Exploring the merger-starburst connection and its impact on the observed bimodality in galaxy properties.

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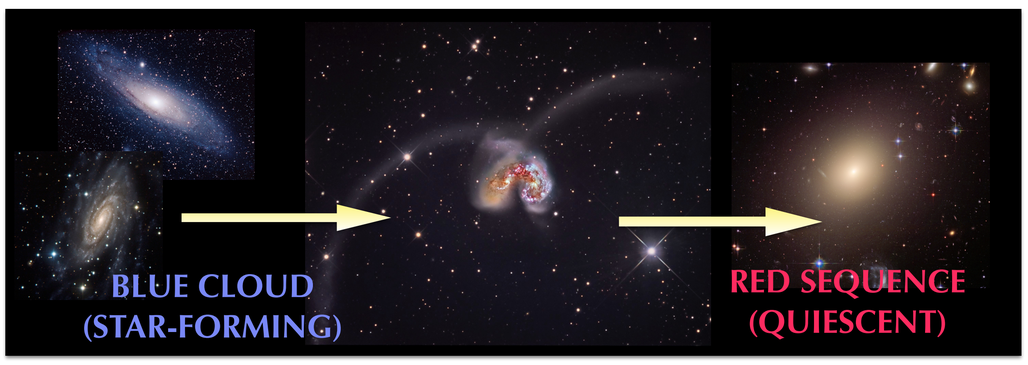
INTRODUCTION

Local galaxies can generally be classified into two families: blue star-forming systems with a rotating disk component and spiral arms, and quiescent red galaxies, with either elliptical or lenticular morphologies.

These families could be different stages of an evolutionary track. Models show that a transformation between the star-forming and quiescent mode is possible via gas-rich galaxy mergers, which can trigger centralised starbursts and, with aid of energy feedback, rid the galaxy of a significant portion of its gas supply, leading to quenching of its star formation [1],[2].



Galaxies that have undergone a recent starburst (post-starburst galaxies) could be the transition phase, during which the star formation is ceased over a timescale of ~1Gyr [3]. Many of them have been found to show signs of a recent merger [4].

QUESTIONS:

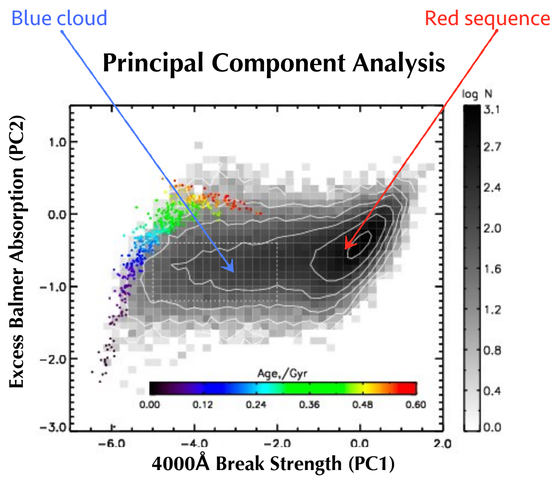
- WHAT FRACTION OF (POST-)STARBURST GALAXIES SHOW VISUAL SIGNS OF A PAST MERGER ?
- HOW DOES THE MORPHOLOGY OF GALAXIES CHANGE AS THEY ADVANCE THROUGH THE (POST-)STARBURST PHASE?
- ARE (POST-)STARBURST GALAXIES TRANSITIONING TO THE RED SEQUENCE?

SAMPLE SELECTION

Evolutionary sample of local (post-)starburst galaxies

The main features in a (post-)starburst spectrum are the Balmer absorption lines and 4000Å break strength, which are incorporated in the principal components, PC1 and PC2 [5].

These features are weak in young starbursts (high SFR, presence of O/B stars) but become more prominent as the starburst ages (A-stars become dominant).



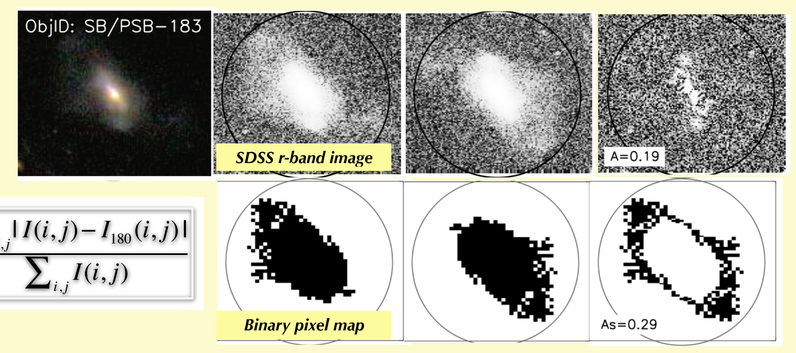
By considering the edge of the distribution in PC1-PC2, we can select a sequence of ageing starbursts. The figure shows a sample of 400 such galaxies (colour) with estimated starburst ages: t_{SB}<0.6 Gyr, selected at 0.01<z<0.07 from a bulge-dominated parent sample of SDSS DR7 [6] galaxies with spectral SNR>8 in the g-band (grey) [7].

IMAGE ANALYSIS & RESULTS

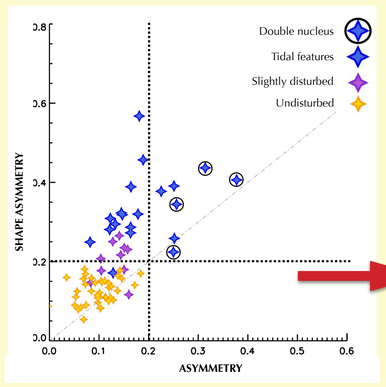
1. The origin of (post-)starburst galaxies - searching for tidal features, visual signatures of a recent major merger

Method: Shape asymmetry

- Using the standard definition of the asymmetry parameter [8], applied to a binary map of `galaxy pixels'



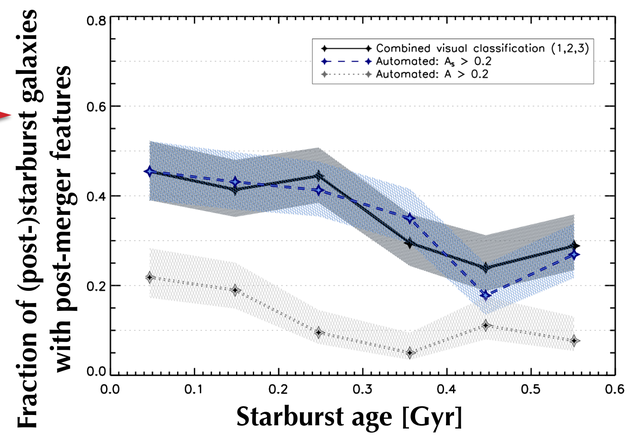
$$A = \frac{\sum_{i,j} |I(i,j) - I_{180}(i,j)|}{\sum_{i,j} I(i,j)}$$



- 180º-rotation about the light-weighted minimum-A centroid
- Analysis of a test sample shows that As>0.2 is a robust discriminant between galaxies with post-merger features and those with regular morphology [9].

Results:

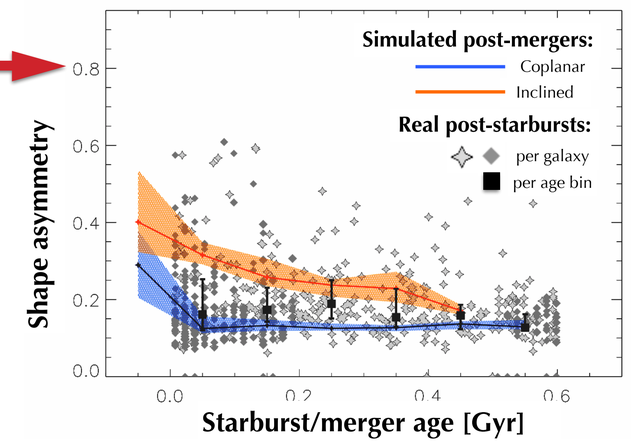
Visual and automated classification suggest that 45% of the local (post-)starburst galaxies with t_{SB}<0.1 Gyr had a recent merger, and this fraction decreases with the starburst age [9].



Comparison with merger simulations

- Equal-mass merger of Sab galaxies from [12]
- 2 cases: coplanar + inclined geometries
- Synthesis of mock SDSS images

Analysis of simulated post-mergers reveals a decreasing trend in As with the merger age, matching that found for (post-)starburst galaxies.
Simulations show that even those (post-)starburst galaxies with no visible tidal features could have had a recent merger!

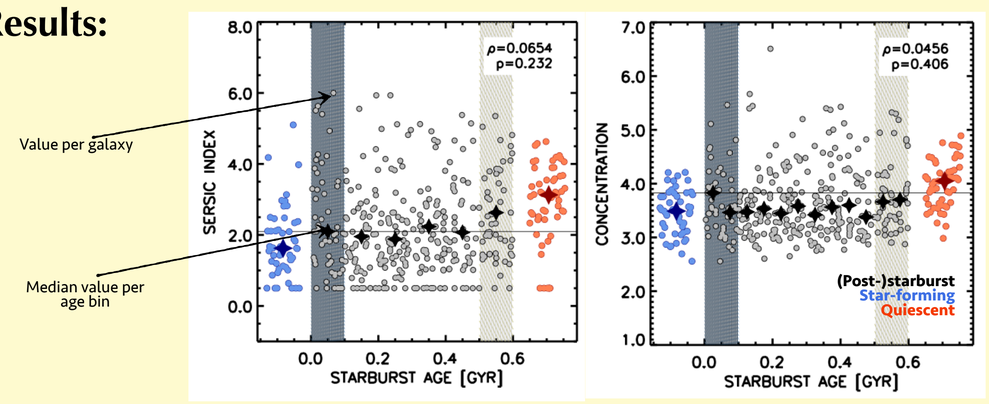


2. The fate of (post-)starburst galaxies - tracing the structural evolution following the starburst

Method: Structural parameters

- **SERSIC INDEX, n** [10] - a measure of steepness of the galaxy light profile;
- **CONCENTRATION INDEX, C** [11] - logarithmic ratio of growth curve radii defining apertures at 80% and 20% of the total light;

Results:



The lack of significant evolution in the central concentration of (post-)starburst galaxies with the starburst age suggests that they do not attain the highly concentrated structure characteristic of red-sequence galaxies during the first 0.6 Gyr after the starburst [9].

CONCLUSIONS:

- AT LEAST 45% OF THE YOUNGEST (POST-)STARBURST GALAXIES ARE LIKELY TO HAVE UNDERGONE A RECENT MERGER
- (POST-)STARBURST GALAXIES UNLIKELY TO REACH THE RED SEQUENCE DURING THE FIRST 0.6 GYR AFTER THE BURST

WORK IN PROGRESS:

- INVESTIGATING THE EVOLUTION BEYOND t_{SB}=0.6 GYR AND ITS DEPENDENCE ON THE STELLAR MASS OF THE GALAXIES
- CONSIDERING A LARGE SUITE OF MERGER SIMULATIONS

For more details see Pawlik et al. 2016

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