Using HI-MaNGA to Study Interacting Galaxies

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Introduction

• Galaxy Interactions
  • When two galaxies are in close proximity, a galaxy interaction occurs

• Galaxy Interactions are a key process when discussing galaxy evolution

Antennae Galaxy (NGC 4038 (top) and NFC 4039 (bottom))
https://www.nasa.gov/multimedia/imagegallery/image_feature_1086.html
Introduction – Current Research Topic

• Using the Mapping Nearby Galaxies at APO (MaNGA) Catalogue to investigate spatially resolved SFH of local interacting galaxies

• Classification using Convolutional Neural Networks/Transfer Learning

• Limitations of visual based classifications – new classification method
HI-MaNGA Data Release 1

• Program of 21 cm neutral hydrogen followup of MaNGA galaxies observed using the Robert C. Byrd Green Bank Telescope (GBT)
  • Surveyed 331 MaNGA galaxies

• Will help to achieve MaNGA’s science goals – understanding physical mechanisms of galaxy evolution
  • Answer some key questions
    • Gas accretion
  • Star formation

Spectra of MaNGA galaxy with high S/N in the HI detection (Masters et al. 2019)
Purpose of Using Radio Emission

• Many previous works, such as Galaxy Zoo (Darg et al. 2009), have attempted to classify galaxies visually – with some success
• CNNs have also been used with varying success
• Possible method for classification – galaxy dynamics

• Previous works (such as Ellison et al. 2015 and Dutta et al. 2019) suggest a high detection rate of HI in late stage to post-merging interacting galaxies
• Identify post-merger galaxies using dynamical properties – check consistency with HI detections
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Classify post-merger galaxies using dynamics
Check for HI-detection and investigate SFH
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- Identify post-merger galaxies using dynamical properties – check consistency with HI detections
- Classify post-merger galaxies using dynamics
- Check for HI-detection and investigate SFH
- Possible new method for classification?
Sample Selection

- Using MaNGA galaxies in SDSS DR15
- Identification process using Galaxy Dynamics

**Criteria:** Counterrotating discs in stellar velocity

- Counterrotation as a tracer of merger remnants (Barnes et al. 2001) – post-mergers have counterrotating features
Sample Section

- Of the entire MaNGA catalogue, 10 clear + 7 unclear counterrotating discs were found.

- Matching data with HI-MaNGA + ALFALFA data gave us 2 HI detections (rest were not surveyed in current DR).

- Future data may tell us if counterrotating discs and HI detection have a connection.

MaNGA Cutouts of HI-detected galaxies with counterrotating disks, with stellar velocity maps shown below: 9502-12702 (left) and 9027-3703 (right).
MaNGA 9502-12702 – SFH Map

• Each region is divided into a maximum of 8 stellar populations, sorted from youngest (1) to oldest (8)
• Blue regions are young stellar populations, red are old
• Outer regions of galaxy have more recent star formation compared to central region
  • Multiple young stellar populations in outer regions
• Regions of recent star formation are somewhat perpendicular to counterrotation
Similar to previous galaxy, outer regions of galaxy have more recent star formation compared to central region.

Regions of recent star formation are somewhat perpendicular to counterrotation.
MaNGA 9027-3703

• Both galaxies seem to have more recent star formation episodes in outer regions

• Star formation episodes are less recent in central region

• Similar to previous galaxy, outer regions of galaxy have more recent star formation compared to central region

• Regions of heavy star formation are somewhat perpendicular to counterrotation
Future Works

• The MaNGA HI followup will in the future have:
  • HI detections/measurements for all MaNGA galaxies
  • Spatially resolved followups

• Followups will give us more data to work with, as well as give us information on where the galaxies are gas rich

• Further followups will investigate the relation between HI content and star formation properties
Conclusion

• We have investigated whether or not post-merger galaxies (identified using galaxy dynamics) have HI detection, as well as their star formation histories

• 2 galaxies from the sample showed HI detections – future data will tell us if galaxy dynamics will be a feasible method for interacting galaxy identification

• Future HI followups of MaNGA galaxies will tell us more about HI properties and star formation properties
Appendix – HI Plots

9502-12702 HI Plot

9027-3703 HI Plot
Appendix – SF Gradient 9502-12702

![Graph showing log SFR vs. log Stellar Mass](image)

- Log SFR [M⊙ yr⁻¹]
- Log Stellar Mass [M⊙]

- R/Reff

- SKA Japan Symposium - September 5, 2019
Appendix – SF Gradient 9027-3703

SKA Japan Symposium - September 5, 2019