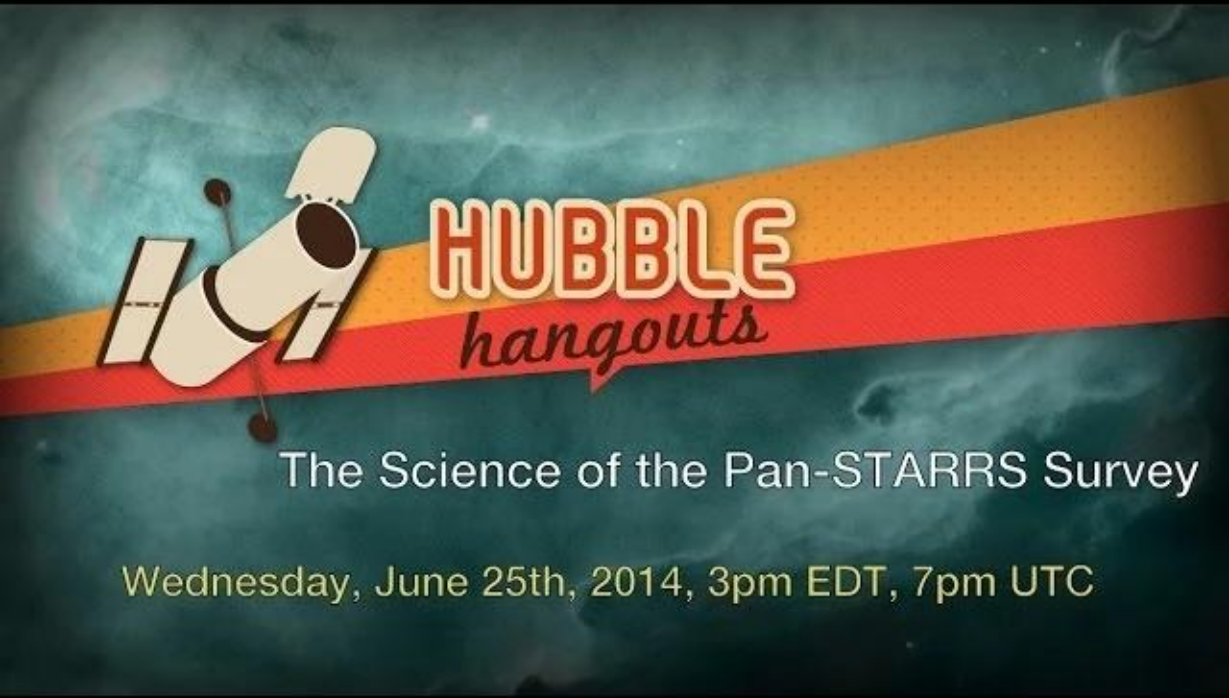
HUBBLE
hangouts
The Science of the Pan-STARRS Survey
Wednesday, June 25th, 2014, 3pm EDT, 7pm UTC

1
00:00:03,669 --> 00:00:01,510
hello everybody and welcome to our

2
00:00:05,670 --> 00:00:03,679
latest hubble hangout this is a place

3
00:00:07,829 --> 00:00:05,680
where you can come each week and learn

4
00:00:09,910 --> 00:00:07,839
about the latest science and discoveries

5
00:00:11,589 --> 00:00:09,920
of the hubble space telescope my name is

6
00:00:12,950 --> 00:00:11,599
tony darnell i work at space telescope

7
00:00:14,870 --> 00:00:12,960
science institute and today we've got a

8
00:00:16,150 --> 00:00:14,880
really great hangout plan for you i i'm

9
00:00:17,590 --> 00:00:16,160
very excited about this particular one

10
00:00:18,870 --> 00:00:17,600
because there's people on it that i

11
00:00:20,630 --> 00:00:18,880
haven't seen in a long time and i'm

12
00:00:22,390 --> 00:00:20,640
looking forward to catching up we're

13
00:00:24,710 --> 00:00:22,400

going to be discussing ground-based

14
00:00:26,550 --> 00:00:24,720
surveys today in particular the panstar

15
00:00:28,390 --> 00:00:26,560
survey because we're having a workshop

16
00:00:30,630 --> 00:00:28,400
here at the institute all week long on

17
00:00:32,310 --> 00:00:30,640
on the science of this particular uh

18
00:00:34,870 --> 00:00:32,320
survey so we'll talk about what the

19
00:00:36,790 --> 00:00:34,880
survey is what it's up to and as a bonus

20
00:00:39,110 --> 00:00:36,800
we're also going to talk about a future

21
00:00:41,430 --> 00:00:39,120
ground-based uh survey

22
00:00:42,790 --> 00:00:41,440
that's going to be even larger and out

23
00:00:44,790 --> 00:00:42,800
in the uh

24
00:00:47,990 --> 00:00:44,800
is being built right now uh the large

25
00:00:49,510 --> 00:00:48,000
synoptic sky survey or lsst so before i

26
00:00:52,470 --> 00:00:49,520
get to my introductions let me just say

27
00:00:55,110 --> 00:00:52,480
that we are hoping you will comment and

28
00:00:57,350 --> 00:00:55,120
uh tweet at us uh let us know any

29
00:00:59,270 --> 00:00:57,360
questions or comments while we're here

30
00:01:01,430 --> 00:00:59,280
you can i'm looking at the google plus

31
00:01:04,549 --> 00:01:01,440
hangout page you can also tweet using

32
00:01:06,390 --> 00:01:04,559
the hubble hangout and you can also do

33
00:01:09,030 --> 00:01:06,400
the uh are using the hubble hangout

34
00:01:11,910 --> 00:01:09,040
hashtag too many h's in that

35
00:01:13,429 --> 00:01:11,920
and you can also use the q a app that

36
00:01:14,870 --> 00:01:13,439
the hangout is being broadcast from

37
00:01:16,230 --> 00:01:14,880
we're monitoring all of that and we'll

38
00:01:19,190 --> 00:01:16,240

take some time out toward the end here

39
00:01:21,749 --> 00:01:19,200
and take some comments and questions so

40
00:01:23,590 --> 00:01:21,759
let's get started pan stars

41
00:01:25,910 --> 00:01:23,600
is a

42
00:01:28,469 --> 00:01:25,920
panoramic survey telescope and rapid

43
00:01:30,230 --> 00:01:28,479
response system every time i say that i

44
00:01:32,310 --> 00:01:30,240
feel like i'm talking about some kind of

45
00:01:34,710 --> 00:01:32,320
anti-terrorist organization or a first

46
00:01:36,469 --> 00:01:34,720
response team or something like that but

47
00:01:38,149 --> 00:01:36,479
that's where the money came

48
00:01:40,310 --> 00:01:38,159
but here to discuss some of these things

49
00:01:42,310 --> 00:01:40,320
with me as always is dr carol christian

50
00:01:44,310 --> 00:01:42,320
she is the hubble space telescope

51
00:01:45,749 --> 00:01:44,320
outreach astronomer hi carol thanks for

52
00:01:47,749 --> 00:01:45,759
coming along she's going to help me with

53
00:01:48,710 --> 00:01:47,759
this discussion hopefully wrangle these

54
00:01:51,990 --> 00:01:48,720
guys

55
00:01:54,630 --> 00:01:52,000
because with me are and i'll go from my

56
00:01:56,789 --> 00:01:54,640
left to right as i see you on the screen

57
00:01:57,749 --> 00:01:56,799
dr armand rest he is an astronomer here

58
00:01:59,429 --> 00:01:57,759
at the

59
00:02:00,950 --> 00:01:59,439
space telescope science institute and i

60
00:02:05,350 --> 00:02:00,960
guess you're pretty heavily involved in

61
00:02:07,190 --> 00:02:05,360
pan star so you're uh so i'm told um i'm

62
00:02:08,469 --> 00:02:07,200
i'm excited to finally have you in one

63
00:02:10,070 --> 00:02:08,479

of these hangouts i've been trying to do

64
00:02:11,270 --> 00:02:10,080
this for a while because i first heard

65
00:02:13,430 --> 00:02:11,280
about you

66
00:02:15,750 --> 00:02:13,440
in my dark energy survey days when i was

67
00:02:16,949 --> 00:02:15,760
working in illinois and i learned about

68
00:02:18,790 --> 00:02:16,959
that you were also at south pole

69
00:02:20,229 --> 00:02:18,800
telescope and doing a lot of great work

70
00:02:23,110 --> 00:02:20,239
in cosmology and black holes and all

71
00:02:26,470 --> 00:02:23,120
kinds of stuff so that is awesome

72
00:02:27,910 --> 00:02:26,480
and uh also with me is eddie and

73
00:02:29,430 --> 00:02:27,920
i forgot to write down your last name

74
00:02:31,030 --> 00:02:29,440
can you speak your name for me uh yeah

75
00:02:32,470 --> 00:02:31,040
i'm eddie schlafly i'm a post doc

76
00:02:34,710 --> 00:02:32,480
working at the max planck institute for

77
00:02:36,390 --> 00:02:34,720
astronomy in germany thank you i was

78
00:02:38,630 --> 00:02:36,400
remiss and not writing that down and i

79
00:02:41,190 --> 00:02:38,640
also have with me dr robert lupton from

80
00:02:43,750 --> 00:02:41,200
princeton he is i haven't seen him since

81
00:02:46,229 --> 00:02:43,760
my dark energy survey days either and

82
00:02:47,589 --> 00:02:46,239
i'm very excited to talk to him again

83
00:02:49,670 --> 00:02:47,599
and get caught up with some of the

84
00:02:53,110 --> 00:02:49,680
latest news he gave talk yesterday on

85
00:02:55,430 --> 00:02:53,120
the lsst so uh welcome guys and let's

86
00:02:57,030 --> 00:02:55,440
get started so armin

87
00:02:59,190 --> 00:02:57,040
panstarrs

88
00:03:00,790 --> 00:02:59,200

this is a hubble hangout

89
00:03:05,110 --> 00:03:00,800
what are we doing talking about a ground

90
00:03:07,750 --> 00:03:05,120
survey in a hst hangout well uh you know

91
00:03:09,589 --> 00:03:07,760
hst has a very small area that it

92
00:03:11,110 --> 00:03:09,599
observes on the sky it only observes a

93
00:03:12,309 --> 00:03:11,120
very small area

94
00:03:14,869 --> 00:03:12,319
and

95
00:03:16,790 --> 00:03:14,879
so if you want to follow up or if you

96
00:03:19,270 --> 00:03:16,800
want to observe interesting objects they

97
00:03:21,509 --> 00:03:19,280
are normally very rare and in order to

98
00:03:23,110 --> 00:03:21,519
find them you have to cover and observe

99
00:03:26,229 --> 00:03:23,120
a huge area

100
00:03:27,509 --> 00:03:26,239
of the sky so with hst we cannot do that

101
00:03:28,790 --> 00:03:27,519
and that's the reason

102
00:03:32,710 --> 00:03:28,800
let me just interrupt you real quick i

103
00:03:34,229 --> 00:03:32,720
have up now on my screen uh a graphic

104
00:03:35,910 --> 00:03:34,239
that's going to illustrate what armin is

105
00:03:38,949 --> 00:03:35,920
talking about we have the pan stars

106
00:03:40,789 --> 00:03:38,959
field of view and uh go ahead arm and

107
00:03:42,309 --> 00:03:40,799
you can continue i just wanted to let

108
00:03:46,470 --> 00:03:42,319
people know i had that up

109
00:03:49,190 --> 00:03:46,480
so if you click on the pan stars uh

110
00:03:52,229 --> 00:03:49,200
here we are so this is a field of view

111
00:03:55,110 --> 00:03:52,239
of panzers this is the area that panzers

112
00:03:56,949 --> 00:03:55,120
can observe this one single image

113
00:03:58,309 --> 00:03:56,959

and if you now click on the hubble space

114
00:03:59,190 --> 00:03:58,319
telescope

115
00:04:01,190 --> 00:03:59,200
one

116
00:04:02,309 --> 00:04:01,200
this is hubble space telescope i don't

117
00:04:04,710 --> 00:04:02,319
know if you guys can see it but there's

118
00:04:07,429 --> 00:04:04,720
a little tiny yellow square

119
00:04:09,110 --> 00:04:07,439
right in the center of this yep

120
00:04:11,350 --> 00:04:09,120
yeah so that's what hubble sees it's

121
00:04:13,190 --> 00:04:11,360
like looking at the universe through a

122
00:04:16,870 --> 00:04:13,200
not even a straw one of those cocktail

123
00:04:19,030 --> 00:04:16,880
straws it's really really narrow

124
00:04:20,949 --> 00:04:19,040
and also by comparison there's some

125
00:04:22,870 --> 00:04:20,959
other telescopes here this is the this

126
00:04:25,030 --> 00:04:22,880
is on the subaru uh this is a i'm told

127
00:04:27,189 --> 00:04:25,040
by robert an older camera the sub the

128
00:04:29,110 --> 00:04:27,199
super prime cam only looks at a half a

129
00:04:31,830 --> 00:04:29,120
degree in this image which as you can

130
00:04:33,670 --> 00:04:31,840
see is equal to roughly the full moon

131
00:04:35,510 --> 00:04:33,680
but robert how big is the new one it's

132
00:04:39,270 --> 00:04:35,520
1.8 square degrees

133
00:04:41,189 --> 00:04:39,280
1.8 about three times three times larger

134
00:04:43,350 --> 00:04:41,199
and finally the palomar sky survey and

135
00:04:45,990 --> 00:04:43,360
this particular thing is the entire uh

136
00:04:47,670 --> 00:04:46,000
square uh very very wild feet wide field

137
00:04:49,270 --> 00:04:47,680
so pan stars can see a pretty good

138
00:04:51,189 --> 00:04:49,280

section of sky what's that good for

139
00:04:53,110 --> 00:04:51,199
armin what's the what's that useful for

140
00:04:55,510 --> 00:04:53,120
well you can cover a huge amount of the

141
00:04:58,950 --> 00:04:55,520
sky and so you can look for rare objects

142
00:05:01,189 --> 00:04:58,960
and for clusters for supernovae

143
00:05:02,390 --> 00:05:01,199
for asteroids for all different kinds of

144
00:05:04,469 --> 00:05:02,400
things and

145
00:05:06,390 --> 00:05:04,479
one of the big advantages of panzers is

146
00:05:08,230 --> 00:05:06,400
it not only has

147
00:05:10,870 --> 00:05:08,240
this very big field of view this big

148
00:05:13,670 --> 00:05:10,880
area it also has it's a relatively big

149
00:05:16,790 --> 00:05:13,680
telescope for for that field of view and

150
00:05:19,909 --> 00:05:16,800
so not only can we cover a very big area

151
00:05:22,310 --> 00:05:19,919
30 000 square degrees of the sky but we

152
00:05:25,189 --> 00:05:22,320
can also go pretty deep deeper than any

153
00:05:27,270 --> 00:05:25,199
other survey of that scale

154
00:05:29,670 --> 00:05:27,280
and that means you can really push into

155
00:05:32,550 --> 00:05:29,680
new areas of science by covering these

156
00:05:34,550 --> 00:05:32,560
big areas to an unprecedented depth so

157
00:05:50,550 --> 00:05:34,560
one very rare thing would be the moon in

158
00:05:54,629 --> 00:05:51,590
yeah that was a little bit of a

159
00:05:57,189 --> 00:05:54,639
photoshop uh so i i just wanted to jump

160
00:05:59,350 --> 00:05:57,199
in here and say that that

161
00:06:00,710 --> 00:05:59,360
when we have big surveys like this and

162
00:06:02,469 --> 00:06:00,720
people work hard on finding all

163
00:06:05,110 --> 00:06:02,479

different kinds of objects

164
00:06:07,749 --> 00:06:05,120
um it's very helpful because there are

165
00:06:11,029 --> 00:06:07,759
big catalogs that are built and also the

166
00:06:14,150 --> 00:06:11,039
data is archived so the entire community

167
00:06:15,510 --> 00:06:14,160
as well as the public can can use that

168
00:06:17,990 --> 00:06:15,520
archival data and that's what we're

169
00:06:20,390 --> 00:06:18,000
working on here we're going to help host

170
00:06:22,629 --> 00:06:20,400
the panstarrs data and then once the

171
00:06:25,029 --> 00:06:22,639
science begins scientists then go out

172
00:06:27,270 --> 00:06:25,039
and they use different observatories to

173
00:06:29,670 --> 00:06:27,280
then investigate the particular objects

174
00:06:32,230 --> 00:06:29,680
they're interested in and very often

175
00:06:35,110 --> 00:06:32,240
they will use ground-based observatories

176
00:06:38,230 --> 00:06:35,120
as well as the space observatories

177
00:06:40,469 --> 00:06:38,240
hubble spitzer chandra etc because

178
00:06:44,070 --> 00:06:40,479
they're looking at a specific kind of

179
00:06:46,790 --> 00:06:44,080
object like a galaxy title tales who

180
00:06:48,950 --> 00:06:46,800
knows what and so they need all of those

181
00:06:51,189 --> 00:06:48,960
kinds of observations to understand that

182
00:06:53,350 --> 00:06:51,199
astrophysical phenomenon yeah so there's

183
00:06:54,950 --> 00:06:53,360
the relevance there that that that's

184
00:06:56,710 --> 00:06:54,960
that's nicely summed up because in

185
00:06:59,990 --> 00:06:56,720
addition to operating the hubble space

186
00:07:01,749 --> 00:07:00,000
telescope the the institute also has the

187
00:07:03,189 --> 00:07:01,759
mikulski archive for space telescopes

188
00:07:04,790 --> 00:07:03,199

which as carol said has a lot of you

189
00:07:06,790 --> 00:07:04,800
know it has a lot of different data sets

190
00:07:08,150 --> 00:07:06,800
in it for example all of the kepler data

191
00:07:10,469 --> 00:07:08,160
are stored there and we're going to be

192
00:07:12,550 --> 00:07:10,479
doing the pan source i guess we're not

193
00:07:13,749 --> 00:07:12,560
doing it yet that's still at hawaii is

194
00:07:15,670 --> 00:07:13,759
that correct

195
00:07:17,830 --> 00:07:15,680
yeah so data is currently still at

196
00:07:20,150 --> 00:07:17,840
hawaii uh we're still working on getting

197
00:07:21,430 --> 00:07:20,160
everything into a database getting the

198
00:07:24,710 --> 00:07:21,440
data ready

199
00:07:27,270 --> 00:07:24,720
making sure that the data is correct and

200
00:07:29,110 --> 00:07:27,280
uh so dates that we will make the data

201
00:07:33,110 --> 00:07:29,120
public is

202
00:07:34,309 --> 00:07:33,120
april of next year 2015. so in one year

203
00:07:37,189 --> 00:07:34,319
okay so

204
00:07:40,710 --> 00:07:37,199
as i said it was it was started by the

205
00:07:42,309 --> 00:07:40,720
university of hawaii and uh it was i

206
00:07:43,670 --> 00:07:42,319
guess they started doing all of this

207
00:07:48,390 --> 00:07:43,680
back in

208
00:07:53,749 --> 00:07:50,870
so first observation we had in actually

209
00:07:56,790 --> 00:07:53,759
in the summer of 2009 we were operating

210
00:07:58,710 --> 00:07:56,800
it for about i think it was two months

211
00:08:01,430 --> 00:07:58,720
and then we we shut it down for a while

212
00:08:04,230 --> 00:08:01,440
we worked on uh the telescope

213
00:08:07,270 --> 00:08:04,240

and uh then we really started to to do

214
00:08:08,710 --> 00:08:07,280
the real survey uh in spring of 2010.

215
00:08:10,070 --> 00:08:08,720
yes oh okay

216
00:08:11,270 --> 00:08:10,080
okay and it's like i said it was

217
00:08:14,550 --> 00:08:11,280
developed at the university of hawaii

218
00:08:17,350 --> 00:08:14,560
it's got a 1.8 mirror or 1.8 meter

219
00:08:19,589 --> 00:08:17,360
mirror um which is pretty amazing i mean

220
00:08:20,469 --> 00:08:19,599
here let me uh let me just show you uh a

221
00:08:21,990 --> 00:08:20,479
quick

222
00:08:24,390 --> 00:08:22,000
picture that i have

223
00:08:26,950 --> 00:08:24,400
of this

224
00:08:29,589 --> 00:08:26,960
of the of the observatory itself

225
00:08:32,070 --> 00:08:29,599
so here's here's what it looks like

226
00:08:33,430 --> 00:08:32,080
and i've got it up now and

227
00:08:34,870 --> 00:08:33,440
uh that's a pretty nice that's a

228
00:08:37,350 --> 00:08:34,880
beautiful place up there i've been up

229
00:08:41,110 --> 00:08:37,360
there a couple of times and uh

230
00:08:42,550 --> 00:08:41,120
it's uh is is is haleakala dedicated to

231
00:08:43,430 --> 00:08:42,560
pan stars right now or do they do other

232
00:08:46,949 --> 00:08:43,440
things

233
00:08:48,949 --> 00:08:46,959
uh panzers is definitely one of the main

234
00:08:49,670 --> 00:08:48,959
things right well asts is just going

235
00:08:53,670 --> 00:08:49,680
there

236
00:08:55,110 --> 00:08:53,680
advanced technology solar telescope

237
00:08:57,030 --> 00:08:55,120
that's right that's right that is being

238
00:08:58,230 --> 00:08:57,040

built there um

239
00:09:00,790 --> 00:08:58,240
when is that well that's a different

240
00:09:02,230 --> 00:09:00,800
topic so um

241
00:09:04,389 --> 00:09:02,240
you got me you got me distracted with

242
00:09:06,230 --> 00:09:04,399
shiny objects now

243
00:09:07,590 --> 00:09:06,240
so i was reading the website and

244
00:09:09,750 --> 00:09:07,600
following along on the talks and

245
00:09:13,350 --> 00:09:09,760
everything and it turns out that pan

246
00:09:16,630 --> 00:09:13,360
stars has the world's largest digital

247
00:09:19,750 --> 00:09:16,640
camera i think you're boasting 1.4

248
00:09:23,190 --> 00:09:19,760
billion pixels or 1400 megapixels if you

249
00:09:25,110 --> 00:09:23,200
want to go with the uh with the usual

250
00:09:25,910 --> 00:09:25,120
unit that digital cameras are measured

251
00:09:29,430 --> 00:09:25,920
by

252
00:09:31,509 --> 00:09:29,440
uh is it really the largest one

253
00:09:33,750 --> 00:09:31,519
uh i think it is actually the largest

254
00:09:35,509 --> 00:09:33,760
one right now i mean it's 1.4 gigapixel

255
00:09:37,430 --> 00:09:35,519
actually not megapixels it's the largest

256
00:09:39,190 --> 00:09:37,440
unclassified one

257
00:09:42,150 --> 00:09:39,200
yeah that's the same i said one point

258
00:09:44,949 --> 00:09:42,160
that's a 100 megapixels oh okay yeah

259
00:09:47,910 --> 00:09:44,959
yeah so 1.4 gigapixels that's correct

260
00:09:49,030 --> 00:09:47,920
1.4 billion pixels and we had a

261
00:09:58,070 --> 00:09:49,040
uh

262
00:10:02,790 --> 00:09:58,080
the focal plane or the ccd array can you

263
00:10:06,870 --> 00:10:04,470

oh yeah there it is

264
00:10:09,030 --> 00:10:06,880
back one more one back

265
00:10:10,949 --> 00:10:09,040
there it is so here's a slide of a guy

266
00:10:12,630 --> 00:10:10,959
holding

267
00:10:14,230 --> 00:10:12,640
it's actually john taundry he actually

268
00:10:16,310 --> 00:10:14,240
builds this camera

269
00:10:18,150 --> 00:10:16,320
so he's not gonna hold it yes he's no

270
00:10:20,230 --> 00:10:18,160
one else how much money is in his hands

271
00:10:21,670 --> 00:10:20,240
right there i wonder if he i oh i don't

272
00:10:24,470 --> 00:10:21,680
know but uh you don't want to drop it

273
00:10:26,790 --> 00:10:24,480
that's for sure that would be a disaster

274
00:10:29,350 --> 00:10:26,800
you could replace the chips if you did

275
00:10:32,470 --> 00:10:30,790
you're not gonna see the

276
00:10:34,630 --> 00:10:32,480
the uh the webcam version of this

277
00:10:37,190 --> 00:10:34,640
anytime soon that's pretty big so

278
00:10:38,389 --> 00:10:37,200
um that's what 1.4 billion pixels looks

279
00:10:39,829 --> 00:10:38,399
like folks and right now it's the

280
00:10:41,750 --> 00:10:39,839
biggest camera

281
00:10:44,230 --> 00:10:41,760
in existence dcam which was another

282
00:10:45,430 --> 00:10:44,240
large one is uh 500 megapixels i believe

283
00:10:47,269 --> 00:10:45,440
is that right robert

284
00:10:49,430 --> 00:10:47,279
i don't remember hyper supreme cam is

285
00:10:51,030 --> 00:10:49,440
800 megapixels oh okay so that one's

286
00:10:53,269 --> 00:10:51,040
even better okay so

287
00:10:55,590 --> 00:10:53,279
so uh that was the one that's brand new

288
00:10:56,870 --> 00:10:55,600

on the subaru telescope as well so okay

289
00:10:59,670 --> 00:10:56,880
so what are we doing with this stuff so

290
00:11:02,870 --> 00:10:59,680
we've got cool cameras we've got um

291
00:11:04,710 --> 00:11:02,880
we've got you know wide fields of view

292
00:11:07,110 --> 00:11:04,720
we're looking at the sky how often does

293
00:11:10,550 --> 00:11:07,120
this thing observe armin uh it it

294
00:11:12,550 --> 00:11:10,560
observes every day that is good enough

295
00:11:16,710 --> 00:11:12,560
and uh nights as well

296
00:11:16,720 --> 00:11:19,590
that is true

297
00:11:22,310 --> 00:11:20,710
you know

298
00:11:23,990 --> 00:11:22,320
we were doing the email exchanges back

299
00:11:26,310 --> 00:11:24,000
and forth for this hangout robert's

300
00:11:38,550 --> 00:11:26,320
email showed up as robert lupton the

301
00:11:42,550 --> 00:11:39,990
this is what you can say when you have a

302
00:11:44,550 --> 00:11:42,560
non-existing telescope you know nothing

303
00:11:46,550 --> 00:11:44,560
up in the bad was eaten by a black hole

304
00:11:50,069 --> 00:11:46,560
it was hawking radiation only the goods

305
00:11:51,110 --> 00:11:50,079
survived and you see it today

306
00:11:54,230 --> 00:11:51,120
anyway

307
00:11:55,750 --> 00:11:54,240
apologies hangout observers these guys

308
00:11:57,750 --> 00:11:55,760
have been sitting in a meeting for two

309
00:12:01,350 --> 00:11:57,760
and a half days

310
00:12:03,350 --> 00:12:01,360
only talking about tan stars

311
00:12:05,269 --> 00:12:03,360
been talking about the football as well

312
00:12:06,710 --> 00:12:05,279
uh football as well

313
00:12:07,430 --> 00:12:06,720

tomorrow's a big day tomorrow's a big

314
00:12:08,790 --> 00:12:07,440
day

315
00:12:10,550 --> 00:12:08,800
yeah

316
00:12:11,509 --> 00:12:10,560
we digress big

317
00:12:14,790 --> 00:12:11,519
big

318
00:12:16,710 --> 00:12:14,800
yes let's get to the science of pan star

319
00:12:19,190 --> 00:12:16,720
so this thing's wide field of view three

320
00:12:22,870 --> 00:12:19,200
degrees and it and it can it's got a

321
00:12:26,470 --> 00:12:22,880
huge camera can see down to 24th

322
00:12:28,230 --> 00:12:26,480
magnitude very very faint things so

323
00:12:29,430 --> 00:12:28,240
what's that good for uh eddie let's get

324
00:12:31,430 --> 00:12:29,440
you in on this let's talk a little bit

325
00:12:34,230 --> 00:12:31,440
about some of the science that's being

326
00:12:36,069 --> 00:12:34,240
done with pan stars uh well so there so

327
00:12:38,389 --> 00:12:36,079
the pan pan stars as we've discussed is

328
00:12:40,230 --> 00:12:38,399
just a survey telescope that observes

329
00:12:41,430 --> 00:12:40,240
the entire sky basically three quarters

330
00:12:43,030 --> 00:12:41,440
of the sky

331
00:12:44,870 --> 00:12:43,040
four times each year so they're actually

332
00:12:46,949 --> 00:12:44,880
a huge range of projects that are

333
00:12:48,790 --> 00:12:46,959
underway in pan stars

334
00:12:51,030 --> 00:12:48,800
they've divided it up into like 12

335
00:12:52,949 --> 00:12:51,040
nominal projects ranging from everything

336
00:12:55,190 --> 00:12:52,959
to the inner solar system trying to find

337
00:12:57,990 --> 00:12:55,200
asteroids that might hit the earth

338
00:13:00,069 --> 00:12:58,000

to the very most distant things and sort

339
00:13:02,710 --> 00:13:00,079
of the observable universe the large

340
00:13:04,389 --> 00:13:02,720
scale structure the

341
00:13:06,470 --> 00:13:04,399
imprint of the cosmic microwave

342
00:13:08,629 --> 00:13:06,480
background on the

343
00:13:09,910 --> 00:13:08,639
structure where where we find galaxies

344
00:13:11,590 --> 00:13:09,920
in the universe today so there's a

345
00:13:13,350 --> 00:13:11,600
tremendous range of projects actually

346
00:13:16,310 --> 00:13:13,360
that are being worked on

347
00:13:18,710 --> 00:13:16,320
in the pan source project

348
00:13:20,550 --> 00:13:18,720
as for highlights i can i can talk about

349
00:13:22,230 --> 00:13:20,560
my own personal research which is you

350
00:13:24,389 --> 00:13:22,240
know the tiniest drop in the bucket of

351
00:13:26,150 --> 00:13:24,399
what pan starts does well elena has a

352
00:13:28,069 --> 00:13:26,160
picture up here what are we what are we

353
00:13:30,310 --> 00:13:28,079
looking at there

354
00:13:31,910 --> 00:13:30,320
right so so this is this is a project

355
00:13:34,470 --> 00:13:31,920
that i've been doing uh with

356
00:13:36,310 --> 00:13:34,480
collaborators at harvard and in germany

357
00:13:38,710 --> 00:13:36,320
uh where we're trying to

358
00:13:40,710 --> 00:13:38,720
map uh the structure of the galaxy in

359
00:13:42,550 --> 00:13:40,720
three dimensions and so this in

360
00:13:44,870 --> 00:13:42,560
particular here is a map of the dust in

361
00:13:48,470 --> 00:13:44,880
the galaxy and so if i can tell a little

362
00:13:51,190 --> 00:13:48,480
story to explain like what dust is so uh

363
00:13:52,870 --> 00:13:51,200

i like to say so the our galaxy is a

364
00:13:55,509 --> 00:13:52,880
giant pile of stars and each one of

365
00:13:57,590 --> 00:13:55,519
these stars is in some sense a fire a

366
00:13:59,990 --> 00:13:57,600
nuclear fire that's burning hydrogen and

367
00:14:02,470 --> 00:14:00,000
helium into heavier elements and when it

368
00:14:04,710 --> 00:14:02,480
when these stars burn hydrogen helium

369
00:14:06,629 --> 00:14:04,720
heavier elements they make dust and so

370
00:14:08,389 --> 00:14:06,639
each each star is some kind of little

371
00:14:10,870 --> 00:14:08,399
fire that's giving off the smoke and the

372
00:14:13,750 --> 00:14:10,880
smoke is this dust that that's filling

373
00:14:16,150 --> 00:14:13,760
our galaxy up and so this map that we're

374
00:14:19,509 --> 00:14:16,160
showing here is is a sort of map of the

375
00:14:21,910 --> 00:14:19,519
galaxy uh which is really a sphere but

376
00:14:24,710 --> 00:14:21,920
it's been unfolded here in this image

377
00:14:27,269 --> 00:14:24,720
and each pixel on this map is trying to

378
00:14:28,629 --> 00:14:27,279
show how much dust how much of the smoke

379
00:14:30,470 --> 00:14:28,639
produced by the stars is in each

380
00:14:33,590 --> 00:14:30,480
direction on the sky

381
00:14:35,269 --> 00:14:33,600
uh and until re so these maps these maps

382
00:14:38,150 --> 00:14:35,279
are crucial every almost everyone in

383
00:14:40,230 --> 00:14:38,160
astronomy cares about dust because

384
00:14:41,829 --> 00:14:40,240
uh when when you look at any star in the

385
00:14:44,629 --> 00:14:41,839
sky even even when you look at the sun

386
00:14:46,710 --> 00:14:44,639
from the earth uh the color of the sun

387
00:14:48,790 --> 00:14:46,720
depends on how much dust there is

388
00:14:50,550 --> 00:14:48,800

between you and the sun which is why

389
00:14:52,150 --> 00:14:50,560
when you look at the sun at sunset the

390
00:14:53,670 --> 00:14:52,160
sun appears red and that's because all

391
00:14:56,230 --> 00:14:53,680
the blue light from the sun has been

392
00:14:58,069 --> 00:14:56,240
scattered away by duster

393
00:15:00,069 --> 00:14:58,079
stuff in the atmosphere so you only see

394
00:15:01,829 --> 00:15:00,079
the red light that gets through and in

395
00:15:03,750 --> 00:15:01,839
exactly the same way when you look at a

396
00:15:05,990 --> 00:15:03,760
star in the sky if there's a lot of dust

397
00:15:07,509 --> 00:15:06,000
between you and it uh it appears redder

398
00:15:09,269 --> 00:15:07,519
than it actually is

399
00:15:11,030 --> 00:15:09,279
and astronomers care about what the

400
00:15:13,430 --> 00:15:11,040
stars really look like not just what

401
00:15:15,670 --> 00:15:13,440
they appear to look uh to us because of

402
00:15:17,269 --> 00:15:15,680
the dust between us and the stars and so

403
00:15:18,870 --> 00:15:17,279
whenever they want to try to figure out

404
00:15:20,550 --> 00:15:18,880
what the real colors of the stars are

405
00:15:22,949 --> 00:15:20,560
not just the colors that they appear to

406
00:15:25,030 --> 00:15:22,959
be they need to use maps of dust to

407
00:15:26,710 --> 00:15:25,040
figure out what the dust is doing to

408
00:15:28,389 --> 00:15:26,720
their observations

409
00:15:30,069 --> 00:15:28,399
uh and until recent so people have

410
00:15:31,670 --> 00:15:30,079
always used massive dust for a long time

411
00:15:33,189 --> 00:15:31,680
but until recently they won't they

412
00:15:35,189 --> 00:15:33,199
haven't been able to look at where the

413
00:15:37,750 --> 00:15:35,199

dust is in three dimensions they only

414
00:15:39,509 --> 00:15:37,760
look at dust the total column of dust

415
00:15:42,150 --> 00:15:39,519
going out in any direction and so what

416
00:15:44,230 --> 00:15:42,160
i'm showing in this panel is uh nearby

417
00:15:46,470 --> 00:15:44,240
dust which is in blue in this picture

418
00:15:48,470 --> 00:15:46,480
and then further away dust which is in

419
00:15:50,550 --> 00:15:48,480
green and the furthest away dust which

420
00:15:52,389 --> 00:15:50,560
is in red and we have more fidelity than

421
00:15:53,990 --> 00:15:52,399
this but i only have three colors to

422
00:15:55,350 --> 00:15:54,000
work with and still make something that

423
00:15:57,590 --> 00:15:55,360
looks plausible

424
00:15:59,910 --> 00:15:57,600
and so this is just one picture of how

425
00:16:01,990 --> 00:15:59,920
where the dust in the galaxy resides

426
00:16:03,430 --> 00:16:02,000
okay wait um so i'm confused what is the

427
00:16:05,030 --> 00:16:03,440
weight we never asked what's the

428
00:16:06,949 --> 00:16:05,040
wavelength range of pan stars what

429
00:16:09,310 --> 00:16:06,959
wavelengths are we looking at here yeah

430
00:16:13,910 --> 00:16:09,320
so pencils observes everything between

431
00:16:16,790 --> 00:16:13,920
400 nanometers and about 1000 maybe 1100

432
00:16:19,269 --> 00:16:16,800
i've forgotten on the red visible

433
00:16:21,110 --> 00:16:19,279
yeah visible too maybe a little bit of

434
00:16:22,470 --> 00:16:21,120
air right

435
00:16:24,470 --> 00:16:22,480
yeah

436
00:16:26,790 --> 00:16:24,480
so how are you able to get dust in those

437
00:16:28,790 --> 00:16:26,800
wavelengths how are you able to see dust

438
00:16:30,629 --> 00:16:28,800

well right so in exactly the same way

439
00:16:32,870 --> 00:16:30,639
that when you when you look at the star

440
00:16:34,870 --> 00:16:32,880
at sorry the sun sometimes it's red and

441
00:16:36,389 --> 00:16:34,880
when you look uh at sunset and when you

442
00:16:37,670 --> 00:16:36,399
look at other times it's more yellow in

443
00:16:39,350 --> 00:16:37,680
the same way

444
00:16:41,829 --> 00:16:39,360
pan stars has observed hundreds and

445
00:16:44,870 --> 00:16:41,839
hundreds of millions of stars so we use

446
00:16:46,790 --> 00:16:44,880
600 million observations of stars and we

447
00:16:48,470 --> 00:16:46,800
compare their colors and so many of

448
00:16:50,629 --> 00:16:48,480
these stars are very blue many of these

449
00:16:52,150 --> 00:16:50,639
stars are very red and there are

450
00:16:53,509 --> 00:16:52,160
definitely certain places on the sky

451
00:16:54,870 --> 00:16:53,519
where all of the stars you look at

452
00:16:56,629 --> 00:16:54,880
practically are very red and that's

453
00:16:58,629 --> 00:16:56,639
because there's a giant cloud of dust

454
00:17:00,870 --> 00:16:58,639
between us and those stars that's making

455
00:17:03,509 --> 00:17:00,880
all those stars look too red and we do

456
00:17:05,510 --> 00:17:03,519
some statistical modeling of the colors

457
00:17:06,309 --> 00:17:05,520
of all of those stars to try to locate

458
00:17:09,110 --> 00:17:06,319
where

459
00:17:11,350 --> 00:17:09,120
the dust clouds have to be to make the

460
00:17:14,470 --> 00:17:11,360
stars have the colors that we observe

461
00:17:16,549 --> 00:17:14,480
uh and so then and plots like these uh

462
00:17:18,470 --> 00:17:16,559
when you see that there's a bunch of red

463
00:17:19,829 --> 00:17:18,480

dust in this plot so towards the center

464
00:17:21,350 --> 00:17:19,839
of this image we see a bunch of red

465
00:17:23,590 --> 00:17:21,360
that's saying that all the stars that

466
00:17:25,270 --> 00:17:23,600
are very far away are much redder than

467
00:17:27,510 --> 00:17:25,280
we expect and so there's probably a big

468
00:17:29,590 --> 00:17:27,520
cloud of dust that's far away that's

469
00:17:30,870 --> 00:17:29,600
making those stars redder than they

470
00:17:32,390 --> 00:17:30,880
might otherwise have appeared if there

471
00:17:35,350 --> 00:17:32,400
weren't any dust

472
00:17:37,669 --> 00:17:35,360
so you're looking at these stars as they

473
00:17:39,750 --> 00:17:37,679
appear to us in pan stars at the

474
00:17:42,310 --> 00:17:39,760
wavelengths that the cameras operate

475
00:17:44,070 --> 00:17:42,320
exactly and we

476
00:17:45,750 --> 00:17:44,080
but we don't trust that they don't

477
00:17:47,830 --> 00:17:45,760
really look that way we know this

478
00:17:49,830 --> 00:17:47,840
because there must be dust how do we go

479
00:17:51,190 --> 00:17:49,840
from what we see

480
00:17:52,630 --> 00:17:51,200
and you said you did a model i

481
00:17:54,310 --> 00:17:52,640
understand that but how do you know what

482
00:17:56,310 --> 00:17:54,320
they should be

483
00:17:58,310 --> 00:17:56,320
right uh

484
00:18:01,590 --> 00:17:58,320
yes that's a good question uh so when

485
00:18:03,990 --> 00:18:01,600
you look so the galaxy is sort of a disc

486
00:18:05,909 --> 00:18:04,000
uh and as we can see sort of from that

487
00:18:08,070 --> 00:18:05,919
image almost all of the dust in the

488
00:18:09,830 --> 00:18:08,080

galaxy is in the plane of the galaxy so

489
00:18:10,789 --> 00:18:09,840
it's all confined to sort of a thin

490
00:18:13,430 --> 00:18:10,799
layer

491
00:18:15,110 --> 00:18:13,440
uh in the main plane of the galaxy when

492
00:18:17,590 --> 00:18:15,120
you look up out of that plane so when

493
00:18:19,270 --> 00:18:17,600
you look uh straight up in some sense if

494
00:18:20,230 --> 00:18:19,280
the galaxy is some disk when you look

495
00:18:21,830 --> 00:18:20,240
straight up out of it there's

496
00:18:23,909 --> 00:18:21,840
practically no dust

497
00:18:26,230 --> 00:18:23,919
and so from areas like that you can see

498
00:18:29,430 --> 00:18:26,240
what colored stars normally have and

499
00:18:31,110 --> 00:18:29,440
then when you compare what the colors

500
00:18:32,870 --> 00:18:31,120
that stars normally have with the colors

501
00:18:35,909 --> 00:18:32,880
that they have when they're at different

502
00:18:37,830 --> 00:18:35,919
locations in the galaxy you can uh

503
00:18:39,990 --> 00:18:37,840
infer what they really look like okay so

504
00:18:42,710 --> 00:18:40,000
you look outside the plane of the galaxy

505
00:18:44,950 --> 00:18:42,720
you look up as far as galactic up

506
00:18:47,110 --> 00:18:44,960
and try to see what stars really look

507
00:18:48,470 --> 00:18:47,120
like without all that dust you go aha

508
00:18:51,110 --> 00:18:48,480
here's what they really look like now

509
00:18:53,430 --> 00:18:51,120
how do i go from here to what i'm seeing

510
00:18:55,590 --> 00:18:53,440
and that's where the model comes in and

511
00:18:58,070 --> 00:18:55,600
you're able to model that that dust this

512
00:18:59,510 --> 00:18:58,080
way now but i should point out that what

513
00:19:01,270 --> 00:18:59,520

people are looking at there that long

514
00:19:02,950 --> 00:19:01,280
line is actually the galaxy this is what

515
00:19:04,870 --> 00:19:02,960
we see when we look up at the sky so

516
00:19:06,470 --> 00:19:04,880
well not in those colors but that's the

517
00:19:08,950 --> 00:19:06,480
milky way and what's also cool about

518
00:19:12,150 --> 00:19:08,960
this image is that it gives us a good

519
00:19:12,950 --> 00:19:12,160
sense of where pan stars cannot see

520
00:19:16,390 --> 00:19:12,960
right

521
00:19:20,710 --> 00:19:16,400
so

522
00:19:23,590 --> 00:19:20,720
map around uh

523
00:19:26,470 --> 00:19:23,600
galactic longitude of -50 where there's

524
00:19:28,390 --> 00:19:26,480
no data it's just giant black blob

525
00:19:30,310 --> 00:19:28,400
and that's a region where so that the

526
00:19:31,909 --> 00:19:30,320
telescope is on the earth and if we

527
00:19:33,430 --> 00:19:31,919
imagine that the telescope were on the

528
00:19:34,710 --> 00:19:33,440
north pole

529
00:19:36,230 --> 00:19:34,720
then it would be impossible for the

530
00:19:37,510 --> 00:19:36,240
telescope to observe half the sky

531
00:19:39,430 --> 00:19:37,520
because half the sky would always be

532
00:19:41,110 --> 00:19:39,440
blocked by the earth

533
00:19:42,870 --> 00:19:41,120
uh the telescope isn't quite on the

534
00:19:44,630 --> 00:19:42,880
north pole it's but it's not on the

535
00:19:46,310 --> 00:19:44,640
equator either and so there's a region

536
00:19:49,430 --> 00:19:46,320
of the sky that's challenging to observe

537
00:19:51,190 --> 00:19:49,440
and so pan stars never observes uh south

538
00:19:53,669 --> 00:19:51,200

of that line and so that's what leads to

539
00:19:55,669 --> 00:19:53,679
a region of no observations in the data

540
00:19:57,430 --> 00:19:55,679
and it says a lot about where we locate

541
00:19:58,710 --> 00:19:57,440
uh these telescopes for ground surface

542
00:20:01,590 --> 00:19:58,720
sky surveys too and we'll talk about

543
00:20:04,230 --> 00:20:01,600
that with lsst in a minute but uh but uh

544
00:20:06,150 --> 00:20:04,240
so there's just some places you cannot

545
00:20:08,150 --> 00:20:06,160
see from hawaii and that and these are

546
00:20:09,430 --> 00:20:08,160
those places there what what about the

547
00:20:10,950 --> 00:20:09,440
gaps around the

548
00:20:12,549 --> 00:20:10,960
the parts we can see there's just these

549
00:20:14,630 --> 00:20:12,559
islands of black

550
00:20:17,350 --> 00:20:14,640
yeah so there so this this particular

551
00:20:19,270 --> 00:20:17,360
figure was taken from the data that the

552
00:20:21,590 --> 00:20:19,280
telescope had produced within the first

553
00:20:24,150 --> 00:20:21,600
one and a half years of the survey

554
00:20:25,430 --> 00:20:24,160
uh we now have three years of the survey

555
00:20:27,430 --> 00:20:25,440
and hopefully all these little holes

556
00:20:29,830 --> 00:20:27,440
should fill in but i mean these are just

557
00:20:31,830 --> 00:20:29,840
things like on one day the telescope

558
00:20:35,029 --> 00:20:31,840
went down because the shutter was broken

559
00:20:36,630 --> 00:20:35,039
for one week we had bad storms and so

560
00:20:38,950 --> 00:20:36,640
there was it was impossible to take

561
00:20:40,070 --> 00:20:38,960
observations so a variety of complicated

562
00:20:41,750 --> 00:20:40,080
factors

563
00:20:43,669 --> 00:20:41,760

ends up making you know determining

564
00:20:45,110 --> 00:20:43,679
where particular holes in the data are

565
00:20:47,029 --> 00:20:45,120
in this plot

566
00:20:48,149 --> 00:20:47,039
okay so armand let's move on to you what

567
00:20:51,190 --> 00:20:48,159
are you doing what are you doing with

568
00:20:53,830 --> 00:20:51,200
pan stars besides running at workshops

569
00:20:56,630 --> 00:20:53,840
well i'm mostly interested in

570
00:20:59,029 --> 00:20:56,640
things that go boom like supernovae and

571
00:21:01,350 --> 00:20:59,039
uh and other things and

572
00:21:03,430 --> 00:21:01,360
so supernova are really important end

573
00:21:06,070 --> 00:21:03,440
stage of stellar evolution

574
00:21:08,070 --> 00:21:06,080
all the massive stars end up as core

575
00:21:10,390 --> 00:21:08,080
collapse supernovae so they burn also

576
00:21:13,510 --> 00:21:10,400
fuel and at some point they run out of

577
00:21:15,110 --> 00:21:13,520
fuel and the core collapses and then it

578
00:21:17,110 --> 00:21:15,120
explodes

579
00:21:18,630 --> 00:21:17,120
uh so that this type of supernova and

580
00:21:21,590 --> 00:21:18,640
there are also other type of supernovae

581
00:21:24,470 --> 00:21:21,600
that are thermonuclear explosions where

582
00:21:26,549 --> 00:21:24,480
you have kind of like a corpse of a of a

583
00:21:28,870 --> 00:21:26,559
star it's called a white dwarf it's a

584
00:21:31,190 --> 00:21:28,880
leftover and normally white dwarf would

585
00:21:33,110 --> 00:21:31,200
just like float in space and cool down

586
00:21:35,590 --> 00:21:33,120
but it has if it has a companion star

587
00:21:37,350 --> 00:21:35,600
that dumps more material on top of it at

588
00:21:38,230 --> 00:21:37,360

some point when it goes over certain

589
00:21:41,029 --> 00:21:38,240
mass

590
00:21:42,549 --> 00:21:41,039
gravity wins and then that white dwarf

591
00:21:44,950 --> 00:21:42,559
also explodes

592
00:21:47,510 --> 00:21:44,960
and so they're important end stages of

593
00:21:49,270 --> 00:21:47,520
evolution and uh also what's really

594
00:21:51,430 --> 00:21:49,280
important all of the

595
00:21:55,110 --> 00:21:51,440
elements that you see on earth like you

596
00:21:57,350 --> 00:21:55,120
know carbon and oxygen all of these uh

597
00:21:59,110 --> 00:21:57,360
everything's but hydrogen and helium a

598
00:22:02,390 --> 00:21:59,120
little bit of lithium was actually

599
00:22:04,789 --> 00:22:02,400
produced in stars and or the supernovae

600
00:22:06,870 --> 00:22:04,799
and then the supernovae basically blast

601
00:22:09,350 --> 00:22:06,880
out and distribute all of these things

602
00:22:11,029 --> 00:22:09,360
in the interstellar medium and then when

603
00:22:12,789 --> 00:22:11,039
the next stars form out of this

604
00:22:14,870 --> 00:22:12,799
interstellar medium then you have

605
00:22:16,789 --> 00:22:14,880
planets that form from this material

606
00:22:19,430 --> 00:22:16,799
that was produced before

607
00:22:22,710 --> 00:22:19,440
and uh so with a you know white field

608
00:22:25,270 --> 00:22:22,720
survey like pan stars we can detect

609
00:22:27,270 --> 00:22:25,280
hundreds or even thousands of supernovae

610
00:22:29,669 --> 00:22:27,280
and then we can observe them and learn

611
00:22:31,669 --> 00:22:29,679
about them and that's one of my main

612
00:22:33,510 --> 00:22:31,679
interests so is it kind of like a is it

613
00:22:35,350 --> 00:22:33,520

a statistical thing where you're looking

614
00:22:36,870 --> 00:22:35,360
at large areas of the sky and you're

615
00:22:38,870 --> 00:22:36,880
seeing more stars your chances of

616
00:22:42,230 --> 00:22:38,880
finding a supernova go up

617
00:22:44,870 --> 00:22:42,240
yes is it like that okay it's like that

618
00:22:48,310 --> 00:22:44,880
how many have so you said thousands have

619
00:22:51,669 --> 00:22:48,320
been seen in pan stars yeah so uh

620
00:22:54,789 --> 00:22:51,679
i'm mainly looking at the data where we

621
00:22:57,990 --> 00:22:54,799
get daily observations of the same field

622
00:23:01,029 --> 00:22:58,000
and so we get very nice light curves

623
00:23:03,830 --> 00:23:01,039
and in these fields we have found about

624
00:23:05,110 --> 00:23:03,840
4000 supernovae and from these 4000

625
00:23:07,909 --> 00:23:05,120
supernovae

626
00:23:10,310 --> 00:23:07,919
we have confirmed with spectroscopy

627
00:23:12,149 --> 00:23:10,320
about 500 supernovae so wait a minute

628
00:23:14,390 --> 00:23:12,159
we've been pan stars has been observing

629
00:23:16,149 --> 00:23:14,400
for three years and has found thousands

630
00:23:19,190 --> 00:23:16,159
of supernovae that means there's a lot

631
00:23:21,350 --> 00:23:19,200
of stars blowing up oh yeah

632
00:23:23,350 --> 00:23:21,360
what's the supernova rate in this galaxy

633
00:23:25,110 --> 00:23:23,360
these are all within our galaxy right no

634
00:23:27,669 --> 00:23:25,120
no they're outside our galaxy so they're

635
00:23:29,909 --> 00:23:27,679
all in in other galaxies in in a given

636
00:23:33,029 --> 00:23:29,919
galaxy you have an average about one

637
00:23:37,669 --> 00:23:33,039
supernova per 100 years good i was

638
00:23:42,549 --> 00:23:39,830

the last lowest one supernovae was a

639
00:23:45,190 --> 00:23:42,559
supernova 87a in the large magellanic

640
00:23:49,669 --> 00:23:45,200
cloud which is the satellite galaxy that

641
00:23:49,679 --> 00:23:53,190
in 1987.

642
00:23:55,510 --> 00:23:54,789
thank you robert

643
00:23:56,470 --> 00:23:55,520
yeah

644
00:23:58,470 --> 00:23:56,480
so

645
00:24:00,230 --> 00:23:58,480
and uh

646
00:24:01,909 --> 00:24:00,240
yeah so it's actually you know it's very

647
00:24:04,230 --> 00:24:01,919
difficult to find supernova that are

648
00:24:05,830 --> 00:24:04,240
close by because they're so rare and so

649
00:24:08,390 --> 00:24:05,840
when you have this deeper service you

650
00:24:10,390 --> 00:24:08,400
can find lots of these supernovae in in

651
00:24:13,750 --> 00:24:10,400
other galaxies

652
00:24:15,029 --> 00:24:13,760
so i'm i'm pretty old and as people go

653
00:24:15,909 --> 00:24:15,039
and i remember

654
00:24:19,029 --> 00:24:15,919
when

655
00:24:20,710 --> 00:24:19,039
i first started studying astronomy uh it

656
00:24:22,870 --> 00:24:20,720
was it was still very common to think

657
00:24:24,710 --> 00:24:22,880
about the sky as a pretty static place

658
00:24:26,310 --> 00:24:24,720
not a whole lot happened except planets

659
00:24:27,510 --> 00:24:26,320
moved and they i mean i'm not as old to

660
00:24:30,710 --> 00:24:27,520
say the babylonians or something

661
00:24:32,230 --> 00:24:30,720
although i feel that way uh the

662
00:24:34,310 --> 00:24:32,240
but what's what's been amazing to me

663
00:24:36,789 --> 00:24:34,320

over the over the decades has been this

664
00:24:39,190 --> 00:24:36,799
talk of transient astronomy where you're

665
00:24:40,950 --> 00:24:39,200
actually looking for things that change

666
00:24:43,029 --> 00:24:40,960
in the night sky we're looking at

667
00:24:44,630 --> 00:24:43,039
supernovae expanding we're looking at

668
00:24:47,029 --> 00:24:44,640
stars moving we're looking at them

669
00:24:49,590 --> 00:24:47,039
exploding and and things that weren't

670
00:24:51,830 --> 00:24:49,600
there last week are are there now and

671
00:24:53,830 --> 00:24:51,840
and uh we have detectors and and

672
00:24:55,269 --> 00:24:53,840
telescopes that let us get all of this

673
00:24:57,430 --> 00:24:55,279
stuff and pan stars

674
00:24:58,830 --> 00:24:57,440
is of course one of them and another

675
00:25:00,870 --> 00:24:58,840
area of

676
00:25:02,549 --> 00:25:00,880
transient astronomy i guess you could

677
00:25:04,470 --> 00:25:02,559
call it is a little bit closer to home

678
00:25:06,310 --> 00:25:04,480
these wide field

679
00:25:07,830 --> 00:25:06,320
surveys do a pretty good job at helping

680
00:25:10,149 --> 00:25:07,840
us find things that are going to hit us

681
00:25:12,950 --> 00:25:10,159
right near earth objects

682
00:25:16,470 --> 00:25:12,960
and how how does pan stars help us do

683
00:25:19,750 --> 00:25:16,480
that who wants to take that one

684
00:25:21,830 --> 00:25:19,760
well i i could take that one okay um

685
00:25:25,110 --> 00:25:21,840
yeah i mean panzers is really it's uh

686
00:25:27,269 --> 00:25:25,120
one of the one of the best machines

687
00:25:28,630 --> 00:25:27,279
so let's say to to find these earth

688
00:25:31,110 --> 00:25:28,640

asteroids asteroids

689
00:25:34,149 --> 00:25:31,120
comets all different all these different

690
00:25:35,590 --> 00:25:34,159
types of objects that we have in our

691
00:25:38,230 --> 00:25:35,600
solar system

692
00:25:44,149 --> 00:25:41,269
the the way to find these is again you

693
00:25:46,070 --> 00:25:44,159
have to cover a big area and just like

694
00:25:47,430 --> 00:25:46,080
you know look for this uh needle in a

695
00:25:48,789 --> 00:25:47,440
haystack

696
00:25:51,029 --> 00:25:48,799
and uh

697
00:25:53,190 --> 00:25:51,039
so it's just like helps tremendously to

698
00:25:56,549 --> 00:25:53,200
have these huge cameras with a with a

699
00:25:57,830 --> 00:25:56,559
reasonably uh big telescopes and uh you

700
00:26:00,630 --> 00:25:57,840
know we

701
00:26:03,909 --> 00:26:00,640
we have had a couple of uh events in in

702
00:26:06,710 --> 00:26:03,919
uh recent years uh one in russia where

703
00:26:09,830 --> 00:26:06,720
we there was a i think a 20 meter

704
00:26:12,549 --> 00:26:09,840
meteor coming down and uh what was

705
00:26:13,830 --> 00:26:12,559
really a gigantic fireball in the sky it

706
00:26:16,789 --> 00:26:13,840
was amazing

707
00:26:19,029 --> 00:26:16,799
and uh this is a pressure wave uh i

708
00:26:20,149 --> 00:26:19,039
think like about a thousand people got a

709
00:26:21,110 --> 00:26:20,159
insured

710
00:26:22,710 --> 00:26:21,120
so

711
00:26:24,789 --> 00:26:22,720
if you want to guard against things like

712
00:26:26,630 --> 00:26:24,799
that and that was a very benign one in a

713
00:26:29,590 --> 00:26:26,640

way if a big

714
00:26:32,630 --> 00:26:29,600
object comes like a 50 meter object or

715
00:26:34,950 --> 00:26:32,640
even 100 or 200 meter object in that

716
00:26:37,590 --> 00:26:34,960
moment you really have an issue if it

717
00:26:40,710 --> 00:26:37,600
hits a city i mean it really could wipe

718
00:26:42,630 --> 00:26:40,720
out a city the chamberlains was what 500

719
00:26:44,789 --> 00:26:42,640
kilo tons yeah something like that there

720
00:26:46,470 --> 00:26:44,799
was a 20 meter one so it was

721
00:26:50,070 --> 00:26:46,480
you know it was a pretty good one but

722
00:26:52,149 --> 00:26:50,080
half a maggot yeah yeah but it could be

723
00:26:54,630 --> 00:26:52,159
much bigger and so there are you know

724
00:26:57,510 --> 00:26:54,640
objects out there that uh get close to

725
00:26:59,909 --> 00:26:57,520
earth and uh you know in the past these

726
00:27:02,470 --> 00:26:59,919
big things have hit earth and had a

727
00:27:04,870 --> 00:27:02,480
major impact on the environment

728
00:27:07,350 --> 00:27:04,880
and so one of the goals is

729
00:27:10,390 --> 00:27:07,360
from us and some of these other surveys

730
00:27:12,230 --> 00:27:10,400
is to to basically catalog all possible

731
00:27:16,390 --> 00:27:12,240
near-earth asteroids that are

732
00:27:18,789 --> 00:27:16,400
potentially hazardous so that if one

733
00:27:20,630 --> 00:27:18,799
gets close or

734
00:27:22,470 --> 00:27:20,640
is likely to hit earth that we can do

735
00:27:24,470 --> 00:27:22,480
something at least if we can move the

736
00:27:26,230 --> 00:27:24,480
people out of the way so it's a very

737
00:27:28,549 --> 00:27:26,240
important part

738
00:27:30,549 --> 00:27:28,559

so here is an animation that i got from

739
00:27:33,350 --> 00:27:30,559
the pan stars website this is on their

740
00:27:36,149 --> 00:27:33,360
pan stars and neo threat and in here you

741
00:27:38,230 --> 00:27:36,159
get an idea of just how

742
00:27:40,230 --> 00:27:38,240
little animation of how these are the i

743
00:27:42,549 --> 00:27:40,240
guess the asteroids that we know about

744
00:27:44,870 --> 00:27:42,559
these are the ones that whose orbits

745
00:27:46,630 --> 00:27:44,880
we've figured out and there's a lot of

746
00:27:49,350 --> 00:27:46,640
them and you you can of course see that

747
00:27:51,669 --> 00:27:49,360
uh most of them are uh

748
00:27:54,310 --> 00:27:51,679
situated in a certain in a certain area

749
00:27:56,070 --> 00:27:54,320
in our solar system but it's the ones we

750
00:27:58,149 --> 00:27:56,080
don't see the ones that are not in this

751
00:27:59,590 --> 00:27:58,159
animation that are the most uh worrying

752
00:28:01,909 --> 00:27:59,600
and that's the ones that come from us

753
00:28:03,510 --> 00:28:01,919
from the like the the russian meteor

754
00:28:05,430 --> 00:28:03,520
last year and things like that so pan

755
00:28:07,110 --> 00:28:05,440
stars does pan stars have the kind of

756
00:28:10,549 --> 00:28:07,120
time frequency and does it have an alert

757
00:28:13,269 --> 00:28:10,559
system i mean uh it part of its acronym

758
00:28:15,350 --> 00:28:13,279
is rapid response so i'm assuming

759
00:28:17,590 --> 00:28:15,360
there's some way of letting people know

760
00:28:19,830 --> 00:28:17,600
when something is on the way yeah of

761
00:28:22,149 --> 00:28:19,840
course i mean as soon uh we we have the

762
00:28:24,149 --> 00:28:22,159
observations they get reduced and if you

763
00:28:26,870 --> 00:28:24,159

find any asteroid

764
00:28:27,909 --> 00:28:26,880
they're getting uh sent to the to the

765
00:28:30,789 --> 00:28:27,919
npc

766
00:28:33,190 --> 00:28:30,799
uh minor planet center

767
00:28:35,510 --> 00:28:33,200
it's a it's a minor planet sensor now

768
00:28:37,350 --> 00:28:35,520
okay so you basically submit all of your

769
00:28:39,510 --> 00:28:37,360
detections that you find all of your

770
00:28:42,070 --> 00:28:39,520
asteroid detections to this minor planet

771
00:28:44,549 --> 00:28:42,080
center and it collects all uh all

772
00:28:46,789 --> 00:28:44,559
asteroids all sort of system objects

773
00:28:48,870 --> 00:28:46,799
from all these different surveys because

774
00:28:51,110 --> 00:28:48,880
lots of time it's really advantageous to

775
00:28:53,029 --> 00:28:51,120
actually connect uh

776
00:28:56,149 --> 00:28:53,039
the detections from one survey to the

777
00:28:59,269 --> 00:28:56,159
detection of another survey so you have

778
00:29:00,950 --> 00:28:59,279
found a and your earth asteroids in one

779
00:29:03,510 --> 00:29:00,960
survey and then we observe it with

780
00:29:05,350 --> 00:29:03,520
another survey a year later or two years

781
00:29:06,870 --> 00:29:05,360
later you have a much better orbit

782
00:29:07,990 --> 00:29:06,880
because you have a much longer time

783
00:29:08,950 --> 00:29:08,000
baseline

784
00:29:11,669 --> 00:29:08,960
so

785
00:29:14,310 --> 00:29:11,679
collecting all of this data in one place

786
00:29:15,909 --> 00:29:14,320
really makes sense and uh

787
00:29:17,590 --> 00:29:15,919
so yeah i mean of course if there would

788
00:29:19,190 --> 00:29:17,600

be anything dangerous

789
00:29:20,789 --> 00:29:19,200
it would be you know people would be

790
00:29:21,990 --> 00:29:20,799
immediately notified

791
00:29:24,630 --> 00:29:22,000
great okay

792
00:29:26,789 --> 00:29:24,640
so um what's all so when i was at the

793
00:29:28,870 --> 00:29:26,799
workshop i was listening to talks i'm

794
00:29:30,070 --> 00:29:28,880
hearing about pan stars one and pan

795
00:29:31,830 --> 00:29:30,080
stars two

796
00:29:33,350 --> 00:29:31,840
uh what's what's all that about are

797
00:29:34,789 --> 00:29:33,360
there two of them now or is there

798
00:29:36,870 --> 00:29:34,799
another one

799
00:29:39,269 --> 00:29:36,880
well the second one is basically under

800
00:29:41,269 --> 00:29:39,279
construction right now so

801
00:29:43,350 --> 00:29:41,279
the camera already exists or it's

802
00:29:46,149 --> 00:29:43,360
getting put together right now it's the

803
00:29:48,389 --> 00:29:46,159
same as a telescope uh the schedule is

804
00:29:50,789 --> 00:29:48,399
that pen stars 2

805
00:29:52,310 --> 00:29:50,799
will be finished and commissioned

806
00:29:55,430 --> 00:29:52,320
beginning of next year so that's a

807
00:29:57,590 --> 00:29:55,440
schedule so it is in a way not an exact

808
00:29:58,549 --> 00:29:57,600
clone of pan stars one but it's very

809
00:30:01,110 --> 00:29:58,559
similar

810
00:30:03,830 --> 00:30:01,120
and then you have you know twice it's a

811
00:30:05,190 --> 00:30:03,840
firepower in a way and you can do twice

812
00:30:07,750 --> 00:30:05,200
as many things

813
00:30:10,389 --> 00:30:07,760

okay so the website says first light for

814
00:30:12,310 --> 00:30:10,399
ps2 is supposed to be in uh 2013 and did

815
00:30:15,029 --> 00:30:12,320
that does not happen together

816
00:30:17,510 --> 00:30:15,039
no that hasn't happened yet that is uh

817
00:30:19,269 --> 00:30:17,520
i think with a lot of uh astronomical

818
00:30:21,590 --> 00:30:19,279
projects you you do have a couple of

819
00:30:23,510 --> 00:30:21,600
years a delay oh but i've forgotten

820
00:30:25,029 --> 00:30:23,520
actually i think the telescope might be

821
00:30:27,029 --> 00:30:25,039
finished and they have a dumb little

822
00:30:29,350 --> 00:30:27,039
camera on they might have actually seen

823
00:30:31,110 --> 00:30:29,360
photons but not with the final setup yes

824
00:30:32,950 --> 00:30:31,120
yes i mean so the final camera

825
00:30:34,310 --> 00:30:32,960
is it's not inside yeah i think i think

826
00:30:35,909 --> 00:30:34,320
you're right eddie because i thought i

827
00:30:39,110 --> 00:30:35,919
saw a press release that that you know

828
00:30:40,549 --> 00:30:39,120
some light had come through okay

829
00:30:42,789 --> 00:30:40,559
it's nowhere near

830
00:30:44,149 --> 00:30:42,799
right and the field of view for ps2 is

831
00:30:46,310 --> 00:30:44,159
i'm sorry did you say it was twice as

832
00:30:48,470 --> 00:30:46,320
big or is that just a detector size no

833
00:30:50,789 --> 00:30:48,480
no i mean it's basically the same size

834
00:30:52,149 --> 00:30:50,799
than uh ps1 but uh now we have two

835
00:30:54,549 --> 00:30:52,159
telescopes and this there's two

836
00:30:56,549 --> 00:30:54,559
telescopes you can uh of course oh i see

837
00:30:59,590 --> 00:30:56,559
so it's twice as much

838
00:31:01,510 --> 00:30:59,600

i understand now okay good so uh so

839
00:31:03,590 --> 00:31:01,520
we're using it to find neos we're using

840
00:31:06,789 --> 00:31:03,600
it for supernova search wide field wide

841
00:31:08,950 --> 00:31:06,799
field studies coming up and it is uh

842
00:31:11,190 --> 00:31:08,960
so this there is there a mission

843
00:31:13,269 --> 00:31:11,200
timeline when this will all end or is it

844
00:31:13,909 --> 00:31:13,279
just ongoing is the university of hawaii

845
00:31:15,990 --> 00:31:13,919
and

846
00:31:19,190 --> 00:31:16,000
everybody else just funding this for

847
00:31:22,149 --> 00:31:19,200
until long people use it so the ps1 the

848
00:31:23,669 --> 00:31:22,159
panzers one science collaboration uh

849
00:31:25,990 --> 00:31:23,679
basically finished

850
00:31:28,149 --> 00:31:26,000
this year so it was a

851
00:31:29,990 --> 00:31:28,159
three-year survey where we had uh you

852
00:31:33,269 --> 00:31:30,000
know several institutions from all over

853
00:31:35,590 --> 00:31:33,279
the world coming together and doing this

854
00:31:37,590 --> 00:31:35,600
these first signs but that collaboration

855
00:31:41,190 --> 00:31:37,600
is right now finished and uh for the

856
00:31:43,990 --> 00:31:41,200
next year ps1 will be

857
00:31:46,789 --> 00:31:44,000
focusing i think over 90

858
00:31:48,070 --> 00:31:46,799
on finding the earth asteroids and other

859
00:31:50,070 --> 00:31:48,080
solar system

860
00:31:51,029 --> 00:31:50,080
so

861
00:31:52,789 --> 00:31:51,039
go ahead

862
00:31:54,549 --> 00:31:52,799
yeah so so this this science

863
00:31:57,190 --> 00:31:54,559

collaboration meeting that we have right

864
00:32:00,310 --> 00:31:57,200
now is actually our last real science

865
00:32:02,070 --> 00:32:00,320
collaboration meeting

866
00:32:04,230 --> 00:32:02,080
so this the data

867
00:32:06,149 --> 00:32:04,240
it's not available yet to everyone we've

868
00:32:08,389 --> 00:32:06,159
got some time before people can get it

869
00:32:09,509 --> 00:32:08,399
is that right carol or or

870
00:32:11,430 --> 00:32:09,519
i mean

871
00:32:13,110 --> 00:32:11,440
we're ultimately i think going to be

872
00:32:15,509 --> 00:32:13,120
serving the data here at the institute

873
00:32:17,909 --> 00:32:15,519
right yeah and i i want to wanted to

874
00:32:19,669 --> 00:32:17,919
point out i mean harmon is kind of you

875
00:32:22,549 --> 00:32:19,679
know you're saying there's alert system

876
00:32:24,870 --> 00:32:22,559
and you know all these observations

877
00:32:26,470 --> 00:32:24,880
these surveys are not i mean they need

878
00:32:29,990 --> 00:32:26,480
to be calibrated and there's a whole

879
00:32:32,389 --> 00:32:30,000
process of getting the data

880
00:32:34,870 --> 00:32:32,399
processed the instrument signature

881
00:32:36,509 --> 00:32:34,880
removed

882
00:32:39,190 --> 00:32:36,519
and you know

883
00:32:41,830 --> 00:32:39,200
registered and understanding what the

884
00:32:43,509 --> 00:32:41,840
data means and of course

885
00:32:46,070 --> 00:32:43,519
even though they look at the same part

886
00:32:47,750 --> 00:32:46,080
of the sky the observations might not

887
00:32:49,029 --> 00:32:47,760
look exactly the same and you have to

888
00:32:50,870 --> 00:32:49,039

make sure

889
00:32:52,789 --> 00:32:50,880
that it's not the instrument or the

890
00:32:55,350 --> 00:32:52,799
telescope or the atmosphere which is

891
00:32:58,070 --> 00:32:55,360
causing things to look different so the

892
00:33:01,110 --> 00:32:58,080
processing is very important

893
00:33:03,269 --> 00:33:01,120
for before you can let the archive open

894
00:33:05,269 --> 00:33:03,279
to everyone because

895
00:33:07,110 --> 00:33:05,279
you want to make sure

896
00:33:11,350 --> 00:33:07,120
that the data that the community is

897
00:33:14,149 --> 00:33:11,360
using is really robust data and so this

898
00:33:15,190 --> 00:33:14,159
data has been a challenge to get in that

899
00:33:18,470 --> 00:33:15,200
state

900
00:33:20,549 --> 00:33:18,480
any kind of survey data is like that hst

901
00:33:22,470 --> 00:33:20,559
data is a challenge you know the people

902
00:33:24,710 --> 00:33:22,480
who are doing these large surveys with

903
00:33:27,110 --> 00:33:24,720
hst have a challenge as well to make

904
00:33:29,590 --> 00:33:27,120
sure that the data is calibrated as well

905
00:33:31,029 --> 00:33:29,600
as we possibly can possibly can there's

906
00:33:33,269 --> 00:33:31,039
always a

907
00:33:35,590 --> 00:33:33,279
possibility of reprocessing the data but

908
00:33:37,990 --> 00:33:35,600
when you release the archive you want

909
00:33:39,909 --> 00:33:38,000
people to kind of be be able to use it

910
00:33:42,230 --> 00:33:39,919
out of the box and that is a big

911
00:33:43,190 --> 00:33:42,240
challenge and it's a lot of data as well

912
00:33:47,909 --> 00:33:43,200
so

913
00:33:50,950 --> 00:33:47,919

just handing it over is is not that easy

914
00:33:53,669 --> 00:33:50,960
yeah it's actually two petabytes of data

915
00:33:56,230 --> 00:33:53,679
ah you read my mind okay

916
00:33:58,470 --> 00:33:56,240
right so you have this 1.4 gigapixel

917
00:34:00,070 --> 00:33:58,480
camera that literally all night long

918
00:34:03,029 --> 00:34:00,080
every single night takes pictures as

919
00:34:05,350 --> 00:34:03,039
fast as it can yeah you save all of that

920
00:34:08,149 --> 00:34:05,360
little camera yeah and if you think

921
00:34:09,990 --> 00:34:08,159
that's a lot of data

922
00:34:11,430 --> 00:34:10,000
you should ask robert that's a lot of

923
00:34:13,190 --> 00:34:11,440
data will be

924
00:34:15,109 --> 00:34:13,200
well that let us now segue this is a

925
00:34:16,710 --> 00:34:15,119
good segment if you think that is a lot

926
00:34:19,430 --> 00:34:16,720
of data

927
00:34:21,349 --> 00:34:19,440
then we have got a lot more in store in

928
00:34:24,069 --> 00:34:21,359
the coming years i'm very pleased to

929
00:34:26,869 --> 00:34:24,079
have here in my in this hangouts with me

930
00:34:28,869 --> 00:34:26,879
uh dr robert lupton he's working on the

931
00:34:31,909 --> 00:34:28,879
lsst

932
00:34:34,310 --> 00:34:31,919
uh uh sky survey which has been in the

933
00:34:35,909 --> 00:34:34,320
planning stages and the building stages

934
00:34:37,829 --> 00:34:35,919
i learned about it when i was at

935
00:34:39,349 --> 00:34:37,839
illinois with dark energy survey a lot

936
00:34:40,790 --> 00:34:39,359
of people around me and were working on

937
00:34:41,829 --> 00:34:40,800
it the data management system things

938
00:34:44,310 --> 00:34:41,839

like that

939
00:34:47,030 --> 00:34:44,320
and now i watched robert lupton

940
00:34:49,270 --> 00:34:47,040
yesterday and i'm hearing that this is

941
00:34:51,030 --> 00:34:49,280
actually actually he was giving us a

942
00:34:53,510 --> 00:34:51,040
really funny slide about all the the top

943
00:34:56,230 --> 00:34:53,520
10 lessons he's learned and one of his

944
00:34:58,470 --> 00:34:56,240
lessons was don't join a project until

945
00:35:00,630 --> 00:34:58,480
it's been funded uh so i guess that's

946
00:35:02,950 --> 00:35:00,640
been that's changed now right lsst is a

947
00:35:04,310 --> 00:35:02,960
go is that right robert i think that's

948
00:35:05,910 --> 00:35:04,320
true yeah

949
00:35:07,109 --> 00:35:05,920
i didn't think they were a funny slide i

950
00:35:10,069 --> 00:35:07,119
thought they were very deep and

951
00:35:12,550 --> 00:35:10,079
insightful 10 lessons actually well i

952
00:35:14,710 --> 00:35:12,560
didn't feel like

953
00:35:16,230 --> 00:35:14,720
oh yeah things have changed i started

954
00:35:17,670 --> 00:35:16,240
working with ccd cameras when the

955
00:35:19,510 --> 00:35:17,680
biggest one in the world was a quarter

956
00:35:20,390 --> 00:35:19,520
megapixel on the biggest telescope in

957
00:35:22,870 --> 00:35:20,400
the world

958
00:35:25,349 --> 00:35:22,880
lsst is going to have a 3.2 gigapixel

959
00:35:27,589 --> 00:35:25,359
camera which is something like what

960
00:35:32,630 --> 00:35:27,599
three times bigger than pan stars on a

961
00:35:36,790 --> 00:35:34,710
you know my previous camera was 140

962
00:35:39,030 --> 00:35:36,800
megapixels on the sloan so we're moving

963
00:35:41,670 --> 00:35:39,040

up in the system so yeah lsst is a

964
00:35:43,829 --> 00:35:41,680
project it's about there is

965
00:35:46,670 --> 00:35:43,839
every expectation that we will get an

966
00:35:49,589 --> 00:35:46,680
official funding start in early july

967
00:35:52,150 --> 00:35:49,599
2014 in fact the national science board

968
00:35:54,630 --> 00:35:52,160
which is the sort of top level

969
00:35:55,910 --> 00:35:54,640
governing body for science in the us has

970
00:35:58,470 --> 00:35:55,920
instructed the national science

971
00:36:00,870 --> 00:35:58,480
foundation to release the funding

972
00:36:03,430 --> 00:36:00,880
for the construction of this project

973
00:36:04,950 --> 00:36:03,440
um nominally by july 1 we expect it'll

974
00:36:07,109 --> 00:36:04,960
take a little longer due to technical

975
00:36:09,190 --> 00:36:07,119
details and crossing eyes and

976
00:36:11,670 --> 00:36:09,200
crossing dollar signs really

977
00:36:13,270 --> 00:36:11,680
um but sometime in july we expected

978
00:36:14,710 --> 00:36:13,280
construction start

979
00:36:18,230 --> 00:36:14,720
uh the primary mirror is eight and a

980
00:36:20,310 --> 00:36:18,240
half meters across so that's what 25 26

981
00:36:23,349 --> 00:36:20,320
feet i can't do it in my head especially

982
00:36:24,870 --> 00:36:23,359
0.48 is the magic number i think there's

983
00:36:26,870 --> 00:36:24,880
some pictures actually of the mirrors

984
00:36:27,910 --> 00:36:26,880
which have already been made so elena

985
00:36:30,310 --> 00:36:27,920
can we

986
00:36:32,710 --> 00:36:30,320
i just wanted to comment robert said

987
00:36:35,030 --> 00:36:32,720
something he said it is a project and

988
00:36:37,910 --> 00:36:35,040

that wasn't a throwaway statement that

989
00:36:40,870 --> 00:36:37,920
is a significant thing it's one thing to

990
00:36:42,470 --> 00:36:40,880
have your concept on powerpoint slides

991
00:36:43,990 --> 00:36:42,480
and convince everybody you have this

992
00:36:46,310 --> 00:36:44,000
great idea and you've got lots of

993
00:36:49,990 --> 00:36:46,320
technology and engineers and all that

994
00:36:51,829 --> 00:36:50,000
but when you are a project that means

995
00:36:54,150 --> 00:36:51,839
you actually might be able to build the

996
00:36:57,430 --> 00:36:54,160
telescope and so it's a very significant

997
00:36:59,349 --> 00:36:57,440
milestone for lsst to be a project

998
00:37:02,150 --> 00:36:59,359
it's been a long time coming and it's

999
00:37:04,390 --> 00:37:02,160
very exciting people are very excited so

1000
00:37:05,910 --> 00:37:04,400
somebody had yeah was it you attorney

1001
00:37:08,630 --> 00:37:05,920
was the picture somebody had a picture

1002
00:37:11,750 --> 00:37:08,640
of the sun there we go i do can you see

1003
00:37:12,550 --> 00:37:11,760
my screen uh would i have right now the

1004
00:37:14,470 --> 00:37:12,560
uh

1005
00:37:15,430 --> 00:37:14,480
the rendering of where they're going to

1006
00:37:18,470 --> 00:37:15,440
build this

1007
00:37:20,310 --> 00:37:18,480
you have that up this is chile uh cerro

1008
00:37:22,069 --> 00:37:20,320
pachon and uh they're gonna be building

1009
00:37:25,109 --> 00:37:22,079
it right across the street or down the

1010
00:37:27,510 --> 00:37:25,119
road from the gemini telescope uh this

1011
00:37:29,109 --> 00:37:27,520
will be as construction start when will

1012
00:37:31,589 --> 00:37:29,119
construction start on this robert do we

1013
00:37:33,750 --> 00:37:31,599

know i don't remember we blew the top

1014
00:37:35,829 --> 00:37:33,760
off the mountain the only truth the only

1015
00:37:39,829 --> 00:37:35,839
truth in this picture is the flat top

1016
00:37:41,910 --> 00:37:39,839
where it says lsst rendering on elephant

1017
00:37:44,069 --> 00:37:41,920
we actually did that it's actually just

1018
00:37:46,390 --> 00:37:44,079
a flat thing now

1019
00:37:48,150 --> 00:37:46,400
the telescope isn't there we're about to

1020
00:37:50,790 --> 00:37:48,160
start letting contracts for things like

1021
00:37:53,270 --> 00:37:50,800
steel here's a picture of the telescope

1022
00:37:57,030 --> 00:37:53,280
so it's a very squat not quite as ugly

1023
00:37:58,710 --> 00:37:57,040
as the sloan telescope but pretty bad

1024
00:38:01,670 --> 00:37:58,720
so none of the steel has been ordered

1025
00:38:03,510 --> 00:38:01,680
yet it's very very compact it's a 1.2 f

1026
00:38:06,790 --> 00:38:03,520
ratio primary if we can go to the

1027
00:38:08,470 --> 00:38:06,800
pictures of the primary the photos tony

1028
00:38:10,550 --> 00:38:08,480
that's just an artist impression there

1029
00:38:12,390 --> 00:38:10,560
we go that's the actual mirror so that's

1030
00:38:15,109 --> 00:38:12,400
a big piece of glass sitting underneath

1031
00:38:17,510 --> 00:38:15,119
the football stadium in arizona you'll

1032
00:38:19,990 --> 00:38:17,520
see it's really bizarre it's two mirrors

1033
00:38:21,670 --> 00:38:20,000
in one the outer part has one curvature

1034
00:38:24,230 --> 00:38:21,680
and the inner part that looks a little

1035
00:38:25,510 --> 00:38:24,240
bit like a hand basin has another

1036
00:38:27,190 --> 00:38:25,520
curvature

1037
00:38:28,950 --> 00:38:27,200
so we actually have a three mirror

1038
00:38:31,109 --> 00:38:28,960

system so the light comes in it backs

1039
00:38:32,870 --> 00:38:31,119
off the outer part it hits an enormous

1040
00:38:34,790 --> 00:38:32,880
secondary mirror which isn't in this

1041
00:38:36,950 --> 00:38:34,800
picture which is three and a half meters

1042
00:38:38,790 --> 00:38:36,960
across it bounces down it hits the

1043
00:38:41,430 --> 00:38:38,800
center part then goes back out into this

1044
00:38:43,270 --> 00:38:41,440
enormous camera which will be the

1045
00:38:45,349 --> 00:38:43,280
biggest certainly astronomical camera in

1046
00:38:47,990 --> 00:38:45,359
the world at that point the data rate is

1047
00:38:50,390 --> 00:38:48,000
400 megabytes per second sustained

1048
00:38:52,710 --> 00:38:50,400
that's the average data rate so i think

1049
00:38:54,710 --> 00:38:52,720
we end up with 60 petabytes of imaging

1050
00:38:57,510 --> 00:38:54,720
data you know not that much more than

1051
00:39:00,630 --> 00:38:57,520
pen styles but but bigger and worse

1052
00:39:03,910 --> 00:39:02,150
what do we get with this shape i mean

1053
00:39:05,589 --> 00:39:03,920
okay so the outer the outer donut or

1054
00:39:07,109 --> 00:39:05,599
taurus or whatever you want to call it

1055
00:39:11,349 --> 00:39:07,119
has a certain

1056
00:39:13,910 --> 00:39:11,359
the secondary like you said then bounces

1057
00:39:16,790 --> 00:39:13,920
back and hits this bowl this deeper bowl

1058
00:39:18,870 --> 00:39:16,800
which then goes straight to the

1059
00:39:21,829 --> 00:39:18,880
camera what do you get with this what's

1060
00:39:23,349 --> 00:39:21,839
the you've got a very large field so we

1061
00:39:24,870 --> 00:39:23,359
we showed you the hubble field which is

1062
00:39:26,950 --> 00:39:24,880
about the zero

1063
00:39:29,190 --> 00:39:26,960

and then the new supreme cam field which

1064
00:39:31,190 --> 00:39:29,200
is 1.8 square degrees and the pan starts

1065
00:39:33,270 --> 00:39:31,200
which is three they're bigger and bigger

1066
00:39:36,550 --> 00:39:33,280
this is a 10 degree field

1067
00:39:38,310 --> 00:39:36,560
so that the diameter of the field is six

1068
00:39:40,550 --> 00:39:38,320
times larger than the full moon so you

1069
00:39:42,550 --> 00:39:40,560
see it in a very large area of the sky

1070
00:39:43,990 --> 00:39:42,560
at once i've never seen a mirror like

1071
00:39:46,150 --> 00:39:44,000
this what is there a name for it or is

1072
00:39:49,270 --> 00:39:46,160
it like oh they're called tmas which

1073
00:39:50,310 --> 00:39:49,280
stands for three mirror enastic maps

1074
00:39:52,630 --> 00:39:50,320
that's what they call them in the

1075
00:39:53,589 --> 00:39:52,640
business in fact the w first mirror is a

1076
00:39:55,030 --> 00:39:53,599
similar

1077
00:39:57,990 --> 00:39:55,040
it's done in different ways but it's

1078
00:39:59,990 --> 00:39:58,000
also a three mirror design wfirst is a

1079
00:40:01,829 --> 00:40:00,000
space another space telescope i'm sure

1080
00:40:03,030 --> 00:40:01,839
carrier will be telling you all about

1081
00:40:05,109 --> 00:40:03,040
some others yes we've got hangouts

1082
00:40:07,510 --> 00:40:05,119
planned on that one so yeah definitely

1083
00:40:09,349 --> 00:40:07,520
um in fact wfirst is going to play very

1084
00:40:10,870 --> 00:40:09,359
nicely with the lsst data they're very

1085
00:40:12,950 --> 00:40:10,880
well matched

1086
00:40:14,710 --> 00:40:12,960
so you just get more degrees of freedom

1087
00:40:16,230 --> 00:40:14,720
you can get a bigger field why do you

1088
00:40:19,109 --> 00:40:16,240

want a bigger field because you can

1089
00:40:20,470 --> 00:40:19,119
carry cover more of the sky at one time

1090
00:40:22,790 --> 00:40:20,480
why do you want to do that well you can

1091
00:40:25,030 --> 00:40:22,800
cover the whole sky in less time and in

1092
00:40:27,030 --> 00:40:25,040
fact with the lsst system

1093
00:40:29,270 --> 00:40:27,040
uh we can cover the complete sky or

1094
00:40:31,030 --> 00:40:29,280
heart that all we can see at one time in

1095
00:40:32,710 --> 00:40:31,040
about three days

1096
00:40:35,430 --> 00:40:32,720
so we can take a

1097
00:40:36,710 --> 00:40:35,440
monochromatic picture of the entire sky

1098
00:40:38,390 --> 00:40:36,720
twice a week

1099
00:40:40,310 --> 00:40:38,400
we've got six filters

1100
00:40:41,510 --> 00:40:40,320
so we can actually take a color picture

1101
00:40:42,470 --> 00:40:41,520
of the sky

1102
00:40:48,470 --> 00:40:42,480
every

1103
00:40:51,990 --> 00:40:48,480
emphasize that because that is an

1104
00:40:54,950 --> 00:40:52,000
amazing thing to say i mean here we have

1105
00:40:56,309 --> 00:40:54,960
uh we are they're going to be taking 800

1106
00:40:58,710 --> 00:40:56,319
images a night

1107
00:41:00,630 --> 00:40:58,720
and cover the entire sky

1108
00:41:03,270 --> 00:41:00,640
in about a week and a half yeah

1109
00:41:06,950 --> 00:41:03,280
no cover the whole sky in three days

1110
00:41:10,150 --> 00:41:09,030
in each color so we cover this so twice

1111
00:41:12,470 --> 00:41:10,160
each week

1112
00:41:13,910 --> 00:41:12,480
i i that just blows me away i mean that

1113
00:41:15,829 --> 00:41:13,920

the amount of data and the fact that we

1114
00:41:17,589 --> 00:41:15,839
can do that at all is and there will be

1115
00:41:18,870 --> 00:41:17,599
no blind spots like in pan stars it'll

1116
00:41:20,630 --> 00:41:18,880
be able to

1117
00:41:22,470 --> 00:41:20,640
no we're in the south so we'll see the

1118
00:41:24,150 --> 00:41:22,480
southern part of the sky we can't see

1119
00:41:27,270 --> 00:41:24,160
the north pole you can't see polaris

1120
00:41:29,829 --> 00:41:27,280
from chile um and that was cerro pachan

1121
00:41:32,550 --> 00:41:29,839
which is in in chile so we'll see the

1122
00:41:34,309 --> 00:41:32,560
part of the sky pan stars can't see

1123
00:41:35,670 --> 00:41:34,319
it has various advantages there's lots

1124
00:41:38,150 --> 00:41:35,680
of big glass in the south and the

1125
00:41:40,069 --> 00:41:38,160
galactic centre is in the south

1126
00:41:42,069 --> 00:41:40,079
um so the complement i mean people like

1127
00:41:44,390 --> 00:41:42,079
eddie who really care about dust and

1128
00:41:45,829 --> 00:41:44,400
things like that will be really excited

1129
00:41:48,630 --> 00:41:45,839
because we'll get a great view of the

1130
00:41:50,150 --> 00:41:48,640
southern sky on an on actually rather a

1131
00:41:52,790 --> 00:41:50,160
bigger telescope will go a lot deeper

1132
00:41:54,309 --> 00:41:52,800
than pan stars but um you'll still get

1133
00:41:56,550 --> 00:41:54,319
the complete coverage from the north

1134
00:41:58,309 --> 00:41:56,560
from telescopes like pan studs so we'll

1135
00:41:59,910 --> 00:41:58,319
see the whole sky

1136
00:42:02,309 --> 00:41:59,920
well as you mentioned a while ago you

1137
00:42:04,470 --> 00:42:02,319
came from the sloan digital sky survey

1138
00:42:07,510 --> 00:42:04,480

which was run from new mexico and was we

1139
00:42:09,030 --> 00:42:07,520
an amazingly detailed uh rendering of a

1140
00:42:10,790 --> 00:42:09,040
lot of just you know millions of

1141
00:42:12,790 --> 00:42:10,800
galaxies and

1142
00:42:14,309 --> 00:42:12,800
you guys made a 3d map of the universe

1143
00:42:16,710 --> 00:42:14,319
that you could see

1144
00:42:18,309 --> 00:42:16,720
with uh sloan which what you know it had

1145
00:42:20,550 --> 00:42:18,319
slices in it and

1146
00:42:22,230 --> 00:42:20,560
it it basically amounted to the areas

1147
00:42:24,710 --> 00:42:22,240
that sloan could see are you going to

1148
00:42:26,630 --> 00:42:24,720
make something like that with lsst well

1149
00:42:28,150 --> 00:42:26,640
the trouble is that sloane did two

1150
00:42:30,150 --> 00:42:28,160
things when the conditions were really

1151
00:42:31,670 --> 00:42:30,160
good we took pictures of the sky with

1152
00:42:34,710 --> 00:42:31,680
what was then the biggest camera in the

1153
00:42:36,950 --> 00:42:34,720
world is now in the smithsonian

1154
00:42:38,630 --> 00:42:36,960
and the rest of the time we took spectra

1155
00:42:41,030 --> 00:42:38,640
so we could measure the distances to

1156
00:42:42,870 --> 00:42:41,040
galaxies by using a spectrograph which

1157
00:42:45,510 --> 00:42:42,880
is still there and takes a thousand

1158
00:42:47,430 --> 00:42:45,520
spectra at the time the lsst is just an

1159
00:42:48,550 --> 00:42:47,440
imaging camera it'll be taking pictures

1160
00:42:50,630 --> 00:42:48,560
all the time

1161
00:42:52,390 --> 00:42:50,640
in fact one of the really difficult

1162
00:42:54,710 --> 00:42:52,400
things for the next generation of big

1163
00:42:57,109 --> 00:42:54,720

surveys is there is no big imaging big

1164
00:42:59,030 --> 00:42:57,119
spectrographic camera i'm one of my many

1165
00:43:00,390 --> 00:42:59,040
projects i have many is to build an

1166
00:43:02,069 --> 00:43:00,400
instrument called the prime focus

1167
00:43:04,550 --> 00:43:02,079
spectrograph that goes on subaru or

1168
00:43:06,710 --> 00:43:04,560
mauna kea so not that far from the panda

1169
00:43:09,910 --> 00:43:06,720
stars telescope which will in fact take

1170
00:43:12,390 --> 00:43:09,920
spectra over 2 400 objects at a time

1171
00:43:14,790 --> 00:43:12,400
12 tons of spectrograph but there's no

1172
00:43:17,190 --> 00:43:14,800
equivalent some object in this telescope

1173
00:43:18,790 --> 00:43:17,200
no equivalent instrument in the south

1174
00:43:20,950 --> 00:43:18,800
there are there are an attempt to put

1175
00:43:22,870 --> 00:43:20,960
such instruments on mauna kea but i'm

1176
00:43:24,230 --> 00:43:22,880
not sure where they're going

1177
00:43:26,550 --> 00:43:24,240
okay well i'm confused then robert

1178
00:43:29,270 --> 00:43:26,560
because i have up now the web page of

1179
00:43:31,670 --> 00:43:29,280
lsst and it says here right on it data

1180
00:43:33,349 --> 00:43:31,680
from lsst will be used to create a 3d

1181
00:43:35,750 --> 00:43:33,359
map of the universe with unprecedented

1182
00:43:37,670 --> 00:43:35,760
depth and detail this map can be used to

1183
00:43:39,109 --> 00:43:37,680
locate mysterious dark matter and to

1184
00:43:41,589 --> 00:43:39,119
characterize the properties and even

1185
00:43:43,270 --> 00:43:41,599
more mysterious dark energy okay well i

1186
00:43:45,990 --> 00:43:43,280
can tell you what that means i even tell

1187
00:43:47,910 --> 00:43:46,000
you why it's true

1188
00:43:49,430 --> 00:43:47,920

the easiest and best way to measure the

1189
00:43:51,109 --> 00:43:49,440
distance to something is to take its

1190
00:43:52,470 --> 00:43:51,119
spectrum and we did that for i can't

1191
00:43:54,870 --> 00:43:52,480
remember many million objects in the

1192
00:43:56,470 --> 00:43:54,880
sdss the slogan now

1193
00:43:59,109 --> 00:43:56,480
but there are various surrogates for

1194
00:44:01,030 --> 00:43:59,119
that one is to say well if i can find

1195
00:44:03,510 --> 00:44:01,040
out where the dust is and i know this

1196
00:44:05,349 --> 00:44:03,520
star is behind this layer of dust i get

1197
00:44:07,589 --> 00:44:05,359
some idea how far away it is and that's

1198
00:44:09,910 --> 00:44:07,599
what eddie and his friends are doing

1199
00:44:12,230 --> 00:44:09,920
another way is to say well

1200
00:44:13,589 --> 00:44:12,240
as you move as you look at galaxies

1201
00:44:15,670 --> 00:44:13,599
which are further and further and

1202
00:44:17,829 --> 00:44:15,680
further away from us they get more and

1203
00:44:19,589 --> 00:44:17,839
more redshifted and just by looking at

1204
00:44:21,910 --> 00:44:19,599
the colors of the galaxies you can get a

1205
00:44:22,790 --> 00:44:21,920
pretty good guess as to how far away

1206
00:44:24,230 --> 00:44:22,800
they are

1207
00:44:26,390 --> 00:44:24,240
so that's what's called a photometric

1208
00:44:28,630 --> 00:44:26,400
redshift and that's perhaps good to

1209
00:44:30,710 --> 00:44:28,640
three percent if you work hard and if

1210
00:44:32,550 --> 00:44:30,720
you believe the optimist it's bet it's a

1211
00:44:34,710 --> 00:44:32,560
little bit better than that it depends

1212
00:44:37,670 --> 00:44:34,720
on how many different colors you measure

1213
00:44:39,589 --> 00:44:37,680

so the lsst project will be able to

1214
00:44:41,829 --> 00:44:39,599
measure photometric redshifts to a large

1215
00:44:44,870 --> 00:44:41,839
number of objects which enables you to

1216
00:44:46,550 --> 00:44:44,880
do a sort of poor man's distance and in

1217
00:44:49,030 --> 00:44:46,560
fact one of the reasons why i'm excited

1218
00:44:51,430 --> 00:44:49,040
about w first is because it makes that

1219
00:44:53,030 --> 00:44:51,440
work very much better because at higher

1220
00:44:54,150 --> 00:44:53,040
redshift you need to go into the near

1221
00:44:56,790 --> 00:44:54,160
infrared

1222
00:44:58,950 --> 00:44:56,800
so yeah we get sort of few percent

1223
00:45:01,109 --> 00:44:58,960
distances and then because you could

1224
00:45:03,190 --> 00:45:01,119
look at the distortion of images

1225
00:45:05,270 --> 00:45:03,200
of those far distant galaxies by the

1226
00:45:06,950 --> 00:45:05,280
material between us you can measure

1227
00:45:09,430 --> 00:45:06,960
where the mass is between us and the

1228
00:45:11,829 --> 00:45:09,440
galaxies and that's what that propaganda

1229
00:45:13,990 --> 00:45:11,839
blurb on that page you pulled up is

1230
00:45:15,589 --> 00:45:14,000
talking about okay so good i know i'm

1231
00:45:17,109 --> 00:45:15,599
glad you brought that's exactly what i

1232
00:45:18,390 --> 00:45:17,119
wanted to hear photometric redshift is

1233
00:45:20,230 --> 00:45:18,400
something that we hear a lot about in

1234
00:45:21,990 --> 00:45:20,240
astronomy and it's a it's a good

1235
00:45:23,430 --> 00:45:22,000
technique for doing a rough

1236
00:45:24,870 --> 00:45:23,440
a rougher estimate of how far away

1237
00:45:26,790 --> 00:45:24,880
things are then be able them being able

1238
00:45:28,790 --> 00:45:26,800

to get their spectra only because they

1239
00:45:30,550 --> 00:45:28,800
look different in different filters uh

1240
00:45:31,589 --> 00:45:30,560
and you can you can infer their distance

1241
00:45:32,390 --> 00:45:31,599
from those

1242
00:45:37,349 --> 00:45:32,400
so

1243
00:45:39,430 --> 00:45:37,359
of uh a couple of questions oh wait

1244
00:45:40,790 --> 00:45:39,440
before i do that though your talk robert

1245
00:45:43,829 --> 00:45:40,800
you said that there was some challenges

1246
00:45:45,510 --> 00:45:43,839
for hs for lsst and one of them was uh

1247
00:45:46,470 --> 00:45:45,520
you had outlined that doing things that

1248
00:45:49,270 --> 00:45:46,480
you know

1249
00:45:50,550 --> 00:45:49,280
that we don't have to get into here like

1250
00:45:52,069 --> 00:45:50,560
background subtraction and things like

1251
00:45:53,190 --> 00:45:52,079
that what do you see as the biggest

1252
00:45:55,430 --> 00:45:53,200
challenge

1253
00:45:57,109 --> 00:45:55,440
in getting lsst built

1254
00:45:59,670 --> 00:45:57,119
oh getting well there are three things

1255
00:46:01,750 --> 00:45:59,680
about the lss team uh many things about

1256
00:46:04,069 --> 00:46:01,760
the lssd the first is we have to build a

1257
00:46:06,069 --> 00:46:04,079
telescope that's not that bad i mean i

1258
00:46:07,670 --> 00:46:06,079
couldn't do it i've done it before

1259
00:46:09,349 --> 00:46:07,680
it's been done before i mean you've got

1260
00:46:11,109 --> 00:46:09,359
to do it really well

1261
00:46:12,630 --> 00:46:11,119
you know that'll be fine we've got to

1262
00:46:14,470 --> 00:46:12,640
build the biggest camera in the world i

1263
00:46:16,150 --> 00:46:14,480

couldn't do that either but that's also

1264
00:46:18,470 --> 00:46:16,160
been done before i mean it's somewhat

1265
00:46:20,309 --> 00:46:18,480
bigger than john turner's camera

1266
00:46:21,750 --> 00:46:20,319
um it's bigger than the sloan camera

1267
00:46:26,390 --> 00:46:21,760
that's again something that i believe

1268
00:46:29,990 --> 00:46:28,630
this is a challenge

1269
00:46:30,950 --> 00:46:30,000
that's true

1270
00:46:32,630 --> 00:46:30,960
yes

1271
00:46:34,630 --> 00:46:32,640
but on the other hand

1272
00:46:36,150 --> 00:46:34,640
many of these

1273
00:46:38,550 --> 00:46:36,160
okay in that case

1274
00:46:40,710 --> 00:46:38,560
if you want to figure out what orbit the

1275
00:46:42,950 --> 00:46:40,720
hubble space telescope is in

1276
00:46:45,030 --> 00:46:42,960
if you take the cost of the hubble space

1277
00:46:47,270 --> 00:46:45,040
telescope don't figure out how many

1278
00:46:48,630 --> 00:46:47,280
kilometers that comes to it piled up

1279
00:46:50,630 --> 00:46:48,640
dollar bills

1280
00:46:52,470 --> 00:46:50,640
you get quite a good estimate

1281
00:46:54,470 --> 00:46:52,480
anyway that wasn't that i was intending

1282
00:46:57,190 --> 00:46:54,480
to come here to talk no but you did

1283
00:47:04,069 --> 00:47:00,950
you have to advertise for 25 years

1284
00:47:05,270 --> 00:47:04,079
yeah yeah 25 years

1285
00:47:06,790 --> 00:47:05,280
yeah well

1286
00:47:07,990 --> 00:47:06,800
that's a long time all these projects

1287
00:47:09,990 --> 00:47:08,000
what i was going to say is actually the

1288
00:47:12,069 --> 00:47:10,000

software is all the software is really

1289
00:47:14,390 --> 00:47:12,079
hard so the thing that scares me most is

1290
00:47:16,230 --> 00:47:14,400
getting the the good enough brilliant p

1291
00:47:17,510 --> 00:47:16,240
enough people and persuading them to

1292
00:47:19,510 --> 00:47:17,520
work for me

1293
00:47:21,109 --> 00:47:19,520
so as to get the software written

1294
00:47:23,270 --> 00:47:21,119
was that a pretty hard sell in your talk

1295
00:47:25,109 --> 00:47:23,280
about that yesterday oh yes absolutely

1296
00:47:27,430 --> 00:47:25,119
i'm definitely breakers

1297
00:47:29,270 --> 00:47:27,440
not yet

1298
00:47:31,349 --> 00:47:29,280
but i'm really nice

1299
00:47:34,230 --> 00:47:31,359
oh wait well you're good too it says so

1300
00:47:35,910 --> 00:47:34,240
when you're wait wait wait

1301
00:47:37,750 --> 00:47:35,920
but i'm serious i mean the software

1302
00:47:38,870 --> 00:47:37,760
analysis is hard the sort of things we

1303
00:47:41,670 --> 00:47:38,880
have to do

1304
00:47:43,270 --> 00:47:41,680
is measure the distortions in the shapes

1305
00:47:44,309 --> 00:47:43,280
of galaxies

1306
00:47:46,390 --> 00:47:44,319
to

1307
00:47:48,470 --> 00:47:46,400
well less than one percent in the

1308
00:47:51,109 --> 00:47:48,480
presence of the atmosphere which smears

1309
00:47:53,430 --> 00:47:51,119
all the stars out in complicated ways

1310
00:47:55,430 --> 00:47:53,440
and that's an extremely hard measurement

1311
00:47:57,109 --> 00:47:55,440
we have to be able to say what's the

1312
00:47:59,510 --> 00:47:57,119
color of an object so i can do these

1313
00:48:01,190 --> 00:47:59,520

photometric redshifts when in fact

1314
00:48:03,589 --> 00:48:01,200
galaxies don't have a single color they

1315
00:48:05,430 --> 00:48:03,599
have red bulges they have blue discs

1316
00:48:08,230 --> 00:48:05,440
they've got star forming regions off to

1317
00:48:10,630 --> 00:48:08,240
the side they overlap so one galaxy here

1318
00:48:13,349 --> 00:48:10,640
overlaps this galaxy you have to sort of

1319
00:48:15,990 --> 00:48:13,359
sort all of those things out in reliable

1320
00:48:17,589 --> 00:48:16,000
enough ways that as carol says you can

1321
00:48:18,710 --> 00:48:17,599
make a database that people could do

1322
00:48:20,550 --> 00:48:18,720
science of

1323
00:48:22,790 --> 00:48:20,560
what

1324
00:48:24,790 --> 00:48:22,800
unfortunately we've promised the world

1325
00:48:26,950 --> 00:48:24,800
that all that data will be public to

1326
00:48:29,430 --> 00:48:26,960
everybody in the us and chile

1327
00:48:30,950 --> 00:48:29,440
immediately we will put out the alerts

1328
00:48:33,349 --> 00:48:30,960
on everything that changes the moves

1329
00:48:35,030 --> 00:48:33,359
within 60 seconds of closing the shutter

1330
00:48:36,790 --> 00:48:35,040
so we don't have a lot of time to get an

1331
00:48:38,549 --> 00:48:36,800
army of graduate students

1332
00:48:40,870 --> 00:48:38,559
to look at all these images in fact

1333
00:48:43,349 --> 00:48:40,880
we're not even planning to do that no

1334
00:48:44,950 --> 00:48:43,359
software is is not trivial is there any

1335
00:48:45,750 --> 00:48:44,960
brilliant people out there who'd love a

1336
00:48:48,230 --> 00:48:45,760
job

1337
00:48:50,710 --> 00:48:48,240
there you go folks this is your chance

1338
00:48:52,710 --> 00:48:50,720

sen that's robert lupton the good at

1339
00:48:54,710 --> 00:48:52,720
princeton

1340
00:48:57,270 --> 00:48:54,720
just google for rubble up to the good i

1341
00:49:02,870 --> 00:49:00,150
okay so i got a couple questions here um

1342
00:49:04,790 --> 00:49:02,880
from the uh from the q a app uh hugo

1343
00:49:06,710 --> 00:49:04,800
hugo burnham is going is asking how big

1344
00:49:09,190 --> 00:49:06,720
is a pixel and i guess we could do it

1345
00:49:10,549 --> 00:49:09,200
for either one lsst or uh pen stars but

1346
00:49:12,309 --> 00:49:10,559
let's do pan starts first how big is a

1347
00:49:16,470 --> 00:49:12,319
pis how big is a pixel

1348
00:49:19,270 --> 00:49:16,480
uh one pixel is uh 0.27 like seconds

1349
00:49:21,829 --> 00:49:19,280
and uh so one eight seconds is one

1350
00:49:24,790 --> 00:49:21,839
sixtieth of an arc minutes and uh one

1351
00:49:26,950 --> 00:49:24,800
like minute is a 160s of one degree

1352
00:49:29,510 --> 00:49:26,960
so one like second there's a one over

1353
00:49:31,829 --> 00:49:29,520
three thousand six hundred degrees

1354
00:49:33,670 --> 00:49:31,839
but more interestingly stars on fan

1355
00:49:35,190 --> 00:49:33,680
stars are something like one arc second

1356
00:49:36,710 --> 00:49:35,200
across because of the atmosphere

1357
00:49:38,230 --> 00:49:36,720
blurring them out that's not how big

1358
00:49:40,230 --> 00:49:38,240
they really are it's how big they look

1359
00:49:43,030 --> 00:49:40,240
yes yeah so what you want to do in a

1360
00:49:45,349 --> 00:49:43,040
camera you want to basically resolve uh

1361
00:49:47,270 --> 00:49:45,359
the stars how it appears to you and so

1362
00:49:48,470 --> 00:49:47,280
you have basically four pixels on each

1363
00:49:49,990 --> 00:49:48,480

side

1364
00:49:52,150 --> 00:49:50,000
to bear first power

1365
00:49:54,630 --> 00:49:52,160
and for the hyper supreme cam the pixels

1366
00:49:57,510 --> 00:49:54,640
are 0.168 arc seconds because the

1367
00:49:59,109 --> 00:49:57,520
telescope is in fact widely believed

1368
00:50:01,910 --> 00:49:59,119
with the best telescope in the world you

1369
00:50:04,150 --> 00:50:01,920
need rather smaller pixels and lsst is

1370
00:50:05,910 --> 00:50:04,160
less ambitious they're 0.2 arc second

1371
00:50:07,670 --> 00:50:05,920
pixels

1372
00:50:10,230 --> 00:50:07,680
and they're about 15 microns if you

1373
00:50:11,510 --> 00:50:10,240
really want to know

1374
00:50:13,589 --> 00:50:11,520
that's right so these were all

1375
00:50:15,910 --> 00:50:13,599
previously the amount of sky that

1376
00:50:16,870 --> 00:50:15,920
projects into each pixel but then

1377
00:50:18,950 --> 00:50:16,880
robert's

1378
00:50:21,109 --> 00:50:18,960
was the actual physical size of each

1379
00:50:22,630 --> 00:50:21,119
pixel on the camera yeah if you took a

1380
00:50:28,230 --> 00:50:22,640
micrometer and tried to measure it

1381
00:50:32,790 --> 00:50:30,950
0.2 second pixels

1382
00:50:34,630 --> 00:50:32,800
the same size as pen stars yeah it's

1383
00:50:36,870 --> 00:50:34,640
very similar they're very similar yeah

1384
00:50:38,549 --> 00:50:36,880
what is the limit for seeing on earth

1385
00:50:41,670 --> 00:50:38,559
the best place in the world gives you

1386
00:50:44,069 --> 00:50:41,680
what seeing the best it partly depends

1387
00:50:46,790 --> 00:50:44,079
on the wavelength um somewhere around

1388
00:50:48,390 --> 00:50:46,800

point four zero point four x seconds and

1389
00:50:51,270 --> 00:50:48,400
in fact on hyper supreme cam we've

1390
00:50:53,030 --> 00:50:51,280
routinely seen point four two arc second

1391
00:50:55,349 --> 00:50:53,040
point four five across the whole focal

1392
00:50:57,589 --> 00:50:55,359
plane but most ground-based telescopes

1393
00:50:59,430 --> 00:50:57,599
aren't that good

1394
00:51:01,190 --> 00:50:59,440
you can do what's called adaptive optics

1395
00:51:02,790 --> 00:51:01,200
where you look at a star and you adjust

1396
00:51:04,950 --> 00:51:02,800
the mirror to take out the effects of

1397
00:51:07,030 --> 00:51:04,960
the atmosphere and that works very well

1398
00:51:09,670 --> 00:51:07,040
over very very small fields of view they

1399
00:51:11,829 --> 00:51:09,680
make hst look good put it that way yeah

1400
00:51:14,230 --> 00:51:11,839
they but neither pan stars nor lsst is

1401
00:51:16,150 --> 00:51:14,240
doing a adaptive optics right you can't

1402
00:51:18,309 --> 00:51:16,160
is the problem because you can correct

1403
00:51:19,990 --> 00:51:18,319
this teeny tiny part of the sky but

1404
00:51:21,670 --> 00:51:20,000
we're looking at a very large part of

1405
00:51:22,790 --> 00:51:21,680
the sky but not the whole area that

1406
00:51:24,790 --> 00:51:22,800
they're looking at that's yeah that

1407
00:51:26,470 --> 00:51:24,800
would be a big challenge right so i used

1408
00:51:28,710 --> 00:51:26,480
to work at canada france and we got

1409
00:51:30,950 --> 00:51:28,720
better seeing that on a routine basis

1410
00:51:33,109 --> 00:51:30,960
but as they point out it's in a very

1411
00:51:35,670 --> 00:51:33,119
small field of view the outside field of

1412
00:51:37,990 --> 00:51:35,680
view wouldn't be as good because the way

1413
00:51:40,950 --> 00:51:38,000

the atmosphere moves you can get little

1414
00:51:42,710 --> 00:51:40,960
little snippets of places where the

1415
00:51:45,030 --> 00:51:42,720
image quality is magnificent and in

1416
00:51:47,510 --> 00:51:45,040
other places it's not so good so as far

1417
00:51:50,150 --> 00:51:47,520
as wide field you have a problem we're

1418
00:51:52,710 --> 00:51:50,160
always going to be limited by uh the sky

1419
00:51:53,829 --> 00:51:52,720
it looks like as well that's why we put

1420
00:51:55,750 --> 00:51:53,839
telescopes

1421
00:51:57,670 --> 00:51:55,760
yeah and there are various ideas for

1422
00:51:59,349 --> 00:51:57,680
doing better from the ground so we may

1423
00:52:01,430 --> 00:51:59,359
be able to get somewhat bigger fields

1424
00:52:02,630 --> 00:52:01,440
but that's a different talk i think

1425
00:52:04,790 --> 00:52:02,640
all right let me get to another question

1426
00:52:07,829 --> 00:52:04,800
uh is this is from adam synergy also

1427
00:52:10,950 --> 00:52:07,839
from the q a app is pan stars used to

1428
00:52:12,950 --> 00:52:10,960
hunt for kuiper belt objects um and is

1429
00:52:16,790 --> 00:52:12,960
it being used to help find a second

1430
00:52:18,230 --> 00:52:16,800
target for the new horizons flyby

1431
00:52:19,589 --> 00:52:18,240
recently in case you don't know it was

1432
00:52:21,510 --> 00:52:19,599
recently announced that hubble is going

1433
00:52:23,430 --> 00:52:21,520
to look and try to give some targets for

1434
00:52:25,750 --> 00:52:23,440
new horizons to go to i could take the

1435
00:52:27,430 --> 00:52:25,760
second half if you want to yeah so we

1436
00:52:29,430 --> 00:52:27,440
definitely look for for chiba build

1437
00:52:31,750 --> 00:52:29,440
objects yes that's one of the science

1438
00:52:33,270 --> 00:52:31,760

goals and we have already put out a a

1439
00:52:36,390 --> 00:52:33,280
few papers i don't know exactly the

1440
00:52:38,630 --> 00:52:36,400
details but uh yes i mean it's ideal to

1441
00:52:40,470 --> 00:52:38,640
find capable objects as well

1442
00:52:42,150 --> 00:52:40,480
right so one of penstar's main missions

1443
00:52:44,630 --> 00:52:42,160
is finding objects that move and the

1444
00:52:46,790 --> 00:52:44,640
coip objects move and so it's ideally

1445
00:52:48,710 --> 00:52:46,800
suited for pen stars in principle

1446
00:52:51,910 --> 00:52:48,720
and of course lsst will do that too but

1447
00:52:54,150 --> 00:52:51,920
it's going to be on the sky around 2022

1448
00:52:55,670 --> 00:52:54,160
rather than now so pan stars gets a good

1449
00:52:57,990 --> 00:52:55,680
chance to take a first bite at the

1450
00:53:01,430 --> 00:52:58,000
cherry or apple or everyone takes bites

1451
00:53:03,109 --> 00:53:01,440
off these days

1452
00:53:05,349 --> 00:53:03,119
well i think the answer is which country

1453
00:53:07,829 --> 00:53:05,359
is ecuadorians isn't it no

1454
00:53:12,950 --> 00:53:11,270
so on the new horizons um so this is a

1455
00:53:14,309 --> 00:53:12,960
pluto mission as you know and it's

1456
00:53:16,950 --> 00:53:14,319
trying to find a copper belt object

1457
00:53:19,030 --> 00:53:16,960
behind pluto the trouble is pluto is

1458
00:53:20,950 --> 00:53:19,040
currently in front of the sagittarius

1459
00:53:23,910 --> 00:53:20,960
that's the center of the galaxy so it's

1460
00:53:27,030 --> 00:53:23,920
a very very crowded field

1461
00:53:29,270 --> 00:53:27,040
the to find moving things behind that

1462
00:53:30,790 --> 00:53:29,280
you really need very good image quality

1463
00:53:32,309 --> 00:53:30,800

so it's not quite clear how that's going

1464
00:53:34,150 --> 00:53:32,319
to be done but probably not with pen

1465
00:53:35,829 --> 00:53:34,160
stars there's a chance you can do it

1466
00:53:37,589 --> 00:53:35,839
with hyper supreme cam

1467
00:53:39,109 --> 00:53:37,599
as i mentioned the subaru telescope

1468
00:53:41,589 --> 00:53:39,119
which was an incredibly expensive

1469
00:53:44,069 --> 00:53:41,599
japanese telescope does produce superb

1470
00:53:48,390 --> 00:53:44,079
image quality and there is an attempt to

1471
00:53:51,349 --> 00:53:48,400
use hsc hyper supreme cam not hst

1472
00:53:54,069 --> 00:53:51,359
to find copper belt objects behind um

1473
00:53:55,910 --> 00:53:54,079
behind pluto and it's not clear if that

1474
00:53:57,589 --> 00:53:55,920
will work there's also an attempt to use

1475
00:53:59,270 --> 00:53:57,599
hubble space telescope to do it and i'm

1476
00:54:01,349 --> 00:53:59,280
not sure which is going to end up being

1477
00:54:03,510 --> 00:54:01,359
the correct answer

1478
00:54:04,710 --> 00:54:03,520
yeah so yeah so it is but they are going

1479
00:54:06,230 --> 00:54:04,720
to at least they're i think they're

1480
00:54:08,309 --> 00:54:06,240
working now on finding some targets or

1481
00:54:10,150 --> 00:54:08,319
at least looking to plan the observing

1482
00:54:12,230 --> 00:54:10,160
for hubble to do the same thing so we'll

1483
00:54:14,630 --> 00:54:12,240
see how that plays out well guys i guess

1484
00:54:16,150 --> 00:54:14,640
that's i'll go ahead and stop here um i

1485
00:54:17,589 --> 00:54:16,160
want to thank you guys very much for

1486
00:54:19,349 --> 00:54:17,599
taking time out of the workshop to speak

1487
00:54:20,790 --> 00:54:19,359
to us this has been a lot of fun robert

1488
00:54:23,190 --> 00:54:20,800

and armin it was wonderful to see you

1489
00:54:24,790 --> 00:54:23,200
guys again and i hope i can get you guys

1490
00:54:27,270 --> 00:54:24,800
back and eddie welcome for the first

1491
00:54:28,549 --> 00:54:27,280
time was a pleasure to meet you

1492
00:54:30,790 --> 00:54:28,559
yeah you guys coming back for another

1493
00:54:32,790 --> 00:54:30,800
one how about some more lsst hangouts

1494
00:54:34,870 --> 00:54:32,800
robert we can make that happen let us

1495
00:54:43,270 --> 00:54:34,880
know all right all right we hope that

1496
00:54:46,790 --> 00:54:44,950
looking in the future is looking at

1497
00:54:49,430 --> 00:54:46,800
these guys

1498
00:54:52,950 --> 00:54:51,510
between jwst and lsst the future is

1499
00:54:54,549 --> 00:54:52,960
looking really good yeah absolutely

1500
00:54:56,390 --> 00:54:54,559
you're in a good place

1501
00:54:58,549 --> 00:54:56,400
yeah you're in a good spot for astronomy

1502
00:55:00,390 --> 00:54:58,559
for sure very exciting

1503
00:55:01,670 --> 00:55:00,400
okay so i'll uh i want to thank

1504
00:55:03,510 --> 00:55:01,680
everybody for watching on behalf of

1505
00:55:05,109 --> 00:55:03,520
carol christian i want to thank you very

1506
00:55:05,990 --> 00:55:05,119
much for watching our hubble hangout i

1507
00:55:07,670 --> 00:55:06,000
hope you'll

1508
00:55:08,870 --> 00:55:07,680
won't be around next week we are going

1509
00:55:10,630 --> 00:55:08,880
to be doing we are

1510
00:55:11,750 --> 00:55:10,640
because of the july 4th holiday we will

1511
00:55:12,870 --> 00:55:11,760
have one

1512
00:55:15,910 --> 00:55:12,880
oh what

1513
00:55:17,430 --> 00:55:15,920

fireworks yeah that's right yes and uh

1514
00:55:19,349 --> 00:55:17,440
but we will we will be back the

1515
00:55:20,870 --> 00:55:19,359
following week july 9th we'll be talking

1516
00:55:22,470 --> 00:55:20,880
about some citizen science initiatives

1517
00:55:24,790 --> 00:55:22,480
that are coming out so we hope you'll

1518
00:55:26,470 --> 00:55:24,800
join us then uh might actually be the

1519
00:55:27,910 --> 00:55:26,480
10th but yeah

1520
00:55:28,950 --> 00:55:27,920
is it the 10th i thought it was the 9th

1521
00:55:31,510 --> 00:55:28,960
okay

1522
00:55:34,630 --> 00:55:31,520
is the 4th if that helps

1523
00:55:39,270 --> 00:55:37,190
i believe it's thursday the 10th but far

1524
00:55:40,790 --> 00:55:39,280
be it for me

1525
00:55:41,750 --> 00:55:40,800
i think we're going back to our thursday

1526
00:55:43,829 --> 00:55:41,760
schedule

1527
00:55:45,670 --> 00:55:43,839
okay and and i just got a really brief

1528
00:55:48,309 --> 00:55:45,680
comment from petaflux on youtube that

1529
00:55:50,390 --> 00:55:48,319
says i think you should build an ist an

1530
00:55:52,309 --> 00:55:50,400
international space telescope that gets

1531
00:55:53,990 --> 00:55:52,319
bigger and bigger over time i'm not sure

1532
00:55:56,230 --> 00:55:54,000
what that would look like maybe it could

1533
00:55:58,230 --> 00:55:56,240
have mirrors and a total diameter yeah

1534
00:55:59,910 --> 00:55:58,240
well one kilometer that is not the

1535
00:56:01,670 --> 00:55:59,920
stupidest idea in the world because

1536
00:56:03,750 --> 00:56:01,680
there was a proposal to do something

1537
00:56:06,069 --> 00:56:03,760
like that is to you know have you would

1538
00:56:07,670 --> 00:56:06,079

have these segments and then you would

1539
00:56:10,230 --> 00:56:07,680
build a basic telescope and then

1540
00:56:11,910 --> 00:56:10,240
eventually you know you'd send up robots

1541
00:56:14,230 --> 00:56:11,920
with additional pieces that would all

1542
00:56:17,030 --> 00:56:14,240
fit together be quite challenging but

1543
00:56:19,190 --> 00:56:17,040
interesting nonetheless yeah

1544
00:56:20,309 --> 00:56:19,200
thank you for that okay guys

1545
00:56:22,630 --> 00:56:20,319
that's it