Constraining merger triggering of AGN with Illustris

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Although integral to most cosmological models, the extent to which galaxy mergers trigger Active Galactic Nuclei (AGN) remains an open question. Identifying galaxy mergers, either by human visual classification or automated measures, is difficult due to the transience and low surface brightness of features. Measuring other parameters such as galaxy mass ratios or the time elapsed since a merger is even harder, and so robust tests of AGN triggering models remain elusive. Using Illustris [1,2], a cosmological hydrodynamical simulation, we know the information which observers typically lack. Samples of realistic mock SDSS images (at z=0) were created to test a range of possible triggering models: assuming mergers trigger AGN with some probability we can uncover what would be detected in the real universe using visual classification or structural parameters, and compare to data. We present preliminary results here.

1. Data

~400 mergers within the last 800Myr were selected using merger trees [2]. Additionally a random sample of ~2000 galaxies and a control group (~100 galaxies), containing no mergers in the last Gyr with a mass ratio < 100:1, were selected.

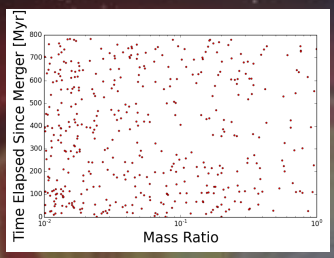

Figure 1: Distribution of merger mass ratios and the approximate times since the merger.

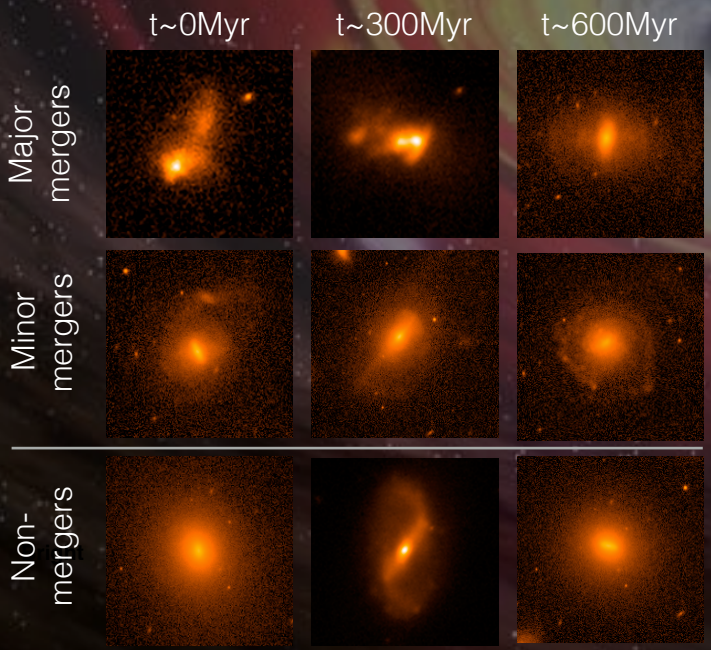

Figure 2: Examples of Illustris mock images.

2. Methodology

- Measure structural parameters: asymmetry, shape asymmetry (SA), concentration, Gini, M20.
- Enlist humans to visually classify galaxies.
- Construct a control sample with a representative fraction of mergers (~2% major, ~7% minor mergers).
- Construct an "AGN" sample with an enhanced fraction of mergers, as expected from models. An enhancement of 2 equates to twice the fraction of major mergers in the AGN sample relative to controls.
- Compare detected "AGN" merger fractions to controls, as in observations.

3. Preliminary results

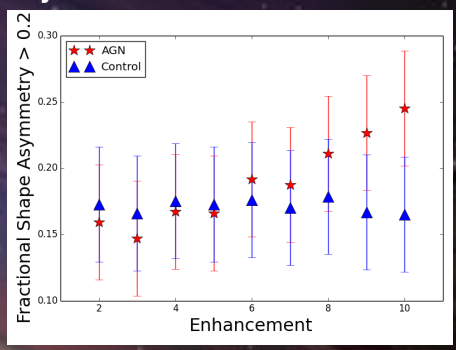

Figure 3: Fraction with SA>0.2 [3] with some enhancement factor of the fraction of mergers in the AGN sample relative to controls. SA, the asymmetry of the binary detection mask of a galaxy, is found to be the most effective of the structural parameters at detecting real merger features.

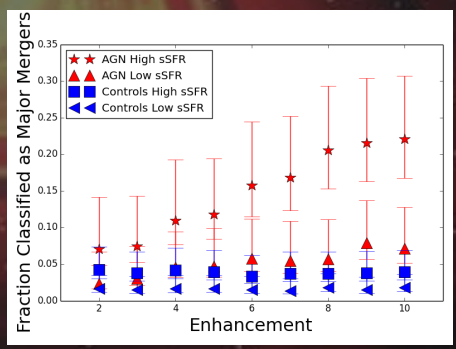

Figure 4: Fraction visually classified as major mergers, split by specific star formation rate, again with some enhancement factor as above. Observers tend to mass-match control and AGN samples; perhaps we should focus more on sSFR [4].

4. Future work

- Investigate fully the possible role of minor mergers.
- Compare directly to observations to constrain effect of mergers on the AGN duty cycle.
- Extend to higher redshifts and add AGN point sources to images.

References:

[1] Nelson et al., 2015, Astronomy and Computing, 13, 12
[2] Rodriguez-Gomez V., et al., 2015, MNRAS 64, 49
[3] Pawlik et al., 2016, MNRAS, 456, 3032