Spatially resolved star formation and metallicity profiles in post-merger galaxies from MaNGA

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Galaxy Mergers

- Mergers alter **morphologies**, **star formation rates** (SFRs), **metallicities**, and **nuclear accretion**
- Observational analysis requires large survey sizes given rarity of interactions
- Until recently, most surveys were limited to global values

Image Credit: ESA/Hubble & NASA

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Image Credit: ESA/Hubble & NASA

Shocks, turbulence, and compressive tidal forces can influence non-central star-formation activity

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- We need to understand the spatially resolved qualities of galaxies undergoing interactions
- **Focus on post-mergers:** clear morphological indications that interaction has occurred

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Mapping Nearby Galaxies at Apache Point Observatory

Sloan Digital Sky Survey (SDSS)
Integral Field Unit (IFU) Spectroscopy Survey

Wavelength: 360-1000 nm, resolution R~2000, z~0.03
Goal: 10,000 galaxies across 2700 square degrees
Merger studies have been limited to global surveys, where one datapoint is provided for each galaxy. This limits our understanding of how a galaxy-galaxy interaction shapes and changes a galaxy in a spatially resolved manner.

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IFU Spectroscopy

Each pixel has a spectrum (spaxel), allowing us to analyze how emission line derived quantities differ across the surface of a post-merger galaxy.

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Resolved Star-Forming Main Sequence

- Sánchez et al. 2013
- Cano-Díaz et al. 2016
- González-Delgado et al. 2016
- Hsieh et al. 2017
- Ellison et al. 2018
Resolved Star-Forming Main Sequence

For individual spaxel, want to find offset from “regular” behavior defined by star-forming main sequence.
Resolved Star-Forming Main Sequence

Match for spaxels with similar mass density

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Resolved Star-Forming Main Sequence

Within $\Sigma^*$ bin, select spaxels with similar global stellar mass
Of those spaxels, select those at similar distance from center of galaxy.
Resolved Star-Forming Main Sequence

Of those spaxels, select those at similar distance from center of galaxy

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Resolved Star-Forming Main Sequence

“Average” star-forming spaxel

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Resolved Star-Forming Main Sequence

“Average” star-forming spaxel

\[ \Delta \Sigma SFR \]
Create maps to measure enhancements/suppression in post-mergers

MaNGA ID: 8320-6104

MaNGA ID: 7992-6102

MaNGA ID: 8134-6103

Thorp et al. 2019: 10.1093/mnrasl/sly185
Ellison et al. 2018: Star-formation is boosted (and quenched) from the inside out

- Examine how $\Delta \Sigma_{SFR}$ varies for galaxies of different global enhancement/suppression in SFR

- Star-formation activity is dominated by central changes created by gas inflows

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Individual radial profile in $\Delta \Sigma \text{SFR}$ for each post-merger

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Individual radial profile in $\Delta \Sigma$SFR for each post-merger

- Variable behaviour exhibited in the outer regions

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Individual radial profile in $\Delta \Sigma SFR$ for each post-merger

- Variable behaviour exhibited in the outer regions
- Both enhanced and suppressed SFR observed

Thorpe 2019

Thorpe et al. 2019: 10.1093/mnrasl/sly185
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Moreno et al. 2015
Individual radial profile in $\Delta \Sigma SFR$ for each post-merger

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Individual radial profile in $\Delta \Sigma \text{SFR}$ for each post-merger.

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- Both enhanced and suppressed SFR observed
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Thorp et al. 2019: 10.1093/mnrasl/sly185
On average, post-mergers experience central burst in star-formation rate as expected, but also exhibit SFR enhancement out to 2 effective radii.

Thorp et al. 2019: 10.1093/mnrasl/sly185
Individual radial profiles in $\Delta\text{O/H}$ for each post-merger

Thorp 2019

Thorp et al. 2019: 10.1093/mnrasl/sly185
On average, post-mergers experience are consistently suppressed in metallicity across the galaxy’s surface.

Thorpe et al. 2019: 10.1093/mnrasl/sly185
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Summary

- Post-Mergers exhibit a central burst in star-formation, with lesser enhancement out to 2 effective radii.
- Metallicity in Post-Mergers is consistently suppressed.
- There is more variable behaviour at the outer edges of post-mergers to be further examined.
- Thorp, M. D., Ellison, S. L., Simard, L., Sánchez, S. F., & Antonio, B. 2019, MNRAS, 482, L55.