Investigating the Star Formation History of Local Interacting Galaxies

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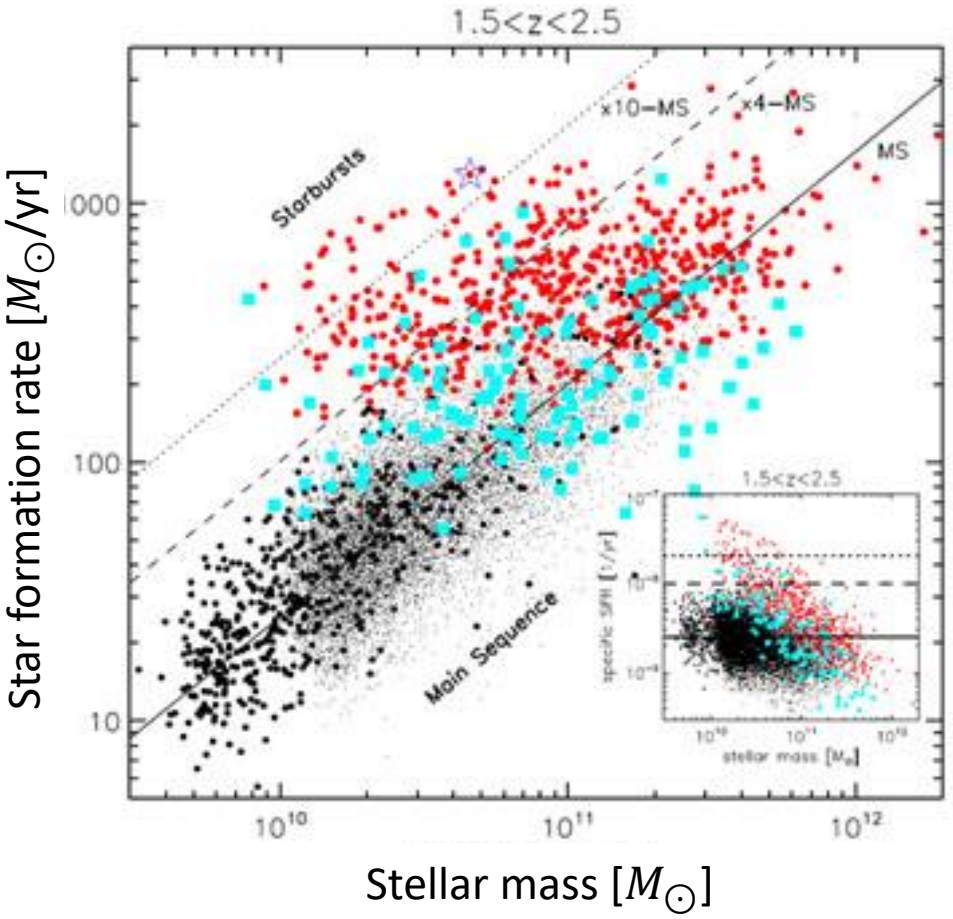
Introduction/Motivation

- Galaxy interactions can cause starbursts and star formation
- Galaxies that are starbursting on the right diagram can be mergers
- Is the high star formation rate actually caused by interaction?

Rodighiero et al. (2011)



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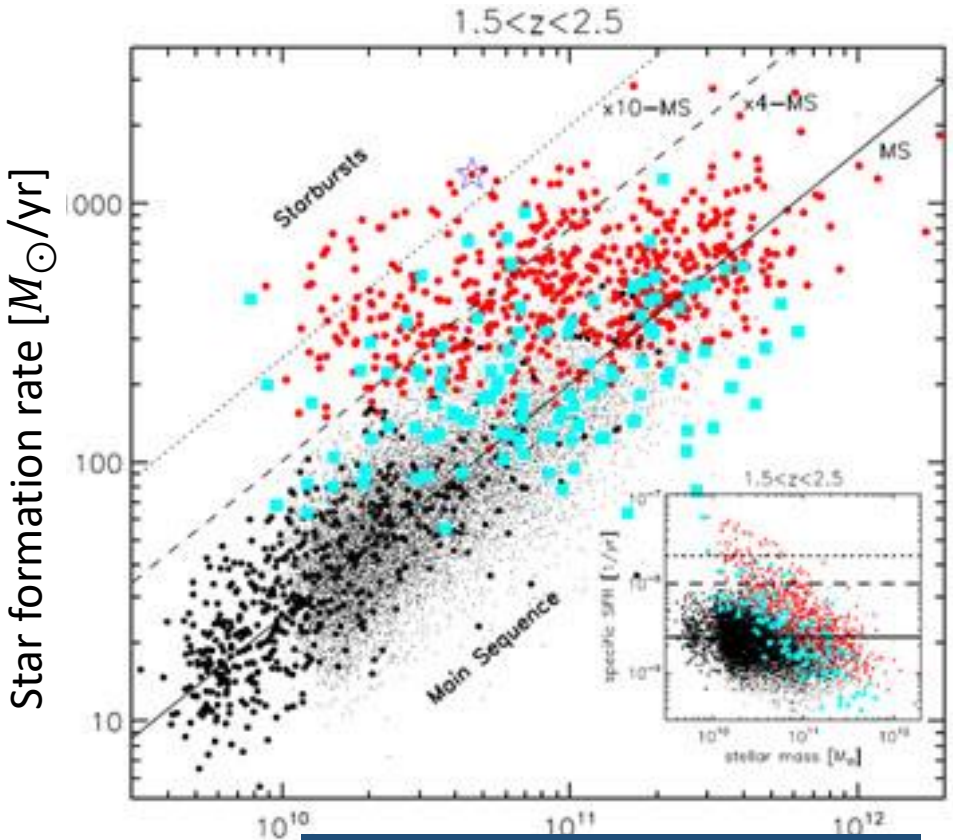
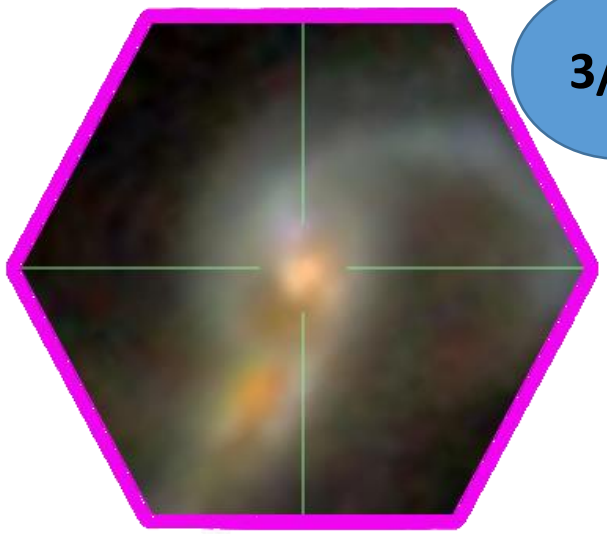


It is necessary to study SFH!

MaNGA – Spatially Resolved Properties

- Mapping Nearby Galaxies at APO (MaNGA) Catalogue
- Maps detailed composition and kinematic structure of nearby galaxies
- 2-D maps of various physical properties



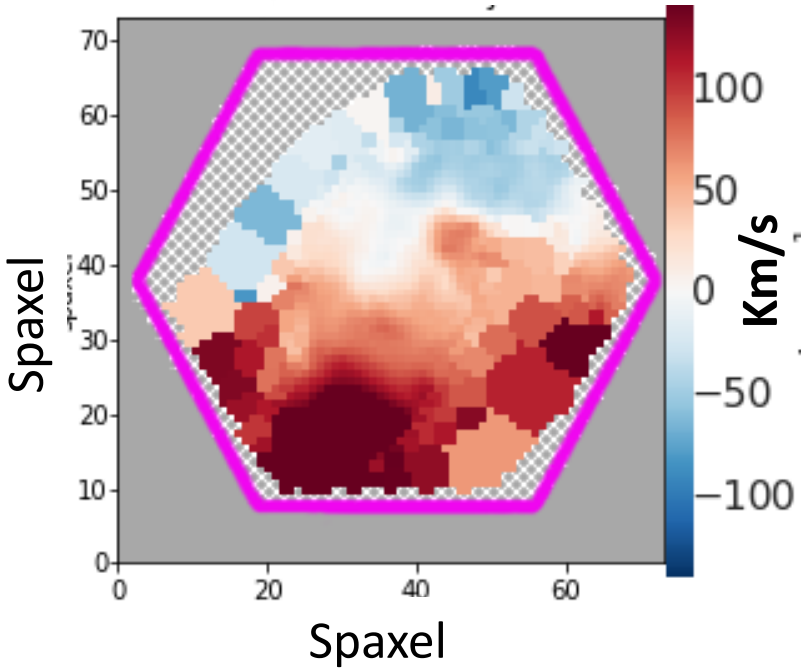
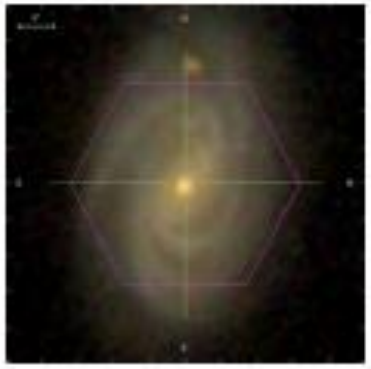
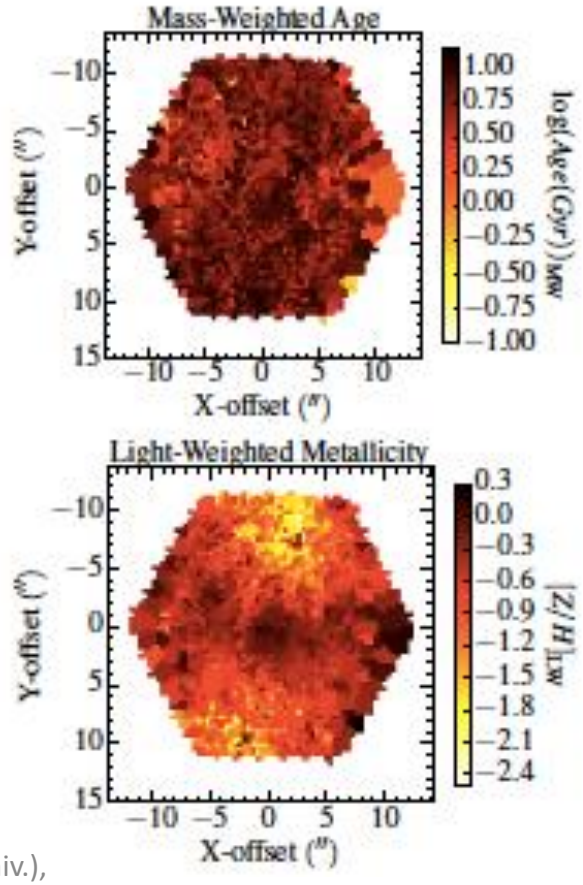


Image and Stellar Velocity Maps of MaNGA 7443-12703

MaNGA FIREFLY VAC – SED Fitting



- MaNGA FIREFLY VAC (Goddard et al. 2017)
- Conducts spectral energy distribution (SED) fitting on spatially binned spectra using the FIREFLY (Wilkinson et al. 2017) code
- Provides measurements of spatially resolved stellar population properties such as age and metallicity



Goddard et al. (2017)

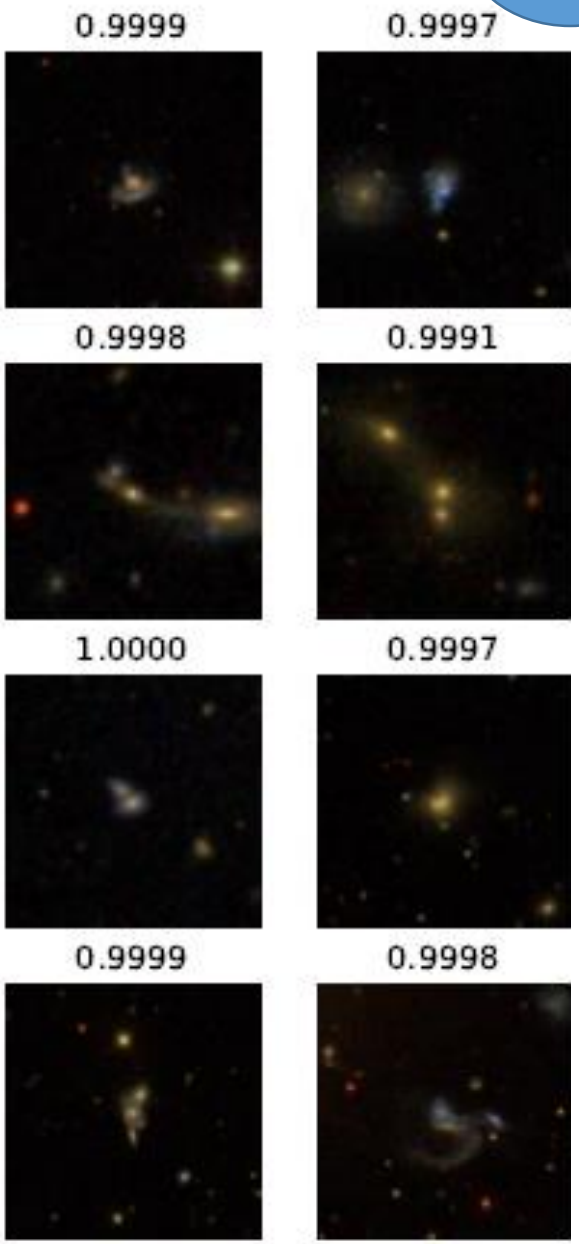
Identification of Interacting Galaxies

- We have identified interacting galaxies using **space.ml :: Transfer Learning – Using transfer learning to detect galaxy mergers** (Ackermann et al. 2018)

- 2 step method to identify galaxies
  - **Transfer Learning**
  - **Convolutional Neural Networks (CNN)**

spaceML

- Model is pre-trained using IMAGENET (Deng et al. 2009)
- Model is re-trained using *Galaxy Zoo* (Darg et al. 2010) as training data
  - Training Set – stratified sample from 3003 GZ mergers and 10000 random non-mergers
- Outperforms previous methods in identification



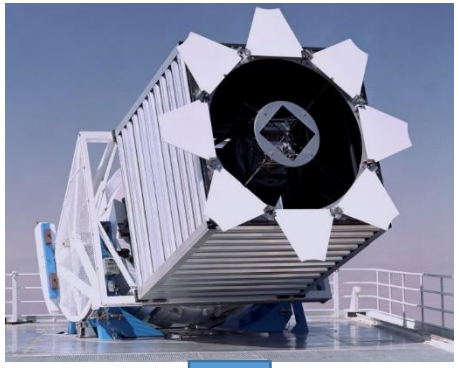
Ackermann et al. (2018)

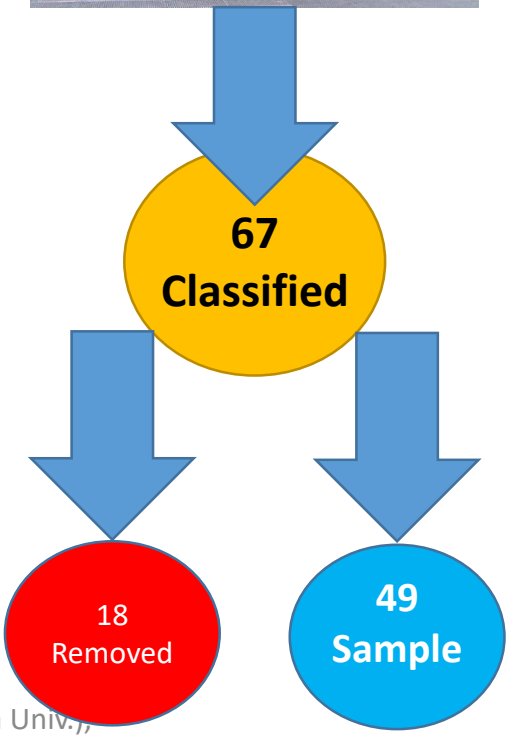
Target Selection

- We have used this model on images of MaNGA FIREFLY VAC galaxies

- 4675 galaxies in the catalogue
  - 67 interacting objects
    - 18 Removed
    - **49 interacting < - Our focus**

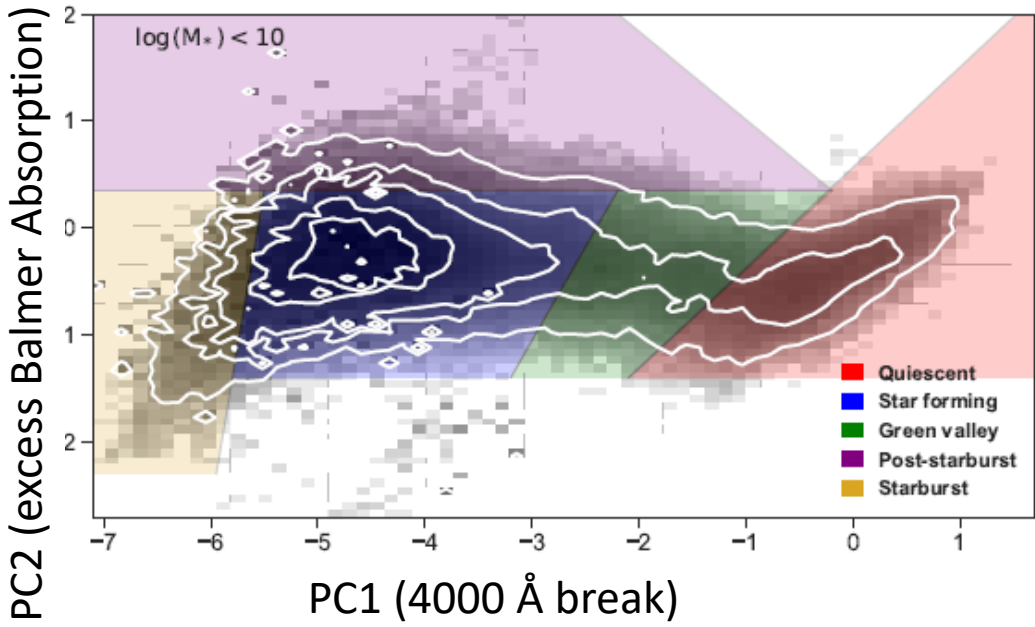
https://www.sdss.org/instruments/





Where are the galaxies building mass?

- We have used the PCA method taken by Rowlands et al. (2018)
  - Apply PCA on galaxy optical spectra of spatially resolved spaxels in MaNGA catalogue
- Follows the method in Wild et al. (2007)
  - PC1 – related to strength of 4000 Å break
  - PC2 – total excess Balmer absorption



Rowlands et al. (2018)

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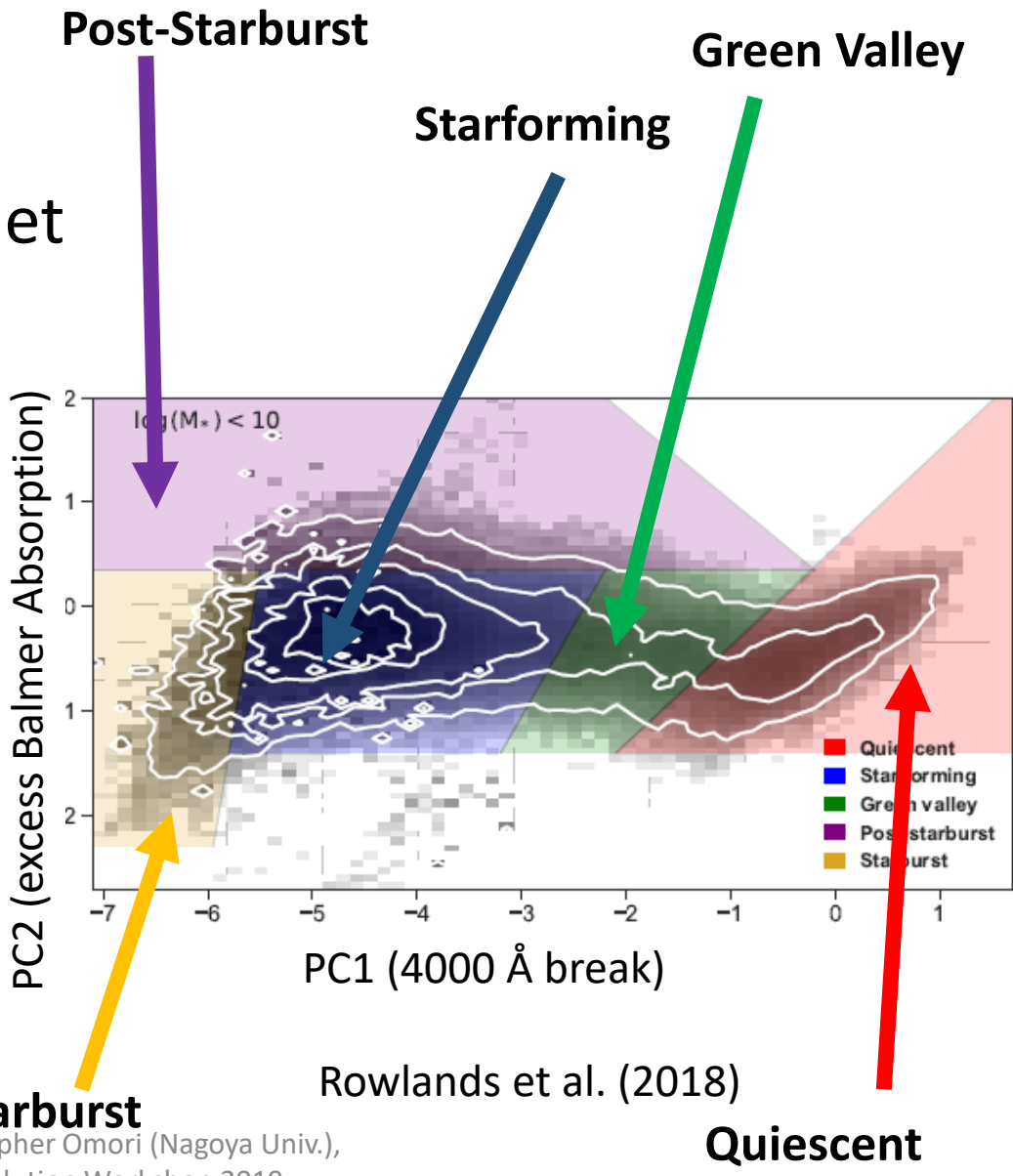
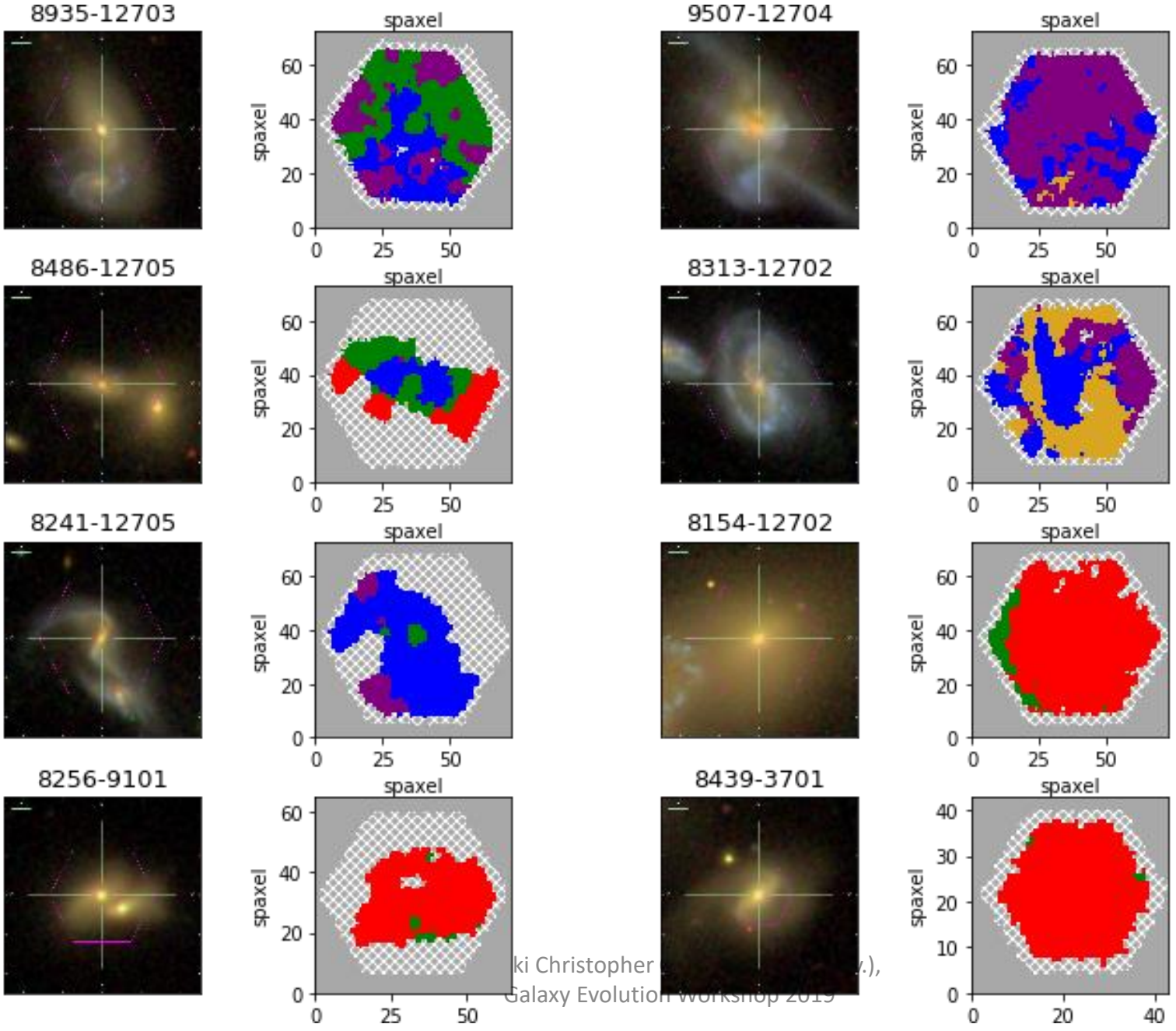


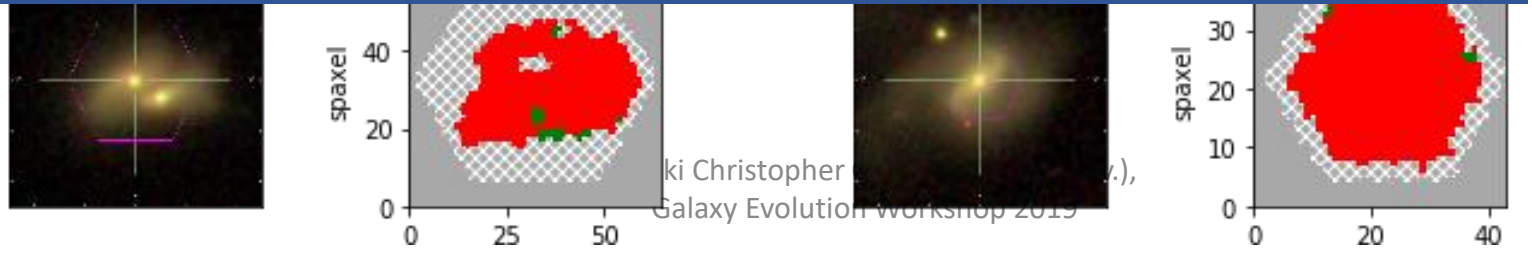
Some Results of PCA



Some Results of PCA

GENERAL OBSERVATIONS:

- Galaxies show increased star formation in **interacting** regions
- No conclusive “trend” or “relation” as interacting galaxies are all different
- We will focus on a particular galaxy for this presentation



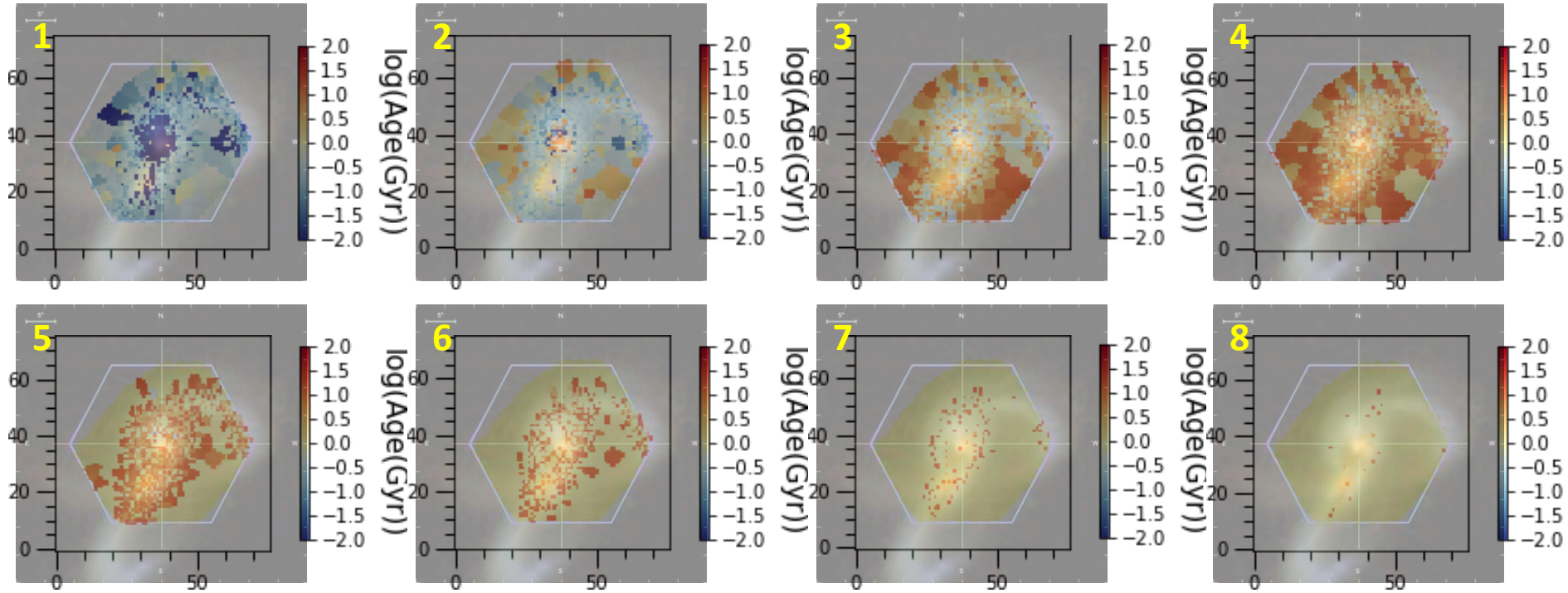
MaNGA 7443-12703

- Mrk 848
- $z \cong 0.049$
- Binary AGN and SF-composite pair (Fu et al. 2018)
- Two cores are approximately 4.9 kpc apart (HST)
- Thought to be in process of merger (HST)

https://www.spacetelescope.org/images/heic0810bw/

MaNGA 7443-12703 – SFH

- We have obtained SFH using MaNGA FIREFLY VAC



- We have plotted the spatially resolved stellar ages, from youngest (top left) to oldest (bottom right) (Note:Not all regions require 8 SSPs to resolve!)
- It can be seen that there exists recent star formation episodes, particularly in **interacting** locations, as shown by the **blue** patches in the top left plot

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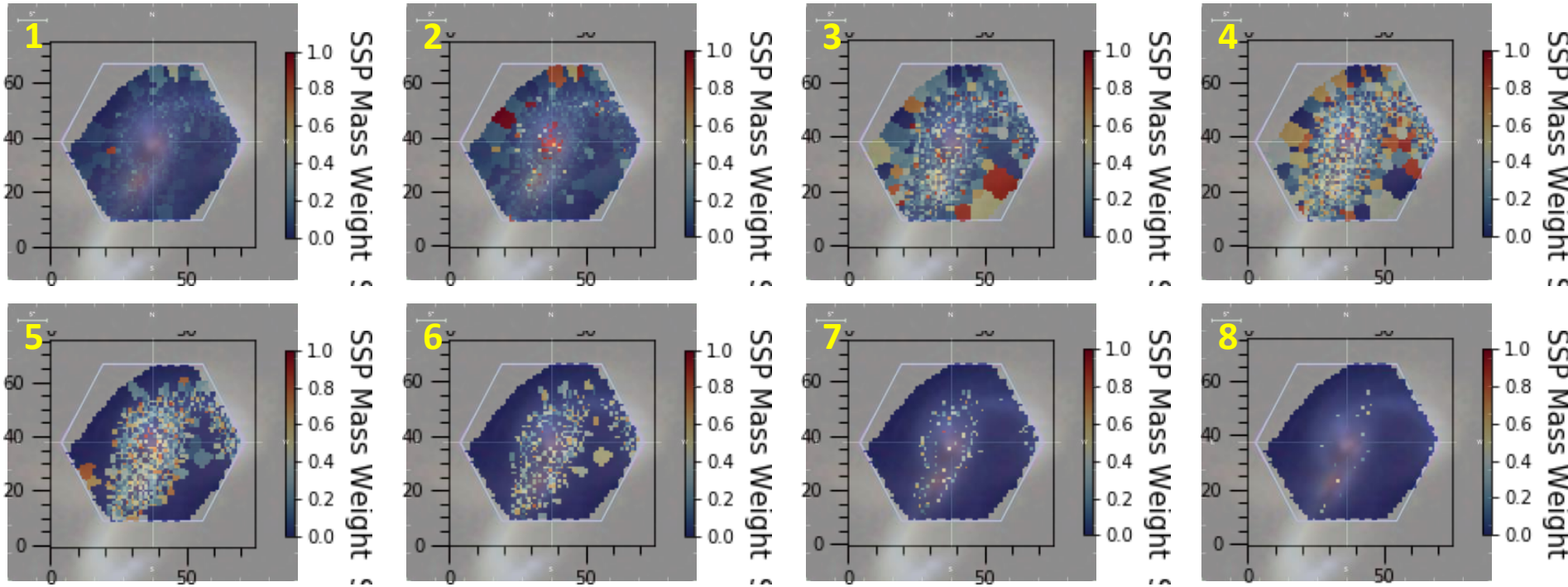

- This plots the mass-weighted contribution of each SSP for each region, with **blue** regions having very little contribution and **red** regions having a high contribution

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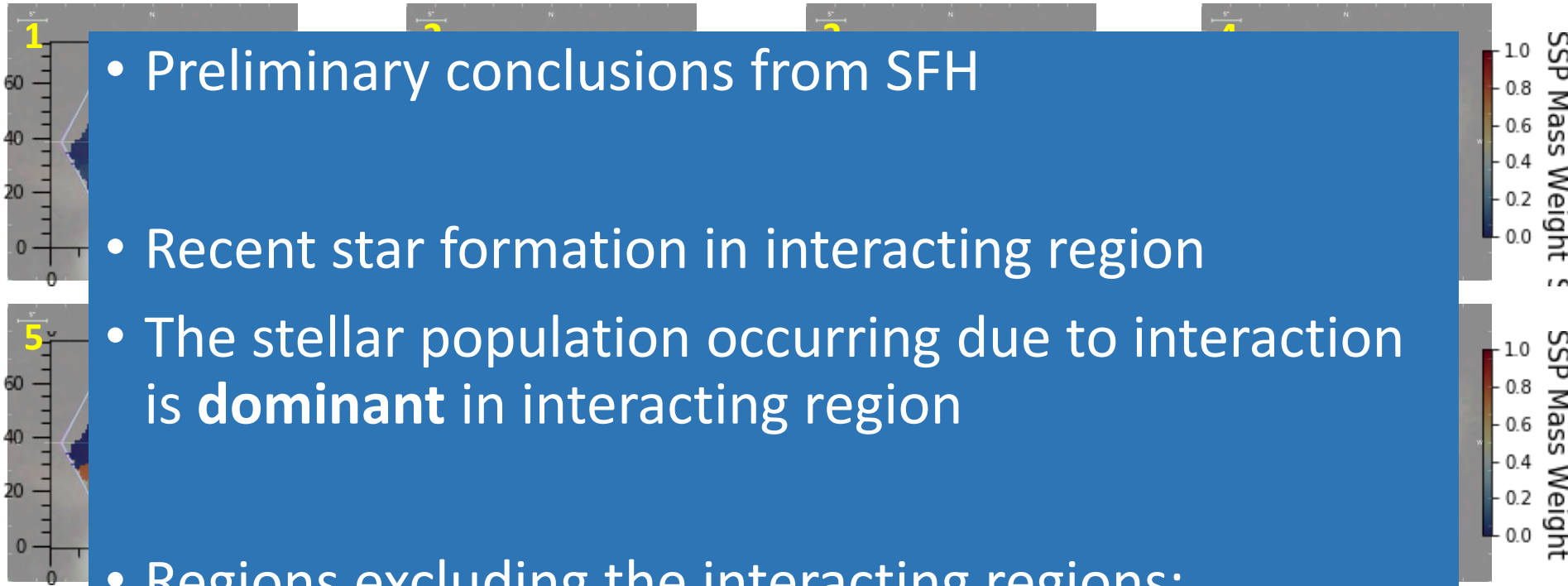
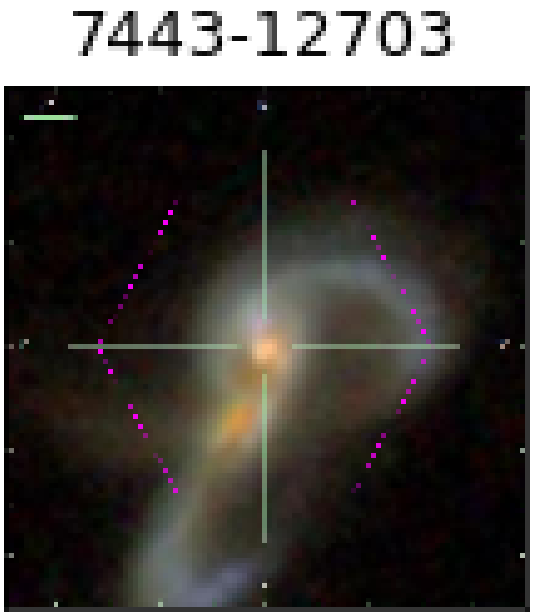
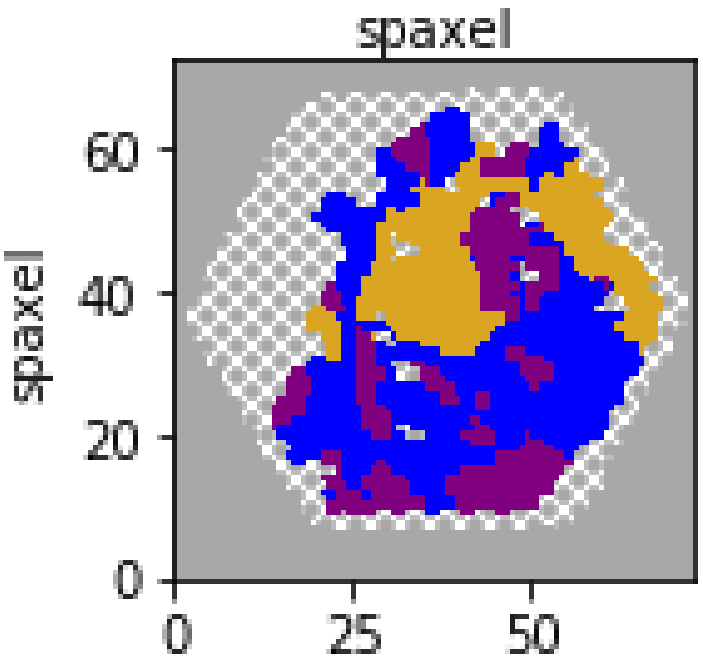


- Preliminary conclusions from SFH
- Recent star formation in interacting region
- The stellar population occurring due to interaction is **dominant** in interacting region
- Regions excluding the interacting regions:
  - Can be resolved using less SSPs
  - Dominant stellar population is older

- This
  blu

MaNGA 7443-12703 – PCA Results





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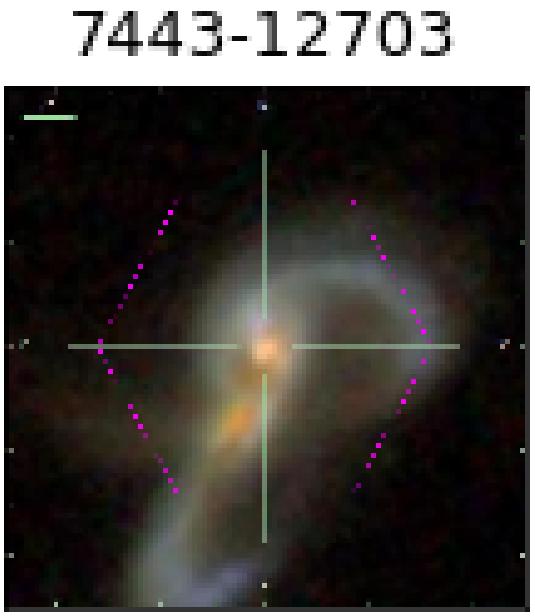

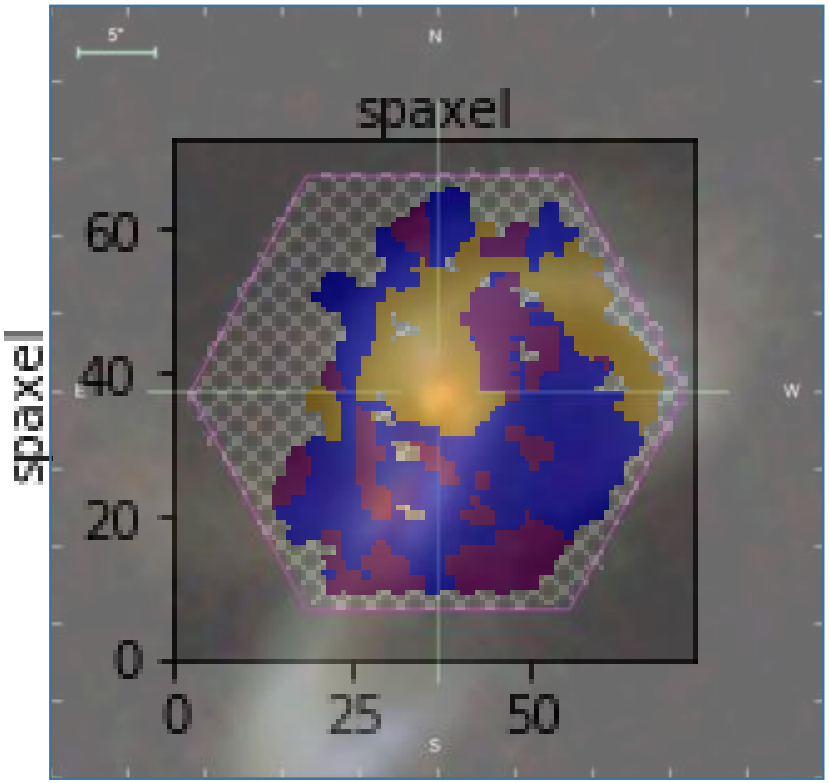

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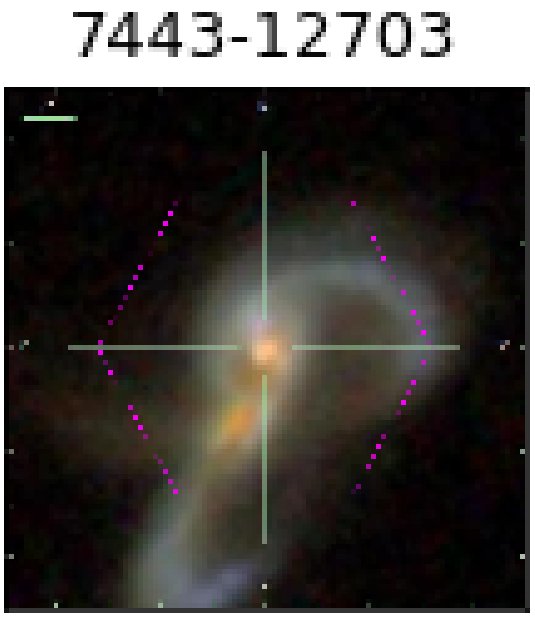
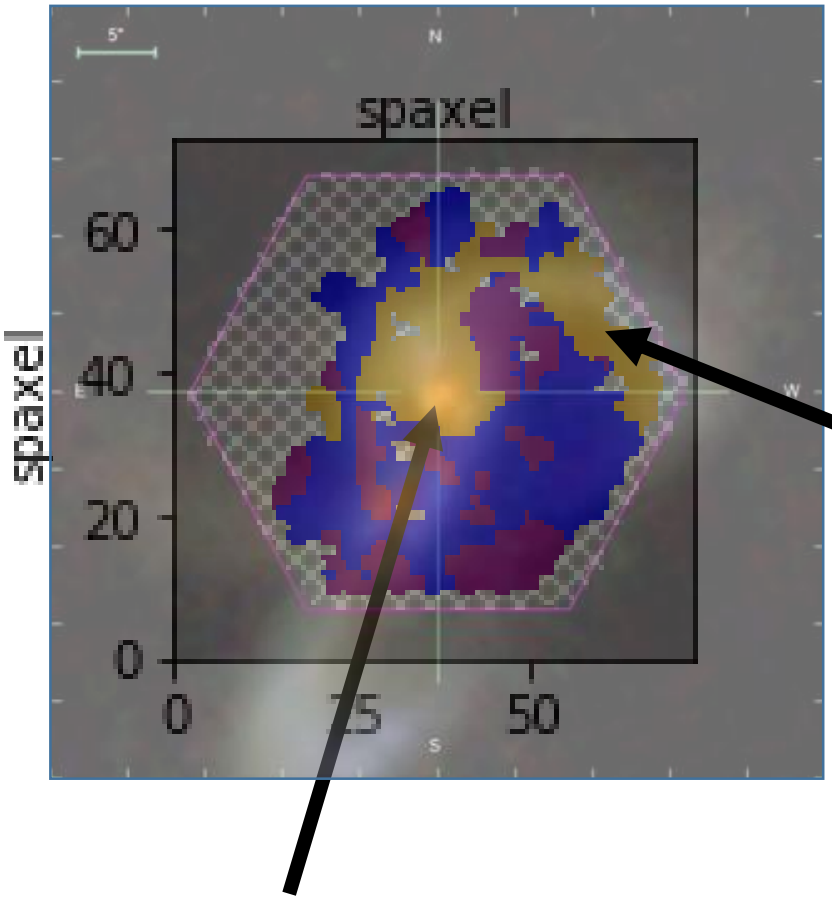
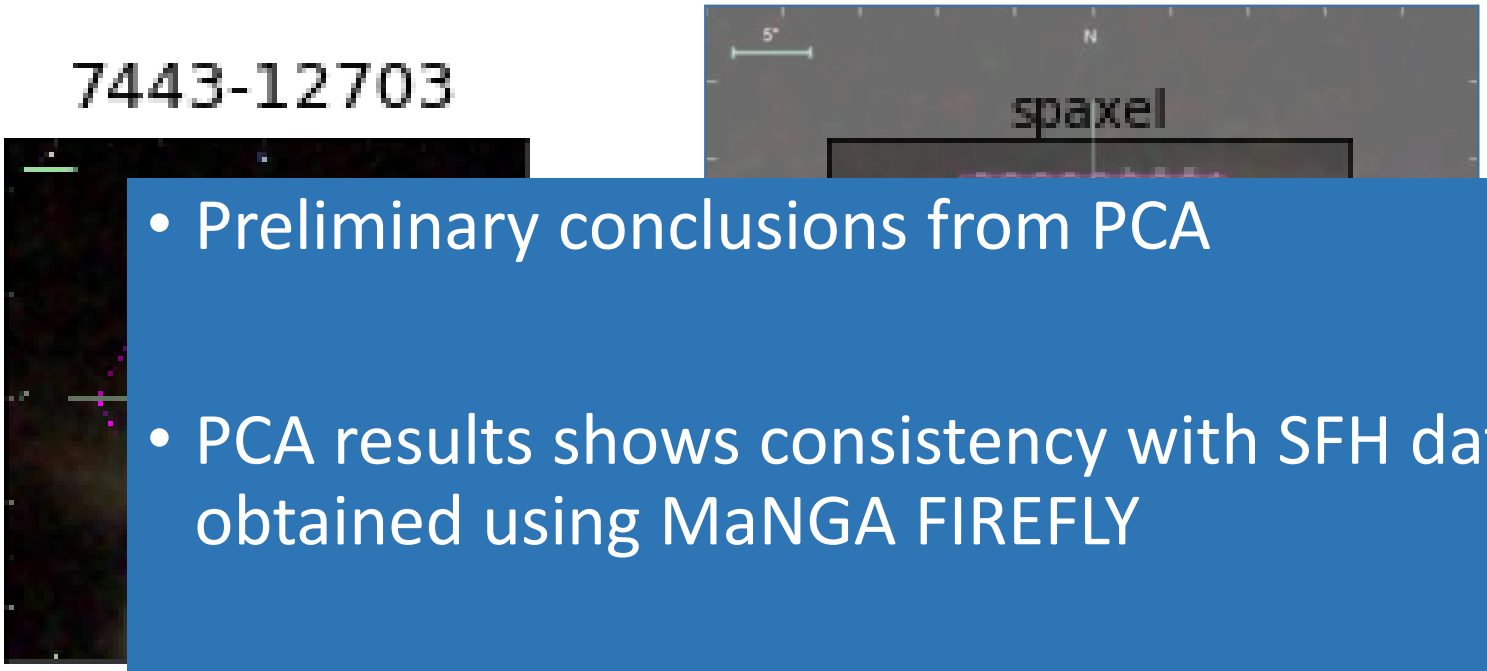




Starburst here as well…what process here?

Starburst in interacting region

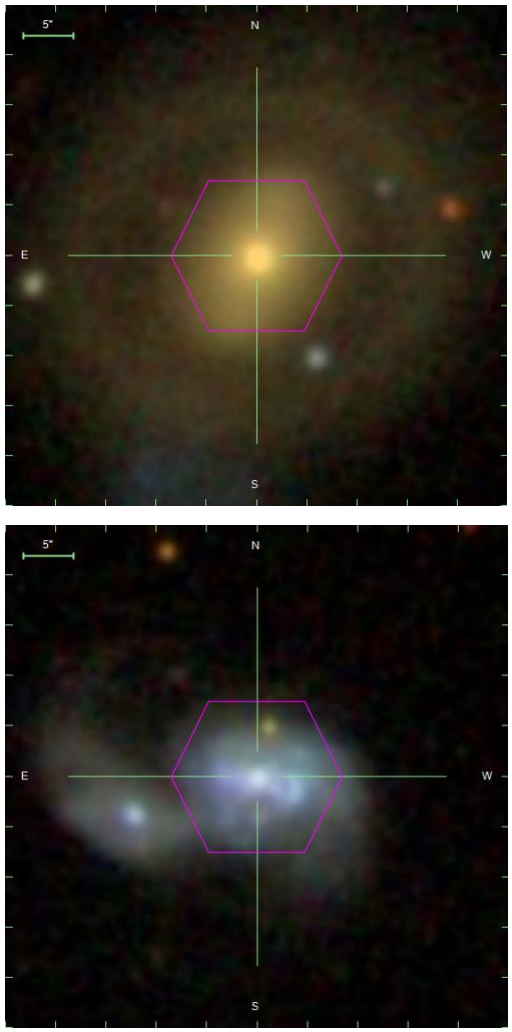
MaNGA 7443-12703 – PCA Results



- Preliminary conclusions from PCA
- PCA results shows consistency with SFH data obtained using MaNGA FIREFLY
- However there exists another starbursting region
  - Other data will be required for further analysis

Issues

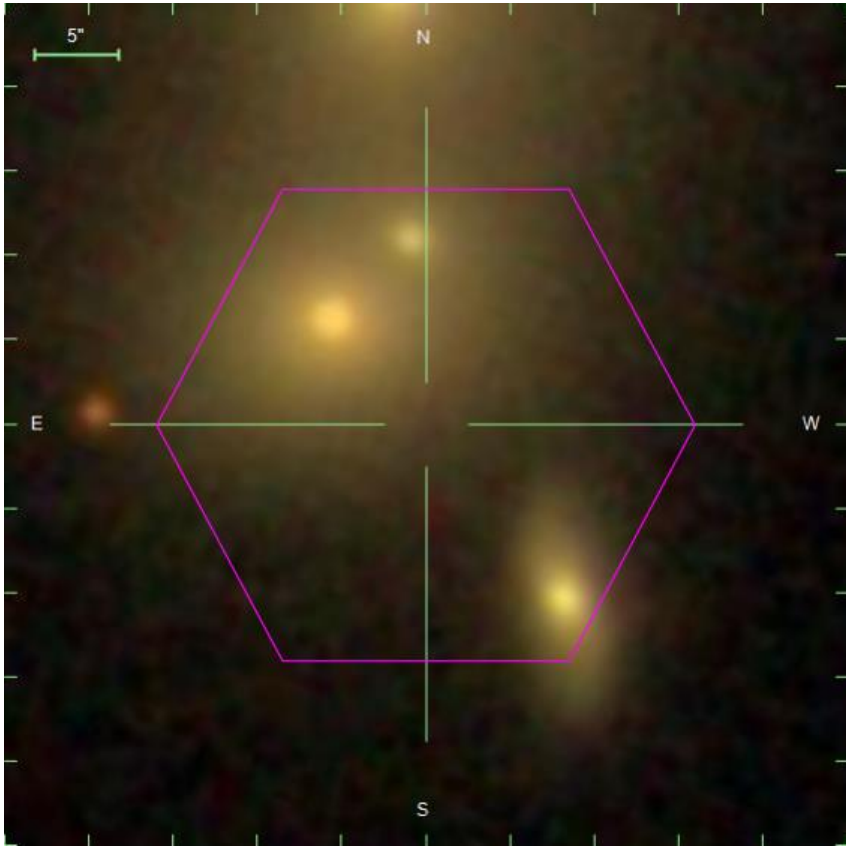
- Issues with CNN
  - False Positives and False Negatives – classification is still questionable on accuracy
  - Is transfer learning really the most efficient?
- Issues with PCA
  - PCA itself is a WIP – edge-on galaxies have poor results,
    not all data is reliable
  - Inconsistencies with PCA and observational data



False Positive (Above) and False Negative (Below) classified galaxies

MaNGA 8568-12704 – Inconsistent

- Example of inconsistent data
- MaNGA *r*-band shows no observation in bottom left region



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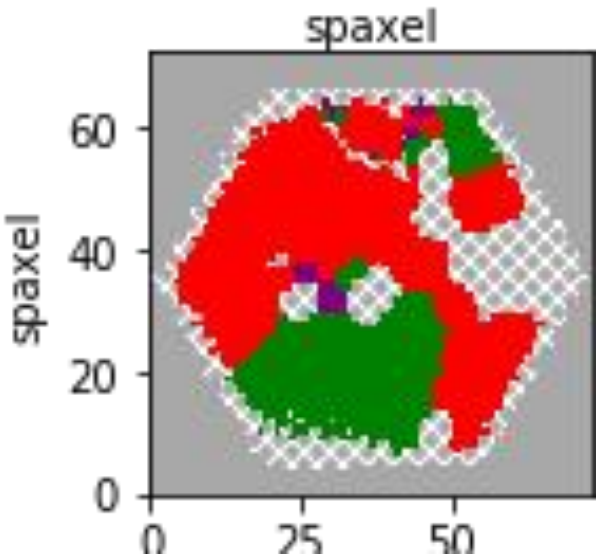
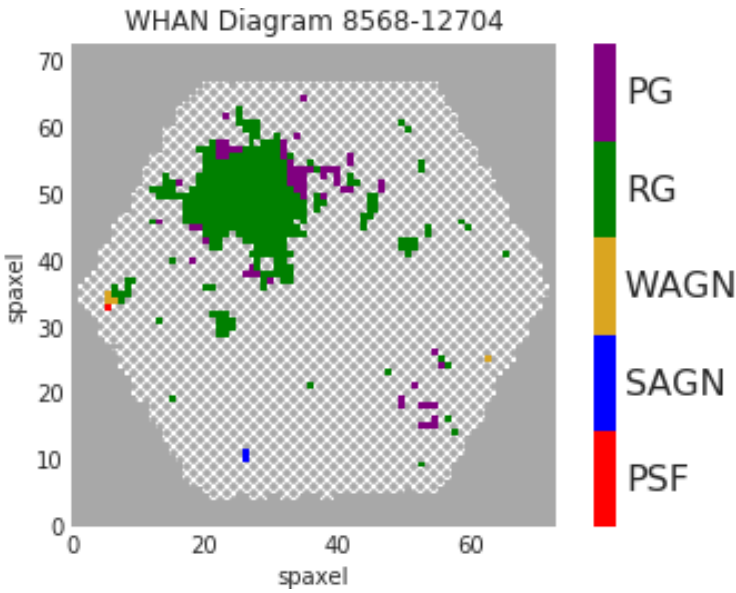




- However PCA shows the bottom left region as **green valley**
- Other MaNGA related data (for example WHAN diagram) show no observations in area

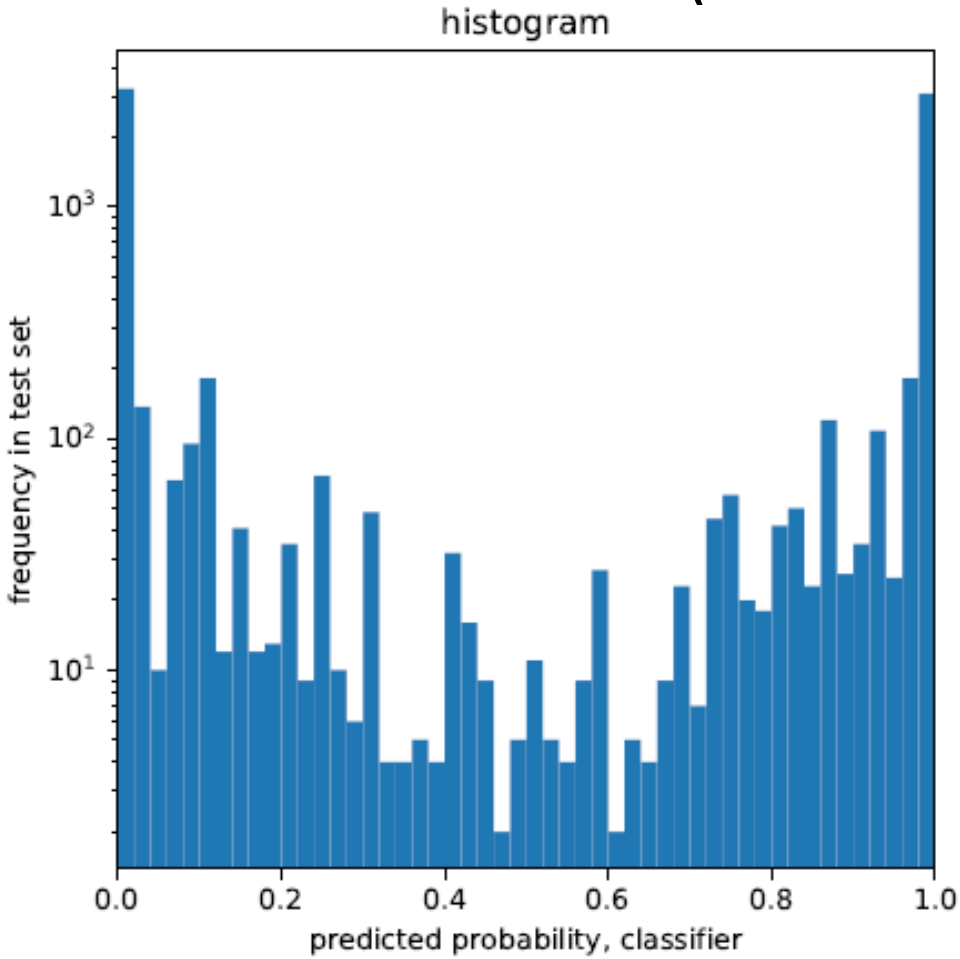
Conclusions

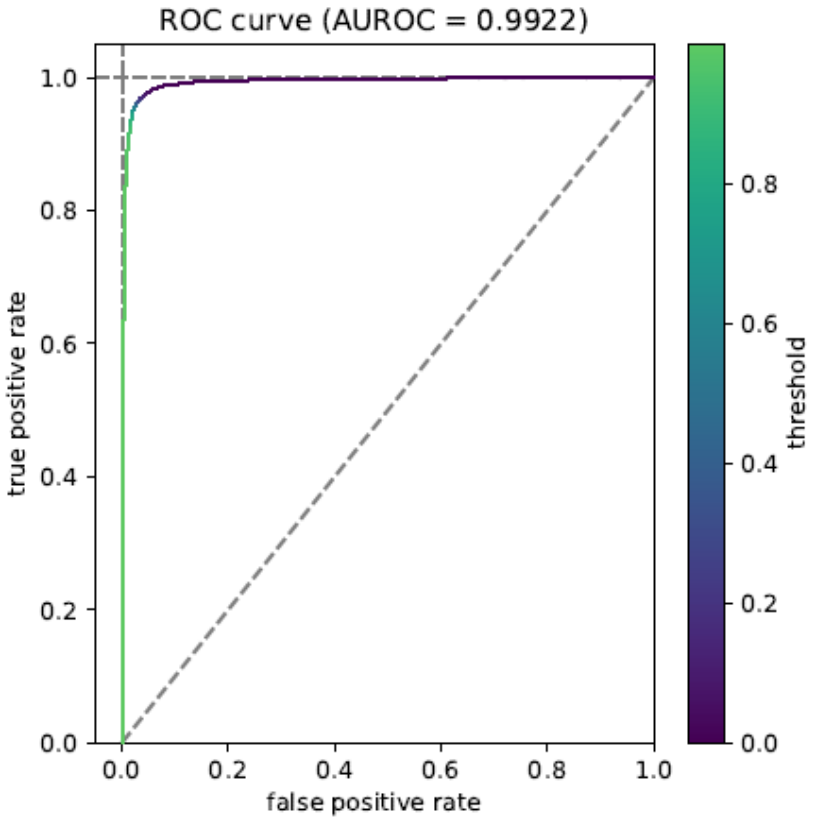
- Using **MaNGA FIREFLY VAC** information and **PCA** method highlighted in Rowlands et al. (2018), we have taken a look into the **SFH of interacting galaxies**

- For many interacting galaxies, there exists an increased star formation in interacting regions, which confirms that higher SFR is a result of interaction
- However issues and inconsistencies exist which need to be looked at

Appendix

- CNN Information (Ackermann et al. 2018)





Left: Probability distribution of classifier

Right: ROC curve of classifier

Appendix – Other Data

- Reddening Data (Dust Extinction)
- Dust Attenuation in interacting regions