Environmental dependence of cluster formation and evolution in M51

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SFDE17: from local clouds to distant galaxies
ICISE, Quy Nhon, 8 August 2017

Goal

SFDE: Star Formation in Different Environments

Do (how) star formation properties depend on the environment?

Stellar clusters

WHY

HOW

WHY star clusters?

Star formation is a hierarchical process

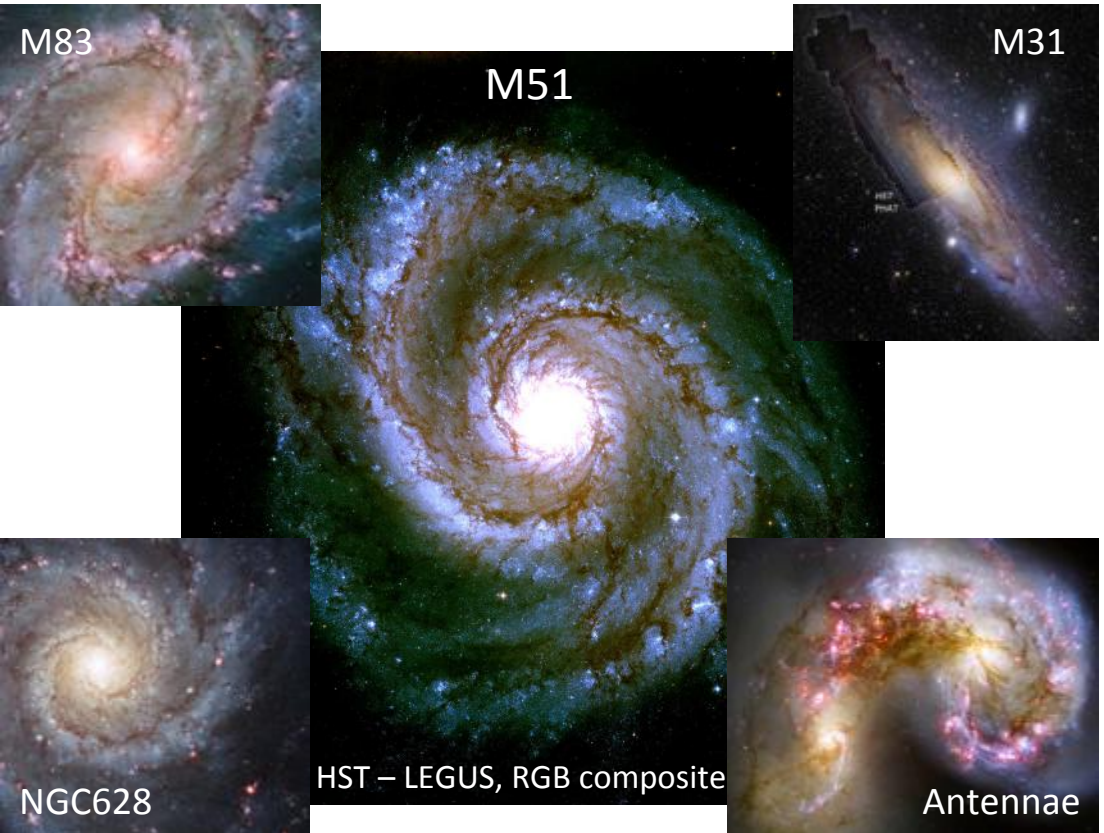
- Most (all?) stars do not form in isolation
- Some clusters bound for hundred Myrs
  - Can be used as tracers of SF in space and time

HOW?

Do (how) star cluster properties depend on the environment?

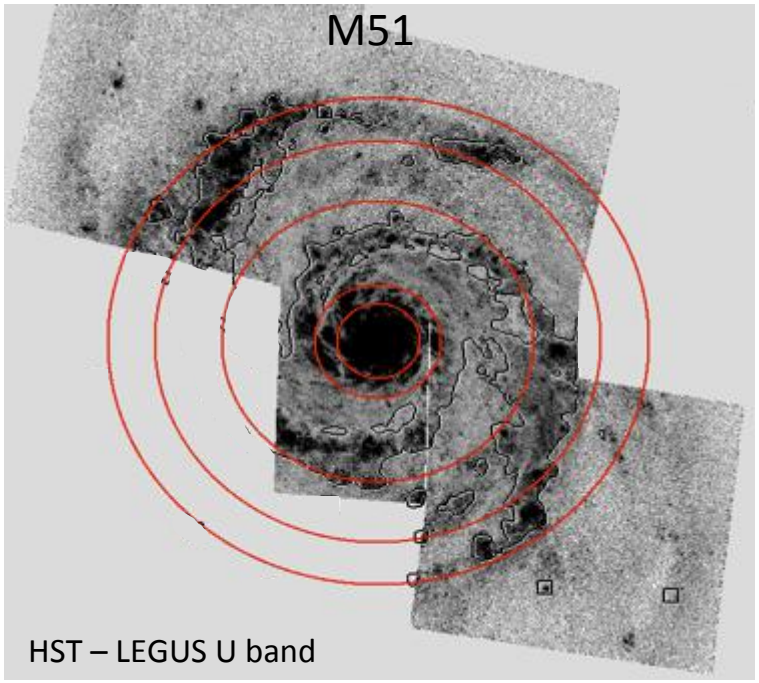
GALACTIC SCALE

(Messa et al., 2017 subm – Paper I)



SUB-GALACTIC SCALE

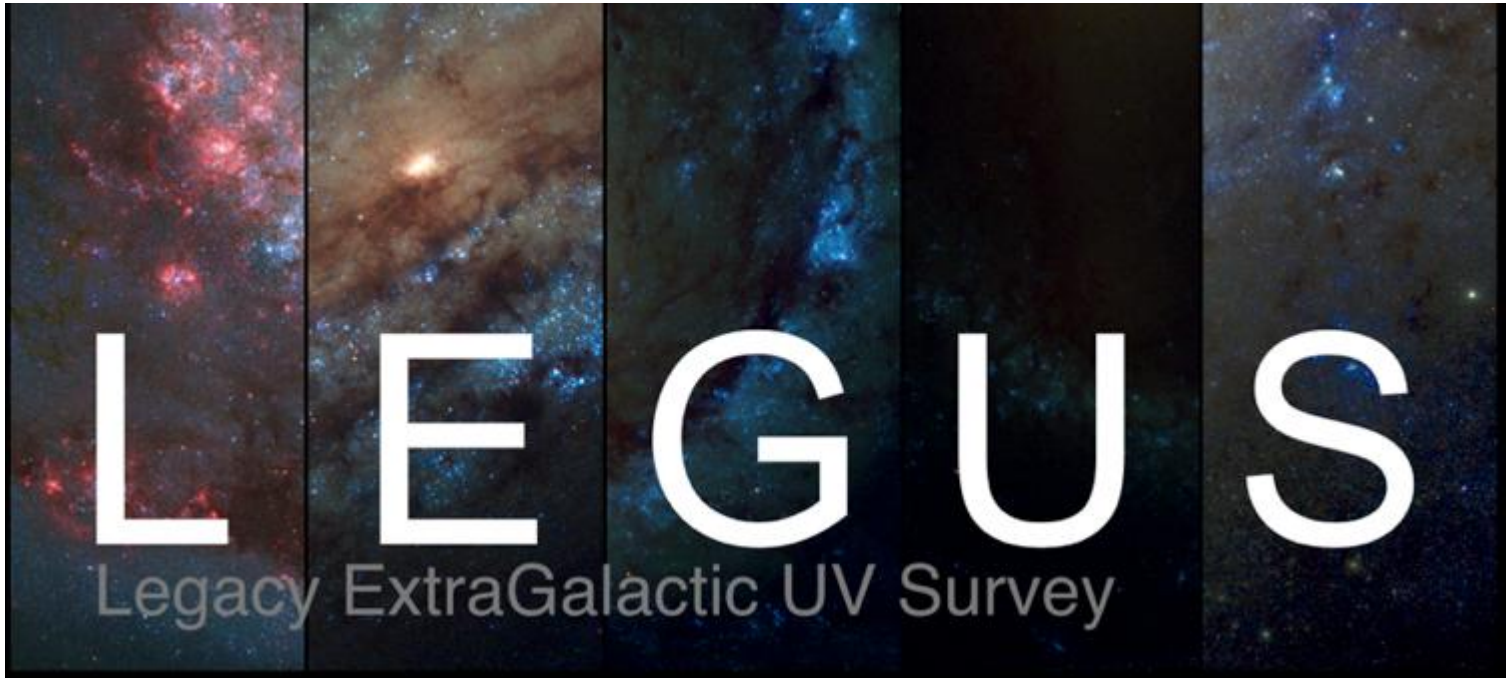
(Messa et al., in prep – Paper II)



Data

LEGUS project (Calzetti et al 2015) - HST Broadband photometry

50 nearby galaxies



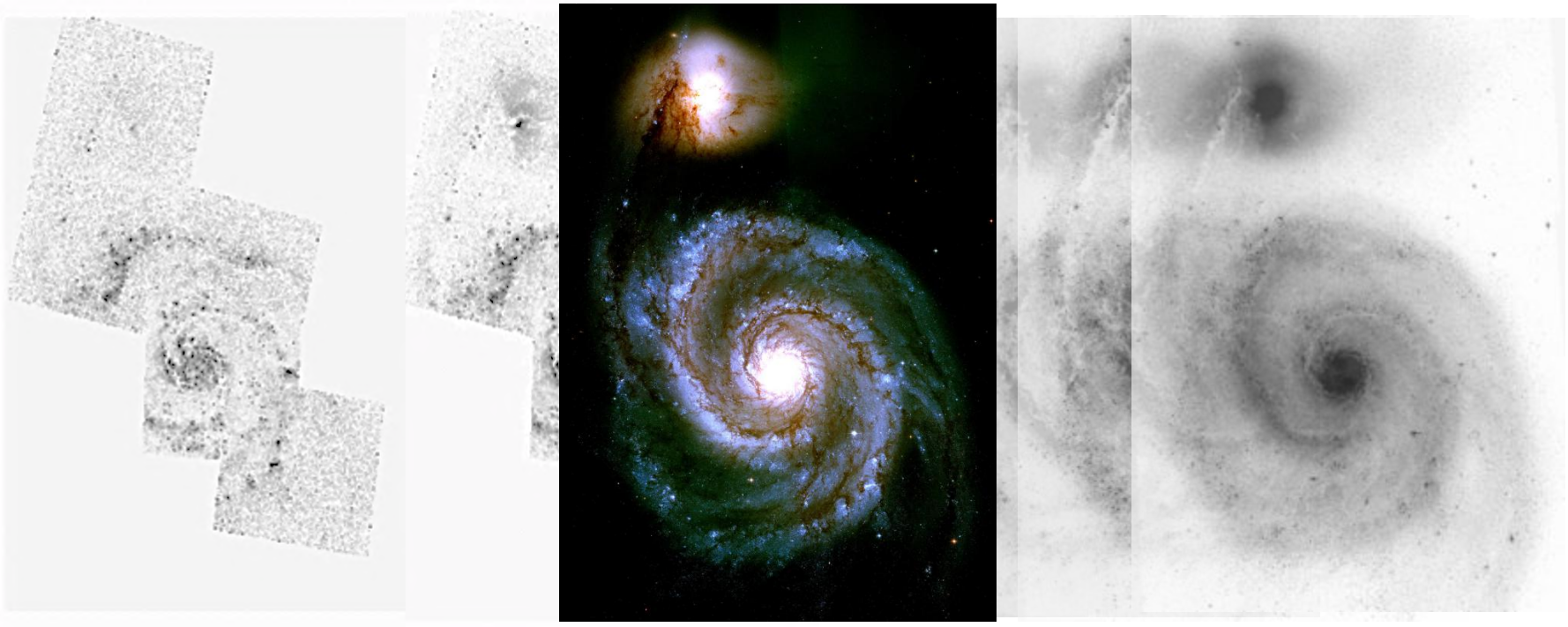
Data

LEGUS project (Calzetti et al 2015) - HST Broadband photometry

M51

NEW: WFC3 UV – U Bands

ARCHIVAL: B V I Bands

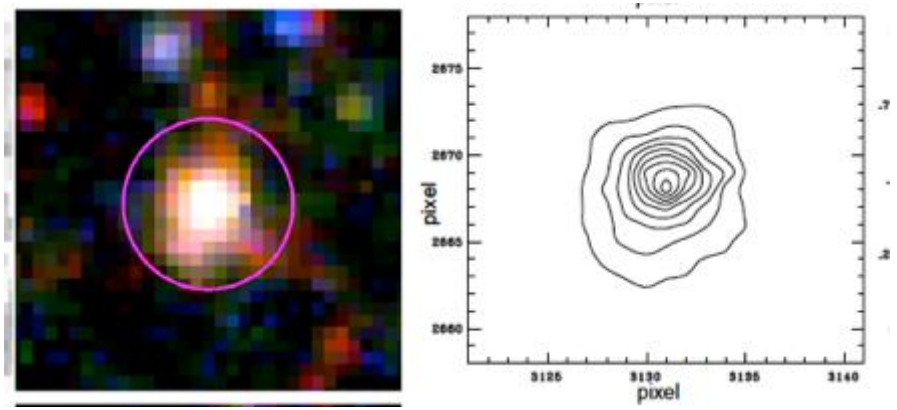


Data

LEGUS project (Calzetti et al 2015) - HST Broadband photometry
M51

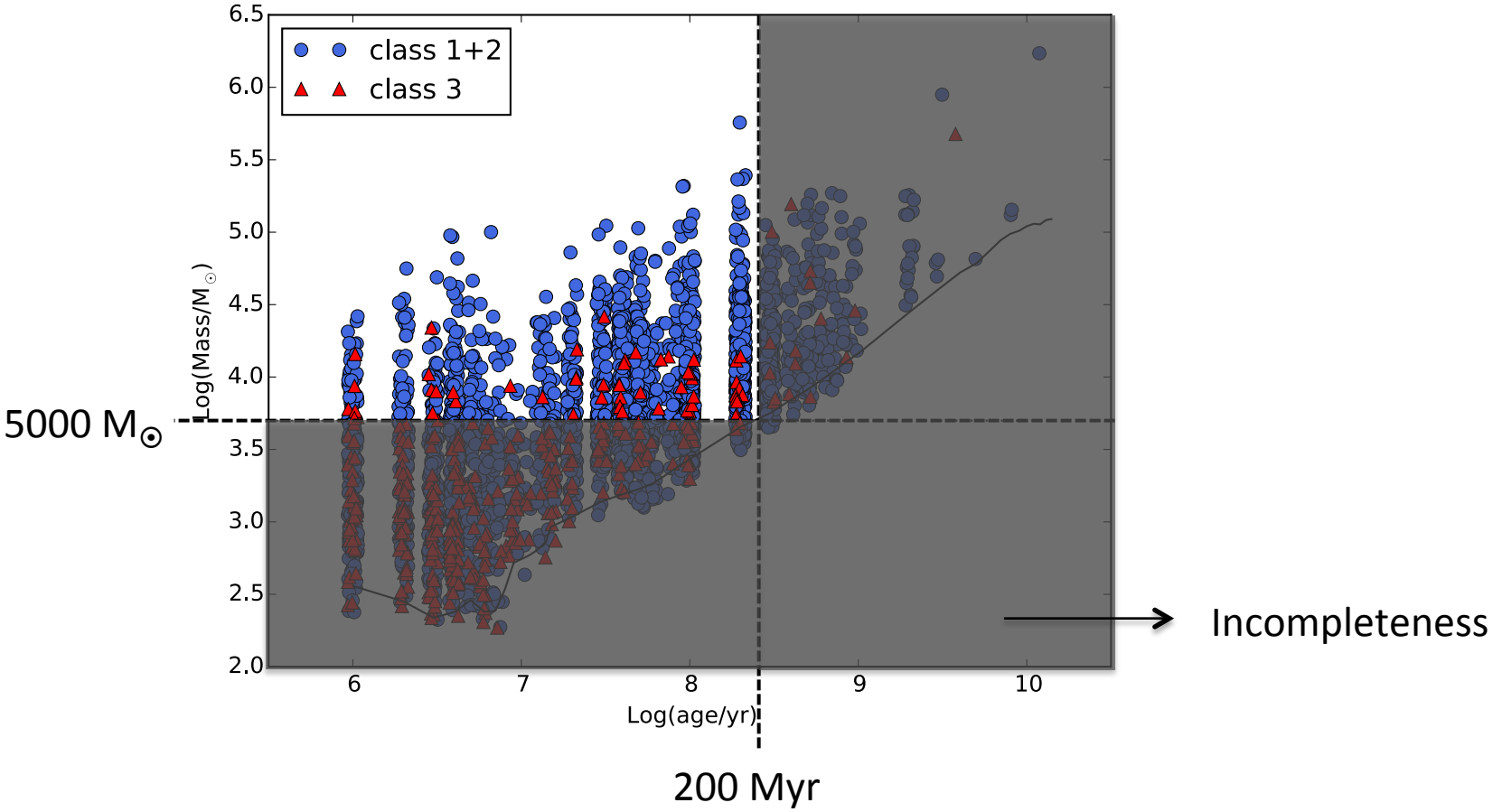
Our catalogue: ~3000 clusters, compact and uniform color

SED fitting: age and mass estimates



Sample selection

mass-limited complete sample

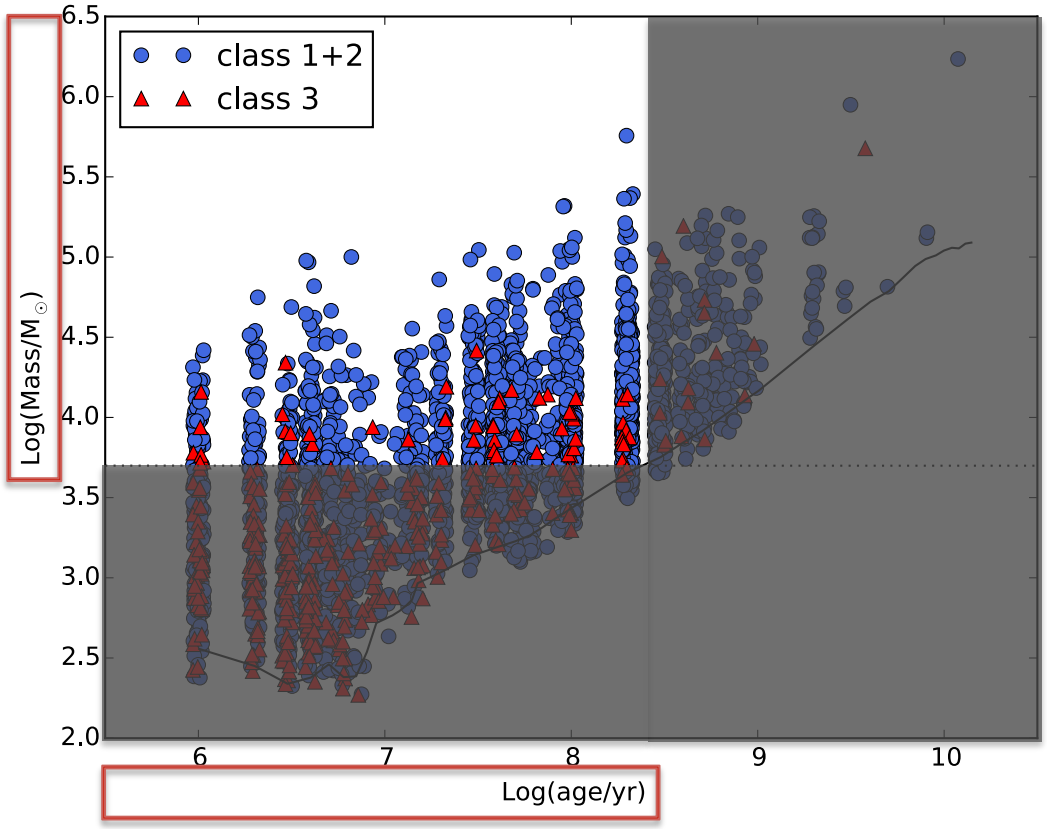


Paper I

Sample selection

mass-limited complete sample

Mass distribution:
Formation

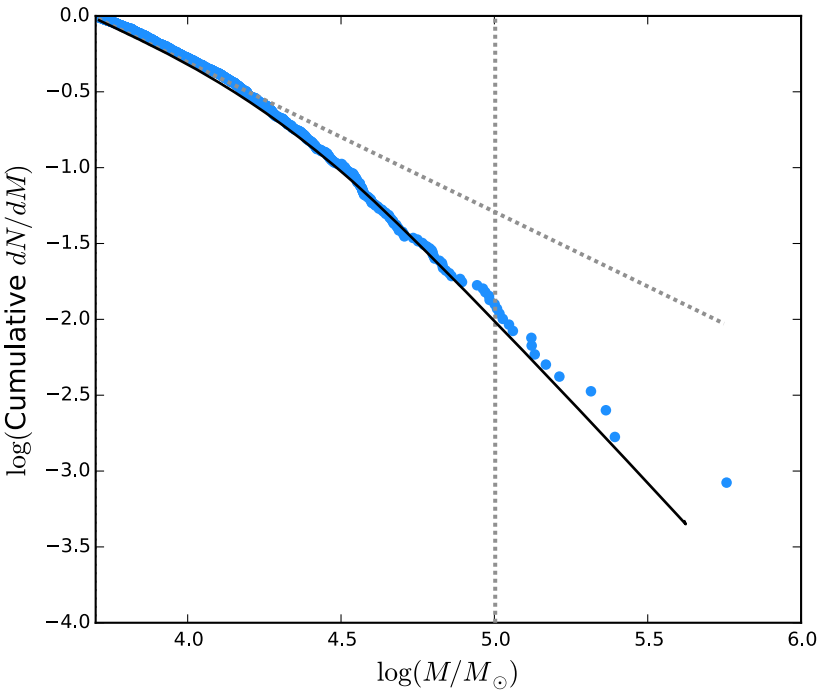


Age distribution: Evolution

Mass Function

How cluster masses are distributed: dN/dM

Cumulative form



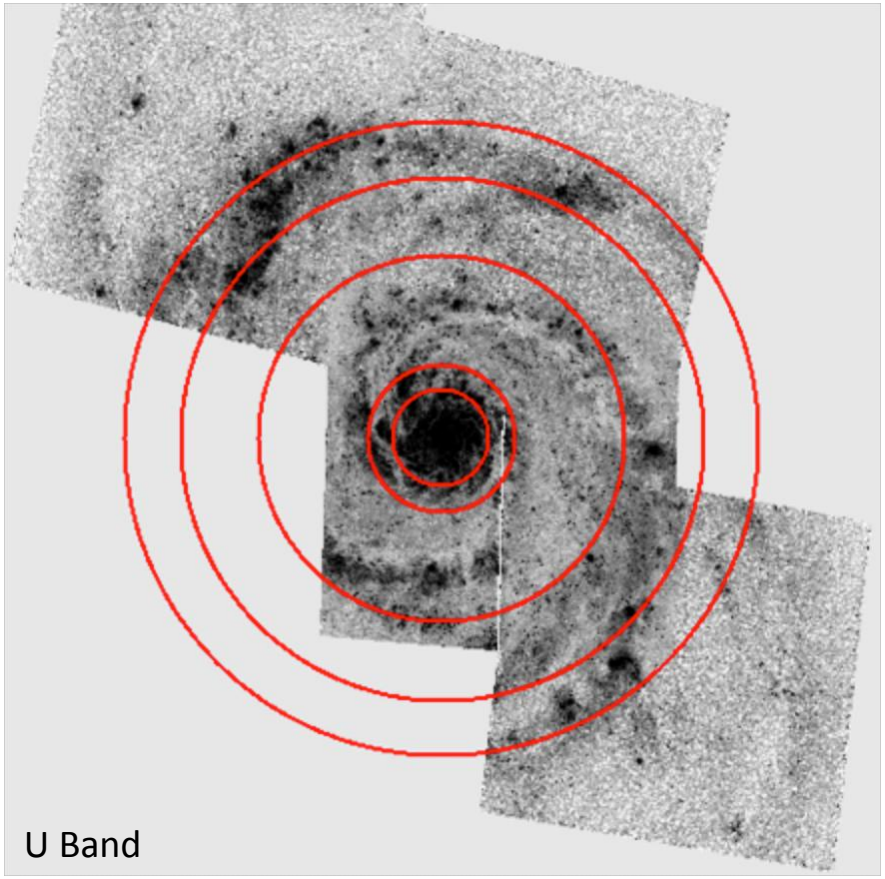
Paper I

Truncated power law

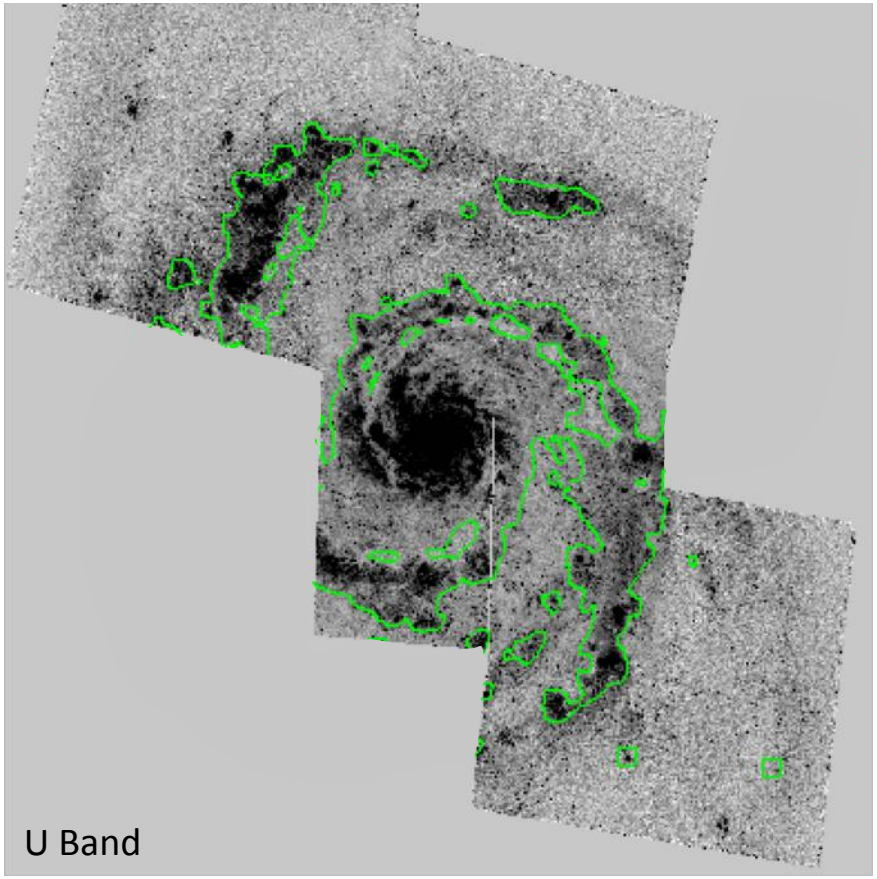
- SLOPE: -2
  - Hierarchy (e.g. Elmegreen 2010)
- Exponential cut -> M_c:10^5 $M_\odot$

Environment division

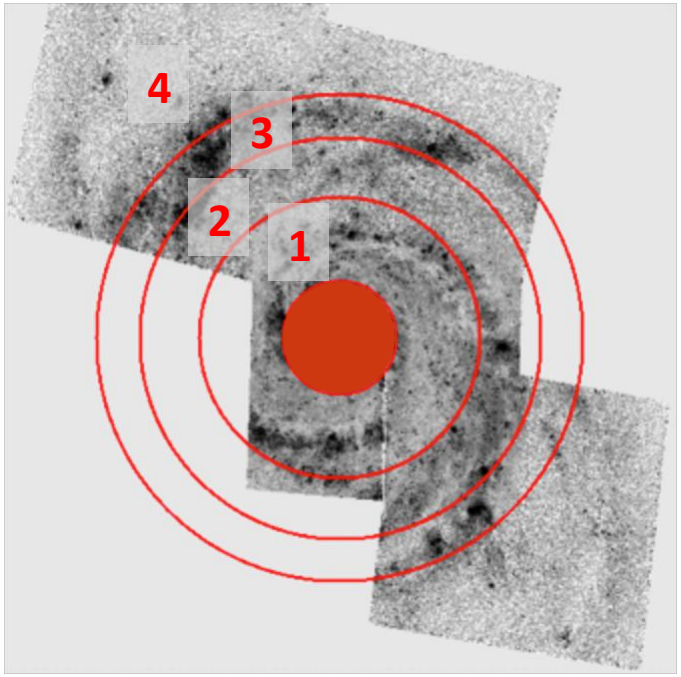
RADIAL



ARM/INTER-ARM



Mass Function



In all bins:

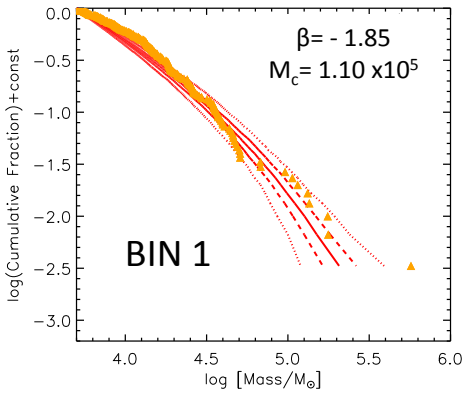
Truncated mass function

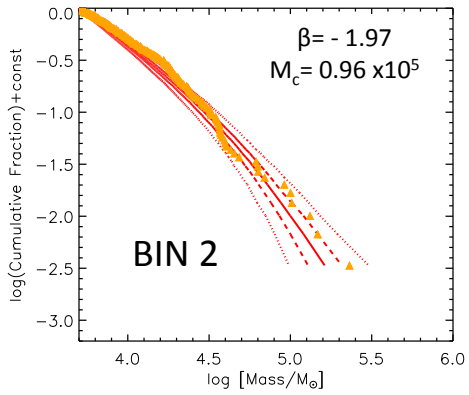
$\beta \sim -2$

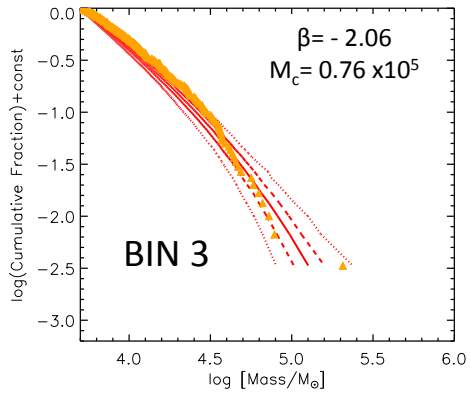
$M_c \sim 10^5\ M_\odot$

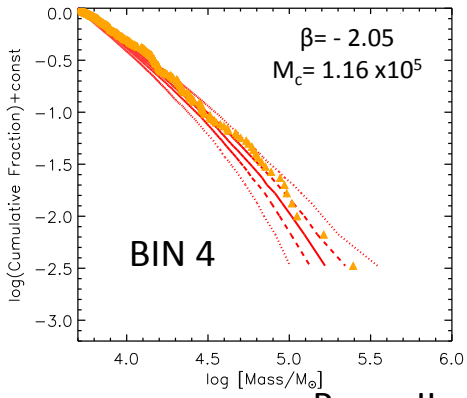
No radial variation in GMC properties

Colombo+2014



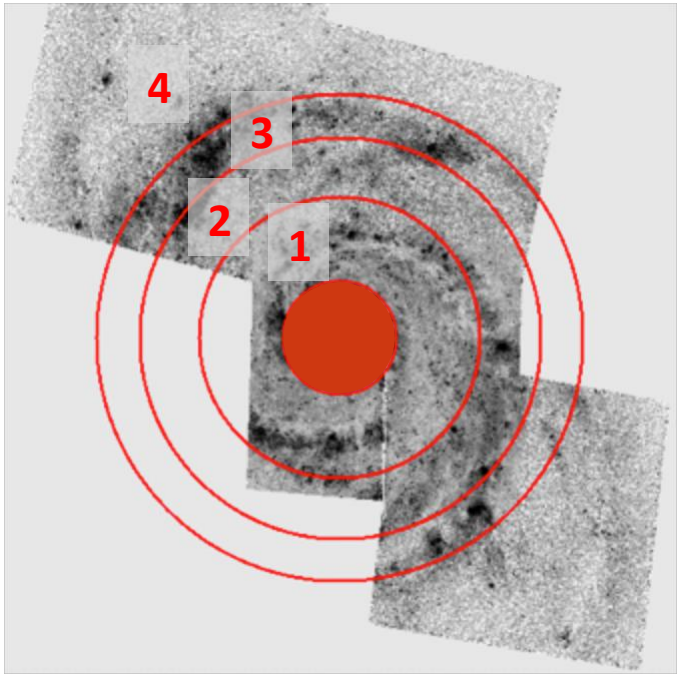






Paper II

Mass Function



In all bins:

Truncated mass function

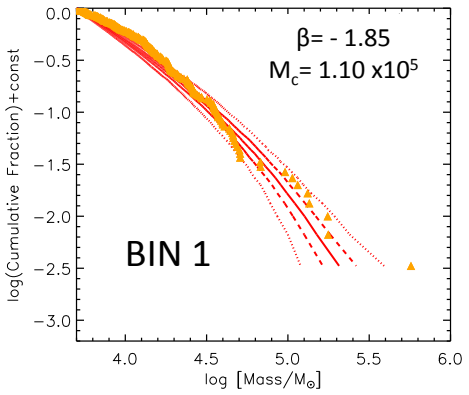
$\beta \sim -2$

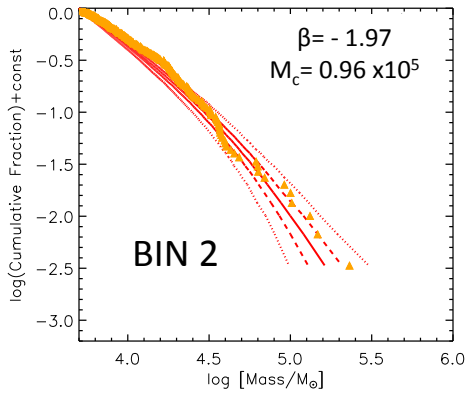
$M_c \sim 10^5\ M_\odot$

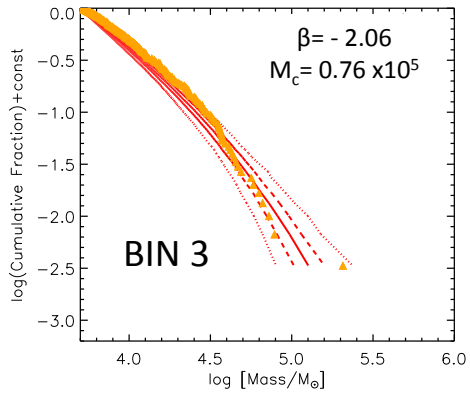
Different from M83: radial trend

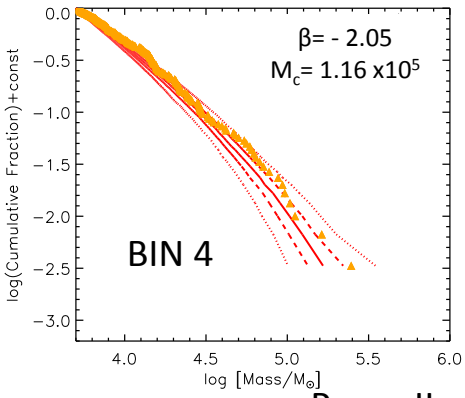
Clusters: Adamo+2015

GMCs: Freeman+2017









Paper II

Mass Function

Maximum cluster mass

Self consistent model (Reina-Campos & Kruijssen 2017)

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

↓

Shear-feedback hybrid model

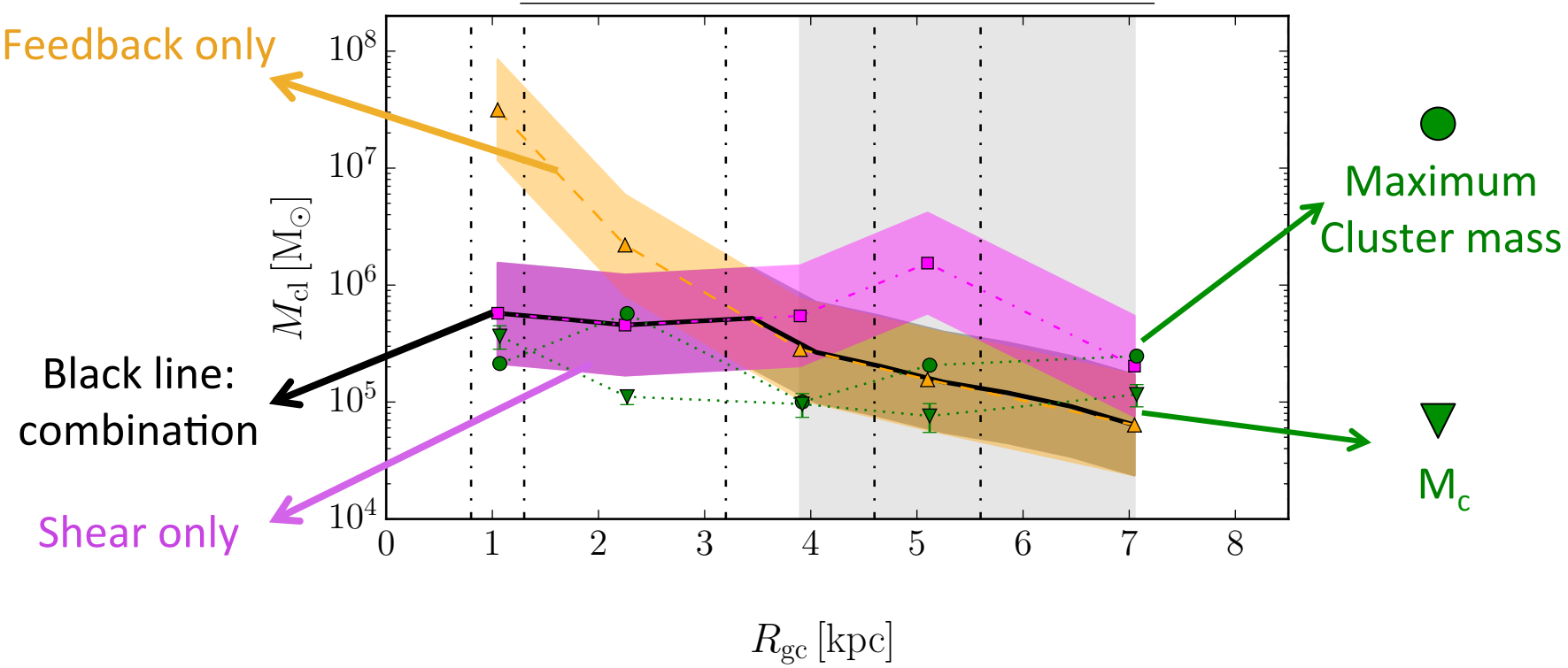
- Gas surface density
- Epicyclic frequency
- Gas velocity dispersion

↓

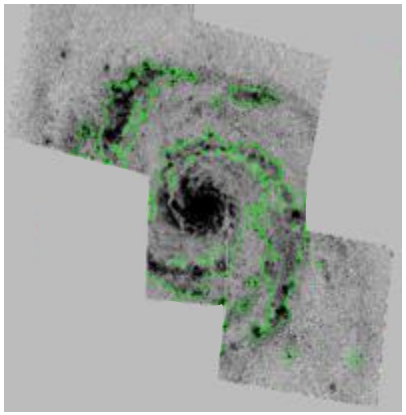
Max_{GMC} converted into Max_{CL} via ε and Γ

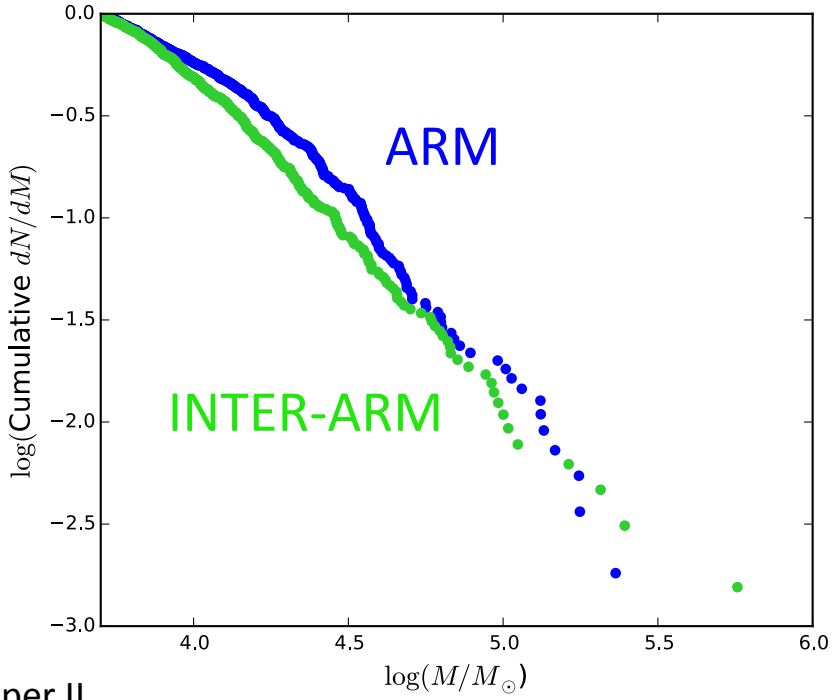
Mass Function

Maximum cluster mass
in M51
as function of R_{gal}



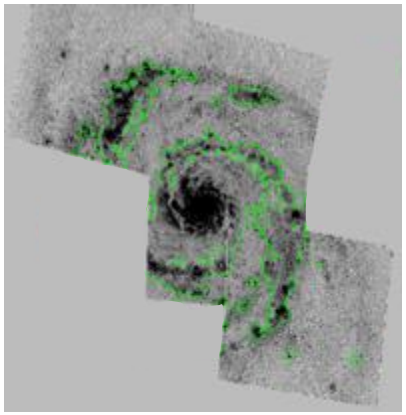
Mass Function

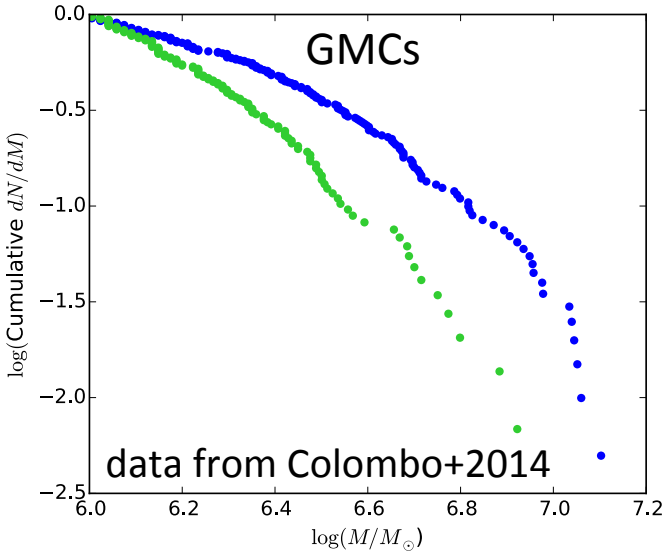


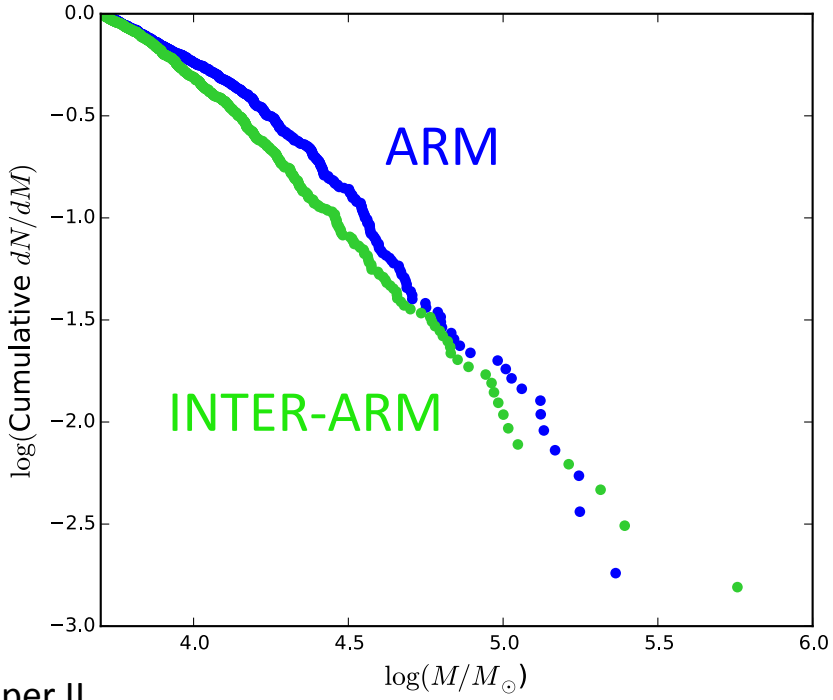


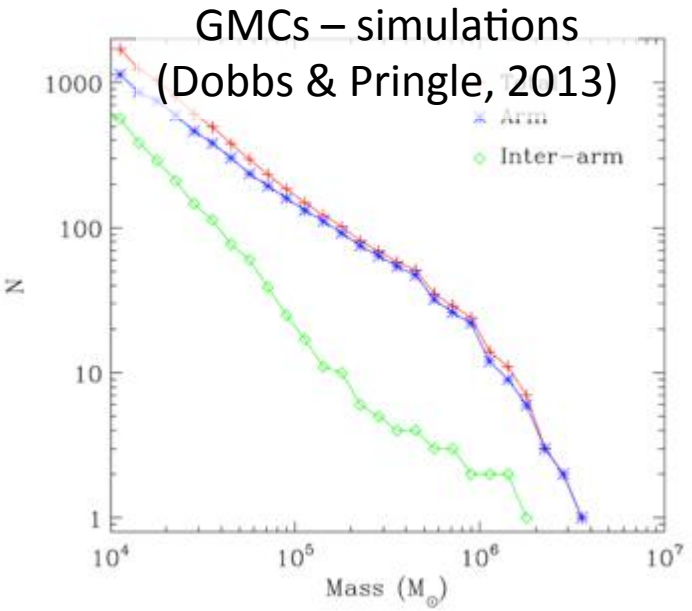
Paper II

Mass Function





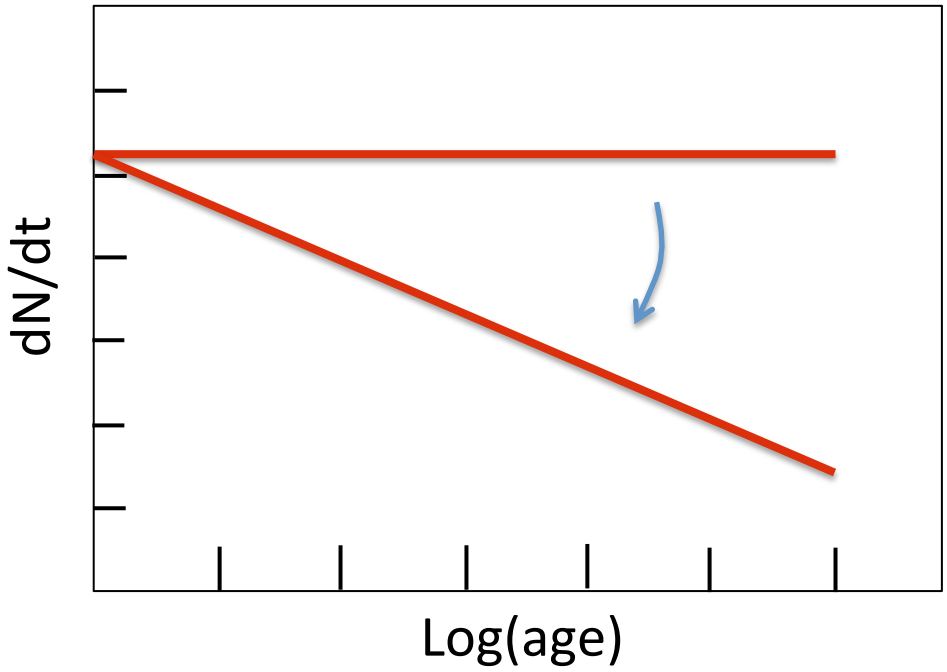




Paper II

Age Function

Distribution of ages dN/dt



Studying the age function:

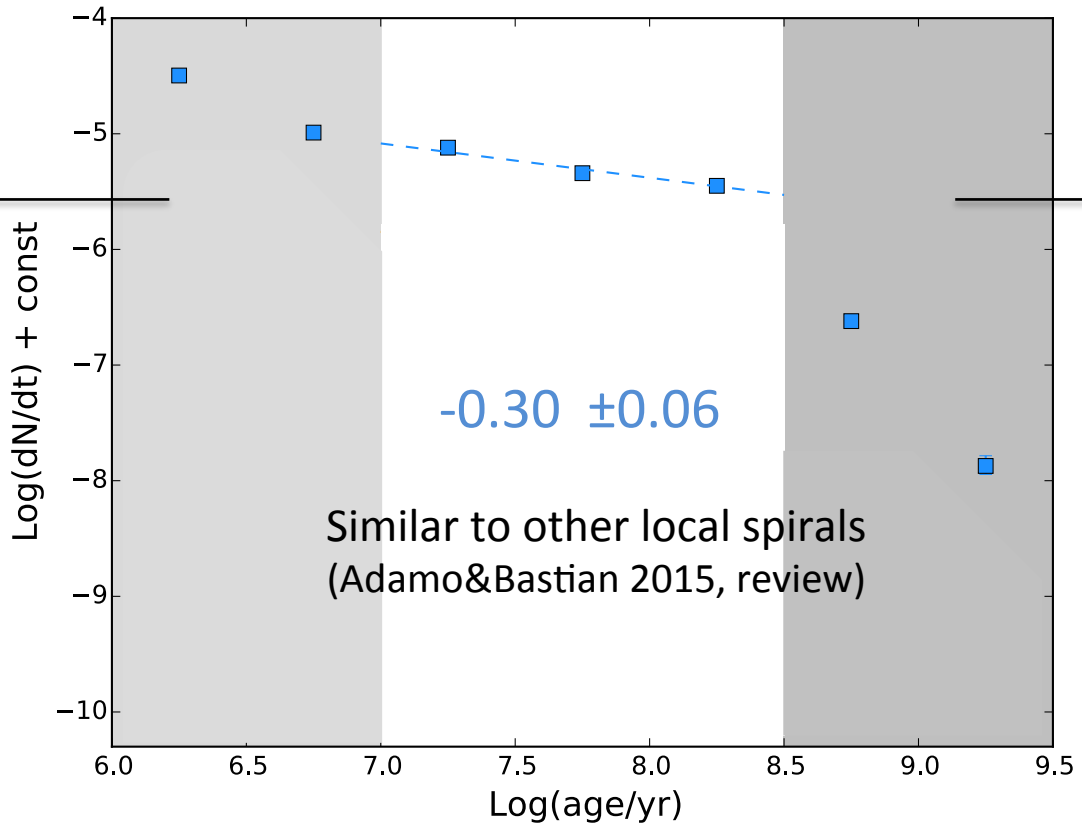
Constant SFR:
- Constant value

Disruption:
- Steepening
- Slope depends on the strength

Age Function

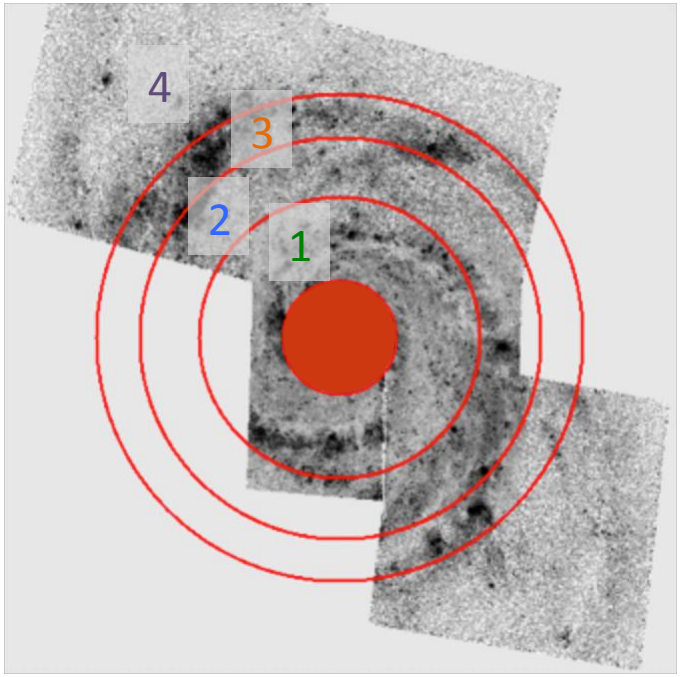
Distribution of ages dN/dt

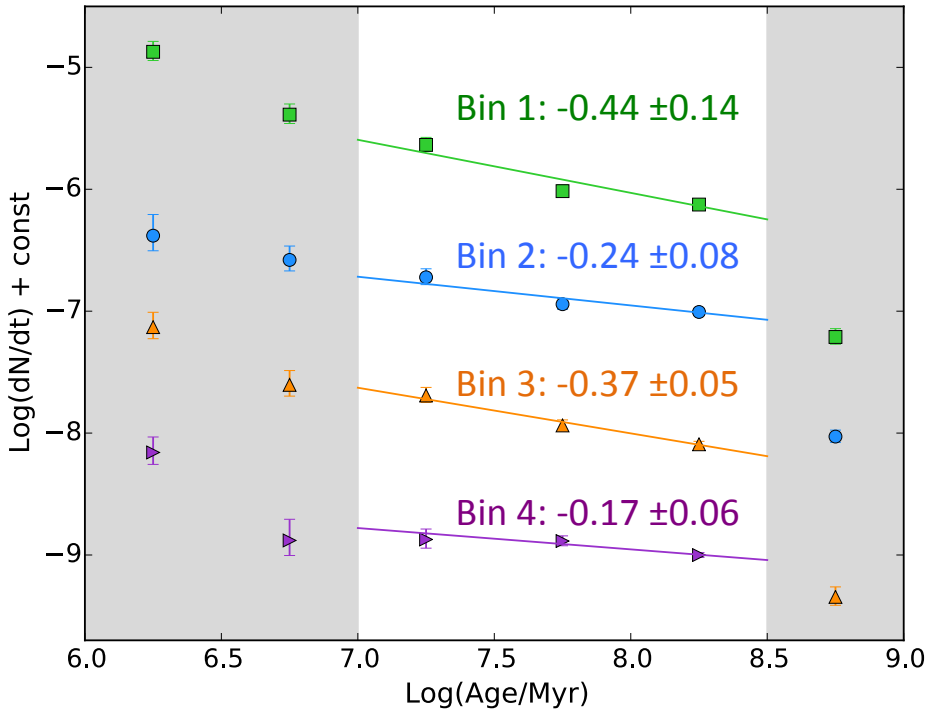
Contamination by unbound sources



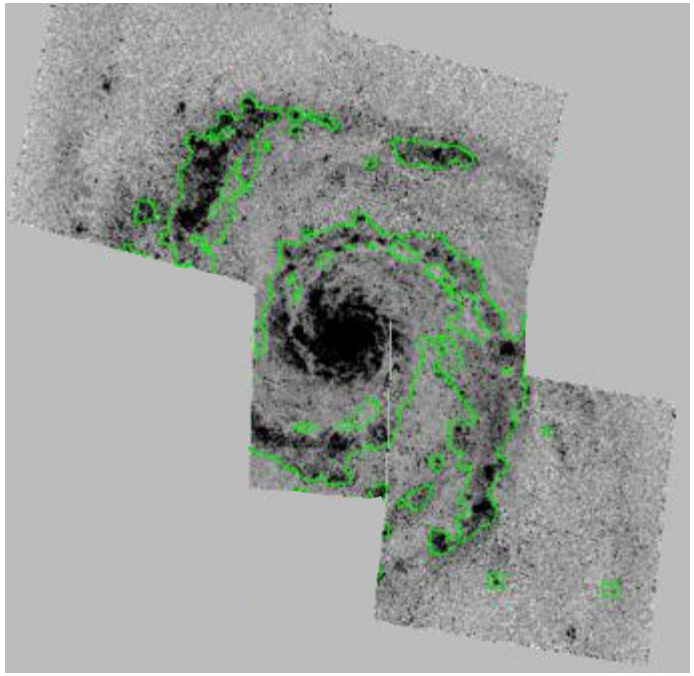
Older than 200 Myr

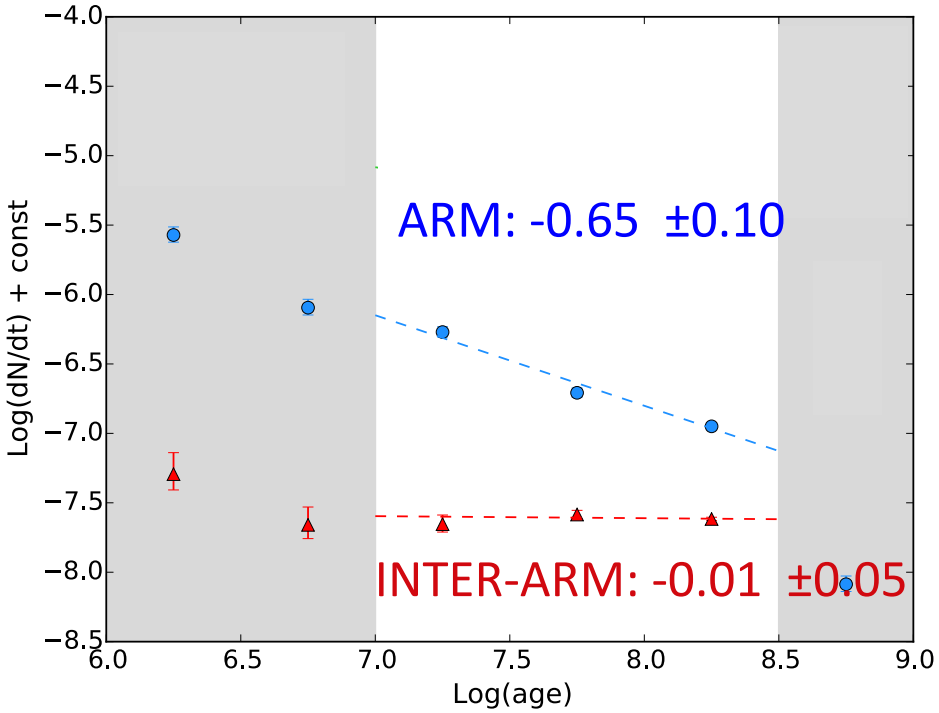
Age Function





Age Function





Stronger disruption in
- Centre
- Arm

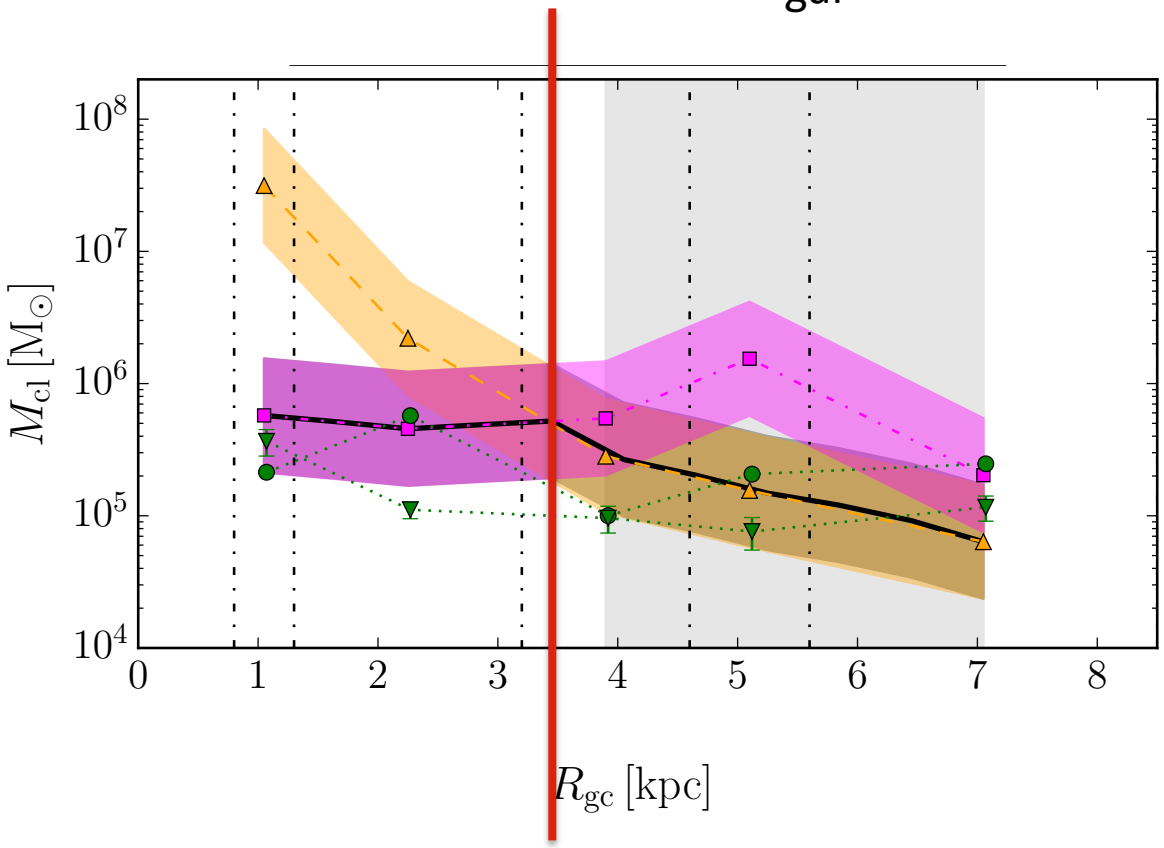
→ Disruption by GMCs
Tidal fields

(Elmegreen and Hunter 2010; Kruijssen 2011)

Summary

Do (how) star cluster properties depend on the environment?

- Mass function
  - Similar truncation mass at all R_{gal}



Summary

Do (how) star cluster properties depend on the environment?

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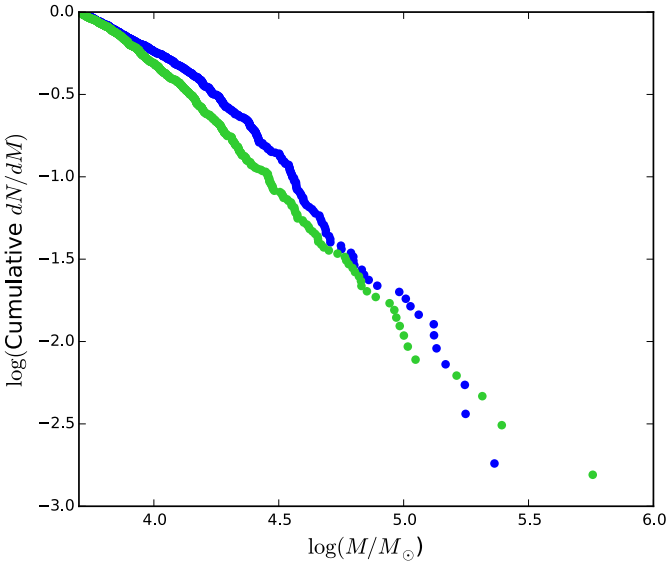
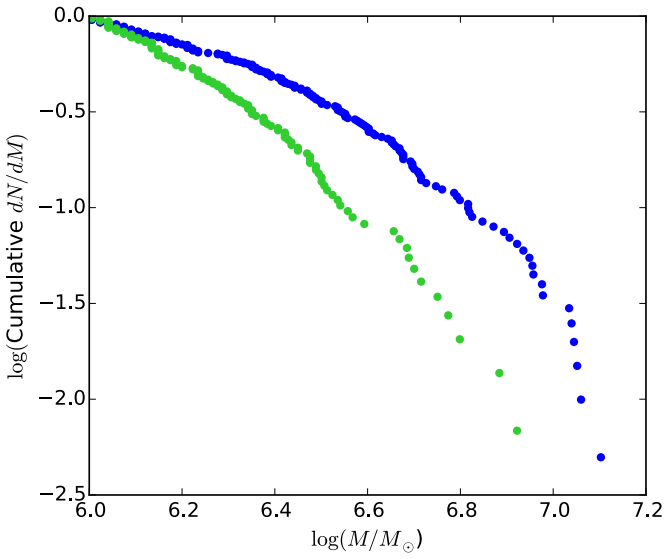
  - Similar truncation mass at all R_{gal}
  - Arm/inter-arm: behavior similar to GMCs





Summary

Do (how) star cluster properties depend on the environment?

- Mass function
  - Similar truncation mass at all R_{gal}
  - Arm/inter-arm: behavior similar to GMCs

- Age function
  - Environmental dependent