ALFALFA: The Arecibo Legacy Fast ALFA Survey
The January 2011 Undergraduate ALFALFA Team Workshop
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Catherine Weigel	Hartwick College ('12)
Jenn Cooper	Cornell University ('13)
Matthew Dunlap	George Mason University ('11)
Melissa Abler	Universtiy of Wisconsin - Madison ('13)
Melanie Amason	West Texas A&M ('11)
Carla Bacco	Humboldt University ('11)
Alexander Bahr	Universtiy of Wisconsin - Stevens Point ('12)
Stephen Ball	Saint Mary's College of California ('13)
Elizabeth Charpentier	Skidmore College('11)
Heather Cutler	St. Lawerence University ('12)
Halley Darling	Union College ('13)
Colby Dennis	West Texas A&M ('12)
Alissa Earle	Sienna College ('13)
Adina Micula	Skidmore College('14)
Steven Mohammed	Colgate University ('11)
Daniel Ngyuen	Saint Mary's College of California ('13)
Jaclyn Patterson	Hartwick College ('12)

Abstract

The Arecibo Legacy Fast ALFA (ALFALFA) survey is a blind extragalactic HI survey that is aiming to map an area of 7000 deg^2 covering a declination range 0° to +36°. The 2011 Undergraduate ALFALFA Team Workshop will take place January 17-19 at the Arecibo Observatory, where undergraduates and their faculty mentors will gain research experience through contribution to the ALFALFA survey. Three drifts will be observed with right ascensions and declinations of 09^h04^m-13^h49^m (J2000) and +322906, 08^h53^m-13^h38^m and +332730, and 08^h56^m-13^h42^m and +325818 , selected from the ALFALFA master drift list. The drifts are located north of the Virgo Cluster, covering structures including the Leo supercluster and groups such as Canes Venatici.

Introduction

The 21-cm emission line provides vital information such as mass, speed, and neutral hydrogen (HI) content. At 1420 MHz, this wave can penetrate cosmic dust, producing a survey of HI-containing objects that is less biased than an optical survey. The Arecibo Legacy Fast ALFA (ALFALFA) multi-year survey plans to cover 7000 deg^2 of extragalactic area with right ascension ranging from 07^h30^m-16^h30^m and 22^h00^m-03^h00^m and declination spanning from 0 to 36 degrees (Giovanelli et al. 2005). In comparison to other HI surveys such as HIPASS and HIJASS, the large diameter of Arecibo and 7 beam coverage of ALFA increases sensitivity and sky coverage significantly.

This ongoing study hopes to identify and catalog 35,000 objects to be examined by the scientific community. Information gathered will also help piece together the evolution of gas-rich galaxies and may contribute data to investigate the missing satellite problem (*e.g.*, Kauffmann et al. 1993). The survey's wide aerial coverage,

sensitivity, and spectral resolution will be used to study diverse regions such as the Virgo Cluster to provide unique, unbiased data (Haynes et al. 2008). Four catalogs have been produced of observations in various regions of the sky (Giovanelli et al. 2007; Saintonge et al. 2008; Kent et al. 2008; Martin et al. 2009).

Prime targets for the project are galaxies in dense environments. For example, the Virgo Cluster contains approximately 2,000 known objects (Binggeli et al. 1985) enabling the study of the evolution of galaxies and environmental interactions. The full sky coverage of the survey will make possible the study of the HI content of galaxy groups with a wide range of properties, which can be compared with galaxies in cluster and field environments for a better understanding of environmental effects.

A part of the ALFALFA survey is the Undergraduate ALFALFA Team (UAT) Groups Project. This project has undergraduates work alongside faculty mentors in analyzing an assigned galaxy group with data provided from the ALFALFA survey and any literature on the group. Each institute studies their individual group's properties (mass, size, velocity, etc.) and any interactions between the galaxies. The groups vary in density and HI gas content, providing a wide range of environments to explore. The institutions currently involved in the UAT Groups Project are Colgate, Cornell, Georgia Southern, Hartwick, Lafayette, St. Lawrence, St. Mary's College of California, Sienna, Skidmore, Union, and University of Wisconsin-Stevens Point.

The fourth NSF-sponsored ALFALFA Undergraduate workshop will host students and their faculty advisers from 14 institutions and allow them to be a part of this large scale research project in the scientific community. This opportunity will provide training to operate the world's largest radio telescope and insight on the inner workings of ALFALFA.

Observations and Data Reduction

The ALFALFA two-pass strategy will be employed by the undergraduate team on a fixed-azimuth drift scan. The combination of these techniques will greatly reduce RFI inclusion while taking advantage of minimum intrusion (Giovanelli et al. 2005).

Observations will be carried out on the nights of January 17^{th},18^{th}, and 19^{th}. The telescope will be centered on a declination given by the master drift list and the range of right ascension is determined by the time and duration of the scan. A summary of the observations is included in Table 1.

Date	Time of Observation (AST)	Center Declination	Range of Right Ascension	Range of Declination
Jan 17	01:45 to 06:30	+322906	09h04m to 13h49m	+322042 to +323730
Jan 18	01:30 to 06:15	+332730	08h53m to 13h38m	+331906 to +333554
Jan 19	01:30 to 06:15	+325818	08h56m to 13h42m	+324954 to +330642

Table 1: **Sky covered by ALFALFA during undergraduate workshop.**

The undergraduate team will be guided through the data reduction process by experienced students and faculty familiar with the current ALFALFA reduction software.

Focus of Observations

The observations to be carried out are to complement the ALFALFA survey by introducing new data in which galaxy evolution can be studied. The region these drifts cover is north of the Virgo cluster in declination, including galaxies within the Leo supercluster. It is an area that contains galaxy groups and clusters that can be studied in order to better understand galaxy-galaxy interactions through tidal interactions. This is the first pass of this region, which allows new galaxies to be catalogued and studied.

Within this region is a target of prime interest, the galaxy group NGC 4631 also known as the Canes Venatici Group. The group has 78 members that have been studied to understand star formation rates in galaxies

with minimal interactions (Kaisin et al. 2008). Within the group is the starburst galaxy NGC 4631. It has two companion galaxies, NGC 4627 and NGC 4656 (Rand 1994). NGC 4631 has two HI shells and both the inner disk and outer galaxy contribute to star formation within the galaxy. The system around NGC 4631 also includes three dwarf galaxies with HI emission. These dwarf galaxies can be seen with NGC 4631 along with one of its companion galaxies, NGC 4656, in Figure 1. A SDSS spectrum of NGC 4631, as shown in Figure 2, has a strong Hα line, indicating continuous star formation. Upon studying this region, ALFALFA will be able to look at not only NGC 4631 and its companions but also the other members in the group.

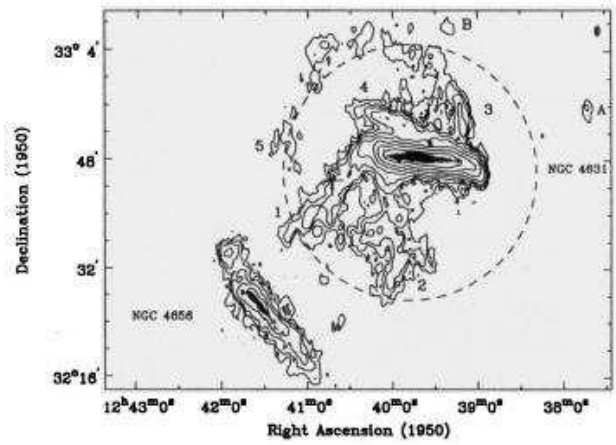

Figure 1: **HI contour of NGC 4631, NGC 4656 and the three dwarf galaxies indicated with symbols A, B, and + from Rand (1994).**

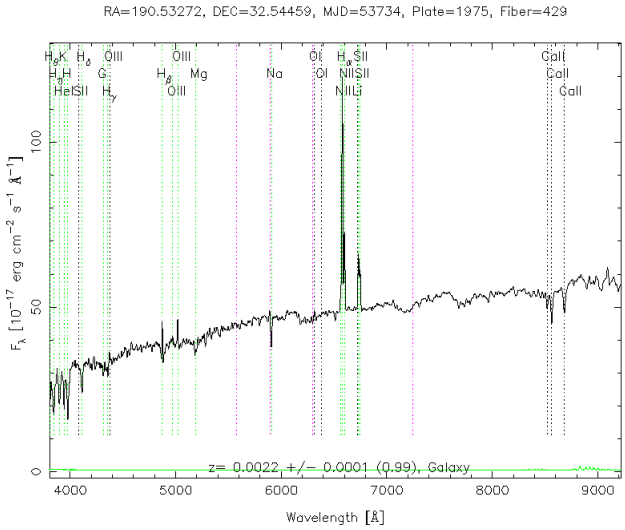

Figure 2: **Spectrum of NGC 4631 from SDSS (York et al. 2000).**

Also within this area are the two interacting galaxies NGC 3396 (UGC 5935) and NGC 3395 (UGC 5931). The interaction between the two galaxies affects the smaller NGC 3396 which was determined by the galaxy's rotation curve (Garrido et al. 2002). Garrido et al. has taken HI data which shows the tidal interactions between the two. With the data taken by ALFALFA, further analysis of these galaxies and those around it can be obtained.

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