Ultra-Diffuse Galaxies Are More Abundant In Higher Mass Clusters!
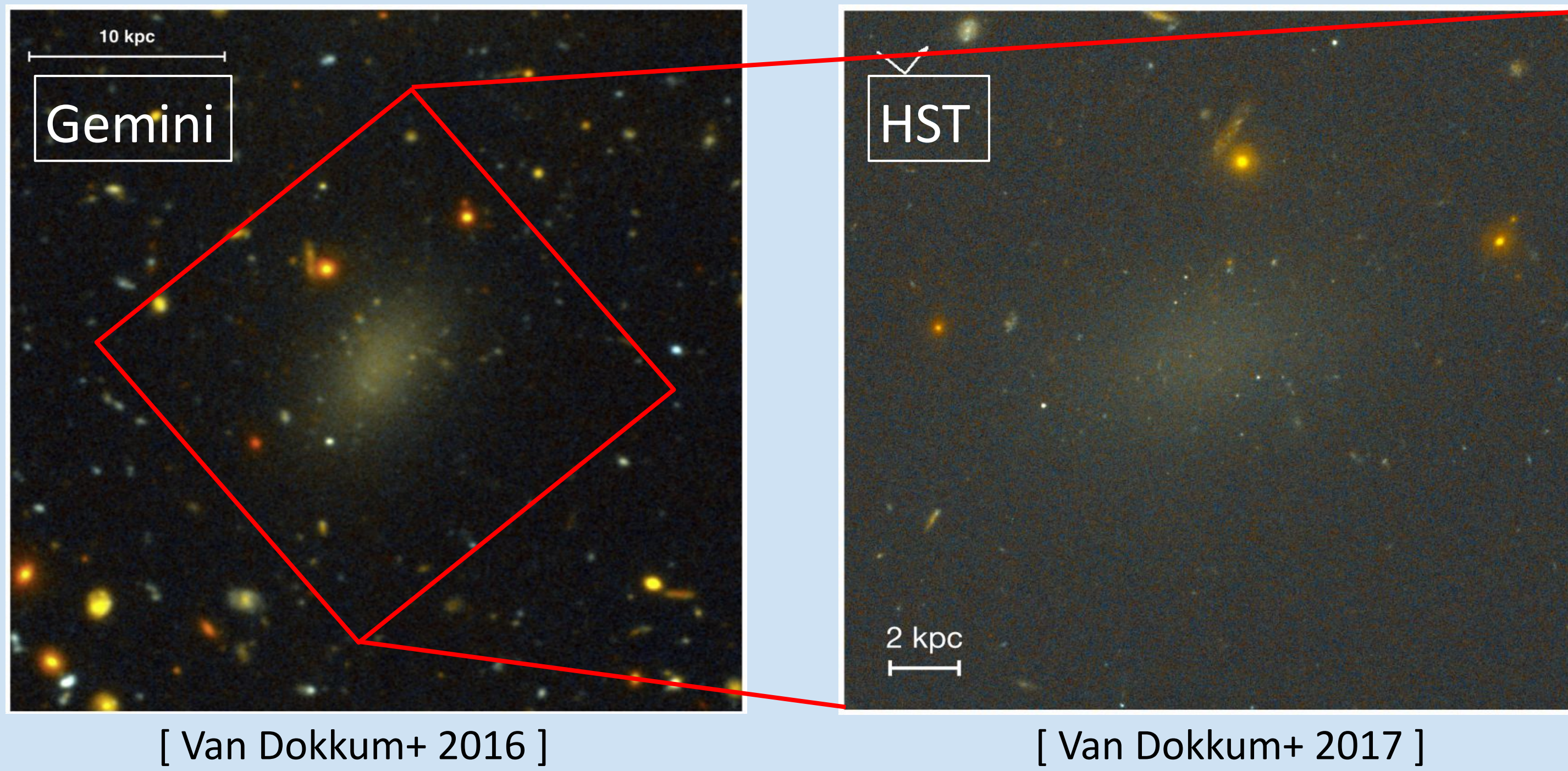
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NRF | SAAO National Research Foundation | South African Astronomical Observatory

AfAS African Astronomical Society

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What are Ultra-Diffuse Galaxies?

Ultra-Diffuse Galaxies(UDGs) are a classification of galaxies exhibiting low surface brightness as well as having extended sizes. For a galaxy to be a UDG it must have a surface brightness in the g-band greater than 24 mag/arcsec[2] and an effective radius greater than 1.5 kpc. The images below show one of the UDGs identified by Van Dokkum et al. 2016. Their low surface brightness make detection and measuring their properties very difficult.

Gemini — 10 kpc

HST — 2 kpc

[Van Dokkum+ 2016]   [Van Dokkum+ 2017]

Identifying UDGs in Clusters

The steps taken to detect UDGs in the IAC Stripe 82 data and measure their properties:

- Identify clusters using the RedMaPPer Cluster Catalogue. Select low redshift (z<0.15) clusters in the Stripe 82 Region
- Identify candidate sources within the cluster radius in the IAC Stripe 82 source catalog
- Identify cluster members using the red sequence. Select galaxies with colours similar to those found in the RedMaPPer clusters.
- Estimate cluster member properties through model fitting with GALFIT
- Apply UDG candidate selection criteria :
  - $\mu_g(0) \geq 22.2$ mag/arcsec^2
  - $r_{eff} \geq 1.5$ kpc
- Implement image coverage and background correction. Estimate uncertainties using bootstrap resampling.

Results : In the Stripe 82 clusters the number of UDGs increases with cluster halo mass.

Legend:
- Stripe 82 UDGs
- Nearby clusters - Van der Burg + 2016
- Abell 2744 - janssen + 2017
- Abe1l 168 - Román & Trujillo 2017
- Nearby clusters - Román & Trujillo 2017
- Fornax - Muñoz + 2015
- Coma - Yagi + 2016
- Coma - Koda + 2015

This work
$$N \propto M^{1.11 \pm 0.25}$$

Van der Burg et al. 2016
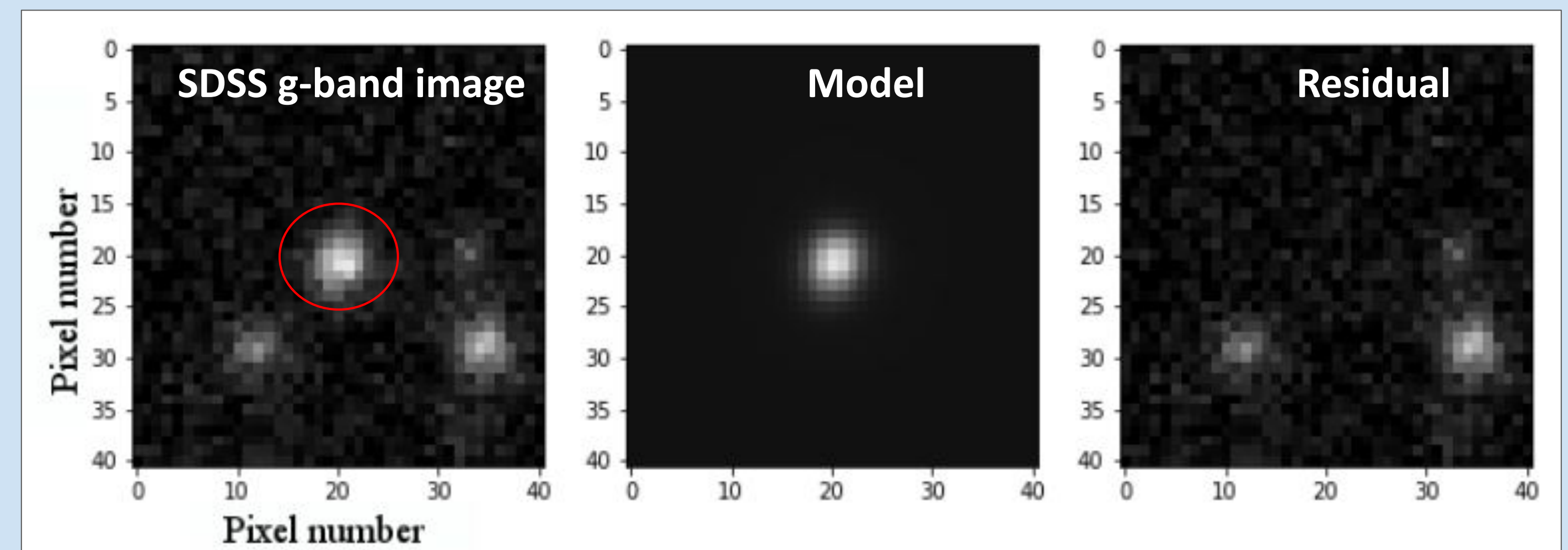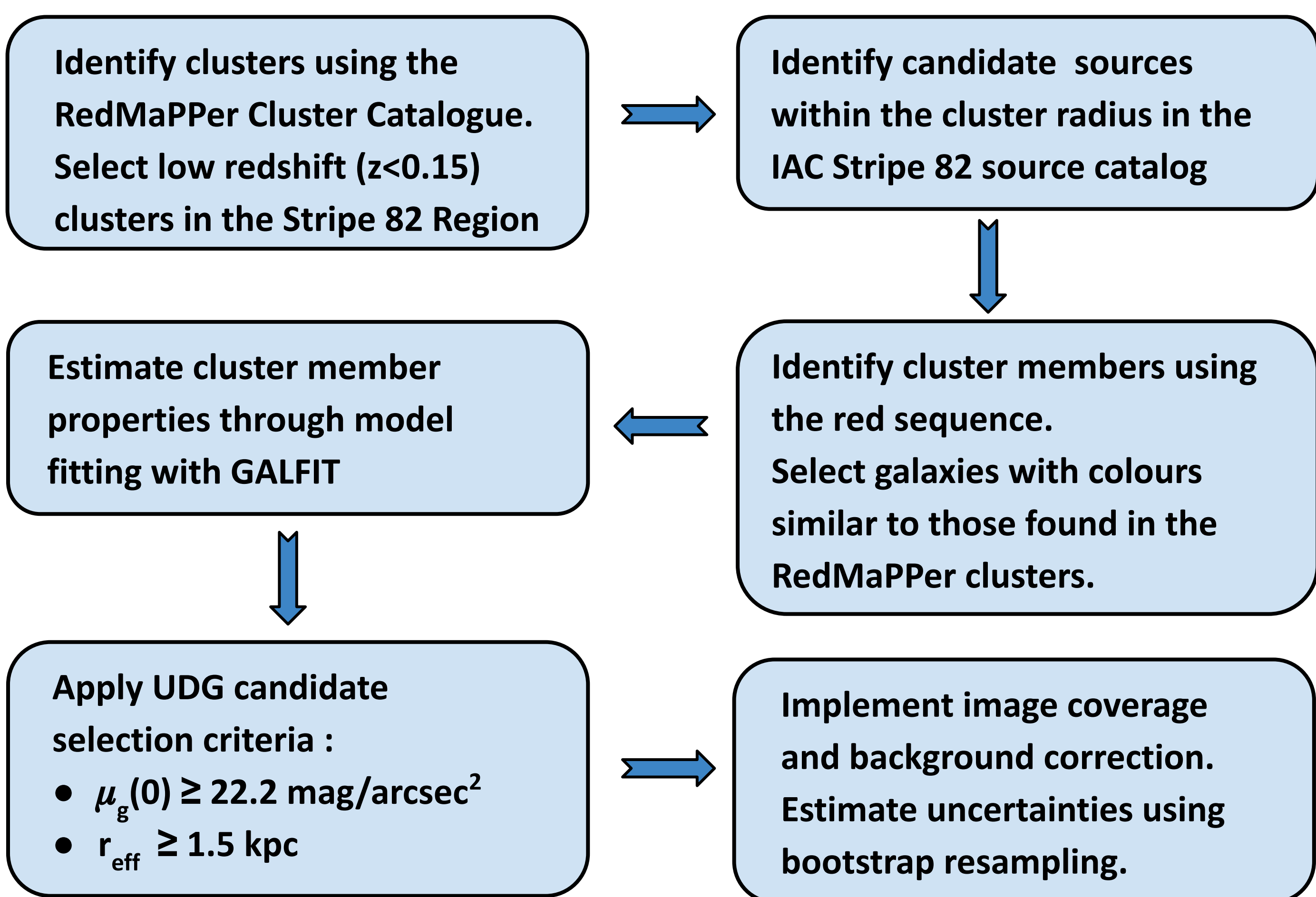$$N \propto M^{0.93 \pm 0.16}$$

Why Search for UDGs in clusters?

UDGs have been found in abundance in galaxy clusters. However, the faint and extended nature of the UDGs suggest a high susceptibility to tidal harassment and ram pressure stripping within the cluster environment. Their existence and survival in these strong tidal field environments may indicate large amounts of dark matter in UDGs. Our aim is to identify and understand the processes affecting the formation and evolution of UDGs in the cluster environment. Therefore, we searched for UDGs in Stripe 82 clusters and studied their properties. The image below shows the position of Stripe 82 relative to the Milky Way.
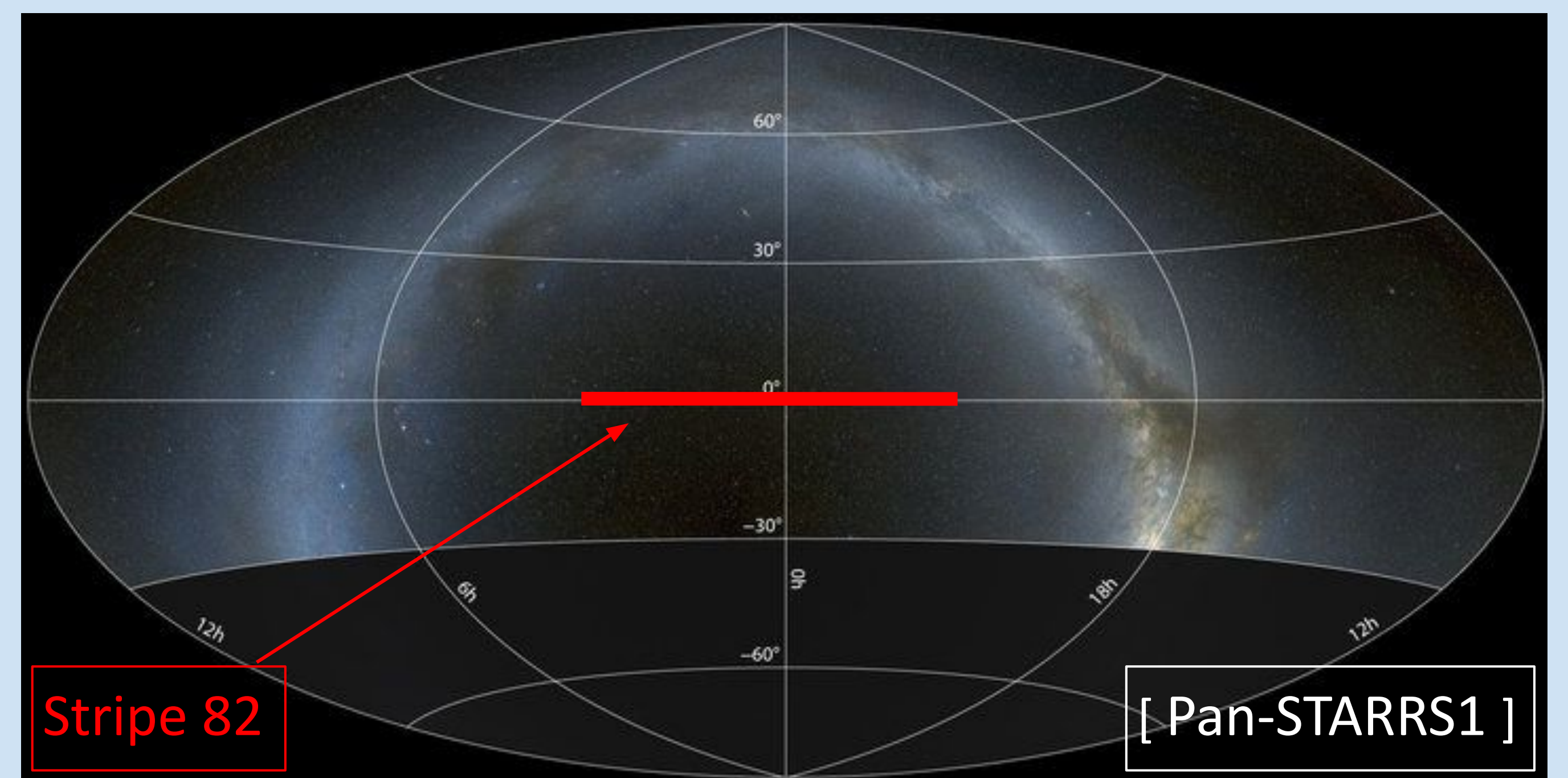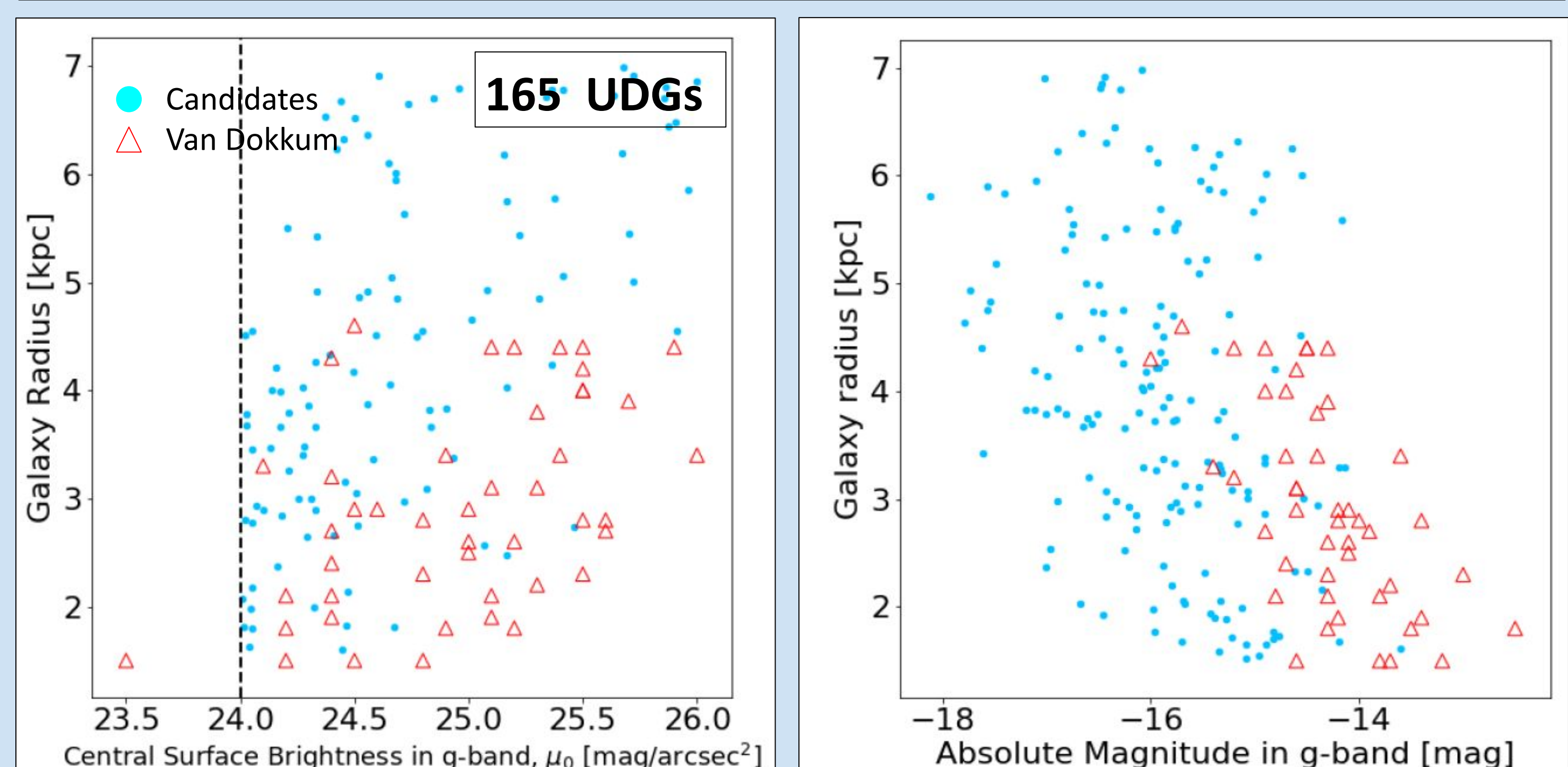
Stripe 82   [Pan-STARRS1]
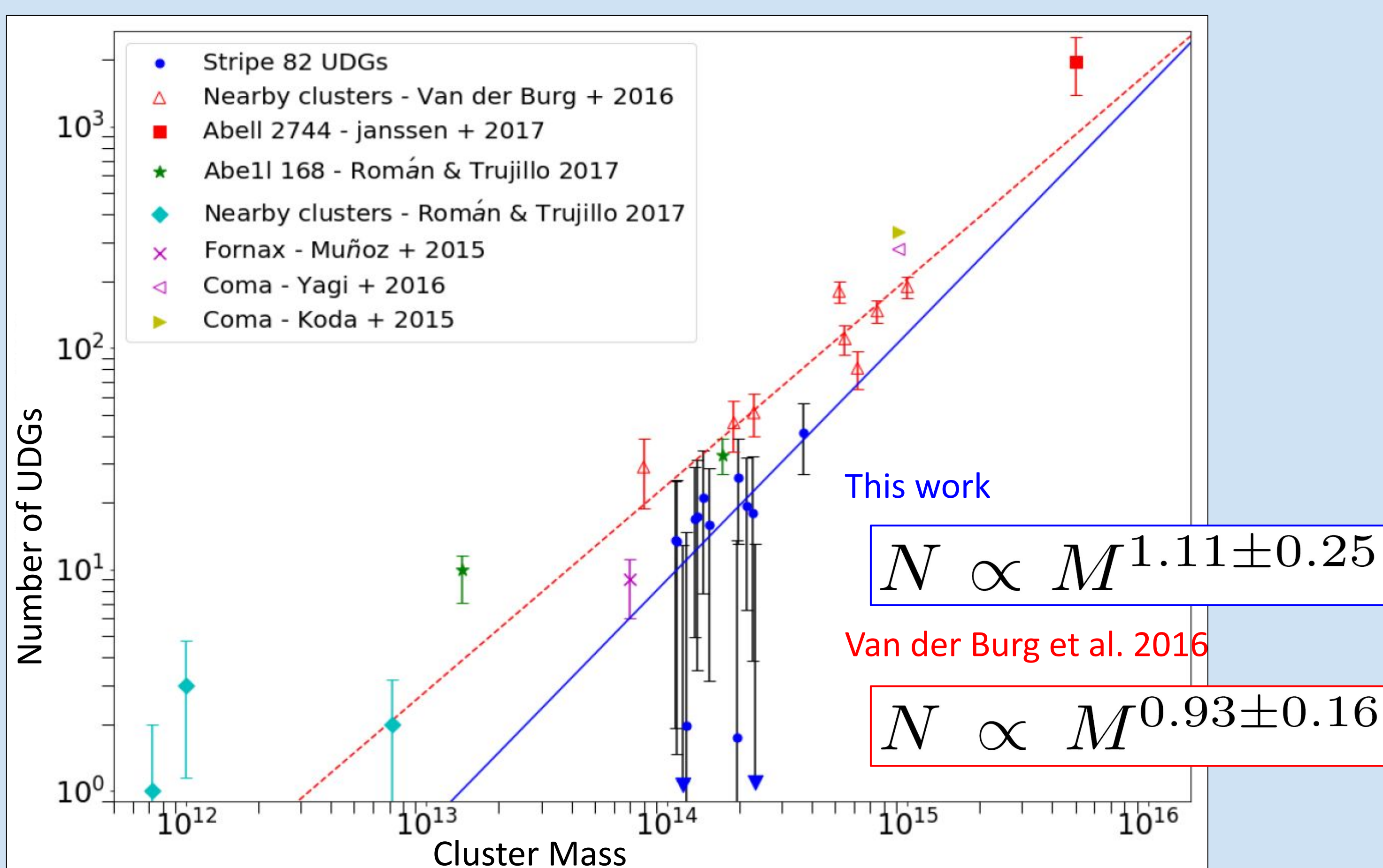
SDSS g-band image   Model   Residual

An example of the GALFIT output from one of our UDGs is shown above (UDG is indicated by the red circle).

The plots below compare the properties of our UDGs to van Dokkum et al. (2015).

165 UDGs
- Candidates
- Van Dokkum

Galaxy Radius [kpc] vs Central Surface Brightness in g-band, μ_0 [mag/arcsec^2]

Galaxy radius [kpc] vs Absolute Magnitude in g-band [mag]

Summary

- We found 165 UDG candidates in 16 Stripe 82 clusters that satisfy the UDG surface brightness and radii criteria.
- Over the redshift range (0.08 - 0.15) of our search we do not find a relation between redshift and the number of UDGs in clusters.
- The abundance of UDGs in clusters increases with cluster halo mass, $N \propto M^{1.11 \pm 0.25}$, after bootstrap resampling the trend follows as $N \propto M^{1.05 \pm 0.45}$.

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