Investigating Merger-Induced Star Formation with Resolved Spectroscopy

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KEY TERMS

- **Integral field unit (IFU) -** device attached to a spectrograph for obtaining various spectra simultaneously of different locations in the sky (Sánchez, 2020)
- **Spaxel (spatial pixel) -** the spatial sampling element of an IFU datacube (Sánchez, 2020)
- **Star-Forming Main Sequence (Main Sequence) -** (Figure 1, left panel) thight correlation between the star formation rate (SFR) and the stellar mass (M*) of star-forming galaxies (Sánchez, 2020)
- **Resolved Star-Forming Main Sequence -** (Figure 1, right panel) thight correlation between the surface density of star formation (**Σ**SFR) and the surface density of stellar mass (**Σ**M*) of star-forming galaxies (Ellison et al., 2018)
- **△SFR -** measurement of the offset from the global star-forming main sequence. Anything above the average behavior is considered an enhancement in SFR whereas anything below it is a deficit (Figure 1, left panel).
- **△ΣSFR -** measurement of the offset from the resolved star-forming main sequence on a spaxel by spaxel basis. Anything above the average behavior is considered an enhancement in **Σ**SFR whereas anything below it is a deficit (Figure 1, right panel).
- **Effective Radius (Re) -** distance from the center of a galaxy at which half of the total flux intensity is encircled (Sánchez, 2020)

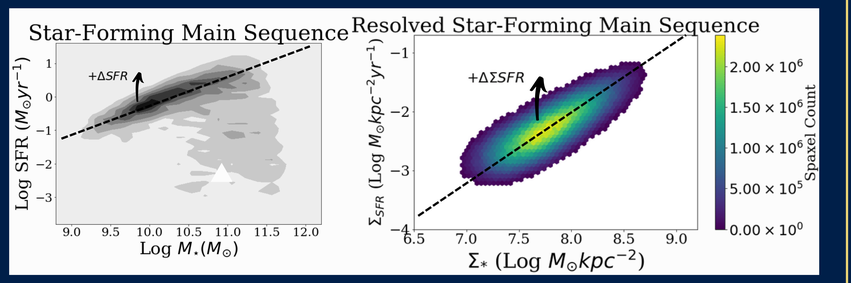

Figure 1. *Left panel:* Global star-forming main sequence of the DR17 data set. *Right panel:* Resolved star-forming main sequence of the DR17 data set colorcoded by spaxel number. The black diagonal line in both panels represents the average behavior.

To complete this work, we utilized the SFR surface densities (**Σ** SFR), the global SFR values, and stellar mass surface densities (**Σ**M*) data products from MaNGA.

SAMPLE SELECTION

Out of the 400 visually-classified post-mergers (Thorp et al., in prep.) from DR17 from MaNGA (scatter plot, Figure 2), 178 of them were classified as starburst post-mergers (i.e., post-merger galaxies that lie at least 0.1 dex above the main sequence) (red points in the scatter plot, Figure 2).

We selected isolated control galaxies from DR17 for each of the post-mergers, matching on redshift, stellar mass and △SFR, expecting a minimum of 5 controls for each of the post-mergers. 3 post-mergers were dropped due to lack of controls, leaving 175 post-merger galaxies left to study.

We divided both our post-merger and control sample into three groups based on their global △SFR values.

BACKGROUND

Galaxy mergers are very chaotic events which have been proven, using both observations (Ellison et al. 2008, Thorp et al. 2019) and simulations (Barnes & Hernquist 1991, Hopkins et al. 2013), to drastically alter the morphologies and star formation rates (SFRs) of galaxies.

Correspondingly, secular starbursts also exist, showing extreme star formation rates but no sign of a recent merger event. The aim of the project was to determine whether merger starbursts are different from secular starbursts by comparing the **△Σ**SFR radial profiles of both groups. For this work, we used the newest data release (DR17) of the SDSS Maping Nearby Galaxies at Apache Point Observatory (MaNGA) survey. MaNGA is an integral field unit spectroscopy survey, meaning that it measures spectra for multiple points within each galaxy. This data release covers around 10,000 nearby galaxies. (SDSS, 2022)

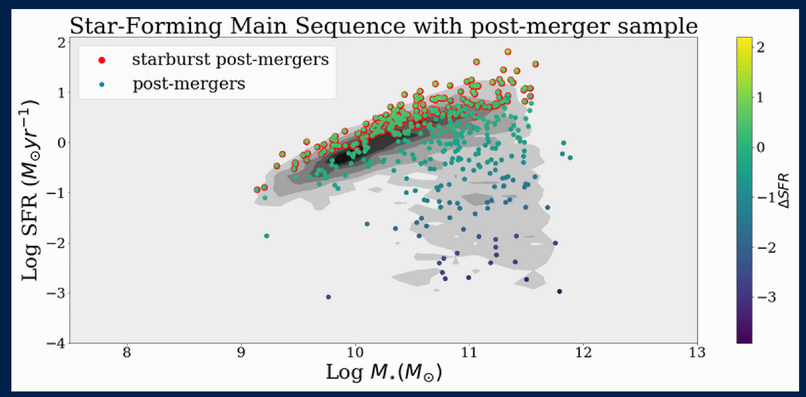

Figure 2. Global star-forming main sequence of the DR17 data set (grey contour plot), post-merger sample colorcoded by △SFR (scatter plot). Points with red outline in the scatter represent the starburst post-mergers.

RESULTS

- On average, star formation is significantly enhanced in starburst post-merger galaxies at inner radii (Figure 3, left panels).
- In spite of the great diversity within the starburst post-mergers, the central star formation boost is much greater in starburst post-merger galaxies than in isolated starburst galaxies (Figure 3, central and right panels).

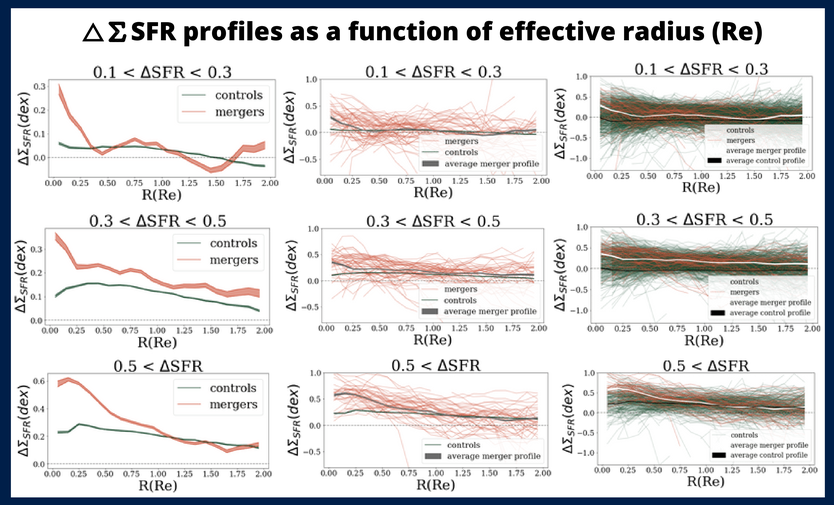

Figure 3. **△Σ**SFR profiles as a function of effective radius (Re). *Left column panels:* Average SFR distributions of the post-merger and control groups as a function of effective radius (Re) for each of the 3 △SFR groups. *Central panels:* Individual post-merger SFR radial distribution (each salmon line represents a single post-merger). *Right panels:* Individual post-merger and control SFR radial distributions (each salmon line represents a single post-merger and each green line a single control galaxy).

DISCUSSION

We quantified enhancements/deficits in SFR in 175 visually-classified starburst post-merger galaxies in MaNGA DR17. We find that galaxy mergers trigger star formation in their constituents and that post-merger starbursts have, on average, central **△Σ**SFR enhancements of ~0.2 dex and up to ~0.6 dex in comparison to the average control behavior.

Thus, starbursts created by interactions are unique in comparison to those created by secular processes. Further investigation of these mergers, in particular investigating the gas which fuels star formation, could help us better understand why merger events create such a uniquely strong starburst.

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