1
00:00:00,030 --> 00:00:11,819
thank you when I was asked to do this

2
00:00:08,849 --> 00:00:15,298
talk I really didn't have much idea of

3
00:00:11,820 --> 00:00:18,179
how it would fit or who would be

4
00:00:15,298 --> 00:00:22,198
listening and so forth and I'm happy to

5
00:00:18,179 --> 00:00:26,250
say quite by accident that what I plan

6
00:00:22,199 --> 00:00:29,189
to say fits albeit and sometimes curious

7
00:00:26,250 --> 00:00:32,549
ways with the talks that have preceded

8
00:00:29,189 --> 00:00:36,299
it let me just highlight a couple of

9
00:00:32,549 --> 00:00:39,299
those things very quickly one Eric

10
00:00:36,299 --> 00:00:42,628
Davis's comment about how when you do

11
00:00:39,299 --> 00:00:47,128
advanced propulsion that's beyond the

12
00:00:42,628 --> 00:00:49,468
box or beyond what my colleagues in the

13
00:00:47,128 --> 00:00:52,799
physics department at CSU Fullerton

14
00:00:49,469 --> 00:00:56,000
would think of as normal everyday type

15
00:00:52,799 --> 00:00:58,229
physics you do it very very

16
00:00:56,000 --> 00:01:02,878
conservatively and discreetly and in

17
00:00:58,229 --> 00:01:04,618
small steps the other thing that I would

18
00:01:02,878 --> 00:01:07,140
like to call attention to is that when

19
00:01:04,618 --> 00:01:09,239
you do this sort of thing as York Dobyns

20
00:01:07,140 --> 00:01:11,939
has pointed out you want to be sure that

21
00:01:09,239 --> 00:01:13,949
you're doing real physics because it's

22
00:01:11,938 --> 00:01:16,618
easy to delude yourself into thinking

23
00:01:13,950 --> 00:01:19,799
that something might be serious physics

24
00:01:16,618 --> 00:01:25,950
and it turns out that it's not so my

25
00:01:19,799 --> 00:01:28,670
talk I suspect the headline title from

26
00:01:25,950 --> 00:01:32,189
Stephen Hawking's recent thing on TV

27
00:01:28,670 --> 00:01:33,978
reaching out to the stars because that's

28
00:01:32,188 --> 00:01:39,839
primarily what I want to talk about

29

00:01:33,978 --> 00:01:42,780
today or if for the past 15 years really

30
00:01:39,840 --> 00:01:44,670
I've been doing the small steps trying

31
00:01:42,780 --> 00:01:48,840
to keep it on it's physics and all of

32
00:01:44,670 --> 00:01:50,579
that but in the early days when I was

33
00:01:48,840 --> 00:01:53,368
figuring out what I thought might be

34
00:01:50,578 --> 00:01:56,069
going on it was clear to me that there

35
00:01:53,368 --> 00:01:58,170
was more to it than simply small scale

36
00:01:56,069 --> 00:02:01,579
thrusters that vibrate and do weird

37
00:01:58,170 --> 00:02:04,070
things and stuff like that about

38
00:02:01,579 --> 00:02:06,370
I was invited to give it well I was

39
00:02:04,069 --> 00:02:09,590
invited to John Kramer 75th birthday

40
00:02:06,370 --> 00:02:11,960
symposium and when I told John that I'd

41
00:02:09,590 --> 00:02:14,270
come he suggested that I should give a

42
00:02:11,960 --> 00:02:16,810
talk and I availed myself of the

43
00:02:14,270 --> 00:02:19,310

opportunity to start talking about what

44
00:02:16,810 --> 00:02:21,860
I'm going to spend part of my time on

45
00:02:19,310 --> 00:02:24,020
today than experimental stuff but there

46
00:02:21,860 --> 00:02:26,420
is some experimental stuff that is say

47
00:02:24,020 --> 00:02:33,610
reality doesn't pinch on some of this a

48
00:02:26,419 --> 00:02:37,009
bit okay serious advanced professional

49
00:02:33,610 --> 00:02:39,230
in the modern world really starts with

50
00:02:37,009 --> 00:02:41,870
this guy here it's a picture of Kip

51
00:02:39,229 --> 00:02:43,849
Thorne Caltech Fineman professor of

52
00:02:41,870 --> 00:02:48,110
theoretical physics at Caltech for many

53
00:02:43,849 --> 00:02:51,099
years now recently retired this is from

54
00:02:48,110 --> 00:02:54,560
the time at which he did his

55
00:02:51,099 --> 00:02:56,359
epoch-making papers on wormholes which

56
00:02:54,560 --> 00:03:00,469
you've heard discussed earlier today

57
00:02:56,360 --> 00:03:02,600
that is so around 1987 or 88

58
00:03:00,469 --> 00:03:04,340
I'm not going to revisit the story of

59
00:03:02,599 --> 00:03:07,129
how he came to do that because of his

60
00:03:04,340 --> 00:03:11,209
buddy Carl Sagan I am going to show you

61
00:03:07,129 --> 00:03:13,310
the abstract of his paper okay he tried

62
00:03:11,209 --> 00:03:16,550
to present this as a pedagogical tool

63
00:03:13,310 --> 00:03:19,039
for teaching general relativity of

64
00:03:16,550 --> 00:03:20,719
course nobody knew nobody figured that

65
00:03:19,039 --> 00:03:24,229
that what he was what he was really up

66
00:03:20,719 --> 00:03:27,229
to debated in an appendix to his paper

67
00:03:24,229 --> 00:03:30,079
is this and this is the reason why Eric

68
00:03:27,229 --> 00:03:33,199
earlier this morning and others have

69
00:03:30,080 --> 00:03:36,530
commented that you need other levy otic

70
00:03:33,199 --> 00:03:39,759
amounts of negative west mass material

71
00:03:36,530 --> 00:03:44,390
in order to do anything like so-called

72
00:03:39,759 --> 00:03:47,509
al-kabir what drives or traversable

73
00:03:44,389 --> 00:03:50,089
wormholes indeed that is what you need

74
00:03:47,509 --> 00:03:53,599
in order to produce what is what they

75
00:03:50,090 --> 00:03:55,430
call an absurdly benign wormhole it

76
00:03:53,599 --> 00:03:58,609
turns out that you can use smaller

77
00:03:55,430 --> 00:04:02,390
amounts than a Jupiter mass of negative

78
00:03:58,610 --> 00:04:04,760
West mass matter to produce a one hell

79
00:04:02,389 --> 00:04:07,189
throat but if it's less than the Jupiter

80
00:04:04,759 --> 00:04:09,048
mass for most interesting configurations

81
00:04:07,189 --> 00:04:09,650
they're going to get throat flowing

82
00:04:09,049 --> 00:04:12,950
that's

83
00:04:09,650 --> 00:04:15,530
up everything for miles around okay so

84
00:04:12,949 --> 00:04:19,399
it really is on the order of a

85
00:04:15,530 --> 00:04:22,819
jupiter-mass of- rest mass manner in say

86

00:04:19,399 --> 00:04:25,219
sphere on the order of say 40 meters in

87
00:04:22,819 --> 00:04:27,259
diameter with a ray of thickness on the

88
00:04:25,220 --> 00:04:29,750
order of maybe a meter or so plus or

89
00:04:27,259 --> 00:04:31,669
minus event know what and if you do the

90
00:04:29,750 --> 00:04:34,129
calculation you find out that turns out

91
00:04:31,668 --> 00:04:37,038
to be much much much higher than nuclear

92
00:04:34,129 --> 00:04:39,740
densities of that sort of stuff I'm

93
00:04:37,038 --> 00:04:42,319
going to show you the obligatory

94
00:04:39,740 --> 00:04:44,269
pictures that have been produced for

95
00:04:42,319 --> 00:04:46,279
this this is the wormhole that Eric

96
00:04:44,269 --> 00:04:48,409
showed you a different version of this

97
00:04:46,279 --> 00:04:51,469
actually to my knowledge first appeared

98
00:04:48,410 --> 00:04:54,620
in Morris in Mizner Thorne and wheelers

99
00:04:51,470 --> 00:04:58,250
book on gravitation back in 1973

100
00:04:54,620 --> 00:05:00,680

published in 73 by Freeman and it was

101
00:04:58,250 --> 00:05:03,199
primarily that the instigation of mr.

102
00:05:00,680 --> 00:05:05,030
and Thorne's doctoral dissertation

103
00:05:03,199 --> 00:05:08,650
supervisor John Wheeler that it was

104
00:05:05,029 --> 00:05:11,598
included this is the world bowl a

105
00:05:08,649 --> 00:05:15,609
hyperspace embedding diagram that you've

106
00:05:11,598 --> 00:05:19,819
seen this is a recent rendition of a

107
00:05:15,610 --> 00:05:23,120
warp drive ship that's shown up on the

108
00:05:19,819 --> 00:05:27,139
web and so on this is for one of Stephen

109
00:05:23,120 --> 00:05:30,978
Hawking's illustrated books a spaceship

110
00:05:27,139 --> 00:05:33,439
in the act of producing negative rest

111
00:05:30,978 --> 00:05:35,689
mass matter and the ring and inducing in

112
00:05:33,439 --> 00:05:40,009
a warm oil throat through which it is

113
00:05:35,689 --> 00:05:43,370
about to proceed this is from nineteen

114
00:05:40,009 --> 00:05:46,009
no not 19 2002 Scientific American

115
00:05:43,370 --> 00:05:49,069
summer issue I think one of those it's

116
00:05:46,009 --> 00:05:51,709
it's what is referred to in the trade

117
00:05:49,069 --> 00:05:56,240
now as a Stargate but it is is really

118
00:05:51,709 --> 00:06:00,109
short throat wormhole ok spiracle in

119
00:05:56,240 --> 00:06:02,418
this case one of the people who I have a

120
00:06:00,110 --> 00:06:04,280
virtual group of folks who look over my

121
00:06:02,418 --> 00:06:07,279
shoulder or throw rocks from time to

122
00:06:04,279 --> 00:06:09,519
time and stuff like that and remember

123
00:06:07,279 --> 00:06:11,469
well dreamy if you were looking

124
00:06:09,519 --> 00:06:13,029
carefully enteric slides you would have

125
00:06:11,470 --> 00:06:15,400
found that he was one of the authors in

126
00:06:13,029 --> 00:06:18,279
one of the articles and book that they

127
00:06:15,399 --> 00:06:20,859
edited okay men go put this together for

128
00:06:18,279 --> 00:06:23,318
me about a month ago or so when I made

129
00:06:20,860 --> 00:06:26,788
some comment about infringing copyrights

130
00:06:23,319 --> 00:06:29,680
and that I was worried about that okay

131
00:06:26,788 --> 00:06:33,759
in order to get the right perspective on

132
00:06:29,680 --> 00:06:35,860
this and it's always no actually the

133
00:06:33,759 --> 00:06:38,169
real reason for this is this is the best

134
00:06:35,860 --> 00:06:42,750
Calvin and Hobbes cartoon I've ever seen

135
00:06:38,168 --> 00:06:47,549
it's posted in my laboratory okay

136
00:06:42,750 --> 00:06:47,550
I'll do this without comment

137
00:07:14,459 --> 00:07:23,789
okay now with that as preparation you

138
00:07:18,689 --> 00:07:27,810
need to be shorting serious skepticism

139
00:07:23,790 --> 00:07:29,129
is required in this business okay okay

140
00:07:27,810 --> 00:07:31,829
what does it take to do this so

141
00:07:29,129 --> 00:07:33,959
jupiter-mass of- rest mass matter okay

142
00:07:31,829 --> 00:07:35,250
that's really basically what you've got

143

00:07:33,959 --> 00:07:37,169
to do and what i want to talk about

144
00:07:35,250 --> 00:07:38,610
today i'll tell you a little bit about

145
00:07:37,170 --> 00:07:40,290
the experimental work that I've been

146
00:07:38,610 --> 00:07:43,920
doing later on but what I want to talk

147
00:07:40,290 --> 00:07:46,740
about today is this because what often

148
00:07:43,920 --> 00:07:50,069
passes for conversation about this this

149
00:07:46,740 --> 00:07:52,590
is a point which I think is important

150
00:07:50,069 --> 00:07:55,199
and just to remind you how much a

151
00:07:52,589 --> 00:07:59,269
jupiter-mass of matter is it's 2 times

152
00:07:55,199 --> 00:08:01,649
10 to the 27th kilograms of stuff that's

153
00:07:59,269 --> 00:08:04,049
600 times the mass of the earth or

154
00:08:01,649 --> 00:08:07,139
something it's a very large amount of

155
00:08:04,050 --> 00:08:10,500
mass okay is there any chance that this

156
00:08:07,139 --> 00:08:13,529
can be done and especially using only

157
00:08:10,500 --> 00:08:17,399

low and by low I mean the best we can

158
00:08:13,529 --> 00:08:20,489
possibly produce they are all low energy

159
00:08:17,399 --> 00:08:22,379
electromagnetic fields because in this

160
00:08:20,490 --> 00:08:23,629
business electromagnetic fields are

161
00:08:22,379 --> 00:08:26,490
pretty much what you're limited to

162
00:08:23,629 --> 00:08:31,230
steams the other option and steam power

163
00:08:26,490 --> 00:08:34,560
isn't obviously yeah okay where do you

164
00:08:31,230 --> 00:08:37,379
get a Jupiter mass of exotic matter okay

165
00:08:34,559 --> 00:08:40,079
remember this has to be rest mass matter

166
00:08:37,379 --> 00:08:40,889
stuff that you can stop in laboratory

167
00:08:40,080 --> 00:08:42,840
okay

168
00:08:40,889 --> 00:08:44,610
not stuff that's zipping along at the

169
00:08:42,840 --> 00:08:46,410
speed of light I suppose you could

170
00:08:44,610 --> 00:08:48,779
contain it in something or something

171
00:08:46,409 --> 00:08:51,719
like that but rest mass matter is the

172
00:08:48,779 --> 00:08:55,379
stuff that Morrison thorne we're talking

173
00:08:51,720 --> 00:08:58,290
about the usual story and when you see

174
00:08:55,379 --> 00:09:00,509
stuff on this topic on TV what people

175
00:08:58,289 --> 00:09:03,919
usually talk about is by amplifying

176
00:09:00,509 --> 00:09:06,870
Planck scale wormholes presumably

177
00:09:03,919 --> 00:09:10,019
quantum gravity which doesn't exist yet

178
00:09:06,870 --> 00:09:12,629
the theory doesn't exist yet nonetheless

179
00:09:10,019 --> 00:09:14,759
suggests that space-time form at the

180
00:09:12,629 --> 00:09:16,529
Planck scale occurs and that there are

181
00:09:14,759 --> 00:09:19,088
wormholes flitting into and out of

182
00:09:16,529 --> 00:09:21,308
existence at that scale and so forth

183
00:09:19,089 --> 00:09:23,829
and the idea here and this was by the

184
00:09:21,308 --> 00:09:26,230
way proposed by Thoren himself in his

185
00:09:23,828 --> 00:09:29,229
early papers on this is that somehow you

186
00:09:26,230 --> 00:09:31,240
get really super small quantum tweezers

187
00:09:29,230 --> 00:09:32,980
and grab one of these Planck scale

188
00:09:31,240 --> 00:09:35,558
wormholes and then you stretch it out

189
00:09:32,980 --> 00:09:39,579
and amplify it whatever that means

190
00:09:35,558 --> 00:09:43,719
of to macroscopic dimensions oops wrong

191
00:09:39,578 --> 00:09:46,179
way okay here we go next one another

192
00:09:43,720 --> 00:09:48,339
suggestions have been made is that there

193
00:09:46,179 --> 00:09:51,878
may be naturally-occurring exotic matter

194
00:09:48,339 --> 00:09:53,649
cosmic strings remnants from the initial

195
00:09:51,879 --> 00:09:55,749
creation of the universe and stuff like

196
00:09:53,649 --> 00:09:57,698
that and then if you motor around in

197
00:09:55,749 --> 00:10:01,449
deep space and identify some of this

198
00:09:57,698 --> 00:10:03,219
stuff and put it your tractor beam on it

199
00:10:01,448 --> 00:10:07,208
and drive it around and so on you might

200

00:10:03,220 --> 00:10:09,819
be able to do that okay by figuring out

201
00:10:07,208 --> 00:10:12,159
how to transform normal matter into

202
00:10:09,818 --> 00:10:17,139
exotic matter this may sound to you like

203
00:10:12,159 --> 00:10:19,289
the least likely that and I must admit I

204
00:10:17,139 --> 00:10:22,930
didn't think it was very likely either

205
00:10:19,289 --> 00:10:25,088
but I should point out as Peter Maloney

206
00:10:22,929 --> 00:10:27,818
pointed out to me many years ago and a

207
00:10:25,089 --> 00:10:30,610
delightful conversation about all of

208
00:10:27,818 --> 00:10:33,278
this stuff he said you realize of course

209
00:10:30,610 --> 00:10:36,490
that in quantum electrodynamics the bare

210
00:10:33,278 --> 00:10:40,120
masses of elementary particles are

211
00:10:36,490 --> 00:10:42,579
negative and an infinite they have to be

212
00:10:40,120 --> 00:10:44,799
because the renormalization program in

213
00:10:42,578 --> 00:10:47,818
effect adds positive infinite energy

214
00:10:44,799 --> 00:10:57,698

that trusses it down to a finite value

215
00:10:47,818 --> 00:11:01,058
okay that's this okay question is how do

216
00:10:57,698 --> 00:11:04,149
you undress elementary particles and in

217
00:11:01,058 --> 00:11:05,799
the standard view of the standard model

218
00:11:04,149 --> 00:11:08,139
of quantum mechanics the answer to that

219
00:11:05,799 --> 00:11:11,948
is you don't okay because the

220
00:11:08,139 --> 00:11:14,068
fluctuation process that produces the

221
00:11:11,948 --> 00:11:17,198
cloud of virtual photons and electrons

222
00:11:14,068 --> 00:11:18,870
Ron pairs is not something that you can

223
00:11:17,198 --> 00:11:23,620
manipulate using low-energy

224
00:11:18,870 --> 00:11:25,470
electromagnetic fields okay the question

225
00:11:23,620 --> 00:11:27,149
then arises in the reason

226
00:11:25,470 --> 00:11:29,670
why Melanie and I were talking about

227
00:11:27,149 --> 00:11:31,980
this many years ago was because I was

228
00:11:29,669 --> 00:11:34,919
interested in the Thai at the time in

229
00:11:31,980 --> 00:11:36,240
the question of how do gravity and

230
00:11:34,919 --> 00:11:39,299
inertia and all of this stuff

231
00:11:36,240 --> 00:11:41,879
interrelate and what do elementary

232
00:11:39,299 --> 00:11:43,769
particles look like it was obvious I

233
00:11:41,879 --> 00:11:45,659
wasn't going to invent quantum gravity

234
00:11:43,769 --> 00:11:48,659
there are a lot smarter people than me

235
00:11:45,659 --> 00:11:52,469
who've spent lifetimes trying to do that

236
00:11:48,659 --> 00:11:55,769
and having not succeeded so I went

237
00:11:52,470 --> 00:11:58,440
looking at general relativistic semi

238
00:11:55,769 --> 00:12:01,079
classical and classical models of the

239
00:11:58,440 --> 00:12:02,940
electron elementary particles and it

240
00:12:01,080 --> 00:12:05,730
turns out there's this cottage industry

241
00:12:02,940 --> 00:12:08,130
in this there are a bunch of people out

242
00:12:05,730 --> 00:12:10,920
there who at least used to sit around

243
00:12:08,129 --> 00:12:13,350
working out various models for

244
00:12:10,919 --> 00:12:15,149
elementary particles there are some

245
00:12:13,350 --> 00:12:16,680
requirements that you're going to want

246
00:12:15,149 --> 00:12:19,679
if you're interested in gravity and

247
00:12:16,679 --> 00:12:22,319
inertia it should include gravity is

248
00:12:19,679 --> 00:12:24,629
gratifi gravity modification is

249
00:12:22,320 --> 00:12:28,110
something that will likely be involved

250
00:12:24,629 --> 00:12:30,779
okay and it should be exact so that

251
00:12:28,110 --> 00:12:32,820
approximations don't cloud any issues in

252
00:12:30,779 --> 00:12:34,620
other words you want to theory that

253
00:12:32,820 --> 00:12:36,480
people aren't going to look at saying oh

254
00:12:34,620 --> 00:12:38,909
that's just an approximation that's all

255
00:12:36,480 --> 00:12:44,460
just a lot of nonsense if you can get it

256
00:12:38,909 --> 00:12:45,629
okay the people there suddenly off on

257

00:12:44,460 --> 00:12:48,570
the track that I'm going to tell you

258
00:12:45,629 --> 00:12:51,299
about briefly now was published around

259
00:12:48,570 --> 00:12:53,730
1990 in the New York Academy of Sciences

260
00:12:51,299 --> 00:12:56,459
it was a review article by a by ashtekar

261
00:12:53,730 --> 00:12:59,100
on his work on what he called new

262
00:12:56,460 --> 00:13:02,220
hamiltonian variables for general

263
00:12:59,100 --> 00:13:04,440
relativity his attempt at a quantum

264
00:13:02,220 --> 00:13:07,830
theory of gravity which at the time

265
00:13:04,440 --> 00:13:10,260
around 1990 was very fashionable I was

266
00:13:07,830 --> 00:13:12,450
informed last fall at the Cramer

267
00:13:10,259 --> 00:13:15,269
symposium by somebody who does this

268
00:13:12,450 --> 00:13:17,910
stuff that ashtekar view on this is no

269
00:13:15,269 --> 00:13:21,629
longer considered viable which may or

270
00:13:17,909 --> 00:13:23,730
may not be the case but ashtekar singled

271
00:13:21,629 --> 00:13:28,279

out that was a particular interest to me

272
00:13:23,730 --> 00:13:32,519
was several pages later and that is that

273
00:13:28,279 --> 00:13:35,939
1960 Arnold wit deser and Misner ADM as

274
00:13:32,519 --> 00:13:37,639
they're referred to had constructed an

275
00:13:35,940 --> 00:13:40,440
exact

276
00:13:37,639 --> 00:13:43,289
relativistic general relativistic not

277
00:13:40,440 --> 00:13:45,510
special relativistic model of elementary

278
00:13:43,289 --> 00:13:48,299
particles because they found the

279
00:13:45,509 --> 00:13:51,269
solution for cloud spherical cloud of

280
00:13:48,299 --> 00:13:54,269
charged dust okay and it turns out that

281
00:13:51,269 --> 00:13:57,419
you can do this as a schtick or lays it

282
00:13:54,269 --> 00:14:00,899
out here and let me see if I think AHA

283
00:13:57,419 --> 00:14:04,019
wait a second am i pushing the right

284
00:14:00,899 --> 00:14:07,139
thing yes okay this is a result you come

285
00:14:04,019 --> 00:14:09,090
to in general relativity of course you

286
00:14:07,139 --> 00:14:11,490
can't treat the mass and Newtonian

287
00:14:09,090 --> 00:14:14,820
fashion so when you get this equation

288
00:14:11,490 --> 00:14:16,560
here you have to treat that as a an

289
00:14:14,820 --> 00:14:19,170
equation if you're solving for M is

290
00:14:16,559 --> 00:14:22,079
quadratic in M you apply the standard

291
00:14:19,169 --> 00:14:24,719
formula you get this and then as a shtak

292
00:14:22,080 --> 00:14:27,930
are pointed out if you let R go to 0 or

293
00:14:24,720 --> 00:14:30,330
R is actually epsilon in this article

294
00:14:27,929 --> 00:14:32,909
what you find is that some of the terms

295
00:14:30,330 --> 00:14:35,460
go to 0 but you end up with a finite

296
00:14:32,909 --> 00:14:37,589
result ok and you didn't have to

297
00:14:35,460 --> 00:14:39,540
enormous anything you didn't have to

298
00:14:37,590 --> 00:14:41,610
fudge you didn't have to wave your hands

299
00:14:39,539 --> 00:14:44,159
or anything like that you automatically

300
00:14:41,610 --> 00:14:46,289
get a finite result when you include

301
00:14:44,159 --> 00:14:49,559
both electromagnetism and gravity in

302
00:14:46,289 --> 00:14:52,980
this fashion ok the problem of course is

303
00:14:49,559 --> 00:14:54,119
as this is called the ADM mass turns out

304
00:14:52,980 --> 00:14:56,460
to be a square root of the

305
00:14:54,120 --> 00:14:58,799
fine-structure constant smaller than the

306
00:14:56,460 --> 00:15:01,740
Planck mass okay which is 10 to the

307
00:14:58,799 --> 00:15:04,139
minus fifth grams which is obviously not

308
00:15:01,740 --> 00:15:07,680
the mass of any elementary particle with

309
00:15:04,139 --> 00:15:09,860
which we're familiar ok this is an

310
00:15:07,679 --> 00:15:14,279
enlargement at the bottom of that slide

311
00:15:09,860 --> 00:15:20,190
ok it has some positive features but it

312
00:15:14,279 --> 00:15:23,419
has some drawbacks it's too big the

313
00:15:20,190 --> 00:15:27,180
simple bare mass of the ADM electron is

314

00:15:23,419 --> 00:15:30,120
positive and what we know is that the

315
00:15:27,179 --> 00:15:32,250
bale mass should be negative ok or at

316
00:15:30,120 --> 00:15:35,039
least if you take the standard model

317
00:15:32,250 --> 00:15:37,340
seriously it should be negative the

318
00:15:35,039 --> 00:15:41,429
question is what happens if you put in a

319
00:15:37,340 --> 00:15:43,710
negative bear mass in the ADM mono ok

320
00:15:41,429 --> 00:15:47,279
gravitation only Andrews has a local

321
00:15:43,710 --> 00:15:48,310
self energy in the ADM model that is to

322
00:15:47,279 --> 00:15:50,860
say no account

323
00:15:48,309 --> 00:15:53,949
has taken of coupling to the distant

324
00:15:50,860 --> 00:15:58,360
matter in the universe okay now for

325
00:15:53,950 --> 00:16:01,960
reasons other than anything having to do

326
00:15:58,360 --> 00:16:03,580
with this back at the time that I was

327
00:16:01,960 --> 00:16:05,410
fiddling around with us it had already

328
00:16:03,580 --> 00:16:07,960

occurred to me that you needed to take

329
00:16:05,409 --> 00:16:10,059
machs principle seriously if you were

330
00:16:07,960 --> 00:16:15,070
going to get very far in advanced

331
00:16:10,059 --> 00:16:17,199
propulsion okay there is an interesting

332
00:16:15,070 --> 00:16:19,600
thing about the ADM mass however a

333
00:16:17,200 --> 00:16:22,300
difference from the electron mass by

334
00:16:19,600 --> 00:16:25,899
almost exactly the square of the speed

335
00:16:22,299 --> 00:16:29,079
like it's to within ten percent which

336
00:16:25,899 --> 00:16:31,750
tells you something well it may be just

337
00:16:29,080 --> 00:16:34,200
a coincidence and it may be a red

338
00:16:31,750 --> 00:16:38,169
herring but there may be something there

339
00:16:34,200 --> 00:16:41,140
if you take machs principle seriously

340
00:16:38,169 --> 00:16:43,269
what you discover is that the value of

341
00:16:41,139 --> 00:16:46,539
the total scale or gravitational

342
00:16:43,269 --> 00:16:48,879
potential is C squared which suggests

343
00:16:46,539 --> 00:16:53,289
that maybe this has something to do with

344
00:16:48,879 --> 00:16:56,080
the ATM mass okay and that if you take

345
00:16:53,289 --> 00:16:58,029
into consideration machs principle you

346
00:16:56,080 --> 00:17:01,120
might be able to get back a realistic

347
00:16:58,029 --> 00:17:03,129
value for the electron mass okay the

348
00:17:01,120 --> 00:17:06,809
bare mass should be negative as I said

349
00:17:03,129 --> 00:17:10,240
and what does all of this lead to well

350
00:17:06,809 --> 00:17:12,309
if you're interested in finding out the

351
00:17:10,240 --> 00:17:14,709
details I'll be happy to read a pointer

352
00:17:12,309 --> 00:17:16,740
to paper said I've already published or

353
00:17:14,709 --> 00:17:19,500
if you like I'll be happy to send you a

354
00:17:16,740 --> 00:17:22,240
manuscript that's presently in progress

355
00:17:19,500 --> 00:17:26,709
that spells out all of this stuff about

356
00:17:22,240 --> 00:17:29,289
the ADM s what you wind up with when you

357
00:17:26,709 --> 00:17:31,150
take a negative bear mass and you insist

358
00:17:29,289 --> 00:17:33,519
that the equivalence principle be

359
00:17:31,150 --> 00:17:36,190
correct that is to say that when the

360
00:17:33,519 --> 00:17:38,559
gravitational mass of an object is

361
00:17:36,190 --> 00:17:41,620
negative its inertial mass has to be

362
00:17:38,559 --> 00:17:44,829
negative - okay this is by the way a

363
00:17:41,619 --> 00:17:47,889
mistake that is made by actually some

364
00:17:44,829 --> 00:17:50,409
rather surprising folks they when you

365
00:17:47,890 --> 00:17:53,560
drop a negative biomass off when you

366
00:17:50,410 --> 00:17:55,630
drop a negative mass object in the

367
00:17:53,559 --> 00:17:57,399
Earth's gravitational field you will

368
00:17:55,630 --> 00:17:58,080
hear people who want to know better say

369
00:17:57,400 --> 00:18:00,480
that it's for

370
00:17:58,079 --> 00:18:02,759
held and therefore go so the fact of the

371

00:18:00,480 --> 00:18:04,769
matter is that it fells just like normal

372
00:18:02,759 --> 00:18:08,369
mass because while the force is

373
00:18:04,769 --> 00:18:10,048
repulsive the emotional reaction to the

374
00:18:08,369 --> 00:18:13,018
repulsive forces to make the thing

375
00:18:10,048 --> 00:18:15,028
accelerate downward okay if that weren't

376
00:18:13,019 --> 00:18:17,159
so the equivalence principle would be

377
00:18:15,028 --> 00:18:20,369
first general relativity would be wrong

378
00:18:17,159 --> 00:18:23,010
and Libreville and deep trouble okay

379
00:18:20,369 --> 00:18:25,500
because it's a metric nature of general

380
00:18:23,009 --> 00:18:28,169
relativity that allows you to talk

381
00:18:25,500 --> 00:18:30,298
seriously about wormholes and stargates

382
00:18:28,169 --> 00:18:32,519
and stuff like that advanced propulsion

383
00:18:30,298 --> 00:18:36,000
wouldn't be nearly as much fun

384
00:18:32,519 --> 00:18:39,569
if general relativity were wrong okay

385
00:18:36,000 --> 00:18:40,888

let me point out here that let's push

386
00:18:39,569 --> 00:18:42,839
the wrong button sorry

387
00:18:40,888 --> 00:18:47,129
oops that's the wrong direction here we

388
00:18:42,839 --> 00:18:50,158
are okay this is the total gravitational

389
00:18:47,130 --> 00:18:54,269
potential due to the universe as a value

390
00:18:50,159 --> 00:18:58,019
of C squared up to some numerical factor

391
00:18:54,269 --> 00:18:59,970
of order unity this is the potential due

392
00:18:58,019 --> 00:19:03,058
to the cloud of electrically charged

393
00:18:59,970 --> 00:19:05,159
dust it has negative bear mass so this

394
00:19:03,058 --> 00:19:07,109
is a negative potential this is a

395
00:19:05,159 --> 00:19:09,269
positive potential when you add those

396
00:19:07,109 --> 00:19:12,418
things together they're both equal to

397
00:19:09,269 --> 00:19:15,058
about C squared what you end up with is

398
00:19:12,419 --> 00:19:17,278
this thing dominating the denominator

399
00:19:15,058 --> 00:19:21,869
and that gives you back the electron

400
00:19:17,278 --> 00:19:24,659
mass okay up to orders a up two factors

401
00:19:21,869 --> 00:19:27,388
of order unity to within ten percent of

402
00:19:24,659 --> 00:19:31,500
you fudge or lose order unity numbers

403
00:19:27,388 --> 00:19:36,240
right what okay if you could figure out

404
00:19:31,500 --> 00:19:38,730
how to suppress this this will make

405
00:19:36,240 --> 00:19:41,759
longer be cancelled in effect by an

406
00:19:38,730 --> 00:19:43,679
equal and opposite potential and what

407
00:19:41,759 --> 00:19:46,619
you would end up with is this thing

408
00:19:43,679 --> 00:19:49,950
being a hoarder unity and you would end

409
00:19:46,619 --> 00:19:52,048
up with the ADM mass being exposed the

410
00:19:49,950 --> 00:19:55,788
bare hands of the elementary particles

411
00:19:52,048 --> 00:19:59,038
and as you work out the algebra for

412
00:19:55,788 --> 00:20:02,638
arithmetic for this what you discover is

413
00:19:59,038 --> 00:20:03,690
that if you have a sphere 30 meters in

414
00:20:02,638 --> 00:20:07,019
diameter about

415
00:20:03,690 --> 00:20:08,820
metre thick of normal stuff and you

416
00:20:07,019 --> 00:20:11,250
figure out how to suppress this thing

417
00:20:08,819 --> 00:20:15,809
here this thing turns it into a

418
00:20:11,250 --> 00:20:18,690
jupiter-mass of- rest mass matter okay

419
00:20:15,809 --> 00:20:22,230
so when principal if there's anything to

420
00:20:18,690 --> 00:20:25,470
this and i emphasize if there's anything

421
00:20:22,230 --> 00:20:29,730
to this in principle you should be able

422
00:20:25,470 --> 00:20:33,710
to make jupiter masses of negative rest

423
00:20:29,730 --> 00:20:36,089
mass matter to produce wormholes and

424
00:20:33,710 --> 00:20:41,940
both drives and all the rest of that

425
00:20:36,089 --> 00:20:44,730
okay if this is right okay how do you do

426
00:20:41,940 --> 00:20:52,130
it well by making feasts of MU c feasts

427
00:20:44,730 --> 00:20:56,450
of you small or zero okay can it be done

428

00:20:52,130 --> 00:21:01,100
with low energy electromagnetic fields

429
00:20:56,450 --> 00:21:06,150
how that's where Marx principle comes in

430
00:21:01,099 --> 00:21:09,000
okay that by the way is here in smock

431
00:21:06,150 --> 00:21:12,960
and his study I believe it was around

432
00:21:09,000 --> 00:21:14,880
1888 or there abouts in Vienna hey what

433
00:21:12,960 --> 00:21:20,519
does max principle you push on something

434
00:21:14,880 --> 00:21:24,210
it pushes back that well people who used

435
00:21:20,519 --> 00:21:26,549
to argue about this but if you look at

436
00:21:24,210 --> 00:21:28,680
the physics of it you can say the

437
00:21:26,549 --> 00:21:32,730
gravitational action of distant stuff

438
00:21:28,680 --> 00:21:34,529
out there okay now as you've heard there

439
00:21:32,730 --> 00:21:37,710
are many different versions of machs

440
00:21:34,529 --> 00:21:40,259
principle indeed the subtlety of the

441
00:21:37,710 --> 00:21:43,019
distinctions in some cases becomes

442
00:21:40,259 --> 00:21:45,059

almost illusory and all that and people

443
00:21:43,019 --> 00:21:48,839
used to fight about this quite

444
00:21:45,059 --> 00:21:51,750
vehemently at times okay but this guy

445
00:21:48,839 --> 00:21:54,629
here in his doctoral work with Paul

446
00:21:51,750 --> 00:21:57,779
Dirac back in the early 1950s at Stennis

447
00:21:54,630 --> 00:22:01,470
Shyama died about five years ago okay in

448
00:21:57,779 --> 00:22:03,089
a few lines showed in a vector theory of

449
00:22:01,470 --> 00:22:05,759
gravitation which is of course only

450
00:22:03,089 --> 00:22:09,000
approximation to general relativity but

451
00:22:05,759 --> 00:22:11,279
nonetheless at the time Shyama thought

452
00:22:09,000 --> 00:22:12,210
it wasn't general relativity it's turned

453
00:22:11,279 --> 00:22:15,509
out that it

454
00:22:12,210 --> 00:22:18,990
general relativity in disguise okay it

455
00:22:15,509 --> 00:22:22,589
turns out that if you take the gravity

456
00:22:18,990 --> 00:22:24,859
electric field to be the analog of the

457
00:22:22,589 --> 00:22:28,740
electric field in electrodynamics and

458
00:22:24,859 --> 00:22:30,479
then you ask what a is the vector part

459
00:22:28,740 --> 00:22:33,180
of the four potential further

460
00:22:30,480 --> 00:22:36,569
gravitational field it turns out to be

461
00:22:33,180 --> 00:22:39,900
the integral of matter currents over all

462
00:22:36,569 --> 00:22:42,539
space and all that Shyama used a neat

463
00:22:39,900 --> 00:22:44,820
trick here so that you don't get

464
00:22:42,539 --> 00:22:47,940
involved in lengthy tedious calculations

465
00:22:44,819 --> 00:22:50,279
involving lots of algebra okay he said

466
00:22:47,940 --> 00:22:52,529
hey look if you look at an object and

467
00:22:50,279 --> 00:22:54,690
it's being accelerated it looks to that

468
00:22:52,529 --> 00:22:56,519
object as if the universe is rigidly

469
00:22:54,690 --> 00:22:59,759
being accelerated in the opposite

470
00:22:56,519 --> 00:23:01,920
direction okay so you can take V out of

471
00:22:59,759 --> 00:23:03,299
the integral here and I only have to do

472
00:23:01,920 --> 00:23:06,690
is integrate over the matter density

473
00:23:03,299 --> 00:23:09,299
okay when you do the integration over

474
00:23:06,690 --> 00:23:12,180
the matter density to get a what you

475
00:23:09,299 --> 00:23:15,119
find is that you get just the scalar

476
00:23:12,180 --> 00:23:18,539
gravitational potential okay

477
00:23:15,119 --> 00:23:24,000
so the gravity electric field end up

478
00:23:18,539 --> 00:23:27,960
being minus the gradient of fee minus V

479
00:23:24,000 --> 00:23:30,960
over C squared times the time derivative

480
00:23:27,960 --> 00:23:33,920
of the velocity of the object if the

481
00:23:30,960 --> 00:23:37,110
velocity is constant that term is zero

482
00:23:33,920 --> 00:23:39,300
okay if the velocity is not constant

483
00:23:37,109 --> 00:23:42,799
that is to say if it's being accelerated

484
00:23:39,299 --> 00:23:49,109
of course then that term is not zero and

485

00:23:42,799 --> 00:23:50,909
if the term in front of it the factor in

486
00:23:49,109 --> 00:23:53,309
front of it feel over C squared is equal

487
00:23:50,910 --> 00:23:56,160
to one it turns out to be the inertial

488
00:23:53,309 --> 00:24:00,000
reaction force okay it's as simple as

489
00:23:56,160 --> 00:24:03,990
that what this means is that in any

490
00:24:00,000 --> 00:24:06,380
theory of gravity where you have so

491
00:24:03,990 --> 00:24:09,750
called critical cosmic matter density

492
00:24:06,380 --> 00:24:12,930
okay which is characterized by space

493
00:24:09,750 --> 00:24:15,950
being flattened okay fee turns out to

494
00:24:12,930 --> 00:24:18,690
have that property it turns out that

495
00:24:15,950 --> 00:24:21,630
emotional reaction forces in general

496
00:24:18,690 --> 00:24:24,429
relativity are provided by the

497
00:24:21,630 --> 00:24:27,309
gravitational action of distant matter

498
00:24:24,429 --> 00:24:30,249
since the what w map results we know

499
00:24:27,308 --> 00:24:33,460

that space is flat okay it's as simple

500
00:24:30,249 --> 00:24:35,558
as that now of course there scads and

501
00:24:33,460 --> 00:24:37,629
scads of people who don't care or it

502
00:24:35,558 --> 00:24:40,089
don't pay attention and don't know this

503
00:24:37,628 --> 00:24:41,528
okay but this isn't a matter of

504
00:24:40,089 --> 00:24:44,519
something that you can really argue

505
00:24:41,528 --> 00:24:47,319
about anymore where ten years ago it was

506
00:24:44,519 --> 00:24:49,980
okay that's nice but how does this help

507
00:24:47,319 --> 00:24:53,378
with a jupiter mass of exotic matter

508
00:24:49,980 --> 00:24:58,538
okay well we need to ask about local

509
00:24:53,378 --> 00:25:01,778
sources of the field okay

510
00:24:58,538 --> 00:25:05,829
part of getting a part of advancing

511
00:25:01,778 --> 00:25:08,740
middle age yes you become less concerned

512
00:25:05,829 --> 00:25:10,960
about covering your tracks and more

513
00:25:08,740 --> 00:25:13,480
concerned about making sure people get

514
00:25:10,960 --> 00:25:15,759
what you're trying to say and hopefully

515
00:25:13,480 --> 00:25:17,919
that they will have interesting

516
00:25:15,759 --> 00:25:21,519
criticisms because you can learn from

517
00:25:17,919 --> 00:25:22,869
that if you just wave your hands and all

518
00:25:21,519 --> 00:25:28,079
the rest of that and they don't get it

519
00:25:22,868 --> 00:25:28,079
then of course no progress is made okay

520
00:25:28,470 --> 00:25:33,159
before I got interested mocks prince

521
00:25:31,089 --> 00:25:34,808
will not really but before I got

522
00:25:33,159 --> 00:25:38,350
seriously interested in machs principle

523
00:25:34,808 --> 00:25:40,960
I was interested in theories that

524
00:25:38,349 --> 00:25:43,449
coupled gravity and electromagnetism in

525
00:25:40,960 --> 00:25:47,230
ways other than the naive

526
00:25:43,450 --> 00:25:49,298
Einstein Maxwell equations okay one of

527
00:25:47,230 --> 00:25:51,069
those was a suggestion by Arthur

528
00:25:49,298 --> 00:25:53,918
Schuster back around the turn of the

529
00:25:51,069 --> 00:25:56,769
19th 20th century which had been

530
00:25:53,919 --> 00:25:59,559
followed up by Patrick black at the 1947

531
00:25:56,769 --> 00:26:02,950
Nobel laureate in physics for work on

532
00:25:59,558 --> 00:26:04,960
cosmic rays that rotating neutral mass

533
00:26:02,950 --> 00:26:07,538
of objects might generate magnetic

534
00:26:04,960 --> 00:26:09,819
fields rule magnetic fields not gravity

535
00:26:07,538 --> 00:26:13,480
tow magnetic fields a real magnetic

536
00:26:09,819 --> 00:26:17,980
field a fellow who was then a graduate

537
00:26:13,480 --> 00:26:20,288
student in Ontario Canada named George

538
00:26:17,980 --> 00:26:22,329
Luke who I believe ended up as a

539
00:26:20,288 --> 00:26:25,210
professor of Electrical Engineering at

540
00:26:22,329 --> 00:26:27,038
Princeton for most of his career okay

541
00:26:25,210 --> 00:26:30,249
sat down wrote out a set of coupled

542

00:26:27,038 --> 00:26:33,190
field equations to go with Blackett

543
00:26:30,249 --> 00:26:35,730
hypothesis published in canadian journal

544
00:26:33,190 --> 00:26:39,000
of physics 1953

545
00:26:35,730 --> 00:26:40,799
from his paper okay those are the couple

546
00:26:39,000 --> 00:26:45,299
field equations that give you back the

547
00:26:40,799 --> 00:26:48,059
Schuster pocket effect okay new track

548
00:26:45,299 --> 00:26:50,549
wasn't interested in the details of

549
00:26:48,059 --> 00:26:53,069
general relativity so when he did was he

550
00:26:50,549 --> 00:26:57,019
wrote down his coupled field equations

551
00:26:53,069 --> 00:26:58,849
as the four-dimensional formalism being

552
00:26:57,019 --> 00:27:00,990
electrodynamics maxwellian

553
00:26:58,849 --> 00:27:03,889
electrodynamics and then he used his

554
00:27:00,990 --> 00:27:06,269
fifth dimension to include a

555
00:27:03,890 --> 00:27:08,390
relativistically invariant version of

556
00:27:06,269 --> 00:27:12,059

Newtonian gravity that's these three

557
00:27:08,390 --> 00:27:17,100
equations here okay the one that's of

558
00:27:12,059 --> 00:27:20,490
interest here looks very very much like

559
00:27:17,099 --> 00:27:25,549
this equation up here well similar

560
00:27:20,490 --> 00:27:28,980
anyway oops wrong direction okay okay

561
00:27:25,549 --> 00:27:32,220
the standard equation to stand alone

562
00:27:28,980 --> 00:27:34,890
some very an equation for a propagating

563
00:27:32,220 --> 00:27:38,190
field of course is one where you have

564
00:27:34,890 --> 00:27:41,130
the divergence of the force plus one

565
00:27:38,190 --> 00:27:43,830
over C squared times the time derivative

566
00:27:41,130 --> 00:27:46,020
us the field and so on is equal to the

567
00:27:43,829 --> 00:27:50,819
sources the Dalembert ssin of the field

568
00:27:46,019 --> 00:27:53,940
is equal to its sources okay so if you

569
00:27:50,819 --> 00:27:56,369
look at this term here that turns out to

570
00:27:53,940 --> 00:27:59,190
be the rate at which the field does work

571
00:27:56,369 --> 00:28:01,199
on its sources cute it turns out to be

572
00:27:59,190 --> 00:28:03,799
that and in fact there's a good reason

573
00:28:01,200 --> 00:28:07,650
for that as you can discover by reading

574
00:28:03,799 --> 00:28:09,500
Wolfgang winners outstanding little book

575
00:28:07,650 --> 00:28:13,230
on introduction to special relativity

576
00:28:09,500 --> 00:28:16,829
okay and you will find in section 35

577
00:28:13,230 --> 00:28:18,480
this little discussion here okay for

578
00:28:16,829 --> 00:28:21,240
example if two particles collide

579
00:28:18,480 --> 00:28:25,860
elastically their rest masses during

580
00:28:21,240 --> 00:28:27,960
collision will vary okay that might be

581
00:28:25,859 --> 00:28:30,509
when you're interested in them and then

582
00:28:27,960 --> 00:28:32,730
he develops his formalism unfortunately

583
00:28:30,509 --> 00:28:34,799
it was only laid out this clearly in the

584
00:28:32,730 --> 00:28:36,269
second edition which was after I had

585
00:28:34,799 --> 00:28:36,930
struggled through all of this stuff

586
00:28:36,269 --> 00:28:39,750
myself

587
00:28:36,930 --> 00:28:43,330
okay and wasn't quite sure that it was

588
00:28:39,750 --> 00:28:48,609
right it turns out that it is okay

589
00:28:43,329 --> 00:28:53,019
what three pages of algebra gets you

590
00:28:48,609 --> 00:28:56,259
from that aha that's where the three

591
00:28:53,019 --> 00:28:57,579
pages of algebra okay basically what you

592
00:28:56,259 --> 00:29:00,039
do is you ask yourself the following

593
00:28:57,579 --> 00:29:03,069
question if an inertial reaction force

594
00:29:00,039 --> 00:29:05,079
is indeed being generated by the

595
00:29:03,069 --> 00:29:08,500
gravitational field due to the distant

596
00:29:05,079 --> 00:29:11,649
matter in the universe okay what happens

597
00:29:08,500 --> 00:29:13,359
as you would accelerate the object you

598
00:29:11,650 --> 00:29:16,750
can just simply ask what are the local

599

00:29:13,359 --> 00:29:20,859
sources of the field and if you take F

600
00:29:16,750 --> 00:29:22,450
the for vector F here as being divided

601
00:29:20,859 --> 00:29:24,729
by the mass of the object that's being

602
00:29:22,450 --> 00:29:26,890
accelerated as the field in question

603
00:29:24,730 --> 00:29:30,099
then I can simply sit down and calculate

604
00:29:26,890 --> 00:29:34,390
using this expression for the full force

605
00:29:30,099 --> 00:29:37,769
what that has to be three pages of

606
00:29:34,390 --> 00:29:40,450
algebra get you there

607
00:29:37,769 --> 00:29:42,789
okay the dala motion of the field is

608
00:29:40,450 --> 00:29:45,160
equal to what we normally think of as a

609
00:29:42,789 --> 00:29:47,019
sources plus a bunch of transient terms

610
00:29:45,160 --> 00:29:49,990
and the thing that I want to emphasize

611
00:29:47,019 --> 00:29:54,129
for you here is if there is no hand

612
00:29:49,990 --> 00:29:56,289
waving involved this is really to be

613
00:29:54,130 --> 00:30:01,350

perfectly honest about it undergraduate

614
00:29:56,289 --> 00:30:05,559
level physics this isn't some esoteric

615
00:30:01,349 --> 00:30:08,799
thing like that okay what that ends up

616
00:30:05,559 --> 00:30:11,319
with is the equation that York Dobyns

617
00:30:08,799 --> 00:30:13,839
showed you earlier this morning and then

618
00:30:11,319 --> 00:30:15,730
pointed out that it comes to it makes

619
00:30:13,839 --> 00:30:18,359
some predictions if treated in a fairly

620
00:30:15,730 --> 00:30:21,039
straightforward naive way that are

621
00:30:18,359 --> 00:30:23,889
dubious to say the least

622
00:30:21,039 --> 00:30:26,139
okay but you end up with is this

623
00:30:23,890 --> 00:30:29,080
equation and notice it has two parts

624
00:30:26,140 --> 00:30:31,840
the linear term which is the one that he

625
00:30:29,079 --> 00:30:35,169
was talking about produces enormous

626
00:30:31,839 --> 00:30:37,539
effects you can engineer situations

627
00:30:35,170 --> 00:30:40,090
where you can get really in principle

628
00:30:37,539 --> 00:30:42,069
and practices turns out to be a

629
00:30:40,089 --> 00:30:44,439
different matter but in principle you

630
00:30:42,069 --> 00:30:47,230
can produce very large effects with that

631
00:30:44,440 --> 00:30:48,590
term indeed so large that if you can

632
00:30:47,230 --> 00:30:50,720
figure out how to do it

633
00:30:48,589 --> 00:30:52,849
you can make thrusters that you should

634
00:30:50,720 --> 00:30:54,409
be able to sell to NASA because you're

635
00:30:52,849 --> 00:30:56,750
not blowing any propellant out the

636
00:30:54,409 --> 00:30:59,090
tailpipe you're gravitationally coupling

637
00:30:56,750 --> 00:31:01,609
directly to the rest of the universe and

638
00:30:59,089 --> 00:31:04,308
so on and so forth you have to put

639
00:31:01,609 --> 00:31:05,990
energy and to do this but you don't have

640
00:31:04,308 --> 00:31:08,740
to worry about carrying along a lot of

641
00:31:05,990 --> 00:31:11,990
stuff that goes out the tailpipe okay

642
00:31:08,740 --> 00:31:14,058
but I'm going to emphasize today however

643
00:31:11,990 --> 00:31:16,759
is this term oops

644
00:31:14,058 --> 00:31:19,700
I keep pushing the wrong button this

645
00:31:16,759 --> 00:31:24,288
term here notice that it's smaller by a

646
00:31:19,700 --> 00:31:29,000
factor of C squared then this thing here

647
00:31:24,288 --> 00:31:32,869
the coefficient of the power terms P is

648
00:31:29,000 --> 00:31:35,778
a power IV for a capacitor or something

649
00:31:32,869 --> 00:31:38,449
like that this by the way is not voltage

650
00:31:35,778 --> 00:31:41,089
that's the volume notice that the first

651
00:31:38,450 --> 00:31:42,679
term is independent of the volume of

652
00:31:41,089 --> 00:31:45,109
whatever you're doing but this one turns

653
00:31:42,679 --> 00:31:47,298
out to be a density so you have to get

654
00:31:45,109 --> 00:31:50,538
high densities in order to make this

655
00:31:47,298 --> 00:31:53,148
term large the really interesting thing

656

00:31:50,538 --> 00:31:55,640
about this term is that there's a minus

657
00:31:53,148 --> 00:31:59,239
sign in front of it and everything else

658
00:31:55,640 --> 00:32:04,038
is squared or positive okay that means

659
00:31:59,240 --> 00:32:06,169
that term is always negative okay and as

660
00:32:04,038 --> 00:32:07,819
a result we call it the wormhole Terr me

661
00:32:06,169 --> 00:32:13,159
and my group of virtual

662
00:32:07,819 --> 00:32:14,839
over-the-shoulder lookers okay it turns

663
00:32:13,159 --> 00:32:17,299
out you can do a crude numerical

664
00:32:14,839 --> 00:32:19,939
integration and you discover that with

665
00:32:17,298 --> 00:32:23,408
reasonable assumptions that you can

666
00:32:19,940 --> 00:32:27,679
transiently by cycling the first term

667
00:32:23,409 --> 00:32:30,260
here so that Rho 0 which occurs in the

668
00:32:27,679 --> 00:32:34,130
denominator of these coefficients can be

669
00:32:30,259 --> 00:32:35,960
driven to zero when the coefficient is 0

670
00:32:34,130 --> 00:32:38,990

in the denominator the coefficient

671
00:32:35,960 --> 00:32:41,329
becomes infinite of course formally that

672
00:32:38,990 --> 00:32:44,058
means that this term here normally a

673
00:32:41,329 --> 00:32:47,058
factor of C squared smaller than the

674
00:32:44,058 --> 00:32:50,538
leading term dominates the equation and

675
00:32:47,058 --> 00:32:52,809
in principle you ought to be able if

676
00:32:50,538 --> 00:32:54,940
there's anything to all of this

677
00:32:52,809 --> 00:32:57,730
in principle you ought to be able to

678
00:32:54,940 --> 00:33:00,160
make idiotic amounts of negative rest

679
00:32:57,730 --> 00:33:03,789
mass matter that is Sailor Jupiter

680
00:33:00,160 --> 00:33:06,550
masses in reasonable size structures and

681
00:33:03,789 --> 00:33:09,220
since this is a process which is induced

682
00:33:06,549 --> 00:33:11,409
in situ you won't have to worry about

683
00:33:09,220 --> 00:33:14,980
collecting a bunch of stuff and trying

684
00:33:11,410 --> 00:33:18,060
to compact it down into your 30 meter of

685
00:33:14,980 --> 00:33:20,410
diameter sphere it's already there

686
00:33:18,059 --> 00:33:23,529
because you and me and everything else

687
00:33:20,410 --> 00:33:26,560
in the world has this lurking inside of

688
00:33:23,529 --> 00:33:30,849
our elementary particles the negative

689
00:33:26,559 --> 00:33:32,589
rest mass is already there okay okay now

690
00:33:30,849 --> 00:33:34,509
the question is is there anything to

691
00:33:32,589 --> 00:33:36,879
this at all and the answer to that

692
00:33:34,509 --> 00:33:39,490
question is if it doesn't get supported

693
00:33:36,880 --> 00:33:41,890
by experiments convincing experiments

694
00:33:39,490 --> 00:33:43,299
the answer is nobody's gonna pay any

695
00:33:41,890 --> 00:33:44,980
attention to it then we're not paying

696
00:33:43,299 --> 00:33:48,460
any attention to it anyway but that's

697
00:33:44,980 --> 00:33:50,470
their problem not yours my problem is to

698
00:33:48,460 --> 00:33:53,980
see if there's anything to this well and

699
00:33:50,470 --> 00:33:56,079
indeed following this this is from an

700
00:33:53,980 --> 00:33:57,940
earlier presentation where I was talking

701
00:33:56,079 --> 00:34:02,639
about small steps and all that but I'll

702
00:33:57,940 --> 00:34:05,830
show it to you anyway okay what you do

703
00:34:02,640 --> 00:34:08,200
is you try and induce a fluctuation and

704
00:34:05,829 --> 00:34:10,179
push on the object when you're making

705
00:34:08,199 --> 00:34:12,158
the thing a little bit more massive and

706
00:34:10,179 --> 00:34:15,820
pull back on it when it's a little bit

707
00:34:12,159 --> 00:34:19,929
less massive this is the linear analogue

708
00:34:15,820 --> 00:34:23,850
of york's wheel okay fair enough fair

709
00:34:19,929 --> 00:34:26,889
enough okay

710
00:34:23,849 --> 00:34:28,960
this is number build Rainey's animation

711
00:34:26,889 --> 00:34:34,148
for a presentation that he did that I

712
00:34:28,960 --> 00:34:36,099
got from him okay it's a really much

713

00:34:34,148 --> 00:34:39,190
cleverer than anything I could have come

714
00:34:36,099 --> 00:34:41,259
up with okay is there any other didn't

715
00:34:39,190 --> 00:34:44,860
says well let's suggest that this might

716
00:34:41,260 --> 00:34:47,200
be right okay I'm gonna tell you a

717
00:34:44,860 --> 00:34:50,019
little bit and how am i doing on time do

718
00:34:47,199 --> 00:34:52,858
it well then it's okay

719
00:34:50,019 --> 00:34:56,369
five minutes quickly

720
00:34:52,858 --> 00:34:59,369
okay the experiment that I'm working on

721
00:34:56,369 --> 00:35:00,838
now implements an idea of a former

722
00:34:59,369 --> 00:35:03,809
graduate student of mine which is

723
00:35:00,838 --> 00:35:07,159
basically to take some active material

724
00:35:03,809 --> 00:35:10,079
which are going to drive with a

725
00:35:07,159 --> 00:35:12,058
alternating voltage which will produce a

726
00:35:10,079 --> 00:35:14,009
sort of internal energy fluctuations

727
00:35:12,059 --> 00:35:17,548

that should produce mass fluctuations

728
00:35:14,009 --> 00:35:19,909
one may coincide with an acceleration a

729
00:35:17,548 --> 00:35:23,099
mistake that we made including myself

730
00:35:19,909 --> 00:35:25,949
for a long time was to assume that you

731
00:35:23,099 --> 00:35:27,838
could just simply apply an AC voltage to

732
00:35:25,949 --> 00:35:30,058
a capacitor and you should induce mass

733
00:35:27,838 --> 00:35:32,818
fluctuation if there isn't any bulk

734
00:35:30,059 --> 00:35:34,950
acceleration present there's no mass

735
00:35:32,818 --> 00:35:37,068
fluctuation and the reason why is

736
00:35:34,949 --> 00:35:39,598
because when you construct the equation

737
00:35:37,068 --> 00:35:41,429
to which you get the transient terms

738
00:35:39,599 --> 00:35:43,619
from you assume that your bulk

739
00:35:41,429 --> 00:35:47,159
accelerating the thing that has the

740
00:35:43,619 --> 00:35:50,369
energy change taking place okay the

741
00:35:47,159 --> 00:35:53,489
other ends of these are also piezo

742
00:35:50,369 --> 00:35:55,709
electric actuators in this case their

743
00:35:53,489 --> 00:35:58,338
polarities are set up this way so when

744
00:35:55,708 --> 00:36:01,108
you apply a voltage to them one of them

745
00:35:58,338 --> 00:36:03,568
contracts the other expands it basically

746
00:36:01,108 --> 00:36:07,348
shuttles the material in between back

747
00:36:03,568 --> 00:36:10,909
and forth then all you do is apply there

748
00:36:07,349 --> 00:36:13,979
is one of these devices sitting between

749
00:36:10,909 --> 00:36:15,989
clamping blocks here aluminum clamping

750
00:36:13,978 --> 00:36:18,179
blocks on the end of a very very

751
00:36:15,989 --> 00:36:21,028
sensitive torsion balance which I'll get

752
00:36:18,179 --> 00:36:24,118
to in a moment what you do is you apply

753
00:36:21,028 --> 00:36:26,869
a voltage to the capacitative material

754
00:36:24,119 --> 00:36:30,420
in between and you apply another voltage

755
00:36:26,869 --> 00:36:33,568
which has two components run at the

756
00:36:30,420 --> 00:36:35,818
frequency of the applied voltage to the

757
00:36:33,568 --> 00:36:39,208
so-called capacitor up here what I'm

758
00:36:35,818 --> 00:36:41,489
calling a capacitor to accelerate it to

759
00:36:39,208 --> 00:36:45,028
produce your so-called bulk acceleration

760
00:36:41,489 --> 00:36:47,579
and a second double frequency signal

761
00:36:45,028 --> 00:36:49,829
because the mass fluctuation and

762
00:36:47,579 --> 00:36:51,568
allegedly occurs at the power frequency

763
00:36:49,829 --> 00:36:53,759
of what you're doing and that of course

764
00:36:51,568 --> 00:36:55,650
is the product of a couple of sine and a

765
00:36:53,759 --> 00:36:57,838
cosine or whatever that gives you a

766
00:36:55,650 --> 00:37:00,180
double frequency signal and then you

767
00:36:57,838 --> 00:37:01,940
have to provide for phase shifting and

768
00:37:00,179 --> 00:37:04,489
locking and stuff like that

769
00:37:01,940 --> 00:37:06,559
okay bunch of technical details this is

770

00:37:04,489 --> 00:37:11,088
more or less what the device looks like

771
00:37:06,559 --> 00:37:14,179
okay the reason why this these are see

772
00:37:11,088 --> 00:37:17,809
flex flexural bearings supporting these

773
00:37:14,179 --> 00:37:19,759
torsion balance so on that was because

774
00:37:17,809 --> 00:37:23,059
of nimble bulge Ernie's use of Martin

775
00:37:19,760 --> 00:37:25,940
Tamar's truss balance which looks like

776
00:37:23,059 --> 00:37:28,489
this okay similar to this at any rate

777
00:37:25,940 --> 00:37:31,519
okay there's a counterweight over here

778
00:37:28,489 --> 00:37:34,279
to counterweight the device there are

779
00:37:31,519 --> 00:37:36,500
some calibration coils here so that you

780
00:37:34,280 --> 00:37:38,359
can calibrate the system the really

781
00:37:36,500 --> 00:37:41,599
important part of this device is right

782
00:37:38,358 --> 00:37:43,670
here coaxial with the flexural bearings

783
00:37:41,599 --> 00:37:45,588
here you have a set of Galan stand

784
00:37:43,670 --> 00:37:48,200

contacts because you're putting a fair

785
00:37:45,588 --> 00:37:50,509
amount of power on the order of ten or

786
00:37:48,199 --> 00:37:52,639
fifteen or twenty watts through these

787
00:37:50,510 --> 00:37:55,310
contacts and if you're trying to measure

788
00:37:52,639 --> 00:37:58,368
things on the order of ten to a hundred

789
00:37:55,309 --> 00:38:00,650
nano Newton's you've got to be extremely

790
00:37:58,369 --> 00:38:02,480
careful about stuff like this because

791
00:38:00,650 --> 00:38:05,660
it's real easy to mask what you're

792
00:38:02,480 --> 00:38:07,490
looking for with spurious stuff okay

793
00:38:05,659 --> 00:38:11,719
this is a close-up of the gallant stand

794
00:38:07,489 --> 00:38:14,598
contacts this is I especially like yes

795
00:38:11,719 --> 00:38:18,500
one minute this picture of it okay real

796
00:38:14,599 --> 00:38:19,849
quickly results from January the way in

797
00:38:18,500 --> 00:38:21,920
which you do this is you turn the whole

798
00:38:19,849 --> 00:38:23,930
thing one that's what happens you just

799
00:38:21,920 --> 00:38:26,809
wait a second pushing the wrong button

800
00:38:23,929 --> 00:38:29,029
that's what happens here that offset is

801
00:38:26,809 --> 00:38:31,250
just an electrical offset basically what

802
00:38:29,030 --> 00:38:33,440
you do when you turn on the power is you

803
00:38:31,250 --> 00:38:35,690
shift the ground level in the system

804
00:38:33,440 --> 00:38:39,409
because of ground return currents and

805
00:38:35,690 --> 00:38:41,329
all what okay the red trace here is an

806
00:38:39,409 --> 00:38:43,009
accelerometer in the middle of the stack

807
00:38:41,329 --> 00:38:45,829
which tells you what's going on in the

808
00:38:43,010 --> 00:38:48,170
stack the blue trace is the position

809
00:38:45,829 --> 00:38:49,550
sensor an optical position sensor so

810
00:38:48,170 --> 00:38:51,800
that it doesn't get the electromagnetic

811
00:38:49,550 --> 00:38:53,810
pick up and so forth and as you can see

812
00:38:51,800 --> 00:38:56,859
when you turn it on the thing does this

813
00:38:53,809 --> 00:39:00,289
when you flip a switch and reverse

814
00:38:56,858 --> 00:39:03,619
invert the phase of the actuator signal

815
00:39:00,289 --> 00:39:06,710
what happens is the thrust changes and

816
00:39:03,619 --> 00:39:08,750
that should not happen if there is no

817
00:39:06,710 --> 00:39:10,849
effect present okay

818
00:39:08,750 --> 00:39:12,050
and then when you turn flip it back it

819
00:39:10,849 --> 00:39:15,079
goes back and so on

820
00:39:12,050 --> 00:39:17,810
okay and for a while late in January and

821
00:39:15,079 --> 00:39:20,920
early in February opps time to shut up

822
00:39:17,809 --> 00:39:24,289
huh take two seconds okay

823
00:39:20,920 --> 00:39:26,150
quickly as possible these are the sort

824
00:39:24,289 --> 00:39:28,519
of traces you're getting what I'm

825
00:39:26,150 --> 00:39:30,920
showing you is reality what happens in

826
00:39:28,519 --> 00:39:33,230
reality as you can see things are

827

00:39:30,920 --> 00:39:35,510
beginning to gray do a little bit the

828
00:39:33,230 --> 00:39:37,429
height of this thing here isn't the same

829
00:39:35,510 --> 00:39:39,650
as the height of this thing here which

830
00:39:37,429 --> 00:39:41,839
means that you have thermal evolution in

831
00:39:39,650 --> 00:39:46,010
this region here where the thing is one

832
00:39:41,840 --> 00:39:48,650
there's major thermal evolution okay and

833
00:39:46,010 --> 00:39:50,420
this is catastrophic thermal evolution

834
00:39:48,650 --> 00:39:53,180
and after this happened the device never

835
00:39:50,420 --> 00:39:54,889
worked that way again okay which is not

836
00:39:53,179 --> 00:39:56,659
good news from the point of view of

837
00:39:54,889 --> 00:39:58,969
continuing to fiddle around with it but

838
00:39:56,659 --> 00:40:01,519
it is good news from one point of view

839
00:39:58,969 --> 00:40:03,289
it tells you immediately that a whole

840
00:40:01,519 --> 00:40:05,719
bunch of spurious things that you might

841
00:40:03,289 --> 00:40:08,269

have to investigate or not the cause of

842
00:40:05,719 --> 00:40:09,859
the signal you're looking at okay after

843
00:40:08,269 --> 00:40:10,489
a few months of fooling around with no

844
00:40:09,860 --> 00:40:12,559
device

845
00:40:10,489 --> 00:40:14,209
there it is wired there it is on the end

846
00:40:12,559 --> 00:40:18,619
of the balance there's some neat stuff

847
00:40:14,210 --> 00:40:20,360
more stuff and that's the trace that was

848
00:40:18,619 --> 00:40:22,099
to be the beginning of a series of

849
00:40:20,360 --> 00:40:24,230
traces that I would have told you about

850
00:40:22,099 --> 00:40:28,039
in great detail here today instead of

851
00:40:24,230 --> 00:40:32,360
wormholes and negative mass matter the

852
00:40:28,039 --> 00:40:34,730
power amplifier died right there that's

853
00:40:32,360 --> 00:40:38,570
a transient of the power amplifier dying

854
00:40:34,730 --> 00:40:43,699
at which word I decided these are signal

855
00:40:38,570 --> 00:40:47,240
generators okay okay and now I there is

856
00:40:43,699 --> 00:40:50,559
no time for questions I assume yes there

857
00:40:47,239 --> 00:40:53,869
is there are a few minutes for questions

858
00:40:50,559 --> 00:40:56,840
okay and I will recuse myself from

859
00:40:53,869 --> 00:40:59,210
asking anything because dr. Woodward and

860
00:40:56,840 --> 00:41:00,710
I have had a sort of indirect

861
00:40:59,210 --> 00:41:02,809
correspondence on a number of these

862
00:41:00,710 --> 00:41:11,150
topics

863
00:41:02,809 --> 00:41:13,219
for hours yes if a nursery is viewed as

864
00:41:11,150 --> 00:41:14,480
a reaction from the rest of the universe

865
00:41:13,219 --> 00:41:16,039
then how does that happen

866
00:41:14,480 --> 00:41:19,130
instantaneously for any kind of

867
00:41:16,039 --> 00:41:20,420
acceleration that's why John Kramer and

868
00:41:19,130 --> 00:41:22,789
I are really good friends

869
00:41:20,420 --> 00:41:25,070
it's a radiation reaction interaction

870
00:41:22,789 --> 00:41:27,349
presumably which involves a wheeler

871
00:41:25,070 --> 00:41:29,780
Fineman advance for target interaction

872
00:41:27,349 --> 00:41:32,719
yes that is the obvious question to ask

873
00:41:29,780 --> 00:41:35,300
if you say that one way of answering it

874
00:41:32,719 --> 00:41:37,189
which there is another way of getting it

875
00:41:35,300 --> 00:41:40,580
instantaneously and I should tell you to

876
00:41:37,190 --> 00:41:43,309
be full disclosure nets to use the

877
00:41:40,579 --> 00:41:45,230
constraint equations which are elliptic

878
00:41:43,309 --> 00:41:47,860
instead of hyperbolic and then you have

879
00:41:45,230 --> 00:41:47,860
a field here