Exploring galaxy evolution with HI profile asymmetries

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WITH THANKS TO ANDREW BAKER, ED ELSON, MARTHA HAYNES, KELLEY HESS, DAVID GILBANK ET AL, ...
Motivation

• We use HI to study galaxy evolution
• MeerKAT is coming!
• For the highest Z galaxies: HI velocity profile ONLY
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• We use HI to study galaxy evolution
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• For the highest Z galaxies: HI velocity profile ONLY
• What can asymmetry tell us?
Background

- Asymmetry is a GENERAL phenomenon (Jogg & Combs 2009)
- HI is a good tracer for asymmetry (Rix & Zaritsky)
- A qualitative study found ~ 50% of HI velocity profiles to be asymmetric (Richter & Sancisi 1994, Haynes 1998)
- Link between asymmetric profiles and lopsided HI distribution (Richter & Sancisi 1994)

- Global velocity profile asymmetries are good tracers of the disk mass asymmetry
What might cause these asymmetries?

- mergers and tidal interactions
  - satellite galaxy accretion
  - off-centre disk in the halo
  - intergalactic gas ram pressure
- asymmetric accretion of gas from the cosmic web...
My project

KEY QUESTION: Can HI profile asymmetries tell us about mergers?

APPROACH: Investigate HI profile asymmetries of galaxies within close pairs

• Define a sample of close pairs
• Quantitatively describe asymmetry
• Compare with isolated galaxies (are mergers a likely candidate for causing asymmetries?)
Data

- ALFALFA α.40 catalogue (code 1’s with OCs in SDSS -8835 galaxies) + SDSS DR7 (spectroscopic)

PAIRS: as per Robatham et al’s close pair criteria + HI isolated out to 10’ (confusion)

136 pairs
212 pairs
349 pairs

\[ \Delta v < 500 \text{ km/s} \]
\[ \Delta v < 1000 \text{ km/s} \]

SDSS DR7
Data

• ALFALFA α.40 catalogue (code 1’s with OCs in SDSS -8835 galaxies) + SDSS DR7 (photometric)

**ISOLATED:**

\[ \begin{align*}
    r_{sep} & > 800 \text{ kpc} \\
    v_{sep} & > 1000 \text{ km/s}
\end{align*} \]

64 isolated galaxies
Measuring profile asymmetry

\[ A_c = \frac{\text{Area}_{\text{big}}}{\text{Area}_{\text{small}}} = \frac{\int_{v_{\text{low}}}^{v_{\text{med}}} I}{\int_{v_{\text{med}}}^{v_{\text{high}}} I} \]

\[ \text{AGC 8727} \]

\[ A_c = 1.04 \]
Measuring profile asymmetry

\[ A_c = \frac{\text{Area}_{\text{big}}}{\text{Area}_{\text{small}}} = \frac{\int_{v_{\text{low}}}^{v_{\text{med}}} I}{\int_{v_{\text{high}}}^{v_{\text{med}}} I} \]

\[ A_c = 1.24 \]
Measuring profile asymmetry

\[ A_c = \frac{\text{Area}_{\text{big}}}{\text{Area}_{\text{small}}} = \frac{\int_{v_{\text{med}}}^{v_{\text{med}}} I}{\int_{v_{\text{low}}}^{v_{\text{high}}} I} \]

\[ \text{AGC 7574} \]
\[ A_c = 1.53 \]
Preliminary results

Using $A_c > 1.15$ as a lower limit on asymmetry:

**PAIRS:**

- **72/136 galaxies (53%)**
- **108/212 (51%)**
- **194/349 (56%)**
Preliminary results

Using $A_c > 1.15$ as a lower limit on asymmetry:

PAIRS:
• $72/136$ galaxies (53%)
• $108/212$ (51%)
• $194/349$ (56%)

ISOLATED:
• $27/63$ galaxies (39.7%)
Next steps:

• Verify our isolated sample is indeed isolated (AGC 7574= NGC 4438 = pair!)

• Investigate and compare alternative techniques for quantitatively describing asymmetry:
  ➢ Direct methods (see previous)
  ➢ Model fitting (e.g. Stewart et al., Westmeier et al.)

• Model the effect of inclination

• Investigate other possible causes of profile asymmetries (confusion)

• Compare with optical properties for the sample galaxies (SDSS data)
And then?

- MeerKAT is coming, we’ll be seeing deeper than ever before, and getting HI profiles for galaxies over 2/3 the age of the universe
- Use methods developed in this work to extend studies to higher redshift samples to learn more about galaxy evolution over cosmic time
AKA NGC 4438
AKA a member of The Eyes galaxy pair!