Exploring galaxy evolution with HI profile asymmetries

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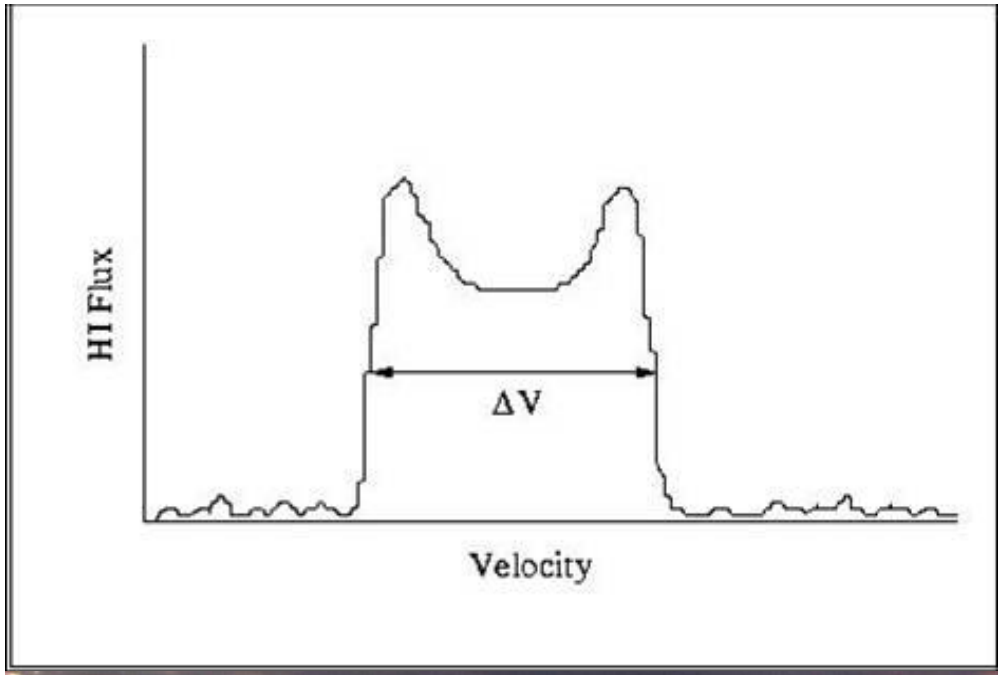
WITH THANKS TO ANDREW BAKER, ED ELSON, MARTHA HAYNES, KELLEY HESS, DAVID GILBANK ET AL, …

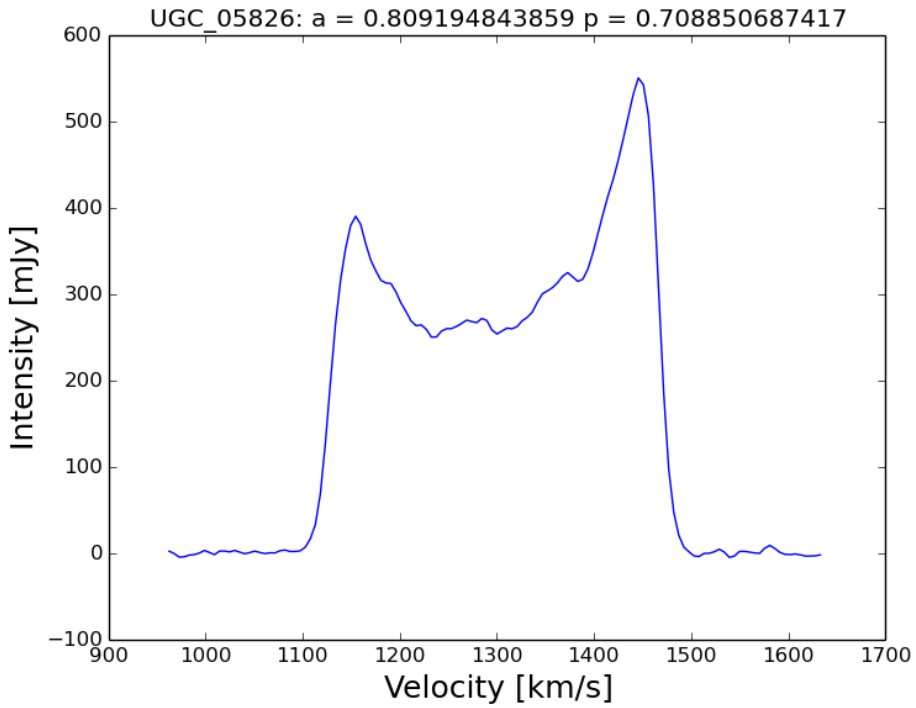
Motivation

- We use HI to study galaxy evolution
- MeerKAT is coming!
- For the highest Z galaxies: HI velocity profile ONLY



Motivation

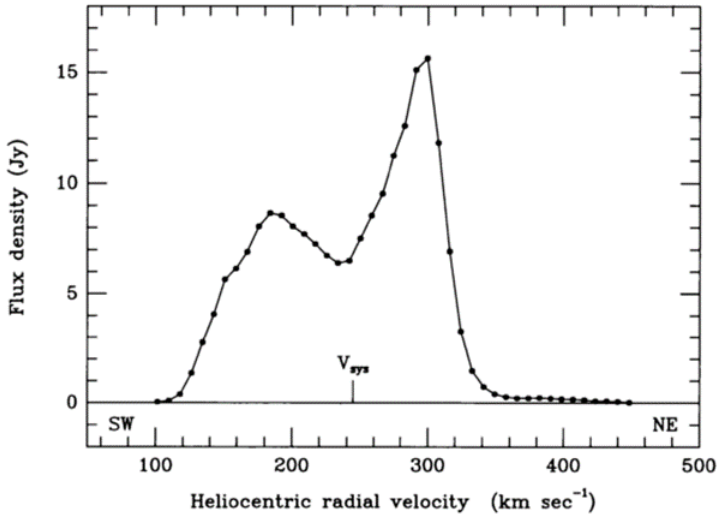
- We use HI to study galaxy evolution
- MeerKAT is coming!
- For the highest Z galaxies: HI velocity profile ONLY
- What can asymmetry tell us?

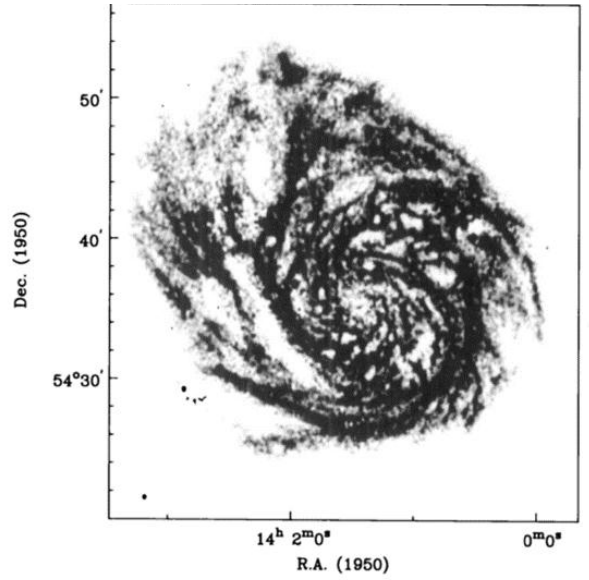


Background

- 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?

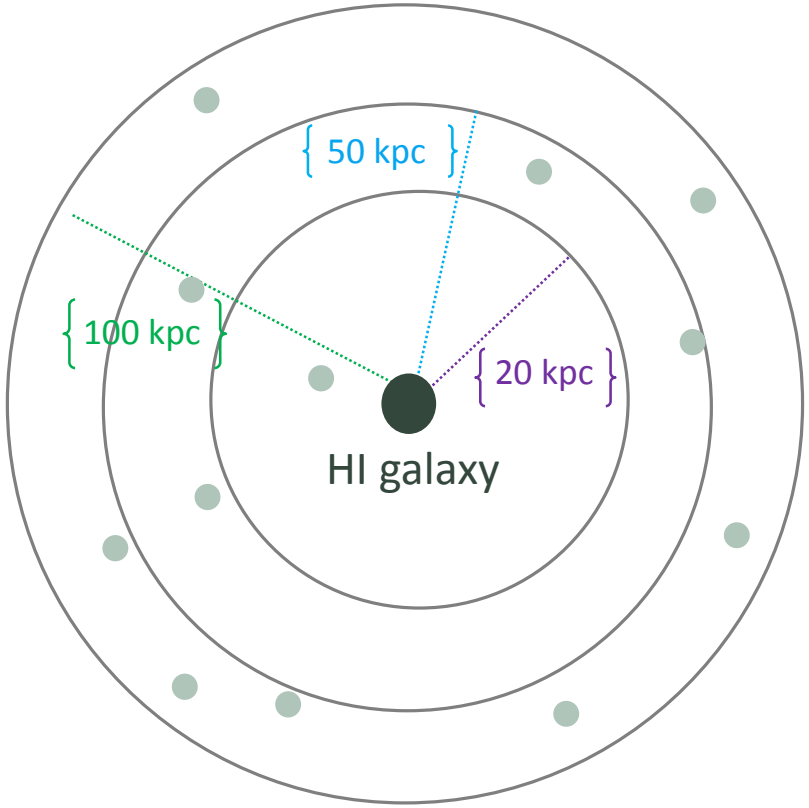
APPROACH: Investigate HI profile asymmetries of galaxies within close pairs

- 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

Δv < 500 km/s
Δv < 500 km/s
Δv < 1000 km/s
SDSS DR7

Data

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

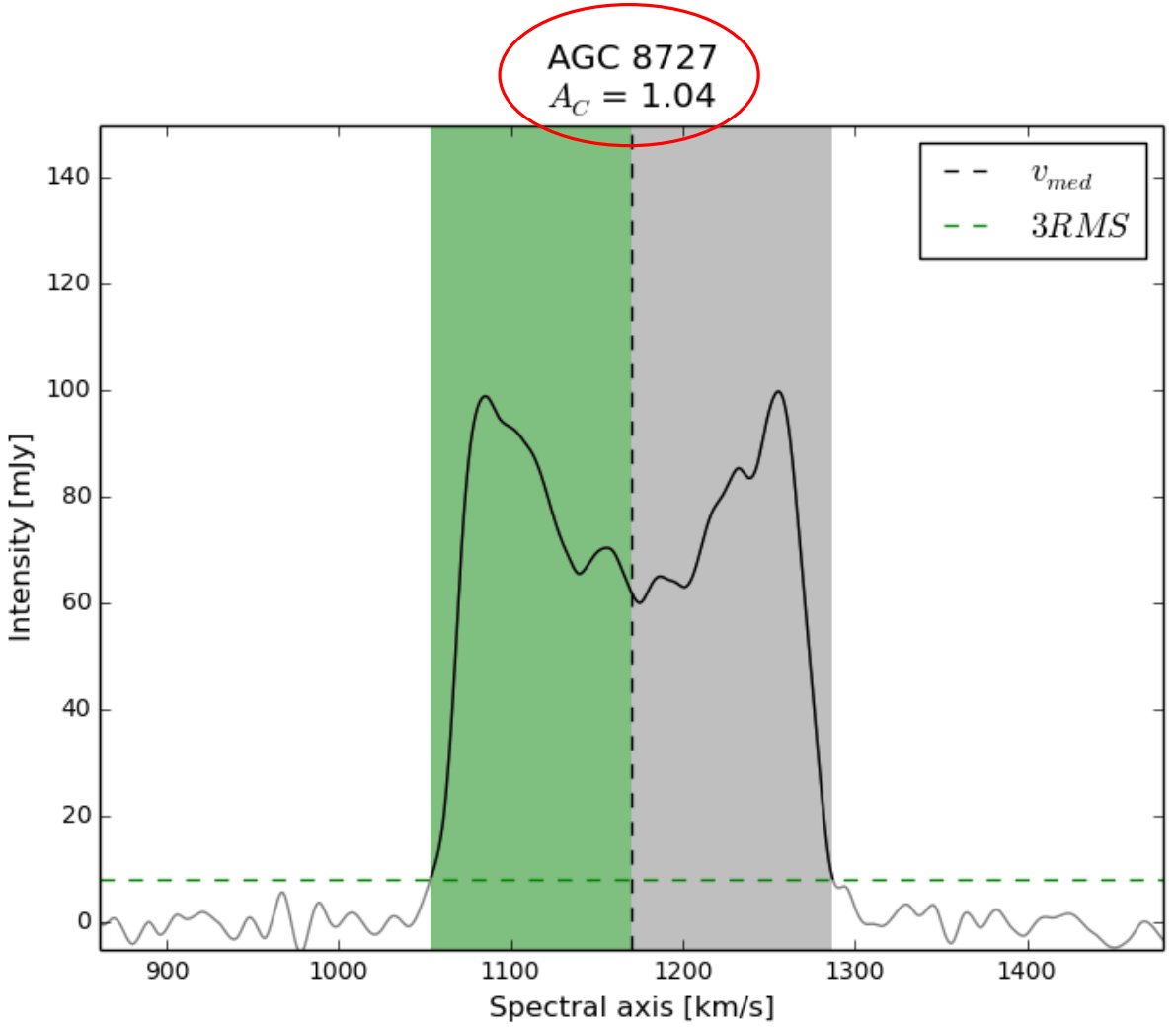
ISOLATED:

$$\begin{cases} r_{sep} > 800\ kpc \\ v_{sep} > 1000\ km/s \end{cases}$$

64 isolated galaxies

Measuring profile asymmetry

$$A_c = \frac{Area_{big}}{Area_{small}} = \frac{\int_{v_{low}}^{v_{med}} I}{\int_{v_{med}}^{v_{high}} I}$$



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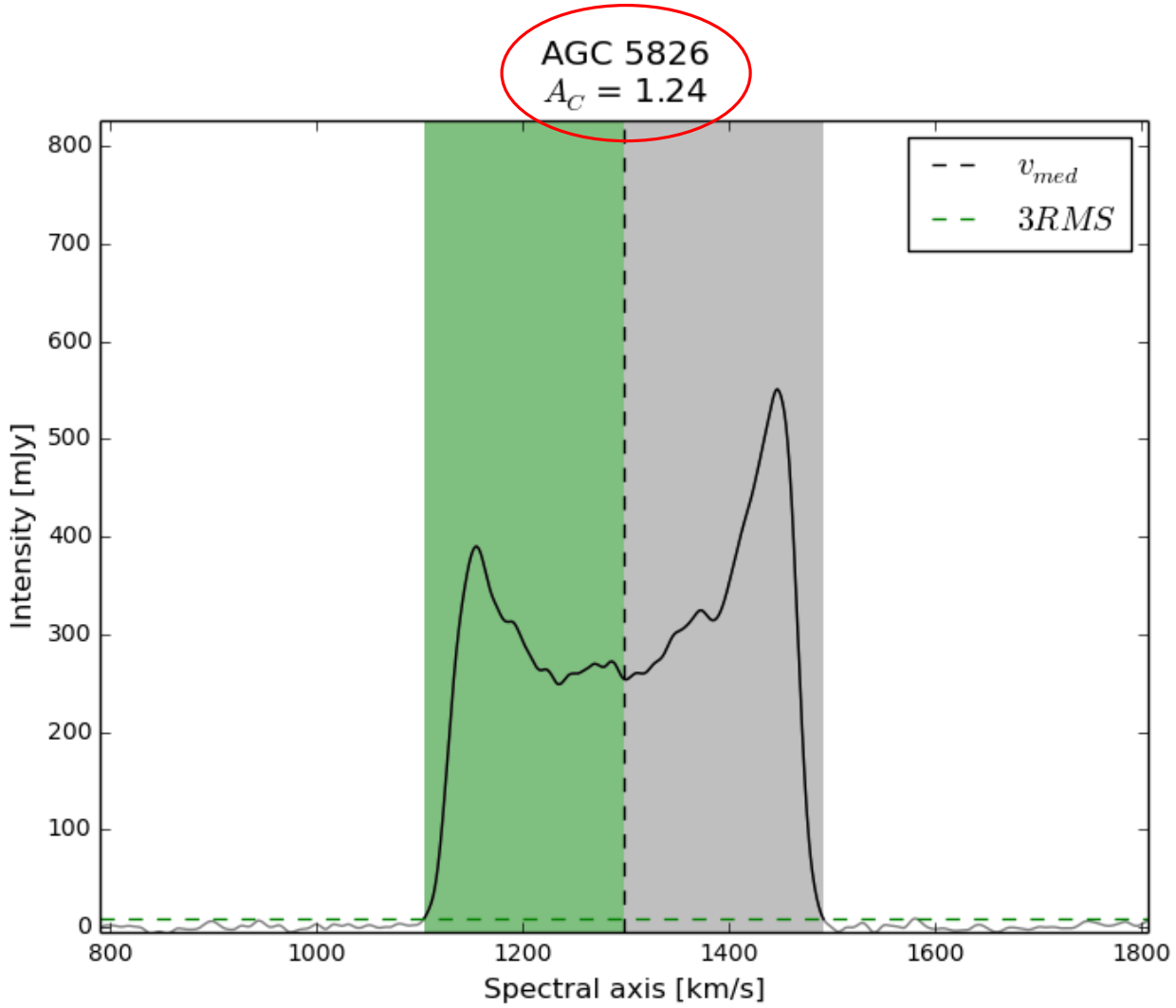

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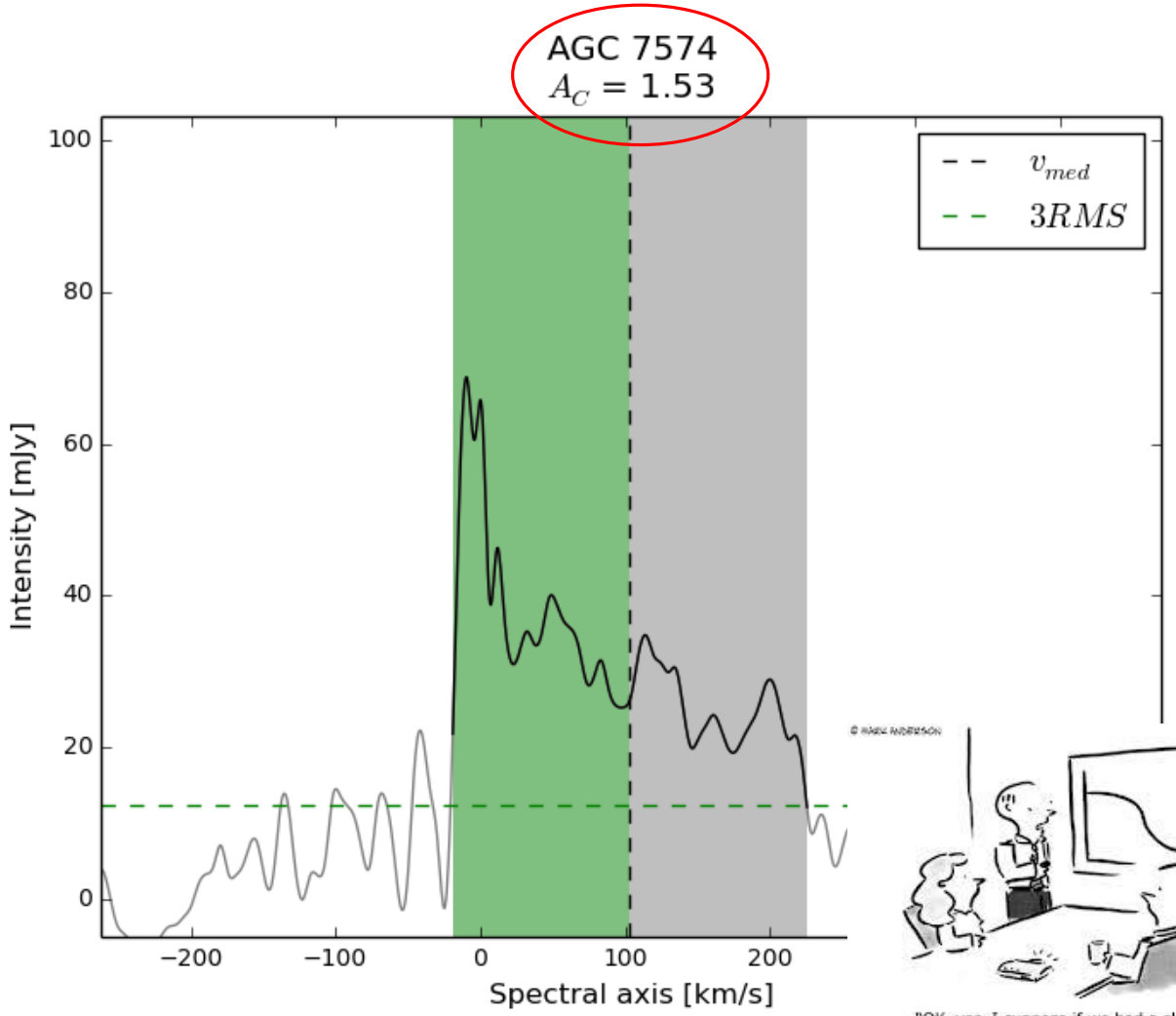
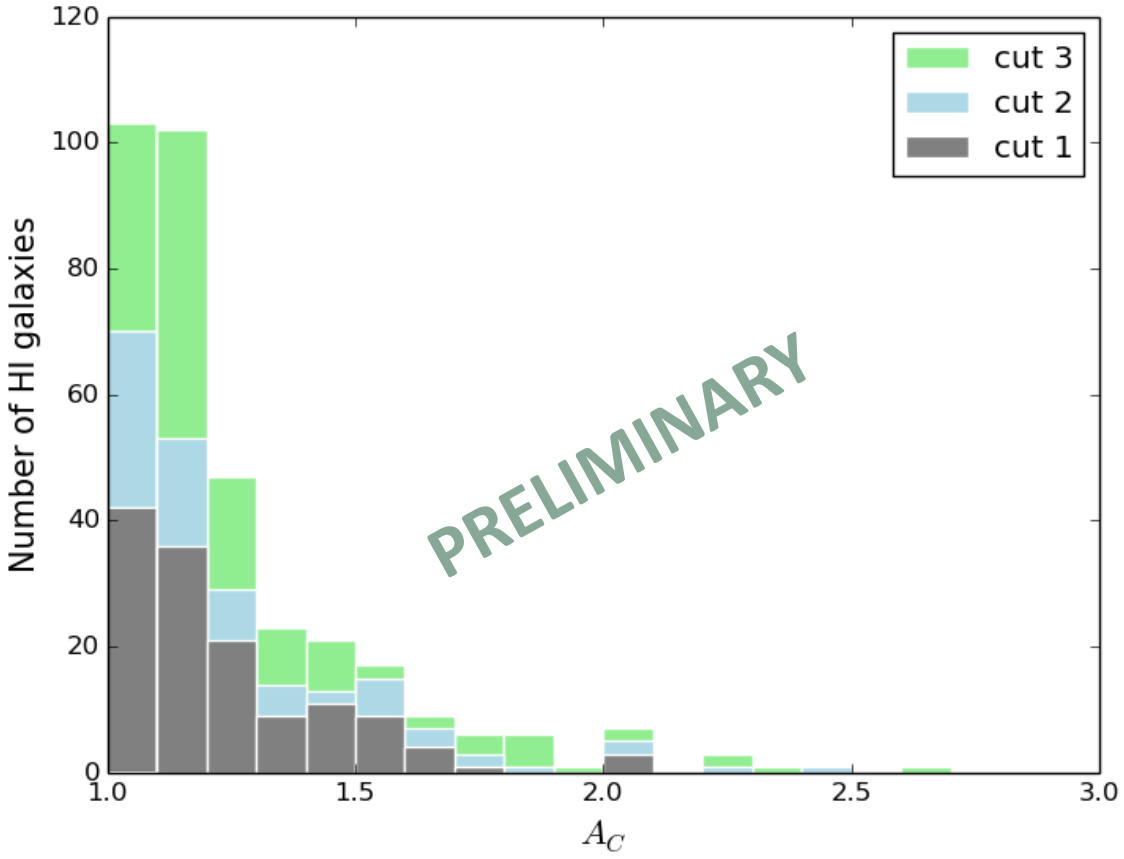


Preliminary results

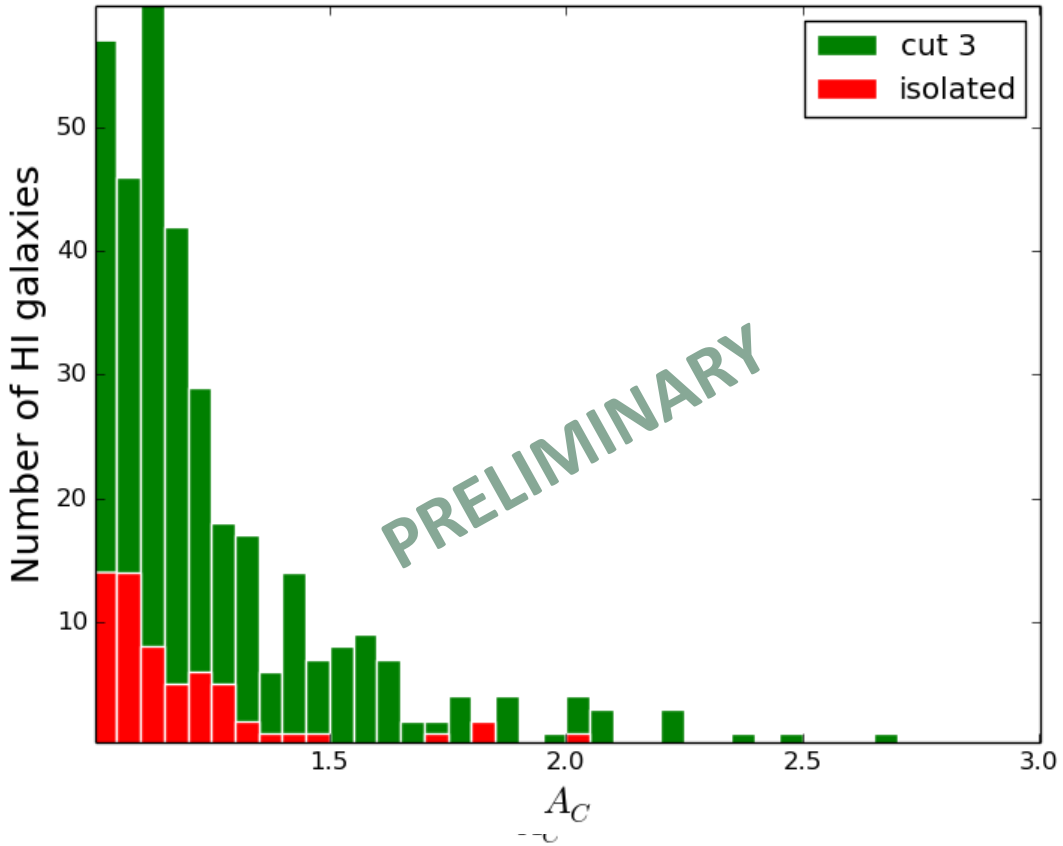


Using A_C>1.15 as a lower limit on asymmetry:

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:

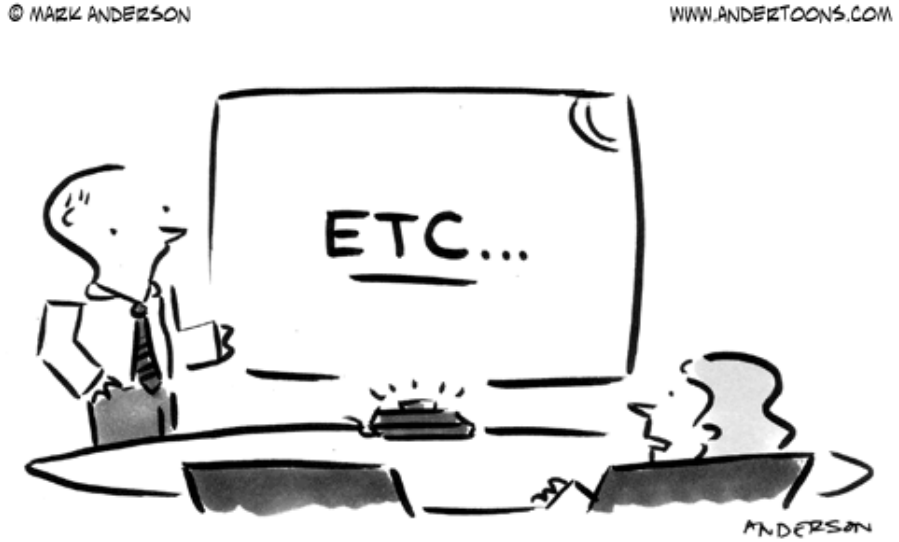
- **27/63 galaxies (39.7%)**

Next steps:

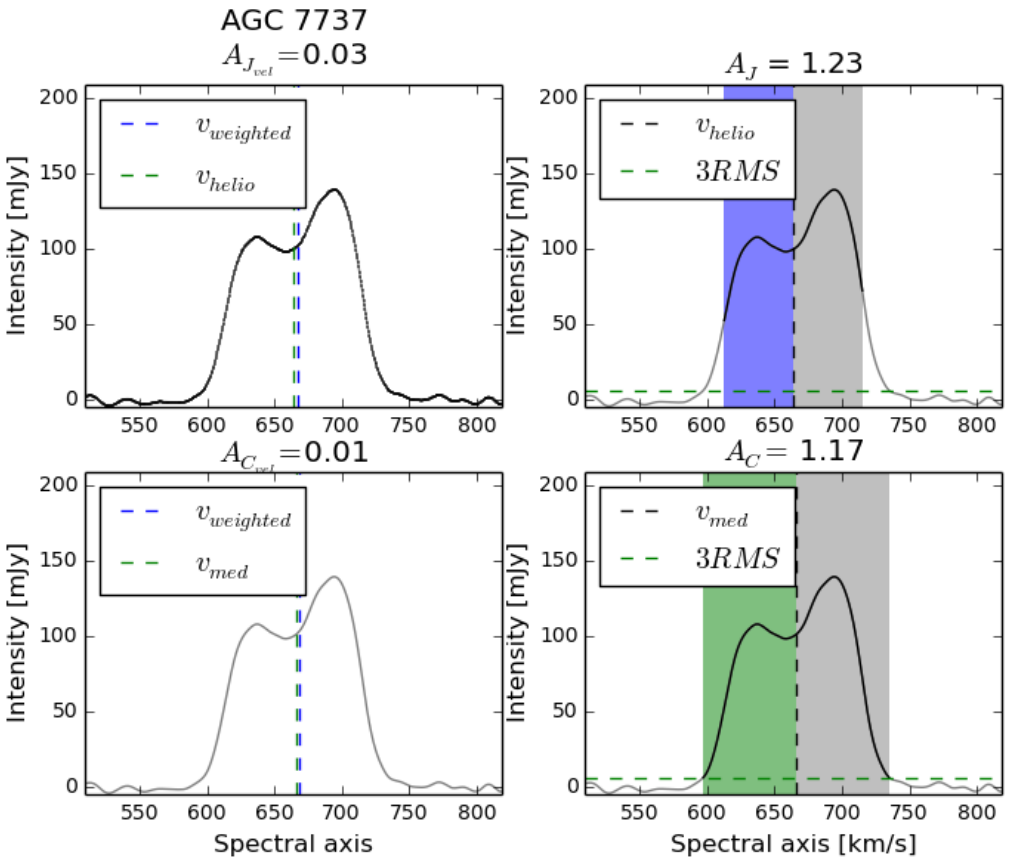
- Verify our isolated sample is indeed isolated (AGC 7574= NGC 4438 = pair!)
- Investigate and compare alternative techniques for quantitatively describing asymmetry:
  - Direct methods (see previous)
  - Model fitting (e.g. Stewart et al., Westmeier et al.)
- Model the effect of inclination
- Investigate other possible causes of profile asymmetries (confusion)
- Compare with optical properties for the sample galaxies (SDSS data)

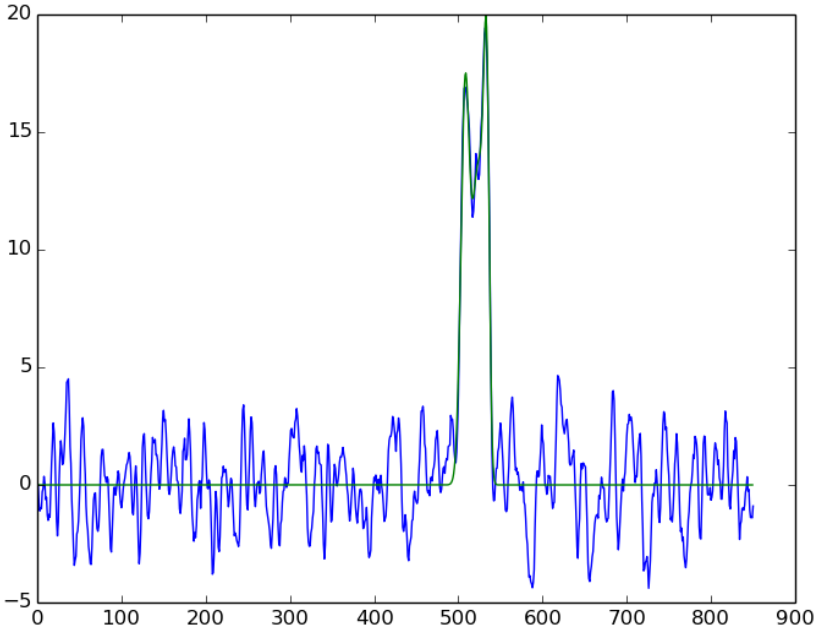
And then?

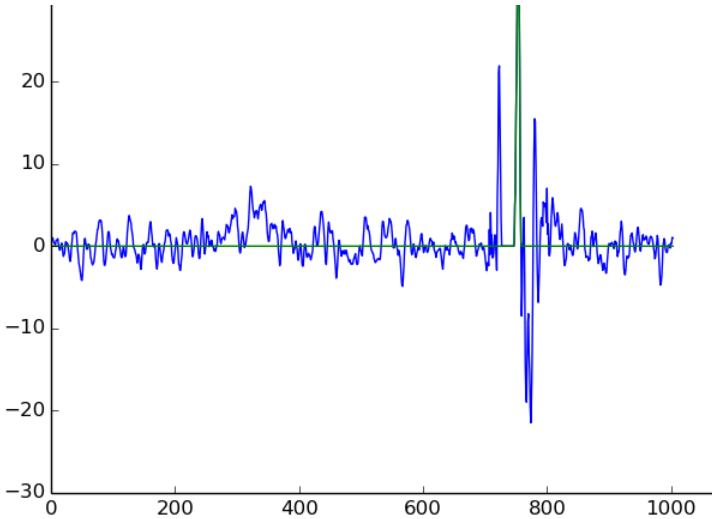
- MeerKAT is coming, we'll be seeing deeper than ever before, and getting HI profiles for galaxies over 2/3 the age of the universe
- Use methods developed in this work to extend studies to higher redshift samples to learn more about galaxy evolution over cosmic time

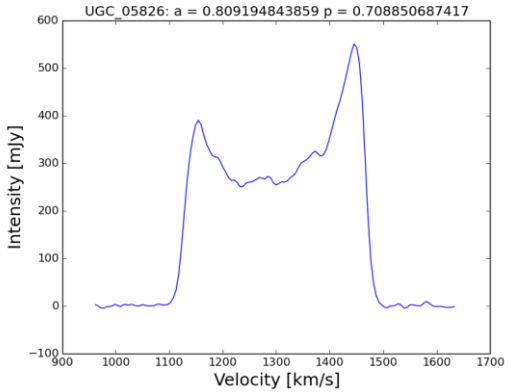


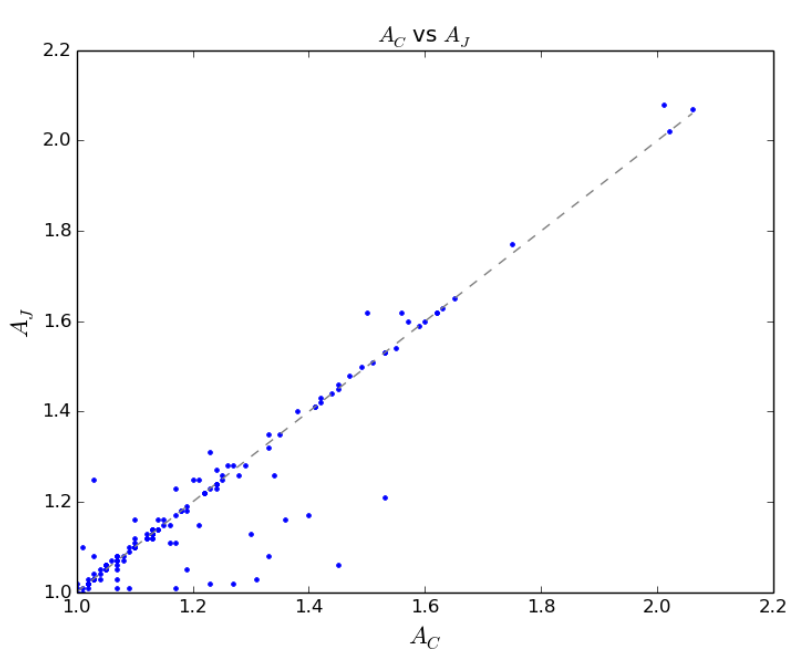
"This slide needs work."

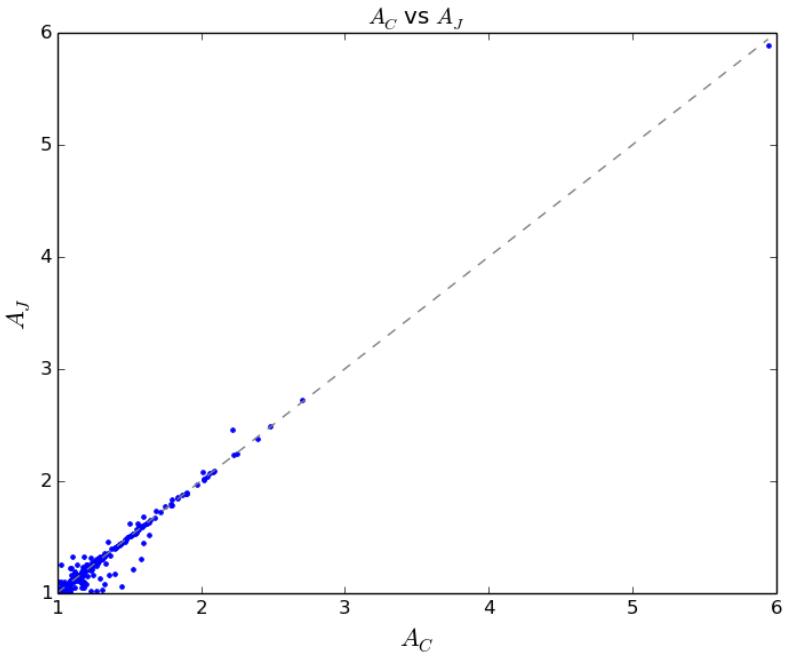

AGC 7737
$A_{J_{vel}}$=0.03
A_J = 1.23
$A_{C_{vel}}$=0.01
A_C= 1.17
$v_{weighted}$
v_{helio}
v_{med}
3RMS
Intensity [mJy]
Spectral axis
Spectral axis [km/s]






UGC_05826: a = 0.809194843859 p = 0.708850687417
Intensity [mJy]
Velocity [km/s]


A_C vs A_J
2.2
2.0
1.8
1.6
1.4
1.2
1.0
A_J
1.0
1.2
1.4
1.6
1.8
2.0
2.2
A_C


A_C vs A_J
6
5
4
3
2
1
A_J
1
2
3
4
5
6
A_C

AKA NGC 4438

AKA a member of The Eyes galaxy **pair!**