



1
00:00:05,749 --> 00:00:04,150
nasa's jet propulsion laboratory

2
00:00:08,390 --> 00:00:05,759
presents

3
00:00:10,470 --> 00:00:08,400
the von carmen lecture a series of talks

4
00:00:13,669 --> 00:00:10,480
by scientists and engineers who are

5
00:00:21,740 --> 00:00:13,679
exploring our planet our solar system

6
00:00:27,429 --> 00:00:24,790
[Music]

7
00:00:31,269 --> 00:00:27,439
it's a shame but living in the city

8
00:00:34,229 --> 00:00:31,279
very rarely do you get to see stars

9
00:00:36,709 --> 00:00:34,239
i feel like i have a new connection to

10
00:00:38,069 --> 00:00:36,719
them in a way that i haven't before

11
00:00:39,750 --> 00:00:38,079
i'm out in the desert and i look up at

12
00:00:41,750 --> 00:00:39,760
the sky you just

13
00:00:45,110 --> 00:00:41,760

see millions and millions of places that

14

00:00:47,110 --> 00:00:45,120

we should be going

15

00:00:48,790 --> 00:00:47,120

hey the desire to go and explore right

16

00:00:51,029 --> 00:00:48,800

that's the whole reason why we left the

17

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

forest and then traveled across oceans

18

00:00:55,350 --> 00:00:52,800

just to see what's out there

19

00:00:57,510 --> 00:00:55,360

i was born in 1969 which is the year we

20

00:00:58,389 --> 00:00:57,520

landed on the moon so i am

21

00:01:25,030 --> 00:00:58,399

a

22

00:01:26,710 --> 00:01:25,040

it's too hot the pressure's too high our

23

00:01:28,149 --> 00:01:26,720

instruments would melt can't drill a

24

00:01:29,910 --> 00:01:28,159

hole that deep in the earth or other

25

00:01:32,469 --> 00:01:29,920

planets it turns out

26

00:01:34,710 --> 00:01:32,479

we can study a planetary core out in

27

00:01:37,510 --> 00:01:34,720

space because there's this one object

28

00:01:40,230 --> 00:01:37,520

it's one object called psyche 16 psyche

29

00:01:42,950 --> 00:01:40,240

is an asteroid that orbits the sun out

30

00:01:46,710 --> 00:01:42,960

between mars and jupiter it is the only

31

00:01:49,190 --> 00:01:46,720

asteroid that we're aware of that is 95

32

00:01:53,350 --> 00:01:51,590

which is about 200 kilometers across in

33

00:01:54,870 --> 00:01:53,360

one axis so it's about the size of

34

00:01:57,270 --> 00:01:54,880

massachusetts

35

00:01:59,670 --> 00:01:57,280

it's believed that it may be a remnant

36

00:02:01,590 --> 00:01:59,680

core of an early planetesimal that was

37

00:02:03,830 --> 00:02:01,600

formed in the very very earliest parts

38

00:02:05,670 --> 00:02:03,840

of the formation of the solar system and

39

00:02:07,830 --> 00:02:05,680

after this planet started forming and

40

00:02:09,910 --> 00:02:07,840

this metal core formed inside of that

41

00:02:11,910 --> 00:02:09,920

collided with other bodies that then

42

00:02:15,350 --> 00:02:11,920

stripped off the rocky mantle leaving

43

00:02:17,990 --> 00:02:16,790

the first thing that came actually was

44

00:02:19,510 --> 00:02:18,000

the theory

45

00:02:21,350 --> 00:02:19,520

some people from jet propulsion

46

00:02:22,390 --> 00:02:21,360

laboratory contacted me and said we

47

00:02:23,750 --> 00:02:22,400

would like to

48

00:02:26,710 --> 00:02:23,760

plan a mission

49

00:02:29,670 --> 00:02:26,720

that would test your hypotheses and that

50

00:02:30,790 --> 00:02:29,680

starts you down a road that takes years

51

00:02:33,030 --> 00:02:30,800

so we

52

00:02:35,750 --> 00:02:33,040

wrote a proposal to send a nasa

53

00:02:38,390 --> 00:02:35,760

spacecraft to visit this this big ball

54

00:02:41,190 --> 00:02:38,400

of metal and then about a year ago lindy

55

00:02:42,790 --> 00:02:41,200

gets a phone call you win

56

00:02:45,430 --> 00:02:42,800

and then we're all like oh my god now we

57

00:02:49,430 --> 00:02:47,190

psyche gives us the opportunity to visit

58

00:02:54,070 --> 00:02:49,440

a corps the only way that humankind can

59

00:02:58,949 --> 00:02:56,309

we've been approved to go in august of

60

00:03:00,949 --> 00:02:58,959

2022. so we talked with our mission

61

00:03:03,190 --> 00:03:00,959

design and navigation team and in fact

62

00:03:05,110 --> 00:03:03,200

they were able to come up with what is

63

00:03:08,470 --> 00:03:05,120

probably the most optimal trajectory

64

00:03:12,630 --> 00:03:10,630

flies past mars gives us a gravity

65

00:03:14,470 --> 00:03:12,640

assist uses that propulsion system to

66

00:03:17,270 --> 00:03:14,480

then slowly creep up

67

00:03:22,949 --> 00:03:17,280

so at the end of 2025 getting there in

68

00:03:28,309 --> 00:03:25,350

ssl is building the solar electric

69

00:03:31,110 --> 00:03:28,319

propulsion chassis when we do the

70

00:03:33,509 --> 00:03:31,120

mechanical physical integration of each

71

00:03:35,750 --> 00:03:33,519

instrument on the spacecraft we'll work

72

00:03:38,149 --> 00:03:35,760

hand in hand with each of the providers

73

00:03:40,229 --> 00:03:38,159

to get out the psyche and do a full

74

00:03:42,710 --> 00:03:40,239

discovery mission we've figured out a

75

00:03:45,190 --> 00:03:42,720

way for many many people to build

76
00:03:47,350 --> 00:03:45,200
something together so complicated no one

77
00:03:49,350 --> 00:03:47,360
person can understand it but it all has

78
00:03:51,350 --> 00:03:49,360
to work together perfectly for decades

79
00:03:53,509 --> 00:03:51,360
without fail just the fact that these

80
00:03:57,509 --> 00:03:53,519
things work at all is a thrill

81
00:04:01,190 --> 00:03:59,270
that we collaborate with

82
00:04:04,630 --> 00:04:01,200
that they can build these things it's

83
00:04:06,869 --> 00:04:04,640
exciting for me to be able to be a woman

84
00:04:08,630 --> 00:04:06,879
winning and leading a deep space mission

85
00:04:09,830 --> 00:04:08,640
the only previous

86
00:04:11,750 --> 00:04:09,840
woman who

87
00:04:13,990 --> 00:04:11,760
competed won and led a deep space

88
00:04:17,509 --> 00:04:14,000

mission was maria zuber who was my

89

00:04:18,550 --> 00:04:17,519

friend and mentor at mit and so my

90

00:04:21,110 --> 00:04:18,560

drive

91

00:04:23,270 --> 00:04:21,120

is to make everyone feel welcome and to

92

00:04:24,870 --> 00:04:23,280

have every voice heard we want as many

93

00:04:26,710 --> 00:04:24,880

undergraduates as we can we want to

94

00:04:28,390 --> 00:04:26,720

involve as much of the public as we can

95

00:04:30,469 --> 00:04:28,400

we want people to feel like

96

00:04:32,150 --> 00:04:30,479

this is their mission you get that first

97

00:04:33,110 --> 00:04:32,160

picture back and

98

00:04:34,629 --> 00:04:33,120

one of the first things that goes

99

00:04:36,870 --> 00:04:34,639

through myself thank god i didn't leave

100

00:04:38,950 --> 00:04:36,880

the lens cap

101
00:04:41,030 --> 00:04:38,960
we will put our pictures out there as

102
00:04:43,110 --> 00:04:41,040
soon as they come down

103
00:04:44,390 --> 00:04:43,120
so we'll discover

104
00:04:46,150 --> 00:04:44,400
at the same time that the public

105
00:04:47,830 --> 00:04:46,160
discovers we'll be scratching our heads

106
00:04:49,189 --> 00:04:47,840
it's like i don't know what's going on

107
00:04:51,100 --> 00:04:49,199
same time everybody else is like wow

108
00:04:53,510 --> 00:04:51,110
that what is that let's figure it out

109
00:04:56,230 --> 00:04:53,520
[Music]

110
00:04:58,790 --> 00:04:56,240
i did get to look at psyche through an

111
00:05:02,070 --> 00:04:58,800
optical telescope in my backyard some

112
00:05:05,909 --> 00:05:04,710
it's a very very tiny faint dot

113
00:05:07,909 --> 00:05:05,919

and that

114

00:05:10,469 --> 00:05:07,919

made a bunch of us cry to think that we

115

00:05:12,710 --> 00:05:10,479

could send something to investigate that

116

00:05:15,189 --> 00:05:12,720

speck of light we can understand this

117

00:05:17,590 --> 00:05:15,199

universe that we live in we can explore

118

00:05:19,029 --> 00:05:17,600

it we can learn about it and we can be a

119

00:05:21,029 --> 00:05:19,039

part of something which is much bigger

120

00:05:22,390 --> 00:05:21,039

than just us or just this planet we will

121

00:05:24,240 --> 00:05:22,400

see new things when we visit a world

122

00:05:40,870 --> 00:05:24,250

made of metal

123

00:05:45,670 --> 00:05:43,110

welcome everyone my name is mark razzie

124

00:05:47,110 --> 00:05:45,680

from the public services office at jpl

125

00:05:48,629 --> 00:05:47,120

i want to thank you all for joining us

126
00:05:49,670 --> 00:05:48,639
for this edition of the von carmen

127
00:05:51,430 --> 00:05:49,680
series

128
00:05:53,670 --> 00:05:51,440
as you saw in our intro video tonight

129
00:05:55,990 --> 00:05:53,680
we're going to be talking about psyche

130
00:05:57,909 --> 00:05:56,000
both the asteroid and the mission the

131
00:06:00,150 --> 00:05:57,919
asteroid is potentially the core of a

132
00:06:01,830 --> 00:06:00,160
former planet and the spacecraft will be

133
00:06:03,590 --> 00:06:01,840
sent to explore it

134
00:06:05,430 --> 00:06:03,600
helping me out tonight as our co-host

135
00:06:08,309 --> 00:06:05,440
public outreach specialist lindsay

136
00:06:10,070 --> 00:06:08,319
mclaren hi lindsay

137
00:06:11,749 --> 00:06:10,080
hi mark thank you so much for having me

138
00:06:13,270 --> 00:06:11,759

tonight and to everyone watching from

139

00:06:15,590 --> 00:06:13,280

home we just want to remind you that

140

00:06:16,550 --> 00:06:15,600

this is your space program and we really

141

00:06:18,309 --> 00:06:16,560

want you to be involved in the

142

00:06:19,990 --> 00:06:18,319

conversation tonight

143

00:06:21,670 --> 00:06:20,000

so from wherever you're joining us use

144

00:06:23,590 --> 00:06:21,680

the chat feature to ask questions and

145

00:06:25,990 --> 00:06:23,600

one of our members of our amazing social

146

00:06:28,309 --> 00:06:26,000

media team will get them to us we'll try

147

00:06:29,670 --> 00:06:28,319

to answer as many questions as possible

148

00:06:31,670 --> 00:06:29,680

and for some reason if you don't see the

149

00:06:34,629 --> 00:06:31,680

chat simply refresh your browser and it

150

00:06:36,790 --> 00:06:34,639

should be there let's get started mark

151

00:06:38,950 --> 00:06:36,800

thank you so much lindsay

152

00:06:40,710 --> 00:06:38,960

so to tell us more about both psyches is

153

00:06:42,950 --> 00:06:40,720

our very special guest tonight the

154

00:06:46,309 --> 00:06:42,960

psyche principal investigator

155

00:06:48,150 --> 00:06:46,319

dr lindy elkins tanton good evening

156

00:06:49,749 --> 00:06:48,160

lindy thank you so much for joining us

157

00:06:51,749 --> 00:06:49,759

tonight

158

00:06:52,950 --> 00:06:51,759

hi it's great to be here thank you so

159

00:06:54,309 --> 00:06:52,960

much

160

00:06:55,110 --> 00:06:54,319

it's our pleasure it's our honor thank

161

00:06:56,469 --> 00:06:55,120

you

162

00:06:58,150 --> 00:06:56,479

so

163

00:06:59,909 --> 00:06:58,160

one of the first questions i like to ask

164

00:07:01,270 --> 00:06:59,919

when we do these things is for all the

165

00:07:04,469 --> 00:07:01,280

students out there that might be

166

00:07:06,710 --> 00:07:04,479

watching tell us about what inspired you

167

00:07:07,990 --> 00:07:06,720

to become a scientist

168

00:07:09,830 --> 00:07:08,000

um

169

00:07:11,909 --> 00:07:09,840

you know i i think in some ways i was

170

00:07:14,070 --> 00:07:11,919

kind of born a scientist i grew up in a

171

00:07:15,270 --> 00:07:14,080

family where we were just interested in

172

00:07:17,510 --> 00:07:15,280

i mean i guess

173

00:07:19,510 --> 00:07:17,520

the currency of our family was interest

174

00:07:21,510 --> 00:07:19,520

and so be interested in music be

175

00:07:23,830 --> 00:07:21,520

interested in art be interested in

176
00:07:25,589 --> 00:07:23,840
nature and my dad would walk us around

177
00:07:28,070 --> 00:07:25,599
the yard and teach us the latin names of

178
00:07:29,670 --> 00:07:28,080
plants and stuff um the thing i didn't

179
00:07:30,390 --> 00:07:29,680
know was what kind of scientist i wanted

180
00:07:32,469 --> 00:07:30,400
to be

181
00:07:35,189 --> 00:07:32,479
and maybe i'm still not totally sure

182
00:07:37,110 --> 00:07:35,199
what kind of scientist i wanted to be

183
00:07:38,550 --> 00:07:37,120
but it came along and i and i moved kind

184
00:07:40,950 --> 00:07:38,560
of from biology to earth science and

185
00:07:42,710 --> 00:07:40,960
then into planetary science there just

186
00:07:44,869 --> 00:07:42,720
are always bigger and bigger questions

187
00:07:47,110 --> 00:07:44,879
to ask and that's the thrill of science

188
00:07:49,350 --> 00:07:47,120

to me

189

00:07:50,150 --> 00:07:49,360

well that's cool that's a great answer

190

00:07:54,230 --> 00:07:50,160

so

191

00:07:56,790 --> 00:07:54,240

being the potential core of a planet

192

00:07:58,150 --> 00:07:56,800

i think the appeal to explore

193

00:07:59,830 --> 00:07:58,160

psyche just might be obvious i mean

194

00:08:02,309 --> 00:07:59,840

that's the coolest thing ever

195

00:08:04,550 --> 00:08:02,319

the core of a planet but right i mean

196

00:08:07,350 --> 00:08:04,560

that's just crazy um but how did you get

197

00:08:10,390 --> 00:08:07,360

involved in the project

198

00:08:12,550 --> 00:08:10,400

well i had really never contemplated

199

00:08:15,189 --> 00:08:12,560

leading a mission or proposing a mission

200

00:08:18,070 --> 00:08:15,199

in the hopes of leading a mission but i

201
00:08:19,830 --> 00:08:18,080
was studying how planets form and my

202
00:08:22,710 --> 00:08:19,840
friends and colleagues and i ben weiss

203
00:08:24,710 --> 00:08:22,720
and maria zuber and i wrote a paper that

204
00:08:26,790 --> 00:08:24,720
had to do with the formation of the very

205
00:08:28,790 --> 00:08:26,800
first tiny bodies in the solar system

206
00:08:31,670 --> 00:08:28,800
these are called planetesimals it means

207
00:08:34,469 --> 00:08:31,680
tiny planets that were just tens to

208
00:08:36,230 --> 00:08:34,479
hundreds of miles across and they formed

209
00:08:37,829 --> 00:08:36,240
really fast early in the solar system

210
00:08:39,829 --> 00:08:37,839
and they're basically where the material

211
00:08:41,589 --> 00:08:39,839
from which our big planets were built i

212
00:08:45,110 --> 00:08:41,599
wrote a paper about this

213
00:08:47,509 --> 00:08:45,120

and i got an email from a couple of guys

214

00:08:50,230 --> 00:08:47,519

at jpl daniel weinkert and bruce bill

215

00:08:51,750 --> 00:08:50,240

saying let's propose a mission to test

216

00:08:53,190 --> 00:08:51,760

this hypothesis that's what i was

217

00:08:55,430 --> 00:08:53,200

talking about in the video when i said

218

00:08:57,990 --> 00:08:55,440

about testing our hypotheses and so we

219

00:08:59,350 --> 00:08:58,000

started working on it then and and and

220

00:09:01,350 --> 00:08:59,360

we didn't even know we weren't even

221

00:09:03,350 --> 00:09:01,360

focused on the asteroid psyche at that

222

00:09:06,070 --> 00:09:03,360

moment we were just looking for a place

223

00:09:07,750 --> 00:09:06,080

to learn about those early planetesimals

224

00:09:10,870 --> 00:09:07,760

and we decided in the end that this

225

00:09:13,670 --> 00:09:10,880

mysterious really truly unknown asteroid

226

00:09:15,110 --> 00:09:13,680

psyche was the place to go

227

00:09:16,470 --> 00:09:15,120

oh that's super cool that's got to be

228

00:09:18,070 --> 00:09:16,480

such a great feeling to have your

229

00:09:21,269 --> 00:09:18,080

proposal accepted and know you're going

230

00:09:22,710 --> 00:09:21,279

to start this journey so cool so tell us

231

00:09:24,630 --> 00:09:22,720

more about it tell us more about the

232

00:09:27,030 --> 00:09:24,640

mission

233

00:09:28,790 --> 00:09:27,040

yeah well as we famously always start

234

00:09:30,310 --> 00:09:28,800

these descriptions that psyche is both

235

00:09:31,590 --> 00:09:30,320

the name of the asteroid and the name of

236

00:09:33,910 --> 00:09:31,600

the mission we're trying to make it

237

00:09:36,310 --> 00:09:33,920

really easy for people to remember

238

00:09:40,550 --> 00:09:36,320

what it was about and so it's a robotic

239

00:09:43,590 --> 00:09:40,560

spacecraft and our launch um our launch

240

00:09:45,910 --> 00:09:43,600

period opens in under a year on august

241

00:09:47,750 --> 00:09:45,920

1st 2022 that's our first option to

242

00:09:50,150 --> 00:09:47,760

launch we're going to launch we'll

243

00:09:51,670 --> 00:09:50,160

cruise through space for 3.4 years until

244

00:09:53,430 --> 00:09:51,680

we reach the asteroid and then we're

245

00:09:55,910 --> 00:09:53,440

going to orbit it for 21 months and try

246

00:09:58,230 --> 00:09:55,920

to figure out what it is and we've been

247

00:10:00,790 --> 00:09:58,240

describing it so far as

248

00:10:03,430 --> 00:10:00,800

maybe the core of a planetesimal that

249

00:10:05,509 --> 00:10:03,440

got some of the outside rock knocked off

250

00:10:06,550 --> 00:10:05,519

it through collisions but the truth is

251
00:10:08,150 --> 00:10:06,560
and here's something i'm going to say a

252
00:10:10,310 --> 00:10:08,160
couple times

253
00:10:12,790 --> 00:10:10,320
we don't really know we don't really

254
00:10:14,550 --> 00:10:12,800
know all right so let's talk about uh

255
00:10:17,829 --> 00:10:14,560
should we go should we go to the slides

256
00:10:19,430 --> 00:10:17,839
now go for it jump in all right so what

257
00:10:20,710 --> 00:10:19,440
we're showing you right here after that

258
00:10:24,069 --> 00:10:20,720
little intro

259
00:10:25,430 --> 00:10:24,079
uh is the orientale basin on the moon in

260
00:10:26,870 --> 00:10:25,440
case any of you thought this was psyche

261
00:10:29,110 --> 00:10:26,880
this is not psyche we haven't seen

262
00:10:30,470 --> 00:10:29,120
psyche in anything like this detail

263
00:10:32,150 --> 00:10:30,480

it's on the limb of the moon it's not

264

00:10:33,990 --> 00:10:32,160

quite in sight of the earth and this is

265

00:10:36,069 --> 00:10:34,000

my favorite lunar impact base and i

266

00:10:37,590 --> 00:10:36,079

encourage you to have a favorite basin

267

00:10:39,030 --> 00:10:37,600

this is a really good one

268

00:10:41,430 --> 00:10:39,040

we have this photo thanks to lunar

269

00:10:43,990 --> 00:10:41,440

orbiter 4 which is a robotic spacecraft

270

00:10:45,030 --> 00:10:44,000

it took this photo in 1967 when i was

271

00:10:47,269 --> 00:10:45,040

two

272

00:10:49,269 --> 00:10:47,279

and with other robotic spacecraft we've

273

00:10:50,870 --> 00:10:49,279

sworn many rocky bodies in our solar

274

00:10:53,590 --> 00:10:50,880

system that's the point of my starting

275

00:10:55,430 --> 00:10:53,600

here a primary rocky target besides the

276

00:10:57,030 --> 00:10:55,440

moon is of course mars which i'll show

277

00:10:59,430 --> 00:10:57,040

on the next slide

278

00:11:01,110 --> 00:10:59,440

and so here is burns cliff on mars what

279

00:11:03,990 --> 00:11:01,120

a graph by the rover opportunity in

280

00:11:05,670 --> 00:11:04,000

2004. roger burns for whom this was

281

00:11:07,350 --> 00:11:05,680

named was a wonderful person and someone

282

00:11:09,750 --> 00:11:07,360

i knew i took classes for him when i was

283

00:11:11,350 --> 00:11:09,760

an undergraduate so these places the

284

00:11:13,190 --> 00:11:11,360

pictures of the moon the pictures of

285

00:11:14,710 --> 00:11:13,200

mars familiar from decades of

286

00:11:16,710 --> 00:11:14,720

photographs they begin to feel like part

287

00:11:18,630 --> 00:11:16,720

of our natural landscapes

288

00:11:21,269 --> 00:11:18,640

we've also visited planets made of ice

289

00:11:24,389 --> 00:11:21,279

or gas like jupiter on the next slide

290

00:11:25,190 --> 00:11:24,399

we'll show you the beautiful red spot uh

291

00:11:26,790 --> 00:11:25,200

shown

292

00:11:29,990 --> 00:11:26,800

a photo taken from by the juno

293

00:11:33,269 --> 00:11:30,000

spacecraft in 2019 and we visited icy

294

00:11:34,870 --> 00:11:33,279

moons like europa on the next slide

295

00:11:38,470 --> 00:11:34,880

shown here in a photo taken by the

296

00:11:41,350 --> 00:11:38,480

galileo spacecraft in 1996 and so rock

297

00:11:43,509 --> 00:11:41,360

and gas and ice but not yet have we ever

298

00:11:45,910 --> 00:11:43,519

visited a metallic world a world that

299

00:11:47,190 --> 00:11:45,920

had metal on its surface so this is the

300

00:11:48,710 --> 00:11:47,200

the point i'm trying to make here is

301
00:11:51,110 --> 00:11:48,720
that these all these images become

302
00:11:53,829 --> 00:11:51,120
familiar to those of us who love space

303
00:11:56,150 --> 00:11:53,839
but we don't have any photos of psyche

304
00:11:59,110 --> 00:11:56,160
so in the next slide i'll show you what

305
00:12:00,870 --> 00:11:59,120
we think that the asteroid 16 psyche is

306
00:12:03,590 --> 00:12:00,880
we think it's largely made of metal

307
00:12:06,310 --> 00:12:03,600
there are about 40 asteroids classified

308
00:12:08,069 --> 00:12:06,320
as m-type meaning their reflected light

309
00:12:10,550 --> 00:12:08,079
spectra the light that reflects back to

310
00:12:13,350 --> 00:12:10,560
the earth look the same as psyches and

311
00:12:15,110 --> 00:12:13,360
of those only about 10 are candidates

312
00:12:17,430 --> 00:12:15,120
really to be made of metal and psyche is

313
00:12:19,750 --> 00:12:17,440

the largest of these we think that

314

00:12:22,710 --> 00:12:19,760

psyche is actually between 30 and 60

315

00:12:25,509 --> 00:12:22,720

percent metal and tracy drain our

316

00:12:27,269 --> 00:12:25,519

fabulous she's our deputy uh systems

317

00:12:30,470 --> 00:12:27,279

engineer she's gone on to work on europa

318

00:12:31,750 --> 00:12:30,480

clipper in that video she said maybe 90

319

00:12:33,910 --> 00:12:31,760

metal and at the time we wrote the

320

00:12:36,550 --> 00:12:33,920

proposal that was the best data now it

321

00:12:38,470 --> 00:12:36,560

looks like maybe 30 to 60 percent metal

322

00:12:40,310 --> 00:12:38,480

although if it has a lot of pore space

323

00:12:42,470 --> 00:12:40,320

and fractures and it's really a rebel

324

00:12:44,470 --> 00:12:42,480

pile it could be still as high as 80

325

00:12:46,629 --> 00:12:44,480

metal we don't know

326

00:12:49,430 --> 00:12:46,639

and so what else won't we know until we

327

00:12:51,030 --> 00:12:49,440

get there well almost everything

328

00:12:52,870 --> 00:12:51,040

most especially we won't know what the

329

00:12:54,790 --> 00:12:52,880

asteroid looks like until we get there

330

00:12:57,110 --> 00:12:54,800

we have no images of psyche that were

331

00:12:59,110 --> 00:12:57,120

taken closer than from the earth and so

332

00:13:02,069 --> 00:12:59,120

this is an artist's impression by peter

333

00:13:03,910 --> 00:13:02,079

rubin based on our best scientific ideas

334

00:13:04,829 --> 00:13:03,920

now here is what psyche really looks

335

00:13:07,590 --> 00:13:04,839

like from

336

00:13:08,389 --> 00:13:07,600

earth uh if you move to the next slide

337

00:13:10,310 --> 00:13:08,399

now

338

00:13:13,430 --> 00:13:10,320

uh this is this photo of psyche that was

339

00:13:15,110 --> 00:13:13,440

taken from my backyard back in 2017 uh

340

00:13:16,629 --> 00:13:15,120

just after we were selected and we knew

341

00:13:18,230 --> 00:13:16,639

we were going to really do this although

342

00:13:20,150 --> 00:13:18,240

honestly psyche doesn't look that much

343

00:13:22,230 --> 00:13:20,160

different through mount wilson's 60-inch

344

00:13:23,910 --> 00:13:22,240

telescope it's just a point of light so

345

00:13:26,470 --> 00:13:23,920

far away and of course that's what the

346

00:13:27,829 --> 00:13:26,480

word asteroid means it means little star

347

00:13:29,670 --> 00:13:27,839

because that's what they looked like to

348

00:13:32,389 --> 00:13:29,680

the first people who discovered them in

349

00:13:33,110 --> 00:13:32,399

the early 19 early 1800s

350

00:13:34,790 --> 00:13:33,120

so

351

00:13:37,430 --> 00:13:34,800

even though it's just a point of light

352

00:13:39,350 --> 00:13:37,440

psyche is large as asteroids go as

353

00:13:41,910 --> 00:13:39,360

you'll see in the next slide

354

00:13:45,110 --> 00:13:41,920

um psyche is not quite a sphere but if

355

00:13:47,350 --> 00:13:45,120

it was its diameter would be about 226

356

00:13:49,590 --> 00:13:47,360

kilometers and here's how the size

357

00:13:51,750 --> 00:13:49,600

compares to the distances between cities

358

00:13:52,949 --> 00:13:51,760

in southern california and in arizona

359

00:13:54,710 --> 00:13:52,959

where i live

360

00:13:55,910 --> 00:13:54,720

psyches about the size of massachusetts

361

00:13:57,269 --> 00:13:55,920

without the cape

362

00:13:59,110 --> 00:13:57,279

uh it's just a little smaller than

363

00:14:01,670 --> 00:13:59,120

switzerland

364

00:14:03,829 --> 00:14:01,680

and so let me show you now the very best

365

00:14:06,629 --> 00:14:03,839

images we have of psyche

366

00:14:09,550 --> 00:14:06,639

these images on this next slide are

367

00:14:11,670 --> 00:14:09,560

taken using sphere the

368

00:14:13,910 --> 00:14:11,680

spectropolarimetric high contrast

369

00:14:15,829 --> 00:14:13,920

exoplanet research instrument here

370

00:14:18,069 --> 00:14:15,839

turned not toward exoplanets but toward

371

00:14:20,150 --> 00:14:18,079

this little asteroid psyche it's part of

372

00:14:21,829 --> 00:14:20,160

the european southern observatory now

373

00:14:23,430 --> 00:14:21,839

these are pictures of psyche at

374

00:14:25,189 --> 00:14:23,440

different times so you can see how the

375

00:14:28,230 --> 00:14:25,199

shape apparently changes as psyche

376

00:14:29,350 --> 00:14:28,240

rotates which psyche rotates every 4.2

377

00:14:31,990 --> 00:14:29,360

hours

378

00:14:35,110 --> 00:14:32,000

also by the way it goes around the sun

379

00:14:36,310 --> 00:14:35,120

once every 4.99 years just about five

380

00:14:37,670 --> 00:14:36,320

earth years

381

00:14:39,990 --> 00:14:37,680

you can see that psyche is really more

382

00:14:41,750 --> 00:14:40,000

of a potato shape than it is a sphere

383

00:14:43,590 --> 00:14:41,760

and so one of the main questions we have

384

00:14:45,269 --> 00:14:43,600

obviously as i've been talking it's

385

00:14:46,629 --> 00:14:45,279

probably becoming clear is what is

386

00:14:47,990 --> 00:14:46,639

psyche made of

387

00:14:49,910 --> 00:14:48,000

from the characteristics of its

388

00:14:51,590 --> 00:14:49,920

reflected light spectra almost all the

389

00:14:53,829 --> 00:14:51,600

researchers who studied it think its

390

00:14:55,750 --> 00:14:53,839

surface is largely made of metal and the

391

00:14:58,870 --> 00:14:55,760

density of the asteroid is high meaning

392

00:15:00,310 --> 00:14:58,880

that it can't be made just of rock

393

00:15:02,550 --> 00:15:00,320

one thing we can do

394

00:15:04,389 --> 00:15:02,560

is compare the density and the spectra

395

00:15:06,069 --> 00:15:04,399

that reflected light of meteorites we

396

00:15:08,310 --> 00:15:06,079

have here on earth and see if any of

397

00:15:10,389 --> 00:15:08,320

them match the asteroid most meteorites

398

00:15:12,790 --> 00:15:10,399

fault that fall to earth have come from

399

00:15:15,269 --> 00:15:12,800

the relatively recent past from the

400

00:15:16,949 --> 00:15:15,279

asteroid belt and so the meteorites we

401
00:15:18,389 --> 00:15:16,959
have only a few of them come from mars

402
00:15:19,990 --> 00:15:18,399
or the moon most of them come right from

403
00:15:22,150 --> 00:15:20,000
the asteroid belt

404
00:15:24,310 --> 00:15:22,160
so there's one really interesting match

405
00:15:27,189 --> 00:15:24,320
with meteorites that matches psyche in

406
00:15:30,870 --> 00:15:27,199
the next slide these are very strange

407
00:15:33,110 --> 00:15:30,880
meteorites called the cb chondrites

408
00:15:35,269 --> 00:15:33,120
in these two samples the light gray that

409
00:15:37,509 --> 00:15:35,279
you see is iron nickel metal and the

410
00:15:39,509 --> 00:15:37,519
darker parts are silicate rock

411
00:15:41,110 --> 00:15:39,519
there is a lot of metal in these

412
00:15:43,430 --> 00:15:41,120
meteorites and their density and their

413
00:15:44,949 --> 00:15:43,440

spectra is a good fit for psyche but

414

00:15:47,110 --> 00:15:44,959

because these two samples in the

415

00:15:49,509 --> 00:15:47,120

pictures here are really hand sample

416

00:15:50,629 --> 00:15:49,519

sized they're not the size of an

417

00:15:52,550 --> 00:15:50,639

asteroid

418

00:15:54,790 --> 00:15:52,560

here it looks like the rock and the

419

00:15:57,030 --> 00:15:54,800

metal would be very intimately mixed

420

00:15:59,189 --> 00:15:57,040

it's also possible that the metal would

421

00:16:01,590 --> 00:15:59,199

appear in great patches if it really is

422

00:16:03,990 --> 00:16:01,600

the part of a core we don't know

423

00:16:06,629 --> 00:16:04,000

and so how might a metal rich body like

424

00:16:09,030 --> 00:16:06,639

psyche form let's talk about the theory

425

00:16:11,829 --> 00:16:09,040

in the next slide

426

00:16:14,150 --> 00:16:11,839

now start at the top left that big green

427

00:16:15,590 --> 00:16:14,160

circle on the top left very early in the

428

00:16:17,749 --> 00:16:15,600

solar system as i mentioned the

429

00:16:20,310 --> 00:16:17,759

equivalent of just the first few seconds

430

00:16:22,710 --> 00:16:20,320

if our solar system were a year old

431

00:16:24,629 --> 00:16:22,720

tiny planets called planetesimals formed

432

00:16:26,870 --> 00:16:24,639

these planets as i was saying were just

433

00:16:28,550 --> 00:16:26,880

tens to hundreds of kilometers in radius

434

00:16:30,230 --> 00:16:28,560

so around the size of psyche and the

435

00:16:32,230 --> 00:16:30,240

other large asteroids

436

00:16:34,310 --> 00:16:32,240

some of the planetesimals had enough

437

00:16:37,110 --> 00:16:34,320

short-lived radioactive elements in them

438

00:16:38,629 --> 00:16:37,120

particularly this element aluminum 26

439

00:16:40,629 --> 00:16:38,639

that the heat of the radiation actually

440

00:16:42,069 --> 00:16:40,639

melted them like i'm showing in the top

441

00:16:44,069 --> 00:16:42,079

left image here

442

00:16:45,749 --> 00:16:44,079

inside these melted planetesimals the

443

00:16:47,509 --> 00:16:45,759

liquid metals drain to the center

444

00:16:49,030 --> 00:16:47,519

because of their density leaving the

445

00:16:51,590 --> 00:16:49,040

rock that i'm showing here in green

446

00:16:53,749 --> 00:16:51,600

outside that's what you see there and

447

00:16:55,590 --> 00:16:53,759

that planet is called then that process

448

00:16:57,670 --> 00:16:55,600

is called differentiation

449

00:17:00,470 --> 00:16:57,680

the planetesimal differentiated into a

450

00:17:03,030 --> 00:17:00,480

metal core and a rocky exterior so how

451
00:17:04,789 --> 00:17:03,040
do you create an asteroid with a metal

452
00:17:06,309 --> 00:17:04,799
surface from this starting point where

453
00:17:09,510 --> 00:17:06,319
the metal is really deeply in the

454
00:17:11,829 --> 00:17:09,520
interior we assume in our simplest model

455
00:17:13,909 --> 00:17:11,839
for what psyche might be that multiple

456
00:17:15,829 --> 00:17:13,919
impacts struck the planetesimal and

457
00:17:18,630 --> 00:17:15,839
smashed off parts until the core was

458
00:17:20,630 --> 00:17:18,640
revealed as you see on the top right

459
00:17:22,549 --> 00:17:20,640
uh that's our top hypothesis for what

460
00:17:24,949 --> 00:17:22,559
psyche might be we still think that is

461
00:17:26,789 --> 00:17:24,959
the simplest way to explain a body the

462
00:17:28,870 --> 00:17:26,799
size of psyche that has a very high

463
00:17:30,789 --> 00:17:28,880

metal content we think it's still a

464

00:17:33,110 --> 00:17:30,799

remnant a cracked open remnant of a

465

00:17:34,230 --> 00:17:33,120

planetesimal but if you look at the

466

00:17:36,950 --> 00:17:34,240

bottom

467

00:17:39,510 --> 00:17:36,960

there's also the possibility that psyche

468

00:17:41,350 --> 00:17:39,520

might be a planetesimal that never

469

00:17:43,110 --> 00:17:41,360

melted and differentiated here with this

470

00:17:45,270 --> 00:17:43,120

with these brown layers i'm indicating

471

00:17:47,270 --> 00:17:45,280

it just heated up it never melted

472

00:17:49,029 --> 00:17:47,280

very few meteorites

473

00:17:51,590 --> 00:17:49,039

from unmelted

474

00:17:53,270 --> 00:17:51,600

parent bodies have the right spectra

475

00:17:55,190 --> 00:17:53,280

or enough metal in them but it's

476

00:17:56,470 --> 00:17:55,200

plausible that psyche might be the

477

00:17:58,470 --> 00:17:56,480

battered remnants of something that

478

00:18:00,230 --> 00:17:58,480

never melted but was just very high in

479

00:18:01,909 --> 00:18:00,240

metal and in a way that would be even

480

00:18:04,470 --> 00:18:01,919

more surprising

481

00:18:06,710 --> 00:18:04,480

and so to summarize psyche might be a

482

00:18:08,789 --> 00:18:06,720

battered differentiated planetesimal

483

00:18:11,590 --> 00:18:08,799

showing its core its core being revealed

484

00:18:13,669 --> 00:18:11,600

from impacts or it might be an unmelted

485

00:18:15,750 --> 00:18:13,679

undifferentiated planet chest with a lot

486

00:18:17,909 --> 00:18:15,760

of metal in it so either way this is

487

00:18:19,830 --> 00:18:17,919

surprising and maybe i could maybe it

488

00:18:22,630 --> 00:18:19,840

might be clear at this moment to say why

489

00:18:24,870 --> 00:18:22,640

this is so intriguing to me because that

490

00:18:26,630 --> 00:18:24,880

top hypothesis it melted and

491

00:18:29,430 --> 00:18:26,640

differentiated and then was battered

492

00:18:31,669 --> 00:18:29,440

until the core showed is pretty unlikely

493

00:18:33,750 --> 00:18:31,679

it takes a lot of coincidence as many

494

00:18:35,909 --> 00:18:33,760

strikes that that knocked rock off

495

00:18:39,110 --> 00:18:35,919

without breaking it entirely apart or

496

00:18:41,270 --> 00:18:39,120

without uh mashing it into a larger body

497

00:18:43,510 --> 00:18:41,280

it's it's it's there's a little bit of

498

00:18:45,110 --> 00:18:43,520

unlikeliness in that top in that top one

499

00:18:47,350 --> 00:18:45,120

but the bottom one where it didn't melt

500

00:18:49,190 --> 00:18:47,360

at all but it still has a lot of metal

501
00:18:51,669 --> 00:18:49,200
we have very few samples that match that

502
00:18:54,070 --> 00:18:51,679
either so either one of these top ideas

503
00:18:55,590 --> 00:18:54,080
is pretty unlikely and so the key

504
00:18:57,750 --> 00:18:55,600
message i want to give you right now is

505
00:18:59,350 --> 00:18:57,760
though we have these ideas they're based

506
00:19:01,350 --> 00:18:59,360
on data they're based on good theory

507
00:19:02,950 --> 00:19:01,360
they're based on models we do not know

508
00:19:04,390 --> 00:19:02,960
them to be correct and when we get there

509
00:19:07,029 --> 00:19:04,400
we will be surprised it will be

510
00:19:09,029 --> 00:19:07,039
something we're not expecting

511
00:19:11,510 --> 00:19:09,039
so now in the next slide you can see

512
00:19:14,630 --> 00:19:11,520
what we were depicting with our cover

513
00:19:16,390 --> 00:19:14,640

art of our step two proposal before we

514

00:19:18,630 --> 00:19:16,400

won this was the cover the cover art

515

00:19:20,789 --> 00:19:18,640

also by peter rubin this is just after

516

00:19:22,950 --> 00:19:20,799

an impact between two planetesimals you

517

00:19:25,110 --> 00:19:22,960

can see the impactor screaming off to

518

00:19:26,870 --> 00:19:25,120

the bottom left and at the top right you

519

00:19:28,950 --> 00:19:26,880

see the red hot metal core of the

520

00:19:31,270 --> 00:19:28,960

planetesimal being revealed from under

521

00:19:33,430 --> 00:19:31,280

shrouds of disturbed rock so maybe this

522

00:19:35,510 --> 00:19:33,440

is what psyche is so let's move on to

523

00:19:38,150 --> 00:19:35,520

the mission itself

524

00:19:39,750 --> 00:19:38,160

the psyche mission is lead out of

525

00:19:42,470 --> 00:19:39,760

arizona state university which you'll

526

00:19:45,029 --> 00:19:42,480

see in the next slide where i am and

527

00:19:47,190 --> 00:19:45,039

managed by jet propulsion laboratory and

528

00:19:49,430 --> 00:19:47,200

our industry partner who built the

529

00:19:51,909 --> 00:19:49,440

chassis and the solar electric power

530

00:19:53,909 --> 00:19:51,919

system for the spacecraft is r

531

00:19:55,750 --> 00:19:53,919

we have three science instruments we're

532

00:19:56,710 --> 00:19:55,760

going to fly the payload

533

00:19:58,710 --> 00:19:56,720

um

534

00:20:00,950 --> 00:19:58,720

and a gravity science experiment the

535

00:20:02,390 --> 00:20:00,960

gamma ray and neutron spectrometer a

536

00:20:04,870 --> 00:20:02,400

kind of instrument i really didn't know

537

00:20:06,789 --> 00:20:04,880

much about before about 10 years ago

538

00:20:09,430 --> 00:20:06,799

will tell us the elemental composition

539

00:20:11,029 --> 00:20:09,440

of psyche surface while we're in orbit

540

00:20:13,830 --> 00:20:11,039

and that's being built by applied

541

00:20:15,270 --> 00:20:13,840

physics lab that instrument has recently

542

00:20:16,950 --> 00:20:15,280

been delivered to jet propulsion

543

00:20:19,990 --> 00:20:16,960

laboratory to be integrated onto the

544

00:20:22,470 --> 00:20:20,000

spacecraft and it is just about the

545

00:20:23,909 --> 00:20:22,480

finest one of its kind of instrument

546

00:20:25,669 --> 00:20:23,919

that's ever been built we're really

547

00:20:26,789 --> 00:20:25,679

excited about how that one's turned down

548

00:20:28,710 --> 00:20:26,799

full job

549

00:20:30,549 --> 00:20:28,720

the imagers that is the cameras come

550

00:20:32,549 --> 00:20:30,559

from male and space science systems and

551
00:20:34,870 --> 00:20:32,559
arizona state university and the

552
00:20:36,870 --> 00:20:34,880
magnetometers with which we'll find out

553
00:20:38,549 --> 00:20:36,880
did psyche have a magnetic field did it

554
00:20:40,070 --> 00:20:38,559
once have a core dynamo the way the

555
00:20:42,230 --> 00:20:40,080
earth did maybe

556
00:20:44,470 --> 00:20:42,240
uh or built come from danish technical

557
00:20:46,549 --> 00:20:44,480
university and the gravity experiment is

558
00:20:48,149 --> 00:20:46,559
led out of mit so these three

559
00:20:49,430 --> 00:20:48,159
experiments in the gravity experiment

560
00:20:51,830 --> 00:20:49,440
together

561
00:20:54,070 --> 00:20:51,840
are enough to be able to answer these

562
00:20:56,070 --> 00:20:54,080
questions we're asking about psyche

563
00:20:58,149 --> 00:20:56,080

they were extremely carefully selected

564

00:21:00,310 --> 00:20:58,159

to be able to together

565

00:21:02,390 --> 00:21:00,320

decipher what psyche might be

566

00:21:03,750 --> 00:21:02,400

considering the very broad landscape of

567

00:21:05,190 --> 00:21:03,760

possibilities because if you think about

568

00:21:06,950 --> 00:21:05,200

it think back to those first slides i

569

00:21:08,789 --> 00:21:06,960

was showing we've been to the moon many

570

00:21:10,230 --> 00:21:08,799

times we've been to mars many times we

571

00:21:12,470 --> 00:21:10,240

have many many photographs of these

572

00:21:14,149 --> 00:21:12,480

places it's seldom that we go to a place

573

00:21:15,510 --> 00:21:14,159

where we have no photographs so we don't

574

00:21:16,390 --> 00:21:15,520

know what to expect so that's what we're

575

00:21:18,149 --> 00:21:16,400

doing

576

00:21:20,630 --> 00:21:18,159

we've worked really hard to unite these

577

00:21:22,549 --> 00:21:20,640

sub teams into one transparently

578

00:21:24,549 --> 00:21:22,559

communicative team and one of our big

579

00:21:27,029 --> 00:21:24,559

successes is jpl and maxar who've

580

00:21:29,029 --> 00:21:27,039

developed ways to work really seamlessly

581

00:21:32,230 --> 00:21:29,039

we're very excited that maxar is lending

582

00:21:33,909 --> 00:21:32,240

the solar electric expertise uh to jpl's

583

00:21:35,750 --> 00:21:33,919

expertise in this area and we're sending

584

00:21:37,350 --> 00:21:35,760

the first hall effect thruster outside

585

00:21:38,870 --> 00:21:37,360

of earth moon orbit

586

00:21:40,950 --> 00:21:38,880

so in the next slide you'll see what the

587

00:21:43,350 --> 00:21:40,960

how big the spacecraft and how it will

588

00:21:45,669 --> 00:21:43,360

look after it unfolds its solar arrays

589

00:21:47,270 --> 00:21:45,679

once it's in space you see the person to

590

00:21:49,909 --> 00:21:47,280

the left it's about the size of a

591

00:21:52,789 --> 00:21:49,919

singles tennis court and the solar rays

592

00:21:54,630 --> 00:21:52,799

will produce 20 kilowatts at earth orbit

593

00:21:56,390 --> 00:21:54,640

and only about one tenth of that by the

594

00:21:58,230 --> 00:21:56,400

time we're out at psyche because the

595

00:22:00,950 --> 00:21:58,240

because the uh sunlight is so much

596

00:22:02,630 --> 00:22:00,960

weaker at that distance

597

00:22:06,310 --> 00:22:02,640

the next slide you'll see

598

00:22:08,070 --> 00:22:06,320

an image of a spacex falcon heavy launch

599

00:22:10,470 --> 00:22:08,080

and we are going to be on a falcon heavy

600

00:22:13,029 --> 00:22:10,480

for all our launch out of cape canaveral

601
00:22:14,789 --> 00:22:13,039
uh spacex will be attempting to land the

602
00:22:17,190 --> 00:22:14,799
boosters that's a real personal thrill

603
00:22:19,110 --> 00:22:17,200
for me and again our launch period opens

604
00:22:20,549 --> 00:22:19,120
august 1st and so keep your fingers

605
00:22:22,070 --> 00:22:20,559
crossed we have so much work to do

606
00:22:23,909 --> 00:22:22,080
between now and then

607
00:22:26,710 --> 00:22:23,919
so in the next slide how do we make all

608
00:22:28,870 --> 00:22:26,720
this work it is all about the people

609
00:22:30,950 --> 00:22:28,880
people make all the miracles and people

610
00:22:33,270 --> 00:22:30,960
make all the tragedies

611
00:22:35,590 --> 00:22:33,280
so much of our effectiveness and success

612
00:22:37,830 --> 00:22:35,600
depends upon how we treat each other

613
00:22:39,430 --> 00:22:37,840

positive team culture matters it matters

614

00:22:41,830 --> 00:22:39,440

because when everyone is invited to be

615

00:22:43,830 --> 00:22:41,840

heard then more ideas are available

616

00:22:46,070 --> 00:22:43,840

calmer heads think better and better

617

00:22:47,669 --> 00:22:46,080

decisions are made and therefore project

618

00:22:50,549 --> 00:22:47,679

risk is reduced it's actually a

619

00:22:52,390 --> 00:22:50,559

significant way to reduce project risk

620

00:22:53,990 --> 00:22:52,400

this is a photo of just a small part of

621

00:22:55,590 --> 00:22:54,000

the team here in front of a max our

622

00:22:56,950 --> 00:22:55,600

building at our step two site visit

623

00:22:58,310 --> 00:22:56,960

before we won

624

00:22:59,830 --> 00:22:58,320

we've worked very hard to create this

625

00:23:01,909 --> 00:22:59,840

culture where we share our challenges

626
00:23:04,070 --> 00:23:01,919
and errors willingly and help people

627
00:23:05,750 --> 00:23:04,080
step in to help our relationship with

628
00:23:07,350 --> 00:23:05,760
nasa headquarters has been especially

629
00:23:09,350 --> 00:23:07,360
positive and supportive i think as a

630
00:23:11,750 --> 00:23:09,360
result of this policy we have an

631
00:23:14,070 --> 00:23:11,760
unofficial motto which is the best news

632
00:23:16,070 --> 00:23:14,080
is bad news brought early brought early

633
00:23:17,909 --> 00:23:16,080
so we can do something about it

634
00:23:19,510 --> 00:23:17,919
so think about that fundamental

635
00:23:21,830 --> 00:23:19,520
astonishment of being able to create a

636
00:23:23,750 --> 00:23:21,840
robot so complicated that no one person

637
00:23:25,750 --> 00:23:23,760
understands all of how it works this is

638
00:23:27,510 --> 00:23:25,760

this giant step in human evolution the

639

00:23:30,070 --> 00:23:27,520

ability to create a mechanism this

640

00:23:32,230 --> 00:23:30,080

complex and successful and i think part

641

00:23:35,190 --> 00:23:32,240

of the reason we explore space

642

00:23:37,510 --> 00:23:35,200

is to show how bold and brave we can be

643

00:23:39,110 --> 00:23:37,520

as a species and what we can do so if we

644

00:23:40,310 --> 00:23:39,120

can do this think of what we can do here

645

00:23:41,750 --> 00:23:40,320

on earth

646

00:23:43,669 --> 00:23:41,760

the next slide

647

00:23:46,070 --> 00:23:43,679

the next to last slide i'll show you

648

00:23:47,590 --> 00:23:46,080

that we are dedicated to outreach and

649

00:23:49,669 --> 00:23:47,600

student engagement for all of these very

650

00:23:51,510 --> 00:23:49,679

reasons if you look at this graph on the

651
00:23:53,430 --> 00:23:51,520
horizontal axis the one along the bottom

652
00:23:55,350 --> 00:23:53,440
is the timeline from the time we were

653
00:23:57,669 --> 00:23:55,360
selected in september actually were

654
00:23:58,870 --> 00:23:57,679
selected in january of 2017 but right

655
00:24:00,789 --> 00:23:58,880
that year when we got student

656
00:24:03,029 --> 00:24:00,799
collaborations going in september all

657
00:24:04,470 --> 00:24:03,039
the way up to may of 2021

658
00:24:06,630 --> 00:24:04,480
and on the vertical axis is the

659
00:24:09,750 --> 00:24:06,640
cumulative student participation every

660
00:24:11,430 --> 00:24:09,760
horizontal purple line is one student

661
00:24:12,710 --> 00:24:11,440
and the length of the line shows the

662
00:24:14,630 --> 00:24:12,720
time period over which they were

663
00:24:16,390 --> 00:24:14,640

involved so mostly students are involved

664

00:24:18,950 --> 00:24:16,400

during the school year these are college

665

00:24:21,190 --> 00:24:18,960

and university students but some

666

00:24:22,390 --> 00:24:21,200

students have gone on to work in fact

667

00:24:23,909 --> 00:24:22,400

some have been with us through the whole

668

00:24:26,630 --> 00:24:23,919

mission so far

669

00:24:28,070 --> 00:24:26,640

since we started in september of 2017

670

00:24:30,549 --> 00:24:28,080

nine months after selection we've had

671

00:24:33,029 --> 00:24:30,559

almost 900 students participate in our

672

00:24:35,510 --> 00:24:33,039

four student collaboration programs we

673

00:24:37,350 --> 00:24:35,520

have capstone projects where they're

674

00:24:39,350 --> 00:24:37,360

given real problems the psyche mission

675

00:24:41,430 --> 00:24:39,360

is facing from hardware to software

676
00:24:43,510 --> 00:24:41,440
public engagement and science we have 11

677
00:24:44,870 --> 00:24:43,520
universities working with us with

678
00:24:47,350 --> 00:24:44,880
capstone teams

679
00:24:49,510 --> 00:24:47,360
we have a psyche inspired art program we

680
00:24:51,590 --> 00:24:49,520
compete and then choose 16 student

681
00:24:53,190 --> 00:24:51,600
artists every year and they're supported

682
00:24:54,950 --> 00:24:53,200
then to create original artworks that

683
00:24:57,830 --> 00:24:54,960
have to do with space exploration and

684
00:25:00,230 --> 00:24:57,840
psyche and being part of a team we've

685
00:25:03,029 --> 00:25:00,240
engaged 30 universities in that program

686
00:25:04,950 --> 00:25:03,039
we also have free online courses in the

687
00:25:07,029 --> 00:25:04,960
evolution and life cycle of a space

688
00:25:08,870 --> 00:25:07,039

mission and in creating inclusive teams

689

00:25:10,549 --> 00:25:08,880

and those are available through our

690

00:25:13,029 --> 00:25:10,559

psyche website which i will show you on

691

00:25:15,190 --> 00:25:13,039

the next slide our final slide

692

00:25:17,110 --> 00:25:15,200

i want to thank you all so much for your

693

00:25:19,830 --> 00:25:17,120

time today and i hope you'll join us on

694

00:25:22,549 --> 00:25:19,840

twitter face facebook and instagram and

695

00:25:25,190 --> 00:25:22,559

and and on our website uh for psyche the

696

00:25:28,310 --> 00:25:25,200

journey to a metal rich world thank you

697

00:25:30,710 --> 00:25:28,320

so much

698

00:25:32,310 --> 00:25:30,720

wow lindy that's uh that's amazing thank

699

00:25:33,990 --> 00:25:32,320

you so much for sharing that with us and

700

00:25:35,430 --> 00:25:34,000

you know blasting through it in that

701
00:25:36,149 --> 00:25:35,440
short amount of time

702
00:25:37,990 --> 00:25:36,159
so

703
00:25:39,669 --> 00:25:38,000
um i think we'd like to go to see if we

704
00:25:41,110 --> 00:25:39,679
have any questions so lindsay how are

705
00:25:43,190 --> 00:25:41,120
things looking out there in the social

706
00:25:45,190 --> 00:25:43,200
media world

707
00:25:47,269 --> 00:25:45,200
we have had an abundant amount of

708
00:25:49,830 --> 00:25:47,279
questions for you lindy the first one is

709
00:25:52,390 --> 00:25:49,840
going to come from finn on facebook and

710
00:25:55,110 --> 00:25:52,400
he was wondering how do you determine

711
00:25:57,669 --> 00:25:55,120
what this particular rock is metal rich

712
00:25:59,590 --> 00:25:57,679
or likely to be

713
00:26:01,909 --> 00:25:59,600

that is such a great question how can we

714

00:26:04,310 --> 00:26:01,919

possibly tell from here what psyche is

715

00:26:06,230 --> 00:26:04,320

made of well the first clue that people

716

00:26:09,110 --> 00:26:06,240

have been looking at now for over a

717

00:26:11,190 --> 00:26:09,120

decade is the density of psyche it turns

718

00:26:13,110 --> 00:26:11,200

out we have ways to tell

719

00:26:14,789 --> 00:26:13,120

when asteroids have very small

720

00:26:18,310 --> 00:26:14,799

gravitational interactions with other

721

00:26:20,710 --> 00:26:18,320

bodies and by guessing at their size

722

00:26:22,710 --> 00:26:20,720

estimating their size and knowing the

723

00:26:24,390 --> 00:26:22,720

gravitational interaction between bodies

724

00:26:26,390 --> 00:26:24,400

we can know both their volume

725

00:26:27,430 --> 00:26:26,400

and their mass and that gives their

726
00:26:29,990 --> 00:26:27,440
density

727
00:26:32,390 --> 00:26:30,000
and if you remember those best images i

728
00:26:35,830 --> 00:26:32,400
have of psyche that i showed

729
00:26:38,230 --> 00:26:35,840
the many different images of it rotating

730
00:26:40,470 --> 00:26:38,240
you could see how using a computer model

731
00:26:43,029 --> 00:26:40,480
you could get the volume of psyche from

732
00:26:44,950 --> 00:26:43,039
those images so then we get the density

733
00:26:47,350 --> 00:26:44,960
now we know how dense rock is we know

734
00:26:49,669 --> 00:26:47,360
how dense metal is metal is twice as

735
00:26:50,710 --> 00:26:49,679
dense as rock

736
00:26:52,070 --> 00:26:50,720
yeah we're going to go look at those

737
00:26:52,950 --> 00:26:52,080
pictures which is great i think that

738
00:26:54,870 --> 00:26:52,960

they're

739

00:26:57,430 --> 00:26:54,880

earlier in the than you started there we

740

00:27:00,149 --> 00:26:57,440

go those guys so using a computer model

741

00:27:01,430 --> 00:27:00,159

of those you can estimate the volume and

742

00:27:02,789 --> 00:27:01,440

looking at the gravitational

743

00:27:04,390 --> 00:27:02,799

interactions between psyche and other

744

00:27:05,990 --> 00:27:04,400

bodies you can get the mass and that way

745

00:27:07,990 --> 00:27:06,000

you get the density and i should say

746

00:27:09,590 --> 00:27:08,000

that this team beacon koski has done a

747

00:27:10,870 --> 00:27:09,600

super job but there are three or four

748

00:27:12,149 --> 00:27:10,880

other teams who've also done it

749

00:27:14,950 --> 00:27:12,159

independently

750

00:27:16,390 --> 00:27:14,960

they agree within say 10 to 30 so we

751
00:27:18,549 --> 00:27:16,400
don't really know exactly what the

752
00:27:20,870 --> 00:27:18,559
density is but we know psyche is too

753
00:27:23,190 --> 00:27:20,880
dense to be just rock it has to be rock

754
00:27:24,789 --> 00:27:23,200
plus metal so we know that for sure and

755
00:27:26,549 --> 00:27:24,799
the next thing we do is we look at the

756
00:27:28,149 --> 00:27:26,559
reflected light off the surface you can

757
00:27:29,830 --> 00:27:28,159
just look at it through a telescope and

758
00:27:32,789 --> 00:27:29,840
analyze the light cut that comes in the

759
00:27:35,669 --> 00:27:32,799
telescope and see whether it has the

760
00:27:37,669 --> 00:27:35,679
same spectral characteristic as sunlight

761
00:27:39,430 --> 00:27:37,679
or if material on psyche is actually

762
00:27:41,430 --> 00:27:39,440
absorbing some of that light rather than

763
00:27:44,149 --> 00:27:41,440

reflecting it off and we can compare

764

00:27:47,190 --> 00:27:44,159

that spectra to meteorites and to pure

765

00:27:49,510 --> 00:27:47,200

materials this is work that jim bell and

766

00:27:51,669 --> 00:27:49,520

dibber doing an asu in particular and it

767

00:27:53,750 --> 00:27:51,679

does look like the spectrum matches

768

00:27:55,190 --> 00:27:53,760

something that is very rich in metal so

769

00:27:57,029 --> 00:27:55,200

those are two really good ways you can

770

00:27:59,110 --> 00:27:57,039

also look at radar bounces if you can

771

00:28:01,190 --> 00:27:59,120

believe it we can actually bounce radar

772

00:28:03,669 --> 00:28:01,200

sadly this was done mostly with arecibo

773

00:28:05,350 --> 00:28:03,679

now crushed uh through the loss of its

774

00:28:07,269 --> 00:28:05,360

towers uh

775

00:28:08,389 --> 00:28:07,279

this is to me a miracle anybody who's

776

00:28:10,149 --> 00:28:08,399

listening who doesn't know about this

777

00:28:11,909 --> 00:28:10,159

maybe you'll be amazed as i as i was

778

00:28:14,070 --> 00:28:11,919

when i first learned about this they can

779

00:28:16,470 --> 00:28:14,080

actually bounce a radar beam from

780

00:28:17,990 --> 00:28:16,480

arecibo off of psyche

781

00:28:20,310 --> 00:28:18,000

three times further from the sun than

782

00:28:22,789 --> 00:28:20,320

earth is and catch the return from the

783

00:28:24,549 --> 00:28:22,799

reflection off of of psyche and tell

784

00:28:26,230 --> 00:28:24,559

things about the characteristics of its

785

00:28:29,190 --> 00:28:26,240

surface from the kind of radar that's

786

00:28:31,110 --> 00:28:29,200

returned so all those pieces of data

787

00:28:46,149 --> 00:28:31,120

amazingly gathered by us here on earth

788

00:28:50,230 --> 00:28:49,029

yes our next question comes from medea27

789

00:28:51,750 --> 00:28:50,240
on youtube

790

00:28:54,149 --> 00:28:51,760
and they would like to know how do you

791

00:28:56,310 --> 00:28:54,159
manage the integration of the work of so

792

00:28:57,350 --> 00:28:56,320
many different teams

793

00:28:58,789 --> 00:28:57,360
oh

794

00:29:00,149 --> 00:28:58,799
yeah this is something i'm learning

795

00:29:01,909 --> 00:29:00,159
about because it's not something i was

796

00:29:04,230 --> 00:29:01,919
trained in for this you need your

797

00:29:06,070 --> 00:29:04,240
professional project manager for us it's

798

00:29:08,070 --> 00:29:06,080
henry stone at jet propulsion laboratory

799

00:29:10,389 --> 00:29:08,080
and you saw him in that video uh

800

00:29:11,510 --> 00:29:10,399
fantastic person to work with you could

801
00:29:14,230 --> 00:29:11,520

imagine

802
00:29:16,230 --> 00:29:14,240

how much study has gone into the theory

803
00:29:17,269 --> 00:29:16,240

of how you get teams of people to work

804
00:29:20,710 --> 00:29:17,279

like this

805
00:29:23,430 --> 00:29:20,720

and one of the ways uh that it happens

806
00:29:25,110 --> 00:29:23,440

is through the system of requirements so

807
00:29:26,870 --> 00:29:25,120

starting from the very top there are

808
00:29:28,950 --> 00:29:26,880

five main science things we want to

809
00:29:30,710 --> 00:29:28,960

answer on this mission and we write down

810
00:29:33,110 --> 00:29:30,720

exactly what measurements we need in

811
00:29:35,110 --> 00:29:33,120

order to answer those three those five

812
00:29:37,350 --> 00:29:35,120

science questions and then what we need

813
00:29:38,630 --> 00:29:37,360

to build for an instrument in order to

814

00:29:40,310 --> 00:29:38,640

make those measurements and then what

815

00:29:42,070 --> 00:29:40,320

kind of spacecraft we have to build in

816

00:29:43,990 --> 00:29:42,080

order to support those instruments and

817

00:29:46,070 --> 00:29:44,000

you go on and on and down in detail

818

00:29:47,590 --> 00:29:46,080

until you have requirements for every

819

00:29:49,909 --> 00:29:47,600

single little part of the spacecraft

820

00:29:51,669 --> 00:29:49,919

that needs to be built we have over 2000

821

00:29:53,510 --> 00:29:51,679

requirements for the mission and we

822

00:29:54,870 --> 00:29:53,520

check on every single one of them and

823

00:29:56,789 --> 00:29:54,880

all the teams that are building the

824

00:29:58,549 --> 00:29:56,799

spacecraft are united through this

825

00:30:00,070 --> 00:29:58,559

requirements tree to make sure that we

826

00:30:02,389 --> 00:30:00,080

build something that works exactly how

827

00:30:05,110 --> 00:30:02,399

we want that's one little part of the

828

00:30:07,269 --> 00:30:05,120

theory of uh project systems uh

829

00:30:09,430 --> 00:30:07,279

management that that goes into this at

830

00:30:10,470 --> 00:30:09,440

our peak we had 800 people working on

831

00:30:12,950 --> 00:30:10,480

the team

832

00:30:14,630 --> 00:30:12,960

and so you know to my sadness i don't

833

00:30:16,310 --> 00:30:14,640

even know everyone's name let alone be

834

00:30:18,230 --> 00:30:16,320

able to recognize them

835

00:30:19,909 --> 00:30:18,240

uh but we have this way of bringing

836

00:30:26,389 --> 00:30:19,919

everybody together i think it's

837

00:30:30,070 --> 00:30:27,669

thanks lindy

838

00:30:32,549 --> 00:30:30,080

our next question comes from ethan on

839

00:30:34,710 --> 00:30:32,559

linkedin and he would like to know why

840

00:30:37,110 --> 00:30:34,720

do you suspect that psyche is an old

841

00:30:41,029 --> 00:30:37,120

core

842

00:30:42,710 --> 00:30:41,039

all right so it goes back to that

843

00:30:44,950 --> 00:30:42,720

question of

844

00:30:46,470 --> 00:30:44,960

if we believe that it's mostly metal or

845

00:30:48,470 --> 00:30:46,480

largely metal

846

00:30:51,110 --> 00:30:48,480

we have to ask ourselves

847

00:30:53,510 --> 00:30:51,120

how in planet formation anywhere in the

848

00:30:56,950 --> 00:30:53,520

solar system do we see a situation where

849

00:30:59,190 --> 00:30:56,960

metal is really collected together in in

850

00:31:00,630 --> 00:30:59,200

in high concentration you know if you

851
00:31:02,870 --> 00:31:00,640
walk around on the surface of the earth

852
00:31:04,630 --> 00:31:02,880
and you pick up rocks very few of them

853
00:31:06,070 --> 00:31:04,640
are rich in metal you have to go to

854
00:31:08,070 --> 00:31:06,080
special places you know where there are

855
00:31:09,830 --> 00:31:08,080
mines and things like that and it turns

856
00:31:11,269 --> 00:31:09,840
out that here on earth on the surface

857
00:31:13,269 --> 00:31:11,279
when you find something that's made of a

858
00:31:16,070 --> 00:31:13,279
lot of metal it's usually because of the

859
00:31:18,070 --> 00:31:16,080
processes of water here on earth uh and

860
00:31:19,990 --> 00:31:18,080
so that doesn't really apply to us so on

861
00:31:21,110 --> 00:31:20,000
the planetary scale how do you get a lot

862
00:31:23,110 --> 00:31:21,120
of metal

863
00:31:25,430 --> 00:31:23,120

well the best way that we know is by

864

00:31:27,350 --> 00:31:25,440

core formation this process of melting

865

00:31:29,430 --> 00:31:27,360

and the sinking of that dense material

866

00:31:30,950 --> 00:31:29,440

to the inside of our planets that's

867

00:31:33,750 --> 00:31:30,960

what's inside the earth of course a

868

00:31:35,430 --> 00:31:33,760

great big metal core for the earth

869

00:31:37,029 --> 00:31:35,440

the inside of the core is solid metal

870

00:31:38,710 --> 00:31:37,039

and the outside is liquid metal that's

871

00:31:41,509 --> 00:31:38,720

how we get our magnetic field the

872

00:31:43,830 --> 00:31:41,519

magnetic dynamo is formed by the mixing

873

00:31:46,389 --> 00:31:43,840

of that liquid out of co outer core and

874

00:31:48,549 --> 00:31:46,399

by studying how planets spin

875

00:31:49,990 --> 00:31:48,559

and what their densities are we know

876

00:31:52,549 --> 00:31:50,000

that there's a metal core inside of

877

00:31:54,470 --> 00:31:52,559

mercury and venus and mars and the earth

878

00:31:55,669 --> 00:31:54,480

and also inside the moon there's a small

879

00:31:59,110 --> 00:31:55,679

metal core

880

00:32:01,909 --> 00:31:59,120

so that is seems like the most common

881

00:32:04,310 --> 00:32:01,919

planet-forming process that concentrates

882

00:32:05,590 --> 00:32:04,320

metal so that's why it's our top

883

00:32:07,669 --> 00:32:05,600

hypothesis

884

00:32:09,909 --> 00:32:07,679

but don't forget that there are these

885

00:32:11,830 --> 00:32:09,919

funny meteorites that also have high

886

00:32:13,909 --> 00:32:11,840

metal contents that never melted they

887

00:32:16,870 --> 00:32:13,919

just have a lot of metal maybe they

888

00:32:18,789 --> 00:32:16,880

formed close to the sun that's possible

889

00:32:20,070 --> 00:32:18,799

we might really learn about solar system

890

00:32:22,070 --> 00:32:20,080

processes

891

00:32:24,710 --> 00:32:22,080

that have to do with clumping up those

892

00:32:26,630 --> 00:32:24,720

first bits of dust and pebbles maybe in

893

00:32:28,310 --> 00:32:26,640

a metal rich way that we haven't quite

894

00:32:31,190 --> 00:32:28,320

figured out before maybe that's what

895

00:32:34,149 --> 00:32:31,200

psyche is but really what it comes down

896

00:32:35,750 --> 00:32:34,159

to is that creative aspect of science

897

00:32:37,990 --> 00:32:35,760

we're pretty sure there's a lot of metal

898

00:32:39,750 --> 00:32:38,000

in this asteroid now what are all of the

899

00:32:41,990 --> 00:32:39,760

processes we can think of that are

900

00:32:43,430 --> 00:32:42,000

chemically and physically plausible that

901
00:32:45,350 --> 00:32:43,440
would cause a lot of metal to come

902
00:32:47,190 --> 00:32:45,360
together and these are our favorite ones

903
00:32:49,350 --> 00:32:47,200
and i asked scientists in talks that i

904
00:32:51,430 --> 00:32:49,360
give all around the world how else could

905
00:32:53,269 --> 00:32:51,440
psyche be made and so we collect these

906
00:32:54,870 --> 00:32:53,279
ideas and we encourage people to think

907
00:32:59,750 --> 00:32:54,880
about it because probably it's something

908
00:33:05,190 --> 00:33:02,630
great thank you lindy tim on youtube

909
00:33:08,870 --> 00:33:05,200
asked do you have any idea what the mix

910
00:33:13,269 --> 00:33:10,630
well we again we go for what the

911
00:33:16,310 --> 00:33:13,279
simplest possible answer might be

912
00:33:17,830 --> 00:33:16,320
and if you think about core formation uh

913
00:33:19,509 --> 00:33:17,840

we're almost certain

914

00:33:20,950 --> 00:33:19,519

that the earth's core i mean we're

915

00:33:23,029 --> 00:33:20,960

certain as we could be there are many

916

00:33:25,350 --> 00:33:23,039

different indirect ways to measure

917

00:33:27,990 --> 00:33:25,360

characteristics of the earth core and it

918

00:33:29,509 --> 00:33:28,000

seems like it's it's mostly iron

919

00:33:31,669 --> 00:33:29,519

and some nickel

920

00:33:33,509 --> 00:33:31,679

and then a smattering of other light

921

00:33:35,750 --> 00:33:33,519

elements so

922

00:33:38,149 --> 00:33:35,760

iron is the most common

923

00:33:39,669 --> 00:33:38,159

heavy element that goes into metals in

924

00:33:41,430 --> 00:33:39,679

the solar system and so that would be

925

00:33:43,029 --> 00:33:41,440

your top candidate and then you look for

926

00:33:45,830 --> 00:33:43,039

other kinds of metal that might like to

927

00:33:48,070 --> 00:33:45,840

dissolve into iron and then you look at

928

00:33:49,830 --> 00:33:48,080

the iron meteorites that fall to earth

929

00:33:51,990 --> 00:33:49,840

there are meteorites that fall to earth

930

00:33:55,350 --> 00:33:52,000

that are made almost entirely or in some

931

00:33:57,110 --> 00:33:55,360

cases entirely of iron and nickel metal

932

00:33:58,710 --> 00:33:57,120

so that's what we think psyche is we

933

00:34:00,310 --> 00:33:58,720

think those iron meteorites that fall to

934

00:34:02,070 --> 00:34:00,320

earth are parts of cores of little

935

00:34:04,470 --> 00:34:02,080

planetesimals and i'm talking about hand

936

00:34:06,310 --> 00:34:04,480

samples or boulders the size of your

937

00:34:07,669 --> 00:34:06,320

desk and in a couple of cases there are

938

00:34:09,909 --> 00:34:07,679

even bigger ones like the size of a

939

00:34:12,149 --> 00:34:09,919

garden shed and they're all iron nickel

940

00:34:14,950 --> 00:34:12,159

metal it's mostly iron

941

00:34:16,869 --> 00:34:14,960

maybe two to ten percent nickel there's

942

00:34:18,869 --> 00:34:16,879

copper and then there are other kinds of

943

00:34:20,869 --> 00:34:18,879

metal elements mixed in as well so we

944

00:34:22,470 --> 00:34:20,879

look at that what's the simplest answer

945

00:34:23,909 --> 00:34:22,480

the simplest answer is that it would be

946

00:34:30,470 --> 00:34:23,919

like these meteorites are like the

947

00:34:35,349 --> 00:34:32,710

great thank you lindy and our last

948

00:34:37,349 --> 00:34:35,359

question will be will from musical

949

00:34:39,829 --> 00:34:37,359

wolves on youtube will a return core

950

00:34:43,909 --> 00:34:39,839

sample be made

951
00:34:46,310 --> 00:34:43,919
oh i wish i wish yeah and uh no we we're

952
00:34:48,149 --> 00:34:46,320
not doing a sample return sadly

953
00:34:49,510 --> 00:34:48,159
and so i i hope that you all have been

954
00:34:51,829 --> 00:34:49,520
have been following with great interest

955
00:34:54,790 --> 00:34:51,839
the osiris and rex mission that's gone

956
00:34:56,629 --> 00:34:54,800
to this small fascinating asteroid bennu

957
00:34:59,109 --> 00:34:56,639
and they're bringing back a sample and

958
00:35:00,950 --> 00:34:59,119
the hayabusa missions from jaxa the

959
00:35:03,990 --> 00:35:00,960
japanese space agency that are bringing

960
00:35:04,870 --> 00:35:04,000
back samples um and those are from

961
00:35:06,870 --> 00:35:04,880
uh

962
00:35:08,390 --> 00:35:06,880
bodies like asteroids and asteroids and

963
00:35:11,030 --> 00:35:08,400

other bodies that are quite close to the

964

00:35:12,550 --> 00:35:11,040

earth psyche is very far away it's way

965

00:35:14,870 --> 00:35:12,560

on the other side of mars it's actually

966

00:35:17,829 --> 00:35:14,880

closer to jupiter than it is to mars and

967

00:35:19,109 --> 00:35:17,839

to send a spacecraft out there land take

968

00:35:20,710 --> 00:35:19,119

a sample

969

00:35:23,349 --> 00:35:20,720

take off again and come all the way back

970

00:35:26,470 --> 00:35:23,359

to earth would be so expensive that we

971

00:35:28,710 --> 00:35:26,480

could not possibly afford to do it uh in

972

00:35:31,190 --> 00:35:28,720

the budget that we've got and so we're

973

00:35:33,829 --> 00:35:31,200

you know it's if nasa famously says that

974

00:35:35,750 --> 00:35:33,839

that uh that they start by doing a flyby

975

00:35:37,510 --> 00:35:35,760

of a new object and then you do an

976

00:35:39,190 --> 00:35:37,520

orbiter and then a lander and then a

977

00:35:40,790 --> 00:35:39,200

rover that's kind of the process by

978

00:35:42,470 --> 00:35:40,800

which you learn enough about a body to

979

00:35:44,310 --> 00:35:42,480

always take the next steps we're kind of

980

00:35:46,069 --> 00:35:44,320

skipping the flyby with with psyche and

981

00:35:48,470 --> 00:35:46,079

we're going right to orbiter so we'll

982

00:35:50,150 --> 00:35:48,480

orbit for 21 months but the spacecraft

983

00:35:52,710 --> 00:35:50,160

will not return to the earth and it will

984

00:35:53,750 --> 00:35:52,720

not bring any samples back to earth and

985

00:35:55,910 --> 00:35:53,760

um

986

00:35:58,550 --> 00:35:55,920

i just started today i started a little

987

00:36:00,550 --> 00:35:58,560

uh twitter series uh myth busting about

988

00:36:02,710 --> 00:36:00,560

psyche because there there's a there's a

989

00:36:05,190 --> 00:36:02,720

lot of speculation about it in the press

990

00:36:07,190 --> 00:36:05,200

and uh and i'm here to tell you that uh

991

00:36:09,750 --> 00:36:07,200

psyche is really never a target for

992

00:36:11,910 --> 00:36:09,760

returning to the earth it just would

993

00:36:13,670 --> 00:36:11,920

not comprehensively be economically

994

00:36:15,270 --> 00:36:13,680

feasible to bring it back so psyche is

995

00:36:20,230 --> 00:36:15,280

never ever ever going to come back to

996

00:36:24,230 --> 00:36:22,069

lindy thank you so much lindsay thank

997

00:36:26,390 --> 00:36:24,240

you so much that's all the time we have

998

00:36:28,390 --> 00:36:26,400

for questions tonight

999

00:36:32,150 --> 00:36:28,400

but do you have any parting thoughts for

1000

00:36:36,390 --> 00:36:33,670

well

1001
00:36:38,710 --> 00:36:36,400
i'd like us to think a little bit about

1002
00:36:41,910 --> 00:36:38,720
the miracle that is the fact that we

1003
00:36:43,910 --> 00:36:41,920
humans can explore space and what it can

1004
00:36:45,990 --> 00:36:43,920
do for us uh

1005
00:36:47,589 --> 00:36:46,000
i love to think of what we're doing with

1006
00:36:49,109 --> 00:36:47,599
psyche mission and the other robotic

1007
00:36:51,589 --> 00:36:49,119
missions we're sending as being on

1008
00:36:53,430 --> 00:36:51,599
behalf of all of humankind so in that

1009
00:36:55,510 --> 00:36:53,440
video when jim bell says we're going to

1010
00:36:56,950 --> 00:36:55,520
put these photos up on the internet

1011
00:36:58,790 --> 00:36:56,960
immediately for everyone to see that's

1012
00:37:01,030 --> 00:36:58,800
right we've already been building the

1013
00:37:03,270 --> 00:37:01,040

software pipeline such that within a

1014

00:37:05,030 --> 00:37:03,280

half hour of our receipt the images of

1015

00:37:07,349 --> 00:37:05,040

psyche are going to be free for everyone

1016

00:37:08,870 --> 00:37:07,359

to look at on the world wide web we're

1017

00:37:10,390 --> 00:37:08,880

not going to curate them we're not going

1018

00:37:12,550 --> 00:37:10,400

to save them for the science team until

1019

00:37:14,710 --> 00:37:12,560

we publish or not publish something that

1020

00:37:16,069 --> 00:37:14,720

we think looks i don't know weird or

1021

00:37:17,829 --> 00:37:16,079

unexplainable it's all going to go out

1022

00:37:19,829 --> 00:37:17,839

there so we can all look at it at once

1023

00:37:22,150 --> 00:37:19,839

because i would like space exploration

1024

00:37:24,390 --> 00:37:22,160

to be something that unites us and shows

1025

00:37:26,390 --> 00:37:24,400

us more about our where we are in our

1026

00:37:28,790 --> 00:37:26,400

solar system our perspective of

1027

00:37:31,910 --> 00:37:28,800

ourselves in this planet we live on a

1028

00:37:34,550 --> 00:37:31,920

planet it is our precious planet and we

1029

00:37:36,470 --> 00:37:34,560

as a whole species not just as a country

1030

00:37:38,069 --> 00:37:36,480

or as a single people or as people from

1031

00:37:39,670 --> 00:37:38,079

a single city we all have the

1032

00:37:41,589 --> 00:37:39,680

responsibility for it and i think by

1033

00:37:43,270 --> 00:37:41,599

looking out that helps us figure out

1034

00:37:44,870 --> 00:37:43,280

what we should do at home and i really

1035

00:37:46,950 --> 00:37:44,880

mean that it sounds like a little bit

1036

00:37:48,310 --> 00:37:46,960

high flown but it's very heartfelt and

1037

00:37:50,470 --> 00:37:48,320

that's what i hope that we do with

1038

00:37:52,550 --> 00:37:50,480

psyche mission

1039

00:37:54,310 --> 00:37:52,560

that's that's awesome i know for one i

1040

00:37:55,750 --> 00:37:54,320

can't wait to see the images and to see

1041

00:37:57,430 --> 00:37:55,760

what the science is and what this thing

1042

00:37:59,109 --> 00:37:57,440

is really made of

1043

00:38:01,349 --> 00:37:59,119

so ladies and gentlemen that's all the

1044

00:38:03,430 --> 00:38:01,359

time we have tonight a big thank you to

1045

00:38:05,430 --> 00:38:03,440

our guest lindy we really do appreciate

1046

00:38:07,670 --> 00:38:05,440

you giving us some of your time tonight

1047

00:38:09,750 --> 00:38:07,680

my co-host lindsay thanks for monitoring

1048

00:38:11,030 --> 00:38:09,760

and managing the questions tonight of

1049

00:38:12,790 --> 00:38:11,040

course all of you folks behind the

1050

00:38:14,630 --> 00:38:12,800

scenes that make all of this happen and

1051

00:38:16,310 --> 00:38:14,640

all of you for watching

1052

00:38:18,790 --> 00:38:16,320

please join us next month when we talk

1053

00:38:19,910 --> 00:38:18,800

about how engineers make the science

1054

00:38:23,030 --> 00:38:19,920

possible

1055

00:38:25,910 --> 00:38:23,040

should be a good one stay safe say well