The SC2RG Survey : Overview and case study of the stellar clumps in ARP 261

Kanto Ranaivomanantsoa[1]
1 University of Antananarivo Madagascar

KANTY ASTRONOMY Research Group

This work aims to understand star formation by studying stellar clusters and clumps in collisional ring galaxies. Using multiband Hubble Space Telescope data, a case study of Arp 261 identifies 18 young blue clumps. Comparison with Yggdrasil SSP models suggests these clumps are massive and trace recent star formation. These results provide a baseline for the full SC2RG survey.

Background

Collisional Ring Galaxies (CRGs) are rare and short-lived systems formed when a smaller galaxy undergoes a **head-on** collision with a larger disk galaxy. This interaction creates an expanding ring where **star formation is strongly enhanced, leading to the emergence of bright blue stellar clumps.** Despite their striking appearance, the physical processes driving these events are **still not fully understood.**

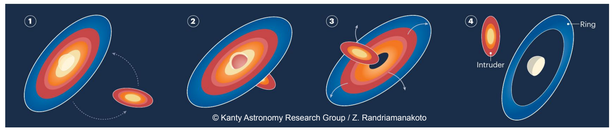
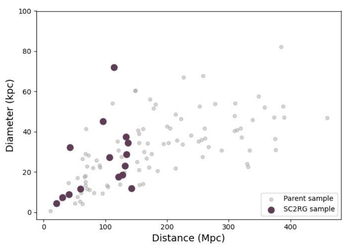


Fig 1 : A sketch of the formation scenario of a typical CRG such as the Cartwheel galaxy.

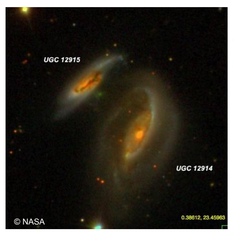
SC2RG SURVEY

SC2RG Survey is a dedicated project to **study a sample of CRGs** in order to understand SF histories and gas dynamics of systems produced by head-on galaxy collisions.

SC2RG Survey :
A representative sample of 15 southern CRGs drawn from Madore et al. (2009) CRG catalogue (see Fig in the left).



The SC2RG sample includes potential **Taffy Like Galaxies** (TLGs) which could represent earlier evolutionary stage of CRGs.



TLGs are **interacting systems** formed by **high-velocity, head-on collision** between two galaxies, characterised by a **bridge connecting the galaxies**. They are :

- **extremely rare** (<0.1% of interaction);
- **possibly evolve to become CRGs;**
- The bridge **contains large amount of gas** and is **short-lived** (<25 Myr).

Fig 2 : UGC 12914 and UGC 12915, known as the "**Taffy Galaxies"**, form an interacting pair of elongated spiral galaxies with distorted structures and a prominent bridge.

Case study : Arp 261

- ***WHY Arp 261?***
- A **nearby** (z ~ 0.006, i.e. a physical scale of 120 pc/arcsec) **Taffy-like system** with a **gas-rich, star-formation-poor bridge**
- Belongs to an **extremely rare class** of interacting galaxies.
- Hosts **numerous young star clusters and clumps**.
- A **poorly explored system**, offering strong potential to constrain **collision dynamics and evolution**.

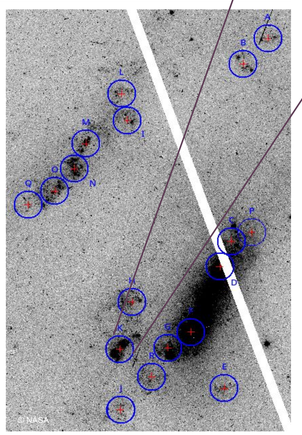


Fig 3 : *Left panel:* multiband image of Arp 261 taken with VLT. *Right:* *R*-band image of Arp 261 taken with HST/ACS. It shows the positions of the selected clumps in this work.

Clump properties of Arp 261

- At least 18 clumps
- Size ~ 0.7 kpc
- Age < 200 Myr

Our data: Multiband HST ACS & WFPC2 images

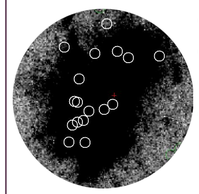
F300W, F555W, F625W, F658N, F814W

Upcoming data:

SALT/RSS slit-mask IFU

Preliminary results

The brightest clump



. PSF ~ 0.1"
. *R*-band mag: **16.9**
. **Age ~ 20 Myr**
. **Mass ~1.2✕10^6 M$_\odot$**
. A host of 16+ clusters

- Age and mass are fitted from Yggdrasil SSP models.
- **Mass range ~ 10^6 - 10^7 M$_\odot$**
- **Age range ~ 20 - 70 Myr**

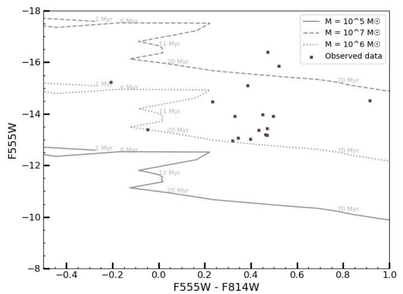


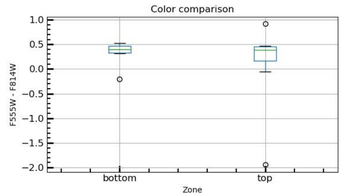
Fig 4 : Stellar clumps in a color–magnitude diagram, key ages represented by marker size.

❖ Interpretations

- Clumps are relatively young and massive
- Suggests spatial variation in SF history

Color comparison

- Similar distributions
- Stellar populations broadly comparable
- some outlier.

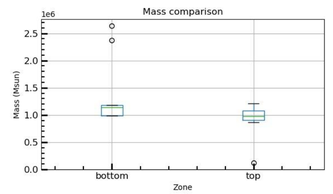


Mass comparison

- Eastern (top) zone: slightly lower median mass, some very low-mass outlier
- Western (bottom): slightly higher median mass, some very massive clumps.

Age comparison

- Top zone : larger spread, one very old outlier (~100 Myr)
- Bottom zone : ages more concentrated, generally young.



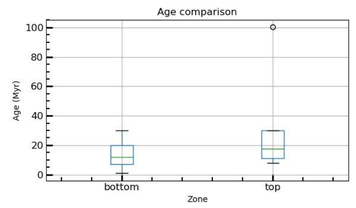


Fig 5 : Comparison of clumps properties in the *eastern* and *western* regions of Arp 261

❖ Limitations

Choice of zone →somewhat arbitrary, could modify observed trend
Photometric uncertainties →due to faint clumps
Temporal interpretation caution →bottom zones suggest recent SF but this does not guarantee a higher SFR

❖ Future works

- Systematic study of the cluster population inside and outside the clumps
- Robust age and mass modelling
- Analysis of upcoming SALT/SMI data

References : Peterson 2011, PhD thesis, Iowa State University · Kennicutt 1998, ARA&A, 36, 189 · Randriamanakoto et al. 2019, MNRAS, 482, 2530 · Peterson et al. 2018, ApJ, 855, 141 · Adamo et al. 2017, ApJ, 841, 131 · Zackrisson E. et al. 2011, ApJ, 740, 13 · Randriamanakoto et al. 2022, MNRAS, 513, 4232 · Bastian N., 2008, MNRAS, 390, 759 · Madore B. F. et al., 2009, ApJS, 181, 572