# ALFALFA HI OBSERVATIONS OF THE NGC 5846 GALAXY GROUP

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## ABSTRACT

The intermediate density NGC 5846 group of galaxies has one of the highest fractions of early-type galaxies in the local Universe. Based on Arecibo Legacy Fast ALFA (ALFALFA) observations, the Union College group has shown that NGC 5846 contains few galaxies with detectable HI. We compare the gas and stellar properties of gas-poor galaxies in the group by measuring upper limits for the HI content of galaxies not detected using the ALFALFA survey, based on a list of group members constructed from the Sloan Digital Sky Survey (SDSS). We present contour maps of HI emission in member galaxies. This project is part of the Undergraduate ALFALFA Team Groups project whose general goal is to measure and compare HI and multi-wavelength observations for groups with different properties. This work is supported by NSF grants AST-0724918 and AST-0725380.

## NGC 5846 GROUP OF GALAXIES

- Well-defined, relatively isolated group in Local Supercluster.
- Distance = 26.1 Mpc.
- High density, intermediate mass system, > 300 members, 4 with L > L*
- Early- type rich population.
- Velocity: 1749 km/s with a velocity dispersion of 322 km/s.
- X-ray emission; possible intragroup medium.

## GOALS OF THE PROJECT

- Find member galaxies with HI in NGC 5846
- Compare stellar and gas properties
- HI upper limits for galaxies not detected by ALFALFA
- Compare multiwavelength properties

## ALFALFA SURVEY (Arecibo Legacy Fast ALFA Survey)

- Blind HI survey of 7000 deg$^2$ with Arecibo feed Array (ALFA) (Giovanelli *et al.* 2005).
- Frequency range of 1225 and 1525 MHz. corresponding to redshifts -1600 km/s and 18,000 km/s.
- Will detect at least 30,000 extragalactic objects

*Arceibo Telescope http://www.underhill.ca/Projects/Arecibo.jpg*

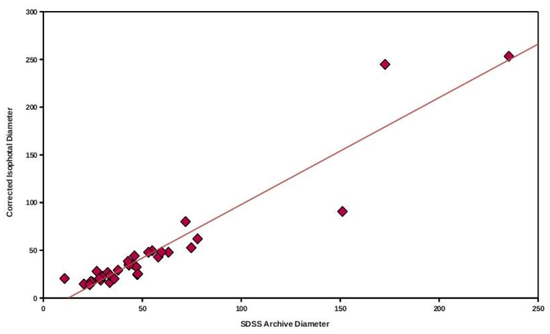
## SLOAN DIGITAL SKY SURVEY (SDSS)

- Optical survey of 10,000 deg$^2$ (York *et al.* 2000)
- Photometric survey in the u, g, r, i, and z bands .
- Spectroscopic survey of selected targets.

## SDDS CORRECTED PHOTOMETRY

- Motivation:
  - SDSS photometry routines optimized for redshift of 0.1
  - Photometry of nearby galaxies has issues (e.g. West *et al*. 2010):
    - ✓ Larger galaxies "shredded".
    - ✓ Incorrect sky subtraction for low surface brightness galaxies
- Method:
  - Download SDSS galaxy images
  - Remove stars
  - Correct photometry (by Andrew West)
- Results for galaxies in the group with SDSS spectra:

❖ Note large deviations for extended galaxies




*Corrected. photometry by West and Rosenberg vs. SDSS archive photometry*

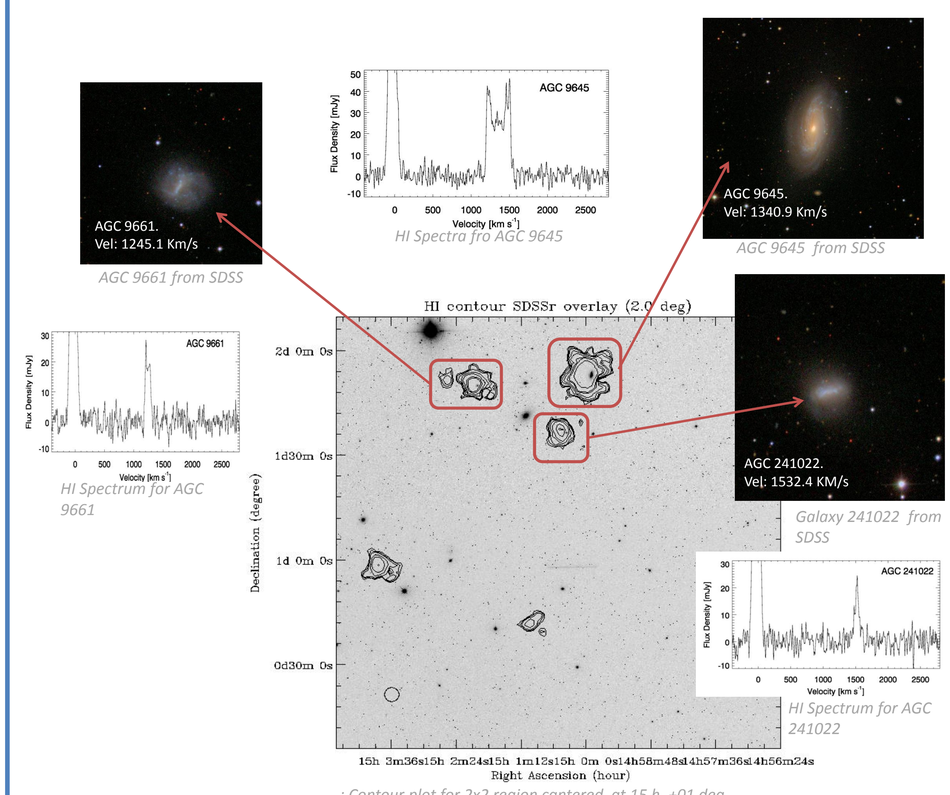
## HI RESULTS

- 4.8 X 8° region covering NGC5846 group center
- 26 galaxies detected by ALFALFA
- The HI mass in a galaxy is calculated from:

$$M_{HI} = 2.36 \times 10^5 D^2 F_{HI} M_\odot$$

where $F_{HI}$ is the corrected HI flux density integrated over the profile width in units of Jy km s$^{-1}$ and D is the distance in Mpc (Giovanelli et al. 2005).

### ❑ EXAMPLE CONTOUR MAPS OF HI EMISSION




*AGC 9661 from SDSS*

*HI Spectra fro AGC 9645*

*AGC 9645 from SDSS*

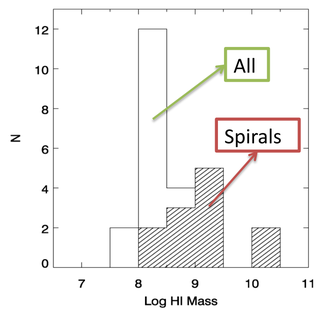
*HI Spectrum for AGC 9661*

*Galaxy 241022 from SDSS*

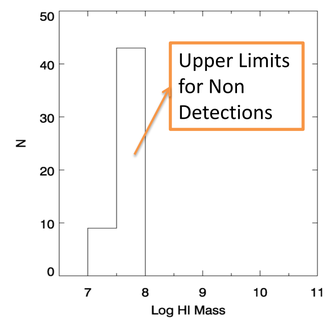
*HI Spectrum for AGC 241022*

*: Contour plot for 2x2 region cantered at 15 h, +01 deg.*
*Contour Levels= 8.45 13.0 19.5 39.0 65.0 130.0 169.0 325.0 mJy/ Bean*

- **HI MASS**

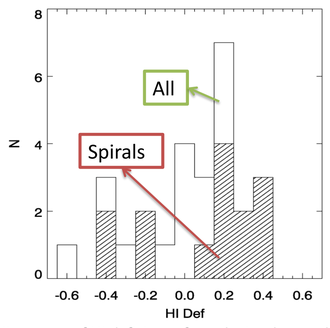



*Histogram of HI mass for galaxies detected in ALFALFA.*




*Histogram of upper limit HI mass galaxies not detected by ALFALFA*

- **HI DEFICIENCY**




*Histogram of HI deficiency for galaxies detected in ALFALFA*

- HI deficiency (HI Def) parameter calculated following Solanes *et al.* (1996)
- Median HI deficiency for spirals: 0.2
- Some spirals are moderately HI deficient

## HI UPPER LIMITS

- 89 galaxies in velocity range of the group not detected by ALFALFA.
- Most are dwarf ellipticals, some are star forming according to SDSS spectra.
- The **predicted** HI mass upper limit for ALFALFA is given by Giovanelli *et al. (*2005):

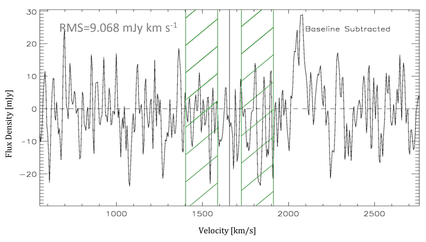
$$F_c = \frac{\frac{S}{N} W_{50}\, \sigma_{rms}}{1000 W_{smo}^{1/2}}$$

Where:

- ❑ S/N: Signal to noise ratio of 6.5
- ❑ $W_{50}$: line width
- ❑ $W_{smo}$: smoothing width factor ($W_{50}$/20 for $W_{50}$ < 400 km/s)
- ❑ $\sigma_{rms}$: typical noise level of 2.5 mJy

  - For a width of 10 km/s : 3.7 x 10$^7$M$_\odot$
  - For a width of 50 km/s : 8.3 x 10$^7$M$_\odot$
  - For a width of 100 km/s : 1.2 x 10$^8$M$_\odot$

- **Measured** upper limits based on RMS
  - We use SDSS to find coordinates of galaxies not detected by ALFALFA.
  - We measured the rms level for each galaxy in ALFALFA data cube.
  - Calculate HI mass upper limit using rms value, assuming line width of 100 km/s




*Spectrum of AGC 253933 and rms region measured.*

❖ Average HI mass upper limit for galaxies not detected is 3.9 ± 0.7 x 10$^7$M$_\odot$

## FUTURE WORK

- Complete photometry for all members of the group.
- Analyze the relation of HI mass to morphology, luminosity and stellar mass
- Compare to other groups and clusters

## REFERENCES

Giovanelli, R. et al. 2005, AJ, 130, 2598
Solanes, M. et al. 1996, ApJ, 461,609
York, D.G. et al 2000, AJ, 120, 1579
West, A. et al. 2009, AJ, 138,796