ALFALFA OBSERVATIONS

THE VIRGO CLUSTER AND ITS ENVIRONS

Brian R. Kent, Cornell University

Riccardo Giovanelli, Martha P. Haynes, Amélie Saintonge, Sabrina Stierwalt (Cornell University)

Barbara Catinella, Emmanuel Momjian (NAIC), Noah Brosch (Wise Obs.)

G. Lyle Hoffman (Lafayette), Jessica L. Rosenberg (CfA)

ABSTRACT

The extragalactic HI ALFALFA survey (Giovanelli 2005a and astro-ph/0508301) will map 900 square degrees of the Local Supercluster and yield complete coverage of the entire Virgo cluster. The ALFALFA survey uses the ALFA multibeam feed array and will cover 7000 square degrees of sky. The first observing season with the Arecibo 305m radio telescope in Spring 2005 has yielded a nearly complete dataset over sixty square degrees (12^h < RA < 13^h and $+9^o$ < DEC < $+13^o$), focusing primarily on the region south of the center of Virgo. Gridded data cubes have been produced of bandpass calibrated and RFI-flagged data, resulting in maps with four arcminute resolution and a final integration time of 48 seconds per beam. A catalog of detections has been extracted from the cubes with reliable integrated fluxes, velocity widths, redshifts and positions down to a signal-to-noise ratio threshold of four. These positions have been carefully examined in online optical databases including SDSS DR4 and the Digital Sky Survey, as well as galaxy catalogs such as the Arecibo General Catalog. In addition to testing pre-survey simulations of number density and galaxy distributions in the Virgo region, the HI properties of the derived catalog will be discussed.

This work has been supported by NSF grants AST--0307661 and AST--0435697 and by the Brinson Foundation.

Why Virgo?

- Highest overdensity sample of galaxies in the local universe.
- Nearest rich cluster and close proximity compared to other environments.
- Can distinguish between infall and expansion regions due to known distances from primary and secondary distance indicators.
- Need to have a dynamical understanding of surrounding groups.
- Periphery is important to study as the galaxies there are gas rich – those in the cluster core are not due to interaction with the intracluster gas.

Science Applications in Virgo

- Study of cluster membership and outlying groups (Binggeli 1987).
- Discovery of new gas rich dwarfs and even optically-inert galaxies .
- Study of known and new groups and substructure.
- Discovery of satellite objects with $M_{HI} < 10^{7.5} M_\odot$
- Combined with SDSS DR4 measurements, ALFALFA HI measurements will allow dynamics studies in the cluster and surrounding periphery.
- HI measurements are crucial complements to existing SDSS, 2MASS, and GALEX measurements (see oral session Haynes 192.08).

Highlights: Detections so far

- Among the objects so far are 135 individual detections in 60 square degrees from –800 < *cz* < 7000 km/s. Highlights among these include:
  - *106 objects with previously known redshifts from optical or 21 cm measurements*
  - *11 objects visible in SDSS DR4 imaging, with no prior redshift*
  - *Multiple detections with no apparent optical counterparts*
  - *A new extended detection that may be a new high-velocity cloud or gaseous remnants of galaxy harassment*
  - *An extended dark cloud, mapped with both ALFALFA data and VLA CnD configuration imaging (see posters Giovanelli 179.22 and Spekkens 179.25)*

Future Work for ALFALFA

- Completion of the 900 square degree Virgo region
- Study of the environmental dependency of the HI mass function
- VLA follow-up on various HI detections – extended objects and those lacking apparent optical counterparts.
- Compare known detections with the Digital HI Archive (Springob 2005) and Virgo literature (Binggeli 1993, van Zee 2004)
- See the ALFALFA overview oral session at Giovanelli 192.03

References

- Binggeli, B. et al., 1993, A&AS, 98, 275
- Binggeli, B. et al., 1987, AJ, 94,251
- Chamaraux, et al., 1980, A&A,83,38
- Côté, P., et al., 2004, ApJS, 153,,223
- Giovanelli, R., et al. 2005a, AJ, 130, 2598
- Giovanelli, R., et al. 2005b, AJ, 130, 2613
- Hoffman et al., 2003, AJ, 126, 2774
- Mamon, et al., 2004, A&A, 414, 445
- Moore, et al., 1998, ApJ, 495, 139
- Sabatini, S. et al., 2005, MNRAS, 357, 819
- Sanchis, T. et al., 2004, A&A, 418 393
- Springob, et al., 2005, ApJ, 621, 215
- Wakker, B.P. & van Woerden, H. 1997, ARA&A, 35, 217
- Van Zee, et al., 2004. AJ, 128,121

Gaseous remnants in Virgo?

Galaxy harassment, tidal striping, and ram-pressure striping may be the cause of various gaseous filaments in the Virgo cluster, as small galaxies are stripped of their gas during passes near larger galaxies. Are these gaseous filaments remnants of a morphological transition from spirals with well defined disks to gas-deficient spheriodals? (Moore 1998)

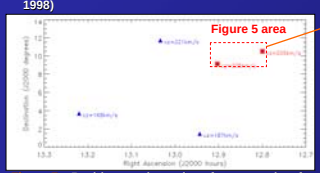
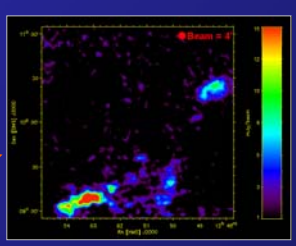


Figure 7. Positions and *cz* values for two peaks of ALFALFA detections ■ and three galactic HVCs ▲ from the catalog of Wakker et al. (See review Wakker 1997)



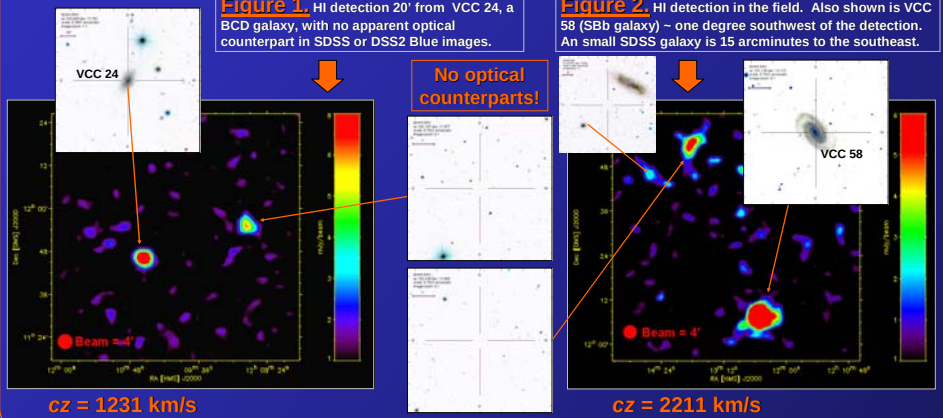
cz = 205 km/s

Figure 6. High-velocity cloud in the Milky Way periphery or remnants of galaxy harassment in the Virgo cluster? These extended gaseous structures play an important part in the understanding of the cluster dynamics and evolution.

21 cm detections with no apparent optical counterparts

Figure 1. HI detection 20' from VCC 24, a BCD galaxy, with no apparent optical counterpart in SDSS or DSS2 Blue images.

Figure 2. HI detection in the field. Also shown is VCC 58 (SBb galaxy) ~ one degree southwest of the detection. An small SDSS galaxy is 15 arcminutes to the southeast.



cz = 1231 km/s

cz = 2211 km/s

4° x 15° SDSS mosaic showing the sky coverage for this study. Figures in this poster are indicated by the numbered labels.

Quick Stats

21 cm data

- 60 square degrees (4 deg x 15 deg)
- -800 < *cz* < 7000 km/s
- Effective integration : t_{int} = 48 sec/beam
- 4 arcminute resolution

New 21 cm detections in the Virgo periphery and beyond. . .

Below are galaxies that are clearly visible in SDSS DR4 imaging, but have no published redshift information (21cm or otherwise)

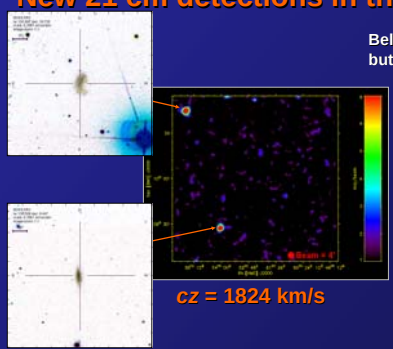
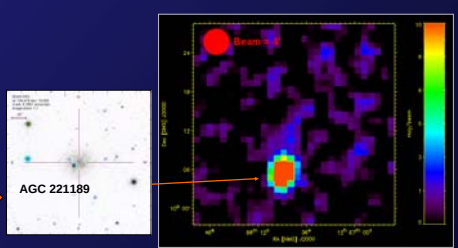


Figure 3. Two small galaxies with HI, clearly shown in SDSS DR4, but not targeted for spectroscopy.

cz = 1824 km/s

Figure 4. A new HI detection of a small galaxy AGC 221189 with no previously known redshift.



cz = 6728 km/s

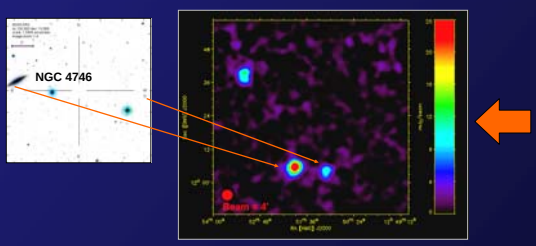


Figure 5. A new HI detection of a small dwarf irregular galaxy (MAPS O_497_0345489) in the vicinity of NGC 4746 (Sabatini 2005)

cz = 1811 km/s

The NASA/IPAC Extragalactic Database (NED) is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA.

The Arecibo Observatory is part of the National Astronomy and Ionosphere Center, which is operated by Cornell University under a cooperative agreement with the National Science Foundation.

ALFALFA

Visit ALFALFA on the web @ http://egg.astro.cornell.edu/alfalfa/