51:23,520

that's a lot easier to do with somebody

3184

01:51:26,629 --> 01:51:25,280

who's not really human anymore who's

3185

01:51:27,910 --> 01:51:26,639

been like mentally uploaded onto a

3186

01:51:29,109 --> 01:51:27,920

computer chip

3187

01:51:30,390 --> 01:51:29,119

but you always have that problem that

3188

01:51:33,430 --> 01:51:30,400

whenever you're doing things like this

3189

01:51:35,189 --> 01:51:33,440

you're not actually moving that person

3190

01:51:37,030 --> 01:51:35,199

you're copying them

3191

01:51:38,390 --> 01:51:37,040

what do you do with a copy or was the

3192

01:51:40,629 --> 01:51:38,400

copy destroyed in the process of

3193

01:51:41,910 --> 01:51:40,639

scanning and if you're using a method

3194

01:51:43,270 --> 01:51:41,920

that tends to destroy things when you

3195

01:51:44,950 --> 01:51:43,280

scan them

3196

01:51:46,470 --> 01:51:44,960

what happens when you do a scan it

3197

01:51:48,390 --> 01:51:46,480

doesn't work perfectly

3198

01:51:51,030 --> 01:51:48,400

and is it still the same person if

3199

01:51:53,109 --> 01:51:51,040

they're not quite copied perfectly

3200

01:51:55,669 --> 01:51:53,119

uh would

3201
01:51:57,350 --> 01:51:55,679
some advanced form of error correction

3202
01:51:59,109 --> 01:51:57,360
have to take place

3203
01:52:00,950 --> 01:51:59,119
i think so well i mean you've got a

3204
01:52:02,550 --> 01:52:00,960
compression issue first almost

3205
01:52:04,870 --> 01:52:02,560
everything in your body is a copy you

3206
01:52:06,870 --> 01:52:04,880
know say you want to send every last bit

3207
01:52:09,270 --> 01:52:06,880
of information of a person's body about

3208
01:52:11,510 --> 01:52:09,280
them every last molecule or atom

3209
01:52:13,189 --> 01:52:11,520
how accurate does that need to be

3210
01:52:15,109 --> 01:52:13,199
do i actually care if it reassembles a

3211
01:52:16,709 --> 01:52:15,119
bit of fat that's not the same as a bit

3212
01:52:17,990 --> 01:52:16,719
of fat elsewhere in my body i mean

3213
01:52:18,870 --> 01:52:18,000

there's only so many types of fat

3214

01:52:21,510 --> 01:52:18,880

wouldn't really make much of a

3215

01:52:23,270 --> 01:52:21,520

difference right same for muscle can i

3216

01:52:25,109 --> 01:52:23,280

just rely on that as encrypted can i

3217

01:52:28,310 --> 01:52:25,119

just send along the thing that says

3218

01:52:30,550 --> 01:52:28,320

make 1.5 pounds of of alm in this place

3219

01:52:31,589 --> 01:52:30,560

it's the same template arm as everybody

3220

01:52:32,550 --> 01:52:31,599

else has

3221

01:52:34,550 --> 01:52:32,560

um

3222

01:52:36,629 --> 01:52:34,560

and then of course

3223

01:52:38,390 --> 01:52:36,639

how good of a copy is that if you're

3224

01:52:39,990 --> 01:52:38,400

compressing that much

3225

01:52:41,750 --> 01:52:40,000

and you almost have to could say well

3226

01:52:43,270 --> 01:52:41,760

maybe we won't do it at all we'll scan

3227

01:52:45,510 --> 01:52:43,280

literally every atom

3228

01:52:48,149 --> 01:52:45,520

and so there's a problem there they are

3229

01:52:49,270 --> 01:52:48,159

you know 10 to the 30 or so random atoms

3230

01:52:51,189 --> 01:52:49,280

in your body

3231

01:52:53,189 --> 01:52:51,199

if each one of those requires a very

3232

01:52:55,030 --> 01:52:53,199

high powered photon to reach your

3233

01:52:56,629 --> 01:52:55,040

destination you know a very high power

3234

01:52:58,470 --> 01:52:56,639

transmission

3235

01:53:00,709 --> 01:52:58,480

when you're sending that beam with all

3236

01:53:02,310 --> 01:53:00,719

that information it would be not just

3237

01:53:03,830 --> 01:53:02,320

very energy-intensive to make you're

3238

01:53:05,270 --> 01:53:03,840

basically firing at death ray at the

3239

01:53:07,109 --> 01:53:05,280

location just to send all that

3240

01:53:10,390 --> 01:53:07,119

information

3241

01:53:12,550 --> 01:53:10,400

it's it's a huge huge amount we're not

3242

01:53:15,270 --> 01:53:12,560

talking terabytes

3243

01:53:17,830 --> 01:53:15,280

right we're talking about a crazy amount

3244

01:53:19,270 --> 01:53:17,840

of data yeah if it's not compressed i

3245

01:53:21,990 --> 01:53:19,280

mean it almost has to be compressed to

3246

01:53:23,510 --> 01:53:22,000

only be a digital copy of the brain if

3247

01:53:25,750 --> 01:53:23,520

you're trying to send the states of

3248

01:53:27,430 --> 01:53:25,760

every last atom in that body you are

3249

01:53:29,270 --> 01:53:27,440

effectively sending a signal that's got

3250

01:53:31,990 --> 01:53:29,280

to be so powerful just to contain all

3251

01:53:33,990 --> 01:53:32,000

that data that it really is a death ray

3252

01:53:36,709 --> 01:53:34,000

so you would

3253

01:53:39,189 --> 01:53:36,719

the concept would be an easier concept

3254

01:53:41,189 --> 01:53:39,199

for teleportation is you would have a

3255

01:53:42,629 --> 01:53:41,199

generic body

3256

01:53:45,030 --> 01:53:42,639

or pretty close to that yeah you'd

3257

01:53:47,350 --> 01:53:45,040

upload a brain to it as a war or you'd

3258

01:53:49,030 --> 01:53:47,360

merely replicate these specific states

3259

01:53:51,109 --> 01:53:49,040

of the neurons you know you're recording

3260

01:53:52,310 --> 01:53:51,119

what those neurons each have

3261

01:53:54,390 --> 01:53:52,320

that's problematic though because we

3262

01:53:56,149 --> 01:53:54,400

don't really know how much i mean you'll

3263

01:53:58,550 --> 01:53:56,159

hear figures about how much memory we

3264

01:54:00,470 --> 01:53:58,560

need to simulate a human brain uh or

3265

01:54:02,310 --> 01:54:00,480

processor speed those are kind of

3266

01:54:03,270 --> 01:54:02,320

guesses we look at how many neurons

3267

01:54:05,189 --> 01:54:03,280

there are in the body and how many

3268

01:54:07,189 --> 01:54:05,199

connections they have and say that's our

3269

01:54:08,709 --> 01:54:07,199

ground state we don't know for sure if

3270

01:54:10,229 --> 01:54:08,719

that's actually the case there might be

3271

01:54:11,270 --> 01:54:10,239

levels beneath that that are actually

3272

01:54:13,109 --> 01:54:11,280

relevant

3273

01:54:14,310 --> 01:54:13,119

and so if you're not copying somebody

3274

01:54:16,550 --> 01:54:14,320

perfectly

3275

01:54:19,350 --> 01:54:16,560

uh and there's you know what is perfect

3276

01:54:21,350 --> 01:54:19,360

um how close do you need to be

3277

01:54:22,709 --> 01:54:21,360

to actually achieve the goal and of

3278

01:54:24,229 --> 01:54:22,719

course you can make the argument that

3279

01:54:25,750 --> 01:54:24,239

i'm not the same person i was when i

3280

01:54:28,149 --> 01:54:25,760

opened my mouth to say that sentence i'm

3281

01:54:30,709 --> 01:54:28,159

constantly that's right

3282

01:54:33,109 --> 01:54:30,719

but how much is enough for the change

3283

01:54:35,910 --> 01:54:33,119

how much is enough for you

3284

01:54:38,229 --> 01:54:35,920

right for you to say yes okay i'm going

3285

01:54:40,750 --> 01:54:38,239

to go ahead and do this in that

3286

01:54:43,189 --> 01:54:40,760

uh if if they said well it's going to be

3287

01:54:45,030 --> 01:54:43,199

99.9 percent

3288

01:54:47,430 --> 01:54:45,040

that's not enough

3289

01:54:49,350 --> 01:54:47,440

not for me no

3290

01:54:50,550 --> 01:54:49,360

not for me though and i mean there was

3291

01:54:53,189 --> 01:54:50,560

presumably a part where you say well

3292

01:54:55,430 --> 01:54:53,199

look if i've just got one tiny little

3293

01:54:57,430 --> 01:54:55,440

data point different in my head so that

3294

01:54:59,669 --> 01:54:57,440

you know i remember one extra leaf on a

3295

01:55:01,669 --> 01:54:59,679

tree i saw 10 years ago that can't

3296

01:55:04,149 --> 01:55:01,679

possibly really matter so that's

3297

01:55:05,430 --> 01:55:04,159

probably good enough but if you teleport

3298

01:55:06,629 --> 01:55:05,440

somebody and it's not quite a good

3299

01:55:08,870 --> 01:55:06,639

enough copy

3300

01:55:10,709 --> 01:55:08,880

for you know how good of a copy does it

3301

01:55:12,390 --> 01:55:10,719

need to be and that would obviously

3302

01:55:14,070 --> 01:55:12,400

depend a lot on the individual so there

3303

01:55:15,990 --> 01:55:14,080

are examples where you might use uh

3304

01:55:17,750 --> 01:55:16,000

teleportation where it's very compressed

3305

01:55:19,270 --> 01:55:17,760

like that where you'll really not

3306

01:55:21,030 --> 01:55:19,280

getting rid of the original person it's

3307

01:55:23,109 --> 01:55:21,040

just a rapid copy

3308

01:55:24,629 --> 01:55:23,119

kind of like of an export you know

3309

01:55:25,910 --> 01:55:24,639

but since you still got that speed of

3310

01:55:27,990 --> 01:55:25,920

light issue for most types of

3311

01:55:29,830 --> 01:55:28,000

teleportation you might say why don't i

3312

01:55:31,669 --> 01:55:29,840

just keep a bunch of exports on ice with

3313

01:55:33,270 --> 01:55:31,679

my my spaceship to travel to another

3314

01:55:35,430 --> 01:55:33,280

place and i just wake them up for that

3315

01:55:37,109 --> 01:55:35,440

occasion because that's a lot more data

3316

01:55:39,669 --> 01:55:37,119

you can carry around that way

3317

01:55:42,310 --> 01:55:39,679

well and the

3318

01:55:44,470 --> 01:55:42,320

the problem that i see with it

3319

01:55:46,470 --> 01:55:44,480

um and i want to talk about the amount

3320

01:55:47,510 --> 01:55:46,480

of data here in just a second

3321

01:55:50,790 --> 01:55:47,520

is that

3322

01:55:53,030 --> 01:55:50,800

that's teleporting one time

3323

01:55:55,430 --> 01:55:53,040

yep but then you walk right right and

3324

01:55:57,669 --> 01:55:55,440

you walk into a bar and you see somebody

3325

01:56:00,870 --> 01:55:57,679

at the end of the bar that his hands are

3326

01:56:02,390 --> 01:56:00,880

shaking maybe his skin is wrong you know

3327

01:56:04,790 --> 01:56:02,400

and you're like oh that dude's

3328

01:56:06,870 --> 01:56:04,800

teleported 25 times

3329

01:56:08,870 --> 01:56:06,880

you know because now the copy of the

3330

01:56:10,709 --> 01:56:08,880

copy of the copy of the copy of the copy

3331

01:56:12,229 --> 01:56:10,719

and the degradation that happens in your

3332

01:56:14,709 --> 01:56:12,239

digital file

3333

01:56:16,709 --> 01:56:14,719

through so many uh error corrections

3334

01:56:18,149 --> 01:56:16,719

data loss and competition it's not like

3335

01:56:19,669 --> 01:56:18,159

normal cloning like if i just want to

3336

01:56:21,270 --> 01:56:19,679

clone you i don't get fatigue because i

3337

01:56:23,430 --> 01:56:21,280

can keep using that original sample or

3338

01:56:25,030 --> 01:56:23,440

even repair the damage because we know

3339

01:56:26,070 --> 01:56:25,040

what a damaged bit of dna looks like and

3340

01:56:28,390 --> 01:56:26,080

what's supposed to look like when it's

3341

01:56:31,189 --> 01:56:28,400

right right how do i remove the damage

3342

01:56:32,470 --> 01:56:31,199

of a copy on someone's memory

3343

01:56:34,709 --> 01:56:32,480

that's that's a you know that's one of

3344

01:56:36,950 --> 01:56:34,719

those gray areas there if you teleport

3345

01:56:38,390 --> 01:56:36,960

someone and they are you know you're

3346

01:56:40,470 --> 01:56:38,400

making a copy of them you're making a

3347

01:56:42,709 --> 01:56:40,480

copy of them now not the copy of them

3348

01:56:44,229 --> 01:56:42,719

that you teleport 10 times back

3349

01:56:45,270 --> 01:56:44,239

so you could get copy fatigue very

3350

01:56:46,790 --> 01:56:45,280

easily

3351
01:56:47,910 --> 01:56:46,800
especially because when you start

3352
01:56:50,229 --> 01:56:47,920
thinking about how you go about scanning

3353
01:56:52,870 --> 01:56:50,239
somebody at that kind of resolution

3354
01:56:54,229 --> 01:56:52,880
that's a pretty destructive process if

3355
01:56:55,589 --> 01:56:54,239
you want to do any kind of real-time

3356
01:56:57,510 --> 01:56:55,599
speed

3357
01:56:58,470 --> 01:56:57,520
and and so

3358
01:57:01,750 --> 01:56:58,480
uh

3359
01:57:05,910 --> 01:57:01,760
the amount of data okay in here in the

3360
01:57:08,310 --> 01:57:05,920
bunker i'm running uh i have wide open

3361
01:57:11,030 --> 01:57:08,320
very expensive uh

3362
01:57:15,030 --> 01:57:11,040
gigabit internet okay

3363
01:57:16,709 --> 01:57:15,040

and what we are running here is extreme

3364

01:57:18,790 --> 01:57:16,719

okay it's rare

3365

01:57:20,229 --> 01:57:18,800

okay not too many people have what we

3366

01:57:21,109 --> 01:57:20,239

have here

3367

01:57:24,870 --> 01:57:21,119

but

3368

01:57:27,189 --> 01:57:24,880

uh to run this kind of data

3369

01:57:29,910 --> 01:57:27,199

down a pipeline

3370

01:57:32,310 --> 01:57:29,920

how long would that take

3371

01:57:33,360 --> 01:57:32,320

okay atom by atom scan potentially

3372

01:57:35,510 --> 01:57:33,370

billions of years

3373

01:57:38,229 --> 01:57:35,520

[Laughter]

3374

01:57:39,910 --> 01:57:38,239

now just for a copy of like someone's um

3375

01:57:41,910 --> 01:57:39,920

neurologist was like

3376

01:57:44,790 --> 01:57:41,920

billions of years

3377

01:57:46,149 --> 01:57:44,800

i think i might be going low too though

3378

01:57:47,669 --> 01:57:46,159

i'd have to run the numbers on the

3379

01:57:49,910 --> 01:57:47,679

civics for that but yeah it's a very

3380

01:57:52,790 --> 01:57:49,920

long time yeah because we all remember

3381

01:57:54,790 --> 01:57:52,800

downloading you know with uh dial-in

3382

01:57:57,189 --> 01:57:54,800

modems right and looking at a picture

3383

01:57:59,030 --> 01:57:57,199

and watching the stages come down and

3384

01:58:00,470 --> 01:57:59,040

and then finally you got a jpeg on your

3385

01:58:02,709 --> 01:58:00,480

screen

3386

01:58:06,149 --> 01:58:02,719

when we are talking about this kind of

3387

01:58:08,470 --> 01:58:06,159

data for a teleportation situation where

3388

01:58:10,550 --> 01:58:08,480

you and i need to go to paris

3389

01:58:12,629 --> 01:58:10,560

right we don't want to fly we want to

3390

01:58:16,149 --> 01:58:12,639

teleport to paris

3391

01:58:18,470 --> 01:58:16,159

we could fly there uh quicker

3392

01:58:21,030 --> 01:58:18,480

than the teleportation side of it

3393

01:58:22,709 --> 01:58:21,040

because of the data transfer

3394

01:58:24,229 --> 01:58:22,719

would take forever

3395

01:58:26,310 --> 01:58:24,239

yeah and there's also the heat angle on

3396

01:58:28,629 --> 01:58:26,320

this because you know running computers

3397

01:58:30,390 --> 01:58:28,639

is not energy free you could actually

3398

01:58:32,070 --> 01:58:30,400

melt a planet down by actually running

3399

01:58:33,669 --> 01:58:32,080

one of these things there might be that

3400

01:58:35,109 --> 01:58:33,679

much energy involved right now that's

3401

01:58:36,870 --> 01:58:35,119

that's for the atom by atom scan if

3402

01:58:38,950 --> 01:58:36,880

you're just trying to uh copy the of a

3403

01:58:40,149 --> 01:58:38,960

memory right a copy of the brain

3404

01:58:42,149 --> 01:58:40,159

that potentially could be something you

3405

01:58:43,430 --> 01:58:42,159

could compress so much and i it wouldn't

3406

01:58:45,990 --> 01:58:43,440

just be the brain you'd be sitting along

3407

01:58:47,430 --> 01:58:46,000

things like physical specs so you could

3408

01:58:49,589 --> 01:58:47,440

nail the body pretty close but that

3409

01:58:51,270 --> 01:58:49,599

doesn't have to be huge amounts of data

3410

01:58:52,629 --> 01:58:51,280

um because so much of it's gonna be the

3411

01:58:53,990 --> 01:58:52,639

same as for anybody else so it really

3412

01:58:55,589 --> 01:58:54,000

wouldn't matter you don't care if your

3413

01:58:57,430 --> 01:58:55,599

muscle cells are exactly identical to

3414

01:58:59,270 --> 01:58:57,440

what they were before though that brings

3415

01:59:01,350 --> 01:58:59,280

up the use of technology like this to

3416

01:59:02,790 --> 01:59:01,360

heal people instantly or to add muscle

3417

01:59:04,709 --> 01:59:02,800

mass on right

3418

01:59:06,790 --> 01:59:04,719

um those extra applications of

3419

01:59:09,589 --> 01:59:06,800

technology if you're just doing a brain

3420

01:59:10,870 --> 01:59:09,599

scan and it really is just like that uh

3421

01:59:12,470 --> 01:59:10,880

i can't remember how many petabytes are

3422

01:59:14,310 --> 01:59:12,480

saying the human brain would have its

3423

01:59:15,589 --> 01:59:14,320

memory right now but it's it's pretty

3424

01:59:17,750 --> 01:59:15,599

big but it's not

3425

01:59:19,350 --> 01:59:17,760

insanely big something like that you

3426
01:59:20,470 --> 01:59:19,360
probably could send down down the

3427
01:59:21,350 --> 01:59:20,480
pipeline

3428
01:59:24,149 --> 01:59:21,360
now

3429
01:59:25,830 --> 01:59:24,159
on the other end

3430
01:59:27,350 --> 01:59:25,840
how do we

3431
01:59:30,790 --> 01:59:27,360
i can almost

3432
01:59:34,629 --> 01:59:30,800
understand the the body scan aspect of

3433
01:59:36,470 --> 01:59:34,639
it okay and if it was adam by adam let's

3434
01:59:38,709 --> 01:59:36,480
that that's a scan

3435
01:59:39,990 --> 01:59:38,719
but on the other end you need to do

3436
01:59:41,910 --> 01:59:40,000
assembly

3437
01:59:45,350 --> 01:59:41,920
yeah that's not happening that's not

3438
01:59:48,390 --> 01:59:45,360

happening right uh what you remember uh

3439

01:59:51,750 --> 01:59:48,400

uh the fifth element right

3440

01:59:54,310 --> 01:59:51,760

when they when they build her body uh at

3441

01:59:56,070 --> 01:59:54,320

the beginning of the movie this is like

3442

01:59:58,470 --> 01:59:56,080

3d printing right this is it you know

3443

02:00:00,709 --> 01:59:58,480

the the the they do the skeleton they do

3444

02:00:02,390 --> 02:00:00,719

the muscle tissue and the nervous system

3445

02:00:03,189 --> 02:00:02,400

and then the skin

3446

02:00:05,750 --> 02:00:03,199

um

3447

02:00:06,950 --> 02:00:05,760

and they do that in a couple of minutes

3448

02:00:09,109 --> 02:00:06,960

but

3449

02:00:10,790 --> 02:00:09,119

it's almost like a 3d printing concept

3450

02:00:12,790 --> 02:00:10,800

is what i'm visualizing here at the

3451

02:00:14,950 --> 02:00:12,800

other end uh

3452

02:00:16,950 --> 02:00:14,960

how long would that take and how much

3453

02:00:18,390 --> 02:00:16,960

energy are we talking about here to

3454

02:00:21,350 --> 02:00:18,400

reassemble

3455

02:00:23,109 --> 02:00:21,360

uh atomically our body if we want that

3456

02:00:24,550 --> 02:00:23,119

if we went that way better not take more

3457

02:00:25,589 --> 02:00:24,560

than a second because otherwise what's

3458

02:00:27,270 --> 02:00:25,599

happened to all the liquids they're

3459

02:00:28,550 --> 02:00:27,280

putting inside your body how about yours

3460

02:00:30,790 --> 02:00:28,560

all your blood gushing out from the

3461

02:00:32,310 --> 02:00:30,800

holes in your arteries who build you up

3462

02:00:34,550 --> 02:00:32,320

what about the liquid in your cells you

3463

02:00:36,229 --> 02:00:34,560

know you got to do that very quickly and

3464

02:00:37,669 --> 02:00:36,239

the problem is that means all those

3465

02:00:38,870 --> 02:00:37,679

atoms that you're moving into place have

3466

02:00:41,270 --> 02:00:38,880

to be moving very quickly because you're

3467

02:00:42,950 --> 02:00:41,280

printing line by line but they can't be

3468

02:00:44,870 --> 02:00:42,960

moving too quickly or they'll bounce off

3469

02:00:47,109 --> 02:00:44,880

each other when they try to assemble or

3470

02:00:48,229 --> 02:00:47,119

you'll catch on fire or because the

3471

02:00:49,510 --> 02:00:48,239

sheer amount of energy and speed

3472

02:00:51,189 --> 02:00:49,520

involved being that high if you're

3473

02:00:53,750 --> 02:00:51,199

trying to do this in just a second you

3474

02:00:55,030 --> 02:00:53,760

would probably blow up the local city

3475

02:00:56,189 --> 02:00:55,040

it would be

3476

02:00:59,430 --> 02:00:56,199

i i i

3477

02:01:02,390 --> 02:00:59,440

i imagine here

3478

02:01:04,470 --> 02:01:02,400

uh the mechanics and we're getting into

3479

02:01:06,070 --> 02:01:04,480

you know the thermal side of

3480

02:01:08,070 --> 02:01:06,080

pure physics

3481

02:01:10,870 --> 02:01:08,080

that the mechanics that would be

3482

02:01:13,350 --> 02:01:10,880

involved we don't have metals that could

3483

02:01:15,669 --> 02:01:13,360

withstand that kind of heat

3484

02:01:17,189 --> 02:01:15,679

because this would it would have to work

3485

02:01:18,149 --> 02:01:17,199

so fast

3486

02:01:21,350 --> 02:01:18,159

that

3487

02:01:22,709 --> 02:01:21,360

mechanically in the analog world

3488

02:01:24,870 --> 02:01:22,719

we don't have anything that could do

3489

02:01:26,229 --> 02:01:24,880

that kind of assembly sure you've got a

3490

02:01:28,149 --> 02:01:26,239

printer nozzle now you could put many

3491

02:01:29,830 --> 02:01:28,159

different printer nozzles on on a device

3492

02:01:31,750 --> 02:01:29,840

so it's printing as a grid but it's kind

3493

02:01:33,510 --> 02:01:31,760

of like the uh space gun example we say

3494

02:01:35,669 --> 02:01:33,520

well i can't see you shoot a laser beam

3495

02:01:37,669 --> 02:01:35,679

at me until the beam hits but i can see

3496

02:01:39,910 --> 02:01:37,679

you move that cannon and how fast you

3497

02:01:41,669 --> 02:01:39,920

can rotate that cannon towards me you

3498

02:01:43,510 --> 02:01:41,679

can't rotate it too fast or you'll rip

3499

02:01:45,990 --> 02:01:43,520

the cannon off its housing when it it

3500

02:01:47,270 --> 02:01:46,000

turns uh no matter what special metal

3501

02:01:49,750 --> 02:01:47,280

you make it out of it's still got a

3502

02:01:51,510 --> 02:01:49,760

limit as to how fast you can turn it uh

3503

02:01:53,189 --> 02:01:51,520

you know you try to make a million mile

3504

02:01:54,790 --> 02:01:53,199

long gun that's very powerful but it

3505

02:01:56,229 --> 02:01:54,800

takes a century to turn the thing to its

3506

02:01:57,669 --> 02:01:56,239

new target you know

3507

02:01:59,030 --> 02:01:57,679

now okay and that's kind of the same

3508

02:02:01,270 --> 02:01:59,040

thing applies to the printing level only

3509

02:02:03,589 --> 02:02:01,280

it's really tiny instead right and it

3510

02:02:06,149 --> 02:02:03,599

would i just can't imagine the amount of

3511

02:02:08,709 --> 02:02:06,159

heat that would be you're right we would

3512

02:02:10,709 --> 02:02:08,719

black hole into a you know into nothing

3513

02:02:13,669 --> 02:02:10,719

it would just be something incredible

3514

02:02:15,669 --> 02:02:13,679

but now that's that's in our traditional

3515

02:02:17,430 --> 02:02:15,679

way of trying to

3516

02:02:20,229 --> 02:02:17,440

uh think about this

3517

02:02:23,270 --> 02:02:20,239

but what about and the other concept

3518

02:02:25,669 --> 02:02:23,280

that they have in in star trek

3519

02:02:28,310 --> 02:02:25,679

where this is done by light and the

3520

02:02:31,189 --> 02:02:28,320

assembly it is just uh

3521

02:02:32,709 --> 02:02:31,199

moving you from one place to another

3522

02:02:34,550 --> 02:02:32,719

now that's one of those options like we

3523

02:02:36,470 --> 02:02:34,560

were saying with the uh with the warp

3524

02:02:37,669 --> 02:02:36,480

drive earlier how it's not actually

3525

02:02:39,589 --> 02:02:37,679

you're not really moving you're just

3526
02:02:40,870 --> 02:02:39,599
sucking space and time around you you

3527
02:02:42,390 --> 02:02:40,880
might be able to set something like that

3528
02:02:43,669 --> 02:02:42,400
up so that here you're standing and then

3529
02:02:46,149 --> 02:02:43,679
all the space between you and the

3530
02:02:47,830 --> 02:02:46,159
destination goes away for you know as

3531
02:02:49,510 --> 02:02:47,840
you pass down there and you just it stop

3532
02:02:51,030 --> 02:02:49,520
when you get to the destination that's

3533
02:02:52,390 --> 02:02:51,040
kind of your classic teleportation

3534
02:02:54,550 --> 02:02:52,400
similar to a wormhole in that way you're

3535
02:02:56,310 --> 02:02:54,560
just stepping out at the destination

3536
02:02:57,750 --> 02:02:56,320
that one works just fine other than the

3537
02:02:59,189 --> 02:02:57,760
problems we've mentioned about the vast

3538
02:03:00,629 --> 02:02:59,199

amounts of energy involved in creating

3539

02:03:02,229 --> 02:03:00,639

any of those too

3540

02:03:03,669 --> 02:03:02,239

the universe doesn't like me try to move

3541

02:03:05,109 --> 02:03:03,679

things very fast

3542

02:03:07,350 --> 02:03:05,119

so

3543

02:03:08,950 --> 02:03:07,360

uh it becomes problematic usually about

3544

02:03:11,189 --> 02:03:08,960

the only way you could realistically do

3545

02:03:12,950 --> 02:03:11,199

it is that mind upload into you know a

3546

02:03:15,109 --> 02:03:12,960

robot body on the end it might be a very

3547

02:03:16,629 --> 02:03:15,119

elaborate android i mean it might be

3548

02:03:17,830 --> 02:03:16,639

it's so good that you really couldn't

3549

02:03:19,030 --> 02:03:17,840

tell the difference because you'll poke

3550

02:03:20,790 --> 02:03:19,040

eat your skin

3551

02:03:22,550 --> 02:03:20,800

um it just depends on how good of a

3552

02:03:23,830 --> 02:03:22,560

android just need to be for you to feel

3553

02:03:25,750 --> 02:03:23,840

comfortable in it

3554

02:03:27,109 --> 02:03:25,760

um but

3555

02:03:28,390 --> 02:03:27,119

or you could maybe clone a body for

3556

02:03:29,830 --> 02:03:28,400

somebody if the stuff's coming in at

3557

02:03:31,910 --> 02:03:29,840

light speed it takes a long time to

3558

02:03:33,910 --> 02:03:31,920

arrive you send them the basic body

3559

02:03:35,350 --> 02:03:33,920

template and then regrow the body while

3560

02:03:37,189 --> 02:03:35,360

the rest of the data is arriving and we

3561

02:03:38,870 --> 02:03:37,199

pump you into it those are real

3562

02:03:40,550 --> 02:03:38,880

potential options people might travel

3563

02:03:42,070 --> 02:03:40,560

the solar system in the future at light

3564

02:03:44,149 --> 02:03:42,080

speed because they're just you know

3565

02:03:45,910 --> 02:03:44,159

uploading into a body at the other end

3566

02:03:47,189 --> 02:03:45,920

uh but that implies that they don't you

3567

02:03:49,030 --> 02:03:47,199

know they already kind of download into

3568

02:03:51,030 --> 02:03:49,040

their current body too that the one

3569

02:03:52,550 --> 02:03:51,040

they're wearing here is not

3570

02:03:53,750 --> 02:03:52,560

really their traditional body more but

3571

02:03:56,629 --> 02:03:53,760

more like an android they're walking

3572

02:03:58,470 --> 02:03:56,639

around on here on earth too um but that

3573

02:04:00,950 --> 02:03:58,480

again that still comes down that copying

3574

02:04:03,270 --> 02:04:00,960

thing you're not actually moving

3575

02:04:05,109 --> 02:04:03,280

yourself you're just making a copy at a

3576
02:04:06,149 --> 02:04:05,119
destination what happens to the original

3577
02:04:15,430 --> 02:04:06,159
you

3578
02:04:18,229 --> 02:04:15,440
did do that in that there are now two of

3579
02:04:20,310 --> 02:04:18,239
you there's one here in los angeles and

3580
02:04:22,870 --> 02:04:20,320
there's one of you in paris

3581
02:04:24,470 --> 02:04:22,880
at that instant let's say you don't kill

3582
02:04:26,310 --> 02:04:24,480
the original you

3583
02:04:29,669 --> 02:04:26,320
which i would assume that you would have

3584
02:04:31,189 --> 02:04:29,679
to do but let's say that well okay

3585
02:04:33,270 --> 02:04:31,199
it's a great method of colonizing the

3586
02:04:34,470 --> 02:04:33,280
universe like people often say we're not

3587
02:04:36,229 --> 02:04:34,480
going to colonize the universe because

3588
02:04:38,229 --> 02:04:36,239

home is so nice that we're never getting

3589

02:04:39,510 --> 02:04:38,239

volunteers to go or say well if i can

3590

02:04:42,070 --> 02:04:39,520

just send a copy of me to the

3591

02:04:43,830 --> 02:04:42,080

destination instead then i've got i only

3592

02:04:46,070 --> 02:04:43,840

need a few crewmen you know maybe a

3593

02:04:47,750 --> 02:04:46,080

thousand folks i can mix and match and

3594

02:04:49,109 --> 02:04:47,760

they're going to diverge from me once

3595

02:04:51,510 --> 02:04:49,119

they arrive whole different life

3596

02:04:52,550 --> 02:04:51,520

experience right so you got a unique

3597

02:04:55,350 --> 02:04:52,560

colony from all those different

3598

02:04:56,709 --> 02:04:55,360

permutations of your thousand volunteers

3599

02:04:58,149 --> 02:04:56,719

and that's an example where you could

3600

02:05:00,629 --> 02:04:58,159

actually use you know something like

3601
02:05:02,310 --> 02:05:00,639
teleportation that way it's a different

3602
02:05:03,750 --> 02:05:02,320
application the same way we say well you

3603
02:05:05,910 --> 02:05:03,760
could also use teleportation to heal

3604
02:05:07,189 --> 02:05:05,920
wounds or build muscle mass or make it

3605
02:05:09,669 --> 02:05:07,199
so you have to visit the bathroom that

3606
02:05:11,350 --> 02:05:09,679
kind of thing right but

3607
02:05:13,270 --> 02:05:11,360
i i would see

3608
02:05:15,430 --> 02:05:13,280
in in theory

3609
02:05:17,750 --> 02:05:15,440
the the problem would be the

3610
02:05:20,870 --> 02:05:17,760
entanglement literal quantum

3611
02:05:22,070 --> 02:05:20,880
entanglement of the two minds

3612
02:05:26,950 --> 02:05:22,080
you have two

3613
02:05:29,350 --> 02:05:26,960

you entangled

3614

02:05:31,109 --> 02:05:29,360

and it would be the voices in my head

3615

02:05:32,149 --> 02:05:31,119

concept right

3616

02:05:33,830 --> 02:05:32,159

well that actually is one of those

3617

02:05:35,270 --> 02:05:33,840

concerns we haven't completely ruled out

3618

02:05:36,790 --> 02:05:35,280

yet with things like awkward that

3619

02:05:38,790 --> 02:05:36,800

suggests it might be a quantum component

3620

02:05:40,870 --> 02:05:38,800

to the brain but at the same time

3621

02:05:42,390 --> 02:05:40,880

speaking of entanglement people often

3622

02:05:44,390 --> 02:05:42,400

say you can use entanglement to do

3623

02:05:45,430 --> 02:05:44,400

teleportation and you can we have

3624

02:05:47,109 --> 02:05:45,440

something called the no cloning

3625

02:05:49,350 --> 02:05:47,119

principle um the thing about

3626
02:05:51,510 --> 02:05:49,360
teleportation via quantum entanglement

3627
02:05:53,510 --> 02:05:51,520
is you're not actually um

3628
02:05:55,910 --> 02:05:53,520
moving the matter you're copying the

3629
02:05:57,350 --> 02:05:55,920
state of that person perfectly and it

3630
02:05:59,589 --> 02:05:57,360
does actually destroy the original when

3631
02:06:01,669 --> 02:05:59,599
you do that you move that data to a new

3632
02:06:03,750 --> 02:06:01,679
new place so in a way that would if you

3633
02:06:06,070 --> 02:06:03,760
get that to walk if you could entangle

3634
02:06:08,310 --> 02:06:06,080
an entire person that would be one way

3635
02:06:10,870 --> 02:06:08,320
to to uh to move somebody

3636
02:06:12,550 --> 02:06:10,880
prom is and this that we have a heck of

3637
02:06:14,629 --> 02:06:12,560
a problem in tackling even a thousand

3638
02:06:17,350 --> 02:06:14,639

atoms and you need to do like a trillion

3639

02:06:18,790 --> 02:06:17,360

trillion times that to do a person right

3640

02:06:19,750 --> 02:06:18,800

and so

3641

02:06:21,910 --> 02:06:19,760

what

3642

02:06:24,310 --> 02:06:21,920

i i just talked about uh you know the

3643

02:06:26,550 --> 02:06:24,320

the two minds the two consciousness that

3644

02:06:29,109 --> 02:06:26,560

could potentially be entangled

3645

02:06:31,350 --> 02:06:29,119

but the original you

3646

02:06:33,669 --> 02:06:31,360

and you've got the new one that is you

3647

02:06:36,310 --> 02:06:33,679

know walking around on europa or

3648

02:06:37,109 --> 02:06:36,320

wherever you just you know uh entangled

3649

02:06:39,910 --> 02:06:37,119

to

3650

02:06:41,430 --> 02:06:39,920

but you would have possibly two sets of

3651

02:06:42,870 --> 02:06:41,440

vision

3652

02:06:44,709 --> 02:06:42,880

right if there's a connection between

3653

02:06:45,910 --> 02:06:44,719

the mind right you know we can't really

3654

02:06:47,669 --> 02:06:45,920

discuss that from a scientific

3655

02:06:48,790 --> 02:06:47,679

perspective because we don't have uh you

3656

02:06:50,229 --> 02:06:48,800

know anything to indicate that there

3657

02:06:51,510 --> 02:06:50,239

would be a connection between those two

3658

02:06:54,310 --> 02:06:51,520

minds but that does bring up the other

3659

02:06:56,790 --> 02:06:54,320

aspect if i'm traveling this way to go

3660

02:06:59,030 --> 02:06:56,800

visit places how do i reintegrate those

3661

02:07:01,430 --> 02:06:59,040

memories back in my head did i go on ice

3662

02:07:03,750 --> 02:07:01,440

while my copy is exploring mars and

3663

02:07:04,550 --> 02:07:03,760

then it uploads that new mind state to

3664

02:07:06,950 --> 02:07:04,560

my

3665

02:07:08,550 --> 02:07:06,960

on ice brain or do i find some way to

3666

02:07:10,550 --> 02:07:08,560

reintegrate these two and how confusing

3667

02:07:12,310 --> 02:07:10,560

would that be right you would have i've

3668

02:07:14,149 --> 02:07:12,320

been experiencing day here and on mars

3669

02:07:16,550 --> 02:07:14,159

and i'd make those memories fit together

3670

02:07:19,030 --> 02:07:16,560

yeah that's right you would wake up with

3671

02:07:21,030 --> 02:07:19,040

uh additional memories that you didn't

3672

02:07:22,390 --> 02:07:21,040

actually physically

3673

02:07:23,990 --> 02:07:22,400

encounter

3674

02:07:25,270 --> 02:07:24,000

and from an engineering standpoint this

3675

02:07:26,870 --> 02:07:25,280

is doubly problematic because you're

3676

02:07:28,629 --> 02:07:26,880

probably going to use some of those same

3677

02:07:30,149 --> 02:07:28,639

neurons for your experience here on

3678

02:07:32,550 --> 02:07:30,159

earth and your experience there on mars

3679

02:07:34,470 --> 02:07:32,560

so we got to carefully find new pathways

3680

02:07:35,830 --> 02:07:34,480

that we can insert those memories into

3681

02:07:37,750 --> 02:07:35,840

that's why we say we'd probably be

3682

02:07:39,030 --> 02:07:37,760

easier to sticky on ice and actually are

3683

02:07:40,310 --> 02:07:39,040

nice too because your brain doesn't shut

3684

02:07:42,550 --> 02:07:40,320

down while you're asleep so we need to

3685

02:07:44,709 --> 02:07:42,560

freeze that thing while you're off away

3686

02:07:47,669 --> 02:07:44,719

if we want to just copy it back well and

3687

02:07:48,790 --> 02:07:47,679

then you would have the learning that

3688

02:07:50,069 --> 02:07:48,800

you did

3689

02:07:52,069 --> 02:07:50,079

uh

3690

02:07:52,950 --> 02:07:52,079

in the new location maybe you read a

3691

02:07:55,189 --> 02:07:52,960

book

3692

02:07:56,470 --> 02:07:55,199

right maybe you learned karate or

3693

02:07:58,069 --> 02:07:56,480

whatever

3694

02:07:59,750 --> 02:07:58,079

and now you translate that into your

3695

02:08:01,589 --> 02:07:59,760

brain if i can translate that onto your

3696

02:08:03,430 --> 02:08:01,599

brain why can't i translate that onto

3697

02:08:04,950 --> 02:08:03,440

someone else's brain so i can just take

3698

02:08:06,790 --> 02:08:04,960

some of these experiences from their

3699

02:08:08,390 --> 02:08:06,800

trip to mars and give it to everybody

3700

02:08:10,629 --> 02:08:08,400

yeah that's fantastic

3701

02:08:14,229 --> 02:08:10,639

that's an amazing concept but

3702

02:08:17,109 --> 02:08:14,239

what i are you strongly suggesting here

3703

02:08:19,270 --> 02:08:17,119

uh are you poo pooing teleportation like

3704

02:08:21,750 --> 02:08:19,280

you did time travel

3705

02:08:22,950 --> 02:08:21,760

no no i think teleportation is one of

3706

02:08:24,790 --> 02:08:22,960

those things you can do i just think you

3707

02:08:25,910 --> 02:08:24,800

have to limit it to inside that that

3708

02:08:27,589 --> 02:08:25,920

scope of

3709

02:08:29,189 --> 02:08:27,599

you know how from a physical standpoint

3710

02:08:30,709 --> 02:08:29,199

of what we know how to do now again if

3711

02:08:33,189 --> 02:08:30,719

we invent a wormhole there you go that's

3712

02:08:34,790 --> 02:08:33,199

teleportation for you but if we have to

3713

02:08:36,310 --> 02:08:34,800

stay inside what we have now

3714

02:08:38,149 --> 02:08:36,320

technologically speaking then you've got

3715

02:08:39,830 --> 02:08:38,159

to go that mind uploader out and you

3716

02:08:41,270 --> 02:08:39,840

have to find some way to to put that

3717

02:08:43,589 --> 02:08:41,280

data into

3718

02:08:45,669 --> 02:08:43,599

uh a receptacle at the end and then copy

3719

02:08:47,109 --> 02:08:45,679

it back to the original or to a new one

3720

02:08:48,390 --> 02:08:47,119

you've made back home

3721

02:08:49,510 --> 02:08:48,400

and i think a lot of folks would feel

3722

02:08:50,870 --> 02:08:49,520

that really doesn't count as

3723

02:08:51,669 --> 02:08:50,880

teleportation

3724

02:08:55,189 --> 02:08:51,679

no

3725

02:08:58,069 --> 02:08:55,199

it arguably is it arguably is and if we

3726

02:08:59,990 --> 02:08:58,079

go full circle here and we go back to uh

3727

02:09:01,510 --> 02:09:00,000

what we talked about earlier in the show

3728

02:09:04,310 --> 02:09:01,520

with wormholes

3729

02:09:06,629 --> 02:09:04,320

and using wormholes not to necessarily

3730

02:09:10,069 --> 02:09:06,639

go across the universe or to go to the

3731

02:09:11,669 --> 02:09:10,079

moon but to use them in a local sense

3732

02:09:14,709 --> 02:09:11,679

where you would have

3733

02:09:17,430 --> 02:09:14,719

wormholes between here and houston

3734

02:09:19,830 --> 02:09:17,440

and you could use that to travel between

3735

02:09:23,990 --> 02:09:19,840

houston and that would be

3736

02:09:26,069 --> 02:09:24,000

uh teleportation but not teleportation

3737

02:09:27,589 --> 02:09:26,079

but it would certainly be transportation

3738

02:09:29,669 --> 02:09:27,599

and you could

3739

02:09:30,709 --> 02:09:29,679

you know technically teleport between

3740

02:09:33,270 --> 02:09:30,719

points

3741

02:09:35,270 --> 02:09:33,280

locally oh that's that's you gotta think

3742

02:09:37,109 --> 02:09:35,280

about how far else we can do this i

3743

02:09:39,189 --> 02:09:37,119

don't have a teleporter in my house to

3744

02:09:40,790 --> 02:09:39,199

go to houston i have one in my closet to

3745

02:09:43,030 --> 02:09:40,800

that warehouse i keep all my closet

3746

02:09:44,950 --> 02:09:43,040

stuff in right i don't have a teleporter

3747

02:09:47,589 --> 02:09:44,960

in my house to go to houston to go visit

3748

02:09:49,109 --> 02:09:47,599

the fusion plant there i have a wormhole

3749

02:09:51,189 --> 02:09:49,119

that goes in the center of the sun to

3750

02:09:53,030 --> 02:09:51,199

suck out heat to use to run that engine

3751

02:09:55,750 --> 02:09:53,040

or i have a place i dump all my waste

3752

02:09:57,350 --> 02:09:55,760

heat and garbage onto i can run a really

3753

02:09:58,709 --> 02:09:57,360

powerful heat engine on one side of a

3754

02:10:01,750 --> 02:09:58,719

wormhole that's hot and on the side

3755

02:10:04,229 --> 02:10:01,760

that's cold they'll you know i can go to

3756

02:10:06,629 --> 02:10:04,239

my refrigerator reach in and grab a

3757

02:10:08,950 --> 02:10:06,639

thing of orange juice from the store

3758

02:10:09,830 --> 02:10:08,960

that you'd never left your house for

3759

02:10:13,189 --> 02:10:09,840

yep

3760

02:10:15,030 --> 02:10:13,199

and the amount of energy

3761

02:10:16,950 --> 02:10:15,040

for that and we're at the end of the

3762

02:10:17,990 --> 02:10:16,960

show so let's get this as quick as

3763

02:10:20,149 --> 02:10:18,000

possible

3764

02:10:22,310 --> 02:10:20,159

the amount of energy to reach into your

3765

02:10:24,550 --> 02:10:22,320

refrigerator to get the orange juice

3766

02:10:26,830 --> 02:10:24,560

from the store down the street or

3767

02:10:30,229 --> 02:10:26,840

from a fresh market in

3768

02:10:32,149 --> 02:10:30,239

florida an orange plantation the amount

3769

02:10:35,430 --> 02:10:32,159

of energy to do that

3770

02:10:38,069 --> 02:10:35,440

it would have to be less than the energy

3771

02:10:40,149 --> 02:10:38,079

you would need to transport on the back

3772

02:10:41,669 --> 02:10:40,159

of a truck

3773

02:10:43,430 --> 02:10:41,679

right

3774

02:10:45,030 --> 02:10:43,440

i mean if you've got if you can make you

3775

02:10:46,870 --> 02:10:45,040

know your power plants out of stars and

3776

02:10:49,030 --> 02:10:46,880

dump your waste heat into the void do

3777

02:10:50,950 --> 02:10:49,040

you care how much energy you're using

3778

02:10:52,709 --> 02:10:50,960

does it matter that you might have used

3779

02:10:54,470 --> 02:10:52,719

more energy than the whole us used in

3780

02:10:56,870 --> 02:10:54,480

the last 50 years to grab that bottle of

3781

02:10:58,149 --> 02:10:56,880

orange juice that's right that's right

3782

02:11:02,310 --> 02:10:58,159

fascinating

3783

02:11:03,270 --> 02:11:02,320

uh

3784

02:11:05,189 --> 02:11:03,280

to

3785

02:11:05,990 --> 02:11:05,199

uh sit here and actually think about

3786

02:11:07,910 --> 02:11:06,000

this

3787

02:11:11,910 --> 02:11:07,920

the with the

3788

02:11:14,790 --> 02:11:11,920

amount of technology that we have uh

3789

02:11:18,629 --> 02:11:14,800

overcome in the last hundred years we

3790

02:11:20,950 --> 02:11:18,639

have it's been absolutely incredible

3791

02:11:22,310 --> 02:11:20,960

how close are we to seeing some of these

3792

02:11:25,430 --> 02:11:22,320

come into play

3793

02:11:27,350 --> 02:11:25,440

is it 10 years is it 5 years is it 50 is

3794

02:11:28,550 --> 02:11:27,360

it something that we can enjoy in our

3795

02:11:30,390 --> 02:11:28,560

lifetime

3796

02:11:31,669 --> 02:11:30,400

for so many things like warm horse time

3797

02:11:33,430 --> 02:11:31,679

travel or fast and light or

3798

02:11:34,629 --> 02:11:33,440

teleportation i tend to think it's

3799

02:11:36,069 --> 02:11:34,639

either we're going to get in the next

3800

02:11:37,990 --> 02:11:36,079

century or two

3801

02:11:38,950 --> 02:11:38,000

or we're never going to get it ever

3802

02:11:40,470 --> 02:11:38,960

because it's one of those things where

3803

02:11:41,830 --> 02:11:40,480

if it's possible i don't think it's

3804

02:11:42,950 --> 02:11:41,840

going to take us all that much longer to

3805

02:11:45,990 --> 02:11:42,960

figure it out

3806

02:11:47,189 --> 02:11:46,000

next couple centuries or it's not going

3807

02:11:50,709 --> 02:11:47,199

to happen

3808

02:11:53,189 --> 02:11:50,719

and what about as crazy as uh this warp

3809

02:11:54,950 --> 02:11:53,199

drive idea is

3810

02:11:56,550 --> 02:11:54,960

when nasa says you know what we're going

3811

02:11:58,390 --> 02:11:56,560

to put this on the drawing board we're

3812

02:11:59,430 --> 02:11:58,400

going to get this from proof of concept

3813

02:12:01,510 --> 02:11:59,440

to

3814

02:12:05,109 --> 02:12:01,520

something very soon here

3815

02:12:06,870 --> 02:12:05,119

that is real science fiction clark tech

3816

02:12:08,069 --> 02:12:06,880

uh ideas

3817

02:12:09,589 --> 02:12:08,079

uh but

3818

02:12:11,669 --> 02:12:09,599

if you were gonna put

3819

02:12:14,069 --> 02:12:11,679

you know a time stamp on this how close

3820

02:12:16,069 --> 02:12:14,079

are we to a warp drive

3821

02:12:18,470 --> 02:12:16,079

say man so sometime in the next century

3822

02:12:21,350 --> 02:12:18,480

or never really you don't think it would

3823

02:12:23,589 --> 02:12:21,360

be ten years well i mean it could be

3824

02:12:25,589 --> 02:12:23,599

that soon i i think as i tend to be on

3825

02:12:27,270 --> 02:12:25,599

the side of neville for that but uh i

3826

02:12:29,109 --> 02:12:27,280

tend to think that if you can find me

3827

02:12:30,550 --> 02:12:29,119

one atom of negative matter just one

3828

02:12:32,470 --> 02:12:30,560

atom that we can prove is negative

3829

02:12:33,910 --> 02:12:32,480

matter then within a couple decades they

3830

02:12:35,430 --> 02:12:33,920

are tops you know because you've proven

3831

02:12:37,109 --> 02:12:35,440

it can be done you know what's there

3832

02:12:38,950 --> 02:12:37,119

you're going to throw a resource at it

3833

02:12:40,310 --> 02:12:38,960

until you get it working but until

3834

02:12:42,709 --> 02:12:40,320

you've got that

3835

02:12:44,550 --> 02:12:42,719

basic proof of concept that says this is

3836

02:12:46,229 --> 02:12:44,560

definitely possible here's your one atom

3837

02:12:47,430 --> 02:12:46,239

of negative matter

3838

02:12:48,310 --> 02:12:47,440

we don't know if it can be done at all

3839

02:12:50,149 --> 02:12:48,320

and we're not really putting a lot of

3840

02:12:52,229 --> 02:12:50,159

effort into it so

3841

02:12:54,069 --> 02:12:52,239

10 20 years after we discover negative

3842

02:12:55,750 --> 02:12:54,079

matter we'll have the thing that might

3843

02:12:57,589 --> 02:12:55,760

be now that might be next year that

3844

02:12:59,350 --> 02:12:57,599

might be next century that might be 10

3845

02:13:02,550 --> 02:12:59,360

days after doomsday

3846

02:13:04,870 --> 02:13:02,560

your next episode of future science you

3847

02:13:06,790 --> 02:13:04,880

release stuff on thursdays what's coming

3848

02:13:08,629 --> 02:13:06,800

up for you uh this week

3849

02:13:09,270 --> 02:13:08,639

ah space toys and we're actually talking

3850

02:13:11,109 --> 02:13:09,280

about that a little bit with

3851

02:13:13,270 --> 02:13:11,119

teleportation you can run off to mars

3852

02:13:14,709 --> 02:13:13,280

we're gonna look at uh space hotels and

3853

02:13:16,390 --> 02:13:14,719

things in the near future and like we so

3854

02:13:17,910 --> 02:13:16,400

often do we look at the near future and

3855

02:13:20,149 --> 02:13:17,920

then we have to jump centuries ahead and

3856

02:13:21,910 --> 02:13:20,159

see what's really on the agenda for our

3857

02:13:23,430 --> 02:13:21,920

descendants or maybe even us if we

3858

02:13:25,910 --> 02:13:23,440

managed to make it around that long

3859

02:13:28,470 --> 02:13:25,920

thank you so much thursdays uh have

3860

02:13:30,629 --> 02:13:28,480

never been the same

3861

02:13:31,589 --> 02:13:30,639

thank you so much isaac enjoy the rest

3862

02:13:33,030 --> 02:13:31,599

of your life

3863

02:13:36,390 --> 02:13:33,040

i know you've got a lot of work to do

3864

02:13:41,189 --> 02:13:38,470

isaac arthur

3865

02:13:44,149 --> 02:13:41,199

incredible now for everybody it's uh all

3866

02:13:46,709 --> 02:13:44,159

simple to do isaacarthur.net

3867

02:13:49,109 --> 02:13:46,719

and future science right there on

3868

02:13:50,790 --> 02:13:49,119

youtube what a great conversation

3869

02:13:53,109 --> 02:13:50,800

tonight isaac stay right there i'll talk

3870

02:13:54,950 --> 02:13:53,119

to you as soon as we sign off

3871

02:13:56,709 --> 02:13:54,960

fade to black's executive producer is

3872

02:13:58,709 --> 02:13:56,719

rita murray on shows produced by hilton

3873

02:14:00,790 --> 02:13:58,719

j paul renee dennis and bob announcers

3874

02:14:03,750 --> 02:14:00,800

are steve harter gene vettel and mark d

3875

02:14:06,229 --> 02:14:03,760

kovar webmaster is drew the geek music

3876

02:14:08,390 --> 02:14:06,239

doug aldrige intro spaceboy

3877

02:14:10,550 --> 02:14:08,400

spaceboymusic.com

3878

02:14:12,310 --> 02:14:10,560

dated black is produced by kjcr for the

3879

02:14:13,830 --> 02:14:12,320

game changer network and syndication is

3880

02:14:15,669 --> 02:14:13,840

kgra

3881

02:14:17,830 --> 02:14:15,679

the planet this broadcast zone and

3882

02:14:19,830 --> 02:14:17,840

copyrighted 2019 by fade to black and

3883

02:14:21,990 --> 02:14:19,840

the game changer network it cannot be

3884

02:14:23,990 --> 02:14:22,000

re-broadcast downloaded copied or used

3885

02:14:25,750 --> 02:14:24,000

anywhere in the known universe

3886

02:14:27,350 --> 02:14:25,760

without written permission from paid to

3887

02:14:29,510 --> 02:14:27,360

black or the game changer network i'm

3888

02:14:31,510 --> 02:14:29,520

your host jimmy church tomorrow night

3889

02:14:34,310 --> 02:14:31,520

jason quit right here

3890

02:14:35,589 --> 02:14:34,320

his new drone footage that he just shot

3891

02:14:38,470 --> 02:14:35,599

in italy

3892

02:14:40,470 --> 02:14:38,480

and what is in it is incredible we'll do

3893

02:14:43,589 --> 02:14:40,480

all of that tomorrow night but until

3894

02:14:45,580 --> 02:14:43,599

then i want everybody to be safe

3895

02:14:58,950 --> 02:14:45,590

go backly tappy

3896

02:14:58,960 --> 02:15:03,510

wow

3897

02:15:03,520 --> 02:15:13,589

[Music]

3898

02:15:13,599 --> 02:15:22,540

so