

# **(A Better) Intro to Measuring the Stellar IMF**

**Astro 250: Spring 2026**

**Jan 27, 2026**

## THE LUMINOSITY FUNCTION AND STELLAR EVOLUTION

EDWIN E. SALPETER\*

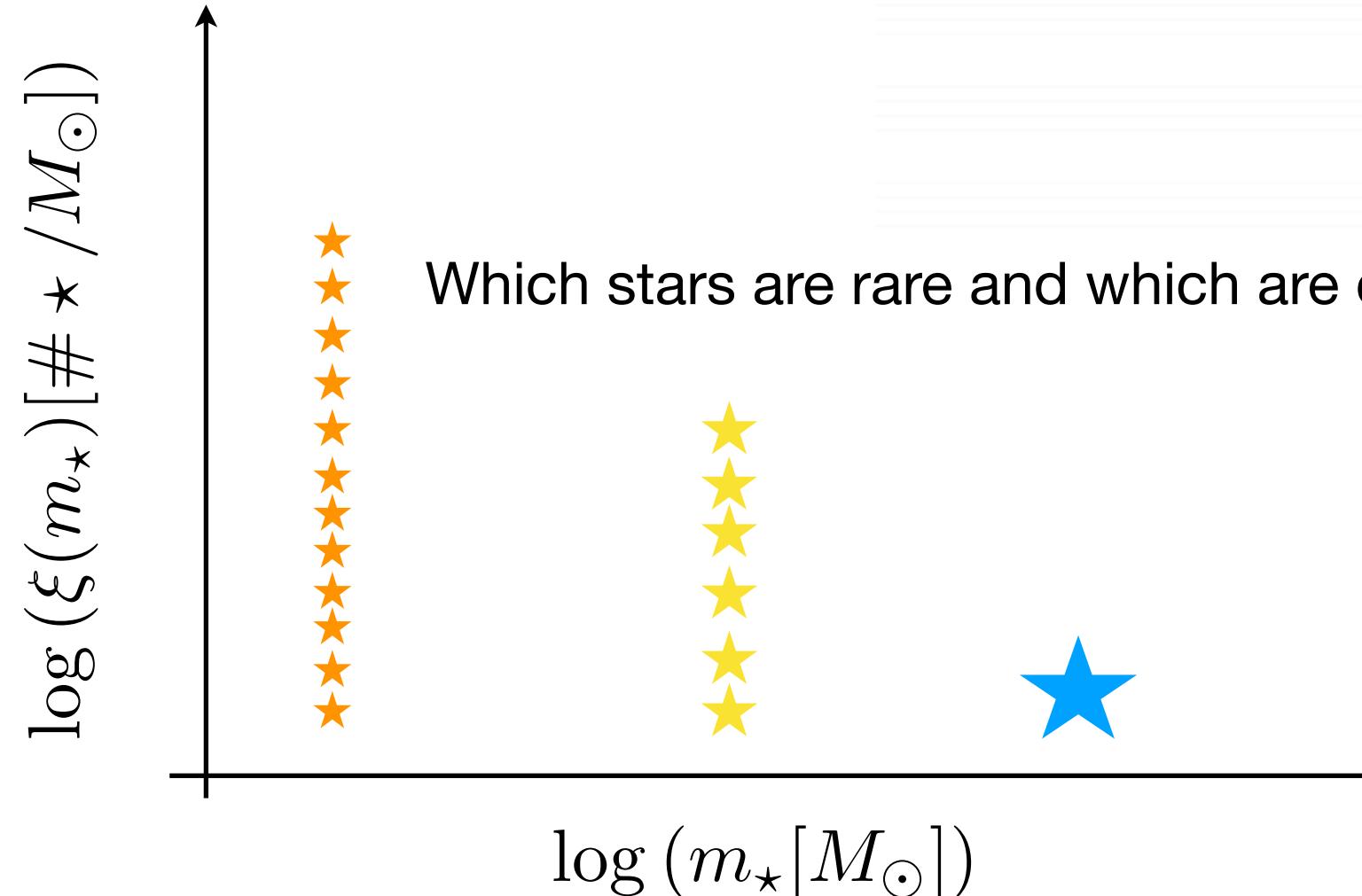
Australian National University, Canberra, and Cornell University

*Received July 29, 1954*

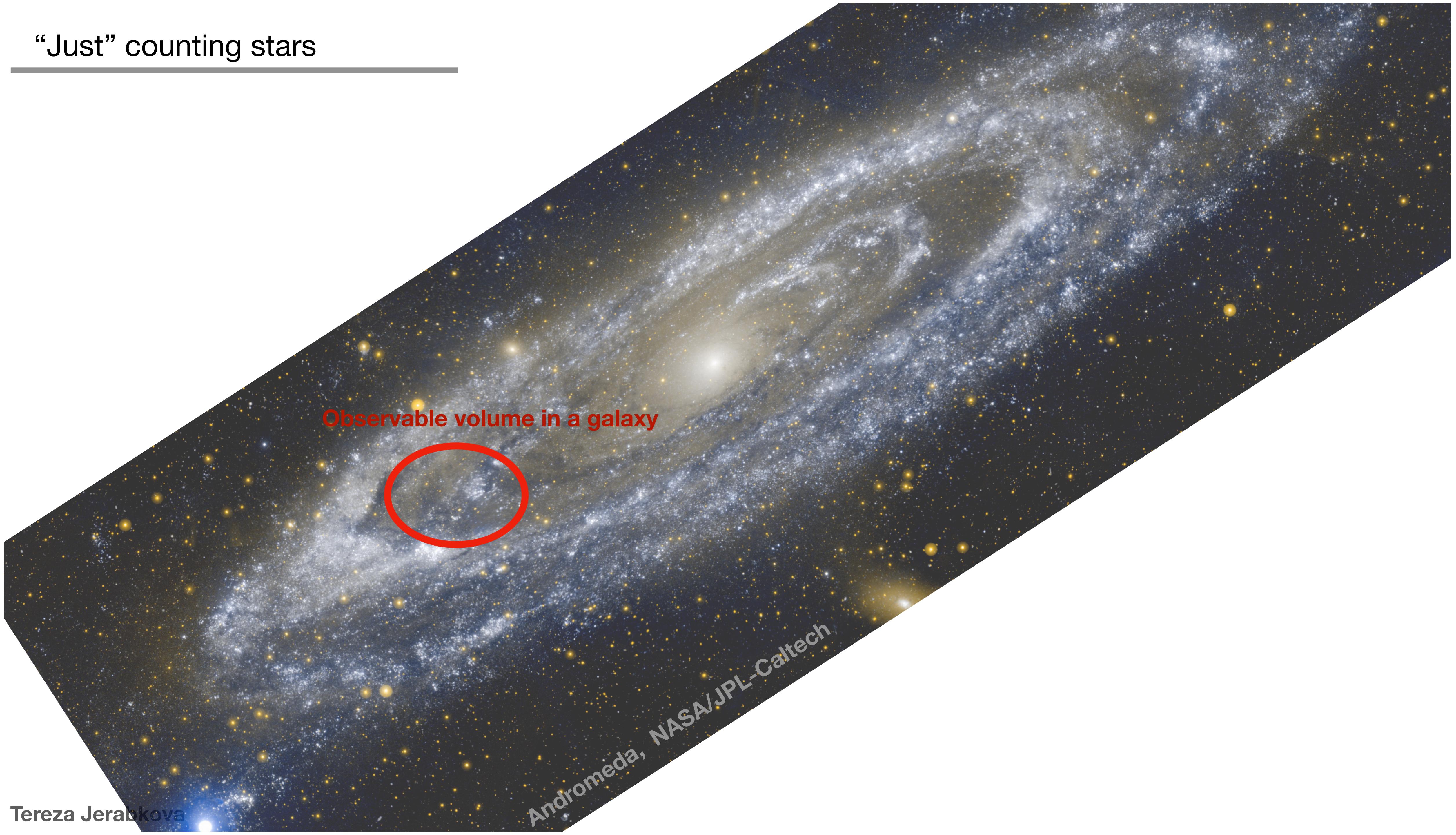
GCs were “missing” massive stars at that time

We defined the “original mass function,”  $\xi(\mathfrak{M})$ , by

$$\# \star \quad \downarrow \quad \text{Mass bin} \\ dN = \xi(\mathfrak{M}) d(\log_{10} \mathfrak{M}) \frac{dt}{T_0}, \quad \text{Stars form over } T_0$$



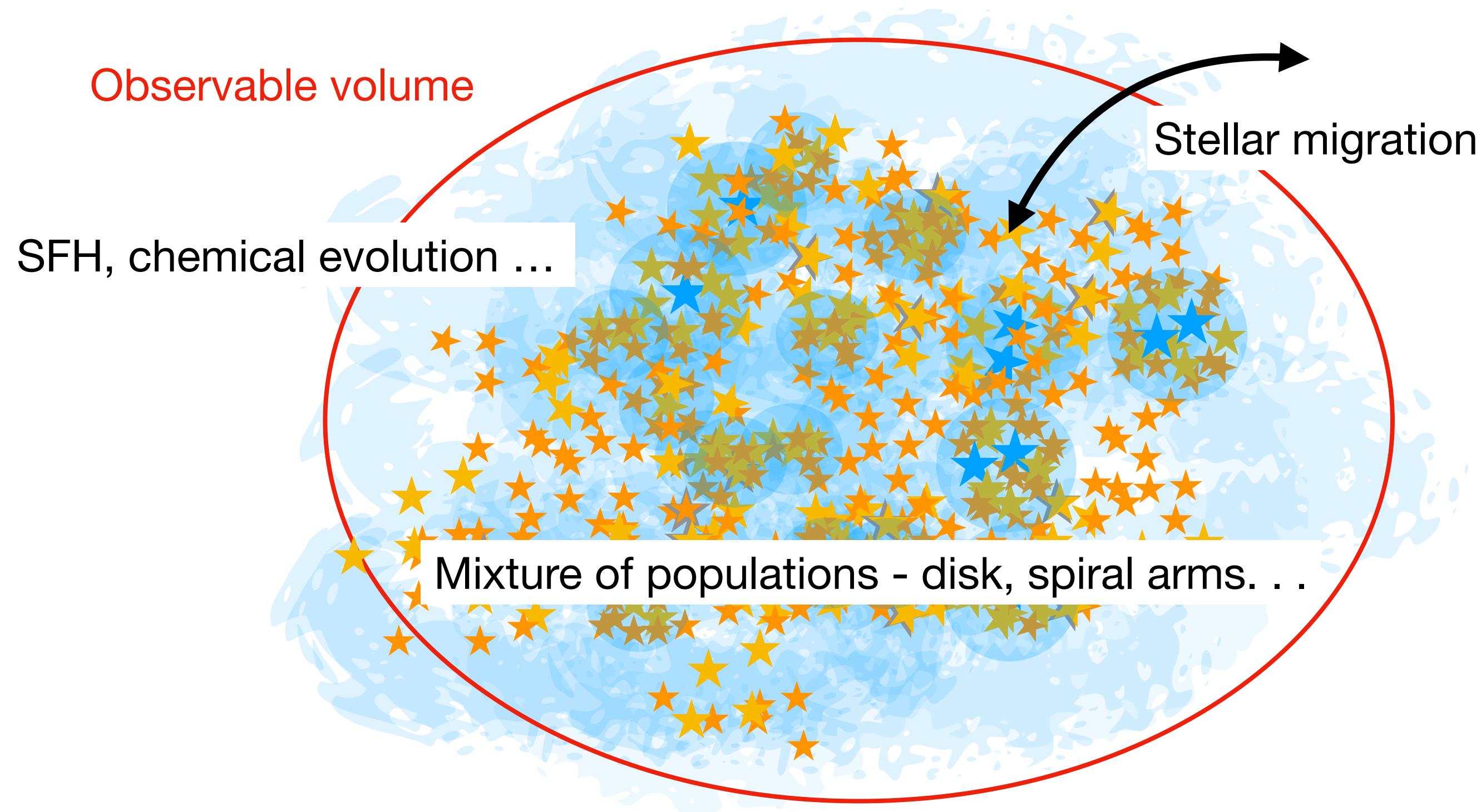
# “Just” counting stars



Andromeda, NASA/JPL-Caltech

# “Just” counting stars

---



# “Just” counting stars

The measured quantity

- 1) Present day luminosity function  
need to correct for biases!

- 2) Salpeter (1955) Scalo(1986)  
Miller & Scalo(1979) Kroupa, Tout, Gilmore(1990-93)

Stellar mass-luminosity relation (its derivative)  
Scale height distribution as a function luminosity (age)  
Main sequence brightening  
Correction for evolved (still alive stars)  
Metallicity variations  
Unresolved binaries (important issue by itself!)  
Embedded stars , extinction

Correction for finite stellar lives, SFH  
Salpeter (1955)



?The stellar Initial Mass Function?

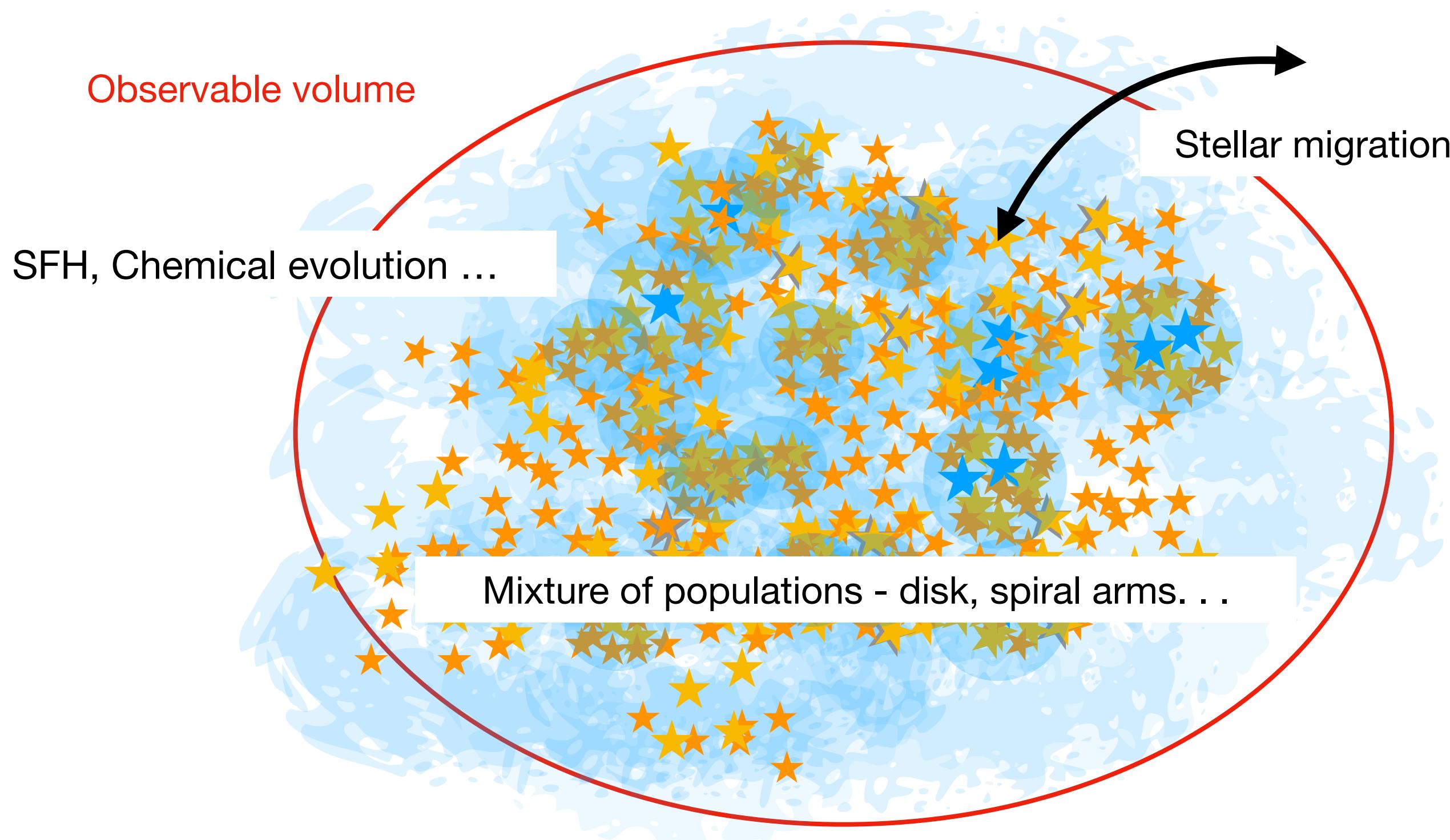
Present day mass function

$$\Phi_m(\log_{10} m_*) = \Phi(M_V) \left| \frac{dM_V}{d \log_{10} m_*} \right| 2H(M_V) f_{ms}(M_V)$$

By counting stars one looks into the internal structure of stars!

Kroupa, Tout & Gilmore (1990)

Empirical stellar Initial Mass Function  
(with all the issues connected to the SHF, stellar migration, ...)



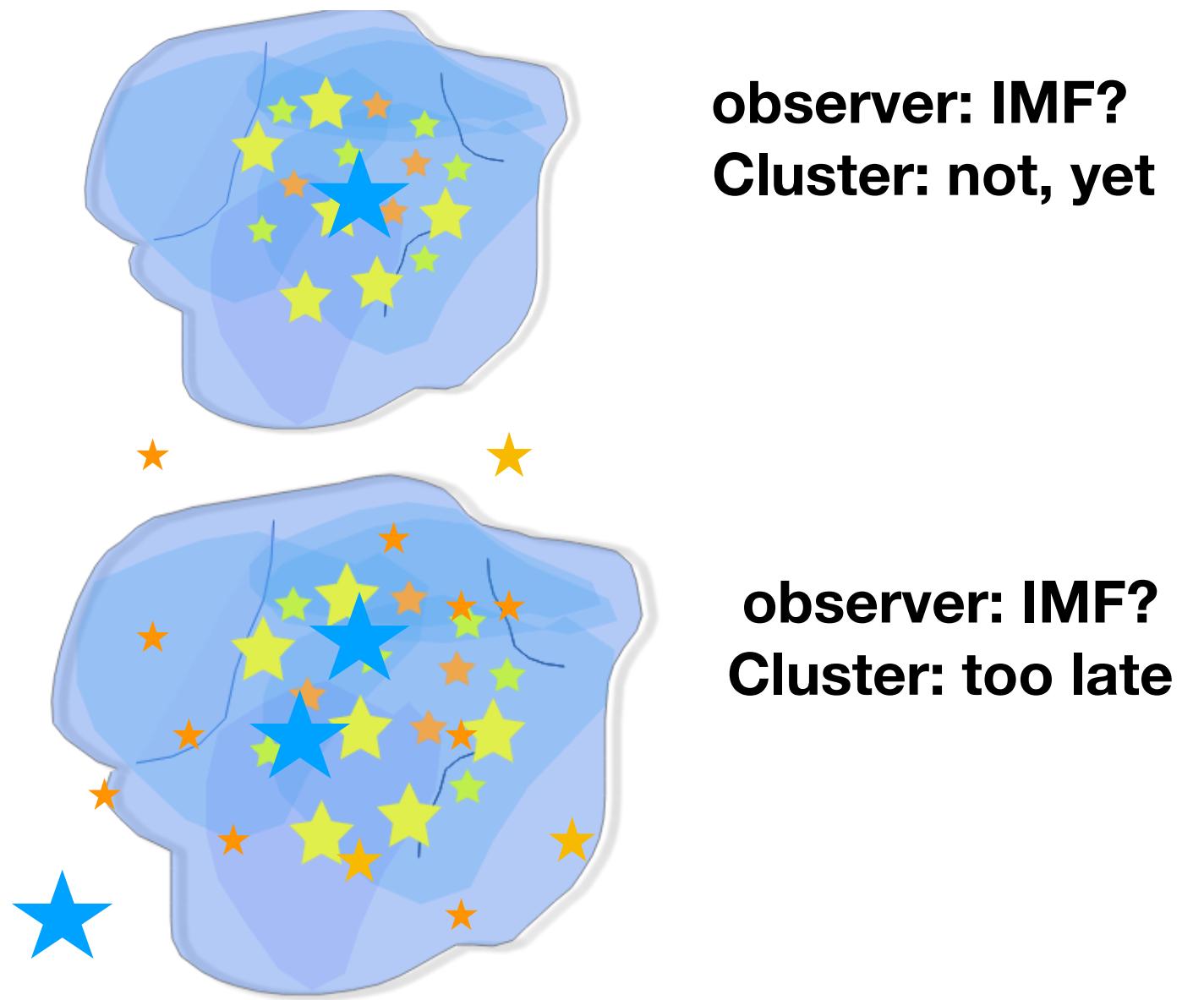
Kroupa & Jerabkova (2017)

IMF does not exist in nature (it's a Hilfskonstrukt),  
we need to *infer* the IMF to interpret measurements and make calculations

# “Just” counting stars

## What about star clusters?

- Small number statistics
- dynamical effects, mass segregation —> initial conditions! (ejections, mergers) Kroupa (1995), De Marchi, Paresce, Portegies Zwart (2010)
- binary stars Oh & Kroupa (2016, 2018)
- field contamination
- cluster's SFH Elmegreen & Scalo (2005), Beccari+2017, Jerabkova+2017



### 1) MW & nearby clusters: consistent with no variations within (large) uncertainties

Massey+1995ab, Weisz+2015 —> see also Oh & Kroupa (2016)

Scalo (1986): Average over star clusters is well defined if IMF is universal

What variations of the IMF are consistent with the data?

See Dib (2014), and use KDE as Prisinzano+ (2001)

### 2) Variations detected in extreme environments - high densities, low metallicity

Dabringhausen+2008,2012, Bartko+2010, Marks+2012, Schneider+2018, Kalari+2018, Hosek+2019

More massive stars relative to the canonical IMF

+ more evidence from unresolved stellar populations, stellar population synthesis and chemical evolution



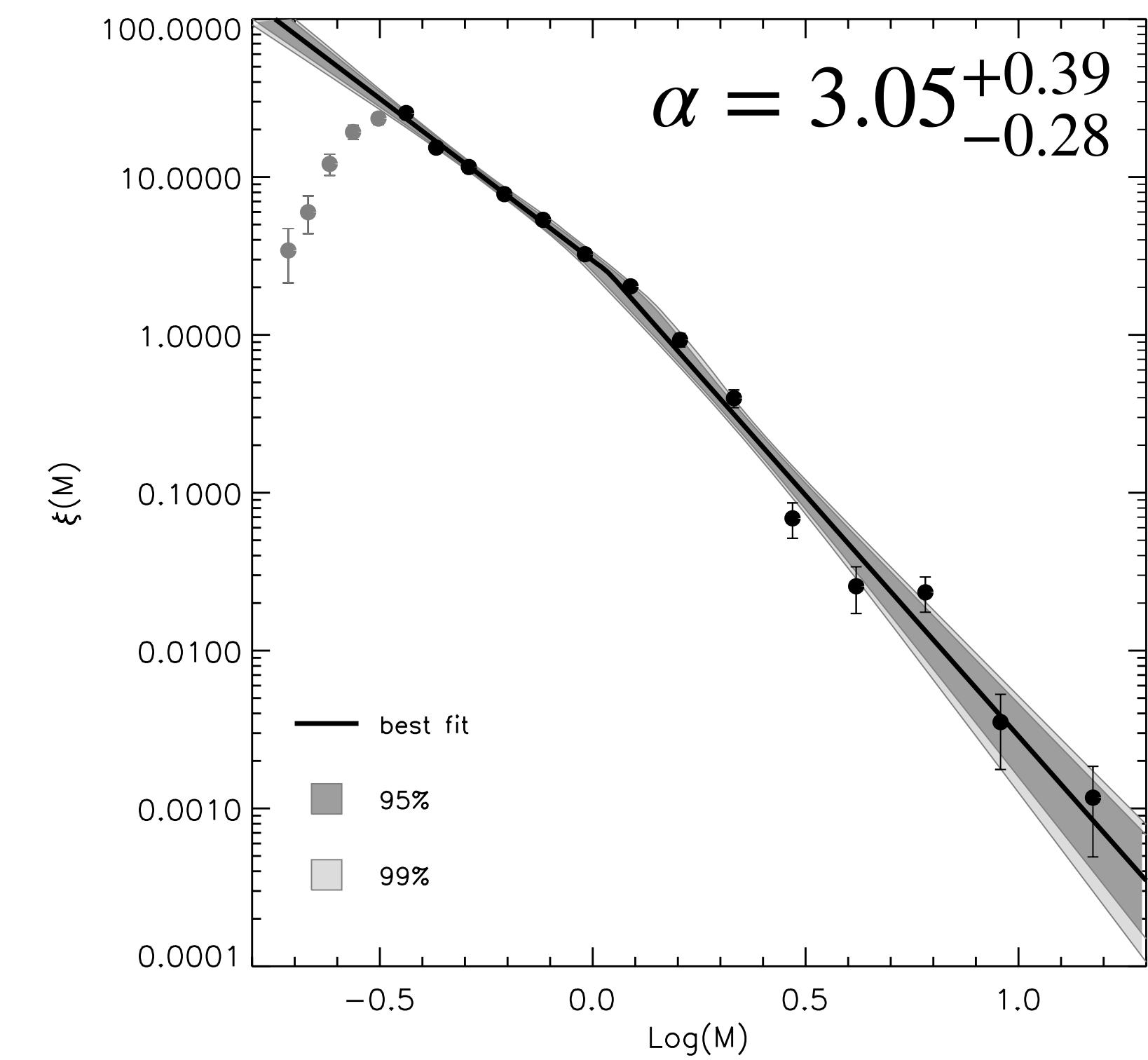
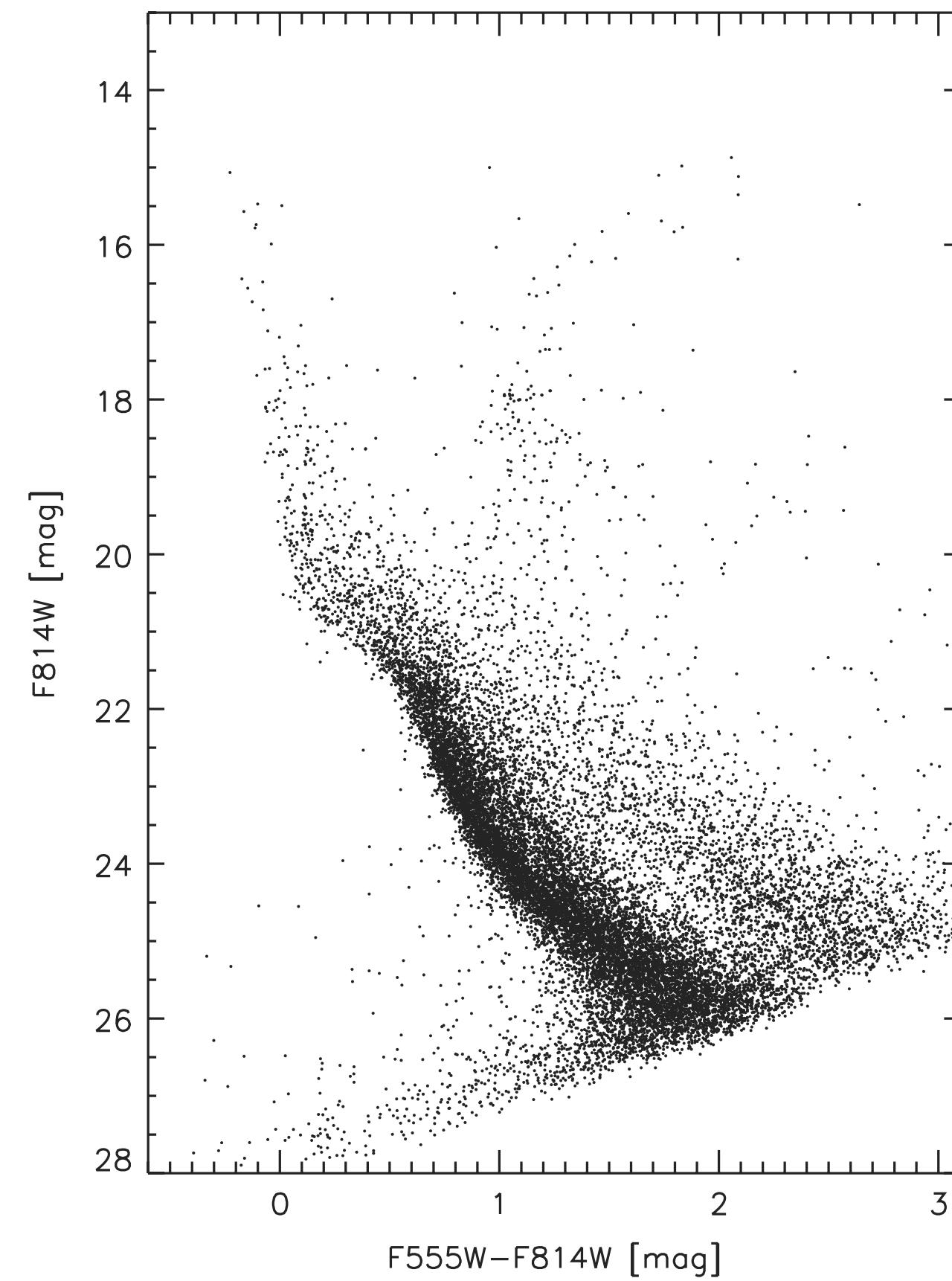
### 3) Low density environments

Hsu, Hartmann+2012,2013, Megeath+2012, Watts+2017

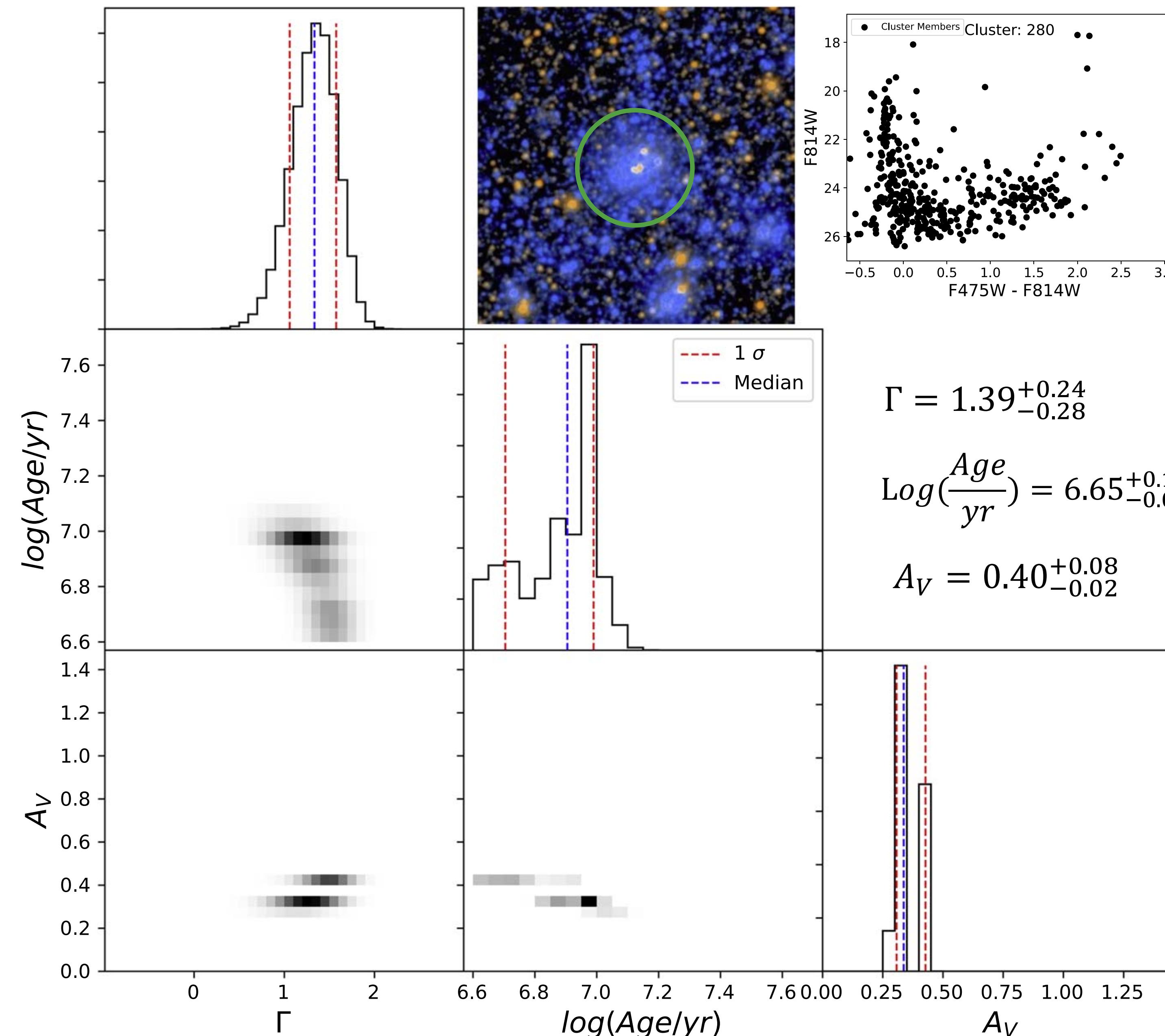
Lack of massive stars relative to the canonical IMF

# IMF in Star Cluster LH 90 in the Large Magellanic Cloud

$$\alpha_{\text{MW}} = 2.35$$



# IMF in Star Cluster AP 280 in M33



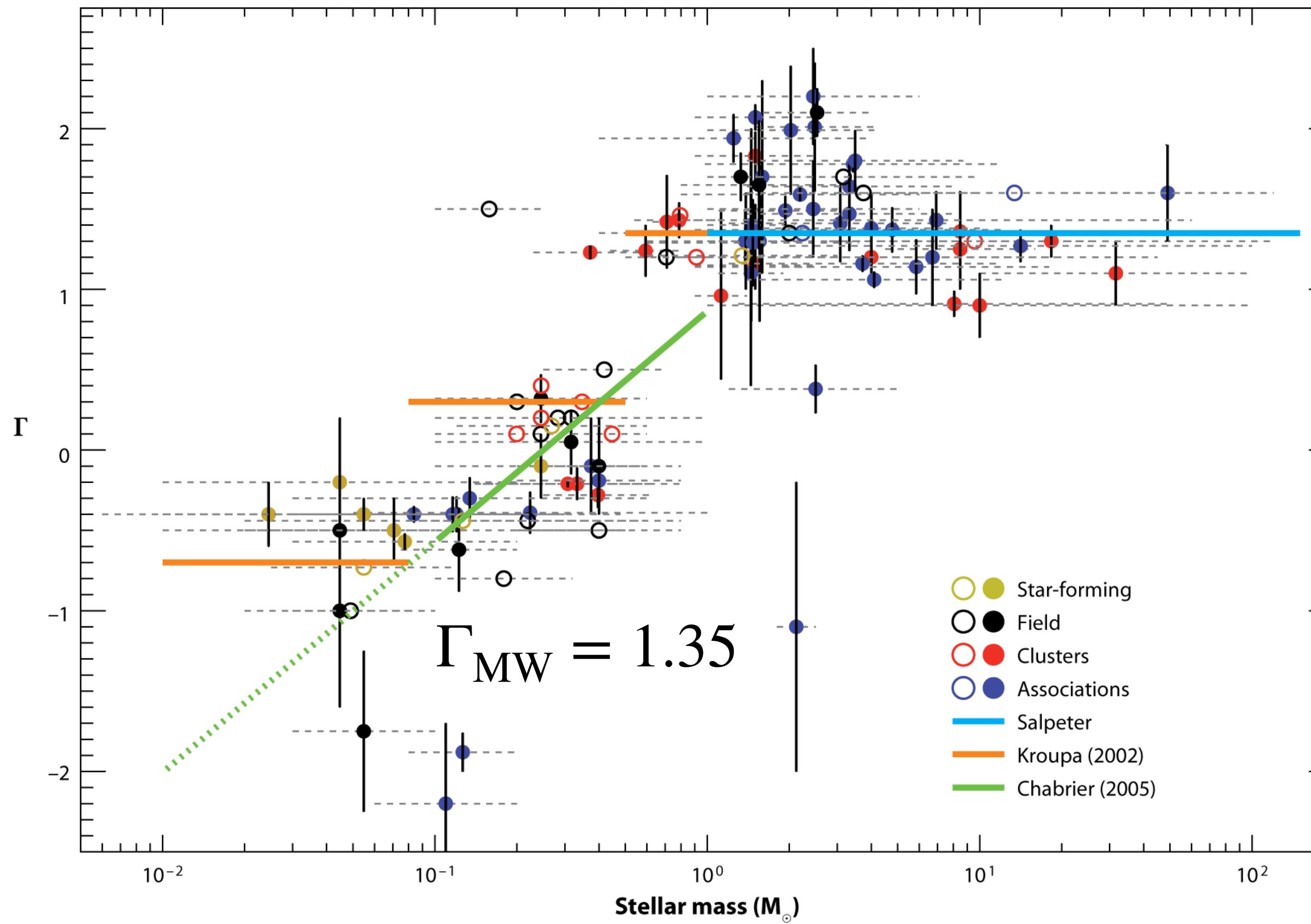
$$\Gamma = 1.39^{+0.24}_{-0.28}$$

$$\log\left(\frac{\text{Age}}{\text{yr}}\right) = 6.65^{+0.17}_{-0.05}$$

$$A_V = 0.40^{+0.08}_{-0.02}$$

$$\Gamma_{\text{MW}} = 1.35$$

# Aggregate of IMF Measurements from Resolved Star Counts



Bastian N, et al. 2010.

Annu. Rev. Astron. Astrophys. 48:339–89

# Motivation for our in-class exercise

- Resolved star counts are the gold-standard for IMF measurements.
- But many studies, even of the same object, show conflicting results, often to high-levels of formal significance?
- How can we assess the reliability of these results without entirely re-doing the studies?
- Can we at least assess whether their claims are plausible given the most optimistic assumptions?
  - The exact number of how many stars were used
  - The exact masses of the stars
  - All other complications were perfectly dealt with