
HUBBLE
hangouts
3-D Astronomy:
Modelling the Universe with 3D Printers
Thursday September 25, 2014, 3pm EDT 7pm GMT

1
00:00:09,830 --> 00:00:07,249
hello everybody and welcome to our

2
00:00:11,360 --> 00:00:09,840
latest Hubble hang out my name is Tony

3
00:00:12,680 --> 00:00:11,370
Darnell I work at the space stealth I

4
00:00:14,570 --> 00:00:12,690
work at the Space Telescope Science

5
00:00:16,400 --> 00:00:14,580
Institute and today we have a really

6
00:00:18,830 --> 00:00:16,410
interesting and I think really unique

7
00:00:20,510 --> 00:00:18,840
hangout plan for you today because we're

8
00:00:23,000 --> 00:00:20,520
going to be talking about modeling the

9
00:00:24,920 --> 00:00:23,010
universe using 3d printers and we've got

10
00:00:27,140 --> 00:00:24,930
people using Hubble data and other

11
00:00:31,070 --> 00:00:27,150
astronomical data sources to create

12
00:00:32,479 --> 00:00:31,080
these really cool objects from 3d

13
00:00:34,340 --> 00:00:32,489

printers and they're using them for all

14
00:00:36,740 --> 00:00:34,350
kinds of different things for example

15
00:00:37,970 --> 00:00:36,750
they're using them for helping to

16
00:00:38,990 --> 00:00:37,980
educate the visually impaired but

17
00:00:41,569 --> 00:00:39,000
they're also usually they're also

18
00:00:43,369 --> 00:00:41,579
finding things out about these objects

19
00:00:45,410 --> 00:00:43,379
about the various astronomical objects

20
00:00:48,950 --> 00:00:45,420
in the printers that we may not be able

21
00:00:50,420 --> 00:00:48,960
to ordinarily see from the from just the

22
00:00:52,400 --> 00:00:50,430
3d renderings of the images themselves

23
00:00:53,930 --> 00:00:52,410
so really interesting stuff planned they

24
00:00:56,510 --> 00:00:53,940
got a lot of people here from both the

25
00:00:58,010 --> 00:00:56,520
Institute and NASA Goddard and I'll

26
00:00:59,810 --> 00:00:58,020
introduce them in just a minute before I

27
00:01:02,599 --> 00:00:59,820
do let me tell you how to interact with

28
00:01:05,630 --> 00:01:02,609
us the easiest way is to hit the QA app

29
00:01:07,130 --> 00:01:05,640
on the on the event page or on the video

30
00:01:09,080 --> 00:01:07,140
that you're watching send us a question

31
00:01:11,690 --> 00:01:09,090
or a comment I'll read them out as the

32
00:01:13,460 --> 00:01:11,700
as the Hangout progresses alternatively

33
00:01:14,810 --> 00:01:13,470
you could comment on the youtube page

34
00:01:17,810 --> 00:01:14,820
i'm looking at those comments as well

35
00:01:20,450 --> 00:01:17,820
you could use the G+ event page and last

36
00:01:22,160 --> 00:01:20,460
and one and but not least although it is

37
00:01:24,490 --> 00:01:22,170
least because nobody ever seems to prove

38
00:01:27,499 --> 00:01:24,500

it please tweet at us using the hashtag

39
00:01:29,600 --> 00:01:27,509
hubble hang out and we will i'm also

40
00:01:30,830 --> 00:01:29,610
looking at those right now so if you

41
00:01:32,929 --> 00:01:30,840
have a question or comment you'd like to

42
00:01:35,390 --> 00:01:32,939
send on Twitter please do it that way so

43
00:01:38,330 --> 00:01:35,400
with me today is as she always is every

44
00:01:39,770 --> 00:01:38,340
single week dr. carol christian from the

45
00:01:41,840 --> 00:01:39,780
Space Telescope Science Institute but

46
00:01:43,880 --> 00:01:41,850
now while she ordinarily helps me

47
00:01:46,580 --> 00:01:43,890
moderate these things today she's going

48
00:01:47,810 --> 00:01:46,590
to be more of a guest because she's part

49
00:01:49,999 --> 00:01:47,820
of the project that we're going to

50
00:01:51,830 --> 00:01:50,009
highlight today hi Carol don't forget

51
00:01:53,210 --> 00:01:51,840
that we have her muted so she's going to

52
00:01:55,130 --> 00:01:53,220
be muting and I'm muting throughout the

53
00:01:59,149 --> 00:01:55,140
whole thing they would mostly like me to

54
00:02:01,999 --> 00:01:59,159
be quiet yes we try as hard as we can

55
00:02:03,679 --> 00:02:02,009
without Owens very successful so we're

56
00:02:06,200 --> 00:02:03,689
not always very successful in beauty

57
00:02:09,139 --> 00:02:06,210
also with with us today is dr. Antonella

58
00:02:11,780 --> 00:02:09,149
notice she's also at the Institute but I

59
00:02:13,550 --> 00:02:11,790
see that you also work at ISA right the

60
00:02:15,250 --> 00:02:13,560
European Space Agency is that right

61
00:02:18,080 --> 00:02:15,260
yes I'm part of the international

62
00:02:19,760 --> 00:02:18,090
contingent of my own right there are

63
00:02:22,250 --> 00:02:19,770

some people but can the Institute from

64
00:02:24,890 --> 00:02:22,260
you so working on Hubble so welcome

65
00:02:31,420 --> 00:02:24,900
welcome and she's also problem go ahead

66
00:02:34,400 --> 00:02:31,430
hi everybody I joining us also is a

67
00:02:39,290 --> 00:02:34,410
Thomas Madera believes the last name is

68
00:02:41,110 --> 00:02:39,300
what is your third go uh that's good it

69
00:02:44,960 --> 00:02:41,120
should be showing but it's not showing

70
00:02:46,789 --> 00:02:44,970
it says its own oh okay all right he's

71
00:02:49,699 --> 00:02:46,799
also from NASA Goddard part of the 3d

72
00:02:52,250 --> 00:02:49,709
printing project welcome as well as

73
00:02:56,059 --> 00:02:52,260
Frank ready from also from NASA Goddard

74
00:02:57,440 --> 00:02:56,069
he's a science writer and I should

75
00:02:59,509 --> 00:02:57,450
mention tom is also an astrophysicist

76
00:03:01,729 --> 00:02:59,519
it's not up there on his lower third but

77
00:03:05,960 --> 00:03:01,739
it is up on his lower therapist or thurs

78
00:03:07,130 --> 00:03:05,970
up so anyway welcome guys uh so let's go

79
00:03:08,720 --> 00:03:07,140
ahead and let's go ahead and get started

80
00:03:11,390 --> 00:03:08,730
I think I'd like to start with you Carol

81
00:03:13,759 --> 00:03:11,400
can you give us a sort of overview of

82
00:03:15,380 --> 00:03:13,769
the printing project what do you guys

83
00:03:17,750 --> 00:03:15,390
what you guys doing what are you hoping

84
00:03:21,349 --> 00:03:17,760
to accomplish things it's good it's good

85
00:03:24,110 --> 00:03:21,359
sure um so our project which is called

86
00:03:25,970 --> 00:03:24,120
3d astronomy I mean I'm at 3d astronomy

87
00:03:28,460 --> 00:03:25,980
that's the three yeah 3d funny is based

88
00:03:32,809 --> 00:03:28,470

on hubble space specifically hubble

89
00:03:34,210 --> 00:03:32,819
space telescope data and we as many

90
00:03:36,710 --> 00:03:34,220
people know we have a very large

91
00:03:38,599 --> 00:03:36,720
education outreach program associated

92
00:03:41,509 --> 00:03:38,609
with the Hubble Space Telescope but

93
00:03:44,690 --> 00:03:41,519
there are some groups of people that we

94
00:03:46,610 --> 00:03:44,700
can't reach easily and so we've been

95
00:03:49,670 --> 00:03:46,620
thinking about and starting to work on a

96
00:03:51,830 --> 00:03:49,680
bit of a suite of products that for the

97
00:03:54,080 --> 00:03:51,840
visually impaired and but also are

98
00:03:57,920 --> 00:03:54,090
beneficial for people who learn in

99
00:04:00,440 --> 00:03:57,930
different ways and so we have been

100
00:04:02,870 --> 00:04:00,450
thinking about the beautiful images from

101
00:04:05,479 --> 00:04:02,880
HST and how can we share those with the

102
00:04:08,860 --> 00:04:05,489
visually impaired and we have we have

103
00:04:12,440 --> 00:04:08,870
collaborators who have done some work in

104
00:04:14,390 --> 00:04:12,450
making tactile imagery so that people

105
00:04:17,270 --> 00:04:14,400
can understand the complexity and beauty

106
00:04:18,650 --> 00:04:17,280
of host-based telescope images and then

107
00:04:21,680 --> 00:04:18,660
also understanding the underlying

108
00:04:25,399 --> 00:04:21,690
science and so that's basically the idea

109
00:04:27,629 --> 00:04:25,409
was to use 3d printing to create tactile

110
00:04:33,779 --> 00:04:27,639
models that people can use their finger

111
00:04:36,089 --> 00:04:33,789
to explore imagery rather than using

112
00:04:39,809 --> 00:04:36,099
their eyes and so our challenge is to

113
00:04:42,510 --> 00:04:39,819

try to represent the complexity of the

114
00:04:44,640 --> 00:04:42,520
images and if you don't mind I was going

115
00:04:47,760 --> 00:04:44,650
to show an image and actually Antonella

116
00:04:49,290 --> 00:04:47,770
is the science p IM this project might

117
00:04:52,080 --> 00:04:49,300
be able to explain some of the comp

118
00:04:54,480 --> 00:04:52,090
complexity of our prototype images yes

119
00:04:56,159 --> 00:04:54,490
no that is fine but before we start I

120
00:04:59,640 --> 00:04:56,169
just want to get more I want to have the

121
00:05:01,980 --> 00:04:59,650
the NASA Goddard folks also introduce

122
00:05:04,559 --> 00:05:01,990
their stuff garbage Tom can you give us

123
00:05:05,790 --> 00:05:04,569
a little uh what can you add anything to

124
00:05:08,100 --> 00:05:05,800
that what are you guys doing at Goddard

125
00:05:10,950 --> 00:05:08,110
that maybe parallels or augments what

126
00:05:12,659 --> 00:05:10,960
what carol was just say yes so here at

127
00:05:16,320 --> 00:05:12,669
Goddard the our first project actually

128
00:05:19,890 --> 00:05:16,330
did not use Hubble data um we use data

129
00:05:22,610 --> 00:05:19,900
from the very large telescope in Chile

130
00:05:27,329 --> 00:05:22,620
and the thing that we modeled was the

131
00:05:31,439 --> 00:05:27,339
the ADA kareena homunculus nebula and um

132
00:05:33,719 --> 00:05:31,449
okay this is just a 3d 3d print model of

133
00:05:36,779 --> 00:05:33,729
that and we have a press release come

134
00:05:40,260 --> 00:05:36,789
out but we also are working on some some

135
00:05:43,589 --> 00:05:40,270
HST data but that is that is some work

136
00:05:44,999 --> 00:05:43,599
work in progress of it okay so so both

137
00:05:47,189 --> 00:05:45,009
of you both of your groups it sounds

138
00:05:49,379 --> 00:05:47,199

like you're trying to get people to

139
00:05:51,179 --> 00:05:49,389
visualize data in a slightly different

140
00:05:52,800 --> 00:05:51,189
way with getting away from images a

141
00:05:55,200 --> 00:05:52,810
little bit using these technologies a

142
00:05:56,700 --> 00:05:55,210
Carol so I'm going to go ahead and just

143
00:05:57,990 --> 00:05:56,710
give a quick cut away to the printer

144
00:06:00,029 --> 00:05:58,000
that's working in your office if you

145
00:06:01,829 --> 00:06:00,039
live on if you look behind Carol over

146
00:06:03,510 --> 00:06:01,839
her shoulder you can see there's this

147
00:06:05,879 --> 00:06:03,520
arm moving back and forth and here's a

148
00:06:07,889 --> 00:06:05,889
close-up of it here's the 3d printer

149
00:06:09,839 --> 00:06:07,899
working right now on right now you're

150
00:06:12,059 --> 00:06:09,849
printing something out right Carol right

151
00:06:15,240 --> 00:06:12,069
now yes we're actually printing a 3d

152
00:06:18,839 --> 00:06:15,250
galaxy which is our second phase of our

153
00:06:22,200 --> 00:06:18,849
project which we can talk about in a

154
00:06:23,999 --> 00:06:22,210
minute we thought we might talk a little

155
00:06:27,600 --> 00:06:24,009
bit about where we started which will

156
00:06:31,079 --> 00:06:27,610
make texture maps and elevation maps of

157
00:06:33,510 --> 00:06:31,089
star clusters and and antonella actually

158
00:06:36,600 --> 00:06:33,520
has some of those products I can show

159
00:06:38,579 --> 00:06:36,610
the image and then she can she can talk

160
00:06:40,640 --> 00:06:38,589
about it because you can expert a bit

161
00:06:45,050 --> 00:06:40,650
okay so I'm going to try to screen

162
00:06:48,770 --> 00:06:45,060
your folks yeah there's well let me know

163
00:06:52,490 --> 00:06:48,780

if we are sharing we should be sharing

164
00:06:56,240 --> 00:06:52,500
now yep we see and I will bring in the

165
00:06:59,330 --> 00:06:56,250
image that everybody can see so there it

166
00:07:02,570 --> 00:06:59,340
is ah you see so Antonella can talk

167
00:07:04,610 --> 00:07:02,580
about oh this is this is NGC 602 which

168
00:07:08,029 --> 00:07:04,620
is a beautiful cluster in the small

169
00:07:10,279 --> 00:07:08,039
module on a cloud and when we saw this

170
00:07:13,040 --> 00:07:10,289
image without this is a great image to

171
00:07:16,779 --> 00:07:13,050
convey the basic science behind our

172
00:07:20,779 --> 00:07:16,789
cluster form and a ball and so just to

173
00:07:23,050 --> 00:07:20,789
who think how to explain this image to

174
00:07:26,390 --> 00:07:23,060
people who cannot appreciate the beauty

175
00:07:28,370 --> 00:07:26,400
without to be still a couple of messages

176
00:07:30,740 --> 00:07:28,380
what are the things that the fundamental

177
00:07:33,290 --> 00:07:30,750
concept that we want to convey right it

178
00:07:36,350 --> 00:07:33,300
is a star cluster at the center just

179
00:07:38,719 --> 00:07:36,360
newly formed and the star cluster has

180
00:07:42,020 --> 00:07:38,729
very massive stars and the massive stars

181
00:07:44,689 --> 00:07:42,030
are swept away the cocoon of gas and

182
00:07:48,770 --> 00:07:44,699
dust and you can still see the filaments

183
00:07:51,620 --> 00:07:48,780
around the sort of bubble shape shell

184
00:07:55,430 --> 00:07:51,630
and you can see small stars still

185
00:07:58,490 --> 00:07:55,440
forming around so this is a collegian

186
00:08:00,469 --> 00:07:58,500
banks in gas and dust with stars of the

187
00:08:03,620 --> 00:08:00,479
center and stuff when you start forming

188
00:08:05,600 --> 00:08:03,630

in this round if we have to think how

189
00:08:10,010 --> 00:08:05,610
you convey these messages to people

190
00:08:14,060 --> 00:08:10,020
house right traditionally the work was

191
00:08:18,140 --> 00:08:14,070
done with info screen so this image

192
00:08:20,930 --> 00:08:18,150
would use generate a printout shed

193
00:08:24,439 --> 00:08:20,940
emboss features for people to touch it

194
00:08:26,210 --> 00:08:24,449
and recognize the variance and you can

195
00:08:29,719 --> 00:08:26,220
see the example cattle will just pull

196
00:08:33,050 --> 00:08:29,729
the example of a embossed form exactly

197
00:08:35,350 --> 00:08:33,060
for NGC 602 those website work Carol

198
00:08:39,560 --> 00:08:35,360
showing something here what is this now

199
00:08:42,170 --> 00:08:39,570
this is a way for you to understand how

200
00:08:45,199 --> 00:08:42,180
our process points so you know when you

201
00:08:48,170 --> 00:08:45,209
talk into a blind person they have to

202
00:08:50,870 --> 00:08:48,180
feel the way through the astronomical

203
00:08:53,930 --> 00:08:50,880
object so the traditional way the way

204
00:08:54,230 --> 00:08:53,940
before 3d printers was that you would

205
00:08:57,019 --> 00:08:54,240
for

206
00:09:01,280 --> 00:08:57,029
do something like the sheet that you can

207
00:09:05,720 --> 00:09:01,290
see where it later embosses the future

208
00:09:07,220 --> 00:09:05,730
and you associate a very fixtures with

209
00:09:09,530 --> 00:09:07,230
the feature so if you can see the

210
00:09:13,070 --> 00:09:09,540
picture again you see the circles of

211
00:09:16,400 --> 00:09:13,080
stars and the vertical lines are dust

212
00:09:20,060 --> 00:09:16,410
and the dotted the pattern is dustin so

213
00:09:23,240 --> 00:09:20,070

people would put their hand on on that

214
00:09:25,730 --> 00:09:23,250
sheet and identify the feature now with

215
00:09:28,760 --> 00:09:25,740
the 3d printers we have taken it one

216
00:09:32,690 --> 00:09:28,770
step further and we have created 3d

217
00:09:36,740 --> 00:09:32,700
print out exactly on the same sort of

218
00:09:39,019 --> 00:09:36,750
concept and may be careful rock can open

219
00:09:42,530 --> 00:09:39,029
up i can show you one here you can

220
00:09:44,410 --> 00:09:42,540
probably see so that's that's a 3d

221
00:09:47,150 --> 00:09:44,420
texture map you were just showing us

222
00:09:50,780 --> 00:09:47,160
right exactly of the same star cluster

223
00:09:53,900 --> 00:09:50,790
so you can see the cluster here at the

224
00:09:56,269 --> 00:09:53,910
center you can see the areas of dust and

225
00:09:59,990 --> 00:09:56,279
gas and they are all characterized by

226
00:10:02,449 --> 00:10:00,000
different textures so peep 40 who comes

227
00:10:06,050 --> 00:10:02,459
you can put their hands on this printout

228
00:10:09,980 --> 00:10:06,060
and and basically build a mental image

229
00:10:13,579 --> 00:10:09,990
of the object so then this was step

230
00:10:16,280 --> 00:10:13,589
number one fact number two is basically

231
00:10:20,630 --> 00:10:16,290
capturing the intensity of the baddest

232
00:10:23,750 --> 00:10:20,640
future and so this now we call this

233
00:10:27,980 --> 00:10:23,760
elevation map and the invalidation math

234
00:10:32,300 --> 00:10:27,990
is basically for at every point it has a

235
00:10:34,699 --> 00:10:32,310
death hi that is exactly related to the

236
00:10:37,940 --> 00:10:34,709
intensity of the image so people can

237
00:10:40,220 --> 00:10:37,950
understand how brightest are the stars

238
00:10:43,850 --> 00:10:40,230

than the gas so what's the relative

239
00:10:46,250 --> 00:10:43,860
intensity of the gas and dust hey so the

240
00:10:47,630 --> 00:10:46,260
first map was what was the uchitel with

241
00:10:49,490 --> 00:10:47,640
the different whether something was

242
00:10:51,350 --> 00:10:49,500
casted us whether something was a star

243
00:10:53,000 --> 00:10:51,360
whether something well you know what

244
00:10:55,519 --> 00:10:53,010
they were and the second thing you

245
00:10:58,730 --> 00:10:55,529
showed was how bright they were yes

246
00:11:02,060 --> 00:10:58,740
exactly and what when we did our testing

247
00:11:04,610 --> 00:11:02,070
we found very interesting that people

248
00:11:07,040 --> 00:11:04,620
who were blind from birth and had

249
00:11:07,639 --> 00:11:07,050
learned how to use tackle materials

250
00:11:10,460 --> 00:11:07,649
including

251
00:11:13,220 --> 00:11:10,470
breil could go straight to the elevation

252
00:11:16,340 --> 00:11:13,230
map and so they could use intensity plus

253
00:11:19,009 --> 00:11:16,350
texture so it's like if you you know

254
00:11:21,319 --> 00:11:19,019
when if you are cited you look at a

255
00:11:23,119 --> 00:11:21,329
visual image and you understand there

256
00:11:24,889 --> 00:11:23,129
are different colors but there's also

257
00:11:26,809 --> 00:11:24,899
brightness and you get that right away

258
00:11:29,689 --> 00:11:26,819
and so people who are blind from birth

259
00:11:32,030 --> 00:11:29,699
or blind very early on could tell that

260
00:11:35,600 --> 00:11:32,040
right away people who were losing their

261
00:11:38,299 --> 00:11:35,610
site or partially visually impaired they

262
00:11:40,549 --> 00:11:38,309
needed to feel the textures first and

263
00:11:42,710 --> 00:11:40,559

understand the overall structure unless

264
00:11:44,900 --> 00:11:42,720
they got that in their head then they

265
00:11:47,689 --> 00:11:44,910
could move to the elevation map and then

266
00:11:50,030 --> 00:11:47,699
say oh these are stars they're much

267
00:11:52,549 --> 00:11:50,040
brighter than the dust oh here's the

268
00:11:55,069 --> 00:11:52,559
dust here's the gas so they needed a two

269
00:11:56,629 --> 00:11:55,079
step process were lots of so it's very

270
00:11:59,030 --> 00:11:56,639
interesting that different people who

271
00:12:03,319 --> 00:11:59,040
learn in different ways needed different

272
00:12:06,499 --> 00:12:03,329
products ok so at AA Madera from Goddard

273
00:12:08,419 --> 00:12:06,509
do you was that your motivation for

274
00:12:09,889 --> 00:12:08,429
starting to do some printing on this too

275
00:12:13,100 --> 00:12:09,899
was to help visually impaired to do you

276
00:12:15,429 --> 00:12:13,110
have other other things in mind I think

277
00:12:19,610 --> 00:12:15,439
part of the initial project actually was

278
00:12:22,519 --> 00:12:19,620
to help with the visually impaired but

279
00:12:26,689 --> 00:12:22,529
another part was just to be able to see

280
00:12:29,660 --> 00:12:26,699
parts of a Astrophysical object that we

281
00:12:32,509 --> 00:12:29,670
normally cannot visualize so a lot of

282
00:12:35,799 --> 00:12:32,519
the stuff that we do or is the geometry

283
00:12:38,559 --> 00:12:35,809
is intrinsically three-dimensional and

284
00:12:41,179 --> 00:12:38,569
you don't always get all the information

285
00:12:44,419 --> 00:12:41,189
about an object just from a

286
00:12:46,600 --> 00:12:44,429
two-dimensional image so the project was

287
00:12:51,530 --> 00:12:46,610
originally designed for doing a

288
00:12:55,309 --> 00:12:51,540

planetary nebula but the physics and the

289
00:12:56,809 --> 00:12:55,319
methods involved are directly applicable

290
00:13:01,100 --> 00:12:56,819
to go to what we were doing with ada

291
00:13:03,829 --> 00:13:01,110
kareena and so we asked our collaborator

292
00:13:06,230 --> 00:13:03,839
Wolfgang Stefan who's at you name in

293
00:13:10,759 --> 00:13:06,240
Baja California Mexico if he would take

294
00:13:12,079 --> 00:13:10,769
his um if he would take his code that

295
00:13:14,919 --> 00:13:12,089
was originally designed for modeling

296
00:13:18,410 --> 00:13:14,929
planetary nebula and extend it to

297
00:13:20,119 --> 00:13:18,420
modeling 80 kareena and muggy also he

298
00:13:21,319 --> 00:13:20,129
has a big project and one of his main

299
00:13:24,650 --> 00:13:21,329
motivations is

300
00:13:27,410 --> 00:13:24,660
so you do modeling or for the visually

301
00:13:30,049 --> 00:13:27,420
impaired okay so the so let's get to a

302
00:13:32,720 --> 00:13:30,059
decree native karina is the object you

303
00:13:35,090 --> 00:13:32,730
guys started with and frank is showing

304
00:13:38,229 --> 00:13:35,100
something on his screen Frank you want

305
00:13:40,400 --> 00:13:38,239
to describe what you're showing us here

306
00:13:43,759 --> 00:13:40,410
can you hear you're muted there you go

307
00:13:48,590 --> 00:13:43,769
sure that's the that's the digital model

308
00:13:51,259 --> 00:13:48,600
of actually on my printer before you go

309
00:13:54,590 --> 00:13:51,269
to print you would bring the model into

310
00:13:57,019 --> 00:13:54,600
the data model into software and where

311
00:13:58,939 --> 00:13:57,029
it gets sliced into layers and this is

312
00:14:02,569 --> 00:13:58,949
what you see if you were using my part

313
00:14:05,059 --> 00:14:02,579

in this model okay this is an astronomy

314
00:14:06,889 --> 00:14:05,069
redeemed hang out and we have an

315
00:14:09,079 --> 00:14:06,899
astrophysicist Tom tell us what ADA

316
00:14:11,629 --> 00:14:09,089
kareena is before we go any further I

317
00:14:16,759 --> 00:14:11,639
sure because you have Carl put up Donna

318
00:14:18,669 --> 00:14:16,769
your image of a beta Carina yeah so

319
00:14:22,100 --> 00:14:18,679
while we're getting the image up I'll

320
00:14:23,869 --> 00:14:22,110
give me ok so here's here's the image

321
00:14:26,929 --> 00:14:23,879
yeah the thing that you notice right

322
00:14:29,720 --> 00:14:26,939
away is that a decree nuh has a very

323
00:14:31,960 --> 00:14:29,730
specific geometry it's it's a bipolar

324
00:14:35,859 --> 00:14:31,970
nebulae you know what makes a to karina

325
00:14:38,900 --> 00:14:35,869
specialist it's one of the most evolved

326
00:14:41,479 --> 00:14:38,910
and most massive stars in our galaxy and

327
00:14:43,970 --> 00:14:41,489
it's also relatively close and it's very

328
00:14:47,720 --> 00:14:43,980
bright which means that we can study it

329
00:14:52,579 --> 00:14:47,730
in in great detail and in the mid-1800s

330
00:14:54,710 --> 00:14:52,589
a decree nuh had a very powerful

331
00:14:57,319 --> 00:14:54,720
outburst it was almost as powerful as a

332
00:14:59,179 --> 00:14:57,329
supernova explosion before then everyone

333
00:15:01,400 --> 00:14:59,189
thought it was just a normal regular

334
00:15:02,689 --> 00:15:01,410
star in the sky and actually he could

335
00:15:04,789 --> 00:15:02,699
barely even see it with the naked eye

336
00:15:07,729 --> 00:15:04,799
but then it had this eruption and it

337
00:15:11,329 --> 00:15:07,739
became the second brightest non solar

338
00:15:14,059 --> 00:15:11,339

system objects in the sky and it was

339
00:15:17,509 --> 00:15:14,069
during this time that it objected all

340
00:15:19,729 --> 00:15:17,519
this material that forms this nebula but

341
00:15:22,189 --> 00:15:19,739
it was not a supernova no it was not a

342
00:15:24,979 --> 00:15:22,199
supernova that's what's that's what

343
00:15:26,809 --> 00:15:24,989
makes it a cleaner so fascinating is

344
00:15:28,460 --> 00:15:26,819
that well now we know that it's actually

345
00:15:31,429 --> 00:15:28,470
two stars we know now that at the very

346
00:15:34,549 --> 00:15:31,439
very center of this nebula are two very

347
00:15:34,940 --> 00:15:34,559
massive stars in total the total mass of

348
00:15:38,630 --> 00:15:34,950
this

349
00:15:41,270 --> 00:15:38,640
system is about a 120 times the mass of

350
00:15:44,240 --> 00:15:41,280
our Sun and the brain is of this thing

351
00:15:47,000 --> 00:15:44,250
is about 5 million times the brightness

352
00:15:49,010 --> 00:15:47,010
of our Sun but again what's amazing is

353
00:15:51,200 --> 00:15:49,020
it objective this gigantic nebula and

354
00:15:54,950 --> 00:15:51,210
the mass in the nebula itself is at

355
00:15:57,260 --> 00:15:54,960
least probably between 10 and 40 solar

356
00:15:59,390 --> 00:15:57,270
masses or 40 times the mass of our Sun

357
00:16:02,090 --> 00:15:59,400
but the star the star wasn't destroyed

358
00:16:03,770 --> 00:16:02,100
in this explosion and then we have no we

359
00:16:05,150 --> 00:16:03,780
have no idea Alice's how this is

360
00:16:08,200 --> 00:16:05,160
possible whether it was an explosion

361
00:16:10,400 --> 00:16:08,210
from a single star or whether two stars

362
00:16:12,530 --> 00:16:10,410
collided or whether two stars merge

363
00:16:13,880 --> 00:16:12,540

together I know it's an amazing looking

364
00:16:16,610 --> 00:16:13,890
object and Hubble's got some awesome

365
00:16:18,710 --> 00:16:16,620
images of this thing out but one of the

366
00:16:22,100 --> 00:16:18,720
things that I I guess I'm I look at this

367
00:16:24,310 --> 00:16:22,110
in this picture here and how there's a

368
00:16:26,660 --> 00:16:24,320
3d model of this thing how do you know

369
00:16:28,640 --> 00:16:26,670
what like it even on the right side of

370
00:16:30,710 --> 00:16:28,650
here says model side facing away from

371
00:16:32,960 --> 00:16:30,720
Earth how do you get that information I

372
00:16:36,290 --> 00:16:32,970
mean all we're seeing is you know a

373
00:16:39,710 --> 00:16:36,300
one-hour 2d projection of this of this

374
00:16:41,300 --> 00:16:39,720
object how do you get the 3d data points

375
00:16:43,640 --> 00:16:41,310
that you need to make it to make this

376
00:16:45,980 --> 00:16:43,650
accurate yeah so this was this was part

377
00:16:48,100 --> 00:16:45,990
of a very intense observing programme

378
00:16:51,920 --> 00:16:48,110
and like I said it was done with a

379
00:16:54,800 --> 00:16:51,930
telescope and so 80 kareena is in the in

380
00:16:56,330 --> 00:16:54,810
a constellation in the southern sky so

381
00:16:59,450 --> 00:16:56,340
unfortunately you can't see it from from

382
00:17:01,760 --> 00:16:59,460
the blue sky so we had to use a

383
00:17:04,160 --> 00:17:01,770
telescope in Chile and we used an

384
00:17:09,439 --> 00:17:04,170
instrument that is called X shooter and

385
00:17:12,290 --> 00:17:09,449
it's a spectrograph so the light passes

386
00:17:14,780 --> 00:17:12,300
through a slit and it disperses that

387
00:17:18,560 --> 00:17:14,790
light and that gives us not only spatial

388
00:17:20,360 --> 00:17:18,570

information along one dimension of the

389
00:17:22,850 --> 00:17:20,370
slit but it also gives us the loss of

390
00:17:25,310 --> 00:17:22,860
the information and what we did is we

391
00:17:29,420 --> 00:17:25,320
used this instrument to map the entire

392
00:17:32,780 --> 00:17:29,430
among culous nebula and we used a very

393
00:17:34,280 --> 00:17:32,790
specific emission line we used we didn't

394
00:17:36,950 --> 00:17:34,290
do this in optical light so the image

395
00:17:39,020 --> 00:17:36,960
that that is being displayed is as a

396
00:17:45,080 --> 00:17:39,030
Hubble image so it's it's it's optical

397
00:17:48,080 --> 00:17:45,090
but we used a mission from hydrogen that

398
00:17:48,530 --> 00:17:48,090
submitted in near-infrared wavelengths

399
00:17:50,960 --> 00:17:48,540
and up

400
00:17:54,440 --> 00:17:50,970
that's good about the near-infrared is

401
00:17:56,270 --> 00:17:54,450
that allows us to see through

402
00:17:59,210 --> 00:17:56,280
essentially almost see through the

403
00:18:01,580 --> 00:17:59,220
nebula and we can actually see the back

404
00:18:03,020 --> 00:18:01,590
side of that of that lobe that's

405
00:18:05,270 --> 00:18:03,030
pointing away from us and we can get

406
00:18:07,010 --> 00:18:05,280
information about that about the

407
00:18:09,800 --> 00:18:07,020
structure that to spend expanding away

408
00:18:11,630 --> 00:18:09,810
from this I've based on based on all

409
00:18:14,300 --> 00:18:11,640
this when we get off the state and then

410
00:18:18,830 --> 00:18:14,310
we model it we can we can construct our

411
00:18:20,870 --> 00:18:18,840
our 3d model great okay so Carol you

412
00:18:23,630 --> 00:18:20,880
guys you guys said that you guys started

413
00:18:27,530 --> 00:18:23,640

with these texture maps and these

414
00:18:29,060 --> 00:18:27,540
luminosity maps with the with that one

415
00:18:32,270 --> 00:18:29,070
star forming region that you just that

416
00:18:35,240 --> 00:18:32,280
we just saw has there been used in

417
00:18:40,640 --> 00:18:35,250
classrooms yet or what's the what's the

418
00:18:43,940 --> 00:18:40,650
plan you're muted unfortunately thank

419
00:18:47,270 --> 00:18:43,950
you so our strategy has been to use the

420
00:18:49,630 --> 00:18:47,280
first cluster NGC 602 to test it

421
00:18:53,660 --> 00:18:49,640
actually we decided to test it with some

422
00:18:55,790 --> 00:18:53,670
small focus groups who were visually

423
00:18:58,240 --> 00:18:55,800
impaired at different levels and who

424
00:19:00,620 --> 00:18:58,250
have some or sometimes even no

425
00:19:03,650 --> 00:19:00,630
experience with taco materials and also

426
00:19:05,720 --> 00:19:03,660
had a range of Education and the reason

427
00:19:10,550 --> 00:19:05,730
was that we wanted to get a wide

428
00:19:12,950 --> 00:19:10,560
diversity of user to refine the textures

429
00:19:16,070 --> 00:19:12,960
and we actually had to refine the

430
00:19:18,140 --> 00:19:16,080
texture several times because what we

431
00:19:19,670 --> 00:19:18,150
thought were good textures and what we

432
00:19:24,470 --> 00:19:19,680
thought were good textures on the paper

433
00:19:26,000 --> 00:19:24,480
this swell form paper which has the

434
00:19:28,580 --> 00:19:26,010
raised surface which we talked about

435
00:19:30,110 --> 00:19:28,590
first it worked for the paper but it

436
00:19:34,430 --> 00:19:30,120
didn't really work for the 3d print so

437
00:19:36,850 --> 00:19:34,440
we had to modify that and also the the

438
00:19:39,050 --> 00:19:36,860

people who gave us feedback

439
00:19:41,050 --> 00:19:39,060
traditionally a lot of tactile stuff is

440
00:19:43,700 --> 00:19:41,060
done with like straight lines and

441
00:19:45,980 --> 00:19:43,710
slanted lines and thoughts and stuff

442
00:19:48,590 --> 00:19:45,990
like that and so we had to make sure

443
00:19:52,010 --> 00:19:48,600
that we could distinguish the stars from

444
00:19:53,630 --> 00:19:52,020
other dotted surfaces and then the users

445
00:19:57,200 --> 00:19:53,640
wanted us to do something that was a

446
00:19:59,660 --> 00:19:57,210
vocativ of dust or gas so we had to

447
00:20:01,610 --> 00:19:59,670
think about textures so it's taken us a

448
00:20:02,120 --> 00:20:01,620
while to refine the texture so we didn't

449
00:20:04,490 --> 00:20:02,130
think we

450
00:20:06,440 --> 00:20:04,500
take it to the classroom before I mean

451
00:20:08,120 --> 00:20:06,450
there's no point in taking a product to

452
00:20:10,640 --> 00:20:08,130
a classroom when you're not really sure

453
00:20:13,010 --> 00:20:10,650
that the product even works right trying

454
00:20:14,540 --> 00:20:13,020
to do proof of concept and then what

455
00:20:16,700 --> 00:20:14,550
we're going to do is we're going to

456
00:20:20,360 --> 00:20:16,710
create a process so that we can

457
00:20:24,020 --> 00:20:20,370
basically manufacture elevation maps and

458
00:20:25,820 --> 00:20:24,030
and texture maps for many Hubble images

459
00:20:29,030 --> 00:20:25,830
so we'll have a library of those and

460
00:20:31,100 --> 00:20:29,040
people can print those and then the next

461
00:20:33,980 --> 00:20:31,110
step is actually what is being printed

462
00:20:39,290 --> 00:20:33,990
now is that we we also have a galaxy

463
00:20:42,590 --> 00:20:39,300

project and we have these we're making

464
00:20:44,780 --> 00:20:42,600
3d models of galaxies now and they are

465
00:20:48,080 --> 00:20:44,790
also textured using our preferred

466
00:20:50,960 --> 00:20:48,090
textures there are star clusters there's

467
00:20:52,670 --> 00:20:50,970
gas and dust when just a little bit more

468
00:20:56,180 --> 00:20:52,680
torture windows so we can get the light

469
00:20:57,710 --> 00:20:56,190
from the angler my own a desk lamp is is

470
00:21:00,260 --> 00:20:57,720
on the printer oh that's good that's

471
00:21:02,600 --> 00:21:00,270
better but now now kind of angle it to

472
00:21:04,130 --> 00:21:02,610
there you go perfect perfect hey no no

473
00:21:05,090 --> 00:21:04,140
no that's good i just want to be able I

474
00:21:07,940 --> 00:21:05,100
wanted people to be able it was

475
00:21:12,020 --> 00:21:07,950
saturated there I know yeah hey I can a

476
00:21:14,600 --> 00:21:12,030
black one which is he blows our galaxy

477
00:21:19,060 --> 00:21:14,610
so sir galaxies are galaxies and I have

478
00:21:22,910 --> 00:21:19,070
to agree um with the our Goddard

479
00:21:24,650 --> 00:21:22,920
colleagues that we we're doing we're

480
00:21:26,960 --> 00:21:24,660
doing this for the visually impaired to

481
00:21:29,240 --> 00:21:26,970
you know convey science and all this up

482
00:21:33,620 --> 00:21:29,250
but when you print this stuff and you

483
00:21:36,020 --> 00:21:33,630
start looking at it you're like oh oh so

484
00:21:40,700 --> 00:21:36,030
we're learning things as well and I

485
00:21:42,860 --> 00:21:40,710
think of Thomasson and Frank of it

486
00:21:44,480 --> 00:21:42,870
verbalize that as well is that you start

487
00:21:46,610 --> 00:21:44,490
printing these things and you start

488
00:21:48,740 --> 00:21:46,620

learning things about the astronomical

489
00:21:51,710 --> 00:21:48,750
object as well what you did like oh

490
00:21:54,320 --> 00:21:51,720
that's interesting so that's a good

491
00:21:56,840 --> 00:21:54,330
point we know we knew in our heads that

492
00:21:59,500 --> 00:21:56,850
it had wide applicability not just for

493
00:22:01,610 --> 00:21:59,510
the visually impaired but it really even

494
00:22:04,820 --> 00:22:01,620
scientists can learn something by

495
00:22:06,290 --> 00:22:04,830
printing something in 30 right well

496
00:22:07,820 --> 00:22:06,300
Frank I promise I'm going to get you in

497
00:22:09,050 --> 00:22:07,830
and this is just a sack out but I want

498
00:22:10,700 --> 00:22:09,060
to ask I want to go but I want to

499
00:22:12,350 --> 00:22:10,710
reinforce a little bit of what Carol

500
00:22:15,920 --> 00:22:12,360
just the point she just made with Tom

501
00:22:16,130 --> 00:22:15,930
Tom and apparently i think it was there

502
00:22:17,480 --> 00:22:16,140
with

503
00:22:20,330 --> 00:22:17,490
things you learned about eight a car

504
00:22:21,770 --> 00:22:20,340
that you didn't know by just looking but

505
00:22:22,910 --> 00:22:21,780
once you had the printouts is that

506
00:22:25,850 --> 00:22:22,920
correct it was there there was some

507
00:22:27,890 --> 00:22:25,860
action scientific uh insight from

508
00:22:31,100 --> 00:22:27,900
printing these things yes so well here

509
00:22:35,720 --> 00:22:31,110
I'll use this are our biggest print

510
00:22:38,630 --> 00:22:35,730
model of the nebula and wow it's

511
00:22:41,570 --> 00:22:38,640
color-coded for a reason so the the red

512
00:22:43,700 --> 00:22:41,580
low is the lobe that is pointing away

513
00:22:46,220 --> 00:22:43,710

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

514
00:22:48,040 --> 00:22:46,230
that's proceeding in a blue low ready

515
00:22:51,050 --> 00:22:48,050
dread shifting away sort of right

516
00:22:52,850 --> 00:22:51,060
exactly exactly right and then the blue

517
00:22:54,950 --> 00:22:52,860
lobe is the lobe that's in the in the

518
00:22:58,310 --> 00:22:54,960
foreground of the HST image so it's the

519
00:23:00,260 --> 00:22:58,320
lobe that's coming towards us and we

520
00:23:03,770 --> 00:23:00,270
actually discovered some new features

521
00:23:06,890 --> 00:23:03,780
that were previously unknown to exist in

522
00:23:10,010 --> 00:23:06,900
the 80 car indiana car nebula the the

523
00:23:14,060 --> 00:23:10,020
first are these protrusions that you see

524
00:23:15,950 --> 00:23:14,070
um jutting out of the modes there's one

525
00:23:18,440 --> 00:23:15,960
phone from the from the bottom blue lobe

526
00:23:20,480 --> 00:23:18,450
and one from the top load and then there

527
00:23:22,760 --> 00:23:20,490
are these uh hopefully they'll show up

528
00:23:26,480 --> 00:23:22,770
well on the webcam but there are these

529
00:23:27,740 --> 00:23:26,490
trenches yeah we can see them yeah that

530
00:23:30,680 --> 00:23:27,750
are there's one on look again there's

531
00:23:32,360 --> 00:23:30,690
one on the foreground lobe and there's

532
00:23:34,310 --> 00:23:32,370
one on the receding lou and what's

533
00:23:36,230 --> 00:23:34,320
what's interesting is that those are

534
00:23:38,330 --> 00:23:36,240
real those are real these these are real

535
00:23:42,440 --> 00:23:38,340
physical real physical features in the

536
00:23:44,020 --> 00:23:42,450
nebula itself and some some really

537
00:23:49,130 --> 00:23:44,030
interesting things so for instance the

538
00:23:50,960 --> 00:23:49,140

the protrusions are not visible or at

539
00:23:53,060 --> 00:23:50,970
least they're not they're not clearly

540
00:23:57,500 --> 00:23:53,070
apparent in in for instance the Hubble

541
00:24:00,410 --> 00:23:57,510
image but you see them in this in this

542
00:24:02,540 --> 00:24:00,420
molecular hydrogen line that we observed

543
00:24:06,230 --> 00:24:02,550
and then also that the trenches you can

544
00:24:09,230 --> 00:24:06,240
see one in the bottom of the in the

545
00:24:11,510 --> 00:24:09,240
bottom lobe in the Hubble image but the

546
00:24:13,310 --> 00:24:11,520
one on the far side of the low on this

547
00:24:15,380 --> 00:24:13,320
on this mode that's pointing away from

548
00:24:21,380 --> 00:24:15,390
us we did not know that that existed

549
00:24:23,180 --> 00:24:21,390
until we did the the 3d modeling ok wow

550
00:24:24,880 --> 00:24:23,190
that's so are you as an astrophysicist

551
00:24:27,110 --> 00:24:24,890
or are you excited about this new

552
00:24:28,430 --> 00:24:27,120
insight into some of these I mean let's

553
00:24:29,030 --> 00:24:28,440
say you printed some other things out I

554
00:24:30,740 --> 00:24:29,040
mean

555
00:24:32,780 --> 00:24:30,750
their chances are pretty good you might

556
00:24:36,560 --> 00:24:32,790
glean other insights from things that

557
00:24:38,480 --> 00:24:36,570
yes we are and I not going to say too

558
00:24:41,360 --> 00:24:38,490
much now but we are working on something

559
00:24:43,040 --> 00:24:41,370
that is a something new that we are

560
00:24:45,380 --> 00:24:43,050
doing with 3d printing that as far as we

561
00:24:47,600 --> 00:24:45,390
know has never been done before and we

562
00:24:50,270 --> 00:24:47,610
have potentially discovered something

563
00:24:52,820 --> 00:24:50,280

new and we're hoping to make you

564
00:24:54,830 --> 00:24:52,830
possibly make an announcement in the

565
00:24:56,630 --> 00:24:54,840
near future about that sounds like

566
00:24:59,030 --> 00:24:56,640
another hangouts on the way here soon

567
00:25:00,560 --> 00:24:59,040
cold I let us know Franklin let me get I

568
00:25:02,570 --> 00:25:00,570
want to finally get you i'm sorry it's

569
00:25:04,100 --> 00:25:02,580
taken me a bit but i wanted to get

570
00:25:06,500 --> 00:25:04,110
through some of the intros and stuff and

571
00:25:08,870 --> 00:25:06,510
you're a science writer at Goddard and

572
00:25:10,790 --> 00:25:08,880
you're you're involved in the 3d

573
00:25:12,080 --> 00:25:10,800
printing project I want you give us a

574
00:25:13,520 --> 00:25:12,090
little what Witcher what do you uh what

575
00:25:15,410 --> 00:25:13,530
are you excited about what are you

576
00:25:18,110 --> 00:25:15,420
working on with this well principally

577
00:25:20,420 --> 00:25:18,120
I'm involved as a hobbyist I I had got

578
00:25:24,080 --> 00:25:20,430
involved a couple of months before the

579
00:25:28,190 --> 00:25:24,090
ADA kareena material that commute in my

580
00:25:31,670 --> 00:25:28,200
office and there were efforts to try to

581
00:25:34,700 --> 00:25:31,680
use a older 3d printer that we had a

582
00:25:36,980 --> 00:25:34,710
daughter and I took a stab at getting it

583
00:25:38,990 --> 00:25:36,990
on my home printer and we wound up

584
00:25:45,650 --> 00:25:39,000
making something like a hundred edema

585
00:25:47,030 --> 00:25:45,660
stays local I these were dispute I what

586
00:25:49,760 --> 00:25:47,040
a great word i'm going to start using it

587
00:25:52,130 --> 00:25:49,770
i work that into a sentence homunculi i

588
00:25:53,900 --> 00:25:52,140

printed up probably about a hundred of

589
00:25:55,700 --> 00:25:53,910
these we distributed something to the

590
00:26:00,320 --> 00:25:55,710
co-authors of the paper the talmage on

591
00:26:02,180 --> 00:26:00,330
and to another couple dozen to people

592
00:26:07,490 --> 00:26:02,190
who are just getting an ask social and

593
00:26:11,150 --> 00:26:07,500
daughter and so it was really a trial by

594
00:26:14,060 --> 00:26:11,160
fire to get all that done but the real

595
00:26:17,990 --> 00:26:14,070
learning experience for me as i said i

596
00:26:19,970 --> 00:26:18,000
got into it just out of curiosity but

597
00:26:21,380 --> 00:26:19,980
and because you want and you bought one

598
00:26:23,270 --> 00:26:21,390
of the and you owned a printer so you

599
00:26:24,470 --> 00:26:23,280
did well so what can you tell us a

600
00:26:26,690 --> 00:26:24,480
little bit about the technology i'm

601
00:26:29,690 --> 00:26:26,700
going to have Carol's printer up here

602
00:26:30,710 --> 00:26:29,700
and how do these things work what tell

603
00:26:32,690 --> 00:26:30,720
us a little bit about the technology

604
00:26:34,810 --> 00:26:32,700
here well there a number of different

605
00:26:37,490 --> 00:26:34,820
technologies but the one that's becoming

606
00:26:42,169 --> 00:26:37,500
affordable very quickly is the food

607
00:26:47,149 --> 00:26:42,179
filament fabrication which makes a roll

608
00:26:49,359 --> 00:26:47,159
uh plastic filament and sort of places

609
00:26:53,320 --> 00:26:49,369
it down the way you would ice a cake

610
00:26:55,909 --> 00:26:53,330
just drawing the outline of the object

611
00:27:00,350 --> 00:26:55,919
software goes through and slices that

612
00:27:03,409 --> 00:27:00,360
object into small layers and the printer

613
00:27:07,330 --> 00:27:03,419

simply draws each layer in succession

614
00:27:09,730 --> 00:27:07,340
and gradually builds up the object and

615
00:27:13,129 --> 00:27:09,740
Carol you said you were printing out

616
00:27:15,019 --> 00:27:13,139
what happened oh there you go she all be

617
00:27:17,299 --> 00:27:15,029
no go ahead yeah please show that yeah

618
00:27:21,070 --> 00:27:17,309
Carol showing the material a spool of

619
00:27:25,369 --> 00:27:21,080
some kind of what is that stuff Frank

620
00:27:28,430 --> 00:27:25,379
it's it's probably abs plastic a lot so

621
00:27:33,680 --> 00:27:28,440
PLA with your beauty Carol ok ok I

622
00:27:36,259 --> 00:27:33,690
couldn't see the lady feeling he's to

623
00:27:39,320 --> 00:27:36,269
come in common filaments near their

624
00:27:41,180 --> 00:27:39,330
obvious Taiwan is also low so that stuff

625
00:27:42,830 --> 00:27:41,190
gets spooled through the printer head

626
00:27:45,980 --> 00:27:42,840
which we're seeing right now go back and

627
00:27:47,810 --> 00:27:45,990
forth and the third dimension we don't

628
00:27:49,519 --> 00:27:47,820
see as well which is coming at us and

629
00:27:52,549 --> 00:27:49,529
back away from us so in the plane of the

630
00:27:54,710 --> 00:27:52,559
camera so in the printer today at the

631
00:28:01,180 --> 00:27:54,720
tip of the further is it is a heater in

632
00:28:05,210 --> 00:28:01,190
the formula ceded to DC and dribbled out

633
00:28:07,580 --> 00:28:05,220
very precisely as the head moves

634
00:28:09,289 --> 00:28:07,590
applause and Carol this thing is

635
00:28:11,659 --> 00:28:09,299
ubiquitous in your office we've had

636
00:28:13,220 --> 00:28:11,669
every almost every hangout somebody has

637
00:28:15,499 --> 00:28:13,230
commented what's that going on behind

638
00:28:17,629 --> 00:28:15,509

Carol you're always printing something

639
00:28:19,489 --> 00:28:17,639
on it how long does it take usually to

640
00:28:21,499 --> 00:28:19,499
make on up you're printing out a galaxy

641
00:28:24,590 --> 00:28:21,509
you said right now right I'm gonna lie

642
00:28:27,730 --> 00:28:24,600
antonella taco the time it takes and

643
00:28:34,639 --> 00:28:27,740
what it's been gone I go ahead Antonella

644
00:28:37,580 --> 00:28:34,649
hello time it takes appropriate half of

645
00:28:39,320 --> 00:28:37,590
the galaxy as a matter of fact one of

646
00:28:42,289 --> 00:28:39,330
the things that we realize with the

647
00:28:44,629 --> 00:28:42,299
testing with our group of visually

648
00:28:47,450 --> 00:28:44,639
impaired is that the larger form of

649
00:28:49,789 --> 00:28:47,460
healthy fun to recognize the future so

650
00:28:51,859 --> 00:28:49,799
one of the limitation of the maker ball

651
00:28:55,009 --> 00:28:51,869
which is the low end printer we are

652
00:28:55,760 --> 00:28:55,019
using is that the format is more so we

653
00:28:58,460 --> 00:28:55,770
are building

654
00:29:00,920 --> 00:28:58,470
our prototypes and pieces and then we

655
00:29:03,950 --> 00:29:00,930
glue them so we can make a larger format

656
00:29:05,930 --> 00:29:03,960
because we know that that is easy but

657
00:29:08,360 --> 00:29:05,940
the reason why we chose the MakerBot in

658
00:29:11,300 --> 00:29:08,370
our case is because it is affordable and

659
00:29:14,030 --> 00:29:11,310
so you know you would think that schools

660
00:29:17,030 --> 00:29:14,040
can reasonably purchase something like

661
00:29:19,970 --> 00:29:17,040
that libraries and so one of our

662
00:29:23,270 --> 00:29:19,980
long-term goals is actually making a

663
00:29:25,160 --> 00:29:23,280

library of images and make them

664
00:29:28,970 --> 00:29:25,170
available to people so that actually

665
00:29:31,430 --> 00:29:28,980
people can take them and and bring them

666
00:29:33,860 --> 00:29:31,440
in their own you know printer at home or

667
00:29:35,900 --> 00:29:33,870
its full on the library and kind of

668
00:29:38,030 --> 00:29:35,910
experience what are we talking about

669
00:29:39,890 --> 00:29:38,040
here as far as cost couple grand for you

670
00:29:42,170 --> 00:29:39,900
know hat 5,000 what are we talking a

671
00:29:44,330 --> 00:29:42,180
little thousand a couple grant okay so

672
00:29:46,310 --> 00:29:44,340
you're right that could be in the realm

673
00:29:49,090 --> 00:29:46,320
of possibility for a lot of schools is

674
00:29:51,980 --> 00:29:49,100
there any plans for maybe uh

675
00:29:53,510 --> 00:29:51,990
distributing I don't know how how does

676
00:29:55,490 --> 00:29:53,520
this thing know what to print what do

677
00:29:58,580 --> 00:29:55,500
you send it you sended a file of some

678
00:30:00,950 --> 00:29:58,590
kind of 3d file or what do you do these

679
00:30:04,160 --> 00:30:00,960
printers with a very specific format

680
00:30:06,650 --> 00:30:04,170
which is called stl so part of the

681
00:30:09,230 --> 00:30:06,660
process is to convert the images as we

682
00:30:11,930 --> 00:30:09,240
know them or the models whatever into an

683
00:30:17,420 --> 00:30:11,940
STL format than a 3d printer any

684
00:30:21,380 --> 00:30:17,430
educator can take and think it's pretty

685
00:30:23,270 --> 00:30:21,390
standard format used by old days Carol

686
00:30:26,060 --> 00:30:23,280
do you have a finished thing of what

687
00:30:30,410 --> 00:30:26,070
you're printing right now do you know

688
00:30:37,570 --> 00:30:30,420

actually I'm printing um yes we have

689
00:30:40,910 --> 00:30:37,580
that we have to test galaxies 3344 and

690
00:30:44,330 --> 00:30:40,920
1566 i think and the black one that i

691
00:30:49,220 --> 00:30:44,340
have here we are we are printing a

692
00:30:51,080 --> 00:30:49,230
purple version of that one and then we

693
00:30:53,240 --> 00:30:51,090
have a programmer who's working on some

694
00:30:56,780 --> 00:30:53,250
more the galaxies and the interface and

695
00:30:59,240 --> 00:30:56,790
we're going to start printing more of

696
00:31:01,970 --> 00:30:59,250
those I actually want to have the

697
00:31:03,890 --> 00:31:01,980
texture and elevation map of this galaxy

698
00:31:06,680 --> 00:31:03,900
as well so that we have the three

699
00:31:09,470 --> 00:31:06,690
products so that we can test the three

700
00:31:12,320 --> 00:31:09,480
products and see whether people prefer

701
00:31:14,299 --> 00:31:12,330
just this or whether they would like to

702
00:31:18,260 --> 00:31:14,309
use the other ones to kind of teach

703
00:31:19,700 --> 00:31:18,270
themselves about the science so what

704
00:31:21,680 --> 00:31:19,710
we're thinking about what are the

705
00:31:24,650 --> 00:31:21,690
different formats that work with what

706
00:31:27,080 --> 00:31:24,660
kind of users best wow this is like

707
00:31:29,060 --> 00:31:27,090
totally cutting edge stuff here so Frank

708
00:31:31,280 --> 00:31:29,070
when you did your when your initial

709
00:31:32,930 --> 00:31:31,290
printing what did you print how did you

710
00:31:34,870 --> 00:31:32,940
print on astronomy things or was it

711
00:31:39,140 --> 00:31:34,880
something what what else did you print

712
00:31:41,180 --> 00:31:39,150
my initial efforts were to print spare

713
00:31:44,510 --> 00:31:41,190

parts or replacement parts for my

714
00:31:46,100 --> 00:31:44,520
kitchen floors that's like you

715
00:31:48,770 --> 00:31:46,110
definitely being preg knows were

716
00:31:51,400 --> 00:31:48,780
expensive parts that weren't they I

717
00:31:55,010 --> 00:31:51,410
can't buy the mating there because the

718
00:31:56,659 --> 00:31:55,020
furniture is sold ok so further

719
00:31:57,890 --> 00:31:56,669
replaceable parts you can't just go to

720
00:32:01,850 --> 00:31:57,900
lowes and get them you print them out

721
00:32:04,070 --> 00:32:01,860
yourself so I know that this the primary

722
00:32:06,830 --> 00:32:04,080
focus educationally at least is for the

723
00:32:09,890 --> 00:32:06,840
visually impaired but for someone you

724
00:32:11,210 --> 00:32:09,900
know for those of us who can see these

725
00:32:13,190 --> 00:32:11,220
models one of the one of the things that

726
00:32:15,620 --> 00:32:13,200
strikes me is it would be really cool if

727
00:32:19,220 --> 00:32:15,630
we could do different colors is that

728
00:32:22,520 --> 00:32:19,230
possible Frank oh absolutely different

729
00:32:23,870 --> 00:32:22,530
colors are one in a sacred yeah is that

730
00:32:27,799 --> 00:32:23,880
possible what do you do switch out the

731
00:32:29,600 --> 00:32:27,809
spool or what do you do there are there

732
00:32:32,000 --> 00:32:29,610
are printers that have multiple

733
00:32:36,289 --> 00:32:32,010
extruders and therefore you as many

734
00:32:40,360 --> 00:32:36,299
colors as you have excluders trigger the

735
00:32:44,350 --> 00:32:40,370
pressure ha day there is in fact 111

736
00:32:46,250 --> 00:32:44,360
printer head that contains for exteriors

737
00:32:50,539 --> 00:32:46,260
estranging an interesting name

738
00:32:53,110 --> 00:32:50,549

diffracted reckon I've better you think

739
00:32:57,320 --> 00:32:53,120
that's one one way to do it would be to

740
00:32:59,840 --> 00:32:57,330
have four columns simultaneously you

741
00:33:01,970 --> 00:32:59,850
know this reminds me I'm really dating

742
00:33:05,270 --> 00:33:01,980
myself here but my first computer had a

743
00:33:06,620 --> 00:33:05,280
printer an epson MX 80 and when you when

744
00:33:08,480 --> 00:33:06,630
you printed on it it made this

745
00:33:11,570 --> 00:33:08,490
horrendous racket and it would go back

746
00:33:13,669 --> 00:33:11,580
and forth in one color only and it would

747
00:33:16,310 --> 00:33:13,679
take you like minutes to print the page

748
00:33:20,120 --> 00:33:16,320
of text it's a real I see a similar

749
00:33:22,259 --> 00:33:20,130
experience so when I look at this thing

750
00:33:24,269 --> 00:33:22,269
go I have to say I've kind of reminded

751
00:33:26,249 --> 00:33:24,279
those days where we've got this dot

752
00:33:27,629 --> 00:33:26,259
matrix printer going back and forth and

753
00:33:30,269 --> 00:33:27,639
then Frank was just telling us about the

754
00:33:32,209 --> 00:33:30,279
crack in which can has color and I don't

755
00:33:36,180 --> 00:33:32,219
know if you remember when color came out

756
00:33:39,089 --> 00:33:36,190
girls a big deal uh and so this is kind

757
00:33:40,949 --> 00:33:39,099
of like mimicking that sort of

758
00:33:43,259 --> 00:33:40,959
technology or at least in my eyes well

759
00:33:45,599 --> 00:33:43,269
so happily it will only get better from

760
00:33:48,539 --> 00:33:45,609
here that's what I guess and Matt and

761
00:33:50,159 --> 00:33:48,549
like winners today or although there's

762
00:33:51,119 --> 00:33:50,169
more or less now our kind of obsolete I

763
00:33:53,129 --> 00:33:51,129

don't think we use them very much

764
00:33:54,869 --> 00:33:53,139
anyways i don't i only own a printer

765
00:33:58,680 --> 00:33:54,879
because i sometimes have to print but

766
00:34:03,629 --> 00:33:58,690
very rarely okay so i would i want to

767
00:34:07,139 --> 00:34:03,639
talk a little bit about um the UH going

768
00:34:08,609 --> 00:34:07,149
from data to the printer i'm not quite

769
00:34:10,529 --> 00:34:08,619
sure the best person asked but i'm

770
00:34:13,109 --> 00:34:10,539
thinking Carol but maybe it's Frank I

771
00:34:14,669 --> 00:34:13,119
you got data or maybe it's even Tom and

772
00:34:16,260 --> 00:34:14,679
I'm just gonna let one of your aunt's

773
00:34:18,210 --> 00:34:16,270
now i'll let you just chime in if you

774
00:34:20,279 --> 00:34:18,220
know this it's actually for our group

775
00:34:23,220 --> 00:34:20,289
it's on to know it's Antonella ok good

776
00:34:25,589 --> 00:34:23,230
let me see drained a student to do this

777
00:34:28,139 --> 00:34:25,599
too constraining a programmer now so you

778
00:34:29,940 --> 00:34:28,149
can thank you k ok good so Antonella

779
00:34:33,029 --> 00:34:29,950
you've got some data from Hubble whether

780
00:34:35,819 --> 00:34:33,039
it is an image with intensities or maybe

781
00:34:38,279 --> 00:34:35,829
spectra with velocities how do you go

782
00:34:42,389 --> 00:34:38,289
from that to something that the printer

783
00:34:45,299 --> 00:34:42,399
needs how hard is that something similar

784
00:34:47,639 --> 00:34:45,309
to walk tom for e-toc are basically you

785
00:34:49,169 --> 00:34:47,649
build the data cube when you try to be

786
00:34:52,409 --> 00:34:49,179
able to basically put all the

787
00:34:55,589 --> 00:34:52,419
information that you have and for

788
00:34:58,260 --> 00:34:55,599

example for NGC 602 we did fight a lot

789
00:35:01,049 --> 00:34:58,270
of little cursor to see what was

790
00:35:02,970 --> 00:35:01,059
published about where the various

791
00:35:05,549 --> 00:35:02,980
feature in the cluster are spatially

792
00:35:08,250 --> 00:35:05,559
located to try to understand you know

793
00:35:10,319 --> 00:35:08,260
what is the true 3d structure on that

794
00:35:13,799 --> 00:35:10,329
altar so this is working progress

795
00:35:16,829 --> 00:35:13,809
because it's not simple and it's a

796
00:35:19,260 --> 00:35:16,839
combination of astrophysics things that

797
00:35:21,539 --> 00:35:19,270
we can measure from the images we can

798
00:35:23,519 --> 00:35:21,549
measure the position of the stars we can

799
00:35:26,549 --> 00:35:23,529
measure the thickness of the filaments

800
00:35:28,529 --> 00:35:26,559
their intensity we also know where they

801
00:35:31,380 --> 00:35:28,539
are specially located like the gas

802
00:35:34,079 --> 00:35:31,390
system or lose the back end of the

803
00:35:35,770 --> 00:35:34,089
bubble the past is the front end but

804
00:35:38,050 --> 00:35:35,780
some you know 21

805
00:35:46,980 --> 00:35:38,060
what the visual representation al Sam is

806
00:35:50,890 --> 00:35:46,990
also guest ah oh I think we're overlap

807
00:35:52,870 --> 00:35:50,900
can you hear me bill okay so you cut out

808
00:35:54,730 --> 00:35:52,880
there toward the very yeah you cut out

809
00:35:57,550 --> 00:35:54,740
just a little bit toward it's all easy

810
00:36:01,330 --> 00:35:57,560
are you there can you hear me still can

811
00:36:03,400 --> 00:36:01,340
you I we can hear you now you dropped

812
00:36:06,910 --> 00:36:03,410
out just a little bit there okay so it's

813
00:36:10,870 --> 00:36:06,920

a it's no sonic six right it's an

814
00:36:12,670 --> 00:36:10,880
overlap between what is data you know

815
00:36:15,280 --> 00:36:12,680
data that we have from the England

816
00:36:18,610 --> 00:36:15,290
measurement from the image data from the

817
00:36:22,720 --> 00:36:18,620
literature and some guesswork and trying

818
00:36:25,870 --> 00:36:22,730
to put it all together and our goal also

819
00:36:29,140 --> 00:36:25,880
for NGC 602 is to try to do a 3d model

820
00:36:31,810 --> 00:36:29,150
of of the nebula and we'll get there

821
00:36:36,160 --> 00:36:31,820
like exactly like founded for each other

822
00:36:37,390 --> 00:36:36,170
okay so I I talk do you have anything

823
00:36:39,190 --> 00:36:37,400
you'd like to add to that as far as the

824
00:36:42,970 --> 00:36:39,200
difficulty level of going from data to

825
00:36:45,220 --> 00:36:42,980
to a printout yes i would say that part

826
00:36:48,910 --> 00:36:45,230
of the part of the issue at least that

827
00:36:52,240 --> 00:36:48,920
we learned was you could generate a 3d

828
00:36:54,040 --> 00:36:52,250
model that looks good on a computer

829
00:36:56,620 --> 00:36:54,050
screen but that doesn't necessarily mean

830
00:37:00,040 --> 00:36:56,630
that you can 3d print it again there was

831
00:37:02,350 --> 00:37:00,050
a bit of a steep learning curve to to

832
00:37:05,140 --> 00:37:02,360
learn what is necessary in order to have

833
00:37:07,450 --> 00:37:05,150
a successful to have a successful print

834
00:37:09,190 --> 00:37:07,460
but we've been playing around with with

835
00:37:12,670 --> 00:37:09,200
different software and some of its even

836
00:37:14,560 --> 00:37:12,680
freely available online one piece

837
00:37:19,080 --> 00:37:14,570
software that we've started using is

838
00:37:23,140 --> 00:37:19,090

called blender and that allows you to do

839
00:37:25,810 --> 00:37:23,150
some very fine adjustments to the 3d

840
00:37:28,240 --> 00:37:25,820
mesh or the witch which defines the

841
00:37:32,170 --> 00:37:28,250
geometry of your object it allows you to

842
00:37:33,910 --> 00:37:32,180
make some very nice intricate changes to

843
00:37:36,250 --> 00:37:33,920
your to your lash like for instance if

844
00:37:38,770 --> 00:37:36,260
one of the problems is here your object

845
00:37:40,030 --> 00:37:38,780
has to be watertight which means for

846
00:37:42,010 --> 00:37:40,040
instance if you took your model and you

847
00:37:46,600 --> 00:37:42,020
dip it in water you don't look the water

848
00:37:48,100 --> 00:37:46,610
to drain out or to get in and so you

849
00:37:49,000 --> 00:37:48,110
have to make sure that your model

850
00:37:50,950 --> 00:37:49,010
doesn't have any and

851
00:37:53,320 --> 00:37:50,960
obvious holes in it and there there are

852
00:37:55,450 --> 00:37:53,330
some other some other details that you

853
00:37:57,700 --> 00:37:55,460
have to make the check to make sure that

854
00:37:59,800 --> 00:37:57,710
here your model will print but that was

855
00:38:01,750 --> 00:37:59,810
the that was the largest thing and then

856
00:38:03,790 --> 00:38:01,760
also just the intricacies with the

857
00:38:06,850 --> 00:38:03,800
printers themselves they can be they can

858
00:38:09,670 --> 00:38:06,860
be fickle from time to time and I'm Tom

859
00:38:12,880 --> 00:38:09,680
agrees that there must be another a lot

860
00:38:15,340 --> 00:38:12,890
of custom-made software goes into

861
00:38:17,770 --> 00:38:15,350
putting all together you can just do

862
00:38:19,270 --> 00:38:17,780
this using off-the-shelf product ah

863
00:38:21,190 --> 00:38:19,280

that's what I was going to ask so you

864
00:38:25,240 --> 00:38:21,200
had to write some code to do this right

865
00:38:30,190 --> 00:38:25,250
yes especially for the tiktok to go from

866
00:38:32,320 --> 00:38:30,200
the spectra from the telescope to a 3d

867
00:38:35,920 --> 00:38:32,330
model of the nebula itself yes that that

868
00:38:37,750 --> 00:38:35,930
was that was specialized so exactly well

869
00:38:39,430 --> 00:38:37,760
what about availability what if I wanted

870
00:38:40,840 --> 00:38:39,440
what if I go out and I spend some money

871
00:38:43,150 --> 00:38:40,850
and I buy a printer but I want to do

872
00:38:44,230 --> 00:38:43,160
this too can I get that software or are

873
00:38:46,690 --> 00:38:44,240
you guys going to make it available to

874
00:38:50,710 --> 00:38:46,700
people or is it something that one has

875
00:38:53,170 --> 00:38:50,720
to do themselves actually yes so so

876
00:38:55,360 --> 00:38:53,180
Wolfgang Stefan who was again but the

877
00:38:57,460 --> 00:38:55,370
first author on the on the a tocar 3d

878
00:39:01,300 --> 00:38:57,470
modeling paper this software is called

879
00:39:03,790 --> 00:39:01,310
shape and it is it is publicly available

880
00:39:06,160 --> 00:39:03,800
it is freely available but I don't think

881
00:39:08,860 --> 00:39:06,170
he's still working on putting I think

882
00:39:10,780 --> 00:39:08,870
the 3d capabilities in so as Antonella

883
00:39:12,580 --> 00:39:10,790
was saying you have to have a special

884
00:39:15,370 --> 00:39:12,590
file format usually for these printers

885
00:39:17,290 --> 00:39:15,380
that's called an STL file and I think

886
00:39:20,500 --> 00:39:17,300
the current version of shape doesn't

887
00:39:22,870 --> 00:39:20,510
have he doesn't have the capability to

888
00:39:25,030 --> 00:39:22,880

output that file but from what I

889
00:39:26,980 --> 00:39:25,040
understand a new version that will be

890
00:39:28,360 --> 00:39:26,990
coming out will and one of the other

891
00:39:31,420 --> 00:39:28,370
things that we have that we've done

892
00:39:34,480 --> 00:39:31,430
especially for the further for the ADA

893
00:39:37,060 --> 00:39:34,490
car is in the meantime we've leave at

894
00:39:38,830 --> 00:39:37,070
least been trying to make the the STL

895
00:39:40,840 --> 00:39:38,840
files available to the public so if they

896
00:39:42,730 --> 00:39:40,850
want to print their own model on their

897
00:39:45,070 --> 00:39:42,740
own 3d printer or there are even

898
00:39:47,800 --> 00:39:45,080
companies now where you can give them a

899
00:39:50,170 --> 00:39:47,810
file and they will 3d print it for you

900
00:39:53,890 --> 00:39:50,180
if you can't afford or have your own 3d

901
00:39:56,650 --> 00:39:53,900
printer so yes so the goal is to try and

902
00:39:58,300 --> 00:39:56,660
make this as as available as we can to

903
00:40:00,940 --> 00:39:58,310
the public so that baking so that they

904
00:40:02,620 --> 00:40:00,950
can play with it themselves great ok

905
00:40:05,559 --> 00:40:02,630
afraid

906
00:40:07,749 --> 00:40:05,569
was going to you for the last question I

907
00:40:09,309 --> 00:40:07,759
was just going to say that that it's

908
00:40:12,279 --> 00:40:09,319
somewhat similar like with our

909
00:40:14,289 --> 00:40:12,289
visualization people here when we are

910
00:40:16,329 --> 00:40:14,299
working on a press release and we have

911
00:40:18,880 --> 00:40:16,339
one of our animators start to work with

912
00:40:21,150 --> 00:40:18,890
somebody the scientist has the data and

913
00:40:23,740 --> 00:40:21,160

then there has to be some translation

914
00:40:25,960 --> 00:40:23,750
before it goes into some program like

915
00:40:30,099 --> 00:40:25,970
Maya or some other visualization said

916
00:40:32,890 --> 00:40:30,109
that step still requires you know art is

917
00:40:35,410 --> 00:40:32,900
re and science and all that so that that

918
00:40:38,140 --> 00:40:35,420
stuff isn't quite you know just can't

919
00:40:39,849 --> 00:40:38,150
take and because you know that's why we

920
00:40:41,950 --> 00:40:39,859
do the science is because when you take

921
00:40:43,809 --> 00:40:41,960
an image you analyze it and you measure

922
00:40:45,730 --> 00:40:43,819
it and all that and then you take those

923
00:40:48,130 --> 00:40:45,740
measurements and you put them into

924
00:40:50,859 --> 00:40:48,140
another file format and if you late it

925
00:40:53,559 --> 00:40:50,869
and end up with a 3d visualization or 3d

926
00:40:54,910 --> 00:40:53,569
print so that's where the science is so

927
00:40:57,370 --> 00:40:54,920
there's a lot of work and getting the

928
00:40:59,049 --> 00:40:57,380
science right before you even even

929
00:41:01,059 --> 00:40:59,059
decide to translate it into something

930
00:41:03,789 --> 00:41:01,069
you can manipulate on a computer or an

931
00:41:05,710 --> 00:41:03,799
eternity yeah and and I I was

932
00:41:07,120 --> 00:41:05,720
particularly fascinated when Tom said

933
00:41:08,799 --> 00:41:07,130
that they you know they found features

934
00:41:09,819 --> 00:41:08,809
in natick are that they didn't see

935
00:41:11,740 --> 00:41:09,829
really I didn't even know they were

936
00:41:13,240 --> 00:41:11,750
there until they printed them out one of

937
00:41:15,309 --> 00:41:13,250
the thing that's why I asked is it real

938
00:41:17,289 --> 00:41:15,319

and I guess at that whole step of going

939
00:41:20,529 --> 00:41:17,299
from the data translation to the printer

940
00:41:22,779 --> 00:41:20,539
file could be a big source of error but

941
00:41:24,009 --> 00:41:22,789
it sounds like everybody's being you

942
00:41:26,980 --> 00:41:24,019
know they got a pretty good plan for

943
00:41:29,230 --> 00:41:26,990
doing that translation and I don't know

944
00:41:31,480 --> 00:41:29,240
I think this is amazing Frank can I just

945
00:41:33,460 --> 00:41:31,490
ask you real quick are the are the data

946
00:41:36,249 --> 00:41:33,470
are all printers more or less the same

947
00:41:38,349 --> 00:41:36,259
in terms of how they work for input like

948
00:41:40,410 --> 00:41:38,359
if I made a file for the MakerBot would

949
00:41:46,480 --> 00:41:40,420
it work on some other brand of printer

950
00:41:49,660 --> 00:41:46,490
in principle or are simply what goes to

951
00:41:52,539 --> 00:41:49,670
third is material called G code after it

952
00:41:56,970 --> 00:41:52,549
comes out of the slicing tool that

953
00:42:00,039 --> 00:41:56,980
repeat to be used by different printers

954
00:42:01,779 --> 00:42:00,049
it depends on but there are specific

955
00:42:04,089 --> 00:42:01,789
commands that might be specific to their

956
00:42:08,380 --> 00:42:04,099
to the further yes T upload the comp

957
00:42:12,480 --> 00:42:08,390
mentioned earlier about is universal and

958
00:42:15,410 --> 00:42:12,490
input as there is good so that is the

959
00:42:17,120 --> 00:42:15,420
21st century of a parallel printer then

960
00:42:22,490 --> 00:42:17,130
remember when you could get parallel and

961
00:42:25,250 --> 00:42:22,500
serial printer anyway I'm costs I will

962
00:42:31,940 --> 00:42:25,260
say that the printer I own is under five

963
00:42:34,700 --> 00:42:31,950

hundred dollars their costume oh okay

964
00:42:36,289 --> 00:42:34,710
great so who's got some stuff to show us

965
00:42:37,849 --> 00:42:36,299
I mean I we see some stuff from Carol

966
00:42:40,339 --> 00:42:37,859
Tom to you and you showed us some of the

967
00:42:41,690 --> 00:42:40,349
human cool i or at least one of them do

968
00:42:44,210 --> 00:42:41,700
you have any other things handy you

969
00:42:46,700 --> 00:42:44,220
could show us any other models um at the

970
00:42:50,329 --> 00:42:46,710
moment unfortunately I do not I just

971
00:42:53,690 --> 00:42:50,339
have so so just some smaller homunculus

972
00:42:55,970 --> 00:42:53,700
and these were these were giant word of

973
00:42:58,870 --> 00:42:55,980
authority thanks we go the thief these

974
00:43:01,190 --> 00:42:58,880
were done on on Frank's on Frank's no

975
00:43:04,250 --> 00:43:01,200
five-hundred-dollar printer and they

976
00:43:06,589 --> 00:43:04,260
actually are quite quite do it I'm

977
00:43:09,049 --> 00:43:06,599
actually really impressed with with the

978
00:43:10,400 --> 00:43:09,059
quality that you can get out of a

979
00:43:13,240 --> 00:43:10,410
five-hundred-dollar for interest I

980
00:43:16,549 --> 00:43:13,250
wanted those take to make roughly Frank

981
00:43:21,500 --> 00:43:16,559
I believe empower for the smaller ones

982
00:43:23,599 --> 00:43:21,510
in tomorrow's so we've been at this for

983
00:43:29,990 --> 00:43:23,609
an hour here's the progress on our maker

984
00:43:33,039 --> 00:43:30,000
by that you for 25 minutes hey it's big

985
00:43:35,750 --> 00:43:33,049
it's all it'll be going quite a while

986
00:43:36,890 --> 00:43:35,760
and once you want you get it out though

987
00:43:39,289 --> 00:43:36,900
Carol don't you have to do something

988
00:43:41,630 --> 00:43:39,299

else to it after it's done you have to

989
00:43:46,250 --> 00:43:41,640
cut stuff away or on these particular

990
00:43:48,020 --> 00:43:46,260
ones what what so that so the ones that

991
00:43:50,299 --> 00:43:48,030
we showed you which were the texture map

992
00:43:54,710 --> 00:43:50,309
and the elevation map which Antonella

993
00:43:58,490 --> 00:43:54,720
has those the elevation or the textures

994
00:44:01,760 --> 00:43:58,500
is on a on a platform so that you can

995
00:44:04,010 --> 00:44:01,770
handle it so we print a couple

996
00:44:06,799 --> 00:44:04,020
millimeters thick platform then the

997
00:44:12,589 --> 00:44:06,809
texture is on top of that in the case of

998
00:44:14,569 --> 00:44:12,599
the 3d objects the way it works and I if

999
00:44:17,059 --> 00:44:14,579
you look really carefully off to the

1000
00:44:19,130 --> 00:44:17,069
right of the thing that's being printed

1001
00:44:22,400 --> 00:44:19,140
you'll see that it's kind of this

1002
00:44:26,299 --> 00:44:22,410
purpley reddish material and then as you

1003
00:44:28,790 --> 00:44:26,309
move to the left there's a darkish kind

1004
00:44:32,480 --> 00:44:28,800
of looks like a little river that

1005
00:44:35,930 --> 00:44:32,490
is actually very thin a very thin

1006
00:44:38,360 --> 00:44:35,940
material so the the stuff on the far

1007
00:44:41,120 --> 00:44:38,370
right is a couple as a millimeter or two

1008
00:44:44,090 --> 00:44:41,130
thick and then the stuff that's that

1009
00:44:46,460 --> 00:44:44,100
little river which is around the contour

1010
00:44:50,930 --> 00:44:46,470
that you see being printed that little

1011
00:44:53,840 --> 00:44:50,940
darkest region is very thin it's like a

1012
00:44:56,960 --> 00:44:53,850
thread thick and so what happens when

1013
00:44:59,390 --> 00:44:56,970

this object is finished is that part

1014
00:45:02,240 --> 00:44:59,400
will be cracked off and then if you're

1015
00:45:05,360 --> 00:45:02,250
really you know a TD then what you'll do

1016
00:45:07,550 --> 00:45:05,370
is you'll polish the edges but in order

1017
00:45:10,700 --> 00:45:07,560
to make the 3d object we have to

1018
00:45:12,500 --> 00:45:10,710
stabilize it some somehow so most of the

1019
00:45:14,720 --> 00:45:12,510
models that I leave and pulled off the

1020
00:45:16,730 --> 00:45:14,730
web or that we've created we have to

1021
00:45:19,730 --> 00:45:16,740
create some kind of platform to support

1022
00:45:22,190 --> 00:45:19,740
the object especially if it's

1023
00:45:24,770 --> 00:45:22,200
complicated like there's this toy HST

1024
00:45:26,750 --> 00:45:24,780
model and a couple of the pieces have

1025
00:45:29,600 --> 00:45:26,760
additional supports that you have to

1026
00:45:31,550 --> 00:45:29,610
break off and polish because of the way

1027
00:45:34,550 --> 00:45:31,560
the printer works some of the other

1028
00:45:36,560 --> 00:45:34,560
technology printers don't require that

1029
00:45:38,540 --> 00:45:36,570
kind of support because it's like a gel

1030
00:45:40,490 --> 00:45:38,550
or a powder or something and it works in

1031
00:45:42,200 --> 00:45:40,500
a different way but these extrusion

1032
00:45:44,990 --> 00:45:42,210
printers that go back and forth and they

1033
00:45:47,270 --> 00:45:45,000
lay down material you can't kind of lay

1034
00:45:51,230 --> 00:45:47,280
down material in space so you need some

1035
00:45:53,570 --> 00:45:51,240
kind of a platform that will hold the

1036
00:45:57,140 --> 00:45:53,580
material so we're just breaking off the

1037
00:45:59,420 --> 00:45:57,150
outer edges of the galaxies to to make

1038
00:46:01,400 --> 00:45:59,430

them usable object so when we made the

1039
00:46:02,540 --> 00:46:01,410
Hubble model did you take it and be made

1040
00:46:05,420 --> 00:46:02,550
into pieces and then glued it together

1041
00:46:07,610 --> 00:46:05,430
or well I originally had downloaded the

1042
00:46:10,070 --> 00:46:07,620
kit which is a whole bunch a little

1043
00:46:12,560 --> 00:46:10,080
connected pieces and it doesn't work

1044
00:46:14,750 --> 00:46:12,570
very well I even scaled it up a couple

1045
00:46:17,330 --> 00:46:14,760
times i recently printed out the

1046
00:46:20,960 --> 00:46:17,340
individual which are is in the it is on

1047
00:46:22,880 --> 00:46:20,970
the MakerBot web page I did the

1048
00:46:24,920 --> 00:46:22,890
individual pieces and some of the pieces

1049
00:46:28,700 --> 00:46:24,930
I had to do a couple times like the

1050
00:46:31,040 --> 00:46:28,710
antenna the when I was doing it for

1051
00:46:32,990 --> 00:46:31,050
another because somebody asked me can we

1052
00:46:36,980 --> 00:46:33,000
print these and are they reasonable toys

1053
00:46:38,900 --> 00:46:36,990
and I it's difficult because sometimes

1054
00:46:41,180 --> 00:46:38,910
the thread gets just starts making

1055
00:46:41,750 --> 00:46:41,190
spaghetti because it's not adhering or

1056
00:46:44,540 --> 00:46:41,760
it's not

1057
00:46:47,480 --> 00:46:44,550
enough on the surface but the main body

1058
00:46:49,220 --> 00:46:47,490
of the telescope was fine yeah I know

1059
00:46:50,780 --> 00:46:49,230
one thing I when I was a kid I used to

1060
00:46:53,030 --> 00:46:50,790
love to make models and of course all

1061
00:46:55,400 --> 00:46:53,040
the models I made were rockets of Saturn

1062
00:46:57,320 --> 00:46:55,410
5 and Gemini and things like that but if

1063
00:46:58,520 --> 00:46:57,330

I but now don't have time to make any of

1064
00:47:00,740 --> 00:46:58,530
that stuff so if I had one of these I

1065
00:47:03,080 --> 00:47:00,750
just be a lazy man I'd be printing out

1066
00:47:05,570 --> 00:47:03,090
rockets and stuff on mine if I had one I

1067
00:47:06,980 --> 00:47:05,580
already know that's what i do if i could

1068
00:47:10,160 --> 00:47:06,990
i'd like to elaborate a little further

1069
00:47:12,800 --> 00:47:10,170
on what carol was saying sure um so that

1070
00:47:14,780 --> 00:47:12,810
one of the printer that we just have

1071
00:47:16,910 --> 00:47:14,790
here just got here at Goddard for our

1072
00:47:19,790 --> 00:47:16,920
projects in which is which is available

1073
00:47:22,490 --> 00:47:19,800
it's just a consumer-grade MakerBot is

1074
00:47:25,120 --> 00:47:22,500
one of the ones that Frank discuss what

1075
00:47:27,470 --> 00:47:25,130
has to two extruders so two nozzles and

1076
00:47:29,060 --> 00:47:27,480
one of the things you can do for really

1077
00:47:32,030 --> 00:47:29,070
complicated prints and we're doing now

1078
00:47:33,710 --> 00:47:32,040
is um instead of doing like what carol

1079
00:47:36,730 --> 00:47:33,720
does so if i'm correct it looks like

1080
00:47:40,010 --> 00:47:36,740
carol has a single nozzle on her printer

1081
00:47:43,190 --> 00:47:40,020
but they have what's called a hips

1082
00:47:44,510 --> 00:47:43,200
filament and what that is is it's a it's

1083
00:47:46,970 --> 00:47:44,520
a special type of plastic that is

1084
00:47:48,500 --> 00:47:46,980
dissolvable and so what you can do is

1085
00:47:50,030 --> 00:47:48,510
when you're creating these complicated

1086
00:47:52,610 --> 00:47:50,040
structures like Carol said you have to

1087
00:47:54,590 --> 00:47:52,620
have support for them you have to have

1088
00:47:57,440 --> 00:47:54,600

something for the plastic to attach to

1089
00:48:00,740 --> 00:47:57,450
and you can print so what I'm going to

1090
00:48:02,420 --> 00:48:00,750
do is it'll print this hips support and

1091
00:48:04,790 --> 00:48:02,430
then the plastic will adhere to it oh

1092
00:48:07,790 --> 00:48:04,800
it's nice about this is then you take

1093
00:48:09,410 --> 00:48:07,800
your model and you just dip it in a

1094
00:48:11,570 --> 00:48:09,420
substance called limonene which is

1095
00:48:14,060 --> 00:48:11,580
pretty much just a fancy word for like

1096
00:48:16,460 --> 00:48:14,070
such a coil of citric acid and it's

1097
00:48:19,520 --> 00:48:16,470
non-toxic and it's biodegradable and it

1098
00:48:21,470 --> 00:48:19,530
just dissolves that filament away and

1099
00:48:23,320 --> 00:48:21,480
you're left with your with your with

1100
00:48:28,370 --> 00:48:23,330
your model without having to worry about

1101
00:48:29,600 --> 00:48:28,380
necessarily breaking pieces off and it

1102
00:48:32,750 --> 00:48:29,610
seems to work it seems to work

1103
00:48:34,490 --> 00:48:32,760
reasonably well are those printers more

1104
00:48:38,210 --> 00:48:34,500
expensive or dude dude they're

1105
00:48:41,360 --> 00:48:38,220
comparable to so ours was on the order

1106
00:48:45,260 --> 00:48:41,370
of a couple thousand dollars oh okay all

1107
00:48:47,240 --> 00:48:45,270
right well um I have I I think I met

1108
00:48:49,940 --> 00:48:47,250
something happen to the QA app when I

1109
00:48:53,120 --> 00:48:49,950
started it today ah and I'm not seeing

1110
00:48:55,610 --> 00:48:53,130
any Q any Q&A questions but twitter has

1111
00:48:58,010 --> 00:48:55,620
got some stuff thank you guys for

1112
00:48:59,810 --> 00:48:58,020
printing using Hubble hang out Kim are

1113
00:49:04,160 --> 00:48:59,820

canada's on there she's been doing a lot

1114
00:49:05,780 --> 00:49:04,170
of great tweets uh 3d modeling and 3d

1115
00:49:08,240 --> 00:49:05,790
printing can't be two very different

1116
00:49:10,610 --> 00:49:08,250
beasts that's true i was when i made the

1117
00:49:14,120 --> 00:49:10,620
title of this hangout or of this event i

1118
00:49:16,760 --> 00:49:14,130
was I sort of took a little liberty with

1119
00:49:19,640 --> 00:49:16,770
the modeling aspect of it but I did like

1120
00:49:21,650 --> 00:49:19,650
it is in a sense a model but I agree

1121
00:49:26,450 --> 00:49:21,660
that it they're not quite the same thing

1122
00:49:28,310 --> 00:49:26,460
so thank you for that the Alessandra

1123
00:49:29,990 --> 00:49:28,320
rosada is also here and she says she

1124
00:49:32,360 --> 00:49:30,000
tweets so cool that scientists learned

1125
00:49:34,490 --> 00:49:32,370
that nebula had protrusions and trenches

1126
00:49:37,070 --> 00:49:34,500
using 3d tech and that was what tom was

1127
00:49:40,100 --> 00:49:37,080
talking about with the ADA card nebula

1128
00:49:43,940 --> 00:49:40,110
they didn't they didn't know before and

1129
00:49:45,800 --> 00:49:43,950
that is great kim also tweets textured

1130
00:49:49,160 --> 00:49:45,810
3d print outs have wide applicability

1131
00:49:52,070 --> 00:49:49,170
for accessibility and for education for

1132
00:49:54,980 --> 00:49:52,080
non-experts but also exploration for the

1133
00:49:57,080 --> 00:49:54,990
experts so that's a good segue into what

1134
00:49:59,060 --> 00:49:57,090
i would like to ask you guys next what

1135
00:50:00,820 --> 00:49:59,070
is the future what do you guys what are

1136
00:50:02,510 --> 00:50:00,830
you guys doing next carolina and

1137
00:50:06,740 --> 00:50:02,520
antonella what do you guys do what you

1138
00:50:11,900 --> 00:50:06,750

guys got on tap for this go for it ends

1139
00:50:14,720 --> 00:50:11,910
no go for it i think that you know the

1140
00:50:17,060 --> 00:50:14,730
process as we said is complicated and so

1141
00:50:19,430 --> 00:50:17,070
rather than trying to make the salsa

1142
00:50:22,880 --> 00:50:19,440
available we would like to produce as

1143
00:50:25,730 --> 00:50:22,890
many STL files as we can and make those

1144
00:50:28,490 --> 00:50:25,740
available the one of our big goal is to

1145
00:50:32,600 --> 00:50:28,500
select you know a number of very iconic

1146
00:50:34,940 --> 00:50:32,610
Hubble images and produce STL files for

1147
00:50:37,250 --> 00:50:34,950
them so that people in schools can

1148
00:50:40,700 --> 00:50:37,260
actually you know print at least a

1149
00:50:43,040 --> 00:50:40,710
texture map and elevation map and in

1150
00:50:47,330 --> 00:50:43,050
some cases where the modeling is easily

1151
00:50:50,810 --> 00:50:47,340
maybe a 3d object holding the head so I

1152
00:50:54,020 --> 00:50:50,820
think that that would be our way to make

1153
00:50:56,060 --> 00:50:54,030
the beautiful level images of accessible

1154
00:50:58,730 --> 00:50:56,070
to more people can't appreciate the

1155
00:51:00,530 --> 00:50:58,740
beauty of I agreed I would and

1156
00:51:02,600 --> 00:51:00,540
presumably these files once we get them

1157
00:51:03,980 --> 00:51:02,610
out we'll be on our website Hubble site

1158
00:51:06,830 --> 00:51:03,990
Dow to work so you'll be able to forget

1159
00:51:08,800 --> 00:51:06,840
them from there for free and be able to

1160
00:51:13,270 --> 00:51:08,810
print these things out all on your own

1161
00:51:15,310 --> 00:51:13,280
alright and so I and to to leverage on

1162
00:51:18,010 --> 00:51:15,320
for that I'm hoping to convince the

1163
00:51:19,930 --> 00:51:18,020

education and news group that that if we

1164
00:51:23,590 --> 00:51:19,940
do come up with a reasonable process

1165
00:51:25,300 --> 00:51:23,600
that when a scientist does do a press

1166
00:51:29,380 --> 00:51:25,310
release that maybe we can coach them

1167
00:51:32,290 --> 00:51:29,390
through an interface to make if

1168
00:51:34,360 --> 00:51:32,300
appropriate 3d print outs of their

1169
00:51:36,160 --> 00:51:34,370
object so that we can include the file

1170
00:51:38,620 --> 00:51:36,170
on the press release and also

1171
00:51:40,360 --> 00:51:38,630
incorporate those products into like if

1172
00:51:44,490 --> 00:51:40,370
you have a star formation module you

1173
00:51:48,040 --> 00:51:44,500
want to use 602 and it's other famous

1174
00:51:49,240 --> 00:51:48,050
clusters wenig NGC 3603 and stuff like

1175
00:51:51,280 --> 00:51:49,250
that so you can learn about star

1176
00:51:53,710 --> 00:51:51,290
formation you learn that galaxies and so

1177
00:51:56,500 --> 00:51:53,720
integrated into the educational products

1178
00:51:58,780 --> 00:51:56,510
ah Tom Snyder is commenting here's a

1179
00:52:01,240 --> 00:51:58,790
comment why isn't the show opening on G+

1180
00:52:02,920 --> 00:52:01,250
I had to go over to youtube to watch and

1181
00:52:05,020 --> 00:52:02,930
you know something I think something's

1182
00:52:06,940 --> 00:52:05,030
up with G+ today folks I'm sorry and I

1183
00:52:08,710 --> 00:52:06,950
don't because when I started it when I

1184
00:52:10,780 --> 00:52:08,720
started to hang out I also had to

1185
00:52:13,060 --> 00:52:10,790
restart the Q&A app for some bizarre

1186
00:52:14,710 --> 00:52:13,070
reason and it was already queued up so

1187
00:52:16,500 --> 00:52:14,720
maybe there's some technical technical

1188
00:52:19,870 --> 00:52:16,510

issues over at Google anyway thanks for

1189
00:52:22,600 --> 00:52:19,880
Scott's I agree Scott's not here driving

1190
00:52:23,800 --> 00:52:22,610
the internet for me so no it is a thank

1191
00:52:25,270 --> 00:52:23,810
you for going to YouTube Tom and

1192
00:52:27,340 --> 00:52:25,280
watching it instead I do appreciate and

1193
00:52:30,310 --> 00:52:27,350
I apologize for the technical issues

1194
00:52:32,560 --> 00:52:30,320
today nobody not a single one of you

1195
00:52:36,040 --> 00:52:32,570
have talked about planets or any of that

1196
00:52:37,750 --> 00:52:36,050
kind of stuff is there any way I would

1197
00:52:39,760 --> 00:52:37,760
like a printout of Jupiter so I could

1198
00:52:42,280 --> 00:52:39,770
you know maybe see the band or feel the

1199
00:52:44,530 --> 00:52:42,290
bands and the different is that possible

1200
00:52:47,080 --> 00:52:44,540
or is that too is it again spherical

1201
00:52:48,280 --> 00:52:47,090
things not possible with these that has

1202
00:52:50,940 --> 00:52:48,290
been done and there are models available

1203
00:52:53,950 --> 00:52:50,950
I know nASA has a site where several

1204
00:52:55,810 --> 00:52:53,960
asteroids that have been modeled that

1205
00:52:57,220 --> 00:52:55,820
had been imaged so we have these these

1206
00:52:59,950 --> 00:52:57,230
probes that will go and work it around

1207
00:53:02,740 --> 00:52:59,960
various assets and comets and get get

1208
00:53:05,590 --> 00:53:02,750
surface data on so there are 3d

1209
00:53:08,110 --> 00:53:05,600
principal asteroids and there is data

1210
00:53:10,660 --> 00:53:08,120
from the surface of the Moon and I know

1211
00:53:13,060 --> 00:53:10,670
that there's also data available for for

1212
00:53:16,360 --> 00:53:13,070
surface features on Mars so that that

1213
00:53:17,680 --> 00:53:16,370

type of thing is is possible oh good oh

1214
00:53:19,300 --> 00:53:17,690
that's right minds me you could also

1215
00:53:21,160 --> 00:53:19,310
have like you said features like the

1216
00:53:22,180 --> 00:53:21,170
Valles Marineris on Mars then well what

1217
00:53:27,010 --> 00:53:22,190
do you got there carol

1218
00:53:28,810 --> 00:53:27,020
best are no it's a globe oh wow no that

1219
00:53:32,770 --> 00:53:28,820
is really cool first I was a Death Star

1220
00:53:34,840 --> 00:53:32,780
oh wow no hold that would hold it still

1221
00:53:37,750 --> 00:53:34,850
hold us though what is it so that is a 0

1222
00:53:41,140 --> 00:53:37,760
us a miracle as possible this is again

1223
00:53:44,740 --> 00:53:41,150
on the MakerBot page ok yeah oh ok all

1224
00:53:47,050 --> 00:53:44,750
kinds of like the demo yeah look at and

1225
00:53:49,540 --> 00:53:47,060
I can show you our bracelets too but

1226
00:53:51,190 --> 00:53:49,550
anyway those guys know about bracelets

1227
00:53:54,400 --> 00:53:51,200
because it's one of the test things that

1228
00:53:56,260 --> 00:53:54,410
comes in the image it's a test module so

1229
00:53:57,790 --> 00:53:56,270
we love the bracelets we have bracelets

1230
00:53:58,930 --> 00:53:57,800
in all different colors yeah I remember

1231
00:54:00,460 --> 00:53:58,940
when you first got that printer of

1232
00:54:03,360 --> 00:54:00,470
everybody had one of course I didn't

1233
00:54:07,870 --> 00:54:03,370
forgot one but you know re all right ah

1234
00:54:10,840 --> 00:54:07,880
ok now look another QA on Kaylee Kaylee

1235
00:54:12,670 --> 00:54:10,850
s nice taxi I'm sorry if I pronounced

1236
00:54:14,560 --> 00:54:12,680
that wrong or what are you guys looking

1237
00:54:19,300 --> 00:54:14,570
forward to seeing printed on the

1238
00:54:21,310 --> 00:54:19,310

International Space Station anybody want

1239
00:54:24,130 --> 00:54:21,320
to try that I'd love to see a homunculus

1240
00:54:29,110 --> 00:54:24,140
printed insurrection you and your

1241
00:54:31,410 --> 00:54:29,120
homunculi yes by the way if anyone's

1242
00:54:33,820 --> 00:54:31,420
curious homunculus means little man

1243
00:54:35,200 --> 00:54:33,830
that's what if that's that's the

1244
00:54:36,760 --> 00:54:35,210
translation because when they went it

1245
00:54:39,070 --> 00:54:36,770
when you looked at it first through a

1246
00:54:40,690 --> 00:54:39,080
through my telescope we didn't have this

1247
00:54:42,370 --> 00:54:40,700
great office back then so it kind of

1248
00:54:44,560 --> 00:54:42,380
looked like the Pillsbury Doughboy oh

1249
00:54:46,870 --> 00:54:44,570
that's what it means I thought it meant

1250
00:54:51,550 --> 00:54:46,880
something really big like a boy anything

1251
00:54:53,260 --> 00:54:51,560
is humonculon but i guess not ok so but

1252
00:54:56,230 --> 00:54:53,270
but to back to the comment here though

1253
00:54:58,450 --> 00:54:56,240
we they are doing some 3d printing in

1254
00:55:02,650 --> 00:54:58,460
space on the International Space Station

1255
00:55:04,150 --> 00:55:02,660
the goal of which is to push the bounds

1256
00:55:05,080 --> 00:55:04,160
of what's possible I suppose on these I

1257
00:55:06,910 --> 00:55:05,090
don't know what kind of printers are

1258
00:55:08,650 --> 00:55:06,920
going to have or anything like that but

1259
00:55:10,240 --> 00:55:08,660
if I were going to print something out

1260
00:55:12,640 --> 00:55:10,250
on there i would want something that is

1261
00:55:15,250 --> 00:55:12,650
super delicate and doesn't require any

1262
00:55:16,900 --> 00:55:15,260
you know lots of little tendrils and

1263
00:55:18,670 --> 00:55:16,910

stuff like that and that maybe you

1264
00:55:22,270 --> 00:55:18,680
couldn't print here in space but

1265
00:55:24,130 --> 00:55:22,280
unfortunately burning cards but remember

1266
00:55:26,550 --> 00:55:24,140
we're having a hangout on that while i

1267
00:55:29,590 --> 00:55:26,560
was hoping you would you would plug that

1268
00:55:31,540 --> 00:55:29,600
we are having a hangout we are we are in

1269
00:55:33,670 --> 00:55:31,550
the future we have we have a hangout

1270
00:55:35,650 --> 00:55:33,680
plan with the maiden space guys so that

1271
00:55:38,140 --> 00:55:35,660
will be coming up in a

1272
00:55:40,990 --> 00:55:38,150
couple of weeks so it stay tuned for

1273
00:55:43,809 --> 00:55:41,000
that guys okay couple one more comment

1274
00:55:45,730 --> 00:55:43,819
on Twitter alessandra Rosati is also

1275
00:55:47,650 --> 00:55:45,740
tweeting really cool to know that the

1276
00:55:49,750 --> 00:55:47,660
Hubble telescope is working with people

1277
00:55:52,089 --> 00:55:49,760
who are visually impaired using 3d

1278
00:55:55,420 --> 00:55:52,099
technology and with that I am going to

1279
00:55:58,240 --> 00:55:55,430
say yes I agree that is it is really

1280
00:55:59,859 --> 00:55:58,250
cool and it is only the beginning is

1281
00:56:02,230 --> 00:55:59,869
everybody here in this panel has pointed

1282
00:56:05,230 --> 00:56:02,240
out I want to thank you all for joining

1283
00:56:09,039 --> 00:56:05,240
us thank you uh thanks to thanks to Tom

1284
00:56:11,740 --> 00:56:09,049
madura Frank Frank ready antonella nota

1285
00:56:13,510 --> 00:56:11,750
and carol christian i'm driving the

1286
00:56:15,549 --> 00:56:13,520
internet guys which is why you're seeing

1287
00:56:17,650 --> 00:56:15,559
all these click ease going by really

1288
00:56:21,640 --> 00:56:17,660

fast because I don't have I just click

1289
00:56:25,480 --> 00:56:21,650
on stuff I don't pay attention next week

1290
00:56:26,770 --> 00:56:25,490
is our hub will hangout will feature not

1291
00:56:28,870 --> 00:56:26,780
Hubble but the James Webb Space

1292
00:56:31,450 --> 00:56:28,880
Telescope we will be talking with

1293
00:56:33,789 --> 00:56:31,460
members of northrop grumman team and

1294
00:56:35,740 --> 00:56:33,799
nasa goddard to give an update on the

1295
00:56:37,150 --> 00:56:35,750
James Webb Space Telescope then the

1296
00:56:38,859 --> 00:56:37,160
deployment test that has recently

1297
00:56:41,319 --> 00:56:38,869
happened so we hope you guys will check

1298
00:56:44,589 --> 00:56:41,329
in with us there thank you all for

1299
00:56:46,329 --> 00:56:44,599
commenting and Lee I'm sorry about the

1300
00:56:48,069 --> 00:56:46,339
technical difficulties on google+ but I

1301
00:56:50,829 --> 00:56:48,079
thank you for your patience and as