



**DR. KEVIN KNUTH ON: THE
RESPONSE TO HIS
CONVERSATION.COM/NEWSWEEK
ARTICLE ON UFOS . . . THE
CURRENT STATE OF EXOPLANET
HUNTING . . . HOW MIGHT ET
ACTUALLY GET HERE FROM THERE .**

UFONN
SUNDAY

1
00:01:26,280 --> 00:00:24,340

[Music]

2
00:02:07,560 --> 00:01:35,440
professor's fine thank you yeah about

3
00:02:23,400 --> 00:02:11,730
oh good morning to you as well and thank

4
00:02:23,410 --> 00:02:28,780
Shh

5
00:02:37,690 --> 00:02:36,039
oh yes certainly I had I've always been

6
00:02:43,660 --> 00:02:37,700
interested in the UFOs since I was a

7
00:02:47,110 --> 00:02:43,670
young teenager and a few years ago I had

8
00:02:49,000 --> 00:02:47,120
been teaching a class in astronomy and

9
00:02:50,759 --> 00:02:49,010
was spending some time on on

10
00:02:53,830 --> 00:02:50,769
astrobiology and thought it would be

11
00:02:55,990 --> 00:02:53,840
interesting to discuss the possibility

12
00:02:59,979 --> 00:02:56,000
of beings traveling here and what that

13
00:03:02,589 --> 00:02:59,989

would be like so I had started

14

00:03:04,360 --> 00:03:02,599

researching UFOs a little bit looking

15

00:03:07,210 --> 00:03:04,370

into it in a little more detail and and

16

00:03:09,190 --> 00:03:07,220

found some of the some of the

17

00:03:16,089 --> 00:03:09,200

information compelling and interesting

18

00:03:19,390 --> 00:03:16,099

and that lecture over over about two

19

00:03:21,520 --> 00:03:19,400

years morphed into a one-hour talk that

20

00:03:22,899 --> 00:03:21,530

I had given to our actually more like a

21

00:03:27,879 --> 00:03:22,909

two-hour talk that I'd given to our

22

00:03:30,309 --> 00:03:27,889

physics department and and the response

23

00:03:32,110 --> 00:03:30,319

was very positive from from the other

24

00:03:37,420 --> 00:03:32,120

professors and the students and I was I

25

00:03:40,689 --> 00:03:37,430

was kind of surprised by that and and I

26

00:03:42,759 --> 00:03:40,699

had thought that you know what this is

27

00:03:44,289 --> 00:03:42,769

interesting maybe if you know we

28

00:03:46,990 --> 00:03:44,299

scientists learned a little bit more

29

00:03:48,729 --> 00:03:47,000

about this phenomenon and saw some of

30

00:03:51,309 --> 00:03:48,739

the interesting correlations that appear

31

00:03:53,610 --> 00:03:51,319

to be observed then you know maybe maybe

32

00:03:57,460 --> 00:03:53,620

this should be studied more carefully

33

00:04:01,569 --> 00:03:57,470

and so a few weeks ago I was approached

34

00:04:03,280 --> 00:04:01,579

by our media department the the online

35

00:04:04,719 --> 00:04:03,290

magazine the conversation they were

36

00:04:08,349 --> 00:04:04,729

looking for someone to write an article

37

00:04:09,430 --> 00:04:08,359

about UFOs for world UFO day which

38

00:04:14,309 --> 00:04:09,440

happened

39

00:04:21,729 --> 00:04:18,039

and so they were they it was funny they

40

00:04:24,640 --> 00:04:21,739

had as the media often often does they

41

00:04:26,439 --> 00:04:24,650

they they kind of spun it this way they

42

00:04:30,550 --> 00:04:26,449

said we'd like somebody to talk to write

43

00:04:33,040 --> 00:04:30,560

an article about UFOs and why UFOs are

44

00:04:34,420 --> 00:04:33,050

so interesting to people despite the

45

00:04:36,879 --> 00:04:34,430

fact that there's no evidence for them

46

00:04:38,560 --> 00:04:36,889

so so I thought about this and I thought

47

00:04:41,230 --> 00:04:38,570

well you know that's not quite right and

48

00:04:42,250 --> 00:04:41,240

so I you know so I came back and I said

49

00:04:43,690 --> 00:04:42,260

well you know I would

50

00:04:47,140 --> 00:04:43,700

interested in writing an article but I

51
00:04:49,120 --> 00:04:47,150
would have I would you know take this

52
00:04:51,580 --> 00:04:49,130
different approach and and they were

53
00:04:54,010 --> 00:04:51,590
actually very excited by that they you

54
00:04:56,640 --> 00:04:54,020
know the editor I spoke to said well you

55
00:05:00,670 --> 00:04:56,650
know we took the stance we you know that

56
00:05:02,740 --> 00:05:00,680
we took because the we made that

57
00:05:04,900 --> 00:05:02,750
proposal because we expected that an

58
00:05:08,230 --> 00:05:04,910
academic would not be not look at these

59
00:05:09,940 --> 00:05:08,240
favorably so and I said well I don't I

60
00:05:11,950 --> 00:05:09,950
don't know exactly how to look at them

61
00:05:13,030 --> 00:05:11,960
but I think that you know this is

62
00:05:16,630 --> 00:05:13,040
something that should be carefully

63
00:05:18,580 --> 00:05:16,640

studied and so I wrote the article and

64

00:05:44,560 --> 00:05:18,590

so far the response has been rather

65

00:05:46,630 --> 00:05:44,570

positive well I was certainly I'm taking

66

00:05:49,570 --> 00:05:46,640

a risk and I and I worried about that I

67

00:05:54,160 --> 00:05:49,580

I told them before actually accepting

68

00:05:56,350 --> 00:05:54,170

the the assignment I I said well give me

69

00:05:58,960 --> 00:05:56,360

a day or two to to try writing something

70

00:06:02,380 --> 00:05:58,970

up and seeing you know so I can see what

71

00:06:03,820 --> 00:06:02,390

I could do and and and after I felt

72

00:06:05,860 --> 00:06:03,830

confident that I could write something

73

00:06:09,400 --> 00:06:05,870

that was you know pretty level-headed

74

00:06:11,580 --> 00:06:09,410

and and careful then I you know that I

75

00:06:14,740 --> 00:06:11,590

said alright I'm willing to try this so

76

00:06:16,870 --> 00:06:14,750

yeah but I was very I was very pleased

77

00:06:20,470 --> 00:06:16,880

by the positive response I've had many

78

00:06:23,680 --> 00:06:20,480

academics and even even an astronaut

79

00:06:25,300 --> 00:06:23,690

contact me and say you know this is you

80

00:06:27,010 --> 00:06:25,310

know Bravo for doing this you know this

81

00:06:28,660 --> 00:06:27,020

should be studied we should we agree

82

00:06:47,340 --> 00:06:28,670

this should be carefully studied it

83

00:06:47,350 --> 00:07:16,810

yes

84

00:07:23,920 --> 00:07:19,240

oh I would agree with that yeah

85

00:07:27,730 --> 00:07:23,930

certainly the the I think the big

86

00:07:29,380 --> 00:07:27,740

difficulty is that the radar systems you

87

00:07:32,200 --> 00:07:29,390

know in those situations aren't being

88

00:07:35,250 --> 00:07:32,210

operated by scientists so the scientists

89

00:07:37,630 --> 00:07:35,260

aren't as able to assess the equipment

90

00:07:41,620 --> 00:07:37,640

make sure there's no glitches occurring

91

00:07:45,120 --> 00:07:41,630

and and other other anomalies so I think

92

00:07:48,520 --> 00:07:45,130

that makes you know the use of such data

93

00:08:08,550 --> 00:07:48,530

in difficult but but I I would agree

94

00:08:08,560 --> 00:08:14,940

just

95

00:08:14,950 --> 00:08:25,990

[Music]

96

00:08:26,000 --> 00:08:32,940

Shh

97

00:08:39,969 --> 00:08:34,870

well that's a good question

98

00:08:42,279 --> 00:08:39,979

I'd regarding scientists reactions to

99

00:08:51,310 --> 00:08:42,289

this are very funny and I find that

100

00:08:54,009 --> 00:08:51,320

curious I especially when we see cyan't

101
00:08:56,380 --> 00:08:54,019
a scientist misrepresenting information

102
00:08:59,860 --> 00:08:56,390
about UFOs I think that you know I'm not

103
00:09:01,540 --> 00:08:59,870
sure what exactly what the situation is

104
00:09:04,509 --> 00:09:01,550
and it probably varies from case to case

105
00:09:06,910 --> 00:09:04,519
or situation to situation but you know

106
00:09:08,889 --> 00:09:06,920
some of it is perhaps from the

107
00:09:11,829 --> 00:09:08,899
scientists not not doing their homework

108
00:09:15,519 --> 00:09:11,839
and not looking into this properly and

109
00:09:22,060 --> 00:09:15,529
and and I'm not going to be too critical

110
00:09:24,100 --> 00:09:22,070
of that because the as a scientist

111
00:09:26,410 --> 00:09:24,110
we're often working on other projects

112
00:09:28,180 --> 00:09:26,420
that are you know much more you know

113
00:09:32,139 --> 00:09:28,190

immediately profitable and much more

114

00:09:36,310 --> 00:09:32,149

interesting in some cases so so you know

115

00:09:38,319 --> 00:09:36,320

looking into UFOs is time-consuming and

116

00:09:40,660 --> 00:09:38,329

and you know we also have other things

117

00:09:42,790 --> 00:09:40,670

to do so that I can see that that can

118

00:09:44,949 --> 00:09:42,800

happen but but in that case if that's

119

00:09:47,800 --> 00:09:44,959

the situation then you should be very

120

00:09:52,480 --> 00:09:47,810

careful about you're you know expressing

121

00:09:57,730 --> 00:09:52,490

your professional opinion so I suspect

122

00:09:59,680 --> 00:09:57,740

that one of the problems especially I

123

00:10:03,730 --> 00:09:59,690

you know as somebody who's taught

124

00:10:08,079 --> 00:10:03,740

astronomy I see that we our society

125

00:10:12,610 --> 00:10:08,089

still has this very strange belief in

126

00:10:15,760 --> 00:10:12,620

things like astrology and you know and

127

00:10:19,660 --> 00:10:15,770

pseudoscience is like this so one of the

128

00:10:23,650 --> 00:10:19,670

things that you tend to try to do as a

129

00:10:25,780 --> 00:10:23,660

scientist is you want to educate people

130

00:10:29,230 --> 00:10:25,790

as the difference between pseudoscience

131

00:10:31,240 --> 00:10:29,240

and science and you know so in the case

132

00:10:33,220 --> 00:10:31,250

of astrology this is you know this is

133

00:10:35,530 --> 00:10:33,230

done you know we'd we'd handle this an

134

00:10:41,320 --> 00:10:35,540

astronomy class is quite a bit

135

00:10:43,000 --> 00:10:41,330

and I suspect that for many scientists

136

00:10:46,150 --> 00:10:43,010

who don't know much about the UFO

137

00:10:49,960 --> 00:10:46,160

phenomenon they well it falls it rather

138

00:10:56,020 --> 00:10:49,970

than being a fringe science they view it

139

00:10:59,200 --> 00:10:56,030

as a pseudoscience and so you're the the

140

00:11:01,960 --> 00:10:59,210

perceived job the the job we perceive is

141

00:11:06,700 --> 00:11:01,970

that that we have is to educate the

142

00:11:09,640 --> 00:11:06,710

public about pseudoscience and to to do

143

00:11:13,150 --> 00:11:09,650

not promote this so so I think that when

144

00:11:15,670 --> 00:11:13,160

people when scientists view this topic

145

00:11:17,860 --> 00:11:15,680

as soon as pseudoscience they then

146

00:11:22,060 --> 00:11:17,870

operate to basically shut it down which

147

00:11:24,580 --> 00:11:22,070

is which is problematic because they you

148

00:11:26,860 --> 00:11:24,590

know and that sometimes I think that you

149

00:11:28,420 --> 00:11:26,870

know the short they take shortcuts so

150

00:11:32,140 --> 00:11:28,430

the short cut is basically let's just

151

00:11:33,430 --> 00:11:32,150

shut this down and and I think they

152

00:11:39,520 --> 00:11:33,440

sometimes get a little sloppy and

153

00:11:49,870 --> 00:11:39,530

misrepresent facts and and that's

154

00:11:52,000 --> 00:11:49,880

unfortunate I think that's difficult one

155

00:11:54,250 --> 00:11:52,010

of the biggest problems with something

156

00:11:57,490 --> 00:11:54,260

like this is that it's a phenomenon

157

00:12:01,900 --> 00:11:57,500

that's not controllable so you can't

158

00:12:05,650 --> 00:12:01,910

control it and it's not assured to be

159

00:12:07,840 --> 00:12:05,660

repeatable so you know in science we

160

00:12:10,870 --> 00:12:07,850

study things that you can control and

161

00:12:13,270 --> 00:12:10,880

repeat and that are that are repeatable

162

00:12:14,650 --> 00:12:13,280

or that you can somehow control and

163

00:12:17,860 --> 00:12:14,660

that's typically what we study in

164

00:12:23,140 --> 00:12:17,870

science that's the way we verify our

165

00:12:25,000 --> 00:12:23,150

hypotheses so the the fact that that the

166

00:12:28,750 --> 00:12:25,010

phenomenon is and controllable means

167

00:12:30,730 --> 00:12:28,760

that it's it's not easy to verify your

168

00:12:31,960 --> 00:12:30,740

hypothesis that you know so if you've

169

00:12:34,570 --> 00:12:31,970

got a hypothesis that it's an

170

00:12:35,920 --> 00:12:34,580

extraterrestrial spacecraft then how do

171

00:12:37,960 --> 00:12:35,930

you verify that well you have to wait

172

00:12:40,000 --> 00:12:37,970

till another one shows up and you can't

173

00:12:42,100 --> 00:12:40,010

control the situation in which they show

174

00:12:45,940 --> 00:12:42,110

up so it's very difficult to handle

175

00:12:47,090 --> 00:12:45,950

things like this a similar example that

176

00:12:49,880 --> 00:12:47,100

happened you know

177

00:12:52,070 --> 00:12:49,890

two centuries ago was that of meteorites

178

00:12:56,060 --> 00:12:52,080

the theory of meteorites that the idea

179

00:12:58,670 --> 00:12:56,070

that rocks fall from space and this was

180

00:13:01,550 --> 00:12:58,680

considered ridiculous for a long period

181

00:13:03,530 --> 00:13:01,560

of time and you know how do you prove

182

00:13:05,150 --> 00:13:03,540

that rocks fall from space well you have

183

00:13:08,660 --> 00:13:05,160

to wait for one to fall and then you

184

00:13:11,780 --> 00:13:08,670

have to find it and that's extremely

185

00:13:14,090 --> 00:13:11,790

difficult and and it really was a big

186

00:13:18,260 --> 00:13:14,100

problem until I think it was burrow in

187

00:13:20,330 --> 00:13:18,270

1802 where you had a meteorite came over

188

00:13:23,390 --> 00:13:20,340

a small town in France and broke into

189

00:13:25,280 --> 00:13:23,400

several small several pieces and there

190

00:13:26,810 --> 00:13:25,290

were many witnesses in this town that

191

00:13:29,780 --> 00:13:26,820

witnessed it falling into several pieces

192

00:13:31,400 --> 00:13:29,790

and and landed and I think it was about

193

00:13:34,600 --> 00:13:31,410

four different places in town and

194

00:13:37,300 --> 00:13:34,610

started fires each of those places so

195

00:13:43,640 --> 00:13:37,310

the in those that case they were able to

196

00:13:45,350 --> 00:13:43,650

find the rocks and and a geologist you

197

00:13:47,780 --> 00:13:45,360

know geologists then showed up and

198

00:13:50,870 --> 00:13:47,790

looked at the rocks and they knew about

199

00:13:52,400 --> 00:13:50,880

the the geography of the region and you

200

00:13:55,760 --> 00:13:52,410

know could easily tell these rocks did

201
00:13:57,620 --> 00:13:55,770
not come from this region so you know

202
00:13:59,210 --> 00:13:57,630
with that many witnesses in the in the

203
00:14:01,820 --> 00:13:59,220
town and having the physical evidence

204
00:14:04,490 --> 00:14:01,830
that actually changed changed the tide

205
00:14:06,800 --> 00:14:04,500
and you know the theory that rocks fall

206
00:14:09,220 --> 00:14:06,810
from the sky or rocks can fall from the

207
00:14:11,960 --> 00:14:09,230
sky became something that's accepted so

208
00:14:14,090 --> 00:14:11,970
so there are other examples in science

209
00:14:17,170 --> 00:14:14,100
where you know there were hypotheses

210
00:14:19,490 --> 00:14:17,180
that were very difficult to validate and

211
00:14:21,920 --> 00:14:19,500
that eventually were eventually it

212
00:14:24,140 --> 00:14:21,930
turned around no now if you kind of

213
00:14:26,060 --> 00:14:24,150

turned this whole topic on on edge and

214

00:14:28,850 --> 00:14:26,070

imagine well what would it look like if

215

00:14:31,640 --> 00:14:28,860

we did have an alien probe or a

216

00:14:34,010 --> 00:14:31,650

spacecraft with full of explorers come

217

00:14:37,400 --> 00:14:34,020

to earth you know you would have some

218

00:14:41,210 --> 00:14:37,410

craft you know a you know flying over

219

00:14:42,770 --> 00:14:41,220

some region on the planet and probably

220

00:14:45,170 --> 00:14:42,780

going to be seen by somebody eventually

221

00:14:46,580 --> 00:14:45,180

and those witnesses are gonna come

222

00:14:48,110 --> 00:14:46,590

forward and describe something very

223

00:14:52,460 --> 00:14:48,120

strange and nobody's going to believe

224

00:14:55,130 --> 00:14:52,470

them so so now you have exactly the

225

00:14:56,580 --> 00:14:55,140

situation that we have occurring so so

226

00:14:58,470 --> 00:14:56,590

it's very hard to

227

00:15:01,260 --> 00:14:58,480

you know immediately discount some of

228

00:15:02,940 --> 00:15:01,270

this especially when you have we need to

229

00:15:05,220 --> 00:15:02,950

have data like radar data that

230

00:15:08,880 --> 00:15:05,230

corroborates eyewitness reports and and

231

00:15:27,020 --> 00:15:08,890

such so I think that it is I think it's

232

00:15:38,390 --> 00:15:35,420

I think most most UFOs that are observed

233

00:15:39,800 --> 00:15:38,400

are not not extraterrestrial spacecraft

234

00:15:44,300 --> 00:15:39,810

I think most people would agree to that

235

00:15:45,710 --> 00:15:44,310

and you know especially especially cases

236

00:15:51,110 --> 00:15:45,720

where you have lights in the sky those

237

00:15:53,420 --> 00:15:51,120

are those are very very difficult it's

238

00:15:55,460 --> 00:15:53,430

very difficult to assess and and I don't

239

00:15:57,320 --> 00:15:55,470

really find those cases very interesting

240

00:16:01,850 --> 00:15:57,330

I'm more interested in the situation

241

00:16:03,470 --> 00:16:01,860

where somebody was able to identify the

242

00:16:06,200 --> 00:16:03,480

object as being some kind of

243

00:16:08,450 --> 00:16:06,210

unidentified structured craft and I

244

00:16:11,990 --> 00:16:08,460

think that's one of the big problems and

245

00:16:15,380 --> 00:16:12,000

maybe it's an unfortunate you know fact

246

00:16:18,350 --> 00:16:15,390

of the terminology that we have come to

247

00:16:21,770 --> 00:16:18,360

think of identified and unidentified as

248

00:16:24,760 --> 00:16:21,780

being a binary situation and that's not

249

00:16:28,100 --> 00:16:24,770

precisely accurate I'm a bird watcher so

250

00:16:30,500 --> 00:16:28,110

there are there many cases if you go

251
00:16:31,640 --> 00:16:30,510
through my my bird-watching notes you

252
00:16:34,280 --> 00:16:31,650
know especially when I'm in a foreign

253
00:16:36,710 --> 00:16:34,290
country so I was in Brazil recently and

254
00:16:40,790 --> 00:16:36,720
I might have some notes that says I done

255
00:16:44,420 --> 00:16:40,800
unidentified well it's not completely

256
00:16:46,490 --> 00:16:44,430
identified I know it was a bird and I

257
00:16:48,860 --> 00:16:46,500
might know okay it's not a great blue

258
00:16:50,720 --> 00:16:48,870
heron and it's not a bald eagle so I can

259
00:16:53,690 --> 00:16:50,730
rule out certain situations certain

260
00:16:57,500 --> 00:16:53,700
cases and so something being

261
00:17:00,800 --> 00:16:57,510
unidentified is not it's not black and

262
00:17:03,660 --> 00:17:00,810
white and and I think those those cases

263
00:17:08,640 --> 00:17:03,670

the UFO cases where

264

00:17:09,900 --> 00:17:08,650

you have witnesses who were able to you

265

00:17:12,270 --> 00:17:09,910

know where they're able to describe the

266

00:17:16,590 --> 00:17:12,280

objects they saw they recognize them as

267

00:17:19,500 --> 00:17:16,600

objects and and in some cases identified

268

00:17:40,230 --> 00:17:19,510

them as structured craft those I find

269

00:17:42,510 --> 00:17:40,240

those I find very interesting let's see

270

00:17:44,760 --> 00:17:42,520

I mean I've been I've been doing

271

00:17:47,520 --> 00:17:44,770

research in astrophysics for several

272

00:17:49,440 --> 00:17:47,530

years now since before I worked at NASA

273

00:17:52,289 --> 00:17:49,450

so I was at and that's a research

274

00:17:57,659 --> 00:17:52,299

scientist for four years before coming

275

00:18:02,730 --> 00:17:57,669

to the University at Albany and I got

276

00:18:04,669 --> 00:18:02,740

into the exoplanet work just after the

277

00:18:09,330 --> 00:18:04,679

Kepler space telescope started producing

278

00:18:14,460 --> 00:18:09,340

results Bilborough key he was the PI of

279

00:18:17,480 --> 00:18:14,470

the Kepler project he had published a

280

00:18:20,430 --> 00:18:17,490

paper in science that I was reading and

281

00:18:23,010 --> 00:18:20,440

the one of the figures showed the light

282

00:18:25,260 --> 00:18:23,020

curves from the exoplanet and and I

283

00:18:26,990 --> 00:18:25,270

noticed some you know some curious you

284

00:18:29,789 --> 00:18:27,000

know there were some curves to this

285

00:18:31,590 --> 00:18:29,799

curves on this light curve it was kind

286

00:18:33,240 --> 00:18:31,600

of curvy around the edges they were most

287

00:18:35,760 --> 00:18:33,250

people are interested in the transits so

288

00:18:37,560 --> 00:18:35,770

so basically what you do is the Kepler

289

00:18:41,039 --> 00:18:37,570

space telescope watched a patch of sky

290

00:18:44,370 --> 00:18:41,049

and recorded the light coming from about

291

00:18:46,919 --> 00:18:44,380

a hundred fifty thousand stars and if

292

00:18:48,960 --> 00:18:46,929

you plot the if you watch how the light

293

00:18:51,690 --> 00:18:48,970

from the stars vary over time sometimes

294

00:18:54,570 --> 00:18:51,700

you see these dips these periodic dips

295

00:18:55,770 --> 00:18:54,580

occur and these dips are from planets

296

00:18:57,330 --> 00:18:55,780

passing in front of the star and

297

00:18:59,789 --> 00:18:57,340

blocking out a little bit of starlight

298

00:19:01,650 --> 00:18:59,799

and these are called transits and that's

299

00:19:04,919 --> 00:19:01,660

what most people typically had been

300

00:19:06,330 --> 00:19:04,929

focusing on but while I was looking at

301

00:19:11,400 --> 00:19:06,340

this I could see well there was some

302

00:19:14,070 --> 00:19:11,410

wavy type behavior going around going on

303

00:19:15,630 --> 00:19:14,080

around the transits and and I realized

304

00:19:17,490 --> 00:19:15,640

wait a minute that's reflect that's

305

00:19:21,990 --> 00:19:17,500

probably reflected light from the plane

306

00:19:25,020 --> 00:19:22,000

it and I thought I bet you could you

307

00:19:26,940 --> 00:19:25,030

could use this reflected light to learn

308

00:19:28,290 --> 00:19:26,950

much learn more about the planets and

309

00:19:29,820 --> 00:19:28,300

you might even be able to detect planets

310

00:19:31,230 --> 00:19:29,830

that aren't transiting that aren't

311

00:19:35,400 --> 00:19:31,240

passing in front of the star just by

312

00:19:38,880 --> 00:19:35,410

looking for reflected light so my chance

313

00:19:42,810 --> 00:19:38,890

I had been well I had been giving a

314

00:19:44,400 --> 00:19:42,820

lecture on astrophysics and one of our

315

00:19:45,600 --> 00:19:44,410

new graduate students came up to me and

316

00:19:47,340 --> 00:19:45,610

said he wanted to do something with

317

00:19:49,620 --> 00:19:47,350

astrophysics and wanted to know if I had

318

00:19:51,800 --> 00:19:49,630

any projects to work on and at the time

319

00:19:54,780 --> 00:19:51,810

I did and I told him I'm sorry I don't

320

00:19:57,660 --> 00:19:54,790

have any ideas for projects right now

321

00:20:00,270 --> 00:19:57,670

and he looked rather disappointed and

322

00:20:02,040 --> 00:20:00,280

and walked away and and I was thinking

323

00:20:04,290 --> 00:20:02,050

about it I thought about that paper that

324

00:20:06,990 --> 00:20:04,300

I had just read I thought well what if

325

00:20:09,270 --> 00:20:07,000

we tried looking at reflected light you

326

00:20:11,580 --> 00:20:09,280

know and tried studying that reflected

327

00:20:15,630 --> 00:20:11,590

light from exoplanets using the Kepler

328

00:20:18,840 --> 00:20:15,640

data and so I caught up with the student

329

00:20:20,760 --> 00:20:18,850

I said you know I do have an idea and

330

00:20:23,310 --> 00:20:20,770

the problem is that it's risky it's not

331

00:20:24,810 --> 00:20:23,320

been done yet and there's a chance that

332

00:20:27,600 --> 00:20:24,820

it might not work but here's what the

333

00:20:29,400 --> 00:20:27,610

here's the idea and I want you to go you

334

00:20:30,840 --> 00:20:29,410

know read about this think about it and

335

00:20:34,500 --> 00:20:30,850

then get back to me to see if you want

336

00:20:36,300 --> 00:20:34,510

to do that and and so so a couple days

337

00:20:37,770 --> 00:20:36,310

later he he got back to me and said he

338

00:20:39,180 --> 00:20:37,780

really wanted to work on this project so

339

00:20:49,470 --> 00:20:39,190

we basically took it on and that's how

340

00:20:59,280 --> 00:20:56,850

ah that's possible I don't know what the

341

00:21:16,169 --> 00:20:59,290

exact numbers are but I but yes but the

342

00:21:30,440 --> 00:21:28,049

oh yeah I totally agree I think the

343

00:21:32,820 --> 00:21:30,450

Kepler mission was a huge success and

344

00:21:34,850 --> 00:21:32,830

and I'm looking forward to some of the

345

00:21:37,799 --> 00:21:34,860

new missions like tests which is the

346

00:21:42,149 --> 00:21:37,809

transiting exoplanet survey satellite

347

00:21:44,430 --> 00:21:42,159

and and so we have several new missions

348

00:21:46,109 --> 00:21:44,440

coming up which will be giving us a lot

349

00:21:48,629 --> 00:21:46,119

more information about exoplanets so

350

00:21:50,369 --> 00:21:48,639

we're we're really entering a new era of

351
00:21:52,109 --> 00:21:50,379
astronomy where we're beginning to learn

352
00:21:53,580 --> 00:21:52,119
about planets around other stars and

353
00:22:03,360 --> 00:21:53,590
what these other worlds are actually

354
00:22:06,980 --> 00:22:05,010
yeah I don't know exactly what the

355
00:22:11,250 --> 00:22:06,990
status is and when they're planning to

356
00:22:32,320 --> 00:22:11,260
release data but but it's it it yeah

357
00:22:32,330 --> 00:22:56,139
and lira yep

358
00:23:06,980 --> 00:23:04,850
hum parallel I think that's right I

359
00:23:09,529 --> 00:23:06,990
think that's correct yeah and and the

360
00:23:12,070 --> 00:23:09,539
the if you hold your hand up in that

361
00:23:14,200 --> 00:23:12,080
region you know with arm extended

362
00:23:16,370 --> 00:23:14,210
basically the area of your palm

363
00:23:19,879 --> 00:23:16,380

represents that patch of sky that it's

364

00:23:21,769 --> 00:23:19,889

looking at so the 150,000 stars that has

365

00:23:23,240 --> 00:23:21,779

been studying in the several thousand

366

00:23:25,669 --> 00:23:23,250

planets that have been discovered all or

367

00:23:37,470 --> 00:23:25,679

behind your pub palm when your hand

368

00:23:37,480 --> 00:24:20,090

okay yeah

369

00:24:24,930 --> 00:24:22,860

right yeah I think it's been repurposed

370

00:24:30,570 --> 00:24:24,940

and what they're calling the k2 mission

371

00:24:32,010 --> 00:24:30,580

right now so they because they they had

372

00:24:36,930 --> 00:24:32,020

problems with some of the gyroscopes

373

00:24:39,870 --> 00:24:36,940

abled so they couldn't maintain maintain

374

00:24:42,390 --> 00:24:39,880

the pose to to watch that one patch of

375

00:24:43,620 --> 00:24:42,400

sky so now they're they they repurposed

376

00:24:44,970 --> 00:24:43,630

it and they're doing things a bit

377

00:25:26,939 --> 00:24:44,980

differently now but still collecting

378

00:25:34,329 --> 00:25:29,609

yeah that's that's exactly right we had

379

00:25:35,799 --> 00:25:34,339

the my former graduate students were the

380

00:25:39,459 --> 00:25:35,809

one who I had been speaking of actually

381

00:25:43,719 --> 00:25:39,469

who got got some started as being

382

00:25:47,649 --> 00:25:43,729

involved in this dr. Ben phasic he he

383

00:25:52,029 --> 00:25:47,659

developed this this software which we

384

00:25:54,430 --> 00:25:52,039

call eczema stand so and that's what we

385

00:25:58,779 --> 00:25:54,440

basically use to analyze the data from

386

00:26:01,359 --> 00:25:58,789

the Kepler space telescope and the oh

387

00:26:03,189 --> 00:26:01,369

I'm sorry in that yeah this other so

388

00:26:05,829 --> 00:26:03,199

this software not only models the

389

00:26:09,249 --> 00:26:05,839

transits it describes the uses

390

00:26:11,709 --> 00:26:09,259

information about the what happens to

391

00:26:14,069 --> 00:26:11,719

starlight as planet passes in front of

392

00:26:16,689 --> 00:26:14,079

the star but it also takes into account

393

00:26:19,599 --> 00:26:16,699

the fact that you can have reflected

394

00:26:21,459 --> 00:26:19,609

light the fact that the planet could be

395

00:26:25,269 --> 00:26:21,469

very close to the star and be very hot

396

00:26:30,189 --> 00:26:25,279

so you might get thermal emissions you

397

00:26:33,669 --> 00:26:30,199

see can get radiation due to due to the

398

00:26:35,169 --> 00:26:33,679

heat from the planet and there are two

399

00:26:37,689 --> 00:26:35,179

other effects that it takes into account

400

00:26:39,369 --> 00:26:37,699

to that one of them having to do with

401
00:26:41,259 --> 00:26:39,379
the fact that if the planets close to

402
00:26:42,729 --> 00:26:41,269
the star the gravitational force from

403
00:26:45,519 --> 00:26:42,739
the planet can actually distort the

404
00:26:49,149 --> 00:26:45,529
shape of the star slightly and you can

405
00:26:51,159 --> 00:26:49,159
see that that effect the light that you

406
00:26:57,219 --> 00:26:51,169
record as well so we can use several

407
00:26:59,319 --> 00:26:57,229
different effects to to obtain more

408
00:27:11,700 --> 00:26:59,329
information about what you know the

409
00:27:11,710 --> 00:27:37,250
you see

410
00:27:44,420 --> 00:27:40,190
most of the data has been been pre

411
00:27:47,170 --> 00:27:44,430
processed you and you can down the

412
00:27:51,350 --> 00:27:47,180
download the data from a portal which

413
00:27:52,940 --> 00:27:51,360

describes the format that it's in so off

414

00:27:54,950 --> 00:27:52,950

the top of my head I don't know how

415

00:27:57,410 --> 00:27:54,960

different the formats are from each

416

00:27:59,720 --> 00:27:57,420

other there's there's usually at least

417

00:28:02,750 --> 00:27:59,730

usually small differences at the very

418

00:28:04,580 --> 00:28:02,760

least so you have to do have to spend a

419

00:28:10,280 --> 00:28:04,590

little time reading about how the data

420

00:28:12,620 --> 00:28:10,290

is formatted and and and and often have

421

00:28:14,420 --> 00:28:12,630

to reformat it a bit to put it into the

422

00:28:18,590 --> 00:28:14,430

form that your software is ready for but

423

00:28:20,630 --> 00:28:18,600

but that information is all available on

424

00:28:46,810 --> 00:28:20,640

the download sites so that's not a

425

00:28:53,720 --> 00:28:49,810

Yeah right now they're mostly written

426
00:28:58,279 --> 00:28:53,730
written as basically as subroutines that

427
00:29:01,129 --> 00:28:58,289
you you can insert or utilize within the

428
00:29:04,879 --> 00:29:01,139
main software so so each each of these

429
00:29:08,810 --> 00:29:04,889
subroutines computes a photometric

430
00:29:10,940 --> 00:29:08,820
effect which basically is some some

431
00:29:12,169 --> 00:29:10,950
physical effect that changes the the

432
00:29:16,759 --> 00:29:12,179
amount of light that you're getting from

433
00:29:18,139 --> 00:29:16,769
the star so or that system so each one

434
00:29:21,980 --> 00:29:18,149
of these has written up as a subroutine

435
00:29:24,619 --> 00:29:21,990
and then you know for additional or

436
00:29:29,149 --> 00:29:24,629
future effects or refinements to these

437
00:29:31,669 --> 00:29:29,159
effects you you would basically rewrite

438
00:29:33,590 --> 00:29:31,679

the code for for a refinement you would

439

00:29:36,440 --> 00:29:33,600

you would edit the code for that

440

00:29:37,879 --> 00:29:36,450

subroutine or you if you wanted to take

441

00:29:41,060 --> 00:29:37,889

into account a new effect you would

442

00:29:42,350 --> 00:29:41,070

introduce a new subroutine which you

443

00:29:52,499 --> 00:29:42,360

basically just linked to the main

444

00:29:52,509 --> 00:30:10,380

Shh

445

00:30:15,210 --> 00:30:12,750

oh I think I think that's basically the

446

00:30:17,460 --> 00:30:15,220

situation that's been you know revealed

447

00:30:20,190 --> 00:30:17,470

from this data set I think the

448

00:30:24,200 --> 00:30:20,200

statistics the the last last time I

449

00:30:29,010 --> 00:30:24,210

looked at this the statistics were that

450

00:30:32,310 --> 00:30:29,020

one out of five stars in the sky would

451
00:30:34,800 --> 00:30:32,320
have a planet in the zone we call the

452
00:30:36,180 --> 00:30:34,810
habitable zone where you can have where

453
00:30:39,510 --> 00:30:36,190
the temperatures are just right to have

454
00:30:41,520 --> 00:30:39,520
liquid water so I think that's really

455
00:30:43,230 --> 00:30:41,530
exciting because that you go outside and

456
00:30:45,150 --> 00:30:43,240
just count out go outside and I count

457
00:30:47,820 --> 00:30:45,160
out five stars and one of those stars

458
00:30:49,350 --> 00:30:47,830
will have a planet that's within the

459
00:31:19,120 --> 00:30:49,360
right range to be able to have liquid

460
00:31:24,140 --> 00:31:22,040
now well the whole idea of a habitable

461
00:31:27,169 --> 00:31:24,150
zone is it's a little tricky because

462
00:31:29,240 --> 00:31:27,179
they buy that what's typically meant is

463
00:31:31,010 --> 00:31:29,250

that the surface temperatures of the

464

00:31:33,169 --> 00:31:31,020

planets would be such that you could

465

00:31:35,060 --> 00:31:33,179

have liquid water but that doesn't mean

466

00:31:37,850 --> 00:31:35,070

that the planet is necessarily habitable

467

00:31:39,770 --> 00:31:37,860

and and as you're saying just like

468

00:31:41,390 --> 00:31:39,780

you're saying there are other worlds you

469

00:31:43,910 --> 00:31:41,400

know that lie outside that zone where

470

00:31:45,530 --> 00:31:43,920

you can have still have liquid water and

471

00:31:59,690 --> 00:31:45,540

it still could be still could be

472

00:31:59,700 --> 00:32:26,070

that's right

473

00:32:43,049 --> 00:32:40,950

right well I wouldn't say hundred

474

00:32:45,539 --> 00:32:43,059

percent confident I would I would say

475

00:32:47,399 --> 00:32:45,549

that the probabilities are rather high

476

00:32:49,799 --> 00:32:47,409

that there's you know life elsewhere in

477

00:32:51,899 --> 00:32:49,809

the galaxy but you know like ice like

478

00:32:53,639 --> 00:32:51,909

weed at this point we don't know yet so

479

00:32:57,840 --> 00:32:53,649

we don't really know we don't really

480

00:33:00,090 --> 00:32:57,850

know what you know how life you know in

481

00:33:04,860 --> 00:33:00,100

what situations life can arise and and

482

00:33:06,480 --> 00:33:04,870

how long it can last and it's there's

483

00:33:20,580 --> 00:33:06,490

there's still a lot of uncertainty in

484

00:34:04,509 --> 00:33:27,340

Shh that's right yeah it is a big step

485

00:34:10,789 --> 00:34:08,389

well yeah I don't I don't necessarily

486

00:34:14,960 --> 00:34:10,799

see the two is being related directly

487

00:34:16,609 --> 00:34:14,970

but I I do you know one of the other

488

00:34:18,950 --> 00:34:16,619

hats I wear as I do do work in

489

00:34:21,049 --> 00:34:18,960

theoretical physics looking at either

490

00:34:25,099 --> 00:34:21,059

foundations of physics basically where

491

00:34:26,839 --> 00:34:25,109

where do why does why do we have the

492

00:34:28,940 --> 00:34:26,849

physical laws that we have and not other

493

00:34:30,260 --> 00:34:28,950

laws that's you know one way to look at

494

00:34:32,960 --> 00:34:30,270

it where do the laws of physics come

495

00:34:53,260 --> 00:34:32,970

from why why is why is physics the way

496

00:35:01,840 --> 00:34:59,060

sure yeah the I really started thinking

497

00:35:04,790 --> 00:35:01,850

about this because you know when we

498

00:35:07,100 --> 00:35:04,800

learn physics we learn you know you're

499

00:35:08,900 --> 00:35:07,110

first you're taught about a set a set of

500

00:35:12,950 --> 00:35:08,910

concepts you know you have position

501
00:35:16,840 --> 00:35:12,960
velocity energy mass momentum things

502
00:35:23,530 --> 00:35:16,850
like this and these are all empirically

503
00:35:26,090 --> 00:35:23,540
defined concepts so so you know

504
00:35:28,190 --> 00:35:26,100
sometimes you wonder well what what is

505
00:35:30,980 --> 00:35:28,200
what is you know what are these what do

506
00:35:32,930 --> 00:35:30,990
these things really represent and and we

507
00:35:35,090 --> 00:35:32,940
become familiar with them and their

508
00:35:36,950 --> 00:35:35,100
relationships to one another and that's

509
00:35:41,990 --> 00:35:36,960
one of the essential steps of becoming a

510
00:35:44,540 --> 00:35:42,000
physicist but but at some point you know

511
00:35:47,510 --> 00:35:44,550
reflecting back I realized well we often

512
00:35:49,850 --> 00:35:47,520
talk about you know say a billiard ball

513
00:35:51,680 --> 00:35:49,860

or an electron or something has a

514

00:35:56,270 --> 00:35:51,690

certain amount of energy and we say this

515

00:35:58,340 --> 00:35:56,280

all the time and and one day it really

516

00:36:01,430 --> 00:35:58,350

occurred to me that I really sank in

517

00:36:05,240 --> 00:36:01,440

that well isn't really right to say that

518

00:36:07,250 --> 00:36:05,250

something has energy and because if you

519

00:36:09,800 --> 00:36:07,260

had another observer racing volley in a

520

00:36:11,390 --> 00:36:09,810

spacecraft looking at it they would they

521

00:36:13,970 --> 00:36:11,400

would say that it has a different energy

522

00:36:17,960 --> 00:36:13,980

than the energy that I would assign to

523

00:36:20,090 --> 00:36:17,970

it so these a lot of these physical

524

00:36:21,860 --> 00:36:20,100

concepts that we are familiar with our

525

00:36:29,210 --> 00:36:21,870

observer base they depend on the

526

00:36:30,680 --> 00:36:29,220

observer and so so if the inter if

527

00:36:32,510 --> 00:36:30,690

something like the energy of an object

528

00:36:34,040 --> 00:36:32,520

depends actually depends on the observer

529

00:36:36,320 --> 00:36:34,050

then it doesn't really represent

530

00:36:38,690 --> 00:36:36,330

something that the object possesses it

531

00:36:40,790 --> 00:36:38,700

represents a description of the

532

00:36:44,060 --> 00:36:40,800

relationship between that object and the

533

00:36:46,880 --> 00:36:44,070

observer and so I really started

534

00:36:49,100 --> 00:36:46,890

pondering well what well what is the

535

00:36:52,850 --> 00:36:49,110

nature of this relationship between an

536

00:36:55,100 --> 00:36:52,860

object and an observer such that we use

537

00:36:57,980 --> 00:36:55,110

these fees what we think of as physical

538

00:37:00,780 --> 00:36:57,990

quantities to describe this so

539

00:37:03,630 --> 00:37:00,790

so we started playing around with with

540

00:37:05,910 --> 00:37:03,640

troy models trying to describe how you

541

00:37:08,099 --> 00:37:05,920

know if we can come up with a very

542

00:37:09,809 --> 00:37:08,109

simplified picture of what could be

543

00:37:12,359 --> 00:37:09,819

going on and see if we can drive the

544

00:37:14,220 --> 00:37:12,369

laws of physics this way so he came up

545

00:37:17,099 --> 00:37:14,230

with this model we're not calling it

546

00:37:22,730 --> 00:37:17,109

influence theory this idea that things

547

00:37:26,540 --> 00:37:22,740

influence one another and that and we're

548

00:37:30,660 --> 00:37:26,550

looking to see how one could possibly

549

00:37:34,079 --> 00:37:30,670

describe these the fact that things are

550

00:37:35,730 --> 00:37:34,089

influencing you as you're you know is

551
00:37:38,010 --> 00:37:35,740
there an observer in the universe and

552
00:37:39,780 --> 00:37:38,020
we've been able to show that you know

553
00:37:43,920 --> 00:37:39,790
with this very simple model that you can

554
00:37:45,630 --> 00:37:43,930
actually derive several you know some of

555
00:37:50,550 --> 00:37:45,640
the laws of physics this way basically

556
00:37:51,750 --> 00:37:50,560
that the laws of physics then that you

557
00:37:57,720 --> 00:37:51,760
know that we've been able to work with

558
00:37:59,760 --> 00:37:57,730
here basically are describing are just

559
00:38:04,260 --> 00:37:59,770
describing your relationship to the rest

560
00:38:06,000 --> 00:38:04,270
of the universe and so so I think that

561
00:38:09,109 --> 00:38:06,010
this is this is a very different

562
00:38:12,270 --> 00:38:09,119
perspective and it's very new and and

563
00:38:14,359 --> 00:38:12,280

and we're still making developments in

564

00:38:16,349 --> 00:38:14,369

this in this direction so but it's a

565

00:38:19,920 --> 00:38:16,359

different way of thinking about the

566

00:38:21,720 --> 00:38:19,930

physical laws it's not that from this

567

00:38:23,550 --> 00:38:21,730

perspective it's not that you have laws

568

00:38:25,800 --> 00:38:23,560

of nature and you have energy and

569

00:38:28,050 --> 00:38:25,810

momentum and these these physical

570

00:38:31,050 --> 00:38:28,060

concepts that are are somehow important

571

00:38:32,940 --> 00:38:31,060

it's it turned its instead that you know

572

00:38:37,230 --> 00:38:32,950

these concepts are actually descriptions

573

00:38:40,220 --> 00:38:37,240

are optimal descriptions of of how

574

00:39:01,990 --> 00:38:40,230

things interact with each other and and

575

00:39:09,770 --> 00:39:04,910

sure yeah that that's related to this

576

00:39:13,130 --> 00:39:09,780

idea and the well what we were able to

577

00:39:15,790 --> 00:39:13,140

do in one paper that I that I wrote with

578

00:39:19,820 --> 00:39:15,800

one of my former graduate students

579

00:39:25,090 --> 00:39:19,830

dr. Nisha bahraini and I we were looking

580

00:39:27,500 --> 00:39:25,100

at how an observer would be able to

581

00:39:30,880 --> 00:39:27,510

mathematically describe events that are

582

00:39:35,140 --> 00:39:30,890

happening that are causally related and

583

00:39:37,790 --> 00:39:35,150

and we were able to derive the

584

00:39:39,830 --> 00:39:37,800

mathematics of relativistic space-time

585

00:39:42,200 --> 00:39:39,840

the space-time that that Einstein had

586

00:39:43,790 --> 00:39:42,210

come up with and we were able to show

587

00:39:46,790 --> 00:39:43,800

that that's the only way you could

588

00:39:49,690 --> 00:39:46,800

possibly the only way an observer could

589

00:39:52,640 --> 00:39:49,700

possibly describe such events and so

590

00:40:01,880 --> 00:39:52,650

that was kind of exciting and strange

591

00:40:04,760 --> 00:40:01,890

because we we realized that that the

592

00:40:06,830 --> 00:40:04,770

implication was that space and time need

593

00:40:09,070 --> 00:40:06,840

not be physical things but we're

594

00:40:14,960 --> 00:40:09,080

basically just a description of events

595

00:40:16,520 --> 00:40:14,970

and so in some ways I guess this is a

596

00:40:19,850 --> 00:40:16,530

pun in some ways this changes the

597

00:40:26,750 --> 00:40:19,860

landscape of how to think about space

598

00:40:28,610 --> 00:40:26,760

and time and and so one way to think

599

00:40:30,020 --> 00:40:28,620

about it is that you know if you looks

600

00:40:32,540 --> 00:40:30,030

at look at something on the other side

601
00:40:35,300 --> 00:40:32,550
of the room you know you you're

602
00:40:38,300 --> 00:40:35,310
basically thinking about it as being at

603
00:40:40,340 --> 00:40:38,310
the other side of the room but it's but

604
00:40:42,830 --> 00:40:40,350
that is really representing is your

605
00:40:46,820 --> 00:40:42,840
relationship between you and that object

606
00:40:48,680 --> 00:40:46,830
and your relationship between you and

607
00:40:50,240 --> 00:40:48,690
something far away is different than

608
00:40:53,900 --> 00:40:50,250
your relationship to you and something

609
00:40:58,100 --> 00:40:53,910
close by and so this object this concept

610
00:41:02,240 --> 00:40:58,110
of closeness or far away or of distance

611
00:41:06,890 --> 00:41:02,250
is really a way of describing your

612
00:41:09,020 --> 00:41:06,900
relationship to things so so that's it's

613
00:41:11,510 --> 00:41:09,030

a different perspective and so with with

614

00:41:13,250 --> 00:41:11,520

a different perspective you know now can

615

00:41:18,050 --> 00:41:13,260

ask more interesting questions well

616

00:41:20,030 --> 00:41:18,060

let's say we take you know so so if this

617

00:41:21,680 --> 00:41:20,040

whole idea of way over there is really

618

00:41:25,490 --> 00:41:21,690

just a description of something well

619

00:41:27,410 --> 00:41:25,500

then maybe how do you then think about

620

00:41:28,910 --> 00:41:27,420

motion what does it mean to move from

621

00:41:30,020 --> 00:41:28,920

one point to another well what you're

622

00:41:34,490 --> 00:41:30,030

doing is you're changing your

623

00:41:35,930 --> 00:41:34,500

relationship to objects and so you know

624

00:41:37,970 --> 00:41:35,940

what is that what does that tell you

625

00:41:42,290 --> 00:41:37,980

about motion is an interesting question

626
00:41:44,120 --> 00:41:42,300
that we've been looking at so so I think

627
00:41:47,170 --> 00:41:44,130
it's a it's a new perspective it's so

628
00:41:49,910 --> 00:41:47,180
far it's so far it's been successful and

629
00:41:52,430 --> 00:41:49,920
whether we can can the theory can

630
00:41:54,020 --> 00:41:52,440
continue to be successful and will

631
00:41:56,780 --> 00:41:54,030
continue to work or it remains to be

632
00:42:18,750 --> 00:41:56,790
seen but that's something that we're

633
00:42:38,790 --> 00:42:34,790
oh well this is kind of difficult I I

634
00:42:43,260 --> 00:42:38,800
tried to avoid talking about specific

635
00:42:45,600 --> 00:42:43,270
cases for a simple reason usually you

636
00:42:48,320 --> 00:42:45,610
know if you if I pick a favorite case or

637
00:42:51,720 --> 00:42:48,330
something that I found to be compelling

638
00:42:53,670 --> 00:42:51,730

it doesn't take very long until somebody

639

00:42:57,090 --> 00:42:53,680

jumps in and says oh look but so-and-so

640

00:42:59,100 --> 00:42:57,100

debunked that case well what does that

641

00:43:01,740 --> 00:42:59,110

mean that so-and-so debunked that case

642

00:43:04,020 --> 00:43:01,750

and and and so you know and very often

643

00:43:06,810 --> 00:43:04,030

I've gone back and looked and see how so

644

00:43:09,780 --> 00:43:06,820

and so is debunked the case and the

645

00:43:13,440 --> 00:43:09,790

proposed explanation the proposed

646

00:43:16,710 --> 00:43:13,450

prosaic explanation is very often kind

647

00:43:21,180 --> 00:43:16,720

of ridiculous so I never sure what to

648

00:43:22,590 --> 00:43:21,190

make of this I think that maybe I can

649

00:43:31,140 --> 00:43:22,600

talk a little more generally I think

650

00:43:33,480 --> 00:43:31,150

there are there are cases where where

651
00:43:35,850 --> 00:43:33,490
you have especially you've had pilots or

652
00:43:38,250 --> 00:43:35,860
multiple pilots have seen large objects

653
00:43:40,170 --> 00:43:38,260
and some of these objects are very you

654
00:43:44,270 --> 00:43:40,180
know perceived to be very large you know

655
00:43:47,400 --> 00:43:44,280
in some cases ranging from 300 feet to

656
00:43:49,260 --> 00:43:47,410
you know to 800 feet however half a mile

657
00:43:52,590 --> 00:43:49,270
across or something like this various

658
00:43:56,150 --> 00:43:52,600
descriptions now you know I as a

659
00:43:58,770 --> 00:43:56,160
scientist I would ask myself well you

660
00:44:01,020 --> 00:43:58,780
you would be tempted in saying well how

661
00:44:03,150 --> 00:44:01,030
do you know you know judging distances

662
00:44:04,530 --> 00:44:03,160
or sizes at distances is a very

663
00:44:06,930 --> 00:44:04,540

difficult thing so how do you really

664

00:44:08,250 --> 00:44:06,940

know it was a half a mile across so

665

00:44:09,990 --> 00:44:08,260

that's an easy thing to say of course

666

00:44:13,470 --> 00:44:10,000

they don't know precisely that it was a

667

00:44:14,790 --> 00:44:13,480

half mile across but but I in a lot of

668

00:44:17,460 --> 00:44:14,800

my research I deal a lot with

669

00:44:19,560 --> 00:44:17,470

uncertainty so really the question ask

670

00:44:24,210 --> 00:44:19,570

is well how wrong could the person be

671

00:44:26,400 --> 00:44:24,220

right and you know so now here let's say

672

00:44:29,160 --> 00:44:26,410

we have a pilot who estimates the size

673

00:44:31,620 --> 00:44:29,170

of this craft as being 300 feet across

674

00:44:32,620 --> 00:44:31,630

well how wrong could the person be I

675

00:44:35,650 --> 00:44:32,630

don't know

676

00:44:36,790 --> 00:44:35,660

and it depends on the situation but but

677

00:44:38,830 --> 00:44:36,800

when you have a pilot that says

678

00:44:40,510 --> 00:44:38,840

basically that I looked out the front

679

00:44:42,790 --> 00:44:40,520

window and all I could see was this

680

00:44:45,610 --> 00:44:42,800

craft well they're not that wrong I mean

681

00:44:49,210 --> 00:44:45,620

they're the things obviously large and

682

00:44:54,160 --> 00:44:49,220

so so I so I find those cases

683

00:44:56,230 --> 00:44:54,170

interesting I you know I and clearly in

684

00:44:58,210 --> 00:44:56,240

those cases they saw something that was

685

00:45:00,460 --> 00:44:58,220

large whether you know large is a

686

00:45:03,130 --> 00:45:00,470

hundred feet across or 300 feet across I

687

00:45:06,390 --> 00:45:03,140

don't know but you know it's bigger than

688

00:45:07,540 --> 00:45:06,400

zero perches and which has I've been

689

00:45:19,860 --> 00:45:07,550

interesting

690

00:45:24,970 --> 00:45:22,630

the motion of the craft where you can

691

00:45:28,810 --> 00:45:24,980

make some inferences about the rates of

692

00:45:31,540 --> 00:45:28,820

acceleration and in especially in cases

693

00:45:35,590 --> 00:45:31,550

where you have this corroborated by

694

00:45:37,180 --> 00:45:35,600

radar data so so I've you know there are

695

00:45:39,010 --> 00:45:37,190

a few cases where exist where you can

696

00:45:41,140 --> 00:45:39,020

make estimates of the accelerations of

697

00:45:43,270 --> 00:45:41,150

these objects and they range anywhere

698

00:45:45,910 --> 00:45:43,280

from I've found them to range anywhere

699

00:45:49,690 --> 00:45:45,920

from 40 G the acceleration 40 times the

700

00:45:52,780 --> 00:45:49,700

acceleration of gravity to you know in

701
00:45:55,510 --> 00:45:52,790
one case up to over a thousand G of

702
00:45:56,320 --> 00:45:55,520
acceleration now and that and that's

703
00:46:05,950 --> 00:45:56,330
insane

704
00:46:07,420 --> 00:46:05,960
that's an exam acceleration and 25 G

705
00:46:09,940 --> 00:46:07,430
would kill a person yeah

706
00:46:15,700 --> 00:46:09,950
almost almost nothing biologically is

707
00:46:17,710 --> 00:46:15,710
gonna survive 25 G yeah so now so now

708
00:46:21,190 --> 00:46:17,720
some of these UFOs are accelerating at a

709
00:46:22,840 --> 00:46:21,200
hundred G or a thousand G well you know

710
00:46:25,330 --> 00:46:22,850
of course now you ask how wrong the

711
00:46:27,910 --> 00:46:25,340
person could be so you know in some

712
00:46:29,320 --> 00:46:27,920
cases I you know I basically went

713
00:46:31,870 --> 00:46:29,330

through and said well they're probably

714

00:46:33,910 --> 00:46:31,880

they're probably within 10 percent here

715

00:46:35,470 --> 00:46:33,920

or 50 percent there and you can actually

716

00:46:38,230 --> 00:46:35,480

redo the calculations and figure out

717

00:46:40,120 --> 00:46:38,240

what the uncertainties are so but still

718

00:46:41,320 --> 00:46:40,130

these and these accelerations are large

719

00:46:46,270 --> 00:46:41,330

so

720

00:46:49,060 --> 00:46:46,280

thing accelerated anywhere between 30 G

721

00:46:52,780 --> 00:46:49,070

and 70 G you know of acceleration but

722

00:46:56,530 --> 00:46:52,790

that's still a crazy acceleration and so

723

00:46:58,150 --> 00:46:56,540

what I what I like to ask is you know as

724

00:47:01,690 --> 00:46:58,160

a scientist you know it comes down to

725

00:47:04,420 --> 00:47:01,700

testing hypotheses so if I'm going to

726

00:47:07,090 --> 00:47:04,430

test this hypothesis that it's an

727

00:47:08,560 --> 00:47:07,100

interstellar spacecraft well what what

728

00:47:10,600 --> 00:47:08,570

do I expect an interstellar spacecraft

729

00:47:13,720 --> 00:47:10,610

to be able to do well you better be able

730

00:47:16,210 --> 00:47:13,730

to accelerate rapidly and at least and

731

00:47:17,710 --> 00:47:16,220

so because you have to get up to high

732

00:47:21,070 --> 00:47:17,720

speeds if you're gonna get anywhere

733

00:47:24,550 --> 00:47:21,080

within a reasonable period of time so

734

00:47:26,500 --> 00:47:24,560

it's very easy to sit and say well would

735

00:47:31,030 --> 00:47:26,510

you know what a hundred g of

736

00:47:34,750 --> 00:47:31,040

acceleration be something reasonable for

737

00:47:36,430 --> 00:47:34,760

an interstellar spacecraft well so you

738

00:47:41,260 --> 00:47:36,440

can actually do those calculations and

739

00:47:43,630 --> 00:47:41,270

so the the the result is if you were to

740

00:47:45,970 --> 00:47:43,640

accelerate at a hundred G which would of

741

00:47:48,430 --> 00:47:45,980

course kill you but so I don't know

742

00:47:50,860 --> 00:47:48,440

physically how anybody would pull this

743

00:47:53,800 --> 00:47:50,870

off or it probably would destroy most

744

00:47:55,930 --> 00:47:53,810

equipment that we could make as well but

745

00:47:59,280 --> 00:47:55,940

if you could do that which would be an

746

00:48:02,920 --> 00:47:59,290

engineering problem then you could

747

00:48:04,390 --> 00:48:02,930

literally traverse the galaxy one side

748

00:48:08,890 --> 00:48:04,400

of the galaxy to the other in about a

749

00:48:11,290 --> 00:48:08,900

hundred and twenty days ship time so the

750

00:48:13,930 --> 00:48:11,300

idea that what would basically you'd be

751
00:48:15,820 --> 00:48:13,940
happening is that the that when you get

752
00:48:19,360 --> 00:48:15,830
up to very high speeds relativity works

753
00:48:21,040 --> 00:48:19,370
with you as the traveler relative to the

754
00:48:24,250 --> 00:48:21,050
rest of the galaxy your time is going

755
00:48:26,200 --> 00:48:24,260
more slowly so you can actually traverse

756
00:48:29,280 --> 00:48:26,210
larger just you know great distances in

757
00:48:32,170 --> 00:48:29,290
short periods of time you know for you

758
00:48:34,660 --> 00:48:32,180
so let's imagine you have a ship that

759
00:48:36,520 --> 00:48:34,670
takes off at a hundred G and accelerates

760
00:48:38,170 --> 00:48:36,530
halfway and then decelerates at a

761
00:48:41,160 --> 00:48:38,180
hundred G the rest of their way and

762
00:48:43,810 --> 00:48:41,170
makes it to the other side of the galaxy

763
00:48:45,520 --> 00:48:43,820

the the inhabitants of the ship there

764

00:48:47,800 --> 00:48:45,530

their clocks are going slower with

765

00:48:49,690 --> 00:48:47,810

respect to the rest of the galaxy so the

766

00:48:54,200 --> 00:48:49,700

rest of us looking at the ship would see

767

00:48:57,960 --> 00:48:54,210

that they could do it in

768

00:48:59,490 --> 00:48:57,970

about four months their time whereas for

769

00:49:03,510 --> 00:48:59,500

us it would take about a hundred fifty

770

00:49:05,430 --> 00:49:03,520

thousand years for them to do this so so

771

00:49:08,730 --> 00:49:05,440

this is why this is why in

772

00:49:12,930 --> 00:49:08,740

science-fiction spaceships don't just go

773

00:49:15,059 --> 00:49:12,940

fast because if you could accelerate a

774

00:49:18,000 --> 00:49:15,069

hundred G and race across the galaxy and

775

00:49:20,579 --> 00:49:18,010

then turn around and come back by the

776

00:49:22,079 --> 00:49:20,589

time you got back about three hundred

777

00:49:26,339 --> 00:49:22,089

thousand years will have passed on earth

778

00:49:30,420 --> 00:49:26,349

and even though for you the the

779

00:49:33,299 --> 00:49:30,430

round-trip voyage would just take

780

00:49:35,670 --> 00:49:33,309

something like two times four months

781

00:49:37,020 --> 00:49:35,680

which would be eight months so so you

782

00:49:39,450 --> 00:49:37,030

could make the trip in less than a year

783

00:49:41,250 --> 00:49:39,460

but three hundred thousand years would

784

00:49:43,530 --> 00:49:41,260

pass on earth and of course you wouldn't

785

00:49:45,299 --> 00:49:43,540

be able to see your loved ones you know

786

00:49:55,980 --> 00:49:45,309

probably America wouldn't be here

787

00:49:59,730 --> 00:49:55,990

anymore most of the countries people and

788

00:50:03,870 --> 00:49:59,740

so so that doesn't make for a very good

789

00:50:06,089 --> 00:50:03,880

science fiction story but that but what

790

00:50:09,539 --> 00:50:06,099

it does highlight is that the physics

791

00:50:11,549 --> 00:50:09,549

doesn't stop you from traveling through

792

00:50:19,260 --> 00:50:11,559

interstellar space

793

00:50:22,710 --> 00:50:20,910

yeah you can't share your information

794

00:50:24,120 --> 00:50:22,720

with anybody so you can't tell anybody

795

00:50:24,630 --> 00:50:24,130

what you found on the other side of the

796

00:50:27,330 --> 00:50:24,640

galaxy

797

00:50:29,580 --> 00:50:27,340

now of course there are a whole whole

798

00:50:31,890 --> 00:50:29,590

set of engineering problems how do you

799

00:50:34,380 --> 00:50:31,900

continue to accelerate it you know at a

800

00:50:36,390 --> 00:50:34,390

rate like that how do you survive

801
00:50:38,820 --> 00:50:36,400
accelerating at a hundred G how do you

802
00:50:41,160 --> 00:50:38,830
well you can you can do it at a

803
00:50:42,840 --> 00:50:41,170
comfortable 1g and it would still you

804
00:50:44,640 --> 00:50:42,850
could traverse the galaxy and it would

805
00:50:46,370 --> 00:50:44,650
still it would take you a bit longer but

806
00:50:48,690 --> 00:50:46,380
you could do it within your lifetime so

807
00:50:50,790 --> 00:50:48,700
but how do you keep accelerating a

808
00:50:53,880 --> 00:50:50,800
spacecraft you know our our technology

809
00:50:56,520 --> 00:50:53,890
works by throwing hot gasses out the

810
00:50:58,680 --> 00:50:56,530
back right and so conservation of

811
00:51:01,290 --> 00:50:58,690
momentum is what moves the craft forward

812
00:51:03,720 --> 00:51:01,300
but eventually you run out of stuff to

813
00:51:06,240 --> 00:51:03,730

throw out the back your ship so you run

814

00:51:07,440 --> 00:51:06,250

out of fuel so we can only accelerate

815

00:51:10,430 --> 00:51:07,450

for short periods of time with our

816

00:51:14,160 --> 00:51:10,440

technology and then the other the other

817

00:51:17,609 --> 00:51:14,170

huge problem is that as you're racing

818

00:51:20,760 --> 00:51:17,619

through intergalactic space at close to

819

00:51:23,130 --> 00:51:20,770

the speed of light you space isn't empty

820

00:51:26,849 --> 00:51:23,140

you've got about one hydrogen atom per

821

00:51:30,090 --> 00:51:26,859

cubic meter so you're going to be and

822

00:51:31,560 --> 00:51:30,100

and of course relativity from your

823

00:51:34,109 --> 00:51:31,570

perspective relativity is going to

824

00:51:35,940 --> 00:51:34,119

shorten distances so so all of this

825

00:51:37,380 --> 00:51:35,950

hydrogen gas is going to be compressed

826

00:51:39,690 --> 00:51:37,390

and you're basically flying through a

827

00:51:41,010 --> 00:51:39,700

hydrogen cloud at close to the speed of

828

00:51:44,609 --> 00:51:41,020

light and that would tear your ship

829

00:51:47,990 --> 00:51:44,619

apart in short order so so there are you

830

00:51:50,580 --> 00:51:48,000

know while there are some enormous and

831

00:51:54,270 --> 00:51:50,590

difficult to imagine engineering feats

832

00:51:56,940 --> 00:51:54,280

that you'd have to have to accomplish to

833

00:51:58,920 --> 00:51:56,950

do something like this it's important to

834

00:52:00,930 --> 00:51:58,930

recognize that the physics doesn't stop

835

00:52:03,480 --> 00:52:00,940

it from happening you know there's no

836

00:52:06,780 --> 00:52:03,490

law of nature that says this is

837

00:52:10,109 --> 00:52:06,790

impossible to do in your lifetime and so

838

00:52:11,520 --> 00:52:10,119

I find that I find that interesting now

839

00:52:13,500 --> 00:52:11,530

then you can go a step further and you

840

00:52:15,120 --> 00:52:13,510

can imagine well what would a what would

841

00:52:17,280 --> 00:52:15,130

a let's assume that you have a

842

00:52:20,660 --> 00:52:17,290

civilization that pulled this off that

843

00:52:23,299 --> 00:52:20,670

could could do the engineering

844

00:52:25,640 --> 00:52:23,309

you know so you've got a bunch of people

845

00:52:28,010 --> 00:52:25,650

or beings that are traveling across the

846

00:52:32,270 --> 00:52:28,020

galaxy of these very high accelerations

847

00:52:34,700 --> 00:52:32,280

and very high speeds well they can't go

848

00:52:35,960 --> 00:52:34,710

back home because they go from one side

849

00:52:39,620 --> 00:52:35,970

of the galaxy the other and come back

850

00:52:42,380 --> 00:52:39,630

and 300,000 years will have passed so so

851
00:52:43,970 --> 00:52:42,390
you literally will have the only way you

852
00:52:46,160 --> 00:52:43,980
could do it is to form a breakaway

853
00:52:49,970 --> 00:52:46,170
Society of travelers where you have

854
00:52:51,980 --> 00:52:49,980
beings that they travel the galaxy and

855
00:52:54,710 --> 00:52:51,990
that's what they do and they don't go

856
00:52:56,690 --> 00:52:54,720
home they if they're clever they could

857
00:52:59,390 --> 00:52:56,700
meet up with their friends as long as

858
00:53:00,770 --> 00:52:59,400
their friends keep travelling so I'm

859
00:53:02,270 --> 00:53:00,780
gonna go to this side of the galaxy you

860
00:53:05,030 --> 00:53:02,280
go to this side of the galaxy and we'll

861
00:53:07,190 --> 00:53:05,040
both meet back here you know in in in

862
00:53:10,160 --> 00:53:07,200
nine months and we could arrange that

863
00:53:13,250 --> 00:53:10,170

and and if we do it right when we meet

864

00:53:16,690 --> 00:53:13,260

back here you can tell me what you found

865

00:53:19,670 --> 00:53:16,700

I can tell you what you what I found and

866

00:53:21,829 --> 00:53:19,680

it'll be you know 300 thousand years

867

00:53:24,980 --> 00:53:21,839

later but but we don't care we'll just

868

00:53:26,450 --> 00:53:24,990

keep traveling and so you'd end up with

869

00:53:29,599 --> 00:53:26,460

you know you could end up with this

870

00:53:30,890 --> 00:53:29,609

Society of nomads nomadic explorers

871

00:53:33,109 --> 00:53:30,900

where that's what they do they just

872

00:53:38,059 --> 00:53:33,119

explore and I don't know I think that

873

00:53:40,760 --> 00:53:38,069

would be quite fun but then it also

874

00:53:43,400 --> 00:53:40,770

which it would change it would be that

875

00:53:45,910 --> 00:53:43,410

you know we often think that an advanced

876
00:53:48,530 --> 00:53:45,920
technologically advanced society would

877
00:53:50,589 --> 00:53:48,540
have a very different perspective of

878
00:53:54,010 --> 00:53:50,599
things and that's true but if you had

879
00:53:56,150 --> 00:53:54,020
somebody who was traveling you know

880
00:53:57,349 --> 00:53:56,160
performing interstellar travel in this

881
00:53:59,480 --> 00:53:57,359
way

882
00:54:02,680 --> 00:53:59,490
they're basically racing forward into

883
00:54:04,430 --> 00:54:02,690
the future constantly so so their

884
00:54:06,470 --> 00:54:04,440
perspective of things would be very

885
00:54:09,920 --> 00:54:06,480
different than somebody who lived on a

886
00:54:15,589 --> 00:54:09,930
planet basically everything becomes

887
00:54:17,510 --> 00:54:15,599
ephemeral and and so I can imagine you

888
00:54:19,160 --> 00:54:17,520

know so when I hear people say why why

889

00:54:21,470 --> 00:54:19,170

don't I lian's land on the White House

890

00:54:22,569 --> 00:54:21,480

lawn and my whole thing is what's the

891

00:54:24,920 --> 00:54:22,579

point

892

00:54:26,809 --> 00:54:24,930

why bother because the next time you

893

00:54:28,880 --> 00:54:26,819

come back it could be 300,000 years

894

00:54:30,920 --> 00:54:28,890

later or something depending on how far

895

00:54:33,660 --> 00:54:30,930

you travel and how you know where you're

896

00:54:37,240 --> 00:54:33,670

going to and what your plans are

897

00:54:39,040 --> 00:54:37,250

so I think that that I think it really

898

00:54:40,660 --> 00:54:39,050

is true that it's hard to imagine what

899

00:54:45,040 --> 00:54:40,670

the perspective of an interstellar

900

00:54:47,350 --> 00:54:45,050

traveler would be but I think it's fun

901
00:54:49,240 --> 00:54:47,360
too it's important to realize that you

902
00:54:52,900 --> 00:54:49,250
don't have to go faster than light to do

903
00:55:07,570 --> 00:54:52,910
it but there are huge engineering

904
00:55:12,620 --> 00:55:10,220
yeah I still think it's a hard limit I

905
00:55:14,930 --> 00:55:12,630
think that you know for for a few

906
00:55:20,000 --> 00:55:14,940
reasons first they you know there's

907
00:55:21,740 --> 00:55:20,010
nothing in that there's there's no

908
00:55:23,870 --> 00:55:21,750
experiments have been performed that

909
00:55:26,330 --> 00:55:23,880
suggests that you can you can break

910
00:55:28,610 --> 00:55:26,340
break this limit and the theoretical

911
00:55:33,170 --> 00:55:28,620
work that we've developed reproduces

912
00:55:35,510 --> 00:55:33,180
Einstein's work on relativity so I which

913
00:55:42,820 --> 00:55:35,520

which says that the speed of light is

914

00:55:42,830 --> 00:56:17,150

of course he was a genie yes yep

915

00:56:36,960 --> 00:56:19,829

I'm at warp space-time according to

916

00:56:48,809 --> 00:56:46,410

oh we could it depends on yeah it

917

00:56:53,069 --> 00:56:48,819

depends on what ideas we would possibly

918

00:57:00,859 --> 00:56:53,079

have that we could that we could

919

00:57:15,380 --> 00:57:03,569

no I think I think we've covered most of

920

00:57:25,530 --> 00:57:22,829

yes several this is my sis is my second

921

00:57:38,490 --> 00:57:25,540

one I did I think yeah I did

922

00:57:40,859 --> 00:57:38,500

the API case files last night so no not

923

00:57:42,780 --> 00:57:40,869

at all I loved my day job and I love

924

00:57:44,609 --> 00:57:42,790

looking at exoplanets and I love the

925

00:58:17,900 --> 00:57:44,619

theoretical work we're doing and it's

