

Einstein and Eddington

LIGHTS ALL ASKEW IN THE HEAVENS

Men of Science Wore or Less
Eyes Over Heads of Eclipse
Observations.

EINSTEIN THEORY TRIUMPHS

Stars Not Where They Seemed
or Were Calculated to be,
but Nobody Need Worry.

A BOOK FOR 12 WISE MEN

No Man in All the World Could
Comprehend It, Said Einstein When
He Was First Asked to Write It.



In 1919, Einstein's theory of general relativity was confirmed by two expeditions led by Sir Arthur Eddington — one to Sobral in Brazil and the other to the island of Principe off the west coast of Africa — to observe a solar eclipse.

1
00:00:05,690 --> 00:00:03,439
first speaker this afternoon is Bernard

2
00:00:08,000 --> 00:00:05,700
hide from the Caliph Idzik sin stitute

3
00:00:11,749 --> 00:00:08,010
an astro physicist and author of over

4
00:00:13,490 --> 00:00:11,759
130 scientific publications former

5
00:00:15,169 --> 00:00:13,500
editor of the Astrophysical Journal and

6
00:00:18,529 --> 00:00:15,179
a former editor of the journal of

7
00:00:22,759 --> 00:00:18,539
scientific exploration so without

8
00:00:24,950 --> 00:00:22,769
further ado Bernie Nike York well this

9
00:00:26,269 --> 00:00:24,960
talk grew out of a book that I published

10
00:00:28,519 --> 00:00:26,279
a couple of years ago called the God

11
00:00:30,080 --> 00:00:28,529
theory and i'll be talking about

12
00:00:32,690 --> 00:00:30,090
consciousness having to do with this

13
00:00:35,810 --> 00:00:32,700

theory in the talk this afternoon but it

14

00:00:38,000 --> 00:00:35,820

stems from the discovery of the last 20

15

00:00:39,470 --> 00:00:38,010

years or so that our universe seems to

16

00:00:40,910 --> 00:00:39,480

be a very finely tuned place I'm not

17

00:00:42,560 --> 00:00:40,920

going to go through these in any detail

18

00:00:44,690 --> 00:00:42,570

but these are nine properties of the

19

00:00:46,729 --> 00:00:44,700

universe that pretty much today

20

00:00:49,130 --> 00:00:46,739

astrophysicists agree our rather

21

00:00:50,450 --> 00:00:49,140

remarkably finely tuned to make it

22

00:00:51,560 --> 00:00:50,460

possible for life to evolve in the

23

00:00:52,959 --> 00:00:51,570

universe they are the ratio of the

24

00:00:55,189 --> 00:00:52,969

gravitation with the Coulomb force

25

00:00:57,229 --> 00:00:55,199

strength of the nuclear force if that

26
00:00:58,910 --> 00:00:57,239
one were ten or twenty percent higher or

27
00:01:01,279 --> 00:00:58,920
lower than it is we wouldn't have stars

28
00:01:02,990 --> 00:01:01,289
a certain carbon resonance that allows

29
00:01:04,630 --> 00:01:03,000
carbon to form in the interiors of stars

30
00:01:06,980 --> 00:01:04,640
which of course is necessary for life

31
00:01:09,620 --> 00:01:06,990
the expansion property of water upon

32
00:01:11,300 --> 00:01:09,630
freezing the fact of neutron is slightly

33
00:01:13,789 --> 00:01:11,310
heavier than the proton and not the

34
00:01:15,200 --> 00:01:13,799
other way around the average density of

35
00:01:18,289 --> 00:01:15,210
matter in the universe the strength of

36
00:01:20,510 --> 00:01:18,299
the dark energy quantum clumping and the

37
00:01:22,700 --> 00:01:20,520
slight prevalence of matter over

38
00:01:24,020 --> 00:01:22,710

antimatter in the universe formed now

39

00:01:25,940 --> 00:01:24,030

all of these taken together could have

40

00:01:28,280 --> 00:01:25,950

been rather different than what they are

41

00:01:30,679 --> 00:01:28,290

and if they were we wouldn't be here no

42

00:01:32,030 --> 00:01:30,689

were another life be here but the arbor

43

00:01:34,069 --> 00:01:32,040

rather finely tuned and there are two

44

00:01:37,219 --> 00:01:34,079

explanations for this which I'll talk

45

00:01:38,840 --> 00:01:37,229

about next but first to mention that in

46

00:01:39,740 --> 00:01:38,850

current astrophysical theory we think

47

00:01:42,020 --> 00:01:39,750

that the universe went through a

48

00:01:43,490 --> 00:01:42,030

tremendous period of inflation before it

49

00:01:45,770 --> 00:01:43,500

settled down into the rather slow

50

00:01:47,270 --> 00:01:45,780

expansion that we now call the Hubble

51
00:01:49,580 --> 00:01:47,280
expansion that is characterizing the

52
00:01:52,160 --> 00:01:49,590
universe in the first 10 to the minus 34

53
00:01:53,510 --> 00:01:52,170
seconds or thereabouts and that's sort

54
00:01:56,030 --> 00:01:53,520
of a billionth of a billionth of a

55
00:01:58,340 --> 00:01:56,040
billionth of a millionth of a second the

56
00:02:01,039 --> 00:01:58,350
universe expanded tremendously into a

57
00:02:02,899 --> 00:02:01,049
region of well it became a region of

58
00:02:04,249 --> 00:02:02,909
space that led to the formation of our

59
00:02:07,069 --> 00:02:04,259
universe and perhaps even other

60
00:02:08,570 --> 00:02:07,079
universes so the idea that there could

61
00:02:12,050 --> 00:02:08,580
be other universes forming out of this

62
00:02:13,880 --> 00:02:12,060
inflation function leads to the

63
00:02:15,950 --> 00:02:13,890

explanation that maybe our universes

64

00:02:17,090 --> 00:02:15,960

not really special it's only that there

65

00:02:18,680 --> 00:02:17,100

are lots and lots of other universes

66

00:02:21,080 --> 00:02:18,690

that came out of this inflationary

67

00:02:23,240 --> 00:02:21,090

period in fact there may be literally an

68

00:02:25,070 --> 00:02:23,250

infinite number of other universes that

69

00:02:26,750 --> 00:02:25,080

came out of this inflationary period and

70

00:02:28,820 --> 00:02:26,760

therefore there must be a whole

71

00:02:30,670 --> 00:02:28,830

distribution whole ensemble of different

72

00:02:32,660 --> 00:02:30,680

laws and constants of nature that

73

00:02:34,490 --> 00:02:32,670

characterizes in different universes and

74

00:02:35,720 --> 00:02:34,500

ours is the one we happen to be able to

75

00:02:36,830 --> 00:02:35,730

live in we wouldn't be in any of the

76
00:02:38,810 --> 00:02:36,840
others because we couldn't have arisen

77
00:02:40,640 --> 00:02:38,820
in them and so this multiverse

78
00:02:42,350 --> 00:02:40,650
explanation for why our universe is

79
00:02:44,000 --> 00:02:42,360
finely tuned is the one that you'll find

80
00:02:46,340 --> 00:02:44,010
in mainstream astrophysics and there are

81
00:02:47,720 --> 00:02:46,350
books out on this by people such as

82
00:02:49,850 --> 00:02:47,730
Sir Martin Rees the astronomer royal

83
00:02:51,590 --> 00:02:49,860
Leonard Susskind the Stanford physicist

84
00:02:53,030 --> 00:02:51,600
and one of the fathers of string theory

85
00:02:55,250 --> 00:02:53,040
and it's a perfectly plausible

86
00:02:57,110 --> 00:02:55,260
explanation that we are not special it's

87
00:02:59,060 --> 00:02:57,120
just that we are part of an ensemble of

88
00:03:01,850 --> 00:02:59,070

a huge vast number of other universes

89

00:03:03,440 --> 00:03:01,860

that unfortunately we can never see we

90

00:03:06,199 --> 00:03:03,450

can never directly detect we can never

91

00:03:07,580 --> 00:03:06,209

measure the other alternative of course

92

00:03:09,440 --> 00:03:07,590

the alternative is that there is an

93

00:03:11,360 --> 00:03:09,450

intelligence with a purpose behind the

94

00:03:12,590 --> 00:03:11,370

laws of nature not at all something

95

00:03:14,479 --> 00:03:12,600

having to do with intelligent design by

96

00:03:16,759 --> 00:03:14,489

the way but having to do with dreaming

97

00:03:18,710 --> 00:03:16,769

into existence the laws of nature and

98

00:03:20,690 --> 00:03:18,720

constants that would lead to a life

99

00:03:23,270 --> 00:03:20,700

friendly universe not just life on Earth

100

00:03:24,860 --> 00:03:23,280

I'm assuming but presumably life on many

101
00:03:27,080 --> 00:03:24,870
other planets around lots of other stars

102
00:03:29,060 --> 00:03:27,090
and lots of other galaxies in fact even

103
00:03:31,310 --> 00:03:29,070
sir Fred Hoyle for the end of his life

104
00:03:33,050 --> 00:03:31,320
called universe and obvious fix when we

105
00:03:36,050 --> 00:03:33,060
looked at the the properties of the

106
00:03:38,000 --> 00:03:36,060
universe so I began to think about the

107
00:03:39,650 --> 00:03:38,010
notion that maybe the universe is the

108
00:03:42,020 --> 00:03:39,660
way it is because there is a conscious

109
00:03:44,690 --> 00:03:42,030
intelligence behind it behind the the

110
00:03:46,190 --> 00:03:44,700
origin of the universe this is Sir James

111
00:03:47,600 --> 00:03:46,200
jeans one of the the prominent

112
00:03:50,509 --> 00:03:47,610
astrophysicists of the first half of the

113
00:03:52,160 --> 00:03:50,519

last century and he wrote about this he

114

00:03:53,630 --> 00:03:52,170

says the universe begins to look more

115

00:03:56,449 --> 00:03:53,640

like a great thought than like a great

116

00:03:57,949 --> 00:03:56,459

machine mine no longer appears as an

117

00:04:00,650 --> 00:03:57,959

accidental intruder into the realm of

118

00:04:02,780 --> 00:04:00,660

matter we are beginning to think that we

119

00:04:04,910 --> 00:04:02,790

ought rather to hail it that is mind as

120

00:04:06,920 --> 00:04:04,920

the creator and governor of the realm of

121

00:04:08,270 --> 00:04:06,930

matter and so he was proposing that

122

00:04:10,670 --> 00:04:08,280

there is an intelligence behind the

123

00:04:12,340 --> 00:04:10,680

universe to make it be the sort of

124

00:04:14,990 --> 00:04:12,350

special place that we're now we really

125

00:04:17,240 --> 00:04:15,000

determined with the great precision that

126

00:04:18,979 --> 00:04:17,250

it appears to be another brilliant

127

00:04:20,120 --> 00:04:18,989

astrophysicist from that same error sir

128

00:04:22,460 --> 00:04:20,130

arthur eddington and here he is with

129

00:04:24,589 --> 00:04:22,470

Einstein Eddington was the one who made

130

00:04:27,770 --> 00:04:24,599

Einstein famous and you can see on the

131

00:04:29,240 --> 00:04:27,780

left side the headlines

132

00:04:31,040 --> 00:04:29,250

I seem to have lost the other point are

133

00:04:34,220 --> 00:04:31,050

there it is the headlines from the new

134

00:04:37,520 --> 00:04:34,230

york times when the discovery was made

135

00:04:39,710 --> 00:04:37,530

that the the Sun causes the bending of

136

00:04:41,629 --> 00:04:39,720

starlight during the eclipse of 1919

137

00:04:43,580 --> 00:04:41,639

lights all askew in the heavens men of

138

00:04:45,290 --> 00:04:43,590

science more or less ago of results of

139

00:04:49,520 --> 00:04:45,300

eclipse observations einstein theory

140

00:04:51,020 --> 00:04:49,530

triumphs a book for 12 wise men so this

141

00:04:52,129 --> 00:04:51,030

is what made Einstein famous and it was

142

00:04:53,990 --> 00:04:52,139

Sir Arthur Eddington who led that

143

00:04:56,960 --> 00:04:54,000

Eclipse expedition to print repay in

144

00:04:58,280 --> 00:04:56,970

1919 that made the observation sir

145

00:05:00,290 --> 00:04:58,290

arthur eddington was a brilliant man

146

00:05:01,850 --> 00:05:00,300

probably the predominant the most

147

00:05:04,250 --> 00:05:01,860

prominent astrophysicist of the first

148

00:05:07,100 --> 00:05:04,260

half of the last century and he wrote as

149

00:05:09,140 --> 00:05:07,110

many books one of them the mathematical

150

00:05:11,030 --> 00:05:09,150

theory of relativity which was a the

151

00:05:13,100 --> 00:05:11,040

exposition of general relativity the

152

00:05:14,300 --> 00:05:13,110

first textbook on that which by the way

153

00:05:18,080 --> 00:05:14,310

I also used when I was a graduate

154

00:05:20,690 --> 00:05:18,090

student back in the 1970s and 1980s the

155

00:05:22,460 --> 00:05:20,700

original edition came out in 1923 he was

156

00:05:24,710 --> 00:05:22,470

also the one who proposed the

157

00:05:28,760 --> 00:05:24,720

thermonuclear reactions as the basis for

158

00:05:31,250 --> 00:05:28,770

the the energy of stars a brilliant man

159

00:05:33,320 --> 00:05:31,260

he also wrote however science and the

160

00:05:35,810 --> 00:05:33,330

unseen world because he was also a

161

00:05:37,550 --> 00:05:35,820

mystic it was a Quaker new mystic and he

162

00:05:39,680 --> 00:05:37,560

asked the question therein are we in

163

00:05:41,390 --> 00:05:39,690

pursuing the mystical outlook facing the

164

00:05:44,719 --> 00:05:41,400

hard facts of experience surely we are

165

00:05:47,000 --> 00:05:44,729

and so he was not on the shame to write

166

00:05:49,550 --> 00:05:47,010

about and talked about his view that in

167

00:05:50,930 --> 00:05:49,560

fact there's more to the reality more to

168

00:05:57,710 --> 00:05:50,940

reality than simply the physical

169

00:05:59,570 --> 00:05:57,720

universe now as it turns out there is

170

00:06:00,830 --> 00:05:59,580

more reason than ever today to take

171

00:06:02,719 --> 00:06:00,840

seriously the notion that the

172

00:06:04,940 --> 00:06:02,729

consciousness is not some epithet

173

00:06:06,770 --> 00:06:04,950

nominal byproduct of life arising

174

00:06:08,719 --> 00:06:06,780

through evolution but rather than

175

00:06:10,909 --> 00:06:08,729

consciousness as a primary primary

176

00:06:13,550 --> 00:06:10,919

formative element in the universe and in

177

00:06:17,360 --> 00:06:13,560

fact consciousness is the basis of the

178

00:06:19,130 --> 00:06:17,370

universe this is another book that just

179

00:06:21,740 --> 00:06:19,140

came out a couple of years ago by a

180

00:06:23,360 --> 00:06:21,750

couple of physicists at the University

181

00:06:26,090 --> 00:06:23,370

of California Santa Cruz in fact one of

182

00:06:27,680 --> 00:06:26,100

the bruce rosenblum was the chair of the

183

00:06:31,100 --> 00:06:27,690

department and what they've done is to

184

00:06:32,810 --> 00:06:31,110

write a book for undergraduates or

185

00:06:35,540 --> 00:06:32,820

anyone interested in the philosophy of

186

00:06:38,990 --> 00:06:35,550

quantum physics the idea being that

187

00:06:40,490 --> 00:06:39,000

there are the interpretation of quantum

188

00:06:41,390 --> 00:06:40,500

physics has now gotten us to the point

189

00:06:43,010 --> 00:06:41,400

where

190

00:06:45,920 --> 00:06:43,020

it's really necessary to invoke

191

00:06:47,900 --> 00:06:45,930

consciousness as the necessary

192

00:06:49,420 --> 00:06:47,910

ingredient to make reality happen to

193

00:06:52,159 --> 00:06:49,430

shape reality at the quantum level

194

00:06:53,719 --> 00:06:52,169

conscious is something you can't do

195

00:06:55,520 --> 00:06:53,729

without that's up going to be talking

196

00:06:57,409 --> 00:06:55,530

about doing the rest of the presentation

197

00:06:59,990 --> 00:06:57,419

let me give you a few quotes from the

198

00:07:02,180 --> 00:07:00,000

book quantum theory is the most

199

00:07:04,400 --> 00:07:02,190

stunningly successful theory in all of

200

00:07:06,050 --> 00:07:04,410

science not a single one of its

201
00:07:08,540 --> 00:07:06,060
predictions has ever been proven wrong

202
00:07:11,689 --> 00:07:08,550
so quantum mechanics quantum theory

203
00:07:14,270 --> 00:07:11,699
really is a a wonderfully valid one

204
00:07:16,219 --> 00:07:14,280
wonderfully robust theory however

205
00:07:18,800 --> 00:07:16,229
quantum experiments hint at a worldview

206
00:07:20,180 --> 00:07:18,810
that has not yet been grasped the

207
00:07:22,370 --> 00:07:20,190
existence of something beyond what we

208
00:07:23,960 --> 00:07:22,380
usually consider physics beyond what we

209
00:07:26,330 --> 00:07:23,970
usually consider the physical world and

210
00:07:28,550 --> 00:07:26,340
they wrote this sort of thing with you

211
00:07:30,230 --> 00:07:28,560
can read in the book their trepidation

212
00:07:33,080 --> 00:07:30,240
at putting ideas like this out because

213
00:07:35,379 --> 00:07:33,090

they're afraid of being criticized by

214

00:07:38,870 --> 00:07:35,389

their colleagues for putting a sort of

215

00:07:40,430 --> 00:07:38,880

new-age fuzzy-wuzzy kinds of notions out

216

00:07:41,749 --> 00:07:40,440

there that might confuse people into

217

00:07:42,920 --> 00:07:41,759

thinking that somehow physics proves

218

00:07:44,990 --> 00:07:42,930

that there's God it doesn't of course

219

00:07:46,969 --> 00:07:45,000

and I'm not about to say that it is

220

00:07:49,400 --> 00:07:46,979

lecture either but what physics does do

221

00:07:51,379 --> 00:07:49,410

today at the quantum level and therefore

222

00:07:53,390 --> 00:07:51,389

at all higher levels i think is to

223

00:07:57,050 --> 00:07:53,400

require that consciousness is necessary

224

00:07:59,330 --> 00:07:57,060

element in creating reality at that in

225

00:08:02,300 --> 00:07:59,340

the measurement of things at the quantum

226

00:08:03,830 --> 00:08:02,310

phase the other point they made which I

227

00:08:06,950 --> 00:08:03,840

had not really appreciated was that to

228

00:08:08,450 --> 00:08:06,960

really understand the philosophical

229

00:08:10,520 --> 00:08:08,460

implications of quantum physics you

230

00:08:12,200 --> 00:08:10,530

don't have to be a physicist you don't

231

00:08:14,420 --> 00:08:12,210

have to know the mathematics at all of

232

00:08:16,969 --> 00:08:14,430

quantum physics to appreciate the

233

00:08:19,430 --> 00:08:16,979

conundrum in quantum mechanics of

234

00:08:21,920 --> 00:08:19,440

requiring an observer with consciousness

235

00:08:23,810 --> 00:08:21,930

to actually make things happen you can

236

00:08:25,730 --> 00:08:23,820

perfectly well engage in philosophical

237

00:08:27,110 --> 00:08:25,740

discussions of quantum physics by

238

00:08:30,379 --> 00:08:27,120

understanding quantum physics at a

239

00:08:32,510 --> 00:08:30,389

qualitative level the operators the the

240

00:08:34,430 --> 00:08:32,520

Hilbert spaces all of that that's fine

241

00:08:36,709 --> 00:08:34,440

if you're going to manipulate equations

242

00:08:38,480 --> 00:08:36,719

and you know solve quantum problems but

243

00:08:40,730 --> 00:08:38,490

in terms of understanding what quantum

244

00:08:43,130 --> 00:08:40,740

physics really implies philosophically

245

00:08:44,630 --> 00:08:43,140

you don't need any of that you can be an

246

00:08:46,490 --> 00:08:44,640

undergraduate having taken this course

247

00:08:49,640 --> 00:08:46,500

with some deep thinking about what it

248

00:08:51,740 --> 00:08:49,650

means and discuss with other people and

249

00:08:54,769 --> 00:08:51,750

with physicists what it all means with

250

00:08:55,100 --> 00:08:54,779

some level of credibility and with you

251
00:08:57,829 --> 00:08:55,110
know

252
00:08:59,210 --> 00:08:57,839
no no less a deep understanding of what

253
00:09:00,860 --> 00:08:59,220
it means then if you could manipulate

254
00:09:03,050 --> 00:09:00,870
all the mathematics of quantum theory

255
00:09:05,180 --> 00:09:03,060
which is quite formidable which I've had

256
00:09:09,199 --> 00:09:05,190
some experience with both positively and

257
00:09:11,150 --> 00:09:09,209
negatively the quantum enigma quantum

258
00:09:12,590 --> 00:09:11,160
mechanics applies to everything we can

259
00:09:14,990 --> 00:09:12,600
now manipulate individual atoms and

260
00:09:17,000 --> 00:09:15,000
here's an example from 1989 already of a

261
00:09:21,190 --> 00:09:17,010
scanning tunneling microscope image of

262
00:09:25,009 --> 00:09:21,200
the IBM spelled out on individual atoms

263
00:09:26,690 --> 00:09:25,019

now what's not widely realized is that

264

00:09:29,269 --> 00:09:26,700

an atom and it's wavefunction are the

265

00:09:30,769 --> 00:09:29,279

same thing it you know when I first

266

00:09:33,620 --> 00:09:30,779

started studying quantum physics I

267

00:09:34,940 --> 00:09:33,630

thought that the wave function which is

268

00:09:36,139 --> 00:09:34,950

the thing that the fuzzy thing that

269

00:09:37,490 --> 00:09:36,149

describes sort of where you're going to

270

00:09:40,430 --> 00:09:37,500

find a party when we make a measurement

271

00:09:42,590 --> 00:09:40,440

that that wave function is something to

272

00:09:44,930 --> 00:09:42,600

sort of over and above the particle that

273

00:09:46,670 --> 00:09:44,940

it's there and the particle is sort of

274

00:09:48,800 --> 00:09:46,680

jostled around or somehow is spread out

275

00:09:50,810 --> 00:09:48,810

within this wave function but it's

276

00:09:53,449 --> 00:09:50,820

actually the case that the wave function

277

00:09:55,400 --> 00:09:53,459

is the object and when you collapse the

278

00:09:57,350 --> 00:09:55,410

wave function you're causing the object

279

00:09:59,600 --> 00:09:57,360

to appear in a certain place it's not a