
NASA
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Medical Director at SpaceX

1
00:00:14,070 --> 00:00:04,420
ignition sequence stars

2
00:00:16,230 --> 00:00:14,080
[Music]

3
00:00:18,390 --> 00:00:16,240
good morning and welcome to this look

4
00:00:20,150 --> 00:00:18,400
over the shoulders of the international

5
00:00:22,790 --> 00:00:20,160
space station flight control team

6
00:00:24,870 --> 00:00:22,800
members on console at nasa's johnson

7
00:00:26,790 --> 00:00:24,880
space center these are the folks charged

8
00:00:28,790 --> 00:00:26,800
with keeping a close eye on space

9
00:00:31,429 --> 00:00:28,800
station systems while assisting the

10
00:00:33,510 --> 00:00:31,439
expedition 66 crew members as they work

11
00:00:35,990 --> 00:00:33,520
through their daily agenda of science

12
00:00:37,830 --> 00:00:36,000
support and station maintenance

13
00:00:39,590 --> 00:00:37,840

commander anton shkaplerov and his

14
00:00:41,750 --> 00:00:39,600
crewmates have been busy with all of

15
00:00:44,310 --> 00:00:41,760
that this week on top of their work

16
00:00:46,630 --> 00:00:44,320
supporting the arrival of three new

17
00:00:51,270 --> 00:00:46,640
short-term crewmates who docked the

18
00:00:55,990 --> 00:00:53,670
houston station on space to ground

19
00:00:58,549 --> 00:00:56,000
welcome to the 400th episode of space to

20
00:01:00,389 --> 00:00:58,559
ground i'm leah cheshire mustachio

21
00:01:01,910 --> 00:01:00,399
two japanese space flight participants

22
00:01:04,070 --> 00:01:01,920
arrived at the orbiting laboratory

23
00:01:05,990 --> 00:01:04,080
earlier this week

24
00:01:07,350 --> 00:01:06,000
on wednesday december 8th three people

25
00:01:09,190 --> 00:01:07,360
launched to the international space

26
00:01:11,190 --> 00:01:09,200
station aboard the soyuz ms-20

27
00:01:13,510 --> 00:01:11,200
spacecraft and liftoff spaceflight

28
00:01:15,109 --> 00:01:13,520
participants usaku mezawa and yozo

29
00:01:17,590 --> 00:01:15,119
harano were led by commander and

30
00:01:19,910 --> 00:01:17,600
rascosmos cosmonaut alexander misurkin

31
00:01:21,749 --> 00:01:19,920
as the spacecraft launched at 2 38 a.m

32
00:01:24,149 --> 00:01:21,759
eastern time and docked just over six

33
00:01:25,830 --> 00:01:24,159
hours later the trio joined the seven

34
00:01:27,830 --> 00:01:25,840
astronauts and cosmonauts living aboard

35
00:01:30,710 --> 00:01:27,840
the space station for a scheduled 11-day

36
00:01:33,030 --> 00:01:30,720
mission before returning to earth

37
00:01:35,270 --> 00:01:33,040
this week nasa announced the 10 newest

38
00:01:37,350 --> 00:01:35,280

astronaut candidates out of 12 000

39
00:01:39,510 --> 00:01:37,360
applicants let's give them a big round

40
00:01:40,950 --> 00:01:39,520
of applause the 2021 nasa astronaut

41
00:01:43,270 --> 00:01:40,960
candidates were announced on monday

42
00:01:44,950 --> 00:01:43,280
december 6th over the next two years

43
00:01:46,710 --> 00:01:44,960
these astronauts will train at nasa's

44
00:01:49,030 --> 00:01:46,720
johnson space center in disciplines like

45
00:01:52,069 --> 00:01:49,040
space station systems russian language

46
00:01:53,830 --> 00:01:52,079
spacewalk training t-38 flying and more

47
00:01:55,109 --> 00:01:53,840
these candidates may someday travel to

48
00:01:57,109 --> 00:01:55,119
the space station commercial

49
00:01:59,510 --> 00:01:57,119
destinations and eventually the moon

50
00:02:01,270 --> 00:01:59,520
with the artemis program

51
00:02:04,149 --> 00:02:01,280
a new facility is finding its home

52
00:02:06,149 --> 00:02:04,159
aboard the orbiting laboratory this week

53
00:02:08,710 --> 00:02:06,159
on tuesday installation began of the

54
00:02:10,229 --> 00:02:08,720
flow boiling and condensation experiment

55
00:02:12,070 --> 00:02:10,239
the goal of this new facility is to

56
00:02:14,309 --> 00:02:12,080
collect data about two-phase flow and

57
00:02:15,910 --> 00:02:14,319
heat transfer in microgravity we'll need

58
00:02:17,910 --> 00:02:15,920
to generate more power during longer

59
00:02:20,070 --> 00:02:17,920
space missions meaning the heat produced

60
00:02:21,750 --> 00:02:20,080
needs to be dissipated

61
00:02:23,670 --> 00:02:21,760
two-phase thermal management systems

62
00:02:25,830 --> 00:02:23,680
reduce the size and weight of the system

63
00:02:27,750 --> 00:02:25,840

and make heat removal more efficient

64
00:02:29,430 --> 00:02:27,760
this experiment is yet another way the

65
00:02:31,030 --> 00:02:29,440
work being done on the space station

66
00:02:32,790 --> 00:02:31,040
continues to prepare us for future

67
00:02:33,970 --> 00:02:32,800
destinations deeper into the solar

68
00:02:35,990 --> 00:02:33,980
system

69
00:02:37,509 --> 00:02:36,000
[Music]

70
00:02:38,930 --> 00:02:37,519
all for today on space to ground we'll

71
00:02:44,660 --> 00:02:38,940
see you next week

72
00:02:51,509 --> 00:02:49,670
[Music]

73
00:02:53,750 --> 00:02:51,519
the international space station crew

74
00:02:56,309 --> 00:02:53,760
members are also on the lookout for the

75
00:02:59,110 --> 00:02:56,319
next delivery due later this month when

76
00:03:01,509 --> 00:02:59,120
a spacex cargo dragon ship arrives with

77
00:03:03,830 --> 00:03:01,519
a new load of science experiments and

78
00:03:05,589 --> 00:03:03,840
technology demonstrations here's a few

79
00:03:07,070 --> 00:03:05,599
of the highlights of what's on the way

80
00:03:18,170 --> 00:03:07,080
to space

81
00:05:12,230 --> 00:03:18,180
[Music]

82
00:05:16,469 --> 00:05:14,550
each group of astronauts and cosmonauts

83
00:05:18,629 --> 00:05:16,479
who complete a long-duration mission to

84
00:05:21,350 --> 00:05:18,639
the international space station spend

85
00:05:22,870 --> 00:05:21,360
time on a unique subset of the kinds of

86
00:05:24,710 --> 00:05:22,880
experiments that are headed to the

87
00:05:26,629 --> 00:05:24,720
station later this month

88
00:05:29,270 --> 00:05:26,639

recently the astronauts who rode to

89
00:05:31,510 --> 00:05:29,280
space on the crew 2 spaceship came back

90
00:05:33,990 --> 00:05:31,520
to earth with their own legacy of work

91
00:05:35,749 --> 00:05:34,000
on hundreds of experiments here's a look

92
00:05:40,290 --> 00:05:35,759
at just some of their accomplishments

93
00:05:44,550 --> 00:05:40,300
during 199 days in space

94
00:05:49,430 --> 00:05:44,560
[Music]

95
00:05:53,350 --> 00:05:52,150
the crew is go for ingress and you can

96
00:05:55,909 --> 00:05:53,360
see

97
00:05:57,830 --> 00:05:55,919
aki is the first to

98
00:05:59,110 --> 00:05:57,840
ingress onto the international space

99
00:06:00,469 --> 00:05:59,120
station

100
00:06:02,230 --> 00:06:00,479
we're so excited to be here we're ready

101
00:06:04,309 --> 00:06:02,240
to get to work there's a lot of great

102
00:06:08,270 --> 00:06:04,319
science and that we're just excited to

103
00:06:13,189 --> 00:06:11,590
[Music]

104
00:06:15,029 --> 00:06:13,199
the experiment that's taking up most of

105
00:06:16,870 --> 00:06:15,039
my time right now is called celestial

106
00:06:19,110 --> 00:06:16,880
immunity and it's a really interesting

107
00:06:21,510 --> 00:06:19,120
experiment that involves looking at

108
00:06:23,110 --> 00:06:21,520
immune pathways and i have an expert

109
00:06:25,029 --> 00:06:23,120
that's looking over my shoulder via

110
00:06:26,390 --> 00:06:25,039
camera and she can talk with me kind of

111
00:06:28,950 --> 00:06:26,400
step by step as we go through the

112
00:06:30,950 --> 00:06:28,960
process that looks good megan

113
00:06:32,710 --> 00:06:30,960

all right thank you very much i'm sure

114
00:06:34,790 --> 00:06:32,720
i'll be talking to you again tomorrow

115
00:06:36,390 --> 00:06:34,800
yes you will

116
00:06:38,390 --> 00:06:36,400
recently i've been working on a really

117
00:06:40,309 --> 00:06:38,400
interesting educational experiment it's

118
00:06:43,110 --> 00:06:40,319
called the blob it's that that

119
00:06:45,830 --> 00:06:43,120
crazy monocellular being that has no

120
00:06:48,230 --> 00:06:45,840
brain but can learn uh and can actually

121
00:06:49,670 --> 00:06:48,240
search food and solve mazes it's pretty

122
00:06:51,909 --> 00:06:49,680
contained on the space station don't

123
00:06:53,749 --> 00:06:51,919
worry about it it's very tiny uh but so

124
00:06:55,909 --> 00:06:53,759
we're we're working on all kinds of

125
00:06:57,909 --> 00:06:55,919
endeavors like this and every day you

126
00:06:59,270 --> 00:06:57,919
know brings its uh it's a lot of

127
00:07:00,710 --> 00:06:59,280
discoveries on the space station that's

128
00:07:03,350 --> 00:07:00,720
very exciting

129
00:07:05,670 --> 00:07:03,360
we're tracking a full and good deploy of

130
00:07:07,909 --> 00:07:05,680
that solar array so well done both of

131
00:07:10,070 --> 00:07:07,919
you it's beautiful

132
00:07:12,070 --> 00:07:10,080
we're in a season now actually of doing

133
00:07:14,309 --> 00:07:12,080
cargo ops we have two spacecraft that

134
00:07:15,749 --> 00:07:14,319
are attached to us that brought us cargo

135
00:07:17,990 --> 00:07:15,759
and now we're packing them back up to

136
00:07:19,749 --> 00:07:18,000
get them ready for departure

137
00:07:22,469 --> 00:07:19,759
onboard the international space station

138
00:07:26,309 --> 00:07:22,479

we do help out some of the development

139
00:07:29,510 --> 00:07:26,319
of medicine without gravity you get

140
00:07:31,749 --> 00:07:29,520
larger chunks of pure protein crystals

141
00:07:33,749 --> 00:07:31,759
what we're looking for today are

142
00:07:37,189 --> 00:07:33,759
needle-like structures perfect there

143
00:07:40,390 --> 00:07:39,029
well it is a fantastic view that we have

144
00:07:41,990 --> 00:07:40,400
we see the thin layer of atmosphere

145
00:07:43,909 --> 00:07:42,000
that's protecting all of you down on

146
00:07:45,909 --> 00:07:43,919
earth so just taking care of our planet

147
00:07:48,950 --> 00:07:45,919
has kind of been a change maybe mentally

148
00:07:51,110 --> 00:07:48,960
from seeing it from this perspective

149
00:07:53,110 --> 00:07:51,120
we are growing some chili peppers in the

150
00:07:54,550 --> 00:07:53,120
plant habitat here in the japanese

151
00:07:55,909 --> 00:07:54,560
experiment module

152
00:07:57,670 --> 00:07:55,919
it's one of the more complicated things

153
00:07:59,670 --> 00:07:57,680
that have been grown in space and so

154
00:08:01,350 --> 00:07:59,680
they do take a little longer to come to

155
00:08:03,110 --> 00:08:01,360
fruition so we're really hoping that we

156
00:08:04,790 --> 00:08:03,120
get to try some peppers before the end

157
00:08:06,950 --> 00:08:04,800
of our mission

158
00:08:09,350 --> 00:08:06,960
over the years the capabilities of the

159
00:08:10,869 --> 00:08:09,360
laboratory have expanded and grown along

160
00:08:12,230 --> 00:08:10,879
with the interest in doing this kind of

161
00:08:14,309 --> 00:08:12,240
research in low earth orbit which i

162
00:08:15,749 --> 00:08:14,319
think is really remarkable so we are

163
00:08:17,510 --> 00:08:15,759

really kind of at the peak of that i

164
00:08:19,110 --> 00:08:17,520
think and so we've seen a little bit of

165
00:08:21,430 --> 00:08:19,120
everything right we've done

166
00:08:24,230 --> 00:08:21,440
human immune system research so lots of

167
00:08:26,550 --> 00:08:24,240
research into medication formation

168
00:08:28,629 --> 00:08:26,560
fluids research combustion research even

169
00:08:29,990 --> 00:08:28,639
robotics research this huge range of

170
00:08:31,830 --> 00:08:30,000
different things that we've gotten to

171
00:08:33,909 --> 00:08:31,840
touch during our mission and the way

172
00:08:35,750 --> 00:08:33,919
science works as you know is this is the

173
00:08:37,829 --> 00:08:35,760
building blocks for stuff to come and so

174
00:08:39,509 --> 00:08:37,839
the results from these experiments will

175
00:08:40,949 --> 00:08:39,519
come out in the years to come but they

176
00:08:42,389 --> 00:08:40,959
will also be the foundation of

177
00:08:43,990 --> 00:08:42,399
experiments that are designed in the

178
00:08:45,829 --> 00:08:44,000
following years and so all of the

179
00:08:47,269 --> 00:08:45,839
research is going to be stuff that we

180
00:08:48,790 --> 00:08:47,279
get to say oh we had a little part of

181
00:08:49,990 --> 00:08:48,800
that we got we got our hands on a little

182
00:08:52,680 --> 00:08:50,000
bit of that which is a pretty neat

183
00:09:00,870 --> 00:08:52,690
feeling

184
00:09:05,430 --> 00:09:03,269
some potential future crew members on

185
00:09:07,509 --> 00:09:05,440
the international space station also

186
00:09:09,750 --> 00:09:07,519
were the center of attention this week

187
00:09:12,470 --> 00:09:09,760
as leah noted a moment ago nasa

188
00:09:14,630 --> 00:09:12,480

introduced a new class of 10 astronaut

189
00:09:17,350 --> 00:09:14,640
candidates who will begin training here

190
00:09:19,350 --> 00:09:17,360
at the johnson space center next month

191
00:09:21,269 --> 00:09:19,360
take a look these are the faces that

192
00:09:23,430 --> 00:09:21,279
you're going to be seeing from space and

193
00:09:27,910 --> 00:09:23,440
maybe from the moon and mars in the

194
00:09:32,150 --> 00:09:29,750
ladies and gentlemen

195
00:09:41,829 --> 00:09:32,160
today we are introducing to you

196
00:09:45,829 --> 00:09:43,990
my name is luke delaney i'm a retired

197
00:09:47,829 --> 00:09:45,839
major from the marine corps working at

198
00:09:50,470 --> 00:09:47,839
nasa langley as a research pilot and i'm

199
00:09:53,590 --> 00:09:50,480
now an astronaut candidate nasa

200
00:09:55,829 --> 00:09:53,600
astronaut to me is explorer at heart i

201
00:09:57,509 --> 00:09:55,839
think they're the very embodiment of it

202
00:10:05,350 --> 00:09:57,519
you get to inspire people from all walks

203
00:10:10,949 --> 00:10:08,389
to me it's somebody who's always

204
00:10:12,069 --> 00:10:10,959
challenging themselves and always trying

205
00:10:14,550 --> 00:10:12,079
to

206
00:10:16,310 --> 00:10:14,560
you know push the bounds of mankind

207
00:10:18,389 --> 00:10:16,320
i wanted to be an astronaut since i was

208
00:10:20,310 --> 00:10:18,399
a little kid i grew up wanting to learn

209
00:10:22,310 --> 00:10:20,320
how to fly learn how to go to space so

210
00:10:24,790 --> 00:10:22,320
some of my earliest memories are

211
00:10:26,389 --> 00:10:24,800
are of wanting to become an astronaut

212
00:10:28,790 --> 00:10:26,399
since i was little i've always had an

213
00:10:31,509 --> 00:10:28,800

affinity for the sky and for space and

214
00:10:34,010 --> 00:10:31,519
the stars and so i set my sights as a

215
00:10:36,310 --> 00:10:34,020
very young child on getting here

216
00:10:38,630 --> 00:10:36,320
[Music]

217
00:10:40,630 --> 00:10:38,640
it is just a chance to explore and just

218
00:10:42,870 --> 00:10:40,640
keep pushing where we can go and what's

219
00:10:45,590 --> 00:10:42,880
possible and what people are capable of

220
00:10:47,350 --> 00:10:45,600
a nasa astronaut is an explorer they get

221
00:10:49,190 --> 00:10:47,360
to go up and live in space and do

222
00:10:51,350 --> 00:10:49,200
research so that we can learn more about

223
00:10:53,990 --> 00:10:51,360
human space flight

224
00:10:57,030 --> 00:10:54,000
i think a nasa astronaut is the most

225
00:10:59,670 --> 00:10:57,040
visible part of a much larger team of

226
00:11:01,590 --> 00:10:59,680
individuals that are striving to

227
00:11:04,230 --> 00:11:01,600
improve humanity

228
00:11:06,470 --> 00:11:04,240
nasa astronaut to me

229
00:11:08,230 --> 00:11:06,480
is an ambassador for

230
00:11:09,430 --> 00:11:08,240
the nasa organization as well as its

231
00:11:11,910 --> 00:11:09,440
mission

232
00:11:13,430 --> 00:11:11,920
we're really lucky to be sort of the tip

233
00:11:15,269 --> 00:11:13,440
of a huge organization that's all

234
00:11:16,330 --> 00:11:15,279
working together to try to achieve some

235
00:11:26,829 --> 00:11:16,340
pretty amazing

236
00:11:29,509 --> 00:11:26,839
[Music]

237
00:11:32,230 --> 00:11:29,519
things international space station crew

238
00:11:34,389 --> 00:11:32,240

members and astronaut candidates get

239
00:11:36,389 --> 00:11:34,399
focused training on how to operate

240
00:11:38,710 --> 00:11:36,399
station equipment such as the

241
00:11:41,110 --> 00:11:38,720
microgravity sciences glove box an

242
00:11:43,910 --> 00:11:41,120
enclosed space for experiments that

243
00:11:46,150 --> 00:11:43,920
involve potentially hazardous materials

244
00:11:48,150 --> 00:11:46,160
in this speedy time segment astronaut

245
00:11:50,790 --> 00:11:48,160
peggy whitson pulls the rack out of the

246
00:11:53,509 --> 00:11:50,800
wall in the destiny laboratory to show

247
00:11:55,910 --> 00:11:53,519
us how the msg works

248
00:11:58,310 --> 00:11:55,920
today we wanted to talk to you about

249
00:11:59,910 --> 00:11:58,320
microgravity sciences glovebox we do all

250
00:12:01,430 --> 00:11:59,920
kinds of experiments in here i've grown

251
00:12:02,870 --> 00:12:01,440
tissue culture cells i've looked at how

252
00:12:04,470 --> 00:12:02,880
air and fluids separate i've grown

253
00:12:06,310 --> 00:12:04,480
superconductor crystals in here and they

254
00:12:07,670 --> 00:12:06,320
got up to over 700 degrees fahrenheit so

255
00:12:09,190 --> 00:12:07,680
this environment was to protect us from

256
00:12:10,870 --> 00:12:09,200
what was happening inside the experiment

257
00:12:12,230 --> 00:12:10,880
now i'm growing cells and they have to

258
00:12:13,750 --> 00:12:12,240
be grown in a sterile environment so now

259
00:12:14,790 --> 00:12:13,760
i'm protecting the cells from me by

260
00:12:16,389 --> 00:12:14,800
having them inside this environment so

261
00:12:17,750 --> 00:12:16,399
it's very flexible and we can change out

262
00:12:19,030 --> 00:12:17,760
all the experiments by opening up this

263
00:12:20,230 --> 00:12:19,040

big door on the front then once we've

264
00:12:21,590 --> 00:12:20,240
got the experiment set up inside you can

265
00:12:22,949 --> 00:12:21,600
access from the sides or we have this

266
00:12:24,150 --> 00:12:22,959
little air lock down here that if you

267
00:12:25,430 --> 00:12:24,160
wanted to you could access from here as

268
00:12:26,150 --> 00:12:25,440
well it's kind of like a transformer at

269
00:12:27,509 --> 00:12:26,160
the end of the day when you're done

270
00:12:29,190 --> 00:12:27,519
working with it you just push it back

271
00:12:30,550 --> 00:12:29,200
into the rack there we go and it fits

272
00:12:31,829 --> 00:12:30,560
right in very nicely within the rack

273
00:12:32,870 --> 00:12:31,839
volume the other thing that goes along

274
00:12:33,910 --> 00:12:32,880
with this or is attached to this is a

275
00:12:35,269 --> 00:12:33,920
microscope we have a fantastic

276
00:12:36,550 --> 00:12:35,279
microscope with capability to send the

277
00:12:37,350 --> 00:12:36,560
videos and pictures down to the ground

278
00:12:38,310 --> 00:12:37,360
on the ground been looking at the

279
00:12:39,670 --> 00:12:38,320
structures that are forming differently

280
00:12:40,870 --> 00:12:39,680
here in zero gravity that's why they're

281
00:12:42,710 --> 00:12:40,880
doing the research here is to see what

282
00:12:45,110 --> 00:12:42,720
what new they can discover so very cool

283
00:12:53,590 --> 00:12:45,120
science very cool piece of hardware

284
00:12:57,590 --> 00:12:55,430
astronauts on the international space

285
00:12:59,750 --> 00:12:57,600
station spend some of their time doing

286
00:13:02,389 --> 00:12:59,760
science experiments some of their time

287
00:13:04,389 --> 00:13:02,399
keeping their spaceship operating safely

288
00:13:07,350 --> 00:13:04,399

and sometimes they help explain

289
00:13:09,670 --> 00:13:07,360
scientific concepts to students on earth

290
00:13:11,910 --> 00:13:09,680
in this demonstration video one time

291
00:13:14,870 --> 00:13:11,920
station commander suni williams guides

292
00:13:16,790 --> 00:13:14,880
us as mark vandehei and jeff williams

293
00:13:24,640 --> 00:13:16,800
use the weightless environment to

294
00:13:46,389 --> 00:13:44,230
[Music]

295
00:13:48,230 --> 00:13:46,399
hi i'm sunny williams and i'm an

296
00:13:50,069 --> 00:13:48,240
astronaut who's lived and worked aboard

297
00:13:52,310 --> 00:13:50,079
the international space station

298
00:13:54,949 --> 00:13:52,320
an amazing research laboratory that's

299
00:13:55,990 --> 00:13:54,959
orbiting the earth about 250 miles above

300
00:13:57,750 --> 00:13:56,000
us

301
00:13:59,990 --> 00:13:57,760
while we're at the space station we

302
00:14:03,030 --> 00:14:00,000
astronauts live and work in a

303
00:14:05,030 --> 00:14:03,040
microgravity environment do you think

304
00:14:06,629 --> 00:14:05,040
the laws of physics will hold up in the

305
00:14:08,310 --> 00:14:06,639
space station while experiencing

306
00:14:10,310 --> 00:14:08,320
microgravity

307
00:14:12,150 --> 00:14:10,320
let's check with nasa astronaut mark

308
00:14:18,389 --> 00:14:12,160
vandehei on the international space

309
00:14:22,629 --> 00:14:20,550
newton's first law of motion says an

310
00:14:26,629 --> 00:14:22,639
object at rest tends to stay at rest

311
00:14:27,670 --> 00:14:26,639
unless acted on by an outside force

312
00:14:30,310 --> 00:14:27,680
also

313
00:14:32,710 --> 00:14:30,320

an object in motion

314
00:14:34,870 --> 00:14:32,720
tends to stay in motion unless acted on

315
00:14:40,230 --> 00:14:34,880
by an outside force

316
00:14:44,389 --> 00:14:42,629
let's look at this from another angle

317
00:14:46,550 --> 00:14:44,399
over time the international space

318
00:14:49,910 --> 00:14:46,560
station slows down from experiencing a

319
00:14:53,030 --> 00:14:49,920
very small amount of drag or force

320
00:14:54,150 --> 00:14:53,040
from a tiny amount of atomic oxygen in

321
00:14:56,470 --> 00:14:54,160
space

322
00:14:58,470 --> 00:14:56,480
this is like the force you feel from the

323
00:14:59,750 --> 00:14:58,480
air if you stick your hand out of a

324
00:15:02,310 --> 00:14:59,760
moving car

325
00:15:04,470 --> 00:15:02,320
because of this the space station does

326
00:15:06,870 --> 00:15:04,480
what we call a reboost

327
00:15:08,870 --> 00:15:06,880
a reboost uses rocket engines to put a

328
00:15:11,829 --> 00:15:08,880
force on the space station

329
00:15:14,310 --> 00:15:11,839
this allows it to speed up just a little

330
00:15:16,550 --> 00:15:14,320
to remain in orbit around the earth

331
00:15:18,710 --> 00:15:16,560
let's join nasa astronaut jeff williams

332
00:15:22,230 --> 00:15:18,720
to check out what happens to the objects

333
00:15:23,910 --> 00:15:22,240
inside the space station when it begins

334
00:15:25,269 --> 00:15:23,920
now the way i'm going to demonstrate the

335
00:15:28,310 --> 00:15:25,279
acceleration that comes during the

336
00:15:30,949 --> 00:15:28,320
reboost is by using this camera uh 800

337
00:15:32,470 --> 00:15:30,959
millimeter land so it's pretty massive

338
00:15:35,110 --> 00:15:32,480

actually

339
00:15:36,230 --> 00:15:35,120
and you can see i can float it here

340
00:15:37,990 --> 00:15:36,240
and

341
00:15:39,350 --> 00:15:38,000
there's no reapers going on right now so

342
00:15:41,189 --> 00:15:39,360
the camera's not going to go anywhere

343
00:15:44,069 --> 00:15:41,199
just going to slowly drift due to the

344
00:15:46,310 --> 00:15:44,079
ventilation or or if i put any

345
00:15:47,749 --> 00:15:46,320
uh velocity into it it'll drift out of

346
00:15:49,990 --> 00:15:47,759
the scene but i'm going to try to hold

347
00:15:51,990 --> 00:15:50,000
it here steady and you can see that it

348
00:15:54,310 --> 00:15:52,000
stays very steady

349
00:15:56,150 --> 00:15:54,320
there's my camera i'm setting it up for

350
00:15:57,430 --> 00:15:56,160
ignition

351
00:16:00,310 --> 00:15:57,440
there it goes

352
00:16:02,470 --> 00:16:00,320
it actually came a little bit early

353
00:16:03,829 --> 00:16:02,480
now watch the camera accelerate

354
00:16:05,350 --> 00:16:03,839
toward you

355
00:16:06,310 --> 00:16:05,360
there it goes i'm going to reach out and

356
00:16:09,030 --> 00:16:06,320
grab it

357
00:16:11,350 --> 00:16:09,040
and bring it back in the view here

358
00:16:13,350 --> 00:16:11,360
and i'm holding it i'm actually feeling

359
00:16:14,389 --> 00:16:13,360
the acceleration i'm going to let go

360
00:16:18,710 --> 00:16:14,399
again

361
00:16:18,720 --> 00:16:23,430
i'll try not to let it hit you

362
00:16:23,440 --> 00:16:27,430
just gonna miss you

363
00:16:31,269 --> 00:16:29,430

yeah i'm gonna let go now

364
00:16:33,189 --> 00:16:31,279
and here i go drifting back toward you

365
00:16:36,790 --> 00:16:33,199
again so the acceleration applies to me

366
00:16:41,990 --> 00:16:39,670
reached our 2.7 meters per second that

367
00:16:43,030 --> 00:16:42,000
we desired and now if i let go of the

368
00:16:44,949 --> 00:16:43,040
camera

369
00:16:46,069 --> 00:16:44,959
it's not going anywhere so the burn is

370
00:16:48,470 --> 00:16:46,079
over

371
00:16:50,550 --> 00:16:48,480
reboost complete we'll stay in orbit for

372
00:16:52,310 --> 00:16:50,560
a little while longer

373
00:16:54,389 --> 00:16:52,320
can you use newton's first law to

374
00:16:56,230 --> 00:16:54,399
explain why the camera began moving

375
00:16:58,230 --> 00:16:56,240
without an astronaut putting a force

376
00:17:00,550 --> 00:16:58,240
directly on it

377
00:17:02,710 --> 00:17:00,560
i'm going to send you back to class so

378
00:17:04,630 --> 00:17:02,720
you can start to investigate this with

379
00:17:07,429 --> 00:17:04,640
the classroom connection found at

380
00:17:09,429 --> 00:17:07,439
nasa.gov demonstrations

381
00:17:11,669 --> 00:17:09,439
thanks for exploring a little physics on

382
00:17:15,950 --> 00:17:11,679
the space station with us today see you

383
00:17:15,960 --> 00:17:29,830
[Music]

384
00:17:34,310 --> 00:17:32,310
there is an instrument on the outside of

385
00:17:36,470 --> 00:17:34,320
the international space station that has

386
00:17:39,669 --> 00:17:36,480
been sifting through cosmic ray

387
00:17:42,070 --> 00:17:39,679
particles since 2011 to help us learn

388
00:17:44,390 --> 00:17:42,080

more about the origins of our universe

389
00:17:47,190 --> 00:17:44,400
but the alpha magnetic spectrometer

390
00:17:49,270 --> 00:17:47,200
wasn't designed to operate that long or

391
00:17:51,669 --> 00:17:49,280
to be repaired in space so it could

392
00:17:53,990 --> 00:17:51,679
continue its mission but nasa's

393
00:17:55,830 --> 00:17:54,000
exploration and in-space services

394
00:17:57,990 --> 00:17:55,840
project division at the goddard space

395
00:18:00,470 --> 00:17:58,000
flight center along with some folks here

396
00:18:03,190 --> 00:18:00,480
at the johnson space center figured out

397
00:18:05,669 --> 00:18:03,200
how to do just that and in today's tech

398
00:18:08,150 --> 00:18:05,679
on deck episode they show us how they

399
00:18:12,830 --> 00:18:10,310
before i started there and digging in

400
00:18:14,390 --> 00:18:12,840
that one that other bag here we go no

401
00:18:15,990 --> 00:18:14,400
problem

402
00:18:17,830 --> 00:18:16,000
if you need to fix something in space

403
00:18:19,590 --> 00:18:17,840
that wasn't designed to be fixed it's

404
00:18:21,510 --> 00:18:19,600
going to take all the experience you can

405
00:18:23,270 --> 00:18:21,520
get with that in mind when the

406
00:18:25,909 --> 00:18:23,280
international space station's alpha

407
00:18:27,029 --> 00:18:25,919
magnetic spectrometer or ams needed

408
00:18:29,029 --> 00:18:27,039
repairs

409
00:18:30,789 --> 00:18:29,039
nasa's johnson space center and goddard

410
00:18:32,789 --> 00:18:30,799
space flight center used their joint

411
00:18:34,950 --> 00:18:32,799
expertise to make it happen

412
00:18:37,270 --> 00:18:34,960
at goddard that expertise resides in

413
00:18:39,909 --> 00:18:37,280

nasa's exploration and in-space services

414
00:18:41,510 --> 00:18:39,919
division or nexus which evolved from the

415
00:18:43,190 --> 00:18:41,520
office that was responsible for the

416
00:18:45,270 --> 00:18:43,200
hubble space telescope servicing

417
00:18:47,590 --> 00:18:45,280
missions key to these missions was the

418
00:18:49,270 --> 00:18:47,600
development of specialized tools

419
00:18:51,590 --> 00:18:49,280
while you've probably heard of hubble

420
00:18:54,430 --> 00:18:51,600
you may not be as familiar with ams so

421
00:19:06,390 --> 00:18:54,440
let's start there

422
00:19:08,230 --> 00:19:06,400
[Music]

423
00:19:10,870 --> 00:19:08,240
designed for a three-year mission of

424
00:19:12,310 --> 00:19:10,880
sifting through cosmic ray particles ams

425
00:19:14,070 --> 00:19:12,320
has been looking for signs of dark

426
00:19:15,669 --> 00:19:14,080
matter from its position on station

427
00:19:17,430 --> 00:19:15,679
since 2011.

428
00:19:19,590 --> 00:19:17,440
hundreds of researchers have used the

429
00:19:21,590 --> 00:19:19,600
data collected to investigate the source

430
00:19:23,590 --> 00:19:21,600
of the mysterious substance to help us

431
00:19:24,470 --> 00:19:23,600
better understand the origins of the

432
00:19:25,990 --> 00:19:24,480
universe

433
00:19:28,630 --> 00:19:26,000
to continue this important data

434
00:19:30,310 --> 00:19:28,640
collection ams needed an upgrade due to

435
00:19:32,870 --> 00:19:30,320
general wear and tear from the harsh

436
00:19:35,430 --> 00:19:32,880
environment of space specifically a new

437
00:19:37,590 --> 00:19:35,440
cooling system a repair could extend its

438
00:19:40,230 --> 00:19:37,600

life beyond what was originally planned

439
00:19:42,150 --> 00:19:40,240
sounds easy enough right in fact due to

440
00:19:44,470 --> 00:19:42,160
the instrument's complexity and the fact

441
00:19:46,390 --> 00:19:44,480
that it was not designed to be repaired

442
00:19:49,430 --> 00:19:46,400
even gaining access to the system to

443
00:19:51,510 --> 00:19:49,440
replace it was difficult ams design did

444
00:19:53,990 --> 00:19:51,520
not incorporate the kinds of interfaces

445
00:19:55,830 --> 00:19:54,000
that make spacewalks easier or have the

446
00:19:58,549 --> 00:19:55,840
ability to be serviced with traditional

447
00:20:00,870 --> 00:19:58,559
multi-purpose tools and so over the

448
00:20:02,470 --> 00:20:00,880
course of four years nasa got to work

449
00:20:04,470 --> 00:20:02,480
designing and developing some of the

450
00:20:06,630 --> 00:20:04,480
most complex spacewalks since the hubble

451
00:20:08,950 --> 00:20:06,640
servicing missions in the 90s and early

452
00:20:11,750 --> 00:20:08,960
2000s to fix ams

453
00:20:13,590 --> 00:20:11,760
the ams tools themselves were

454
00:20:15,830 --> 00:20:13,600
unique they were built specifically for

455
00:20:18,549 --> 00:20:15,840
this task a task that was never intended

456
00:20:20,549 --> 00:20:18,559
to be performed on a spacewalk so that

457
00:20:22,710 --> 00:20:20,559
required a lot of thinking about how we

458
00:20:24,470 --> 00:20:22,720
were going to get inside so that we

459
00:20:26,549 --> 00:20:24,480
could access the tubes that we needed to

460
00:20:28,950 --> 00:20:26,559
cut into and then install the new

461
00:20:31,029 --> 00:20:28,960
thermal control system but also how to

462
00:20:32,390 --> 00:20:31,039
put handling aids on it so that we had a

463
00:20:34,789 --> 00:20:32,400

place to

464
00:20:37,029 --> 00:20:34,799
attach our tethers to attach our foot

465
00:20:39,350 --> 00:20:37,039
restraints to have hand holds have a

466
00:20:40,549 --> 00:20:39,360
place to attach equipment that we needed

467
00:20:42,870 --> 00:20:40,559
out there

468
00:20:45,510 --> 00:20:42,880
nasa developed 20 specialized tools to

469
00:20:48,549 --> 00:20:45,520
make the job possible and on november 15

470
00:20:50,470 --> 00:20:48,559
2019 astronauts andrew morgan and luca

471
00:20:52,390 --> 00:20:50,480
parmitano got to work

472
00:20:55,029 --> 00:20:52,400
on this first spacewalk astronauts

473
00:20:56,789 --> 00:20:55,039
needed to get access by design five of

474
00:20:59,110 --> 00:20:56,799
the tools could be seen floating off

475
00:21:00,950 --> 00:20:59,120
into space attached to the debris shield

476
00:21:03,510 --> 00:21:00,960
that was removed to give the astronauts

477
00:21:05,270 --> 00:21:03,520
access to the heart of ams

478
00:21:08,230 --> 00:21:05,280
the debris shield handling aid was one

479
00:21:11,750 --> 00:21:08,240
of the first tools that luca installed

480
00:21:14,149 --> 00:21:11,760
on the eva and this gave us a handhold

481
00:21:17,270 --> 00:21:14,159
to install on the debris shield to work

482
00:21:19,430 --> 00:21:17,280
from but also a handle for me to hold on

483
00:21:20,710 --> 00:21:19,440
to ultimately when we jettisoned it

484
00:21:22,789 --> 00:21:20,720
overboard

485
00:21:24,310 --> 00:21:22,799
to the aft side of the iss which was a

486
00:21:26,310 --> 00:21:24,320
lot of fun to do

487
00:21:28,310 --> 00:21:26,320
the astronauts continued with three more

488
00:21:29,990 --> 00:21:28,320

spacewalks over the next two months

489
00:21:31,110 --> 00:21:30,000
using all of the specially designed

490
00:21:33,270 --> 00:21:31,120
tools

491
00:21:35,190 --> 00:21:33,280
one such tool was the tube cutting guide

492
00:21:36,870 --> 00:21:35,200
which was a direct result of multiple

493
00:21:38,549 --> 00:21:36,880
practice sessions at johnson space

494
00:21:39,990 --> 00:21:38,559
center facilities like the neutral

495
00:21:42,149 --> 00:21:40,000
buoyancy lab

496
00:21:44,070 --> 00:21:42,159
while practicing astronauts communicated

497
00:21:46,310 --> 00:21:44,080
the need for a way to identify and

498
00:21:47,669 --> 00:21:46,320
verify the correct tubes to cut since

499
00:21:51,190 --> 00:21:47,679
they all look the same to the

500
00:21:53,590 --> 00:21:51,200
astronaut's eyes within the space suit

501
00:21:55,669 --> 00:21:53,600
after we had removed the debris shield

502
00:21:58,230 --> 00:21:55,679
and the vsb cover

503
00:22:00,549 --> 00:21:58,240
now we have the tubes exposed and we

504
00:22:02,149 --> 00:22:00,559
actually had to cut into those tubes in

505
00:22:03,830 --> 00:22:02,159
order to pull out the correct ones to

506
00:22:06,310 --> 00:22:03,840
connect with the new thermal control

507
00:22:08,390 --> 00:22:06,320
system the new pump in order to do that

508
00:22:10,789 --> 00:22:08,400
we had to be very sure of the tubes that

509
00:22:12,789 --> 00:22:10,799
we were cutting these ingenious tube

510
00:22:15,190 --> 00:22:12,799
cutting guides installed over the top of

511
00:22:17,110 --> 00:22:15,200
the tubes and made sure that we knew and

512
00:22:18,710 --> 00:22:17,120
we were communicating correctly with the

513
00:22:20,549 --> 00:22:18,720

ground team to make sure that we were

514
00:22:21,830 --> 00:22:20,559
cutting the correct tube at the right

515
00:22:24,870 --> 00:22:21,840
time

516
00:22:26,870 --> 00:22:24,880
in january 2020 luca parmitano and drew

517
00:22:29,110 --> 00:22:26,880
morgan completed the fourth and final

518
00:22:31,029 --> 00:22:29,120
spacewalk to repair ams

519
00:22:33,270 --> 00:22:31,039
because of their work and the ingenuity

520
00:22:35,270 --> 00:22:33,280
of tool designers and engineers the

521
00:22:37,430 --> 00:22:35,280
instrument is now back in commission and

522
00:22:39,590 --> 00:22:37,440
able to continue to collect data about

523
00:22:43,909 --> 00:22:39,600
the origins of our universe for years to

524
00:22:49,110 --> 00:22:46,710
people from goddard and jfc spent a lot

525
00:22:51,110 --> 00:22:49,120
of time developing these tools

526
00:22:53,830 --> 00:22:51,120
with their knowledge and the support of

527
00:22:56,470 --> 00:22:53,840
astronauts like chris cassidy

528
00:22:59,190 --> 00:22:56,480
we are very thankful that we were

529
00:22:59,610 --> 00:22:59,200
privileged to use those tools and put

530
00:23:00,789 --> 00:22:59,620
them to

531
00:23:02,950 --> 00:23:00,799
[Music]

532
00:23:04,040 --> 00:23:02,960
make successful use

533
00:23:06,230 --> 00:23:04,050
thank you very much

534
00:23:09,909 --> 00:23:06,240
[Music]

535
00:23:11,990 --> 00:23:09,919
it's positioned 250 miles above earth

536
00:23:14,310 --> 00:23:12,000
makes the international space station a

537
00:23:17,350 --> 00:23:14,320
great location for scientific research

538
00:23:18,870 --> 00:23:17,360

about this planet this one right here

539
00:23:21,510 --> 00:23:18,880
and there's an instrument on board that

540
00:23:24,149 --> 00:23:21,520
gathers information about how plants on

541
00:23:26,230 --> 00:23:24,159
earth sweat which provides data to

542
00:23:28,210 --> 00:23:26,240
scientists who are monitoring the health

543
00:23:31,909 --> 00:23:28,220
of earth's vegetation

544
00:23:31,919 --> 00:23:37,590
sweating can be cool

545
00:23:37,600 --> 00:23:42,230
presented by science at nasa

546
00:23:46,950 --> 00:23:44,390
did you ever notice how the air can seem

547
00:23:48,789 --> 00:23:46,960
cooler when you enter a forest humans

548
00:23:51,830 --> 00:23:48,799
aren't the only living things that sweat

549
00:23:53,909 --> 00:23:51,840
to cool off when trees and plants sweat

550
00:23:56,470 --> 00:23:53,919
they cool themselves and can cool the

551
00:23:58,950 --> 00:23:56,480
surrounding air through a process called

552
00:24:01,029 --> 00:23:58,960
transpiration water and nutrients are

553
00:24:03,269 --> 00:24:01,039
taken up by plant roots from soil and

554
00:24:05,190 --> 00:24:03,279
delivered to the stem and leaves as part

555
00:24:06,710 --> 00:24:05,200
of photosynthesis

556
00:24:08,950 --> 00:24:06,720
some of the water drawn up through the

557
00:24:12,230 --> 00:24:08,960
roots exits the plants through pores or

558
00:24:15,269 --> 00:24:12,240
stomata in its leaves hence the sweating

559
00:24:18,149 --> 00:24:15,279
as this sweat evaporates heat is removed

560
00:24:20,390 --> 00:24:18,159
from the air providing a cooling effect

561
00:24:22,549 --> 00:24:20,400
however if there isn't enough water

562
00:24:25,590 --> 00:24:22,559
available or relative humidity gets too

563
00:24:29,909 --> 00:24:25,600

high the stomata close the plant heats

564
00:24:31,510 --> 00:24:29,919
up ceases to grow and can eventually die

565
00:24:33,830 --> 00:24:31,520
healthy plants provide a number of

566
00:24:36,710 --> 00:24:33,840
ecosystem services to humans including

567
00:24:38,710 --> 00:24:36,720
food recreation and building materials

568
00:24:40,310 --> 00:24:38,720
plants also impact earth's global water

569
00:24:42,549 --> 00:24:40,320
and carbon cycles with plant

570
00:24:43,990 --> 00:24:42,559
transpiration accounting for around 10

571
00:24:45,350 --> 00:24:44,000
percent of the moisture in our

572
00:24:47,990 --> 00:24:45,360
atmosphere

573
00:24:50,950 --> 00:24:48,000
a new nasa mission called ecostress

574
00:24:53,590 --> 00:24:50,960
short for ecosystem spaceborne thermal

575
00:24:55,110 --> 00:24:53,600
radiometer experiment on space station

576
00:24:58,830 --> 00:24:55,120
was successfully launched to the

577
00:25:01,669 --> 00:24:58,840
international space station on june 29

578
00:25:04,149 --> 00:25:01,679
2018 ecostress will literally study how

579
00:25:05,669 --> 00:25:04,159
plants sweat providing the most detailed

580
00:25:07,430 --> 00:25:05,679
measurements of plant temperatures

581
00:25:09,110 --> 00:25:07,440
available from space and helping

582
00:25:11,029 --> 00:25:09,120
researchers monitor the health of

583
00:25:12,789 --> 00:25:11,039
earth's vegetation

584
00:25:14,470 --> 00:25:12,799
your temperature is one of the first

585
00:25:16,710 --> 00:25:14,480
things a doctor wants to know when you

586
00:25:18,710 --> 00:25:16,720
go for a checkup says simon hook

587
00:25:21,190 --> 00:25:18,720
ecostress principal investigator from

588
00:25:22,870 --> 00:25:21,200

nasa's jet propulsion laboratory it

589
00:25:25,269 --> 00:25:22,880
tells your doctor a lot about your

590
00:25:27,990 --> 00:25:25,279
condition temperature is an extremely

591
00:25:30,149 --> 00:25:28,000
useful indicator for plants too

592
00:25:32,230 --> 00:25:30,159
temperature data can indicate if a plant

593
00:25:34,710 --> 00:25:32,240
is stressed and needs more water before

594
00:25:36,870 --> 00:25:34,720
the plant collapses providing an early

595
00:25:37,669 --> 00:25:36,880
warning of a possible drought explains

596
00:25:39,669 --> 00:25:37,679
hook

597
00:25:42,230 --> 00:25:39,679
ecostress will be able to measure plant

598
00:25:44,870 --> 00:25:42,240
temperatures and therefore plant health

599
00:25:46,390 --> 00:25:44,880
over areas as small as an individual

600
00:25:48,549 --> 00:25:46,400
field of crops

601
00:25:50,870 --> 00:25:48,559
the international space station is well

602
00:25:51,750 --> 00:25:50,880
suited for the ecostress mission hook

603
00:25:53,830 --> 00:25:51,760
says

604
00:25:56,149 --> 00:25:53,840
most earth observing satellites are in a

605
00:25:58,630 --> 00:25:56,159
sun synchronous orbit so they pass over

606
00:26:00,710 --> 00:25:58,640
an area at the same time each day

607
00:26:02,950 --> 00:26:00,720
providing us a daily snapshot of that

608
00:26:05,750 --> 00:26:02,960
area because of the space station's

609
00:26:08,149 --> 00:26:05,760
orbit ecostress sees the same spot on

610
00:26:10,149 --> 00:26:08,159
earth every few days at different times

611
00:26:12,149 --> 00:26:10,159
of day so it can track changes

612
00:26:14,870 --> 00:26:12,159
throughout a typical day

613
00:26:16,470 --> 00:26:14,880

if during a hot dry afternoon plants

614
00:26:19,430 --> 00:26:16,480
stop releasing water to conserve

615
00:26:21,029 --> 00:26:19,440
supplies ecostress will see a change in

616
00:26:23,110 --> 00:26:21,039
temperature compared with previous

617
00:26:25,029 --> 00:26:23,120
measurements of the same area

618
00:26:27,909 --> 00:26:25,039
it will detect these kinds of responses

619
00:26:31,110 --> 00:26:27,919
in farmer's fields and other ecosystems

620
00:26:33,029 --> 00:26:31,120
data acquired from ecostress may in time

621
00:26:35,669 --> 00:26:33,039
help farmers develop crop watering

622
00:26:37,669 --> 00:26:35,679
protocols give researchers a clearer

623
00:26:39,750 --> 00:26:37,679
understanding of the effects of drought

624
00:26:42,470 --> 00:26:39,760
and assist water resource managers in

625
00:26:43,990 --> 00:26:42,480
planning effective water use its data

626
00:26:46,230 --> 00:26:44,000
could also reveal the effects of

627
00:26:48,549 --> 00:26:46,240
droughts on natural vegetation for

628
00:26:49,990 --> 00:26:48,559
example to help identify vulnerable

629
00:26:52,070 --> 00:26:50,000
types of trees

630
00:26:54,149 --> 00:26:52,080
forest managers and ecologists will be

631
00:26:56,630 --> 00:26:54,159
able to use this information to make

632
00:26:58,230 --> 00:26:56,640
better informed decisions

633
00:27:00,149 --> 00:26:58,240
but that's not all

634
00:27:03,510 --> 00:27:00,159
ecostress temperature data will be

635
00:27:06,070 --> 00:27:03,520
useful in a whole host of ways says hook

636
00:27:08,230 --> 00:27:06,080
we'll be able to use the same techniques

637
00:27:10,230 --> 00:27:08,240
developed to extract plant temperature

638
00:27:12,470 --> 00:27:10,240

to look at other phenomena such as the

639
00:27:16,070 --> 00:27:12,480
temperature of volcanoes urban heat

640
00:27:17,350 --> 00:27:16,080
waves wildfires coastal currents lakes

641
00:27:20,630 --> 00:27:17,360
and more

642
00:27:23,269 --> 00:27:20,640
that's a whole story in itself want to

643
00:27:29,830 --> 00:27:23,279
learn more about this cool mission no

644
00:27:33,590 --> 00:27:31,430
want another look at any of those

645
00:27:35,990 --> 00:27:33,600
stories we showed you today well you can

646
00:27:38,389 --> 00:27:36,000
find them all of them on youtube and

647
00:27:40,549 --> 00:27:38,399
facebook at those addresses right there

648
00:27:43,190 --> 00:27:40,559
along with lots of other great features

649
00:27:44,950 --> 00:27:43,200
on a wide variety of nasa topics

650
00:27:46,870 --> 00:27:44,960
if you're looking for good conversation

651
00:27:49,430 --> 00:27:46,880
about human space flight check out

652
00:27:51,510 --> 00:27:49,440
houston we have a podcast our weekly

653
00:27:53,350 --> 00:27:51,520
show about all aspects of human space

654
00:27:56,310 --> 00:27:53,360
flight and nasa's missions of

655
00:27:58,549 --> 00:27:56,320
exploration today gary jordan talks with

656
00:28:00,950 --> 00:27:58,559
donna mckenzie and steve robinson of

657
00:28:03,590 --> 00:28:00,960
third rock radio to learn more about the

658
00:28:06,389 --> 00:28:03,600
station celebrating its 10th anniversary

659
00:28:09,110 --> 00:28:06,399
of radio powered with nasa go to

660
00:28:11,669 --> 00:28:09,120
nasa.gov podcasts for this week's

661
00:28:13,750 --> 00:28:11,679
episode and all our previous episodes

662
00:28:16,070 --> 00:28:13,760
you'll also find the full library of all

663
00:28:18,789 --> 00:28:16,080

nasa podcasts and you'll find them all

664
00:28:20,950 --> 00:28:18,799
on apple podcasts google podcasts and

665
00:28:23,350 --> 00:28:20,960
soundcloud too and you can get the

666
00:28:26,789 --> 00:28:23,360
latest from all over nasa delivered to

667
00:28:29,190 --> 00:28:26,799
you every week go to nasa.gov