

# Hubble Public Lecture Series

Topic: Terra Sapiens: The Human Chapter  
in the History of the Earth

Speaker: David Grinspoon,  
Library of Congress / DMNS



1  
00:00:04,550 --> 00:00:02,710  
good evening ladies and gentlemen and

2  
00:00:07,030 --> 00:00:04,560  
welcome to the space telescope science

3  
00:00:09,830 --> 00:00:07,040  
institute public lecture series we have

4  
00:00:11,830 --> 00:00:09,840  
a special presentation for you tonight

5  
00:00:13,990 --> 00:00:11,840  
this is not the first tuesday of the

6  
00:00:16,470 --> 00:00:14,000  
month it is actually the last tuesday of

7  
00:00:18,310 --> 00:00:16,480  
the month but we have a special workshop

8  
00:00:19,910 --> 00:00:18,320  
going on here at space telescope this

9  
00:00:21,830 --> 00:00:19,920  
week and

10  
00:00:24,630 --> 00:00:21,840  
the organizers of the workshop were

11  
00:00:26,790 --> 00:00:24,640  
grateful or gracious enough to be able

12  
00:00:28,470 --> 00:00:26,800  
to find one of their speakers who was

13  
00:00:30,470 --> 00:00:28,480

coming to the workshop anyways who's

14

00:00:33,590 --> 00:00:30,480

also a wonderful public speaker

15

00:00:36,150 --> 00:00:33,600

and come give us a public talk tonight

16

00:00:38,470 --> 00:00:36,160

that does not mean we won't have our

17

00:00:41,190 --> 00:00:38,480

usual may lecture

18

00:00:44,389 --> 00:00:41,200

next tuesday night bonnie meinke will be

19

00:00:46,869 --> 00:00:44,399

talking about the making of moons she is

20

00:00:48,229 --> 00:00:46,879

an expert on saturn and

21

00:00:50,630 --> 00:00:48,239

i gotta say saturn has some of the

22

00:00:52,470 --> 00:00:50,640

really coolest moons in the solar system

23

00:00:54,470 --> 00:00:52,480

all right and she's got some really cool

24

00:00:56,310 --> 00:00:54,480

stuff to tell us about

25

00:00:58,310 --> 00:00:56,320

how moons form and how moons interact

26

00:01:00,709 --> 00:00:58,320

with the rings of saturn all sorts of

27

00:01:02,790 --> 00:01:00,719

really cool stuff i'm uh i love

28

00:01:04,549 --> 00:01:02,800

these saturn talks so you're not going

29

00:01:07,109 --> 00:01:04,559

to want to miss that one that will be

30

00:01:08,710 --> 00:01:07,119

next tuesday may 6th

31

00:01:11,510 --> 00:01:08,720

at 8 pm

32

00:01:13,030 --> 00:01:11,520

and at that time i will do my normal

33

00:01:14,870 --> 00:01:13,040

news from the universe where i tell you

34

00:01:16,630 --> 00:01:14,880

the latest discoveries from hubble and

35

00:01:20,310 --> 00:01:16,640

other missions around

36

00:01:21,510 --> 00:01:20,320

uh i as always i never bring one of the

37

00:01:24,630 --> 00:01:21,520

mythographs

38

00:01:26,789 --> 00:01:24,640

if you did not get a lithograph

39

00:01:28,469 --> 00:01:26,799

thank you i always forget to bring these

40

00:01:30,469 --> 00:01:28,479

if you did not get a lithograph they are

41

00:01:33,429 --> 00:01:30,479

on the table over there pick one up on

42

00:01:36,710 --> 00:01:33,439

your way out tonight's lithograph is 30

43

00:01:38,870 --> 00:01:36,720

doradus a turbulent star forming region

44

00:01:40,390 --> 00:01:38,880

which has a really really cool picture

45

00:01:41,590 --> 00:01:40,400

on the front and if you want to

46

00:01:43,910 --> 00:01:41,600

understand a little bit about that

47

00:01:45,109 --> 00:01:43,920

really cool image turn over on the back

48

00:01:47,510 --> 00:01:45,119

and we have

49

00:01:49,109 --> 00:01:47,520

i believe we're allowed 330 words on

50

00:01:50,550 --> 00:01:49,119

these lithographs because i've written a

51  
00:01:53,350 --> 00:01:50,560  
bunch of these lithographs i'm allowed

52  
00:01:56,550 --> 00:01:53,360  
exactly you know no more than 330 words

53  
00:01:57,510 --> 00:01:56,560  
so as much as we can say about it in 330

54  
00:02:01,510 --> 00:01:57,520  
words

55  
00:02:04,630 --> 00:02:03,270  
so i won't be doing any of that tonight

56  
00:02:06,709 --> 00:02:04,640  
um

57  
00:02:08,550 --> 00:02:06,719  
it's raining tonight so we will not have

58  
00:02:10,630 --> 00:02:08,560  
our telescope across the street

59  
00:02:12,949 --> 00:02:10,640  
duncan watts had sent me an email saying

60  
00:02:15,270 --> 00:02:12,959  
hey i'm willing to do it if it's clear

61  
00:02:16,949 --> 00:02:15,280  
it's not clear so you'll have to come

62  
00:02:18,070 --> 00:02:16,959  
back next week and maybe it'll be clear

63  
00:02:20,070 --> 00:02:18,080

and you can do the observing in the

64

00:02:22,390 --> 00:02:20,080

telescope across the street

65

00:02:25,190 --> 00:02:22,400

so we'll go straight to our main feature

66

00:02:28,630 --> 00:02:25,200

tonight without any delay and our main

67

00:02:31,110 --> 00:02:28,640

feature is dr david grinspoon uh talking

68

00:02:32,949 --> 00:02:31,120

on pterosaurs the human chapter in the

69

00:02:36,869 --> 00:02:32,959

history of earth

70

00:02:39,830 --> 00:02:36,879

uh dr grinsburg is a visiting scholar at

71

00:02:42,949 --> 00:02:39,840

the library of congress and he was the

72

00:02:45,190 --> 00:02:42,959

inaugural chair in astrobiology which

73

00:02:47,190 --> 00:02:45,200

has some really fancy complex name that

74

00:02:49,589 --> 00:02:47,200

i didn't bother to memorize

75

00:02:51,550 --> 00:02:49,599

but he can tell you all about that

76

00:02:54,390 --> 00:02:51,560

but showing that the field of

77

00:02:56,710 --> 00:02:54,400

astrobiology which was this melding of

78

00:02:59,750 --> 00:02:56,720

astronomy and biology and was considered

79

00:03:01,030 --> 00:02:59,760

kind of funky and crazy about 10 15

80

00:03:03,589 --> 00:03:01,040

years ago

81

00:03:06,149 --> 00:03:03,599

is now getting a major respect and is a

82

00:03:09,430 --> 00:03:06,159

major field and he is one of the leaders

83

00:03:11,910 --> 00:03:09,440

in it he is also a professor at the

84

00:03:14,070 --> 00:03:11,920

university of colorado

85

00:03:17,350 --> 00:03:14,080

now he is involved in a lot of things in

86

00:03:20,630 --> 00:03:17,360

planetary science he is a co-eye on the

87

00:03:23,430 --> 00:03:20,640

instrument on the mars rover curiosity

88

00:03:26,470 --> 00:03:23,440

so his experiment is on mars on the

89

00:03:28,949 --> 00:03:26,480

surface of mars he is also involved in

90

00:03:31,509 --> 00:03:28,959

the european space agency's venus

91

00:03:33,750 --> 00:03:31,519

express which is currently orbiting

92

00:03:35,830 --> 00:03:33,760

venus so he's got two of the planets

93

00:03:37,350 --> 00:03:35,840

covered okay um you know by the end of

94

00:03:39,030 --> 00:03:37,360

his career he'll have the he'll have the

95

00:03:41,270 --> 00:03:39,040

full suite

96

00:03:44,309 --> 00:03:41,280

he is a prolific writer

97

00:03:45,350 --> 00:03:44,319

writing for various magazines including

98

00:03:48,390 --> 00:03:45,360

doing the

99

00:03:50,789 --> 00:03:48,400

cosmic relief column for space and

100

00:03:53,589 --> 00:03:50,799

science sky and telescope

101

00:03:55,509 --> 00:03:53,599

he is author of several noted books

102

00:03:56,949 --> 00:03:55,519

which have won various prizes that i

103

00:04:00,229 --> 00:03:56,959

didn't memorize

104

00:04:04,630 --> 00:04:00,239

and one of the coolest things is that in

105

00:04:06,949 --> 00:04:04,640

2006 he was awarded the carl sagan medal

106

00:04:08,390 --> 00:04:06,959

for public communication of planetary

107

00:04:14,309 --> 00:04:08,400

sciences

108

00:04:17,909 --> 00:04:16,310

with that kind of resume you know it's

109

00:04:20,150 --> 00:04:17,919

gonna be a good talk i'm looking forward

110

00:04:22,230 --> 00:04:20,160

to it ladies and gentlemen oh i also

111

00:04:26,310 --> 00:04:22,240

have to note and it's uh oh it says sort

112

00:04:27,749 --> 00:04:26,320

of cut off he is also i he also uh

113

00:04:31,110 --> 00:04:27,759

if you want to find out more you can go

114

00:04:35,189 --> 00:04:33,670

or you can follow him on twitter as dr

115

00:04:43,670 --> 00:04:35,199

funky spoon

116

00:04:47,510 --> 00:04:45,430

all right thanks a lot thank you so much

117

00:04:49,670 --> 00:04:47,520

for coming out tonight i really

118

00:04:52,150 --> 00:04:49,680

appreciate it especially uh given the

119

00:04:54,830 --> 00:04:52,160

fact that it's a rainy night here in

120

00:04:57,030 --> 00:04:54,840

baltimore and um there's

121

00:04:59,510 --> 00:04:57,040

also an important

122

00:05:00,230 --> 00:04:59,520

nba playoff game

123

00:05:02,710 --> 00:05:00,240

and

124

00:05:04,070 --> 00:05:02,720

the fact that you've chosen to be here

125

00:05:06,629 --> 00:05:04,080

with me

126

00:05:08,950 --> 00:05:06,639

i'm gratified and i only ask

127

00:05:11,029 --> 00:05:08,960

in return that if you know the score you

128

00:05:13,830 --> 00:05:11,039

don't tell me because i'm going to try

129

00:05:15,990 --> 00:05:13,840

to watch oh is it it's not on do i need

130

00:05:17,749 --> 00:05:16,000

to push a button yes

131

00:05:22,870 --> 00:05:17,759

give me a moment

132

00:05:22,880 --> 00:05:34,629

now

133

00:05:34,639 --> 00:05:45,990

did that work

134

00:05:51,029 --> 00:05:46,790

yeah

135

00:05:52,790 --> 00:05:51,039

the bulls wizards game don't tell me so

136

00:05:56,230 --> 00:05:52,800

i can watch it

137

00:05:57,270 --> 00:05:56,240

later and also a big hello to any of you

138

00:06:01,670 --> 00:05:57,280

watching

139

00:06:03,590 --> 00:06:01,680

on the internet tonight hi mom hi dad

140

00:06:05,590 --> 00:06:03,600

and at least i know those of you

141

00:06:07,830 --> 00:06:05,600

watching on the web are watching the

142

00:06:10,309 --> 00:06:07,840

basketball game at the same time

143

00:06:12,070 --> 00:06:10,319

that's what i'd be doing or you're like

144

00:06:14,070 --> 00:06:12,080

oh a time out quick let's watch some

145

00:06:16,710 --> 00:06:14,080

master biology

146

00:06:19,830 --> 00:06:16,720

all right anyways so pterosan is the

147

00:06:22,550 --> 00:06:19,840

human chapter in the history of earth

148

00:06:26,390 --> 00:06:22,560

what am i an astra a mere astrobiologist

149

00:06:27,749 --> 00:06:26,400

doing talking about this well

150

00:06:29,590 --> 00:06:27,759

it all began

151  
00:06:32,230 --> 00:06:29,600  
when i saw an advertisement for this

152  
00:06:35,590 --> 00:06:32,240  
kind of unusual job that was mentioned

153  
00:06:37,189 --> 00:06:35,600  
in the introduction a couple years ago i

154  
00:06:39,510 --> 00:06:37,199  
saw that there was a new position being

155  
00:06:41,350 --> 00:06:39,520  
established for a chair of astrobiology

156  
00:06:44,469 --> 00:06:41,360  
in the library of congress jointly

157  
00:06:47,110 --> 00:06:44,479  
supported by nasa and the library

158  
00:06:48,629 --> 00:06:47,120  
and they were specifically and and that

159  
00:06:49,909 --> 00:06:48,639  
kind of caught my attention i said wait

160  
00:06:51,909 --> 00:06:49,919  
what what are they talking about a chair

161  
00:06:53,110 --> 00:06:51,919  
of astrobiology at the library i've

162  
00:06:54,710 --> 00:06:53,120  
never heard of such a thing and then i

163  
00:06:56,950 --> 00:06:54,720

read the fine print and it said they

164

00:06:59,110 --> 00:06:56,960

were specifically looking for somebody

165

00:07:00,710 --> 00:06:59,120

to do sustained research at the

166

00:07:03,670 --> 00:07:00,720

intersection between the science of

167

00:07:06,230 --> 00:07:03,680

astrobiology and its humanistic and

168

00:07:07,990 --> 00:07:06,240

societal aspects

169

00:07:10,469 --> 00:07:08,000

and i thought huh maybe that's an

170

00:07:12,629 --> 00:07:10,479

opportunity to write that book i've been

171

00:07:14,629 --> 00:07:12,639

thinking about and had back bernard for

172

00:07:17,749 --> 00:07:14,639

the last several years

173

00:07:20,070 --> 00:07:17,759

about human civilization as a sort of

174

00:07:23,749 --> 00:07:20,080

almost astrophysical or cosmic

175

00:07:25,270 --> 00:07:23,759

phenomenon and so i already had a

176

00:07:28,469 --> 00:07:25,280

proposal in the works which i

177

00:07:30,950 --> 00:07:28,479

reformatted in the proper

178

00:07:33,990 --> 00:07:30,960

form for this proposal and added some

179

00:07:36,070 --> 00:07:34,000

other things and sent it in and i was

180

00:07:39,430 --> 00:07:36,080

very gratified to be selected as the

181

00:07:41,110 --> 00:07:39,440

inaugural astrobiology chair and

182

00:07:44,150 --> 00:07:41,120

the title

183

00:07:47,029 --> 00:07:44,160

of my proposal that i submitted was this

184

00:07:48,950 --> 00:07:47,039

astrobiology and the anthropocene era

185

00:07:51,510 --> 00:07:48,960

exploring the potential roles of life

186

00:07:53,029 --> 00:07:51,520

and intelligence on earth and beyond

187

00:07:54,950 --> 00:07:53,039

well what are we talking about here so

188

00:07:57,110 --> 00:07:54,960

astrobiology

189

00:08:00,710 --> 00:07:57,120

as some of you i'm sure know is the

190

00:08:02,070 --> 00:08:00,720

scientific study of life in the universe

191

00:08:04,629 --> 00:08:02,080

so we study

192

00:08:06,710 --> 00:08:04,639

very carefully the record and history of

193

00:08:09,510 --> 00:08:06,720

life on earth and the extremes of life

194

00:08:12,230 --> 00:08:09,520

on earth trying to understand the limits

195

00:08:14,390 --> 00:08:12,240

and universals of life and we also study

196

00:08:16,390 --> 00:08:14,400

the environments in the rest of the

197

00:08:18,070 --> 00:08:16,400

universe to try to extrapolate and

198

00:08:21,589 --> 00:08:18,080

understand where

199

00:08:23,510 --> 00:08:21,599

the universe may be life friendly and so

200

00:08:26,790 --> 00:08:23,520

that's the field of astrobiology the

201

00:08:29,189 --> 00:08:26,800

anthropocene is a new term

202

00:08:31,830 --> 00:08:29,199

that is

203

00:08:33,750 --> 00:08:31,840

becoming to be widely used which i'll

204

00:08:35,750 --> 00:08:33,760

talk about a lot tonight but it's the

205

00:08:37,029 --> 00:08:35,760

idea that we in fact have now entered a

206

00:08:39,670 --> 00:08:37,039

new

207

00:08:42,149 --> 00:08:39,680

era or phase of geologic history of the

208

00:08:45,829 --> 00:08:42,159

earth defined by the actions of human

209

00:08:47,269 --> 00:08:45,839

beings as a major geological force it's

210

00:08:49,110 --> 00:08:47,279

not a value judgment it's not

211

00:08:51,509 --> 00:08:49,120

necessarily saying this is good this is

212

00:08:53,910 --> 00:08:51,519

bad it's just recognizing that if you

213

00:08:56,550 --> 00:08:53,920

add up what humans are doing now it is

214

00:08:58,710 --> 00:08:56,560

comparable to the other great forces of

215

00:09:01,190 --> 00:08:58,720

nature so

216

00:09:04,550 --> 00:09:01,200

my idea was to look at this

217

00:09:06,070 --> 00:09:04,560

anthropocene era from an astrobiology

218

00:09:07,990 --> 00:09:06,080

point of view and that's what i've been

219

00:09:10,070 --> 00:09:08,000

doing for the last year and i'll

220

00:09:11,910 --> 00:09:10,080

summarize a little bit of that for you

221

00:09:12,790 --> 00:09:11,920

this evening

222

00:09:14,710 --> 00:09:12,800

so

223

00:09:17,110 --> 00:09:14,720

the anthropocene

224

00:09:19,269 --> 00:09:17,120

as i said it's the time it's the word

225

00:09:22,150 --> 00:09:19,279

that's now being used and it's in fact

226

00:09:24,790 --> 00:09:22,160

been proposed as an official term in the

227

00:09:27,350 --> 00:09:24,800

geologic time scale that proposal is now

228

00:09:29,910 --> 00:09:27,360

up for review and being considered but

229

00:09:33,110 --> 00:09:29,920

it's also come to be widely used whether

230

00:09:36,150 --> 00:09:33,120

or not it gets officially

231

00:09:38,470 --> 00:09:36,160

sanctified as as a geological term and

232

00:09:40,710 --> 00:09:38,480

it's it's the idea is that we've become

233

00:09:42,389 --> 00:09:40,720

a dominant force of planetary change and

234

00:09:45,829 --> 00:09:42,399

there are many interesting ways of

235

00:09:47,990 --> 00:09:45,839

looking at this and one way

236

00:09:51,030 --> 00:09:48,000

is to look at the different ways we

237

00:09:52,870 --> 00:09:51,040

measure time we think of geological time

238

00:09:55,350 --> 00:09:52,880

over here in the left we think of the

239

00:09:58,230 --> 00:09:55,360

history of life biological time and we

240

00:10:00,389 --> 00:09:58,240

think of course of history the the

241

00:10:01,990 --> 00:10:00,399

history of civilization and in a sense

242

00:10:03,750 --> 00:10:02,000

with the anthropocene we're realizing

243

00:10:06,389 --> 00:10:03,760

that these have all become braided

244

00:10:08,550 --> 00:10:06,399

together perhaps irreversibly that in a

245

00:10:11,990 --> 00:10:08,560

certain sense there may be no more

246

00:10:13,750 --> 00:10:12,000

history without geology and vice versa

247

00:10:15,350 --> 00:10:13,760

so

248

00:10:17,030 --> 00:10:15,360

people have been looking at this and

249

00:10:19,030 --> 00:10:17,040

there's a lot of data on this and i'm

250

00:10:21,430 --> 00:10:19,040

not gonna i'm gonna go through this part

251

00:10:24,630 --> 00:10:21,440

very quickly because it's not my

252

00:10:25,430 --> 00:10:24,640

goal here to convince you that humans in

253

00:10:27,030 --> 00:10:25,440

fact

254

00:10:29,350 --> 00:10:27,040

have become a dominant force i think

255

00:10:31,190 --> 00:10:29,360

you're probably aware of a lot of this

256

00:10:33,030 --> 00:10:31,200

but just to summarize

257

00:10:34,949 --> 00:10:33,040

if you look at so many these are all

258

00:10:37,030 --> 00:10:34,959

different indicators of human presence

259

00:10:39,990 --> 00:10:37,040

on earth and certainly if you look at

260

00:10:41,509 --> 00:10:40,000

your population and things like uh

261

00:10:44,150 --> 00:10:41,519

damning of rivers what we've been doing

262

00:10:48,310 --> 00:10:44,160

to the water cycle the hydrological

263

00:10:49,670 --> 00:10:48,320

cycle of earth here's a weird fact that

264

00:10:51,110 --> 00:10:49,680

there is now

265

00:10:54,310 --> 00:10:51,120

more water

266

00:10:56,310 --> 00:10:54,320

in reservoirs behind dams on earth than

267

00:10:58,630 --> 00:10:56,320

in all the natural flowing streams and

268

00:10:59,509 --> 00:10:58,640

rivers on earth by a factor of five or

269

00:11:00,710 --> 00:10:59,519

six

270

00:11:03,350 --> 00:11:00,720

more water

271

00:11:05,110 --> 00:11:03,360

in behind dams so that's not a minor

272

00:11:08,150 --> 00:11:05,120

effect we've had on the hydrological

273

00:11:09,750 --> 00:11:08,160

cycle similarly you can look at so many

274

00:11:11,990 --> 00:11:09,760

of these other indicators and here's

275

00:11:13,990 --> 00:11:12,000

sort of a funny facetious one mcdonald's

276

00:11:16,389 --> 00:11:14,000

restaurants but it actually is an

277

00:11:17,750 --> 00:11:16,399

indicator fertilizer use we're really

278

00:11:19,590 --> 00:11:17,760

changing the nitrogen cycle of the

279

00:11:21,030 --> 00:11:19,600

planet with this and

280

00:11:23,829 --> 00:11:21,040

the interesting thing is that you you

281

00:11:26,630 --> 00:11:23,839

can see a common

282

00:11:27,910 --> 00:11:26,640

form to all of these

283

00:11:29,829 --> 00:11:27,920

you know they're not exactly the same

284

00:11:31,829 --> 00:11:29,839

but you can see a similarity and in

285

00:11:34,550 --> 00:11:31,839

particular there's this big jump

286

00:11:35,670 --> 00:11:34,560

post-war around 1950 and a lot of them

287

00:11:36,870 --> 00:11:35,680

and that's something that scholars of

288

00:11:39,110 --> 00:11:36,880

the anthropocene called the great

289

00:11:40,710 --> 00:11:39,120

acceleration and there's different ideas

290

00:11:42,870 --> 00:11:40,720

as to why that happened but a lot of it

291

00:11:45,269 --> 00:11:42,880

had to do with the sort of suppression

292

00:11:47,750 --> 00:11:45,279

of a lot of activity during the wars and

293

00:11:49,430 --> 00:11:47,760

then the explosion after that so this

294

00:11:51,430 --> 00:11:49,440

these are all indicators of human

295

00:11:52,790 --> 00:11:51,440

presence on the earth and then this next

296

00:11:54,710 --> 00:11:52,800

slide i'll show you one more slide of

297

00:11:57,350 --> 00:11:54,720

data these are all indicators of the

298

00:12:00,550 --> 00:11:57,360

sort of human effects on earth systems

299

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

so the obvious ones co2 of course going

300

00:12:04,389 --> 00:12:02,959

up and other atmospheric gases

301

00:12:06,790 --> 00:12:04,399

and um

302

00:12:08,790 --> 00:12:06,800

you know ozone you know about

303

00:12:10,590 --> 00:12:08,800

different climate indicators the number

304

00:12:13,190 --> 00:12:10,600

of great floods

305

00:12:15,110 --> 00:12:13,200

biodiversity changes and again you see a

306

00:12:16,949 --> 00:12:15,120

lot of this sort of you know they're not

307

00:12:18,870 --> 00:12:16,959

identical because there's a complex

308

00:12:21,190 --> 00:12:18,880

system but you see this common form with

309

00:12:23,350 --> 00:12:21,200

a great acceleration in a lot of these

310

00:12:25,509 --> 00:12:23,360

so there's there's really no doubt

311

00:12:28,069 --> 00:12:25,519

that we are having this massive effect

312

00:12:30,310 --> 00:12:28,079

on our planet so what is the context

313

00:12:31,110 --> 00:12:30,320

through which we should think about this

314

00:12:33,350 --> 00:12:31,120

well

315

00:12:36,069 --> 00:12:33,360

as an astrobiologist i'm drawn to

316

00:12:37,430 --> 00:12:36,079

thinking about things in terms of

317

00:12:39,509 --> 00:12:37,440

the really big picture in terms of

318

00:12:41,750 --> 00:12:39,519

cosmic evolution

319

00:12:43,590 --> 00:12:41,760

and by the way uh as was mentioned in

320

00:12:46,150 --> 00:12:43,600

the introduction i'm here this week for

321

00:12:49,350 --> 00:12:46,160

this extraordinary meeting it's been so

322

00:12:50,790 --> 00:12:49,360

interesting it's it's a a workshop here

323

00:12:53,990 --> 00:12:50,800

our symposium here at the space

324

00:12:56,949 --> 00:12:54,000

telescope science institute called

325

00:12:58,470 --> 00:12:56,959

habitable worlds habitable worlds across

326

00:13:00,150 --> 00:12:58,480

time and space

327

00:13:02,389 --> 00:13:00,160

and it's so interesting because people

328

00:13:04,069 --> 00:13:02,399

are talking about all these different

329

00:13:06,550 --> 00:13:04,079

things that are represented here in this

330

00:13:09,030 --> 00:13:06,560

cartoon about galaxy formation star

331

00:13:10,629 --> 00:13:09,040

formation and planet formation and where

332

00:13:13,030 --> 00:13:10,639

you might get life in the universe and

333

00:13:15,269 --> 00:13:13,040

even the evolution of complex life so on

334

00:13:18,550 --> 00:13:15,279

this on this this this is a one-page

335

00:13:21,190 --> 00:13:18,560

cartoon history of the entire

336

00:13:23,030 --> 00:13:21,200

universe but it's meant to point out

337

00:13:23,990 --> 00:13:23,040

when we think of cosmic evolution we

338

00:13:26,629 --> 00:13:24,000

think of

339

00:13:28,949 --> 00:13:26,639

sort of the major transitions that the

340

00:13:31,750 --> 00:13:28,959

universe has gone through especially in

341

00:13:33,990 --> 00:13:31,760

terms of the way matter is organized and

342

00:13:36,310 --> 00:13:34,000

so obviously originally you had the big

343

00:13:37,910 --> 00:13:36,320

bang and they formed galaxies and then

344

00:13:40,150 --> 00:13:37,920

in these magnifying glasses sort of

345

00:13:43,190 --> 00:13:40,160

what's happening on the micro scale so

346

00:13:44,310 --> 00:13:43,200

you start getting the um the galaxies

347

00:13:47,590 --> 00:13:44,320

and stars

348

00:13:48,470 --> 00:13:47,600

give birth to the the elements and then

349

00:13:51,030 --> 00:13:48,480

you get

350

00:13:53,110 --> 00:13:51,040

simple organic molecules in

351

00:13:56,389 --> 00:13:53,120

interstellar clouds and the the

352

00:13:59,030 --> 00:13:56,399

environments around young stars and then

353

00:14:01,030 --> 00:13:59,040

on the surfaces of at least some planets

354

00:14:03,590 --> 00:14:01,040

you get more complex molecules and at

355

00:14:05,750 --> 00:14:03,600

least on one planet we had an origin of

356

00:14:08,069 --> 00:14:05,760

life and then organic molecules

357

00:14:11,269 --> 00:14:08,079

frolicking in the primordial glop of a

358

00:14:13,350 --> 00:14:11,279

young earth and voila here we have the

359

00:14:15,910 --> 00:14:13,360

evolution of complex life and what we so

360

00:14:17,189 --> 00:14:15,920

perhaps vainly call civilization and it

361

00:14:19,110 --> 00:14:17,199

ends here with

362

00:14:20,550 --> 00:14:19,120

question marks and about what's next

363

00:14:23,430 --> 00:14:20,560

because why should we assume that this

364

00:14:25,670 --> 00:14:23,440

is the apotheosis of cosmic evolution

365

00:14:27,990 --> 00:14:25,680

what we've got going on right here but

366

00:14:30,629 --> 00:14:28,000

the other thing i'll point out is that

367

00:14:32,150 --> 00:14:30,639

part of what we're driven to do in

368

00:14:34,389 --> 00:14:32,160

astrobiology

369

00:14:36,550 --> 00:14:34,399

is try to understand how universal these

370

00:14:37,430 --> 00:14:36,560

processes are so everything on the left

371

00:14:39,110 --> 00:14:37,440

side

372

00:14:40,710 --> 00:14:39,120

of this cartoon

373

00:14:44,790 --> 00:14:40,720

is known to be universal there are

374

00:14:46,629 --> 00:14:44,800

galaxies and stars formed everywhere

375

00:14:48,790 --> 00:14:46,639

in the universe and we're driven to

376

00:14:50,949 --> 00:14:48,800

wonder if these things on the right side

377

00:14:53,430 --> 00:14:50,959

are also similarly

378

00:14:55,590 --> 00:14:53,440

phenomena that are widespread and not

379

00:14:58,150 --> 00:14:55,600

just unique to this location now the

380

00:14:59,990 --> 00:14:58,160

great news of course in the last decade

381

00:15:01,189 --> 00:15:00,000

or two is that now we know that planet

382

00:15:04,470 --> 00:15:01,199

formation

383

00:15:06,870 --> 00:15:04,480

is in fact common i would say universal

384

00:15:09,030 --> 00:15:06,880

we didn't know this even really a decade

385

00:15:10,470 --> 00:15:09,040

ago to the way that we know it now with

386

00:15:11,269 --> 00:15:10,480

the wonderful kepler mission and the

387

00:15:12,710 --> 00:15:11,279

other

388

00:15:14,710 --> 00:15:12,720

discoveries you've been hearing about

389

00:15:16,870 --> 00:15:14,720

but now you know when you look up at

390

00:15:18,870 --> 00:15:16,880

night at the stars

391

00:15:20,230 --> 00:15:18,880

that most of them almost all of them

392

00:15:22,069 --> 00:15:20,240

have planets

393

00:15:23,910 --> 00:15:22,079

and a sizable

394

00:15:26,629 --> 00:15:23,920

percentage of them probably have planets

395

00:15:29,590 --> 00:15:26,639

that in some significant ways resemble

396

00:15:31,269 --> 00:15:29,600

our planet so that is new and profound

397

00:15:34,150 --> 00:15:31,279

we're moving some things into this

398

00:15:36,949 --> 00:15:34,160

column of the either that we wonder

399

00:15:38,389 --> 00:15:36,959

about how universal they are to in fact

400

00:15:41,110 --> 00:15:38,399

knowing that they're universal but we're

401  
00:15:43,430 --> 00:15:41,120  
still on the trail of these last two

402  
00:15:46,470 --> 00:15:43,440  
developments life and complex life

403  
00:15:47,670 --> 00:15:46,480  
that's what we're driven to understand

404  
00:15:49,829 --> 00:15:47,680  
now

405  
00:15:53,590 --> 00:15:49,839  
the story here locally

406  
00:15:56,310 --> 00:15:53,600  
began about 4.6 billion years ago with a

407  
00:16:00,150 --> 00:15:56,320  
process we call accretion

408  
00:16:02,310 --> 00:16:00,160  
where this disk of dust and gas

409  
00:16:03,829 --> 00:16:02,320  
around the young sun went through this

410  
00:16:06,310 --> 00:16:03,839  
process of

411  
00:16:08,790 --> 00:16:06,320  
of congealing and conglomeration and

412  
00:16:10,870 --> 00:16:08,800  
falling together of larger and larger

413  
00:16:13,030 --> 00:16:10,880

objects and more and more violent

414

00:16:15,110 --> 00:16:13,040

collisions so there was this crashing

415

00:16:16,710 --> 00:16:15,120

and bashing and smashing and the sort of

416

00:16:17,670 --> 00:16:16,720

demolition derby

417

00:16:19,749 --> 00:16:17,680

and that

418

00:16:21,110 --> 00:16:19,759

as as the objects got larger their

419

00:16:23,670 --> 00:16:21,120

gravitational

420

00:16:25,990 --> 00:16:23,680

pull got larger and their forces between

421

00:16:27,990 --> 00:16:26,000

them got larger and the so the final

422

00:16:31,030 --> 00:16:28,000

stage was quite violent collisions

423

00:16:33,189 --> 00:16:31,040

including the the late collision that uh

424

00:16:35,749 --> 00:16:33,199

where a very large object hit the earth

425

00:16:37,749 --> 00:16:35,759

and and splashed material into orbit

426

00:16:39,910 --> 00:16:37,759

which made our moon and that was sort of

427

00:16:42,069 --> 00:16:39,920

the end of accretion really other than

428

00:16:45,189 --> 00:16:42,079

just a little mopping up so it was

429

00:16:46,790 --> 00:16:45,199

really this gravitational accretion that

430

00:16:49,269 --> 00:16:46,800

formed the planets

431

00:16:51,189 --> 00:16:49,279

now i'm going to skip some steps and and

432

00:16:52,949 --> 00:16:51,199

rush ahead about four and a half billion

433

00:16:55,829 --> 00:16:52,959

years but

434

00:16:58,150 --> 00:16:55,839

something remarkable has happened on one

435

00:17:00,069 --> 00:16:58,160

of those planets

436

00:17:02,790 --> 00:17:00,079

if you had been watching earth say you

437

00:17:06,789 --> 00:17:02,800

were a patient alien watching earth for

438

00:17:08,230 --> 00:17:06,799

all these billions of years

439

00:17:10,150 --> 00:17:08,240

you would have noticed

440

00:17:12,470 --> 00:17:10,160

a lot of activity in the interim say you

441

00:17:13,909 --> 00:17:12,480

were watching the night side of earth

442

00:17:15,429 --> 00:17:13,919

it would have been pretty dark

443

00:17:17,029 --> 00:17:15,439

throughout most of that period yeah you

444

00:17:19,990 --> 00:17:17,039

would have seen the occasional flash of

445

00:17:22,390 --> 00:17:20,000

lightning the occasional splash of of

446

00:17:24,710 --> 00:17:22,400

aurora the northern and southern lights

447

00:17:26,870 --> 00:17:24,720

and then more recently in the last few

448

00:17:28,950 --> 00:17:26,880

hundred million years once the

449

00:17:31,190 --> 00:17:28,960

continents got forested you would see

450

00:17:32,470 --> 00:17:31,200

the occasional forest fire

451  
00:17:34,310 --> 00:17:32,480  
maybe once in a while you'd see a

452  
00:17:36,230 --> 00:17:34,320  
glowing volcano but in general the night

453  
00:17:38,870 --> 00:17:36,240  
side would have been very dark and then

454  
00:17:40,870 --> 00:17:38,880  
very recently

455  
00:17:42,789 --> 00:17:40,880  
to your alien eyes

456  
00:17:43,830 --> 00:17:42,799  
something really remarkable would have

457  
00:17:44,789 --> 00:17:43,840  
happened

458  
00:17:47,350 --> 00:17:44,799  
and

459  
00:17:49,190 --> 00:17:47,360  
these networks of lights these glowing

460  
00:17:50,950 --> 00:17:49,200  
areas would have sprung up first on some

461  
00:17:53,270 --> 00:17:50,960  
of the coastal areas and then the little

462  
00:17:54,950 --> 00:17:53,280  
filaments of roads between those

463  
00:17:56,870 --> 00:17:54,960

inhabited coastal areas and you would

464

00:18:01,110 --> 00:17:56,880

have said wow something new and

465

00:18:04,710 --> 00:18:01,120

remarkable is happening on this planet

466

00:18:09,750 --> 00:18:07,270

and not only that but if you were a very

467

00:18:11,830 --> 00:18:09,760

observant alien just in the last 50 60

468

00:18:14,789 --> 00:18:11,840

years you would have noticed

469

00:18:18,549 --> 00:18:14,799

a curious anti-accretion

470

00:18:20,950 --> 00:18:18,559

where a few little bits of the planet

471

00:18:22,630 --> 00:18:20,960

started flying back off

472

00:18:24,789 --> 00:18:22,640

out into space

473

00:18:27,590 --> 00:18:24,799

in seeming defiance of the laws of

474

00:18:28,789 --> 00:18:27,600

gravity and going back out to the other

475

00:18:31,510 --> 00:18:28,799

planets

476  
00:18:33,510 --> 00:18:31,520  
and sending radio signals back and so

477  
00:18:35,669 --> 00:18:33,520  
it's a curious anti-accretion in two

478  
00:18:37,270 --> 00:18:35,679  
senses of the word it's curious in that

479  
00:18:38,630 --> 00:18:37,280  
it would be very strange if you didn't

480  
00:18:42,070 --> 00:18:38,640  
understand what's going on but it's also

481  
00:18:43,750 --> 00:18:42,080  
the hallmark of curiosity a species on

482  
00:18:45,590 --> 00:18:43,760  
this one planet

483  
00:18:47,510 --> 00:18:45,600  
has started to

484  
00:18:49,830 --> 00:18:47,520  
send emissaries to the rest of the solar

485  
00:18:53,669 --> 00:18:49,840  
system asking questions seeking

486  
00:18:55,270 --> 00:18:53,679  
information about origins and context

487  
00:18:56,789 --> 00:18:55,280  
so

488  
00:18:58,070 --> 00:18:56,799

there's a lot one can say about what

489

00:19:00,950 --> 00:18:58,080

we've learned through comparative

490

00:19:03,750 --> 00:19:00,960

planetology and that's actually

491

00:19:06,390 --> 00:19:03,760

my day job in to the extent that it

492

00:19:09,190 --> 00:19:06,400

could be considered a day job um

493

00:19:11,350 --> 00:19:09,200

and um so to summer up to summarize sort

494

00:19:13,909 --> 00:19:11,360

of a you know life's work in in one

495

00:19:15,669 --> 00:19:13,919

slide one thing we've learned through

496

00:19:18,230 --> 00:19:15,679

through this study in particular through

497

00:19:20,310 --> 00:19:18,240

studying the trio of venus earth and

498

00:19:22,549 --> 00:19:20,320

mars which is very compelling because

499

00:19:24,710 --> 00:19:22,559

these are the two planets that

500

00:19:26,630 --> 00:19:24,720

seem to start out earth-like and then go

501  
00:19:28,549 --> 00:19:26,640  
off in their own directions what we've

502  
00:19:30,070 --> 00:19:28,559  
learned is that surprisingly these

503  
00:19:31,909 --> 00:19:30,080  
planets seem to have very similar

504  
00:19:34,710 --> 00:19:31,919  
origins in early environments you've

505  
00:19:36,150 --> 00:19:34,720  
heard all about the early water on mars

506  
00:19:38,070 --> 00:19:36,160  
we're still learning more about that but

507  
00:19:39,830 --> 00:19:38,080  
there's a lot of evidence that mars was

508  
00:19:42,789 --> 00:19:39,840  
a warmer wetter place when it was young

509  
00:19:44,549 --> 00:19:42,799  
and venus too we think had had oceans

510  
00:19:46,230 --> 00:19:44,559  
and a sort of warm friendly surface

511  
00:19:48,630 --> 00:19:46,240  
environment when it was young we've got

512  
00:19:50,470 --> 00:19:48,640  
to do a lot more exploring to really get

513  
00:19:52,710 --> 00:19:50,480

that story straight but that's what we

514

00:19:54,070 --> 00:19:52,720

think they had similar origins and so it

515

00:19:55,909 --> 00:19:54,080

may be that the conditions for the

516

00:19:57,190 --> 00:19:55,919

origin of life

517

00:19:58,150 --> 00:19:57,200

are common

518

00:20:03,110 --> 00:19:58,160

that

519

00:20:05,590 --> 00:20:03,120

start out with similar conditions to

520

00:20:07,029 --> 00:20:05,600

those that on earth seem to facilitate

521

00:20:09,430 --> 00:20:07,039

the origin of life and it may be that

522

00:20:11,510 --> 00:20:09,440

what's rare is the persistence of a

523

00:20:13,430 --> 00:20:11,520

habitable planetary environment over

524

00:20:16,150 --> 00:20:13,440

over cosmological time scales over

525

00:20:17,350 --> 00:20:16,160

billions of years

526

00:20:20,230 --> 00:20:17,360

so

527

00:20:22,630 --> 00:20:20,240

it seems like earth under compared to

528

00:20:24,710 --> 00:20:22,640

its neighbors went down a different path

529

00:20:27,830 --> 00:20:24,720

there was an early divergence an origin

530

00:20:31,029 --> 00:20:27,840

of life which has had profound effects

531

00:20:32,470 --> 00:20:31,039

on the further evolution of the planet

532

00:20:35,110 --> 00:20:32,480

in fact uh

533

00:20:36,070 --> 00:20:35,120

my co my colleague colin goldblad at a

534

00:20:37,669 --> 00:20:36,080

recent

535

00:20:39,830 --> 00:20:37,679

meeting put it this way he said the the

536

00:20:41,669 --> 00:20:39,840

defining characteristic of earth is

537

00:20:43,590 --> 00:20:41,679

planetary scale life

538

00:20:45,830 --> 00:20:43,600

and earth teaches us that habitability

539

00:20:47,350 --> 00:20:45,840

and inhabitants are inseparable in other

540

00:20:49,510 --> 00:20:47,360

words the more we study the earth the

541

00:20:51,510 --> 00:20:49,520

more we realize that earth has

542

00:20:53,669 --> 00:20:51,520

that life has really

543

00:20:55,830 --> 00:20:53,679

got earth in its clutches in a deep way

544

00:20:58,310 --> 00:20:55,840

obviously it's changed the atmosphere

545

00:21:00,710 --> 00:20:58,320

it's changed the look of earth from

546

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

space it's changed the hydrological

547

00:21:04,789 --> 00:21:02,480

cycle but even more and more now we're

548

00:21:06,230 --> 00:21:04,799

realizing it's changed the rocks

549

00:21:09,190 --> 00:21:06,240

and the minerals we heard a great talk

550

00:21:11,510 --> 00:21:09,200

about that today that earth has three

551  
00:21:12,390 --> 00:21:11,520  
times the mineral diversity because of

552  
00:21:13,909 --> 00:21:12,400  
life

553  
00:21:16,070 --> 00:21:13,919  
uh there's the range and number of

554  
00:21:17,510 --> 00:21:16,080  
minerals that the chemistry of life does

555  
00:21:19,350 --> 00:21:17,520  
to it that it would have if it was a

556  
00:21:22,470 --> 00:21:19,360  
lifeless planet it's even changed the

557  
00:21:23,510 --> 00:21:22,480  
interior properties of the planet so so

558  
00:21:25,830 --> 00:21:23,520  
life

559  
00:21:27,510 --> 00:21:25,840  
it was this early branching point and

560  
00:21:29,270 --> 00:21:27,520  
then subsequently for nearly four

561  
00:21:30,470 --> 00:21:29,280  
billion years earth has been evolving

562  
00:21:32,710 --> 00:21:30,480  
under the influence

563  
00:21:34,070 --> 00:21:32,720

of global forces that have seemingly not

564

00:21:36,149 --> 00:21:34,080

been at work on our neighboring planet

565

00:21:38,470 --> 00:21:36,159

so there was a branching point

566

00:21:39,830 --> 00:21:38,480

and what i'm interested in is the

567

00:21:42,630 --> 00:21:39,840

possibility that what we're going

568

00:21:44,950 --> 00:21:42,640

through now the anthropocene

569

00:21:46,549 --> 00:21:44,960

looked at in terms of cosmic evolution

570

00:21:48,630 --> 00:21:46,559

and the kinds of things that can happen

571

00:21:50,470 --> 00:21:48,640

to planets maybe in a certain sense

572

00:21:52,710 --> 00:21:50,480

another branching point

573

00:21:55,029 --> 00:21:52,720

more recently as illustrated here by

574

00:21:55,909 --> 00:21:55,039

this illuminated nightside earth

575

00:21:57,590 --> 00:21:55,919

earth

576  
00:21:59,750 --> 00:21:57,600  
has come under the influence of a new

577  
00:22:01,750 --> 00:21:59,760  
type of geological force the global

578  
00:22:03,270 --> 00:22:01,760  
activities of humanity defining the

579  
00:22:05,190 --> 00:22:03,280  
anthropocene

580  
00:22:07,990 --> 00:22:05,200  
so again i want to sort of try to

581  
00:22:09,350 --> 00:22:08,000  
present a context to think about that

582  
00:22:11,350 --> 00:22:09,360  
now

583  
00:22:12,789 --> 00:22:11,360  
we are not the first species the first

584  
00:22:16,149 --> 00:22:12,799  
kind of life to come along and

585  
00:22:17,590 --> 00:22:16,159  
profoundly change the earth

586  
00:22:20,149 --> 00:22:17,600  
in fact

587  
00:22:22,390 --> 00:22:20,159  
the most extreme transition ever in

588  
00:22:24,830 --> 00:22:22,400

earth history happened a little over two

589

00:22:27,270 --> 00:22:24,840

billion years ago and it was the great

590

00:22:29,830 --> 00:22:27,280

oxygenation event

591

00:22:31,590 --> 00:22:29,840

now we think of oxygen as this wonderful

592

00:22:33,990 --> 00:22:31,600

thing and we're glad that the great

593

00:22:35,430 --> 00:22:34,000

oxygen oxygen

594

00:22:37,590 --> 00:22:35,440

oxygenation

595

00:22:39,029 --> 00:22:37,600

event that happened

596

00:22:41,590 --> 00:22:39,039

uh because

597

00:22:44,630 --> 00:22:41,600

we like oxygen i love auction

598

00:22:47,590 --> 00:22:44,640

ah it's a good thing but

599

00:22:49,430 --> 00:22:47,600

at the time it was a disaster it was a

600

00:22:51,350 --> 00:22:49,440

profound

601  
00:22:53,510 --> 00:22:51,360  
change and it led to a mass extinction

602  
00:22:57,350 --> 00:22:53,520  
because oxygen is poisonous to organic

603  
00:22:59,590 --> 00:22:57,360  
life life now has evolved to make use of

604  
00:23:02,149 --> 00:22:59,600  
that violent reaction that oxygen goes

605  
00:23:05,190 --> 00:23:02,159  
through with organic chemistry that's

606  
00:23:06,470 --> 00:23:05,200  
how we live we power ourselves on that

607  
00:23:08,630 --> 00:23:06,480  
that

608  
00:23:10,950 --> 00:23:08,640  
combustion reaction

609  
00:23:13,669 --> 00:23:10,960  
but when the oxygen first appeared and

610  
00:23:16,070 --> 00:23:13,679  
life did not handle it it was disaster a

611  
00:23:17,990 --> 00:23:16,080  
lot of species went extinct so oxygen is

612  
00:23:19,990 --> 00:23:18,000  
poisonous and not only that it may have

613  
00:23:23,669 --> 00:23:20,000

caused a great

614

00:23:25,990 --> 00:23:23,679

huge global global climate disaster

615

00:23:28,230 --> 00:23:26,000

there's something that we call the paleo

616

00:23:30,230 --> 00:23:28,240

protozoa snowball earth

617

00:23:32,230 --> 00:23:30,240

it's one of the few times in history

618

00:23:33,270 --> 00:23:32,240

when earth has become completely iced

619

00:23:35,350 --> 00:23:33,280

over

620

00:23:37,270 --> 00:23:35,360

and may have become almost irreversibly

621

00:23:39,110 --> 00:23:37,280

iced over there's a state where it can

622

00:23:41,350 --> 00:23:39,120

become stably

623

00:23:44,390 --> 00:23:41,360

glaciated because when a planet gets

624

00:23:46,870 --> 00:23:44,400

iced over it reflects more sunlight and

625

00:23:48,870 --> 00:23:46,880

sort of keeps itself cool

626

00:23:51,110 --> 00:23:48,880

fortunately the volcanoes came to the

627

00:23:52,870 --> 00:23:51,120

rescue and pumped up co2 and

628

00:23:54,710 --> 00:23:52,880

got us out of that trap but nonetheless

629

00:23:56,149 --> 00:23:54,720

it's a scary thought that a planet you

630

00:23:57,750 --> 00:23:56,159

know if a planet's a little bit farther

631

00:24:00,630 --> 00:23:57,760

out from the sun maybe it could get

632

00:24:03,750 --> 00:24:00,640

trapped in that state so what happened

633

00:24:05,990 --> 00:24:03,760

was probably at that time earth was

634

00:24:08,630 --> 00:24:06,000

being kept warm by a methane greenhouse

635

00:24:10,870 --> 00:24:08,640

a ch4 greenhouse and then the oxygen

636

00:24:12,630 --> 00:24:10,880

came along and oxygen destroys methane

637

00:24:13,830 --> 00:24:12,640

and it collapsed the climate and led to

638

00:24:15,669 --> 00:24:13,840

this global

639

00:24:17,350 --> 00:24:15,679

freezing so it could have been a close

640

00:24:18,549 --> 00:24:17,360

call to irreversible planetary

641

00:24:20,789 --> 00:24:18,559

destruction

642

00:24:22,630 --> 00:24:20,799

and my you know slightly facetious way

643

00:24:24,310 --> 00:24:22,640

of describing it here is that by

644

00:24:26,110 --> 00:24:24,320

innocently exploiting a new energy

645

00:24:28,470 --> 00:24:26,120

resource because that's all that the

646

00:24:30,470 --> 00:24:28,480

cyanobacteria who did this were doing

647

00:24:32,149 --> 00:24:30,480

they said oh great solar energy we love

648

00:24:34,310 --> 00:24:32,159

it let's multiply and do more and more

649

00:24:36,230 --> 00:24:34,320

of it they free energy that's all they

650

00:24:38,310 --> 00:24:36,240

were doing was exploiting

651  
00:24:42,710 --> 00:24:38,320  
an energy resource

652  
00:24:50,950 --> 00:24:46,630  
how weird i started hearing myself

653  
00:24:56,870 --> 00:24:54,630  
it's going to mess me up all right

654  
00:24:59,190 --> 00:24:56,880  
those irresponsible bacteria cause the

655  
00:25:01,590 --> 00:24:59,200  
global environmental catastrophe now i'm

656  
00:25:03,269 --> 00:25:01,600  
joking because i don't really think that

657  
00:25:06,230 --> 00:25:03,279  
bacteria are capable of being

658  
00:25:07,990 --> 00:25:06,240  
irresponsible but

659  
00:25:10,390 --> 00:25:08,000  
looking at that question what is the

660  
00:25:13,269 --> 00:25:10,400  
difference between what we are doing

661  
00:25:15,110 --> 00:25:13,279  
between us and the cyanobacteria is one

662  
00:25:17,830 --> 00:25:15,120  
interesting way of thinking about the

663  
00:25:20,230 --> 00:25:17,840

transformation that's going on now on

664

00:25:22,149 --> 00:25:20,240

earth so as i said we're not the first

665

00:25:24,230 --> 00:25:22,159

species to cause global change so what

666

00:25:27,110 --> 00:25:24,240

have we got that the cyanobacteria

667

00:25:29,190 --> 00:25:27,120

didn't well now you get into what i'm

668

00:25:31,350 --> 00:25:29,200

sort of grouping together as human

669

00:25:33,750 --> 00:25:31,360

qualities here and these are all sort of

670

00:25:35,830 --> 00:25:33,760

loaded concepts and we could argue them

671

00:25:37,669 --> 00:25:35,840

each one there it's an interesting

672

00:25:40,870 --> 00:25:37,679

question really what does distinguish

673

00:25:42,950 --> 00:25:40,880

humans from the rest of life but

674

00:25:44,310 --> 00:25:42,960

these kinds of things are what are

675

00:25:46,710 --> 00:25:44,320

usually discussed

676  
00:25:49,430 --> 00:25:46,720  
language tool use

677  
00:25:52,470 --> 00:25:49,440  
art technology

678  
00:25:55,350 --> 00:25:52,480  
intelligence consciousness foresight

679  
00:25:56,950 --> 00:25:55,360  
awareness responsibility

680  
00:25:59,350 --> 00:25:56,960  
any one of these you could argue but i

681  
00:26:01,750 --> 00:25:59,360  
think collectively you get the idea they

682  
00:26:03,830 --> 00:26:01,760  
form this set of qualities that makes us

683  
00:26:05,830 --> 00:26:03,840  
human and differentiates us from for

684  
00:26:07,190 --> 00:26:05,840  
example the cyanobacteria now somebody

685  
00:26:09,510 --> 00:26:07,200  
joked to me and i think in a way it's

686  
00:26:11,190 --> 00:26:09,520  
true that these are actually all the

687  
00:26:12,230 --> 00:26:11,200  
things that we don't have quite enough

688  
00:26:15,830 --> 00:26:12,240

of

689

00:26:17,990 --> 00:26:15,840

may be true but you know it's

690

00:26:19,909 --> 00:26:18,000

interesting to look at this as a group

691

00:26:22,149 --> 00:26:19,919

of qualities that we have and you can

692

00:26:24,870 --> 00:26:22,159

ask in evolutionary terms are these

693

00:26:27,269 --> 00:26:24,880

qualities adaptive that is

694

00:26:28,710 --> 00:26:27,279

will we actually do they facilitate

695

00:26:29,590 --> 00:26:28,720

survival

696

00:26:31,909 --> 00:26:29,600

or

697

00:26:33,269 --> 00:26:31,919

are they in some way an evolutionary

698

00:26:34,789 --> 00:26:33,279

dead end

699

00:26:37,029 --> 00:26:34,799

could they be a potential gateway to

700

00:26:39,430 --> 00:26:37,039

great longevity

701  
00:26:42,390 --> 00:26:39,440  
one can see how they might be

702  
00:26:45,110 --> 00:26:42,400  
these are ways of solving problems

703  
00:26:47,190 --> 00:26:45,120  
and obviously you can imagine problems

704  
00:26:50,230 --> 00:26:47,200  
that can be solved by creatures with

705  
00:26:52,230 --> 00:26:50,240  
these that that without these qualities

706  
00:26:54,789 --> 00:26:52,240  
would would threaten your existence if

707  
00:26:56,549 --> 00:26:54,799  
an asteroid is heading your way

708  
00:26:58,630 --> 00:26:56,559  
the cyanobacteria wouldn't be able to do

709  
00:27:00,710 --> 00:26:58,640  
anything about that in theory we could

710  
00:27:02,230 --> 00:27:00,720  
so one can imagine these as qualities

711  
00:27:04,310 --> 00:27:02,240  
that might threaten our survival or

712  
00:27:06,549 --> 00:27:04,320  
might ensure it

713  
00:27:09,350 --> 00:27:06,559

and if civilization is now a planetary

714

00:27:10,950 --> 00:27:09,360

process what are its prospects here and

715

00:27:12,950 --> 00:27:10,960

elsewhere in the universe are there

716

00:27:15,990 --> 00:27:12,960

things about this list that can be

717

00:27:18,630 --> 00:27:16,000

extrapolated to evolution

718

00:27:19,430 --> 00:27:18,640

of complex life on other planets

719

00:27:21,190 --> 00:27:19,440

so

720

00:27:23,430 --> 00:27:21,200

in order to get a little more of a

721

00:27:25,190 --> 00:27:23,440

handle on this and again working on this

722

00:27:26,310 --> 00:27:25,200

question of how to contextualize what is

723

00:27:28,070 --> 00:27:26,320

happening

724

00:27:31,190 --> 00:27:28,080

i'm going to present to you

725

00:27:32,390 --> 00:27:31,200

sort of a taxonomy of catastrophe here

726

00:27:34,310 --> 00:27:32,400

here are

727

00:27:36,310 --> 00:27:34,320

i've looked at the different kinds of

728

00:27:38,549 --> 00:27:36,320

planetary changes that happen not just

729

00:27:41,430 --> 00:27:38,559

on earth but on planets in general and

730

00:27:43,750 --> 00:27:41,440

i've grouped them into four categories

731

00:27:44,870 --> 00:27:43,760

classified with respect to the influence

732

00:27:47,350 --> 00:27:44,880

of life

733

00:27:50,070 --> 00:27:47,360

and i call them natural disasters

734

00:27:53,430 --> 00:27:50,080

biological catastrophes inadvertent

735

00:27:54,870 --> 00:27:53,440

catastrophes and intentional changes

736

00:27:56,070 --> 00:27:54,880

let me say a little bit more what i

737

00:27:57,990 --> 00:27:56,080

actually mean

738

00:27:59,990 --> 00:27:58,000

by these four kinds of planetary change

739

00:28:02,310 --> 00:28:00,000

so planetary changes of the first kind

740

00:28:04,710 --> 00:28:02,320

natural disasters i don't mean exactly

741

00:28:07,190 --> 00:28:04,720

what we normally mean by that phrase

742

00:28:09,110 --> 00:28:07,200

what i mean specifically is

743

00:28:11,269 --> 00:28:09,120

drastic changes that happen to a planet

744

00:28:13,029 --> 00:28:11,279

where life had nothing to do with it

745

00:28:15,190 --> 00:28:13,039

life is not implicated life is an

746

00:28:18,310 --> 00:28:15,200

innocent bystander so the obvious

747

00:28:19,669 --> 00:28:18,320

example is an asteroid impact or a comet

748

00:28:21,590 --> 00:28:19,679

impact and this has happened several

749

00:28:24,789 --> 00:28:21,600

times over the history of the earth most

750

00:28:27,190 --> 00:28:24,799

dramatically 65 million years ago when

751  
00:28:29,029 --> 00:28:27,200  
the dinosaurs and everybody else around

752  
00:28:31,269 --> 00:28:29,039  
at that time or almost everybody around

753  
00:28:34,230 --> 00:28:31,279  
that time went extinct because of the

754  
00:28:35,669 --> 00:28:34,240  
drastic changes caused by an impact but

755  
00:28:37,990 --> 00:28:35,679  
there are other examples that i would

756  
00:28:40,470 --> 00:28:38,000  
put in this category as well what we

757  
00:28:43,350 --> 00:28:40,480  
call large igneous provinces or major

758  
00:28:45,190 --> 00:28:43,360  
volcanic episodes where the earth goes

759  
00:28:46,870 --> 00:28:45,200  
through some sort of burp in its

760  
00:28:48,710 --> 00:28:46,880  
interior and there's a massive

761  
00:28:50,789 --> 00:28:48,720  
outpouring of lava and some of these are

762  
00:28:52,870 --> 00:28:50,799  
so dramatic that they cause huge climate

763  
00:28:54,710 --> 00:28:52,880

excursions and we know they can lead to

764

00:28:57,350 --> 00:28:54,720

mass extinctions

765

00:28:59,029 --> 00:28:57,360

some of the famous ones the deccan traps

766

00:29:00,950 --> 00:28:59,039

in india

767

00:29:03,909 --> 00:29:00,960

close to the time when the dinosaurs got

768

00:29:05,110 --> 00:29:03,919

wiped out over 60 million years ago the

769

00:29:09,029 --> 00:29:05,120

largest

770

00:29:12,389 --> 00:29:09,039

one on earth was the anton java plateau

771

00:29:15,269 --> 00:29:12,399

here in the south pacific and the the um

772

00:29:17,590 --> 00:29:15,279

the siberian traps up here

773

00:29:19,750 --> 00:29:17,600

in siberia uh

774

00:29:21,909 --> 00:29:19,760

have recently been implicated in the

775

00:29:23,669 --> 00:29:21,919

greatest mass extinction of all what we

776

00:29:27,269 --> 00:29:23,679

call the great dying or the perma

777

00:29:30,789 --> 00:29:27,279

triassic extinction 250 million years

778

00:29:34,070 --> 00:29:30,799

ago happened to be just at that moment

779

00:29:36,549 --> 00:29:34,080

when there was a massive outpouring of

780

00:29:38,310 --> 00:29:36,559

volcanic lava and the gases that changed

781

00:29:41,430 --> 00:29:38,320

the climate and changed the chemical

782

00:29:43,669 --> 00:29:41,440

environment that life needs 250 million

783

00:29:45,269 --> 00:29:43,679

years ago now it turns out that the plot

784

00:29:46,310 --> 00:29:45,279

thickens and that that particular

785

00:29:48,630 --> 00:29:46,320

catastrophe might have been a

786

00:29:50,389 --> 00:29:48,640

combination of

787

00:29:52,789 --> 00:29:50,399

category one and category two because

788

00:29:54,549 --> 00:29:52,799

there was a biological component to that

789

00:29:56,710 --> 00:29:54,559

where it seems as though

790

00:29:59,909 --> 00:29:56,720

bacteria that made a lot of methane

791

00:30:02,149 --> 00:29:59,919

might have contributed to that

792

00:30:03,909 --> 00:30:02,159

extinction so that brings us to

793

00:30:05,750 --> 00:30:03,919

planetary changes of the second kind

794

00:30:08,950 --> 00:30:05,760

biological

795

00:30:11,669 --> 00:30:08,960

and i symbolize that here with

796

00:30:12,950 --> 00:30:11,679

the green leaf because the best example

797

00:30:14,310 --> 00:30:12,960

of that is the one i've already been

798

00:30:17,830 --> 00:30:14,320

talking about the evolution of

799

00:30:20,389 --> 00:30:17,840

photosynthesis which was very much

800

00:30:21,510 --> 00:30:20,399

the result of biological evolution and

801  
00:30:23,830 --> 00:30:21,520  
led to

802  
00:30:25,909 --> 00:30:23,840  
a huge catastrophe a huge change in the

803  
00:30:28,149 --> 00:30:25,919  
chemical and climate state of the planet

804  
00:30:29,750 --> 00:30:28,159  
and mass extinction

805  
00:30:31,750 --> 00:30:29,760  
and all that follows

806  
00:30:34,070 --> 00:30:31,760  
now

807  
00:30:34,870 --> 00:30:34,080  
the third kind of change i want to talk

808  
00:30:37,669 --> 00:30:34,880  
about

809  
00:30:39,750 --> 00:30:37,679  
is basically what's happening now

810  
00:30:42,870 --> 00:30:39,760  
inadvertent change

811  
00:30:44,870 --> 00:30:42,880  
and i'm symbolizing it here by traffic

812  
00:30:47,669 --> 00:30:44,880  
and these are all the kinds of

813  
00:30:51,350 --> 00:30:47,679

unplanned but massive changes that

814

00:30:53,669 --> 00:30:51,360

humanity is inducing on earth

815

00:30:56,389 --> 00:30:53,679

and

816

00:30:58,070 --> 00:30:56,399

the fact that we are having these huge

817

00:30:59,750 --> 00:30:58,080

effects on the planet

818

00:31:01,350 --> 00:30:59,760

but they're not it's not intentional

819

00:31:03,269 --> 00:31:01,360

nobody got together and said hey let's

820

00:31:05,990 --> 00:31:03,279

change the co2

821

00:31:08,230 --> 00:31:06,000

it's just happening as a result of our

822

00:31:10,230 --> 00:31:08,240

success at solving certain local

823

00:31:12,149 --> 00:31:10,240

problems with technology

824

00:31:14,070 --> 00:31:12,159

we have these global unintended

825

00:31:16,630 --> 00:31:14,080

consequences and this leads to what i

826

00:31:18,950 --> 00:31:16,640

call the anthropocene dilemma where if

827

00:31:21,750 --> 00:31:18,960

you have a species that has global

828

00:31:24,070 --> 00:31:21,760

influence without global control then

829

00:31:25,669 --> 00:31:24,080

sooner or later that will lead to some

830

00:31:27,510 --> 00:31:25,679

kind of a catastrophe and we're

831

00:31:30,070 --> 00:31:27,520

experiencing that now

832

00:31:31,190 --> 00:31:30,080

uh some other examples of this well

833

00:31:34,230 --> 00:31:31,200

obviously

834

00:31:36,070 --> 00:31:34,240

um atmospheric co2 and this is this is

835

00:31:37,750 --> 00:31:36,080

this is what we call the keeling curve

836

00:31:39,990 --> 00:31:37,760

co2 changing over time and this is

837

00:31:42,070 --> 00:31:40,000

actually this plot's a few years old

838

00:31:43,830 --> 00:31:42,080

it's a decade old and now you'd have to

839

00:31:46,950 --> 00:31:43,840

extend this up we're over we've just

840

00:31:48,789 --> 00:31:46,960

crossed over 400 parts per million co2

841

00:31:51,590 --> 00:31:48,799

and the consequent effects of that of

842

00:31:52,389 --> 00:31:51,600

course the very worrisome disappearance

843

00:31:55,830 --> 00:31:52,399

of

844

00:31:57,029 --> 00:31:55,840

sea ice in in the summer and and fall

845

00:31:59,509 --> 00:31:57,039

and

846

00:32:01,269 --> 00:31:59,519

another example though

847

00:32:02,789 --> 00:32:01,279

that's interesting in this context is

848

00:32:04,230 --> 00:32:02,799

the what you've you've heard about the

849

00:32:06,389 --> 00:32:04,240

ozone hole

850

00:32:08,230 --> 00:32:06,399

where we realized that some what we

851  
00:32:10,230 --> 00:32:08,240  
thought were harmless chemicals that we

852  
00:32:12,389 --> 00:32:10,240  
were using down here in the troposphere

853  
00:32:14,950 --> 00:32:12,399  
where we live when they filtered up to

854  
00:32:17,190 --> 00:32:14,960  
the stratosphere we're having these

855  
00:32:19,430 --> 00:32:17,200  
potentially disastrous effects by the

856  
00:32:21,269 --> 00:32:19,440  
way the fact that chlorine chemicals

857  
00:32:23,669 --> 00:32:21,279  
destroy ozone

858  
00:32:26,230 --> 00:32:23,679  
was discovered in no small part because

859  
00:32:27,590 --> 00:32:26,240  
we were exploring the planet venus

860  
00:32:28,870 --> 00:32:27,600  
and people were looking trying to

861  
00:32:30,789 --> 00:32:28,880  
understand what was going on with the

862  
00:32:32,070 --> 00:32:30,799  
oxygen in the upper atmosphere of venus

863  
00:32:34,070 --> 00:32:32,080

and said oh well maybe if there's some

864

00:32:36,630 --> 00:32:34,080

chlorine let's model that and they went

865

00:32:38,310 --> 00:32:36,640

whoa chlorine makes oxygen eats oxygen

866

00:32:39,990 --> 00:32:38,320

chemicals and then somebody else said

867

00:32:42,470 --> 00:32:40,000

wait a minute we're putting chlorine in

868

00:32:44,870 --> 00:32:42,480

earth's stratosphere what's that oh

869

00:32:47,029 --> 00:32:44,880

and and sort of sounded the the alarm

870

00:32:49,990 --> 00:32:47,039

and so this is this is an example of how

871

00:32:51,750 --> 00:32:50,000

planetary exploration and the larger

872

00:32:53,909 --> 00:32:51,760

intellectual exercise of comparative

873

00:32:56,070 --> 00:32:53,919

planetology can can help us out here and

874

00:32:58,070 --> 00:32:56,080

make us smarter about our own planet but

875

00:33:00,389 --> 00:32:58,080

it's also an example

876

00:33:02,870 --> 00:33:00,399

of the next kind of change the fourth

877

00:33:06,230 --> 00:33:02,880

kind of change that i want to talk about

878

00:33:08,070 --> 00:33:06,240

of planetary change intentional because

879

00:33:09,830 --> 00:33:08,080

the nice thing about

880

00:33:12,070 --> 00:33:09,840

the ozone

881

00:33:14,470 --> 00:33:12,080

in this context is that it's actually

882

00:33:17,029 --> 00:33:14,480

being fixed

883

00:33:20,070 --> 00:33:17,039

the problem was recognized

884

00:33:22,830 --> 00:33:20,080

international discussions ensued

885

00:33:24,630 --> 00:33:22,840

international agreements were

886

00:33:27,430 --> 00:33:24,640

formulated and

887

00:33:29,909 --> 00:33:27,440

it's being fixed it's not perfect

888

00:33:32,230 --> 00:33:29,919

there's still some illegal bootleg using

889

00:33:34,630 --> 00:33:32,240

of freon but it's enough so that we're

890

00:33:38,230 --> 00:33:34,640

on track and if we continue on the path

891

00:33:41,029 --> 00:33:38,240

we're on the ozone is going to be okay

892

00:33:43,110 --> 00:33:41,039

so it is an example of proof of concept

893

00:33:44,230 --> 00:33:43,120

if you will that this fourth kind of

894

00:33:46,149 --> 00:33:44,240

change

895

00:33:49,350 --> 00:33:46,159

which in this context i'm saying is a

896

00:33:52,549 --> 00:33:49,360

different category of global change is

897

00:33:54,149 --> 00:33:52,559

possible intentional change and now i'm

898

00:33:56,149 --> 00:33:54,159

going to tell you some other examples

899

00:33:57,990 --> 00:33:56,159

that i think fit in that category so

900

00:34:00,870 --> 00:33:58,000

what do i mean by intentional global

901  
00:34:02,870 --> 00:34:00,880  
change well i'm talking about change by

902  
00:34:04,470 --> 00:34:02,880  
truly intelligent life

903  
00:34:06,310 --> 00:34:04,480  
and in fact you can say what do i mean

904  
00:34:07,590 --> 00:34:06,320  
by that well i'm actually suggesting

905  
00:34:09,750 --> 00:34:07,600  
here that this is an interesting way of

906  
00:34:11,510 --> 00:34:09,760  
defining intelligent life that maybe a

907  
00:34:14,310 --> 00:34:11,520  
planet doesn't really have intelligent

908  
00:34:15,750 --> 00:34:14,320  
life in a meaningful way until you get

909  
00:34:16,950 --> 00:34:15,760  
life that can

910  
00:34:18,310 --> 00:34:16,960  
enact

911  
00:34:20,069 --> 00:34:18,320  
this kind

912  
00:34:20,950 --> 00:34:20,079  
of global change or at least it's a

913  
00:34:25,349 --> 00:34:20,960

certain

914

00:34:26,710 --> 00:34:25,359

intelligence because what good is

915

00:34:29,349 --> 00:34:26,720

intelligence certainly what good is

916

00:34:31,669 --> 00:34:29,359

technological intelligence if

917

00:34:33,270 --> 00:34:31,679

it's self-destructive that's not really

918

00:34:35,589 --> 00:34:33,280

doesn't seem all that smart or

919

00:34:37,669 --> 00:34:35,599

intelligent to me so one might say that

920

00:34:40,149 --> 00:34:37,679

this is a way you could think about

921

00:34:42,069 --> 00:34:40,159

defining intelligence or certainly an

922

00:34:45,030 --> 00:34:42,079

interesting and worthwhile development

923

00:34:47,349 --> 00:34:45,040

on a planet to reach the stage where you

924

00:34:49,270 --> 00:34:47,359

have this kind of intentional global

925

00:34:51,669 --> 00:34:49,280

change where intelligent life

926  
00:34:53,589 --> 00:34:51,679  
acting with forethought and an awareness

927  
00:34:55,430 --> 00:34:53,599  
of its global role

928  
00:34:58,470 --> 00:34:55,440  
and the global consequences of its

929  
00:35:00,390 --> 00:34:58,480  
actions takes responsibility and so

930  
00:35:03,030 --> 00:35:00,400  
here's some examples i mentioned ozone

931  
00:35:03,910 --> 00:35:03,040  
replenishment which is already underway

932  
00:35:06,230 --> 00:35:03,920  
yay

933  
00:35:08,630 --> 00:35:06,240  
now another example would be intentional

934  
00:35:10,550 --> 00:35:08,640  
halting or reversal of industrial global

935  
00:35:12,390 --> 00:35:10,560  
warming now that's currently under

936  
00:35:13,829 --> 00:35:12,400  
discussion and you know you could

937  
00:35:16,550 --> 00:35:13,839  
chuckle when i say that but actually i

938  
00:35:18,710 --> 00:35:16,560

see that as hugely important it's a big

939

00:35:21,510 --> 00:35:18,720

change this wasn't true we weren't

940

00:35:24,150 --> 00:35:21,520

having a global discussion about this a

941

00:35:25,109 --> 00:35:24,160

decade or two certainly two decades ago

942

00:35:27,109 --> 00:35:25,119

now

943

00:35:29,430 --> 00:35:27,119

you might worry that it's too little too

944

00:35:32,550 --> 00:35:29,440

late i worry about that but i think the

945

00:35:34,470 --> 00:35:32,560

fact that there is now a growing global

946

00:35:37,109 --> 00:35:34,480

awareness and discussion of this is

947

00:35:38,630 --> 00:35:37,119

actually hugely significant and and

948

00:35:40,710 --> 00:35:38,640

quite positive

949

00:35:42,870 --> 00:35:40,720

now other possible examples of this

950

00:35:45,910 --> 00:35:42,880

planetary defense and now i'm talking

951  
00:35:47,270 --> 00:35:45,920  
about defense against asteroids which

952  
00:35:49,990 --> 00:35:47,280  
sooner or later

953  
00:35:51,750 --> 00:35:50,000  
would do in the biosphere in a major way

954  
00:35:53,750 --> 00:35:51,760  
like they did it

955  
00:35:56,630 --> 00:35:53,760  
did in the dinosaurs in their

956  
00:35:59,349 --> 00:35:56,640  
their fellow species at that time but we

957  
00:36:01,990 --> 00:35:59,359  
know now how to find the dangerous

958  
00:36:04,470 --> 00:36:02,000  
asteroids and we think we know how to

959  
00:36:06,069 --> 00:36:04,480  
stop them to build a planetary defense

960  
00:36:08,150 --> 00:36:06,079  
system and it's a work in progress

961  
00:36:09,910 --> 00:36:08,160  
because uh we you know we're already

962  
00:36:13,430 --> 00:36:09,920  
doing the unnecessary observations and

963  
00:36:15,109 --> 00:36:13,440

people have plans and ideas about how to

964

00:36:18,550 --> 00:36:15,119

do this and in fact if we found a

965

00:36:21,430 --> 00:36:18,560

dangerous object and we had a decade or

966

00:36:23,910 --> 00:36:21,440

so which we probably would we could do

967

00:36:26,470 --> 00:36:23,920

something about it so we may have

968

00:36:28,870 --> 00:36:26,480

already passed a threshold where that's

969

00:36:31,030 --> 00:36:28,880

not the threat that it was now people

970

00:36:33,510 --> 00:36:31,040

talk about geoengineering

971

00:36:34,710 --> 00:36:33,520

that's very controversial rightfully

972

00:36:37,670 --> 00:36:34,720

it's not the kind of thing you want to

973

00:36:40,630 --> 00:36:37,680

do callously or

974

00:36:42,950 --> 00:36:40,640

ignorantly but my view of geoengineering

975

00:36:44,630 --> 00:36:42,960

is it would be foolish to attempt it

976  
00:36:46,550 --> 00:36:44,640  
before we know what we're doing but then

977  
00:36:48,630 --> 00:36:46,560  
in the long run it will probably be a

978  
00:36:50,470 --> 00:36:48,640  
good idea and be necessary and i'll talk

979  
00:36:51,990 --> 00:36:50,480  
a little bit more about what i mean by

980  
00:36:54,710 --> 00:36:52,000  
the long run

981  
00:36:56,310 --> 00:36:54,720  
another example well that i would claim

982  
00:36:58,710 --> 00:36:56,320  
goes in this category is the

983  
00:37:00,710 --> 00:36:58,720  
terraforming of mars the idea that we

984  
00:37:03,109 --> 00:37:00,720  
could take another planet and make it

985  
00:37:05,510 --> 00:37:03,119  
more earth-like and a friendly place for

986  
00:37:07,510 --> 00:37:05,520  
earth life if we wanted to

987  
00:37:08,550 --> 00:37:07,520  
now whether or not we do want to is a

988  
00:37:10,710 --> 00:37:08,560

different question there's a whole

989

00:37:12,310 --> 00:37:10,720

ethical dimension of this and i'm

990

00:37:14,390 --> 00:37:12,320

comforted by the fact that we don't

991

00:37:15,670 --> 00:37:14,400

currently really know how to do this

992

00:37:19,510 --> 00:37:15,680

because i don't think it would be a good

993

00:37:22,550 --> 00:37:19,520

idea to rush out and decide to do this

994

00:37:25,349 --> 00:37:22,560

i was on a panel once with um arthur c

995

00:37:27,430 --> 00:37:25,359

clarke he was he was on the panel by

996

00:37:29,430 --> 00:37:27,440

satellite and mostly the satellite link

997

00:37:31,750 --> 00:37:29,440

didn't work at all and we couldn't hear

998

00:37:34,470 --> 00:37:31,760

him which is sort of ironic since arthur

999

00:37:36,870 --> 00:37:34,480

was the you know invented communication

1000

00:37:37,510 --> 00:37:36,880

satellites but the one the question of

1001

00:37:41,349 --> 00:37:37,520

the

1002

00:37:43,829 --> 00:37:41,359

terraform mars and arthur's voice

1003

00:37:45,990 --> 00:37:43,839

actually in a ghostly way came in loud

1004

00:37:47,349 --> 00:37:46,000

and clear for him to say one phrase and

1005

00:37:49,750 --> 00:37:47,359

then it disappeared again and the one

1006

00:37:54,870 --> 00:37:49,760

phrase he said was well i think we

1007

00:37:58,150 --> 00:37:56,870

true story and

1008

00:37:59,510 --> 00:37:58,160

but he's right i mean we don't want to

1009

00:38:01,109 --> 00:37:59,520

even think about really doing this until

1010

00:38:03,109 --> 00:38:01,119

we know if there are martians or if

1011

00:38:05,190 --> 00:38:03,119

there have been martians it would be

1012

00:38:07,270 --> 00:38:05,200

it would be foolish but but what i think

1013

00:38:09,190 --> 00:38:07,280

is very positive about this is that it's

1014

00:38:10,950 --> 00:38:09,200

caused scientists to really think i mean

1015

00:38:13,190 --> 00:38:10,960

people have gotten together and had

1016

00:38:15,190 --> 00:38:13,200

workshops about how you would do this

1017

00:38:17,109 --> 00:38:15,200

and it's caused us to think about how we

1018

00:38:20,150 --> 00:38:17,119

would intentionally change the climate

1019

00:38:22,470 --> 00:38:20,160

of a planet and so as an exercise in

1020

00:38:24,150 --> 00:38:22,480

trying to understand how climate works

1021

00:38:26,069 --> 00:38:24,160

and what are the limits of natural

1022

00:38:28,630 --> 00:38:26,079

climate change and what are the possible

1023

00:38:30,310 --> 00:38:28,640

ways that as opposed to inadvertently

1024

00:38:32,790 --> 00:38:30,320

changing a planetary climate like we're

1025

00:38:35,270 --> 00:38:32,800

doing now how would you

1026  
00:38:36,550 --> 00:38:35,280  
how could you consciously change the

1027  
00:38:38,310 --> 00:38:36,560  
climate of a planet so i think it's been

1028  
00:38:40,710 --> 00:38:38,320  
a very worthwhile exercise to think

1029  
00:38:43,030 --> 00:38:40,720  
about that in the longer run sorry about

1030  
00:38:45,430 --> 00:38:43,040  
the nerdy phrase here malankovic cycle

1031  
00:38:48,069 --> 00:38:45,440  
what i mean is ice ages in the in

1032  
00:38:50,310 --> 00:38:48,079  
earth left to its own devices

1033  
00:38:51,030 --> 00:38:50,320  
in the long run is not a friendly place

1034  
00:38:53,430 --> 00:38:51,040  
for

1035  
00:38:55,190 --> 00:38:53,440  
a global civilization

1036  
00:38:57,030 --> 00:38:55,200  
earth goes through these dramatic

1037  
00:38:58,710 --> 00:38:57,040  
climate changes all by itself just on

1038  
00:39:00,790 --> 00:38:58,720

longer time scales than we're used to

1039

00:39:03,349 --> 00:39:00,800

thinking about we do not want to live

1040

00:39:05,589 --> 00:39:03,359

through another ice age

1041

00:39:07,750 --> 00:39:05,599

we could not sustain the population that

1042

00:39:10,310 --> 00:39:07,760

we have now with agriculture and so

1043

00:39:11,670 --> 00:39:10,320

forth and so if we're around if we solve

1044

00:39:13,030 --> 00:39:11,680

our more immediate problems and we're

1045

00:39:14,710 --> 00:39:13,040

around for

1046

00:39:16,470 --> 00:39:14,720

thousands of years

1047

00:39:18,950 --> 00:39:16,480

we probably will want to do something

1048

00:39:20,950 --> 00:39:18,960

about that and it wouldn't be that hard

1049

00:39:22,950 --> 00:39:20,960

if we can have the kind of effect

1050

00:39:25,190 --> 00:39:22,960

inadvertently we're having on the planet

1051

00:39:26,870 --> 00:39:25,200

now it's not really that it's not really

1052

00:39:28,710 --> 00:39:26,880

a larger effect that we would need to

1053

00:39:31,030 --> 00:39:28,720

have intentionally in fact is probably a

1054

00:39:33,589 --> 00:39:31,040

smaller effect applied in the right way

1055

00:39:35,430 --> 00:39:33,599

to intentionally avoid an ice age so at

1056

00:39:36,310 --> 00:39:35,440

some point if we get through our current

1057

00:39:38,390 --> 00:39:36,320

moment

1058

00:39:40,230 --> 00:39:38,400

we'll be able to do that now thinking on

1059

00:39:42,390 --> 00:39:40,240

much longer time scales and now i'm

1060

00:39:43,990 --> 00:39:42,400

really thinking far future but again i

1061

00:39:45,670 --> 00:39:44,000

think it belongs in this overall

1062

00:39:49,030 --> 00:39:45,680

category

1063

00:39:50,069 --> 00:39:49,040

eventually the sun is going to age

1064

00:39:51,990 --> 00:39:50,079

and

1065

00:39:53,589 --> 00:39:52,000

the earth left to its own devices will

1066

00:39:55,750 --> 00:39:53,599

go through a runaway greenhouse like

1067

00:39:58,310 --> 00:39:55,760

venus did in the past and become

1068

00:40:00,950 --> 00:39:58,320

uninhabitable

1069

00:40:02,790 --> 00:40:00,960

unless we do something about it now

1070

00:40:05,190 --> 00:40:02,800

that's billions of years in the future

1071

00:40:06,630 --> 00:40:05,200

but i would imagine

1072

00:40:09,109 --> 00:40:06,640

or at least a billion years i would

1073

00:40:11,510 --> 00:40:09,119

imagine if somehow we or our descendants

1074

00:40:12,950 --> 00:40:11,520

or our creations or somebody

1075

00:40:16,710 --> 00:40:12,960

with something going on up here or

1076

00:40:18,150 --> 00:40:16,720

wherever it's located at that point um

1077

00:40:20,710 --> 00:40:18,160

is around

1078

00:40:22,790 --> 00:40:20,720

that they would have a have had a lot of

1079

00:40:26,230 --> 00:40:22,800

time to work this problem

1080

00:40:29,510 --> 00:40:26,240

and so this is a sequence

1081

00:40:32,150 --> 00:40:29,520

of ideas on different time scales about

1082

00:40:34,069 --> 00:40:32,160

how intentional global change might

1083

00:40:35,990 --> 00:40:34,079

manifest

1084

00:40:37,910 --> 00:40:36,000

now i've given you these four kinds of

1085

00:40:39,510 --> 00:40:37,920

planetary change let's think about where

1086

00:40:42,950 --> 00:40:39,520

they might exist elsewhere in the

1087

00:40:44,470 --> 00:40:42,960

universe natural disasters

1088

00:40:46,069 --> 00:40:44,480

i think will occur on all planets

1089

00:40:47,829 --> 00:40:46,079

certainly on any planet interesting

1090

00:40:50,790 --> 00:40:47,839

enough to have life

1091

00:40:54,069 --> 00:40:50,800

it will be changeable there will be

1092

00:40:56,550 --> 00:40:54,079

impacts there will be volcanoes

1093

00:40:59,190 --> 00:40:56,560

as the bumper sticker goes stuff happens

1094

00:41:01,430 --> 00:40:59,200

right and that will be true so this will

1095

00:41:03,510 --> 00:41:01,440

be unavoidable anywhere biologically

1096

00:41:06,309 --> 00:41:03,520

induced

1097

00:41:08,550 --> 00:41:06,319

catastrophes i think will occur on all

1098

00:41:10,309 --> 00:41:08,560

planets with life even though we can

1099

00:41:11,990 --> 00:41:10,319

argue about what life is and what its

1100

00:41:13,190 --> 00:41:12,000

properties might be universally and

1101

00:41:15,670 --> 00:41:13,200

believe me that's what we

1102

00:41:18,870 --> 00:41:15,680

astrobiologists do it's almost all we do

1103

00:41:20,630 --> 00:41:18,880

is argue about that but but um i think

1104

00:41:21,990 --> 00:41:20,640

it's safe to say that life is something

1105

00:41:23,990 --> 00:41:22,000

that multiplies and alters its

1106

00:41:25,829 --> 00:41:24,000

environment and if you just have those

1107

00:41:27,910 --> 00:41:25,839

two qualities then i think it's true

1108

00:41:29,510 --> 00:41:27,920

that sooner or later life on a planet

1109

00:41:31,270 --> 00:41:29,520

will cause

1110

00:41:33,430 --> 00:41:31,280

environmental catastrophes and then have

1111

00:41:36,309 --> 00:41:33,440

to deal with the aftermath what about

1112

00:41:39,270 --> 00:41:36,319

these last two categories inadvertent

1113

00:41:41,190 --> 00:41:39,280

catastrophe and intentional change

1114

00:41:42,870 --> 00:41:41,200

when we start wondering where else in

1115

00:41:45,349 --> 00:41:42,880

the universe those might happen then

1116

00:41:48,069 --> 00:41:45,359

we're in the realm of seti the search

1117

00:41:50,150 --> 00:41:48,079

for extraterrestrial intelligence and

1118

00:41:52,150 --> 00:41:50,160

you can start asking this question are

1119

00:41:53,990 --> 00:41:52,160

we alone in the universe is there

1120

00:41:57,990 --> 00:41:54,000

something about this story that makes it

1121

00:42:01,430 --> 00:41:59,270

and

1122

00:42:03,190 --> 00:42:01,440

one of the values of thinking in this

1123

00:42:04,630 --> 00:42:03,200

way is it makes us think of the long

1124

00:42:06,790 --> 00:42:04,640

term

1125

00:42:08,309 --> 00:42:06,800

when we think about other civilizations

1126

00:42:09,750 --> 00:42:08,319

and whether or not they might be out

1127

00:42:11,109 --> 00:42:09,760

there and whether or not we can find

1128

00:42:13,030 --> 00:42:11,119

them you

1129

00:42:15,589 --> 00:42:13,040

the conversation always leads to the

1130

00:42:17,270 --> 00:42:15,599

question of how long civilizations last

1131

00:42:19,510 --> 00:42:17,280

if they don't last very long then

1132

00:42:21,109 --> 00:42:19,520

they're few and far between

1133

00:42:23,349 --> 00:42:21,119

i mean you can do the math i'll actually

1134

00:42:26,150 --> 00:42:23,359

show the equation for this in a minute

1135

00:42:28,470 --> 00:42:26,160

if they last a long time then it's much

1136

00:42:31,510 --> 00:42:28,480

more likely that they're going to be

1137

00:42:33,510 --> 00:42:31,520

less rare and easier to find so whenever

1138

00:42:35,910 --> 00:42:33,520

you start wondering about

1139

00:42:37,910 --> 00:42:35,920

other civilizations existing in the

1140

00:42:40,309 --> 00:42:37,920

cosmos you start wondering about the

1141

00:42:42,950 --> 00:42:40,319

longevity of civilizations and one of

1142

00:42:44,790 --> 00:42:42,960

the values of the anthropocene i think

1143

00:42:46,870 --> 00:42:44,800

as a concept is that it situates

1144

00:42:49,109 --> 00:42:46,880

situates us in in sort of big time in

1145

00:42:50,550 --> 00:42:49,119

deep time and geological time and it's

1146

00:42:52,470 --> 00:42:50,560

not only a way of thinking about our

1147

00:42:53,990 --> 00:42:52,480

past it's a way of thinking about our

1148

00:42:56,630 --> 00:42:54,000

future and we can ask what is the

1149

00:42:59,270 --> 00:42:56,640

anthropocene what will it be in earth

1150

00:43:01,750 --> 00:42:59,280

history will it be an event

1151

00:43:03,670 --> 00:43:01,760

an epoch or some kind of a planetary

1152

00:43:05,270 --> 00:43:03,680

transition and in the geological time

1153

00:43:07,589 --> 00:43:05,280

scale they're examples of all these when

1154

00:43:10,470 --> 00:43:07,599

i say an event i mean something like the

1155

00:43:13,270 --> 00:43:10,480

cretaceous tertiary boundary the little

1156

00:43:15,030 --> 00:43:13,280

centimeter of clay that marks they fall

1157

00:43:17,510 --> 00:43:15,040

out from that asteroid that killed the

1158

00:43:20,550 --> 00:43:17,520

dinosaur 65 million years ago that was

1159

00:43:22,710 --> 00:43:20,560

an event the actual change was very

1160

00:43:25,990 --> 00:43:22,720

brief the aftermath was long and

1161

00:43:27,750 --> 00:43:26,000

interesting and we're still in it but um

1162

00:43:29,510 --> 00:43:27,760

but in terms of the geological history

1163

00:43:31,430 --> 00:43:29,520

it was a thin layer

1164

00:43:34,069 --> 00:43:31,440

so the anthropocene could be like that

1165

00:43:36,390 --> 00:43:34,079

it could just be a strange layer

1166

00:43:39,589 --> 00:43:36,400

of um you know

1167

00:43:43,270 --> 00:43:39,599

water plastic bottles and

1168

00:43:46,470 --> 00:43:43,280

laptops and our other debris

1169

00:43:48,390 --> 00:43:46,480

and and you know if if if all we do is

1170

00:43:50,150 --> 00:43:48,400

burn our fossil fuels in some sort of

1171

00:43:52,069 --> 00:43:50,160

orgy of consumption and don't really

1172

00:43:53,829 --> 00:43:52,079

think about the future

1173

00:43:56,230 --> 00:43:53,839

that may end up being what the

1174

00:43:58,470 --> 00:43:56,240

anthropocene is but it could also be

1175

00:44:00,150 --> 00:43:58,480

something longer lived

1176

00:44:02,390 --> 00:44:00,160

it's actually been proposed in the

1177

00:44:04,230 --> 00:44:02,400

geologic time scale as an epoch people

1178

00:44:06,790 --> 00:44:04,240

talk about the anthropocene epoch well

1179

00:44:08,790 --> 00:44:06,800

if it's really going to be an e-pocket

1180

00:44:10,630 --> 00:44:08,800

in geological time that's often

1181

00:44:12,309 --> 00:44:10,640

something that lasts for say

1182

00:44:14,309 --> 00:44:12,319

10 million years or that kind of time

1183

00:44:15,990 --> 00:44:14,319

scale like the paleocene

1184

00:44:19,190 --> 00:44:16,000

was um

1185

00:44:21,270 --> 00:44:19,200

from 65 to 50 58 million years ago the

1186

00:44:23,829 --> 00:44:21,280

palestinian epoch

1187

00:44:25,190 --> 00:44:23,839

so the third possibility i think is it

1188

00:44:27,670 --> 00:44:25,200

could actually be something more

1189

00:44:30,630 --> 00:44:27,680

profound a planetary transition

1190

00:44:32,390 --> 00:44:30,640

a few times in the history of earth

1191

00:44:34,829 --> 00:44:32,400

the planet has gone through a major

1192

00:44:37,750 --> 00:44:34,839

transition such that the

1193

00:44:39,990 --> 00:44:37,760

rules of change on the planet are

1194

00:44:41,829 --> 00:44:40,000

fundamentally altered before and after

1195

00:44:43,990 --> 00:44:41,839

an example i talked about earlier was

1196

00:44:46,069 --> 00:44:44,000

the origin of life which forever changed

1197

00:44:47,430 --> 00:44:46,079

the planet another example well i

1198

00:44:49,430 --> 00:44:47,440

mentioned the rise of oxygen i think

1199

00:44:51,109 --> 00:44:49,440

that rates is a planetary transition

1200

00:44:54,349 --> 00:44:51,119

there's also the cambrian explosion

1201  
00:44:57,829 --> 00:44:54,359  
about 600 million years ago when

1202  
00:45:00,069 --> 00:44:57,839  
multicellular complex

1203  
00:45:02,230 --> 00:45:00,079  
animal and plant life

1204  
00:45:05,349 --> 00:45:02,240  
burst on the scene

1205  
00:45:08,470 --> 00:45:05,359  
and really forever changed the planet so

1206  
00:45:09,589 --> 00:45:08,480  
i wonder if the anthropocene might also

1207  
00:45:12,069 --> 00:45:09,599  
be

1208  
00:45:14,630 --> 00:45:12,079  
a planetary transition if

1209  
00:45:16,710 --> 00:45:14,640  
somehow this new kind

1210  
00:45:19,109 --> 00:45:16,720  
of geologic change that we've been

1211  
00:45:20,309 --> 00:45:19,119  
discussing might be a part of the

1212  
00:45:22,630 --> 00:45:20,319  
planet's

1213  
00:45:23,829 --> 00:45:22,640

operating system for for the rest of

1214

00:45:26,470 --> 00:45:23,839

time

1215

00:45:28,950 --> 00:45:26,480

on this planet but what would that take

1216

00:45:31,430 --> 00:45:28,960

well this is another way of asking again

1217

00:45:32,950 --> 00:45:31,440

is human style intelligence adaptive or

1218

00:45:35,109 --> 00:45:32,960

self-limiting

1219

00:45:37,030 --> 00:45:35,119

whatever's going on here is it something

1220

00:45:40,030 --> 00:45:37,040

that actually could last

1221

00:45:43,030 --> 00:45:40,040

or is something that is inherently

1222

00:45:44,470 --> 00:45:43,040

self-self-destructive self-limiting um

1223

00:45:46,870 --> 00:45:44,480

the answer of course

1224

00:45:48,230 --> 00:45:46,880

is we have a choice as that great

1225

00:45:52,390 --> 00:45:48,240

philosopher

1226

00:45:54,150 --> 00:45:52,400

sarah connor in the movie terminator

1227

00:45:56,870 --> 00:45:54,160

carved into the picnic table and that

1228

00:45:59,109 --> 00:45:56,880

one scene down in mexico the future is

1229

00:46:03,349 --> 00:45:59,119

unwritten there is no fate but what we

1230

00:46:05,270 --> 00:46:03,359

make okay so obviously we don't know

1231

00:46:07,109 --> 00:46:05,280

but it may be that our actions will

1232

00:46:11,510 --> 00:46:07,119

determine which of these the

1233

00:46:15,910 --> 00:46:13,910

it's funny because people talk about the

1234

00:46:17,589 --> 00:46:15,920

anthropocene and they look over on this

1235

00:46:19,670 --> 00:46:17,599

right side and the big debate now in the

1236

00:46:22,069 --> 00:46:19,680

geologic history is if we've actually

1237

00:46:24,309 --> 00:46:22,079

passed from the holocene epoch to the

1238

00:46:26,470 --> 00:46:24,319

anthropocene epoch but i actually think

1239

00:46:29,109 --> 00:46:26,480

maybe they're looking at the wrong side

1240

00:46:31,030 --> 00:46:29,119

of this chart it may be

1241

00:46:33,270 --> 00:46:31,040

if you look over on the left side at the

1242

00:46:35,349 --> 00:46:33,280

eons

1243

00:46:39,510 --> 00:46:35,359

the really big transitions the origin of

1244

00:46:41,750 --> 00:46:39,520

life the cambrian explosion are

1245

00:46:43,910 --> 00:46:41,760

representative of cambrian explosion a

1246

00:46:46,150 --> 00:46:43,920

representative of new eons and i wonder

1247

00:46:48,309 --> 00:46:46,160

if in fact maybe

1248

00:46:49,750 --> 00:46:48,319

what we are talking about is at least

1249

00:46:51,589 --> 00:46:49,760

potentially

1250

00:46:53,030 --> 00:46:51,599

if it's really going to be a transition

1251

00:46:54,550 --> 00:46:53,040

in the way the planet operates it might

1252

00:46:56,710 --> 00:46:54,560

be something much more profound than a

1253

00:46:59,430 --> 00:46:56,720

new epoch it might be a new eon of

1254

00:47:01,109 --> 00:46:59,440

geologic time that we're entering

1255

00:47:03,829 --> 00:47:01,119

anyways

1256

00:47:05,109 --> 00:47:03,839

the problem of course

1257

00:47:06,069 --> 00:47:05,119

is ourselves

1258

00:47:08,710 --> 00:47:06,079

and

1259

00:47:10,550 --> 00:47:08,720

many of many sagacious smart people have

1260

00:47:13,030 --> 00:47:10,560

talked about a kind of 21st century

1261

00:47:14,630 --> 00:47:13,040

bottleneck that we're facing

1262

00:47:17,190 --> 00:47:14,640

i'm talking about people like sir martin

1263

00:47:19,670 --> 00:47:17,200

reese who wrote this book our final hour

1264

00:47:21,589 --> 00:47:19,680

he gives us a 50 50 chance of surviving

1265

00:47:23,349 --> 00:47:21,599

the 21st century

1266

00:47:25,190 --> 00:47:23,359

which doesn't sound great but it's you

1267

00:47:26,870 --> 00:47:25,200

know it's fighting odds

1268

00:47:31,109 --> 00:47:26,880

um

1269

00:47:33,349 --> 00:47:31,119

the future of life he also talked about

1270

00:47:35,109 --> 00:47:33,359

this 21st century bottleneck that is if

1271

00:47:36,870 --> 00:47:35,119

you look at this

1272

00:47:39,829 --> 00:47:36,880

confluence of all these problems we're

1273

00:47:41,990 --> 00:47:39,839

facing in areas of population energy

1274

00:47:45,030 --> 00:47:42,000

global warming biodiversity and then

1275

00:47:47,109 --> 00:47:45,040

these other potential high-tech problems

1276

00:47:49,829 --> 00:47:47,119

of um potentially dangerous new

1277

00:47:51,670 --> 00:47:49,839

technologies nano bio cyber and

1278

00:47:52,870 --> 00:47:51,680

experiments we might do that might run a

1279

00:47:54,470 --> 00:47:52,880

rock run

1280

00:47:56,550 --> 00:47:54,480

run away from us

1281

00:47:58,470 --> 00:47:56,560

there's this sense of of a bottleneck a

1282

00:48:00,710 --> 00:47:58,480

convergence that either

1283

00:48:02,390 --> 00:48:00,720

we will at the end of

1284

00:48:04,550 --> 00:48:02,400

some period of time it's maybe a century

1285

00:48:07,510 --> 00:48:04,560

maybe 500 years i don't know but it's

1286

00:48:08,550 --> 00:48:07,520

it's less than a thousand years that

1287

00:48:10,150 --> 00:48:08,560

we will

1288

00:48:12,150 --> 00:48:10,160

either

1289

00:48:15,349 --> 00:48:12,160

come to a new maturity in the way that

1290

00:48:17,910 --> 00:48:15,359

we deal globally with our our technology

1291

00:48:19,109 --> 00:48:17,920

and manage our world-changing technology

1292

00:48:20,790 --> 00:48:19,119

i mean this is what we're dealing with

1293

00:48:24,549 --> 00:48:20,800

we now have technology that can change

1294

00:48:26,150 --> 00:48:24,559

the world so can we handle that and the

1295

00:48:28,470 --> 00:48:26,160

the reason why people represented as a

1296

00:48:30,150 --> 00:48:28,480

bottleneck is because of this in a sense

1297

00:48:32,630 --> 00:48:30,160

it's a choice that we have all these

1298

00:48:35,510 --> 00:48:32,640

ways to limit our future but we also

1299

00:48:38,390 --> 00:48:35,520

have ways to greatly enhance our future

1300

00:48:41,030 --> 00:48:38,400

obviously technology um you know these

1301  
00:48:43,670 --> 00:48:41,040  
are this is a focus on the negatives but

1302  
00:48:45,670 --> 00:48:43,680  
you know those of us that that enjoy our

1303  
00:48:46,950 --> 00:48:45,680  
lifespan and the medical technology we

1304  
00:48:49,349 --> 00:48:46,960  
live with and like to think that we

1305  
00:48:51,910 --> 00:48:49,359  
would stop a dangerous asteroid

1306  
00:48:54,390 --> 00:48:51,920  
in its tracks um recognize that there

1307  
00:48:56,309 --> 00:48:54,400  
you know there's a dual-sided nature to

1308  
00:48:58,470 --> 00:48:56,319  
to this and so if you think of it as a

1309  
00:49:00,790 --> 00:48:58,480  
bottleneck that we could get to the

1310  
00:49:03,349 --> 00:49:00,800  
other side and have a more mature

1311  
00:49:06,150 --> 00:49:03,359  
relationship with our technology or that

1312  
00:49:07,910 --> 00:49:06,160  
a civilization could then that

1313  
00:49:10,710 --> 00:49:07,920

introduces another possibility the

1314

00:49:12,870 --> 00:49:10,720

possibility of great longevity where in

1315

00:49:14,870 --> 00:49:12,880

fact natural disasters that otherwise

1316

00:49:16,390 --> 00:49:14,880

would kill us are things that we've

1317

00:49:18,390 --> 00:49:16,400

learned how to handle

1318

00:49:20,710 --> 00:49:18,400

and then that leads to this idea this

1319

00:49:22,870 --> 00:49:20,720

bottleneck idea leads to a sort of

1320

00:49:25,910 --> 00:49:22,880

bifurcation in the lifetime of

1321

00:49:27,190 --> 00:49:25,920

civilizations what do i mean by that oh

1322

00:49:30,309 --> 00:49:27,200

and if this wasn't enough we also have

1323

00:49:32,790 --> 00:49:30,319

to worry about the zombie apocalypse so

1324

00:49:34,870 --> 00:49:32,800

there's really a lot to worry about so

1325

00:49:36,230 --> 00:49:34,880

you know if we if we don't make it

1326

00:49:37,750 --> 00:49:36,240

through this bottleneck you've heard

1327

00:49:39,750 --> 00:49:37,760

about the habitable zone right the

1328

00:49:41,589 --> 00:49:39,760

goldilocks problem well so if we don't

1329

00:49:43,589 --> 00:49:41,599

make it through this bottleneck one way

1330

00:49:45,910 --> 00:49:43,599

of thinking about it is you know mars

1331

00:49:50,630 --> 00:49:45,920

was too hot

1332

00:49:52,630 --> 00:49:50,640

earth was too dumb this is my friend

1333

00:49:54,230 --> 00:49:52,640

my friend john lomborg drew this cartoon

1334

00:49:55,190 --> 00:49:54,240

but there's another possibility of

1335

00:49:56,630 --> 00:49:55,200

course

1336

00:49:58,950 --> 00:49:56,640

and one that i think

1337

00:50:01,190 --> 00:49:58,960

we have no choice but to strive for and

1338

00:50:03,190 --> 00:50:01,200

that is the possibility of

1339

00:50:04,950 --> 00:50:03,200

what i call quasi-immortality

1340

00:50:07,190 --> 00:50:04,960

that if there is this bifurcation in the

1341

00:50:09,430 --> 00:50:07,200

lifetime of civilizations what does a

1342

00:50:10,870 --> 00:50:09,440

civilization look like that has made it

1343

00:50:12,470 --> 00:50:10,880

through the other side of that

1344

00:50:14,309 --> 00:50:12,480

bottleneck that has learned

1345

00:50:17,109 --> 00:50:14,319

really learned to use technology in the

1346

00:50:19,349 --> 00:50:17,119

surf in the service of survival and in

1347

00:50:20,470 --> 00:50:19,359

my view there's a possible

1348

00:50:22,309 --> 00:50:20,480

state that

1349

00:50:23,670 --> 00:50:22,319

even if it's rare maybe most

1350

00:50:25,589 --> 00:50:23,680

civilizations in our state are

1351

00:50:28,390 --> 00:50:25,599

short-lived and maybe technological

1352

00:50:30,230 --> 00:50:28,400

proress is usually not adaptive but if

1353

00:50:31,910 --> 00:50:30,240

some civilizations if any civilizations

1354

00:50:33,750 --> 00:50:31,920

make it through the transition to being

1355

00:50:35,829 --> 00:50:33,760

a sustainable technological global

1356

00:50:37,829 --> 00:50:35,839

civilization i think they may become

1357

00:50:39,990 --> 00:50:37,839

sort of quasi-immortal and what i mean

1358

00:50:41,430 --> 00:50:40,000

by that is a sort of deep enough

1359

00:50:43,190 --> 00:50:41,440

understanding of nature and

1360

00:50:44,870 --> 00:50:43,200

self-understanding and that may be the

1361

00:50:46,710 --> 00:50:44,880

hard part

1362

00:50:48,470 --> 00:50:46,720

which gives an ability to forestall

1363

00:50:50,470 --> 00:50:48,480

natural disasters

1364

00:50:52,950 --> 00:50:50,480

and even eventually maybe spread beyond

1365

00:50:54,470 --> 00:50:52,960

one planet which gives a certain kind of

1366

00:50:56,950 --> 00:50:54,480

life insurance

1367

00:50:58,630 --> 00:50:56,960

policy and i say quasi-immortality

1368

00:51:00,309 --> 00:50:58,640

because the universe is probably not

1369

00:51:01,990 --> 00:51:00,319

going to last forever and i'm not sure

1370

00:51:04,069 --> 00:51:02,000

even these really

1371

00:51:05,109 --> 00:51:04,079

successful civilizations will be able to

1372

00:51:06,950 --> 00:51:05,119

uh

1373

00:51:08,309 --> 00:51:06,960

deal with that well isaac asimov had a

1374

00:51:09,829 --> 00:51:08,319

good science fiction story about that

1375

00:51:11,670 --> 00:51:09,839

but um

1376

00:51:13,670 --> 00:51:11,680

and so

1377

00:51:15,190 --> 00:51:13,680

i i see i see i'm getting a little late

1378

00:51:17,829 --> 00:51:15,200

on time so i'm not going to go through

1379

00:51:19,270 --> 00:51:17,839

all this really but the point of this

1380

00:51:20,390 --> 00:51:19,280

is getting a little nerdy but if you do

1381

00:51:21,670 --> 00:51:20,400

the math

1382

00:51:23,510 --> 00:51:21,680

and you think about the number of

1383

00:51:25,109 --> 00:51:23,520

civilizations here and you think about

1384

00:51:26,549 --> 00:51:25,119

the lifetime of civilizations the way

1385

00:51:28,150 --> 00:51:26,559

people normally think about this is

1386

00:51:30,309 --> 00:51:28,160

there's some average lifetime which

1387

00:51:32,390 --> 00:51:30,319

people call I but if you really take

1388

00:51:35,109 --> 00:51:32,400

seriously this possibility of the

1389

00:51:37,190 --> 00:51:35,119

transition to a really long lifetime

1390

00:51:39,030 --> 00:51:37,200

then the distribution doesn't look like

1391

00:51:41,109 --> 00:51:39,040

this it's not what we call a gaussian

1392

00:51:43,030 --> 00:51:41,119

with some average there would be a

1393

00:51:45,190 --> 00:51:43,040

gaussian some distribution of the

1394

00:51:46,549 --> 00:51:45,200

short-lived civilizations maybe like

1395

00:51:48,230 --> 00:51:46,559

ours the ones that don't make it through

1396

00:51:50,630 --> 00:51:48,240

the bottleneck but then there's some

1397

00:51:53,109 --> 00:51:50,640

other tail some super long-lived almost

1398

00:51:54,710 --> 00:51:53,119

infinite tale of really long life and

1399

00:51:57,109 --> 00:51:54,720

the interesting thing about that if you

1400

00:51:58,950 --> 00:51:57,119

do the math this this drake equation

1401  
00:52:00,710 --> 00:51:58,960  
which you've probably heard of which

1402  
00:52:02,150 --> 00:52:00,720  
calculates the number of communicating

1403  
00:52:03,750 --> 00:52:02,160  
civilizations based on all these

1404  
00:52:04,950 --> 00:52:03,760  
different factors about stars and

1405  
00:52:07,109 --> 00:52:04,960  
planets and the lifetime of

1406  
00:52:09,670 --> 00:52:07,119  
civilizations it sort of assumes a

1407  
00:52:11,829 --> 00:52:09,680  
steady state that is it assumes there is

1408  
00:52:13,510 --> 00:52:11,839  
an average lifetime of the civilization

1409  
00:52:14,950 --> 00:52:13,520  
and therefore the number you can

1410  
00:52:17,430 --> 00:52:14,960  
calculate the number but it's not

1411  
00:52:19,510 --> 00:52:17,440  
changing but if you posit this idea of a

1412  
00:52:21,430 --> 00:52:19,520  
super long lifetime state that's

1413  
00:52:23,270 --> 00:52:21,440

possible then it's not a steady state

1414

00:52:25,670 --> 00:52:23,280

and in fact you calculate that the

1415

00:52:28,470 --> 00:52:25,680

number of civilizations in

1416

00:52:29,750 --> 00:52:28,480

the universe is slowly increasing over

1417

00:52:30,950 --> 00:52:29,760

time

1418

00:52:32,790 --> 00:52:30,960

and if they're

1419

00:52:35,030 --> 00:52:32,800

helping each other out it might even be

1420

00:52:36,630 --> 00:52:35,040

increasing in a non-linear way and then

1421

00:52:38,950 --> 00:52:36,640

you can get to some really bizarre

1422

00:52:42,390 --> 00:52:38,960

possibilities which i won't go into now

1423

00:52:44,950 --> 00:52:42,400

but the bottom line is that well

1424

00:52:47,670 --> 00:52:44,960

one one weird consequence of this is

1425

00:52:49,270 --> 00:52:47,680

that it might be true that the average

1426  
00:52:54,150 --> 00:52:49,280  
civilization

1427  
00:52:56,150 --> 00:52:54,160  
is short-lived and yet

1428  
00:52:57,589 --> 00:52:56,160  
the universe is dominated by these super

1429  
00:52:59,190 --> 00:52:57,599  
long-lived ones because these

1430  
00:53:00,710 --> 00:52:59,200  
quasi-immortals they're sort of like

1431  
00:53:03,030 --> 00:53:00,720  
vampires and that you can create them

1432  
00:53:04,790 --> 00:53:03,040  
but you can't destroy them and so they

1433  
00:53:06,870 --> 00:53:04,800  
slowly accumulate

1434  
00:53:08,630 --> 00:53:06,880  
and so what that means possibly is that

1435  
00:53:09,750 --> 00:53:08,640  
the human process we're used to thinking

1436  
00:53:12,150 --> 00:53:09,760  
of I

1437  
00:53:13,670 --> 00:53:12,160  
as our own future lifetime the people

1438  
00:53:16,230 --> 00:53:13,680

that really came up with this math

1439

00:53:17,829 --> 00:53:16,240

people like carl sagan and frank drake

1440

00:53:19,829 --> 00:53:17,839

and others they used to talk about

1441

00:53:21,589 --> 00:53:19,839

nuclear war and if we blow ourselves up

1442

00:53:24,230 --> 00:53:21,599

in a nuclear war that means I might be

1443

00:53:25,270 --> 00:53:24,240

really short like 50 years or 100 years

1444

00:53:27,270 --> 00:53:25,280

and therefore there aren't any

1445

00:53:27,990 --> 00:53:27,280

civilizations out there

1446

00:53:29,589 --> 00:53:28,000

so

1447

00:53:31,750 --> 00:53:29,599

there was this inherent

1448

00:53:34,230 --> 00:53:31,760

coupling of I

1449

00:53:35,910 --> 00:53:34,240

with our own prospect but but this

1450

00:53:37,670 --> 00:53:35,920

picture actually means that the human

1451

00:53:38,950 --> 00:53:37,680

prospect is not necessarily closely

1452

00:53:41,510 --> 00:53:38,960

linked to the likely abundance of

1453

00:53:42,470 --> 00:53:41,520

long-lived civilizations that is it may

1454

00:53:43,270 --> 00:53:42,480

well be

1455

00:53:46,230 --> 00:53:43,280

that

1456

00:53:48,470 --> 00:53:46,240

glorious future out there for

1457

00:53:52,470 --> 00:53:48,480

intelligent life but just we may not get

1458

00:53:54,150 --> 00:53:52,480

to join the party or as um and my slide

1459

00:53:56,309 --> 00:53:54,160

might be cut off on the bottom here but

1460

00:53:58,549 --> 00:53:56,319

but as uh franz kafka put it oh there it

1461

00:54:00,390 --> 00:53:58,559

is yeah that there is hope there's an

1462

00:54:03,349 --> 00:54:00,400

infinite amount of hope in the universe

1463

00:54:07,670 --> 00:54:05,990

that's one possibility

1464

00:54:11,910 --> 00:54:07,680

so

1465

00:54:13,670 --> 00:54:11,920

the debates what we call the ant what i

1466

00:54:15,910 --> 00:54:13,680

what i call the anthropocene debates

1467

00:54:18,549 --> 00:54:15,920

this this concept of the anthropocene

1468

00:54:20,390 --> 00:54:18,559

has stimulated a lot of interesting and

1469

00:54:21,589 --> 00:54:20,400

some less interesting discussions the

1470

00:54:22,950 --> 00:54:21,599

least interesting is how do you

1471

00:54:25,510 --> 00:54:22,960

pronounce it some people say

1472

00:54:27,750 --> 00:54:25,520

anthropocene and thrombocene if you're

1473

00:54:29,910 --> 00:54:27,760

british or anthropocene

1474

00:54:32,950 --> 00:54:29,920

i don't really care um

1475

00:54:33,910 --> 00:54:32,960

should it be an official geologic era

1476

00:54:35,670 --> 00:54:33,920

that

1477

00:54:37,990 --> 00:54:35,680

to me has become a little bit less

1478

00:54:40,390 --> 00:54:38,000

interesting too many articles magazine

1479

00:54:42,309 --> 00:54:40,400

articles have focused on this debate i

1480

00:54:44,309 --> 00:54:42,319

think it almost doesn't matter now

1481

00:54:45,829 --> 00:54:44,319

whether that official commission on

1482

00:54:48,150 --> 00:54:45,839

stratigraphy

1483

00:54:50,390 --> 00:54:48,160

adopts this or not because it's become

1484

00:54:52,549 --> 00:54:50,400

something that not only geologists but

1485

00:54:54,150 --> 00:54:52,559

historians and archaeologists and

1486

00:54:55,829 --> 00:54:54,160

ethicists and philosophers are

1487

00:54:57,430 --> 00:54:55,839

discussing and it's a worthwhile

1488

00:54:59,670 --> 00:54:57,440

discussion to think of ourselves in

1489

00:55:01,349 --> 00:54:59,680

geologic time and think of ourselves as

1490

00:55:03,589 --> 00:55:01,359

a geologic force

1491

00:55:05,270 --> 00:55:03,599

whether or not it becomes official now

1492

00:55:08,230 --> 00:55:05,280

when did it start that's an interesting

1493

00:55:10,230 --> 00:55:08,240

one i'll come back to that in a minute

1494

00:55:12,230 --> 00:55:10,240

and do we need to fundamentally rethink

1495

00:55:14,230 --> 00:55:12,240

the nature of nature to me this is

1496

00:55:15,910 --> 00:55:14,240

perhaps the most interesting part of

1497

00:55:18,390 --> 00:55:15,920

this

1498

00:55:20,069 --> 00:55:18,400

when you start realizing that we live on

1499

00:55:22,150 --> 00:55:20,079

a planet that we ourselves have been

1500

00:55:23,990 --> 00:55:22,160

profoundly altering

1501

00:55:26,390 --> 00:55:24,000

you start realizing that in some way

1502

00:55:28,150 --> 00:55:26,400

some ways the comfortable dichotomies

1503

00:55:30,950 --> 00:55:28,160

that we're used to thinking of don't

1504

00:55:32,710 --> 00:55:30,960

completely work anymore and for instance

1505

00:55:36,069 --> 00:55:32,720

the divide between what is natural and

1506

00:55:37,750 --> 00:55:36,079

what is artifact well for one thing

1507

00:55:40,069 --> 00:55:37,760

we're products of evolution right so

1508

00:55:42,230 --> 00:55:40,079

we're natural so therefore the things we

1509

00:55:45,750 --> 00:55:42,240

do are natural in a certain sense but

1510

00:55:48,069 --> 00:55:45,760

also in a world where there is nothing

1511

00:55:50,470 --> 00:55:48,079

like it or not really untouched by human

1512

00:55:52,870 --> 00:55:50,480

civilization anymore what does it really

1513

00:55:56,470 --> 00:55:52,880

mean completely when we use the word

1514

00:55:58,390 --> 00:55:56,480

natural and also this is filtered into

1515

00:56:02,549 --> 00:55:58,400

some really interesting debates in the

1516

00:56:05,030 --> 00:56:02,559

conservation and environmental community

1517

00:56:07,750 --> 00:56:05,040

have we been sort of too nostalgic in

1518

00:56:10,470 --> 00:56:07,760

our views of conservation where a lot of

1519

00:56:13,030 --> 00:56:10,480

the talk is of trying to restore some

1520

00:56:15,270 --> 00:56:13,040

pristine pre-human time

1521

00:56:17,270 --> 00:56:15,280

but when you really look for that and

1522

00:56:19,190 --> 00:56:17,280

look for that moment in history it's

1523

00:56:21,030 --> 00:56:19,200

hard to even find what it is we're

1524

00:56:22,630 --> 00:56:21,040

seeking and maybe

1525

00:56:24,950 --> 00:56:22,640

it would be more fruitful to look at the

1526

00:56:26,470 --> 00:56:24,960

world as it actually is now and instead

1527

00:56:28,870 --> 00:56:26,480

of thinking about the past think about

1528

00:56:30,870 --> 00:56:28,880

the future what is it we want to enhance

1529

00:56:32,190 --> 00:56:30,880

what is it we want to preserve and so

1530

00:56:34,230 --> 00:56:32,200

there's this talk of sort of

1531

00:56:36,630 --> 00:56:34,240

eco-pragmatism and and some of these

1532

00:56:40,950 --> 00:56:36,640

debates have really sort of shaken up

1533

00:56:43,829 --> 00:56:40,960

the environmental community

1534

00:56:45,750 --> 00:56:43,839

a lot of people respond negatively to

1535

00:56:47,589 --> 00:56:45,760

the notion of the anthropocene

1536

00:56:49,270 --> 00:56:47,599

it's easy to understand in some ways

1537

00:56:51,270 --> 00:56:49,280

it's a very offensive notion if you're

1538

00:56:52,950 --> 00:56:51,280

not offended in a certain sense you're

1539

00:56:55,670 --> 00:56:52,960

not paying attention

1540

00:56:58,549 --> 00:56:55,680

is it just a narcissistic

1541

00:57:01,109 --> 00:56:58,559

idea who are we to name a geological

1542

00:57:02,710 --> 00:57:01,119

period after ourselves

1543

00:57:04,950 --> 00:57:02,720

it sort of carries an obnoxious

1544

00:57:07,589 --> 00:57:04,960

implication do we think we're we're sort

1545

00:57:09,190 --> 00:57:07,599

of gods now do we think we deserve to be

1546

00:57:11,349 --> 00:57:09,200

in charge

1547

00:57:13,190 --> 00:57:11,359

i mean in reality it's in my view it's

1548

00:57:14,630 --> 00:57:13,200

not about whether we deserve

1549

00:57:17,030 --> 00:57:14,640

this or whether

1550

00:57:19,430 --> 00:57:17,040

we want to play this role it's more

1551  
00:57:21,870 --> 00:57:19,440  
waking up and recognizing that we're in

1552  
00:57:24,470 --> 00:57:21,880  
this position and we better assume that

1553  
00:57:27,990 --> 00:57:24,480  
responsibility but you can understand

1554  
00:57:29,750 --> 00:57:28,000  
why this is is a bothersome notion it

1555  
00:57:32,390 --> 00:57:29,760  
sort of smacks uncomfortably of a

1556  
00:57:33,670 --> 00:57:32,400  
biblical world created just for us and

1557  
00:57:35,829 --> 00:57:33,680  
in certain sense

1558  
00:57:37,670 --> 00:57:35,839  
it's going backwards and that science

1559  
00:57:39,589 --> 00:57:37,680  
has led us in exactly the opposite

1560  
00:57:41,750 --> 00:57:39,599  
direction of this notion of ourselves as

1561  
00:57:44,230 --> 00:57:41,760  
being central you can think of what carl

1562  
00:57:45,589 --> 00:57:44,240  
sagan called the great emotions

1563  
00:57:47,190 --> 00:57:45,599

right if you think of the major

1564

00:57:48,549 --> 00:57:47,200

accomplishments of the scientific

1565

00:57:49,910 --> 00:57:48,559

revolution

1566

00:57:51,430 --> 00:57:49,920

galileo

1567

00:57:53,990 --> 00:57:51,440

showing us that the earth wasn't the

1568

00:57:56,470 --> 00:57:54,000

center of the universe darwin showing us

1569

00:57:59,510 --> 00:57:56,480

that humans were not some special

1570

00:58:01,670 --> 00:57:59,520

distinct species but were related to the

1571

00:58:03,109 --> 00:58:01,680

history of all life

1572

00:58:06,069 --> 00:58:03,119

and we've learned that even more

1573

00:58:08,390 --> 00:58:06,079

profoundly with modern molecular biology

1574

00:58:11,030 --> 00:58:08,400

and with the wonders

1575

00:58:13,190 --> 00:58:11,040

produced by the hubble space telescope

1576

00:58:15,270 --> 00:58:13,200

from operated from right here in

1577

00:58:17,430 --> 00:58:15,280

baltimore we've learned

1578

00:58:20,309 --> 00:58:17,440

that this universe we live in is

1579

00:58:22,470 --> 00:58:20,319

incredibly vast and incredibly old and

1580

00:58:24,309 --> 00:58:22,480

we were not even here for most of the

1581

00:58:26,150 --> 00:58:24,319

story for almost all of the story we

1582

00:58:28,069 --> 00:58:26,160

weren't here so there's no way this

1583

00:58:30,150 --> 00:58:28,079

story could be about us

1584

00:58:32,230 --> 00:58:30,160

we've learned all of this and carl sagan

1585

00:58:34,309 --> 00:58:32,240

said famously it is far better to grasp

1586

00:58:36,069 --> 00:58:34,319

the universe the way it really is than

1587

00:58:38,390 --> 00:58:36,079

to persist in delusions however

1588

00:58:39,750 --> 00:58:38,400

satisfying and reassuring

1589

00:58:41,750 --> 00:58:39,760

so that's what he meant by the great

1590

00:58:43,910 --> 00:58:41,760

demotions and now what we're giving

1591

00:58:45,910 --> 00:58:43,920

ourselves a great promotion we're saying

1592

00:58:47,270 --> 00:58:45,920

we're the center of it all

1593

00:58:48,710 --> 00:58:47,280

um

1594

00:58:50,069 --> 00:58:48,720

is that what we're doing i mean does

1595

00:58:51,829 --> 00:58:50,079

this place us back in the center of the

1596

00:58:54,549 --> 00:58:51,839

story and the answer is yes it kind of

1597

00:58:56,870 --> 00:58:54,559

does and yes that is very disturbing but

1598

00:58:59,190 --> 00:58:56,880

the point of science as carl did like to

1599

00:59:00,789 --> 00:58:59,200

remind us is not to comfort ourselves

1600

00:59:02,390 --> 00:59:00,799

with what feels good but to try to see

1601  
00:59:04,069 --> 00:59:02,400  
things as they really are

1602  
00:59:05,829 --> 00:59:04,079  
and then deal honestly with what we've

1603  
00:59:07,829 --> 00:59:05,839  
learned and you can turn this quote

1604  
00:59:09,190 --> 00:59:07,839  
around if we want to grasp the universe

1605  
00:59:11,030 --> 00:59:09,200  
the way it really is we have to look at

1606  
00:59:12,870 --> 00:59:11,040  
what's really going on on earth and

1607  
00:59:14,870 --> 00:59:12,880  
whether we like it or not we are a big

1608  
00:59:16,069 --> 00:59:14,880  
part of the story right now if we add up

1609  
00:59:17,670 --> 00:59:16,079  
the evidence

1610  
00:59:19,190 --> 00:59:17,680  
earth science has to recognize the

1611  
00:59:21,230 --> 00:59:19,200  
answer scene because the rules have

1612  
00:59:24,630 --> 00:59:21,240  
changed and the earth is becoming

1613  
00:59:26,390 --> 00:59:24,640

unrecognizable so

1614

00:59:28,309 --> 00:59:26,400

a lot of people again have had a strong

1615

00:59:29,750 --> 00:59:28,319

response against this in fact here's

1616

00:59:31,510 --> 00:59:29,760

something that was published recently by

1617

00:59:33,910 --> 00:59:31,520

an environmental philosopher

1618

00:59:35,990 --> 00:59:33,920

whose name is kathleen dean moore she

1619

00:59:39,589 --> 00:59:36,000

called this anthropocene is the wrong

1620

00:59:41,910 --> 00:59:39,599

word and she talks here about

1621

00:59:45,030 --> 00:59:41,920

how yes we're bringing the holocene to a

1622

00:59:46,950 --> 00:59:45,040

dismal end and you can read this

1623

00:59:47,829 --> 00:59:46,960

yourself she's talking about you know

1624

00:59:49,910 --> 00:59:47,839

how

1625

00:59:51,910 --> 00:59:49,920

we we've doomed ourselves and destroyed

1626

00:59:54,230 --> 00:59:51,920

the prospects of all other beings and

1627

00:59:57,030 --> 00:59:54,240

you know basically as a an eloquent

1628

00:59:59,670 --> 00:59:57,040

summary here of this moral monstrosity

1629

01:00:01,190 --> 00:59:59,680

that we are you know it's pretty

1630

01:00:03,670 --> 01:00:01,200

anti-human and you can sort of

1631

01:00:05,750 --> 01:00:03,680

understand why and she suggests no we

1632

01:00:07,990 --> 01:00:05,760

should call this the unforgivable crime

1633

01:00:11,030 --> 01:00:08,000

scene or even just

1634

01:00:13,030 --> 01:00:11,040

the obscene epoch

1635

01:00:14,390 --> 01:00:13,040

now she's got a point

1636

01:00:17,270 --> 01:00:14,400

but

1637

01:00:19,510 --> 01:00:17,280

i worry about this anti-humanism as a

1638

01:00:21,030 --> 01:00:19,520

major theme in the way we talk about the

1639

01:00:23,430 --> 01:00:21,040

environment about what's happening on

1640

01:00:25,990 --> 01:00:23,440

earth if you look at the metaphors we

1641

01:00:28,710 --> 01:00:26,000

typically use to describe the human

1642

01:00:30,630 --> 01:00:28,720

imprint on earth there we talk about

1643

01:00:33,270 --> 01:00:30,640

we're a cancer on the earth we're a

1644

01:00:35,430 --> 01:00:33,280

virus where criminals were raping and

1645

01:00:37,910 --> 01:00:35,440

murdering those rainforests and i mean

1646

01:00:39,750 --> 01:00:37,920

you can understand the origin of these

1647

01:00:41,589 --> 01:00:39,760

there's a truth to this if you look at

1648

01:00:43,750 --> 01:00:41,599

the patterns of our development there is

1649

01:00:46,069 --> 01:00:43,760

a lot that's sort of cancer-like and

1650

01:00:48,470 --> 01:00:46,079

yeah when i when i hear about the

1651  
01:00:51,349 --> 01:00:48,480  
imminent

1652  
01:00:53,349 --> 01:00:51,359  
extinction of some great species of

1653  
01:00:55,270 --> 01:00:53,359  
african rhinos or the way that the

1654  
01:00:56,549 --> 01:00:55,280  
elephants are are threatened or the big

1655  
01:00:58,630 --> 01:00:56,559  
cats are threatened and those are just

1656  
01:01:00,630 --> 01:00:58,640  
the charismatic species so many others

1657  
01:01:03,349 --> 01:01:00,640  
than this mass extinction were causing

1658  
01:01:04,150 --> 01:01:03,359  
it is a kind of crime but i just think

1659  
01:01:06,950 --> 01:01:04,160  
that

1660  
01:01:09,589 --> 01:01:06,960  
these metaphors for ourselves

1661  
01:01:11,670 --> 01:01:09,599  
are maybe not the most helpful as we go

1662  
01:01:12,710 --> 01:01:11,680  
into the future can we think of

1663  
01:01:14,630 --> 01:01:12,720

ourselves

1664

01:01:17,510 --> 01:01:14,640

can we recognize the position that we're

1665

01:01:19,910 --> 01:01:17,520

in and yet think of some other ways to

1666

01:01:20,870 --> 01:01:19,920

envision ourselves that help us

1667

01:01:22,870 --> 01:01:20,880

carry

1668

01:01:24,710 --> 01:01:22,880

into the future a more positive view of

1669

01:01:26,630 --> 01:01:24,720

the imprint that we should be having

1670

01:01:28,710 --> 01:01:26,640

that we could have on the earth and i

1671

01:01:30,230 --> 01:01:28,720

don't know exactly but i've toyed with

1672

01:01:31,829 --> 01:01:30,240

and i'm not the first to suggest some of

1673

01:01:32,950 --> 01:01:31,839

these in a certain sense we're like

1674

01:01:35,670 --> 01:01:32,960

babies

1675

01:01:37,349 --> 01:01:35,680

here we are nobody's ever taught us how

1676  
01:01:39,109 --> 01:01:37,359  
to run a biosphere we don't know what

1677  
01:01:41,270 --> 01:01:39,119  
we're doing but we find ourselves here

1678  
01:01:42,710 --> 01:01:41,280  
and we better learn to get good at it or

1679  
01:01:45,270 --> 01:01:42,720  
it's almost

1680  
01:01:48,630 --> 01:01:45,280  
like somebody who wakes up at the wheel

1681  
01:01:50,470 --> 01:01:48,640  
driving a heavy truck down a road

1682  
01:01:52,549 --> 01:01:50,480  
and it's going well i don't need i don't

1683  
01:01:54,630 --> 01:01:52,559  
know how to drive but here i am what do

1684  
01:01:56,390 --> 01:01:54,640  
i do i mean that's almost the situation

1685  
01:01:59,910 --> 01:01:56,400  
we are on this planet like it or not we

1686  
01:02:02,470 --> 01:01:59,920  
have to learn how to drive this thing

1687  
01:02:05,030 --> 01:02:02,480  
um i have a couple other metaphors but

1688  
01:02:07,430 --> 01:02:05,040

i'm running on time so maybe some of you

1689

01:02:08,950 --> 01:02:07,440

know the notion of a generation ship

1690

01:02:10,230 --> 01:02:08,960

because of probably a two or three of

1691

01:02:12,069 --> 01:02:10,240

you i see a couple nodding heads or

1692

01:02:13,349 --> 01:02:12,079

science fiction geeks and in some sense

1693

01:02:15,270 --> 01:02:13,359

i think we're

1694

01:02:16,870 --> 01:02:15,280

on a generation ship and that we're kind

1695

01:02:18,549 --> 01:02:16,880

of waking up to our new reality and

1696

01:02:20,470 --> 01:02:18,559

realizing we have to find the controls

1697

01:02:22,309 --> 01:02:20,480

of this thing and learn how to drive it

1698

01:02:24,710 --> 01:02:22,319

or you could say maybe we're like the

1699

01:02:27,510 --> 01:02:24,720

microbiome of the earth and we want to

1700

01:02:30,150 --> 01:02:27,520

try to be the commensal microbiome

1701

01:02:32,549 --> 01:02:30,160

the good microbes that actually live

1702

01:02:34,470 --> 01:02:32,559

well with our host or in some sense

1703

01:02:36,390 --> 01:02:34,480

we're like the nervous system maybe we

1704

01:02:37,910 --> 01:02:36,400

want to be the brain of the earth these

1705

01:02:40,150 --> 01:02:37,920

are all just sort of different ways to

1706

01:02:42,309 --> 01:02:40,160

think of ourselves that maybe can be a

1707

01:02:43,589 --> 01:02:42,319

little more aspirational

1708

01:02:46,470 --> 01:02:43,599

um

1709

01:02:48,710 --> 01:02:46,480

i'm going to skip a couple things here

1710

01:02:49,910 --> 01:02:48,720

somebody recently said maybe we

1711

01:02:51,910 --> 01:02:49,920

shouldn't think about the footprint but

1712

01:02:53,430 --> 01:02:51,920

the hand print

1713

01:02:54,870 --> 01:02:53,440

after all this is what really makes us

1714

01:02:56,150 --> 01:02:54,880

human

1715

01:02:58,950 --> 01:02:56,160

interesting idea

1716

01:03:00,470 --> 01:02:58,960

um okay so getting back to very briefly

1717

01:03:02,150 --> 01:03:00,480

to this question of when it started

1718

01:03:03,910 --> 01:03:02,160

people have talked about well maybe it

1719

01:03:06,150 --> 01:03:03,920

goes back

1720

01:03:08,470 --> 01:03:06,160

five or even ten thousand years to when

1721

01:03:09,990 --> 01:03:08,480

we we really started or at least five

1722

01:03:12,549 --> 01:03:10,000

thousand years when we started altering

1723

01:03:14,549 --> 01:03:12,559

the landscape with agriculture and in

1724

01:03:16,630 --> 01:03:14,559

fact at that time not only started

1725

01:03:18,470 --> 01:03:16,640

changing the land surface of the planet

1726

01:03:20,470 --> 01:03:18,480

but changing the carbon cycle and

1727

01:03:22,150 --> 01:03:20,480

actually there's evidence that climate

1728

01:03:24,390 --> 01:03:22,160

change by humans has started thousands

1729

01:03:26,470 --> 01:03:24,400

of years ago some people think it should

1730

01:03:28,390 --> 01:03:26,480

have started

1731

01:03:30,470 --> 01:03:28,400

around the beginning of the industrial

1732

01:03:31,910 --> 01:03:30,480

revolution with when steam engines

1733

01:03:34,150 --> 01:03:31,920

started up and we really started using

1734

01:03:35,990 --> 01:03:34,160

fossil fuels and changing the atmosphere

1735

01:03:39,109 --> 01:03:36,000

there's been this idea that we should

1736

01:03:42,470 --> 01:03:39,119

market from the date of the first atomic

1737

01:03:44,789 --> 01:03:42,480

bomb test after all that leaves a nifty

1738

01:03:46,710 --> 01:03:44,799

isotopic signature for future

1739

01:03:49,349 --> 01:03:46,720

generations to find and it certainly has

1740

01:03:50,950 --> 01:03:49,359

a metaphorical potency of our realizing

1741

01:03:53,349 --> 01:03:50,960

our powers

1742

01:03:55,670 --> 01:03:53,359

now these are all interesting moments in

1743

01:03:57,829 --> 01:03:55,680

the development of humanity as a global

1744

01:04:00,309 --> 01:03:57,839

species and unfortunately this is sort

1745

01:04:02,789 --> 01:04:00,319

of devolved into an argument people are

1746

01:04:04,470 --> 01:04:02,799

actually fighting over this is when the

1747

01:04:06,549 --> 01:04:04,480

anthropocene should start no this isn't

1748

01:04:07,990 --> 01:04:06,559

because they want to make it official

1749

01:04:09,750 --> 01:04:08,000

and i think that's a little bit silly

1750

01:04:11,510 --> 01:04:09,760

it's a little bit like arguing over you

1751

01:04:13,109 --> 01:04:11,520

know whether pluto's a planet or not

1752

01:04:15,430 --> 01:04:13,119

because what's interesting is the

1753

01:04:18,069 --> 01:04:15,440

qualities of pluto like objects not what

1754

01:04:19,750 --> 01:04:18,079

we call it right and similarly it's

1755

01:04:21,910 --> 01:04:19,760

interesting to note these different

1756

01:04:24,069 --> 01:04:21,920

stages in human presence on earth and i

1757

01:04:25,430 --> 01:04:24,079

don't really care what they

1758

01:04:27,109 --> 01:04:25,440

you know how that argument comes out

1759

01:04:29,670 --> 01:04:27,119

about what officially gets proclaimed as

1760

01:04:31,990 --> 01:04:29,680

the beginning of the anthropocene but as

1761

01:04:33,750 --> 01:04:32,000

i think about this i've also thought of

1762

01:04:36,150 --> 01:04:33,760

a new way perhaps to think of the

1763

01:04:38,069 --> 01:04:36,160

beginning that that is maybe even a

1764

01:04:40,150 --> 01:04:38,079

little bit more hopeful and that is that

1765

01:04:42,390 --> 01:04:40,160

in a certain sense maybe it's just

1766

01:04:43,990 --> 01:04:42,400

getting started

1767

01:04:45,270 --> 01:04:44,000

maybe it begins with the end of our

1768

01:04:47,029 --> 01:04:45,280

innocence

1769

01:04:48,789 --> 01:04:47,039

with a mass awareness of our role as

1770

01:04:53,750 --> 01:04:48,799

world changers

1771

01:04:56,230 --> 01:04:53,760

this time the anthropocene unprecedented

1772

01:04:58,390 --> 01:04:56,240

here on the planet and worthy of a new

1773

01:05:00,710 --> 01:04:58,400

name is our growing knowledge of what

1774

01:05:03,589 --> 01:05:00,720

we're doing on this planet

1775

01:05:06,150 --> 01:05:03,599

self-aware self-conscious global change

1776

01:05:08,309 --> 01:05:06,160

i think is a completely new phenomenon

1777

01:05:10,309 --> 01:05:08,319

and a remarkable one on this planet and

1778

01:05:13,109 --> 01:05:10,319

so i'm wondering if we can define a new

1779

01:05:14,630 --> 01:05:13,119

phase the mature anthropocene

1780

01:05:16,470 --> 01:05:14,640

marked by that

1781

01:05:17,990 --> 01:05:16,480

fourth kind of planetary change

1782

01:05:20,230 --> 01:05:18,000

intentional

1783

01:05:21,589 --> 01:05:20,240

and regard that as something that we are

1784

01:05:23,990 --> 01:05:21,599

trying to

1785

01:05:26,309 --> 01:05:24,000

bring on in that sense we can think of

1786

01:05:28,069 --> 01:05:26,319

the anthropocene as something to be that

1787

01:05:30,230 --> 01:05:28,079

we should strive for rather than we

1788

01:05:32,470 --> 01:05:30,240

should run away from and in that sense

1789

01:05:33,990 --> 01:05:32,480

also it's just getting started in our

1790

01:05:37,029 --> 01:05:34,000

conversations and what we're doing

1791

01:05:39,270 --> 01:05:37,039

tonight we're hopefully in some tiny way

1792

01:05:41,430 --> 01:05:39,280

helping to bring on the mature

1793

01:05:43,190 --> 01:05:41,440

anthropocene so this is where i get the

1794

01:05:45,750 --> 01:05:43,200

title of my talk in the title of the

1795

01:05:48,069 --> 01:05:45,760

book i'm writing now pterosaurs it's the

1796

01:05:50,789 --> 01:05:48,079

notion the vision of a wise earth that's

1797

01:05:52,069 --> 01:05:50,799

what these words look literally mean

1798

01:05:53,829 --> 01:05:52,079

and

1799

01:05:56,230 --> 01:05:53,839

in order to get there we have to become

1800

01:05:58,150 --> 01:05:56,240

a new kind of entity on this planet

1801  
01:06:00,069 --> 01:05:58,160  
we need to learn comfortably need to

1802  
01:06:01,510 --> 01:06:00,079  
learn to live comfortably

1803  
01:06:05,109 --> 01:06:01,520  
over the long haul with our world

1804  
01:06:06,950 --> 01:06:05,119  
changing technology now one

1805  
01:06:08,630 --> 01:06:06,960  
key to this i think is the widespread

1806  
01:06:11,109 --> 01:06:08,640  
propagation of a worldview that is

1807  
01:06:12,950 --> 01:06:11,119  
global and multi-generational

1808  
01:06:15,029 --> 01:06:12,960  
and one hopeful

1809  
01:06:16,950 --> 01:06:15,039  
truth is that i see this worldview

1810  
01:06:18,630 --> 01:06:16,960  
developing i mean it's very easy to get

1811  
01:06:21,589 --> 01:06:18,640  
discouraged

1812  
01:06:22,710 --> 01:06:21,599  
but the fact is with these little gizmos

1813  
01:06:24,870 --> 01:06:22,720

that we can

1814

01:06:27,109 --> 01:06:24,880

pull out of our pockets and have an

1815

01:06:29,829 --> 01:06:27,119

instant conversation with somebody in

1816

01:06:33,029 --> 01:06:29,839

egypt about what's happening and pull up

1817

01:06:35,029 --> 01:06:33,039

any data set from any satellite

1818

01:06:37,109 --> 01:06:35,039

orbiting the earth we are becoming a new

1819

01:06:38,789 --> 01:06:37,119

kind of entity a globally connected

1820

01:06:42,789 --> 01:06:38,799

communicating

1821

01:06:44,069 --> 01:06:42,799

data exchanging entity and that change

1822

01:06:46,069 --> 01:06:44,079

is not

1823

01:06:48,150 --> 01:06:46,079

necessarily completely apparent when you

1824

01:06:50,069 --> 01:06:48,160

read the newspaper every day and yet it

1825

01:06:51,829 --> 01:06:50,079

it is happening is it happening enough

1826  
01:06:53,910 --> 01:06:51,839  
is it happening fast enough i don't know

1827  
01:06:56,309 --> 01:06:53,920  
but i think there is a profound change

1828  
01:06:59,670 --> 01:06:56,319  
occurring in the way we relate globally

1829  
01:07:01,109 --> 01:06:59,680  
to one another and to our future and one

1830  
01:07:02,789 --> 01:07:01,119  
question one interesting question as a

1831  
01:07:05,270 --> 01:07:02,799  
scientist especially i think what is the

1832  
01:07:07,029 --> 01:07:05,280  
role of science in this

1833  
01:07:08,789 --> 01:07:07,039  
and there's been a lot of discussion

1834  
01:07:10,710 --> 01:07:08,799  
lately in the community about how should

1835  
01:07:11,829 --> 01:07:10,720  
scientists be activists

1836  
01:07:13,670 --> 01:07:11,839  
you know when we're worried about

1837  
01:07:15,430 --> 01:07:13,680  
climate and so forth and it's an

1838  
01:07:17,270 --> 01:07:15,440

interesting question because there's

1839

01:07:19,029 --> 01:07:17,280

dangers there i mean when you see an

1840

01:07:20,549 --> 01:07:19,039

emergency you want to do something about

1841

01:07:23,990 --> 01:07:20,559

it you don't just want to

1842

01:07:24,870 --> 01:07:24,000

model it right but at the same time

1843

01:07:28,470 --> 01:07:24,880

we

1844

01:07:31,029 --> 01:07:28,480

strive to be a sort of objective voice

1845

01:07:32,950 --> 01:07:31,039

and so what is the proper role it's not

1846

01:07:35,670 --> 01:07:32,960

completely clear it's an interesting

1847

01:07:37,510 --> 01:07:35,680

question but one thing that i find

1848

01:07:39,430 --> 01:07:37,520

hopeful is that i think just by doing

1849

01:07:41,349 --> 01:07:39,440

science and communicating science

1850

01:07:44,069 --> 01:07:41,359

science itself does lead to certain

1851  
01:07:45,990 --> 01:07:44,079  
values that may actually be the ones the

1852  
01:07:47,510 --> 01:07:46,000  
very ones that humanity needs to survive

1853  
01:07:49,190 --> 01:07:47,520  
this transition because when we look at

1854  
01:07:50,789 --> 01:07:49,200  
earth from space

1855  
01:07:52,789 --> 01:07:50,799  
say with satellites it doesn't look like

1856  
01:07:55,589 --> 01:07:52,799  
this it looks like this

1857  
01:07:56,470 --> 01:07:55,599  
and what we see what science reveals is

1858  
01:07:58,870 --> 01:07:56,480  
this

1859  
01:08:02,230 --> 01:07:58,880  
global system of connected cycles and

1860  
01:08:04,950 --> 01:08:02,240  
these long this the reality of the world

1861  
01:08:07,190 --> 01:08:04,960  
revealed by science is long-term and

1862  
01:08:09,910 --> 01:08:07,200  
global that's what we notice when we

1863  
01:08:10,710 --> 01:08:09,920

study the earth so science by itself i

1864

01:08:11,750 --> 01:08:10,720

think

1865

01:08:13,270 --> 01:08:11,760

just by

1866

01:08:15,190 --> 01:08:13,280

doing what we do and communicating what

1867

01:08:16,229 --> 01:08:15,200

we do it promotes a worldview that is

1868

01:08:17,829 --> 01:08:16,239

global

1869

01:08:19,669 --> 01:08:17,839

and multi-generational just the world

1870

01:08:21,910 --> 01:08:19,679

view i think that we need

1871

01:08:24,149 --> 01:08:21,920

so it's true science is deeply

1872

01:08:27,110 --> 01:08:24,159

implicated in the answer scene we have a

1873

01:08:28,950 --> 01:08:27,120

responsibility we through technology

1874

01:08:30,070 --> 01:08:28,960

which has a tight relationship with

1875

01:08:34,309 --> 01:08:30,080

science

1876

01:08:36,630 --> 01:08:34,319

thing but they're like that

1877

01:08:38,390 --> 01:08:36,640

we have helped to bring on this great

1878

01:08:39,990 --> 01:08:38,400

acceleration we wouldn't be in this mess

1879

01:08:42,470 --> 01:08:40,000

without science but i think we won't

1880

01:08:45,349 --> 01:08:42,480

survive without a lot more of it and

1881

01:08:47,030 --> 01:08:45,359

without the world view that it naturally

1882

01:08:47,829 --> 01:08:47,040

encourages

1883

01:08:49,910 --> 01:08:47,839

now

1884

01:08:51,430 --> 01:08:49,920

i'm finishing up here but

1885

01:08:53,910 --> 01:08:51,440

one of the joys of working in the

1886

01:08:55,510 --> 01:08:53,920

library of congress over the last year

1887

01:08:58,149 --> 01:08:55,520

has been

1888

01:08:59,749 --> 01:08:58,159

well there's a lot of books there

1889

01:09:02,789 --> 01:08:59,759

and i've gotten to read a lot of them

1890

01:09:03,990 --> 01:09:02,799

and one of my sort of pet side projects

1891

01:09:06,229 --> 01:09:04,000

has been

1892

01:09:08,470 --> 01:09:06,239

something that i think i'll incorporate

1893

01:09:10,470 --> 01:09:08,480

as sort of a a chapter or a section of

1894

01:09:13,189 --> 01:09:10,480

this book i'm writing and i call it a

1895

01:09:14,630 --> 01:09:13,199

brief history of the future

1896

01:09:17,430 --> 01:09:14,640

where i've been reading a lot of books

1897

01:09:18,709 --> 01:09:17,440

about the future written in the past

1898

01:09:20,390 --> 01:09:18,719

because it's very interesting to see

1899

01:09:22,550 --> 01:09:20,400

what people say a hundred years ago said

1900

01:09:24,950 --> 01:09:22,560

about now and what kinds of things they

1901

01:09:27,189 --> 01:09:24,960

predicted and how people get the future

1902

01:09:29,590 --> 01:09:27,199

right and how they get it wrong

1903

01:09:31,829 --> 01:09:29,600

and use that to try to illuminate how

1904

01:09:33,590 --> 01:09:31,839

we're thinking about the future now

1905

01:09:35,829 --> 01:09:33,600

and it's very interesting a lot of smart

1906

01:09:37,030 --> 01:09:35,839

people said a lot of very prescient

1907

01:09:39,189 --> 01:09:37,040

things

1908

01:09:41,349 --> 01:09:39,199

about where we would be now say a

1909

01:09:43,110 --> 01:09:41,359

hundred years ago but they also missed a

1910

01:09:44,709 --> 01:09:43,120

lot and of course what they miss are the

1911

01:09:46,870 --> 01:09:44,719

game changers

1912

01:09:48,870 --> 01:09:46,880

and nobody really gets it right and and

1913

01:09:51,510 --> 01:09:48,880

out of this exercise i've become

1914

01:09:53,269 --> 01:09:51,520

convinced that nobody's right about the

1915

01:09:55,110 --> 01:09:53,279

world 100 years from now the climate

1916

01:09:57,350 --> 01:09:55,120

modelers aren't right the politicians

1917

01:09:59,750 --> 01:09:57,360

aren't right the prophets of doom aren't

1918

01:10:01,510 --> 01:09:59,760

right the techno utopians aren't right

1919

01:10:03,189 --> 01:10:01,520

we don't know and i bet you i'm looking

1920

01:10:05,030 --> 01:10:03,199

back a hundred years that that's the one

1921

01:10:07,270 --> 01:10:05,040

prediction i feel like i can safely say

1922

01:10:08,950 --> 01:10:07,280

we don't know and that that uncertainty

1923

01:10:10,310 --> 01:10:08,960

though gives i think gives us a little

1924

01:10:11,830 --> 01:10:10,320

room for hope

1925

01:10:14,310 --> 01:10:11,840

you know we can't say that we're

1926

01:10:16,630 --> 01:10:14,320

certainly doomed because because the

1927

01:10:18,470 --> 01:10:16,640

future's just so uncertain but

1928

01:10:19,990 --> 01:10:18,480

this book in particular was one of the

1929

01:10:22,070 --> 01:10:20,000

one of my favorites that i've read in

1930

01:10:24,070 --> 01:10:22,080

this sort of brief history of the future

1931

01:10:26,229 --> 01:10:24,080

it's by jd bernal

1932

01:10:27,669 --> 01:10:26,239

um and and it was it's called the world

1933

01:10:28,950 --> 01:10:27,679

the flesh and the devil and i don't have

1934

01:10:30,270 --> 01:10:28,960

the date here but i think it was written

1935

01:10:34,229 --> 01:10:30,280

around

1936

01:10:35,910 --> 01:10:34,239

1926 or 28. um and no less the sage than

1937

01:10:38,310 --> 01:10:35,920

arthur c clarke called this book the

1938

01:10:40,550 --> 01:10:38,320

most brilliant attempt at scientific

1939

01:10:42,950 --> 01:10:40,560

prediction ever made so that's a pretty

1940

01:10:44,709 --> 01:10:42,960

strong endorsement by sir arthur and

1941

01:10:46,390 --> 01:10:44,719

just i recommend the book it's really

1942

01:10:47,669 --> 01:10:46,400

good but just in case you don't get to

1943

01:10:49,910 --> 01:10:47,679

read it i'm going to give you a little

1944

01:10:52,229 --> 01:10:49,920

spoiler here here's the very end of the

1945

01:10:55,270 --> 01:10:52,239

book this is the last paragraph

1946

01:10:57,350 --> 01:10:55,280

jd said we hold the future still timidly

1947

01:10:59,669 --> 01:10:57,360

but perceive it for the first time as a

1948

01:11:01,510 --> 01:10:59,679

function of our own action

1949

01:11:03,189 --> 01:11:01,520

having seen it are we to turn away from

1950

01:11:05,430 --> 01:11:03,199

something that offends the very nature

1951

01:11:07,590 --> 01:11:05,440

of our earliest desires

1952

01:11:10,310 --> 01:11:07,600

or is the recognition of our new powers

1953

01:11:12,390 --> 01:11:10,320

sufficient to change those desires into

1954

01:11:14,149 --> 01:11:12,400

the service of the future which they

1955

01:11:17,430 --> 01:11:14,159

will have to bring about

1956

01:11:22,070 --> 01:11:19,430

technological innovation is changing our

1957

01:11:24,630 --> 01:11:22,080

world in surprising accelerating and

1958

01:11:27,189 --> 01:11:24,640

unpredictable ways and possibilities

1959

01:11:29,110 --> 01:11:27,199

that until recently seem magical

1960

01:11:30,550 --> 01:11:29,120

are now imminent

1961

01:11:32,870 --> 01:11:30,560

so the future is frightening and

1962

01:11:34,310 --> 01:11:32,880

exhilarating but above all it really is

1963

01:11:38,070 --> 01:11:34,320

unpredictable and this uncertainty

1964

01:11:40,229 --> 01:11:38,080

leaves us room for hope and for choice

1965

01:11:41,750 --> 01:11:40,239

and faith in ourselves

1966

01:11:44,070 --> 01:11:41,760

personally my view is that we're just

1967

01:11:45,750 --> 01:11:44,080

getting started on this planet

1968

01:11:47,750 --> 01:11:45,760

and a quote from the

1969

01:11:49,830 --> 01:11:47,760

shakespeare library which i walk past

1970

01:11:52,310 --> 01:11:49,840

every day on my way to work now is

1971

01:11:53,590 --> 01:11:52,320

we know what we are but know not what we

1972

01:12:10,149 --> 01:11:53,600

may be

1973

01:12:13,430 --> 01:12:11,510

microphone here

1974

01:12:15,590 --> 01:12:13,440

all right i'm sure uh

1975

01:12:17,990 --> 01:12:15,600

you all have a lot to think about from

1976

01:12:19,270 --> 01:12:18,000

this talk here and i'm sure there are a

1977

01:12:34,830 --> 01:12:19,280

few questions because we always have

1978

01:12:38,550 --> 01:12:36,390

yes

1979

01:12:40,390 --> 01:12:38,560

i'm always interested to read about

1980

01:12:41,590 --> 01:12:40,400

people who are looking for life

1981

01:12:43,910 --> 01:12:41,600

elsewhere

1982

01:12:45,590 --> 01:12:43,920

but why couldn't there be dry life up

1983

01:12:48,870 --> 01:12:45,600

here why do we have to be looking for

1984

01:12:51,990 --> 01:12:48,880

water uh just a thought and

1985

01:12:53,910 --> 01:12:52,000

and so so2 could be the same thing as

1986

01:12:56,149 --> 01:12:53,920

methane is to us

1987

01:12:57,830 --> 01:12:56,159

or something that didn't generate water

1988

01:13:00,310 --> 01:12:57,840

as long as you had a reason

1989

01:13:02,149 --> 01:13:00,320

so why are you getting yeah

1990

01:13:03,669 --> 01:13:02,159

great great question i think i want to

1991

01:13:05,110 --> 01:13:03,679

repeat it to make sure that's what i was

1992

01:13:07,990 --> 01:13:05,120

going to do yeah go ahead

1993

01:13:10,149 --> 01:13:08,000

my mom and dad can hear it

1994

01:13:12,310 --> 01:13:10,159

the question is

1995

01:13:15,110 --> 01:13:12,320

why are we we guys

1996

01:13:16,550 --> 01:13:15,120

and gals always looking for water-based

1997

01:13:21,590 --> 01:13:16,560

life

1998

01:13:23,590 --> 01:13:21,600

out there in the universe why are we so

1999

01:13:25,910 --> 01:13:23,600

narrow-minded as to assume that life

2000

01:13:28,709 --> 01:13:25,920

chemically needs the same things that we

2001

01:13:31,110 --> 01:13:28,719

need it's a great question and i think

2002

01:13:32,950 --> 01:13:31,120

you're right to ask it and i think that

2003

01:13:35,430 --> 01:13:32,960

we as a community need to keep it in

2004

01:13:37,590 --> 01:13:35,440

mind and in fact it does come up a lot

2005

01:13:39,430 --> 01:13:37,600

at meetings and so there's a couple of

2006

01:13:41,669 --> 01:13:39,440

answers to your question

2007

01:13:43,830 --> 01:13:41,679

one is that

2008

01:13:45,189 --> 01:13:43,840

a lot of smart people have thought about

2009

01:13:47,510 --> 01:13:45,199

this and in fact there are people who

2010

01:13:49,990 --> 01:13:47,520

study this and work on it and nobody yet

2011

01:13:51,750 --> 01:13:50,000

has come up with another chemical basis

2012

01:13:54,470 --> 01:13:51,760

for life that works as well as carbon

2013

01:13:57,750 --> 01:13:54,480

molecules in water now that may well be

2014

01:13:59,510 --> 01:13:57,760

because we are not as smart as nature

2015

01:14:00,950 --> 01:13:59,520

and nature has a way of cooking things

2016

01:14:02,870 --> 01:14:00,960

up that we can't imagine and then we

2017

01:14:06,229 --> 01:14:02,880

discover them through exploration so we

2018

01:14:09,430 --> 01:14:06,239

have to keep our eyes wide open but i

2019

01:14:10,709 --> 01:14:09,440

think it's safe to say

2020

01:14:12,790 --> 01:14:10,719

it may not be

2021

01:14:14,790 --> 01:14:12,800

definitively true but

2022

01:14:17,430 --> 01:14:14,800

it's a reasonable thing to say that life

2023

01:14:19,030 --> 01:14:17,440

needs a liquid medium that is chemical

2024

01:14:20,870 --> 01:14:19,040

life liquid you know it's hard to

2025

01:14:22,790 --> 01:14:20,880

imagine in a solid because solids

2026  
01:14:24,229 --> 01:14:22,800  
crystals nothing moves around it's hard

2027  
01:14:25,510 --> 01:14:24,239  
to imagine it in the gas because

2028  
01:14:27,350 --> 01:14:25,520  
everything's just flying around all over

2029  
01:14:28,870 --> 01:14:27,360  
the place a liquid is a good place for

2030  
01:14:31,350 --> 01:14:28,880  
chemicals to get together and do this

2031  
01:14:33,350 --> 01:14:31,360  
sort of organized dance that life is now

2032  
01:14:34,790 --> 01:14:33,360  
what liquids are there in the universe

2033  
01:14:36,470 --> 01:14:34,800  
there are others there's methane on

2034  
01:14:38,390 --> 01:14:36,480  
titan there are places where there's

2035  
01:14:41,750 --> 01:14:38,400  
probably well we know there's ammonia

2036  
01:14:43,750 --> 01:14:41,760  
water mixtures there's liquid lava so

2037  
01:14:45,189 --> 01:14:43,760  
could you well but i mean people have

2038  
01:14:46,709 --> 01:14:45,199

tried to think about life in these

2039

01:14:48,470 --> 01:14:46,719

different situations and it may be that

2040

01:14:49,990 --> 01:14:48,480

we just haven't come up with it yet but

2041

01:14:52,149 --> 01:14:50,000

there's another answer to the question

2042

01:14:54,229 --> 01:14:52,159

which is more pragmatic you have to

2043

01:14:56,870 --> 01:14:54,239

start the search somewhere and we know

2044

01:14:58,390 --> 01:14:56,880

enough about water-based life even that

2045

01:15:00,149 --> 01:14:58,400

we don't know that much about how it may

2046

01:15:02,470 --> 01:15:00,159

manifest but at least we have some ideas

2047

01:15:03,750 --> 01:15:02,480

about how to start the search now the

2048

01:15:04,950 --> 01:15:03,760

thing we have to be careful is you don't

2049

01:15:06,310 --> 01:15:04,960

want to just be looking for your keys

2050

01:15:08,950 --> 01:15:06,320

under the street light because that's

2051  
01:15:10,310 --> 01:15:08,960  
where they're easy to find and so

2052  
01:15:12,310 --> 01:15:10,320  
but a lot of people have thought about

2053  
01:15:13,830 --> 01:15:12,320  
well how do you find a bio signature a

2054  
01:15:16,149 --> 01:15:13,840  
signature of life

2055  
01:15:18,470 --> 01:15:16,159  
somewhere what do you look for that

2056  
01:15:20,709 --> 01:15:18,480  
isn't assuming that life works just like

2057  
01:15:22,709 --> 01:15:20,719  
us and what a lot of people have come up

2058  
01:15:24,229 --> 01:15:22,719  
with is what we call um chemical

2059  
01:15:26,870 --> 01:15:24,239  
perturbations to an environment or

2060  
01:15:29,110 --> 01:15:26,880  
non-equilibrium atmospheres that is look

2061  
01:15:32,229 --> 01:15:29,120  
for a an atmosphere that is

2062  
01:15:34,550 --> 01:15:32,239  
radically altered as earth's atmosphere

2063  
01:15:36,790 --> 01:15:34,560

is from this from the state it would be

2064

01:15:38,709 --> 01:15:36,800

in without something really weird

2065

01:15:40,709 --> 01:15:38,719

affecting it i mean earth would not have

2066

01:15:42,470 --> 01:15:40,719

all this oxygen and other things like

2067

01:15:43,830 --> 01:15:42,480

methane in the atmosphere without life

2068

01:15:45,910 --> 01:15:43,840

so one thing we want to do is just look

2069

01:15:47,510 --> 01:15:45,920

for weird atmospheres

2070

01:15:49,189 --> 01:15:47,520

that could be perturbed by any kind of

2071

01:15:50,709 --> 01:15:49,199

life and then if you find a weird

2072

01:15:52,229 --> 01:15:50,719

atmosphere that doesn't prove you found

2073

01:15:54,790 --> 01:15:52,239

life but it makes you go aha let's study

2074

01:15:57,430 --> 01:15:54,800

this planet more carefully so it's a

2075

01:15:59,110 --> 01:15:57,440

good question we're working on it we

2076

01:16:01,430 --> 01:15:59,120

have this provisional sense that

2077

01:16:03,669 --> 01:16:01,440

water-based life at least is a good kind

2078

01:16:05,910 --> 01:16:03,679

to find water is a very common substance

2079

01:16:07,830 --> 01:16:05,920

does form liquid on some planets but we

2080

01:16:09,669 --> 01:16:07,840

do have to keep your question in mind

2081

01:16:11,669 --> 01:16:09,679

and somewhere in the universe i'm

2082

01:16:12,790 --> 01:16:11,679

willing to bet there is water-based life

2083

01:16:13,750 --> 01:16:12,800

but somewhere in the universe i'm

2084

01:16:15,910 --> 01:16:13,760

willing to bet there's probably

2085

01:16:19,110 --> 01:16:15,920

non-water-based life and so ultimately

2086

01:16:21,750 --> 01:16:19,120

we have to just keep our eyes open

2087

01:16:23,669 --> 01:16:21,760

yes over here um you touched on it a

2088

01:16:24,709 --> 01:16:23,679

little bit but i'm curious why you

2089

01:16:26,709 --> 01:16:24,719

elevate

2090

01:16:28,950 --> 01:16:26,719

human intelligence

2091

01:16:31,510 --> 01:16:28,960

our awareness of what's going on and any

2092

01:16:34,950 --> 01:16:31,520

actions that we may or may not take

2093

01:16:36,790 --> 01:16:34,960

beyond normal biological and evolution

2094

01:16:37,990 --> 01:16:36,800

you know evolutionary forces you know

2095

01:16:40,149 --> 01:16:38,000

what makes

2096

01:16:42,229 --> 01:16:40,159

our intelligence so much more

2097

01:16:44,630 --> 01:16:42,239

interesting to focus on it as something

2098

01:16:46,310 --> 01:16:44,640

other than just a natural process yeah

2099

01:16:47,990 --> 01:16:46,320

well it's a good question i mean and

2100

01:16:49,750 --> 01:16:48,000

it's nice to repeat the question yeah so

2101

01:16:51,669 --> 01:16:49,760

the question is why am i focusing so

2102

01:16:53,189 --> 01:16:51,679

much on human intelligence

2103

01:16:56,070 --> 01:16:53,199

as some

2104

01:16:57,430 --> 01:16:56,080

really interesting and new process as

2105

01:16:59,189 --> 01:16:57,440

opposed to just looking at all the

2106

01:17:01,669 --> 01:16:59,199

different kinds of natural biological

2107

01:17:03,270 --> 01:17:01,679

changes on earth and that you know it's

2108

01:17:06,070 --> 01:17:03,280

i tried to get at that a little bit but

2109

01:17:07,830 --> 01:17:06,080

maybe i didn't to your satisfaction but

2110

01:17:09,830 --> 01:17:07,840

certainly i mean the whole point of

2111

01:17:12,229 --> 01:17:09,840

looking at the anthropocene is that

2112

01:17:13,750 --> 01:17:12,239

something new is happening on earth and

2113

01:17:16,310 --> 01:17:13,760

it's not something subtle it's really

2114

01:17:18,790 --> 01:17:16,320

dramatic earth is in the grip of some

2115

01:17:20,950 --> 01:17:18,800

forces some kind of change however you

2116

01:17:22,870 --> 01:17:20,960

want to describe it that

2117

01:17:25,110 --> 01:17:22,880

something that wasn't happening

2118

01:17:26,870 --> 01:17:25,120

certainly a hundred thousand years ago

2119

01:17:28,709 --> 01:17:26,880

maybe not ten thousand years ago so

2120

01:17:30,709 --> 01:17:28,719

that's very sudden suddenly in a

2121

01:17:32,870 --> 01:17:30,719

geological time scale earth is going

2122

01:17:35,430 --> 01:17:32,880

through this dramatic change so even

2123

01:17:36,709 --> 01:17:35,440

somebody you know if i were not a

2124

01:17:38,790 --> 01:17:36,719

human

2125

01:17:40,229 --> 01:17:38,800

it's hard to get into that mindset but i

2126  
01:17:42,390 --> 01:17:40,239  
was just looking at this planet and

2127  
01:17:44,229 --> 01:17:42,400  
saying oh well here's this one era of

2128  
01:17:45,830 --> 01:17:44,239  
change you know the asteroids were

2129  
01:17:47,510 --> 01:17:45,840  
hitting and here's this other era of

2130  
01:17:49,110 --> 01:17:47,520  
change oxygen went up in the atmosphere

2131  
01:17:51,270 --> 01:17:49,120  
and now oh here's this other area of

2132  
01:17:53,110 --> 01:17:51,280  
change that's happening now what is

2133  
01:17:55,430 --> 01:17:53,120  
responsible for that how can i

2134  
01:17:57,750 --> 01:17:55,440  
characterize that it's something new and

2135  
01:17:59,189 --> 01:17:57,760  
different so even on that level i think

2136  
01:18:01,110 --> 01:17:59,199  
it merits

2137  
01:18:03,110 --> 01:18:01,120  
a new classification it's not

2138  
01:18:04,950 --> 01:18:03,120

necessarily a value judgment i mean it's

2139

01:18:06,870 --> 01:18:04,960

hard to avoid that part of the

2140

01:18:08,709 --> 01:18:06,880

discussion too you could say this is

2141

01:18:10,550 --> 01:18:08,719

horrible you could say this is wonderful

2142

01:18:12,390 --> 01:18:10,560

but it's different it's new and it's

2143

01:18:14,149 --> 01:18:12,400

worth trying to get at what that

2144

01:18:15,430 --> 01:18:14,159

difference is

2145

01:18:17,669 --> 01:18:15,440

over there

2146

01:18:19,590 --> 01:18:17,679

david ravi here um so just

2147

01:18:21,750 --> 01:18:19,600

one comment and one question regarding

2148

01:18:23,510 --> 01:18:21,760

why what we need to look for water water

2149

01:18:25,990 --> 01:18:23,520

is a good polar molecule and it's a good

2150

01:18:28,070 --> 01:18:26,000

solvent which means it can form bonds

2151

01:18:29,990 --> 01:18:28,080

with uh carbon compounds which have you

2152

01:18:31,669 --> 01:18:30,000

know most life hazard

2153

01:18:33,590 --> 01:18:31,679

in it so that's why it's easier it's an

2154

01:18:35,110 --> 01:18:33,600

easier solvent so it's easier to find

2155

01:18:36,790 --> 01:18:35,120

make life i mean that's one of one

2156

01:18:39,750 --> 01:18:36,800

comment i want to make but other comment

2157

01:18:42,229 --> 01:18:39,760

that in one of the slides you showed

2158

01:18:43,910 --> 01:18:42,239

whether we anthropocene is an epoch or

2159

01:18:45,030 --> 01:18:43,920

an event i think it's somewhere in

2160

01:18:47,030 --> 01:18:45,040

between

2161

01:18:47,910 --> 01:18:47,040

for the following reason that the amount

2162

01:18:49,830 --> 01:18:47,920

of

2163

01:18:52,310 --> 01:18:49,840

co2 that we are having

2164

01:18:54,790 --> 01:18:52,320

in the atmosphere will take about 100

2165

01:18:56,149 --> 01:18:54,800

000 years at least to die down so in the

2166

01:18:57,590 --> 01:18:56,159

next hundred thousand years there will

2167

01:19:00,149 --> 01:18:57,600

be at least ten percent of the current

2168

01:19:02,630 --> 01:19:00,159

co2 from the fossil fuel burning so if

2169

01:19:04,790 --> 01:19:02,640

you go there at that time so if it's an

2170

01:19:06,470 --> 01:19:04,800

epoch and even even it's a short life

2171

01:19:08,149 --> 01:19:06,480

period of time an epoch is a long period

2172

01:19:09,750 --> 01:19:08,159

so the anthropocene probably is

2173

01:19:11,510 --> 01:19:09,760

somewhere in between and i don't know

2174

01:19:13,430 --> 01:19:11,520

what to call that actually yeah that's a

2175

01:19:16,550 --> 01:19:13,440

good point by the way the questioner is

2176

01:19:18,790 --> 01:19:16,560

uh ravi koparapu who's one of the the

2177

01:19:20,630 --> 01:19:18,800

brilliant scientists who's here for our

2178

01:19:23,189 --> 01:19:20,640

meeting this week and he's uh he's one

2179

01:19:25,990 --> 01:19:23,199

of the people who's calculated the edges

2180

01:19:28,229 --> 01:19:26,000

of the habitable zone and the disquiet

2181

01:19:29,910 --> 01:19:28,239

his results show us the disquieting

2182

01:19:31,830 --> 01:19:29,920

result that earth is actually sort of

2183

01:19:34,149 --> 01:19:31,840

near the inner edge of the habitable

2184

01:19:36,470 --> 01:19:34,159

zone and might not be that hard to

2185

01:19:38,790 --> 01:19:36,480

someday push into a venus-like state

2186

01:19:41,990 --> 01:19:38,800

anyways so so uh it's not just some

2187

01:19:44,070 --> 01:19:42,000

random person in the in the audience but

2188

01:19:46,070 --> 01:19:44,080

um

2189

01:19:47,350 --> 01:19:46,080

no it's a very good point first of all

2190

01:19:49,510 --> 01:19:47,360

he i don't know if you heard but he

2191

01:19:52,070 --> 01:19:49,520

addressed your question about water a

2192

01:19:53,990 --> 01:19:52,080

little more scientifically than i did

2193

01:19:55,910 --> 01:19:54,000

specifically water has these properties

2194

01:19:58,149 --> 01:19:55,920

it's a polar molecule that interacts

2195

01:19:59,750 --> 01:19:58,159

with organic molecules in a way that

2196

01:20:01,750 --> 01:19:59,760

really facilitates the kind of

2197

01:20:03,030 --> 01:20:01,760

biochemistry that we depend on and

2198

01:20:04,470 --> 01:20:03,040

that's one of the things that makes

2199

01:20:06,310 --> 01:20:04,480

scientists go oh well this is a hard

2200

01:20:08,390 --> 01:20:06,320

thing to duplicate with other molecules

2201  
01:20:10,070 --> 01:20:08,400  
but whether it's impossible you know

2202  
01:20:12,229 --> 01:20:10,080  
that's an interesting question but his

2203  
01:20:13,189 --> 01:20:12,239  
other point is that yes no matter what

2204  
01:20:15,110 --> 01:20:13,199  
we do

2205  
01:20:18,070 --> 01:20:15,120  
our perturbation to the earth system is

2206  
01:20:20,310 --> 01:20:18,080  
already long-lived because the co2 that

2207  
01:20:22,790 --> 01:20:20,320  
we've put into the atmosphere

2208  
01:20:24,630 --> 01:20:22,800  
left to its own devices the earth takes

2209  
01:20:26,950 --> 01:20:24,640  
at least a hundred thousand years to

2210  
01:20:29,590 --> 01:20:26,960  
kind of suck that co2 back into the

2211  
01:20:31,510 --> 01:20:29,600  
carbon cycle so no matter what we do

2212  
01:20:33,430 --> 01:20:31,520  
we've already left in that sense a

2213  
01:20:35,830 --> 01:20:33,440

long-term mark on the earth hey i asked

2214

01:20:37,430 --> 01:20:35,840

a related question about that day

2215

01:20:39,750 --> 01:20:37,440

i'm interested

2216

01:20:44,229 --> 01:20:39,760

of course we have global warming we have

2217

01:20:47,430 --> 01:20:44,239

increased the amount of co2 by 1 6.

2218

01:20:49,750 --> 01:20:47,440

now there's all this water vapor a more

2219

01:20:52,229 --> 01:20:49,760

powerful greenhouse gas and all this

2220

01:20:53,750 --> 01:20:52,239

methane if we did away with all the cows

2221

01:20:56,229 --> 01:20:53,760

we might be better off than doing one

2222

01:20:59,189 --> 01:20:56,239

with all the factories but

2223

01:21:00,790 --> 01:20:59,199

i'm wondering how can we say that 1 6

2224

01:21:02,550 --> 01:21:00,800

more co2

2225

01:21:03,350 --> 01:21:02,560

with all this methane

2226

01:21:05,830 --> 01:21:03,360

all

2227

01:21:07,750 --> 01:21:05,840

and please don't think i'm a denier i'm

2228

01:21:09,270 --> 01:21:07,760

not yeah no i mean i i understand your

2229

01:21:11,750 --> 01:21:09,280

question he's saying okay so we've

2230

01:21:14,950 --> 01:21:11,760

increased the co2 by uh

2231

01:21:16,550 --> 01:21:14,960

you know by by a sixth um and but but

2232

01:21:18,470 --> 01:21:16,560

yet there's also all this water and

2233

01:21:20,870 --> 01:21:18,480

methane too so why are we always just

2234

01:21:23,350 --> 01:21:20,880

blame it on co2 well but the answer with

2235

01:21:26,070 --> 01:21:23,360

water is that water is passive

2236

01:21:28,390 --> 01:21:26,080

co2 is something we directly do the

2237

01:21:30,790 --> 01:21:28,400

water responds to the temperature

2238

01:21:33,270 --> 01:21:30,800

so if you add co2 and things heat up

2239

01:21:35,189 --> 01:21:33,280

water evaporates so yeah water is a big

2240

01:21:37,110 --> 01:21:35,199

greenhouse gas but we can't do anything

2241

01:21:39,030 --> 01:21:37,120

about that it actually responds to the

2242

01:21:40,790 --> 01:21:39,040

other temperature changes so it's a

2243

01:21:42,950 --> 01:21:40,800

little bit of a red herring to point out

2244

01:21:44,790 --> 01:21:42,960

that water's such a big greenhouse gas

2245

01:21:47,030 --> 01:21:44,800

it is but that's because it's responding

2246

01:21:48,790 --> 01:21:47,040

to other changes methane is a good point

2247

01:21:51,030 --> 01:21:48,800

and it's something we have to watch i

2248

01:21:52,709 --> 01:21:51,040

mean it's going to be probably hard to

2249

01:21:55,030 --> 01:21:52,719

just do away with the cows and it's not

2250

01:21:58,550 --> 01:21:55,040

just cows it's rice paddies and so we

2251

01:21:59,510 --> 01:21:58,560

depend on these things but and termites

2252

01:22:03,990 --> 01:21:59,520

but

2253

01:22:06,149 --> 01:22:04,000

methane you know in our production of of

2254

01:22:08,229 --> 01:22:06,159

natural gas and our oil mining and stuff

2255

01:22:10,229 --> 01:22:08,239

and methane as you mentioned is

2256

01:22:12,470 --> 01:22:10,239

a potent greenhouse gas so it's our

2257

01:22:14,390 --> 01:22:12,480

responsibility at this point to pay

2258

01:22:17,030 --> 01:22:14,400

attention to all these gases and do what

2259

01:22:18,310 --> 01:22:17,040

we can collectively to try to draw down

2260

01:22:19,910 --> 01:22:18,320

the greenhouse

2261

01:22:21,910 --> 01:22:19,920

effect to the extent that we have

2262

01:22:23,350 --> 01:22:21,920

control over it

2263

01:22:25,270 --> 01:22:23,360

okay i'm going to take privilege as the

2264

01:22:27,590 --> 01:22:25,280

host to ask a question

2265

01:22:29,110 --> 01:22:27,600

um so when we talk about whether or not

2266

01:22:30,390 --> 01:22:29,120

we're going to survive the anthropocene

2267

01:22:31,910 --> 01:22:30,400

whether we're going to be a short-lived

2268

01:22:35,110 --> 01:22:31,920

civilization or a long-lived

2269

01:22:36,149 --> 01:22:35,120

civilization it relies on as you

2270

01:22:37,030 --> 01:22:36,159

mentioned

2271

01:22:39,350 --> 01:22:37,040

us

2272

01:22:41,510 --> 01:22:39,360

becoming globally aware becoming

2273

01:22:43,189 --> 01:22:41,520

globally cooperative you know there was

2274

01:22:45,110 --> 01:22:43,199

a the uh the development of

2275

01:22:46,790 --> 01:22:45,120

multicellular life was uh led to the

2276

01:22:48,950 --> 01:22:46,800

cambrian explosion it shows look

2277

01:22:51,430 --> 01:22:48,960

cooperation is really good

2278

01:22:53,189 --> 01:22:51,440

however the question you know often

2279

01:22:54,870 --> 01:22:53,199

comes down to my mind to the question of

2280

01:22:58,870 --> 01:22:54,880

whether life

2281

01:23:03,590 --> 01:23:01,510

reproduces and uses resources but is

2282

01:23:05,270 --> 01:23:03,600

life inherently selfish

2283

01:23:07,830 --> 01:23:05,280

and can it learn to be globally

2284

01:23:09,990 --> 01:23:07,840

cooperative it's a really good question

2285

01:23:11,750 --> 01:23:10,000

yes life is inherently selfish but there

2286

01:23:13,910 --> 01:23:11,760

are different levels of sort of

2287

01:23:15,830 --> 01:23:13,920

enlightened self-interest

2288

01:23:18,149 --> 01:23:15,840

and an interesting example if you go

2289

01:23:21,189 --> 01:23:18,159

back in the history of life is the

2290

01:23:23,590 --> 01:23:21,199

development of a multicellular organism

2291

01:23:26,629 --> 01:23:23,600

where each of your individual cells in a

2292

01:23:28,390 --> 01:23:26,639

lot of ways is like a bacterium

2293

01:23:29,590 --> 01:23:28,400

and in fact now we've learned that in

2294

01:23:34,390 --> 01:23:29,600

fact

2295

01:23:36,470 --> 01:23:34,400

are independent bacteria many of which

2296

01:23:39,750 --> 01:23:36,480

cooperate and work come in this

2297

01:23:42,550 --> 01:23:39,760

commensural commensal microbiome and you

2298

01:23:44,709 --> 01:23:42,560

know so we are actually examples of

2299

01:23:46,950 --> 01:23:44,719

these big cooperating systems that

2300

01:23:48,950 --> 01:23:46,960

multicellular organisms are and the

2301

01:23:49,990 --> 01:23:48,960

individual cells still have their own

2302

01:23:53,830 --> 01:23:50,000

life

2303

01:23:55,910 --> 01:23:53,840

and do what cells do but the

2304

01:23:57,830 --> 01:23:55,920

in a sense the enlightened self-interest

2305

01:24:01,430 --> 01:23:57,840

the collective self-interest still leads

2306

01:24:03,510 --> 01:24:01,440

to this behavior where the larger whole

2307

01:24:06,149 --> 01:24:03,520

does what it needs to survive

2308

01:24:07,990 --> 01:24:06,159

and one can imagine by analogy

2309

01:24:08,790 --> 01:24:08,000

i mean we've got this problem where as

2310

01:24:10,629 --> 01:24:08,800

you

2311

01:24:12,550 --> 01:24:10,639

rightfully point out globally we have

2312

01:24:14,310 --> 01:24:12,560

the challenge of doing that now one

2313

01:24:16,390 --> 01:24:14,320

doesn't need to be completely utopian

2314

01:24:18,550 --> 01:24:16,400

and think that we're going to create

2315

01:24:21,189 --> 01:24:18,560

this work this magical world of perfect

2316

01:24:22,629 --> 01:24:21,199

harmony but one you know all we need is

2317

01:24:25,110 --> 01:24:22,639

a certain level

2318

01:24:27,590 --> 01:24:25,120

enough global cooperation so that we

2319

01:24:29,510 --> 01:24:27,600

don't do these obviously stupid things

2320

01:24:31,110 --> 01:24:29,520

and one can invoke enlightened

2321

01:24:34,070 --> 01:24:31,120

self-interest

2322

01:24:36,390 --> 01:24:34,080

that it's actually not smart

2323

01:24:37,830 --> 01:24:36,400

ultimately for the chinese to burn so

2324

01:24:39,510 --> 01:24:37,840

much coal that they ruin the global

2325

01:24:40,870 --> 01:24:39,520

climate not because they're doing

2326

01:24:44,229 --> 01:24:40,880

something to us but because they're also

2327

01:24:45,750 --> 01:24:44,239

doing something to themselves and so one

2328

01:24:47,110 --> 01:24:45,760

can imagine

2329

01:24:48,390 --> 01:24:47,120

you know a little more global

2330

01:24:51,430 --> 01:24:48,400

cooperation where in some of these

2331

01:24:53,590 --> 01:24:51,440

obvious ways people don't act

2332

01:24:55,590 --> 01:24:53,600

self-destructively in a way that

2333

01:24:57,510 --> 01:24:55,600

collectively leads to enough enlightened

2334

01:25:00,229 --> 01:24:57,520

self-interest so that we learn to handle

2335

01:25:01,750 --> 01:25:00,239

these technologies i think one can allow

2336

01:25:04,070 --> 01:25:01,760

for human nature in the fact that we

2337

01:25:06,629 --> 01:25:04,080

won't have global cooperation but still

2338

01:25:08,149 --> 01:25:06,639

imagine a world where we have enough so

2339

01:25:12,870 --> 01:25:08,159

that we don't do the obviously stupid

2340

01:25:15,669 --> 01:25:12,880

self-destructive things exactly great

2341

01:25:17,750 --> 01:25:15,679

all right uh it's 9 26 time for everyone

2342

01:25:18,870 --> 01:25:17,760

to go home and get a good night's sleep

2343

01:25:20,470 --> 01:25:18,880

um

2344

01:25:22,950 --> 01:25:20,480

next tuesday night

2345

01:25:25,030 --> 01:25:22,960

body mind key the making of moons some

2346

01:25:26,709 --> 01:25:25,040

amazing saturn images and all sorts of

2347

01:25:28,390 --> 01:25:26,719

other things uh ladies and gentlemen