

# Dynamically close galaxy pairs from the unWISE survey: Testing the merger-AGN-star formation connection

Chishala+2025, arXiv: 2512.19236, A&A accepted

## Intro

- Galaxy mergers: key elements in  $\Lambda$ CDM model
- Effect
  - Alter galaxy structures
  - Enhance or quench star formation
  - Trigger AGN activity
- Under debate
- Identification: Close pair vs morphology
- Sample size
- Large close pair sample with various observations including spectroscopic redshift

## Data

- unWISE survey W1(3.4um) selected catalog
- Entire sky coverage
- Less affected extinction
- Dominated old stars  $\sim$  stellar mass selection
- NED-LVS spec-z
- Pair selection
  - Limit to Box1 and Box2:  $\sim$ 1:4 mass ratio
  - $r_p$ :  $\leq 20$ , 20-50, 50-100, 100-250, 250-500, 500-1000 kpc
  - $\Delta V$ :  $\leq 500$ , 500-1000 km/s
- Number of pairs
  - Box1: 12122 (24244 galaxies)
  - Box2: 39757 (79514 galaxies)

## Multiwavelength

- GALEX NUV
- NUV-r as proxy of SF
- PanSTARRS, SkyMapper Optical
- eROSITA X-ray
- NVSS radio

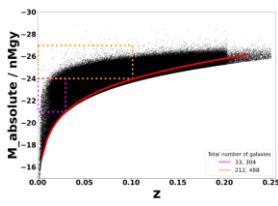


Fig. 4.  $M_{W1}$  vs. spectroscopic redshift for galaxies in our sample. The red line represents the predicted evolution for a slowly evolving galaxy with  $W1 = 14.7$  at  $z = 0$ . The violet and orange boxes define the two volume-limited samples we search for pairs in. We refer to the violet box ( $-21 < M_{W1} < -24$  and  $z < 0.03$ ) as Box 1 and to the orange box ( $-24 < M_{W1} < -27$  and  $z < 0.10$ ) as Box 2.

## Results: SF fraction

- SF fraction declines as the projected separation decreases
  - Apparent quenching reflects the somewhat denser environment?
- Flattening and rising in the closest separation regime
  - (Previous studies said that the enhancement extends to 150 kpc)
    - Shock and tidal stresses compressing the ISM
- (KK's opinion)
- SFR enhancement should also be checked.

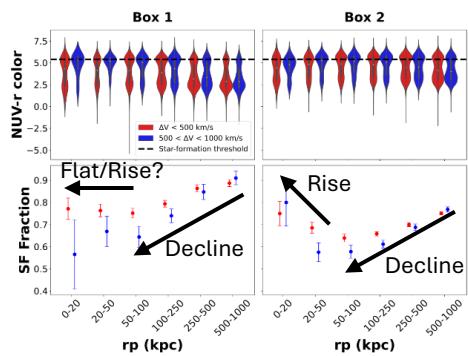


Fig. 5. Top: Violin plots of the distribution of  $(NUV-r)_0$  colours for galaxies in the lower mass sample (Box 1:  $-21 < M_{W1} < -24$  and  $z < 0.03$ ) on the left and higher mass sample (Box 2:  $-24 < M_{W1} < -27$  and  $z < 0.10$ ) on the right as a function of pair separation (on the X-axis) and velocity difference (red for  $< 500 \text{ km s}^{-1}$  and blue for  $500 < \Delta V < 1000 \text{ km s}^{-1}$ ). Note that we have slightly offset the two velocity samples for clarity. Galaxies below the dashed line are classified as star-forming. Bottom: The mean fraction of star-forming galaxies as a function of pair separation and velocity difference (same colour scheme as top panels) in Box 1 (left) and Box 2 (right). For the error bars see the text.

## Results: AGN fraction

- AGN fraction is higher in Box2 (higher mass) as expected
- Weak trend of increased AGN activity with decreasing separation
  - Secular processes are dominant as the trigger of AGN, rather than major merger, in local universe

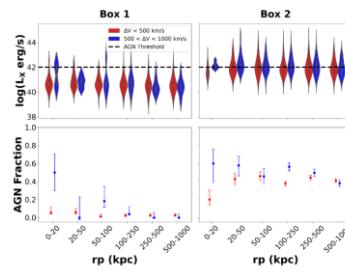


Fig. 8. Distribution of soft (0.2-2.3 keV) X-ray luminosities (top panels) with corresponding X-ray detected mean AGN fractions (bottom panels). Galaxies above the dashed line are classified as AGN. The layout of this figure is as in Fig. 5.

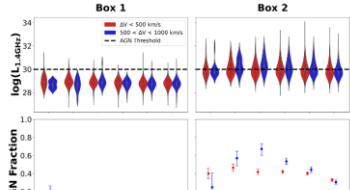


Fig. 10. Distribution of radio luminosity (top) and the mean fraction of radio-selected AGN (bottom). Galaxies above the dashed line are classified as AGN. The layout of this figure is as in Fig. 5.

## Results: Morphology

- Morphology classification
  - Class 1: Strongly interacting
  - Class 2: Weakly interacting
  - Class 3: Undisturbed pairs
- No strong evidence of SF fraction increase
- No strong evidence of AGN fraction increase



Fig. 14. Examples of strongly interacting (top), weakly interacting (middle) and undisturbed galaxies in pairs (bottom) from PanStarrs images of our sample.

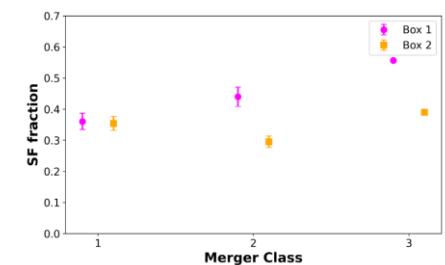


Fig. 17. Mean fraction of star-forming galaxies in strongly interacting (class 1), weakly interacting (class 2) and undisturbed (class 3) galaxies in pairs in Box 1 (violet) and Box 2 (orange) at  $r_p < 50$  kpc separation and all velocity differences. Errors are measured as in sec. 3.1.

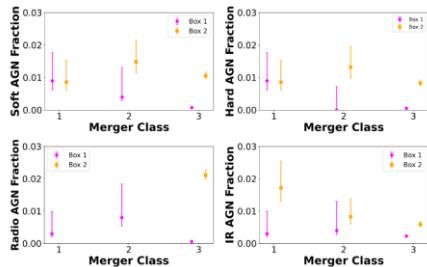


Fig. 18. Mean AGN fractions for pairs with  $r_p < 50$  kpc separation and all velocity differences, detected in soft X-rays (top left), hard X-rays (top right), radio (bottom left), and infrared (bottom right). The colour scheme and identifications of objects are as in Fig. 17.

Table 1. Number of galaxy pairs as a function of projected separation, velocity difference, and absolute magnitude range

$r_p$	Number of pairs Box 1 ( $\Delta V < 500$ km s $^{-1}$ )	Number of pairs Box 1 ( $500 < \Delta V < 1000$ km s $^{-1}$ )	Number of pairs Box 2 ( $\Delta V < 500$ km s $^{-1}$ )	Number of pairs Box 2 ( $500 < \Delta V < 1000$ km s $^{-1}$ )
< 20	355	21	403	72
20 < $r_p$ < 50	719	113	1080	318
50 < $r_p$ < 100	1181	204	1967	625
100 < $r_p$ < 250	2548	558	6072	1935
250 < $r_p$ < 500	2442	558	7969	2914
500 < $r_p$ < 1000	2685	738	11411	4991
Total number of pairs	9930	2192	28902	10855