No Evidence of Enhanced Jellyfish Galaxy Incidence in Cluster Mergers.

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INTRODUCTION

Galaxies are distributed in environments with different densities, through clusters, groups, filaments, and voids glowing in the cosmic web with the most diverse shapes. Elliptical galaxies are more likely to be found in high-density environments while spirals are more commonly found in the low-density regions (Dressler, 1980). This observed dichotomy triggered the search for the physical mechanisms responsible for causing it. Nowadays, a large number of phenomena that influence galaxy evolution are known (See Boselli & Gavazzi 2006 for a review). Among those phenomena, **ram-pressure stripping** (RPS, Gunn & Gott 1972) has been proven to be one of the most efficient physical mechanisms to impact galaxy evolution inside clusters. The RPS depends on the density of the intra-cluster medium (ICM) and on the square of the relative velocity between the galaxy and the ICM. Galaxies falling into the cluster potential well have their cold gas stripped by the hot ICM leading to the formation of the gas tentacles of the iconic **jellyfish galaxies** (See Fig.1).

Figure 1. Example of jellyfish galaxy. Red shows the Hα and white shows the stellar continuum. Credit: ESO/GASP.

According to the hierarchical scenario clusters of galaxies are still on growth accreting small groups through filaments and even colliding with structures of comparable sizes. Those major mergers are the most powerful phenomena in the Universe since the big bang, releasing about 10^{64} ergs.

The idea that such energetic phenomena enhance the RPS comes both from observations (Ebeling & Kalita 2019; Owers et al. 2012; McPartland et al. 2016; Romam-Oliveira et al. 2019) and from hydro-dynamical simulations (Vijayaraghavan & Ricker 2013; Ruggiero et al. 2019; Mcpartland et al. 2016). Shocks caused by cluster collisions are capable of even inducing star formation (Stroe et al. 2015). **The impact of cluster growth on galaxy evolution is not fully understood.** None of the studies, up to date, have measured, for a large number of clusters, the incidence of RPS candidates in a homogeneous way (within the same physical radius and accounting for the infall galaxy population) classifying the clusters' dynamical state in a robust way.

In this work, **we aim to correlate the incidence of RPS candidates with a variety of available proxies of cluster dynamical stage on a large sample of clusters hosting RPS candidates from Poggianti et al. 2016 (P16).**

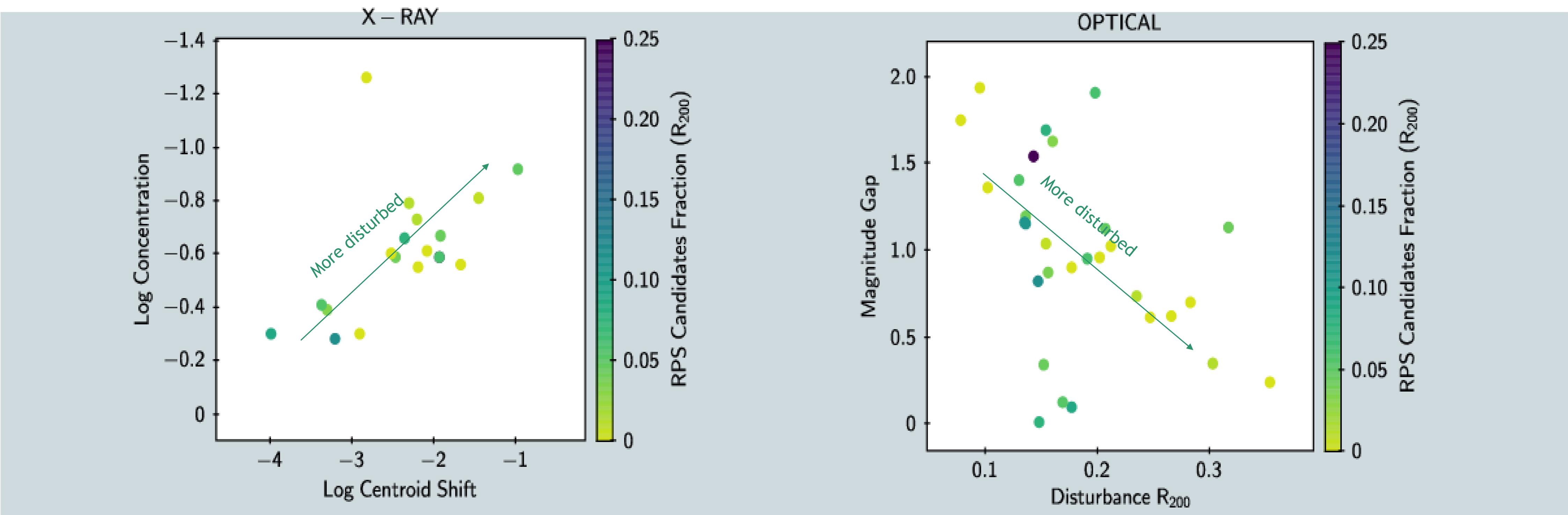

Figure 2. **Dynamical state diagnostics** from X-rays and optical. Both are colour coded by the fractions of P16 RPS candidates within R200.

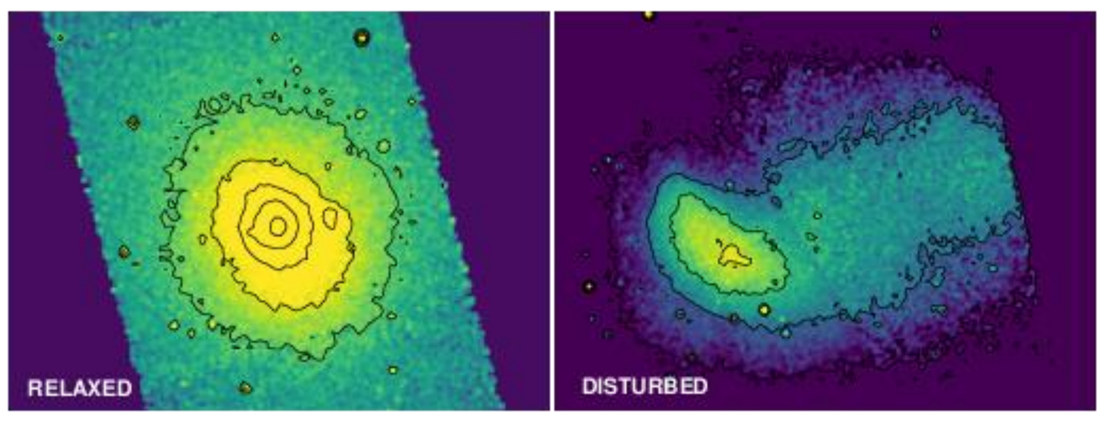

Figure 3. X-ray image examples from Chandra.

METHODOLOGY

We classify the dynamical state of 29 WINGS and OmegaWINGS clusters that have B and V photometry and are spectroscopically complete out to R_{200}. To obtain the disturbance degree of the galaxy clusters in the optical (Fig. 2, right), we use:

- The magnitude gap between the 2 brightest galaxies. Clusters that have no major mergers in recent history often have a large magnitude gap between the first and second-ranked galaxies (e.g. Jones et al. 2003).
- The disturbance parameter computed as the number of members in substructures divided by the number of members within R_{200} (from Biviano et al. 2017).

In the X-ray, we used two morphological parameters available in Yuan et al. (2020) for 18 clusters that match our criteria (Fig. 2, left). See example images in Fig. 3.

- The concentration of the surface brightness, which is usually high for relaxed clusters (e.g. Hudson et al. 2010).
- The centroid shift (difference between centroid and peak, Yuan et al. 2020), which is larger for disturbed clusters.

RESULTS

- The distribution of RPS candidate fractions in both dynamical state diagnostics in Fig. 2, indicates **no evidence of RPS enhancement in disturbed clusters (r ≤ R_{200}).**
- Dividing our sample into massive and non-massive clusters, we still found no correlation between the fractions of RPS candidates and the host cluster dynamical state.
- We built a gallery showing the X-ray peaks, optical substructures, members, blue spirals, P16 candidates, and brightest galaxies. In Fig. 4, we show an example. The dashed grey circles indicate 0.5, 1, and 1.5 R_{200}. This gallery will be available in **Lourenço et al in prep**.

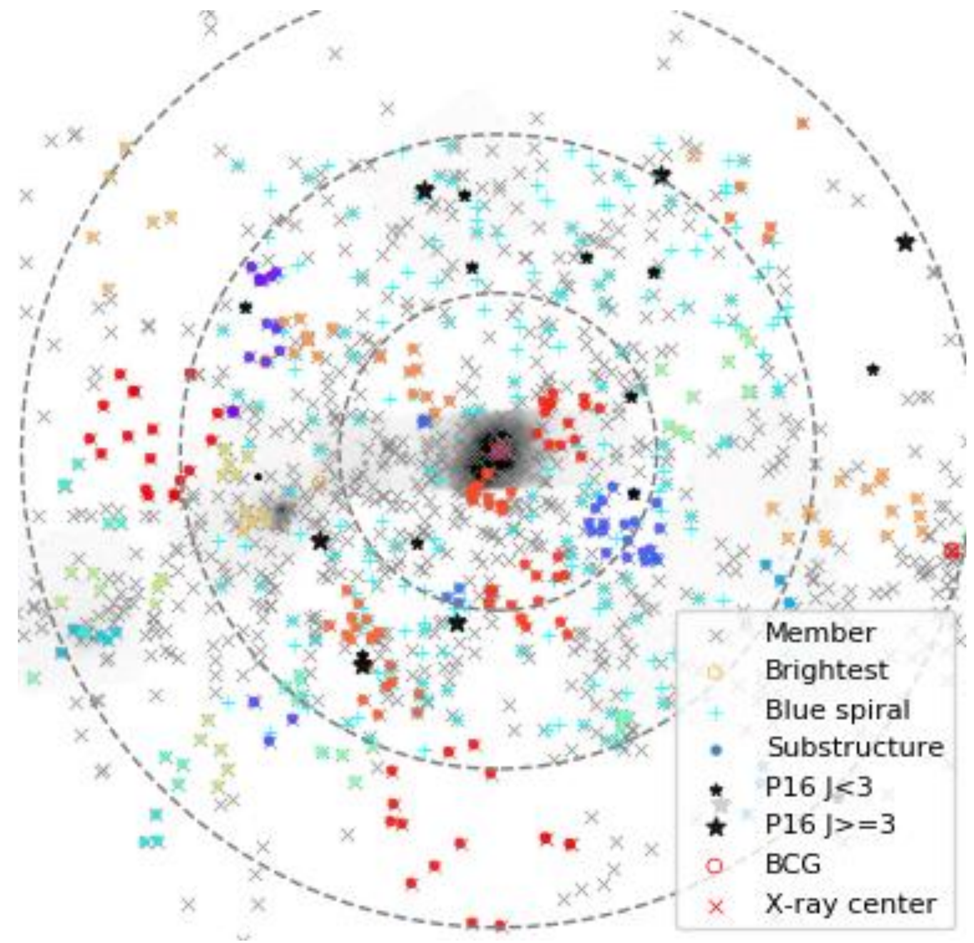

Figure 4. Example of an interacting cluster from our sample.

DISCUSSION

- Our optical and X-ray results show that **despite some focused observational studies and simulations findings that the RPS is enhanced in disturbed clusters, we did not observe this when comparing in a homogeneous way using only spectroscopic data within R200.**
- We should take into consideration that previous studies did not make the comparison in the same physical radii and also did not consider the fractions of RPS candidates with respect to the blue spiral fraction as we did.
- Our results are intriguing since in disturbed clusters we expect to have galaxies with higher velocities with respect to the ICM, and also, we expect to have higher density in the ICM due to shock fronts.
- We suspect that many factors play a role in our findings, including the possibly extended distribution of RPS candidates in merging clusters (See example in Fig. 4) and the state and intensity of the cluster merger, which we are currently analysing.

FUTURE PLANS

- To probe the results from simulations, one of our future goals is to extend the radii of our analysis.
- To analysing photometric data only, which will increase both clusters and RPS candidates samples.

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