

1
00:00:05,089 --> 00:00:09,839
hello everybody and welcome to our

2
00:00:07,259 --> 00:00:11,370
latest Hubble hang out my name is Tony

3
00:00:09,839 --> 00:00:12,689
Darnell I work at the space stealth I

4
00:00:11,369 --> 00:00:14,579
work at the Space Telescope Science

5
00:00:12,689 --> 00:00:16,410
Institute and today we have a really

6
00:00:14,580 --> 00:00:18,839
interesting and I think really unique

7
00:00:16,410 --> 00:00:20,519
hangout plan for you today because we're

8
00:00:18,839 --> 00:00:23,009
going to be talking about modeling the

9
00:00:20,519 --> 00:00:24,929
universe using 3d printers and we've got

10
00:00:23,010 --> 00:00:27,150
people using Hubble data and other

11
00:00:24,929 --> 00:00:31,079
astronomical data sources to create

12
00:00:27,149 --> 00:00:32,488
these really cool objects from 3d

13
00:00:31,079 --> 00:00:34,350
printers and they're using them for all

14
00:00:32,488 --> 00:00:36,750
kinds of different things for example

15
00:00:34,350 --> 00:00:37,980
they're using them for helping to

16
00:00:36,750 --> 00:00:39,000
educate the visually impaired but

17
00:00:37,979 --> 00:00:41,578
they're also usually they're also

18
00:00:39,000 --> 00:00:43,378
finding things out about these objects

19
00:00:41,579 --> 00:00:45,420
about the various astronomical objects

20
00:00:43,378 --> 00:00:48,960
in the printers that we may not be able

21
00:00:45,420 --> 00:00:50,429
to ordinarily see from the from just the

22
00:00:48,960 --> 00:00:52,410
3d renderings of the images themselves

23
00:00:50,429 --> 00:00:53,939
so really interesting stuff planned they

24
00:00:52,409 --> 00:00:56,519
got a lot of people here from both the

25
00:00:53,939 --> 00:00:58,019
Institute and NASA Goddard and I'll

26
00:00:56,520 --> 00:00:59,820
introduce them in just a minute before I

27
00:00:58,020 --> 00:01:02,609
do let me tell you how to interact with

28
00:00:59,820 --> 00:01:05,640
us the easiest way is to hit the QA app

29

00:01:02,609 --> 00:01:07,140
on the on the event page or on the video

30
00:01:05,640 --> 00:01:09,090
that you're watching send us a question

31
00:01:07,140 --> 00:01:11,700
or a comment I'll read them out as the

32
00:01:09,090 --> 00:01:13,469
as the Hangout progresses alternatively

33
00:01:11,700 --> 00:01:14,820
you could comment on the youtube page

34
00:01:13,469 --> 00:01:17,819
i'm looking at those comments as well

35
00:01:14,819 --> 00:01:20,459
you could use the G+ event page and last

36
00:01:17,819 --> 00:01:22,169
and one and but not least although it is

37
00:01:20,459 --> 00:01:24,500
least because nobody ever seems to prove

38
00:01:22,170 --> 00:01:27,509
it please tweet at us using the hashtag

39
00:01:24,500 --> 00:01:29,609
hubble hang out and we will i'm also

40
00:01:27,509 --> 00:01:30,840
looking at those right now so if you

41
00:01:29,609 --> 00:01:32,938
have a question or comment you'd like to

42
00:01:30,840 --> 00:01:35,400
send on Twitter please do it that way so

43
00:01:32,938 --> 00:01:38,339

with me today is as she always is every

44

00:01:35,400 --> 00:01:39,780

single week dr. carol christian from the

45

00:01:38,340 --> 00:01:41,850

Space Telescope Science Institute but

46

00:01:39,780 --> 00:01:43,890

now while she ordinarily helps me

47

00:01:41,849 --> 00:01:46,589

moderate these things today she's going

48

00:01:43,890 --> 00:01:47,820

to be more of a guest because she's part

49

00:01:46,590 --> 00:01:50,009

of the project that we're going to

50

00:01:47,819 --> 00:01:51,839

highlight today hi Carol don't forget

51

00:01:50,009 --> 00:01:53,219

that we have her muted so she's going to

52

00:01:51,840 --> 00:01:55,140

be muting and I'm muting throughout the

53

00:01:53,219 --> 00:01:59,158

whole thing they would mostly like me to

54

00:01:55,140 --> 00:02:02,009

be quiet yes we try as hard as we can

55

00:01:59,159 --> 00:02:03,689

without Owens very successful so we're

56

00:02:02,009 --> 00:02:06,209

not always very successful in beauty

57

00:02:03,688 --> 00:02:09,149

also with with us today is dr. Antonella

58
00:02:06,209 --> 00:02:11,789
notice she's also at the Institute but I

59
00:02:09,149 --> 00:02:13,560
see that you also work at ISA right the

60
00:02:11,789 --> 00:02:15,259
European Space Agency is that right

61
00:02:13,560 --> 00:02:18,090
yes I'm part of the international

62
00:02:15,259 --> 00:02:19,769
contingent of my own right there are

63
00:02:18,090 --> 00:02:22,259
some people but can the Institute from

64
00:02:19,770 --> 00:02:24,900
you so working on Hubble so welcome

65
00:02:22,259 --> 00:02:31,429
welcome and she's also problem go ahead

66
00:02:24,900 --> 00:02:34,409
hi everybody I joining us also is a

67
00:02:31,430 --> 00:02:39,300
Thomas Madera believes the last name is

68
00:02:34,409 --> 00:02:41,120
what is your third go uh that's good it

69
00:02:39,300 --> 00:02:44,969
should be showing but it's not showing

70
00:02:41,120 --> 00:02:46,799
it says its own oh okay all right he's

71
00:02:44,969 --> 00:02:49,709
also from NASA Goddard part of the 3d

72
00:02:46,799 --> 00:02:52,260
printing project welcome as well as

73
00:02:49,709 --> 00:02:56,069
Frank ready from also from NASA Goddard

74
00:02:52,259 --> 00:02:57,449
he's a science writer and I should

75
00:02:56,068 --> 00:02:59,518
mention tom is also an astrophysicist

76
00:02:57,449 --> 00:03:01,738
it's not up there on his lower third but

77
00:02:59,519 --> 00:03:05,969
it is up on his lower therapist or thurs

78
00:03:01,739 --> 00:03:07,140
up so anyway welcome guys uh so let's go

79
00:03:05,969 --> 00:03:08,729
ahead and let's go ahead and get started

80
00:03:07,139 --> 00:03:11,399
I think I'd like to start with you Carol

81
00:03:08,729 --> 00:03:13,768
can you give us a sort of overview of

82
00:03:11,400 --> 00:03:15,390
the printing project what do you guys

83
00:03:13,769 --> 00:03:17,760
what you guys doing what are you hoping

84
00:03:15,389 --> 00:03:21,358
to accomplish things it's good it's good

85
00:03:17,759 --> 00:03:24,120
sure um so our project which is called

86

00:03:21,359 --> 00:03:25,980
3d astronomy I mean I'm at 3d astronomy

87
00:03:24,120 --> 00:03:28,469
that's the three yeah 3d funny is based

88
00:03:25,979 --> 00:03:32,818
on hubble space specifically hubble

89
00:03:28,469 --> 00:03:34,219
space telescope data and we as many

90
00:03:32,818 --> 00:03:36,719
people know we have a very large

91
00:03:34,219 --> 00:03:38,609
education outreach program associated

92
00:03:36,719 --> 00:03:41,519
with the Hubble Space Telescope but

93
00:03:38,609 --> 00:03:44,700
there are some groups of people that we

94
00:03:41,519 --> 00:03:46,620
can't reach easily and so we've been

95
00:03:44,699 --> 00:03:49,679
thinking about and starting to work on a

96
00:03:46,620 --> 00:03:51,840
bit of a suite of products that for the

97
00:03:49,680 --> 00:03:54,090
visually impaired and but also are

98
00:03:51,840 --> 00:03:57,930
beneficial for people who learn in

99
00:03:54,090 --> 00:04:00,450
different ways and so we have been

100
00:03:57,930 --> 00:04:02,879

thinking about the beautiful images from

101

00:04:00,449 --> 00:04:05,488

HST and how can we share those with the

102

00:04:02,879 --> 00:04:08,870

visually impaired and we have we have

103

00:04:05,489 --> 00:04:12,450

collaborators who have done some work in

104

00:04:08,870 --> 00:04:14,400

making tactile imagery so that people

105

00:04:12,449 --> 00:04:17,279

can understand the complexity and beauty

106

00:04:14,400 --> 00:04:18,660

of host-based telescope images and then

107

00:04:17,279 --> 00:04:21,689

also understanding the underlying

108

00:04:18,660 --> 00:04:25,409

science and so that's basically the idea

109

00:04:21,689 --> 00:04:27,639

was to use 3d printing to create tactile

110

00:04:25,408 --> 00:04:33,788

models that people can use their finger

111

00:04:27,639 --> 00:04:36,098

to explore imagery rather than using

112

00:04:33,788 --> 00:04:39,818

their eyes and so our challenge is to

113

00:04:36,098 --> 00:04:42,519

try to represent the complexity of the

114

00:04:39,819 --> 00:04:44,650

images and if you don't mind I was going

115
00:04:42,519 --> 00:04:47,769
to show an image and actually Antonella

116
00:04:44,649 --> 00:04:49,299
is the science p IM this project might

117
00:04:47,769 --> 00:04:52,089
be able to explain some of the comp

118
00:04:49,300 --> 00:04:54,490
complexity of our prototype images yes

119
00:04:52,089 --> 00:04:56,168
no that is fine but before we start I

120
00:04:54,490 --> 00:04:59,650
just want to get more I want to have the

121
00:04:56,168 --> 00:05:01,990
the NASA Goddard folks also introduce

122
00:04:59,649 --> 00:05:04,568
their stuff garbage Tom can you give us

123
00:05:01,990 --> 00:05:05,800
a little uh what can you add anything to

124
00:05:04,569 --> 00:05:08,110
that what are you guys doing at Goddard

125
00:05:05,800 --> 00:05:10,960
that maybe parallels or augments what

126
00:05:08,110 --> 00:05:12,669
what carol was just say yes so here at

127
00:05:10,959 --> 00:05:16,329
Goddard the our first project actually

128
00:05:12,668 --> 00:05:19,899
did not use Hubble data um we use data

129

00:05:16,329 --> 00:05:22,620

from the very large telescope in Chile

130

00:05:19,899 --> 00:05:27,338

and the thing that we modeled was the

131

00:05:22,620 --> 00:05:31,449

the ADA kareena homunculus nebula and um

132

00:05:27,338 --> 00:05:33,728

okay this is just a 3d 3d print model of

133

00:05:31,449 --> 00:05:36,788

that and we have a press release come

134

00:05:33,728 --> 00:05:40,269

out but we also are working on some some

135

00:05:36,788 --> 00:05:43,598

HST data but that is that is some work

136

00:05:40,269 --> 00:05:45,008

work in progress of it okay so so both

137

00:05:43,598 --> 00:05:47,199

of you both of your groups it sounds

138

00:05:45,009 --> 00:05:49,389

like you're trying to get people to

139

00:05:47,199 --> 00:05:51,189

visualize data in a slightly different

140

00:05:49,389 --> 00:05:52,810

way with getting away from images a

141

00:05:51,189 --> 00:05:55,210

little bit using these technologies a

142

00:05:52,810 --> 00:05:56,709

Carol so I'm going to go ahead and just

143

00:05:55,209 --> 00:05:58,000
give a quick cut away to the printer

144
00:05:56,709 --> 00:06:00,038
that's working in your office if you

145
00:05:58,000 --> 00:06:01,838
live on if you look behind Carol over

146
00:06:00,038 --> 00:06:03,519
her shoulder you can see there's this

147
00:06:01,838 --> 00:06:05,889
arm moving back and forth and here's a

148
00:06:03,519 --> 00:06:07,899
close-up of it here's the 3d printer

149
00:06:05,889 --> 00:06:09,848
working right now on right now you're

150
00:06:07,899 --> 00:06:12,069
printing something out right Carol right

151
00:06:09,848 --> 00:06:15,250
now yes we're actually printing a 3d

152
00:06:12,069 --> 00:06:18,848
galaxy which is our second phase of our

153
00:06:15,250 --> 00:06:22,209
project which we can talk about in a

154
00:06:18,848 --> 00:06:24,009
minute we thought we might talk a little

155
00:06:22,209 --> 00:06:27,609
bit about where we started which will

156
00:06:24,009 --> 00:06:31,088
make texture maps and elevation maps of

157
00:06:27,610 --> 00:06:33,520

star clusters and and antonella actually

158

00:06:31,088 --> 00:06:36,610

has some of those products I can show

159

00:06:33,519 --> 00:06:38,588

the image and then she can she can talk

160

00:06:36,610 --> 00:06:40,650

about it because you can expert a bit

161

00:06:38,588 --> 00:06:45,060

okay so I'm going to try to screen

162

00:06:40,649 --> 00:06:48,779

your folks yeah there's well let me know

163

00:06:45,060 --> 00:06:52,500

if we are sharing we should be sharing

164

00:06:48,779 --> 00:06:56,250

now yep we see and I will bring in the

165

00:06:52,500 --> 00:06:59,339

image that everybody can see so there it

166

00:06:56,250 --> 00:07:02,579

is ah you see so Antonella can talk

167

00:06:59,339 --> 00:07:04,619

about oh this is this is NGC 602 which

168

00:07:02,579 --> 00:07:08,038

is a beautiful cluster in the small

169

00:07:04,620 --> 00:07:10,288

module on a cloud and when we saw this

170

00:07:08,038 --> 00:07:13,050

image without this is a great image to

171

00:07:10,288 --> 00:07:16,788

convey the basic science behind our

172
00:07:13,050 --> 00:07:20,788
cluster form and a ball and so just to

173
00:07:16,788 --> 00:07:23,060
who think how to explain this image to

174
00:07:20,788 --> 00:07:26,399
people who cannot appreciate the beauty

175
00:07:23,060 --> 00:07:28,379
without to be still a couple of messages

176
00:07:26,399 --> 00:07:30,750
what are the things that the fundamental

177
00:07:28,379 --> 00:07:33,300
concept that we want to convey right it

178
00:07:30,750 --> 00:07:36,360
is a star cluster at the center just

179
00:07:33,300 --> 00:07:38,728
newly formed and the star cluster has

180
00:07:36,360 --> 00:07:42,030
very massive stars and the massive stars

181
00:07:38,728 --> 00:07:44,699
are swept away the cocoon of gas and

182
00:07:42,029 --> 00:07:48,779
dust and you can still see the filaments

183
00:07:44,699 --> 00:07:51,629
around the sort of bubble shape shell

184
00:07:48,779 --> 00:07:55,439
and you can see small stars still

185
00:07:51,629 --> 00:07:58,500
forming around so this is a collegian

186
00:07:55,439 --> 00:08:00,478
banks in gas and dust with stars of the

187
00:07:58,500 --> 00:08:03,629
center and stuff when you start forming

188
00:08:00,478 --> 00:08:05,610
in this round if we have to think how

189
00:08:03,629 --> 00:08:10,019
you convey these messages to people

190
00:08:05,610 --> 00:08:14,069
house right traditionally the work was

191
00:08:10,019 --> 00:08:18,149
done with info screen so this image

192
00:08:14,069 --> 00:08:20,939
would use generate a printout shed

193
00:08:18,149 --> 00:08:24,448
emboss features for people to touch it

194
00:08:20,939 --> 00:08:26,219
and recognize the variance and you can

195
00:08:24,449 --> 00:08:29,728
see the example cattle will just pull

196
00:08:26,220 --> 00:08:33,060
the example of a embossed form exactly

197
00:08:29,728 --> 00:08:35,360
for NGC 602 those website work Carol

198
00:08:33,059 --> 00:08:39,569
showing something here what is this now

199
00:08:35,360 --> 00:08:42,180
this is a way for you to understand how

200

00:08:39,570 --> 00:08:45,209
our process points so you know when you

201
00:08:42,179 --> 00:08:48,179
talk into a blind person they have to

202
00:08:45,208 --> 00:08:50,879
feel the way through the astronomical

203
00:08:48,179 --> 00:08:53,939
object so the traditional way the way

204
00:08:50,879 --> 00:08:54,240
before 3d printers was that you would

205
00:08:53,940 --> 00:08:57,029
for

206
00:08:54,240 --> 00:09:01,289
do something like the sheet that you can

207
00:08:57,028 --> 00:09:05,730
see where it later embosses the future

208
00:09:01,289 --> 00:09:07,230
and you associate a very fixtures with

209
00:09:05,730 --> 00:09:09,539
the feature so if you can see the

210
00:09:07,230 --> 00:09:13,080
picture again you see the circles of

211
00:09:09,539 --> 00:09:16,409
stars and the vertical lines are dust

212
00:09:13,080 --> 00:09:20,070
and the dotted the pattern is dustin so

213
00:09:16,409 --> 00:09:23,250
people would put their hand on on that

214
00:09:20,070 --> 00:09:25,740

sheet and identify the feature now with

215

00:09:23,250 --> 00:09:28,769

the 3d printers we have taken it one

216

00:09:25,740 --> 00:09:32,700

step further and we have created 3d

217

00:09:28,769 --> 00:09:36,750

print out exactly on the same sort of

218

00:09:32,700 --> 00:09:39,028

concept and may be careful rock can open

219

00:09:36,750 --> 00:09:42,539

up i can show you one here you can

220

00:09:39,028 --> 00:09:44,419

probably see so that's that's a 3d

221

00:09:42,539 --> 00:09:47,159

texture map you were just showing us

222

00:09:44,419 --> 00:09:50,789

right exactly of the same star cluster

223

00:09:47,159 --> 00:09:53,909

so you can see the cluster here at the

224

00:09:50,789 --> 00:09:56,278

center you can see the areas of dust and

225

00:09:53,909 --> 00:10:00,000

gas and they are all characterized by

226

00:09:56,278 --> 00:10:02,458

different textures so peep 40 who comes

227

00:10:00,000 --> 00:10:06,059

you can put their hands on this printout

228

00:10:02,458 --> 00:10:09,989

and and basically build a mental image

229
00:10:06,059 --> 00:10:13,588
of the object so then this was step

230
00:10:09,990 --> 00:10:16,289
number one fact number two is basically

231
00:10:13,589 --> 00:10:20,640
capturing the intensity of the baddest

232
00:10:16,289 --> 00:10:23,759
future and so this now we call this

233
00:10:20,639 --> 00:10:27,990
elevation map and the invalidation math

234
00:10:23,759 --> 00:10:32,309
is basically for at every point it has a

235
00:10:27,990 --> 00:10:34,709
death hi that is exactly related to the

236
00:10:32,309 --> 00:10:37,949
intensity of the image so people can

237
00:10:34,708 --> 00:10:40,229
understand how brightest are the stars

238
00:10:37,950 --> 00:10:43,860
than the gas so what's the relative

239
00:10:40,230 --> 00:10:46,259
intensity of the gas and dust hey so the

240
00:10:43,860 --> 00:10:47,639
first map was what was the uchitel with

241
00:10:46,259 --> 00:10:49,500
the different whether something was

242
00:10:47,639 --> 00:10:51,360
casted us whether something was a star

243
00:10:49,500 --> 00:10:53,009
whether something well you know what

244
00:10:51,360 --> 00:10:55,528
they were and the second thing you

245
00:10:53,009 --> 00:10:58,740
showed was how bright they were yes

246
00:10:55,528 --> 00:11:02,070
exactly and what when we did our testing

247
00:10:58,740 --> 00:11:04,620
we found very interesting that people

248
00:11:02,070 --> 00:11:07,050
who were blind from birth and had

249
00:11:04,620 --> 00:11:07,649
learned how to use tackle materials

250
00:11:07,049 --> 00:11:10,469
including

251
00:11:07,649 --> 00:11:13,230
breil could go straight to the elevation

252
00:11:10,470 --> 00:11:16,350
map and so they could use intensity plus

253
00:11:13,230 --> 00:11:19,019
texture so it's like if you you know

254
00:11:16,350 --> 00:11:21,329
when if you are cited you look at a

255
00:11:19,019 --> 00:11:23,129
visual image and you understand there

256
00:11:21,328 --> 00:11:24,899
are different colors but there's also

257

00:11:23,129 --> 00:11:26,819
brightness and you get that right away

258
00:11:24,899 --> 00:11:29,698
and so people who are blind from birth

259
00:11:26,818 --> 00:11:32,039
or blind very early on could tell that

260
00:11:29,698 --> 00:11:35,609
right away people who were losing their

261
00:11:32,039 --> 00:11:38,308
site or partially visually impaired they

262
00:11:35,610 --> 00:11:40,558
needed to feel the textures first and

263
00:11:38,308 --> 00:11:42,719
understand the overall structure unless

264
00:11:40,558 --> 00:11:44,909
they got that in their head then they

265
00:11:42,720 --> 00:11:47,699
could move to the elevation map and then

266
00:11:44,909 --> 00:11:50,039
say oh these are stars they're much

267
00:11:47,698 --> 00:11:52,558
brighter than the dust oh here's the

268
00:11:50,039 --> 00:11:55,078
dust here's the gas so they needed a two

269
00:11:52,558 --> 00:11:56,639
step process were lots of so it's very

270
00:11:55,078 --> 00:11:59,039
interesting that different people who

271
00:11:56,639 --> 00:12:03,329

learn in different ways needed different

272

00:11:59,039 --> 00:12:06,509

products ok so at AA Madera from Goddard

273

00:12:03,328 --> 00:12:08,428

do you was that your motivation for

274

00:12:06,509 --> 00:12:09,899

starting to do some printing on this too

275

00:12:08,428 --> 00:12:13,110

was to help visually impaired to do you

276

00:12:09,899 --> 00:12:15,438

have other other things in mind I think

277

00:12:13,110 --> 00:12:19,620

part of the initial project actually was

278

00:12:15,438 --> 00:12:22,528

to help with the visually impaired but

279

00:12:19,620 --> 00:12:26,698

another part was just to be able to see

280

00:12:22,528 --> 00:12:29,669

parts of a Astrophysical object that we

281

00:12:26,698 --> 00:12:32,519

normally cannot visualize so a lot of

282

00:12:29,669 --> 00:12:35,808

the stuff that we do or is the geometry

283

00:12:32,519 --> 00:12:38,568

is intrinsically three-dimensional and

284

00:12:35,808 --> 00:12:41,188

you don't always get all the information

285

00:12:38,568 --> 00:12:44,428

about an object just from a

286
00:12:41,188 --> 00:12:46,610
two-dimensional image so the project was

287
00:12:44,428 --> 00:12:51,539
originally designed for doing a

288
00:12:46,610 --> 00:12:55,318
planetary nebula but the physics and the

289
00:12:51,539 --> 00:12:56,818
methods involved are directly applicable

290
00:12:55,318 --> 00:13:01,110
to go to what we were doing with ada

291
00:12:56,818 --> 00:13:03,838
kareena and so we asked our collaborator

292
00:13:01,110 --> 00:13:06,240
Wolfgang Stefan who's at you name in

293
00:13:03,839 --> 00:13:10,769
Baja California Mexico if he would take

294
00:13:06,240 --> 00:13:12,089
his um if he would take his code that

295
00:13:10,769 --> 00:13:14,928
was originally designed for modeling

296
00:13:12,089 --> 00:13:18,420
planetary nebula and extend it to

297
00:13:14,928 --> 00:13:20,129
modeling 80 kareena and muggy also he

298
00:13:18,419 --> 00:13:21,328
has a big project and one of his main

299
00:13:20,129 --> 00:13:24,659
motivations is

300
00:13:21,328 --> 00:13:27,419
so you do modeling or for the visually

301
00:13:24,659 --> 00:13:30,058
impaired okay so the so let's get to a

302
00:13:27,419 --> 00:13:32,729
decree native karina is the object you

303
00:13:30,058 --> 00:13:35,100
guys started with and frank is showing

304
00:13:32,730 --> 00:13:38,239
something on his screen Frank you want

305
00:13:35,100 --> 00:13:40,409
to describe what you're showing us here

306
00:13:38,239 --> 00:13:43,769
can you hear you're muted there you go

307
00:13:40,409 --> 00:13:48,600
sure that's the that's the digital model

308
00:13:43,769 --> 00:13:51,269
of actually on my printer before you go

309
00:13:48,600 --> 00:13:54,600
to print you would bring the model into

310
00:13:51,269 --> 00:13:57,028
the data model into software and where

311
00:13:54,600 --> 00:13:58,949
it gets sliced into layers and this is

312
00:13:57,028 --> 00:14:02,578
what you see if you were using my part

313
00:13:58,948 --> 00:14:05,068
in this model okay this is an astronomy

314

00:14:02,578 --> 00:14:06,899
redeemed hang out and we have an

315
00:14:05,068 --> 00:14:09,088
astrophysicist Tom tell us what ADA

316
00:14:06,899 --> 00:14:11,639
kareena is before we go any further I

317
00:14:09,089 --> 00:14:16,769
sure because you have Carl put up Donna

318
00:14:11,639 --> 00:14:18,678
your image of a beta Carina yeah so

319
00:14:16,769 --> 00:14:22,110
while we're getting the image up I'll

320
00:14:18,678 --> 00:14:23,879
give me ok so here's here's the image

321
00:14:22,110 --> 00:14:26,938
yeah the thing that you notice right

322
00:14:23,879 --> 00:14:29,730
away is that a decree nuh has a very

323
00:14:26,938 --> 00:14:31,969
specific geometry it's it's a bipolar

324
00:14:29,730 --> 00:14:35,869
nebulae you know what makes a to karina

325
00:14:31,970 --> 00:14:38,910
specialist it's one of the most evolved

326
00:14:35,869 --> 00:14:41,489
and most massive stars in our galaxy and

327
00:14:38,909 --> 00:14:43,980
it's also relatively close and it's very

328
00:14:41,489 --> 00:14:47,730

bright which means that we can study it

329

00:14:43,980 --> 00:14:52,589

in in great detail and in the mid-1800s

330

00:14:47,730 --> 00:14:54,720

a decree nuh had a very powerful

331

00:14:52,589 --> 00:14:57,329

outburst it was almost as powerful as a

332

00:14:54,720 --> 00:14:59,189

supernova explosion before then everyone

333

00:14:57,328 --> 00:15:01,409

thought it was just a normal regular

334

00:14:59,188 --> 00:15:02,698

star in the sky and actually he could

335

00:15:01,409 --> 00:15:04,798

barely even see it with the naked eye

336

00:15:02,698 --> 00:15:07,738

but then it had this eruption and it

337

00:15:04,798 --> 00:15:11,338

became the second brightest non solar

338

00:15:07,739 --> 00:15:14,069

system objects in the sky and it was

339

00:15:11,339 --> 00:15:17,519

during this time that it objected all

340

00:15:14,068 --> 00:15:19,738

this material that forms this nebula but

341

00:15:17,519 --> 00:15:22,198

it was not a supernova no it was not a

342

00:15:19,739 --> 00:15:24,989

supernova that's what's that's what

343
00:15:22,198 --> 00:15:26,818
makes it a cleaner so fascinating is

344
00:15:24,989 --> 00:15:28,470
that well now we know that it's actually

345
00:15:26,818 --> 00:15:31,438
two stars we know now that at the very

346
00:15:28,470 --> 00:15:34,559
very center of this nebula are two very

347
00:15:31,438 --> 00:15:34,949
massive stars in total the total mass of

348
00:15:34,558 --> 00:15:38,639
this

349
00:15:34,950 --> 00:15:41,280
system is about a 120 times the mass of

350
00:15:38,639 --> 00:15:44,250
our Sun and the brain is of this thing

351
00:15:41,279 --> 00:15:47,009
is about 5 million times the brightness

352
00:15:44,250 --> 00:15:49,019
of our Sun but again what's amazing is

353
00:15:47,009 --> 00:15:51,210
it objective this gigantic nebula and

354
00:15:49,019 --> 00:15:54,960
the mass in the nebula itself is at

355
00:15:51,210 --> 00:15:57,269
least probably between 10 and 40 solar

356
00:15:54,960 --> 00:15:59,400
masses or 40 times the mass of our Sun

357
00:15:57,269 --> 00:16:02,100
but the star the star wasn't destroyed

358
00:15:59,399 --> 00:16:03,779
in this explosion and then we have no we

359
00:16:02,100 --> 00:16:05,159
have no idea Alice's how this is

360
00:16:03,779 --> 00:16:08,209
possible whether it was an explosion

361
00:16:05,159 --> 00:16:10,409
from a single star or whether two stars

362
00:16:08,210 --> 00:16:12,540
collided or whether two stars merge

363
00:16:10,409 --> 00:16:13,889
together I know it's an amazing looking

364
00:16:12,539 --> 00:16:16,620
object and Hubble's got some awesome

365
00:16:13,889 --> 00:16:18,720
images of this thing out but one of the

366
00:16:16,620 --> 00:16:22,110
things that I I guess I'm I look at this

367
00:16:18,720 --> 00:16:24,320
in this picture here and how there's a

368
00:16:22,110 --> 00:16:26,669
3d model of this thing how do you know

369
00:16:24,320 --> 00:16:28,650
what like it even on the right side of

370
00:16:26,669 --> 00:16:30,719
here says model side facing away from

371

00:16:28,649 --> 00:16:32,970
Earth how do you get that information I

372
00:16:30,720 --> 00:16:36,300
mean all we're seeing is you know a

373
00:16:32,970 --> 00:16:39,720
one-hour 2d projection of this of this

374
00:16:36,299 --> 00:16:41,309
object how do you get the 3d data points

375
00:16:39,720 --> 00:16:43,649
that you need to make it to make this

376
00:16:41,309 --> 00:16:45,989
accurate yeah so this was this was part

377
00:16:43,649 --> 00:16:48,110
of a very intense observing programme

378
00:16:45,990 --> 00:16:51,930
and like I said it was done with a

379
00:16:48,110 --> 00:16:54,810
telescope and so 80 kareena is in the in

380
00:16:51,929 --> 00:16:56,339
a constellation in the southern sky so

381
00:16:54,809 --> 00:16:59,459
unfortunately you can't see it from from

382
00:16:56,340 --> 00:17:01,769
the blue sky so we had to use a

383
00:16:59,460 --> 00:17:04,170
telescope in Chile and we used an

384
00:17:01,769 --> 00:17:09,449
instrument that is called X shooter and

385
00:17:04,170 --> 00:17:12,300

it's a spectrograph so the light passes

386

00:17:09,449 --> 00:17:14,789

through a slit and it disperses that

387

00:17:12,299 --> 00:17:18,569

light and that gives us not only spatial

388

00:17:14,789 --> 00:17:20,369

information along one dimension of the

389

00:17:18,569 --> 00:17:22,859

slit but it also gives us the loss of

390

00:17:20,369 --> 00:17:25,319

the information and what we did is we

391

00:17:22,859 --> 00:17:29,429

used this instrument to map the entire

392

00:17:25,319 --> 00:17:32,789

amongst nebulae and we used a very

393

00:17:29,430 --> 00:17:34,289

specific emission line we used we didn't

394

00:17:32,789 --> 00:17:36,960

do this in optical light so the image

395

00:17:34,289 --> 00:17:39,029

that that is being displayed is as a

396

00:17:36,960 --> 00:17:45,090

Hubble image so it's it's it's optical

397

00:17:39,029 --> 00:17:48,089

but we used a mission from hydrogen that

398

00:17:45,089 --> 00:17:48,539

submitted in near-infrared wavelengths

399

00:17:48,089 --> 00:17:50,970

and up

400
00:17:48,539 --> 00:17:54,450
that's good about the near-infrared is

401
00:17:50,970 --> 00:17:56,279
that allows us to see through

402
00:17:54,450 --> 00:17:59,220
essentially almost see through the

403
00:17:56,279 --> 00:18:01,589
nebula and we can actually see the back

404
00:17:59,220 --> 00:18:03,029
side of that of that lobe that's

405
00:18:01,589 --> 00:18:05,279
pointing away from us and we can get

406
00:18:03,029 --> 00:18:07,019
information about that about the

407
00:18:05,279 --> 00:18:09,809
structure that to spend expanding away

408
00:18:07,019 --> 00:18:11,639
from this I've based on based on all

409
00:18:09,809 --> 00:18:14,309
this when we get off the state and then

410
00:18:11,640 --> 00:18:18,840
we model it we can we can construct our

411
00:18:14,309 --> 00:18:20,879
our 3d model great okay so Carol you

412
00:18:18,839 --> 00:18:23,639
guys you guys said that you guys started

413
00:18:20,880 --> 00:18:27,540
with these texture maps and these

414
00:18:23,640 --> 00:18:29,070
luminosity maps with the with that one

415
00:18:27,539 --> 00:18:32,279
star forming region that you just that

416
00:18:29,069 --> 00:18:35,250
we just saw has there been used in

417
00:18:32,279 --> 00:18:40,649
classrooms yet or what's the what's the

418
00:18:35,250 --> 00:18:43,950
plan you're muted unfortunately thank

419
00:18:40,650 --> 00:18:47,280
you so our strategy has been to use the

420
00:18:43,950 --> 00:18:49,640
first cluster NGC 602 to test it

421
00:18:47,279 --> 00:18:53,670
actually we decided to test it with some

422
00:18:49,640 --> 00:18:55,800
small focus groups who were visually

423
00:18:53,670 --> 00:18:58,250
impaired at different levels and who

424
00:18:55,799 --> 00:19:00,629
have some or sometimes even no

425
00:18:58,250 --> 00:19:03,660
experience with taco materials and also

426
00:19:00,630 --> 00:19:05,730
had a range of Education and the reason

427
00:19:03,660 --> 00:19:10,560
was that we wanted to get a wide

428

00:19:05,730 --> 00:19:12,960
diversity of user to refine the textures

429
00:19:10,559 --> 00:19:16,079
and we actually had to refine the

430
00:19:12,960 --> 00:19:18,150
texture several times because what we

431
00:19:16,079 --> 00:19:19,679
thought were good textures and what we

432
00:19:18,150 --> 00:19:24,480
thought were good textures on the paper

433
00:19:19,680 --> 00:19:26,009
this swell form paper which has the

434
00:19:24,480 --> 00:19:28,589
raised surface which we talked about

435
00:19:26,009 --> 00:19:30,119
first it worked for the paper but it

436
00:19:28,589 --> 00:19:34,439
didn't really work for the 3d print so

437
00:19:30,119 --> 00:19:36,859
we had to modify that and also the the

438
00:19:34,440 --> 00:19:39,059
people who gave us feedback

439
00:19:36,859 --> 00:19:41,059
traditionally a lot of tactile stuff is

440
00:19:39,059 --> 00:19:43,710
done with like straight lines and

441
00:19:41,059 --> 00:19:45,990
slanted lines and thoughts and stuff

442
00:19:43,710 --> 00:19:48,600

like that and so we had to make sure

443

00:19:45,990 --> 00:19:52,019

that we could distinguish the stars from

444

00:19:48,599 --> 00:19:53,639

other dotted surfaces and then the users

445

00:19:52,019 --> 00:19:57,210

wanted us to do something that was a

446

00:19:53,640 --> 00:19:59,670

vocativ of dust or gas so we had to

447

00:19:57,210 --> 00:20:01,620

think about textures so it's taken us a

448

00:19:59,670 --> 00:20:02,130

while to refine the texture so we didn't

449

00:20:01,619 --> 00:20:04,500

think we

450

00:20:02,130 --> 00:20:06,450

take it to the classroom before I mean

451

00:20:04,500 --> 00:20:08,130

there's no point in taking a product to

452

00:20:06,450 --> 00:20:10,650

a classroom when you're not really sure

453

00:20:08,130 --> 00:20:13,020

that the product even works right trying

454

00:20:10,650 --> 00:20:14,550

to do proof of concept and then what

455

00:20:13,019 --> 00:20:16,710

we're going to do is we're going to

456

00:20:14,549 --> 00:20:20,369

create a process so that we can

457
00:20:16,710 --> 00:20:24,029
basically manufacture elevation maps and

458
00:20:20,369 --> 00:20:25,829
and texture maps for many Hubble images

459
00:20:24,029 --> 00:20:29,039
so we'll have a library of those and

460
00:20:25,829 --> 00:20:31,109
people can print those and then the next

461
00:20:29,039 --> 00:20:33,990
step is actually what is being printed

462
00:20:31,109 --> 00:20:39,299
now is that we we also have a galaxy

463
00:20:33,990 --> 00:20:42,599
project and we have these we're making

464
00:20:39,299 --> 00:20:44,789
3d models of galaxies now and they are

465
00:20:42,599 --> 00:20:48,089
also textured using our preferred

466
00:20:44,789 --> 00:20:50,970
textures there are star clusters there's

467
00:20:48,089 --> 00:20:52,679
gas and dust when just a little bit more

468
00:20:50,970 --> 00:20:56,190
torture windows so we can get the light

469
00:20:52,680 --> 00:20:57,720
from the angler my own a desk lamp is is

470
00:20:56,190 --> 00:21:00,269
on the printer oh that's good that's

471
00:20:57,720 --> 00:21:02,610
better but now now kind of angle it to

472
00:21:00,269 --> 00:21:04,139
there you go perfect perfect hey no no

473
00:21:02,609 --> 00:21:05,099
no that's good i just want to be able I

474
00:21:04,140 --> 00:21:07,950
wanted people to be able it was

475
00:21:05,099 --> 00:21:12,029
saturated there I know yeah hey I can a

476
00:21:07,950 --> 00:21:14,610
black one which is he blows our galaxy

477
00:21:12,029 --> 00:21:19,069
so sir galaxies are galaxies and I have

478
00:21:14,609 --> 00:21:22,919
to agree um with the our Goddard

479
00:21:19,069 --> 00:21:24,659
colleagues that we we're doing we're

480
00:21:22,920 --> 00:21:26,970
doing this for the visually impaired to

481
00:21:24,660 --> 00:21:29,250
you know convey science and all this up

482
00:21:26,970 --> 00:21:33,630
but when you print this stuff and you

483
00:21:29,250 --> 00:21:36,029
start looking at it you're like oh oh so

484
00:21:33,630 --> 00:21:40,710
we're learning things as well and I

485

00:21:36,029 --> 00:21:42,869
think of Thomasson and Frank of it

486
00:21:40,710 --> 00:21:44,490
verbalize that as well is that you start

487
00:21:42,869 --> 00:21:46,619
printing these things and you start

488
00:21:44,490 --> 00:21:48,750
learning things about the astronomical

489
00:21:46,619 --> 00:21:51,719
object as well what you did like oh

490
00:21:48,750 --> 00:21:54,329
that's interesting so that's a good

491
00:21:51,720 --> 00:21:56,850
point we know we knew in our heads that

492
00:21:54,329 --> 00:21:59,509
it had wide applicability not just for

493
00:21:56,849 --> 00:22:01,619
the visually impaired but it really even

494
00:21:59,509 --> 00:22:04,829
scientists can learn something by

495
00:22:01,619 --> 00:22:06,299
printing something in 3D right well

496
00:22:04,829 --> 00:22:07,829
Frank I promise I'm going to get you in

497
00:22:06,299 --> 00:22:09,059
and this is just a sack out but I want

498
00:22:07,829 --> 00:22:10,710
to ask I want to go but I want to

499
00:22:09,059 --> 00:22:12,359

reinforce a little bit of what Carol

500

00:22:10,710 --> 00:22:15,930

just the point she just made with Tom

501

00:22:12,359 --> 00:22:16,139

Tom and apparently i think it was there

502

00:22:15,930 --> 00:22:17,490

with

503

00:22:16,140 --> 00:22:20,340

things you learned about eight a car

504

00:22:17,490 --> 00:22:21,779

that you didn't know by just looking but

505

00:22:20,339 --> 00:22:22,919

once you had the printouts is that

506

00:22:21,779 --> 00:22:25,859

correct it was there there was some

507

00:22:22,920 --> 00:22:27,900

action scientific uh insight from

508

00:22:25,859 --> 00:22:31,109

printing these things yes so well here

509

00:22:27,900 --> 00:22:35,730

I'll use this are our biggest print

510

00:22:31,109 --> 00:22:38,639

model of the nebula and wow it's

511

00:22:35,730 --> 00:22:41,579

color-coded for a reason so the the red

512

00:22:38,640 --> 00:22:43,710

low is the lobe that is pointing away

513

00:22:41,579 --> 00:22:46,230

from the earth so it's the lobe that's

514
00:22:43,710 --> 00:22:48,049
that's proceeding in a blue low ready

515
00:22:46,230 --> 00:22:51,059
dread shifting away sort of right

516
00:22:48,049 --> 00:22:52,859
exactly exactly right and then the blue

517
00:22:51,059 --> 00:22:54,960
lobe is the lobe that's in the in the

518
00:22:52,859 --> 00:22:58,319
foreground of the HST image so it's the

519
00:22:54,960 --> 00:23:00,269
lobe that's coming towards us and we

520
00:22:58,319 --> 00:23:03,779
actually discovered some new features

521
00:23:00,269 --> 00:23:06,900
that were previously unknown to exist in

522
00:23:03,779 --> 00:23:10,019
the 80 car indiana car nebula the the

523
00:23:06,900 --> 00:23:14,070
first are these protrusions that you see

524
00:23:10,019 --> 00:23:15,960
um jutting out of the modes there's one

525
00:23:14,069 --> 00:23:18,450
phone from the from the bottom blue lobe

526
00:23:15,960 --> 00:23:20,490
and one from the top load and then there

527
00:23:18,450 --> 00:23:22,769
are these uh hopefully they'll show up

528
00:23:20,490 --> 00:23:26,490
well on the webcam but there are these

529
00:23:22,769 --> 00:23:27,750
trenches yeah we can see them yeah that

530
00:23:26,490 --> 00:23:30,690
are there's one on look again there's

531
00:23:27,750 --> 00:23:32,369
one on the foreground lobe and there's

532
00:23:30,690 --> 00:23:34,320
one on the receding lobe and what's

533
00:23:32,369 --> 00:23:36,239
what's interesting is that those are

534
00:23:34,319 --> 00:23:38,339
real those are real these these are real

535
00:23:36,240 --> 00:23:42,450
physical real physical features in the

536
00:23:38,339 --> 00:23:44,029
nebula itself and some some really

537
00:23:42,450 --> 00:23:49,140
interesting things so for instance the

538
00:23:44,029 --> 00:23:50,970
the protrusions are not visible or at

539
00:23:49,140 --> 00:23:53,070
least they're not they're not clearly

540
00:23:50,970 --> 00:23:57,509
apparent in in for instance the Hubble

541
00:23:53,069 --> 00:24:00,419
image but you see them in this in this

542

00:23:57,509 --> 00:24:02,549
molecular hydrogen line that we observed

543
00:24:00,420 --> 00:24:06,240
and then also that the trenches you can

544
00:24:02,549 --> 00:24:09,240
see one in the bottom of the in the

545
00:24:06,240 --> 00:24:11,519
bottom lobe in the Hubble image but the

546
00:24:09,240 --> 00:24:13,319
one on the far side of the low on this

547
00:24:11,519 --> 00:24:15,389
on this mode that's pointing away from

548
00:24:13,319 --> 00:24:21,389
us we did not know that that existed

549
00:24:15,390 --> 00:24:23,190
until we did the the 3d modeling ok wow

550
00:24:21,390 --> 00:24:24,890
that's so are you as an astrophysicist

551
00:24:23,190 --> 00:24:27,120
or are you excited about this new

552
00:24:24,890 --> 00:24:28,440
insight into some of these I mean let's

553
00:24:27,119 --> 00:24:29,039
say you printed some other things out I

554
00:24:28,440 --> 00:24:30,750
mean

555
00:24:29,039 --> 00:24:32,789
their chances are pretty good you might

556
00:24:30,750 --> 00:24:36,569

glean other insights from things that

557

00:24:32,789 --> 00:24:38,490

yes we are and I not going to say too

558

00:24:36,569 --> 00:24:41,369

much now but we are working on something

559

00:24:38,490 --> 00:24:43,049

that is a something new that we are

560

00:24:41,369 --> 00:24:45,389

doing with 3d printing that as far as we

561

00:24:43,049 --> 00:24:47,609

know has never been done before and we

562

00:24:45,390 --> 00:24:50,280

have potentially discovered something

563

00:24:47,609 --> 00:24:52,829

new and we're hoping to make you

564

00:24:50,279 --> 00:24:54,839

possibly make an announcement in the

565

00:24:52,829 --> 00:24:56,639

near future about that sounds like

566

00:24:54,839 --> 00:24:59,039

another hangouts on the way here soon

567

00:24:56,640 --> 00:25:00,570

cold I let us know Franklin let me get I

568

00:24:59,039 --> 00:25:02,579

want to finally get you i'm sorry it's

569

00:25:00,569 --> 00:25:04,109

taken me a bit but i wanted to get

570

00:25:02,579 --> 00:25:06,509

through some of the intros and stuff and

571
00:25:04,109 --> 00:25:08,879
you're a science writer at Goddard and

572
00:25:06,509 --> 00:25:10,799
you're you're involved in the 3d

573
00:25:08,880 --> 00:25:12,090
printing project I want you give us a

574
00:25:10,799 --> 00:25:13,529
little what Witcher what do you uh what

575
00:25:12,089 --> 00:25:15,419
are you excited about what are you

576
00:25:13,529 --> 00:25:18,119
working on with this well principally

577
00:25:15,420 --> 00:25:20,430
I'm involved as a hobbyist I I had got

578
00:25:18,119 --> 00:25:24,089
involved a couple of months before the

579
00:25:20,430 --> 00:25:28,200
ADA kareena material that commute in my

580
00:25:24,089 --> 00:25:31,679
office and there were efforts to try to

581
00:25:28,200 --> 00:25:34,710
use a older 3d printer that we had a

582
00:25:31,680 --> 00:25:36,990
daughter and I took a stab at getting it

583
00:25:34,710 --> 00:25:39,000
on my home printer and we wound up

584
00:25:36,990 --> 00:25:45,660
making something like a hundred edema

585
00:25:39,000 --> 00:25:47,039
stays local I these were dispute I what

586
00:25:45,660 --> 00:25:49,769
a great word i'm going to start using it

587
00:25:47,039 --> 00:25:52,139
i work that into a sentence homunculi i

588
00:25:49,769 --> 00:25:53,910
printed up probably about a hundred of

589
00:25:52,140 --> 00:25:55,710
these we distributed something to the

590
00:25:53,910 --> 00:26:00,330
co-authors of the paper the talmage on

591
00:25:55,710 --> 00:26:02,190
and to another couple dozen to people

592
00:26:00,329 --> 00:26:07,500
who are just getting an ask social and

593
00:26:02,190 --> 00:26:11,160
daughter and so it was really a trial by

594
00:26:07,500 --> 00:26:14,069
fire to get all that done but the real

595
00:26:11,160 --> 00:26:18,000
learning experience for me as i said i

596
00:26:14,069 --> 00:26:19,980
got into it just out of curiosity but

597
00:26:18,000 --> 00:26:21,390
and because you want and you bought one

598
00:26:19,980 --> 00:26:23,279
of the and you owned a printer so you

599

00:26:21,390 --> 00:26:24,480
did well so what can you tell us a

600
00:26:23,279 --> 00:26:26,700
little bit about the technology i'm

601
00:26:24,480 --> 00:26:29,700
going to have Carol's printer up here

602
00:26:26,700 --> 00:26:30,720
and how do these things work what tell

603
00:26:29,700 --> 00:26:32,700
us a little bit about the technology

604
00:26:30,720 --> 00:26:34,819
here well there a number of different

605
00:26:32,700 --> 00:26:37,500
technologies but the one that's becoming

606
00:26:34,819 --> 00:26:42,178
affordable very quickly is the food

607
00:26:37,500 --> 00:26:47,159
filament fabrication which makes a roll

608
00:26:42,179 --> 00:26:49,369
uh plastic filament and sort of places

609
00:26:47,159 --> 00:26:53,330
it down the way you would ice a cake

610
00:26:49,368 --> 00:26:55,918
just drawing the outline of the object

611
00:26:53,329 --> 00:27:00,359
software goes through and slices that

612
00:26:55,919 --> 00:27:03,419
object into small layers and the printer

613
00:27:00,359 --> 00:27:07,339

simply draws each layer in succession

614

00:27:03,419 --> 00:27:09,740

and gradually builds up the object and

615

00:27:07,339 --> 00:27:13,138

Carol you said you were printing out

616

00:27:09,740 --> 00:27:15,028

what happened oh there you go she all be

617

00:27:13,138 --> 00:27:17,308

no go ahead yeah please show that yeah

618

00:27:15,028 --> 00:27:21,079

Carol showing the material a spool of

619

00:27:17,308 --> 00:27:25,378

some kind of what is that stuff Frank

620

00:27:21,079 --> 00:27:28,439

it's it's probably abs plastic a lot so

621

00:27:25,378 --> 00:27:33,689

PLA with your beauty Carol ok ok I

622

00:27:28,440 --> 00:27:36,269

couldn't see the lady feeling he's to

623

00:27:33,690 --> 00:27:39,330

come in common filaments near their

624

00:27:36,269 --> 00:27:41,190

obvious Taiwan is also low so that stuff

625

00:27:39,329 --> 00:27:42,839

gets spooled through the printer head

626

00:27:41,190 --> 00:27:45,990

which we're seeing right now go back and

627

00:27:42,839 --> 00:27:47,819

forth and the third dimension we don't

628
00:27:45,990 --> 00:27:49,528
see as well which is coming at us and

629
00:27:47,819 --> 00:27:52,558
back away from us so in the plane of the

630
00:27:49,528 --> 00:27:54,720
camera so in the printer today at the

631
00:27:52,558 --> 00:28:01,190
tip of the further is it is a heater in

632
00:27:54,720 --> 00:28:05,220
the formula ceded to DC and dribbled out

633
00:28:01,190 --> 00:28:07,590
very precisely as the head moves

634
00:28:05,220 --> 00:28:09,298
applause and Carol this thing is

635
00:28:07,589 --> 00:28:11,668
ubiquitous in your office we've had

636
00:28:09,298 --> 00:28:13,230
every almost every hangout somebody has

637
00:28:11,669 --> 00:28:15,509
commented what's that going on behind

638
00:28:13,230 --> 00:28:17,639
Carol you're always printing something

639
00:28:15,509 --> 00:28:19,499
on it how long does it take usually to

640
00:28:17,638 --> 00:28:21,508
make on up you're printing out a galaxy

641
00:28:19,499 --> 00:28:24,600
you said right now right I'm gonna lie

642
00:28:21,509 --> 00:28:27,740
antonella taco the time it takes and

643
00:28:24,599 --> 00:28:34,648
what it's been gone I go ahead Antonella

644
00:28:27,740 --> 00:28:37,589
hello time it takes appropriate half of

645
00:28:34,648 --> 00:28:39,329
the galaxy as a matter of fact one of

646
00:28:37,589 --> 00:28:42,298
the things that we realize with the

647
00:28:39,329 --> 00:28:44,638
testing with our group of visually

648
00:28:42,298 --> 00:28:47,460
impaired is that the larger form of

649
00:28:44,638 --> 00:28:49,798
healthy fun to recognize the future so

650
00:28:47,460 --> 00:28:51,869
one of the limitation of the maker ball

651
00:28:49,798 --> 00:28:55,019
which is the low end printer we are

652
00:28:51,868 --> 00:28:55,769
using is that the format is more so we

653
00:28:55,019 --> 00:28:58,470
are building

654
00:28:55,769 --> 00:29:00,930
our prototypes and pieces and then we

655
00:28:58,470 --> 00:29:03,960
glue them so we can make a larger format

656

00:29:00,930 --> 00:29:05,940
because we know that that is easy but

657
00:29:03,960 --> 00:29:08,370
the reason why we chose the MakerBot in

658
00:29:05,940 --> 00:29:11,309
our case is because it is affordable and

659
00:29:08,369 --> 00:29:14,039
so you know you would think that schools

660
00:29:11,309 --> 00:29:17,039
can reasonably purchase something like

661
00:29:14,039 --> 00:29:19,980
that libraries and so one of our

662
00:29:17,039 --> 00:29:23,279
long-term goals is actually making a

663
00:29:19,980 --> 00:29:25,170
library of images and make them

664
00:29:23,279 --> 00:29:28,980
available to people so that actually

665
00:29:25,170 --> 00:29:31,440
people can take them and and bring them

666
00:29:28,980 --> 00:29:33,870
in their own you know printer at home or

667
00:29:31,440 --> 00:29:35,910
its full on the library and kind of

668
00:29:33,869 --> 00:29:38,039
experience what are we talking about

669
00:29:35,910 --> 00:29:39,900
here as far as cost couple grand for you

670
00:29:38,039 --> 00:29:42,180

know that 5,000 what are we talking a

671

00:29:39,900 --> 00:29:44,340

little thousand a couple grant okay so

672

00:29:42,180 --> 00:29:46,320

you're right that could be in the realm

673

00:29:44,339 --> 00:29:49,099

of possibility for a lot of schools is

674

00:29:46,319 --> 00:29:51,990

there any plans for maybe uh

675

00:29:49,099 --> 00:29:53,519

distributing I don't know how how does

676

00:29:51,990 --> 00:29:55,500

this thing know what to print what do

677

00:29:53,519 --> 00:29:58,589

you send it you sent a file of some

678

00:29:55,500 --> 00:30:00,960

kind of 3d file or what do you do these

679

00:29:58,589 --> 00:30:04,169

printers with a very specific format

680

00:30:00,960 --> 00:30:06,660

which is called stl so part of the

681

00:30:04,170 --> 00:30:09,240

process is to convert the images as we

682

00:30:06,660 --> 00:30:11,940

know them or the models whatever into an

683

00:30:09,240 --> 00:30:17,430

STL format than a 3d printer any

684

00:30:11,940 --> 00:30:21,390

educator can take and think it's pretty

685
00:30:17,430 --> 00:30:23,279
standard format used by old days Carol

686
00:30:21,390 --> 00:30:26,070
do you have a finished thing of what

687
00:30:23,279 --> 00:30:30,420
you're printing right now do you know

688
00:30:26,069 --> 00:30:37,579
actually I'm printing um yes we have

689
00:30:30,420 --> 00:30:40,920
that we have to test galaxies 3344 and

690
00:30:37,579 --> 00:30:44,339
1566 i think and the black one that i

691
00:30:40,920 --> 00:30:49,230
have here we are we are printing a

692
00:30:44,339 --> 00:30:51,089
purple version of that one and then we

693
00:30:49,230 --> 00:30:53,250
have a programmer who's working on some

694
00:30:51,089 --> 00:30:56,789
more the galaxies and the interface and

695
00:30:53,250 --> 00:30:59,250
we're going to start printing more of

696
00:30:56,789 --> 00:31:01,980
those I actually want to have the

697
00:30:59,250 --> 00:31:03,900
texture and elevation map of this galaxy

698
00:31:01,980 --> 00:31:06,690
as well so that we have the three

699
00:31:03,900 --> 00:31:09,480
products so that we can test the three

700
00:31:06,690 --> 00:31:12,330
products and see whether people prefer

701
00:31:09,480 --> 00:31:14,308
just this or whether they would like to

702
00:31:12,329 --> 00:31:18,269
use the other ones to kind of teach

703
00:31:14,308 --> 00:31:19,710
themselves about the science so what

704
00:31:18,269 --> 00:31:21,690
we're thinking about what are the

705
00:31:19,710 --> 00:31:24,660
different formats that work with what

706
00:31:21,690 --> 00:31:27,090
kind of users best wow this is like

707
00:31:24,660 --> 00:31:29,070
totally cutting edge stuff here so Frank

708
00:31:27,089 --> 00:31:31,289
when you did your when your initial

709
00:31:29,069 --> 00:31:32,939
printing what did you print how did you

710
00:31:31,289 --> 00:31:34,879
print on astronomy things or was it

711
00:31:32,940 --> 00:31:39,150
something what what else did you print

712
00:31:34,880 --> 00:31:41,190
my initial efforts were to print spare

713

00:31:39,150 --> 00:31:44,519
parts or replacement parts for my

714
00:31:41,190 --> 00:31:46,110
kitchen floors that's like you

715
00:31:44,519 --> 00:31:48,779
definitely being preg knows were

716
00:31:46,109 --> 00:31:51,409
expensive parts that weren't they I

717
00:31:48,779 --> 00:31:55,019
can't buy the mating there because the

718
00:31:51,410 --> 00:31:56,669
furniture is sold ok so further

719
00:31:55,019 --> 00:31:57,900
replaceable parts you can't just go to

720
00:31:56,669 --> 00:32:01,860
lowes and get them you print them out

721
00:31:57,900 --> 00:32:04,080
yourself so I know that this the primary

722
00:32:01,859 --> 00:32:06,839
focus educationally at least is for the

723
00:32:04,079 --> 00:32:09,899
visually impaired but for someone you

724
00:32:06,839 --> 00:32:11,220
know for those of us who can see these

725
00:32:09,900 --> 00:32:13,200
models one of the one of the things that

726
00:32:11,220 --> 00:32:15,630
strikes me is it would be really cool if

727
00:32:13,200 --> 00:32:19,230

we could do different colors is that

728

00:32:15,630 --> 00:32:22,530

possible Frank oh absolutely different

729

00:32:19,230 --> 00:32:23,880

colors are one in a sacred yeah is that

730

00:32:22,529 --> 00:32:27,808

possible what do you do switch out the

731

00:32:23,880 --> 00:32:29,610

spool or what do you do there are there

732

00:32:27,808 --> 00:32:32,009

are printers that have multiple

733

00:32:29,609 --> 00:32:36,298

extruders and therefore you as many

734

00:32:32,009 --> 00:32:40,369

colors as you have excluders trigger the

735

00:32:36,298 --> 00:32:44,359

pressure ha day there is in fact 111

736

00:32:40,369 --> 00:32:46,259

printer head that contains for exteriors

737

00:32:44,359 --> 00:32:50,548

estranging an interesting name

738

00:32:46,259 --> 00:32:53,119

diffracted reckon I've better you think

739

00:32:50,548 --> 00:32:57,329

that's one one way to do it would be to

740

00:32:53,119 --> 00:32:59,849

have four columns simultaneously you

741

00:32:57,329 --> 00:33:01,980

know this reminds me I'm really dating

742
00:32:59,849 --> 00:33:05,279
myself here but my first computer had a

743
00:33:01,980 --> 00:33:06,630
printer an Epson MX 80 and when you when

744
00:33:05,279 --> 00:33:08,490
you printed on it it made this

745
00:33:06,630 --> 00:33:11,580
horrendous racket and it would go back

746
00:33:08,490 --> 00:33:13,679
and forth in one color only and it would

747
00:33:11,579 --> 00:33:16,319
take you like minutes to print the page

748
00:33:13,679 --> 00:33:20,130
of text it's a real I see a similar

749
00:33:16,319 --> 00:33:22,269
experience so when I look at this thing

750
00:33:20,130 --> 00:33:24,278
go I have to say I've kind of reminded

751
00:33:22,269 --> 00:33:26,259
those days where we've got this dot

752
00:33:24,278 --> 00:33:27,638
matrix printer going back and forth and

753
00:33:26,259 --> 00:33:30,278
then Frank was just telling us about the

754
00:33:27,638 --> 00:33:32,218
crack in which can has color and I don't

755
00:33:30,278 --> 00:33:36,190
know if you remember when color came out

756
00:33:32,219 --> 00:33:39,099
girls a big deal uh and so this is kind

757
00:33:36,190 --> 00:33:40,959
of like mimicking that sort of

758
00:33:39,098 --> 00:33:43,269
technology or at least in my eyes well

759
00:33:40,959 --> 00:33:45,609
so happily it will only get better from

760
00:33:43,269 --> 00:33:48,548
here that's what I guess and Matt and

761
00:33:45,608 --> 00:33:50,168
like winners today or although there's

762
00:33:48,548 --> 00:33:51,128
more or less now our kind of obsolete I

763
00:33:50,169 --> 00:33:53,139
don't think we use them very much

764
00:33:51,128 --> 00:33:54,878
anyways i don't i only own a printer

765
00:33:53,138 --> 00:33:58,689
because i sometimes have to print but

766
00:33:54,878 --> 00:34:03,638
very rarely okay so i would i want to

767
00:33:58,690 --> 00:34:07,149
talk a little bit about um the UH going

768
00:34:03,638 --> 00:34:08,618
from data to the printer i'm not quite

769
00:34:07,148 --> 00:34:10,538
sure the best person asked but i'm

770

00:34:08,619 --> 00:34:13,119
thinking Carol but maybe it's Frank I

771
00:34:10,539 --> 00:34:14,679
you got data or maybe it's even Tom and

772
00:34:13,119 --> 00:34:16,269
I'm just gonna let one of your aunt's

773
00:34:14,679 --> 00:34:18,220
now i'll let you just chime in if you

774
00:34:16,269 --> 00:34:20,288
know this it's actually for our group

775
00:34:18,219 --> 00:34:23,230
it's on to know it's Antonella ok good

776
00:34:20,289 --> 00:34:25,599
let me see drained a student to do this

777
00:34:23,230 --> 00:34:28,148
too constraining a programmer now so you

778
00:34:25,599 --> 00:34:29,950
can thank you k ok good so Antonella

779
00:34:28,148 --> 00:34:33,038
you've got some data from Hubble whether

780
00:34:29,949 --> 00:34:35,828
it is an image with intensities or maybe

781
00:34:33,039 --> 00:34:38,289
spectra with velocities how do you go

782
00:34:35,829 --> 00:34:42,399
from that to something that the printer

783
00:34:38,289 --> 00:34:45,309
needs how hard is that something similar

784
00:34:42,398 --> 00:34:47,648

to walk tom for e-toc are basically you

785

00:34:45,309 --> 00:34:49,179

build the data cube when you try to be

786

00:34:47,648 --> 00:34:52,418

able to basically put all the

787

00:34:49,179 --> 00:34:55,599

information that you have and for

788

00:34:52,418 --> 00:34:58,269

example for NGC 602 we did fight a lot

789

00:34:55,599 --> 00:35:01,059

of little cursor to see what was

790

00:34:58,269 --> 00:35:02,980

published about where the various

791

00:35:01,059 --> 00:35:05,559

feature in the cluster are spatially

792

00:35:02,980 --> 00:35:08,260

located to try to understand you know

793

00:35:05,559 --> 00:35:10,329

what is the true 3d structure on that

794

00:35:08,260 --> 00:35:13,809

altar so this is working progress

795

00:35:10,329 --> 00:35:16,839

because it's not simple and it's a

796

00:35:13,809 --> 00:35:19,269

combination of astrophysics things that

797

00:35:16,838 --> 00:35:21,548

we can measure from the images we can

798

00:35:19,269 --> 00:35:23,528

measure the position of the stars we can

799

00:35:21,548 --> 00:35:26,559
measure the thickness of the filaments

800

00:35:23,528 --> 00:35:28,539
their intensity we also know where they

801

00:35:26,559 --> 00:35:31,390
are specially located like the gas

802

00:35:28,539 --> 00:35:34,089
system or lose the back end of the

803

00:35:31,389 --> 00:35:35,779
bubble the past is the front end but

804

00:35:34,088 --> 00:35:38,059
some you know 21

805

00:35:35,780 --> 00:35:46,990
what the visual representation al Sam is

806

00:35:38,059 --> 00:35:50,900
also guest ah oh I think we're overlap

807

00:35:46,989 --> 00:35:52,879
can you hear me bill okay so you cut out

808

00:35:50,900 --> 00:35:54,740
there toward the very yeah you cut out

809

00:35:52,880 --> 00:35:57,559
just a little bit toward it's all easy

810

00:35:54,739 --> 00:36:01,339
are you there can you hear me still can

811

00:35:57,559 --> 00:36:03,409
you I we can hear you now you dropped

812

00:36:01,340 --> 00:36:06,920
out just a little bit there okay so it's

813

00:36:03,409 --> 00:36:10,879

a it's no sonic six right it's an

814

00:36:06,920 --> 00:36:12,680

overlap between what is data you know

815

00:36:10,880 --> 00:36:15,289

data that we have from the England

816

00:36:12,679 --> 00:36:18,619

measurement from the image data from the

817

00:36:15,289 --> 00:36:22,730

literature and some guesswork and trying

818

00:36:18,619 --> 00:36:25,880

to put it all together and our goal also

819

00:36:22,730 --> 00:36:29,150

for NGC 602 is to try to do a 3d model

820

00:36:25,880 --> 00:36:31,820

of of the nebula and we'll get there

821

00:36:29,150 --> 00:36:36,170

like exactly like founded for each other

822

00:36:31,820 --> 00:36:37,400

okay so I I talk do you have anything

823

00:36:36,170 --> 00:36:39,200

you'd like to add to that as far as the

824

00:36:37,400 --> 00:36:42,980

difficulty level of going from data to

825

00:36:39,199 --> 00:36:45,230

to a printout yes i would say that part

826

00:36:42,980 --> 00:36:48,920

of the part of the issue at least that

827

00:36:45,230 --> 00:36:52,250
we learned was you could generate a 3d

828
00:36:48,920 --> 00:36:54,050
model that looks good on a computer

829
00:36:52,250 --> 00:36:56,630
screen but that doesn't necessarily mean

830
00:36:54,050 --> 00:37:00,050
that you can 3d print it again there was

831
00:36:56,630 --> 00:37:02,360
a bit of a steep learning curve to to

832
00:37:00,050 --> 00:37:05,150
learn what is necessary in order to have

833
00:37:02,360 --> 00:37:07,460
a successful to have a successful print

834
00:37:05,150 --> 00:37:09,200
but we've been playing around with with

835
00:37:07,460 --> 00:37:12,679
different software and some of its even

836
00:37:09,199 --> 00:37:14,569
freely available online one piece

837
00:37:12,679 --> 00:37:19,089
software that we've started using is

838
00:37:14,570 --> 00:37:23,150
called blender and that allows you to do

839
00:37:19,090 --> 00:37:25,820
some very fine adjustments to the 3d

840
00:37:23,150 --> 00:37:28,250
mesh or the witch which defines the

841
00:37:25,820 --> 00:37:32,180

geometry of your object it allows you to

842

00:37:28,250 --> 00:37:33,920

make some very nice intricate changes to

843

00:37:32,179 --> 00:37:36,259

your to your lash like for instance if

844

00:37:33,920 --> 00:37:38,780

one of the problems is here your object

845

00:37:36,260 --> 00:37:40,040

has to be watertight which means for

846

00:37:38,780 --> 00:37:42,019

instance if you took your model and you

847

00:37:40,039 --> 00:37:46,610

dip it in water you don't look the water

848

00:37:42,019 --> 00:37:48,110

to drain out or to get in and so you

849

00:37:46,610 --> 00:37:49,010

have to make sure that your model

850

00:37:48,110 --> 00:37:50,960

doesn't have any and

851

00:37:49,010 --> 00:37:53,330

obvious holes in it and there there are

852

00:37:50,960 --> 00:37:55,460

some other some other details that you

853

00:37:53,329 --> 00:37:57,710

have to make the check to make sure that

854

00:37:55,460 --> 00:37:59,809

here your model will print but that was

855

00:37:57,710 --> 00:38:01,760

the that was the largest thing and then

856
00:37:59,809 --> 00:38:03,799
also just the intricacies with the

857
00:38:01,760 --> 00:38:06,860
printers themselves they can be they can

858
00:38:03,800 --> 00:38:09,680
be fickle from time to time and I'm Tom

859
00:38:06,860 --> 00:38:12,890
agrees that there must be another a lot

860
00:38:09,679 --> 00:38:15,349
of custom-made software goes into

861
00:38:12,889 --> 00:38:17,779
putting all together you can just do

862
00:38:15,349 --> 00:38:19,279
this using off-the-shelf product ah

863
00:38:17,780 --> 00:38:21,200
that's what I was going to ask so you

864
00:38:19,280 --> 00:38:25,250
had to write some code to do this right

865
00:38:21,199 --> 00:38:30,199
yes especially for the tiktok to go from

866
00:38:25,250 --> 00:38:32,329
the spectra from the telescope to a 3d

867
00:38:30,199 --> 00:38:35,929
model of the nebula itself yes that that

868
00:38:32,329 --> 00:38:37,759
was that was specialized so exactly well

869
00:38:35,929 --> 00:38:39,440
what about availability what if I wanted

870
00:38:37,760 --> 00:38:40,850
what if I go out and I spend some money

871
00:38:39,440 --> 00:38:43,159
and I buy a printer but I want to do

872
00:38:40,849 --> 00:38:44,239
this too can I get that software or are

873
00:38:43,159 --> 00:38:46,699
you guys going to make it available to

874
00:38:44,239 --> 00:38:50,719
people or is it something that one has

875
00:38:46,699 --> 00:38:53,179
to do themselves actually yes so so

876
00:38:50,719 --> 00:38:55,369
Wolfgang Stefan who was again but the

877
00:38:53,179 --> 00:38:57,469
first author on the on the a tocar 3d

878
00:38:55,369 --> 00:39:01,309
modeling paper this software is called

879
00:38:57,469 --> 00:39:03,799
shape and it is it is publicly available

880
00:39:01,309 --> 00:39:06,170
it is freely available but I don't think

881
00:39:03,800 --> 00:39:08,870
he's still working on putting I think

882
00:39:06,170 --> 00:39:10,789
the 3d capabilities in so as Antonella

883
00:39:08,869 --> 00:39:12,589
was saying you have to have a special

884

00:39:10,789 --> 00:39:15,380
file format usually for these printers

885
00:39:12,590 --> 00:39:17,300
that's called an STL file and I think

886
00:39:15,380 --> 00:39:20,510
the current version of shape doesn't

887
00:39:17,300 --> 00:39:22,880
have he doesn't have the capability to

888
00:39:20,510 --> 00:39:25,040
output that file but from what I

889
00:39:22,880 --> 00:39:26,990
understand a new version that will be

890
00:39:25,039 --> 00:39:28,369
coming out will and one of the other

891
00:39:26,989 --> 00:39:31,429
things that we have that we've done

892
00:39:28,369 --> 00:39:34,489
especially for the further for the ADA

893
00:39:31,429 --> 00:39:37,069
car is in the meantime we've leave at

894
00:39:34,489 --> 00:39:38,839
least been trying to make the the STL

895
00:39:37,070 --> 00:39:40,850
files available to the public so if they

896
00:39:38,840 --> 00:39:42,740
want to print their own model on their

897
00:39:40,849 --> 00:39:45,079
own 3d printer or there are even

898
00:39:42,739 --> 00:39:47,809

companies now where you can give them a

899

00:39:45,079 --> 00:39:50,179

file and they will 3d print it for you

900

00:39:47,809 --> 00:39:53,900

if you can't afford or have your own 3d

901

00:39:50,179 --> 00:39:56,659

printer so yes so the goal is to try and

902

00:39:53,900 --> 00:39:58,309

make this as as available as we can to

903

00:39:56,659 --> 00:40:00,949

the public so that baking so that they

904

00:39:58,309 --> 00:40:02,630

can play with it themselves great ok

905

00:40:00,949 --> 00:40:05,568

afraid

906

00:40:02,630 --> 00:40:07,759

was going to you for the last question I

907

00:40:05,568 --> 00:40:09,318

was just going to say that that it's

908

00:40:07,759 --> 00:40:12,289

somewhat similar like with our

909

00:40:09,318 --> 00:40:14,298

visualization people here when we are

910

00:40:12,289 --> 00:40:16,339

working on a press release and we have

911

00:40:14,298 --> 00:40:18,889

one of our animators start to work with

912

00:40:16,338 --> 00:40:21,159

somebody the scientist has the data and

913
00:40:18,889 --> 00:40:23,750
then there has to be some translation

914
00:40:21,159 --> 00:40:25,969
before it goes into some program like

915
00:40:23,750 --> 00:40:30,108
Maya or some other visualization said

916
00:40:25,969 --> 00:40:32,899
that step still requires you know art is

917
00:40:30,108 --> 00:40:35,420
re and science and all that so that that

918
00:40:32,900 --> 00:40:38,150
stuff isn't quite you know just can't

919
00:40:35,420 --> 00:40:39,858
take and because you know that's why we

920
00:40:38,150 --> 00:40:41,960
do the science is because when you take

921
00:40:39,858 --> 00:40:43,818
an image you analyze it and you measure

922
00:40:41,960 --> 00:40:45,740
it and all that and then you take those

923
00:40:43,818 --> 00:40:48,139
measurements and you put them into

924
00:40:45,739 --> 00:40:50,868
another file format and if you late it

925
00:40:48,139 --> 00:40:53,568
and end up with a 3d visualization or 3d

926
00:40:50,869 --> 00:40:54,920
print so that's where the science is so

927
00:40:53,568 --> 00:40:57,380
there's a lot of work and getting the

928
00:40:54,920 --> 00:40:59,059
science right before you even even

929
00:40:57,380 --> 00:41:01,068
decide to translate it into something

930
00:40:59,059 --> 00:41:03,798
you can manipulate on a computer or an

931
00:41:01,068 --> 00:41:05,719
eternity yeah and and I I was

932
00:41:03,798 --> 00:41:07,130
particularly fascinated when Tom said

933
00:41:05,719 --> 00:41:08,808
that they you know they found features

934
00:41:07,130 --> 00:41:09,829
in natick are that they didn't see

935
00:41:08,809 --> 00:41:11,750
really I didn't even know they were

936
00:41:09,829 --> 00:41:13,250
there until they printed them out one of

937
00:41:11,750 --> 00:41:15,318
the thing that's why I asked is it real

938
00:41:13,250 --> 00:41:17,298
and I guess at that whole step of going

939
00:41:15,318 --> 00:41:20,538
from the data translation to the printer

940
00:41:17,298 --> 00:41:22,788
file could be a big source of error but

941

00:41:20,539 --> 00:41:24,019
it sounds like everybody's being you

942
00:41:22,789 --> 00:41:26,990
know they got a pretty good plan for

943
00:41:24,018 --> 00:41:29,239
doing that translation and I don't know

944
00:41:26,989 --> 00:41:31,489
I think this is amazing Frank can I just

945
00:41:29,239 --> 00:41:33,469
ask you real quick are the are the data

946
00:41:31,489 --> 00:41:36,258
are all printers more or less the same

947
00:41:33,469 --> 00:41:38,358
in terms of how they work for input like

948
00:41:36,259 --> 00:41:40,420
if I made a file for the MakerBot would

949
00:41:38,358 --> 00:41:46,489
it work on some other brand of printer

950
00:41:40,420 --> 00:41:49,670
in principle or are simply what goes to

951
00:41:46,489 --> 00:41:52,548
third is material called G code after it

952
00:41:49,670 --> 00:41:56,980
comes out of the slicing tool that

953
00:41:52,548 --> 00:42:00,048
repeat to be used by different printers

954
00:41:56,980 --> 00:42:01,789
it depends on but there are specific

955
00:42:00,048 --> 00:42:04,099

commands that might be specific to their

956

00:42:01,789 --> 00:42:08,390

to the further yes T upload the comp

957

00:42:04,099 --> 00:42:12,490

mentioned earlier about is universal and

958

00:42:08,389 --> 00:42:15,420

input as there is good so that is the

959

00:42:12,489 --> 00:42:17,129

21st century of a parallel printer then

960

00:42:15,420 --> 00:42:22,500

remember when you could get parallel and

961

00:42:17,130 --> 00:42:25,260

serial printer anyway I'm costs I will

962

00:42:22,500 --> 00:42:31,949

say that the printer I own is under five

963

00:42:25,260 --> 00:42:34,710

hundred dollars their costume oh okay

964

00:42:31,949 --> 00:42:36,298

great so who's got some stuff to show us

965

00:42:34,710 --> 00:42:37,858

I mean I we see some stuff from Carol

966

00:42:36,298 --> 00:42:40,349

Tom to you and you showed us some of the

967

00:42:37,858 --> 00:42:41,699

human cool i or at least one of them do

968

00:42:40,349 --> 00:42:44,220

you have any other things handy you

969

00:42:41,699 --> 00:42:46,710

could show us any other models um at the

970
00:42:44,219 --> 00:42:50,338
moment unfortunately I do not I just

971
00:42:46,710 --> 00:42:53,699
have so so just some smaller homunculus

972
00:42:50,338 --> 00:42:55,980
and these were these were giant word of

973
00:42:53,699 --> 00:42:58,879
authority thanks we go the thief these

974
00:42:55,980 --> 00:43:01,199
were done on on Frank's on Frank's no

975
00:42:58,880 --> 00:43:04,260
five-hundred-dollar printer and they

976
00:43:01,199 --> 00:43:06,598
actually are quite quite do it I'm

977
00:43:04,260 --> 00:43:09,059
actually really impressed with with the

978
00:43:06,599 --> 00:43:10,410
quality that you can get out of a

979
00:43:09,059 --> 00:43:13,250
five-hundred-dollar for interest I

980
00:43:10,409 --> 00:43:16,558
wanted those take to make roughly Frank

981
00:43:13,250 --> 00:43:21,510
I believe empower for the smaller ones

982
00:43:16,559 --> 00:43:23,609
in tomorrow's so we've been at this for

983
00:43:21,510 --> 00:43:30,000
an hour here's the progress on our maker

984
00:43:23,608 --> 00:43:33,048
by that you for 25 minutes hey it's big

985
00:43:30,000 --> 00:43:35,760
it's all it'll be going quite a while

986
00:43:33,048 --> 00:43:36,900
and once you want you get it out though

987
00:43:35,760 --> 00:43:39,299
Carol don't you have to do something

988
00:43:36,900 --> 00:43:41,639
else to it after it's done you have to

989
00:43:39,298 --> 00:43:46,259
cut stuff away or on these particular

990
00:43:41,639 --> 00:43:48,029
ones what what so that so the ones that

991
00:43:46,260 --> 00:43:50,309
we showed you which were the texture map

992
00:43:48,030 --> 00:43:54,720
and the elevation map which Antonella

993
00:43:50,309 --> 00:43:58,500
has those the elevation or the textures

994
00:43:54,719 --> 00:44:01,769
is on a on a platform so that you can

995
00:43:58,500 --> 00:44:04,019
handle it so we print a couple

996
00:44:01,769 --> 00:44:06,809
millimeters thick platform then the

997
00:44:04,019 --> 00:44:12,599
texture is on top of that in the case of

998

00:44:06,809 --> 00:44:14,579
the 3d objects the way it works and I if

999
00:44:12,599 --> 00:44:17,068
you look really carefully off to the

1000
00:44:14,579 --> 00:44:19,140
right of the thing that's being printed

1001
00:44:17,068 --> 00:44:22,409
you'll see that it's kind of this

1002
00:44:19,139 --> 00:44:26,308
purple reddish material and then as you

1003
00:44:22,409 --> 00:44:28,799
move to the left there's a darkish kind

1004
00:44:26,309 --> 00:44:32,490
of looks like a little river that

1005
00:44:28,800 --> 00:44:35,940
is actually very thin a very thin

1006
00:44:32,489 --> 00:44:38,369
material so the the stuff on the far

1007
00:44:35,940 --> 00:44:41,130
right is a couple as a millimeter or two

1008
00:44:38,369 --> 00:44:44,099
thick and then the stuff that's that

1009
00:44:41,130 --> 00:44:46,470
little river which is around the contour

1010
00:44:44,099 --> 00:44:50,940
that you see being printed that little

1011
00:44:46,469 --> 00:44:53,849
darkest region is very thin it's like a

1012
00:44:50,940 --> 00:44:56,970

thread thick and so what happens when

1013

00:44:53,849 --> 00:44:59,400

this object is finished is that part

1014

00:44:56,969 --> 00:45:02,250

will be cracked off and then if you're

1015

00:44:59,400 --> 00:45:05,369

really you know a TD then what you'll do

1016

00:45:02,250 --> 00:45:07,559

is you'll polish the edges but in order

1017

00:45:05,369 --> 00:45:10,710

to make the 3d object we have to

1018

00:45:07,559 --> 00:45:12,509

stabilize it some somehow so most of the

1019

00:45:10,710 --> 00:45:14,730

models that I leave and pulled off the

1020

00:45:12,510 --> 00:45:16,740

web or that we've created we have to

1021

00:45:14,730 --> 00:45:19,740

create some kind of platform to support

1022

00:45:16,739 --> 00:45:22,199

the object especially if it's

1023

00:45:19,739 --> 00:45:24,779

complicated like there's this toy HST

1024

00:45:22,199 --> 00:45:26,759

model and a couple of the pieces have

1025

00:45:24,780 --> 00:45:29,610

additional supports that you have to

1026

00:45:26,760 --> 00:45:31,560

break off and polish because of the way

1027
00:45:29,610 --> 00:45:34,559
the printer works some of the other

1028
00:45:31,559 --> 00:45:36,570
technology printers don't require that

1029
00:45:34,559 --> 00:45:38,549
kind of support because it's like a gel

1030
00:45:36,570 --> 00:45:40,500
or a powder or something and it works in

1031
00:45:38,550 --> 00:45:42,210
a different way but these extrusion

1032
00:45:40,500 --> 00:45:45,000
printers that go back and forth and they

1033
00:45:42,210 --> 00:45:47,280
lay down material you can't kind of lay

1034
00:45:45,000 --> 00:45:51,239
down material in space so you need some

1035
00:45:47,280 --> 00:45:53,580
kind of a platform that will hold the

1036
00:45:51,239 --> 00:45:57,149
material so we're just breaking off the

1037
00:45:53,579 --> 00:45:59,429
outer edges of the galaxies to to make

1038
00:45:57,150 --> 00:46:01,410
them usable object so when we made the

1039
00:45:59,429 --> 00:46:02,549
Hubble model did you take it and be made

1040
00:46:01,409 --> 00:46:05,429
into pieces and then glued it together

1041
00:46:02,550 --> 00:46:07,620
or well I originally had downloaded the

1042
00:46:05,429 --> 00:46:10,079
kit which is a whole bunch a little

1043
00:46:07,619 --> 00:46:12,569
connected pieces and it doesn't work

1044
00:46:10,079 --> 00:46:14,759
very well I even scaled it up a couple

1045
00:46:12,570 --> 00:46:17,340
times i recently printed out the

1046
00:46:14,760 --> 00:46:20,970
individual which are is in the it is on

1047
00:46:17,340 --> 00:46:22,890
the MakerBot web page I did the

1048
00:46:20,969 --> 00:46:24,929
individual pieces and some of the pieces

1049
00:46:22,889 --> 00:46:28,710
I had to do a couple times like the

1050
00:46:24,929 --> 00:46:31,049
antenna the when I was doing it for

1051
00:46:28,710 --> 00:46:33,000
another because somebody asked me can we

1052
00:46:31,050 --> 00:46:36,990
print these and are they reasonable toys

1053
00:46:33,000 --> 00:46:38,909
and I it's difficult because sometimes

1054
00:46:36,989 --> 00:46:41,189
the thread gets just starts making

1055

00:46:38,909 --> 00:46:41,759
spaghetti because it's not adhering or

1056
00:46:41,190 --> 00:46:44,550
it's not

1057
00:46:41,760 --> 00:46:47,490
enough on the surface but the main body

1058
00:46:44,550 --> 00:46:49,230
of the telescope was fine yeah I know

1059
00:46:47,489 --> 00:46:50,789
one thing I when I was a kid I used to

1060
00:46:49,230 --> 00:46:53,039
love to make models and of course all

1061
00:46:50,789 --> 00:46:55,409
the models I made were rockets of Saturn

1062
00:46:53,039 --> 00:46:57,329
5 and Gemini and things like that but if

1063
00:46:55,409 --> 00:46:58,529
I but now don't have time to make any of

1064
00:46:57,329 --> 00:47:00,750
that stuff so if I had one of these I

1065
00:46:58,530 --> 00:47:03,090
just be a lazy man I'd be printing out

1066
00:47:00,750 --> 00:47:05,579
rockets and stuff on mine if I had one I

1067
00:47:03,090 --> 00:47:06,990
already know that's what i do if i could

1068
00:47:05,579 --> 00:47:10,170
i'd like to elaborate a little further

1069
00:47:06,989 --> 00:47:12,809

on what carol was saying sure um so that

1070

00:47:10,170 --> 00:47:14,789

one of the printer that we just have

1071

00:47:12,809 --> 00:47:16,920

here just got here at Goddard for our

1072

00:47:14,789 --> 00:47:19,800

projects in which is which is available

1073

00:47:16,920 --> 00:47:22,500

it's just a consumer-grade MakerBot is

1074

00:47:19,800 --> 00:47:25,130

one of the ones that Frank discuss what

1075

00:47:22,500 --> 00:47:27,480

has to two extruders so two nozzles and

1076

00:47:25,130 --> 00:47:29,070

one of the things you can do for really

1077

00:47:27,480 --> 00:47:32,039

complicated prints and we're doing now

1078

00:47:29,070 --> 00:47:33,720

is um instead of doing like what carol

1079

00:47:32,039 --> 00:47:36,739

does so if i'm correct it looks like

1080

00:47:33,719 --> 00:47:40,019

carol has a single nozzle on her printer

1081

00:47:36,739 --> 00:47:43,199

but they have what's called a hips

1082

00:47:40,019 --> 00:47:44,519

filament and what that is is it's a it's

1083

00:47:43,199 --> 00:47:46,980

a special type of plastic that is

1084
00:47:44,519 --> 00:47:48,509
dissolvable and so what you can do is

1085
00:47:46,980 --> 00:47:50,039
when you're creating these complicated

1086
00:47:48,510 --> 00:47:52,620
structures like Carol said you have to

1087
00:47:50,039 --> 00:47:54,599
have support for them you have to have

1088
00:47:52,619 --> 00:47:57,449
something for the plastic to attach to

1089
00:47:54,599 --> 00:48:00,750
and you can print so what I'm going to

1090
00:47:57,449 --> 00:48:02,429
do is it'll print this hips support and

1091
00:48:00,750 --> 00:48:04,800
then the plastic will adhere to it oh

1092
00:48:02,429 --> 00:48:07,799
it's nice about this is then you take

1093
00:48:04,800 --> 00:48:09,420
your model and you just dip it in a

1094
00:48:07,800 --> 00:48:11,580
substance called limonene which is

1095
00:48:09,420 --> 00:48:14,070
pretty much just a fancy word for like

1096
00:48:11,579 --> 00:48:16,469
such a coil of citric acid and it's

1097
00:48:14,070 --> 00:48:19,530
non-toxic and it's biodegradable and it

1098
00:48:16,469 --> 00:48:21,480
just dissolves that filament away and

1099
00:48:19,530 --> 00:48:23,330
you're left with your with your with

1100
00:48:21,480 --> 00:48:28,380
your model without having to worry about

1101
00:48:23,329 --> 00:48:29,610
necessarily breaking pieces off and it

1102
00:48:28,380 --> 00:48:32,760
seems to work it seems to work

1103
00:48:29,610 --> 00:48:34,500
reasonably well are those printers more

1104
00:48:32,760 --> 00:48:38,220
expensive or dude dude they're

1105
00:48:34,500 --> 00:48:41,369
comparable to so ours was on the order

1106
00:48:38,219 --> 00:48:45,269
of a couple thousand dollars oh okay all

1107
00:48:41,369 --> 00:48:47,250
right well um I have I I think I met

1108
00:48:45,269 --> 00:48:49,949
something happen to the QA app when I

1109
00:48:47,250 --> 00:48:53,130
started it today ah and I'm not seeing

1110
00:48:49,949 --> 00:48:55,619
any Q any Q&A questions but twitter has

1111
00:48:53,130 --> 00:48:58,019
got some stuff thank you guys for

1112

00:48:55,619 --> 00:48:59,819
printing using Hubble hang out Kim are

1113
00:48:58,019 --> 00:49:04,170
canada's on there she's been doing a lot

1114
00:48:59,820 --> 00:49:05,789
of great tweets uh 3d modeling and 3d

1115
00:49:04,170 --> 00:49:08,250
printing can't be two very different

1116
00:49:05,789 --> 00:49:10,619
beasts that's true i was when i made the

1117
00:49:08,250 --> 00:49:14,130
title of this hangout or of this event i

1118
00:49:10,619 --> 00:49:16,769
was I sort of took a little liberty with

1119
00:49:14,130 --> 00:49:19,650
the modeling aspect of it but I did like

1120
00:49:16,769 --> 00:49:21,659
it is in a sense a model but I agree

1121
00:49:19,650 --> 00:49:26,460
that it they're not quite the same thing

1122
00:49:21,659 --> 00:49:28,319
so thank you for that the Alessandra

1123
00:49:26,460 --> 00:49:30,000
rosada is also here and she says she

1124
00:49:28,320 --> 00:49:32,370
tweets so cool that scientists learned

1125
00:49:30,000 --> 00:49:34,500
that nebula had protrusions and trenches

1126
00:49:32,369 --> 00:49:37,079

using 3d tech and that was what tom was

1127

00:49:34,500 --> 00:49:40,110

talking about with the ADA card nebula

1128

00:49:37,079 --> 00:49:43,949

they didn't they didn't know before and

1129

00:49:40,110 --> 00:49:45,809

that is great kim also tweets textured

1130

00:49:43,949 --> 00:49:49,169

3d print outs have wide applicability

1131

00:49:45,809 --> 00:49:52,079

for accessibility and for education for

1132

00:49:49,170 --> 00:49:54,990

non-experts but also exploration for the

1133

00:49:52,079 --> 00:49:57,090

experts so that's a good segue into what

1134

00:49:54,989 --> 00:49:59,069

i would like to ask you guys next what

1135

00:49:57,090 --> 00:50:00,829

is the future what do you guys what are

1136

00:49:59,070 --> 00:50:02,519

you guys doing next carolina and

1137

00:50:00,829 --> 00:50:06,750

antonella what do you guys do what you

1138

00:50:02,519 --> 00:50:11,909

guys got on tap for this go for it ends

1139

00:50:06,750 --> 00:50:14,730

no go for it i think that you know the

1140

00:50:11,909 --> 00:50:17,069

process as we said is complicated and so

1141
00:50:14,730 --> 00:50:19,440
rather than trying to make the salsa

1142
00:50:17,070 --> 00:50:22,890
available we would like to produce as

1143
00:50:19,440 --> 00:50:25,740
many STL files as we can and make those

1144
00:50:22,889 --> 00:50:28,500
available the one of our big goal is to

1145
00:50:25,739 --> 00:50:32,609
select you know a number of very iconic

1146
00:50:28,500 --> 00:50:34,949
Hubble images and produce STL files for

1147
00:50:32,610 --> 00:50:37,260
them so that people in schools can

1148
00:50:34,949 --> 00:50:40,710
actually you know print at least a

1149
00:50:37,260 --> 00:50:43,050
texture map and elevation map and in

1150
00:50:40,710 --> 00:50:47,340
some cases where the modeling is easily

1151
00:50:43,050 --> 00:50:50,820
maybe a 3d object holding the head so I

1152
00:50:47,340 --> 00:50:54,030
think that that would be our way to make

1153
00:50:50,820 --> 00:50:56,070
the beautiful level images of accessible

1154
00:50:54,030 --> 00:50:58,740
to more people can't appreciate the

1155
00:50:56,070 --> 00:51:00,539
beauty of I agreed I would and

1156
00:50:58,739 --> 00:51:02,609
presumably these files once we get them

1157
00:51:00,539 --> 00:51:03,989
out we'll be on our website Hubble site

1158
00:51:02,610 --> 00:51:06,840
Dow to work so you'll be able to forget

1159
00:51:03,989 --> 00:51:08,809
them from there for free and be able to

1160
00:51:06,840 --> 00:51:13,280
print these things out all on your own

1161
00:51:08,809 --> 00:51:15,320
alright and so I and to to leverage on

1162
00:51:13,280 --> 00:51:18,019
for that I'm hoping to convince the

1163
00:51:15,320 --> 00:51:19,940
education and news group that that if we

1164
00:51:18,019 --> 00:51:23,599
do come up with a reasonable process

1165
00:51:19,940 --> 00:51:25,309
that when a scientist does do a press

1166
00:51:23,599 --> 00:51:29,389
release that maybe we can coach them

1167
00:51:25,309 --> 00:51:32,299
through an interface to make if

1168
00:51:29,389 --> 00:51:34,369
appropriate 3d print outs of their

1169

00:51:32,300 --> 00:51:36,170
object so that we can include the file

1170
00:51:34,369 --> 00:51:38,630
on the press release and also

1171
00:51:36,170 --> 00:51:40,369
incorporate those products into like if

1172
00:51:38,630 --> 00:51:44,500
you have a star formation module you

1173
00:51:40,369 --> 00:51:48,049
want to use 602 and it's other famous

1174
00:51:44,500 --> 00:51:49,250
clusters wenig NGC 3603 and stuff like

1175
00:51:48,050 --> 00:51:51,289
that so you can learn about star

1176
00:51:49,250 --> 00:51:53,719
formation you learn that galaxies and so

1177
00:51:51,289 --> 00:51:56,509
integrated into the educational products

1178
00:51:53,719 --> 00:51:58,789
ah Tom Snyder is commenting here's a

1179
00:51:56,510 --> 00:52:01,250
comment why isn't the show opening on G+

1180
00:51:58,789 --> 00:52:02,929
I had to go over to youtube to watch and

1181
00:52:01,250 --> 00:52:05,030
you know something I think something's

1182
00:52:02,929 --> 00:52:06,949
up with G+ today folks I'm sorry and I

1183
00:52:05,030 --> 00:52:08,720

don't because when I started it when I

1184

00:52:06,949 --> 00:52:10,789
started to hang out I also had to

1185

00:52:08,719 --> 00:52:13,069
restart the Q&A app for some bizarre

1186

00:52:10,789 --> 00:52:14,719
reason and it was already queued up so

1187

00:52:13,070 --> 00:52:16,510
maybe there's some technical technical

1188

00:52:14,719 --> 00:52:19,879
issues over at Google anyway thanks for

1189

00:52:16,510 --> 00:52:22,610
Scott's I agree Scott's not here driving

1190

00:52:19,880 --> 00:52:23,809
the internet for me so no it is a thank

1191

00:52:22,610 --> 00:52:25,280
you for going to YouTube Tom and

1192

00:52:23,809 --> 00:52:27,349
watching it instead I do appreciate and

1193

00:52:25,280 --> 00:52:30,320
I apologize for the technical issues

1194

00:52:27,349 --> 00:52:32,569
today nobody not a single one of you

1195

00:52:30,320 --> 00:52:36,050
have talked about planets or any of that

1196

00:52:32,570 --> 00:52:37,760
kind of stuff is there any way I would

1197

00:52:36,050 --> 00:52:39,769
like a printout of Jupiter so I could

1198
00:52:37,760 --> 00:52:42,290
you know maybe see the band or feel the

1199
00:52:39,769 --> 00:52:44,539
bands and the different is that possible

1200
00:52:42,289 --> 00:52:47,090
or is that too is it again spherical

1201
00:52:44,539 --> 00:52:48,289
things not possible with these that has

1202
00:52:47,090 --> 00:52:50,950
been done and there are models available

1203
00:52:48,289 --> 00:52:53,960
I know nASA has a site where several

1204
00:52:50,949 --> 00:52:55,819
asteroids that have been modeled that

1205
00:52:53,960 --> 00:52:57,230
had been imaged so we have these these

1206
00:52:55,820 --> 00:52:59,960
probes that will go and work it around

1207
00:52:57,230 --> 00:53:02,750
various assets and comets and get get

1208
00:52:59,960 --> 00:53:05,599
surface data on so there are 3d

1209
00:53:02,750 --> 00:53:08,119
principal asteroids and there is data

1210
00:53:05,599 --> 00:53:10,670
from the surface of the Moon and I know

1211
00:53:08,119 --> 00:53:13,069
that there's also data available for for

1212
00:53:10,670 --> 00:53:16,369
surface features on Mars so that that

1213
00:53:13,070 --> 00:53:17,690
type of thing is is possible oh good oh

1214
00:53:16,369 --> 00:53:19,309
that's right minds me you could also

1215
00:53:17,690 --> 00:53:21,170
have like you said features like the

1216
00:53:19,309 --> 00:53:22,190
Valles Marineris on Mars then well what

1217
00:53:21,170 --> 00:53:27,019
do you got there carol

1218
00:53:22,190 --> 00:53:28,820
best are no it's a globe oh wow no that

1219
00:53:27,019 --> 00:53:32,780
is really cool first I was a Death Star

1220
00:53:28,820 --> 00:53:34,850
oh wow no hold that would hold it still

1221
00:53:32,780 --> 00:53:37,760
hold us though what is it so that is a 0

1222
00:53:34,849 --> 00:53:41,150
us a miracle as possible this is again

1223
00:53:37,760 --> 00:53:44,750
on the MakerBot page ok yeah oh ok all

1224
00:53:41,150 --> 00:53:47,059
kinds of like the demo yeah look at and

1225
00:53:44,750 --> 00:53:49,550
I can show you our bracelets too but

1226

00:53:47,059 --> 00:53:51,199
anyway those guys know about bracelets

1227
00:53:49,550 --> 00:53:54,410
because it's one of the test things that

1228
00:53:51,199 --> 00:53:56,269
comes in the image it's a test module so

1229
00:53:54,409 --> 00:53:57,799
we love the bracelets we have bracelets

1230
00:53:56,269 --> 00:53:58,940
in all different colors yeah I remember

1231
00:53:57,800 --> 00:54:00,470
when you first got that printer of

1232
00:53:58,940 --> 00:54:03,369
everybody had one of course I didn't

1233
00:54:00,469 --> 00:54:07,879
forgot one but you know re all right ah

1234
00:54:03,369 --> 00:54:10,849
ok now look another QA on Kaylee Kaylee

1235
00:54:07,880 --> 00:54:12,680
s nice taxi I'm sorry if I pronounced

1236
00:54:10,849 --> 00:54:14,569
that wrong or what are you guys looking

1237
00:54:12,679 --> 00:54:19,309
forward to seeing printed on the

1238
00:54:14,570 --> 00:54:21,320
International Space Station anybody want

1239
00:54:19,309 --> 00:54:24,139
to try that I'd love to see a homunculus

1240
00:54:21,320 --> 00:54:29,120

printed insurrection you and your

1241
00:54:24,139 --> 00:54:31,420
homunculi yes by the way if anyone's

1242
00:54:29,119 --> 00:54:33,829
curious homunculus means little man

1243
00:54:31,420 --> 00:54:35,210
that's what if that's that's the

1244
00:54:33,829 --> 00:54:36,769
translation because when they went it

1245
00:54:35,210 --> 00:54:39,079
when you looked at it first through a

1246
00:54:36,769 --> 00:54:40,699
through my telescope we didn't have this

1247
00:54:39,079 --> 00:54:42,380
great office back then so it kind of

1248
00:54:40,699 --> 00:54:44,569
looked like the Pillsbury Doughboy oh

1249
00:54:42,380 --> 00:54:46,880
that's what it means I thought it meant

1250
00:54:44,570 --> 00:54:51,559
something really big like a boy anything

1251
00:54:46,880 --> 00:54:53,269
is humonculon but i guess not ok so but

1252
00:54:51,559 --> 00:54:56,239
but to back to the comment here though

1253
00:54:53,269 --> 00:54:58,460
we they are doing some 3d printing in

1254
00:54:56,239 --> 00:55:02,659
space on the International Space Station

1255
00:54:58,460 --> 00:55:04,159
the goal of which is to push the bounds

1256
00:55:02,659 --> 00:55:05,089
of what's possible I suppose on these I

1257
00:55:04,159 --> 00:55:06,920
don't know what kind of printers are

1258
00:55:05,090 --> 00:55:08,660
going to have or anything like that but

1259
00:55:06,920 --> 00:55:10,250
if I were going to print something out

1260
00:55:08,659 --> 00:55:12,649
on there i would want something that is

1261
00:55:10,250 --> 00:55:15,260
super delicate and doesn't require any

1262
00:55:12,650 --> 00:55:16,910
you know lots of little tendrils and

1263
00:55:15,260 --> 00:55:18,680
stuff like that and that maybe you

1264
00:55:16,909 --> 00:55:22,279
couldn't print here in space but

1265
00:55:18,679 --> 00:55:24,139
unfortunately burning cards but remember

1266
00:55:22,280 --> 00:55:26,560
we're having a hangout on that while i

1267
00:55:24,139 --> 00:55:29,599
was hoping you would you would plug that

1268
00:55:26,559 --> 00:55:31,549
we are having a hangout we are we are in

1269
00:55:29,599 --> 00:55:33,679
the future we have we have a hangout

1270
00:55:31,550 --> 00:55:35,660
plan with the maiden space guys so that

1271
00:55:33,679 --> 00:55:38,149
will be coming up in a

1272
00:55:35,659 --> 00:55:41,000
couple of weeks so it stay tuned for

1273
00:55:38,150 --> 00:55:43,818
that guys okay couple one more comment

1274
00:55:41,000 --> 00:55:45,739
on Twitter alessandra Rosati is also

1275
00:55:43,818 --> 00:55:47,659
tweeting really cool to know that the

1276
00:55:45,739 --> 00:55:49,759
Hubble telescope is working with people

1277
00:55:47,659 --> 00:55:52,098
who are visually impaired using 3d

1278
00:55:49,760 --> 00:55:55,430
technology and with that I am going to

1279
00:55:52,099 --> 00:55:58,250
say yes I agree that is it is really

1280
00:55:55,429 --> 00:55:59,868
cool and it is only the beginning is

1281
00:55:58,250 --> 00:56:02,239
everybody here in this panel has pointed

1282
00:55:59,869 --> 00:56:05,240
out I want to thank you all for joining

1283

00:56:02,239 --> 00:56:09,048
us thank you uh thanks to thanks to Tom

1284
00:56:05,239 --> 00:56:11,750
madura Frank Frank ready antonella nota

1285
00:56:09,048 --> 00:56:13,519
and carol christian i'm driving the

1286
00:56:11,750 --> 00:56:15,559
internet guys which is why you're seeing

1287
00:56:13,519 --> 00:56:17,659
all these click ease going by really

1288
00:56:15,559 --> 00:56:21,650
fast because I don't have I just click

1289
00:56:17,659 --> 00:56:25,489
on stuff I don't pay attention next week

1290
00:56:21,650 --> 00:56:26,780
is our hub will hangout will feature not

1291
00:56:25,489 --> 00:56:28,879
Hubble but the James Webb Space

1292
00:56:26,780 --> 00:56:31,460
Telescope we will be talking with

1293
00:56:28,880 --> 00:56:33,798
members of northrop grumman team and

1294
00:56:31,460 --> 00:56:35,750
nasa goddard to give an update on the

1295
00:56:33,798 --> 00:56:37,159
James Webb Space Telescope then the

1296
00:56:35,750 --> 00:56:38,869
deployment test that has recently

1297
00:56:37,159 --> 00:56:41,328

happened so we hope you guys will check

1298

00:56:38,869 --> 00:56:44,599

in with us there thank you all for

1299

00:56:41,329 --> 00:56:46,339

commenting and Lee I'm sorry about the

1300

00:56:44,599 --> 00:56:48,079

technical difficulties on google+ but I

1301

00:56:46,338 --> 00:56:50,838

thank you for your patience and as

1302

00:56:48,079 --> 00:56:56,890

always thank you for watching and keep

1303

00:56:50,838 --> 00:56:56,889

looking up thank you