A New Method to Measure the LyC Escape Fraction from Galaxies: the escape fraction for NGC 4214

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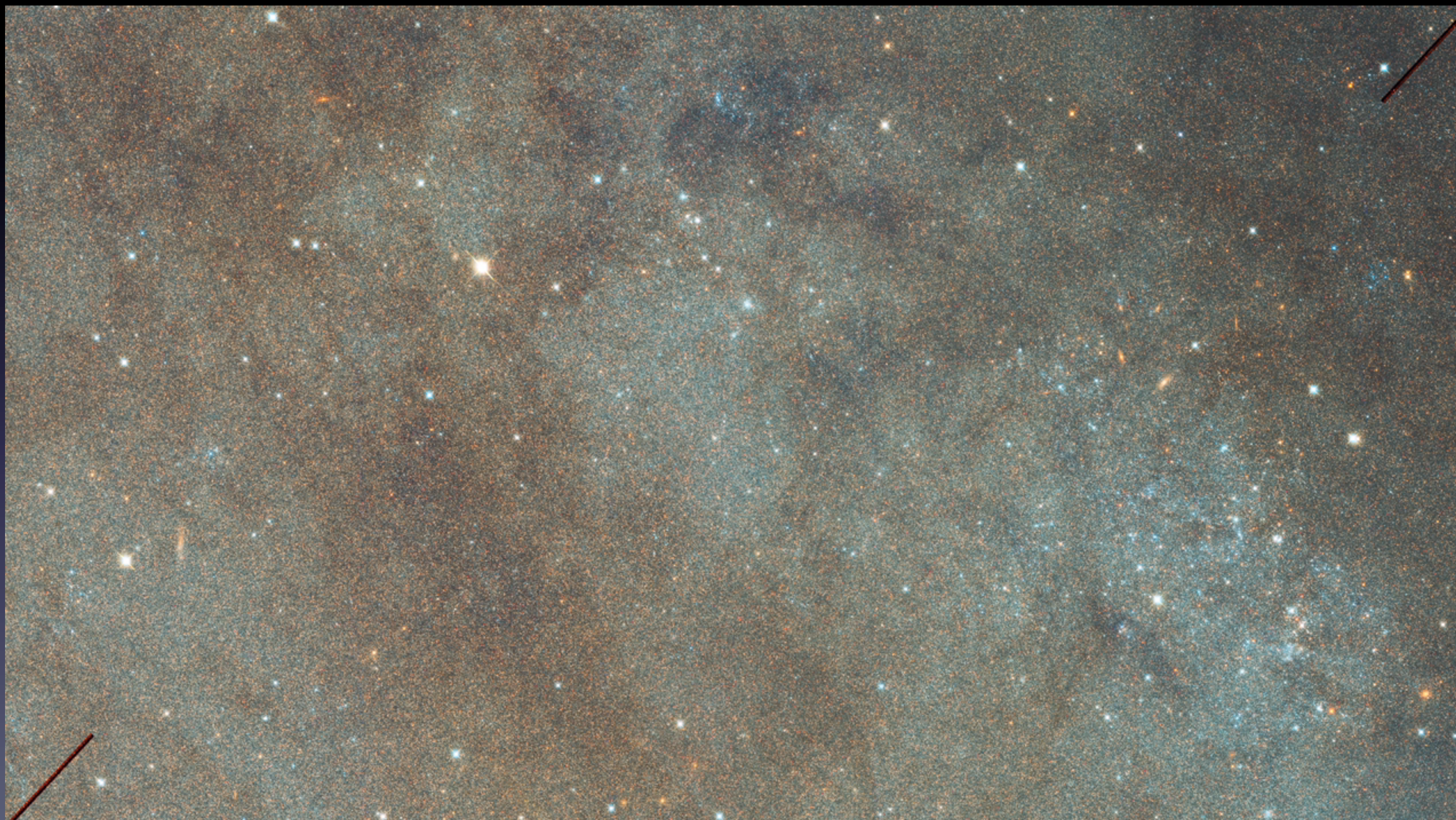
Why local dwarf galaxies?

- High-z dwarf galaxies are believed to be the dominant source for the cosmic reionization at $z > 6$ (e.g., Gnedin 2008, Wise & Cen 2009, Razoumov & Sommer-Larsen 2010; Yajima et al. 2011).
- ISM structure is complicated, but unresolved at high-z
- Intervening IGM is uncertain
- Low-z interlopers
- Need detailed studies with local analogues of high-z dwarfs

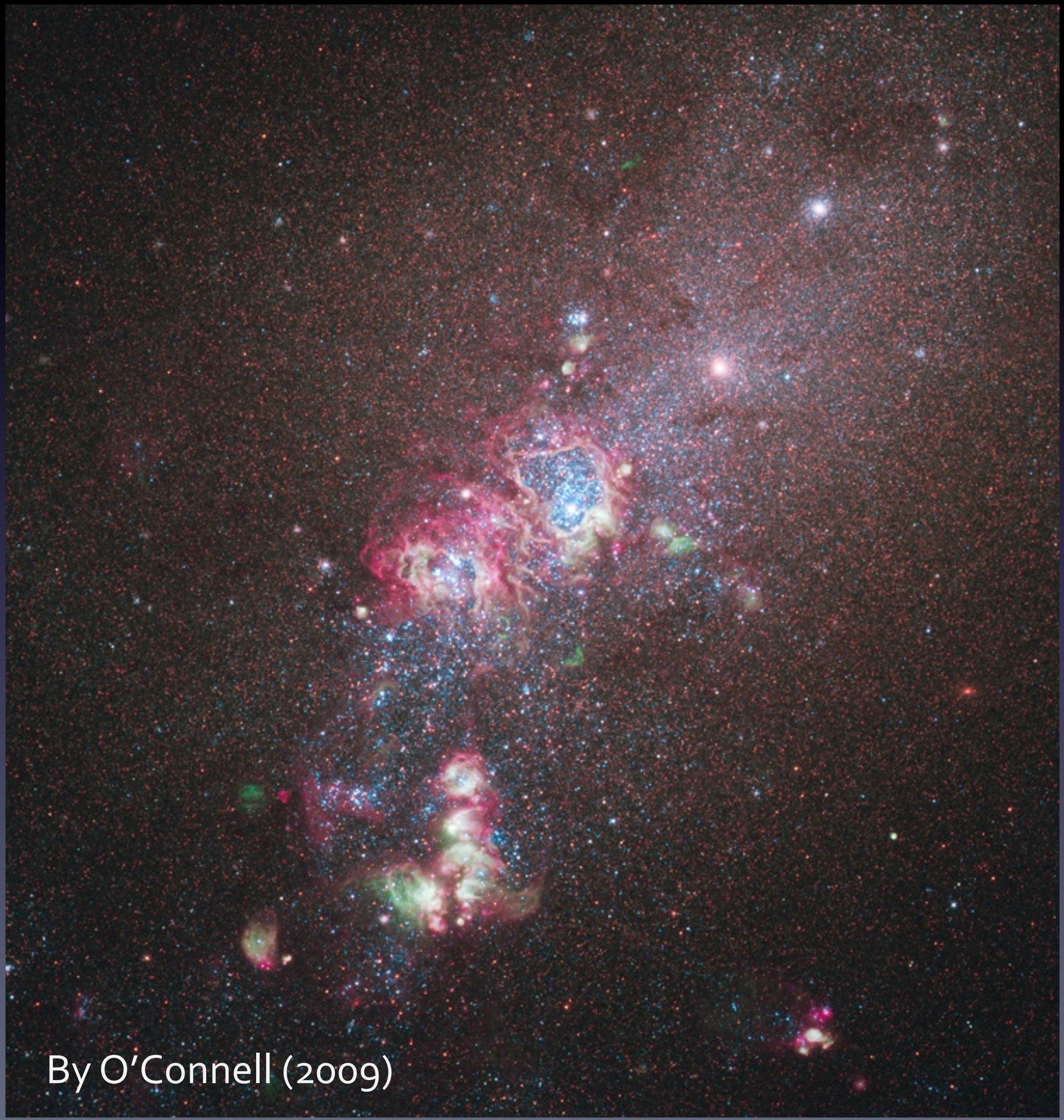
Rich structures at small scales

Brick 15 (~1.5Kpc X 3 Kpc)



PHAT (Dalcanton et al. 2012)

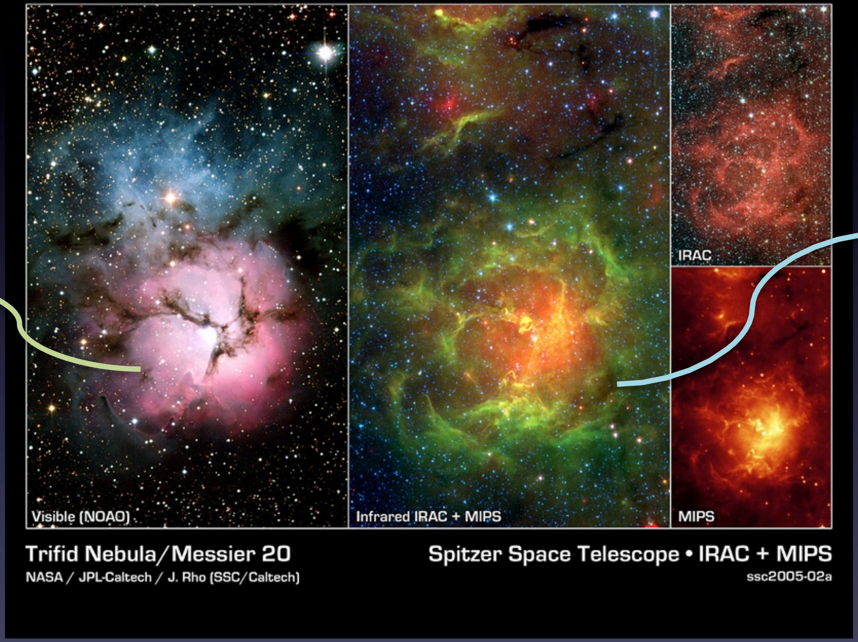
NGC 4214



- Dwarf Irr galaxy
- D = 3.04 Mpc
- Z ~ $0.25Z_{\odot}$
- Starburst system (EW(Hα) ~ 62Å)
- Large SF complexes with holes
- f_{esc} should be > 2-3% (x 10 larger than the previous measurement, Grimes et al. 2009)

Escape fraction measurement

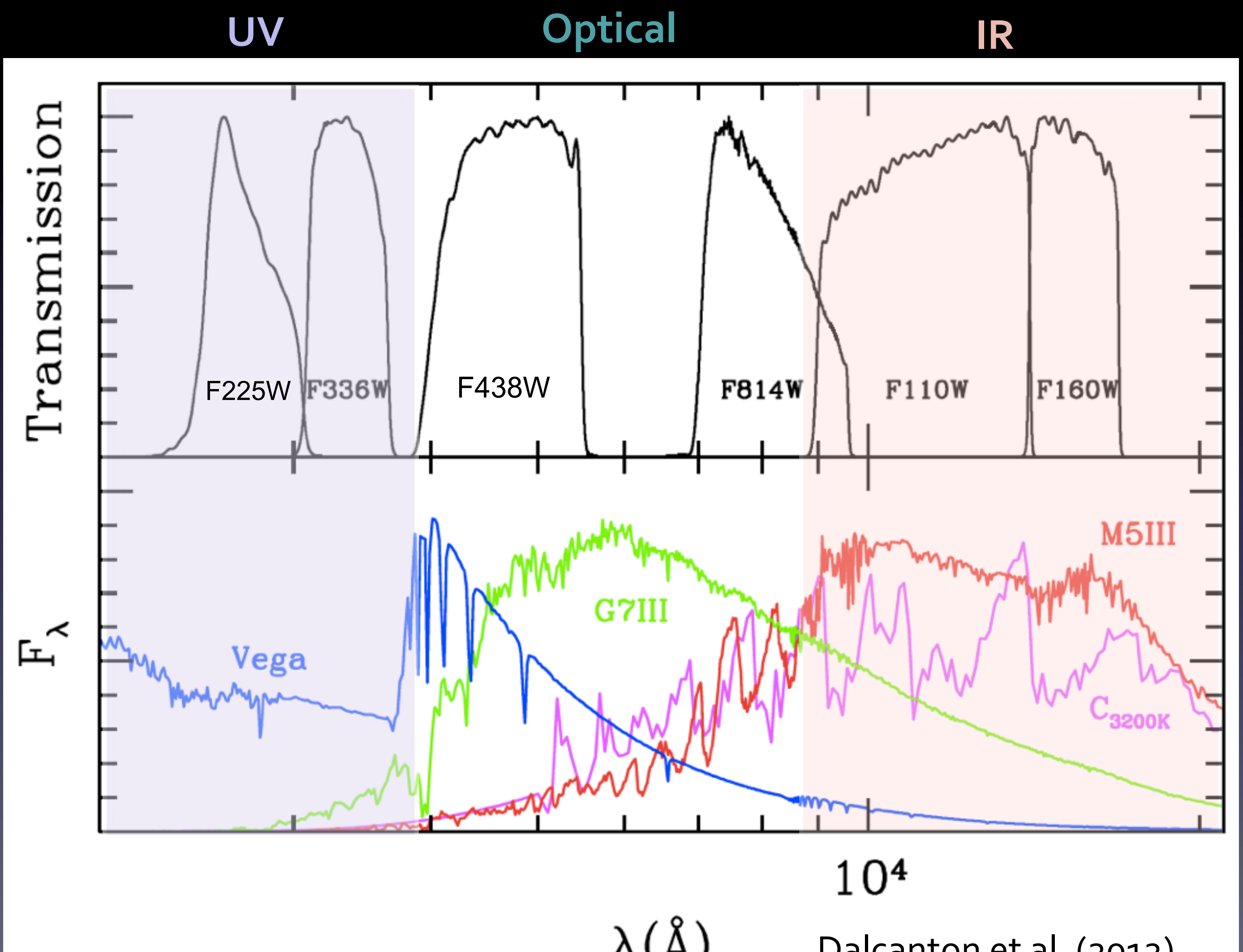
Photoionization: some photons are absorbed by the surrounding neutral gas.



Dust extinction: some photons are absorbed by dust.

$$f_{\mathbf{esc}} = (\dot{N}_{intrinsic} - \dot{N}^{abs}_{ISM} - \dot{N}^{abs}_{dust}) / \dot{N}_{intrinsic}$$

Power of Multiband Photometry



Dalcanton et al. (2012)

Bayesian Extinction And Stellar Tool (BEAST)

(Gordon et al. 2016, submitted)

Multiwavelength observations

- Atmosphere models (LTE; Castelli & Kurucz 2004, non-LTE; Lanz & Hubeny 2003, 2007)
- Stellar tracks (PARSECv1.2S; Tang et al. 2014)

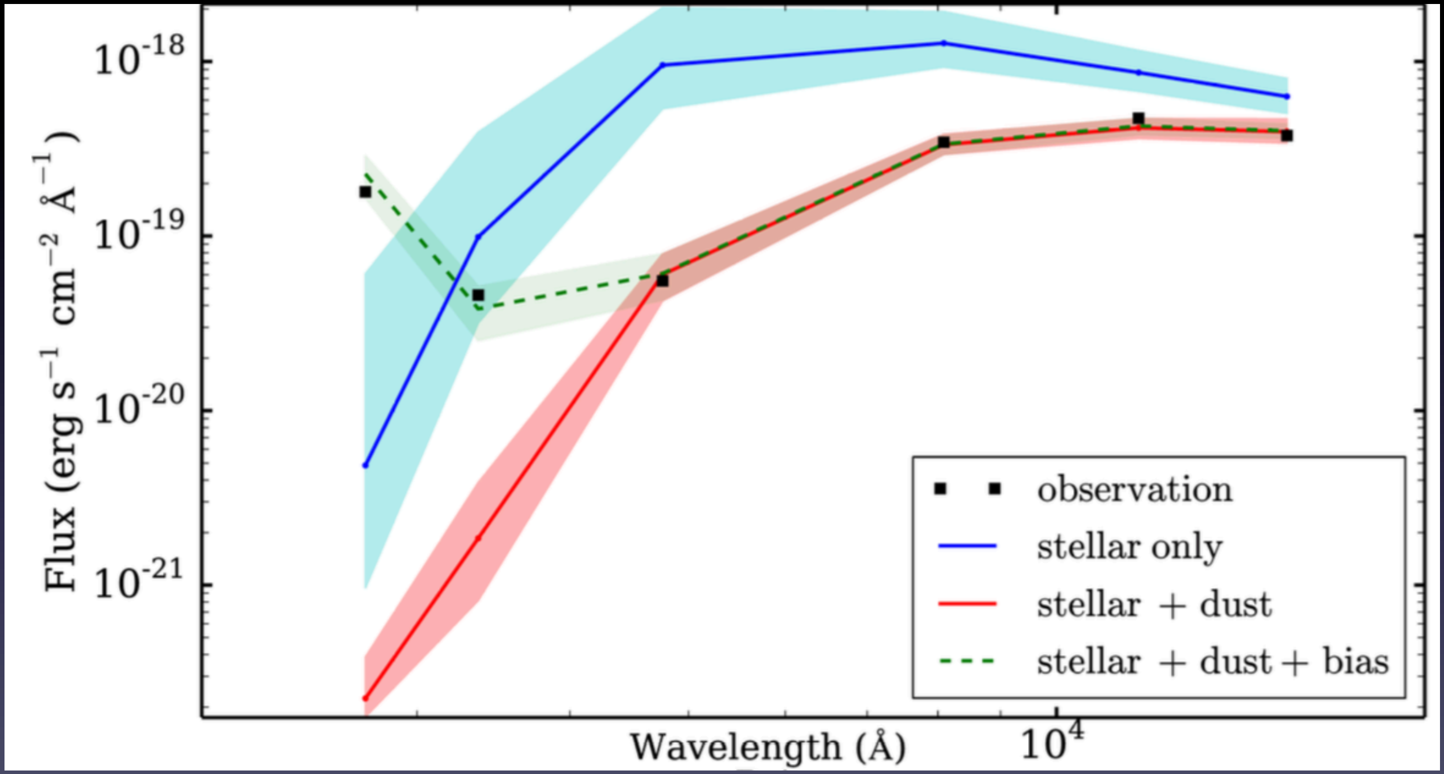
BEAST

- Intrinsic stellar physical properties
- Intervening dust properties (Av, Rv, and f_bump)
- Observational effects (Poisson, completeness, and crowding)

Predictions for the intrinsic properties of star and dust

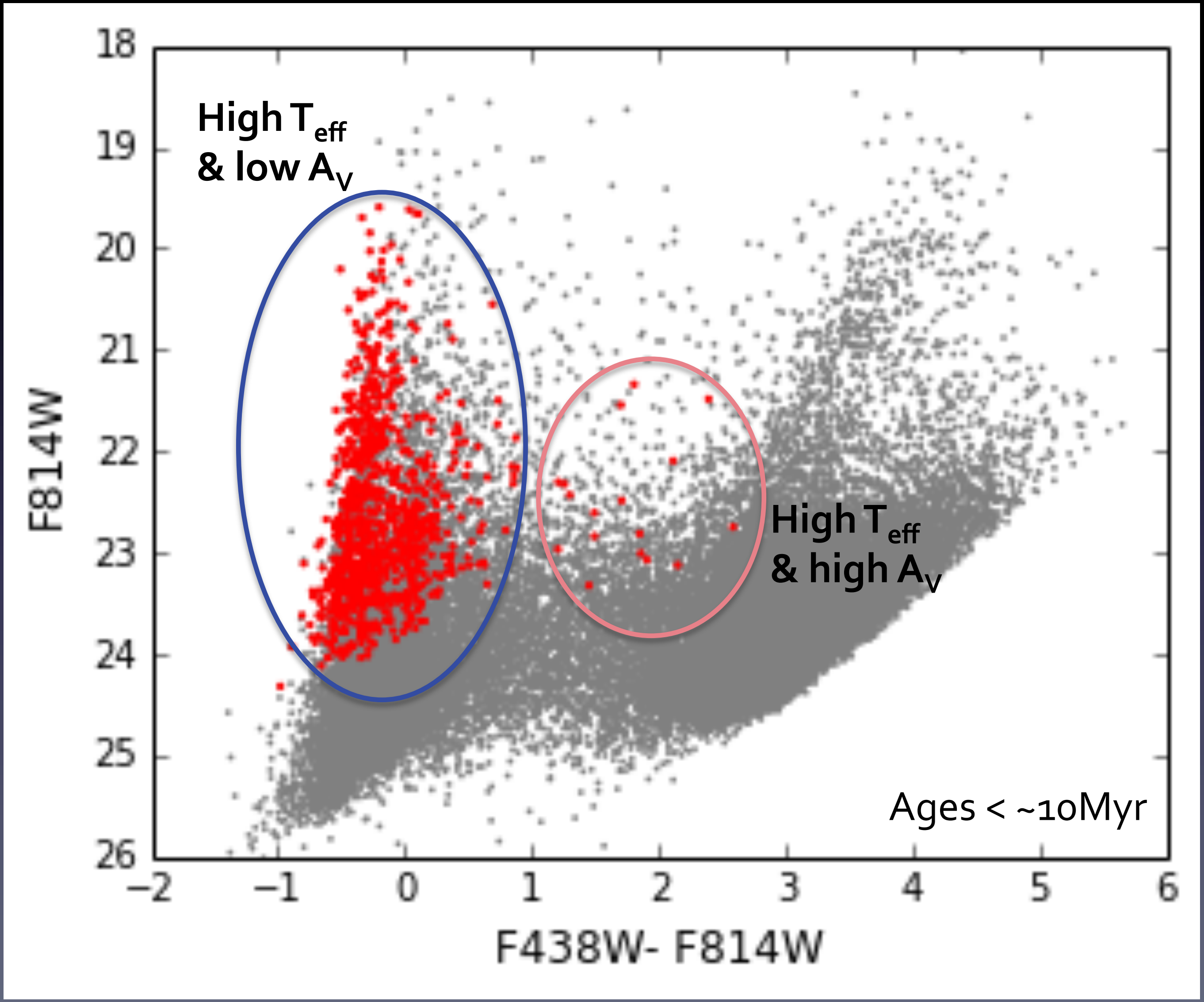
BEAST - example

(Gordon et al. 2016, submitted)



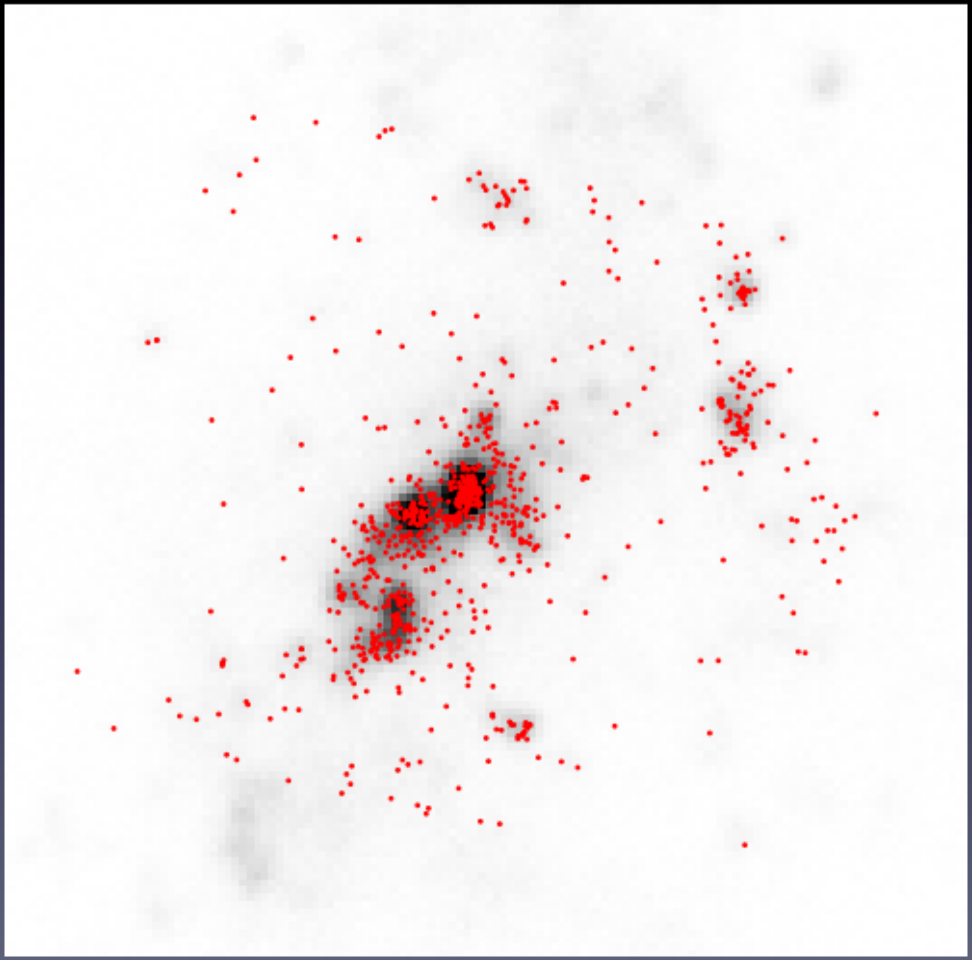
It is important to include full physical models (stellar & dust) and noise model for stellar SED fitting!

O/B stars produce LyC



Spatial Distribution of Low Extinction O/B Stars

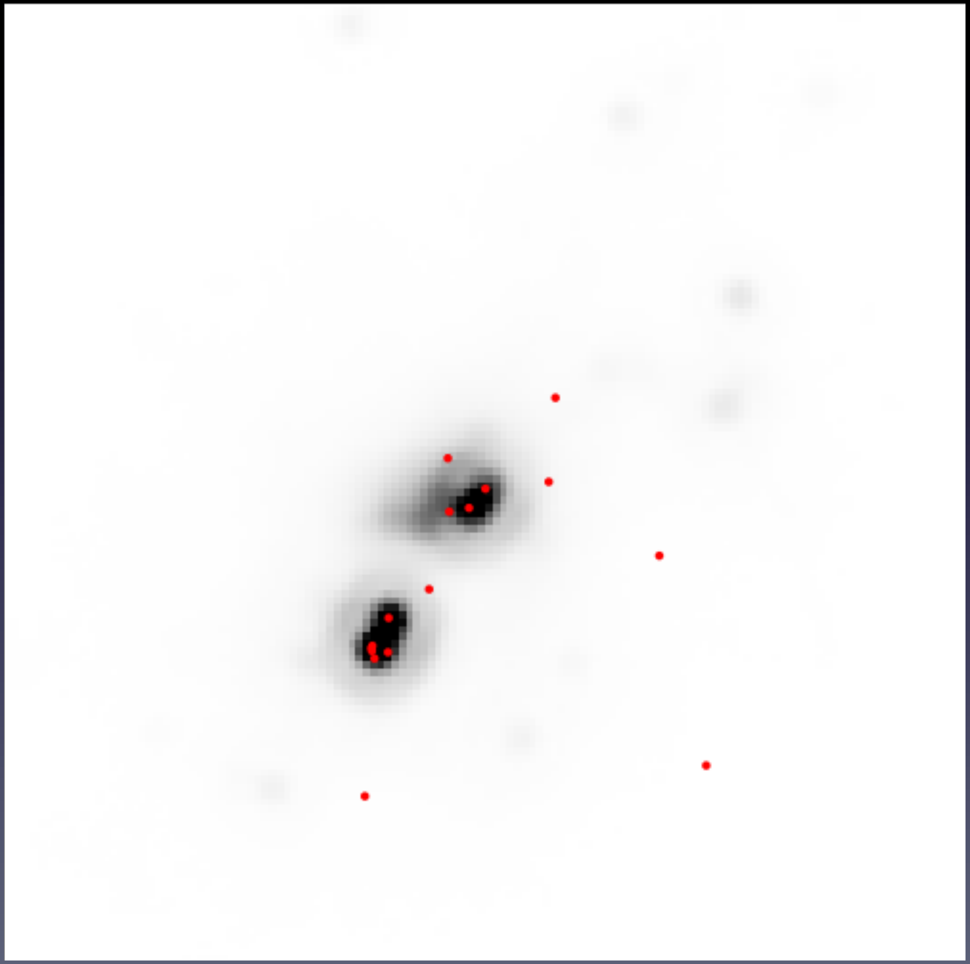
Stars with high T_{eff} & low A_V on GALEX FUV (Lee et al. 2011)



$T_{eff} > 30{,}000K$
$A_V < 1$

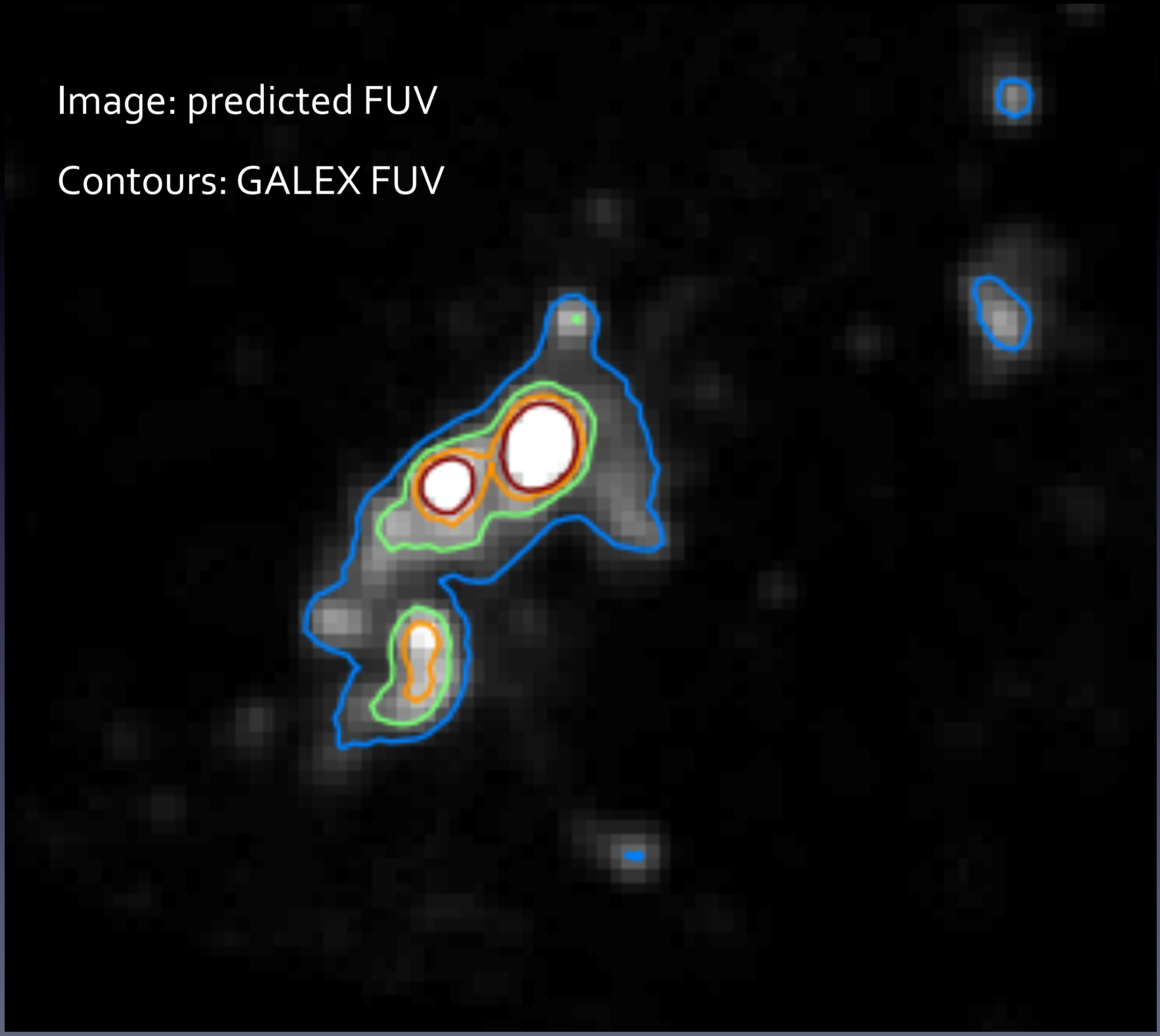
Spatial Distribution of High Extinction O/B Stars

Stars with high T_{eff} & high A_V on Spitzer 24μm (Dale et al. 2009)



T_{eff} > 30,000K
A_V > 3

BEAST FUV prediction reproduces GALEX FUV observation



Escape fraction of NGC 4214

- We have the number of intrinsic ionizing photons, dust extinction along the line-of-sight, and the number of photons used by photoionization as a function of position within NGC 4214.
- The last remaining information we need is covering fraction (f_{cov})!

Escape fraction of NGC 4214

- We have the number of intrinsic ionizing photons, dust extinction along the line-of-sight, and the number of photons used by photoionization as a function of position within NGC 4214.
- The last remaining information we need is covering fraction (f_{cov})!
- If we assume isotropic dust geometry (f_{cov}=1), we get f_{esc} ~2-3% (x 10 larger than the previous measurement, Grimes et al. 2009).
- If we assume f_{cov}=0.6, we get f_{esc} ~13%.

Choi et al. (2016, in prep)

Thank you! Questions?