STAR CLUSTERS IN THE LMC: THE YOUNG, THE OLD AND THE IMF

Theodoros Bitsakis

Instituto de Radioastronomia y Astrofisica, UNAM

G. Bruzual, R. A. Gonzalez, P. Bonfini, V. Ramirez, G. Maravelias and D. Zaritsky

Image Credit: Primoz Cigler

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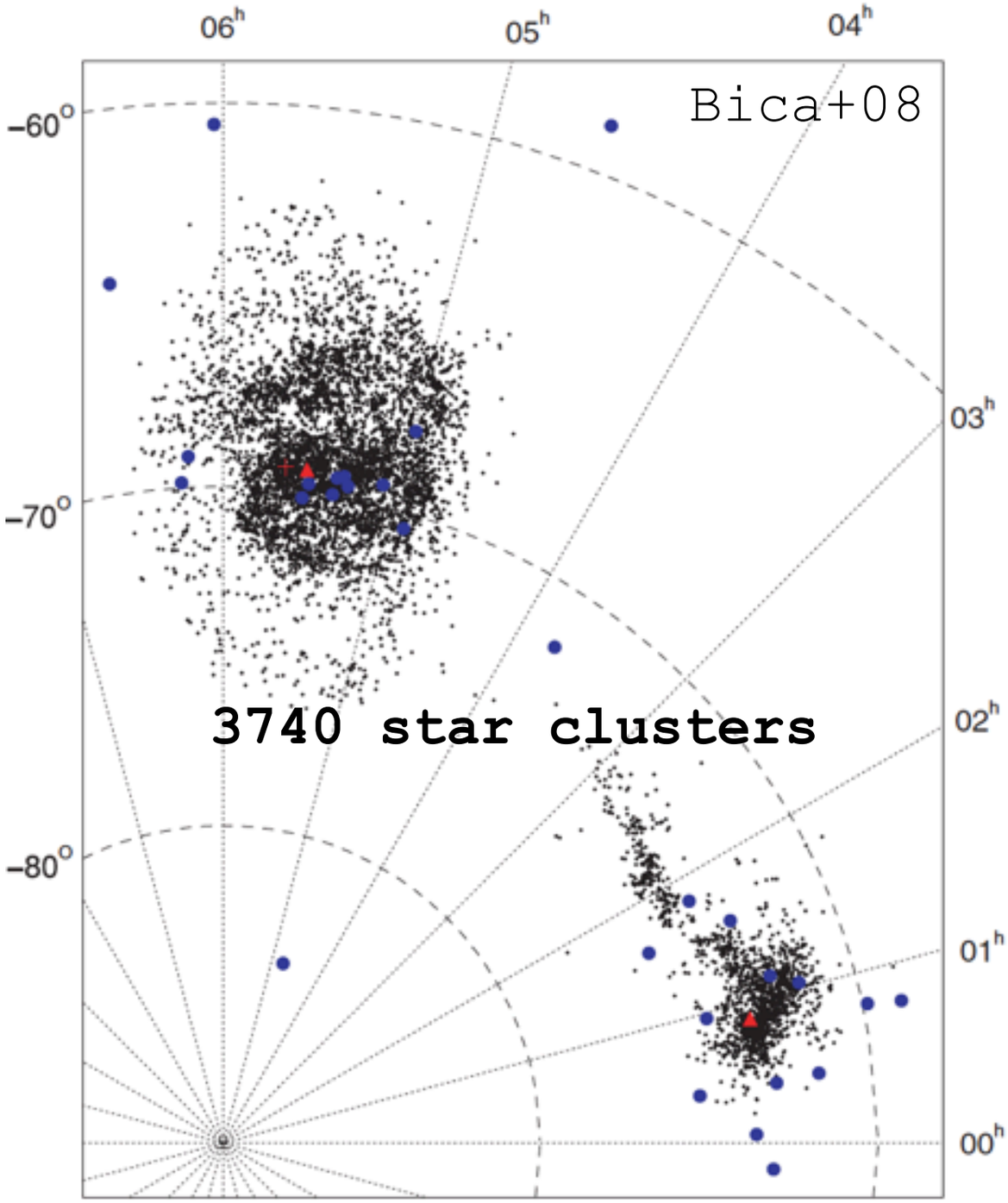
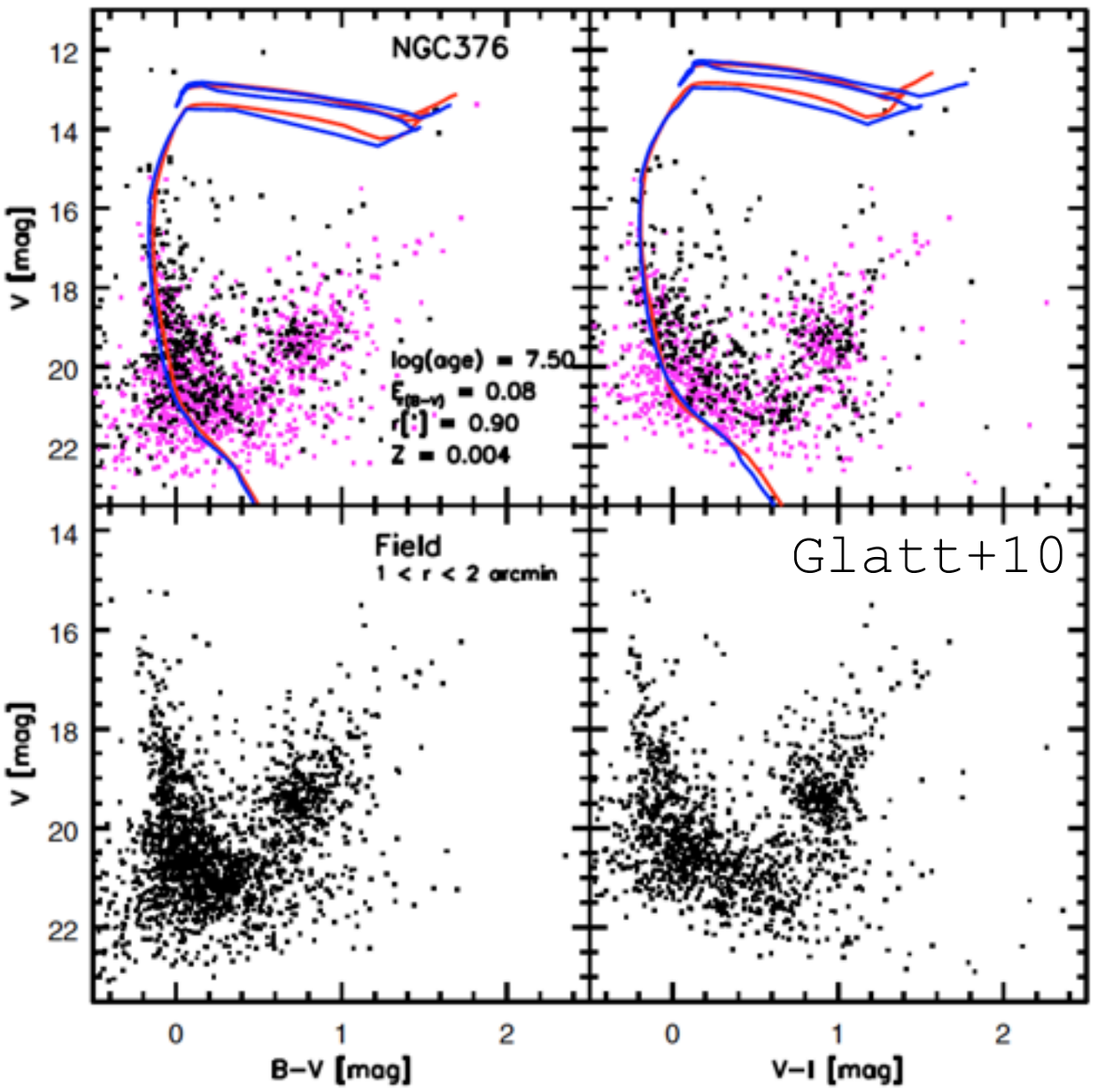
INTRODUCTION

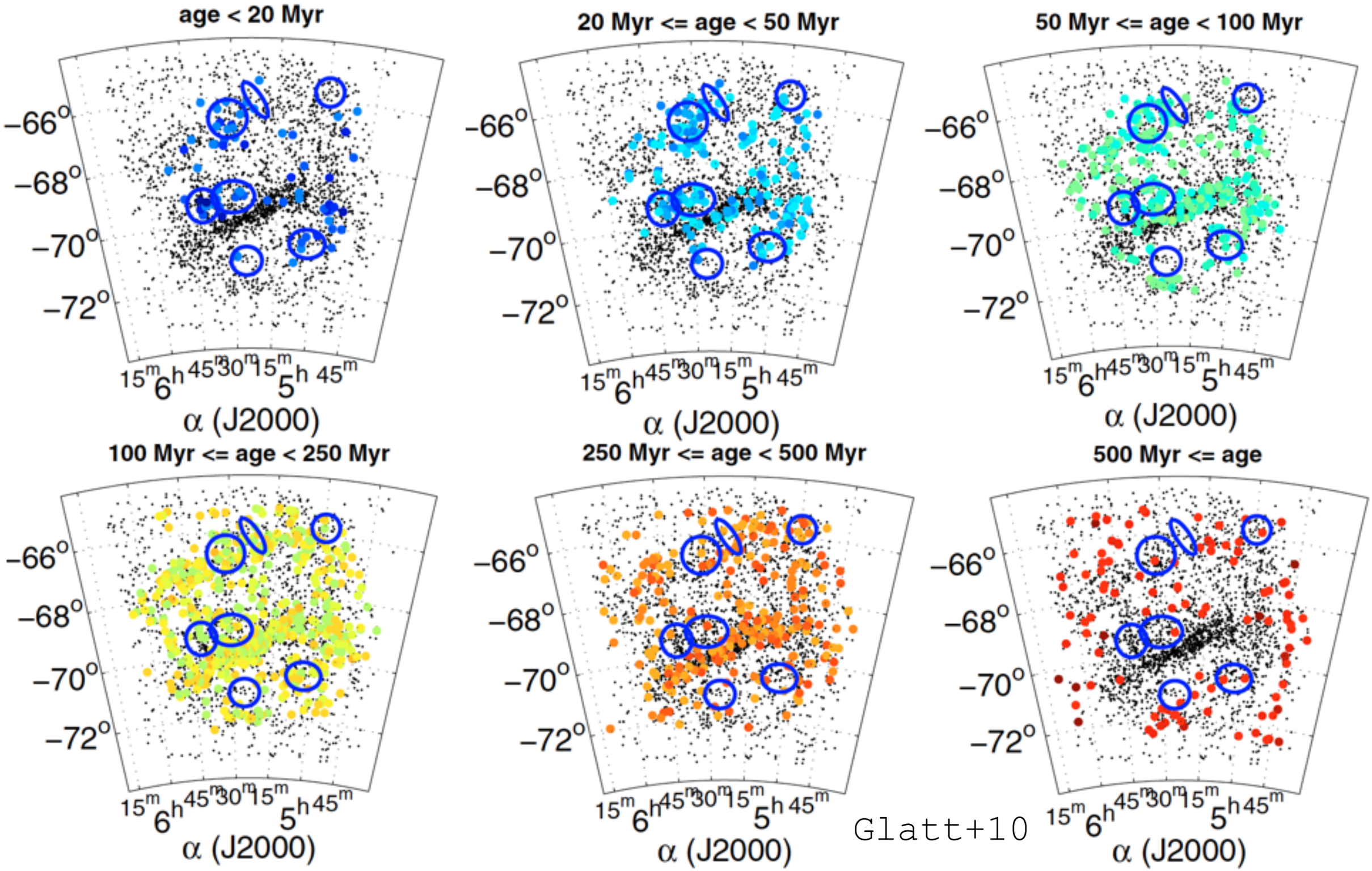
- The Magellanic Clouds have been a triple system with MW for at least 1Gyr (e.g. Bekki&Chiba05)
- Their proximity allows us to study in detail important properties of galaxies (such as the star formation history, luminosity functions, IMF etc)
- These systems contain very rich star clusters at a wide rage of ages (e.g. Hodge61, Olsen+98, Glatt+10, Pietrzynski & Udalki00, Nayak+16)
- Various authors attempted to study their SFH (e.g. Olsen +98, Harris & Zaritsky01)

INTRODUCTION II



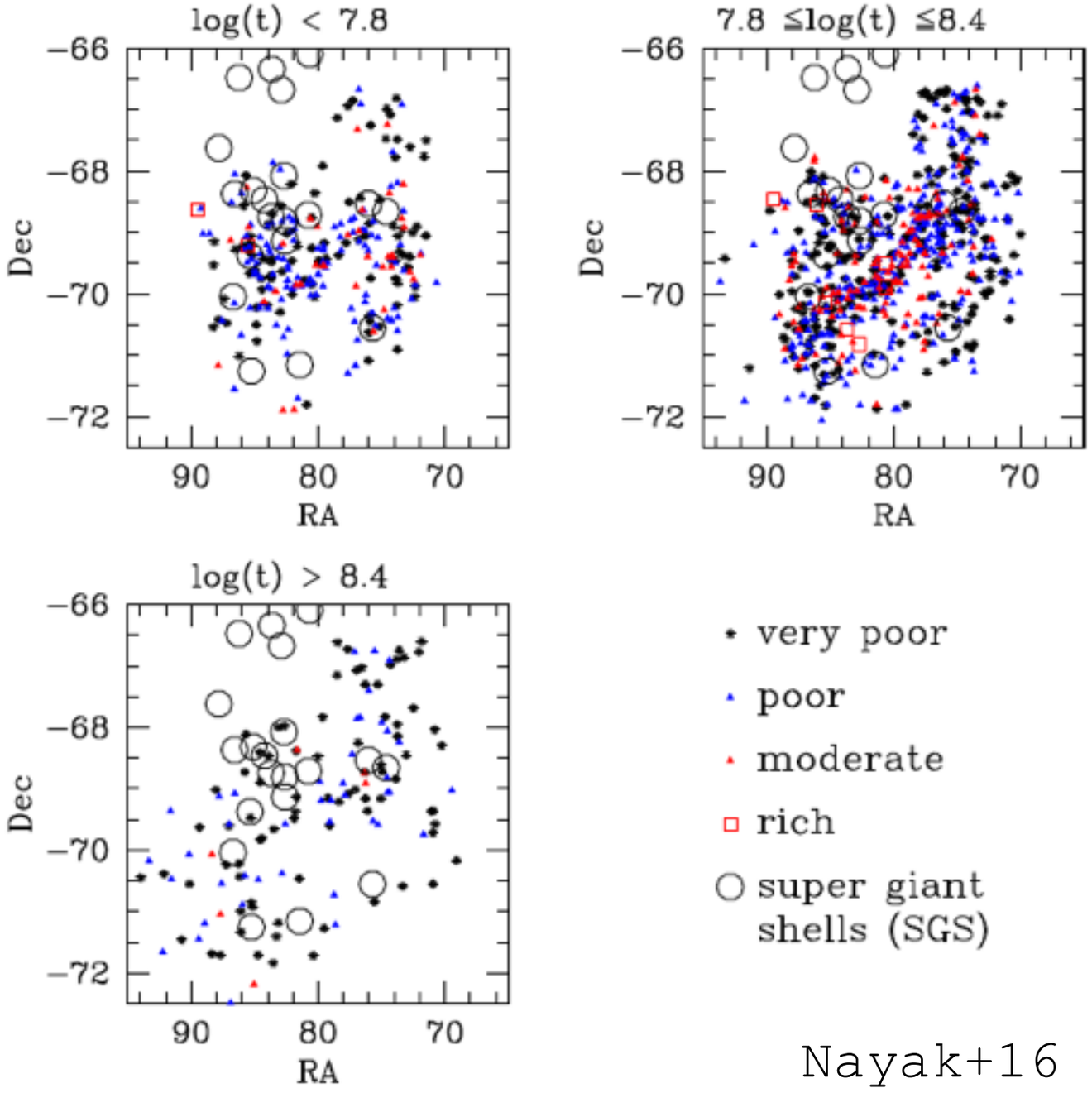


INTRODUCTION III



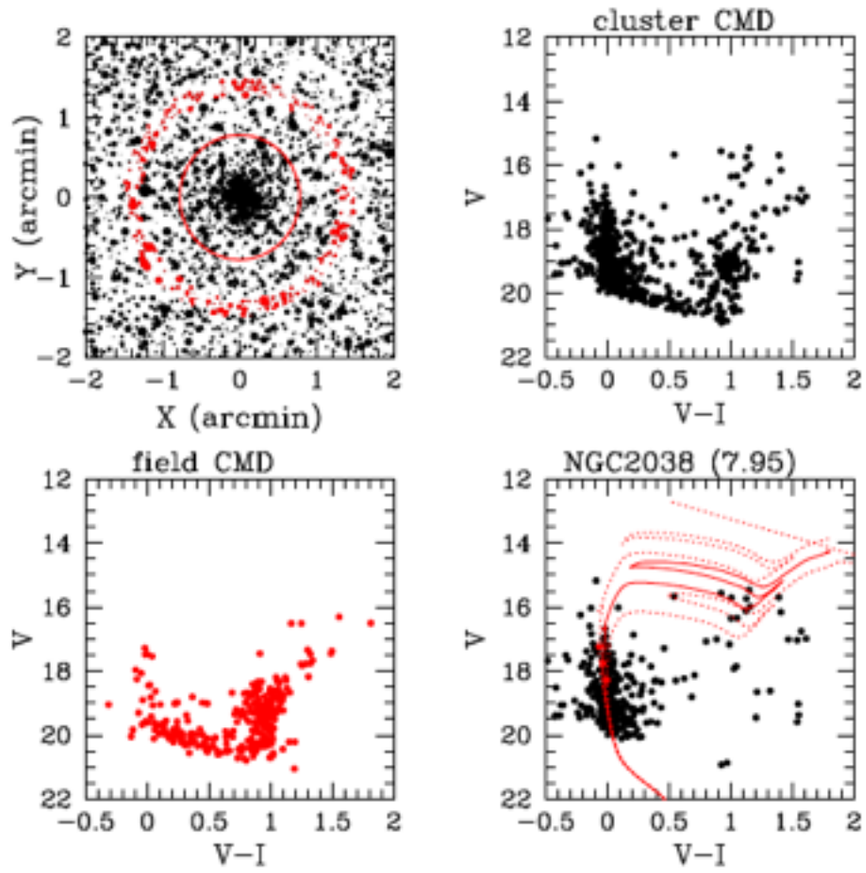
Glatt+10

INTRODUCTION IV



Nayak+16

- 1072 clusters (from Bica+08), using data from OGLE-III
- They estimate the ages using a semi-automated quantitative method

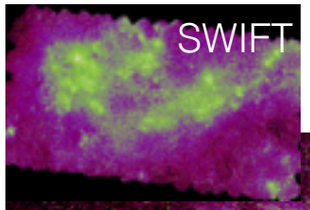


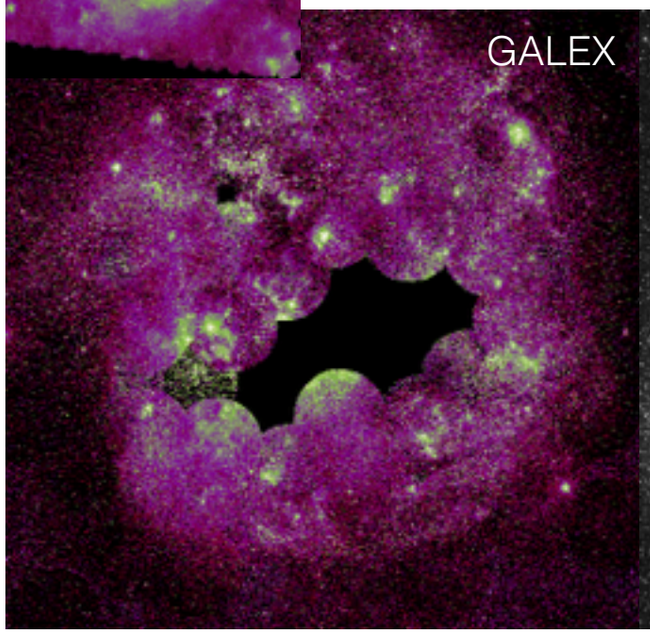
GOALS

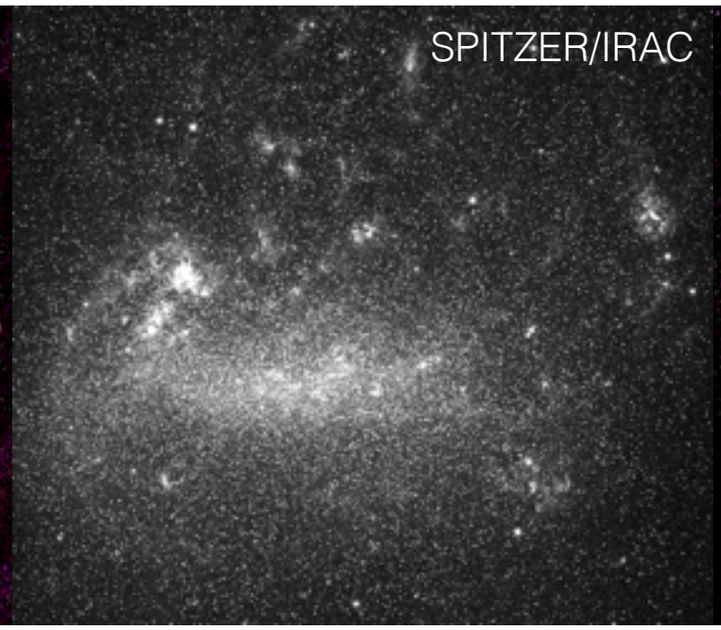
- To create an completely automated method to detect over-densities in nearby galaxies
- To use an automated fitting code to estimate the ages of these clusters
- To study the star formation history of the galaxies as well as the luminosity functions and IMF of the clusters

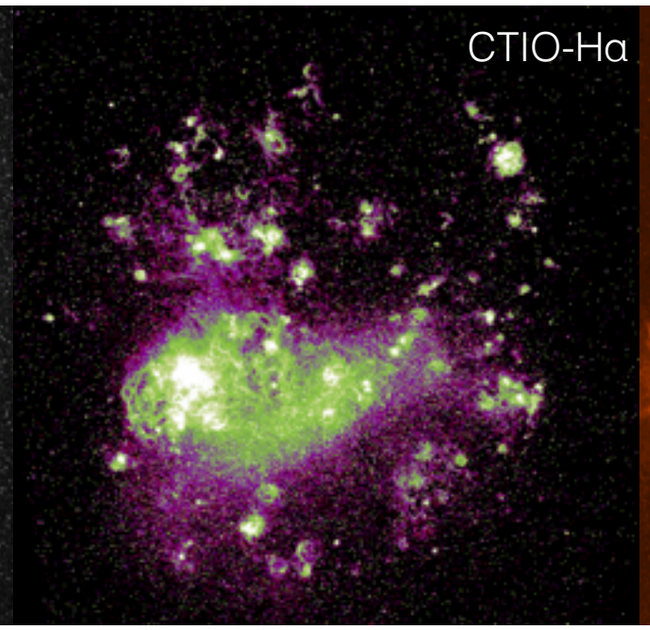
SAMPLE

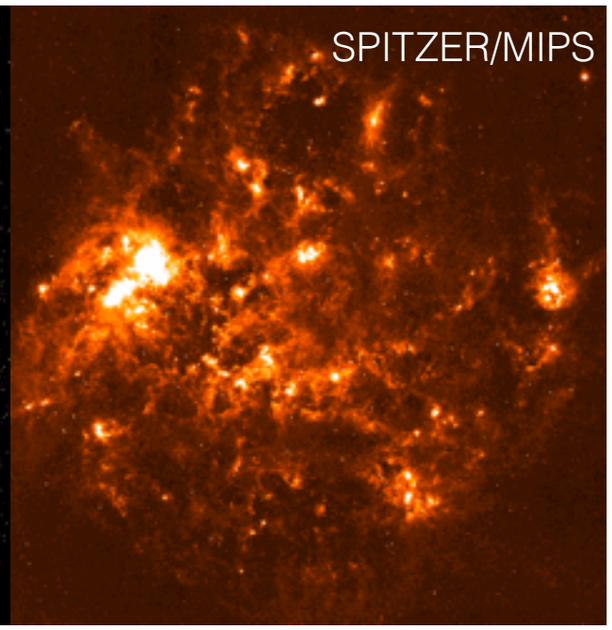
- We start from the **Large Magellanic Cloud**
- We use archival data from Simons+14, SUMAC, MCPS, MCELLS, SAGE, and Herschel Heritage
- Our sample comprises:
  - Ultraviolet: GALEX, SWIFT (coverage 7.5x7.5^{o} of LMC)
  - Optical: Las Campanas, CTIO-Hα
  - Infrared: Spitzer, Herschel
  - Radio: CO(1-0), HI (mom-0 & velocity maps)



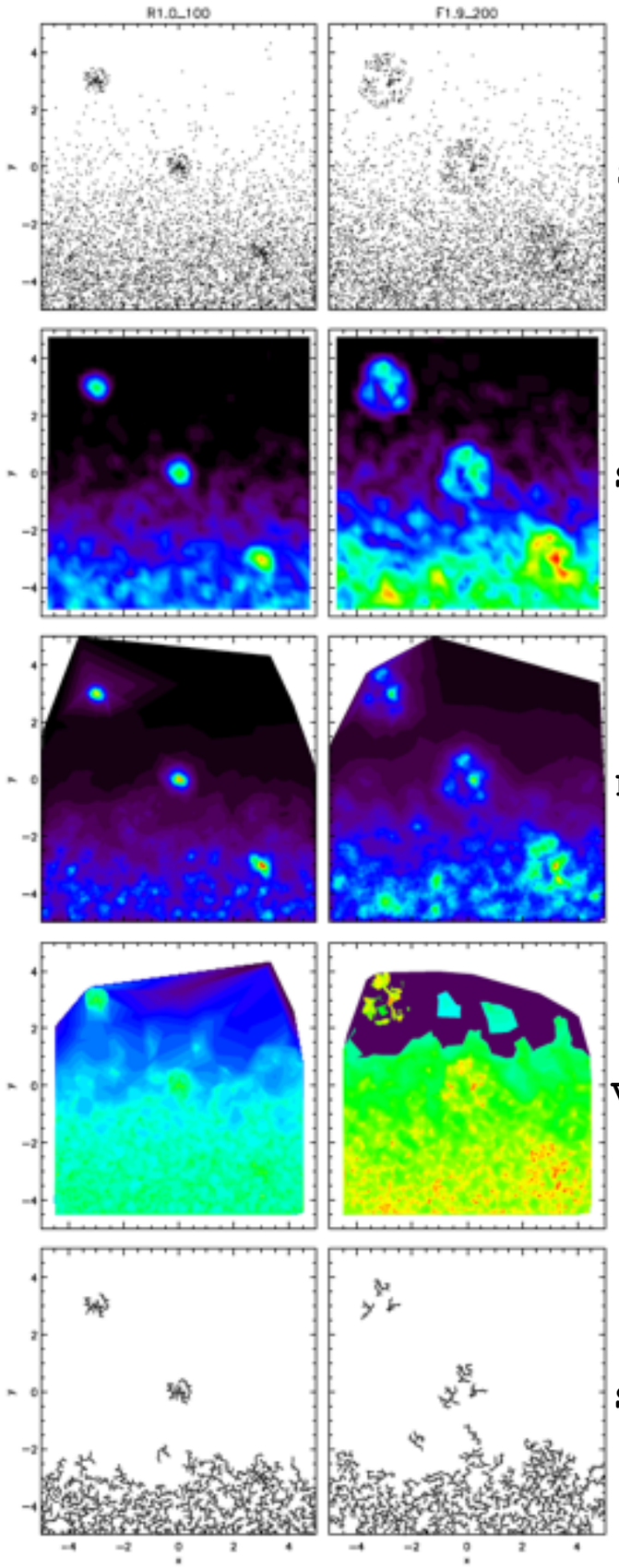








Simulations by Schmeja10



Simulated clusters

Star counts

Nearest neighbor

Voronoi tessellation

Separation of minimum spanning tree

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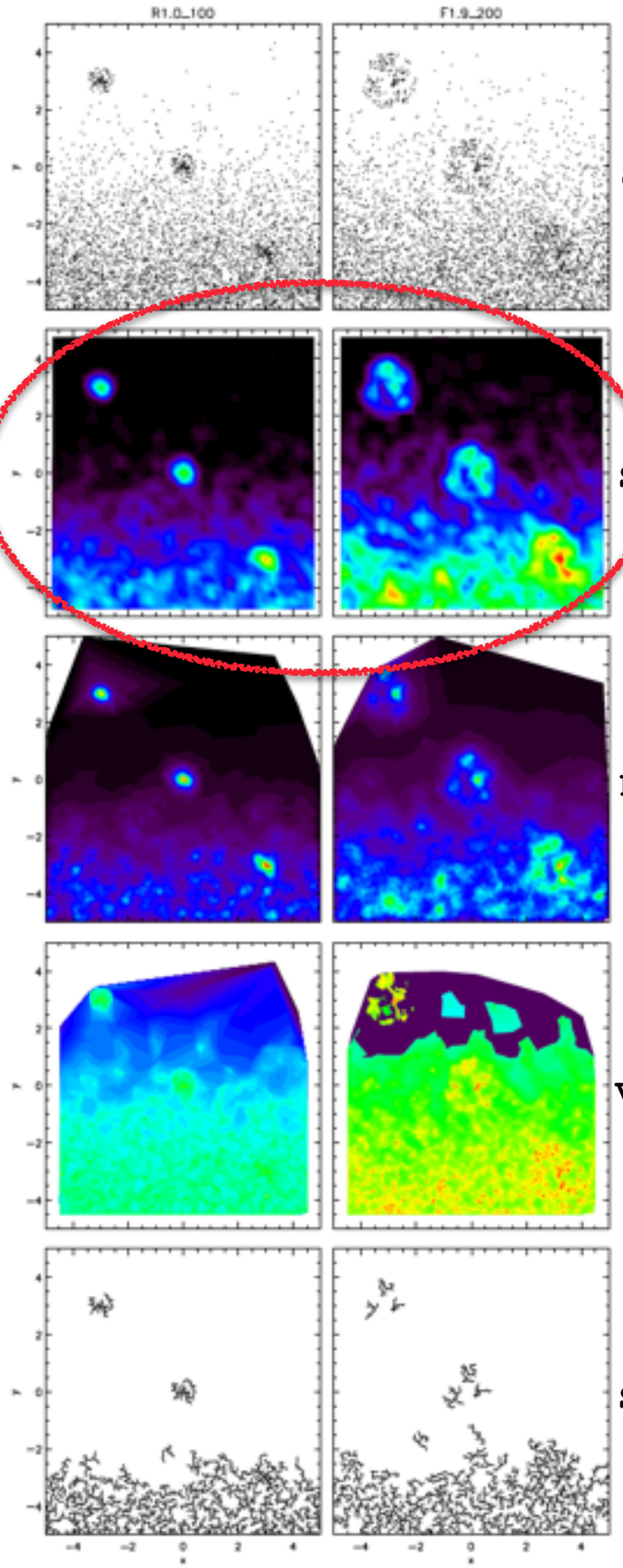

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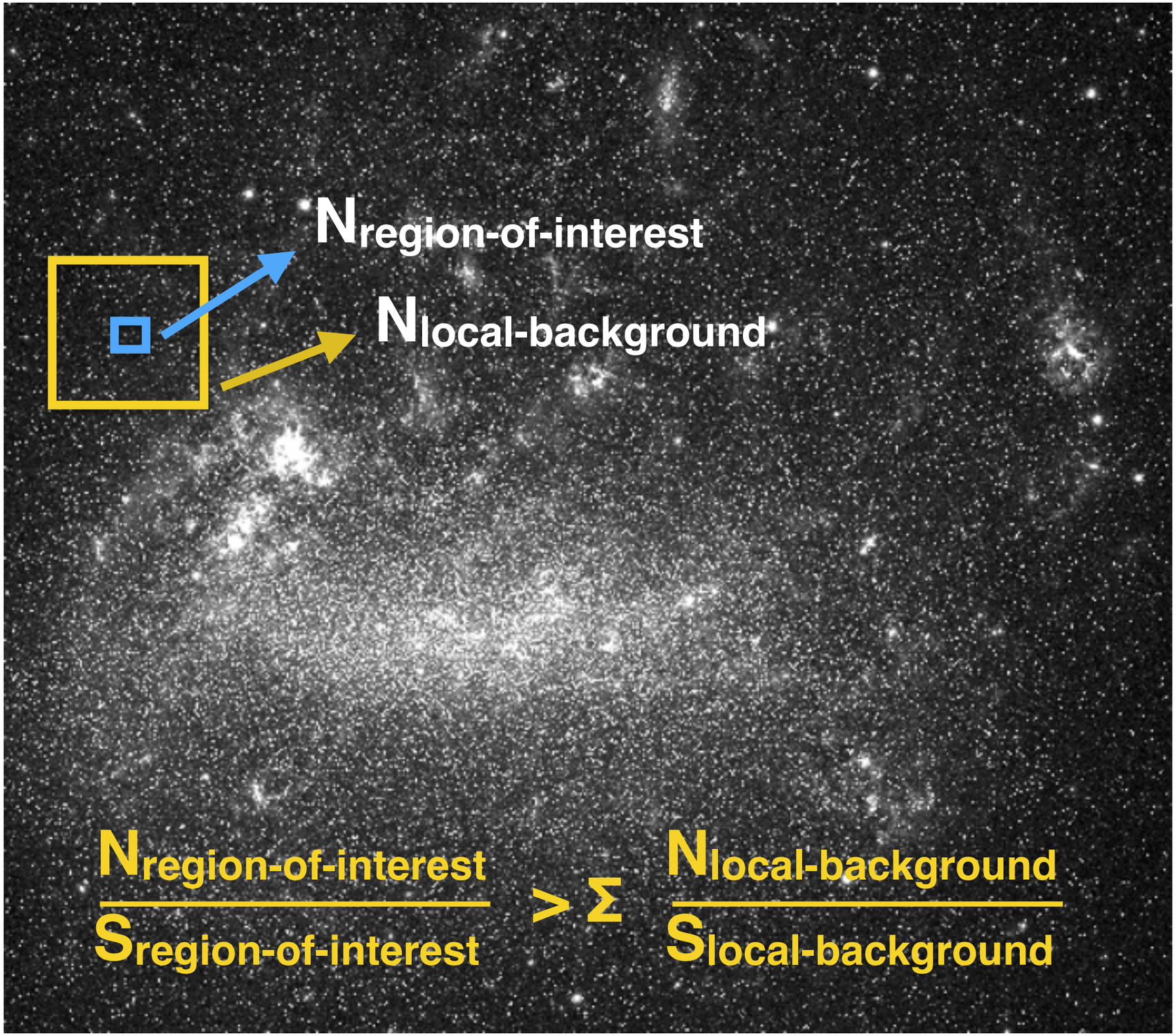
IDENTIFICATION METHOD



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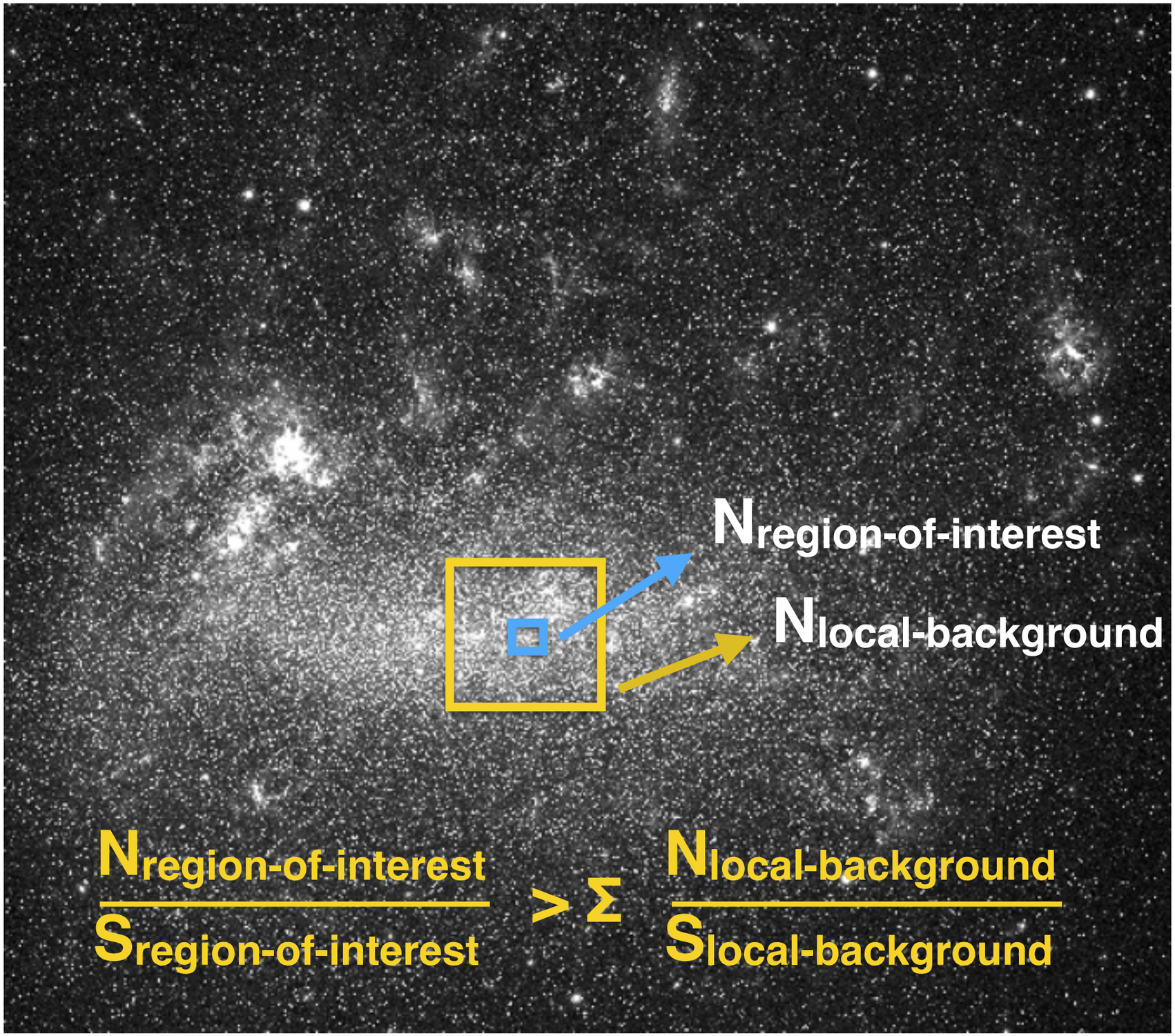
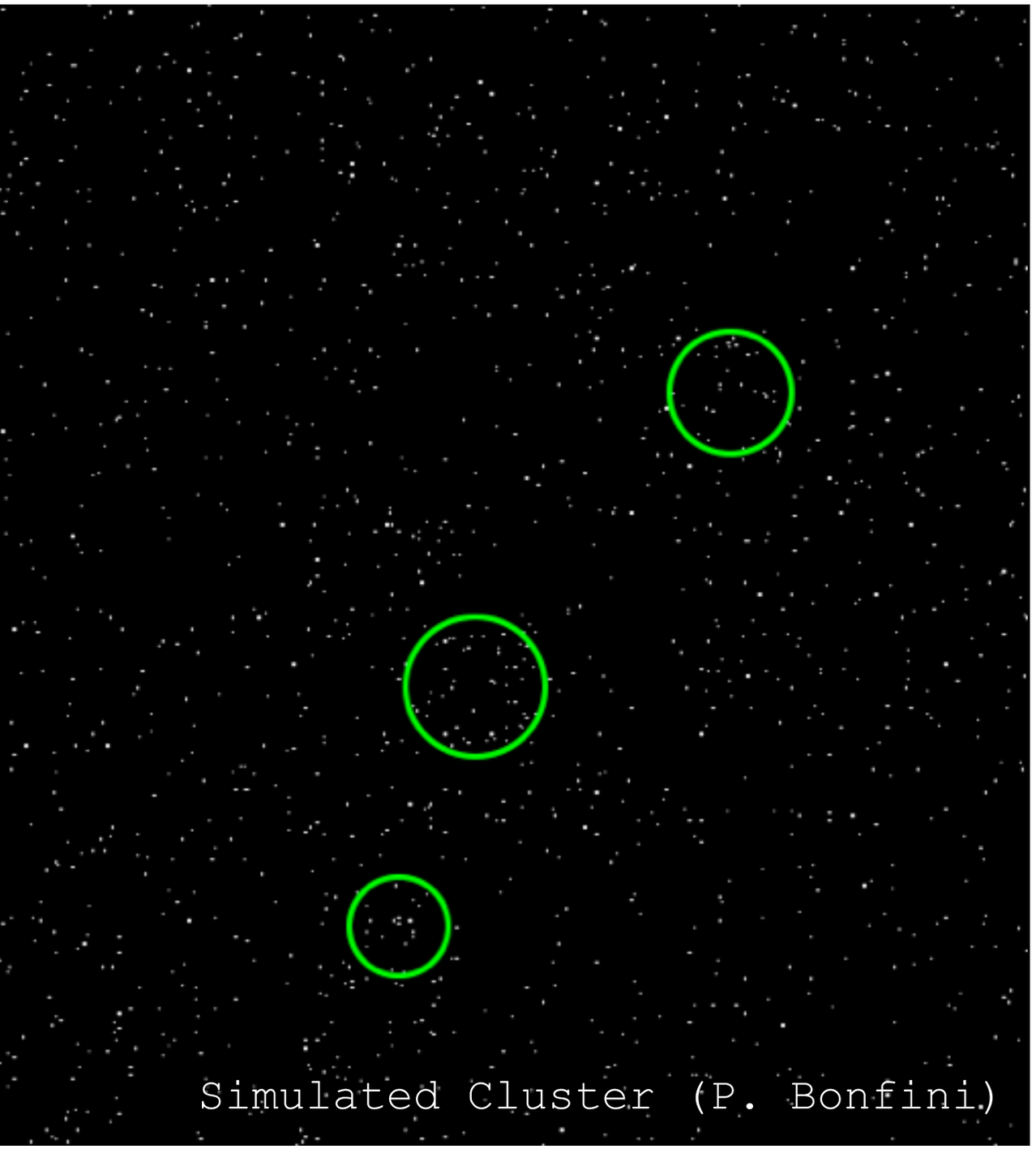
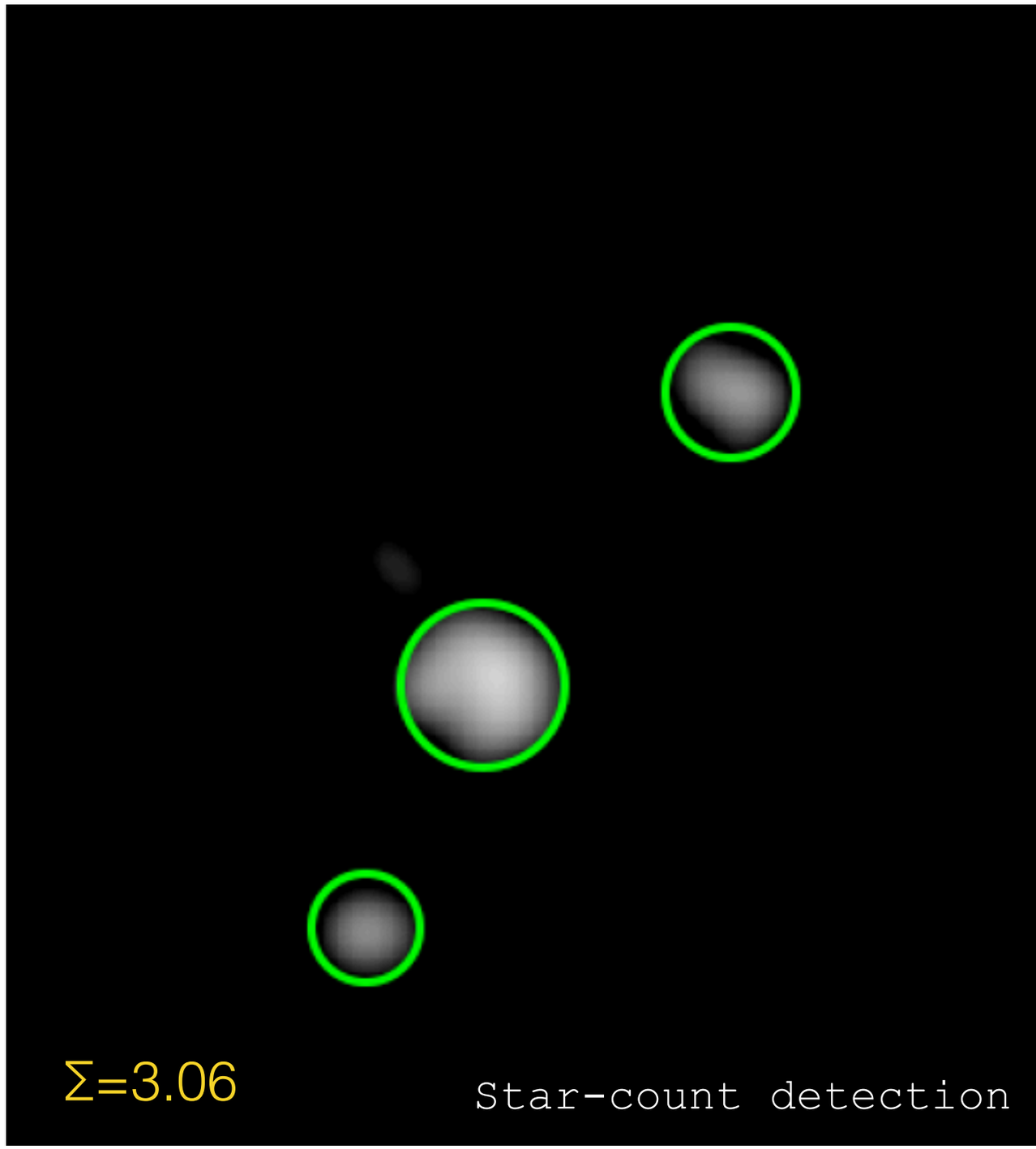


CLUSTER SIMULATIONS





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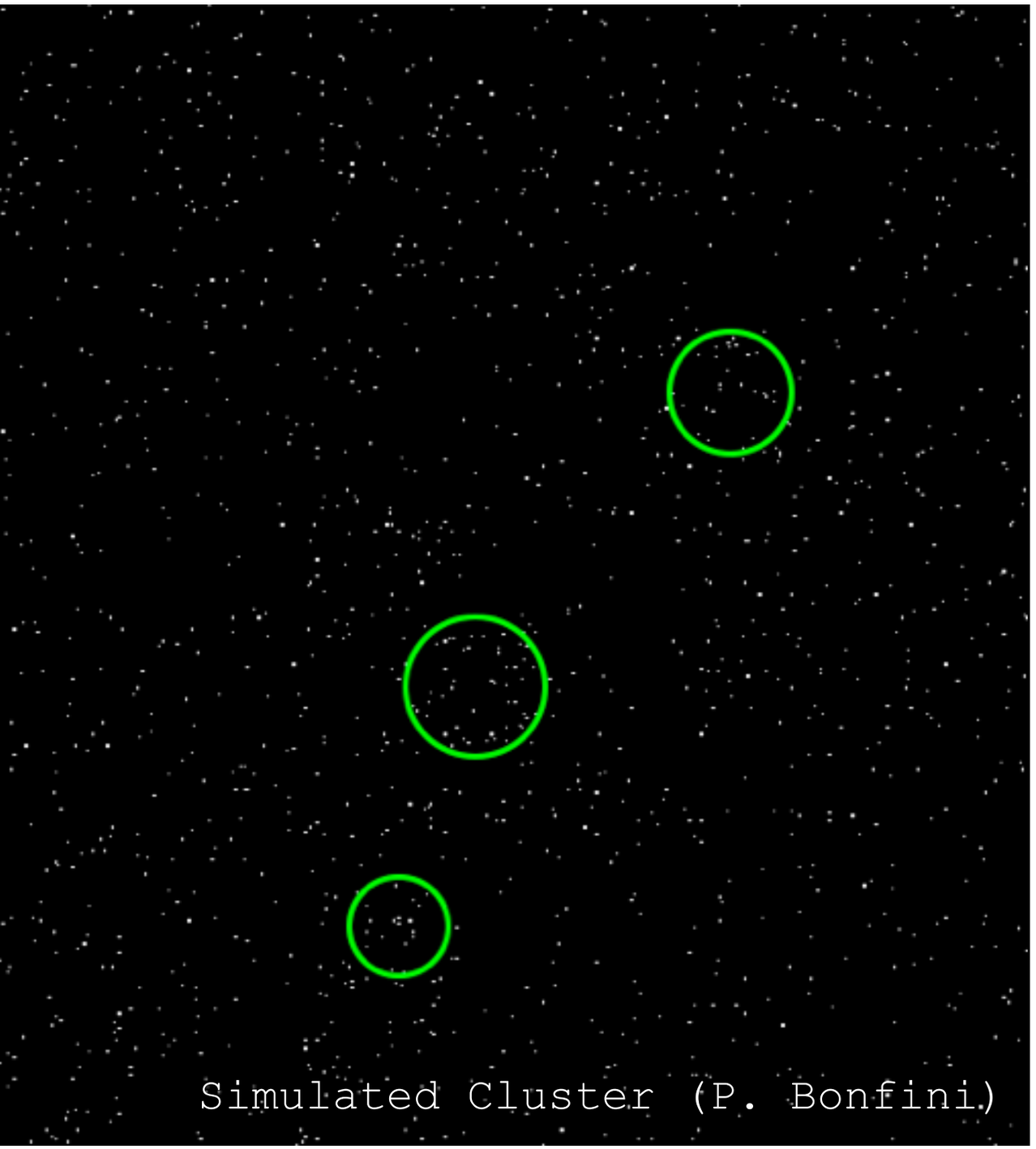

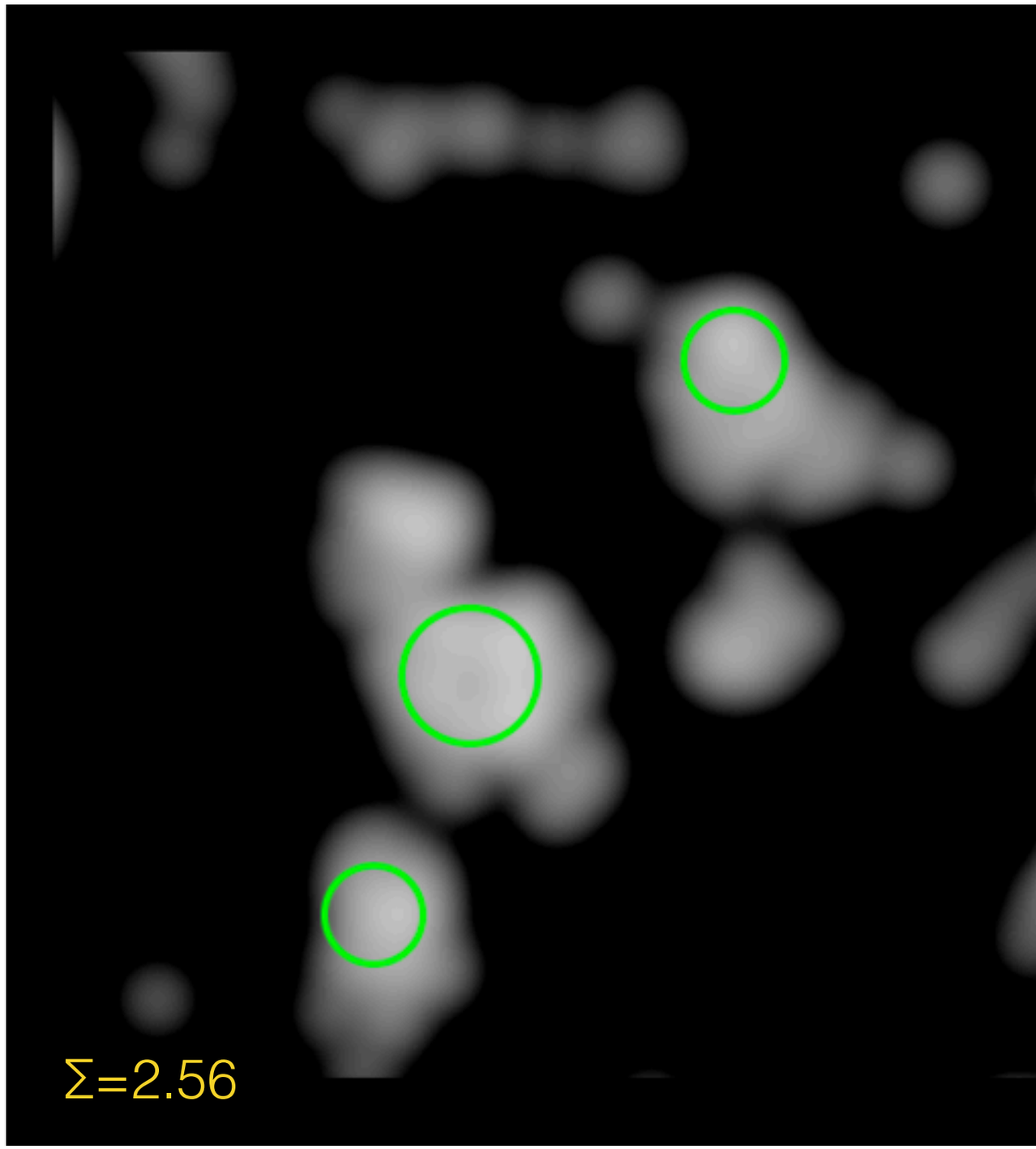

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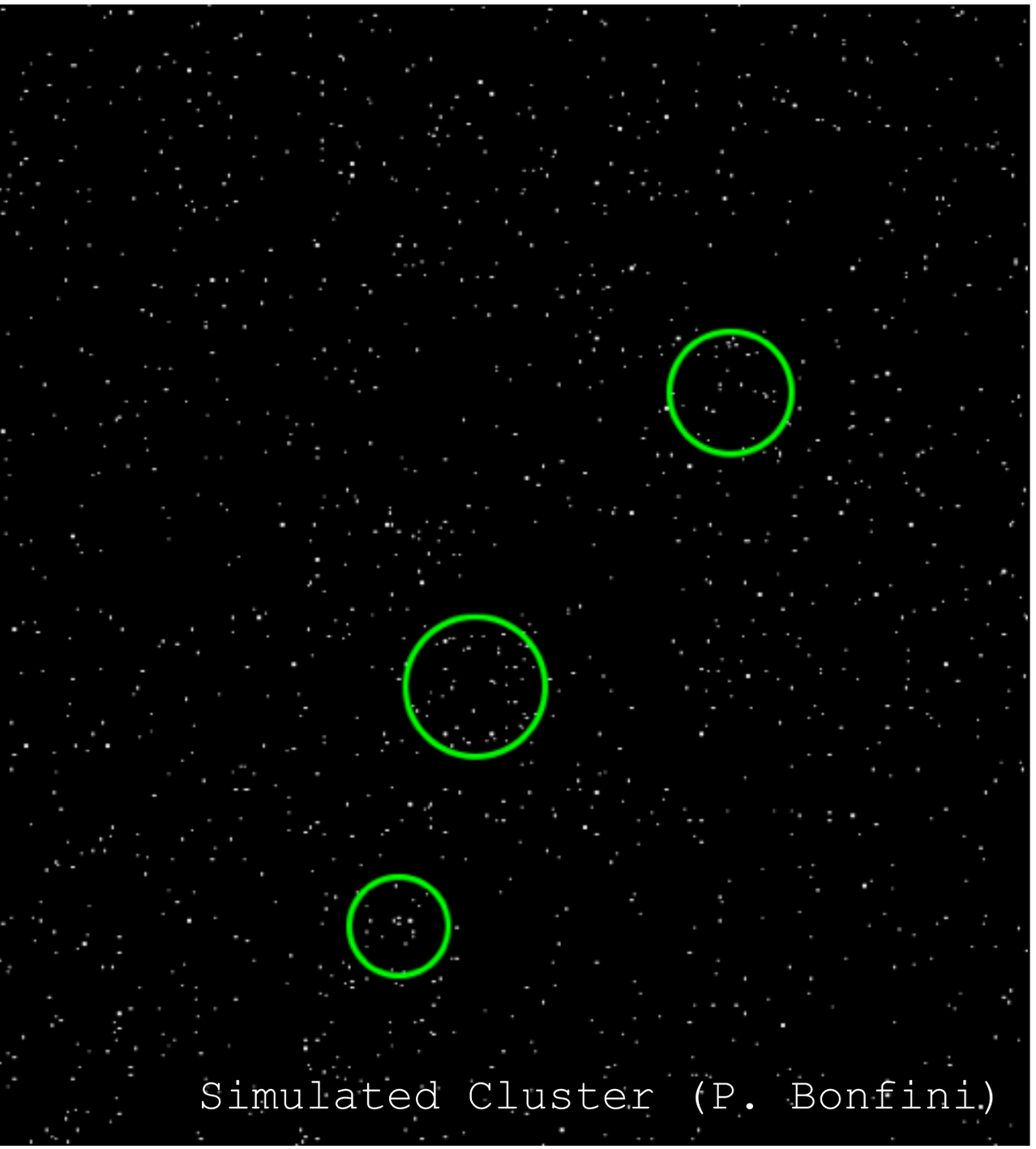

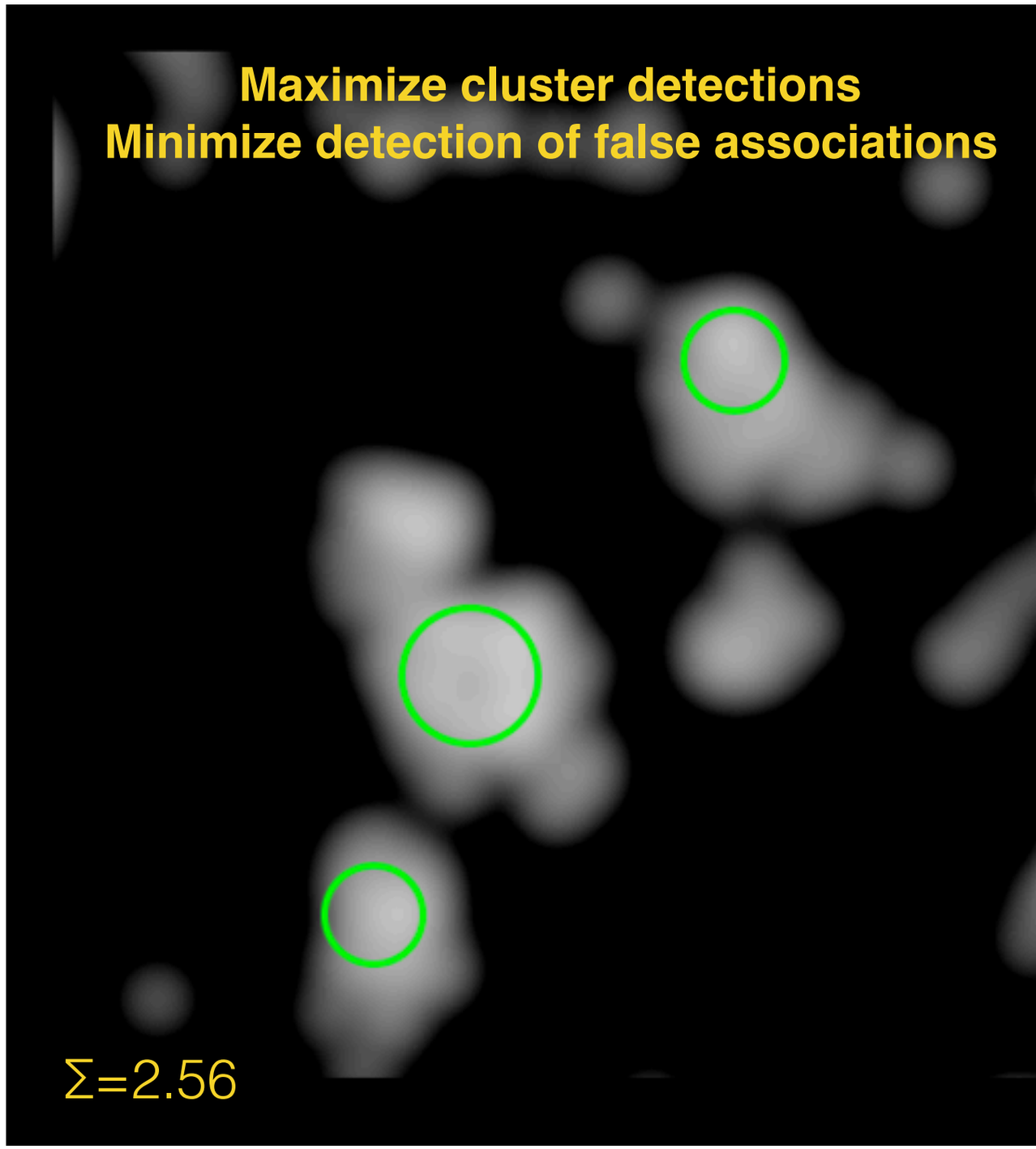

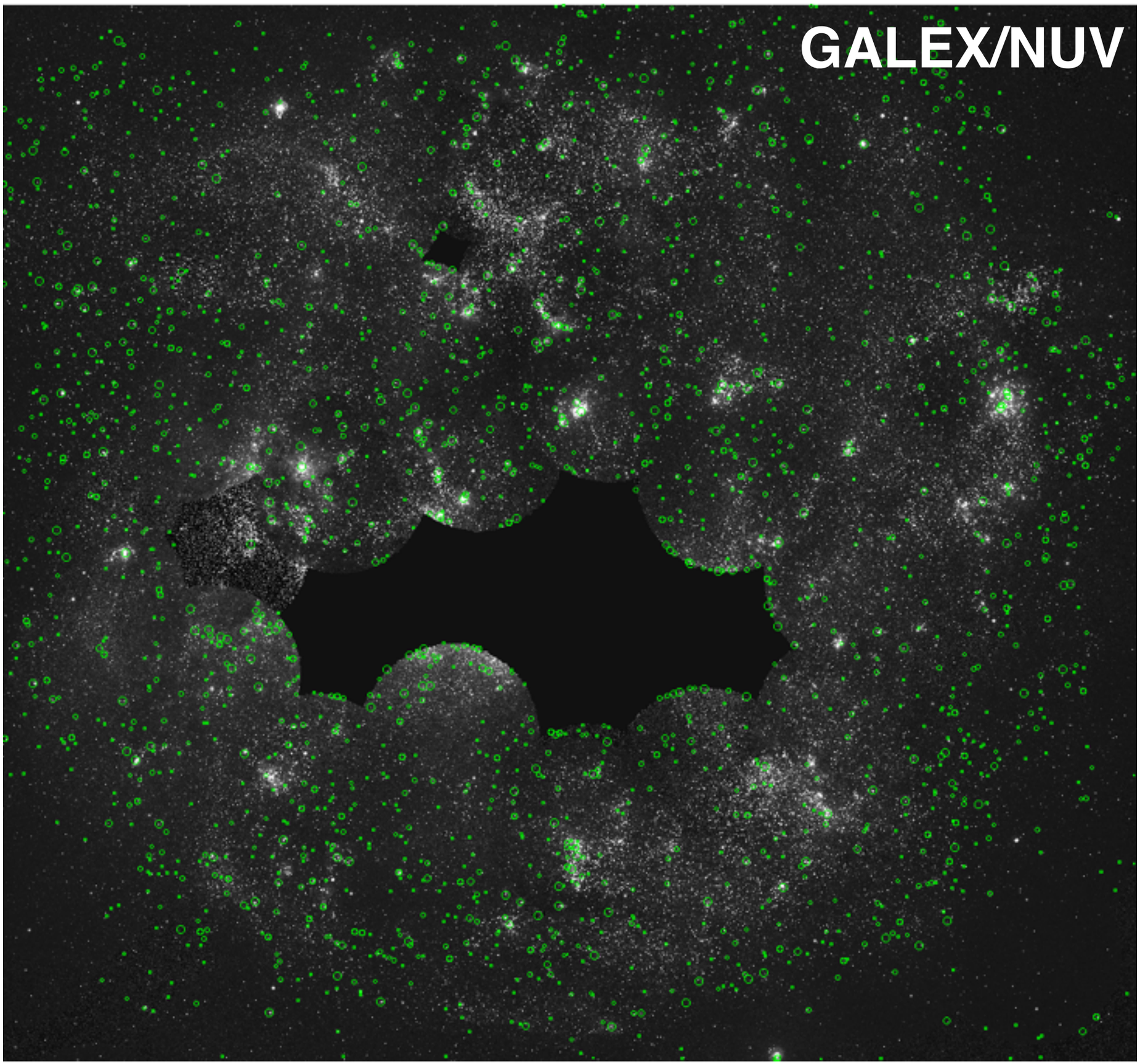
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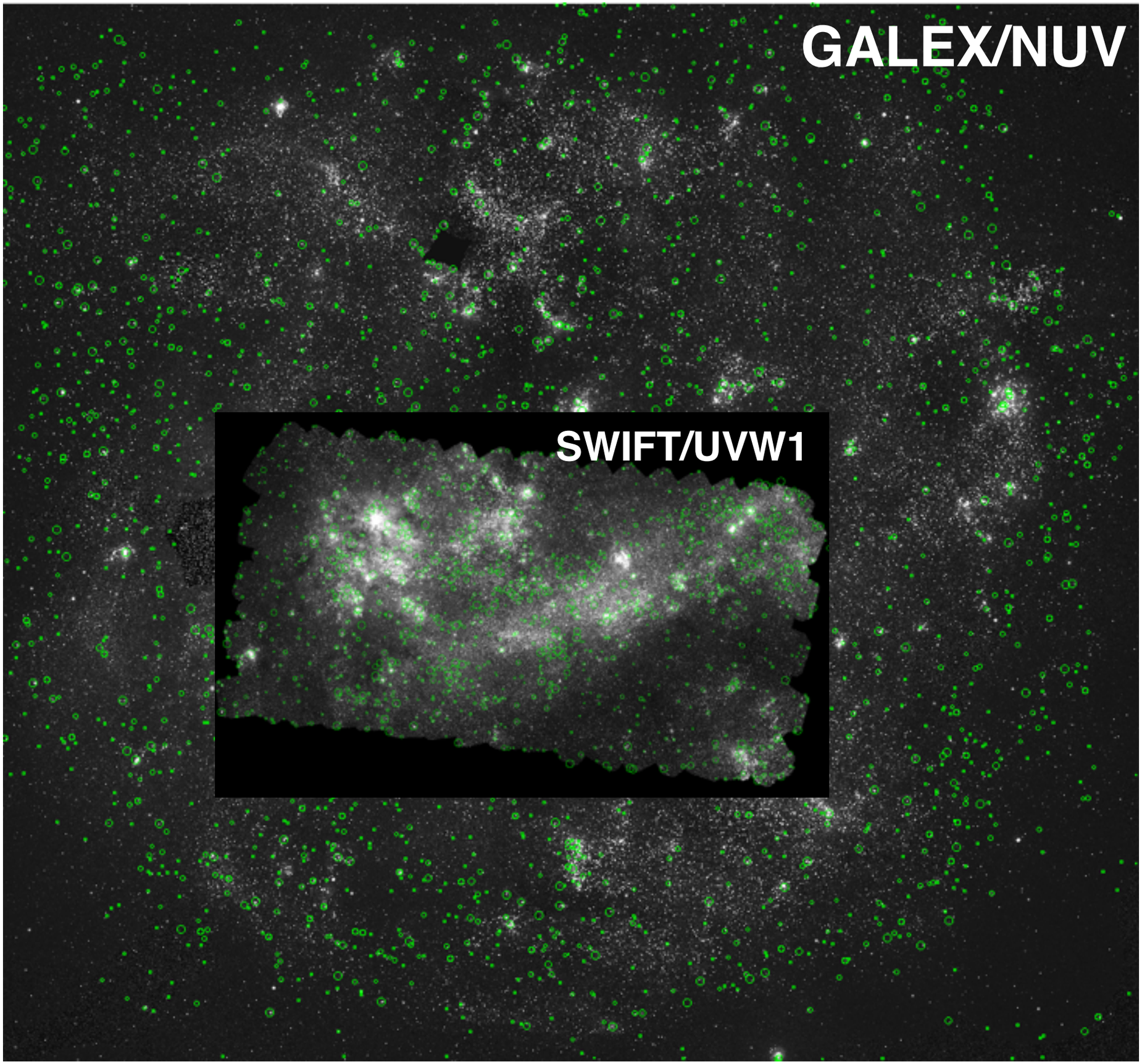
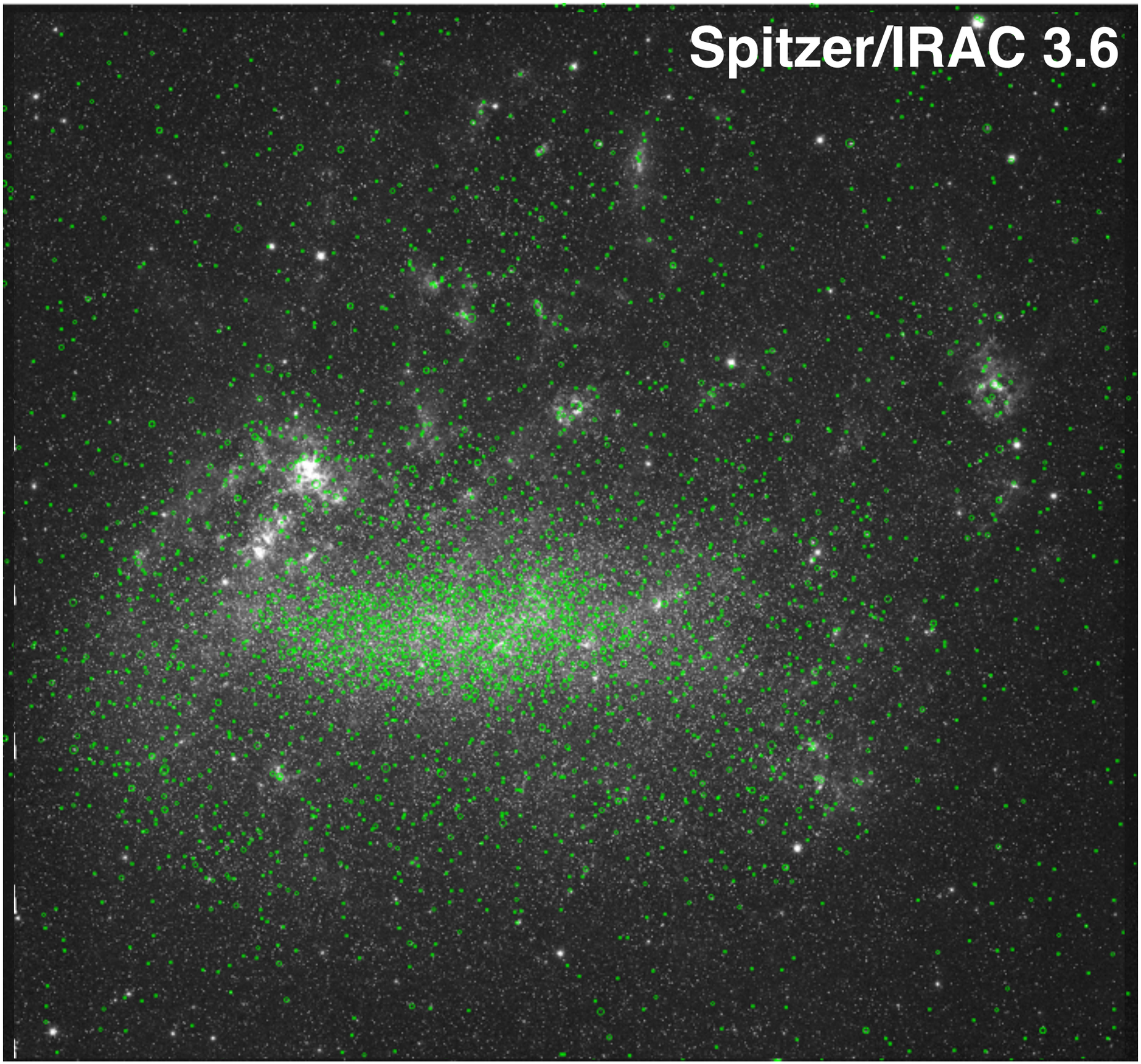
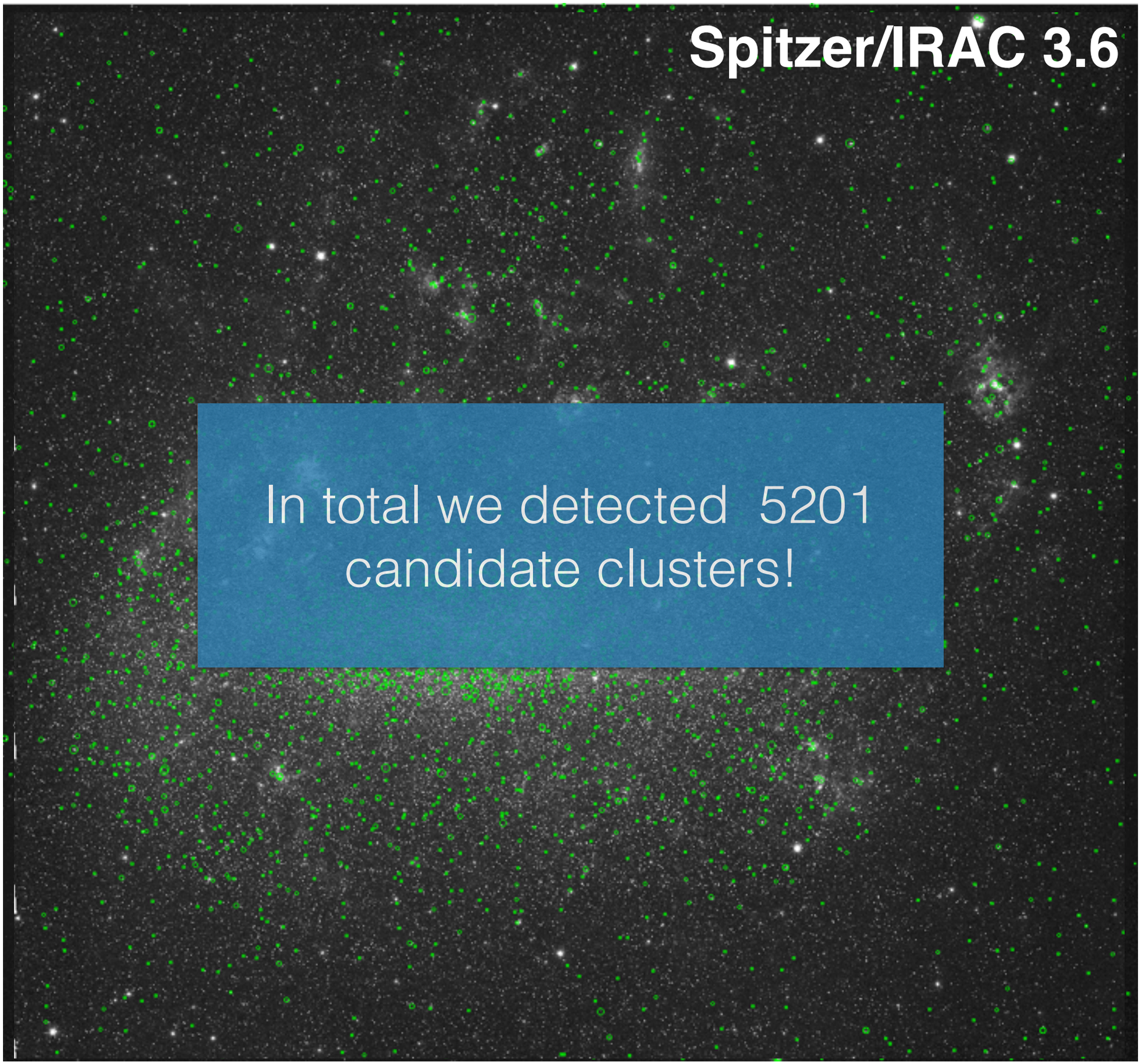
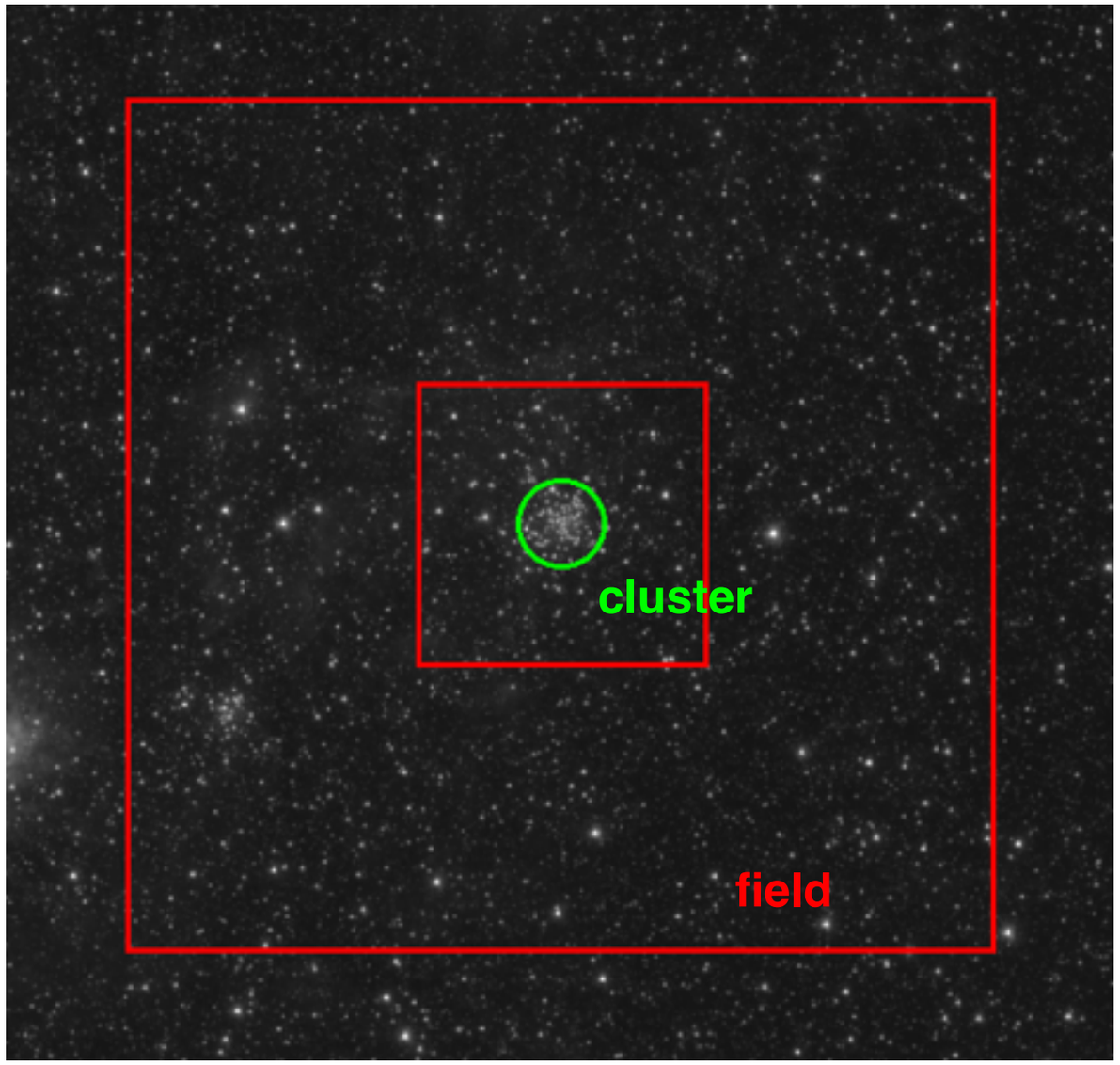

GALEX/NUV
SWIFT/UVW1

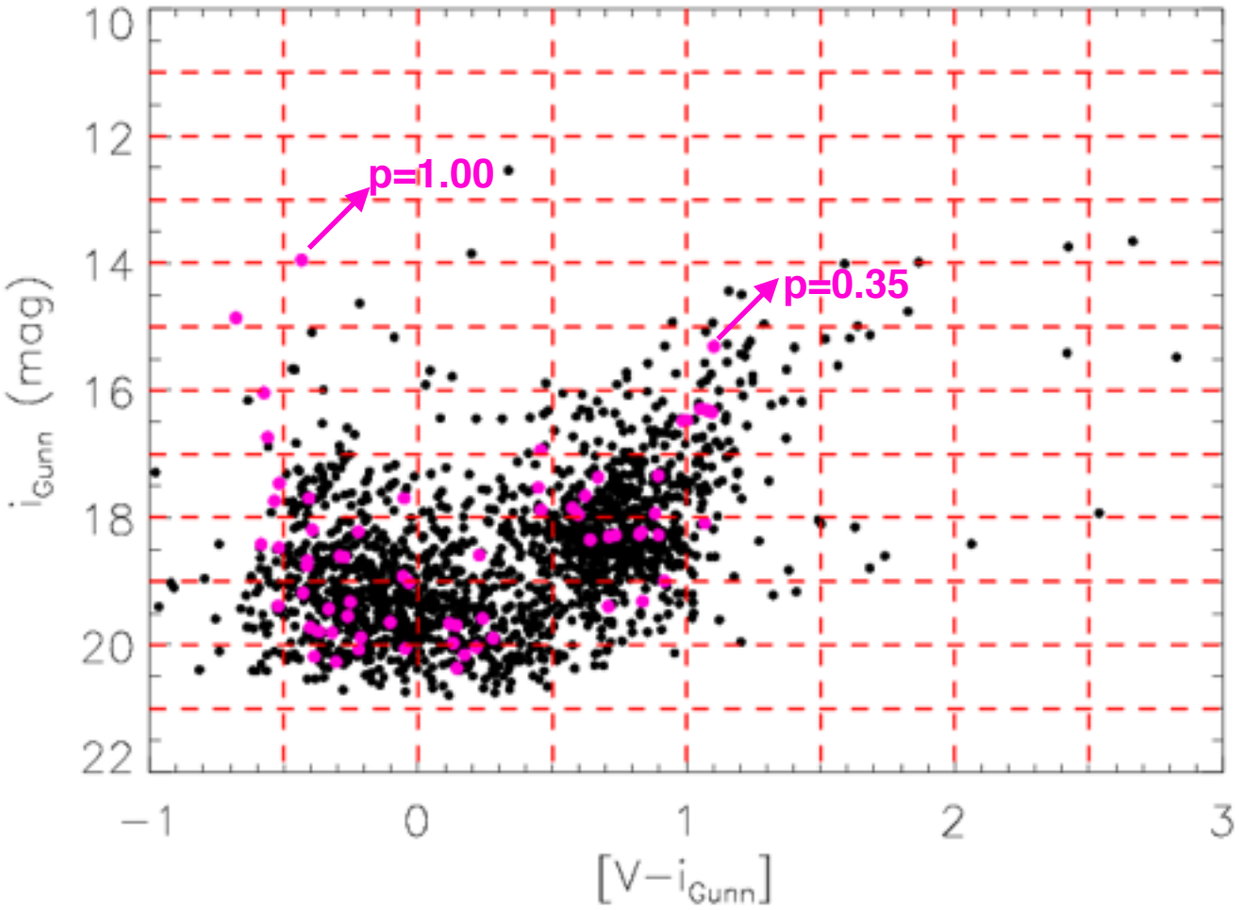

Spitzer/IRAC 3.6


Spitzer/IRAC 3.6
In total we detected 5201 candidate clusters!

FIELD STAR CONTAMINATION

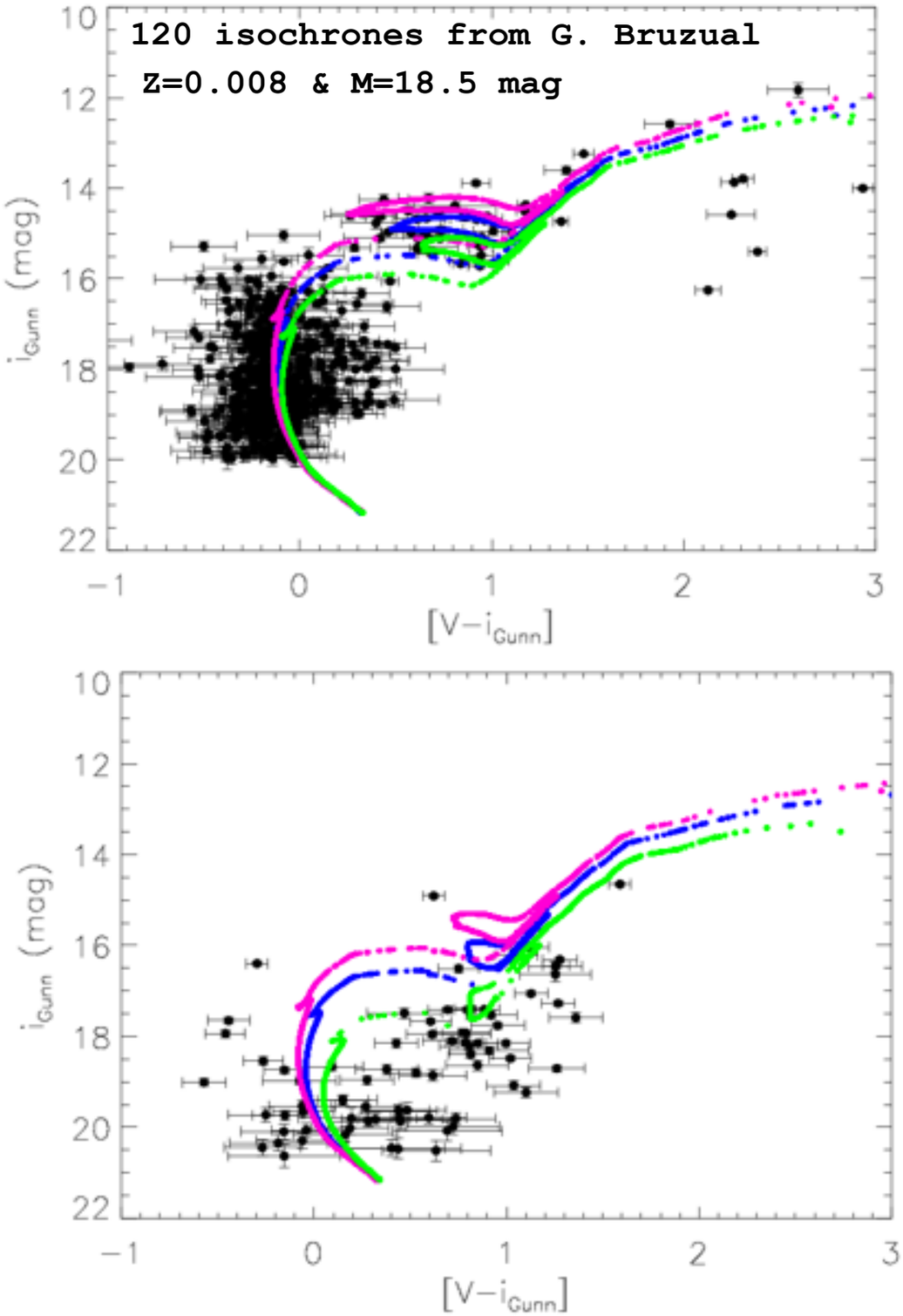


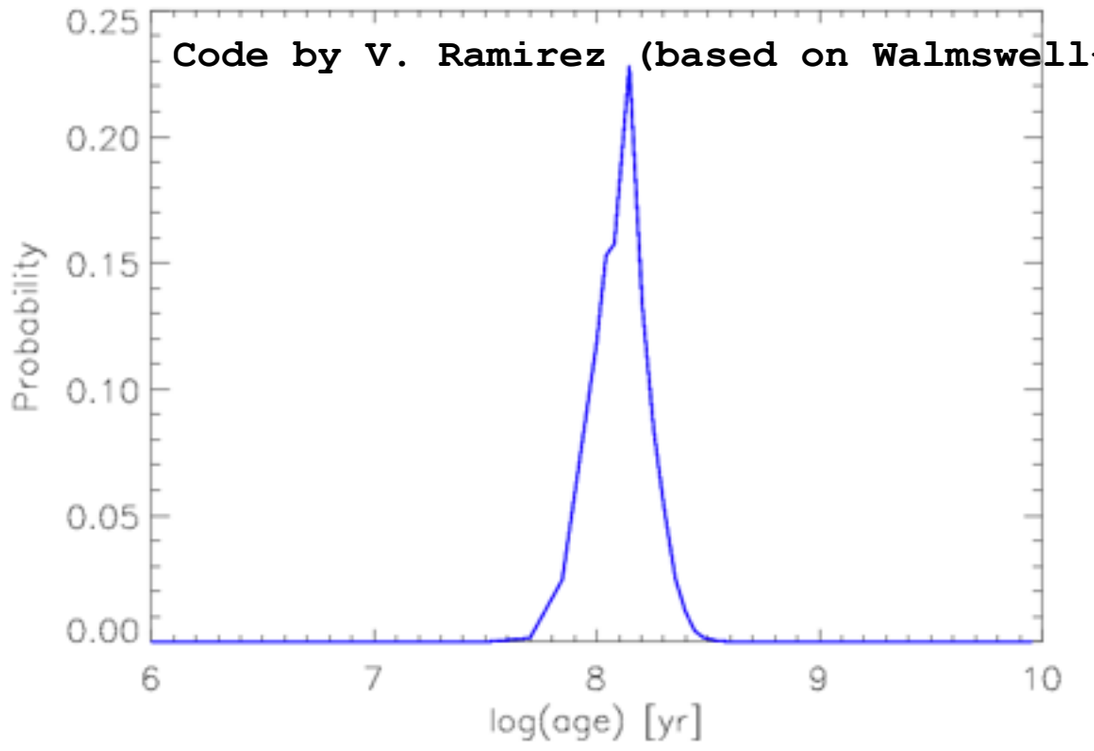
We use a modified version of the field star selection method described in Mighell+96

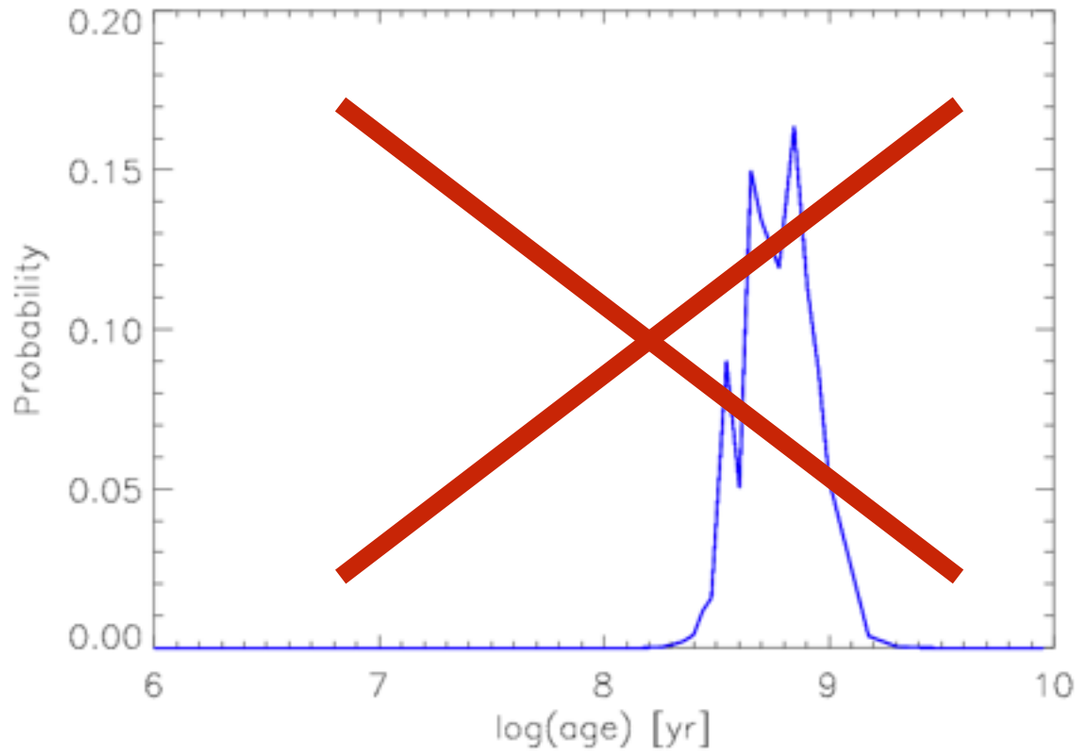


$$p_{color/mag} = 1 - \frac{n_{field}}{n_{cluster+field}}$$

FITTING ISOCHRONES







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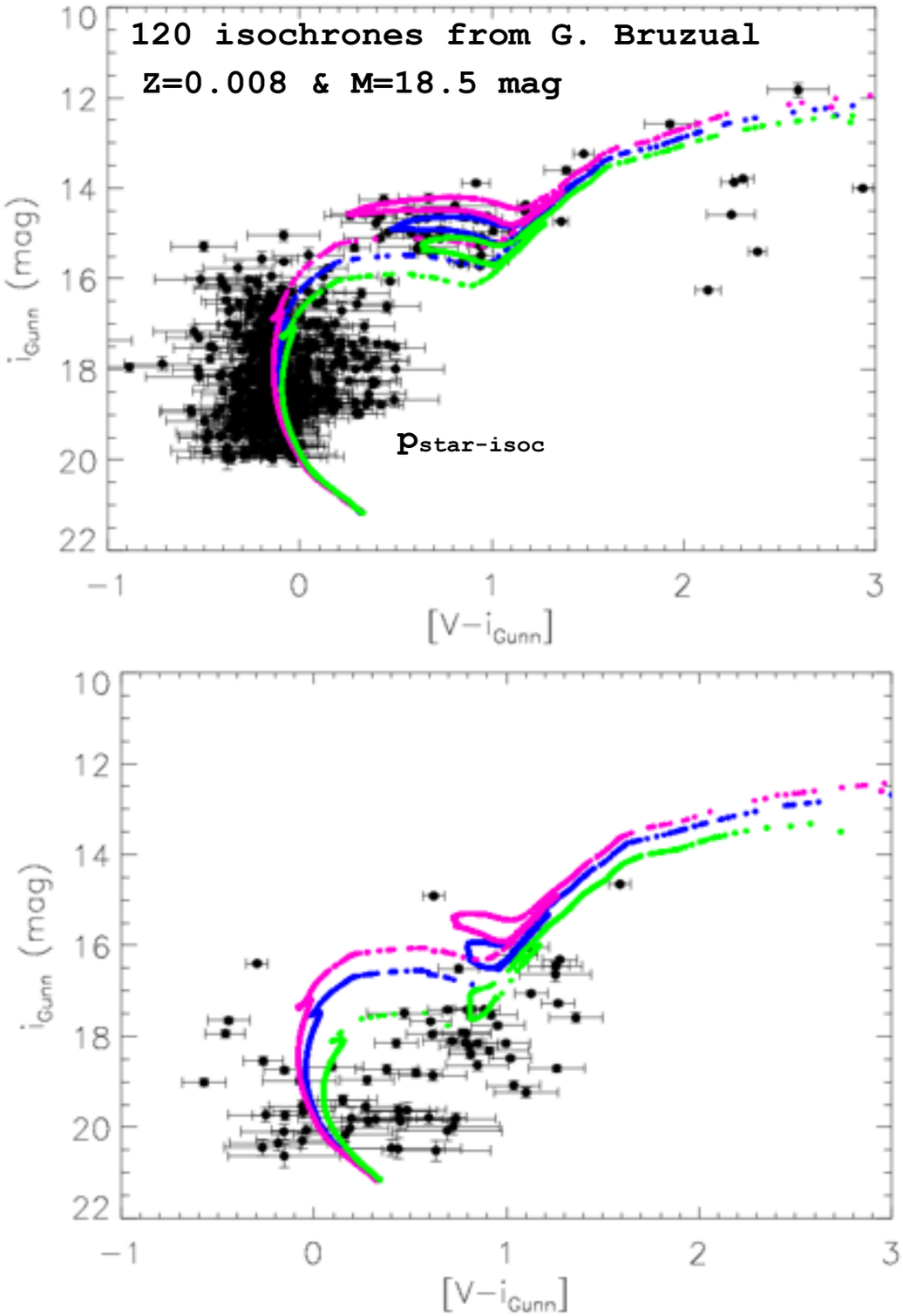

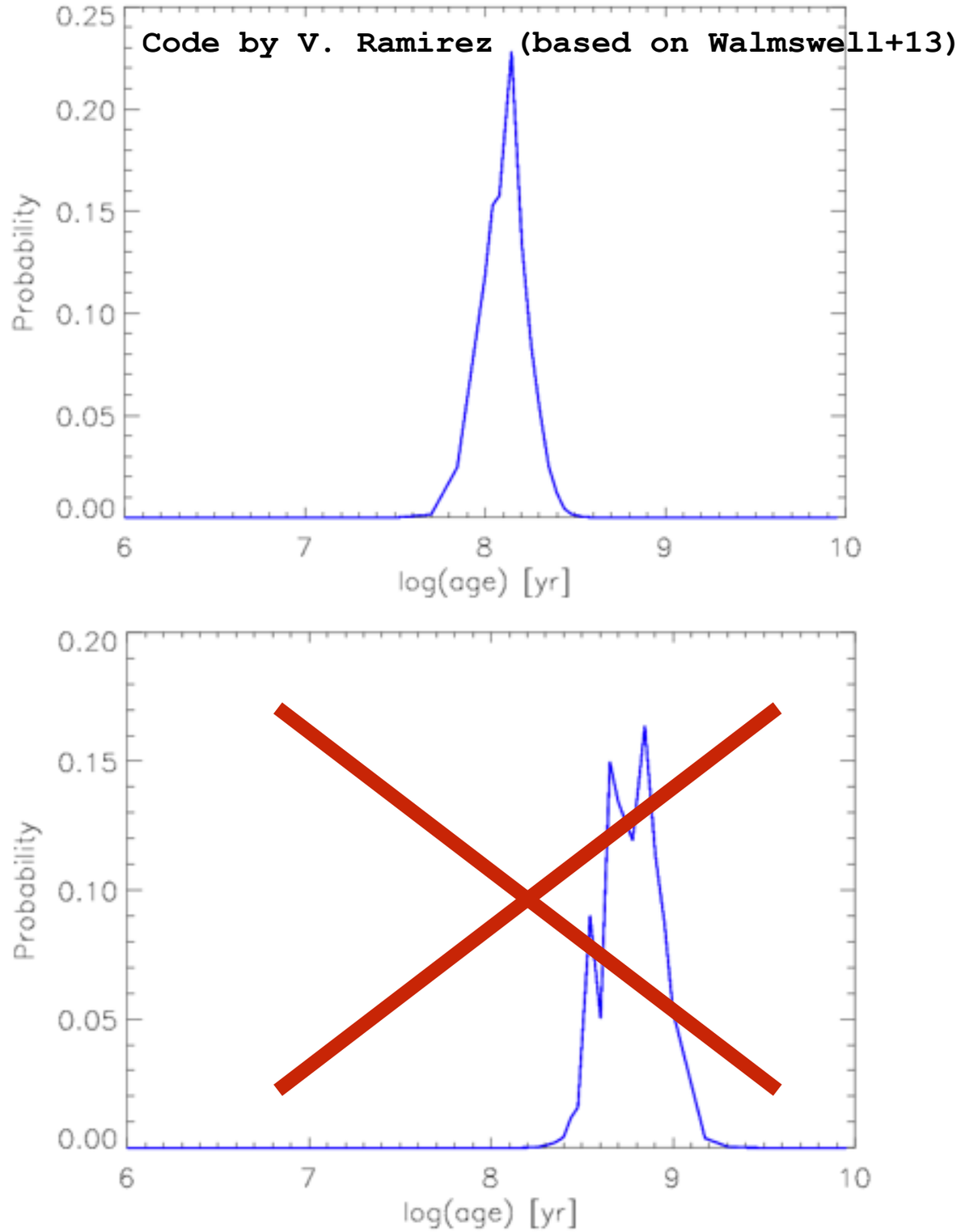

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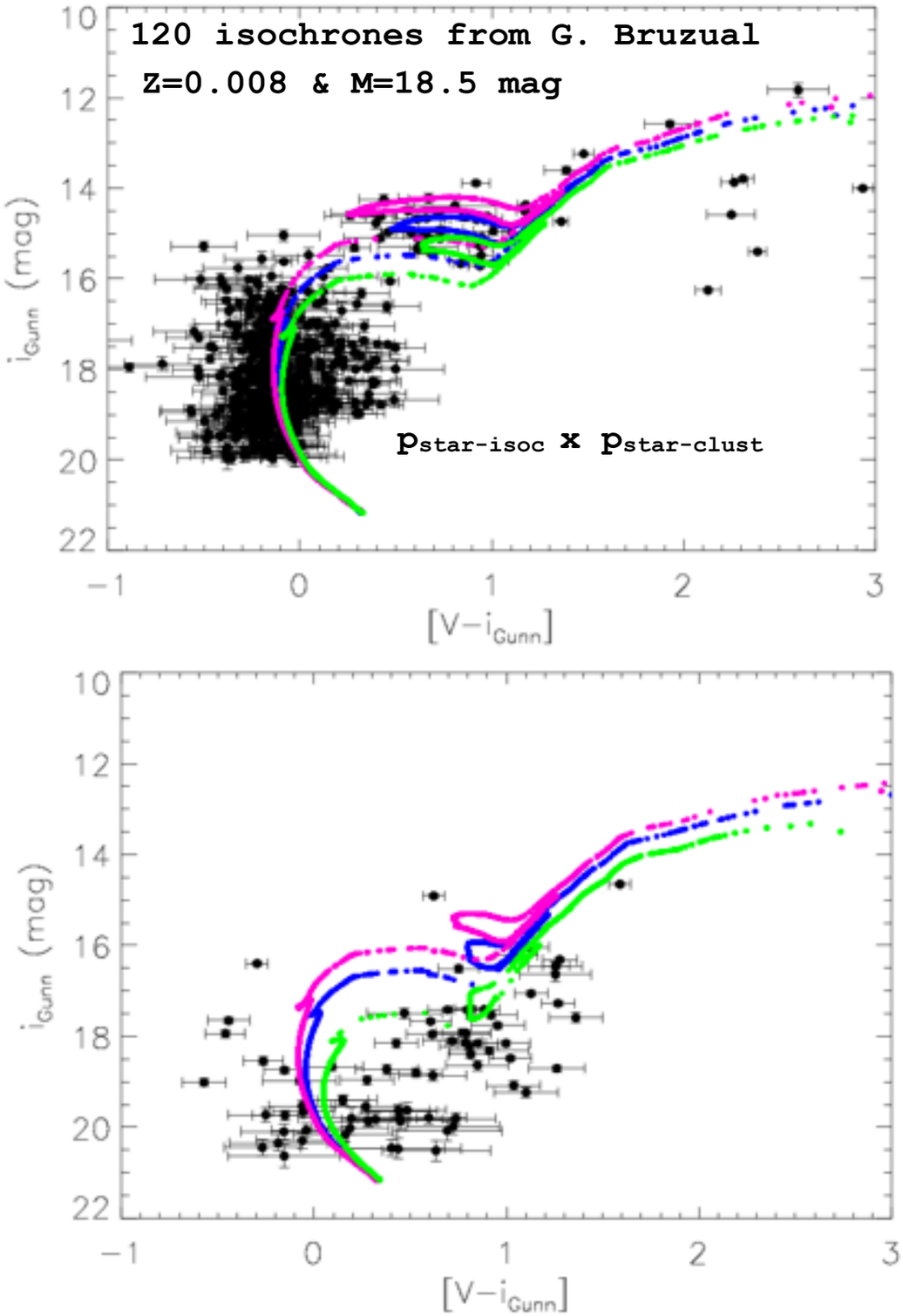

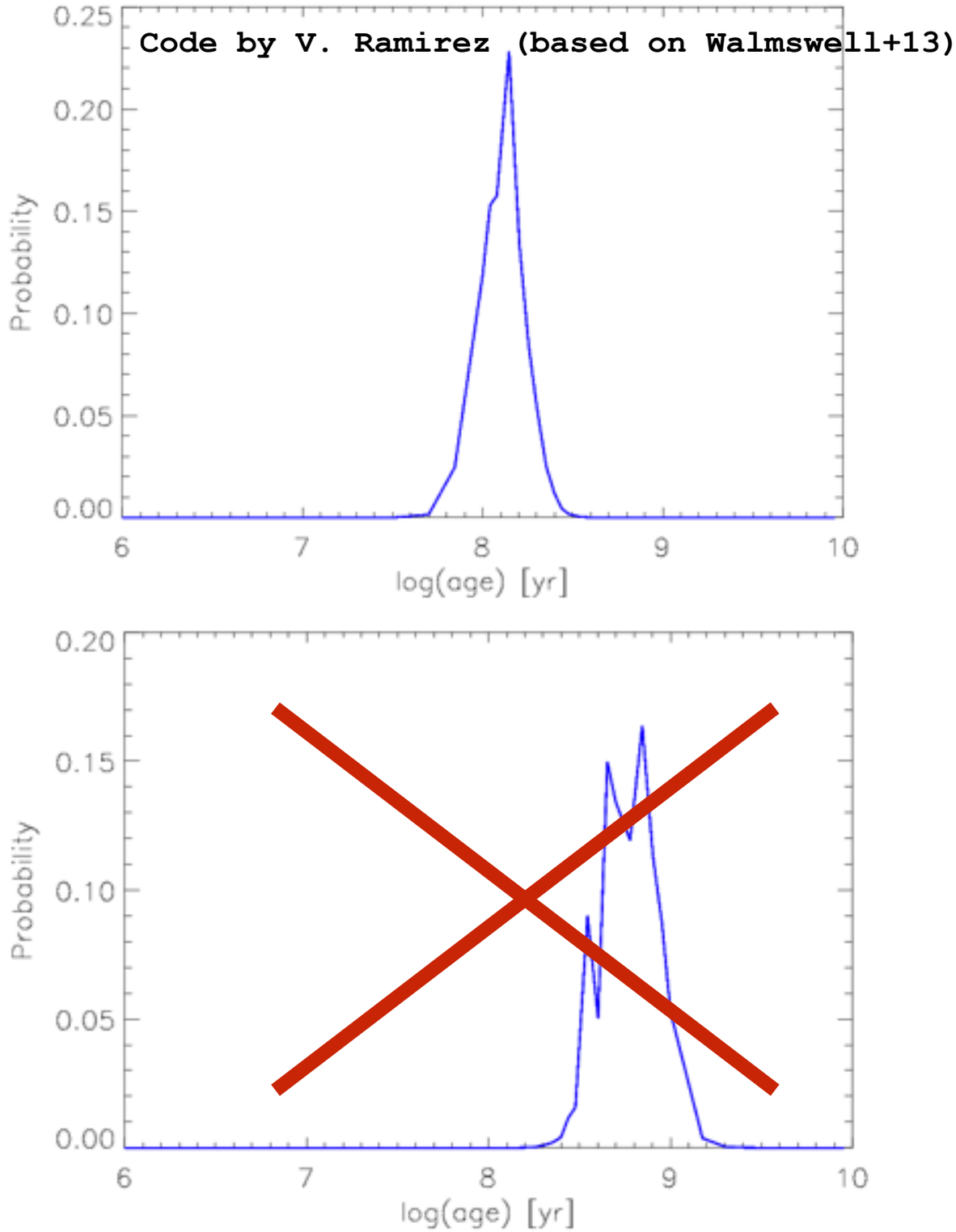

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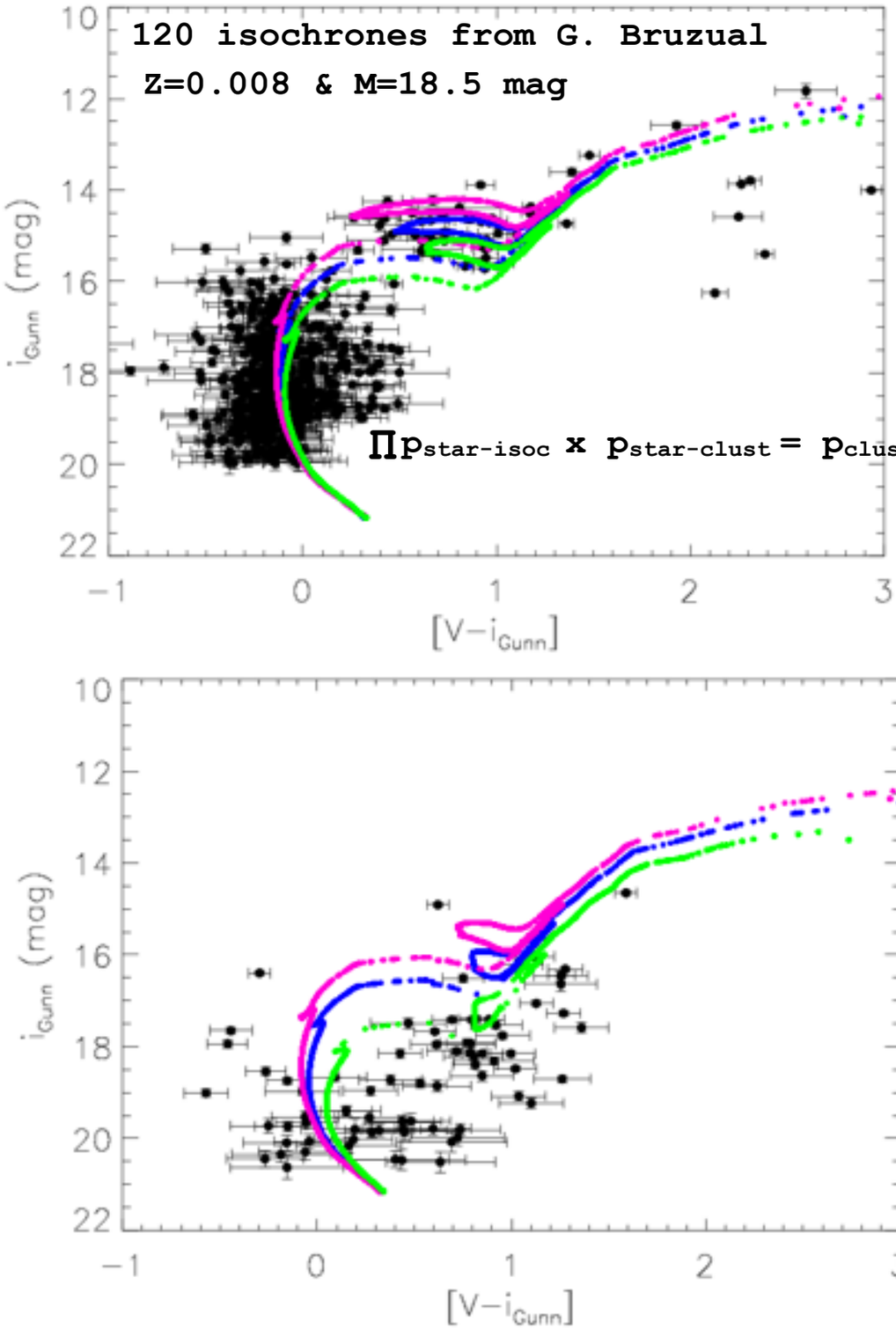

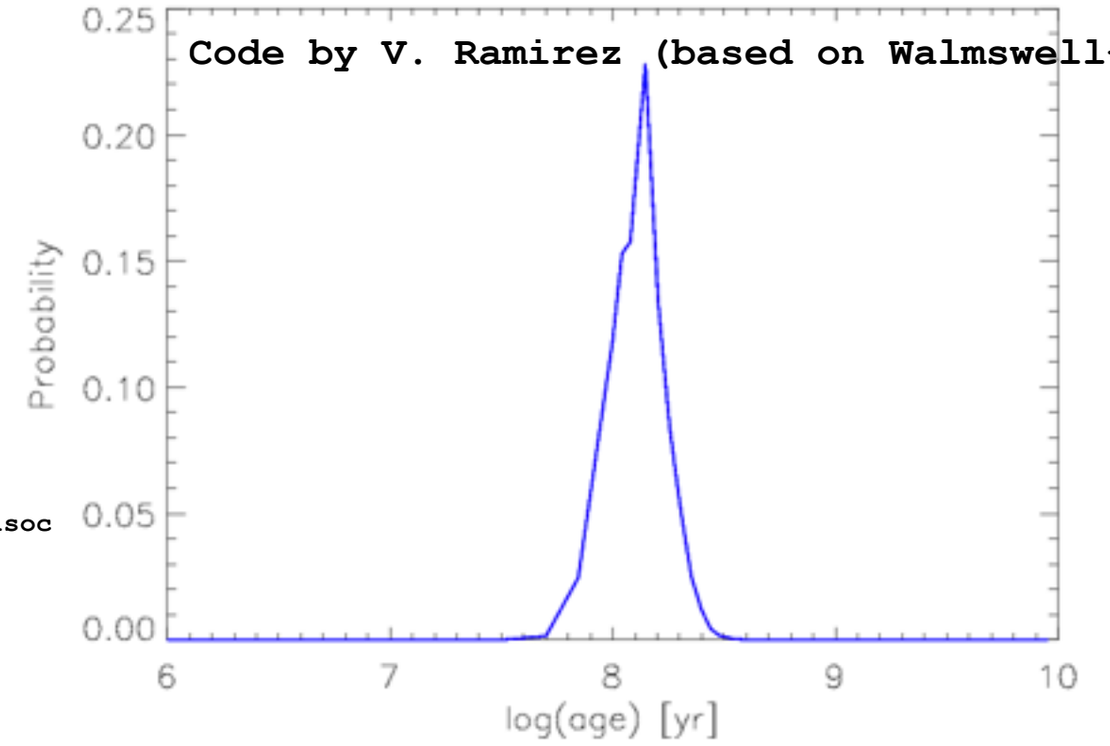

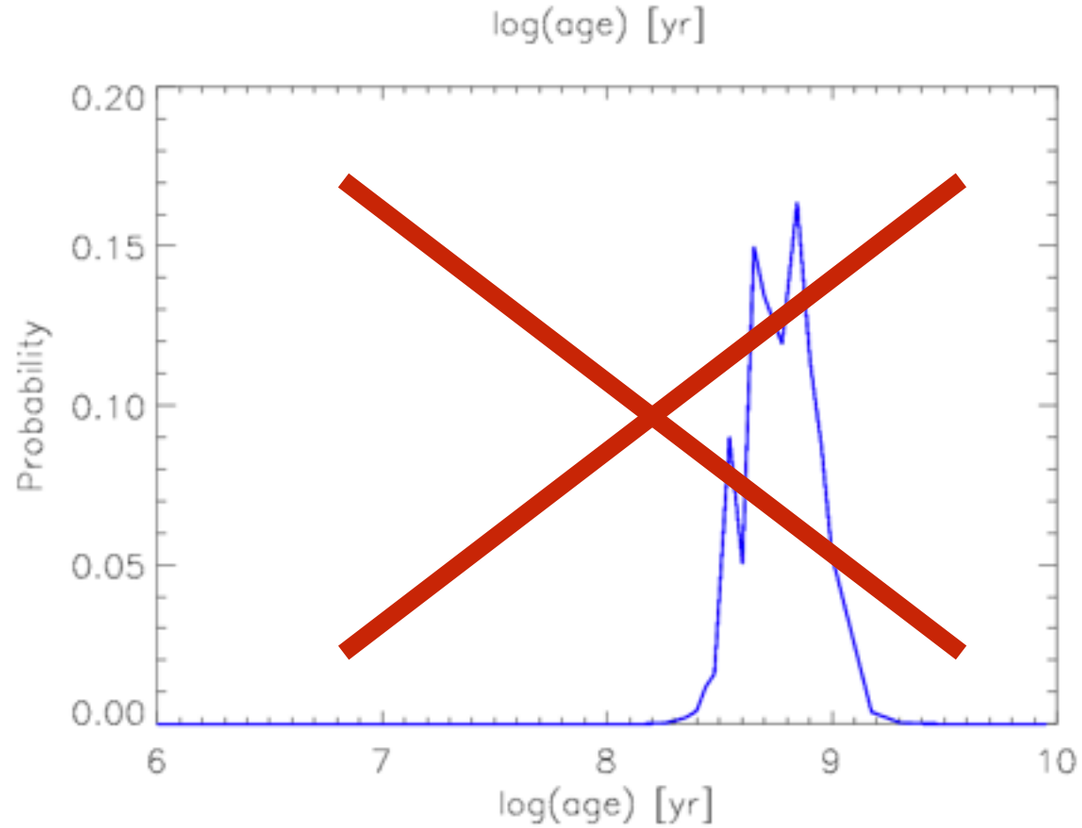

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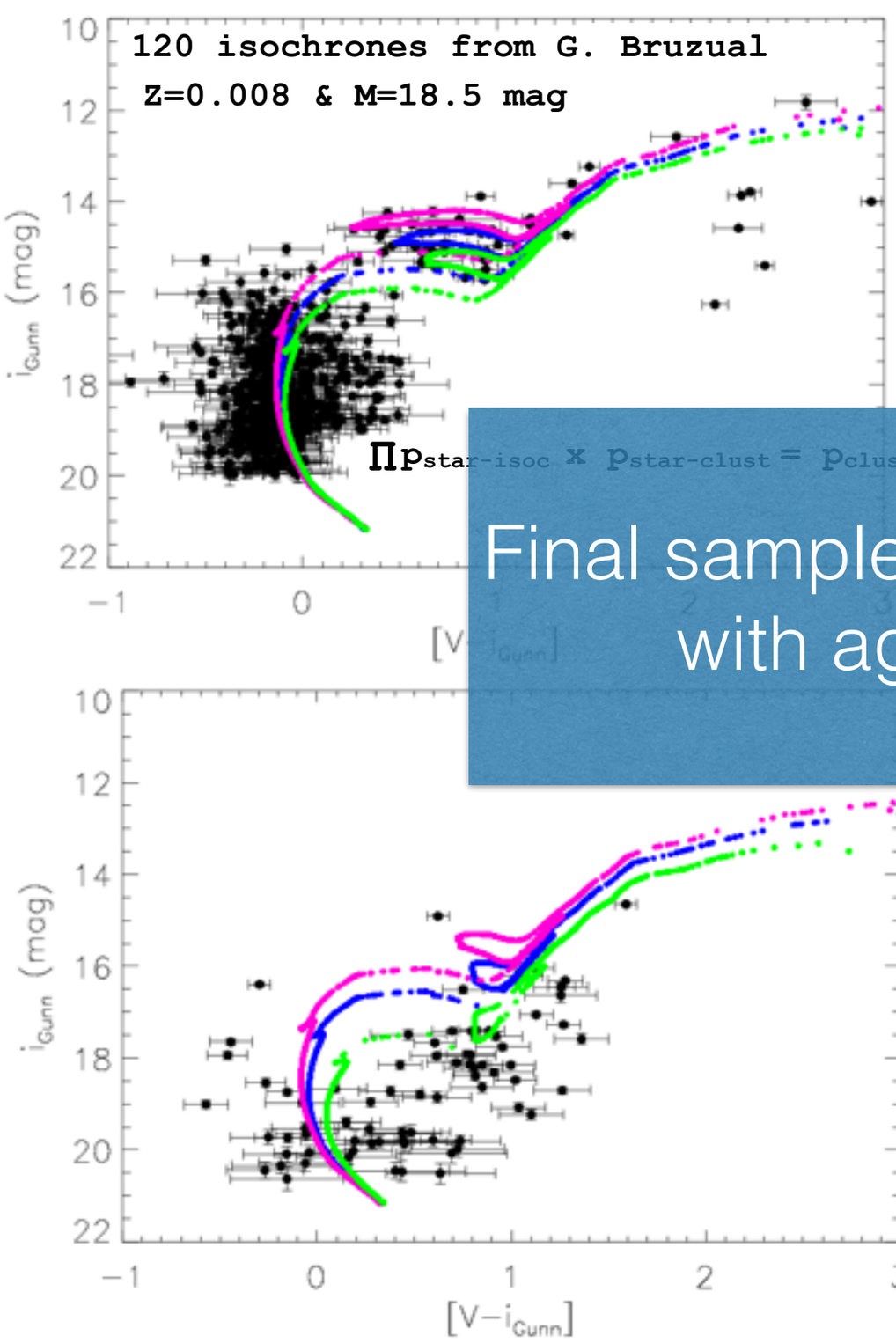
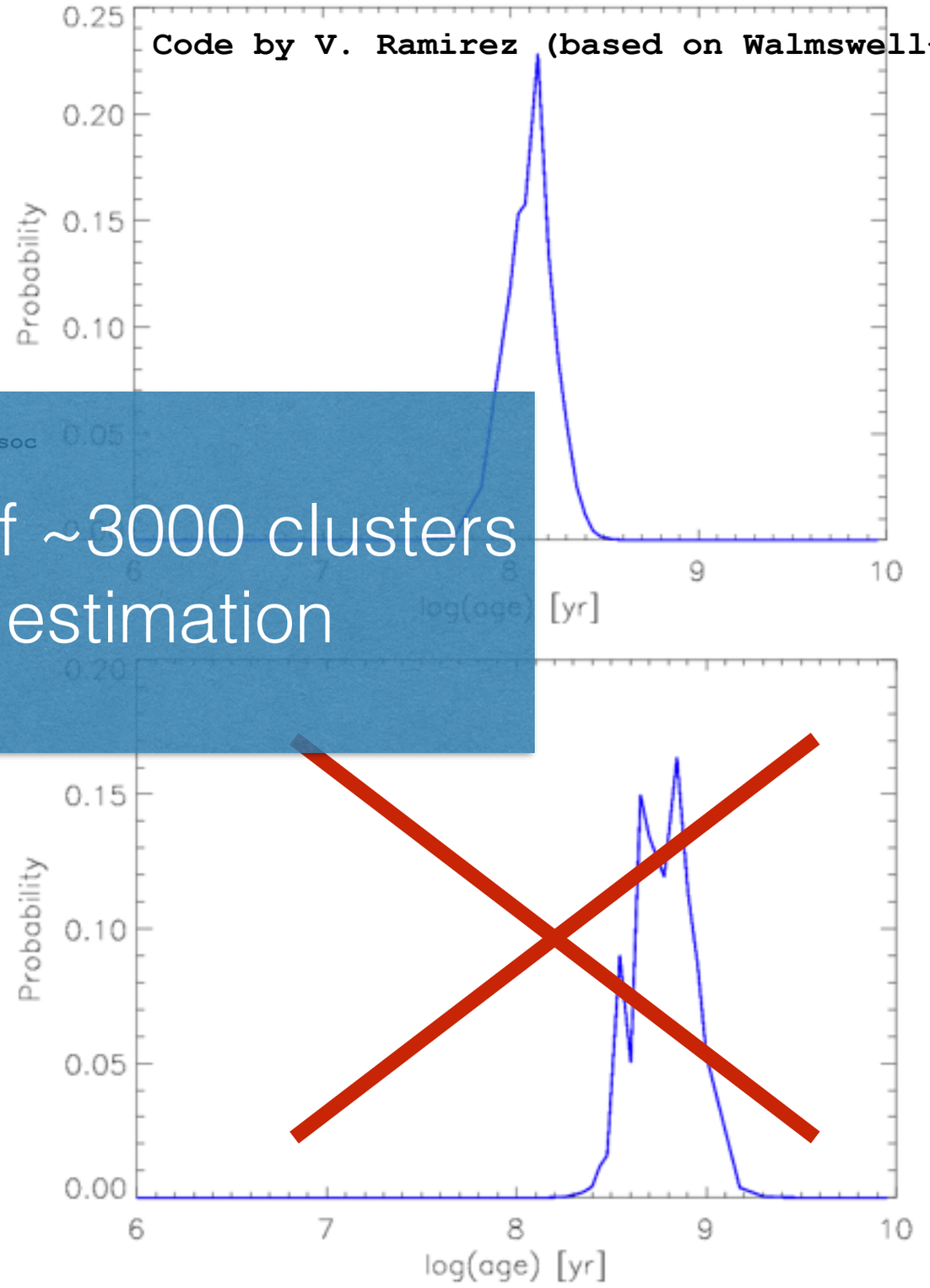
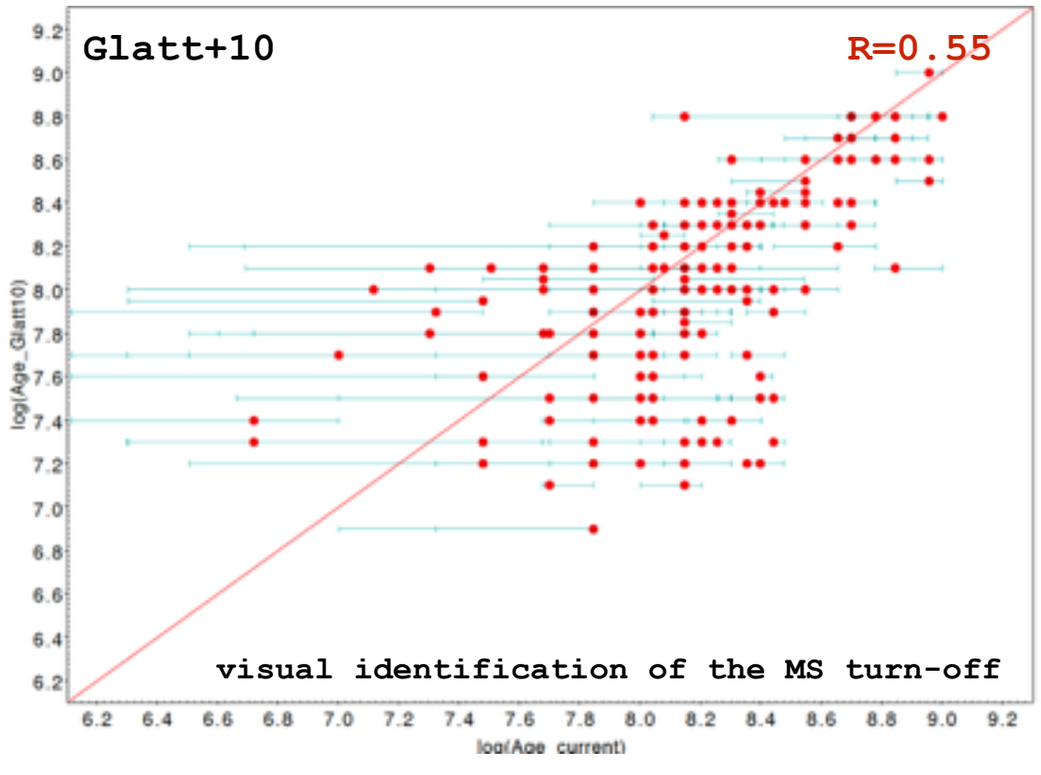
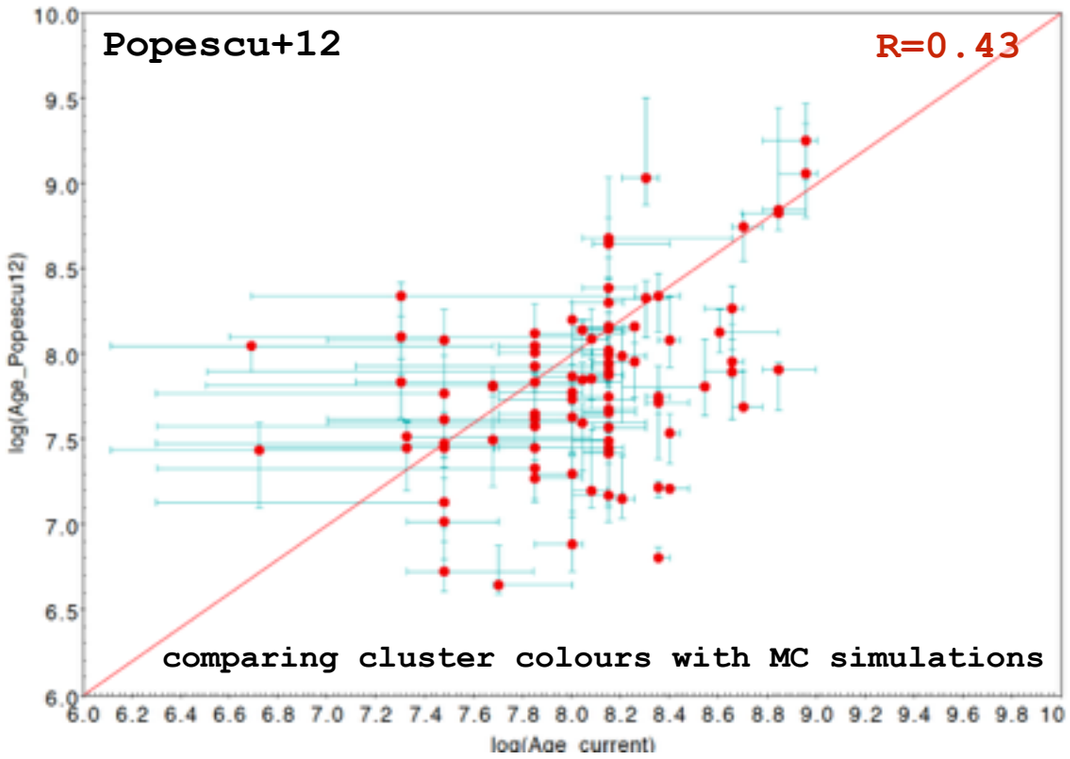


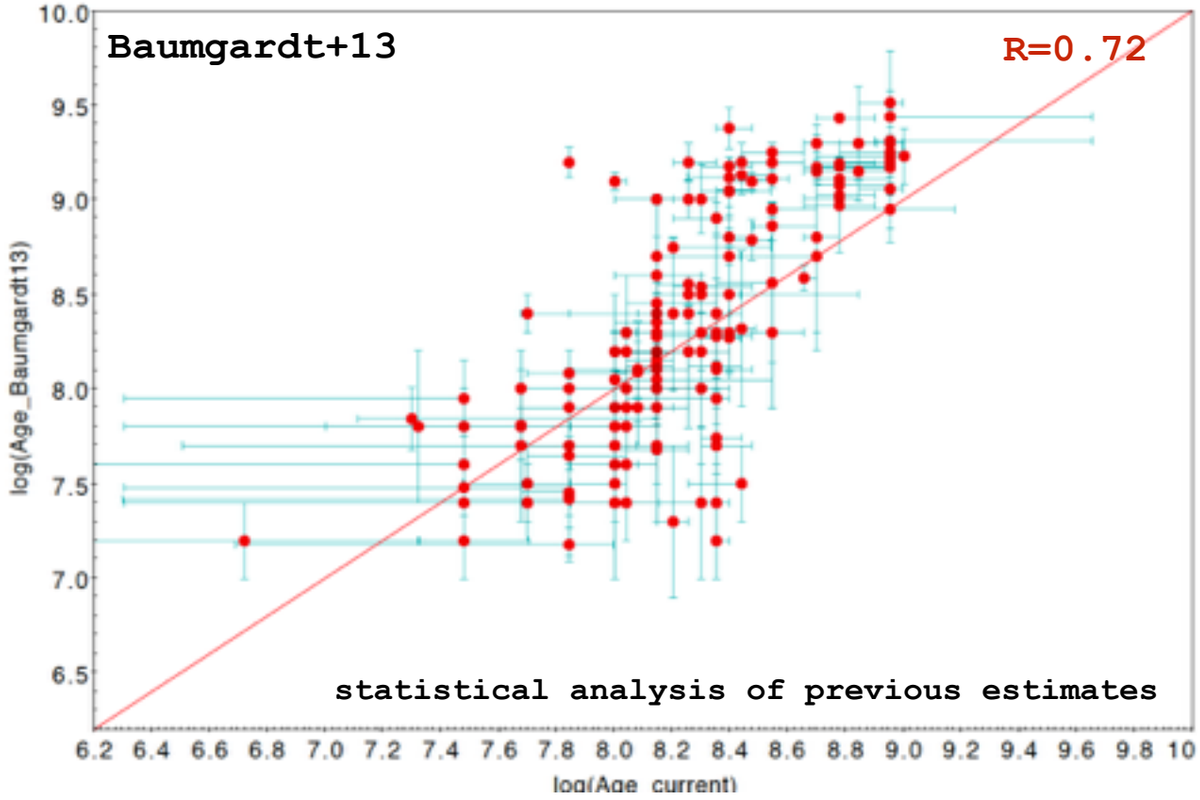


Final sample of ~3000 clusters with age estimation

COMPARISONS







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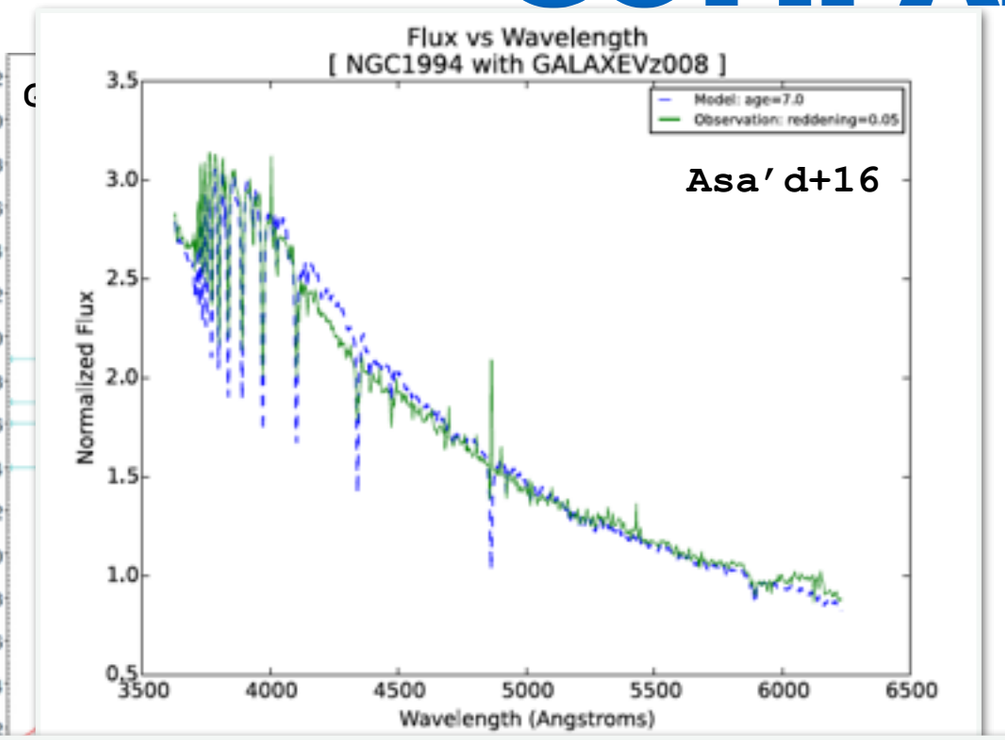
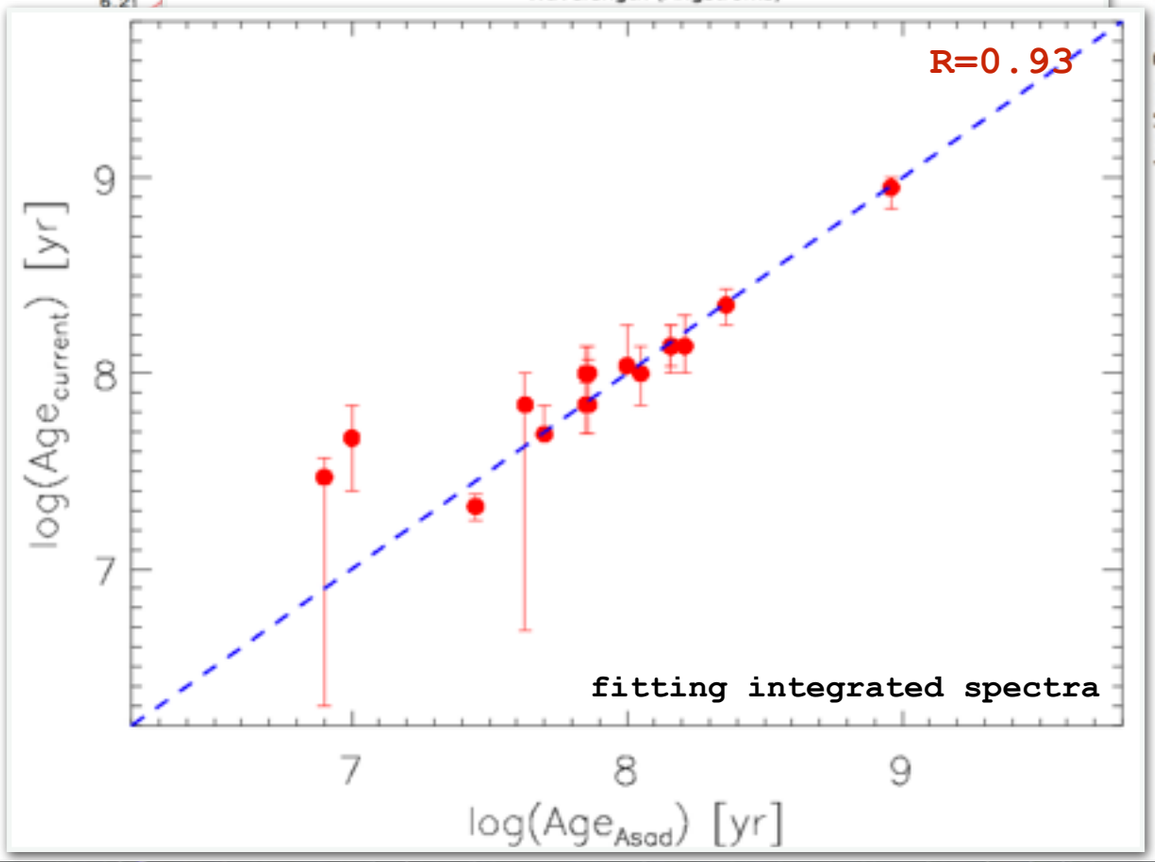
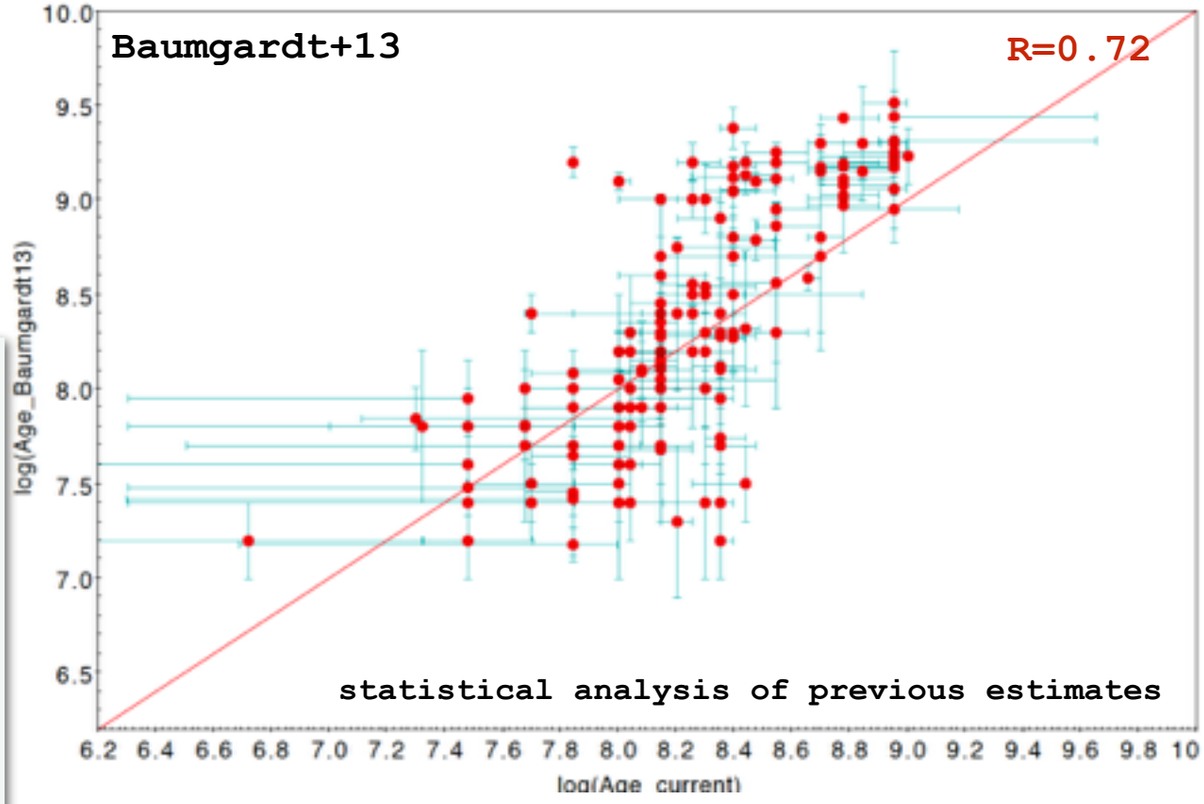
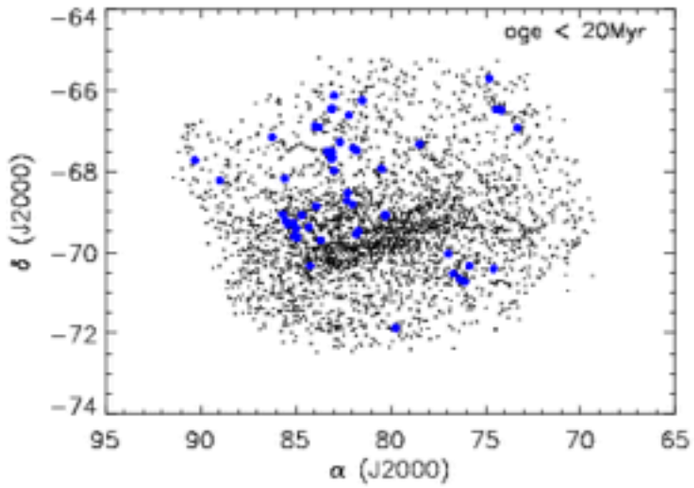


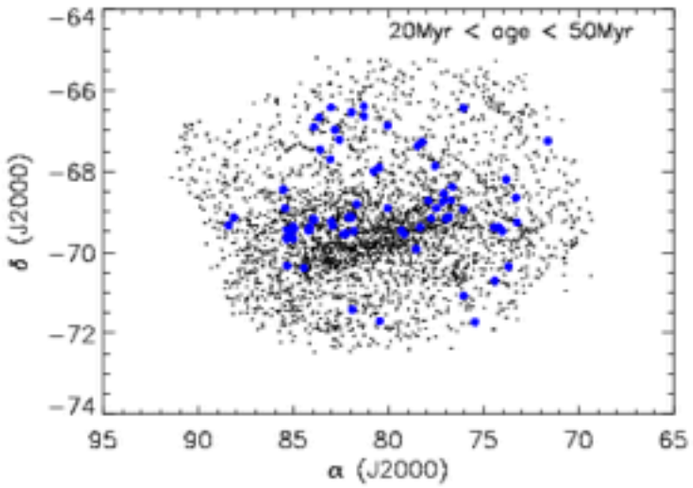


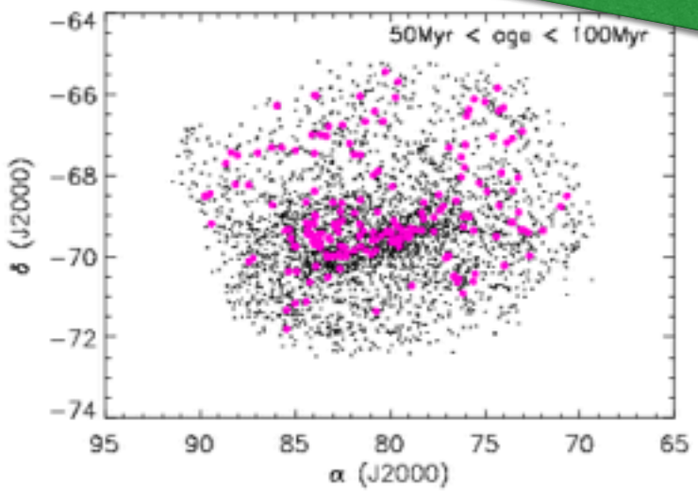


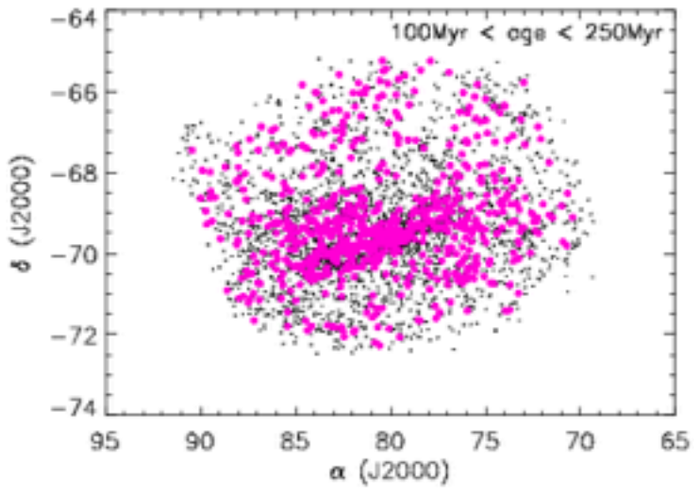
RESULTS

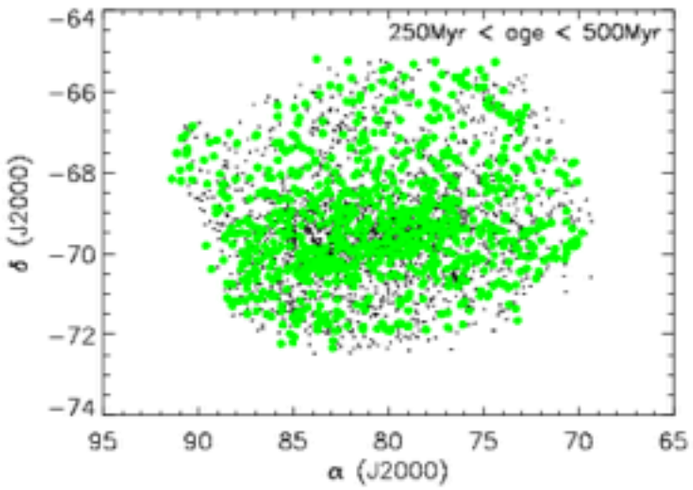
Preliminary

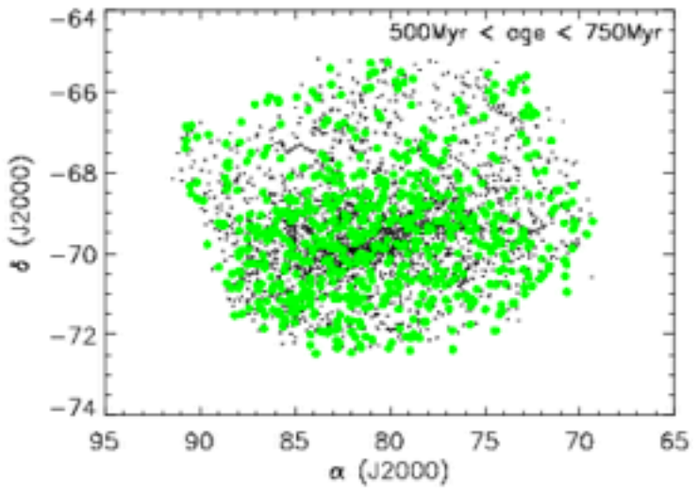


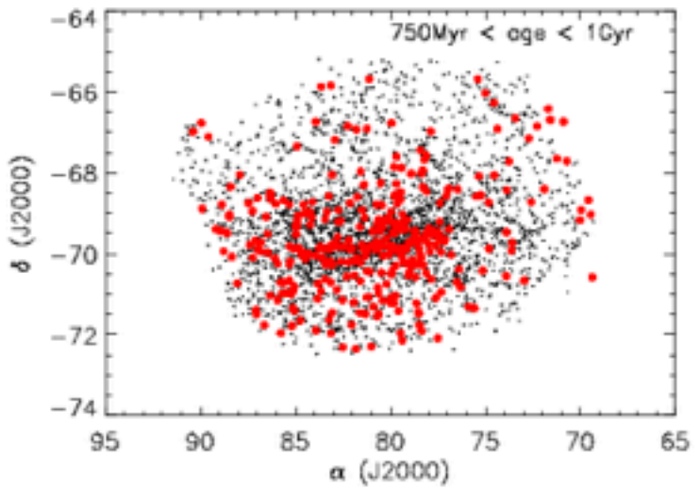


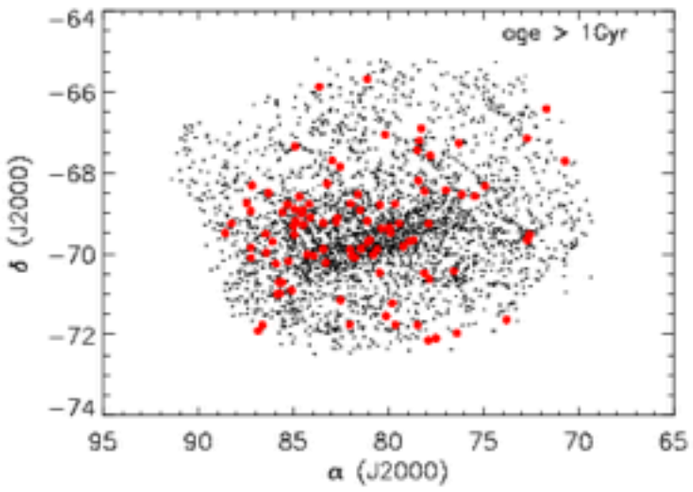






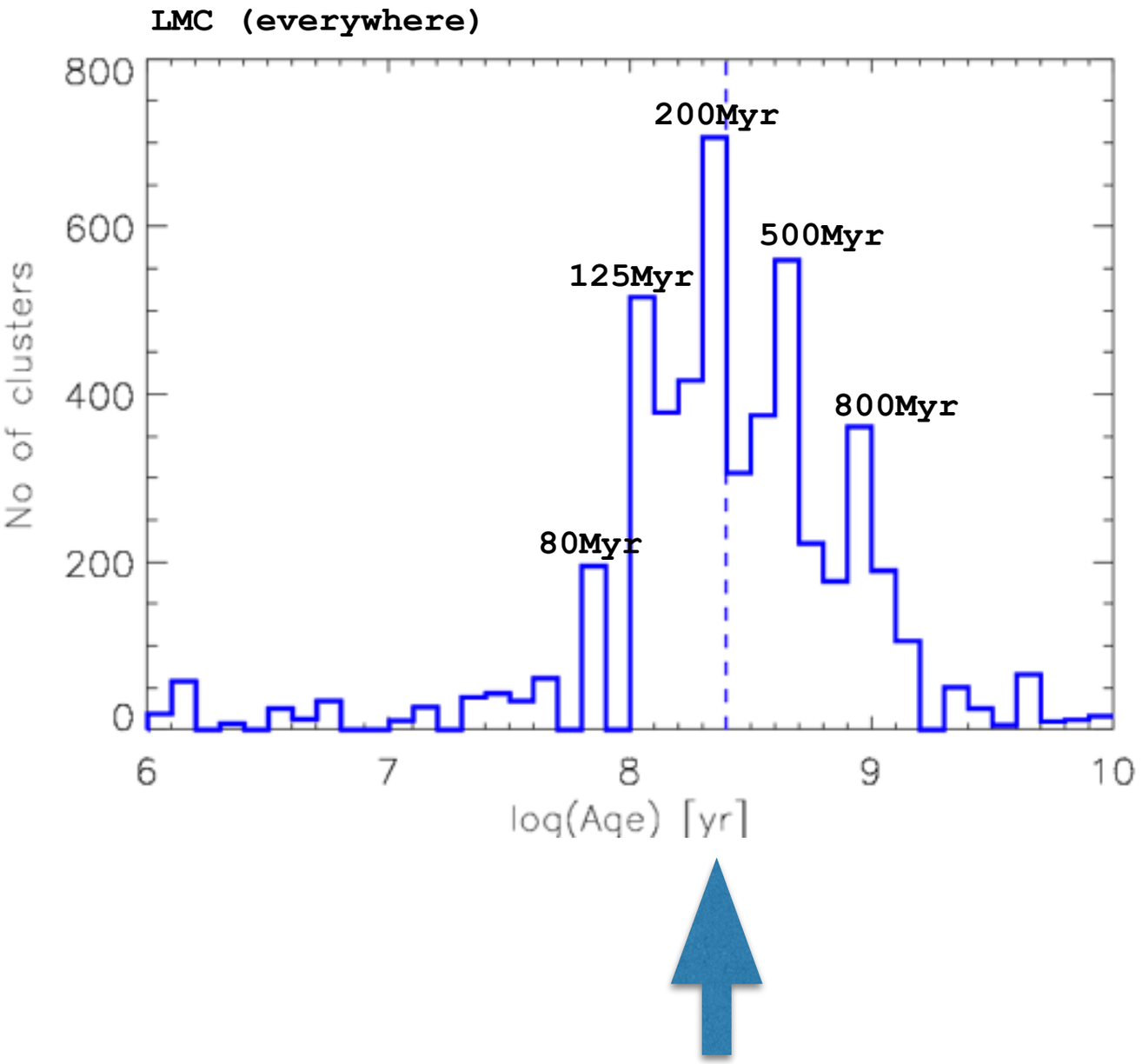


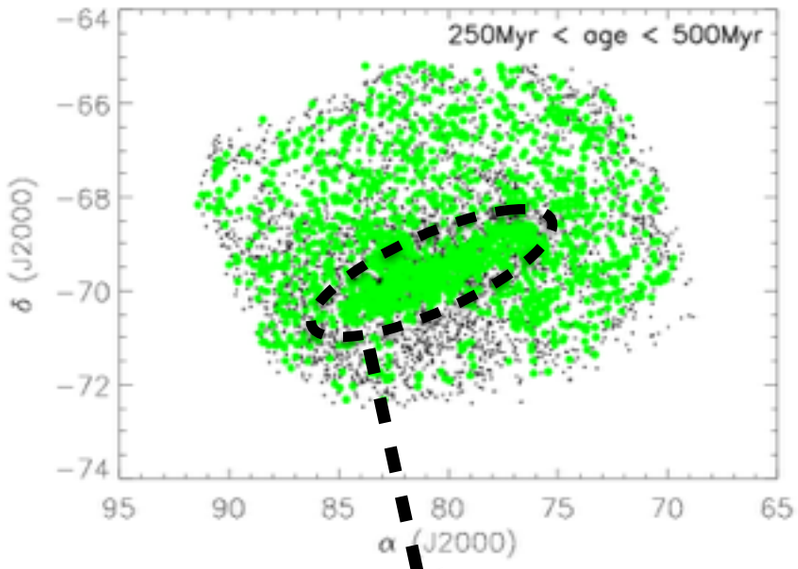


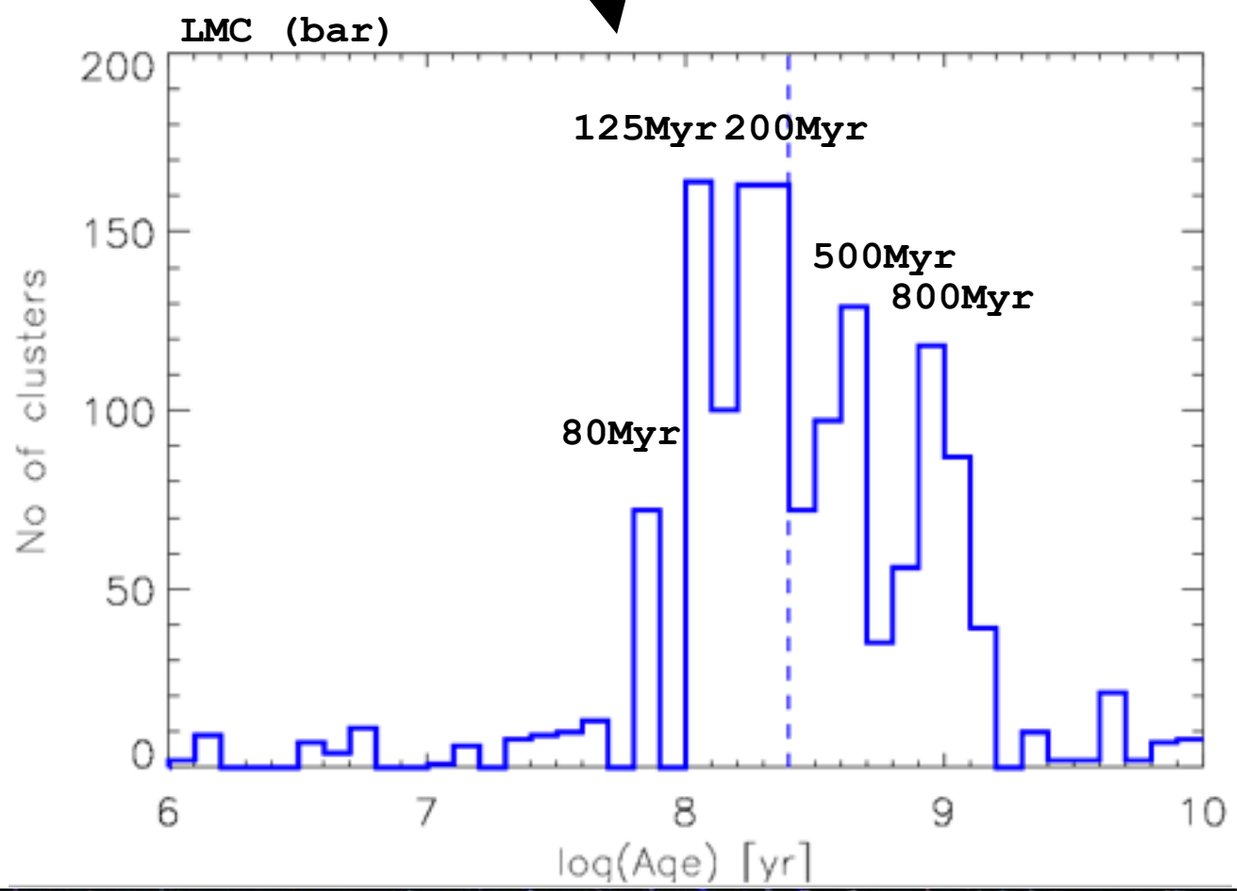


RESULTS II

Preliminary



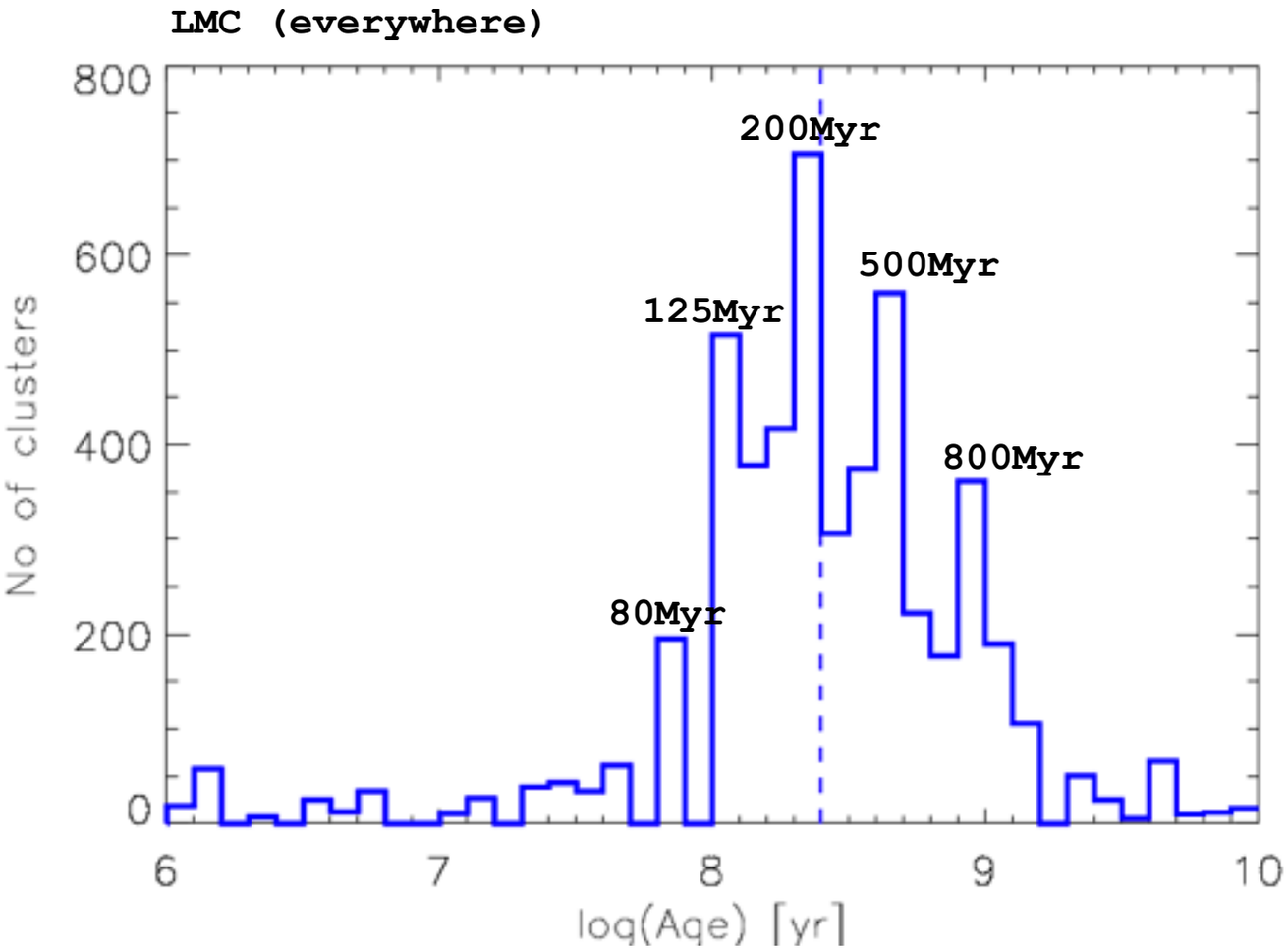




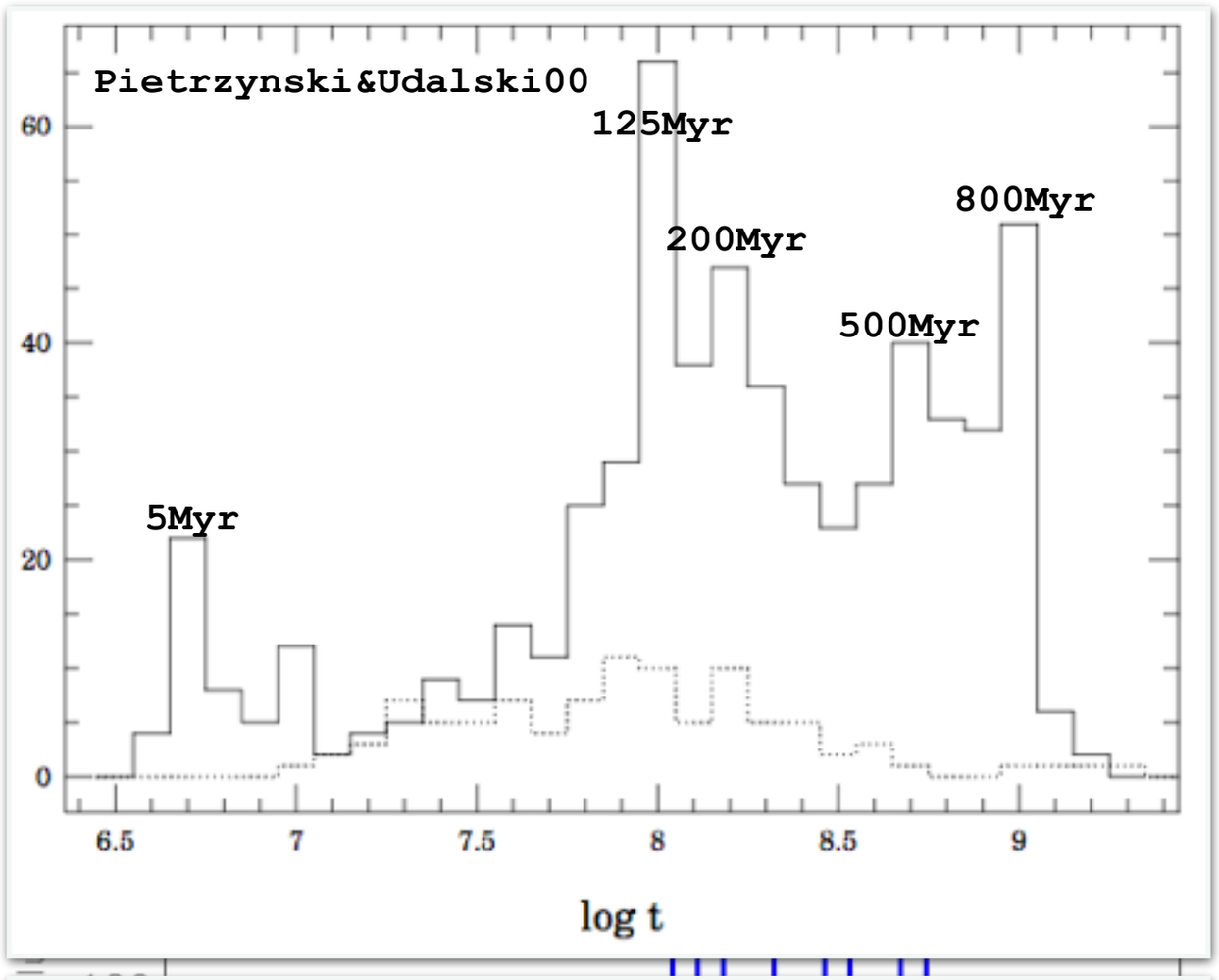
Latest LMC-SMC interaction ~200Myr ago (Yoshizawa+03)

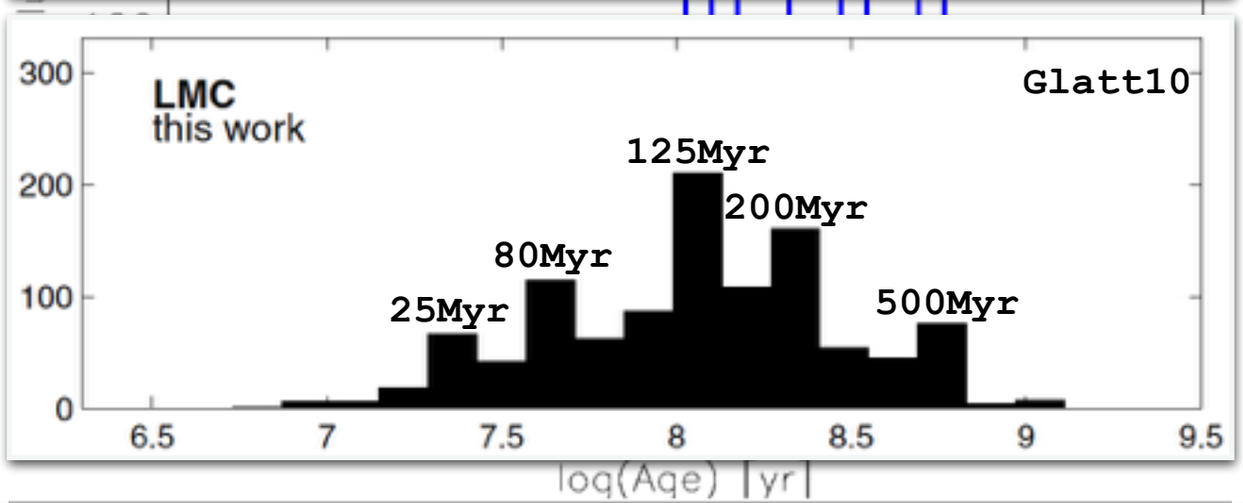
RESULTS II

Preliminary



Latest LMC-SMC interaction ~200Myr ago
(Yoshizawa+03)





CONCLUSIONS

ACCOMPLISHED...

- We have developed a new, fully **automated, method to detect clusters** in nearby galaxies.
- We are using the state-of-the-art **CMD fitting code** and isochrones of Charlot & Bruzual (in prep.) to estimate the ages of the clusters

Preliminary

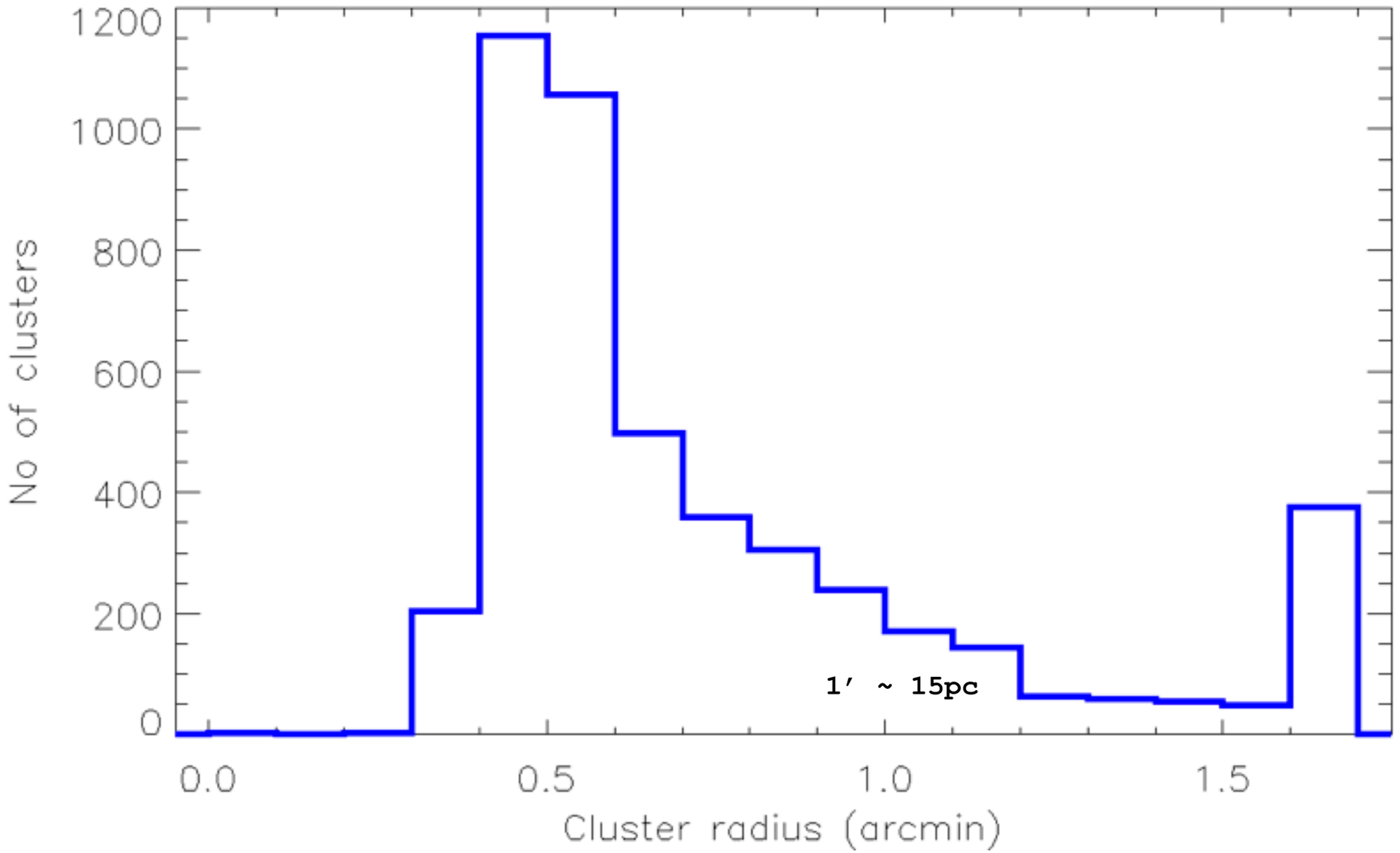
- We compiled a **sample of ~3k clusters** in the LMC
- The distribution of ages implies significant **SF activity** (peaking around 125, 200, 500 & 800Myr ago)

NEXT STEPS...

- Perform tests to better constrain the age estimation
- Completeness tests to study the **IMF** of the young clusters

THANKS!

DANKE!



Nayak+16 sample are 0.20-1.75′

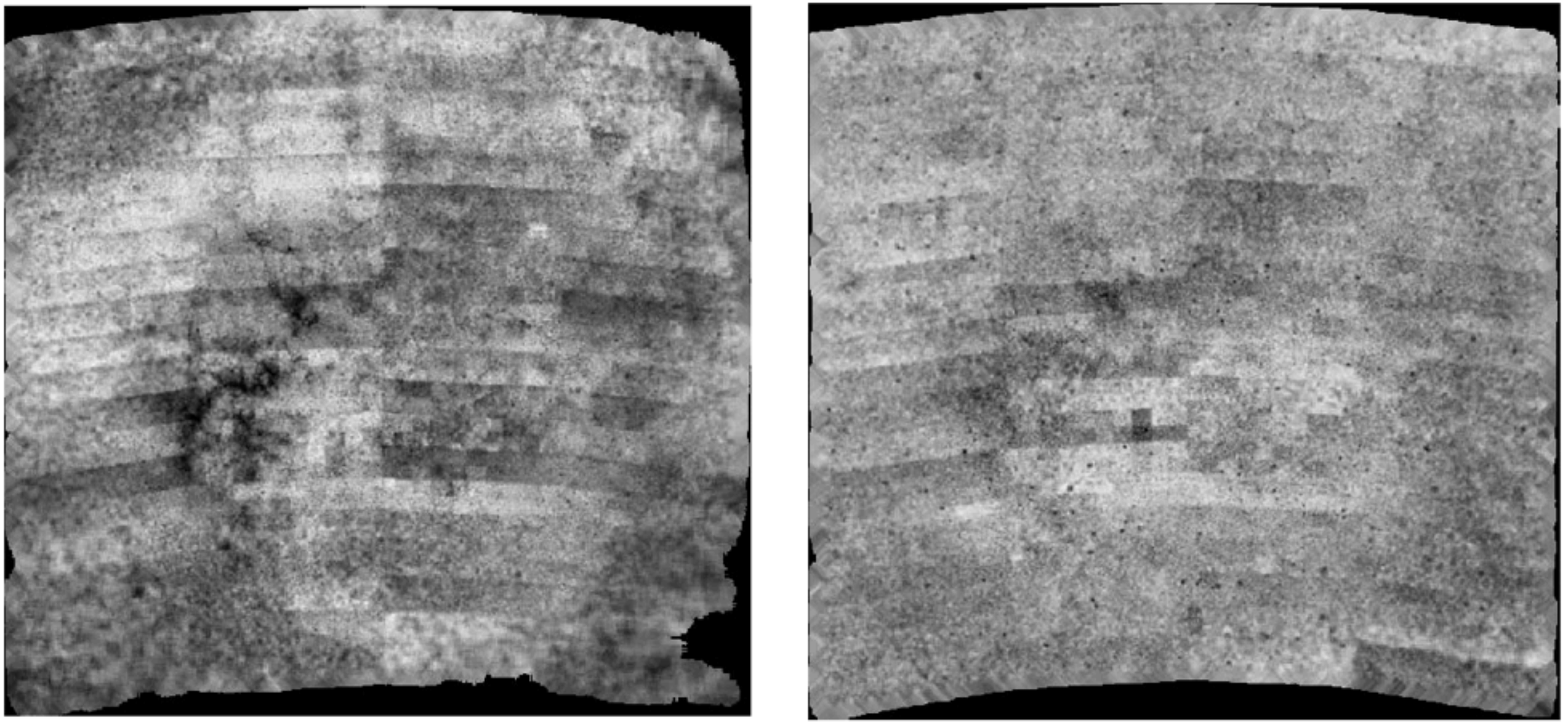
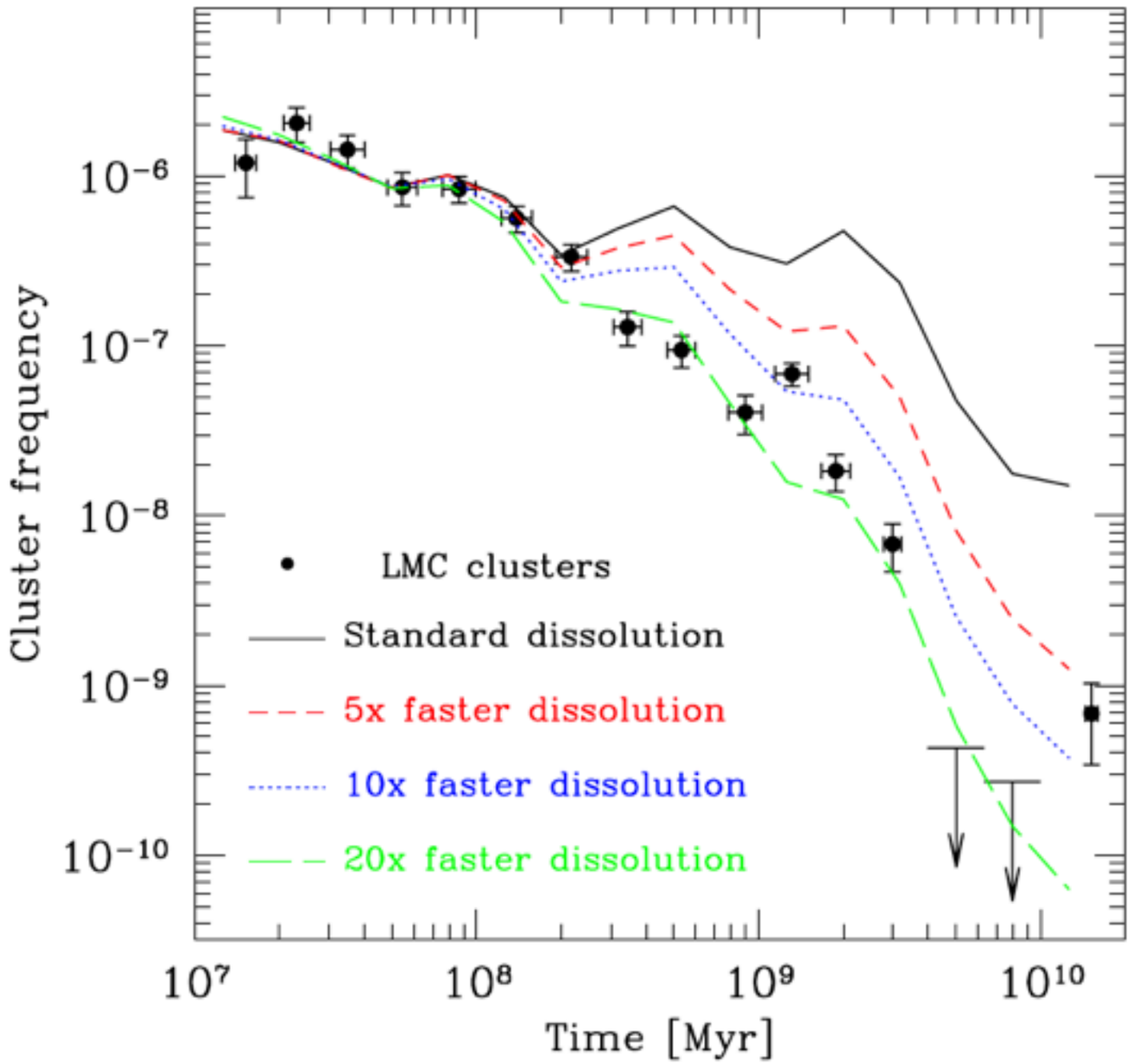


FIG. 8.—Spatial map of extinction values as derived for both the cooler, older stars (5500 K $\leq T_E \leq$ 6500 K; *right*) and the hotter, younger stars (12,000 K $\leq T_E \leq$ 45,000 K; *left*) for the entire survey region. The small localized circular regions of apparent high extinction are globular clusters, which have some anomalous photometry because of their high stellar densities. Sharp spatial variations are due to scan-to-scan photometry differences of a few hundredths of a magnitude.

Zaritsky+04


Cluster frequency
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
LMC clusters
Standard dissolution
5x faster dissolution
10x faster dissolution
20x faster dissolution
10^{7}
10^{8}
10^{9}
10^{10}
Time [Myr]