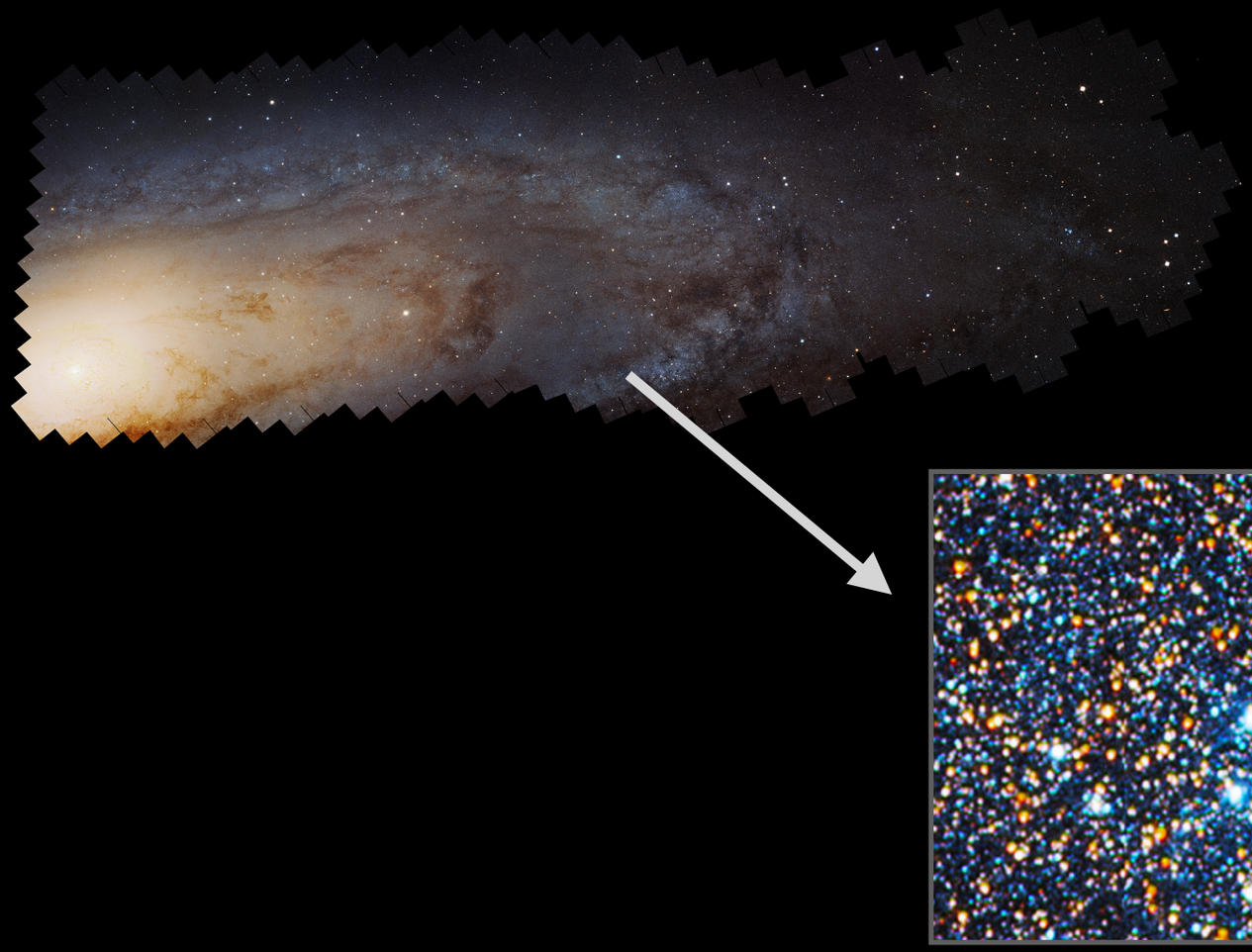
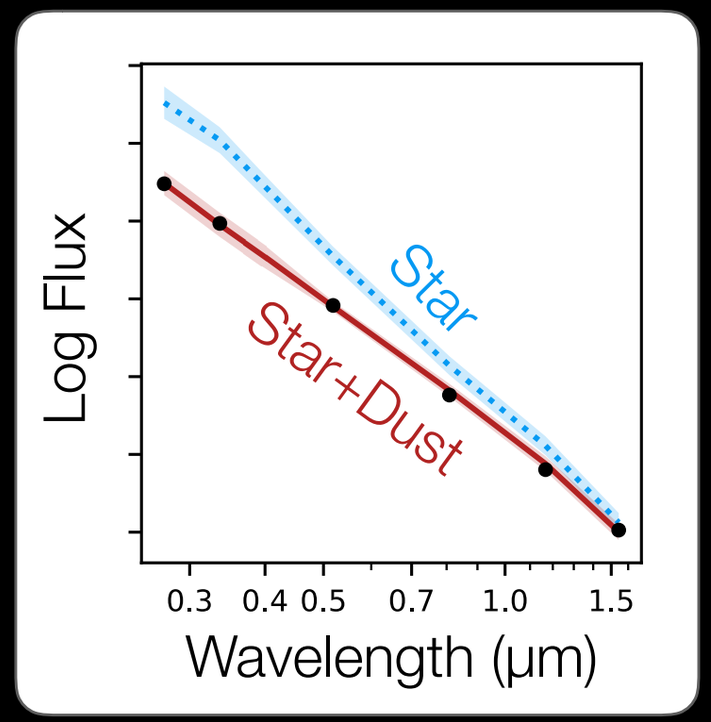
Modeling Stars and Dust with the BEAST





Lea Hagen
Postdoctoral Fellow
STScI

BEAST, METAL, SMIDGE,
LUVIT, and PHAT teams

The BEAST (Gordon+16)

Bayesian **E**xtinction **A**nd **S**tellar **T**ool

- SED fitter for individual stars: stellar and dust physics
- Use probabilistic/Bayesian techniques: can include priors, and allows for hierarchical models
- Artificial star tests to create accurate noise model
- Fast (~7 seconds per star) to fit 100M+ stars
- Open source and open development:
  `github.com/BEAST-Fitting/beast`
- Current active developers: Boyer, Choi, Durbin, Gordon, Goldman, Hagen, Johnson, Murray, Tchernyshyov, Van de Putte, Williams, Yanchulova Merica-Jones

The BEAST: 7 fitting parameters

Stellar parameters: birth mass, age, metallicity
→ map to radius, T_{eff}, log(g)

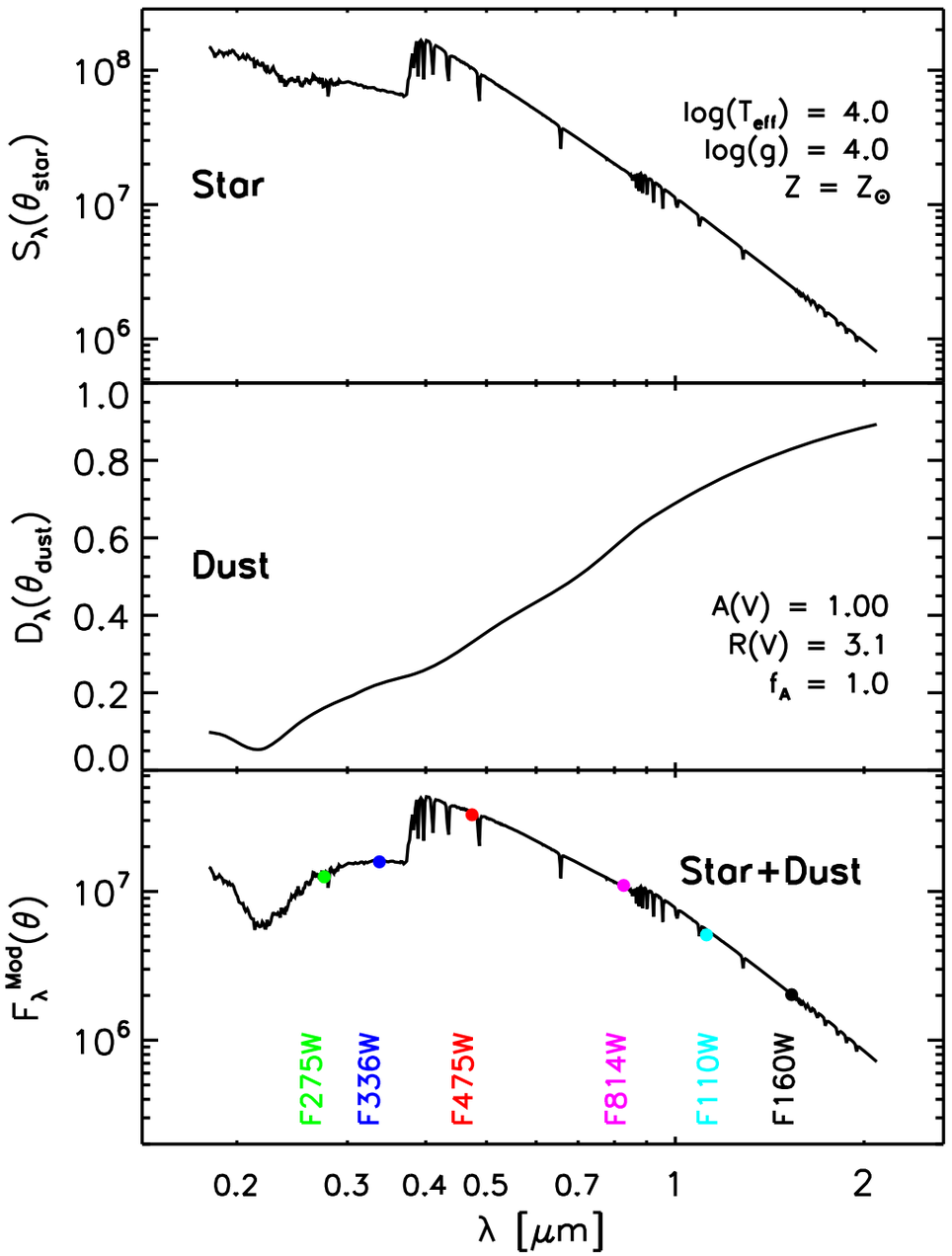
Dust parameters: A_V (dust column), R_V (grain size),
f_A (mixing between dust with/without 2175 Å bump)

Distance: can be constant or variable

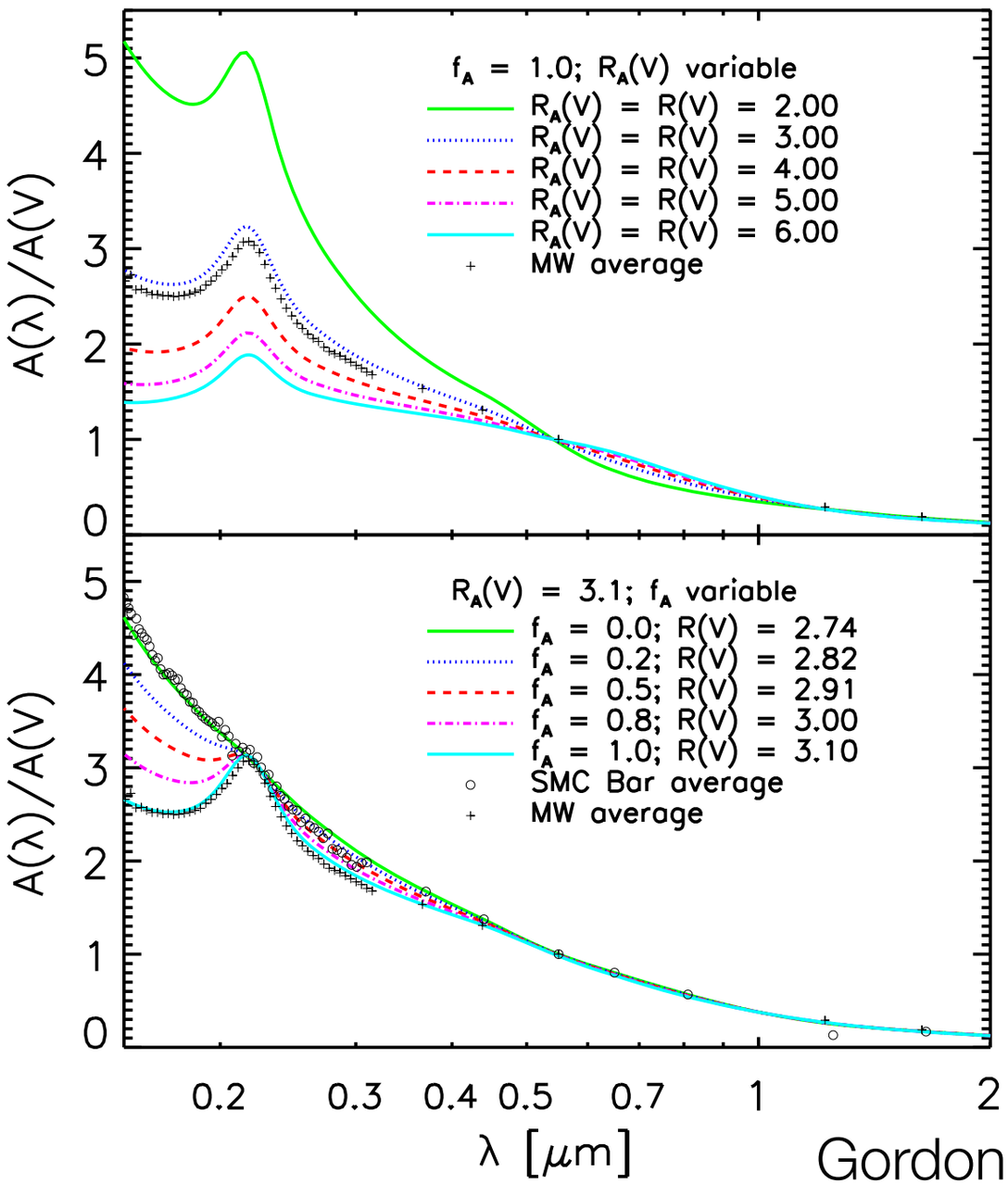
Gordon+16

The BEAST: 7 fitting parameters

SED construction



The family of extinction curves: varying R_V and f_A

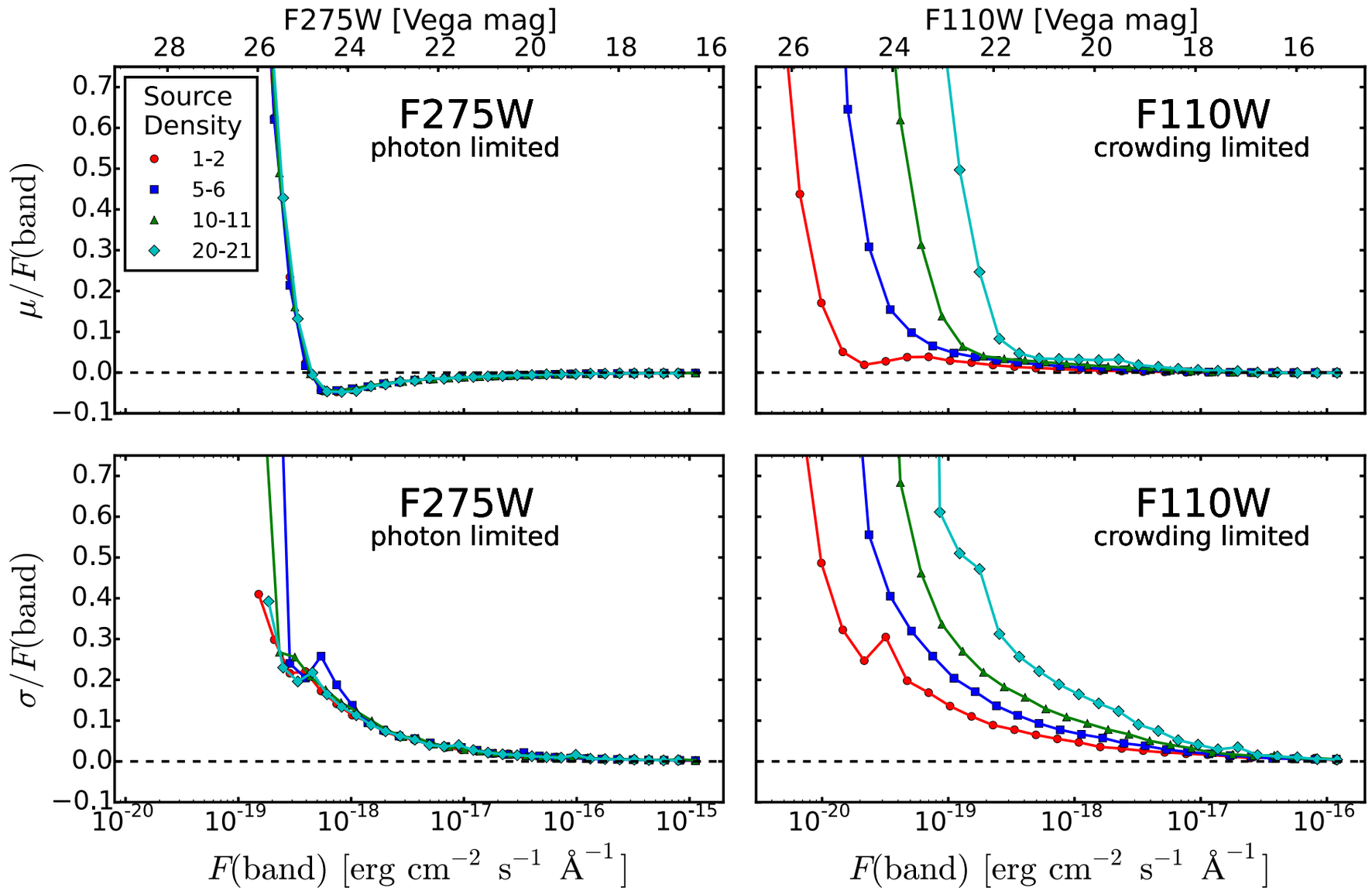


Gordon+16

The BEAST: source crowding impacts the noise properties

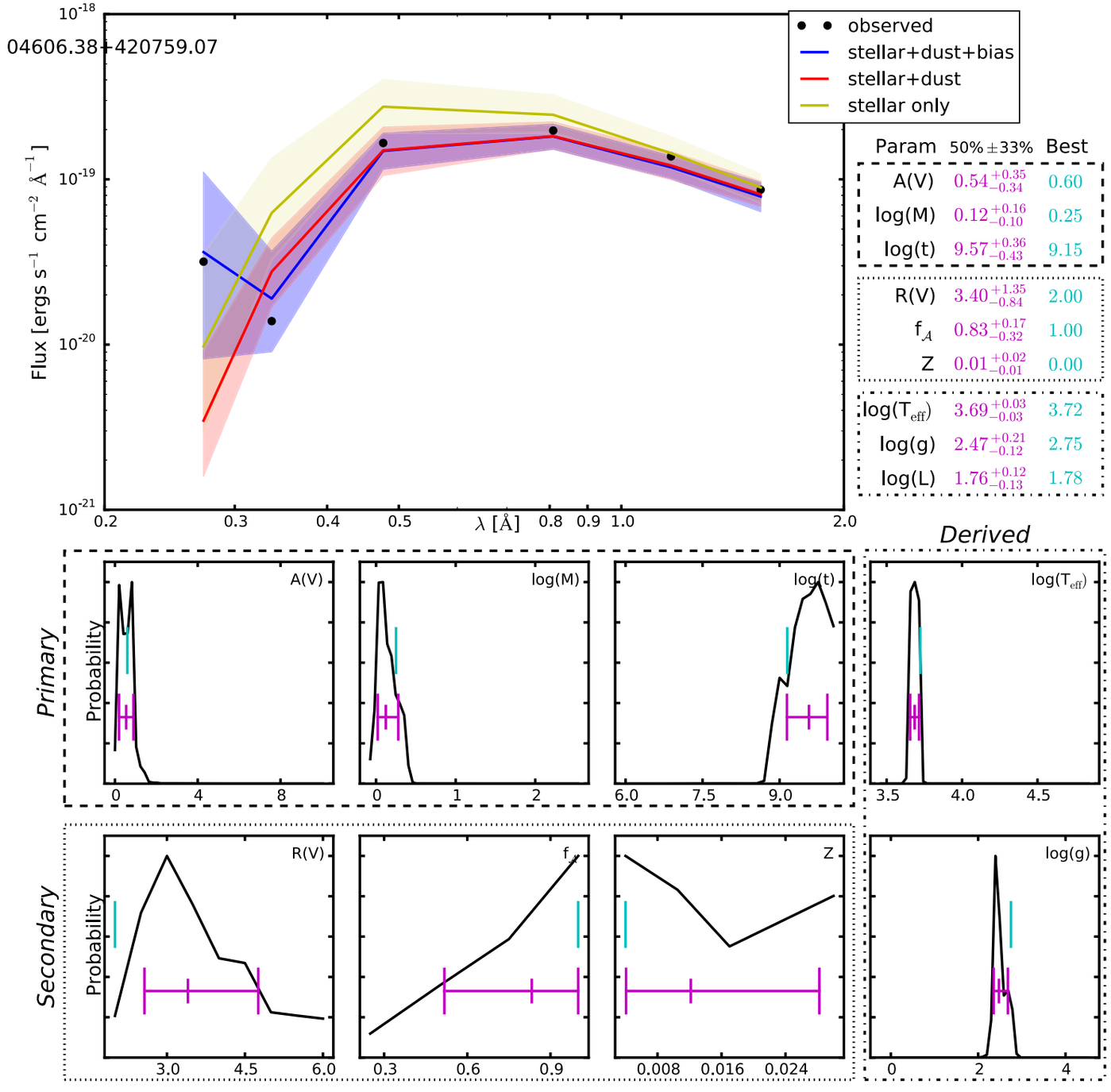
Bias

Uncertainty



Gordon+16

The BEAST: example fit for a PHAT source



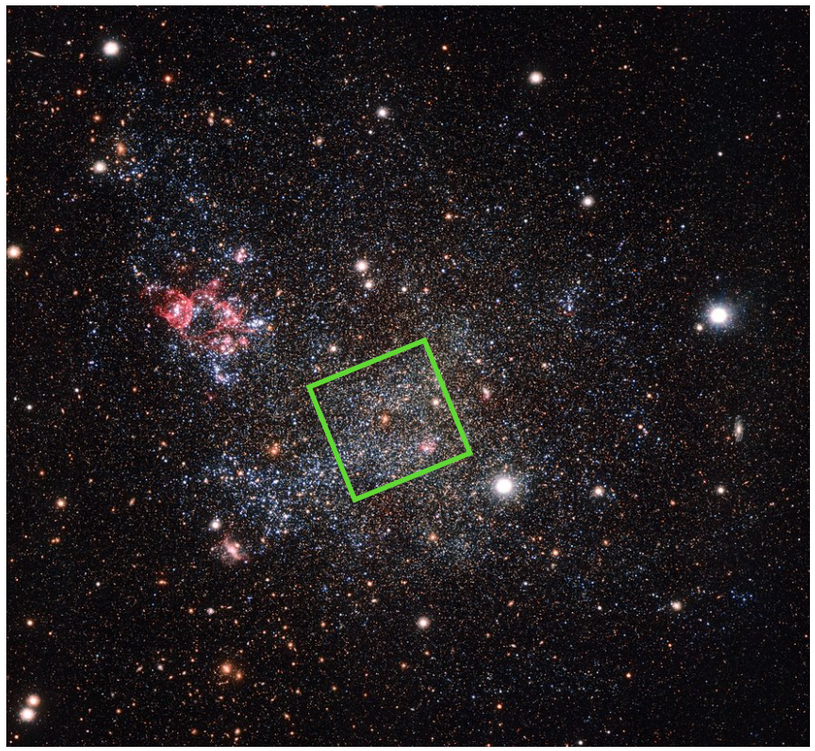
Primary parameters:
A_V, mass, age

Secondary parameters:
R_V, f_A, metallicity

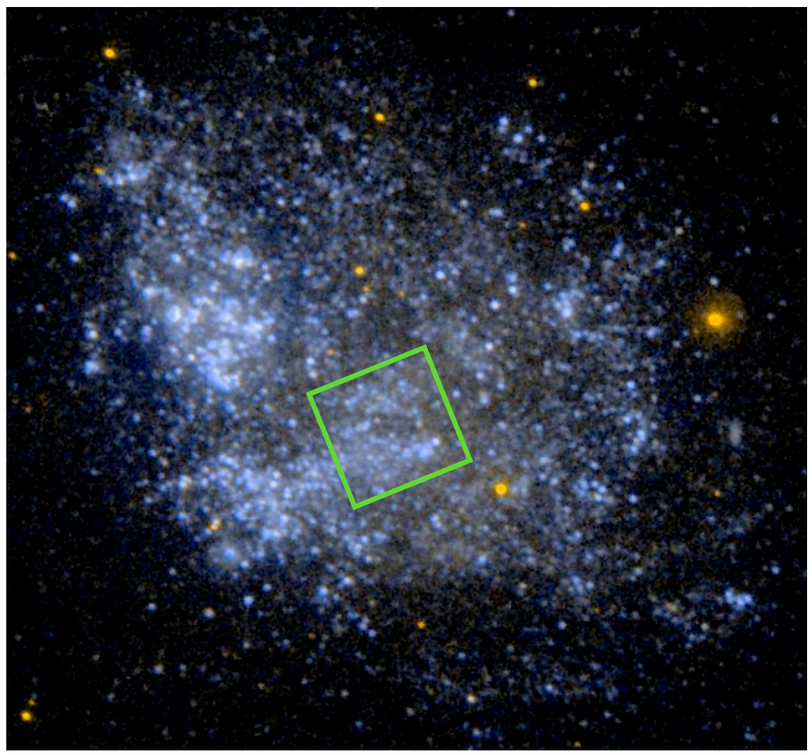
Derived parameters:
T_{eff}, log(g)

Gordon+16

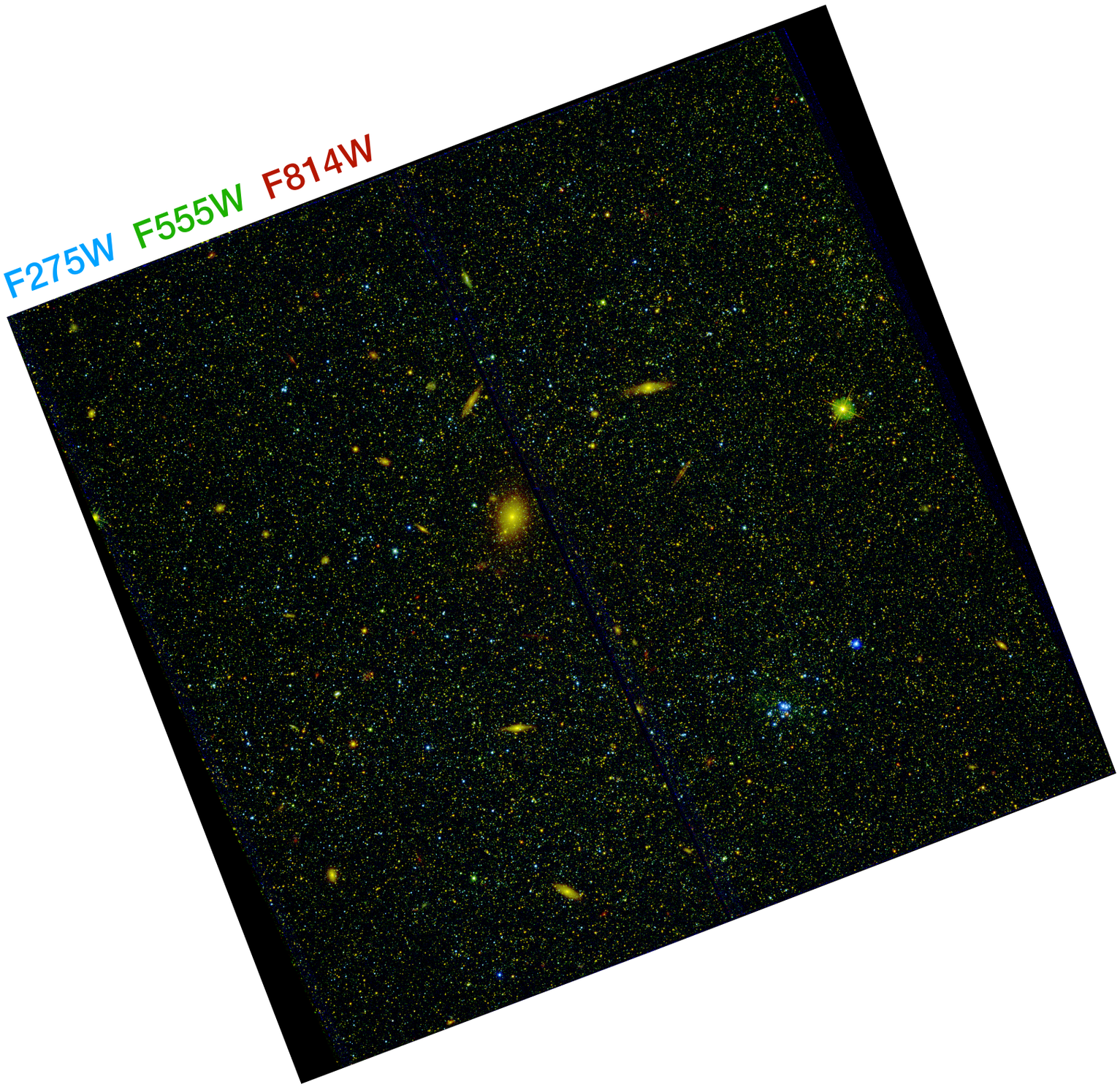
IC1613: ANGST+LUVIT HST imaging



ESO/VLT



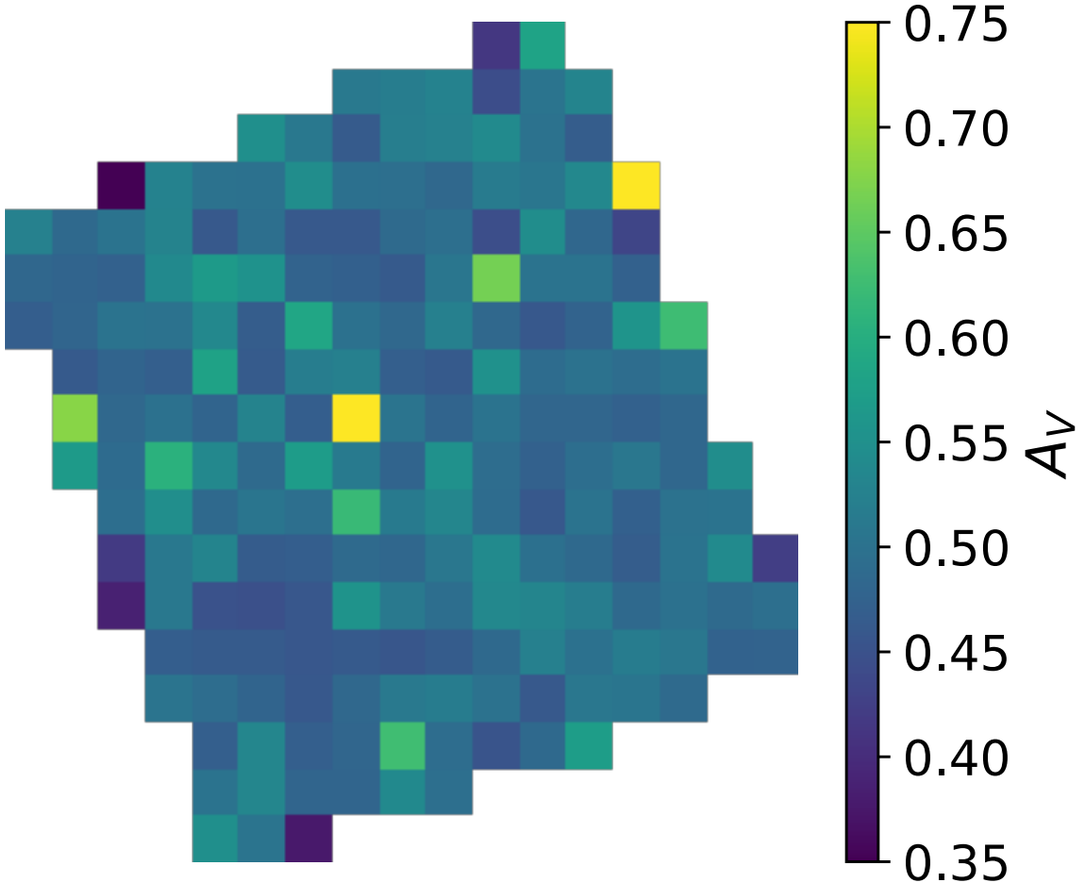
GALEX

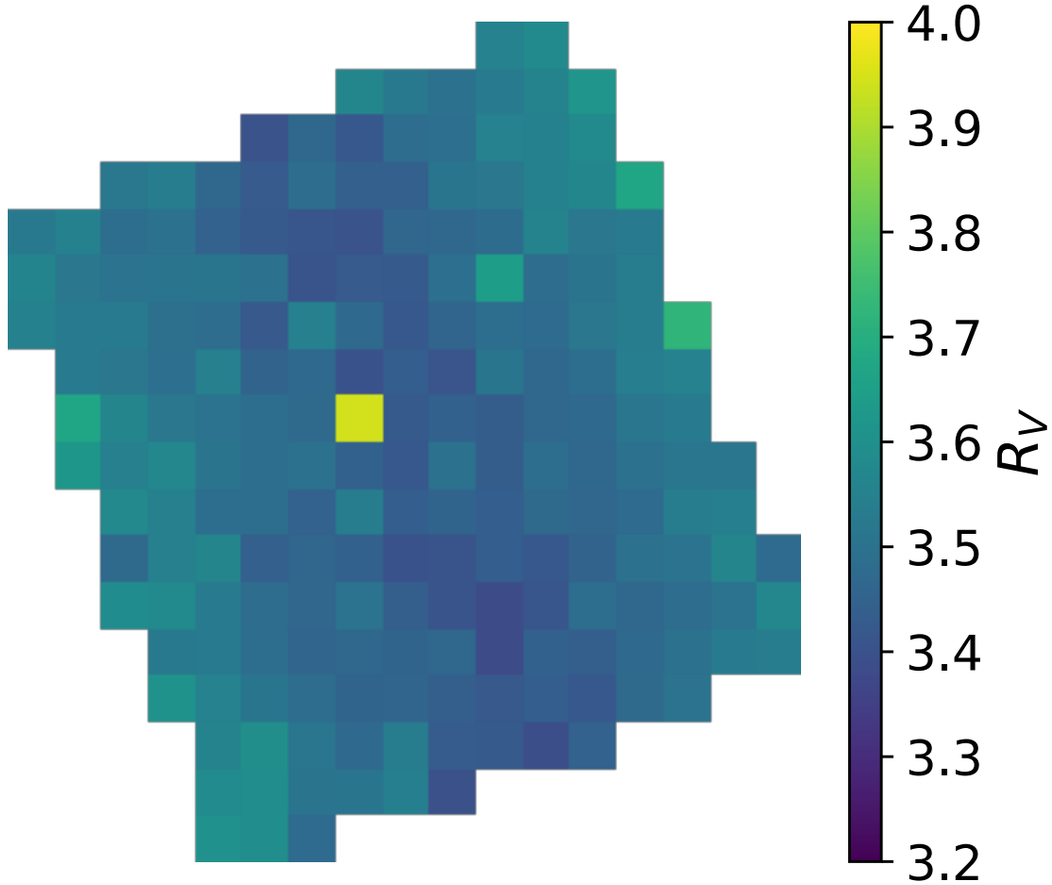


PIs: J. Dalcanton, K. Gilbert

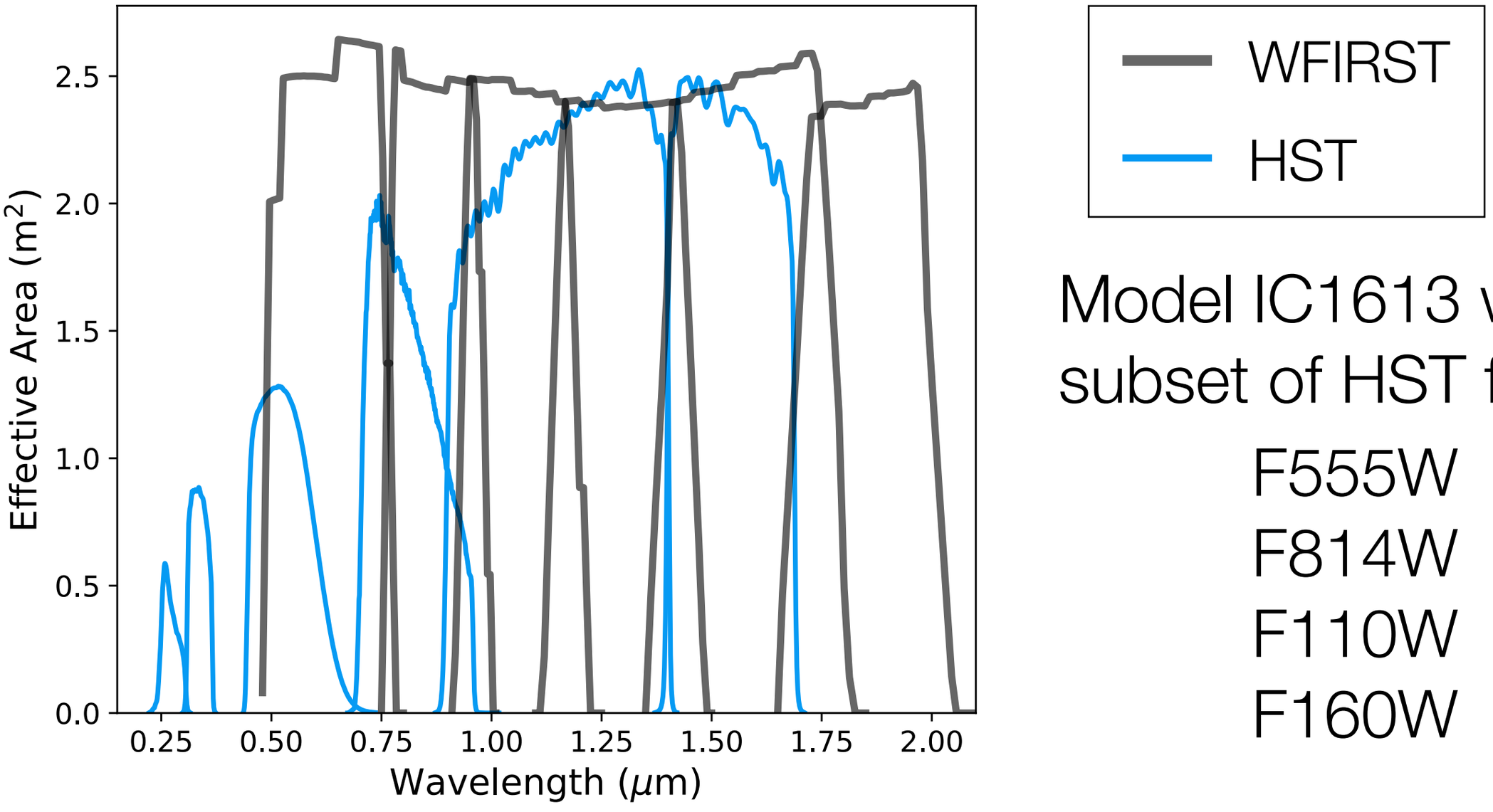
Naive maps of parameters in IC1613

Average of best-fit A_V and R_V in 10" pixels





Simulate WFIRST observations using overlapping HST filters



Model IC1613 with a subset of HST filters:

F555W

F814W

F110W

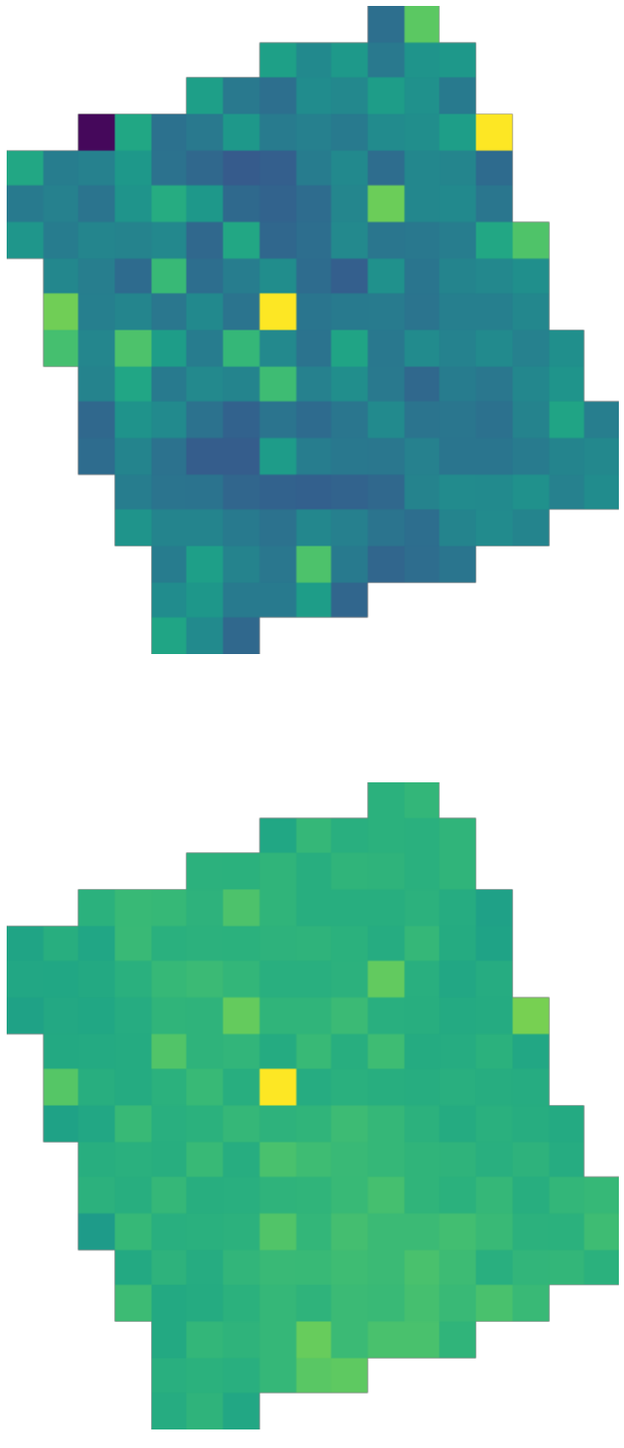
F160W

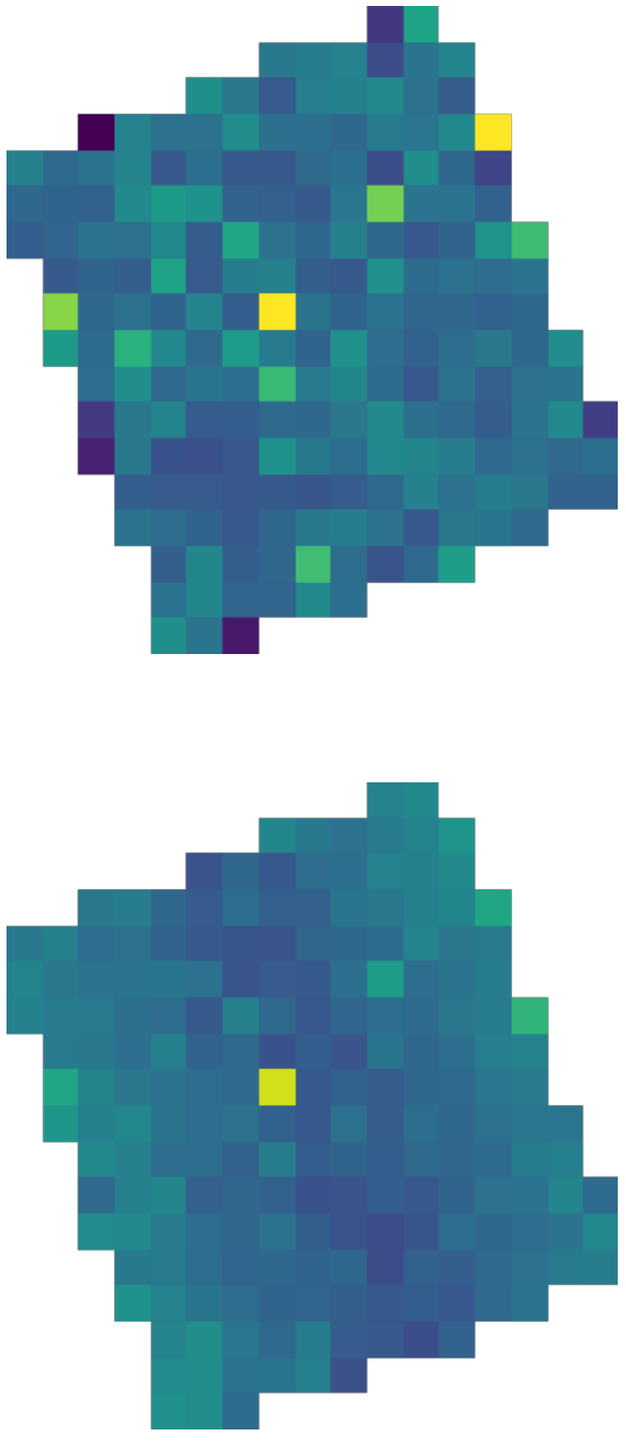
Naive maps of parameters in IC1613

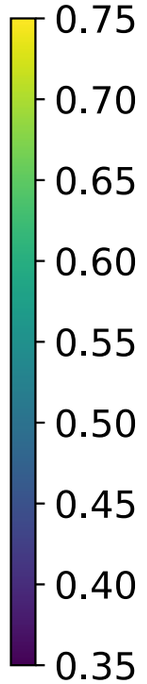
WFIRST simulation

Original filters

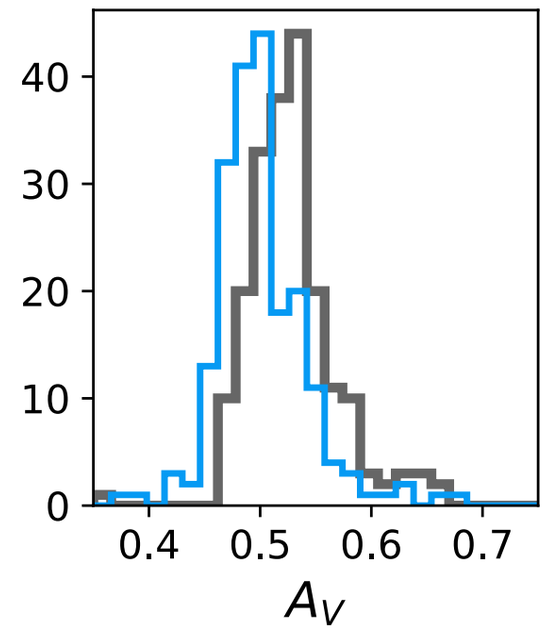
Pixel Histograms

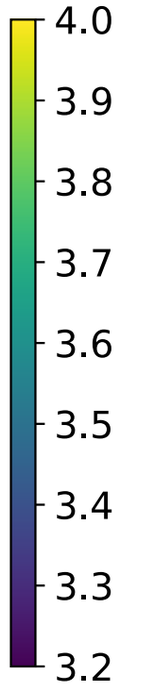




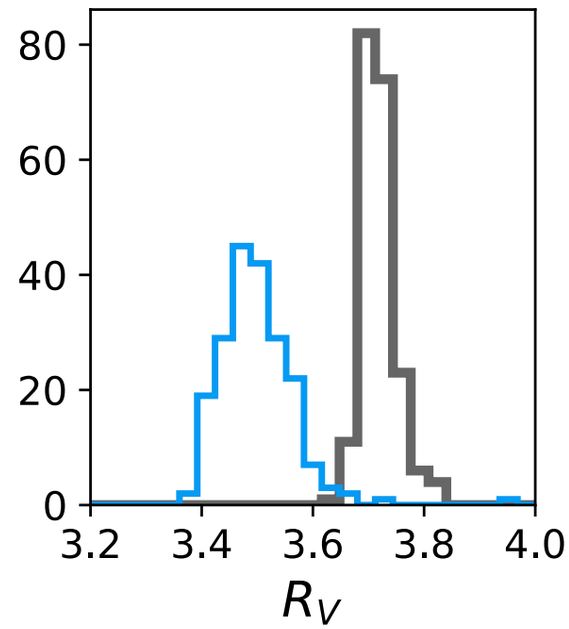


A_V





R_V



MegaBEAST is in development

- Hierarchical Bayesian model for ensembles of stellar populations
- Use BEAST outputs to fit for parameters within 10" pixels

Science Goals

star formation history

initial mass function

mass-metallicity relationship

total dust column (A_V)

average grain size (R_V)

grain composition measure (f_A)

galaxy distance

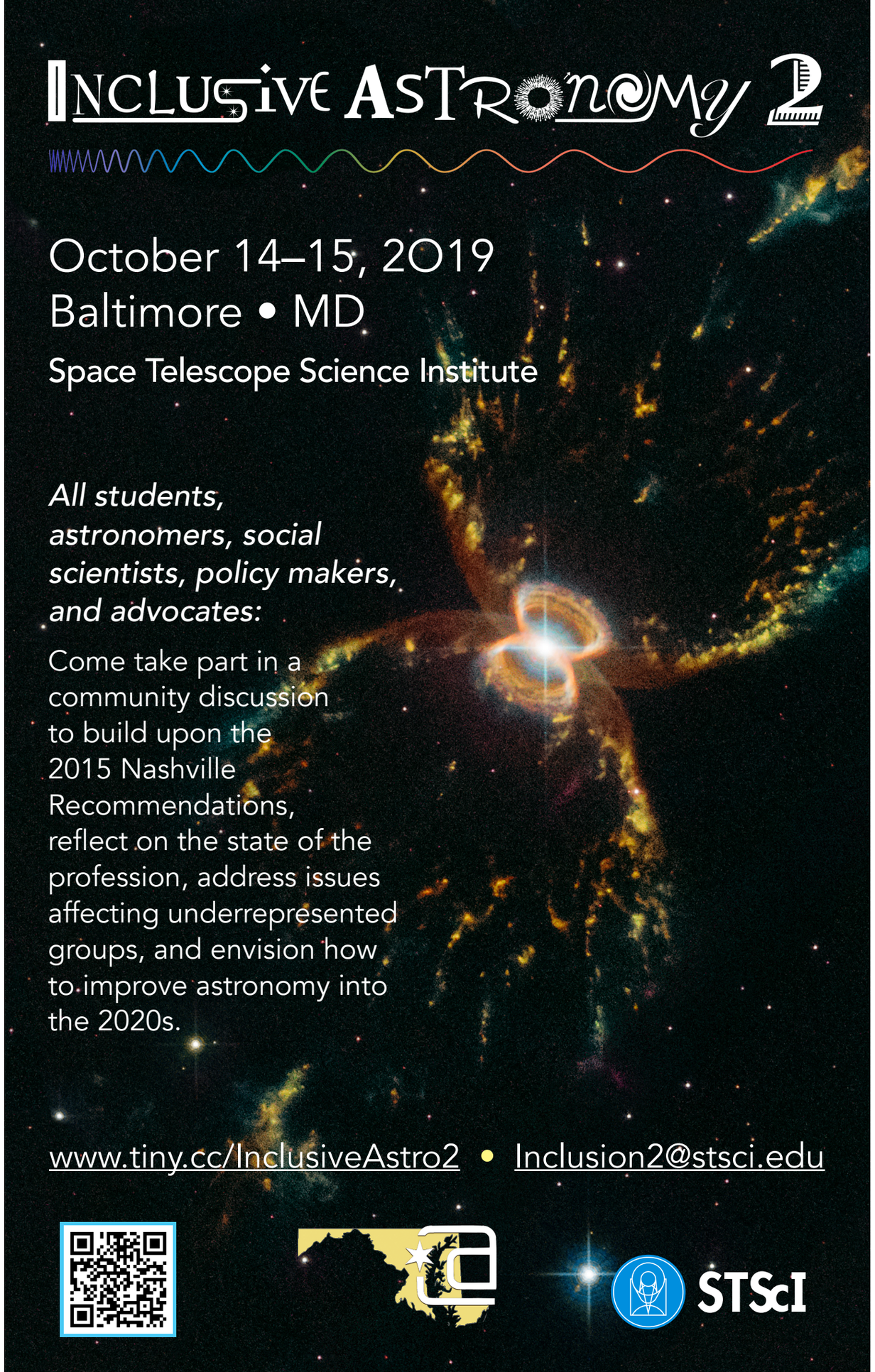
galaxy depth

`github.com/BEAST-Fitting/megabeast`

Inclusive Astronomy 2

October 14-15, 2019
STScI, Baltimore, MD

www.tiny.cc/InclusiveAstro2



Takeaways

- The BEAST is ready to be used for modeling resolved stellar sources: mass, age, metallicity, A_V, R_V, f_A, distance
- The MegaBEAST will combine BEAST results to infer properties of ensemble populations
- WFIRST will allow much of the HST-based BEAST/ MegaBEAST science to expand to large regions of Local Group galaxies

Code contributions are welcomed!

github.com/BEAST-Fitting

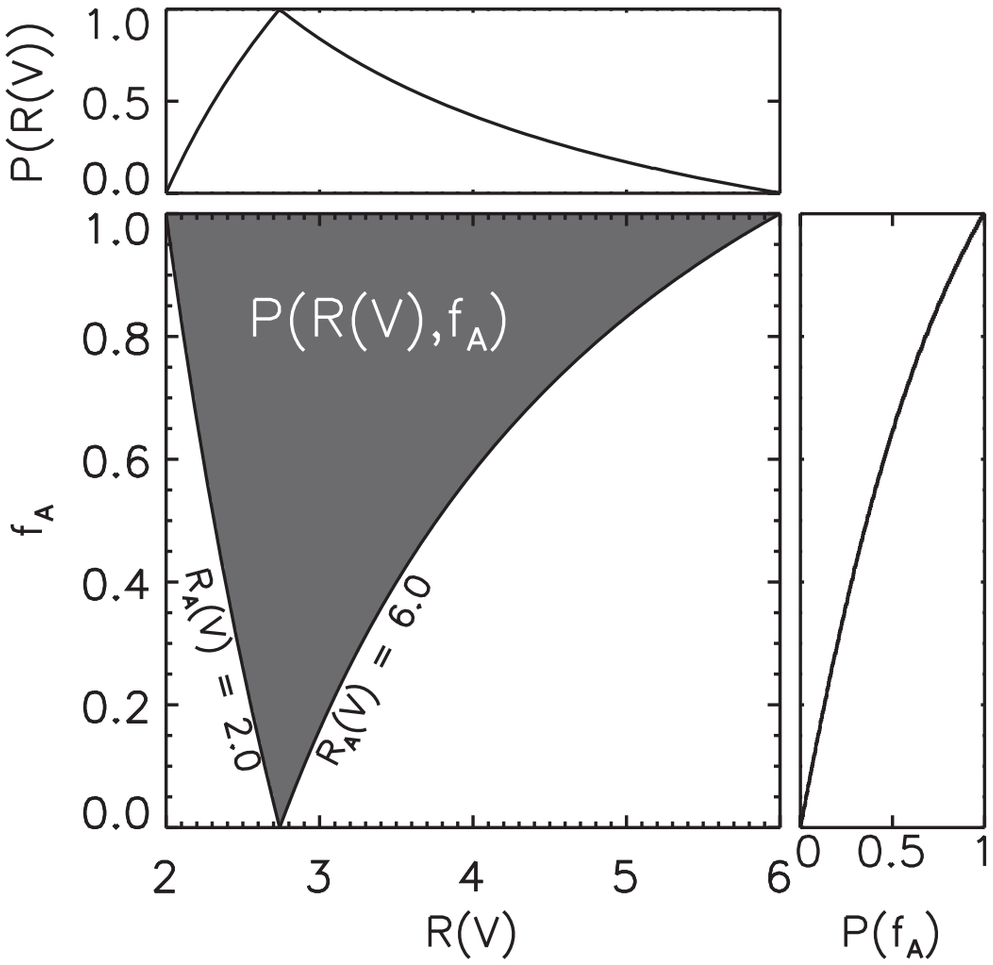
bonus slides

Planned model grid:
LMC, SMC, M33, M31, nearby dwarfs

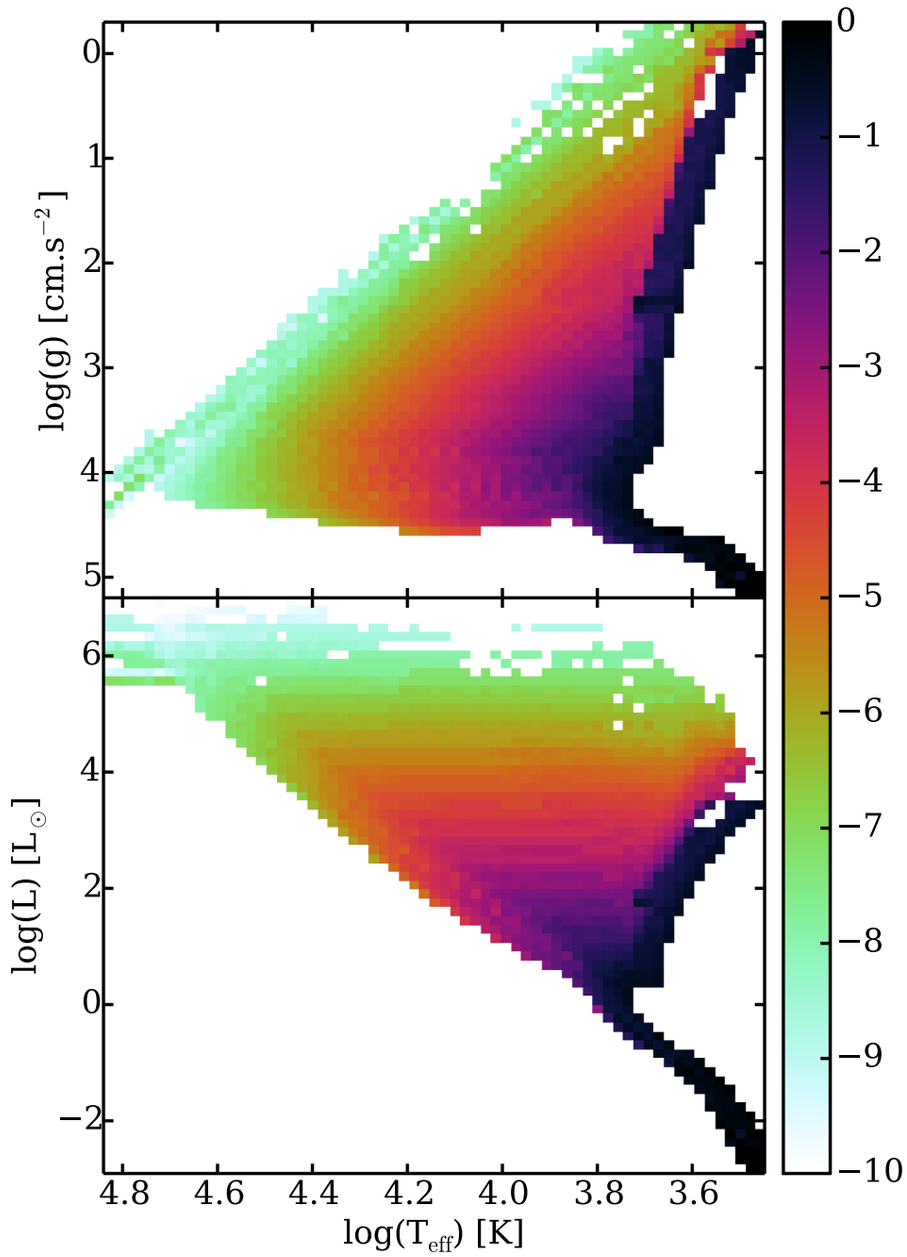
Quantity	Min	Max	Step size	# points
log age	6.0	10.13	0.1	42
log Z	-2.3	0.1	0.3	9
A_V	0.01	10.0	0.05	200
R_V	2.0	6.0	0.5	9
f_A	0.0	1.0	0.2	6
distance	-	-	-	5-10

Priors

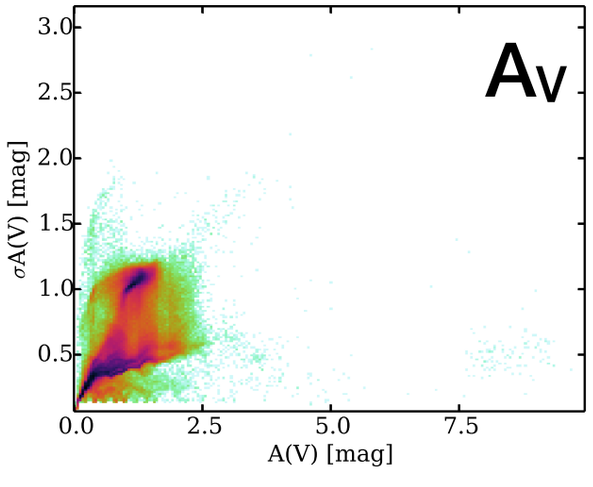
R_V and f_A

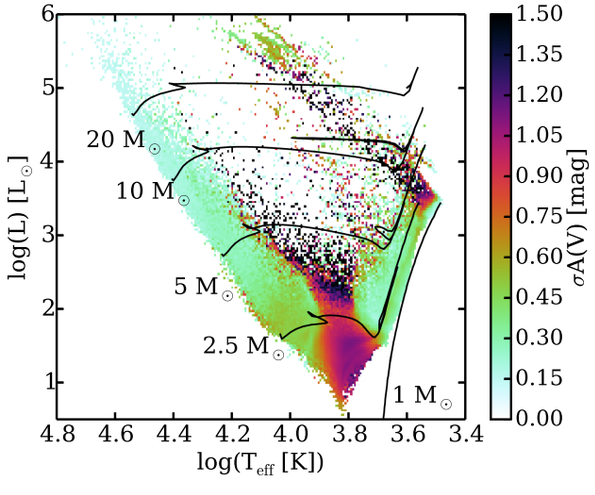


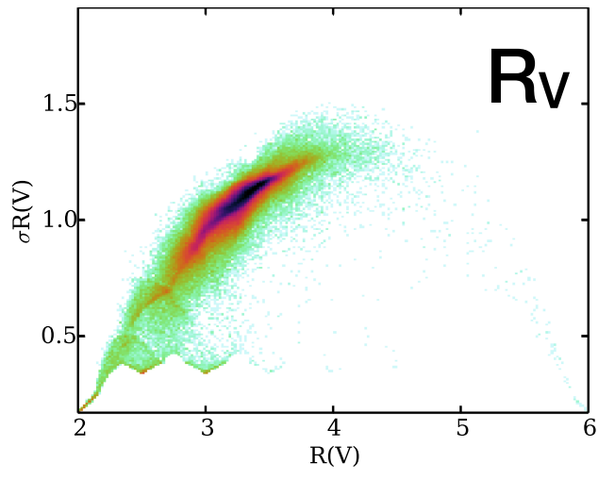
Age and mass

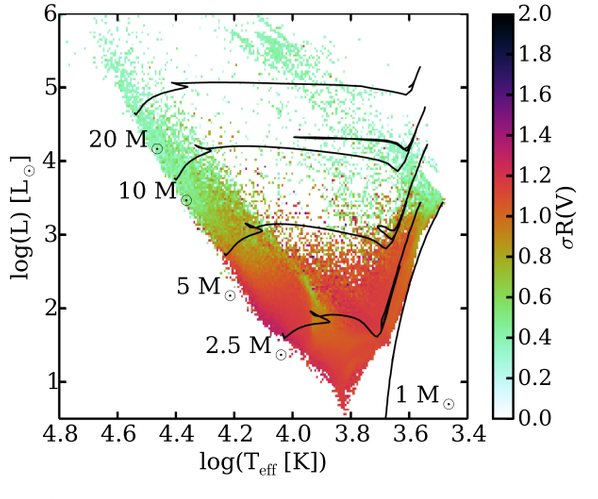


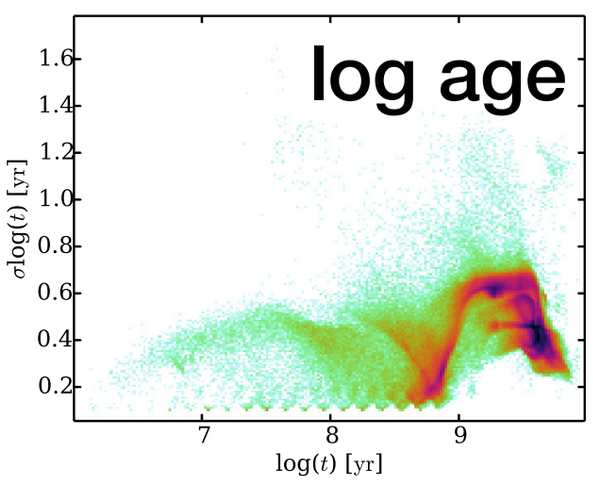
Parameter uncertainties

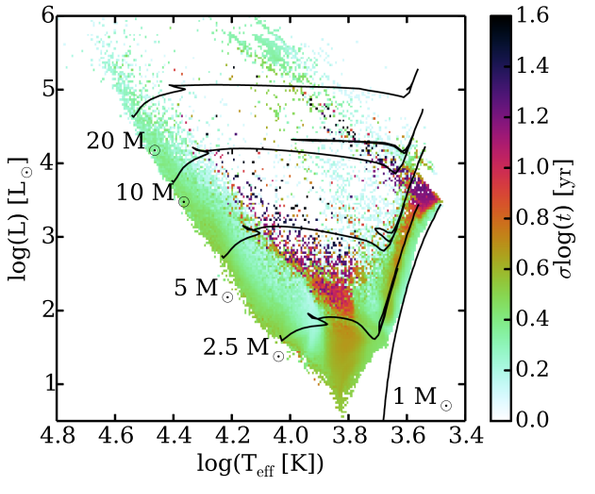


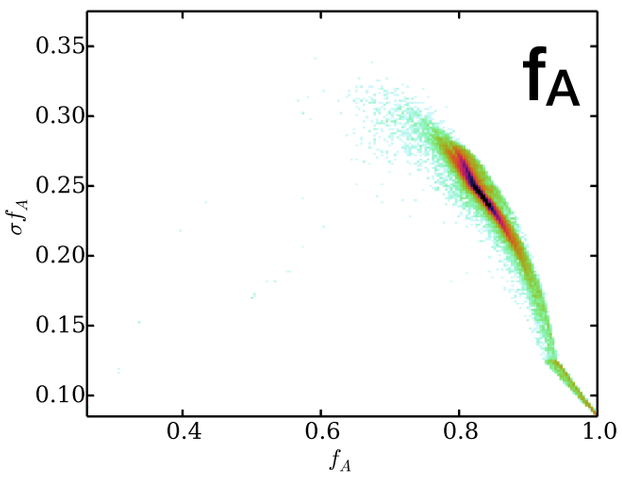


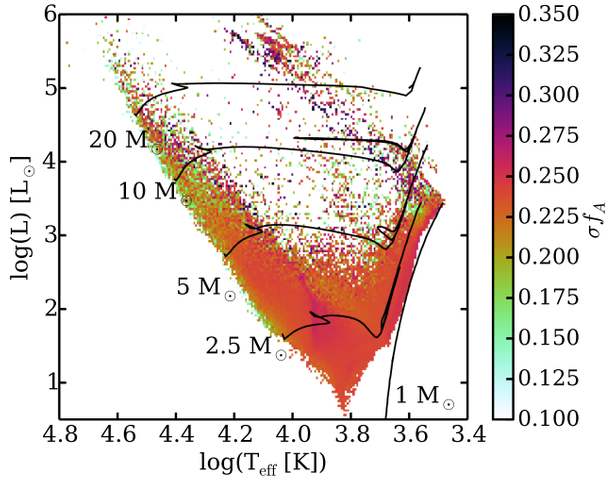


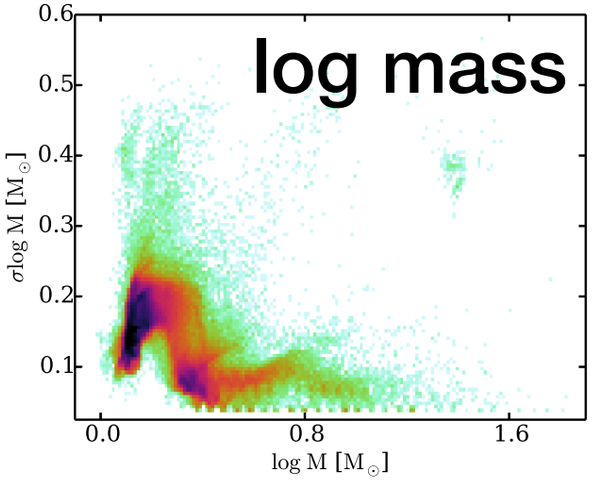


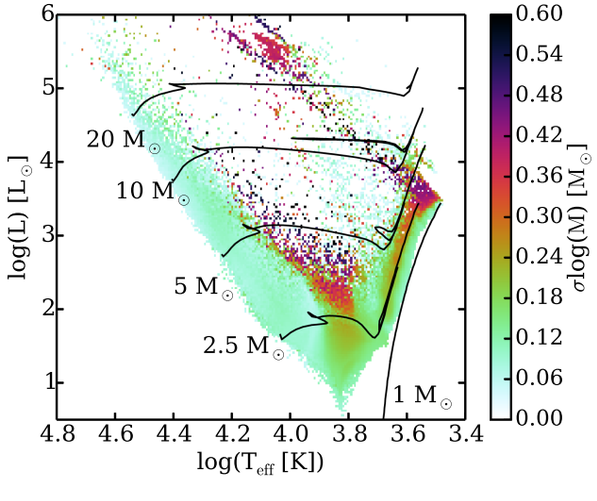


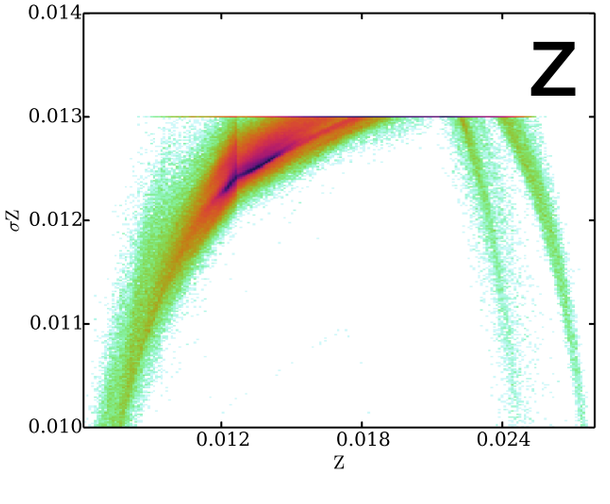


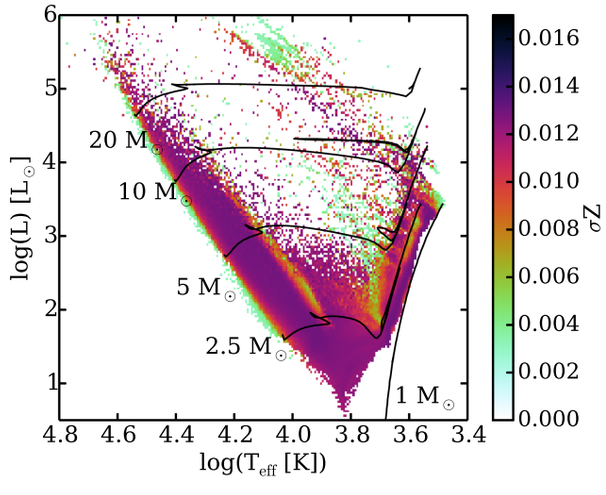












Sensitivity tests