

Dissecting the Star Cluster Population in M51

Testing Environmental Dependencies
of Cluster Formation and Evolution

Matteo Messa, Angela Adamo, Göran Östlin
Stockholm University

& the LEGUS team

Introduction

How do we study star and cluster formation?

- Detailed studies of single objects
 - Milky Way, few local galaxies
- Statistically significant populations : nearby universe
 - Properties on galactic scales
 - Comparison between galaxies

Introduction

How do we study star and cluster formation?

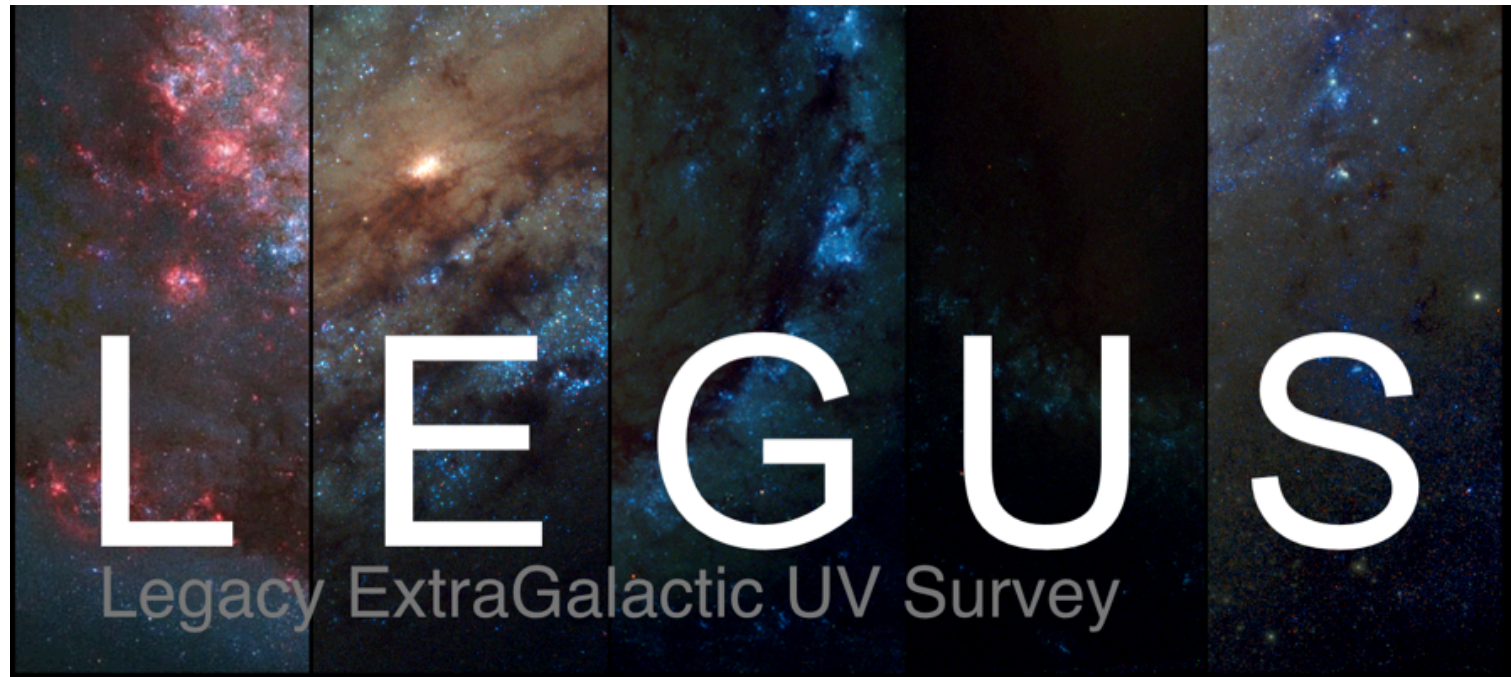
What do we study?

- Environmental dependence of cluster properties
 - Formation of clusters
 - Disruption of clusters
- Comparison with GMC properties
 - Interferometers

Cluster Population of M51

LEGUS project (Calzetti+2015) - HST Broadband photometry

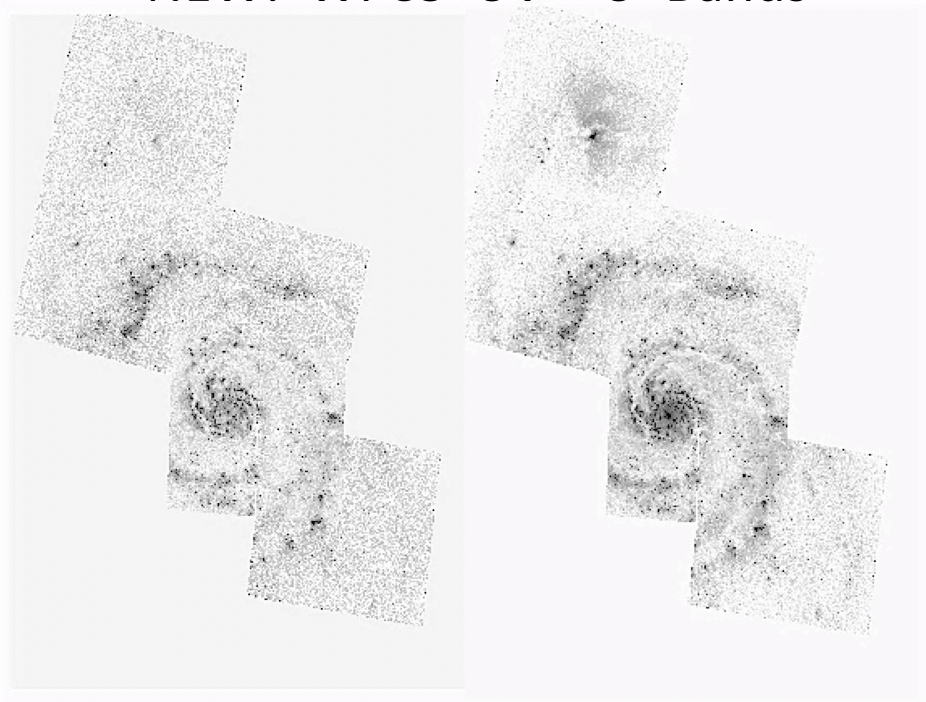
50 nearby galaxies



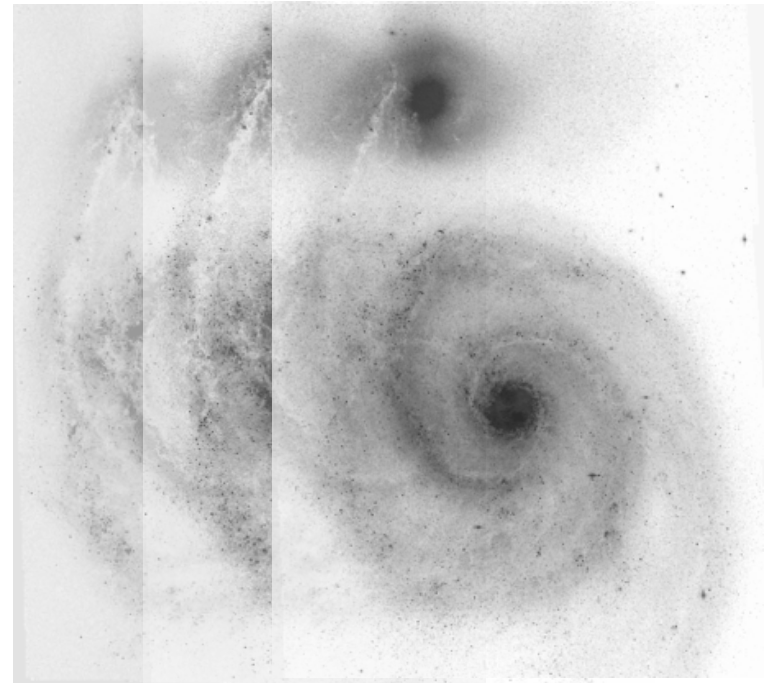
Cluster Population of M51

LEGUS project (Calzetti+2015) - HST Broadband photometry

NEW: WFC3 UV – U Bands



ARCHIVAL: B V I Bands

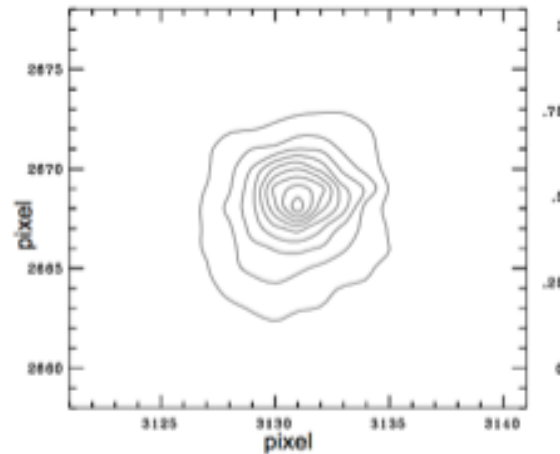
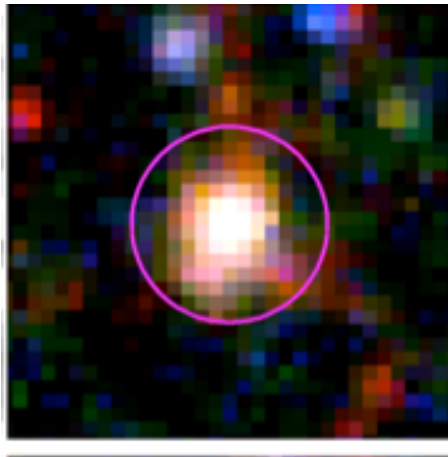


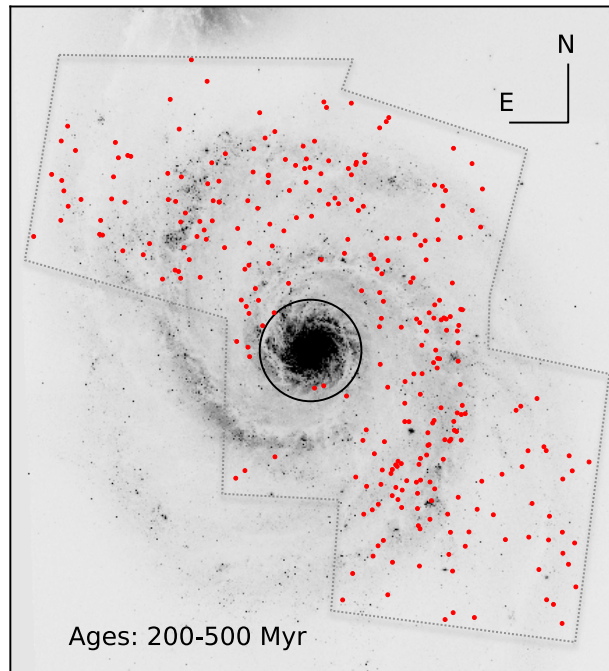
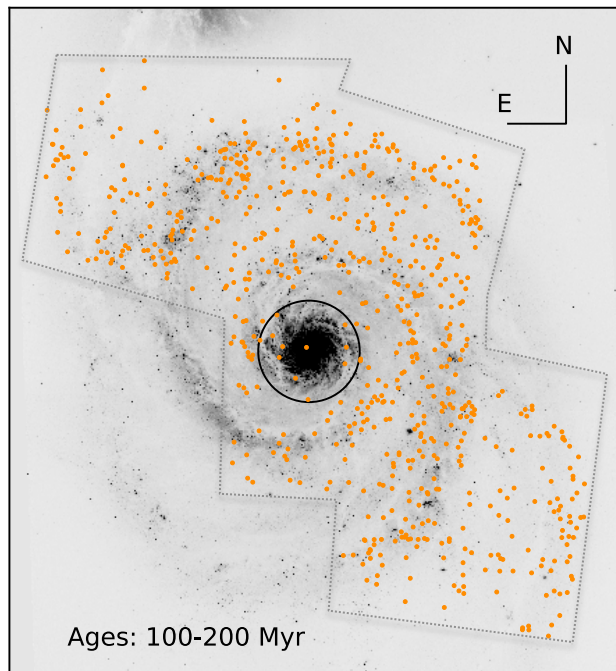
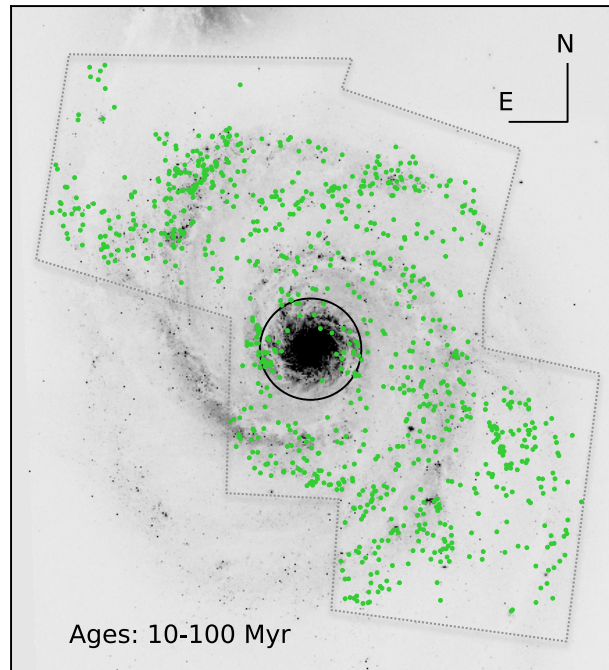
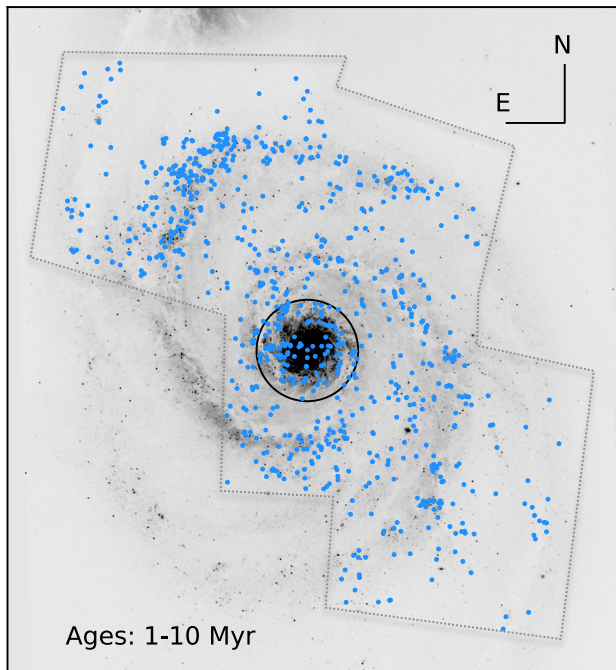
Broadband SED fitting → age and mass estimates

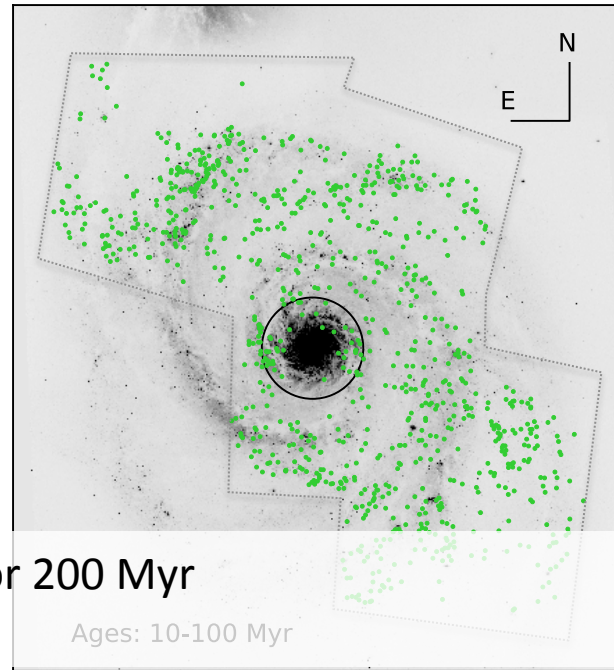
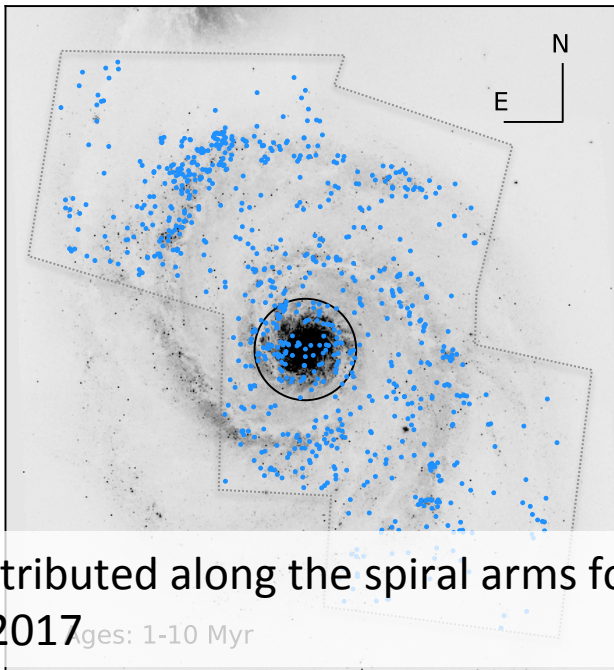
Cluster Population of M51

LEGUS project (Calzetti+2015) - HST Broadband photometry

Our catalogue: ~ 3000 clusters, compact and uniform color

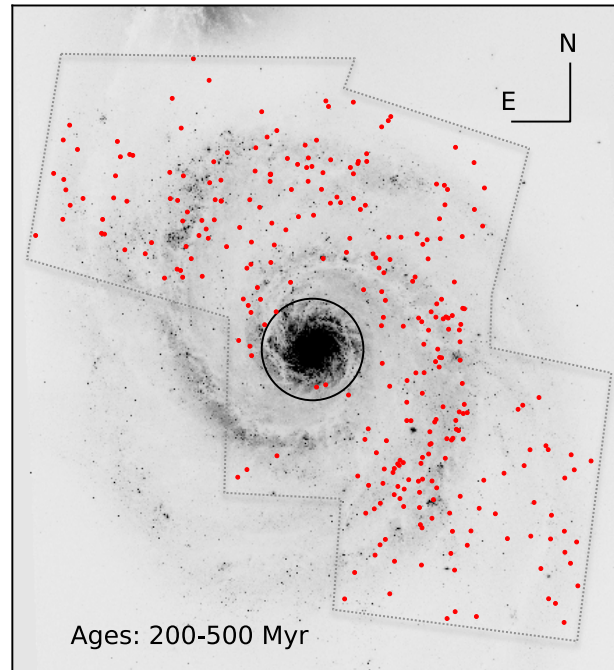
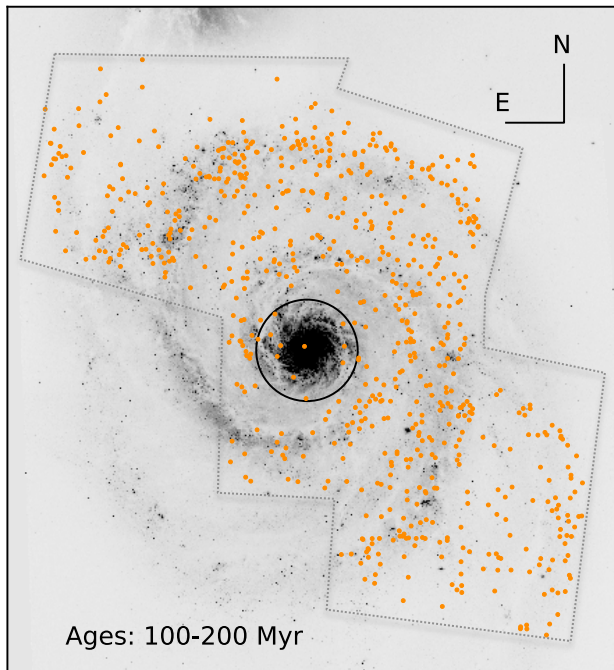






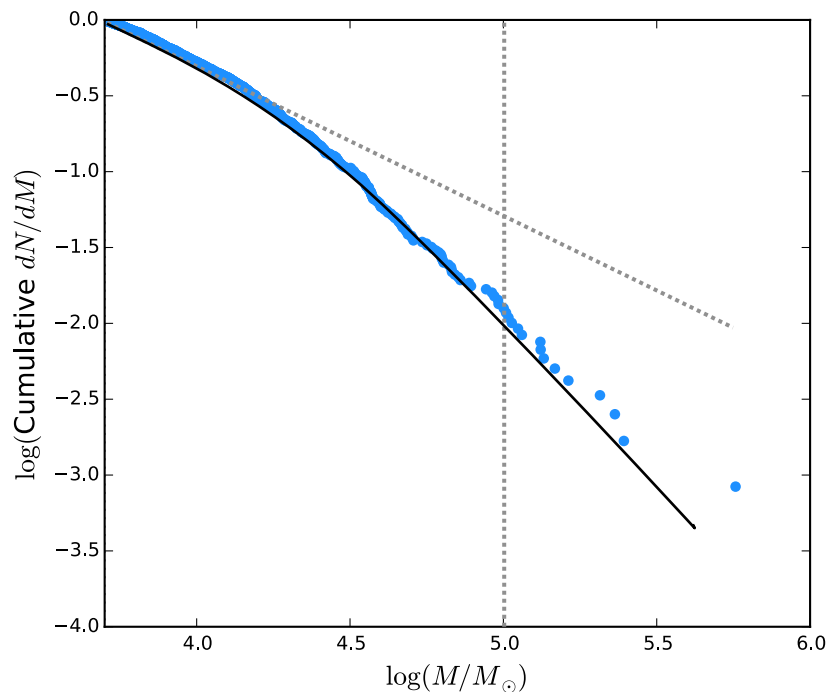
Clusters distributed along the spiral arms for 200 Myr

- Dobbs+2017



Mass Function

How cluster masses are distributed: dN/dM
Cumulative form

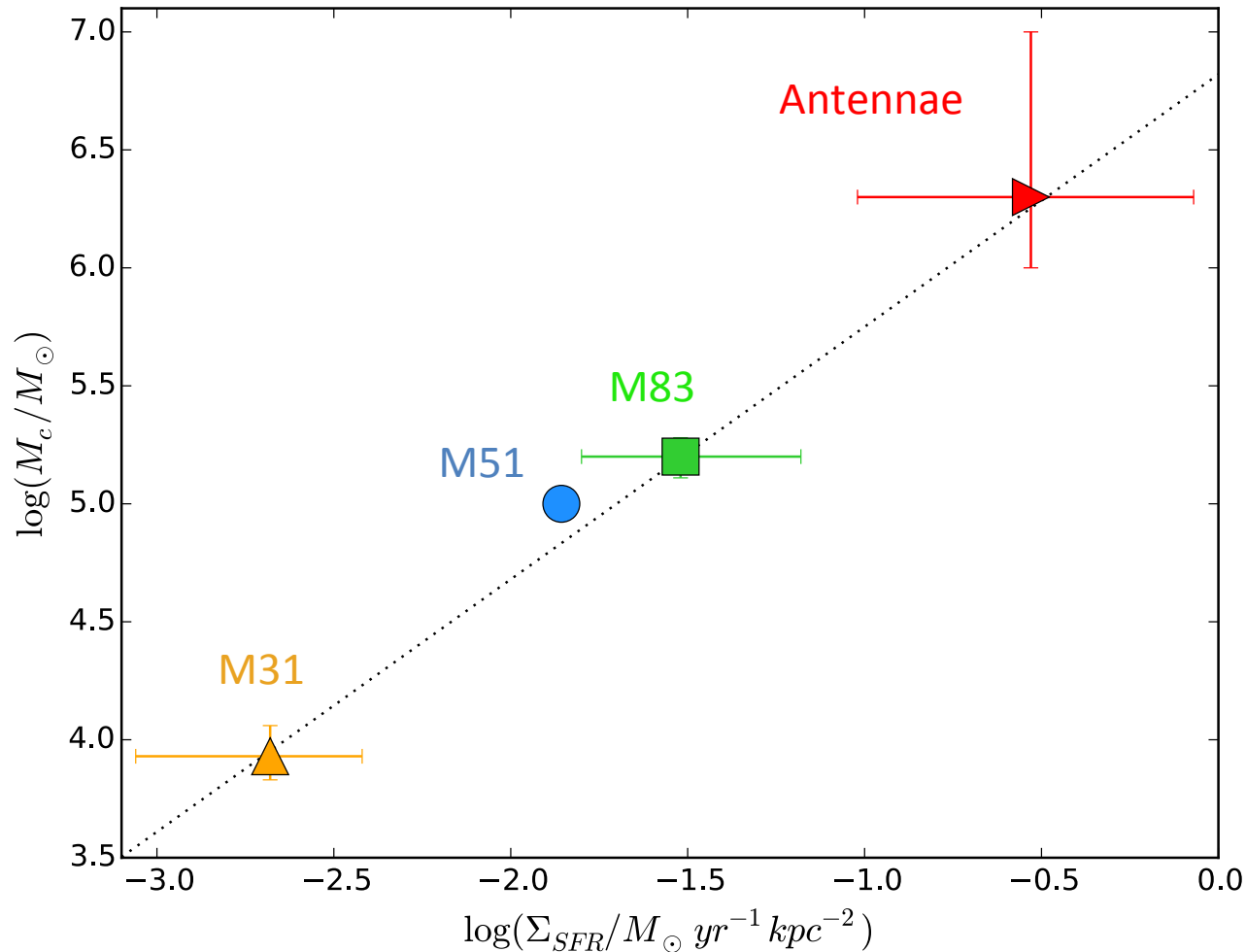


Truncated power law

- SLOPE: -2
 - Hierarchy (e.g. Elmegreen 2010)
- Exponential cut $\rightarrow M_c: 10^5 M_{\odot}$

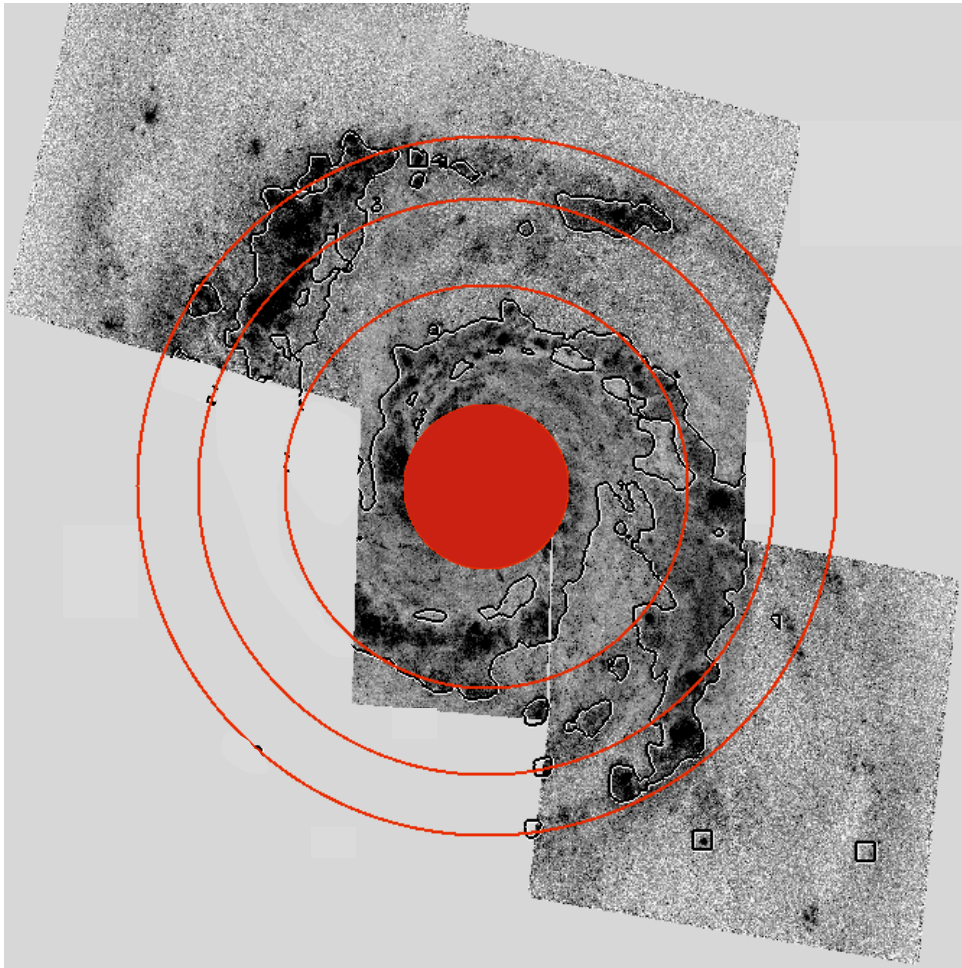
Mass Function

Comparing to other galaxies:



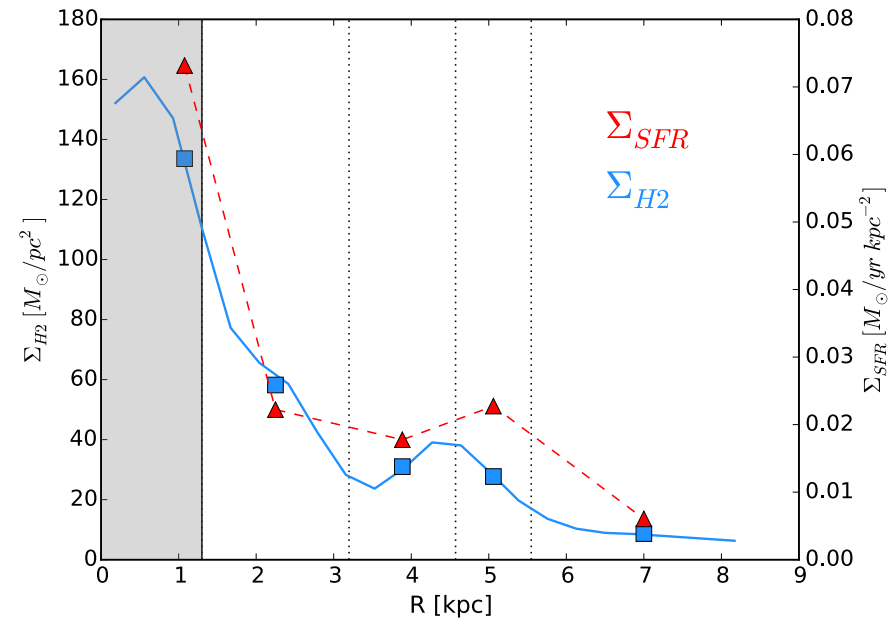
Mass Function

Inside the galaxy



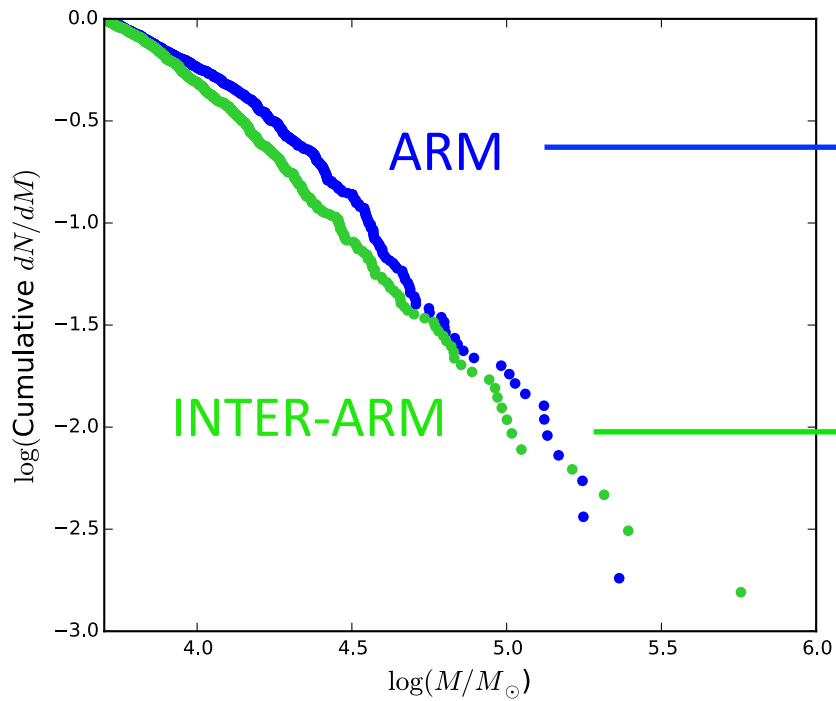
In all bins:

Slope ~ -2
 $M_c \sim 10^5 M_\odot$



Mass Function

Inside the galaxy



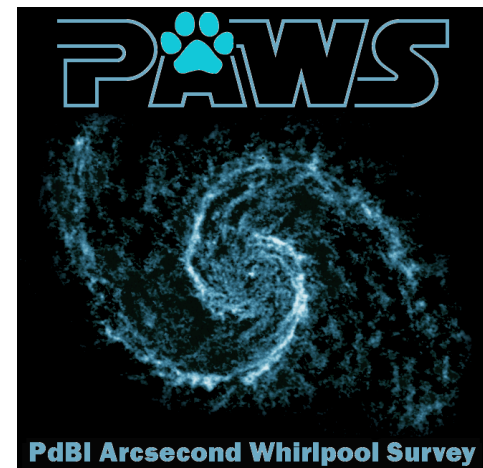
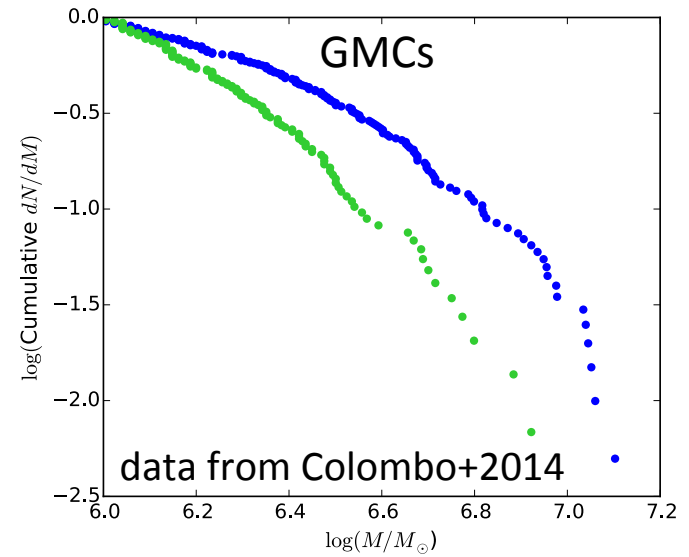
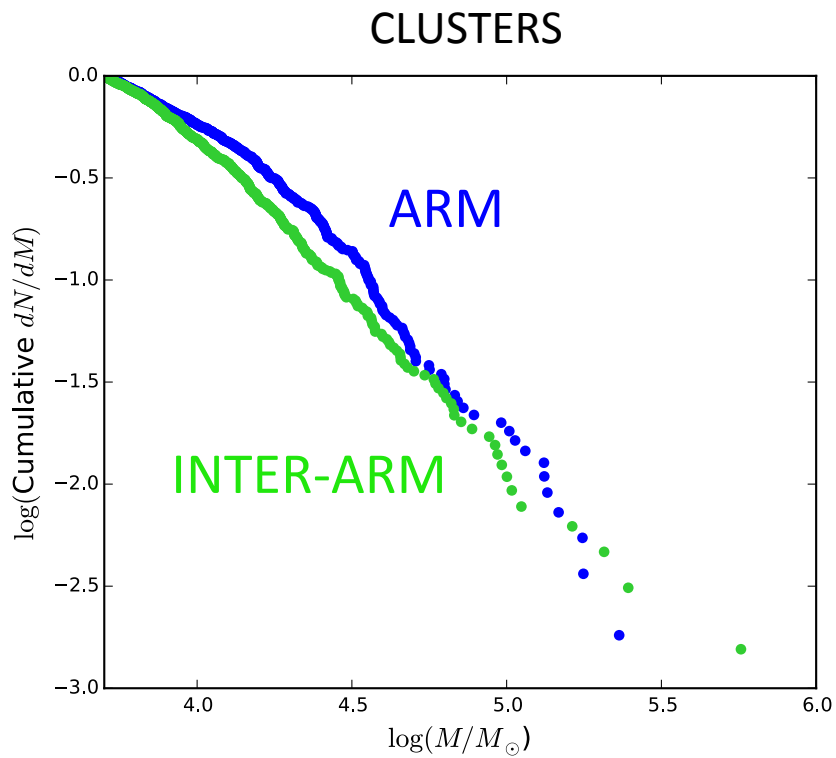
SLOPE: -1.83 ± 0.03

SLOPE: -2.14 ± 0.05

For both: $M_c \sim 10^5 M_{\odot}$

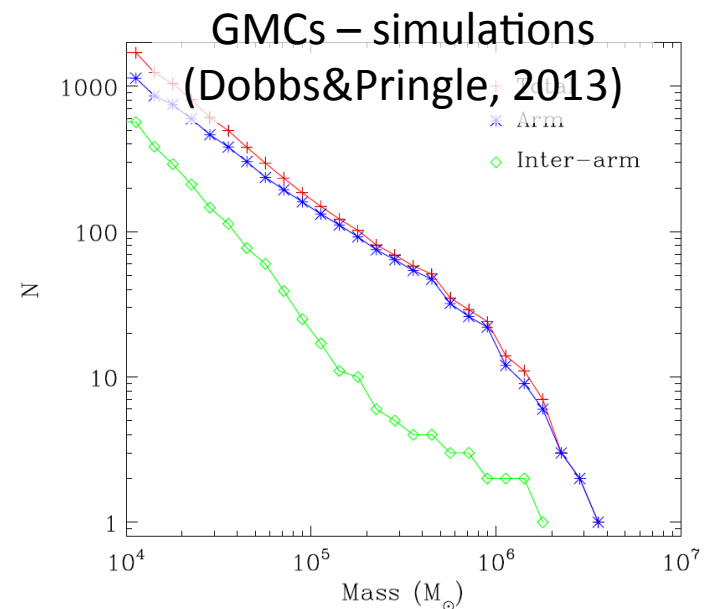
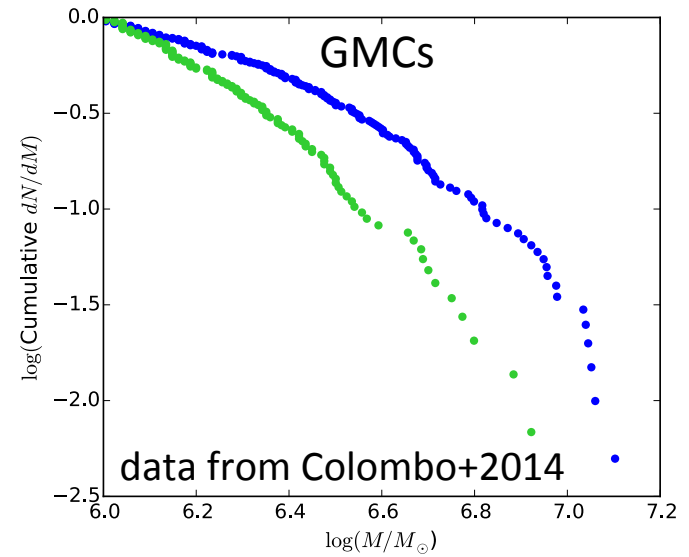
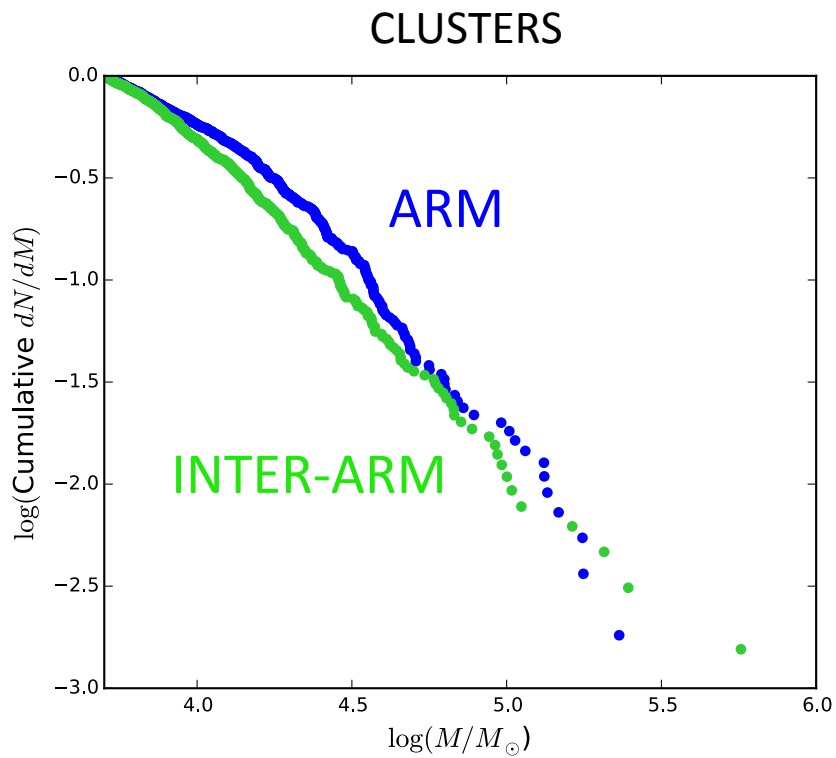
Mass Function

Inside the galaxy



Mass Function

Inside the galaxy



Mass Function

Maximum cluster mass

Self consistent model (Reina-Campos+2017, Kruijssen2014)

- Toomre mass (regulated by gas shear)
- Stellar feedback



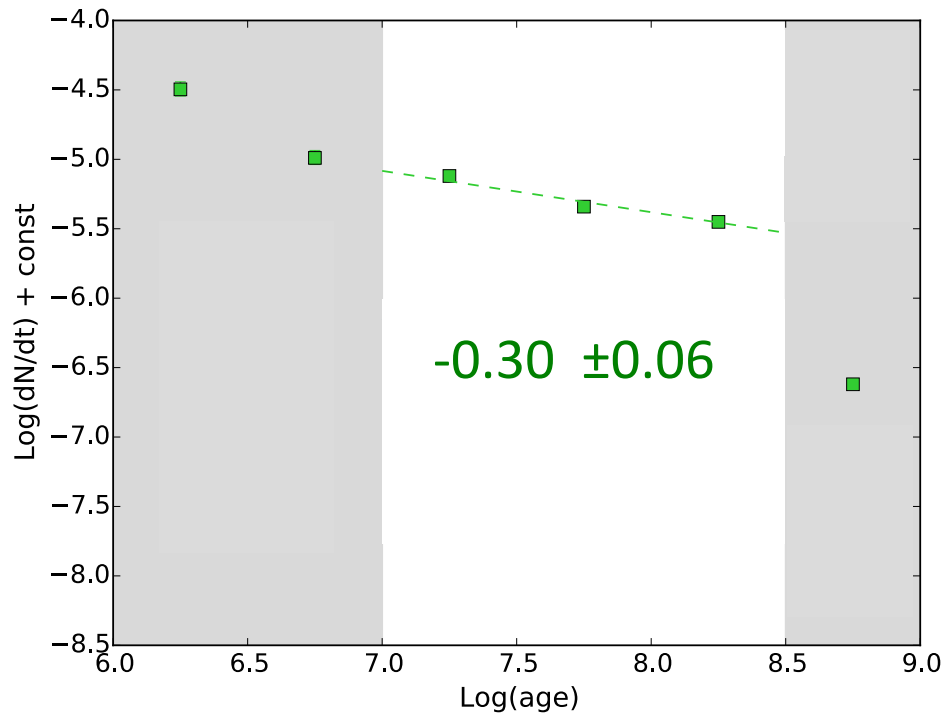
Shear-feedback hybrid model

- Gas surface density
- Epicyclic frequency
- Gas velocity dispersion

Max masses $\sim 10^5 M_{\odot}$ across the whole galaxy

Age Function

Distribution of ages dN/dt



LMC

SMC

Outskirts of spirals

slope ~ -0.1

M51

M83

NGC 628

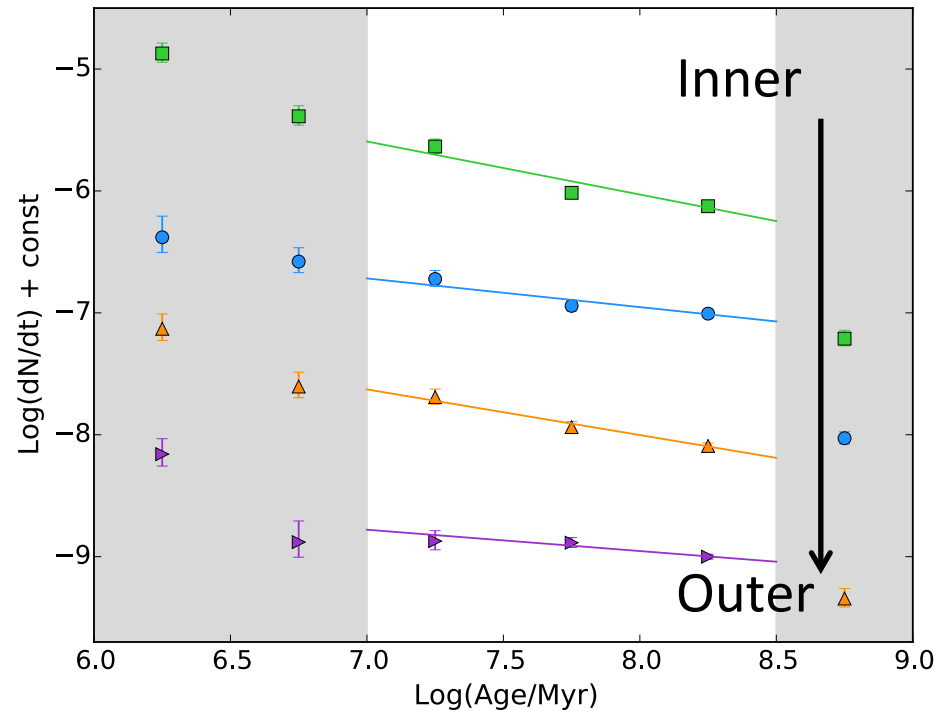
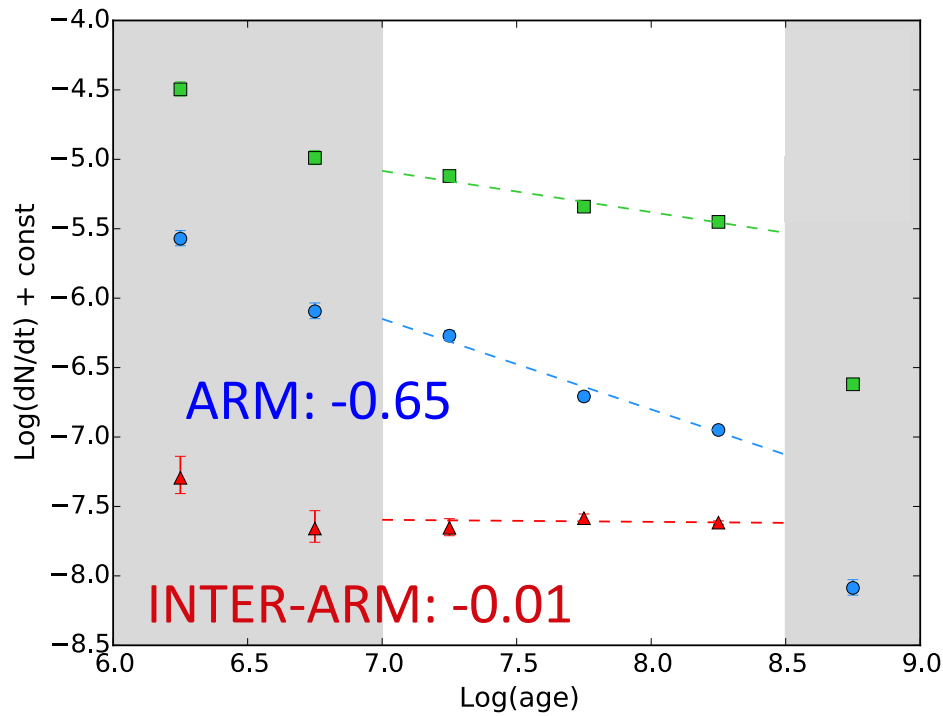
slope ~ -0.3/0.4

Antennae

slope ~ -1.0

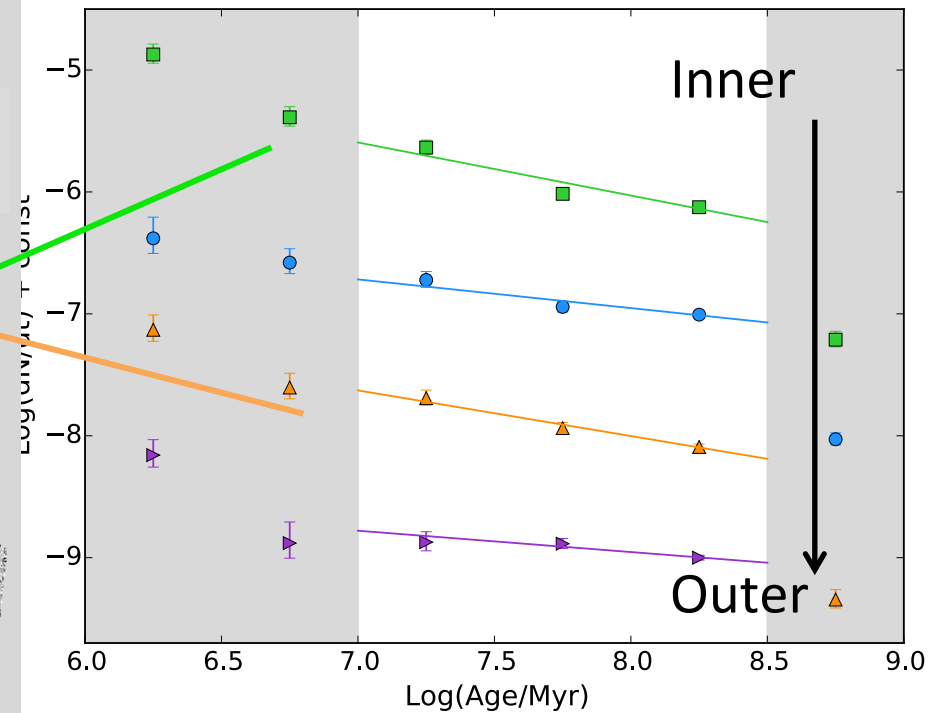
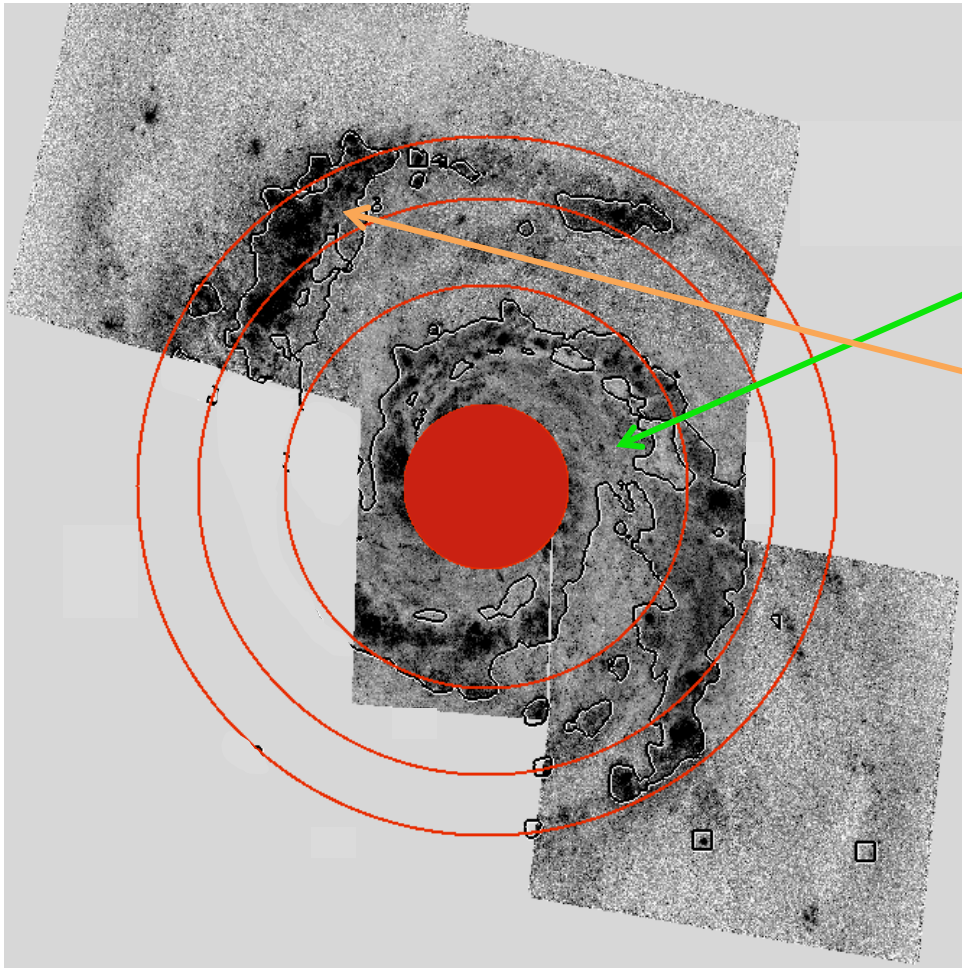
Age Function

Inside the galaxy



Age Function

Inside the galaxy



Stronger disruption in

- Centre

- Arm



Tidal fields

Conclusions

Statistical study of cluster population in M51

- Environmental dependence of SF
 - Mass function
 - Age function
 - OTHERS:
 - Luminosity function
 - Fraction of stars formed in clusters: CFE

Messa et al., MNRAS submitted

- SF at different times
 - Multi-wavelengths studies
 - Compare e.g. YSC to GMC