

1
00:00:02,029 --> 00:00:09,480
well I want to talk about where it all

2
00:00:05,459 --> 00:00:11,039
starts the foundations the the the

3
00:00:09,480 --> 00:00:12,780
deeper understanding that we would all

4
00:00:11,039 --> 00:00:14,968
like about what's going on in the world

5
00:00:12,779 --> 00:00:17,309
and particularly what's going on in the

6
00:00:14,968 --> 00:00:20,969
universe as a whole how it got this way

7
00:00:17,309 --> 00:00:23,129
and how any understanding that we might

8
00:00:20,969 --> 00:00:25,618
have of the universe as a whole could be

9
00:00:23,129 --> 00:00:27,479
applied locally to our own situations

10
00:00:25,618 --> 00:00:32,340
and to some of the phenomenon that we're

11
00:00:27,480 --> 00:00:36,079
interested in in our daily lives Bernie

12
00:00:32,340 --> 00:00:39,149
I talked about the constants of the

13
00:00:36,079 --> 00:00:41,250
universe and physical laws of the

14
00:00:39,149 --> 00:00:44,280
universe and I won't say a whole lot

15
00:00:41,250 --> 00:00:46,259
more about that but it's worth just

16
00:00:44,280 --> 00:00:48,899
reflecting on the fact that it seems

17
00:00:46,259 --> 00:00:50,789
that there are a few numbers a few

18
00:00:48,899 --> 00:00:53,009
constants a few parameters that

19
00:00:50,789 --> 00:00:57,448
determine a great deal of what goes on

20
00:00:53,009 --> 00:01:00,269
in the universe and the phenomenon that

21
00:00:57,448 --> 00:01:03,659
take place within it and these constants

22
00:01:00,270 --> 00:01:06,390
seem at least to be somewhat independent

23
00:01:03,659 --> 00:01:09,679
and rather arbitrary and yet we know

24
00:01:06,390 --> 00:01:12,989
that in several cases these constants

25
00:01:09,680 --> 00:01:14,700
are very finely tuned to support the

26
00:01:12,989 --> 00:01:17,219
kind of universe that we see in the life

27
00:01:14,700 --> 00:01:19,379
that we experience here and if they were

28
00:01:17,219 --> 00:01:21,000
different the universe would have been

29

00:01:19,379 --> 00:01:25,140
different and we would not have evolved

30
00:01:21,000 --> 00:01:26,670
to have noticed this so there's a

31
00:01:25,140 --> 00:01:29,070
question about how it got there how

32
00:01:26,670 --> 00:01:31,200
those constants got that way and by the

33
00:01:29,069 --> 00:01:34,349
way how did all that stuff get out there

34
00:01:31,200 --> 00:01:38,340
in particular places how did all this

35
00:01:34,349 --> 00:01:39,750
get to be the way it is even if we knew

36
00:01:38,340 --> 00:01:41,520
what those constants those parameters

37
00:01:39,750 --> 00:01:43,500
were the determine the physical laws and

38
00:01:41,519 --> 00:01:44,849
the properties of matter and energy we

39
00:01:43,500 --> 00:01:47,450
would still have this question of the

40
00:01:44,849 --> 00:01:50,819
initial condition why is it that the

41
00:01:47,450 --> 00:01:53,939
cosmic background radiation the oldest

42
00:01:50,819 --> 00:01:55,078
thing we can measure is not uniform as a

43
00:01:53,938 --> 00:01:59,728

matter of fact it seems to have some

44

00:01:55,078 --> 00:02:01,559
pattern to it big big mystery how did it

45

00:01:59,728 --> 00:02:03,090
how did it get that way and how are

46

00:02:01,560 --> 00:02:06,478
these parameters derived could the

47

00:02:03,090 --> 00:02:07,950
universe be some other way the constants

48

00:02:06,478 --> 00:02:10,258
could be determined a lot of different

49

00:02:07,950 --> 00:02:13,080
ways here are four of them by some

50

00:02:10,258 --> 00:02:13,829
supernatural being perhaps they are

51

00:02:13,080 --> 00:02:15,300
determinate ran

52

00:02:13,830 --> 00:02:16,860
there are a lot of different sub

53

00:02:15,300 --> 00:02:18,960
universes that have different values for

54

00:02:16,860 --> 00:02:23,120
these constants which case we sort of

55

00:02:18,960 --> 00:02:23,120
invoke an anther anthropic principle

56

00:02:23,930 --> 00:02:27,870
those constants and those laws could

57

00:02:26,159 --> 00:02:30,030
have been in some way determined by our

58
00:02:27,870 --> 00:02:33,210
interactions with them our observations

59
00:02:30,030 --> 00:02:38,250
we created all by observing somewhat

60
00:02:33,210 --> 00:02:40,230
like similar previous talk or the case

61
00:02:38,250 --> 00:02:42,240
that I'm more interested in perhaps that

62
00:02:40,229 --> 00:02:44,189
these constant really aren't independent

63
00:02:42,240 --> 00:02:45,960
and arbitrary but rather are

64
00:02:44,189 --> 00:02:47,669
mathematically derived and related in

65
00:02:45,960 --> 00:02:49,320
some interesting way so I'll give a

66
00:02:47,669 --> 00:02:52,439
couple of thoughts about that I'm

67
00:02:49,319 --> 00:02:55,049
reminded of Clarke's third law and by

68
00:02:52,439 --> 00:02:56,280
the way he added a fourth law in 99 for

69
00:02:55,050 --> 00:03:00,000
every expert there's an equal and

70
00:02:56,280 --> 00:03:02,000
opposite expert if you've ever been

71
00:03:00,000 --> 00:03:07,319
involved in patent litigation as I have

72
00:03:02,000 --> 00:03:08,879
this is very apropos so I think it's any

73
00:03:07,319 --> 00:03:11,219
sufficiently advanced technology is

74
00:03:08,879 --> 00:03:14,310
indistinguishable from God we're really

75
00:03:11,219 --> 00:03:16,199
not imaginative enough to think of what

76
00:03:14,310 --> 00:03:20,640
advanced technology really advanced

77
00:03:16,199 --> 00:03:22,979
technology could be like and to say as

78
00:03:20,639 --> 00:03:25,079
some would say that they can't be here

79
00:03:22,979 --> 00:03:27,329
because it would violate the speed of

80
00:03:25,080 --> 00:03:29,700
light and too much energy has evolved

81
00:03:27,330 --> 00:03:32,070
all that kind of stuff is nonsense they

82
00:03:29,699 --> 00:03:33,988
have complete control of time and space

83
00:03:32,069 --> 00:03:37,889
and a lot more things that we haven't

84
00:03:33,989 --> 00:03:39,300
even thought of yet so if you think you

85
00:03:37,889 --> 00:03:42,149
have a guardian angel or some

86

00:03:39,300 --> 00:03:44,610
interaction with God I don't see any way

87
00:03:42,150 --> 00:03:47,269
to rule out that as being interaction

88
00:03:44,610 --> 00:03:50,340
with really advanced beings in advanced

89
00:03:47,269 --> 00:03:52,459
technology but beside the point back to

90
00:03:50,340 --> 00:03:55,860
physical constants here are some of them

91
00:03:52,459 --> 00:03:57,629
Bernie gave a nice summary of of a

92
00:03:55,860 --> 00:03:59,519
particular list michie ikkaku thinks

93
00:03:57,629 --> 00:04:03,120
maybe there are 19 numbers numerate says

94
00:03:59,519 --> 00:04:04,830
john bayas counts 26 numbers Martin

95
00:04:03,120 --> 00:04:08,759
rhesus book just six numbers which is a

96
00:04:04,830 --> 00:04:10,200
very nice read derives the basis in an

97
00:04:08,759 --> 00:04:12,719
entirely different way using

98
00:04:10,199 --> 00:04:14,729
dimensionless numbers number of spatial

99
00:04:12,719 --> 00:04:16,889
dimensions and so on another interesting

100
00:04:14,729 --> 00:04:19,289

way of saying how many degrees of

101

00:04:16,889 --> 00:04:22,139

freedom are there maybe the real number

102

00:04:19,290 --> 00:04:23,970

is somewhere between 6 and 26 I don't I

103

00:04:22,139 --> 00:04:26,139

don't know

104

00:04:23,970 --> 00:04:27,670

the usual assumptions that are made

105

00:04:26,139 --> 00:04:30,459

before we start thinking about these

106

00:04:27,670 --> 00:04:33,000

things I have some trouble with not

107

00:04:30,459 --> 00:04:34,930

because the principles are necessarily

108

00:04:33,000 --> 00:04:36,750

invalid for any reason but because of

109

00:04:34,930 --> 00:04:39,370

the way they're usually thought about

110

00:04:36,750 --> 00:04:41,800

materialism usually means there's stuff

111

00:04:39,370 --> 00:04:44,110

out there there are things in space

112

00:04:41,800 --> 00:04:46,900

whether those things are particles and

113

00:04:44,110 --> 00:04:51,129

fields or whether they are strings or

114

00:04:46,899 --> 00:04:53,019

some other abstract structure I'm much

115
00:04:51,129 --> 00:04:54,850
more tending these days toward thinking

116
00:04:53,019 --> 00:04:57,789
about differences and boundaries and

117
00:04:54,850 --> 00:05:00,310
transitions rather than the objects to

118
00:04:57,790 --> 00:05:01,990
me the the difference is to find the

119
00:05:00,310 --> 00:05:04,269
objects not the other way around and

120
00:05:01,990 --> 00:05:06,310
there's some precedents for this or

121
00:05:04,269 --> 00:05:09,609
maybe be able to go into that a little

122
00:05:06,310 --> 00:05:10,780
bit more later reductionism the idea

123
00:05:09,610 --> 00:05:12,790
that the hole is equal to sum of the

124
00:05:10,779 --> 00:05:14,259
parts people always say no now something

125
00:05:12,790 --> 00:05:15,970
emerges when you get all the parts

126
00:05:14,259 --> 00:05:18,550
together that wasn't there among the

127
00:05:15,970 --> 00:05:20,290
parts forgetting that if you know the

128
00:05:18,550 --> 00:05:21,939
parts and all their interactions you

129
00:05:20,290 --> 00:05:23,740
really do have the whole nevertheless

130
00:05:21,939 --> 00:05:26,199
reductionism is not the only way to

131
00:05:23,740 --> 00:05:28,060
understand things and i would like to

132
00:05:26,199 --> 00:05:29,860
promote more constructivism that is

133
00:05:28,060 --> 00:05:31,959
starting from first principles or no

134
00:05:29,860 --> 00:05:34,180
principles and building upwards as well

135
00:05:31,959 --> 00:05:36,129
as reductionism taking things apart and

136
00:05:34,180 --> 00:05:38,978
trying to figure out how they work so

137
00:05:36,129 --> 00:05:41,019
the usual interpretation of that bothers

138
00:05:38,978 --> 00:05:43,089
me a bit randomness and the idea that

139
00:05:41,019 --> 00:05:47,079
there are truly causeless events at the

140
00:05:43,089 --> 00:05:48,369
core of physics I've totally bogus that

141
00:05:47,079 --> 00:05:49,689
one it seems to me that quantum

142
00:05:48,370 --> 00:05:50,918
measurement is not random at all and

143

00:05:49,689 --> 00:05:53,620
there's a big mistake that we've been

144
00:05:50,918 --> 00:05:55,478
making by making that assumption and it

145
00:05:53,620 --> 00:05:58,449
is an assumption in quantum mechanics it

146
00:05:55,478 --> 00:06:00,849
happens to work very well so we believe

147
00:05:58,449 --> 00:06:02,469
it but I don't think anything is truly

148
00:06:00,850 --> 00:06:05,020
random in a sense of being causeless

149
00:06:02,470 --> 00:06:06,550
event even at the core of physics cause

150
00:06:05,019 --> 00:06:09,129
and effects might might be the most

151
00:06:06,550 --> 00:06:10,300
pernicious about of these in the sense

152
00:06:09,129 --> 00:06:13,269
that everyone thinks about cause and

153
00:06:10,300 --> 00:06:15,668
effect as a unidirectional thing and

154
00:06:13,269 --> 00:06:17,079
liat this leads to the idea of time as a

155
00:06:15,668 --> 00:06:19,659
dimension and a flowing in one direction

156
00:06:17,079 --> 00:06:21,490
and so on bad idea it seems to me that

157
00:06:19,660 --> 00:06:24,490

physics is telling us that everything is

158

00:06:21,490 --> 00:06:26,740
symmetrical in time and that all

159

00:06:24,490 --> 00:06:30,910
relationships of the causal nature are

160

00:06:26,740 --> 00:06:33,009
bi-directional and influence travels in

161

00:06:30,910 --> 00:06:35,470
both directions if we take these

162

00:06:33,009 --> 00:06:36,728
assumptions and formalize them in some

163

00:06:35,470 --> 00:06:37,390
way we usually get what's called a

164

00:06:36,728 --> 00:06:39,490
system of

165

00:06:37,389 --> 00:06:43,000
seems you could say the standard model

166

00:06:39,490 --> 00:06:44,670
of physics is a kind of set of formal

167

00:06:43,000 --> 00:06:46,930
assumptions quantum theory in

168

00:06:44,670 --> 00:06:49,180
mathematics set theory and predicate

169

00:06:46,930 --> 00:06:50,949
calculus and so forth so we tend to

170

00:06:49,180 --> 00:06:54,069
formalize this and one might say that

171

00:06:50,949 --> 00:06:56,379
the more complex well let's say that

172
00:06:54,069 --> 00:06:58,360
less complex the set of axioms and

173
00:06:56,379 --> 00:06:59,980
beliefs are the more likely it is that

174
00:06:58,360 --> 00:07:01,360
we're close to the bottom that we're

175
00:06:59,980 --> 00:07:03,250
close to really understanding something

176
00:07:01,360 --> 00:07:06,340
or closer to bedrock and the more

177
00:07:03,250 --> 00:07:08,589
complex things are the rivers so here's

178
00:07:06,339 --> 00:07:10,779
an example from mathematics the zoo memo

179
00:07:08,589 --> 00:07:13,269
Frankel and the axiom of choice set

180
00:07:10,779 --> 00:07:17,289
theory eight axioms two of which at

181
00:07:13,269 --> 00:07:19,149
least are infinite axiom schema now I

182
00:07:17,290 --> 00:07:21,430
ask you does this look like we really

183
00:07:19,149 --> 00:07:23,560
understand the foundation zuv set theory

184
00:07:21,430 --> 00:07:25,840
or maybe sets are not such a good idea

185
00:07:23,560 --> 00:07:29,889
in the first place which is where where

186
00:07:25,839 --> 00:07:31,839
it's where I go Henry want want car a

187
00:07:29,889 --> 00:07:33,519
said later generations will regard set

188
00:07:31,839 --> 00:07:35,560
theory as a disease from which one has

189
00:07:33,519 --> 00:07:36,969
recovered what we haven't recovered yet

190
00:07:35,560 --> 00:07:38,470
this is really one of the most

191
00:07:36,970 --> 00:07:43,780
fundamental things that are taught in

192
00:07:38,470 --> 00:07:46,030
mathematics congruent versus deep models

193
00:07:43,779 --> 00:07:47,589
a congruent model is really a kind of a

194
00:07:46,029 --> 00:07:51,869
theory it's an abstract something

195
00:07:47,589 --> 00:07:54,250
another that we sometimes try to tune to

196
00:07:51,870 --> 00:07:56,829
be the same shape as whatever it is

197
00:07:54,250 --> 00:07:59,500
we're modeling and so the more tuning is

198
00:07:56,829 --> 00:08:02,439
necessary that added assumptions and fud

199
00:07:59,500 --> 00:08:04,750
factors show up and and this is not

200

00:08:02,439 --> 00:08:07,209
necessarily explaining things but merely

201
00:08:04,750 --> 00:08:09,819
modeling them so we can do stuff and try

202
00:08:07,209 --> 00:08:11,949
things to the model that will then be

203
00:08:09,819 --> 00:08:14,740
reflected in the in the real world

204
00:08:11,949 --> 00:08:16,300
somehow whereas a deeper model has

205
00:08:14,740 --> 00:08:18,250
something that's simpler and it was

206
00:08:16,300 --> 00:08:21,340
really more fundamental and more like

207
00:08:18,250 --> 00:08:23,350
how it really is how the phenomenon or

208
00:08:21,339 --> 00:08:25,000
whatever it is is actually generate and

209
00:08:23,350 --> 00:08:27,490
tells us something more about its place

210
00:08:25,000 --> 00:08:29,709
in the world here are some discrete

211
00:08:27,490 --> 00:08:32,789
physical models that I think are really

212
00:08:29,709 --> 00:08:35,259
becoming more and more interesting

213
00:08:32,789 --> 00:08:37,120
string theory hasn't quite paid off but

214
00:08:35,259 --> 00:08:39,279

still there's something very importantly

215

00:08:37,120 --> 00:08:41,350

correct about it even if it's not the

216

00:08:39,279 --> 00:08:45,519

whole story even in the standard model

217

00:08:41,350 --> 00:08:47,379

group symmetries as an abstract idea can

218

00:08:45,519 --> 00:08:49,929

model three of the four forces at least

219

00:08:47,379 --> 00:08:50,669

in some respects some of you may have

220

00:08:49,929 --> 00:08:52,889

seen

221

00:08:50,669 --> 00:08:55,019

causal dynamical triangulations a

222

00:08:52,889 --> 00:08:58,309

terrible name if I've ever heard one

223

00:08:55,019 --> 00:08:58,309

that's the