

Neutral Hydrogen Content of Galaxies in Low Density Regions from the ALFALFA Survey

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For the ALFALFA collaboration

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Current HI standards:

Expected HI content for a galaxy given its **optical diameter** D_{opt} and **Hubble type** T .

$$DEF_{HI} = \langle \log M_{HI}(D_{opt}, T) \rangle - \log M_{HI,obs}(HG84)$$

- **Haynes & Giovanelli (1984)**: standards from 324 ClG.
- **Solanes, Giovanelli & Haynes (1996)**: standards from 934 field galaxies in PPS region.

Limitations: HI data from heterogeneous and incomplete observations, optically targeted.

What is ALFALFA?



Arecibo Legacy Fast ALFA Survey

- Blind extragalactic H I survey of Arecibo sky.
- Census of local H I Universe (up to $\leq 18000 \text{ km s}^{-1}$)
- Can detect $7 * 10^4 D^2 M_{\odot}$ ($D =$ distance [Mpc])

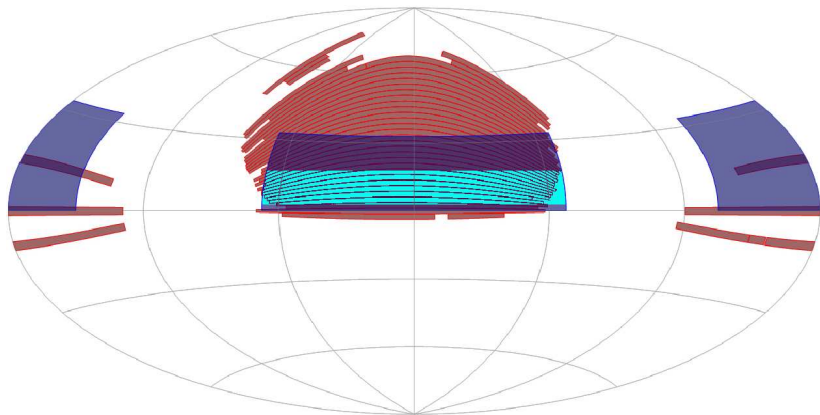
– Dr. R. Giovanelli's talk for more



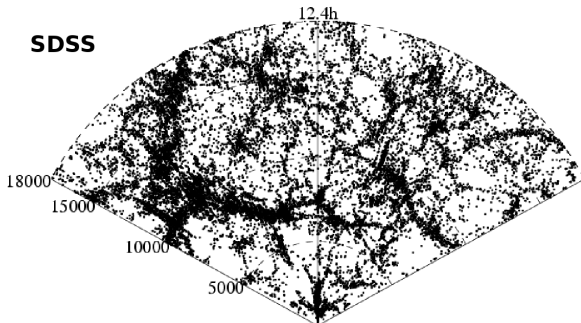
ALFALFA in synergy with surveys at other wavelengths \implies parameters that best correlate with H I content of galaxies.

Outline of BCN project

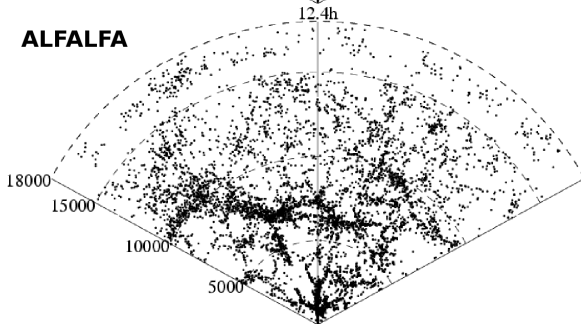
- 1 Cross-correlate ALFALFA with other surveys (SDSS).
- 2 Define a control sample of ALFALFA detections whose H I properties are not affected by the environment.
- 3 Analyze properties of the sample to derive the H I standards.



ALFALFA-SDSS



v_{\odot}	Det.
< 3000	939
3000 – 7000	1749
7000 – 11000	2378
11000 – 15000	1418
15000 – 18000	327
Total	6811



SDSS counterparts:
99% with PHOTO
85% with SPECTRO

Definition of the Low Density Region (LDR) Sample

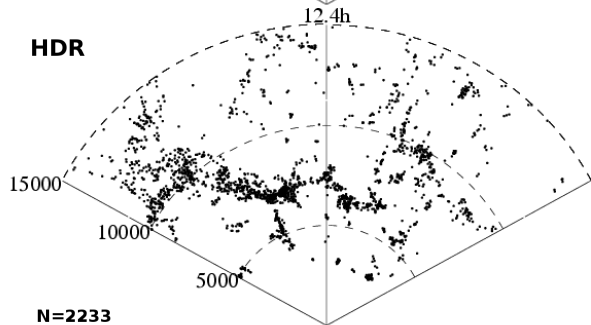
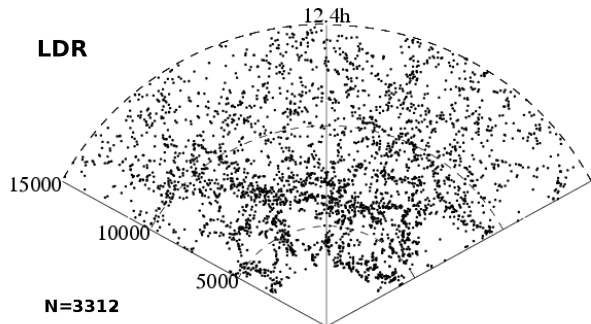
- Ideally: we want the galaxies as less affected by environment as possible.
- We cannot inspect galaxies individually (ALFALFA catalog is large).
- HI Deficiency takes place in cluster regions and groups (e.g. Giovanelli & Haynes 1985, Solanes et al. 2001)

⇒ We will select galaxies in **low 3D local density regions**.

Local Density Calculation

- 1 $3000 \leq v_{helio} \leq 15000 \text{ km s}^{-1}$.
- 2 Radial distances corrected for peculiar motions.
- 3 Compute ρ_6 from **6th SDSS spectro nearest neighbor 3D distance**.
- 4 Corrections for flux cutoff and Galactic extinction using SDSS LF (Blanton et al. 2001).
- 5 Determine **density threshold** that defines low density environment:
 - SGH96 HI standards to check HI Deficiency vs. ρ_6
 $\implies \rho < \rho_{thr} = 0.5 \text{ gal / Mpc}^3$
(discards 2-3 r_{vir} around rich Abell Clusters)

ALFALFA LDR Sample



LDR/Total: $\sim 60\%$

What type of galaxies is ALFALFA detecting in LDR?

For SDSS spectro sample:

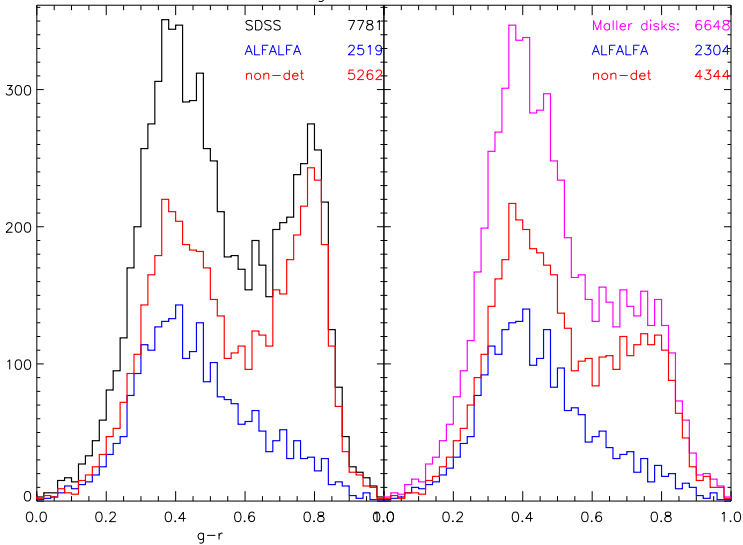
- ALFALFA detections vs non-detections.
- ALFALFA detections w.r.t. galaxies obeying **Maller et al. 2009** criterion:

$$\text{Maller's disks} = \{ b/a \leq 0.55 \text{ or } n_{\text{Sersic}} \leq 3 \}$$

- Split LDR in velocity bins.

Properties of LDR Sample: SDSS g-r color

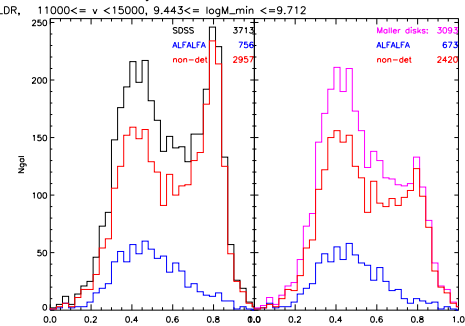
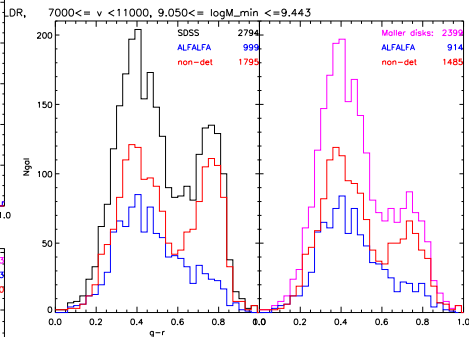
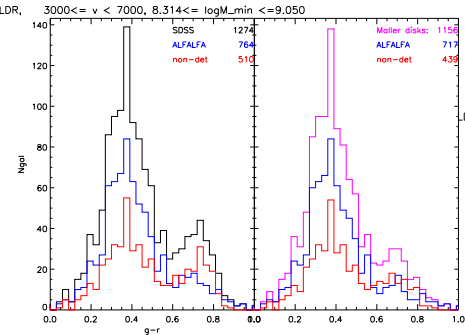
$3000 \leq v < 15000$, $8.314 \leq \log M_{\text{min}} \leq 9.712$



ALFALFA=blue galaxies

ALFALFA=blue disks

Properties of LDR Sample: SDSS g-r color – velocity bins



Bimodality \downarrow as distance \uparrow .
 \Rightarrow Red galaxies have less H I
 and are not detected at large
 distances.

- **g-r color:**

ALFALFA = **blue** galaxies and **blue** disks.

Bimodality ↓ as distance ↑.

⇒ Red galaxies have less HI and are not detected at large distances.

- **Inverse Concentration index:**

ALFALFA = **larger ICI** (corresp. to late-type).

- **Maller's criterion:**

- Most of ALFALFA galaxies verify it.
- Fraction of ALFALFA classified as disks decreases somewhat as velocity ↑
⇒ difficulties in Maller's morphology assignment for distant objects?

Isolation criteria:

- **Photometric Criteria:**

- **CIG (Karachentseva, 1973)**

- **Allam et al. 2005 criterion:**

isolated=any neighboring j of galaxy i satisfies:

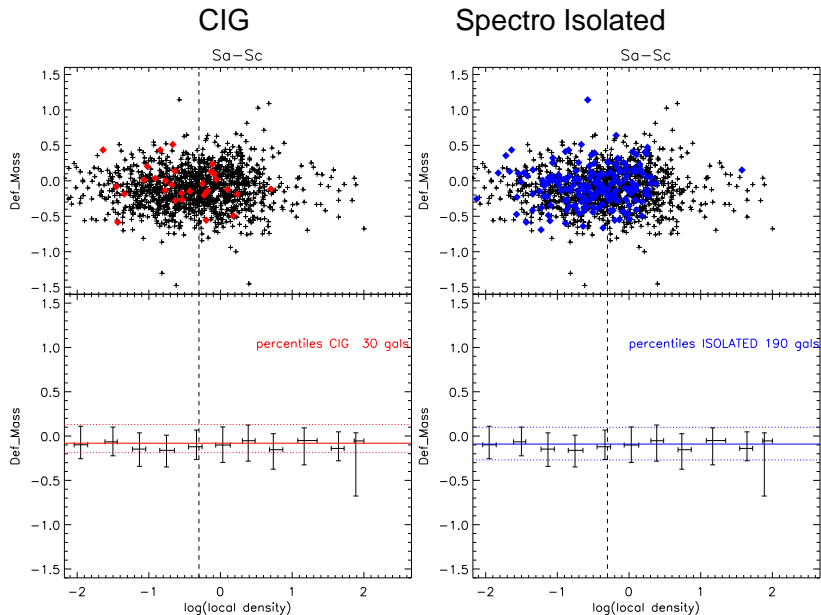
$$x_{i,j} \geq 40R_j \text{ and } |g_i - g_j| > 3$$

- **Photo+Spectroscopic Criteria:**

Isolated=

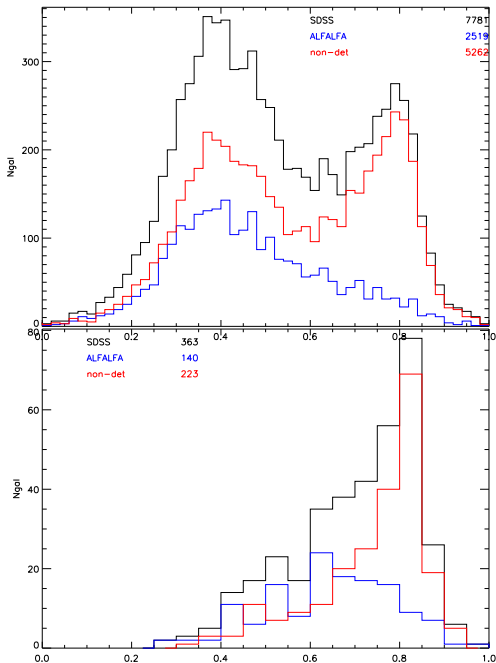
- any neighboring j of galaxy i with $m_j \leq m_i + 1.5$ mag is located further than $280 h^{-1}$ kpc (~ 400 kpc for $h = 0.7$).

Properties of Isolated Sample: 3D local density



Isolated can have $\rho_6 > \rho_{thr}$ (Verley et al. 2007).

Isolated Sample - Photo+Spectro criterion: SDSS g-r color



- SDSS spectro
- ALFALFA
- non detections

Top: LDR

Bottom: Isolated in LDR

No bimodality.
We get the reddest (we selected the brightest; e.g. Ball et al 2008).

- Isolated can have $\rho_6 > \rho_{thr}$.
- H I-Deficiency of isolated galaxies is not higher than H I-Def of LDR galaxies.
- Selection techniques favour detection of isolated red objects (ALFALFA galaxies are not an exception).