

2 ASTROBIOLOGY
0 GRADUATE
1 CONFERENCE
7



CHARLOTTESVILLE, VA

1
00:00:00,790 --> 00:00:09,640

[Music]

2
00:00:14,780 --> 00:00:11,780

good evening everyone thank you for

3
00:00:19,040 --> 00:00:14,790

coming out this is the first session of

4
00:00:21,260 --> 00:00:19,050

Astro biology graduate conference 2017

5
00:00:23,090 --> 00:00:21,270

it's very exciting Thank You Brett for

6
00:00:24,710 --> 00:00:23,100

helping to leave the the charge on this

7
00:00:26,990 --> 00:00:24,720

one what I'm going to introduce to you

8
00:00:28,790 --> 00:00:27,000

guys today is a session that has been

9
00:00:30,500 --> 00:00:28,800

leveling lovingly called the building

10
00:00:33,680 --> 00:00:30,510

planets and listening to the songs of

11
00:00:35,150 --> 00:00:33,690

their peoples session and so what I'm

12
00:00:38,119 --> 00:00:35,160

going to do is introduce you to the

13
00:00:42,410 --> 00:00:38,129

schedule there is a slight change

14

00:00:44,270 --> 00:00:42,420

Amelio is actually currently in transit

15

00:00:47,779 --> 00:00:44,280

so his talk is going to be bumped to

16

00:00:50,389 --> 00:00:47,789

just before the winning PWR presentation

17

00:00:52,490 --> 00:00:50,399

so Ryan Loomis if you're in the audience

18

00:00:53,600 --> 00:00:52,500

if you can come get Mike DUP yeah that's

19

00:00:56,360 --> 00:00:53,610

you

20

00:00:59,869 --> 00:00:56,370

so Ryan's gonna take it off as soon as

21

00:01:01,549 --> 00:00:59,879

we get done with this intro talk but as

22

00:01:04,219 --> 00:01:01,559

you can see we're kind of all over the

23

00:01:06,469 --> 00:01:04,229

map here we've got some SETI we've got a

24

00:01:09,080 --> 00:01:06,479

couple of talks about disks and then

25

00:01:10,820 --> 00:01:09,090

we've got planets orbiting white dwarves

26
00:01:13,330 --> 00:01:10,830
and then we've got some education with

27
00:01:16,460 --> 00:01:13,340
the coherent content storyline on

28
00:01:18,649 --> 00:01:16,470
exoplanets now it seems like these are

29
00:01:21,499 --> 00:01:18,659
all very disparate ideas but I want to

30
00:01:23,510 --> 00:01:21,509
assure you that in the grand scheme of

31
00:01:26,780 --> 00:01:23,520
astrobiology no idea is too far-fetched

32
00:01:29,179 --> 00:01:26,790
to find a home and as you can see here

33
00:01:32,660 --> 00:01:29,189
on this lovely diagram of this entire

34
00:01:34,609 --> 00:01:32,670
session the universe and you know the

35
00:01:36,679 --> 00:01:34,619
galaxies and the solar system starts off

36
00:01:39,289 --> 00:01:36,689
as some nebulous cloud condenses down to

37
00:01:41,929 --> 00:01:39,299
a disk we get a star that star lives for

38
00:01:44,179 --> 00:01:41,939

some 10 billion years or so and then

39

00:01:48,200 --> 00:01:44,189

explodes and dies and leaves us with a

40

00:01:51,649 --> 00:01:48,210

white dwarf now just to put all of the

41

00:01:53,539 --> 00:01:51,659

talks into some sort of context we think

42

00:01:55,819 --> 00:01:53,549

that somewhere in here we might find

43

00:01:58,399 --> 00:01:55,829

some intelligent life form that may want

44

00:02:03,920 --> 00:01:58,409

to communicate with us if you know we're

45

00:02:05,480 --> 00:02:03,930

cool and don't panic the idea here is

46

00:02:08,389 --> 00:02:05,490

that you also need to worry about how

47

00:02:12,380 --> 00:02:08,399

disks form and evolve because that's how

48

00:02:13,680 --> 00:02:12,390

planets form and their host stars around

49

00:02:16,770 --> 00:02:13,690

their host stars

50

00:02:18,930 --> 00:02:16,780

and we're also going to about white

51
00:02:22,190 --> 00:02:18,940
tours which is the the sort of terminal

52
00:02:26,580 --> 00:02:22,200
end point for low mass stellar objects

53
00:02:28,650 --> 00:02:26,590
throughout the universe and then we're

54
00:02:30,090 --> 00:02:28,660
also going to figure out how you might

55
00:02:33,120 --> 00:02:30,100
teach this stuff how you might introduce

56
00:02:36,210 --> 00:02:33,130
it to an audience either your peers or

57
00:02:39,570 --> 00:02:36,220
more likely an audience of middle school

58
00:02:42,060 --> 00:02:39,580
to high school students and so just to

59
00:02:43,830 --> 00:02:42,070
put some names on here this is sort of

60
00:02:49,410 --> 00:02:43,840
the breakdown for who's going to be

61
00:02:51,570 --> 00:02:49,420
talking about what now because I

62
00:02:52,950 --> 00:02:51,580
uploaded this before the last minute

63
00:02:54,210 --> 00:02:52,960

schedule change it's going to be

64

00:02:57,240 --> 00:02:54,220

slightly out of order so I'm going to

65

00:03:00,510 --> 00:02:57,250

introduce you to the SETI talk first

66

00:03:02,100 --> 00:03:00,520

which is based on some work that's being

67

00:03:04,020 --> 00:03:02,110

funded through the break through listen

68

00:03:05,490 --> 00:03:04,030

project which has devoted about a

69

00:03:10,590 --> 00:03:05,500

hundred million dollars over the next

70

00:03:13,130 --> 00:03:10,600

ten years to try to find aliens now the

71

00:03:16,200 --> 00:03:13,140

way they're doing it with modern

72

00:03:17,910 --> 00:03:16,210

technologies is for example 100-meter a

73

00:03:19,830 --> 00:03:17,920

Green Bank telescope which is as I

74

00:03:24,840 --> 00:03:19,840

understand the largest steerable radio

75

00:03:27,500 --> 00:03:24,850

antenna in the world the largest the

76
00:03:29,750 --> 00:03:27,510
largest steerable structure in the world

77
00:03:32,310 --> 00:03:29,760
that's crazy

78
00:03:36,570 --> 00:03:32,320
and then some smaller ones but who cares

79
00:03:38,550 --> 00:03:36,580
about those so those are the current

80
00:03:41,260 --> 00:03:38,560
technologies no we don't care about you

81
00:03:46,580 --> 00:03:43,910
so those are what we're currently using

82
00:03:48,500 --> 00:03:46,590
to try to find these radio signals that

83
00:03:50,810 --> 00:03:48,510
other intelligent species might be

84
00:03:52,820 --> 00:03:50,820
sending out we're also using something

85
00:03:54,950 --> 00:03:52,830
called LOFAR which the low-frequency

86
00:03:56,750 --> 00:03:54,960
array that's looking for similar

87
00:03:59,240 --> 00:03:56,760
transmissions from other types of

88
00:04:01,010 --> 00:03:59,250

objects and together these current

89

00:04:03,140 --> 00:04:01,020

technologies are really trying to reach

90

00:04:05,780 --> 00:04:03,150

out and touch something like the nearest

91

00:04:08,810 --> 00:04:05,790

hundred thousand stars in the system and

92

00:04:10,580 --> 00:04:08,820

if this works okay so we're going to

93

00:04:12,320 --> 00:04:10,590

take a small tour just to give you an

94

00:04:15,970 --> 00:04:12,330

idea of the sense of the scale of this

95

00:04:18,860 --> 00:04:15,980

SETI search so obviously this is the Sun

96

00:04:21,800 --> 00:04:18,870

it's a pretty cool Sun you might say and

97

00:04:24,380 --> 00:04:21,810

then that's the solar system to give you

98

00:04:30,220 --> 00:04:24,390

a sense of scale I'm not entirely sure

99

00:04:34,700 --> 00:04:32,510

obviously voyager is the farthest flung

100

00:04:38,150 --> 00:04:34,710

human innovation in the history of the

101
00:04:41,000 --> 00:04:38,160
earth as far as we know and so that's

102
00:04:43,310 --> 00:04:41,010
one light year you can see that the Oort

103
00:04:44,960 --> 00:04:43,320
cloud is just a tiny little speck in the

104
00:04:48,320 --> 00:04:44,970
middle of the screen of this I'm sorry

105
00:04:49,700 --> 00:04:48,330
the Oort cloud is a speck now because

106
00:04:58,790 --> 00:04:49,710
you're starting to look at some of our

107
00:05:02,150 --> 00:04:58,800
nearest stars come on one more so that's

108
00:05:04,250 --> 00:05:02,160
sort of the local neighborhood these are

109
00:05:07,280 --> 00:05:04,260
some of the the brightest stars in the

110
00:05:08,840 --> 00:05:07,290
sky generally and some of the dimmest

111
00:05:10,159 --> 00:05:08,850
ones too because you can't actually see

112
00:05:15,469 --> 00:05:10,169
them with the naked eye in some cases

113
00:05:18,710 --> 00:05:15,479

and then we pause it here this is the

114

00:05:23,450 --> 00:05:18,720

nearest hundred thousand stars in the

115

00:05:31,510 --> 00:05:23,460

sky that's a lot of places to to knock

116

00:05:31,520 --> 00:05:36,450

bread

117

00:05:45,689 --> 00:05:43,860

I got it okay

118

00:05:46,980 --> 00:05:45,699

so like I said they're looking at

119

00:05:48,930 --> 00:05:46,990

something like the nearest hundred

120

00:05:51,659 --> 00:05:48,940

thousand stars which is a lot of real

121

00:05:54,029 --> 00:05:51,669

estate and not just with the current

122

00:05:55,469 --> 00:05:54,039

technologies but also with several new

123

00:05:59,129 --> 00:05:55,479

arrays that are coming online in the

124

00:06:00,360 --> 00:05:59,139

next couple years or tens of years for

125

00:06:02,490 --> 00:06:00,370

example in the next generation Very

126
00:06:04,920 --> 00:06:02,500
Large Array or the Square Kilometre

127
00:06:09,960 --> 00:06:04,930
Array these are very large radio

128
00:06:11,189 --> 00:06:09,970
telescope arrays and the one I believe

129
00:06:13,439 --> 00:06:11,199
we're going to hear about today

130
00:06:15,600 --> 00:06:13,449
assuming that Emilio actually does make

131
00:06:17,760 --> 00:06:15,610
his travel plans is going to be some

132
00:06:21,480 --> 00:06:17,770
work from the low-frequency array low

133
00:06:23,730 --> 00:06:21,490
farm to of the talks in this session are

134
00:06:26,550 --> 00:06:23,740
going to be about discs so here's a

135
00:06:28,140 --> 00:06:26,560
lovely JPL rendering of what we might

136
00:06:31,219 --> 00:06:28,150
see if we were actually able to get

137
00:06:33,600 --> 00:06:31,229
close enough to one of these discs

138
00:06:36,360 --> 00:06:33,610

thankfully we don't have to rely just on

139

00:06:39,540 --> 00:06:36,370

JPL animations we can actually observe

140

00:06:41,999 --> 00:06:39,550

these out in the the wild this is a

141

00:06:46,439 --> 00:06:42,009

Chell tower II and Alma image and this

142

00:06:48,930 --> 00:06:46,449

is Elias 227 which shows that lovely

143

00:06:51,120 --> 00:06:48,940

spiral arm structure that we tend to

144

00:06:53,060 --> 00:06:51,130

associate with galaxies but it also

145

00:06:57,149 --> 00:06:53,070

shows up in smaller scale features like

146

00:06:58,980 --> 00:06:57,159

protoplanetary disks now one of the

147

00:07:00,839 --> 00:06:58,990

really cool things about these disks is

148

00:07:03,779 --> 00:07:00,849

that they tend to be exceptionally

149

00:07:07,379 --> 00:07:03,789

short-lived and this is showing you how

150

00:07:10,409 --> 00:07:07,389

many stars at what age have a disk for

151

00:07:13,320 --> 00:07:10,419

example so most stars that are fairly

152

00:07:15,120 --> 00:07:13,330

young a few million years old 80 or 90

153

00:07:18,180 --> 00:07:15,130

percent of them tend to have disks and

154

00:07:20,459 --> 00:07:18,190

then as you get past between 15 and 20

155

00:07:22,770 --> 00:07:20,469

million years most of the disks have

156

00:07:24,749 --> 00:07:22,780

gone away so a lot of the planet

157

00:07:27,360 --> 00:07:24,759

building action occurs in an incredibly

158

00:07:30,540 --> 00:07:27,370

short amount of time and there's a lot

159

00:07:32,219 --> 00:07:30,550

of complexity a lot of richness in how

160

00:07:33,600 --> 00:07:32,229

these disks evolve and then we're going

161

00:07:37,050 --> 00:07:33,610

to hear about two different aspects of

162

00:07:39,450 --> 00:07:37,060

disks in terms of visualizing them and

163

00:07:42,450 --> 00:07:39,460

then modeling them with these magneto

164

00:07:44,430 --> 00:07:42,460

hydrodynamic models that couple the

165

00:07:46,439 --> 00:07:44,440

stellar magnetic fields with disk

166

00:07:49,610 --> 00:07:46,449

interactions to figure out how you might

167

00:07:52,490 --> 00:07:49,620

initiate either gap formation or

168

00:07:53,930 --> 00:07:52,500

rich location in material that you can

169

00:07:57,500 --> 00:07:53,940

form planets with it like you can see

170

00:07:59,090 --> 00:07:57,510

the gaps here and the bands so gaps can

171

00:08:00,530 --> 00:07:59,100

either be cleared by planets that are

172

00:08:02,719 --> 00:08:00,540

forming in that region or they can be

173

00:08:04,700 --> 00:08:02,729

cleared by magnetic field interactions

174

00:08:07,340 --> 00:08:04,710

with the disc and so there there's a lot

175

00:08:09,170 --> 00:08:07,350

of really rich material in here that you

176

00:08:11,060 --> 00:08:09,180

can sort of delve into and and you get

177

00:08:16,030 --> 00:08:11,070

different chunks of that disc depending

178

00:08:19,430 --> 00:08:16,040

on what you observe it with now to go to

179

00:08:21,379 --> 00:08:19,440

one of the other talks in our session we

180

00:08:23,810 --> 00:08:21,389

want to figure out where white dwarves

181

00:08:26,240 --> 00:08:23,820

live and so this is the famous

182

00:08:28,279 --> 00:08:26,250

hertzsprung-russell diagram this is the

183

00:08:32,750 --> 00:08:28,289

main sequence here the Sun is sitting

184

00:08:35,209 --> 00:08:32,760

prettily here it's about a g2 star now

185

00:08:37,010 --> 00:08:35,219

as the Sun evolves it will evolve into

186

00:08:38,810 --> 00:08:37,020

the Giants class and then it'll shoot

187

00:08:40,760 --> 00:08:38,820

over here and then down onto the white

188

00:08:43,790 --> 00:08:40,770

dwarf track because it's a smaller star

189

00:08:45,890 --> 00:08:43,800

anything about you know a few solar

190

00:08:47,540 --> 00:08:45,900

masses tends to evolve down onto the

191

00:08:49,910 --> 00:08:47,550

white dwarf tract anything larger than

192

00:08:51,920 --> 00:08:49,920

that turns into a black hole which you

193

00:08:53,810 --> 00:08:51,930

know it's harder to observe or not as

194

00:08:55,269 --> 00:08:53,820

interesting at least for the context of

195

00:09:00,500 --> 00:08:55,279

the session we're talking about today

196

00:09:04,310 --> 00:09:00,510

and white dwarves can start off really

197

00:09:06,710 --> 00:09:04,320

really really hot like tens of thousands

198

00:09:09,290 --> 00:09:06,720

of degrees even up to one literature

199

00:09:10,910 --> 00:09:09,300

survey suggested up to about a hundred

200

00:09:12,860 --> 00:09:10,920

and fifty thousand degrees when they

201

00:09:14,810 --> 00:09:12,870

start out but they cool relatively

202

00:09:17,120 --> 00:09:14,820

rapidly in that initial phase and then

203

00:09:19,130 --> 00:09:17,130

they they sit around the you know five

204

00:09:21,140 --> 00:09:19,140

to ten thousand degree range for a few

205

00:09:22,550 --> 00:09:21,150

billion years as they cool off towards

206

00:09:24,290 --> 00:09:22,560

that background temperature of the

207

00:09:27,470 --> 00:09:24,300

galaxy and one of the things you can see

208

00:09:29,750 --> 00:09:27,480

here is that for a white dwarf at a

209

00:09:32,510 --> 00:09:29,760

similar temperature to the Sun and as a

210

00:09:34,130 --> 00:09:32,520

similar blackbody spectrum so you might

211

00:09:38,390 --> 00:09:34,140

expect that it would be kind of like

212

00:09:40,040 --> 00:09:38,400

living under the Sun and that just shows

213

00:09:42,410 --> 00:09:40,050

you the evolution of habitable zone time

214

00:09:46,579 --> 00:09:42,420

is marching upwards in this diagram and

215

00:09:48,740 --> 00:09:46,589

the distance to the host star is here in

216

00:09:50,780 --> 00:09:48,750

this case it's the white dwarf and so I

217

00:09:55,519 --> 00:09:50,790

just want to point out that this tick

218

00:09:58,790 --> 00:09:55,529

mark here 0.005 au is equivalent to one

219

00:10:01,069 --> 00:09:58,800

solar radius so that means that if you

220

00:10:03,319 --> 00:10:01,079

had a main-sequence solar type star and

221

00:10:05,660 --> 00:10:03,329

you had a terrestrial planet litter

222

00:10:07,400 --> 00:10:05,670

we parked in its envelope and then that

223

00:10:09,619 --> 00:10:07,410

star exploded in that terrestrial planet

224

00:10:11,929 --> 00:10:09,629

managed to survive it would find itself

225

00:10:15,979 --> 00:10:11,939

in the the habitable zone of a white

226

00:10:17,749 --> 00:10:15,989

dwarf after about a billion years and so

227

00:10:20,419 --> 00:10:17,759

there's a lot of complexity and how you

228

00:10:22,069 --> 00:10:20,429

find planets well not in how you find

229

00:10:24,289 --> 00:10:22,079

plants but how you get planets to be

230

00:10:26,269 --> 00:10:24,299

that close to their parent stars after

231

00:10:29,359 --> 00:10:26,279

such a cataclysmic evolutionary event

232

00:10:31,160 --> 00:10:29,369

for them and just to point out that

233

00:10:33,829 --> 00:10:31,170

these white dwarves are incredibly small

234

00:10:35,179 --> 00:10:33,839

as well so they're bright small and

235

00:10:38,989 --> 00:10:35,189

that's why they're habitable zones are

236

00:10:41,859 --> 00:10:38,999

so close in and one of the last talks

237

00:10:45,530 --> 00:10:41,869

we're going to be hearing about today is

238

00:10:47,600 --> 00:10:45,540

the Danny Barringer's talk about the

239

00:10:49,699 --> 00:10:47,610

coherent content storyline which

240

00:10:51,949 --> 00:10:49,709

involves some elements from education

241

00:10:54,289 --> 00:10:51,959

including the claimed evidence and

242

00:10:56,179 --> 00:10:54,299

reasoning strategy where you make a

243

00:10:58,039 --> 00:10:56,189

claim about some result of an

244

00:11:00,530 --> 00:10:58,049

investigation and then you try to back

245

00:11:03,949 --> 00:11:00,540

it up and then you tie together those

246

00:11:06,049 --> 00:11:03,959

claims in that evidence and this is all

247

00:11:08,030 --> 00:11:06,059

part of the next generation science

248

00:11:10,759 --> 00:11:08,040

standards which looks at connecting

249

00:11:13,609 --> 00:11:10,769

scientific practices with core ideas and

250

00:11:15,679 --> 00:11:13,619

then sort of tying that into a broader

251
00:11:19,189 --> 00:11:15,689
context with these cross-cutting ideas

252
00:11:22,159 --> 00:11:19,199
these cross-cutting concepts and the

253
00:11:23,869 --> 00:11:22,169
cohesive content storyline is all about

254
00:11:27,049 --> 00:11:23,879
making sure that when you're telling

255
00:11:31,369 --> 00:11:27,059
someone a story about a scientific event

256
00:11:33,799 --> 00:11:31,379
or concept that the context in which you

257
00:11:37,429 --> 00:11:33,809
provide them that information all feeds

258
00:11:39,079 --> 00:11:37,439
into that main point and all feeds into

259
00:11:45,799 --> 00:11:39,089
that rational discussion about that

260
00:11:47,659 --> 00:11:45,809
concept and the after the session but

261
00:11:48,710 --> 00:11:47,669
it's sort of in the same session we're

262
00:11:50,889 --> 00:11:48,720
going to hear a little bit more about

263
00:11:53,119 --> 00:11:50,899

the proposal writing retreat which is a

264

00:11:54,859 --> 00:11:53,129

workshop that brings together a number

265

00:11:56,989 --> 00:11:54,869

of students it's actually 25

266

00:11:59,720 --> 00:11:56,999

participants this year in 9 different

267

00:12:02,389 --> 00:11:59,730

groups that wrote proposals that range

268

00:12:04,429 --> 00:12:02,399

from spectral polarimetry catalog for

269

00:12:07,280 --> 00:12:04,439

exoplanet surface characterization to

270

00:12:10,999 --> 00:12:07,290

the characterization of the solid geyser

271

00:12:13,400 --> 00:12:11,009

effluent and approach for Enceladus so

272

00:12:15,769 --> 00:12:13,410

lots of crazy stuff that's being

273

00:12:16,610 --> 00:12:15,779

suggested as potentially interesting for

274

00:12:19,490 --> 00:12:16,620

your

275

00:12:23,240 --> 00:12:19,500

peers and we'll hear more from that from

276

00:12:25,070 --> 00:12:23,250

Becky I believe later and so with that I

277

00:12:27,170 --> 00:12:25,080

would be happy to take any potential

278

00:12:29,080 --> 00:12:27,180

questions you might have

279

00:12:31,880 --> 00:12:29,090

first off the answer is going to be 42

280

00:12:34,070 --> 00:12:31,890

and then if you don't know or didn't

281

00:12:38,420 --> 00:12:34,080

catch it and that goes for this whole

282

00:12:48,290 --> 00:12:38,430

conference ask all right so I'll take

283

00:12:50,330 --> 00:12:48,300

questions I'll bring in Mike so you can

284

00:12:54,110 --> 00:12:50,340

be heard by the streamers Brent you get

285

00:12:56,660 --> 00:12:54,120

to be co-chairing um and then Bradley

286

00:13:01,100 --> 00:12:56,670

can be dealer yeah oh yeah you mentioned

287

00:13:03,980 --> 00:13:01,110

the SETI project there hundred thousand

288

00:13:06,380 --> 00:13:03,990

stars does anyone have like a rough

289

00:13:10,870 --> 00:13:06,390

estimation of how many like planets

290

00:13:13,910 --> 00:13:10,880

within that set

291

00:13:15,140 --> 00:13:13,920

I'm sure someone does but I think it's a

292

00:13:18,560 --> 00:13:15,150

large enough sample that it's going to

293

00:13:21,620 --> 00:13:18,570

follow the occurrence rates from Kepler

294

00:13:23,960 --> 00:13:21,630

so you know M star planets did you have

295

00:13:26,270 --> 00:13:23,970

a you have a question so it's going to

296

00:13:28,190 --> 00:13:26,280

follow Kepler statistics so you know

297

00:13:30,470 --> 00:13:28,200

about roughly 1/3 of the M stars will

298

00:13:31,910 --> 00:13:30,480

have planets and then you know roughly a

299

00:13:35,630 --> 00:13:31,920

quarter of the g-type stars will have

300

00:13:39,220 --> 00:13:35,640

plants so so special plants in our

301

00:13:41,900 --> 00:13:39,230

habitable zones I should say scale

302

00:13:43,940 --> 00:13:41,910

magnitude order of magnitude they're

303

00:13:46,040 --> 00:13:43,950

probably going to be anywhere between 10

304

00:13:47,600 --> 00:13:46,050

and 30 thousand terrestrial planets and

305

00:13:50,240 --> 00:13:47,610

available zones where on the nearest

306

00:13:52,470 --> 00:13:50,250

hundred thousand stars cool thank you