The Arecibo Legacy Fast ALFA Survey: HI Sources in the Northern Virgo Region

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ALFALFA (Arecibo Legacy Fast ALFA Survey)
A blind survey of the Arecibo sky for extragalactic HI

The Arecibo Legacy Fast ALFA (ALFALFA) survey is in its second year of mapping 7074 square degrees of the high galactic latitude sky visible from Arecibo, providing an extragalactic HI line spectral database covering the redshift range between -1600 km/s and 18,000 km/s. When completed in 4-5 years, ALFALFA is expected to have detected some 20,000 extragalactic HI sources. This poster presents results from the first catalog of sources in the region of the Northern Virgo Cluster, representing 2% of the total survey (Giovanelli et al. 2007, submitted), and preliminary detections in an extended region.

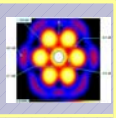
ALFALFA Science Goals:

- Probe the faint end of the HI mass function in the local universe
- Census of HI sources in the surveyed sky area to faint flux limits
- Galaxy evolution and dynamics within local Large Scale Structures
- Extent and Origin of HI Disks
- Nature of High Velocity Clouds
- synergy with wide area surveys conducted at other wavelengths

Parameters of the ALFALFA Survey compared to the HI Parkes All Sky Survey (HIPASS: Barnes et al. 2001). **ALFALFA provides improved angular and velocity resolution** and **depth of survey**.

	ALFALFA	HIPASS
Sky area (square deg)	7074	30,000
Velocity range (km/s)	-1600 to 18,000	300 to 12,700
Right Ascension range (h m)	07 30 – 16 30 22 00 – 0 00	(all)
Declination range (deg)	0 – 36	South of +20
Integration time per beam (sec)	48	450
Beam (arcmin)	3.5	15.5
Velocity Resolution (km/s)	5.5	18
RMS (mJy @ 18 km/s width)	1.7	13
Minimum HI Mass Detected @ 10 Mpc ($M_\odot$)	4.4×10^6	3.6×10^7
Numbers of Galaxies Detected	>20000	5317
Detections in Northern Virgo Region	716 (69% new)	40
Median recessional velocity (km/s)	7000	2800

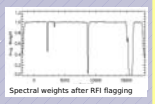
ALFALFA Observations



- 7-beam ALFA (Arecibo L-band Feed Array)
- Fixed azimuth drift scan w/ 2 passes separated by 3-9 months

ALFALFA Data Reductions

IDL-based LOVEDATA routines


Spectral weights after RFI flagging

1. Bandpass calibration
2. Radio Frequency Interference (RFI) flagging
3. As portion of sky filled, 2.4 x 2.4 degree **grids** created, separated by 8m, 2 deg
4. Baseline grid
5. Signal Extraction routine for preliminary source catalog (Saintonge 2007, submitted)
   - matched filtering routine
   - matches Hermite polynomial templates with spectra
   - done in Fourier space
6. Interactive examination of grids for final source catalog
7. Optical counterparts identified via examination of the digital optical imaging databases (SDSS, DSS)
8. Final source catalog released to Digital HI Archive (after publication) http://arecibo.tc.cornell.edu/hiarchive/

Observing and Data Reduction Team

Undergraduate Students
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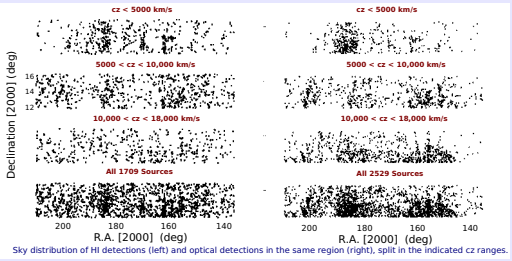
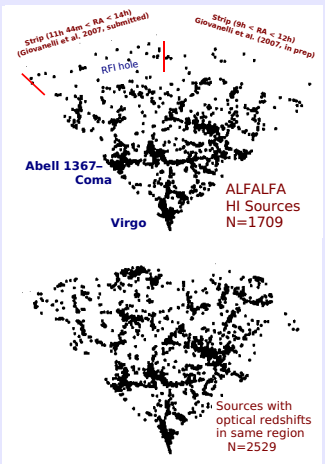
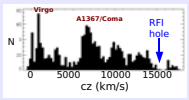
Distribution on Sky and Large Scale Structure



Sky distribution of HI detections (left) and optical detections in the same region (right), split in the indicated cz ranges.



Right ascension vs. recession velocity of all sources in HI detected by ALFALFA (upper) and analogous plot for galaxies with optical redshifts in the same region of the sky (lower). The distributions are similar.



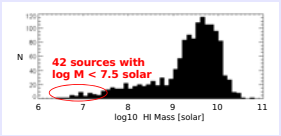
Distribution in velocity space of all sources detected by ALFALFA.

ALFALFA survey delivering high quality data and exceeding predicted performance.

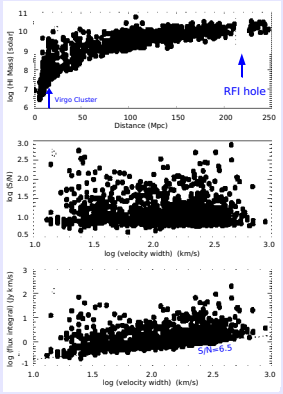
HI Detections in First Catalog of the Northern Virgo Region (RA=11:44-14:00)

- **716 Detections** (Compare to 40 by HIPASS)
- **69% are new HI detections => the many previous optical studies in this region missed the majority of HI sources**
- **Median cz = 7000 km/s => ALFALFA samples well beyond the Local Supercluster**
- **4% are high velocity clouds (HVC)**
- **25% have cz < 3000 km s^{-1} (due to presence of Virgo Cluster)**
- **94% have identified optical counterparts => good positional accuracy of Arecibo (~ 15" for high S/N source) makes optical identification reliable**
- **46 sources have missing or ambiguous optical counterparts:**
  - **many may be perigalactic HVCs**
  - **17 sources unlikely to be HVCs have no discernible optical component (see bottom panel for example)**
- **27 sources have optical counterparts of early morphological type: E, S0, dE/dS0 (see bottom panel for example)**

HI Masses of Detections



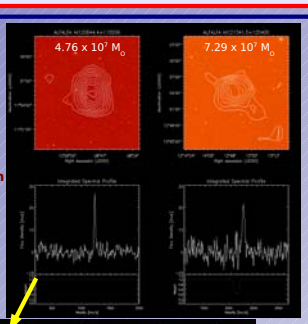
Histogram of HI masses of detected sources. HI masses are derived from observed fluxes and redshifts, corrected in the local Universe (cz < 3000 km/s) using a flow model (see Giovanelli et al. 2005).



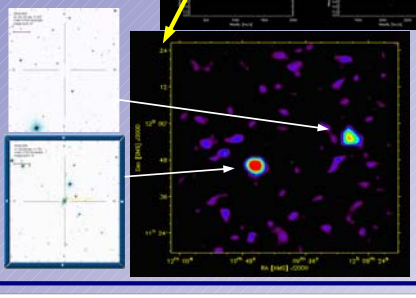
ALFALFA has found 42 sources with log (HI Mass) < 7.5 solar in this region of the survey, compared to 12 sources in HIPASS. ALFALFA observations will unambiguously determine the HI mass function once sufficient solid angle has been sampled.

Note that, for this sample, poor distance determination in the direction of the Virgo Cluster may cause HI masses of nearer low-mass galaxies to be estimated too high, since the flow model would assign such galaxies to the Virgo Cluster.

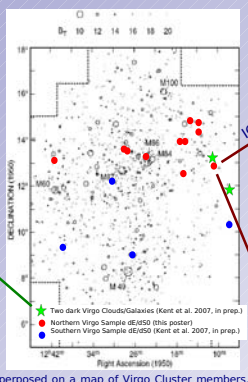
Dark Galaxies in the Virgo Cluster?

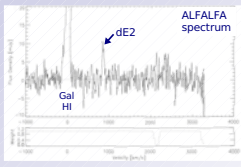


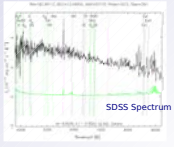
Examples of two galaxies in the Virgo Cluster that have no optical counterparts. (Kent et al. In prep.)



HI Detections of Virgo Dwarf Ellipticals/Spheroidals







Superposed on a map of Virgo Cluster members, with symbol size scaled by luminosity (Binggeli, Sandage, & Tammann 1987), are the locations of candidate dE/dS0 ALFALFA detections from the northern (Giovanelli et al. 2007, submitted) and southern (Kent et al. 2007, in prep.) regions of the Virgo Cluster. Also included are the locations of two galaxies with no optical counterparts (see images at left).