

Complex Structure in the ALFALFA HI Distribution around Virgo HI21

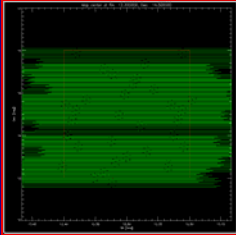
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Introduction

One of the principal drivers of the ALFALFA survey is the exploration of the dynamics of the Virgo cluster and its environs via the cataloguing of all of its gas-rich members and the tracing of disruptive events through the HI remnants they leave behind. The wide area coverage provided by ALFALFA is ideal for the study of extended source structures, and its sensitivity, bandwidth, and resolution (both angular and spectral) allow the detection of HI over the full Virgo redshift range as well as the identification of gas-rich background objects. Several companion posters discuss other aspects of the 2005 ALFALFA dataset covering parts of Virgo: 179.20, 179.22 and 179.25. Here, we present results from the preliminary analysis of the ALFALFA 2005 dataset covering a 3° by 3° field centered at R.A..Dec(J2000) = $12^h18^m, +14^\circ30'$. Lying on the periphery of the dense X-ray gas, this region is rich in spiral galaxies and also includes the enigmatic HI cloud VirgoHI21, suggested by Davies *et al* (2004, MNRAS 349, 922) and Minchin *et al* (2005a, ApJ, 622, L21; see also poster 188.13) to be a starless "dark" cloud.

The Dataset

ALFALFA is a drift scan survey employing the 7-beam Arecibo L-Band Feed Array (ALFA). Two separate drift passages of each sky position are made, separated by 3-9 months, to aid in the discrimination of radio frequency interference (RFI) from cosmic sources.



Coverage of the ALFALFA dataset. Each point indicates a time sample in drift scan mode.

The data cubes used for the present analysis were constructed from the spring 2005 ALFALFA data and do not represent a complete dataset. In particular, several second passes have not yet been performed and several drift sequences were corrupted by RFI. The left panel illustrates the coverage, and its current state of incompleteness. Further observations are scheduled over the next month.

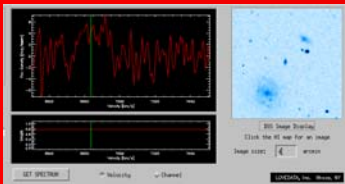
Data Processing

Data processing makes use of the ALFALFA-IDL pipeline.

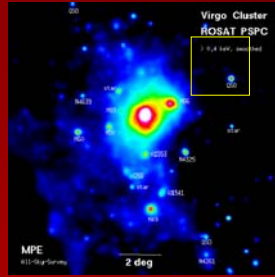
Identification of sources is performed both visually (strong sources) and using both a Fourier domain signal extraction technique applied to both 2-D and 3-D datasets. This algorithm is described in the accompanying poster by Amélie Saintonge (187.02). Here, the full power of the signal extraction has not been applied due to the current incompleteness of the dataset.

Beyond Virgo

The 100 MHz bandwidth employed by ALFALFA delivers a usable spectral window corresponding to HI redshifts from -500 to +17,000 km/s. ALFALFA detects lots of gas-rich late-type galaxies belonging to structures behind Virgo.



Example of a 2MASS object detected at $cz \sim 6840$ km/s -- which just happens to lie halfway between two late-type Virgo galaxies, VCC79 (upper right) and NGC 4192a ($cz \sim 2075$ km/s; lower left)



ROSAT image of the Virgo Region
Böhringer *et al* (1994 Nature 368, 828)

NGC 4254

- Prominent one-armed spiral structure
- Asymmetric HI distribution reported by Phookun *et al* 1993, ApJ 418, 113

cz : 2406 km/s
Type: Sc



DSS Blue image

- Possibly infalling into cluster (Vollmer *et al* 2005, A&A 439, 921)

VirgoHI21

- Discovered first in HIJASS (Davies *et al* 2004), and confirmed through Arecibo single pixel observations (Minchin *et al* 2005a)
- Minchin *et al* (2005b astro-ph/0508153) have acquired a new WSRT map of VirgoHI21. Of most significance, the velocity width of the HI is ~ 200 km/s. Minchin *et al* interpret this as rotation; there is no optical counterpart.

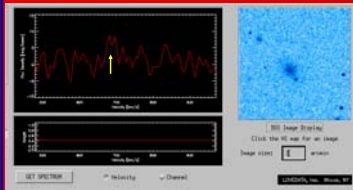
ALFALFA looks at VirgoHI21

ALFALFA is sensitive to extended, low surface brightness structures which can be resolved out by interferometers.

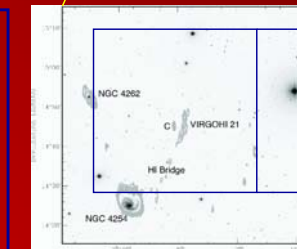
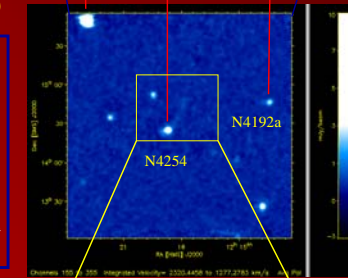
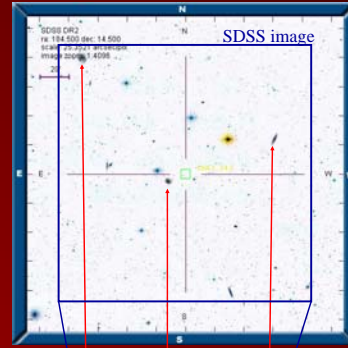
ALFALFA image of HI from NGC4254 northward shows the connection to VirgoHI21 clearly. This image shows emission integrated over the velocity range of both NGC 4254 and VirgoHI21.

Low mass galaxies in Virgo

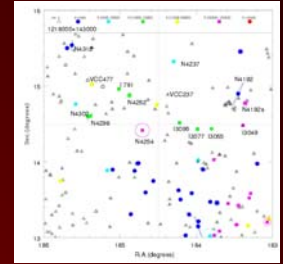
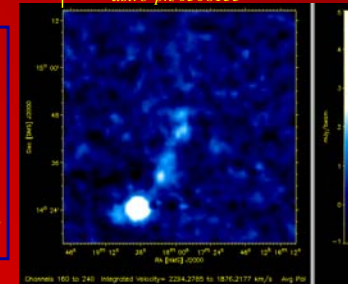
ALFALFA is designed to detect low mass galaxies in the local universe



HI detection of VCC168 at +680 km/s. At the Virgo distance, the HI mass is $2.3 \times 10^7 M_\odot$.



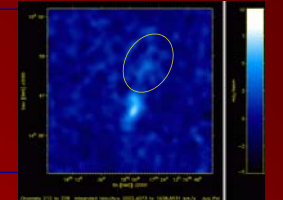
WSRT image of VirgoHI 21 Region
Minchin *et al* (2005b) astro-ph/0508153



Distribution of optically known galaxies in the ALFALFA field.

Complexity in Virgo

- On the edge of the X-ray emission
- Southern portion contains many galaxies at $cz < 500$ km/s, likely members of Virgo Cloud A
- Galaxy density is high
- 35 objects in field clearly detected by ALFALFA (at current sensitivity) in Virgo redshift range

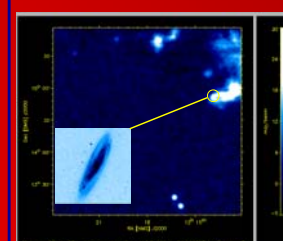


ALFALFA image of VirgoHI 21 alone, smoothed to highlight the apparent low surface brightness extension northward

Dark Cloud or Debris?

- Low surface brightness emission appears to extend to the north of the main body.
- The total extent of the HI is > 30 arcmin (150 kpc at Virgo).
- There are several distinct clumps.
- VirgoHI21 is complex and the region is complicated.

Debris in Virgo or Milky Way HVC?



The only extra-galaxy HI in the velocity window (+91,+143) km/s over the entire field appears to emanate from one edge of NGC 4192.

NGC 4192, a large, massive spiral, has a recessional velocity of -135 km/s. At its southeast edge (+ velocities), the HI warp joins the positive HVC 263+75+101 (Wakker & van Woerden 1991 A&A 250, 509). The HI feature is very broad (80 km/s). Positive velocity HVC's are rare in the northern galactic hemisphere and even more rare are HVC's that broad in velocity.

ALFALFA



The Arecibo Legacy Fast ALFA (ALFALFA) Survey will map 7000 square degrees of high galactic latitude sky visible with the Arecibo telescope. See <http://egg.astro.cornell.edu/alfalfa> for survey details. The ALFALFA team is an open collaboration of more than 50 researchers from 34 institutions in 13 countries. This work was supported in part by NSF grants AST-0307661 and AST-0435697 and by a grant from the Brinson Foundation.