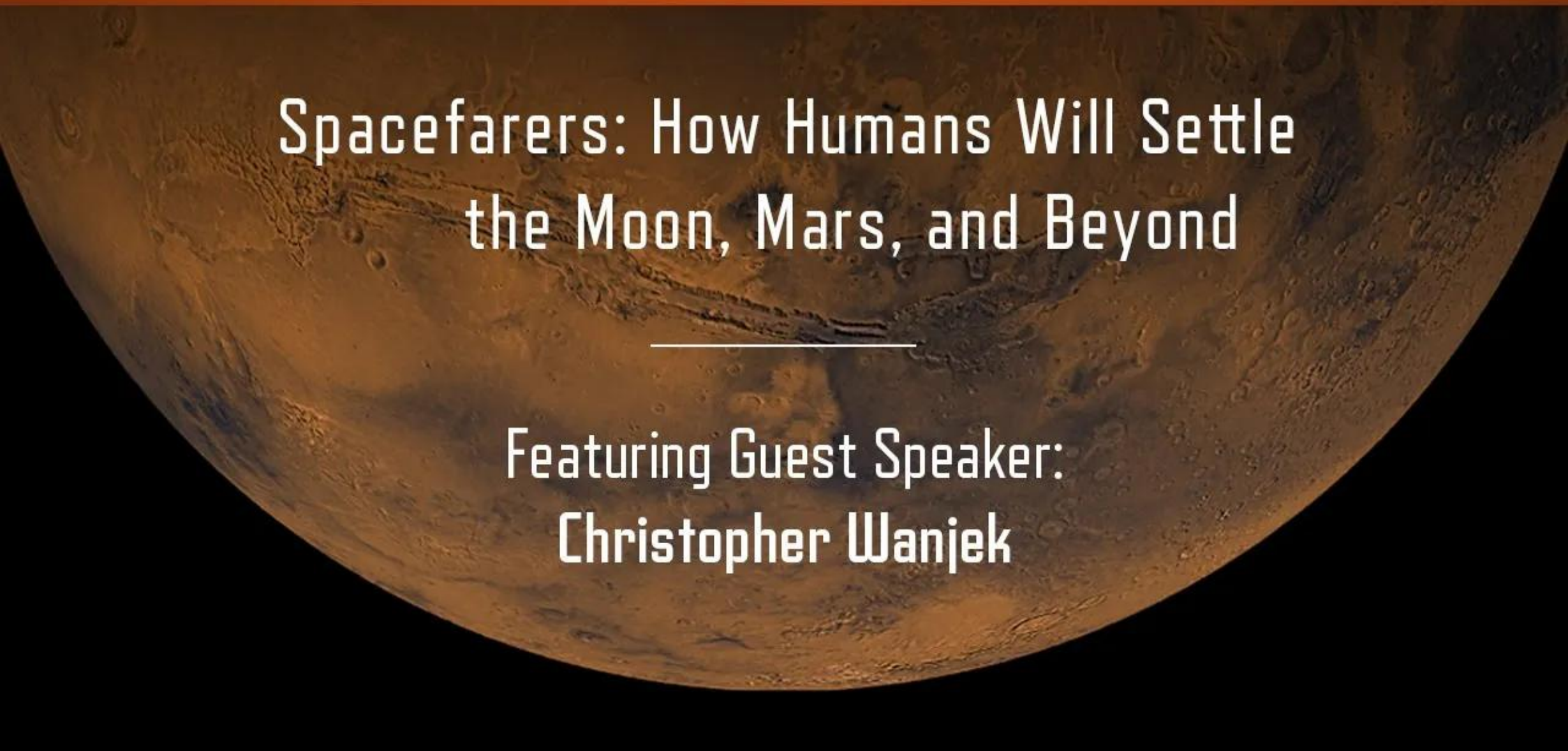
PUBLIC LECTURE SERIES



Spacefarers: How Humans Will Settle the Moon, Mars, and Beyond

Featuring Guest Speaker:

Christopher Wanjek

1
00:00:07,670 --> 00:00:04,230
welcome to the space telescope

2
00:00:10,629 --> 00:00:07,680
public lecture series tonight's talk

3
00:00:11,509 --> 00:00:10,639
space fairs how humans will settle the

4
00:00:15,190 --> 00:00:11,519
moon

5
00:00:19,029 --> 00:00:17,029
i'm dr frank summers your host for this

6
00:00:21,349 --> 00:00:19,039
evening and i want to thank our

7
00:00:23,670 --> 00:00:21,359
wonderful tech team thomas marufu

8
00:00:25,029 --> 00:00:23,680
and grant justice who are taking this

9
00:00:28,070 --> 00:00:25,039
and streaming it out

10
00:00:30,390 --> 00:00:28,080
to you for you to watch uh i will note

11
00:00:32,470 --> 00:00:30,400
that we will be online only until

12
00:00:33,670 --> 00:00:32,480
further notice and that will probably

13
00:00:35,990 --> 00:00:33,680

last throughout

14
00:00:37,270 --> 00:00:36,000
2021 there really hasn't been any

15
00:00:40,229 --> 00:00:37,280
decision on this

16
00:00:41,430 --> 00:00:40,239
on this yet we know we will stay online

17
00:00:45,510 --> 00:00:41,440
through the summer

18
00:00:48,549 --> 00:00:45,520
we'll see about the fall our upcoming

19
00:00:49,670 --> 00:00:48,559
talks next month we have a very special

20
00:00:52,630 --> 00:00:49,680
one for you

21
00:00:53,590 --> 00:00:52,640
on may 4th finding the music of the

22
00:00:56,470 --> 00:00:53,600
spheres

23
00:00:58,869 --> 00:00:56,480
hearing stars this is from the

24
00:01:01,270 --> 00:00:58,879
consonants collective and the bergamot

25
00:01:02,790 --> 00:01:01,280
quartet from the peabody institute here

26
00:01:04,869 --> 00:01:02,800
in baltimore

27
00:01:05,990 --> 00:01:04,879
they have collaborated with the space

28
00:01:10,070 --> 00:01:06,000
telescope science

29
00:01:13,030 --> 00:01:10,080
institute to write music inspired

30
00:01:14,710 --> 00:01:13,040
by astronomical images they will talk

31
00:01:17,190 --> 00:01:14,720
about their compositions

32
00:01:18,950 --> 00:01:17,200
as well as play some music for you now i

33
00:01:19,670 --> 00:01:18,960
want to warn you this one was probably

34
00:01:22,149 --> 00:01:19,680
going to go

35
00:01:24,230 --> 00:01:22,159
long we have several different composers

36
00:01:26,390 --> 00:01:24,240
and several different pieces to play

37
00:01:27,910 --> 00:01:26,400
so we're probably going to go for about

38
00:01:29,910 --> 00:01:27,920

two hours next month

39
00:01:31,270 --> 00:01:29,920
normally we stop at 90 minutes but i

40
00:01:32,310 --> 00:01:31,280
think we're probably gonna go for about

41
00:01:34,550 --> 00:01:32,320
two hours but

42
00:01:36,550 --> 00:01:34,560
this will be a special event and i'm

43
00:01:39,190 --> 00:01:36,560
sure you'll want to see it

44
00:01:41,350 --> 00:01:39,200
in june we will have a talk about

45
00:01:42,950 --> 00:01:41,360
exoplanets by emily rickman

46
00:01:44,469 --> 00:01:42,960
here at the space telescope science

47
00:01:47,910 --> 00:01:44,479
institute and

48
00:01:50,149 --> 00:01:47,920
in july quinn hart who did

49
00:01:51,270 --> 00:01:50,159
this talk last year armchair

50
00:01:53,350 --> 00:01:51,280
astrophysics

51
00:01:55,350 --> 00:01:53,360
is going to come back with a second

52
00:01:56,709 --> 00:01:55,360
version of armchair astrophysics it will

53
00:01:58,230 --> 00:01:56,719
not be the same things that she talked

54
00:02:00,389 --> 00:01:58,240
about last year

55
00:02:01,670 --> 00:02:00,399
she said she had you know so much she

56
00:02:04,069 --> 00:02:01,680
could have talked about last year

57
00:02:05,590 --> 00:02:04,079
that she's going to do a you know

58
00:02:09,029 --> 00:02:05,600
follow-on to her talk

59
00:02:10,710 --> 00:02:09,039
last year you want to know about our

60
00:02:14,190 --> 00:02:10,720
talks upcoming talks you can go to our

61
00:02:18,070 --> 00:02:15,750
www.stscide.edu

62
00:02:19,510 --> 00:02:18,080
public hyphen lectures we'll get you

63
00:02:21,910 --> 00:02:19,520

there

64
00:02:22,790 --> 00:02:21,920
on on our page you can see on the left

65
00:02:25,990 --> 00:02:22,800
hand side

66
00:02:28,229 --> 00:02:26,000
the links to our webcasts both on the uh

67
00:02:29,830 --> 00:02:28,239
our youtube playlist as well as the

68
00:02:31,509 --> 00:02:29,840
webcast archive

69
00:02:33,030 --> 00:02:31,519
housed by the space telescope science

70
00:02:34,949 --> 00:02:33,040
institute uh

71
00:02:36,550 --> 00:02:34,959
on the right you can see how to

72
00:02:38,790 --> 00:02:36,560
subscribe to our

73
00:02:40,869 --> 00:02:38,800
lecture announcements if you want uh

74
00:02:41,750 --> 00:02:40,879
just one or two emails a month reminding

75
00:02:45,190 --> 00:02:41,760
you of these

76
00:02:46,550 --> 00:02:45,200
the presentations also we have the

77
00:02:48,949 --> 00:02:46,560
upcoming lectures the

78
00:02:49,750 --> 00:02:48,959
uh things and if you click those read

79
00:02:52,150 --> 00:02:49,760
more

80
00:02:53,190 --> 00:02:52,160
buttons you'll get to the complete

81
00:02:56,229 --> 00:02:53,200
details of

82
00:02:58,790 --> 00:02:56,239
about the lecture the

83
00:02:59,910 --> 00:02:58,800
description of it as well as after it

84
00:03:02,229 --> 00:02:59,920
has been recorded

85
00:03:03,270 --> 00:03:02,239
the link to the sdsci webcast that you

86
00:03:05,190 --> 00:03:03,280
can see at the top

87
00:03:08,229 --> 00:03:05,200
and the link to the youtube webcast

88
00:03:10,869 --> 00:03:08,239

there on the bottom

89
00:03:11,830 --> 00:03:10,879
uh email well as i've already said sign

90
00:03:15,030 --> 00:03:11,840
up at the

91
00:03:16,869 --> 00:03:15,040
website um very easy to do

92
00:03:18,390 --> 00:03:16,879
but you can also subscribe to our

93
00:03:21,270 --> 00:03:18,400
youtube channel

94
00:03:21,670 --> 00:03:21,280
youtube.com hubble space telescope and

95
00:03:23,830 --> 00:03:21,680
if you're

96
00:03:25,270 --> 00:03:23,840
watching this on youtube hey that's the

97
00:03:27,750 --> 00:03:25,280
channel you're watching

98
00:03:28,949 --> 00:03:27,760
uh if you subscribe then you'll get new

99
00:03:32,149 --> 00:03:28,959
video notices

100
00:03:33,670 --> 00:03:32,159
and reminders of these live events

101
00:03:35,750 --> 00:03:33,680
finally if you have comments or

102
00:03:37,789 --> 00:03:35,760
questions you can send them to the email

103
00:03:40,390 --> 00:03:37,799
public lecture

104
00:03:42,550 --> 00:03:40,400
stsci.edu

105
00:03:44,309 --> 00:03:42,560
space telescope science institute runs

106
00:03:45,990 --> 00:03:44,319
several social media channels for the

107
00:03:48,070 --> 00:03:46,000
hubble space telescope

108
00:03:49,830 --> 00:03:48,080
for the james webb space telescope that

109
00:03:51,509 --> 00:03:49,840
we'll be launching this fall

110
00:03:54,149 --> 00:03:51,519
and for the space telescope science

111
00:03:56,390 --> 00:03:54,159
institute itself we're on facebook we're

112
00:04:00,390 --> 00:03:56,400
on twitter we're on youtube we're on

113
00:04:03,270 --> 00:04:00,400

instagram at the handles provided there

114
00:04:04,869 --> 00:04:03,280
myself i do a tiny bit of social media

115
00:04:08,789 --> 00:04:04,879
on facebook and twitter

116
00:04:14,470 --> 00:04:11,190
and now the news from the universe for

117
00:04:17,830 --> 00:04:14,480
april 2021

118
00:04:21,270 --> 00:04:17,840
our first story the dim prospects

119
00:04:24,230 --> 00:04:21,280
of a bright star so let's start in

120
00:04:25,189 --> 00:04:24,240
this region of the sky now you can see

121
00:04:28,469 --> 00:04:25,199
in the lower right

122
00:04:30,310 --> 00:04:28,479
i've circled the constellation of orion

123
00:04:32,070 --> 00:04:30,320
and that's a very famous constellation

124
00:04:35,030 --> 00:04:32,080
that sort of orients you on the sky

125
00:04:37,110 --> 00:04:35,040
and orion is the hunter and he has

126
00:04:40,310 --> 00:04:37,120
accompanied by his two hunting dogs

127
00:04:40,550 --> 00:04:40,320
canis major and canis minor canis major

128
00:04:43,830 --> 00:04:40,560
is

129
00:04:45,830 --> 00:04:43,840
the big dog and the dog star

130
00:04:46,950 --> 00:04:45,840
the brightest star in canis major is

131
00:04:49,030 --> 00:04:46,960
sirius

132
00:04:51,990 --> 00:04:49,040
now many of you may know that that is

133
00:04:54,070 --> 00:04:52,000
the brightest star on the night sky

134
00:04:55,749 --> 00:04:54,080
but that doesn't necessarily mean it's

135
00:04:58,550 --> 00:04:55,759
the brightest star

136
00:04:59,510 --> 00:04:58,560
anywhere it happens to be a pretty

137
00:05:01,430 --> 00:04:59,520
bright star

138
00:05:04,390 --> 00:05:01,440

but it also is really really really

139
00:05:07,110 --> 00:05:04,400
close that's why it appears bright to us

140
00:05:09,270 --> 00:05:07,120
a really really bright star one of the

141
00:05:12,469 --> 00:05:09,280
brightest stars in the milky way

142
00:05:13,270 --> 00:05:12,479
is just to the left and it's circled and

143
00:05:17,029 --> 00:05:13,280
it's called v

144
00:05:18,870 --> 00:05:17,039
y canis majoris all right and so

145
00:05:20,150 --> 00:05:18,880
let's tell you a little bit about by

146
00:05:23,590 --> 00:05:20,160
cannas majority it's a

147
00:05:26,950 --> 00:05:23,600
red hyper giant star it's

148
00:05:30,710 --> 00:05:26,960
huge this is an evolved star okay

149
00:05:31,909 --> 00:05:30,720
it's 300 000 times more luminous than

150
00:05:34,629 --> 00:05:31,919
our sun

151
00:05:35,189 --> 00:05:34,639
yeah much much much brighter than our

152
00:05:37,990 --> 00:05:35,199
sun

153
00:05:38,550 --> 00:05:38,000
it's also much much much bigger than our

154
00:05:42,310 --> 00:05:38,560
sun

155
00:05:45,430 --> 00:05:42,320
it's 1400 times larger than

156
00:05:48,310 --> 00:05:45,440
our sun how big is that well

157
00:05:49,350 --> 00:05:48,320
that is so large that on this scale

158
00:05:52,230 --> 00:05:49,360
diagram

159
00:05:53,990 --> 00:05:52,240
the sun has been there the entire time

160
00:05:57,270 --> 00:05:54,000
and you haven't noticed it

161
00:05:57,670 --> 00:05:57,280
that's how tiny the sun is let me zoom

162
00:06:00,790 --> 00:05:57,680
in

163
00:06:03,189 --> 00:06:00,800

and you can see here's the sun compared

164
00:06:05,350 --> 00:06:03,199
to vy canis majoris yes

165
00:06:06,950 --> 00:06:05,360
dui cancer drawers one of the biggest

166
00:06:09,749 --> 00:06:06,960
and one of the brightest

167
00:06:11,990 --> 00:06:09,759
stars out there so it's an interesting

168
00:06:14,950 --> 00:06:12,000
star just in its own right

169
00:06:16,070 --> 00:06:14,960
but it's also interesting in its light

170
00:06:18,230 --> 00:06:16,080
curve okay

171
00:06:20,150 --> 00:06:18,240
this is a historical light curve it goes

172
00:06:22,469 --> 00:06:20,160
all the way back to 1800

173
00:06:25,350 --> 00:06:22,479
and all the way up to 2020. so as you've

174
00:06:27,430 --> 00:06:25,360
got over 200 years of light curve here

175
00:06:28,710 --> 00:06:27,440
and i've you'll notice that the plots

176
00:06:30,390 --> 00:06:28,720
are little shifted well

177
00:06:31,990 --> 00:06:30,400
that's because one of them measures

178
00:06:33,110 --> 00:06:32,000
visual magnitude one of them measures

179
00:06:35,029 --> 00:06:33,120
blue magnitude

180
00:06:36,469 --> 00:06:35,039
and one of them measures v band

181
00:06:37,909 --> 00:06:36,479
magnitude and they're slightly different

182
00:06:39,270 --> 00:06:37,919
but they have to be shifted around to

183
00:06:41,430 --> 00:06:39,280
match okay

184
00:06:42,629 --> 00:06:41,440
but what you can see that is since the

185
00:06:46,390 --> 00:06:42,639
early 1800s

186
00:06:48,790 --> 00:06:46,400
through to today vy canis majoris has

187
00:06:50,070 --> 00:06:48,800
dimmed a lot okay it's it's dim by a

188
00:06:52,870 --> 00:06:50,080

couple magnitude

189
00:06:54,710 --> 00:06:52,880
um and also you can see that it's very

190
00:06:55,909 --> 00:06:54,720
variable that it brightens and then it

191
00:06:57,749 --> 00:06:55,919
dims and it brightens

192
00:06:59,510 --> 00:06:57,759
and then it dims all right so it's got

193
00:07:01,830 --> 00:06:59,520
this history of this

194
00:07:02,950 --> 00:07:01,840
all right and previous studies have

195
00:07:06,710 --> 00:07:02,960
figured out

196
00:07:07,749 --> 00:07:06,720
that this history is due to ejections of

197
00:07:10,629 --> 00:07:07,759
material

198
00:07:11,670 --> 00:07:10,639
that vy canis majoris this star in its

199
00:07:14,070 --> 00:07:11,680
older age

200
00:07:14,870 --> 00:07:14,080
is spewing out material and those clouds

201
00:07:16,950 --> 00:07:14,880
of material

202
00:07:17,990 --> 00:07:16,960
can sometimes get in our way and block

203
00:07:21,270 --> 00:07:18,000
the light and

204
00:07:24,150 --> 00:07:21,280
dim it so what they wanted to do was

205
00:07:25,589 --> 00:07:24,160
study those ejections in detail and so

206
00:07:28,150 --> 00:07:25,599
who are you going to call

207
00:07:29,990 --> 00:07:28,160
you're going to call hubble and so

208
00:07:33,350 --> 00:07:30,000
looking in deep and close at

209
00:07:36,790 --> 00:07:33,360
vy canvas majoris hubble was able to get

210
00:07:37,510 --> 00:07:36,800
this image of it now there's all sorts

211
00:07:39,990 --> 00:07:37,520
of stuff

212
00:07:40,790 --> 00:07:40,000
around it this is material that has been

213
00:07:43,749 --> 00:07:40,800

spewed

214
00:07:43,990 --> 00:07:43,759
out of ui canvas majoras and you know

215
00:07:45,670 --> 00:07:44,000
some

216
00:07:47,670 --> 00:07:45,680
people don't quite know where the star

217
00:07:51,670 --> 00:07:47,680
is so i'll point it out to you

218
00:07:54,390 --> 00:07:51,680
it's that bright white dot there okay

219
00:07:54,950 --> 00:07:54,400
and so the researchers then took spectra

220
00:07:57,909 --> 00:07:54,960
along

221
00:07:58,710 --> 00:07:57,919
lines of sight around the star to

222
00:08:00,550 --> 00:07:58,720
examine

223
00:08:01,830 --> 00:08:00,560
some of these ejected knots and

224
00:08:03,990 --> 00:08:01,840
filaments and and

225
00:08:05,830 --> 00:08:04,000
clouds and structures and they could

226
00:08:08,950 --> 00:08:05,840
measure the velocity

227
00:08:09,589 --> 00:08:08,960
of those clouds and then figure out when

228
00:08:12,309 --> 00:08:09,599
they had been

229
00:08:13,909 --> 00:08:12,319
ejected so something that i didn't

230
00:08:17,510 --> 00:08:13,919
mention when i showed you that light

231
00:08:20,469 --> 00:08:17,520
curve is that they're figuring out

232
00:08:21,270 --> 00:08:20,479
when these ejections happened from the

233
00:08:22,869 --> 00:08:21,280
spectra

234
00:08:25,189 --> 00:08:22,879
and then going back to the light curve

235
00:08:28,070 --> 00:08:25,199
and figuring out ah this is when this

236
00:08:29,350 --> 00:08:28,080
knot was ejected from the star they're

237
00:08:30,390 --> 00:08:29,360
going back and they're doing the

238
00:08:33,430 --> 00:08:30,400

forensics

239
00:08:34,870 --> 00:08:33,440
of eruptions that happen you know 30

240
00:08:40,389 --> 00:08:34,880
years ago or

241
00:08:42,149 --> 00:08:40,399
they're actually being able to measure

242
00:08:45,350 --> 00:08:42,159
all right this clump of gas

243
00:08:48,070 --> 00:08:45,360
was ejected during this um this

244
00:08:49,350 --> 00:08:48,080
variation in the light curve and that's

245
00:08:51,910 --> 00:08:49,360
really kind of cool

246
00:08:53,509 --> 00:08:51,920
that you can go back after the fact and

247
00:08:54,230 --> 00:08:53,519
take a look at the historical light

248
00:08:56,470 --> 00:08:54,240
curve

249
00:08:57,509 --> 00:08:56,480
and match it to the physical structures

250
00:09:00,630 --> 00:08:57,519
that you're seeing

251
00:09:03,110 --> 00:09:00,640
in the clouds around it so

252
00:09:05,670 --> 00:09:03,120
we're able to go in really close take a

253
00:09:08,070 --> 00:09:05,680
look at vy canis majoris

254
00:09:10,070 --> 00:09:08,080
but i gotta tell you you don't actually

255
00:09:11,350 --> 00:09:10,080
see the star itself you see all the

256
00:09:13,269 --> 00:09:11,360
stuff around it

257
00:09:15,110 --> 00:09:13,279
but as in the middle image here you can

258
00:09:16,550 --> 00:09:15,120
see although all that we see of the star

259
00:09:19,910 --> 00:09:16,560
itself is this big white

260
00:09:20,310 --> 00:09:19,920
blob so to give people an idea of what

261
00:09:23,110 --> 00:09:20,320
you

262
00:09:23,670 --> 00:09:23,120
might see we had one of our wonderful

263
00:09:26,150 --> 00:09:23,680

artists

264
00:09:27,990 --> 00:09:26,160
do an illustration which is what you see

265
00:09:30,710 --> 00:09:28,000
on the right hand side here

266
00:09:32,150 --> 00:09:30,720
of an illustration of the vy canvas

267
00:09:34,550 --> 00:09:32,160
majorities this red

268
00:09:35,509 --> 00:09:34,560
hyper giant star with all sorts of

269
00:09:37,750 --> 00:09:35,519
activity that's

270
00:09:38,630 --> 00:09:37,760
billowing things and will continue to do

271
00:09:41,350 --> 00:09:38,640
so

272
00:09:43,750 --> 00:09:41,360
at least for another few million years

273
00:09:46,949 --> 00:09:43,760
until it either goes supernova

274
00:09:48,550 --> 00:09:46,959
or it collapses to a black hole so the

275
00:09:51,110 --> 00:09:48,560
future is

276
00:09:52,949 --> 00:09:51,120
quite interesting for vy candice majoris

277
00:09:56,070 --> 00:09:52,959
and we'll continue to watch it

278
00:10:00,389 --> 00:09:56,080
and see all all of its amazing uh

279
00:10:00,790 --> 00:10:00,399
eruptions the second story we have for

280
00:10:04,069 --> 00:10:00,800
you

281
00:10:06,470 --> 00:10:04,079
is double quasars in merging galaxies

282
00:10:07,269 --> 00:10:06,480
all right so let's let's unpack that

283
00:10:10,310 --> 00:10:07,279
first of all

284
00:10:11,990 --> 00:10:10,320
we've got galaxies right this is uh

285
00:10:13,750 --> 00:10:12,000
one of the famous galaxies galaxy's

286
00:10:18,389 --> 00:10:13,760
messier 100 it's a

287
00:10:21,509 --> 00:10:18,399
beautiful spiral galaxy and in the

288
00:10:22,790 --> 00:10:21,519

cores of all large galaxies we believe

289
00:10:25,910 --> 00:10:22,800
there exists

290
00:10:29,110 --> 00:10:25,920
super massive black holes okay

291
00:10:29,509 --> 00:10:29,120
so giant black holes that are millions

292
00:10:33,670 --> 00:10:29,519
to

293
00:10:36,870 --> 00:10:33,680
our sun

294
00:10:39,110 --> 00:10:36,880
live in the cores of galaxies

295
00:10:40,790 --> 00:10:39,120
and if material falls into these

296
00:10:43,269 --> 00:10:40,800
supermassive black holes

297
00:10:45,269 --> 00:10:43,279
well then stuff gets spewed out at

298
00:10:48,150 --> 00:10:45,279
really high energies

299
00:10:50,230 --> 00:10:48,160
and if you see that spew from that

300
00:10:53,670 --> 00:10:50,240
supermassive black hole

301
00:10:56,310 --> 00:10:53,680
you might see something called a quasar

302
00:10:58,630 --> 00:10:56,320
right and quasar originally meant

303
00:11:01,269 --> 00:10:58,640
quasi-stellar radio source

304
00:11:03,829 --> 00:11:01,279
we've actually changed it recently to be

305
00:11:06,230 --> 00:11:03,839
qso quasi stellar object

306
00:11:07,269 --> 00:11:06,240
which is really what it is it looks like

307
00:11:09,110 --> 00:11:07,279
a star

308
00:11:10,550 --> 00:11:09,120
but it's not look you can see the

309
00:11:13,590 --> 00:11:10,560
diffraction spikes here

310
00:11:15,990 --> 00:11:13,600
on this quasar right but it's in

311
00:11:16,630 --> 00:11:16,000
another galaxy it's really really far

312
00:11:18,630 --> 00:11:16,640
away it's

313
00:11:20,630 --> 00:11:18,640

not a star it's something just just

314
00:11:23,190 --> 00:11:20,640
looks as bright as a star

315
00:11:24,790 --> 00:11:23,200
but it's really really far away how do

316
00:11:27,990 --> 00:11:24,800
we know these are in galaxies

317
00:11:30,710 --> 00:11:28,000
well for some qsos we can

318
00:11:31,190 --> 00:11:30,720
actually find the galaxy itself behind

319
00:11:34,230 --> 00:11:31,200
it

320
00:11:35,750 --> 00:11:34,240
diffraction spikes there that that

321
00:11:36,870 --> 00:11:35,760
bright point in the center of this

322
00:11:38,470 --> 00:11:36,880
spiral galaxy

323
00:11:41,350 --> 00:11:38,480
but you can also by looking in the

324
00:11:42,150 --> 00:11:41,360
infrared see the spiral arms of that

325
00:11:44,230 --> 00:11:42,160
galaxy

326
00:11:46,550 --> 00:11:44,240
that's actually kind of rare you rarely

327
00:11:48,870 --> 00:11:46,560
you usually you cannot see

328
00:11:50,949 --> 00:11:48,880
the galaxy behind it but in some cases

329
00:11:53,829 --> 00:11:50,959
so we've confirmed that these quasars

330
00:11:55,670 --> 00:11:53,839
exist in distant galaxies all right

331
00:11:58,870 --> 00:11:55,680
that's part one

332
00:12:01,910 --> 00:11:58,880
part two is we also know

333
00:12:03,910 --> 00:12:01,920
that galaxies merge together

334
00:12:05,629 --> 00:12:03,920
this is an image of the two emerging

335
00:12:08,069 --> 00:12:05,639
galaxies called

336
00:12:10,790 --> 00:12:08,079
eso148 two galaxies that come

337
00:12:12,790 --> 00:12:10,800
smashing together and swirling up and so

338
00:12:14,949 --> 00:12:12,800

the cores of these galaxies are now

339
00:12:17,990 --> 00:12:14,959
mixing together

340
00:12:20,310 --> 00:12:18,000
so shouldn't it follow

341
00:12:21,110 --> 00:12:20,320
that if there's a quasar in a galaxy and

342
00:12:23,269 --> 00:12:21,120
a quasar

343
00:12:24,710 --> 00:12:23,279
in another galaxy and those two galaxies

344
00:12:28,150 --> 00:12:24,720
merge together

345
00:12:31,350 --> 00:12:28,160
that you could find a double quasar

346
00:12:33,590 --> 00:12:31,360
emerging galaxies so

347
00:12:35,030 --> 00:12:33,600
those are really really really difficult

348
00:12:37,670 --> 00:12:35,040
to find okay

349
00:12:38,710 --> 00:12:37,680
so they divide this amazing search

350
00:12:41,350 --> 00:12:38,720
strategy

351
00:12:43,910 --> 00:12:41,360
first of all they found quasars quasars

352
00:12:45,509 --> 00:12:43,920
the sloan survey has a list of quasars

353
00:12:47,190 --> 00:12:45,519
and they found the very distant ones

354
00:12:48,710 --> 00:12:47,200
what are called the high redshift ones

355
00:12:51,750 --> 00:12:48,720
greater than redshift of two

356
00:12:53,350 --> 00:12:51,760
so you get really distant that way that

357
00:12:54,470 --> 00:12:53,360
the emission from the galaxies behind

358
00:12:56,389 --> 00:12:54,480
them is actually minimal

359
00:12:57,670 --> 00:12:56,399
so you'll only see the two bright dots

360
00:12:59,910 --> 00:12:57,680
right

361
00:13:00,870 --> 00:12:59,920
then these two quasars are so close

362
00:13:03,190 --> 00:13:00,880
together

363
00:13:04,710 --> 00:13:03,200

that the gaia satellite would would

364
00:13:08,069 --> 00:13:04,720
confirm would think of them as just

365
00:13:09,750 --> 00:13:08,079
one object but these two quasars are

366
00:13:12,550 --> 00:13:09,760
variable in their light

367
00:13:13,350 --> 00:13:12,560
and they would not be synchronized so

368
00:13:15,750 --> 00:13:13,360
actually

369
00:13:18,150 --> 00:13:15,760
the center that gaia measures would

370
00:13:21,590 --> 00:13:18,160
actually shift around a little bit

371
00:13:22,069 --> 00:13:21,600
so you look for guy that you take the

372
00:13:25,430 --> 00:13:22,079
the

373
00:13:28,389 --> 00:13:25,440
you look

374
00:13:29,430 --> 00:13:28,399
for variability in the gaia position due

375
00:13:32,230 --> 00:13:29,440
to these quasars

376
00:13:33,509 --> 00:13:32,240
of variability and then you say there

377
00:13:35,190 --> 00:13:33,519
you have your candidates they ended up

378
00:13:38,470 --> 00:13:35,200
with 15 candidates

379
00:13:43,430 --> 00:13:38,480
and four were observed by hubble

380
00:13:46,790 --> 00:13:43,440
they found two sets of double quasars

381
00:13:49,189 --> 00:13:46,800
this is really cool those are two bright

382
00:13:51,269 --> 00:13:49,199
quasar spots that guy would look at and

383
00:13:51,990 --> 00:13:51,279
see just one one thing but hubble can

384
00:13:55,030 --> 00:13:52,000
resolve

385
00:13:57,509 --> 00:13:55,040
and see it as two quasars and

386
00:13:58,310 --> 00:13:57,519
the supposition here that hasn't been

387
00:14:01,350 --> 00:13:58,320
proven yet

388
00:14:02,550 --> 00:14:01,360

is that these are in merging galaxies

389
00:14:04,629 --> 00:14:02,560
because how else are you going to get

390
00:14:06,470 --> 00:14:04,639
two quasars in in real close

391
00:14:08,310 --> 00:14:06,480
uh we've never seen galaxies that have

392
00:14:09,990 --> 00:14:08,320
multiple quasars you know

393
00:14:12,150 --> 00:14:10,000
a single galaxy that forms multiple

394
00:14:12,470 --> 00:14:12,160
quasars so the idea is that these would

395
00:14:15,030 --> 00:14:12,480
be

396
00:14:15,990 --> 00:14:15,040
merging galaxies and we'll see the

397
00:14:18,389 --> 00:14:16,000
quasars

398
00:14:19,670 --> 00:14:18,399
uh in as in the core as the galaxies are

399
00:14:21,990 --> 00:14:19,680
getting together

400
00:14:23,750 --> 00:14:22,000
but here this is also uh kind of

401
00:14:24,550 --> 00:14:23,760
unsatisfying because alls you get to see

402
00:14:27,110 --> 00:14:24,560
are the bright

403
00:14:28,949 --> 00:14:27,120
bright quasar dots you know it was

404
00:14:31,990 --> 00:14:28,959
chosen so the galaxy's

405
00:14:34,230 --> 00:14:32,000
emission would actually be minimal so we

406
00:14:36,629 --> 00:14:34,240
take that idea of emerging galaxies and

407
00:14:38,629 --> 00:14:36,639
iso 148

408
00:14:40,310 --> 00:14:38,639
and we combine it with the two bright

409
00:14:42,230 --> 00:14:40,320
dots and we did the calculations on

410
00:14:43,509 --> 00:14:42,240
how far apart would the galaxy bright

411
00:14:45,590 --> 00:14:43,519
dots be at this

412
00:14:47,110 --> 00:14:45,600
at this distance when it scaled to this

413
00:14:50,470 --> 00:14:47,120

galaxy and everything

414
00:14:53,829 --> 00:14:50,480
and an illustrator came up with this

415
00:14:55,910 --> 00:14:53,839
our double quasars illustration okay

416
00:14:57,350 --> 00:14:55,920
so it gives you the idea of these two

417
00:15:00,069 --> 00:14:57,360
emerging galaxies

418
00:15:00,870 --> 00:15:00,079
long long ago and the two quasars in the

419
00:15:04,150 --> 00:15:00,880
center

420
00:15:05,829 --> 00:15:04,160
uh in truth it's not quite the uh uh

421
00:15:07,350 --> 00:15:05,839
with the i would with what and any

422
00:15:08,949 --> 00:15:07,360
telescope would see because the crazy

423
00:15:11,189 --> 00:15:08,959
stars would actually be a lot brighter

424
00:15:13,269 --> 00:15:11,199
they blow out most of the galaxy

425
00:15:15,509 --> 00:15:13,279
but it's an illustration to kind guide

426
00:15:15,910 --> 00:15:15,519
your eye put it in your head that these

427
00:15:19,430 --> 00:15:15,920
are

428
00:15:22,389 --> 00:15:19,440
two quasars emerging galaxies

429
00:15:26,310 --> 00:15:22,399
probably about 9 or 10 billion light

430
00:15:28,949 --> 00:15:26,320
years away

431
00:15:30,230 --> 00:15:28,959
now we go to our featured speaker

432
00:15:33,269 --> 00:15:30,240
tonight

433
00:15:34,949 --> 00:15:33,279
uh let me stop my screen share our

434
00:15:37,990 --> 00:15:34,959
featured speaker tonight is

435
00:15:40,230 --> 00:15:38,000
christopher wonjeck and he is

436
00:15:41,990 --> 00:15:40,240
a health and science writer based in

437
00:15:44,310 --> 00:15:42,000
baltimore

438
00:15:46,550 --> 00:15:44,320

he holds a master's degree in health

439
00:15:48,949 --> 00:15:46,560
from harvard school of public health

440
00:15:49,990 --> 00:15:48,959
and a bachelor's degree in journalism

441
00:15:56,710 --> 00:15:50,000
from temple

442
00:16:00,790 --> 00:15:58,870
and science writer uh he's written more

443
00:16:04,470 --> 00:16:00,800
than 500 newspaper

444
00:16:07,430 --> 00:16:04,480
magazine and website articles uh for

445
00:16:08,230 --> 00:16:07,440
all sorts of famous periodicals um and

446
00:16:11,910 --> 00:16:08,240
for from

447
00:16:15,030 --> 00:16:11,920
1998 to 2007 he was even a senior writer

448
00:16:17,829 --> 00:16:15,040
at the nasa goddard space flight center

449
00:16:19,670 --> 00:16:17,839
he has the author of three books and the

450
00:16:22,310 --> 00:16:19,680
one he's going to tell you about tonight

451
00:16:23,189 --> 00:16:22,320
space farers has received critical

452
00:16:25,509 --> 00:16:23,199
acclaim

453
00:16:26,230 --> 00:16:25,519
and he tells me he got one reviewer to

454
00:16:28,069 --> 00:16:26,240
say

455
00:16:29,829 --> 00:16:28,079
i don't know how much he paid him but he

456
00:16:32,629 --> 00:16:29,839
got this one reviewer to say

457
00:16:34,069 --> 00:16:32,639
the best book on space exploration since

458
00:16:37,110 --> 00:16:34,079
isaac asimov

459
00:16:38,230 --> 00:16:37,120
wow that's uh that's that's a pretty

460
00:16:40,949 --> 00:16:38,240
good comment

461
00:16:42,550 --> 00:16:40,959
um i always ask my speakers for one

462
00:16:43,990 --> 00:16:42,560
interesting tidbit of what they do in

463
00:16:44,870 --> 00:16:44,000

their spare time when they're not doing

464
00:16:46,949 --> 00:16:44,880
their job

465
00:16:48,550 --> 00:16:46,959
um and christopher says he likes to hang

466
00:16:49,990 --> 00:16:48,560
out behind the space telescope science

467
00:16:53,110 --> 00:16:50,000
institute building

468
00:16:55,269 --> 00:16:53,120
uh not because the building is there uh

469
00:16:56,470 --> 00:16:55,279
because he's a forager i mean he looks

470
00:16:58,550 --> 00:16:56,480
for mushrooms and other

471
00:16:59,910 --> 00:16:58,560
other wild things out there and the the

472
00:17:02,629 --> 00:16:59,920
park behind the

473
00:17:03,509 --> 00:17:02,639
institute obviously is a good place who

474
00:17:06,390 --> 00:17:03,519
knew

475
00:17:07,990 --> 00:17:06,400
so ladies and gentlemen christopher

476
00:17:11,189 --> 00:17:08,000
weinjack

477
00:17:18,789 --> 00:17:11,199
excellent thank you for that frank

478
00:17:21,829 --> 00:17:18,799
let me get my

479
00:17:26,309 --> 00:17:21,839
presentation up

480
00:17:32,549 --> 00:17:29,510
all right is that showing right

481
00:17:35,830 --> 00:17:32,559
i'll take that as a yes okay

482
00:17:38,390 --> 00:17:35,840
and i'm not okay i'm not muted all right

483
00:17:39,350 --> 00:17:38,400
so hey thank you uh absolutely thank you

484
00:17:42,630 --> 00:17:39,360
this is

485
00:17:45,350 --> 00:17:42,640
uh wonderful you know to think of myself

486
00:17:46,310 --> 00:17:45,360
giving a talk at the space science uh

487
00:17:48,549 --> 00:17:46,320
lecture hall

488
00:17:50,470 --> 00:17:48,559

however remote and virtual it's it's a

489
00:17:52,630 --> 00:17:50,480
humbling experience i mean

490
00:17:54,630 --> 00:17:52,640
i i've been an audience member so many

491
00:17:57,110 --> 00:17:54,640
times myself listening to

492
00:17:58,310 --> 00:17:57,120
you know the greats like uh john mather

493
00:18:01,669 --> 00:17:58,320
alan stern

494
00:18:03,590 --> 00:18:01,679
um mario olivio adam reese

495
00:18:06,070 --> 00:18:03,600
great science communicators like ray

496
00:18:07,909 --> 00:18:06,080
velard and hannah wakefield

497
00:18:09,510 --> 00:18:07,919
so for me to be included in this lecture

498
00:18:12,070 --> 00:18:09,520
series is really

499
00:18:12,870 --> 00:18:12,080
an honor so thank you for everyone uh

500
00:18:15,750 --> 00:18:12,880
inviting me

501
00:18:17,830 --> 00:18:15,760
i have to say also i'm a a little

502
00:18:18,630 --> 00:18:17,840
intimidated i know this is a public

503
00:18:20,789 --> 00:18:18,640
lecture

504
00:18:21,669 --> 00:18:20,799
uh but i know members of this particular

505
00:18:24,390 --> 00:18:21,679
public

506
00:18:25,110 --> 00:18:24,400
are real space aficionados uh he wearers

507
00:18:28,150 --> 00:18:25,120
of uh

508
00:18:30,710 --> 00:18:28,160
uh star trek so

509
00:18:32,789 --> 00:18:30,720
uh you know i know a lot of you know

510
00:18:33,669 --> 00:18:32,799
astronomy and engineering better than i

511
00:18:34,950 --> 00:18:33,679
do in fact

512
00:18:36,789 --> 00:18:34,960
i don't doubt there are people in the

513
00:18:39,669 --> 00:18:36,799

audience that i actually came to to

514
00:18:42,310 --> 00:18:39,679
interview for my book space fairs

515
00:18:44,230 --> 00:18:42,320
but i hope i can impart to you my

516
00:18:46,310 --> 00:18:44,240
perspective as a health writer

517
00:18:47,350 --> 00:18:46,320
and also as someone i would describe as

518
00:18:49,990 --> 00:18:47,360
a an

519
00:18:51,029 --> 00:18:50,000
optimistic skeptic uh about living in

520
00:18:52,950 --> 00:18:51,039
space

521
00:18:54,150 --> 00:18:52,960
so let me move on and i know we're

522
00:18:55,270 --> 00:18:54,160
supposed to get our financial

523
00:18:57,270 --> 00:18:55,280
disclosures uh

524
00:18:59,350 --> 00:18:57,280
out of the way there because i might be

525
00:19:03,190 --> 00:18:59,360
talking up mars a little later

526
00:19:04,870 --> 00:19:03,200
i'm going to start on mount everest

527
00:19:06,870 --> 00:19:04,880
and i do that because you know we can

528
00:19:08,950 --> 00:19:06,880
reach the top of mount everest

529
00:19:10,870 --> 00:19:08,960
with relative ease now about you know

530
00:19:11,270 --> 00:19:10,880
more than 4 000 people have been to the

531
00:19:14,070 --> 00:19:11,280
top

532
00:19:14,549 --> 00:19:14,080
uh compared to only 400 people in space

533
00:19:17,350 --> 00:19:14,559
and

534
00:19:18,630 --> 00:19:17,360
um despite this relative ease of getting

535
00:19:21,590 --> 00:19:18,640
to this summit

536
00:19:22,070 --> 00:19:21,600
um despite the the fantastic view no

537
00:19:24,950 --> 00:19:22,080
one's

538
00:19:26,710 --> 00:19:24,960

living you know no one chooses to live

539
00:19:28,710 --> 00:19:26,720
on top of mount everest it's

540
00:19:30,230 --> 00:19:28,720
it's not practical right i mean what are

541
00:19:32,310 --> 00:19:30,240
you going to do for a living you know

542
00:19:33,430 --> 00:19:32,320
how are you going to raise your kids air

543
00:19:35,029 --> 00:19:33,440
is kind of thin

544
00:19:36,549 --> 00:19:35,039
you know it sounds obvious but when we

545
00:19:38,870 --> 00:19:36,559
talk about

546
00:19:41,590 --> 00:19:38,880
living on the moon forever you know and

547
00:19:43,990 --> 00:19:41,600
moving and migrating to mars

548
00:19:44,710 --> 00:19:44,000
you know what are how practical is that

549
00:19:47,750 --> 00:19:44,720
despite

550
00:19:48,630 --> 00:19:47,760
the gorgeous view from there um i mean

551
00:19:51,270 --> 00:19:48,640
what would be the

552
00:19:52,950 --> 00:19:51,280
economic and the uh emotional

553
00:19:54,710 --> 00:19:52,960
motivations to get us there

554
00:19:56,950 --> 00:19:54,720
this will be a migration like never

555
00:19:58,950 --> 00:19:56,960
before i would imagine that most of this

556
00:20:00,470 --> 00:19:58,960
audience tonight is in the united states

557
00:20:04,230 --> 00:20:00,480
and think about yourself

558
00:20:06,950 --> 00:20:04,240
here either you or

559
00:20:08,230 --> 00:20:06,960
or someone in your family came here to

560
00:20:11,430 --> 00:20:08,240
the united states

561
00:20:13,110 --> 00:20:11,440
for economic or emotional motivations

562
00:20:14,630 --> 00:20:13,120
you know maybe religious motivations a

563
00:20:16,710 --> 00:20:14,640

couple hundred years ago

564
00:20:17,909 --> 00:20:16,720
and they didn't come here just because

565
00:20:19,830 --> 00:20:17,919
someone innovated a boat

566
00:20:21,190 --> 00:20:19,840
right and likewise we're not going to go

567
00:20:23,669 --> 00:20:21,200
to mars just because someone

568
00:20:25,190 --> 00:20:23,679
invents a rocket now you know that said

569
00:20:27,110 --> 00:20:25,200
i do think we're going to be

570
00:20:28,630 --> 00:20:27,120
on the moon in a scenario that looks

571
00:20:31,510 --> 00:20:28,640
like this in about

572
00:20:33,430 --> 00:20:31,520
10 or 15 years with science bases

573
00:20:36,310 --> 00:20:33,440
absolutely happening

574
00:20:39,110 --> 00:20:36,320
we're going to be on mars maybe in 20 25

575
00:20:41,350 --> 00:20:39,120
years with a simple scenario like this

576
00:20:43,029 --> 00:20:41,360
will we be living in orbit in these uh

577
00:20:45,830 --> 00:20:43,039
you know rotating habitats with

578
00:20:48,549 --> 00:20:45,840
artificial gravity and climate control

579
00:20:49,990 --> 00:20:48,559
maybe i i can think of some emotional

580
00:20:51,270 --> 00:20:50,000
and economic reasons for

581
00:20:53,510 --> 00:20:51,280
for doing this kind of thing and i'll

582
00:20:54,549 --> 00:20:53,520
get to that later in the talk

583
00:20:56,710 --> 00:20:54,559
here's how we're going to get there

584
00:20:59,430 --> 00:20:56,720
we're going to drive

585
00:21:00,149 --> 00:20:59,440
i joke of course but this is a real

586
00:21:03,190 --> 00:21:00,159
photograph

587
00:21:06,070 --> 00:21:03,200
a selfie if you will of a tesla

588
00:21:07,669 --> 00:21:06,080

launched by spacex in 2019 to

589
00:21:08,950 --> 00:21:07,679
demonstrate the strength of its falcon

590
00:21:12,630 --> 00:21:08,960
heavy rocket

591
00:21:16,070 --> 00:21:12,640
this this this car and the mannequin is

592
00:21:18,710 --> 00:21:16,080
whipping around mars

593
00:21:19,990 --> 00:21:18,720
speak that that's fantastic and and i

594
00:21:22,470 --> 00:21:20,000
like this picture because i

595
00:21:24,149 --> 00:21:22,480
for me it's it's symbolic of how

596
00:21:27,110 --> 00:21:24,159
companies like spacex are now

597
00:21:27,909 --> 00:21:27,120
the driving force of of space

598
00:21:29,270 --> 00:21:27,919
exploration

599
00:21:30,630 --> 00:21:29,280
they are making money in space other

600
00:21:31,669 --> 00:21:30,640
companies are making money in space

601
00:21:33,430 --> 00:21:31,679
business the business

602
00:21:35,510 --> 00:21:33,440
and this has never happened before this

603
00:21:37,350 --> 00:21:35,520
is new in this recent decade

604
00:21:38,789 --> 00:21:37,360
it's not uh governments handing over

605
00:21:41,350 --> 00:21:38,799
lots of money to government

606
00:21:42,710 --> 00:21:41,360
to uh military contractors anymore

607
00:21:43,990 --> 00:21:42,720
businesses are involved

608
00:21:46,470 --> 00:21:44,000
we're going to be starting to see some

609
00:21:48,230 --> 00:21:46,480
real innovation that's the most exciting

610
00:21:50,789 --> 00:21:48,240
thing

611
00:21:52,950 --> 00:21:50,799
so let's get back to why we're doing it

612
00:21:55,350 --> 00:21:52,960
because this is an important question

613
00:21:56,310 --> 00:21:55,360

um you know i think the reasons that

614
00:21:57,750 --> 00:21:56,320
people voice

615
00:21:59,350 --> 00:21:57,760
are the wrong reasons and they don't

616
00:22:01,350 --> 00:21:59,360
help us whatsoever in

617
00:22:03,029 --> 00:22:01,360
recruiting more people to our movement

618
00:22:04,549 --> 00:22:03,039
um you know it's all this doom and gloom

619
00:22:06,710 --> 00:22:04,559
we have to get off this planet we have

620
00:22:07,590 --> 00:22:06,720
to be a multi-planet species or else go

621
00:22:09,990 --> 00:22:07,600
extinct

622
00:22:12,149 --> 00:22:10,000
even stephen hawking said that right he

623
00:22:13,190 --> 00:22:12,159
said we have 100 years the physicist the

624
00:22:15,669 --> 00:22:13,200
great physicist

625
00:22:16,470 --> 00:22:15,679
he said we had 100 years to get off the

626
00:22:19,190 --> 00:22:16,480
planet earth

627
00:22:20,549 --> 00:22:19,200
or face extinction and i think this is a

628
00:22:22,710 --> 00:22:20,559
ludicrous idea

629
00:22:24,630 --> 00:22:22,720
because i mean when you think about it

630
00:22:27,830 --> 00:22:24,640
there is there is nothing

631
00:22:29,590 --> 00:22:27,840
that can happen to the earth

632
00:22:32,070 --> 00:22:29,600
that would make it less habitable than

633
00:22:34,149 --> 00:22:32,080
any other place in this solar system

634
00:22:36,630 --> 00:22:34,159
uh i mean let's let's go through the you

635
00:22:39,350 --> 00:22:36,640
know the top reasons that people give

636
00:22:40,789 --> 00:22:39,360
like the population problem you know

637
00:22:43,430 --> 00:22:40,799
first off you know

638
00:22:45,750 --> 00:22:43,440

offloading a billion people to mars

639
00:22:47,190 --> 00:22:45,760
however impossible that would be

640
00:22:49,029 --> 00:22:47,200
that's not going to hardly dent the

641
00:22:50,470 --> 00:22:49,039
population on earth and

642
00:22:52,470 --> 00:22:50,480
i personally don't think there are too

643
00:22:53,590 --> 00:22:52,480
many people on earth i think there's too

644
00:22:55,270 --> 00:22:53,600
much inefficiency

645
00:22:57,430 --> 00:22:55,280
that's the real problem i mean you think

646
00:22:58,070 --> 00:22:57,440
about it we we waste half the food we

647
00:23:00,549 --> 00:22:58,080
grow

648
00:23:01,669 --> 00:23:00,559
we we waste upwards of half the

649
00:23:04,630 --> 00:23:01,679
electricity

650
00:23:05,909 --> 00:23:04,640
in these leaky electrical grids well the

651
00:23:08,310 --> 00:23:05,919
trash we don't recycle

652
00:23:09,750 --> 00:23:08,320
all the fertilizer we let run into the

653
00:23:12,230 --> 00:23:09,760
ocean

654
00:23:13,430 --> 00:23:12,240
these are major uh engineering issues

655
00:23:16,549 --> 00:23:13,440
that we can overcome

656
00:23:18,070 --> 00:23:16,559
and then allow uh with space resources

657
00:23:19,830 --> 00:23:18,080
billions more people living on this

658
00:23:23,430 --> 00:23:19,840
planet and i think that's a good thing

659
00:23:26,990 --> 00:23:23,440
i am pro-life pro people in this regard

660
00:23:28,149 --> 00:23:27,000
more people mean more inventors more

661
00:23:30,630 --> 00:23:28,159
entrepreneurs

662
00:23:32,549 --> 00:23:30,640
more ideas that's for the betterment of

663
00:23:34,230 --> 00:23:32,559

society i would love to see that more

664
00:23:36,310 --> 00:23:34,240
people on earth

665
00:23:38,230 --> 00:23:36,320
the pandemic issue i don't want to be

666
00:23:39,990 --> 00:23:38,240
glib here i mean we're in the middle one

667
00:23:41,430 --> 00:23:40,000
middle of a pandemic right now i i

668
00:23:41,990 --> 00:23:41,440
personally know several people who have

669
00:23:44,390 --> 00:23:42,000
died

670
00:23:46,549 --> 00:23:44,400
uh including a family member um but it's

671
00:23:48,230 --> 00:23:46,559
not an existential threat to humanity

672
00:23:50,070 --> 00:23:48,240
let's face it the virus has never wiped

673
00:23:51,510 --> 00:23:50,080
out humans before obviously

674
00:23:53,430 --> 00:23:51,520
so why would that happen now all of a

675
00:23:55,190 --> 00:23:53,440
sudden this age of uh

676
00:23:56,870 --> 00:23:55,200
dna uh sequencing and vaccine

677
00:23:57,750 --> 00:23:56,880
development doesn't seem to make much

678
00:23:59,830 --> 00:23:57,760
sense there

679
00:24:01,190 --> 00:23:59,840
nuclear war asteroids strike they're

680
00:24:02,789 --> 00:24:01,200
kind of the same thing when you think

681
00:24:05,909 --> 00:24:02,799
about it some horrible

682
00:24:08,549 --> 00:24:05,919
bombardment from the sky

683
00:24:09,430 --> 00:24:08,559
but again not to be clip that won't kill

684
00:24:11,110 --> 00:24:09,440
everyone

685
00:24:12,950 --> 00:24:11,120
even the most conservative estimates

686
00:24:14,310 --> 00:24:12,960
leave hundreds of thousands of people if

687
00:24:16,470 --> 00:24:14,320
not millions of people

688
00:24:18,230 --> 00:24:16,480

uh around to survive in these

689
00:24:19,190 --> 00:24:18,240
well-foughted fortified underground

690
00:24:21,269 --> 00:24:19,200
bunkers or

691
00:24:23,029 --> 00:24:21,279
even in uh abandoned supermarkets living

692
00:24:25,350 --> 00:24:23,039
off of canned beans and spam

693
00:24:26,789 --> 00:24:25,360
i mean we're smarter than the dinosaurs

694
00:24:28,950 --> 00:24:26,799
we'll see something coming

695
00:24:29,909 --> 00:24:28,960
and try to protect ourselves and many

696
00:24:32,710 --> 00:24:29,919
will survive

697
00:24:34,549 --> 00:24:32,720
to continue the human race civilization

698
00:24:36,950 --> 00:24:34,559
will be set back a hundred years or so

699
00:24:38,870 --> 00:24:36,960
i'm not advocating for this but it won't

700
00:24:41,029 --> 00:24:38,880
wipe out humans as we speak

701
00:24:42,390 --> 00:24:41,039
and here's the old logic of it you know

702
00:24:47,269 --> 00:24:42,400
if we were living on

703
00:24:48,710 --> 00:24:47,279
mars in some self-sufficient way we

704
00:24:51,110 --> 00:24:48,720
don't need the earth

705
00:24:51,909 --> 00:24:51,120
if we had that technology to live on

706
00:24:53,510 --> 00:24:51,919
mars that way

707
00:24:55,590 --> 00:24:53,520
well we would have the technology to

708
00:24:56,630 --> 00:24:55,600
detect and deflect an asteroid end of

709
00:24:59,110 --> 00:24:56,640
story

710
00:25:00,070 --> 00:24:59,120
uh likewise with climate change you know

711
00:25:02,710 --> 00:25:00,080
definitely real

712
00:25:04,789 --> 00:25:02,720
it's the worst uh uh issue facing the

713
00:25:06,950 --> 00:25:04,799

earth right now i i truly believe

714
00:25:08,070 --> 00:25:06,960
in the threat to life uh it'll get worse

715
00:25:10,470 --> 00:25:08,080
before it gets better

716
00:25:12,549 --> 00:25:10,480
but it'll get better but nonetheless if

717
00:25:14,070 --> 00:25:12,559
we're on mars same logic if we're on

718
00:25:15,269 --> 00:25:14,080
mars with the technology to be

719
00:25:16,789 --> 00:25:15,279
self-sufficient

720
00:25:18,870 --> 00:25:16,799
obviously we would have mastered the

721
00:25:21,110 --> 00:25:18,880
ability to live in these mini earths

722
00:25:22,870 --> 00:25:21,120
and if we could do that on mars we would

723
00:25:23,909 --> 00:25:22,880
be doing that on earth to save our

724
00:25:25,510 --> 00:25:23,919
species

725
00:25:27,590 --> 00:25:25,520
you know i mean if you could terraform

726
00:25:30,310 --> 00:25:27,600
mars you would terraform earth

727
00:25:31,110 --> 00:25:30,320
back into earth the way he was supposed

728
00:25:33,350 --> 00:25:31,120
to be

729
00:25:34,710 --> 00:25:33,360
so that leaves to me only like this one

730
00:25:37,350 --> 00:25:34,720
possible scenario

731
00:25:38,149 --> 00:25:37,360
of you know of what could happen that we

732
00:25:40,070 --> 00:25:38,159
would have to be

733
00:25:42,470 --> 00:25:40,080
elsewhere in in the universe and that's

734
00:25:44,230 --> 00:25:42,480
you know if a alien force comes by

735
00:25:47,110 --> 00:25:44,240
and vaporizes earth to build an

736
00:25:49,750 --> 00:25:47,120
intergalactic super highway

737
00:25:51,190 --> 00:25:49,760
so yeah kind of jokey there but this is

738
00:25:53,110 --> 00:25:51,200

a real problem because

739
00:25:54,789 --> 00:25:53,120
a lot of you get this issue a lot of

740
00:25:55,510 --> 00:25:54,799
times with members of the public coming

741
00:25:57,430 --> 00:25:55,520
and saying

742
00:25:59,430 --> 00:25:57,440
you know why are we spending billions of

743
00:26:00,950 --> 00:25:59,440
dollars in space when we have all these

744
00:26:03,590 --> 00:26:00,960
problems on earth

745
00:26:04,149 --> 00:26:03,600
well yeah that's why we're going into

746
00:26:06,149 --> 00:26:04,159
space

747
00:26:08,230 --> 00:26:06,159
to solve these problems on earth that's

748
00:26:10,070 --> 00:26:08,240
happened to those space resources

749
00:26:12,149 --> 00:26:10,080
we're already doing that now aren't we

750
00:26:14,630 --> 00:26:12,159
with communication satellites

751
00:26:15,669 --> 00:26:14,640
and weather satellites earth monitoring

752
00:26:17,269 --> 00:26:15,679
satellites that we

753
00:26:19,269 --> 00:26:17,279
understand how much we messed up this

754
00:26:21,430 --> 00:26:19,279
planet that's important stuff

755
00:26:22,950 --> 00:26:21,440
let's keep this going if we can access

756
00:26:24,789 --> 00:26:22,960
space more easily

757
00:26:26,470 --> 00:26:24,799
well we could augment energy production

758
00:26:28,630 --> 00:26:26,480
we could be putting solar panels in

759
00:26:30,230 --> 00:26:28,640
space where there's never a cloudy day

760
00:26:32,070 --> 00:26:30,240
we could even put supercomputers in

761
00:26:33,190 --> 00:26:32,080
space where they would operate far more

762
00:26:36,230 --> 00:26:33,200
efficiently

763
00:26:37,590 --> 00:26:36,240

in the cold of space and 40 kelvin we

764
00:26:39,990 --> 00:26:37,600
could be building these

765
00:26:41,669 --> 00:26:40,000
interesting molecules in zero gravity

766
00:26:43,669 --> 00:26:41,679
and you know and then

767
00:26:45,830 --> 00:26:43,679
uh then we can talk about going to the

768
00:26:48,149 --> 00:26:45,840
moon and mars and and but it's going to

769
00:26:50,470 --> 00:26:48,159
be done in the context of having fun

770
00:26:51,190 --> 00:26:50,480
and and science and exploration not you

771
00:26:53,750 --> 00:26:51,200
know because

772
00:26:54,870 --> 00:26:53,760
life on earth absolutely depends on our

773
00:26:58,070 --> 00:26:54,880
living on another

774
00:26:59,750 --> 00:26:58,080
planet so here's the biggest problem and

775
00:27:00,789 --> 00:26:59,760
everyone knows this is getting off the

776
00:27:02,390 --> 00:27:00,799
earth right that

777
00:27:04,470 --> 00:27:02,400
first hundred kilometers it's not just a

778
00:27:05,190 --> 00:27:04,480
matter of going up you gotta go up and

779
00:27:07,190 --> 00:27:05,200
over at

780
00:27:08,470 --> 00:27:07,200
like a tremendous speed you know eight

781
00:27:10,630 --> 00:27:08,480
kilometers per second

782
00:27:11,990 --> 00:27:10,640
takes a lot of energy that's fast you

783
00:27:16,149 --> 00:27:12,000
know that's going from

784
00:27:19,510 --> 00:27:16,159
space telescope down to the inner

785
00:27:20,870 --> 00:27:19,520
baltimore and a snap really fast you

786
00:27:22,149 --> 00:27:20,880
need a lot of energy so when you see

787
00:27:23,909 --> 00:27:22,159
these rockets

788
00:27:25,350 --> 00:27:23,919

when you see a rocket here you got to

789
00:27:27,590 --> 00:27:25,360
keep in mind they're only about

790
00:27:29,269 --> 00:27:27,600
two or five percent of the mass is the

791
00:27:30,070 --> 00:27:29,279
actual payload what you want to put in

792
00:27:32,470 --> 00:27:30,080
space

793
00:27:33,909 --> 00:27:32,480
the rest the 95 plus percent that's all

794
00:27:35,510 --> 00:27:33,919
metal and fuel to push the thing up

795
00:27:36,389 --> 00:27:35,520
there and then it just disappears that's

796
00:27:38,389 --> 00:27:36,399
why it's so

797
00:27:40,789 --> 00:27:38,399
expensive and inefficient to get things

798
00:27:41,909 --> 00:27:40,799
into space you know elon musk and spacex

799
00:27:43,750 --> 00:27:41,919
say they've lowered the price

800
00:27:46,149 --> 00:27:43,760
considerably and that's that's great

801
00:27:47,990 --> 00:27:46,159
it's you know to get it down much lower

802
00:27:49,430 --> 00:27:48,000
it's an open-ended question here you

803
00:27:51,909 --> 00:27:49,440
know there might be some

804
00:27:53,909 --> 00:27:51,919
incredible fuels coming down the line we

805
00:27:56,070 --> 00:27:53,919
can talk about it later in the question

806
00:27:57,029 --> 00:27:56,080
uh part of this talk about the metallic

807
00:28:00,389 --> 00:27:57,039
hydrogen

808
00:28:03,110 --> 00:28:00,399
which was isolated in the lab at harvard

809
00:28:04,950 --> 00:28:03,120
and uh that would have a tremendous kick

810
00:28:05,830 --> 00:28:04,960
and you might be able to get down to

811
00:28:07,110 --> 00:28:05,840
maybe uh

812
00:28:08,630 --> 00:28:07,120
two dollars a kilogram because that's

813
00:28:09,269 --> 00:28:08,640

like a hundred times more powerful at

814
00:28:10,470 --> 00:28:09,279
that point

815
00:28:12,470 --> 00:28:10,480
that would be exciting if they could

816
00:28:14,789 --> 00:28:12,480
stabilize it but that's a big issue

817
00:28:16,950 --> 00:28:14,799
regardless if we want to get if we want

818
00:28:19,110 --> 00:28:16,960
to be a space-faring people

819
00:28:20,389 --> 00:28:19,120
if we want to get tens of thousands of

820
00:28:22,389 --> 00:28:20,399
people into space

821
00:28:24,710 --> 00:28:22,399
each and every day just like we get

822
00:28:26,070 --> 00:28:24,720
people in the air via airplanes

823
00:28:27,350 --> 00:28:26,080
we want to get that many people into

824
00:28:28,310 --> 00:28:27,360
space we're going to have to get away

825
00:28:29,510 --> 00:28:28,320
from rockets

826
00:28:31,110 --> 00:28:29,520
it's not just because they're

827
00:28:32,470 --> 00:28:31,120
inefficient and it's not just because

828
00:28:35,269 --> 00:28:32,480
they're polluting

829
00:28:37,190 --> 00:28:35,279
think about the noise imagine tens of

830
00:28:38,310 --> 00:28:37,200
thousands of rocket launches every day i

831
00:28:40,710 --> 00:28:38,320
can't believe no one's ever

832
00:28:42,230 --> 00:28:40,720
talking about this i mean the coming and

833
00:28:44,389 --> 00:28:42,240
going and the sonic booms

834
00:28:45,750 --> 00:28:44,399
would just be maddening we're eventually

835
00:28:49,350 --> 00:28:45,760
going to have to build

836
00:28:50,310 --> 00:28:49,360
a highway into space so you forgive me

837
00:28:51,830 --> 00:28:50,320
why i

838
00:28:54,149 --> 00:28:51,840

venture into the future here for these

839
00:28:55,510 --> 00:28:54,159
next couple of slides i'll get this back

840
00:28:57,430 --> 00:28:55,520
to reality

841
00:28:58,870 --> 00:28:57,440
so you know one idea is the space

842
00:29:00,630 --> 00:28:58,880
elevator and

843
00:29:01,990 --> 00:29:00,640
and i feel that i can't see you out

844
00:29:03,990 --> 00:29:02,000
there but i feel half the audience is

845
00:29:05,510 --> 00:29:04,000
saying ooh space elevator what's that

846
00:29:07,350 --> 00:29:05,520
and the other half is saying oh no not

847
00:29:09,269 --> 00:29:07,360
the space elevator idea

848
00:29:10,630 --> 00:29:09,279
you know so what this is and i it's

849
00:29:11,669 --> 00:29:10,640
fascinating i just don't think it can

850
00:29:13,269 --> 00:29:11,679
work on earth

851
00:29:14,950 --> 00:29:13,279
so this is a cable of course that

852
00:29:17,110 --> 00:29:14,960
stretches into space and you can just

853
00:29:19,190 --> 00:29:17,120
climb up slowly on this cable

854
00:29:21,430 --> 00:29:19,200
and it's held tight you know the same

855
00:29:21,990 --> 00:29:21,440
force if you have a ball at the end of

856
00:29:23,669 --> 00:29:22,000
rope

857
00:29:25,350 --> 00:29:23,679
and you're whipping that ball around

858
00:29:25,669 --> 00:29:25,360
that string will stay that rope will

859
00:29:27,669 --> 00:29:25,679
stay

860
00:29:29,430 --> 00:29:27,679
tight as long as you keep on moving it

861
00:29:30,389 --> 00:29:29,440
around well in this case you have a

862
00:29:32,230 --> 00:29:30,399
space station

863
00:29:33,990 --> 00:29:32,240

at the end of a cable and you have the

864
00:29:35,990 --> 00:29:34,000
earth which is rotating

865
00:29:38,549 --> 00:29:36,000
and this space station of course is out

866
00:29:41,669 --> 00:29:38,559
way out there geosynchronous orbit

867
00:29:43,110 --> 00:29:41,679
okay that's 36 000 kilometers away so

868
00:29:44,549 --> 00:29:43,120
the first problem is we don't have a

869
00:29:46,389 --> 00:29:44,559
cable that strong

870
00:29:48,310 --> 00:29:46,399
that won't snap under its own weight

871
00:29:51,110 --> 00:29:48,320
steel and kevlar won't do it

872
00:29:51,350 --> 00:29:51,120
carbon mana tubes maybe but you need you

873
00:29:53,029 --> 00:29:51,360
know

874
00:29:54,389 --> 00:29:53,039
our longest carbon nanotube is only

875
00:29:56,630 --> 00:29:54,399
about a meter long and you're going to

876
00:29:58,310 --> 00:29:56,640
need 36 million of them

877
00:29:59,750 --> 00:29:58,320
but the real issue is where on earth are

878
00:30:02,149 --> 00:29:59,760
you going to put this thing

879
00:30:03,430 --> 00:30:02,159
um i mean you would have to protect it i

880
00:30:04,230 --> 00:30:03,440
mean let's let's face it you have to

881
00:30:07,190 --> 00:30:04,240
protect it from

882
00:30:08,789 --> 00:30:07,200
terrorism right because you know some

883
00:30:09,990 --> 00:30:08,799
nuts going to want to bring this whole

884
00:30:11,990 --> 00:30:10,000
thing down

885
00:30:13,430 --> 00:30:12,000
uh but also more menacing you have all

886
00:30:15,190 --> 00:30:13,440
that space junk

887
00:30:16,789 --> 00:30:15,200
in in the lower earth orbit and and

888
00:30:18,710 --> 00:30:16,799

that's going to be constantly crashing

889
00:30:19,269 --> 00:30:18,720
into this cable destabilizing the whole

890
00:30:21,190 --> 00:30:19,279
thing

891
00:30:22,389 --> 00:30:21,200
so i mean this could work on mars it

892
00:30:23,510 --> 00:30:22,399
might work on the moon

893
00:30:25,750 --> 00:30:23,520
but i just don't think it's going to

894
00:30:26,149 --> 00:30:25,760
work on the earth and that's okay we've

895
00:30:27,750 --> 00:30:26,159
got

896
00:30:29,990 --> 00:30:27,760
a nifty idea here kind of an

897
00:30:30,789 --> 00:30:30,000
intermediate step it's a space hook so

898
00:30:32,870 --> 00:30:30,799
you could build this

899
00:30:33,909 --> 00:30:32,880
it's exactly what it sounds like these

900
00:30:35,590 --> 00:30:33,919
would be

901
00:30:37,750 --> 00:30:35,600
satellites with essentially cables

902
00:30:39,909 --> 00:30:37,760
dangling into the upper atmosphere

903
00:30:41,909 --> 00:30:39,919
and you could build this with modern

904
00:30:44,710 --> 00:30:41,919
modern materials today

905
00:30:46,070 --> 00:30:44,720
you don't need any fancy cabling um and

906
00:30:49,350 --> 00:30:46,080
essentially you could

907
00:30:50,389 --> 00:30:49,360
connect um cargo to that with a high

908
00:30:53,029 --> 00:30:50,399
altitude balloon

909
00:30:54,549 --> 00:30:53,039
or a high altitude airplane and then

910
00:30:56,630 --> 00:30:54,559
flip it into space

911
00:30:57,669 --> 00:30:56,640
uh quite feasible you could get a lot of

912
00:31:00,310 --> 00:30:57,679
stuff

913
00:31:01,029 --> 00:31:00,320

in the space this way for relatively

914
00:31:03,190 --> 00:31:01,039
cheap

915
00:31:06,310 --> 00:31:03,200
uh once you get this infrastructure

916
00:31:08,549 --> 00:31:06,320
built and that gets us to a grand idea

917
00:31:11,430 --> 00:31:08,559
again i know it sounds really futuristic

918
00:31:13,029 --> 00:31:11,440
but someday this is going to make sense

919
00:31:15,190 --> 00:31:13,039
in the same way that the interstate

920
00:31:18,149 --> 00:31:15,200
highway system started to make sense

921
00:31:20,149 --> 00:31:18,159
in the 1950s that was a 500 billion

922
00:31:21,029 --> 00:31:20,159
dollar investment to connect cities for

923
00:31:22,789 --> 00:31:21,039
cars

924
00:31:24,789 --> 00:31:22,799
but it was an investment that paid off

925
00:31:25,750 --> 00:31:24,799
six to one in terms of the commerce it

926
00:31:28,310 --> 00:31:25,760
produced

927
00:31:29,430 --> 00:31:28,320
well likewise with a ring around the

928
00:31:31,750 --> 00:31:29,440
entire planet

929
00:31:33,750 --> 00:31:31,760
you know how saturn has its ring of ice

930
00:31:35,669 --> 00:31:33,760
this would be a ring of metal

931
00:31:38,230 --> 00:31:35,679
you would send up tubes maybe with the

932
00:31:38,870 --> 00:31:38,240
sky hooks send up tubes one after the

933
00:31:40,789 --> 00:31:38,880
other

934
00:31:42,710 --> 00:31:40,799
fuse them together to forms a ring

935
00:31:45,509 --> 00:31:42,720
around the whole planet

936
00:31:47,830 --> 00:31:45,519
and then you magnetize the thing um so

937
00:31:49,750 --> 00:31:47,840
it's rotating at orbital velocity

938
00:31:51,509 --> 00:31:49,760

and it's magnetized it becomes a bit

939
00:31:53,750 --> 00:31:51,519
like a maglev

940
00:31:54,549 --> 00:31:53,760
rail and at that point you could

941
00:31:56,950 --> 00:31:54,559
levitate

942
00:31:58,310 --> 00:31:56,960
a platform above it the platform would

943
00:32:00,149 --> 00:31:58,320
be still it's the rail

944
00:32:01,750 --> 00:32:00,159
underneath it that's moving it's a train

945
00:32:04,470 --> 00:32:01,760
in reverse a bit

946
00:32:05,830 --> 00:32:04,480
and so you could stand on that platform

947
00:32:09,430 --> 00:32:05,840
you would be at orbital

948
00:32:11,430 --> 00:32:09,440
altitude but not orbital velocity

949
00:32:13,190 --> 00:32:11,440
and you would feel the whole you know

950
00:32:15,350 --> 00:32:13,200
gravity of the earth below you more or

951
00:32:17,590 --> 00:32:15,360
less uh and he could have

952
00:32:18,389 --> 00:32:17,600
space planes up there launching off to

953
00:32:21,990 --> 00:32:18,399
the moon or

954
00:32:24,950 --> 00:32:22,000
destinations in between earth and moon

955
00:32:25,830 --> 00:32:24,960
sounds fantastic it is fantastic but at

956
00:32:27,350 --> 00:32:25,840
some point

957
00:32:29,269 --> 00:32:27,360
this will make sense because that'll be

958
00:32:29,909 --> 00:32:29,279
the way to get tens of thousands of

959
00:32:32,470 --> 00:32:29,919
people

960
00:32:34,870 --> 00:32:32,480
into space each and every day okay let's

961
00:32:36,630 --> 00:32:34,880
snap back to reality here

962
00:32:38,549 --> 00:32:36,640
the international space station that's

963
00:32:39,909 --> 00:32:38,559

our total existence in space right now i

964
00:32:41,350 --> 00:32:39,919
think there's six people on there right

965
00:32:44,630 --> 00:32:41,360
now maybe seven

966
00:32:45,509 --> 00:32:44,640
um so this thing cost 150 billion to

967
00:32:47,509 --> 00:32:45,519
build

968
00:32:48,789 --> 00:32:47,519
um it cost at least four billion to

969
00:32:51,590 --> 00:32:48,799
maintain each year

970
00:32:52,149 --> 00:32:51,600
it's only seen about 240 visitors so

971
00:32:54,070 --> 00:32:52,159
that's like

972
00:32:55,590 --> 00:32:54,080
a half a billion dollars per visitor

973
00:32:56,950 --> 00:32:55,600
clearly not sustainable

974
00:32:58,310 --> 00:32:56,960
you can tell by the tone of my voice

975
00:33:00,630 --> 00:32:58,320
that i'm not a big fan of the

976
00:33:02,549 --> 00:33:00,640
international space station

977
00:33:04,549 --> 00:33:02,559
i think it's good for perhaps surprising

978
00:33:07,269 --> 00:33:04,559
reasons to you i think it was excellent

979
00:33:08,789 --> 00:33:07,279
way for us to team up with russia and

980
00:33:11,190 --> 00:33:08,799
other nations in space

981
00:33:12,710 --> 00:33:11,200
that was a major advancement beyond the

982
00:33:14,549 --> 00:33:12,720
engineering just that

983
00:33:16,070 --> 00:33:14,559
that connection to those countries that

984
00:33:16,630 --> 00:33:16,080
was one of the greatest things about

985
00:33:19,269 --> 00:33:16,640
this

986
00:33:20,549 --> 00:33:19,279
international space station um we've

987
00:33:23,590 --> 00:33:20,559
also learned how to dock

988
00:33:25,430 --> 00:33:23,600

and maneuver in space very important but

989
00:33:27,190 --> 00:33:25,440
you know these experiments that they do

990
00:33:29,029 --> 00:33:27,200
on zero gravity i think are really

991
00:33:32,070 --> 00:33:29,039
short-sighted in my opinion

992
00:33:33,830 --> 00:33:32,080
i it's they act we act as if zero

993
00:33:35,669 --> 00:33:33,840
gravity is in our future

994
00:33:37,750 --> 00:33:35,679
when is it just a blip you know a

995
00:33:40,789 --> 00:33:37,760
20-year blip in in humanity

996
00:33:44,070 --> 00:33:40,799
our future is in artificial gravity and

997
00:33:45,669 --> 00:33:44,080
uh the low gravity of the moon in mars

998
00:33:47,430 --> 00:33:45,679
we're not going to be traveling around

999
00:33:50,149 --> 00:33:47,440
everywhere in zero gravity

1000
00:33:50,950 --> 00:33:50,159
you know so we know zero gravity is bad

1001
00:33:52,630 --> 00:33:50,960
for your health

1002
00:33:54,549 --> 00:33:52,640
that's all we need to know we don't need

1003
00:33:56,710 --> 00:33:54,559
to know how to sequence dna in zero

1004
00:33:59,029 --> 00:33:56,720
gravity we don't care if ants can

1005
00:33:59,830 --> 00:33:59,039
reproduce in zero gravity it does

1006
00:34:01,830 --> 00:33:59,840
nothing

1007
00:34:03,509 --> 00:34:01,840
for our future in space because the

1008
00:34:04,389 --> 00:34:03,519
future is going to be in artificial

1009
00:34:05,909 --> 00:34:04,399
gravity

1010
00:34:07,990 --> 00:34:05,919
so here's one of the most exciting

1011
00:34:09,510 --> 00:34:08,000
things uh i have ever seen on the

1012
00:34:13,109 --> 00:34:09,520
international space station

1013
00:34:16,629 --> 00:34:13,119

an inflatable habitat it was put there

1014
00:34:18,829 --> 00:34:16,639
by bigelow aerospace in 2015 by a space

1015
00:34:20,470 --> 00:34:18,839
spacex rocket that business the business

1016
00:34:21,990 --> 00:34:20,480
transaction and

1017
00:34:23,990 --> 00:34:22,000
it's still there today and use it as

1018
00:34:25,589 --> 00:34:24,000
storage and this is step one this is

1019
00:34:28,230 --> 00:34:25,599
step two right here

1020
00:34:29,270 --> 00:34:28,240
these will be free floating expandable

1021
00:34:31,430 --> 00:34:29,280
habitats

1022
00:34:33,030 --> 00:34:31,440
and here's bigelow down here and these

1023
00:34:37,109 --> 00:34:33,040
are called his um

1024
00:34:39,829 --> 00:34:37,119
is b330s and that stands for 330 cubic

1025
00:34:41,190 --> 00:34:39,839
meters of volume which is more volume

1026
00:34:42,790 --> 00:34:41,200
livable volume than the whole

1027
00:34:44,950 --> 00:34:42,800
international space station

1028
00:34:46,629 --> 00:34:44,960
and he's building these for a few tens

1029
00:34:50,149 --> 00:34:46,639
of millions of dollars

1030
00:34:51,669 --> 00:34:50,159
not 150 billion and i think

1031
00:34:54,550 --> 00:34:51,679
right now i i think you're looking at

1032
00:34:57,109 --> 00:34:54,560
the near future of low earth orbit

1033
00:34:58,790 --> 00:34:57,119
these are going to be a relatively low

1034
00:35:01,990 --> 00:34:58,800
cost

1035
00:35:03,910 --> 00:35:02,000
uh microgravity factories and

1036
00:35:05,910 --> 00:35:03,920
microgravity laboratories

1037
00:35:07,829 --> 00:35:05,920
and even space hotels that was that was

1038
00:35:10,150 --> 00:35:07,839

bigelow's original intent

1039
00:35:11,109 --> 00:35:10,160
um he wanted to he's going he plans to

1040
00:35:13,750 --> 00:35:11,119
rent these out for

1041
00:35:14,470 --> 00:35:13,760
60 million dollars a month uh with a lot

1042
00:35:16,069 --> 00:35:14,480
of money but

1043
00:35:18,550 --> 00:35:16,079
there's a market for this with ultra

1044
00:35:21,190 --> 00:35:18,560
rich people and also movie producers

1045
00:35:21,829 --> 00:35:21,200
music video producers to film up in

1046
00:35:23,829 --> 00:35:21,839
space

1047
00:35:25,670 --> 00:35:23,839
that way to generate a lot of excitement

1048
00:35:26,550 --> 00:35:25,680
and it's the it's the first step to

1049
00:35:28,470 --> 00:35:26,560
these grander

1050
00:35:29,750 --> 00:35:28,480
space resorts you may have heard about

1051
00:35:31,829 --> 00:35:29,760
with an external

1052
00:35:33,270 --> 00:35:31,839
rotating gravity component and then a

1053
00:35:35,190 --> 00:35:33,280
central uh

1054
00:35:37,430 --> 00:35:35,200
microgravity for the fun of it and you

1055
00:35:40,150 --> 00:35:37,440
would sleep and eat out here

1056
00:35:41,109 --> 00:35:40,160
in a civilized manner um that's the next

1057
00:35:44,310 --> 00:35:41,119
step here

1058
00:35:46,470 --> 00:35:44,320
and you know the only drag is that um

1059
00:35:48,790 --> 00:35:46,480
the pandemic really has set him back

1060
00:35:50,230 --> 00:35:48,800
bigelow uh he's talking to some nasa

1061
00:35:52,390 --> 00:35:50,240
folks right here but

1062
00:35:54,069 --> 00:35:52,400
um he is planning to launch this within

1063
00:35:56,230 --> 00:35:54,079

a couple years but he's had to lay off

1064
00:35:57,109 --> 00:35:56,240
his entire uh workforce because of the

1065
00:35:58,470 --> 00:35:57,119
pandemic

1066
00:36:00,710 --> 00:35:58,480
so we'll we'll see what happens

1067
00:36:01,670 --> 00:36:00,720
nevertheless i think expandable habitats

1068
00:36:04,630 --> 00:36:01,680
like this which are

1069
00:36:06,550 --> 00:36:04,640
quite inexpensive to build uh are in our

1070
00:36:08,950 --> 00:36:06,560
near future

1071
00:36:10,630 --> 00:36:08,960
so eventually we'll get to the moon and

1072
00:36:12,390 --> 00:36:10,640
um

1073
00:36:13,670 --> 00:36:12,400
i say eventually because you know who

1074
00:36:16,470 --> 00:36:13,680
knows when but

1075
00:36:18,190 --> 00:36:16,480
you know nasa has this plan to be there

1076
00:36:21,349 --> 00:36:18,200
put humans back by

1077
00:36:21,829 --> 00:36:21,359
2024 which is you know no one at nasa

1078
00:36:23,589 --> 00:36:21,839
even

1079
00:36:25,990 --> 00:36:23,599
i think was realizing that's going to

1080
00:36:27,670 --> 00:36:26,000
happen it was a ridiculous deadline set

1081
00:36:28,630 --> 00:36:27,680
by the previous administration purely

1082
00:36:30,630 --> 00:36:28,640
out of ego

1083
00:36:32,150 --> 00:36:30,640
but it was it's a bad idea too because

1084
00:36:33,349 --> 00:36:32,160
in my opinion this

1085
00:36:34,870 --> 00:36:33,359
you really don't want to rush humans

1086
00:36:36,390 --> 00:36:34,880
back to the moon they can't really do

1087
00:36:37,109 --> 00:36:36,400
anything there if you want permanence on

1088
00:36:39,430 --> 00:36:37,119

the moon

1089
00:36:40,310 --> 00:36:39,440
uh which is what china and russia are

1090
00:36:43,270 --> 00:36:40,320
planning

1091
00:36:45,430 --> 00:36:43,280
um you need to set up infrastructure and

1092
00:36:47,109 --> 00:36:45,440
i'll get to that in a second

1093
00:36:49,510 --> 00:36:47,119
what i think is interesting about the

1094
00:36:52,550 --> 00:36:49,520
moon is i i i predict it's going to be

1095
00:36:54,069 --> 00:36:52,560
a lot like what we do in antarctica and

1096
00:36:58,069 --> 00:36:54,079
you might know in antarctica

1097
00:37:00,470 --> 00:36:58,079
no one owns antarctica um but there are

1098
00:37:01,589 --> 00:37:00,480
science bases down there about 70 of

1099
00:37:03,910 --> 00:37:01,599
them run by

1100
00:37:05,430 --> 00:37:03,920
dozens of countries and you have

1101
00:37:07,030 --> 00:37:05,440
scientists that go down there for maybe

1102
00:37:08,790 --> 00:37:07,040
two three months at a time usually in

1103
00:37:10,790 --> 00:37:08,800
the summer and then you have a hearty

1104
00:37:12,710 --> 00:37:10,800
crew that stays over winter maybe a year

1105
00:37:14,790 --> 00:37:12,720
or two and then they come back

1106
00:37:16,390 --> 00:37:14,800
you're gonna find i think the moon a lot

1107
00:37:20,230 --> 00:37:16,400
like that where you'll have

1108
00:37:22,550 --> 00:37:20,240
nation-led bases visited by scientists

1109
00:37:24,550 --> 00:37:22,560
uh going for a couple months at a time

1110
00:37:26,310 --> 00:37:24,560
and maybe a year-round crew depending on

1111
00:37:29,430 --> 00:37:26,320
how we could hold up in that uh

1112
00:37:31,910 --> 00:37:29,440
microgravity of 16 17 percent of earth's

1113
00:37:35,349 --> 00:37:31,920

gravity maybe it's suitable for a year

1114
00:37:38,069 --> 00:37:35,359
we don't know um and

1115
00:37:39,750 --> 00:37:38,079
here's the fascinating thing pure

1116
00:37:40,390 --> 00:37:39,760
coincidence the first place we're going

1117
00:37:44,069 --> 00:37:40,400
to go

1118
00:37:45,990 --> 00:37:44,079
the south pole of the moon

1119
00:37:47,109 --> 00:37:46,000
um because there's a constant

1120
00:37:49,510 --> 00:37:47,119
temperature there of

1121
00:37:50,310 --> 00:37:49,520
of a minus 50 degrees celsius which is

1122
00:37:53,349 --> 00:37:50,320
cold

1123
00:37:55,109 --> 00:37:53,359
but workable elsewhere on the moon see

1124
00:37:57,589 --> 00:37:55,119
the moon doesn't have an atmosphere

1125
00:37:58,950 --> 00:37:57,599
so the temperature fluctuates so greatly

1126
00:38:00,390 --> 00:37:58,960
because there's nothing to trap and

1127
00:38:03,430 --> 00:38:00,400
circulate the heat

1128
00:38:04,950 --> 00:38:03,440
so during the lunar day which will last

1129
00:38:06,790 --> 00:38:04,960
14 earth days

1130
00:38:09,990 --> 00:38:06,800
sun hits the surface and will heat up

1131
00:38:13,030 --> 00:38:10,000
the surface to over 120 degrees celsius

1132
00:38:14,790 --> 00:38:13,040
you know 200 plus degrees fahrenheit you

1133
00:38:16,550 --> 00:38:14,800
know that'll boil your blood

1134
00:38:19,750 --> 00:38:16,560
and then at night time when there's no

1135
00:38:23,030 --> 00:38:19,760
sun it gets down to a minus 200 degrees

1136
00:38:25,030 --> 00:38:23,040
celsius so that it's all but impossible

1137
00:38:27,270 --> 00:38:25,040
to be working there month after month

1138
00:38:29,030 --> 00:38:27,280

but on the moon the north pole and the

1139
00:38:31,910 --> 00:38:29,040
south pole get that steady

1140
00:38:33,510 --> 00:38:31,920
shallow uh angle of sunlight as it's

1141
00:38:35,430 --> 00:38:33,520
rotating

1142
00:38:37,589 --> 00:38:35,440
and uh most of the time there's there's

1143
00:38:38,150 --> 00:38:37,599
sunlight in fact that's what's the fun

1144
00:38:41,030 --> 00:38:38,160
part

1145
00:38:42,470 --> 00:38:41,040
some of these craters uh the rims of the

1146
00:38:44,550 --> 00:38:42,480
craters are high enough

1147
00:38:46,230 --> 00:38:44,560
that there's actually perpetual sunlight

1148
00:38:48,390 --> 00:38:46,240
the sun never sets

1149
00:38:49,589 --> 00:38:48,400
and you could set up solar panels there

1150
00:38:52,069 --> 00:38:49,599
for constant

1151
00:38:53,910 --> 00:38:52,079
energy that would be a huge boom and

1152
00:38:57,349 --> 00:38:53,920
then as an added bonus you see these

1153
00:38:59,349 --> 00:38:57,359
shadowed areas over here

1154
00:39:00,710 --> 00:38:59,359
these are areas with ice deposits that

1155
00:39:02,230 --> 00:39:00,720
haven't seen the light of day for

1156
00:39:04,390 --> 00:39:02,240
millions of years

1157
00:39:06,069 --> 00:39:04,400
and if you could harvest that ice which

1158
00:39:07,589 --> 00:39:06,079
is a big if and we can talk about that

1159
00:39:08,150 --> 00:39:07,599
later it's very difficult to do of

1160
00:39:10,150 --> 00:39:08,160
course

1161
00:39:12,150 --> 00:39:10,160
but if you could harvest that ice you

1162
00:39:14,630 --> 00:39:12,160
would have water to drink

1163
00:39:16,310 --> 00:39:14,640

you would have air to breathe because

1164
00:39:17,750 --> 00:39:16,320
you could take away some of that oxygen

1165
00:39:20,710 --> 00:39:17,760
from the h2o

1166
00:39:22,310 --> 00:39:20,720
and you would have fuel to burn because

1167
00:39:25,510 --> 00:39:22,320
basic rocket

1168
00:39:27,990 --> 00:39:25,520
fuel is hydrogen and oxygen uh

1169
00:39:29,670 --> 00:39:28,000
so that's this is a billion dollar

1170
00:39:31,349 --> 00:39:29,680
industry we're talking about

1171
00:39:34,310 --> 00:39:31,359
nasa has already put a price on it on

1172
00:39:36,470 --> 00:39:34,320
this ice uh they will pay uh 500 uh kill

1173
00:39:38,710 --> 00:39:36,480
5000 dollars a kilogram for the ice

1174
00:39:40,069 --> 00:39:38,720
that's how valuable it is to them

1175
00:39:42,310 --> 00:39:40,079
so what can you do on the move when

1176
00:39:45,270 --> 00:39:42,320
you're there um science

1177
00:39:46,870 --> 00:39:45,280
lots lots of science astronomy geology

1178
00:39:49,270 --> 00:39:46,880
immunology if you will

1179
00:39:49,990 --> 00:39:49,280
and biology so let me get back to the

1180
00:39:54,829 --> 00:39:50,000
iss

1181
00:39:59,109 --> 00:39:56,150
cultures

1182
00:40:00,390 --> 00:39:59,119
some circles but uh i think not that

1183
00:40:02,230 --> 00:40:00,400
anyone's listening to me

1184
00:40:03,910 --> 00:40:02,240
but i think we should make the moon the

1185
00:40:06,390 --> 00:40:03,920
next iss

1186
00:40:07,990 --> 00:40:06,400
um i think and we could do this with

1187
00:40:09,990 --> 00:40:08,000
nasa's budget that it applies to the

1188
00:40:12,150 --> 00:40:10,000

international space station of 4 billion

1189
00:40:13,750 --> 00:40:12,160
a year i think it could i think nasa

1190
00:40:16,790 --> 00:40:13,760
could apply that budget

1191
00:40:17,109 --> 00:40:16,800
to the moon to function on the moon and

1192
00:40:19,270 --> 00:40:17,119
then

1193
00:40:21,510 --> 00:40:19,280
hand over the international space

1194
00:40:23,670 --> 00:40:21,520
station to commercial interests

1195
00:40:25,829 --> 00:40:23,680
you know this isn't surrender this is a

1196
00:40:27,750 --> 00:40:25,839
good thing you know because

1197
00:40:29,430 --> 00:40:27,760
they have done nasa and its partners

1198
00:40:34,309 --> 00:40:29,440
have done so well

1199
00:40:36,630 --> 00:40:34,319
learning so much about working in space

1200
00:40:37,589 --> 00:40:36,640
now it's time to hand it over to the

1201
00:40:42,069 --> 00:40:37,599
commercial

1202
00:40:43,030 --> 00:40:42,079
them further develop this why nasa and

1203
00:40:44,550 --> 00:40:43,040
government entities

1204
00:40:46,710 --> 00:40:44,560
move to the moon and push the next

1205
00:40:47,349 --> 00:40:46,720
frontier this is really important

1206
00:40:49,030 --> 00:40:47,359
because there's a

1207
00:40:50,309 --> 00:40:49,040
very important biology we could be doing

1208
00:40:50,790 --> 00:40:50,319
let me go up to the next slide for a

1209
00:40:53,430 --> 00:40:50,800
second

1210
00:40:56,470 --> 00:40:53,440
and explain you know this gravity issue

1211
00:40:58,550 --> 00:40:56,480
um i keep on harping about gravity but

1212
00:41:00,230 --> 00:40:58,560
you know we only have two data points

1213
00:41:03,030 --> 00:41:00,240

when it comes to gravity

1214
00:41:04,309 --> 00:41:03,040
we know that one g is good it's healthy

1215
00:41:05,430 --> 00:41:04,319
it's you know like we guess that's what

1216
00:41:07,910 --> 00:41:05,440
we evolved in

1217
00:41:09,510 --> 00:41:07,920
and zero g is bad we know that we knew

1218
00:41:11,910 --> 00:41:09,520
that back from the the mir

1219
00:41:13,510 --> 00:41:11,920
uh space station but how do these two

1220
00:41:16,230 --> 00:41:13,520
data points connect

1221
00:41:18,069 --> 00:41:16,240
is it a linear connection maybe it needs

1222
00:41:20,390 --> 00:41:18,079
to need a little bit of gravity

1223
00:41:21,990 --> 00:41:20,400
for relatively good health or maybe you

1224
00:41:24,150 --> 00:41:22,000
need a whole lot of gravity

1225
00:41:25,190 --> 00:41:24,160
uh before you you can have good health

1226
00:41:27,030 --> 00:41:25,200
we don't know

1227
00:41:29,030 --> 00:41:27,040
so by living on the moon and doing your

1228
00:41:29,670 --> 00:41:29,040
experiments on the moon you can at least

1229
00:41:32,470 --> 00:41:29,680
add

1230
00:41:33,829 --> 00:41:32,480
a third data point to this chart and

1231
00:41:36,309 --> 00:41:33,839
that will give you some indication of

1232
00:41:38,470 --> 00:41:36,319
what mars is going to be like

1233
00:41:40,309 --> 00:41:38,480
okay let me go back i love this image

1234
00:41:42,069 --> 00:41:40,319
because it shows

1235
00:41:43,589 --> 00:41:42,079
things that are both practical and

1236
00:41:45,109 --> 00:41:43,599
impractical

1237
00:41:47,030 --> 00:41:45,119
you know i talked about the

1238
00:41:50,150 --> 00:41:47,040

infrastructure idea right

1239
00:41:50,470 --> 00:41:50,160
so here you see this is issa's idea they

1240
00:41:54,630 --> 00:41:50,480
want

1241
00:41:55,829 --> 00:41:54,640
to land and and build habitats and it

1242
00:41:57,510 --> 00:41:55,839
will be done by

1243
00:41:59,190 --> 00:41:57,520
you know you land these things that look

1244
00:42:01,510 --> 00:41:59,200
like these air locks here

1245
00:42:04,630 --> 00:42:01,520
and then the end of the airlock it

1246
00:42:07,349 --> 00:42:04,640
expands into kind of an igloo type shape

1247
00:42:09,589 --> 00:42:07,359
okay made of like rubbery kevlar and

1248
00:42:12,470 --> 00:42:09,599
then another robot comes out

1249
00:42:14,309 --> 00:42:12,480
and covers the thing in regolith about

1250
00:42:14,950 --> 00:42:14,319
three or four meters worth you need a

1251
00:42:16,630 --> 00:42:14,960
lot

1252
00:42:18,069 --> 00:42:16,640
because the moon again doesn't have an

1253
00:42:19,750 --> 00:42:18,079
atmosphere so

1254
00:42:21,910 --> 00:42:19,760
there's no protection from the cosmic

1255
00:42:23,589 --> 00:42:21,920
radiation and the solar radiation

1256
00:42:25,270 --> 00:42:23,599
and even micro meteorites that are

1257
00:42:27,430 --> 00:42:25,280
constantly hitting the moon so you have

1258
00:42:29,349 --> 00:42:27,440
to cover it up with a lot of regolith

1259
00:42:30,710 --> 00:42:29,359
and that could be done before humans

1260
00:42:33,349 --> 00:42:30,720
even get there

1261
00:42:35,109 --> 00:42:33,359
you can also use some robots to start

1262
00:42:37,990 --> 00:42:35,119
generating oxygen

1263
00:42:38,950 --> 00:42:38,000

the the moon actually has lots of oxygen

1264
00:42:42,550 --> 00:42:38,960
the the soil

1265
00:42:43,990 --> 00:42:42,560
the regolith is 40 oxygen by weight

1266
00:42:46,230 --> 00:42:44,000
it's just that it's bound to other

1267
00:42:48,630 --> 00:42:46,240
minerals like uh like

1268
00:42:50,309 --> 00:42:48,640
iron but you can bake that out for your

1269
00:42:51,990 --> 00:42:50,319
oxygen supply

1270
00:42:53,670 --> 00:42:52,000
and we could be doing that in advance

1271
00:42:55,030 --> 00:42:53,680
before people get there just to dance

1272
00:42:57,589 --> 00:42:55,040
around and plant a flag

1273
00:42:58,150 --> 00:42:57,599
i have no idea why nasa wants to rush

1274
00:43:00,710 --> 00:42:58,160
people

1275
00:43:01,990 --> 00:43:00,720
back there so that's the practical

1276
00:43:05,430 --> 00:43:02,000
aspect of this

1277
00:43:05,750 --> 00:43:05,440
you know the uh what's not practical i

1278
00:43:07,430 --> 00:43:05,760
mean

1279
00:43:08,790 --> 00:43:07,440
it makes for great space illustrations

1280
00:43:10,710 --> 00:43:08,800
but this idea of growing

1281
00:43:12,550 --> 00:43:10,720
uh plants under glass you see it all the

1282
00:43:14,150 --> 00:43:12,560
time i just said that humans had to be

1283
00:43:15,109 --> 00:43:14,160
under three or four meters worth of

1284
00:43:17,589 --> 00:43:15,119
regolith

1285
00:43:19,270 --> 00:43:17,599
or let's get killed by the cosmic rays

1286
00:43:21,750 --> 00:43:19,280
so i just don't know how plants can

1287
00:43:23,430 --> 00:43:21,760
survive and such radiation under glass

1288
00:43:25,190 --> 00:43:23,440

there's even a couple people if you look

1289
00:43:26,470 --> 00:43:25,200
closely enough in here

1290
00:43:28,550 --> 00:43:26,480
they're going to get fried by the

1291
00:43:30,069 --> 00:43:28,560
radiation it's ridiculous are you going

1292
00:43:31,829 --> 00:43:30,079
to if you're going to grow food on

1293
00:43:33,109 --> 00:43:31,839
on mars you're going to have to grow it

1294
00:43:35,750 --> 00:43:33,119
under led lights

1295
00:43:36,950 --> 00:43:35,760
excuse me on the moon okay we talked

1296
00:43:38,630 --> 00:43:36,960
about gravity

1297
00:43:39,910 --> 00:43:38,640
here's another big thing about the the

1298
00:43:41,270 --> 00:43:39,920
moon you have to be aware of you're

1299
00:43:43,589 --> 00:43:41,280
gonna if you're gonna go

1300
00:43:45,750 --> 00:43:43,599
and that's the dust uh not many people

1301
00:43:47,829 --> 00:43:45,760
talk about this but it's really menacing

1302
00:43:49,510 --> 00:43:47,839
it's uh these razor sharp particles it's

1303
00:43:51,589 --> 00:43:49,520
a bit like asbestos

1304
00:43:52,630 --> 00:43:51,599
um and it's everywhere it actually

1305
00:43:54,630 --> 00:43:52,640
levitates

1306
00:43:57,270 --> 00:43:54,640
a few inches above the surface of the

1307
00:43:59,349 --> 00:43:57,280
moon in these electrostatic fountains

1308
00:44:00,870 --> 00:43:59,359
so just by going out and walking around

1309
00:44:02,309 --> 00:44:00,880
you pick up this dust

1310
00:44:04,470 --> 00:44:02,319
and then if you bring it back in and

1311
00:44:06,470 --> 00:44:04,480
breathe it in it'll it'll rip up your

1312
00:44:08,710 --> 00:44:06,480
lungs it's deadly stuff

1313
00:44:09,589 --> 00:44:08,720

and it and you can't escape it it's like

1314
00:44:11,109 --> 00:44:09,599
living on the moon

1315
00:44:13,510 --> 00:44:11,119
essentially be like living in an

1316
00:44:15,670 --> 00:44:13,520
asbestos remediation zone

1317
00:44:17,510 --> 00:44:15,680
forever you know there's no getting rid

1318
00:44:18,230 --> 00:44:17,520
of this dust it's always going to be

1319
00:44:20,470 --> 00:44:18,240
there

1320
00:44:21,990 --> 00:44:20,480
so that's that's a real challenge to

1321
00:44:23,430 --> 00:44:22,000
overcome that not that many people are

1322
00:44:25,750 --> 00:44:23,440
talking about

1323
00:44:27,270 --> 00:44:25,760
so keeping that in mind i i wanted to

1324
00:44:27,670 --> 00:44:27,280
throw this out this is kind of fun you

1325
00:44:29,589 --> 00:44:27,680
know

1326
00:44:30,950 --> 00:44:29,599
moving about on the moon keeping you

1327
00:44:32,710 --> 00:44:30,960
know with all the dust

1328
00:44:34,230 --> 00:44:32,720
you know these moon buggies that are

1329
00:44:35,430 --> 00:44:34,240
kicking up dust probably won't be the

1330
00:44:36,790 --> 00:44:35,440
way to go

1331
00:44:38,550 --> 00:44:36,800
an interesting way is with these

1332
00:44:40,710 --> 00:44:38,560
gondolas

1333
00:44:43,030 --> 00:44:40,720
it would be relatively straightforward

1334
00:44:45,109 --> 00:44:43,040
ability just need some poles and cables

1335
00:44:46,790 --> 00:44:45,119
because the gravity is so low they don't

1336
00:44:48,630 --> 00:44:46,800
need much support

1337
00:44:50,710 --> 00:44:48,640
and because there's no air resistance

1338
00:44:52,390 --> 00:44:50,720

these things could fly along the cables

1339
00:44:54,870 --> 00:44:52,400
that would be a fun way to travel around

1340
00:44:57,589 --> 00:44:54,880
on this on the moon i think

1341
00:44:58,390 --> 00:44:57,599
um and here's an interesting idea about

1342
00:44:59,990 --> 00:44:58,400
where to live

1343
00:45:01,349 --> 00:45:00,000
if we're moving away from the polar

1344
00:45:02,390 --> 00:45:01,359
regions where the temperatures are

1345
00:45:04,470 --> 00:45:02,400
extreme

1346
00:45:06,390 --> 00:45:04,480
again the space artists come in and they

1347
00:45:09,430 --> 00:45:06,400
they build these wonderful

1348
00:45:12,230 --> 00:45:09,440
golden lit domes um but it would be very

1349
00:45:13,829 --> 00:45:12,240
hard to have material that can withstand

1350
00:45:17,430 --> 00:45:13,839
i mean you're essentially in fahrenheit

1351
00:45:18,230 --> 00:45:17,440
going like minus 250 to a positive 250

1352
00:45:20,230 --> 00:45:18,240
each month

1353
00:45:21,589 --> 00:45:20,240
500 degree change i mean that that's

1354
00:45:24,790 --> 00:45:21,599
hard to maintain

1355
00:45:26,390 --> 00:45:24,800
structure so to get around this we might

1356
00:45:28,630 --> 00:45:26,400
end up living in caves

1357
00:45:30,550 --> 00:45:28,640
and the moon has lots of them carved out

1358
00:45:33,349 --> 00:45:30,560
by um

1359
00:45:35,109 --> 00:45:33,359
by lava this is a real image and it's

1360
00:45:36,790 --> 00:45:35,119
about a hundred meters deep

1361
00:45:38,309 --> 00:45:36,800
and just like caves on earth these would

1362
00:45:41,510 --> 00:45:38,319
have a constant temperature of about

1363
00:45:43,270 --> 00:45:41,520

minus 20 degrees cold but workable and

1364
00:45:45,109 --> 00:45:43,280
uh you could hide down in here

1365
00:45:46,950 --> 00:45:45,119
build a little habitat down here or give

1366
00:45:48,069 --> 00:45:46,960
you the natural protection you need from

1367
00:45:52,309 --> 00:45:48,079
the

1368
00:45:54,150 --> 00:45:52,319
you know maybe you can come out during

1369
00:45:55,510 --> 00:45:54,160
the dawn or the dusk when it before the

1370
00:45:57,589 --> 00:45:55,520
temperatures get too

1371
00:45:58,950 --> 00:45:57,599
bad that's how the apollo astronauts

1372
00:46:00,710 --> 00:45:58,960
they were on the surface of the moon

1373
00:46:03,910 --> 00:46:00,720
during either the dawn or dusk before

1374
00:46:07,190 --> 00:46:03,920
the temperatures were too extreme

1375
00:46:08,230 --> 00:46:07,200
um we can talk about mooning excuse me

1376
00:46:13,589 --> 00:46:08,240
mining

1377
00:46:14,790 --> 00:46:13,599
in the question period because it's it's

1378
00:46:15,589 --> 00:46:14,800
pretty extensive but if you're

1379
00:46:17,910 --> 00:46:15,599
interested

1380
00:46:19,270 --> 00:46:17,920
it's uh you know you need a market

1381
00:46:20,710 --> 00:46:19,280
that's the problem lots of valuable

1382
00:46:22,710 --> 00:46:20,720
stuff on the moon but there's no market

1383
00:46:25,670 --> 00:46:22,720
just yet that's the gist of it

1384
00:46:28,309 --> 00:46:25,680
um but you know actually before mining i

1385
00:46:31,829 --> 00:46:28,319
think tourism is a real possibility

1386
00:46:34,230 --> 00:46:31,839
um you know so baron hilton

1387
00:46:36,069 --> 00:46:34,240
had this idea in 1967 he was going to

1388
00:46:37,190 --> 00:46:36,079

build a hotel on the moon

1389
00:46:39,270 --> 00:46:37,200
and lots of people called him a

1390
00:46:40,230 --> 00:46:39,280
visionary i i think he might have been

1391
00:46:41,510 --> 00:46:40,240
naive

1392
00:46:44,470 --> 00:46:41,520
in his you know i think this is

1393
00:46:46,710 --> 00:46:44,480
exemplified by his perception of uh

1394
00:46:48,069 --> 00:46:46,720
venus excuse me saturn by looking at the

1395
00:46:49,510 --> 00:46:48,079
bar room window it's not going to be

1396
00:46:50,150 --> 00:46:49,520
that big maybe if you're drunk i don't

1397
00:46:53,430 --> 00:46:50,160
know

1398
00:46:54,870 --> 00:46:53,440
um but um but this is feasible tourism

1399
00:46:55,670 --> 00:46:54,880
on the moon it all comes down to the

1400
00:46:58,550 --> 00:46:55,680
price

1401
00:46:59,190 --> 00:46:58,560
really i mean right now it'll cost maybe

1402
00:47:01,270 --> 00:46:59,200
50

1403
00:47:03,190 --> 00:47:01,280
million dollars to get to the moon in

1404
00:47:06,230 --> 00:47:03,200
fact spacex wants to

1405
00:47:09,349 --> 00:47:06,240
send seven people around the moon

1406
00:47:11,430 --> 00:47:09,359
um for about that price but if you could

1407
00:47:13,829 --> 00:47:11,440
get the price down to a million dollars

1408
00:47:15,349 --> 00:47:13,839
which i think is feasible in 10 or 15

1409
00:47:16,150 --> 00:47:15,359
years if you could get the price down

1410
00:47:17,990 --> 00:47:16,160
that low

1411
00:47:19,990 --> 00:47:18,000
you would have tens of thousands of

1412
00:47:22,470 --> 00:47:20,000
people wanting to go to the moon

1413
00:47:24,950 --> 00:47:22,480

uh that's a real uh market that's the

1414
00:47:26,710 --> 00:47:24,960
beginning of of an industry

1415
00:47:28,950 --> 00:47:26,720
and and if you could get that even

1416
00:47:30,950 --> 00:47:28,960
cheaper you may be in 20 or 30 years

1417
00:47:32,710 --> 00:47:30,960
down to a hundred thousand dollars

1418
00:47:35,589 --> 00:47:32,720
well i think there's people on this uh

1419
00:47:38,230 --> 00:47:35,599
in this listening to this talk right now

1420
00:47:40,470 --> 00:47:38,240
that would do that um it would take out

1421
00:47:41,270 --> 00:47:40,480
loans or or save up for this trip of a

1422
00:47:43,910 --> 00:47:41,280
lifetime

1423
00:47:45,109 --> 00:47:43,920
so i i think lunar tourism is a real

1424
00:47:46,950 --> 00:47:45,119
possibility

1425
00:47:48,390 --> 00:47:46,960
but i don't think this will happen

1426
00:47:49,670 --> 00:47:48,400
cities on the moon

1427
00:47:51,349 --> 00:47:49,680
because it won't happen because there's

1428
00:47:52,790 --> 00:47:51,359
no reason for it to happen just like you

1429
00:47:55,109 --> 00:47:52,800
know no one is living

1430
00:47:56,870 --> 00:47:55,119
uh on uh mount everest and no one's

1431
00:47:58,230 --> 00:47:56,880
living in antarctica it's just not very

1432
00:47:59,990 --> 00:47:58,240
practical

1433
00:48:01,430 --> 00:48:00,000
i mean i'm sure one or two nuts would

1434
00:48:04,230 --> 00:48:01,440
like to go and live there

1435
00:48:05,670 --> 00:48:04,240
but what would drive tens of thousands

1436
00:48:08,870 --> 00:48:05,680
of people to form a city

1437
00:48:10,549 --> 00:48:08,880
on the moon in this gray existence uh

1438
00:48:12,470 --> 00:48:10,559

where you probably can't have children

1439
00:48:14,549 --> 00:48:12,480
because the gravity is so low

1440
00:48:16,390 --> 00:48:14,559
and and you can never go outside you

1441
00:48:18,069 --> 00:48:16,400
can't go outside on the moon even when

1442
00:48:21,349 --> 00:48:18,079
you're outside you're in

1443
00:48:24,069 --> 00:48:21,359
you know a big uh bulky

1444
00:48:25,190 --> 00:48:24,079
space suit so you would never be able to

1445
00:48:28,150 --> 00:48:25,200
smell the moon

1446
00:48:29,030 --> 00:48:28,160
or or taste the moon or feel the moon or

1447
00:48:30,950 --> 00:48:29,040
or even

1448
00:48:32,069 --> 00:48:30,960
hear the moon you know there's no sound

1449
00:48:33,430 --> 00:48:32,079
that travels you might as well

1450
00:48:34,230 --> 00:48:33,440
experience the whole thing in virtual

1451
00:48:36,710 --> 00:48:34,240
reality

1452
00:48:37,589 --> 00:48:36,720
i i can't see any reason i mean sure to

1453
00:48:40,069 --> 00:48:37,599
work on the moon

1454
00:48:41,829 --> 00:48:40,079
but to actually set up at your lifetime

1455
00:48:44,549 --> 00:48:41,839
on the moon and generations on the moon

1456
00:48:46,549 --> 00:48:44,559
it seems to be no purpose to it but

1457
00:48:48,950 --> 00:48:46,559
that's not the case with mars

1458
00:48:51,030 --> 00:48:48,960
you know there's a real possibility here

1459
00:48:53,589 --> 00:48:51,040
um because it's intriguing

1460
00:48:55,589 --> 00:48:53,599
objectively subjectively but maybe

1461
00:48:57,589 --> 00:48:55,599
objectively it's it's it's

1462
00:49:00,870 --> 00:48:57,599
far more beautiful than the moon i mean

1463
00:49:04,069 --> 00:49:00,880

it has a colorful sunsets and sunrises

1464
00:49:06,549 --> 00:49:04,079
uh fantastic mountains and canyons um

1465
00:49:07,589 --> 00:49:06,559
i mean just real color to it and uh it's

1466
00:49:10,630 --> 00:49:07,599
so earth like

1467
00:49:12,470 --> 00:49:10,640
even the day night uh cycle is about 24

1468
00:49:14,309 --> 00:49:12,480
hours incredible coincidence

1469
00:49:16,309 --> 00:49:14,319
and it has a tilt just like earth so

1470
00:49:18,230 --> 00:49:16,319
there's there's actually seasons four

1471
00:49:20,710 --> 00:49:18,240
different seasons on mars

1472
00:49:21,510 --> 00:49:20,720
that has every element we need for life

1473
00:49:25,270 --> 00:49:21,520
um

1474
00:49:26,150 --> 00:49:25,280
the question of gravity is an open-ended

1475
00:49:29,190 --> 00:49:26,160
question

1476
00:49:31,670 --> 00:49:29,200
of course because if 38

1477
00:49:33,109 --> 00:49:31,680
of earth's gravity which is what mars is

1478
00:49:35,510 --> 00:49:33,119
if that's not enough to raise

1479
00:49:36,150 --> 00:49:35,520
children on mars well that's the end of

1480
00:49:37,829 --> 00:49:36,160
uh

1481
00:49:39,430 --> 00:49:37,839
colonization you know case closed you

1482
00:49:40,549 --> 00:49:39,440
can't raise kids there you can't

1483
00:49:43,109 --> 00:49:40,559
colonize a place

1484
00:49:43,990 --> 00:49:43,119
maybe it'll be a science uh basis maybe

1485
00:49:46,790 --> 00:49:44,000
you know retirement

1486
00:49:47,589 --> 00:49:46,800
community but unless the gravity is

1487
00:49:49,190 --> 00:49:47,599
suitable

1488
00:49:50,710 --> 00:49:49,200

uh for children then you will never be

1489
00:49:53,349 --> 00:49:50,720
able to colonize it

1490
00:49:53,990 --> 00:49:53,359
but that's for later to find out the big

1491
00:49:56,470 --> 00:49:54,000
question now

1492
00:49:58,790 --> 00:49:56,480
the big issue now is how to get there

1493
00:50:01,270 --> 00:49:58,800
because it's a long trip

1494
00:50:02,950 --> 00:50:01,280
you know it's we're talking nine months

1495
00:50:05,190 --> 00:50:02,960
in in a in a um

1496
00:50:06,150 --> 00:50:05,200
in a spacecraft that's a long time to be

1497
00:50:08,470 --> 00:50:06,160
at sea

1498
00:50:10,150 --> 00:50:08,480
um no one has ever done that actually

1499
00:50:13,270 --> 00:50:10,160
you know i looked it up with um

1500
00:50:15,270 --> 00:50:13,280
with seafarers you know the longest uh

1501
00:50:17,510 --> 00:50:15,280
sea voyage seems to be about three

1502
00:50:19,190 --> 00:50:17,520
months and that's with when magellan was

1503
00:50:21,190 --> 00:50:19,200
going around the whole globe

1504
00:50:23,109 --> 00:50:21,200
and there was a point in the pacific

1505
00:50:24,309 --> 00:50:23,119
between you know looking for islands

1506
00:50:26,390 --> 00:50:24,319
that these guys were out

1507
00:50:28,309 --> 00:50:26,400
in the ocean for three months looking

1508
00:50:29,109 --> 00:50:28,319
for land that's a long time but we're

1509
00:50:31,670 --> 00:50:29,119
talking

1510
00:50:33,670 --> 00:50:31,680
uh nine months here and you're going

1511
00:50:36,870 --> 00:50:33,680
you're traveling of course through this

1512
00:50:38,069 --> 00:50:36,880
soup of radiation it's very deadly

1513
00:50:39,670 --> 00:50:38,079

once you get out of the earth's

1514
00:50:41,589 --> 00:50:39,680
atmosphere and the protective

1515
00:50:43,750 --> 00:50:41,599
magnetosphere of the earth

1516
00:50:45,829 --> 00:50:43,760
it's it you know you're you're a sitting

1517
00:50:47,190 --> 00:50:45,839
duck out there

1518
00:50:49,190 --> 00:50:47,200
in fact you know when the apollo

1519
00:50:51,510 --> 00:50:49,200
astronauts went to the moon

1520
00:50:52,470 --> 00:50:51,520
they all experienced flashes in their

1521
00:50:55,349 --> 00:50:52,480
eyes

1522
00:50:56,150 --> 00:50:55,359
and what these flashes were were cosmic

1523
00:50:58,710 --> 00:50:56,160
rays

1524
00:51:00,230 --> 00:50:58,720
going through their eyeballs and

1525
00:51:01,190 --> 00:51:00,240
interacting with the molecules and

1526
00:51:02,950 --> 00:51:01,200
fluorescing

1527
00:51:04,790 --> 00:51:02,960
and they would get this at a rate of

1528
00:51:07,190 --> 00:51:04,800
once every few minutes

1529
00:51:07,990 --> 00:51:07,200
so if that's happening every at that

1530
00:51:09,829 --> 00:51:08,000
rate you

1531
00:51:11,190 --> 00:51:09,839
can imagine that every second these

1532
00:51:13,510 --> 00:51:11,200
cosmic rays are are

1533
00:51:14,870 --> 00:51:13,520
slicing through your body uh ripping

1534
00:51:16,950 --> 00:51:14,880
apart your dna

1535
00:51:18,390 --> 00:51:16,960
i mean this this is like cancer waiting

1536
00:51:20,710 --> 00:51:18,400
to happen this is

1537
00:51:22,470 --> 00:51:20,720
a real issue and people are unsure

1538
00:51:24,870 --> 00:51:22,480

whether we could actually survive

1539
00:51:26,549 --> 00:51:24,880
the trip to mars you either have to get

1540
00:51:28,309 --> 00:51:26,559
there as quickly as possible

1541
00:51:30,870 --> 00:51:28,319
you know a couple weeks which seems to

1542
00:51:32,710 --> 00:51:30,880
be impossible right now

1543
00:51:34,150 --> 00:51:32,720
or have some serious radiation

1544
00:51:35,910 --> 00:51:34,160
protection

1545
00:51:38,230 --> 00:51:35,920
and that's complicated because these

1546
00:51:39,030 --> 00:51:38,240
cosmic rays are they're atomic bits of

1547
00:51:41,349 --> 00:51:39,040
matter

1548
00:51:43,190 --> 00:51:41,359
from beyond the solar system um from

1549
00:51:44,950 --> 00:51:43,200
star explosions moving it

1550
00:51:46,630 --> 00:51:44,960
nearly the speed of light they're very

1551
00:51:49,430 --> 00:51:46,640
hard to um

1552
00:51:50,870 --> 00:51:49,440
to protect yourself from on earth we

1553
00:51:53,030 --> 00:51:50,880
have a magnetosphere

1554
00:51:55,109 --> 00:51:53,040
and it's a because these particles are

1555
00:51:56,870 --> 00:51:55,119
charged they approach our magnetosphere

1556
00:51:59,430 --> 00:51:56,880
and then go around it they don't go

1557
00:52:01,430 --> 00:51:59,440
into it um so but when you're on a

1558
00:52:03,349 --> 00:52:01,440
spaceship you don't have much protection

1559
00:52:05,349 --> 00:52:03,359
now a bit of a hope here is something

1560
00:52:08,069 --> 00:52:05,359
called boron nitrite

1561
00:52:10,150 --> 00:52:08,079
nanotubes um this can be made into this

1562
00:52:13,589 --> 00:52:10,160
fluffy material you see here you can

1563
00:52:15,349 --> 00:52:13,599

insulate the spacecraft with it uh

1564
00:52:17,589 --> 00:52:15,359
and you can even insulate your clothes

1565
00:52:19,190 --> 00:52:17,599
with it and boron is interesting it's a

1566
00:52:21,670 --> 00:52:19,200
good absorber of what we call

1567
00:52:23,109 --> 00:52:21,680
secondary cosmic rays so so when that

1568
00:52:26,230 --> 00:52:23,119
cosmic ray hits the

1569
00:52:27,910 --> 00:52:26,240
whole of the space uh uh craft it'll

1570
00:52:30,710 --> 00:52:27,920
create a cascade of

1571
00:52:32,950 --> 00:52:30,720
of slightly less energetic secondary

1572
00:52:35,190 --> 00:52:32,960
particles sort of like shrapnel

1573
00:52:36,150 --> 00:52:35,200
um and the boron is very good at

1574
00:52:38,950 --> 00:52:36,160
capturing

1575
00:52:39,510 --> 00:52:38,960
that uh those secondary particles so

1576
00:52:41,430 --> 00:52:39,520
that's

1577
00:52:43,670 --> 00:52:41,440
some hope some protection but it is a

1578
00:52:45,430 --> 00:52:43,680
dicey proposition

1579
00:52:47,030 --> 00:52:45,440
and the other problem is the gravity i

1580
00:52:48,950 --> 00:52:47,040
keep on getting back to gravity

1581
00:52:50,950 --> 00:52:48,960
i think it's tantamount to homicide

1582
00:52:54,390 --> 00:52:50,960
really to send astronauts

1583
00:52:55,030 --> 00:52:54,400
uh to mars like the plan is in zero

1584
00:52:56,710 --> 00:52:55,040
gravity

1585
00:52:58,710 --> 00:52:56,720
i mean we know what nine months on the

1586
00:53:00,309 --> 00:52:58,720
international space station is like you

1587
00:53:01,510 --> 00:53:00,319
lose all control of your muscles when

1588
00:53:02,790 --> 00:53:01,520

you get back to earth

1589
00:53:04,549 --> 00:53:02,800
you have to be carried out of the

1590
00:53:06,549 --> 00:53:04,559
spacecraft who's going to lift you out

1591
00:53:09,030 --> 00:53:06,559
of the spacecraft once you get to mars

1592
00:53:10,150 --> 00:53:09,040
for the first people to get there um so

1593
00:53:12,549 --> 00:53:10,160
you know i've been talking about this

1594
00:53:14,549 --> 00:53:12,559
artificial gravity concept

1595
00:53:16,069 --> 00:53:14,559
and you might know it and you know if

1596
00:53:17,829 --> 00:53:16,079
you have it's like

1597
00:53:19,270 --> 00:53:17,839
when you have water in a bucket right

1598
00:53:21,349 --> 00:53:19,280
and if you spin

1599
00:53:23,349 --> 00:53:21,359
that bucket over and over around your

1600
00:53:25,190 --> 00:53:23,359
head the water is not going to fall out

1601
00:53:27,109 --> 00:53:25,200
as long as you keep on moving it fast

1602
00:53:28,950 --> 00:53:27,119
enough right it's as if an artificial

1603
00:53:30,470 --> 00:53:28,960
gravity is pinning the water to the

1604
00:53:33,270 --> 00:53:30,480
bottom of the bucket

1605
00:53:34,150 --> 00:53:33,280
well that can happen in space too and

1606
00:53:37,990 --> 00:53:34,160
it's not

1607
00:53:39,349 --> 00:53:38,000
that complicated to try to do this if we

1608
00:53:41,270 --> 00:53:39,359
ever wanted to test it

1609
00:53:42,390 --> 00:53:41,280
imagine a spacecraft that once it gets

1610
00:53:45,589 --> 00:53:42,400
out in the space

1611
00:53:46,309 --> 00:53:45,599
it separates uh and it gets remains

1612
00:53:48,950 --> 00:53:46,319
tethered

1613
00:53:50,549 --> 00:53:48,960

by a cable that you see here maybe um

1614
00:53:52,710 --> 00:53:50,559
it's not to scale but you know

1615
00:53:54,390 --> 00:53:52,720
like a kilometer or two kilometers long

1616
00:53:57,190 --> 00:53:54,400
the longer the better

1617
00:53:59,030 --> 00:53:57,200
and then you fire the engine so that one

1618
00:54:01,190 --> 00:53:59,040
starts going over the other

1619
00:54:03,430 --> 00:54:01,200
all the way to mars you can create an

1620
00:54:05,349 --> 00:54:03,440
artificial gravity of earth like gravity

1621
00:54:06,230 --> 00:54:05,359
or even mars like gravity or somewhere

1622
00:54:07,829 --> 00:54:06,240
in between

1623
00:54:09,510 --> 00:54:07,839
you could be doing that all the way to

1624
00:54:11,349 --> 00:54:09,520
mars um

1625
00:54:13,670 --> 00:54:11,359
yeah it's an engineering feat but it's

1626
00:54:15,109 --> 00:54:13,680
something it can be done and probably

1627
00:54:17,109 --> 00:54:15,119
has to be done if we're ever going to

1628
00:54:18,950 --> 00:54:17,119
travel through the universe uh through

1629
00:54:22,870 --> 00:54:18,960
the solar system anyway

1630
00:54:25,829 --> 00:54:22,880
um okay landing on mars that's a bit

1631
00:54:27,109 --> 00:54:25,839
a dicey proposition we saw mars 2020

1632
00:54:29,430 --> 00:54:27,119
land it was only a

1633
00:54:30,790 --> 00:54:29,440
a ton and uh you know we were there's a

1634
00:54:31,990 --> 00:54:30,800
big nail biter but some of these

1635
00:54:32,950 --> 00:54:32,000
missions that we're talking about of

1636
00:54:36,150 --> 00:54:32,960
sending humans

1637
00:54:37,910 --> 00:54:36,160
we're talking 20 uh 20 tons and elon

1638
00:54:39,670 --> 00:54:37,920

musk wants to send these massive

1639
00:54:41,430 --> 00:54:39,680
spacecraft that are 100 tons

1640
00:54:43,109 --> 00:54:41,440
we don't know how to land that on mars

1641
00:54:45,910 --> 00:54:43,119
without uh crashing

1642
00:54:48,150 --> 00:54:45,920
so that's why mars is really our

1643
00:54:49,750 --> 00:54:48,160
destination is you know 20 years down

1644
00:54:51,589 --> 00:54:49,760
the line here we have to figure that out

1645
00:54:54,390 --> 00:54:51,599
before we go

1646
00:54:56,230 --> 00:54:54,400
um but here's an idea uh it may be that

1647
00:54:58,309 --> 00:54:56,240
if we're gonna send lots of people to

1648
00:55:00,789 --> 00:54:58,319
mars thousands of people

1649
00:55:01,589 --> 00:55:00,799
uh the way to go maybe with like a ferry

1650
00:55:03,589 --> 00:55:01,599
system

1651
00:55:04,950 --> 00:55:03,599
uh these ferries that actually stay in

1652
00:55:07,109 --> 00:55:04,960
space that never land

1653
00:55:08,390 --> 00:55:07,119
on earth or mars in this picture you can

1654
00:55:11,030 --> 00:55:08,400
see the sun in the middle

1655
00:55:12,150 --> 00:55:11,040
and this ferry would be something um

1656
00:55:14,309 --> 00:55:12,160
that

1657
00:55:16,470 --> 00:55:14,319
you know it'll take you closer to mars

1658
00:55:18,230 --> 00:55:16,480
and then closer to earth closer to mars

1659
00:55:18,950 --> 00:55:18,240
and closer to earth around and around

1660
00:55:21,589 --> 00:55:18,960
again

1661
00:55:23,109 --> 00:55:21,599
so when that ferry comes you catch it

1662
00:55:26,069 --> 00:55:23,119
you you jump up

1663
00:55:26,710 --> 00:55:26,079

uh with a shuttle and and get on to that

1664
00:55:28,630 --> 00:55:26,720
ferry

1665
00:55:30,630 --> 00:55:28,640
and then in this trajectory you can get

1666
00:55:33,030 --> 00:55:30,640
to mars in about five months

1667
00:55:33,990 --> 00:55:33,040
which is you know the fastest yet right

1668
00:55:37,270 --> 00:55:34,000
um and then you

1669
00:55:38,309 --> 00:55:37,280
kind of hop off light not with a big

1670
00:55:39,829 --> 00:55:38,319
spacecraft

1671
00:55:41,430 --> 00:55:39,839
you can throw your cargo down there it

1672
00:55:41,990 --> 00:55:41,440
doesn't matter if that crash and burns

1673
00:55:44,150 --> 00:55:42,000
but

1674
00:55:46,150 --> 00:55:44,160
um you know you you get off as lightly

1675
00:55:48,470 --> 00:55:46,160
as possible and get down to mars

1676
00:55:50,230 --> 00:55:48,480
and then uh without any people the

1677
00:55:51,829 --> 00:55:50,240
shuttle returns at this point the

1678
00:55:53,349 --> 00:55:51,839
planets are farther apart so it's going

1679
00:55:53,990 --> 00:55:53,359
to be about a year and a half to get

1680
00:55:57,910 --> 00:55:54,000
back

1681
00:56:00,829 --> 00:55:57,920
more people can get on the ferry

1682
00:56:02,470 --> 00:56:00,839
or two ferries that might be the way to

1683
00:56:04,549 --> 00:56:02,480
go um

1684
00:56:05,910 --> 00:56:04,559
okay so now here's the problem with mars

1685
00:56:09,030 --> 00:56:05,920
it's beautiful

1686
00:56:11,670 --> 00:56:09,040
that's a big problem

1687
00:56:12,549 --> 00:56:11,680
looks like arizona it's so beautiful

1688
00:56:15,670 --> 00:56:12,559

that it

1689
00:56:16,069 --> 00:56:15,680
looks easy and it's not easy to live

1690
00:56:17,670 --> 00:56:16,079
there

1691
00:56:19,589 --> 00:56:17,680
it's not something you can conquer so

1692
00:56:20,069 --> 00:56:19,599
easily there are two problems with this

1693
00:56:23,030 --> 00:56:20,079
um

1694
00:56:23,829 --> 00:56:23,040
this photograph one uh is our old friend

1695
00:56:26,390 --> 00:56:23,839
uh

1696
00:56:27,270 --> 00:56:26,400
plants under glass but for slightly

1697
00:56:29,109 --> 00:56:27,280
different reasons

1698
00:56:31,349 --> 00:56:29,119
um the sunlight is powerful enough it's

1699
00:56:32,549 --> 00:56:31,359
like the angle of the sun in scandinavia

1700
00:56:34,630 --> 00:56:32,559
once you're on mars

1701
00:56:36,710 --> 00:56:34,640
but it's the dust storms that's a real

1702
00:56:38,950 --> 00:56:36,720
problem the dust storms on mars

1703
00:56:40,150 --> 00:56:38,960
block out the sun for weeks or months at

1704
00:56:42,230 --> 00:56:40,160
a time

1705
00:56:43,990 --> 00:56:42,240
it's such a problem that actually solar

1706
00:56:46,870 --> 00:56:44,000
panels are not reliable you have to have

1707
00:56:48,549 --> 00:56:46,880
a backup energy source on mars because

1708
00:56:51,270 --> 00:56:48,559
the sun will blot out the sun

1709
00:56:51,589 --> 00:56:51,280
i mean the the dust will blot out the

1710
00:56:54,309 --> 00:56:51,599
sun

1711
00:56:56,069 --> 00:56:54,319
is that simple so if if that's if you

1712
00:56:58,150 --> 00:56:56,079
can't rely on solar panels you can't

1713
00:56:59,430 --> 00:56:58,160

rely on photosynthesis

1714
00:57:01,750 --> 00:56:59,440
if you want food you're going to have to

1715
00:57:04,150 --> 00:57:01,760
grow it under leds

1716
00:57:05,349 --> 00:57:04,160
the other problem is this guy over here

1717
00:57:07,430 --> 00:57:05,359
in this space suit

1718
00:57:09,030 --> 00:57:07,440
that looks pretty comfortable it's kind

1719
00:57:10,710 --> 00:57:09,040
of form-fitting you can even see his

1720
00:57:12,390 --> 00:57:10,720
butt a little bit you know

1721
00:57:14,549 --> 00:57:12,400
and uh it looks like he's just out there

1722
00:57:16,470 --> 00:57:14,559
for a hike looks pretty cool

1723
00:57:18,710 --> 00:57:16,480
but it's not going to be that way

1724
00:57:19,190 --> 00:57:18,720
unfortunately here's another space suit

1725
00:57:22,470 --> 00:57:19,200
this is an

1726
00:57:25,910 --> 00:57:22,480
engineer at mit um uh

1727
00:57:27,190 --> 00:57:25,920
deva can't remember her last name um she

1728
00:57:30,150 --> 00:57:27,200
she's been trying to

1729
00:57:32,630 --> 00:57:30,160
get a a more comfortable spacesuit and

1730
00:57:35,349 --> 00:57:32,640
it looks great it was built by an

1731
00:57:36,470 --> 00:57:35,359
italian design firm but it's really not

1732
00:57:37,589 --> 00:57:36,480
that practical

1733
00:57:39,750 --> 00:57:37,599
because you have to remember the

1734
00:57:42,549 --> 00:57:39,760
atmospheric pressure on mars

1735
00:57:43,270 --> 00:57:42,559
is only six millibars which is pretty

1736
00:57:45,750 --> 00:57:43,280
close to the

1737
00:57:47,990 --> 00:57:45,760
moon's zero millibars and not even close

1738
00:57:50,950 --> 00:57:48,000

to the earth's 1 000 millibar

1739
00:57:52,470 --> 00:57:50,960
of pressure so our space suits on mars

1740
00:57:54,230 --> 00:57:52,480
are probably going to look like a lot

1741
00:57:57,510 --> 00:57:54,240
like we have on the moon

1742
00:57:58,789 --> 00:57:57,520
these big bulky things where it's hard

1743
00:58:01,510 --> 00:57:58,799
to grab everything

1744
00:58:03,349 --> 00:58:01,520
and that's a shame you know that's a big

1745
00:58:04,630 --> 00:58:03,359
problem we would have to overcome

1746
00:58:07,750 --> 00:58:04,640
otherwise it's not going to be much fun

1747
00:58:10,390 --> 00:58:07,760
to be on mars in those big bulky

1748
00:58:11,270 --> 00:58:10,400
um and the same radiation problem really

1749
00:58:13,589 --> 00:58:11,280
on the moon

1750
00:58:15,430 --> 00:58:13,599
uh with your um habitats it might not

1751
00:58:15,829 --> 00:58:15,440
have to be in a covered with regolith

1752
00:58:18,150 --> 00:58:15,839
though

1753
00:58:20,390 --> 00:58:18,160
actually because mars has water you

1754
00:58:23,750 --> 00:58:20,400
could use the martian water

1755
00:58:25,750 --> 00:58:23,760
to fill a membrane uh

1756
00:58:27,829 --> 00:58:25,760
and use the water as to protection

1757
00:58:30,870 --> 00:58:27,839
waters actually protects better

1758
00:58:31,990 --> 00:58:30,880
you know per volume than um the regolith

1759
00:58:34,069 --> 00:58:32,000
because it's denser

1760
00:58:35,750 --> 00:58:34,079
so that would be a good way to protect

1761
00:58:37,670 --> 00:58:35,760
yourself um

1762
00:58:39,430 --> 00:58:37,680
but it will be somewhat of a translucent

1763
00:58:41,910 --> 00:58:39,440

existence looking out

1764
00:58:42,950 --> 00:58:41,920
uh my idea again not that anyone's

1765
00:58:45,030 --> 00:58:42,960
listening to me

1766
00:58:47,270 --> 00:58:45,040
um but i think you should build a

1767
00:58:49,910 --> 00:58:47,280
habitat into the side of a mountain

1768
00:58:51,349 --> 00:58:49,920
like the northern slope on the uh

1769
00:58:54,069 --> 00:58:51,359
northern hemisphere

1770
00:58:55,990 --> 00:58:54,079
that way you know the mountain would

1771
00:58:57,190 --> 00:58:56,000
block out 100 percent of the solar

1772
00:58:59,750 --> 00:58:57,200
radiation

1773
00:59:01,349 --> 00:58:59,760
and mars itself would be protecting from

1774
00:59:03,510 --> 00:59:01,359
the cosmic rays

1775
00:59:05,190 --> 00:59:03,520
coming from all different angles this

1776
00:59:07,510 --> 00:59:05,200
set for the front

1777
00:59:09,750 --> 00:59:07,520
and but this way you could have a big

1778
00:59:10,470 --> 00:59:09,760
nice window so you can see beautiful

1779
00:59:12,789 --> 00:59:10,480
mars

1780
00:59:14,309 --> 00:59:12,799
that's a huge psychological lift imagine

1781
00:59:15,190 --> 00:59:14,319
going all the way to mars and living

1782
00:59:17,910 --> 00:59:15,200
underground

1783
00:59:19,829 --> 00:59:17,920
or in some translucent world that's and

1784
00:59:22,390 --> 00:59:19,839
because you can't go outside that often

1785
00:59:24,630 --> 00:59:22,400
because of the radiation so you need a

1786
00:59:26,470 --> 00:59:24,640
real psychological lift to be there

1787
00:59:27,910 --> 00:59:26,480
this is what earth looks like from mars

1788
00:59:30,870 --> 00:59:27,920

so it's pretty lonely

1789
00:59:32,309 --> 00:59:30,880
um when you're on mars here's another

1790
00:59:36,630 --> 00:59:32,319
kind of psychological list

1791
00:59:39,270 --> 00:59:36,640
uh left generating oxygen um

1792
00:59:41,349 --> 00:59:39,280
so uh you know there's an instrument on

1793
00:59:42,870 --> 00:59:41,359
mars now called uh moxie

1794
00:59:45,349 --> 00:59:42,880
uh that was just there with the mars

1795
00:59:46,150 --> 00:59:45,359
2020 rover and that's going to generate

1796
00:59:48,549 --> 00:59:46,160
oxygen

1797
00:59:49,589 --> 00:59:48,559
by pulling in carbon dioxide from the

1798
00:59:52,710 --> 00:59:49,599
atmosphere

1799
00:59:56,230 --> 00:59:52,720
and producing oxygen from that

1800
00:59:57,750 --> 00:59:56,240
of the o in the carbon dioxide um

1801
01:00:00,789 --> 00:59:57,760
and that's probably our main way to

1802
01:00:02,390 --> 01:00:00,799
generate oxygen on mars but here's a

1803
01:00:04,069 --> 01:00:02,400
compliment to that this is being built

1804
01:00:04,870 --> 01:00:04,079
by the university of arizona i went out

1805
01:00:07,190 --> 01:00:04,880
to visit them

1806
01:00:07,910 --> 01:00:07,200
when i was writing my book and this is

1807
01:00:10,870 --> 01:00:07,920
lightweight

1808
01:00:11,750 --> 01:00:10,880
it's expandable um and it's made of

1809
01:00:15,190 --> 01:00:11,760
aluminum

1810
01:00:18,630 --> 01:00:15,200
and using leds they are growing um

1811
01:00:21,109 --> 01:00:18,640
and harvesting 1 000 kilocalories of

1812
01:00:22,549 --> 01:00:21,119
food every day and more importantly

1813
01:00:25,109 --> 01:00:22,559

generating 100

1814
01:00:26,950 --> 01:00:25,119
of an adult's oxygen needs so that would

1815
01:00:28,230 --> 01:00:26,960
be pretty cool that everyone on mars

1816
01:00:30,150 --> 01:00:28,240
gets one of uh

1817
01:00:33,109 --> 01:00:30,160
one of these things i like to say you

1818
01:00:36,390 --> 01:00:33,119
can have your air and eat it too

1819
01:00:37,190 --> 01:00:36,400
um because uh farming is gonna be

1820
01:00:39,829 --> 01:00:37,200
difficult

1821
01:00:40,630 --> 01:00:39,839
here's mark watney from the movie the

1822
01:00:43,030 --> 01:00:40,640
martian

1823
01:00:43,670 --> 01:00:43,040
great movie great book i'm not ripping

1824
01:00:46,789 --> 01:00:43,680
it apart

1825
01:00:48,710 --> 01:00:46,799
uh a sensational uh book uh but there

1826
01:00:50,470 --> 01:00:48,720
are two things wrong with this picture

1827
01:00:51,750 --> 01:00:50,480
um one is a bit of a nitpick you know

1828
01:00:52,630 --> 01:00:51,760
tell you truth because i you know i grow

1829
01:00:54,950 --> 01:00:52,640
potatoes

1830
01:00:56,390 --> 01:00:54,960
um he probably wouldn't be able to do it

1831
01:00:57,910 --> 01:00:56,400
under these artificial lights that he

1832
01:00:59,510 --> 01:00:57,920
has they're not strong enough probably

1833
01:01:01,270 --> 01:00:59,520
be able to grow the greens but not the

1834
01:01:03,990 --> 01:01:01,280
big tubers that he has

1835
01:01:05,910 --> 01:01:04,000
again a nitpick but the real issue is

1836
01:01:09,030 --> 01:01:05,920
that the soil is toxic

1837
01:01:10,309 --> 01:01:09,040
unfortunately um that it contains

1838
01:01:12,789 --> 01:01:10,319

perchlorates

1839
01:01:14,950 --> 01:01:12,799
so the potato growing in it would absorb

1840
01:01:15,670 --> 01:01:14,960
the chlorites and whitney eating those

1841
01:01:17,430 --> 01:01:15,680
potatoes

1842
01:01:19,109 --> 01:01:17,440
would probably die after a couple months

1843
01:01:22,710 --> 01:01:19,119
of eating all those dichlorides

1844
01:01:24,710 --> 01:01:22,720
uh so if you're gonna farm directly into

1845
01:01:27,030 --> 01:01:24,720
the regolith you're going to have to

1846
01:01:27,910 --> 01:01:27,040
clear out those somehow which is

1847
01:01:29,190 --> 01:01:27,920
feasible but

1848
01:01:31,910 --> 01:01:29,200
when you're talking about acres of

1849
01:01:35,510 --> 01:01:31,920
farmland it'll be very tedious

1850
01:01:38,470 --> 01:01:35,520
so probably best to grow hydroponically

1851
01:01:39,670 --> 01:01:38,480
aquaponically on mars but to tell you

1852
01:01:40,390 --> 01:01:39,680
the truth everything's going to be

1853
01:01:43,109 --> 01:01:40,400
difficult

1854
01:01:45,349 --> 01:01:43,119
on mars that's why it's it's so far away

1855
01:01:47,349 --> 01:01:45,359
20 30 years before we get there

1856
01:01:50,150 --> 01:01:47,359
major advancements we need on all types

1857
01:01:53,030 --> 01:01:50,160
of uh aspects we can talk about later

1858
01:01:53,430 --> 01:01:53,040
but here's an end game for some like um

1859
01:01:55,589 --> 01:01:53,440
uh

1860
01:01:57,910 --> 01:01:55,599
elon musk to have thousands of people on

1861
01:01:59,270 --> 01:01:57,920
mars uh definitely feasible from an

1862
01:02:01,190 --> 01:01:59,280
engineering point of view

1863
01:02:03,109 --> 01:02:01,200

definitely feasible from an emotional

1864
01:02:05,190 --> 01:02:03,119
point of view i can see people wanting

1865
01:02:09,029 --> 01:02:05,200
to do this i would want to go there

1866
01:02:10,950 --> 01:02:09,039
absolutely it's the economic issue

1867
01:02:12,710 --> 01:02:10,960
uh you know is this feasible from an

1868
01:02:14,789 --> 01:02:12,720
economic point of view because what you

1869
01:02:16,870 --> 01:02:14,799
see here these thousands of people

1870
01:02:18,150 --> 01:02:16,880
when you think about it they're a bunch

1871
01:02:19,829 --> 01:02:18,160
of moochers aren't they

1872
01:02:21,910 --> 01:02:19,839
you know i mean what are they giving

1873
01:02:24,789 --> 01:02:21,920
back to earth what you're seeing here

1874
01:02:25,670 --> 01:02:24,799
is a trillions of dollars in one-way

1875
01:02:27,829 --> 01:02:25,680
investment

1876
01:02:29,270 --> 01:02:27,839
this is a migration like never before as

1877
01:02:31,510 --> 01:02:29,280
i was saying i mean this is not

1878
01:02:33,349 --> 01:02:31,520
a world new world scenario where the new

1879
01:02:36,390 --> 01:02:33,359
world can send back

1880
01:02:38,870 --> 01:02:36,400
timber and fur and fish and

1881
01:02:40,230 --> 01:02:38,880
and have some real trade going on mars

1882
01:02:42,390 --> 01:02:40,240
really has very little

1883
01:02:43,270 --> 01:02:42,400
value aside from some novelty goods to

1884
01:02:45,430 --> 01:02:43,280
trade back

1885
01:02:46,630 --> 01:02:45,440
so this is pure one-way investment

1886
01:02:49,670 --> 01:02:46,640
funded by

1887
01:02:52,309 --> 01:02:49,680
i guess earth taxpayers uh for

1888
01:02:52,870 --> 01:02:52,319

trillions of dollars and how are we

1889
01:02:55,510 --> 01:02:52,880
gonna

1890
01:02:57,910 --> 01:02:55,520
tolerate that just to send a few

1891
01:03:00,789 --> 01:02:57,920
thousand lucky people to mars

1892
01:03:01,349 --> 01:03:00,799
uh for what a grand human experiment you

1893
01:03:03,349 --> 01:03:01,359
know

1894
01:03:04,630 --> 01:03:03,359
that sounds nice but uh how practical is

1895
01:03:06,710 --> 01:03:04,640
it i have to be honest

1896
01:03:07,910 --> 01:03:06,720
but let's let's put some numbers on this

1897
01:03:10,870 --> 01:03:07,920
um you know this um

1898
01:03:12,150 --> 01:03:10,880
this idea uh of of of when to go comes

1899
01:03:14,230 --> 01:03:12,160
from um

1900
01:03:16,789 --> 01:03:14,240
uh freeman tyson a physicist who just

1901
01:03:17,430 --> 01:03:16,799
died a few years ago so he figured you

1902
01:03:19,270 --> 01:03:17,440
know between

1903
01:03:20,950 --> 01:03:19,280
columbus and the mayflower you know that

1904
01:03:24,150 --> 01:03:20,960
first big voyage and then

1905
01:03:26,230 --> 01:03:24,160
the migration 128 years passed

1906
01:03:27,990 --> 01:03:26,240
and a lot of shipping technology uh

1907
01:03:31,829 --> 01:03:28,000
happened during that period

1908
01:03:36,549 --> 01:03:31,839
well if you view sputnik as kind of that

1909
01:03:37,109 --> 01:03:36,559
first voyage uh and you add 128 years to

1910
01:03:39,029 --> 01:03:37,119
that

1911
01:03:41,109 --> 01:03:39,039
we're talking about maybe a colonist

1912
01:03:42,789 --> 01:03:41,119
maybe people can go there by 2085.

1913
01:03:44,150 --> 01:03:42,799

that's curiously an interesting date

1914
01:03:44,630 --> 01:03:44,160
maybe that would be the target date

1915
01:03:47,029 --> 01:03:44,640
where

1916
01:03:48,870 --> 01:03:47,039
uh migration could take place on mars if

1917
01:03:51,190 --> 01:03:48,880
the gravity permits it

1918
01:03:53,029 --> 01:03:51,200
but now think about the cost though that

1919
01:03:54,150 --> 01:03:53,039
mayflower voyage cost about seven and a

1920
01:03:56,390 --> 01:03:54,160
half

1921
01:03:57,910 --> 01:03:56,400
years worth of wages and right now to

1922
01:03:59,829 --> 01:03:57,920
get to mars they're talking about ten

1923
01:04:01,349 --> 01:03:59,839
thousand dollars worth of wages

1924
01:04:03,910 --> 01:04:01,359
so you're going to have to get that cost

1925
01:04:05,750 --> 01:04:03,920
way down you know if we could get mars

1926
01:04:07,109 --> 01:04:05,760
down to a voyage down to a million

1927
01:04:09,750 --> 01:04:07,119
dollars

1928
01:04:11,510 --> 01:04:09,760
about 10 years worth of wages maybe you

1929
01:04:13,029 --> 01:04:11,520
could have migration going on but it's

1930
01:04:14,150 --> 01:04:13,039
going to come down to the money that's

1931
01:04:16,950 --> 01:04:14,160
the economic

1932
01:04:19,589 --> 01:04:16,960
that's the reality of it isn't it okay

1933
01:04:21,910 --> 01:04:19,599
people ask me about terraforming mars

1934
01:04:23,430 --> 01:04:21,920
and it's difficult and we can talk about

1935
01:04:25,029 --> 01:04:23,440
that in the question and answers it's

1936
01:04:27,750 --> 01:04:25,039
not science fiction but

1937
01:04:29,270 --> 01:04:27,760
the the the main way to do this of

1938
01:04:31,910 --> 01:04:29,280

course is to liberate all that

1939
01:04:32,870 --> 01:04:31,920
carbon dry ice that carbon dioxide

1940
01:04:35,829 --> 01:04:32,880
underneath the

1941
01:04:37,750 --> 01:04:35,839
foot get it up into the sky for an

1942
01:04:38,150 --> 01:04:37,760
atmosphere but it's just not enough of

1943
01:04:39,430 --> 01:04:38,160
it

1944
01:04:41,349 --> 01:04:39,440
and you're going to have an atmosphere

1945
01:04:43,190 --> 01:04:41,359
that's only about 100 millibar that's

1946
01:04:45,190 --> 01:04:43,200
still not suitable for any kind of

1947
01:04:46,870 --> 01:04:45,200
higher level life so you'll never be

1948
01:04:48,309 --> 01:04:46,880
able to run around naked on mars which

1949
01:04:50,950 --> 01:04:48,319
of course would be my goal

1950
01:04:52,630 --> 01:04:50,960
uh and that's a real bummer um you know

1951
01:04:53,510 --> 01:04:52,640
at that point it becomes science fiction

1952
01:04:57,270 --> 01:04:53,520
to import

1953
01:05:00,150 --> 01:04:57,280
volatiles import uh nitrogen from uh

1954
01:05:01,990 --> 01:05:00,160
uranus and all that stuff and skim an

1955
01:05:03,430 --> 01:05:02,000
asteroid over the top of the atmosphere

1956
01:05:04,390 --> 01:05:03,440
to liberate stuff you know good luck

1957
01:05:07,109 --> 01:05:04,400
with that

1958
01:05:07,990 --> 01:05:07,119
um so it's a shame but it's a good it's

1959
01:05:11,270 --> 01:05:08,000
worth trying because

1960
01:05:12,950 --> 01:05:11,280
every bit of millibar uh will help uh

1961
01:05:16,150 --> 01:05:12,960
foster some kind of life that could grow

1962
01:05:19,190 --> 01:05:16,160
naturally on mars i'm all for it

1963
01:05:22,789 --> 01:05:19,200

um but that's it my friends

1964
01:05:24,470 --> 01:05:22,799
uh that's mars with its um with its uh

1965
01:05:26,069 --> 01:05:24,480
relatively high gravity the only thing

1966
01:05:26,789 --> 01:05:26,079
that comes close to it is mercury with

1967
01:05:29,750 --> 01:05:26,799
38

1968
01:05:30,710 --> 01:05:29,760
gravity uh similar to mars uh and you

1969
01:05:32,549 --> 01:05:30,720
could live on that

1970
01:05:33,990 --> 01:05:32,559
you know there's a it's the hottest

1971
01:05:34,549 --> 01:05:34,000
planet in the universe but the face

1972
01:05:38,309 --> 01:05:34,559
that's not

1973
01:05:40,309 --> 01:05:38,319
the coldest and there's a line in

1974
01:05:42,630 --> 01:05:40,319
between that if you could stay there

1975
01:05:44,630 --> 01:05:42,640
as it's rotating you could stay in a

1976
01:05:47,109 --> 01:05:44,640
dawn or a dusk you could live on mercury

1977
01:05:48,230 --> 01:05:47,119
uh why i don't know but you can and

1978
01:05:49,589 --> 01:05:48,240
venus you could actually live

1979
01:05:53,109 --> 01:05:49,599
comfortably on venus

1980
01:05:55,430 --> 01:05:53,119
above the atmosphere in temperature

1981
01:05:56,950 --> 01:05:55,440
pressure and gravity similar to the

1982
01:05:58,390 --> 01:05:56,960
earth it's the most comfortable place in

1983
01:06:01,029 --> 01:05:58,400
the solar system

1984
01:06:02,309 --> 01:06:01,039
around a planet but again why would you

1985
01:06:03,910 --> 01:06:02,319
do this

1986
01:06:05,270 --> 01:06:03,920
it's actually not an accurate picture

1987
01:06:06,870 --> 01:06:05,280
here from nasa because you'll probably

1988
01:06:08,390 --> 01:06:06,880

be in the cloud so you wouldn't be able

1989
01:06:11,589 --> 01:06:08,400
to see above and below you

1990
01:06:12,950 --> 01:06:11,599
it's kind of a pretty poor existence uh

1991
01:06:15,589 --> 01:06:12,960
you could live inside an

1992
01:06:17,190 --> 01:06:15,599
asteroid you know some of these things

1993
01:06:19,029 --> 01:06:17,200
are size of a mountain

1994
01:06:20,630 --> 01:06:19,039
and you could carve that out and have a

1995
01:06:23,990 --> 01:06:20,640
rotating habitat

1996
01:06:26,549 --> 01:06:24,000
inside there and with a kick with some

1997
01:06:27,589 --> 01:06:26,559
fusion fuel you could kick yourself off

1998
01:06:29,910 --> 01:06:27,599
and travel to

1999
01:06:31,589 --> 01:06:29,920
alpha centauri at 10 percent light speed

2000
01:06:32,150 --> 01:06:31,599
so you could technically get there in 40

2001
01:06:35,430 --> 01:06:32,160
years

2002
01:06:37,430 --> 01:06:35,440
that's a generation that's a lifetime um

2003
01:06:39,430 --> 01:06:37,440
that's pretty exciting um we can talk

2004
01:06:41,190 --> 01:06:39,440
about that and the questions and answers

2005
01:06:42,870 --> 01:06:41,200
but every place else you know just gets

2006
01:06:46,950 --> 01:06:42,880
harder and harder with

2007
01:06:48,789 --> 01:06:46,960
radiation and extreme cold um

2008
01:06:51,190 --> 01:06:48,799
you know actually it'd be fun to look

2009
01:06:53,910 --> 01:06:51,200
for life out there especially on um

2010
01:06:55,430 --> 01:06:53,920
enceladus uh because i think that's the

2011
01:06:56,950 --> 01:06:55,440
real place that might have uh

2012
01:06:58,230 --> 01:06:56,960
life because not only is there that

2013
01:07:00,230 --> 01:06:58,240

subsurface ocean but there are

2014
01:07:02,630 --> 01:07:00,240
geothermic vents that could actually

2015
01:07:03,589 --> 01:07:02,640
provide food for any microorganisms that

2016
01:07:06,710 --> 01:07:03,599
are there

2017
01:07:08,309 --> 01:07:06,720
um i won't so i can find a way to live

2018
01:07:09,910 --> 01:07:08,319
on any of these planets some people

2019
01:07:12,230 --> 01:07:09,920
actually want to live on titan because

2020
01:07:15,190 --> 01:07:12,240
it's kind of an atmosphere

2021
01:07:15,910 --> 01:07:15,200
uh it's the only place in the uh

2022
01:07:18,230 --> 01:07:15,920
universe

2023
01:07:19,670 --> 01:07:18,240
uh solar system that has an atmosphere

2024
01:07:21,349 --> 01:07:19,680
like uh earth's

2025
01:07:23,990 --> 01:07:21,359
um so you don't need a pressure suit

2026
01:07:25,109 --> 01:07:24,000
array but you need a parka

2027
01:07:28,150 --> 01:07:25,119
pretty thick parka because you're

2028
01:07:30,390 --> 01:07:28,160
talking about a hundred minus minus 180.

2029
01:07:31,990 --> 01:07:30,400
um pluto and sharon you could you know

2030
01:07:33,510 --> 01:07:32,000
actually link those two together because

2031
01:07:35,589 --> 01:07:33,520
they always have the same face

2032
01:07:37,990 --> 01:07:35,599
to each other that would be fun to do

2033
01:07:39,510 --> 01:07:38,000
but all these crazy grand ideas

2034
01:07:41,029 --> 01:07:39,520
they don't make much sense because of

2035
01:07:43,510 --> 01:07:41,039
something

2036
01:07:45,349 --> 01:07:43,520
that isaac asimov came up with this idea

2037
01:07:47,670 --> 01:07:45,359
of terrestrial chauvinism

2038
01:07:49,270 --> 01:07:47,680

why would we live on these rocks why do

2039
01:07:50,230 --> 01:07:49,280
we have to live on a rock why wouldn't

2040
01:07:53,750 --> 01:07:50,240
we live

2041
01:07:55,589 --> 01:07:53,760
in an orbiting um habitat that has

2042
01:07:59,430 --> 01:07:55,599
artificial gravity

2043
01:08:01,430 --> 01:07:59,440
and climate control that's the logical

2044
01:08:02,710 --> 01:08:01,440
thing we're going to be doing look at

2045
01:08:04,950 --> 01:08:02,720
this place it has

2046
01:08:06,710 --> 01:08:04,960
has patio furniture for christ's sake

2047
01:08:07,349 --> 01:08:06,720
would you rather live here than on some

2048
01:08:10,069 --> 01:08:07,359
ice hut

2049
01:08:11,190 --> 01:08:10,079
in on jupiter's moon europa i mean it's

2050
01:08:12,950 --> 01:08:11,200
far more comfortable

2051
01:08:15,349 --> 01:08:12,960
and then if you're living in these kind

2052
01:08:16,470 --> 01:08:15,359
of units you could go down to the

2053
01:08:18,390 --> 01:08:16,480
planets and the moons you want to

2054
01:08:19,349 --> 01:08:18,400
explore for a few days and then get back

2055
01:08:21,749 --> 01:08:19,359
to comfort

2056
01:08:22,950 --> 01:08:21,759
this is what i think is in our future

2057
01:08:24,070 --> 01:08:22,960
you know we're going to have science

2058
01:08:26,309 --> 01:08:24,080
bases on the moon

2059
01:08:27,990 --> 01:08:26,319
we've got possible colonies on mars if

2060
01:08:29,829 --> 01:08:28,000
the gravity permits it

2061
01:08:32,070 --> 01:08:29,839
but other than that i think we're going

2062
01:08:34,550 --> 01:08:32,080
to be in orbiting habitats

2063
01:08:36,870 --> 01:08:34,560

uh so that would enable us to go to the

2064
01:08:37,430 --> 01:08:36,880
more rugged places for a few days at a

2065
01:08:39,829 --> 01:08:37,440
time

2066
01:08:42,070 --> 01:08:39,839
but not actually live in those places

2067
01:08:42,709 --> 01:08:42,080
again in the same way we don't choose to

2068
01:08:45,669 --> 01:08:42,719
live

2069
01:08:47,349 --> 01:08:45,679
on mount everest and my last point is

2070
01:08:50,630 --> 01:08:47,359
why would we want to do this

2071
01:08:54,390 --> 01:08:50,640
so i see two futures in front of us here

2072
01:08:56,470 --> 01:08:54,400
and um one is this idea

2073
01:08:58,229 --> 01:08:56,480
uh that there's no space activity that

2074
01:09:00,309 --> 01:08:58,239
we listen to these people and say why do

2075
01:09:02,470 --> 01:09:00,319
we spend billions of dollars in space

2076
01:09:05,189 --> 01:09:02,480
so if there's no more space activity

2077
01:09:08,550 --> 01:09:05,199
then this is a world of finite resources

2078
01:09:09,110 --> 01:09:08,560
and that every person born in another

2079
01:09:11,189 --> 01:09:09,120
country

2080
01:09:13,430 --> 01:09:11,199
that's your enemy that's a person who's

2081
01:09:14,789 --> 01:09:13,440
going to steal your resources away

2082
01:09:16,470 --> 01:09:14,799
and there's lots of people out there

2083
01:09:18,950 --> 01:09:16,480
there are people in these countries

2084
01:09:21,030 --> 01:09:18,960
of course they want to drive they want

2085
01:09:22,709 --> 01:09:21,040
to have cars they want to have iphones

2086
01:09:24,309 --> 01:09:22,719
they want to have these materials

2087
01:09:25,829 --> 01:09:24,319
and there's going to be a constant fight

2088
01:09:27,110 --> 01:09:25,839

over these kind of resources that

2089
01:09:29,430 --> 01:09:27,120
produce these things

2090
01:09:31,749 --> 01:09:29,440
that's one kind of future the other

2091
01:09:32,149 --> 01:09:31,759
future is this daily access to space to

2092
01:09:35,110 --> 01:09:32,159
tap

2093
01:09:36,229 --> 01:09:35,120
in to the infinite resources and if we

2094
01:09:38,229 --> 01:09:36,239
could do that

2095
01:09:39,269 --> 01:09:38,239
that means every person born on this

2096
01:09:41,990 --> 01:09:39,279
planet

2097
01:09:43,749 --> 01:09:42,000
is a resource himself for herself that

2098
01:09:44,470 --> 01:09:43,759
they can contribute to this wealth of

2099
01:09:46,950 --> 01:09:44,480
knowledge

2100
01:09:47,669 --> 01:09:46,960
to make life better so that's why i'm in

2101
01:09:50,950 --> 01:09:47,679
favor

2102
01:09:54,950 --> 01:09:50,960
of space exploration to make life

2103
01:09:58,630 --> 01:09:54,960
on earth better for all of us

2104
01:10:01,990 --> 01:09:58,640
so that's it thank you

2105
01:10:03,750 --> 01:10:02,000
for your time let me stop

2106
01:10:08,070 --> 01:10:03,760
sharing frank gave me instructions to

2107
01:10:13,510 --> 01:10:11,430
oh thank you um the you brought up a

2108
01:10:16,870 --> 01:10:13,520
tremendous number of

2109
01:10:18,149 --> 01:10:16,880
points um i really liked um your

2110
01:10:20,149 --> 01:10:18,159
comments in the beginning

2111
01:10:22,950 --> 01:10:20,159
that were sort of taking the manifest

2112
01:10:23,590 --> 01:10:22,960
destiny type idea of why we would go out

2113
01:10:25,669 --> 01:10:23,600

to space

2114
01:10:26,950 --> 01:10:25,679
rather than the because it's absolutely

2115
01:10:29,350 --> 01:10:26,960
necessary to save

2116
01:10:29,990 --> 01:10:29,360
life on earth and then you sort of

2117
01:10:33,669 --> 01:10:30,000
finished it

2118
01:10:36,870 --> 01:10:33,679
with a um the same counterpoint to it

2119
01:10:37,270 --> 01:10:36,880
that you know that um if we do go out

2120
01:10:39,830 --> 01:10:37,280
there

2121
01:10:40,630 --> 01:10:39,840
it it if it's to make to make our lives

2122
01:10:42,950 --> 01:10:40,640
better

2123
01:10:44,310 --> 01:10:42,960
um would be the one of the ways that we

2124
01:10:47,350 --> 01:10:44,320
would do that

2125
01:10:50,470 --> 01:10:47,360
one of the reasons for doing it um

2126
01:10:52,470 --> 01:10:50,480
so i i want to actually ask a question

2127
01:10:55,590 --> 01:10:52,480
about one of the points you made

2128
01:10:57,350 --> 01:10:55,600
partially through and that colonization

2129
01:10:58,870 --> 01:10:57,360
you know when we call when when

2130
01:11:01,270 --> 01:10:58,880
countries colonized

2131
01:11:02,790 --> 01:11:01,280
uh here on earth it was driven by access

2132
01:11:06,310 --> 01:11:02,800
to raw materials that

2133
01:11:07,990 --> 01:11:06,320
could be shipped back home uh and the

2134
01:11:09,669 --> 01:11:08,000
strongest argument people usually make

2135
01:11:10,790 --> 01:11:09,679
is about asteroid mining which you

2136
01:11:13,030 --> 01:11:10,800
didn't mention

2137
01:11:16,630 --> 01:11:13,040
what do you think of that in terms of a

2138
01:11:19,030 --> 01:11:16,640

way of getting raw materials

2139
01:11:19,990 --> 01:11:19,040
i i think it's wonderful and it all

2140
01:11:23,030 --> 01:11:20,000
comes down

2141
01:11:26,070 --> 01:11:23,040
to the price of access to these

2142
01:11:29,990 --> 01:11:26,080
um to these objects and

2143
01:11:33,270 --> 01:11:30,000
so you know if we could do that

2144
01:11:35,430 --> 01:11:33,280
um and we could if we could mine space

2145
01:11:36,550 --> 01:11:35,440
and we wouldn't have to mine on earth i

2146
01:11:38,870 --> 01:11:36,560
mean mining is so

2147
01:11:40,630 --> 01:11:38,880
important but it has incredible

2148
01:11:42,630 --> 01:11:40,640
environmental costs let's face it

2149
01:11:45,350 --> 01:11:42,640
especially things like uranium

2150
01:11:46,630 --> 01:11:45,360
and cobalt and these rare earth minerals

2151
01:11:48,470 --> 01:11:46,640
that aren't particularly rare but

2152
01:11:50,149 --> 01:11:48,480
they're just so hard to get

2153
01:11:52,630 --> 01:11:50,159
uh from the earth and they cause

2154
01:11:55,990 --> 01:11:52,640
incredible damage if we could get them

2155
01:11:58,790 --> 01:11:56,000
cheaply from space um that would just be

2156
01:12:00,070 --> 01:11:58,800
a wonderful resource and we could allow

2157
01:12:02,470 --> 01:12:00,080
people

2158
01:12:03,590 --> 01:12:02,480
in in an ironic kind of way to live

2159
01:12:05,350 --> 01:12:03,600
primitively

2160
01:12:07,350 --> 01:12:05,360
because what we're doing is we're just

2161
01:12:09,669 --> 01:12:07,360
tearing up the rain forest

2162
01:12:11,590 --> 01:12:09,679
were we're tearing up places where

2163
01:12:14,470 --> 01:12:11,600

indigenous people live

2164
01:12:16,390 --> 01:12:14,480
um just to get those resources this was

2165
01:12:18,149 --> 01:12:16,400
just in the news today about greenland

2166
01:12:19,830 --> 01:12:18,159
this beautiful greenland is getting torn

2167
01:12:22,149 --> 01:12:19,840
up by this uranium mine

2168
01:12:23,750 --> 01:12:22,159
and it's jobs but it's you know it's

2169
01:12:25,350 --> 01:12:23,760
it's ruining greenland

2170
01:12:27,270 --> 01:12:25,360
if we could get these materials from

2171
01:12:28,950 --> 01:12:27,280
space we could allow people to live like

2172
01:12:29,669 --> 01:12:28,960
they've always lived for thousands of

2173
01:12:31,669 --> 01:12:29,679
years

2174
01:12:33,430 --> 01:12:31,679
uh but still have the resources we need

2175
01:12:35,270 --> 01:12:33,440
to live a modern life it'd be like this

2176
01:12:37,830 --> 01:12:35,280
balance between primitivism

2177
01:12:38,630 --> 01:12:37,840
and modernism but it's all about the

2178
01:12:41,430 --> 01:12:38,640
cost

2179
01:12:43,189 --> 01:12:41,440
to get to these uh these these rocks in

2180
01:12:45,750 --> 01:12:43,199
space or the moon

2181
01:12:47,510 --> 01:12:45,760
yeah uh there there are plenty of

2182
01:12:49,430 --> 01:12:47,520
philosophical arguments for other things

2183
01:12:51,590 --> 01:12:49,440
but the economics really does

2184
01:12:53,350 --> 01:12:51,600
ends up trumping all so we're going to

2185
01:12:55,590 --> 01:12:53,360
bring in grant justice

2186
01:12:56,790 --> 01:12:55,600
uh grant has been monitoring the chat

2187
01:12:58,310 --> 01:12:56,800
we've had i've been

2188
01:13:01,030 --> 01:12:58,320

looking at the chat a bit myself and

2189
01:13:02,470 --> 01:13:01,040
we've had a ton of conversation

2190
01:13:05,110 --> 01:13:02,480
about a lot of things you know somebody

2191
01:13:06,550 --> 01:13:05,120
goes wait a minute isn't mars soil toxic

2192
01:13:08,390 --> 01:13:06,560
and then you know three minutes later

2193
01:13:09,350 --> 01:13:08,400
boom you bring up the point mars soil is

2194
01:13:11,590 --> 01:13:09,360
toxic

2195
01:13:16,630 --> 01:13:11,600
uh so grant have you found some some

2196
01:13:21,110 --> 01:13:18,709
absolutely the chat like you said has

2197
01:13:24,070 --> 01:13:21,120
been has been popping off today

2198
01:13:24,470 --> 01:13:24,080
so one of the you touched on it a little

2199
01:13:26,390 --> 01:13:24,480
bit

2200
01:13:28,470 --> 01:13:26,400
but the chat definitely wants you to

2201
01:13:28,870 --> 01:13:28,480
elaborate a little more on your thoughts

2202
01:13:31,669 --> 01:13:28,880
on

2203
01:13:32,709 --> 01:13:31,679
spacex and private industry and space

2204
01:13:34,149 --> 01:13:32,719
exploration

2205
01:13:36,790 --> 01:13:34,159
kind of bringing it back to our

2206
01:13:40,070 --> 01:13:36,800
economics point you just made

2207
01:13:42,630 --> 01:13:40,080
absolutely it's a real exciting time um

2208
01:13:44,709 --> 01:13:42,640
i think that it's basic economics the

2209
01:13:47,830 --> 01:13:44,719
more competition you have

2210
01:13:50,550 --> 01:13:47,840
um you know the lower this price can be

2211
01:13:52,149 --> 01:13:50,560
and and it's nice to see all types of

2212
01:13:53,270 --> 01:13:52,159
niches getting filled in i didn't

2213
01:13:56,310 --> 01:13:53,280

mention anything about

2214
01:13:57,910 --> 01:13:56,320
um rocket lab down in new zealand

2215
01:13:59,669 --> 01:13:57,920
um this is a company new zealand and

2216
01:14:00,470 --> 01:13:59,679
they have a space program and yet they

2217
01:14:03,430 --> 01:14:00,480
have a company

2218
01:14:04,950 --> 01:14:03,440
launching these simple rockets um

2219
01:14:06,470 --> 01:14:04,960
they're going small

2220
01:14:07,990 --> 01:14:06,480
and they're march they're launching a

2221
01:14:10,470 --> 01:14:08,000
rocket um

2222
01:14:11,590 --> 01:14:10,480
for about five million dollars you could

2223
01:14:14,630 --> 01:14:11,600
buy that rocket

2224
01:14:17,510 --> 01:14:14,640
and and people can team up and put

2225
01:14:19,110 --> 01:14:17,520
their nanosat experiments in there these

2226
01:14:19,830 --> 01:14:19,120
lightweight things and get that into

2227
01:14:22,070 --> 01:14:19,840
space

2228
01:14:23,110 --> 01:14:22,080
that's one very profitable thing and

2229
01:14:24,310 --> 01:14:23,120
that can build a bit of an

2230
01:14:26,470 --> 01:14:24,320
infrastructure

2231
01:14:27,669 --> 01:14:26,480
of miniature communication satellites

2232
01:14:30,709 --> 01:14:27,679
and things like that

2233
01:14:32,790 --> 01:14:30,719
it all adds up in what spacex is doing

2234
01:14:34,790 --> 01:14:32,800
with the big stuff

2235
01:14:37,510 --> 01:14:34,800
and other companies are competing

2236
01:14:39,830 --> 01:14:37,520
finally to get a lunar lander

2237
01:14:40,709 --> 01:14:39,840
that kind of competition is thrilling to

2238
01:14:42,870 --> 01:14:40,719

see

2239
01:14:44,870 --> 01:14:42,880
because it's just been so lazy you know

2240
01:14:47,030 --> 01:14:44,880
with governments handing it over to

2241
01:14:48,149 --> 01:14:47,040
military contractors and there was no

2242
01:14:54,070 --> 01:14:48,159
incentive

2243
01:14:56,310 --> 01:14:54,080
to save money and it was so much has

2244
01:14:58,870 --> 01:14:56,320
been wasted over the years but now

2245
01:15:00,709 --> 01:14:58,880
because of this economic competition

2246
01:15:07,189 --> 01:15:00,719
you're finally seeing some real

2247
01:15:12,630 --> 01:15:10,310
all right thank you and

2248
01:15:14,070 --> 01:15:12,640
yeah absolutely i think competition i

2249
01:15:15,430 --> 01:15:14,080
mean it's at the heart of human nature

2250
01:15:17,590 --> 01:15:15,440
we got to harness it for the right

2251
01:15:19,910 --> 01:15:17,600
reasons for the right things

2252
01:15:20,870 --> 01:15:19,920
um second up and this interested me a

2253
01:15:22,229 --> 01:15:20,880
little bit as well because it's

2254
01:15:23,669 --> 01:15:22,239
something i hadn't necessarily thought

2255
01:15:26,950 --> 01:15:23,679
about before

2256
01:15:27,910 --> 01:15:26,960
what about aquaponics and building on

2257
01:15:31,189 --> 01:15:27,920
that

2258
01:15:33,510 --> 01:15:31,199
using water as some sort of a

2259
01:15:37,910 --> 01:15:33,520
non-permeable

2260
01:15:39,910 --> 01:15:37,920
solution for blocking solar radiation

2261
01:15:44,070 --> 01:15:39,920
yeah now i thought about that too

2262
01:15:46,070 --> 01:15:44,080
um i think aquaponics

2263
01:15:48,310 --> 01:15:46,080

is the most efficient of all the growing

2264
01:15:49,990 --> 01:15:48,320
systems and for people who don't know

2265
01:15:51,669 --> 01:15:50,000
you have the hydroponic system where

2266
01:15:53,910 --> 01:15:51,679
you're growing plants in some

2267
01:15:55,350 --> 01:15:53,920
nutrient-rich water right well the

2268
01:15:57,510 --> 01:15:55,360
aquaponics

2269
01:15:58,790 --> 01:15:57,520
brings in this full cycle idea where you

2270
01:16:01,750 --> 01:15:58,800
have fish

2271
01:16:02,950 --> 01:16:01,760
that you feed the fish produce they eat

2272
01:16:06,229 --> 01:16:02,960
the food they

2273
01:16:08,310 --> 01:16:06,239
produce waste nitrogen uh rich waste

2274
01:16:09,510 --> 01:16:08,320
that gets filtered through some rocks

2275
01:16:11,910 --> 01:16:09,520
and bacteria

2276
01:16:12,709 --> 01:16:11,920
to turn the i believe it's nitrates into

2277
01:16:16,950 --> 01:16:12,719
nitrate

2278
01:16:20,070 --> 01:16:16,960
detroit i'm not quite sure

2279
01:16:21,910 --> 01:16:20,080
but it's they break it down that uh

2280
01:16:23,990 --> 01:16:21,920
nitrogen into stuff that the plants can

2281
01:16:26,790 --> 01:16:24,000
use and the plants absorb that

2282
01:16:27,510 --> 01:16:26,800
uh and then they feed the fish so it's a

2283
01:16:29,510 --> 01:16:27,520
cycle

2284
01:16:31,110 --> 01:16:29,520
that goes around and it's very efficient

2285
01:16:32,229 --> 01:16:31,120
you could be eating the fish raising and

2286
01:16:34,470 --> 01:16:32,239
eating the fish

2287
01:16:36,550 --> 01:16:34,480
and raising and eating the plants now

2288
01:16:39,590 --> 01:16:36,560

you're bringing in this extra element

2289
01:16:42,310 --> 01:16:39,600
of could you use that water

2290
01:16:43,110 --> 01:16:42,320
as radiation protection and that's

2291
01:16:46,550 --> 01:16:43,120
pretty cool

2292
01:16:49,030 --> 01:16:46,560
isn't it uh if it's all around you right

2293
01:16:50,390 --> 01:16:49,040
and um and that would definitely work

2294
01:16:51,990 --> 01:16:50,400
for you

2295
01:16:54,149 --> 01:16:52,000
but would it work for the fish because

2296
01:16:54,870 --> 01:16:54,159
they're swimming around in this radiated

2297
01:16:57,590 --> 01:16:54,880
water

2298
01:16:58,950 --> 01:16:57,600
so it might be a little a little hard to

2299
01:17:00,870 --> 01:16:58,960
pull off

2300
01:17:03,669 --> 01:17:00,880
but it's very cool and water is is an

2301
01:17:05,110 --> 01:17:03,679
excellent insulator

2302
01:17:06,709 --> 01:17:05,120
i mean if i have to live on another

2303
01:17:08,950 --> 01:17:06,719
planet

2304
01:17:10,229 --> 01:17:08,960
underground or something at least like

2305
01:17:12,870 --> 01:17:10,239
sea lab

2306
01:17:14,790 --> 01:17:12,880
or like underwater complex like at least

2307
01:17:17,189 --> 01:17:14,800
give me something you know

2308
01:17:18,550 --> 01:17:17,199
exactly i mean now that's a huge

2309
01:17:20,229 --> 01:17:18,560
psychological lifts and

2310
01:17:23,030 --> 01:17:20,239
you know my previous book was called

2311
01:17:25,910 --> 01:17:23,040
food at work it's kind of an academic

2312
01:17:27,830 --> 01:17:25,920
it's about how to feed workers and that

2313
01:17:29,030 --> 01:17:27,840

was important in antarctica

2314
01:17:31,270 --> 01:17:29,040
um because you're getting a lot of

2315
01:17:33,750 --> 01:17:31,280
frozen food and there's not much crunch

2316
01:17:35,270 --> 01:17:33,760
to the frozen food so they actually

2317
01:17:36,229 --> 01:17:35,280
started building greenhouses in

2318
01:17:38,229 --> 01:17:36,239
antarctica

2319
01:17:39,910 --> 01:17:38,239
and that was a huge psychological lift

2320
01:17:41,590 --> 01:17:39,920
because during the wint in the summer

2321
01:17:43,270 --> 01:17:41,600
you could get airplanes in there

2322
01:17:46,149 --> 01:17:43,280
in the winter actually you can't get

2323
01:17:48,630 --> 01:17:46,159
planes in there so to the south pole

2324
01:17:49,430 --> 01:17:48,640
so they were growing fresh food on the

2325
01:17:51,669 --> 01:17:49,440
south pole

2326
01:17:53,510 --> 01:17:51,679
fresh lettuce and it has that crunch and

2327
01:17:54,550 --> 01:17:53,520
it was a huge psychological lift for

2328
01:17:55,910 --> 01:17:54,560
these people there

2329
01:17:57,669 --> 01:17:55,920
and i think it's going to be very

2330
01:18:00,709 --> 01:17:57,679
important on mars

2331
01:18:02,390 --> 01:18:00,719
and to have fish to have life one other

2332
01:18:03,189 --> 01:18:02,400
thing he didn't mention is it is curious

2333
01:18:07,110 --> 01:18:03,199
you don't know how

2334
01:18:09,270 --> 01:18:07,120
bees and certain uh insects could

2335
01:18:11,350 --> 01:18:09,280
navigate on mars without a magnetic

2336
01:18:13,590 --> 01:18:11,360
field in a north pole

2337
01:18:14,630 --> 01:18:13,600
so it's unclear whether they could fly

2338
01:18:17,990 --> 01:18:14,640

around and

2339
01:18:20,070 --> 01:18:18,000
and find their direction um so

2340
01:18:21,270 --> 01:18:20,080
that's why i said agriculture will be

2341
01:18:23,510 --> 01:18:21,280
challenging

2342
01:18:25,030 --> 01:18:23,520
um but the more animals you can get

2343
01:18:27,510 --> 01:18:25,040
there the more

2344
01:18:30,070 --> 01:18:27,520
greater the humans will feel yeah that

2345
01:18:32,790 --> 01:18:30,080
was one of the comments was that um

2346
01:18:33,590 --> 01:18:32,800
the lack of a magnetosphere on mars will

2347
01:18:37,110 --> 01:18:33,600
change

2348
01:18:40,149 --> 01:18:37,120
will have several implications like that

2349
01:18:43,270 --> 01:18:40,159
uh for the radiation as well

2350
01:18:44,470 --> 01:18:43,280
but yeah the navigational of birds and

2351
01:18:45,830 --> 01:18:44,480
bees and everything

2352
01:18:47,990 --> 01:18:45,840
yeah you would have to maybe hand

2353
01:18:49,350 --> 01:18:48,000
pollinate things it's going to be small

2354
01:18:51,350 --> 01:18:49,360
scale

2355
01:18:53,350 --> 01:18:51,360
maybe the bees can adapt you don't know

2356
01:18:53,990 --> 01:18:53,360
if it's in a small confinement maybe

2357
01:18:55,750 --> 01:18:54,000
they can find

2358
01:18:57,669 --> 01:18:55,760
their way around that way it's an

2359
01:19:00,950 --> 01:18:57,679
unknown exciting

2360
01:19:02,870 --> 01:19:00,960
just comment that um none of the

2361
01:19:05,510 --> 01:19:02,880
pictures of living on the moon that i

2362
01:19:10,070 --> 01:19:05,520
ever ever saw when i was growing up

2363
01:19:14,390 --> 01:19:13,030

it's one of those unfortunate realities

2364
01:19:17,510 --> 01:19:14,400
that that comes across

2365
01:19:20,550 --> 01:19:17,520
all right what's our next question grant

2366
01:19:23,110 --> 01:19:20,560
all right next up is someone wanted to

2367
01:19:26,310 --> 01:19:23,120
know your opinion on

2368
01:19:28,310 --> 01:19:26,320
a.i and using artificial intelligence

2369
01:19:31,830 --> 01:19:28,320
and the expansion of humanity

2370
01:19:35,270 --> 01:19:31,840
to take over a lot of the clerical

2371
01:19:39,430 --> 01:19:35,280
that sort of thing yeah

2372
01:19:41,430 --> 01:19:39,440
um i don't know how to narrow in

2373
01:19:42,790 --> 01:19:41,440
on that question but i i can say a few

2374
01:19:44,310 --> 01:19:42,800
things i always thought it was funny

2375
01:19:46,390 --> 01:19:44,320
when we talk about

2376
01:19:47,990 --> 01:19:46,400
living in space and what are these

2377
01:19:50,470 --> 01:19:48,000
people what are we going to do out there

2378
01:19:52,229 --> 01:19:50,480
and it always comes down to farming

2379
01:19:53,910 --> 01:19:52,239
and mining you know the two oldest

2380
01:19:55,270 --> 01:19:53,920
professions that's what we're going to

2381
01:19:57,350 --> 01:19:55,280
do in the future

2382
01:19:59,990 --> 01:19:57,360
farm in mind when it's probably going to

2383
01:20:02,550 --> 01:20:00,000
be done robotically

2384
01:20:03,430 --> 01:20:02,560
with with robots rather intelligent

2385
01:20:06,390 --> 01:20:03,440
robots

2386
01:20:07,750 --> 01:20:06,400
uh that's one form of of ai that's

2387
01:20:09,830 --> 01:20:07,760
definitely going to be needed

2388
01:20:11,990 --> 01:20:09,840

and i was mentioning that on on mars

2389
01:20:12,950 --> 01:20:12,000
because you know with the rover right

2390
01:20:15,189 --> 01:20:12,960
it's just

2391
01:20:17,110 --> 01:20:15,199
inches along and you're afraid to move

2392
01:20:18,149 --> 01:20:17,120
it too fast because if it crashes you're

2393
01:20:20,870 --> 01:20:18,159
screwed

2394
01:20:22,790 --> 01:20:20,880
and and mars is pretty open it's not

2395
01:20:24,870 --> 01:20:22,800
like it's going to crash into a tree

2396
01:20:26,310 --> 01:20:24,880
right so you know if we could we need

2397
01:20:27,910 --> 01:20:26,320
really need better ai

2398
01:20:30,709 --> 01:20:27,920
i know it's rocks and things like that

2399
01:20:33,270 --> 01:20:30,719
but if it can if it can think for itself

2400
01:20:34,790 --> 01:20:33,280
better then these things can move around

2401
01:20:37,350 --> 01:20:34,800
more easily without

2402
01:20:39,350 --> 01:20:37,360
human interaction so there's major

2403
01:20:43,830 --> 01:20:39,360
advancements to be had there

2404
01:20:45,270 --> 01:20:43,840
with ai to do things for us outdoors

2405
01:20:46,470 --> 01:20:45,280
when we're on these planets because

2406
01:20:48,550 --> 01:20:46,480
we're not going to be able to be

2407
01:20:51,669 --> 01:20:48,560
outdoors very often

2408
01:20:54,870 --> 01:20:51,679
good to the radiation right and you know

2409
01:20:57,669 --> 01:20:54,880
when we've got just one rover on mars

2410
01:20:59,510 --> 01:20:57,679
you can't take any chances with the ai

2411
01:21:01,110 --> 01:20:59,520
but if you had 100 of them on

2412
01:21:02,870 --> 01:21:01,120
well you could take a bit more chances

2413
01:21:03,350 --> 01:21:02,880

with it and you know if you lost one

2414
01:21:05,830 --> 01:21:03,360
okay

2415
01:21:07,270 --> 01:21:05,840
fine we you learn things uh we are of

2416
01:21:09,189 --> 01:21:07,280
course practicing that with our

2417
01:21:12,550 --> 01:21:09,199
self-driving cars and everything

2418
01:21:14,550 --> 01:21:12,560
but um yeah it's gonna take decades uh

2419
01:21:16,149 --> 01:21:14,560
quite some time that's true i've heard

2420
01:21:19,350 --> 01:21:16,159
plans of of

2421
01:21:22,629 --> 01:21:19,360
having many many ones uh

2422
01:21:25,189 --> 01:21:22,639
going out and all like you know like you

2423
01:21:26,870 --> 01:21:25,199
just said 100 little guys going out and

2424
01:21:27,189 --> 01:21:26,880
doing all types of things if you lose

2425
01:21:30,229 --> 01:21:27,199
one

2426
01:21:30,239 --> 01:21:35,270
all right next question

2427
01:21:43,030 --> 01:21:39,430
we can't hear you grant i'm back

2428
01:21:46,470 --> 01:21:43,040
we've got uh we've got one

2429
01:21:48,950 --> 01:21:46,480
what kind of energy production

2430
01:21:49,910 --> 01:21:48,960
is known on mars is there anything that

2431
01:21:51,910 --> 01:21:49,920
we can use as

2432
01:21:53,270 --> 01:21:51,920
fuel without necessarily bringing it

2433
01:21:55,030 --> 01:21:53,280
ourselves

2434
01:21:56,310 --> 01:21:55,040
uh how do you really see that working

2435
01:21:58,070 --> 01:21:56,320
there because you mentioned some sort of

2436
01:21:59,750 --> 01:21:58,080
an issue with solar panels you know

2437
01:22:03,350 --> 01:21:59,760
light collection

2438
01:22:05,669 --> 01:22:03,360

um that's right there will be solar

2439
01:22:07,430 --> 01:22:05,679
there is uranium and things you could do

2440
01:22:10,390 --> 01:22:07,440
nuclear on mars

2441
01:22:12,070 --> 01:22:10,400
um i think i don't have the chemistry

2442
01:22:15,510 --> 01:22:12,080
down completely but

2443
01:22:16,550 --> 01:22:15,520
when you're converting um carbon dioxide

2444
01:22:19,590 --> 01:22:16,560
in the atmosphere

2445
01:22:21,270 --> 01:22:19,600
maybe frank knows this into oxygen

2446
01:22:22,709 --> 01:22:21,280
you're going to be producing carbon

2447
01:22:25,590 --> 01:22:22,719
monoxide

2448
01:22:27,270 --> 01:22:25,600
uh in that process and that could be a

2449
01:22:29,990 --> 01:22:27,280
bit of a fuel too

2450
01:22:31,590 --> 01:22:30,000
there's also the possibility of adding

2451
01:22:33,430 --> 01:22:31,600
hydrogen to this

2452
01:22:35,270 --> 01:22:33,440
mars doesn't have much free hydrogen

2453
01:22:37,270 --> 01:22:35,280
it's in the water and such

2454
01:22:39,430 --> 01:22:37,280
but if you add hydrogen into the mix

2455
01:22:43,830 --> 01:22:39,440
then you could be making methane

2456
01:22:46,950 --> 01:22:43,840
um in fact that was um robert zubrin's

2457
01:22:49,669 --> 01:22:46,960
brilliant idea of

2458
01:22:50,709 --> 01:22:49,679
sending a lander to um start and with

2459
01:22:53,910 --> 01:22:50,719
some hydrogen

2460
01:22:56,790 --> 01:22:53,920
to start turning carbon dioxide into uh

2461
01:22:59,030 --> 01:22:56,800
air water and methane and then storing

2462
01:23:00,870 --> 01:22:59,040
up that methane as rocket fuel to blast

2463
01:23:03,910 --> 01:23:00,880

off mars you wouldn't have to bring

2464
01:23:05,910 --> 01:23:03,920
a shipment of fuel to get off mars so

2465
01:23:10,149 --> 01:23:05,920
definitely methane

2466
01:23:12,950 --> 01:23:10,159
is the most probable gas i think

2467
01:23:14,229 --> 01:23:12,960
okay that's probably not a common

2468
01:23:15,830 --> 01:23:14,239
problem people think of is not

2469
01:23:18,470 --> 01:23:15,840
necessarily getting there but

2470
01:23:20,390 --> 01:23:18,480
getting back or getting things off of

2471
01:23:21,910 --> 01:23:20,400
mars once you're already there

2472
01:23:23,590 --> 01:23:21,920
yeah and i like to think of mars as

2473
01:23:25,430 --> 01:23:23,600
having everything we need but just in

2474
01:23:28,229 --> 01:23:25,440
forms that we're not ready to use

2475
01:23:28,950 --> 01:23:28,239
so we have to manipulate a few things uh

2476
01:23:31,510 --> 01:23:28,960
for us to

2477
01:23:32,310 --> 01:23:31,520
do what we want to do so in terms of

2478
01:23:35,189 --> 01:23:32,320
that um

2479
01:23:37,750 --> 01:23:35,199
in one section of your talk you sort of

2480
01:23:40,149 --> 01:23:37,760
implied that what we've learned from iss

2481
01:23:41,430 --> 01:23:40,159
is sort of a practice that will help us

2482
01:23:43,350 --> 01:23:41,440
do the moon

2483
01:23:44,950 --> 01:23:43,360
uh do you also feel that the doing the

2484
01:23:46,550 --> 01:23:44,960
moon is

2485
01:23:48,709 --> 01:23:46,560
would provide sufficient practice for

2486
01:23:50,870 --> 01:23:48,719
then going to mars is it requisite

2487
01:23:51,830 --> 01:23:50,880
to do moon before mars yeah i'm one of

2488
01:23:54,229 --> 01:23:51,840

those believers

2489
01:23:56,709 --> 01:23:54,239
i really think we have to be on the moon

2490
01:23:59,110 --> 01:23:56,719
it's it's kind of the same thing

2491
01:24:00,149 --> 01:23:59,120
um it's a dress rehearsal for mars to

2492
01:24:02,070 --> 01:24:00,159
tell you the truth

2493
01:24:03,990 --> 01:24:02,080
i mean you essentially need the same

2494
01:24:06,229 --> 01:24:04,000
type of radiation protection

2495
01:24:07,750 --> 01:24:06,239
the same type of oxygen supply the same

2496
01:24:10,310 --> 01:24:07,760
type of water supply

2497
01:24:11,990 --> 01:24:10,320
everything's the same in in my opinion

2498
01:24:12,950 --> 01:24:12,000
and of course the moon is three days

2499
01:24:14,870 --> 01:24:12,960
away

2500
01:24:16,470 --> 01:24:14,880
gonna be even faster if you you know you

2501
01:24:19,510 --> 01:24:16,480
could send a

2502
01:24:20,950 --> 01:24:19,520
a rocket there uh and crash into it if

2503
01:24:22,870 --> 01:24:20,960
you wanted to get there in eight hours

2504
01:24:25,350 --> 01:24:22,880
or so right

2505
01:24:26,950 --> 01:24:25,360
the pluto expressed past uh the moon in

2506
01:24:29,030 --> 01:24:26,960
just about eight hours

2507
01:24:30,629 --> 01:24:29,040
um so i mean you could get to the moon

2508
01:24:33,189 --> 01:24:30,639
rather quickly and you could

2509
01:24:34,550 --> 01:24:33,199
vacate people rather quickly in a funny

2510
01:24:36,470 --> 01:24:34,560
way it's actually

2511
01:24:38,709 --> 01:24:36,480
it'll be it might be easier to get to

2512
01:24:39,910 --> 01:24:38,719
the moon than to antarctica in the

2513
01:24:43,590 --> 01:24:39,920

winter

2514
01:24:45,590 --> 01:24:43,600
uh it's very uh treacherous to get there

2515
01:24:47,030 --> 01:24:45,600
to the south pole in particular in the

2516
01:24:47,510 --> 01:24:47,040
middle of the winter they don't even try

2517
01:24:49,510 --> 01:24:47,520
it

2518
01:24:50,709 --> 01:24:49,520
but to move someplace you can process

2519
01:24:52,390 --> 01:24:50,719
year-round

2520
01:24:54,709 --> 01:24:52,400
without with less of an issue as long as

2521
01:24:58,470 --> 01:24:54,719
you have a rocket ready to go

2522
01:25:00,070 --> 01:24:58,480
all right next question

2523
01:25:02,149 --> 01:25:00,080
that's all we've got from the chat so

2524
01:25:03,350 --> 01:25:02,159
far that's all we've got from chatbot

2525
01:25:07,830 --> 01:25:03,360
let me check my mail

2526
01:25:10,229 --> 01:25:07,840
that i made during the talk um

2527
01:25:11,750 --> 01:25:10,239
yeah all right so you you mentioned a

2528
01:25:13,270 --> 01:25:11,760
lot of these uh zero gravity

2529
01:25:15,189 --> 01:25:13,280
repercussions that we've learned from

2530
01:25:17,910 --> 01:25:15,199
the iss

2531
01:25:19,110 --> 01:25:17,920
and that would be you know slightly

2532
01:25:20,550 --> 01:25:19,120
ameliorated on

2533
01:25:22,790 --> 01:25:20,560
on the moon with you know one-sixth

2534
01:25:24,870 --> 01:25:22,800
gravity uh 16

2535
01:25:26,870 --> 01:25:24,880
and then a little bit more on mars with

2536
01:25:29,910 --> 01:25:26,880
38 percent gravity

2537
01:25:32,390 --> 01:25:29,920
um we to talk about

2538
01:25:33,669 --> 01:25:32,400

creating artificial gravity in space as

2539
01:25:37,270 --> 01:25:33,679
we're flying there

2540
01:25:40,390 --> 01:25:37,280
as we're traveling there i i just

2541
01:25:43,030 --> 01:25:40,400
get if 38 gravity isn't enough for

2542
01:25:43,669 --> 01:25:43,040
reproduction or anything for for kids

2543
01:25:46,629 --> 01:25:43,679
and such

2544
01:25:48,310 --> 01:25:46,639
is there any alternative that it just

2545
01:25:49,030 --> 01:25:48,320
bases around it maybe as you were

2546
01:25:51,430 --> 01:25:49,040
talking about

2547
01:25:53,110 --> 01:25:51,440
yeah i really don't see it i mean people

2548
01:25:55,110 --> 01:25:53,120
talk about these

2549
01:25:57,270 --> 01:25:55,120
you know a tilt-a-wheel on the surface

2550
01:25:59,510 --> 01:25:57,280
of mars or something like that

2551
01:26:00,390 --> 01:25:59,520
i mean that's i mean that's incredible

2552
01:26:02,709 --> 01:26:00,400
engineering

2553
01:26:03,430 --> 01:26:02,719
i mean it's just not logical i'd like to

2554
01:26:05,350 --> 01:26:03,440
think

2555
01:26:06,950 --> 01:26:05,360
in my book space fairs i just talk about

2556
01:26:09,430 --> 01:26:06,960
the logical scenario

2557
01:26:11,270 --> 01:26:09,440
of what would probably happen and if you

2558
01:26:12,709 --> 01:26:11,280
have one set of technology would

2559
01:26:15,030 --> 01:26:12,719
probably do

2560
01:26:16,310 --> 01:26:15,040
something similar that's that's easier

2561
01:26:19,430 --> 01:26:16,320
and it would probably be

2562
01:26:21,270 --> 01:26:19,440
in the rotating habitat above mars

2563
01:26:22,790 --> 01:26:21,280

and then venture down there it would be

2564
01:26:25,030 --> 01:26:22,800
easier than building some type of

2565
01:26:26,950 --> 01:26:25,040
artificial gravity system on a surface

2566
01:26:30,070 --> 01:26:26,960
of a planet

2567
01:26:33,189 --> 01:26:30,080
um and that's a that and the gravity is

2568
01:26:37,110 --> 01:26:35,030
assumption that's why i was trying to

2569
01:26:38,550 --> 01:26:37,120
point out those two data points

2570
01:26:40,070 --> 01:26:38,560
i i don't think we can make any

2571
01:26:41,189 --> 01:26:40,080
assumption about how those lines are

2572
01:26:42,950 --> 01:26:41,199
connected

2573
01:26:45,270 --> 01:26:42,960
wouldn't it be curious whether maybe you

2574
01:26:47,510 --> 01:26:45,280
only need 10 percent of gravity maybe

2575
01:26:48,790 --> 01:26:47,520
you know when you think about minerals

2576
01:26:52,310 --> 01:26:48,800
and mining or stuff

2577
01:26:54,709 --> 01:26:52,320
it's very it's impossible to mine in

2578
01:26:55,590 --> 01:26:54,719
zero gravity because nothing is settling

2579
01:26:57,830 --> 01:26:55,600
but you know

2580
01:26:59,510 --> 01:26:57,840
on asteroids or the moon things

2581
01:27:00,950 --> 01:26:59,520
eventually settle regardless of the

2582
01:27:04,070 --> 01:27:00,960
amount of gravity

2583
01:27:05,990 --> 01:27:04,080
and so maybe human health is is possible

2584
01:27:07,750 --> 01:27:06,000
with with just a little bit of gravity i

2585
01:27:09,750 --> 01:27:07,760
mean it's pure speculation and

2586
01:27:11,830 --> 01:27:09,760
you just have to test it it's a shame

2587
01:27:13,510 --> 01:27:11,840
there was a a proposed mission i think

2588
01:27:16,229 --> 01:27:13,520

it's called mouse hab

2589
01:27:18,070 --> 01:27:16,239
where you would send mice into space

2590
01:27:21,430 --> 01:27:18,080
cared for by a robot right

2591
01:27:23,270 --> 01:27:21,440
um and uh it's a real mission

2592
01:27:25,030 --> 01:27:23,280
and it seems quite practical and it

2593
01:27:26,870 --> 01:27:25,040
would have rotating gravity

2594
01:27:28,550 --> 01:27:26,880
you know artificial gravity and it could

2595
01:27:31,430 --> 01:27:28,560
have 50 50

2596
01:27:31,990 --> 01:27:31,440
and 30 and 10 percent you could test it

2597
01:27:34,310 --> 01:27:32,000
and see how

2598
01:27:35,990 --> 01:27:34,320
the mice do going about their life it's

2599
01:27:37,350 --> 01:27:36,000
just a matter of feeding them and taking

2600
01:27:40,310 --> 01:27:37,360
care of their change uh

2601
01:27:41,830 --> 01:27:40,320
church their cages not that complicated

2602
01:27:44,390 --> 01:27:41,840
for a robot to do

2603
01:27:45,990 --> 01:27:44,400
um and then you could really test what

2604
01:27:49,110 --> 01:27:46,000
it would be like uh

2605
01:27:53,830 --> 01:27:49,120
to see if they can um reproduce and

2606
01:27:57,990 --> 01:27:56,629
be interesting to see the dna changes

2607
01:28:01,110 --> 01:27:58,000
yeah that too

2608
01:28:03,270 --> 01:28:01,120
yeah yeah you'd really you you you'd

2609
01:28:06,310 --> 01:28:03,280
almost want to be make that a a

2610
01:28:07,430 --> 01:28:06,320
a return mission so that you could um do

2611
01:28:10,709 --> 01:28:07,440
the tests afterwards

2612
01:28:12,149 --> 01:28:10,719
right all right well yeah i've got a

2613
01:28:15,270 --> 01:28:12,159

good one to end us on

2614
01:28:16,550 --> 01:28:15,280
okay if i may all right go for it all

2615
01:28:19,750 --> 01:28:16,560
right

2616
01:28:22,390 --> 01:28:19,760
i want to get this one okay

2617
01:28:24,950 --> 01:28:22,400
does the exploration of deep ocean play

2618
01:28:26,950 --> 01:28:24,960
a role in space exploration

2619
01:28:29,590 --> 01:28:26,960
how do you think it might affect moving

2620
01:28:30,950 --> 01:28:29,600
forward

2621
01:28:33,189 --> 01:28:30,960
i don't know i haven't thought about

2622
01:28:36,870 --> 01:28:33,199
that i know there's

2623
01:28:38,470 --> 01:28:36,880
issues there's legal issues of who owns

2624
01:28:39,830 --> 01:28:38,480
the deep oceans

2625
01:28:42,149 --> 01:28:39,840
and what you're allowed to take from

2626
01:28:43,510 --> 01:28:42,159
there and and what nations can benefit

2627
01:28:44,709 --> 01:28:43,520
from that and that's going to come up

2628
01:28:47,270 --> 01:28:44,719
with the moon

2629
01:28:49,270 --> 01:28:47,280
of who owns the moon and who's allowed

2630
01:28:50,709 --> 01:28:49,280
to have these resources who's allowed to

2631
01:28:53,510 --> 01:28:50,719
dig at that ice

2632
01:28:54,470 --> 01:28:53,520
and uh and take it away uh from other

2633
01:28:57,030 --> 01:28:54,480
people

2634
01:28:58,390 --> 01:28:57,040
um so i've seen that kind of issue come

2635
01:29:00,629 --> 01:28:58,400
up with uh

2636
01:29:02,709 --> 01:29:00,639
the deep ocean and um so there might be

2637
01:29:06,950 --> 01:29:02,719
something to learn from there

2638
01:29:07,830 --> 01:29:06,960

um other than that i don't know i i know

2639
01:29:10,229 --> 01:29:07,840
there's this

2640
01:29:11,510 --> 01:29:10,239
kind of a science fiction genre of

2641
01:29:13,910 --> 01:29:11,520
living under

2642
01:29:14,870 --> 01:29:13,920
under under the ocean as a way to you

2643
01:29:18,310 --> 01:29:14,880
know make more

2644
01:29:20,790 --> 01:29:18,320
room for people on on on the land

2645
01:29:22,310 --> 01:29:20,800
um but one thing it always gets glossed

2646
01:29:24,229 --> 01:29:22,320
over is the fact that if you kind of

2647
01:29:26,390 --> 01:29:24,239
have a an

2648
01:29:28,149 --> 01:29:26,400
area that you're living under it'll

2649
01:29:31,430 --> 01:29:28,159
probably be

2650
01:29:32,390 --> 01:29:31,440
you know consumed by algae is this all

2651
01:29:35,030 --> 01:29:32,400
going to be covered with

2652
01:29:36,709 --> 01:29:35,040
gunk you know in a couple weeks and like

2653
01:29:37,590 --> 01:29:36,719
every day you would have to go out there

2654
01:29:40,870 --> 01:29:37,600
and clean your

2655
01:29:41,830 --> 01:29:40,880
beautiful golden lit dome underneath the

2656
01:29:44,229 --> 01:29:41,840
ocean

2657
01:29:44,950 --> 01:29:44,239
um but i haven't really don't like the

2658
01:29:48,870 --> 01:29:44,960
dog

2659
01:29:50,149 --> 01:29:48,880
space really really not a fan of domes

2660
01:29:52,149 --> 01:29:50,159
i'm getting thus far you know

2661
01:29:53,750 --> 01:29:52,159
i mean you got barnacles you know you

2662
01:29:55,910 --> 01:29:53,760
got to deal with them right

2663
01:29:56,790 --> 01:29:55,920

that's fair that's fair i mean they've

2664
01:29:59,430 --> 01:29:56,800
got to be

2665
01:30:00,709 --> 01:29:59,440
i mean they're this i start off my book

2666
01:30:02,470 --> 01:30:00,719
space fairs with

2667
01:30:04,790 --> 01:30:02,480
talking about the space animators

2668
01:30:06,390 --> 01:30:04,800
because they make it look so easy

2669
01:30:07,990 --> 01:30:06,400
but it's really not that easy of course

2670
01:30:09,830 --> 01:30:08,000
they want to make it look easy

2671
01:30:11,430 --> 01:30:09,840
everything just works perfectly and

2672
01:30:14,310 --> 01:30:11,440
everything's clean

2673
01:30:15,669 --> 01:30:14,320
but the reality is is really difficult

2674
01:30:17,669 --> 01:30:15,679
yeah

2675
01:30:19,510 --> 01:30:17,679
all right well thank you you've given

2676
01:30:20,310 --> 01:30:19,520
our audience a tremendous number of

2677
01:30:23,510 --> 01:30:20,320
things to

2678
01:30:25,590 --> 01:30:23,520
to think about i hope that they will uh

2679
01:30:26,550 --> 01:30:25,600
go out and take a look at your book and

2680
01:30:29,830 --> 01:30:26,560
think of them you

2681
01:30:30,709 --> 01:30:29,840
think it think through even more uh next

2682
01:30:33,750 --> 01:30:30,719
month

2683
01:30:34,070 --> 01:30:33,760
may 4th we have the uh finding the music

2684
01:30:37,189 --> 01:30:34,080
of

2685
01:30:38,870 --> 01:30:37,199
the spheres hearing stars

2686
01:30:40,550 --> 01:30:38,880
from the consonants collective and the

2687
01:30:42,229 --> 01:30:40,560
bergamot quartet

2688
01:30:44,070 --> 01:30:42,239

from the peabody institute it's gonna be

2689
01:30:45,030 --> 01:30:44,080
a special one probably gonna run a

2690
01:30:47,189 --> 01:30:45,040
little long

2691
01:30:50,390 --> 01:30:47,199
won't be limited to our 90 minutes here

2692
01:30:52,310 --> 01:30:50,400
uh and uh thank you so much chris

2693
01:30:53,750 --> 01:30:52,320
um really great to have you here and

2694
01:30:54,550 --> 01:30:53,760
we'll see you next month next month