Progress Report and Request for Continuation of the ALFALFA Survey
01Aug2007

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Overview: ALFALFA, the Arecibo Legacy Fast ALFA Survey, is a two-pass spectral line survey to cover 7000 deg^2 of high galactic latitude sky, with ∼8 times the sensitivity, 4 times the angular resolution, 3 times the spectral resolution, and 1.6 times the total bandwidth of HIPASS. The effective integration time is 40 sec per beam area, yielding approximately 2.2 mJy at 10 km s^{-1}resolution (after Hanning). The survey is intended to map, with complete 2-pass coverage, the region from 0° to +36° in declination and from 22^h <R.A.< 3^h (the "fall sky") and 7^h30^m <R.A.< 16^h30^m (the "spring sky"). The fixed azimuth, "minimum intrusion" observing technique that ALFALFA employs delivers high data quality and extremely high observing efficiency. Because of its wide areal coverage and photometric accuracy, ALFALFA is providing a legacy dataset for the astronomical community at large, serving as the basis for numerous studies of the local extragalactic Universe. The survey was initiated in February 2005; as of Aug. 1, 2007, 44% of the survey area has been fully mapped. After the completion of the Spring 2006 season last summer, we were able to begin in earnest the production and extraction of sources from grids in the region of the Virgo cluster. Two catalogs extracted from the Level II data (data cubes or "grids") containing 1169 detections have been published or submitted (Giovanelli *et al.* 2007, Saintonge *et al.* 2007) and four other catalogs containing more than 4000 detections are in the final stages of preparation (Kent *et al.*; Stierwalt *et al.*; Haynes *et al.*; Giovanelli *et al.*). Four other papers containing science results have been published or submitted to refereed journals (Saintonge 2007; Kent *et al.* 2007; Haynes *et al.* 2007; Di Serego Alighieri *et al.* 2007); two papers based on our precursor observations were published in 2005 (Giovanelli *et al.* 2005a,b). Invited talks at international symposia have been presented by Giovanelli (Santiago 2006; Amsterdam 2006; Spineto 2007; Cardiff 2007; Venice 2007), Haynes (Amsterdam 2006, Charlottesville 2007; Cardiff 2007; Venice 2007) and Kent (Cardiff 2007), plus a number of poster presentations and invited colloquia have been given by other consortium members. Precursor ALFA data and archival pointed HI observations for 9000 galaxies are available as a node of the Virtual Observatory at the Cornell Theory Center (CTC); this is already the largest collection of digital HI galaxy spectra in existence. Team members have web access to preliminary, searchable source catalogs for the planning and execution of multiwavelength followup observations. These SQL searchable databases and plotting tools are made public when their associated presentation papers are accepted for publication (by VO requirement). The data reduction, signal extraction and ancillary software has been exported to 15 sites where it is in regular use by team members. Well-developed documentation and hands-on training in observation and reduction techniques are provided to new members by ALFALFA experts at Cornell to insure commonality of standards. The ALFALFA dataset has already served as the basis of seven undergraduate senior thesis projects. Seven graduate students (6 at U.S. institutions) are fully engaged in ALFALFA thesis research; the first ALFALFA-centered Ph.D. thesis has been completed (Saintonge 2007); four other graduate students, more junior, have participated in observations and are formulating thesis plans. Attracted by the initial ALFALFA results, the ALFALFA consortium continues to grow with the addition of new members who seek to be engaged in the team observations at Arecibo, in complementary observations performed or planned using a number of other telescope facilities, and in performing relevant numerical simulations. It might be noted that ALFALFA survey efficiency is extremely high: with the exception of hardware failures, science data are acquired during ∼ 97% of each assigned observing block. A number of new proposals have been submitted to AO by *new users* as a result of interest stimulated by their participation in ALFALFA. Furthermore, the galactic TOGS program has run commensally with ALFALFA since August 2005, with the observing burden for TOGS borne by the ALFALFA team. In all respects, we believe ALFALFA is living up to its promise, and moreover, is now delivering legacy science.

We provide below relevant URLs of ALFALFA documents/websites previously submitted to NAIC.

- ALFALFA Survey proposal, 15Oct2004, with the complete science justification
  http://egg.astro.cornell.edu/alfalfa/docs/alfalfaprop.pdf
- ALFALFA Year 1: Midterm Report, 15Aug2005
  http://egg.astro.cornell.edu/alfalfa/docs/midterm_report_2005.pdf
- ALFALFA A2010 Spring (Jan-Jun) 2006 Additional Time Request, 18Aug2005
  http://egg.astro.cornell.edu/alfalfa/docs/req_spring2006.pdf
- ALFALFA A2010 Request/plan for the year starting 01 Jul 2006, 26Jan2006
  http://egg.astro.cornell.edu/alfalfa/docs/req_feb06.pdf

- ALFALFA A2010 Request/plan for the year starting 01 Jul 2007, 01Feb2007
http://egg.astro.cornell.edu/alfalfa/docs/req_feb07.pdf
- ALFALFA survey public website
http://egg.astro.cornell.edu/alfalfa/
- ALFALFA survey publications page
http://egg.astro.cornell.edu/alfalfa/pubs.php
- ALFALFA observing team website
http://www.naic.edu/∼a2010/galaxy_a2010.html
- Cornell HI digital archive website
http://arecibo.tc.cornell.edu/hiarchive
- ALFALFA public catalog archive at Cornell Theory Center
http://arecibo.tc.cornell.edu/hiarchive/alfalfa

ALFALFA is an *open collaboration*, administered through a simple set of guidelines for joining, spinoff project definition, development and publication (see *http://egg.astro.cornell.edu/alfalfa/joining.php*), with an Oversight Committee of 6 individuals which includes a graduate student and a representative of a foreign institution.

In this document, we provide information which specifically outlines progress in the last year, update our Progress Report submitted on 01Feb07 and propose a plan and request for continuation of ALFALFA for the year commencing 01Aug07.

First ALFALFA Science: Two catalogs of HI sources extracted from 3-D spectral data cubes have been submitted for publication in the first half of 2007. The first (Giovanelli *et al.* 2007) is in the public domain. In that work, 730 HI detections are cataloged and optical counterparts assigned, within the solid angle $11^h44^m <$ R.A.(J2000) $< 14^h00^m$ and $+12^\circ <$ Dec.(J2000) $< +16^\circ$ (which includes the northern part of the Virgo cluster), and redshift range -1600 km s^{-1} $< cz < +18000$ km s^{-1}. In comparison, the HI Parkes All-Sky Survey (HIPASS) detected 40 HI sources in the same region, 2 of which are unconfirmed by ALFALFA. ALFALFA HI detections are reported for three distinct classes of signals: (a) detections with signal-to-noise ratio S/N > 6.5; (b) high velocity clouds in the Milky Way or its periphery; and (c) signals of lower S/N (to ~ 4.5) which coincide spatially with an optical object of known, matching redshift. Although this region of the sky has been heavily surveyed by previous targeted observations based on optical flux– or size– limited samples, 69% of the extracted sources are newly reported HI detections. The positional accuracy of HI sources depends on source S/N: it averages $24''$ ($20''$ median) for all sources with S/N > 6.5 and is $\sim 17''$ ($14''$ median) for signals S/N > 12. The median redshift of the sample is $\sim$7500 km s^{-1} and its distribution reflects the known local large scale structure. Distance uncertainties in and around the Virgo cluster perturb the derived HI mass distribution and suggest a population of low mass objects in the Virgo foreground; these will be targets of redshift-independent distance measures. A first analysis of HI emission from Virgo ellipticals has been submitted by di Serego Alighieri *et al.*; this study is being followed by X–ray observations to study the evolution of the cold/warm gas in early–type systems. A study of the structure of all gas–rich dwarfs ranging from dI to dE in the Virgo cluster is in preparation by Koopmann *et al.*. A small percentage (6%) of HI detections have no identifiable optical counterpart, 2/3 of which are high velocity clouds in the Milky Way vicinity; the remaining 17 objects do not appear to have a clear optical counterpart. The nature of these sources is discussed in two papers in press (Kent *et al.* 2007; Haynes *et al.* 2007). Notably, the latter of the two refutes the interpretation of Virgo HI21 as a "dark galaxy" (Minchin *et al.* ApJ in press). As the far superior ALFALFA map illustrated in Figure 1 clearly shows, Virgo HI21 is only one condensation in a tidal appendage of the bright spiral NGC 4254. The most likely interpretation of the galaxy's asymmetry, its very extended HI tail and the origin of Virgo HI21 is an on-going process of galaxy harassment, resulting from the high speed gravitational perturbations experienced by NGC 4254 as it enters the Virgo cluster. Several additional events of such harassment have been likewise mapped by ALFALFA elsewhere in the outskirts of the Virgo cluster, in the form of tidal streams extending up to 500 kpc, as in the case of the NGC 4532 (Koopmann *et al.* 2007, in preparation) and NGC 4192 (Giovanelli *et al.* 2007, in preparation).

One of the principal aims of ALFALFA is the robust determination of the faint end slope of the HI mass function. Past estimates have been severely limited both by small number statistics and by systematics associated with both distance uncertainties and cosmic variance. Because it will survey a cosmologically significant volume, ALFALFA will deliver parameters associated not only with the HI mass function but also the HI correlation function and its bias parameter at $z = 0$. Already ALFALFA has detected more objects with

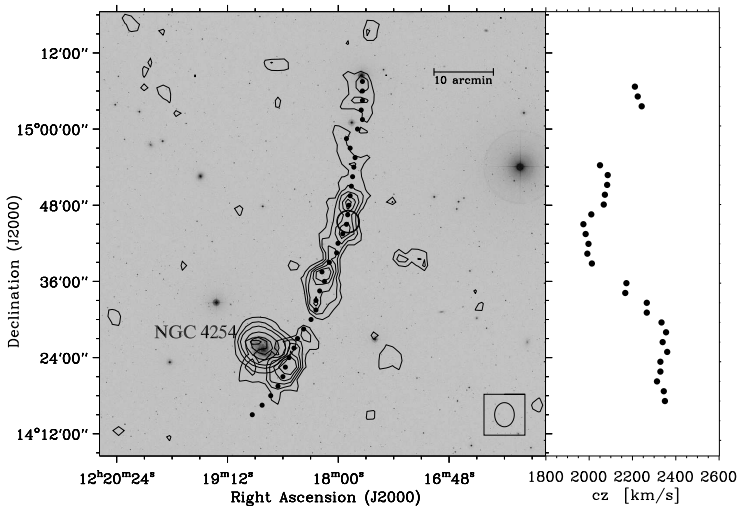

Figure 1: Left: HI flux contours from the ALFALFA survey dataset superposed on a DSS2 Blue image. The 36 filled dots indicate the locations of beam centers for the successive LBW observations. The contours centered on NGC 4254 are at 10, 15, 20, 30, and 40 Jy beam^{-1} km s^{-1}, integrated from 2259 to 2621 km s^{-1}. The contours for the HI stream are at 0.35, 0.52, 0.70, 0.87, and 1.0 Jy beam^{-1} km s^{-1}, integrated from 1946 to 2259 km s^{-1}. The 3′ circle in mid stream indicates the position of Virgo HI21 from Minchin *et al.* (2007). The ellipse on the bottom right indicates the size of the Arecibo beam. Right: The velocity of the HI emission peak from the LBW pointings. See Haynes *et al.* 2007.

HI masses $< 10^8$ than were detected in the entire HIPASS survey, but determination of the most interesting parameters requires the volume sampled by the full ALFALFA survey. In the meantime, a number of studies are underway by ALFALFA team members to investigate the nature of the lowest HI mass galaxies, their star formation rates and histories, the processes by which star formation is triggered within them and their galactic environments. Figure 2 shows one such object, a previously uncatalogued dwarf galaxy with a heliocentric velocity of only +280 km s^{-1}; it is a likely member of a group at a distance of 7.2 Mpc. As such low mass objects are identified by ALFALFA, coordinated followup observations by ALFALFA team members quickly deliver broadband and Hα images (WIYN: van Zee, Salzer; SMARTS: Koopmann; Wise Obs: Brosch; San Pedro Martir: Gavazzi) nebular abundances (Palomar 5m: Saintonge) and HI synthesis maps (GMRT: Begum; VLA: Kent, Momjian, Spekkens and Stierwalt).

Including recently extracted but yet unpublished data, Figure 3 shows a cone diagram of the 2700 ALFALFA sources extracted from a sky strip extending between $7.5^h <$ R.A. $< 16.5^h$, $+12° <$ Dec. $< +16°$. The richness of the large scale structure in that direction is evident; comparison and cross-correlation of the structures seen in ALFALFA with those traced by SDSS and 2MASS are underway. Figure 4 shows the HI mass versus distance distribution of those sources: superimposed are two smooth curves, representing the HIPASS completeness limit (dotted) and the HIPASS detection limit (dashed). The vast majority of the sources detected by ALFALFA would not be detected by a HIPASS–like survey. Figure 4 shows the independence of S/N on velocity width of detections and the expected dependence of flux integral on width, corroborating simulations carried out in preparation for the survey. The sky area of ~ 525 deg^2 of this data set corresponds to 7.5% of the total survey solid angle. The detection rate averaging ~ 5 HI detections per deg^2 reaches peaks of 16 in regions of high galaxy density such as clusters (the global average of 5 is only very mildly affected by the inclusion of the Virgo cluster). These values are significantly higher than expected from scaling relations applied to previous surveys when allowance is made for relative sensitivity and spectral coverage, an indication of the superior data quality and signal extraction technique of ALFALFA. In addition, we are able to identify unambiguous optical counterparts for more than 95% of all ALFALFA sources. A preliminary statistical result emerging with increasing significance from ALFALFA is that *there does not appear to exist a cosmologically important population of optically dark, cold baryon–rich galaxy halos.*

Based on these initial results, ALFALFA is expected to fulfill, and even exceed, its predicted performance objectives in terms of the the number and quality of HI detections. A number of other papers including a second Virgo region catalog release, further study of the Virgo cluster and several enigmatic HI streams discovered within it, are in progress with submission planned by the end of 2007. The submission of papers

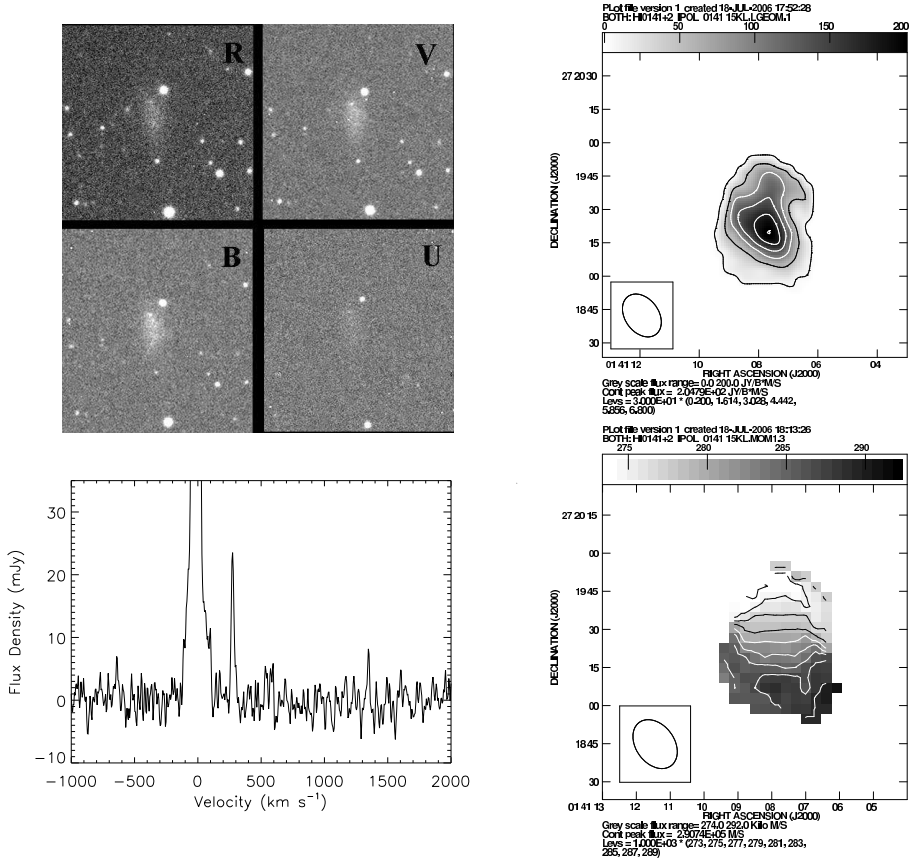

Figure 2: Followup observations of the low mass galaxy HI0141+27 (AGC 112521) discovered by ALFALFA. Lower left: original ALFALFA spectrum. Upper left: Broad-band images obtained with the WIYN 0.9m telescope. Upper right: GMRT Moment 0 map. Lower right: GMRT Moment 1 map. Unlike most dwarf galaxies which are dark-matter dominated, the dynamical mass inferred from the GMRT synthesis map within the boundary of the HI emission can be accounted for, within a factor of two, by the baryonic mass (HI and stars). A Palomar spectrum of two HII regions yields an oxygen abundance, 12+log(O/H) = 7.54, implying that the galaxy is metal poor (Saintonge Ph.D. thesis).

to refereed journals is currently rising to a high rate, which will be maintained through the next several years as ALFALFA data processing has entered "steady state" and numerous follow–up projects initiate.

ALFALFA Refereed Papers to Date: (see *http://egg.astro.cornell.edu/alfalfa/pubs.php*)

"The HI Content of Early-Type Galaxies from the ALFALFA survey: I. Catalogued HI sources in the Virgo Cluster" di Serego Alighieri, S., Gavazzi, G., Giovanardi, C., Giovanelli, R., Grossi, M., Haynes, M.P., Kent, B.R., Koopmann, R.A., Pellegrini, S., Scodeggio, M. & Trinchieri, G. 2007, A.Ap., submitted

"The Arecibo Legacy Fast ALFA Survey: V. HI Source Catalog of the Anti-Virgo Region at Decl. = +27°" Saintonge, A., Giovanelli, R., Haynes, M.P., Brosch, N., Hoffman, G.L., Kent, B.R., Martin, A.M., & Stierwalt, S. 2007, A.J., submitted

"NGC 4254: An Act of Harassment Uncovered by the Arecibo Legacy Fast ALFA Survey" Haynes, M.P., Giovanelli, R. & Kent, B.R. 2007, Ap.J.(Lett), in press

"Optically Unseen HI Detections towards the Virgo Cluster detected in the Arecibo Legacy Fast ALFA Survey" Kent, B.R., Giovanelli, R., Haynes, M.P., Saintonge, A., Stierwalt, S., Balonek, T., Brosch, N., Catinella, B., Koopmann, R.A., Momjian, E.& Spekkens, K. 2007, Ap.J.(Lett), in press

"The Arecibo Legacy Fast ALFA Survey: III. HI Source Catalog of the Northern Virgo Cluster Region" Giovanelli, R., Haynes, M.P., Kent, B.R., Saintonge, A., Stierwalt, S., Altaf, A., Balonek, T., Brosch, N., Brown, S., Catinella, B., Furniss, A., Goldstein, J., Hoffman, G.L., Koopmann, R.A., Kornreich, D.A., Mahmood, B.,

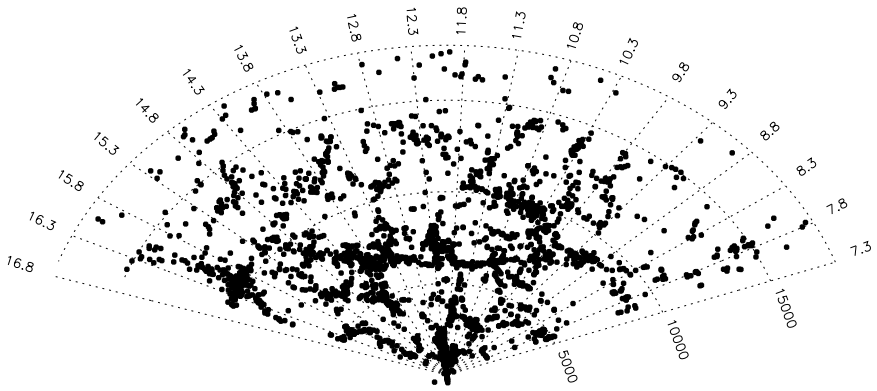

Figure 3: Cone diagram of 2700 ALFALFA sources in the region $7.5^h <$ R.A. $< 16.5^h$, $+12^\circ <$ Dec. $< +16^\circ$.

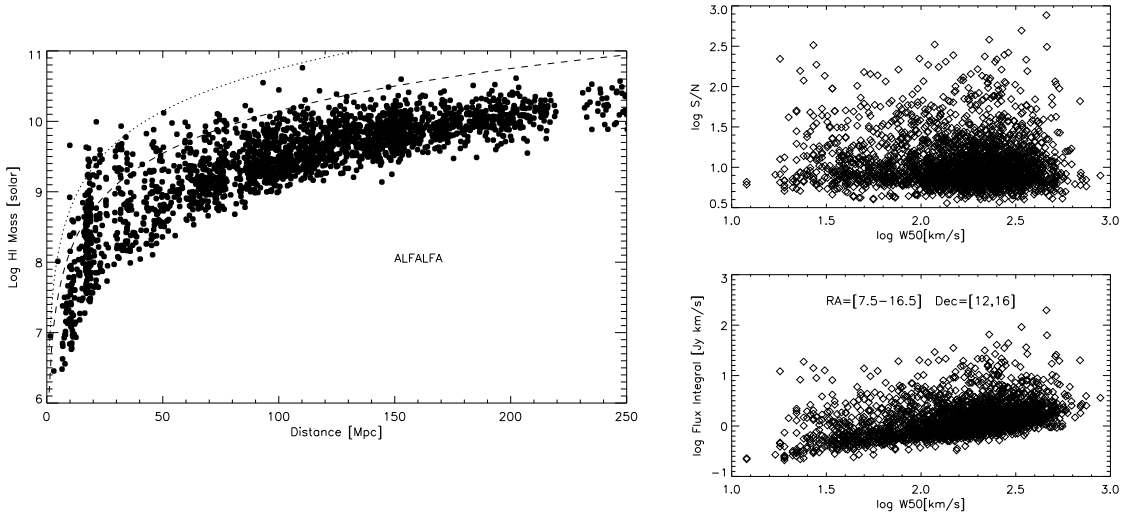

Figure 4: HI mass vs. distance distribution of HI sources in Figure 3. Curves show HIPASS completeness (dotted) and absolute detection (dashed) limits. S/N vs. velocity width (upper right) and integrated flux vs. width (lower right) for HI sources in Figure 3.

Martin, A.M., Mitschang, A., Momjian, E., Nair, P.H., Rosenberg, J.L. & Walsh, B. 2007, A.J., 133, 2569

"The Arecibo Legacy Fast ALFA Survey: IV. Strategies for Signal Identification and Survey Catalog Reliability" Saintonge, A. 2007, A.J., 133, 2087

"The Arecibo Legacy Fast ALFA Survey: II. Results of Precursor Observations" Giovanelli, R., Haynes, M.P., Kent, B.R., Perillat, P., Catinella, B., Hoffman, G.L., Momjian, E., Rosenberg, J., Saintonge, A., Spekkens, K., Brosch, N., Masters, K.L., Springob, C.M., Karachentsev, I.D., Karachentseva, V.E., Koopmann, R.A., Muller, E., van Driel, W. & van Zee, L., 2005, A.J., 130, 2613

"The Arecibo Legacy Fast ALFA Survey: I. Science Goals, Survey Design and Strategy" Giovanelli, R., Haynes, M.P., Kent, B.R., Perillat, P., Saintonge, A., Brosch, N., Catinella, B., Hoffman, G.L., Stierwalt, S., Spekkens, K., Lerner, M., Masters, K.L., Momjian, E., Rosenberg, J., Springob, C.M. plus 25 others 2005, A.J., 130, 2598

A complete list of ALFALFA publications including conference proceedings, invited talks and posters, with links to them, can be found at *http://egg.astro.cornell.edu/alfalfa/pubs.php*.

ALFALFA Highlights since February 2006:

- As of 15Jul2007, Project A2010 has conducted observations during 372 separate observing blocks, totalling about 2197 hours of telescope time; 72 hours have been lost due to equipment failure (not including losses of small blocks due to WAPP failures which require restarting the program). In terms of efficiency, ALFALFA records data continuously, with an "open shutter" rate of 99%. About 5% of the allocated

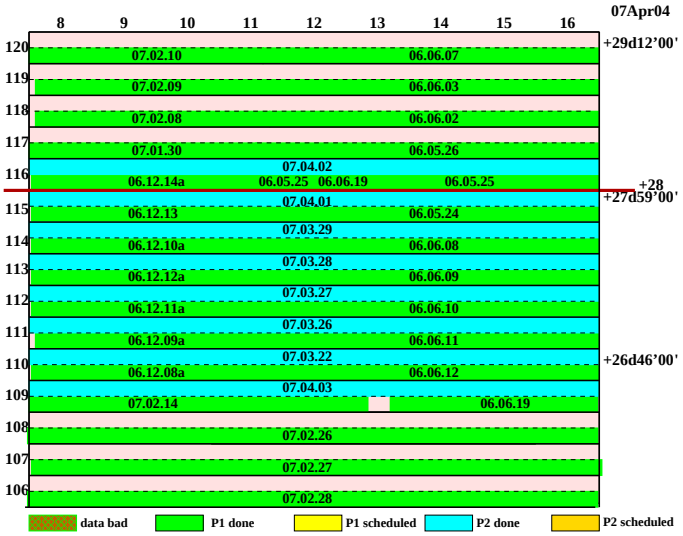

Figure 5: Actual sky coverage for a portion of the spring sky. The left axis indicates the internal "drift number", corresponding to the declination of Beam 0; see *http://egg.astro.cornell.edu/alfalfa/scheds/alfalfa_driftmaster.txt*. The two passes are indicated separately with green shading indicating the first pass, and cyan, the second. The corresponding observing block (designated year.month.date) is indicated. Note that full resolution images for the whole ALFALFA survey region can be found at *http://egg.astro.cornell.edu/alfalfa/scheds/index.php* along with more detailed summary information of completed and planned observations.

time is used for setup and telescope slew time; during another 5% of the time, the allocated LST range is outside of the requested survey solid angle, thus yielding irregular sky coverage. A graphical illustration of the actual map coverage for a region of the spring sky is shown in Figure 5. Completed observations in the two passes are illustrated separately, with green highlighting the first pass, and cyan the second. The superposed text indicates the corresponding observing block (year.month.day). As evident in Figure 5, much of the coverage was obtained in runs shorter than the full 9 hours and over the course of two spring observing seasons. Two-pass coverage of this region is still incomplete so that final grids will not be available until 2008. Full resolution, updated images for the full ALFALFA targeted areas can be found at *http://egg.astro.cornell.edu/alfalfa/scheds/index.php* along with more detail summary information of completed and planned observations.

As illustrated for example in Figure 5, time is often allocated in blocks shorter than optimal for our mapping strategy but of more convenience to the AO scheduler; for A2010, this practice leads to some loss of optimal efficiency and coverage. Of the 372 observing blocks to date, only 186 have covered fully the requested LST range. Smaller blocks are pieced together to produce the map, in practice resulting both in overlaps and gaps with no coverage. We have worked with the scheduler to produce the most efficient coverage within his constraints. The actual allocation within the targeted map region (for which we try to have contiguous coverage) amounts to 1970 hours. This is not 48% of the 4130 hours needed to complete the survey, as extant segments of drifts scans overlap. The *true coverage* of the survey solid angle is presently closer to 44%.

The observing status of ALFALFA (A2010) in different regions of the sky is significantly complicated by the complex juggling required to maximize efficiency of the telescope schedule. The time allocation to date has allowed us sufficient coverage in both passes to construct fully sample grids of the following regions: from $+12°$ to $+16°$ and from $+24°$ to $+32°$ in the fall sky and $+4°$ to $+16°$ in the spring sky; this amounts to only six of the nine 4°-wide bands of tiles we had hoped to have covered since the survey's start. For reference with previous requests for telescope time allocation, we have completed the tiles at $+14°$, $+26°$ and $30°$ (fall) and $+6°$, $+10°$, and $+14°$ (spring), but have not completed the ones included in last year's plan at $+6°$ (fall) and $+26°$ and $+32°$ (spring). Further progress on the spring zones this year was limited by the platform painting project.

- TOGS runs commensally with A2010. In practice, the real-time full burden for running the TOGS calibration is borne by the A2010 observer since it is he/she who executes the TOGS command files both before and after the A2010 observations. We also provide the TOGS team with access to our

observer reports and log files.

- Two workshops for ALFALFA team members were held in summer 2006, one at the Arcetri Observatory (1 Jun 2006) and the other at Cornell (23-24 Jun 2006). Presentations from the latter meeting can be found at *http://egg.astro.cornell.edu/alfalfa/news/mtgs/ithaca06.php*.
- The second undergraduate ALFALFA workshop was held at Union College July 13-14, 2006. See: *http://www.union.edu/PUBLIC/PHYDEPT/koopmanr/ualfaagenda06.php*. In attendance were 13 faculty/researchers and 13 students. New participants included faculty and students from Skidmore College and Rutgers University. As in the previous year, a highlight of this event was a 90 minute remote observing session conducted by the students during the workshop, and as last year, the students were required to submit a plan for the observations in advance. This activity was supported by an NSF grant to Becky Koopmann and a grant from the Brinson Foundation to Martha Haynes. For 2007 activities, see section on "ALFALFA Support Update" below.
- In keeping with the adopted ALFALFA guidelines for the science collaboration, a number of specific science projects, most notably those led by students, have been proposed and approved by the ALFALFA Oversight Committee; more are expected in the coming months. Active project summaries can be found at *http://egg.astro.cornell.edu/alfalfa/projects/projects.php*.
  1. Team projects:
     - *"Blended HI signals from Distant Clusters"*, (Lead: Hoffman)
     - *"H-alpha Imaging of a Volume-Limited Sample of ALFALFA Sources"*, (Lead: Salzer)
     - *"Synthesis Imaging of Low Mass Dwarfs discovered by ALFALFA"*, (Lead: Begum)
     - *"Integrated Spectra of galaxies detected by ALFALFA"*, (Lead: Boselli)
     - *"H-alpha Imaging of ALFALFA Galaxies in Selected Cluster Fields"*, (Lead: Gavazzi)
     - *"ALFALFA survey of the region around ZwCL1400+0949"*, (Lead: Balonek)
     - *"ALFALFA detection of dE/dS0's in Virgo"*, (Lead: Koopmann)
     - *"ALFALFA detections in the region around M33"*, (Leads: Corbelli and Giovanardi)
     - *"ALFALFA as a blind HI absorption line survey"* (Leads: Darling and Momjian)
     - *"GALEX observations of ALFALFA low mass galaxies"* (Lead: Haynes)
     - *"UV Star Formation and HI Content within the ALFALFA volume"* (Lead: Giovanelli)
     - *"High Velocity Clouds in the North Galactic Cap"* (Lead: Giovanelli)
     - *"HI and X-ray properties of Elliptical Galaxies"* (Leads: Di Serego Alighieri, Gavazzi and Trinchieri)
     - *"The structure of the Fastest Rotators"* (Lead: Salucci)
  2. Graduate student projects:
     - *"Properties of low mass galaxies in the ALFALFA survey"*, (Lead: Saintonge, Cornell U.; Adviser: Giovanelli); completed July 2007
     - *"'The ALFALFA Virgo cluster survey"*, (Lead: Kent, Cornell; Adviser: Giovanelli)
     - *"Cross-correlation of ALFALFA HI detections with SMUDGES objects"*, (Lead: Nair, Indiana U.; Adviser: van Zee)
     - *"ALFALFA survey of the Leo region"*, (Lead: Stierwalt, Cornell U.; Adviser: Haynes)
     - *"Extremely Isolated Galaxies"*, (Lead: Spector, Tel-Aviv U.; Adviser: Brosch)
     - *"Extended HI Disks in the ALFALFA survey"*, (Lead: Dowell, Indiana U.; Adviser: van Zee)
     - *"The HI Correlation and Velocity Functions"*, (Lead: Martin, Cornell U.; Adviser: Haynes)
  3. Undergraduate student (senior) projects:
     - *"Low-mass CDM halos in group-free environments"*, (Lead: Altaf, Lafayette Coll.; Adviser: Hoffman); Altaf is currently enrolled in the graduate program at Purdue.
     - *"Rich groups in the ALFALFA survey: Zw1400.4+0949"*, (Lead: Walsh, Colgate U.; Adviser: Balonek); Walsh is currently enrolled in the graduate program at Boston U.
     - *"The Extended Disk of NGC 5701"*, (Lead: Furniss and Mitschang, Humboldt State U.; Adviser: Kornreich); Furniss will enroll in the graduate program at UCSC in fall 2007.
     - *"Distant Clusters in the ALFALFA Volume"*, (Lead: Goldstein, Lafayette; Adviser: Hoffman); Goldstein will enroll in the graduate program at U.Md. in fall 2007.
     - *"The Environments of Galaxy Groups"*, (Lead: Lomax, St. Lawrence U.; Adviser: O'Donoghue)
     - *"The Undergraduate ALFALFA minisurvey"*, (Lead: Ayala, U. Puerto Rico; Adviser: Pantoja)

- The first ALFALFA–based Ph.D. thesis was defended in July 2007 by Amélie Saintonge of Cornell University. In August 2007, Amélie will begin a postdoctoral appointment at the University of Zurich.
- Oral presentations introducing ALFALFA and reporting first results were given by Giovanelli, Haynes and Kent at the December06 workshop on *Cosmic Voids* held at the Royal Netherlands Academy of Sciences (see *http://www.astro.rug.nl/∼ weygaert/knawvoid.program.php*), at the June07 *HI Survival Through Cosmic Times* conference of Spineto (Italy; see *http://www.arcetri.astro.it/hisur/*), the *Fifty Years of NRAO* June07 conference of Charlottesville and the June07 IAU Symp 244 *"Dark Galaxies and Lost Baryons"* in Cardiff. Giovanelli and Haynes are invited to give ALFALFA related presentations at the Aug07 *100 Years of Cosmology* conference in Venice, Italy.
- Two papers were presented at the January 2007 AAS meeting: *"The Arecibo Legacy Fast ALFA Survey: HI Sources in the Northern Virgo Cluster Region"* by Becky Koopmann (also presented at the Hoffleit Centennial) and *"The Arecibo Legacy Fast ALFA Survey: The Rich Galaxy Group Zwicky 1400+0949"* by Tom Balonek. Nine ALFALFA posters were presented at the 2006 AAS meeting in DC, and six were presented at IAU Symp 244 in Cardiff; see *http://egg.astro.cornell.edu/alfalfa/pubs/cardiff.php*. Kent presented a poster at the NRAO 50th Anniversary Workshop.
- The working group on complementary and followup observations engaged in a number of activities leading to the planning and acquisition of new observations. These include:
  - Complementary broadband and narrow-band Hα images were obtained of newly discovered nearby dwarf galaxies with the WIYN 0.9m telescope (Salzer), San Pedro Martir (Gavazzi), the SAO 6-m telescope (Karachentsev), the SMARTS telescope at CTIO (Koopmann) and the Wise Observatory 1-m telescope (Brosch). Following detection of Hα, long-slit spectra were obtained of selected HII regions with the Palomar 5m telescope for the purpose of determining their metallicities (Lead: Saintonge). These continued in Spring 2007 with Stierwalt, Koopmann and Martin. Optical corroboration of redshifts of 200 marginal HI sources was also obtained in spring 2007 at the 5m Hale telescope by Kent and Giovanelli.
  - VLA-C observations were conducted of several newly discovered HI clouds in the Virgo cluster (Lead: Kent) and two objects with extended HI disks (Lead: Stierwalt).
  - A proposal to conduct new GALEX observations of low mass ALFALFA detections (Lead: Haynes) and a second one to conduct a correlative study of ALFALFA and the GALEX archive (Lead: Giovanelli) were approved for GALEX Cycle 3. Two more ALFALFA-related proposals were submitted for Cycle 4 (Leads: Haynes, S. Higdon).
  - A project to conduct synthesis imaging of several newly discovered nearby dwarfs was carried out at the GMRT (Lead: Begum).
  - Observations of low but positive velocity gas in the vicinity of the Virgo cluster were conducted with the GBT (Lead: Kent).
  - A follow-up proposal to corroborate ALFALFA sources with the LBW feed at AO received time and was executed in April 2007.
  - Several proposals for followup time with Spitzer are being prepared for the the next deadline (Leads: Hunt, S. Higdon and Charmandaris).
  - A cross-correlative study of cold (HI) and hot (X-ray, Chandra) properties of Elliptical galaxies is underway (Leads: Di Serego Alighieri, Trinchieri and Gavazzi).
  - A new collaboration with the GALEX MIS/DIS and SDSS legacy project team has been formed; further coordinated observations of galaxies whose colors and spectral characteristics place them in the so-called SDSS "green valley" have been proposed for LBW observations as the GALEX-Arecibo-SDSS Survey, GASS (AO large proposal Schiminovich070601120653 submitted 2007Jun01; Leads: Schiminovich, Kauffmann, and Catinella).
  - The GADGET-2 simulation package (*http://www.mpa-garching.mpg.de/gadget/*) has been installed on a cluster at the Cornell Theory Center and is being used to simulate the galaxy harassment events witnessed by ALFALFA in the Virgo cluster. (Leads: Kent and Kornreich)
- The ALFALFA-IDL package was further developed and extended. The signal extraction algorithm was enhanced to include the fitting of Gauss-Hermite templates. Installation was streamlined for both Linux and Mac-OS users. The software has been successfully deployed at the following institutions: Cornell U., Arecibo, Colgate U., Georgia Southern U., Harvard-SAO/Center for Astrophysics, Arcetri Astrophysical Observatory, Humboldt State U., INAF-Milano, Indiana U., Lafayette Coll., St. Lawrence U., Union Coll., U. Colorado, U. Minnesota, U. Wisconsin, Wesleyan U.

- The Cornell EGG digital HI archive dataset was installed on a SQL database server at the Cornell Theory Center (CTC); see *http://arecibo.tc.cornell.edu/hiarchive*. The archive is SQL and cone searchable and spectra can be downloaded in VOTable, FITS and ASCII format. A JAVA-script based plotting tool was developed to complement the VO-Plot tool for users who do not have access to the required plug-in. The preliminary ALFALFA catalogs have been made available internally within the collaboration for the purpose of planning followup observations; this interface is moved to the CTC server as the associated papers are accepted for publication; see *http://arecibo.tc.cornell.edu/hiarchive/alfalfa*. Access to our datasets has been coordinated with the NASA Extragalactic Database; integration of our public archive fully into NED awaits further developments by IPAC staff.
- We are actively involved in a Cornell collaboration involving the CTC and other large dataset holders, including the PALFA consortium, for development of hardware and software tools for the permanent storage of and access to the ALFALFA data archive. We intend to participate in a University–wide proposal submission for support for research and education in large database-driven science to the NSF Cyberinfrastructure Initiative. To this end, Haynes has recently been appointed to the Advisory Committee of the new Cornell Center for Advanced Computing. The AGES collaboration has asked to take advantage of our developments in this area.
- Several ALFALFA team members have paid extended visits to Cornell to work closely with the Cornell group. Becky Koopmann (Union Coll.) and Tom Balonek (Colgate U.) spent the AY06-07 in residence at Cornell, partially supported by NAIC. Noah Brosch (Wise Obs/U. Tel-Aviv) spent two months at Cornell and one at Arecibo; he was joined for one month by his graduate student Oded Spector. NAIC-Arecibo staff member Emmanual Momjian visited the Cornell team members for a month in the second half of 2006 to develop IDL routines to look for HI absorbers. Marco Grossi (Arcetri) spent several weeks in Ithaca in Spring 2007 learning to use ALFALFA resources and writing new IDL software. David Kornreich (Humboldt) is currently at Cornell and will spend his AY07–08 sabbatical at Arecibo, working on ALFALFA projects and data gathering.
- A number of team members have visited Cornell for short periods of time to receive intensive training in the ALFALFA data taking and reduction processes. Visiting Cornell were graduate students Shea Brown (U. Minnesota), Kelley Hess (U. Wisconsin), and Prasanth Nair and Jayce Dowell (Indiana U.). Team members who spent time at Cornell for the purpose of training include Marco Scodeggio (INAF-Milano) and John Salzer and John Cannon (Wesleyan Univ). Jessica Rosenberg (George Mason) and students are scheduled for a visit in August 2007.
- ALFALFA "experts" provided on-site instruction and training to team members at Arecibo, including several students and first-time Arecibo visitors. In February 2006, David Kornreich (Humboldt State University), his two undergraduate students Amy Furniss and Arik Mitschang, and graduate student Shea Brown (U. Minnesota) spent a week at Arecibo accompanied by Martha Haynes. In November 2006, Tom Balonek (Colgate) conducted observations at Arecibo with Aileen O'Donoghue and Jeff Miller (St. Lawrence U.) and their senior undergraduate Jamie Lomax. In January 2007, Sarah Higdon (Georgia Southern U.) and her undergraduates Josh Davidson and Daniel Richey traveled to Arecibo with Martha Haynes. In Feb. 2007 Becky Koopmann worked with Kristine Spekkens on site at AO. We anticipate that the practice of training new ALFALFA users at AO will continue in future years.

ALFALFA Support Update: Significant resources have been secured through NSF grants to carry out the survey. A three–year grant to Giovanelli (PI) and Haynes (co–PI) allowed the preparation of the survey and the ALFALFA precursor work through 2005. This has been followed by a five–year grant to the same, to carry out the full survey. We underscore the fact that the bulk of funding to carry out this project, through NSF, is dependent on the expectation that the survey will be completed within the grant period as requested in our original proposal. In addition, a one–year grant was obtained by Giovanelli to train graduate students in the development of National Virtual Observatory applications and protocols, with highly successful results as our data management procedures and public access tools can testify. Support specifically for ALFALFA follow-up optical work has also been obtained by other consortium members, in the US (e.g. Salzer) and abroad (e.g. Corbelli, di Serego Alighieri, Brosch). Two NASA grants, respectively to Giovanelli and Haynes, were obtained for cross–correlative work between ALFALFA and GALEX data and for long exposure observations with the GALEX satellite of low mass ALFALFA detections. Haynes has also received grants from the

Brinson Foundation which provides partial support for her and a graduate student (Stierwalt); she has just been invited to apply again in 2007. Entering Cornell graduate student Betsey Adams has brought with her a NSF predoctoral fellowship specifically to work on ALFALFA science.

Becky Koopmann (Union Coll.), Sarah Higdon (Georgia Southern) and Tom Balonek (Colgate U.) have received preliminary approval for a five–year grant proposal to NSF-AST for formal support for the Undergraduate ALFALFA team, involving faculty and students from 14 colleges and universities throughout the US who are committed to participating (Colgate U., Cornell U., George Mason U., Georgia Southern U., Humboldt State U., Lafayette Coll., St. Lawrence U., Siena Coll., Skidmore Coll., Union Coll., U. Puerto Rico, U. Wisconsin-Stevens Point, Wesleyan U., West Texas A&M). A major activity will be an annual undergraduate ALFALFA workshop to be held at Arecibo during each academic year. The first such event is scheduled for October 6–9, 2007.

Dataset and product status: Processing of the data is proceeding according to schedule. Raw data in FITS format are converted to IDL and transferred to Cornell within 24 hours. Processing to Level I (bandpass and flux correction, RFI flagging, continuous source identification and subtraction of 2-D data) usually occurs within days to weeks using a standard pipeline in ALFALFA-IDL. A laborious part of Level I processing is the flagging of RFI, a necessary but extremely beneficial exercise. Construction of data cubes (grids) can be limited by the incomplete coverage of datasets due to the spottiness of time allocation, but we are now engaged in systematic reduction of selected, fully sampled areas. Points worthy of note:

- ALFALFA acquires data at a rate of about 1 GB/hour. Raw data are archived at Arecibo by NAIC. About ∼4 TB of Level I datasets are currently housed at Cornell for quick access; about 2 TB of Level II datasets (regridding, flux scaling, correction for telescope pointing, 3-D grid production) are also housed at Cornell. Reduction status is available on the team-only sections of our website. If the skeptical review panel would like access to this site, it can be provided upon request.
- Both Level I and Level II datasets are produced by numerous team members following a very strict protocol and after several extensive training sessions by a reduction "expert". Each Level I and Level II dataset is later checked for quality by a senior member (RG or MH) before being delivered into the archive. Cataloging and archiving is also carried out by a senior individual, providing a second check.
- The construction of 3-D grids is now continuously underway. Each grid represents a square of $2.4^\circ \times 2.4^\circ$ of sky, with contiguous grid centers separated from each other by 2°. As of June 30, 2007, 355 grids have been generated and sources extracted from them, corresponding to 20% of the total ALFALFA plans. Signal extraction and measurement is a laborious phase of the processing, currently being carried out at several sites with close supervision from senior members of the team at Cornell.
- Signal extraction within the 3-D datasets is performed using a matched filter, Fourier domain technique developed by graduate student Amélie Saintonge and makes use of confirmation in both polarizations, both passes and adjacent beams. Because of the extreme value of these multiple "confirmation" checks, it is necessary to have all data in hand for the full grid, in order to produce final catalogs of reliable detections.
- An advance of ALFALFA over HIPASS is our ability to make immediate identification of the most probable optical counterpart of each HI detection. The examination of optical imaging datasets (e.g. SDSS, DSS2) and redshift databases (e.g. NED) is fully integrated into the ALFALFA-IDL software. The Cornell extragalactic database (the "AGC"), containing ∼83000 extragalactic objects (∼77000 with redshifts including those from SDSS-DR6) in the ALFALFA survey volume, is made available to members of the ALFALFA team with the ALFALFA-IDL distribution.
- An interactive SQL searchable and updatable "followup observations" website is available to team members. This site also serves as a testbed for public catalog releases before they are made public.

Issues of Uncertainty: A major painting project is currently underway at Arecibo, suspending all observing activities. Our early assumption that we would receive a significant allocation of telescope time in the spring season of 2007 was not correct. It is still unclear when observations will resume. This has resulted in loss of the major part of the spring sky time for ALFALFA and apparently will delay the start of the fall 2007 season as well. Having established a team and been granted the necessary resources to conduct the survey, we are concerned about the impact of significant further loss of momentum.

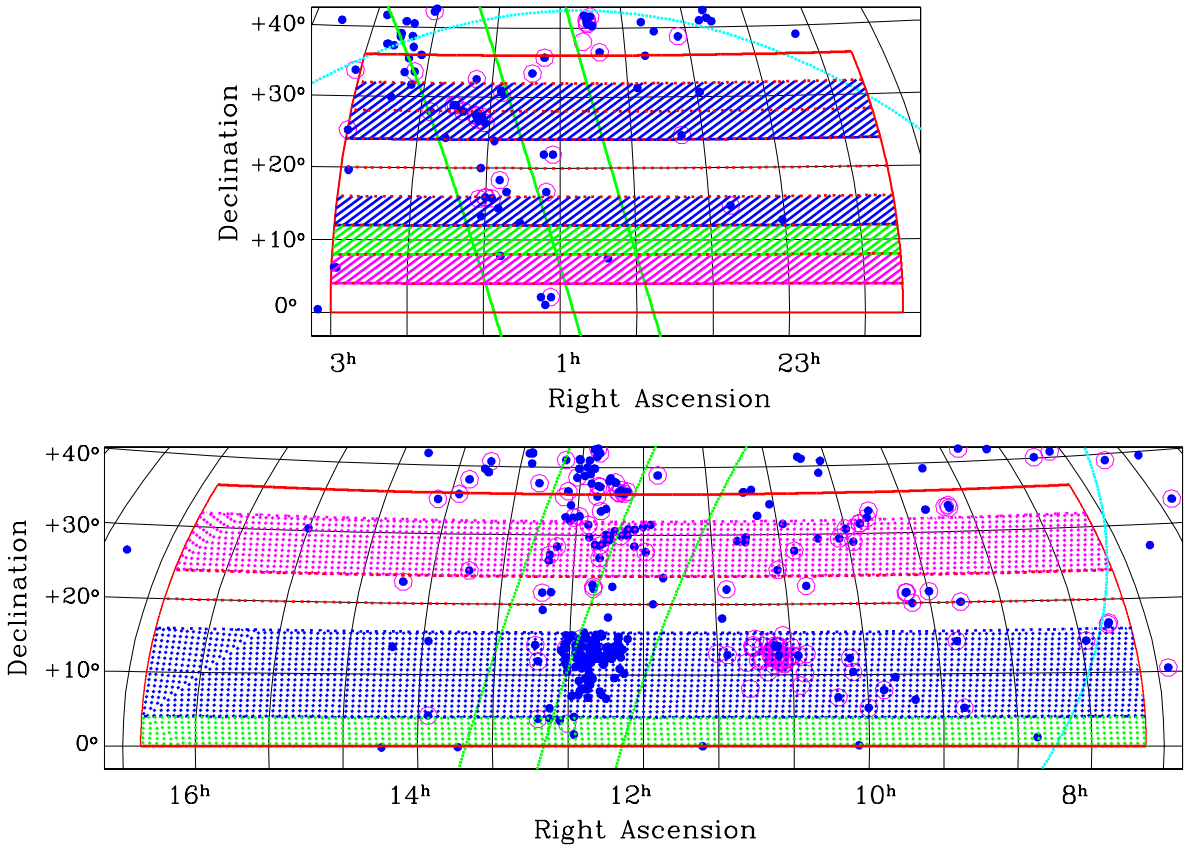

Figure 6: Proposed A2010 sky coverage for the year beginning July 2007: Fall 2007 (upper) and Spring 2008 (lower). Blue shaded areas outline the (nearly) complete coverage as of 03 Apr 2007, from 7^h30^m <R.A.< 16^h30^m, $+4^\circ$ < Dec.< $+16^\circ$ and 22^h <R.A.< 3^h, $+12^\circ$ < Dec.< $+16^\circ$ and $+24^\circ$ < Dec.< $+32^\circ$. The allocation requested here for the year starting 01Jul2007 aims to complete the tiles at Dec. = $+26^\circ$ and $+30^\circ$ (spring) shown as the magenta shaded areas, begun in 2006. Time permitting, we will then initiate the survey of the Dec. = $+10^\circ$ (fall) and Dec. = $+02^\circ$ (spring) tiles, shaded green in each panel. The solid red lines outline the proposed survey area for the full ALFALFA survey, while dotted red lines make the designated ALFALFA tile boundaries. The cyan line traces b = $+20^\circ$, while the green lines trace SGL = -10°, 0° and $+10^\circ$. Blue filled circles mark galaxies with observed heliocentric recessional velocities cz < 700 km s^{-1} while open magenta circles denote objects believed to lie with 10 Mpc, based largely on primary distances (Karachentsev *et al.* 2004).

A new broad-band spectrometer should become available soon. The ALFALFA technical requirements of spectral resolution and bandwidth are met adequately by the WAPPs, so one option for us is simply to continue to use them. However, recurrent WAPP failures continue to occur periodically and have been a major source of telescope time loss in the past two years. We plan to request telescope time to test the new E-ALFA spectrometer in our standard observing mode in late 2007. We plan to stick to the WAPPs through the current season and will make a decision as to whether to switch to the new spectrometer beginning in 2008 after performing system tests.

Plan for the Next Year: Figure 6 illustrates the current and proposed ALFALFA sky coverage, particularly in the context of local large scale structure. Completed regions, general containing bands of 4°-wide "tiles", are shown in blue. Areas proposed to be covered during the current year but not yet complete are shaded in magenta, while new regions which we propose to survey next are shaded green. Our original request planned to complete two sets of 4° tiles per year. In reality, the allocation of telescope time has not been adequate to match that pace, so that our request for the next year assumes that we will spend much of the time completing regions already initiated and that only two new bands of tiles will be started. For the year beginning 01Aug07,

we propose to complete the +06° set of tiles in the "fall" and +26° and +30° in the "spring", and to initiate the +10° one (fall) and +02° one (spring). The priority for coverage of these strips is motivated by the desire to achieve the principal ALFALFA science objectives, with special attention to the timely acquisition of datasets required for PhD theses. Particular reasons for the choice of these particular sets of tiles is highlighted briefly below.

- Completion of the Dec = +06° fall strip will provide full overlap with the optical SMUDGES strip being surveyed at B, V and I optical bands (van Zee, Nair).
- Completion of the +26° and +30° spring strips will allowing mapping of both the Coma cluster (Abell 1656; z= 0.0232) itself and its supercluster environment, extending southward towards Abell 1367. Gavazzi, Scodeggio and collaborators have a large collection of multiwavelength data covering this region in their *GOLDMINE* database. Additionally, these strips cut across the supergalactic plane nearly parallel to the more southerly ALFALFA strips but offset by more than 15° in SGL, providing an excellent sampling of the central regions of the Local Supercluster.
- The fall Dec = +10° strip will fill in the gap between the +06° and the +14° bands and will provide adequate sampling of the anti-Virgo region to allow comparison of the HI mass function in the Virgo and anti-Virgo environments within comparable cosmic volumes.
- The spring Dec = +02° band of tiles includes the southeast extension of the Virgo cluster and is heavily sampled by the GALEX/MIS–SDSS survey for which ALFALFA overlap is required by the GALEX-Arecibo-SDSS Survey (GASS).

We understand that it is more convenient for the AO scheduler to schedule A2010 in more, but shorter blocks, which we can then stitch together to provide complete coverage of the ALFALFA survey region. Such a scheme, while somewhat less efficient and more burdensome in terms of bookkeeping, is acceptable to us as long as the sum is equivalent to the minimum request required to produce complete and gridable datasets. As always, TOGS can run commensally with ALFALFA. We will continue to take responsibility for executing the TOGS calibration scripts to the best of our ability and to give the TOGS team access to our observing schedules, logs and notes.

Summary of Request: Completion of a single strip of ALFALFA 4° tiles in 2-pass mode requires 33 observing sessions with the second half occuring 3-9 months after the first. Our original proposal requested allocation at a rate of completion of two tiles per season per year, an expectation not met in reality. Because of the need for both passes to be completed before grids are made, we propose in the next year to complete regions already begun and to initiate observations of only one new 4° tile in both fall and spring. The tiles we propose to complete in this period are +6° (fall) and +26° and +30° (spring). We will also initiate observations of the +10° fall strip and the +2° spring one. Complete details of current survey status can be found at *http://www.naic.edu/∼a2010/scheds/a2010_schedfall_needed.txt* and *http://www.naic.edu/∼a2010/scheds/a2010_schedspr_needed.txt*. To obtain complete datasets (2-pass coverage) of the contiguous areas illustrated in Figure 6 a minimum allocation is required as follows:

Fall	2007	21h40 to 03h15 LST	37 sessions
		23h40 to 03h15 LST	10 sessions
Spring	2008	07h10 to 16h45 LST	60 sessions

Full two-pass coverage of these regions would render the survey 5/9 complete (fall) and 6/9 complete (spring).

Appendix A. ALFALFA Consortium members

By its open nature, the ALFALFA consortium continues to grow. Current membership of ALFALFA, separated by institution, is as follows, where "OC" stands for "member of the oversight Committee", "G" for "graduate student", "+ U" for "various undergraduate students":

- **Cornell University:** Riccardo Giovanelli (P.I.), Martha Haynes (OC), Betsey Adams (G), Brian Kent (G, OC), Ann Martin (G), Amélie Saintonge (G; now at U. Zurich), Sabrina Stierwalt (G).
- **NAIC:** Barbara Catinella (now at MPIfAp, Garching), Robert Minchin, Emmanuel Momjian (OC)
- **U. of California, Berkeley:** Andrew West
- **Colgate University:** Tom Balonek + U
- **University of Colorado:** Jeremy Darling + G
- **Columbia University:** David Schiminovich
- **George Mason U.:** Jessica Rosenberg + U
- **Georgia Southern U.:** Sarah Higdon, Jim Higdon + U
- **Harvard/Smithsonian CfA:** Karen Masters
- **Humboldt State U.:** David Kornreich + U
- **Indiana University:** Liese van Zee, Jayce Dowell (G), Prasanth Nair (G)
- **Johns Hopkins University:** Tim Heckman
- **Lafayette College:** Lyle Hoffman + U
- **U. of Michigan:** Mary Putman
- **U. of Minnesota:** Evan Skillman, Shea Brown (G)
- **NASA Goddard:** Susan Neff
- **National Radio Astronomy Observatory:** Eduardo Hardy, Kristine Spekkens (also Rutgers)
- **Naval Research Labs:** Chris Springob (now at Washington State U.)
- **U. of Puerto Rico:** Carmen Pantoja + U
- **Rutgers U.:** Kristine Spekkens (also NRAO)
- **St. Lawrence U.:** Aileen O'Donoghue, Jeff Miller + U
- **Siena College.:** Rose Finn + U
- **Skidmore College:** Mary Crone Odekon + U
- **Union College:** Rebecca Koopmann + U
- **Wesleyan U.:** John Salzer (now at Indiana U.), John Cannon (now at Macalester College)
- **West Texas A & M:** David Craig, Paul Fisher + U
- **U. of Wisconsin, Madison:** Eric Wilcots, Kelley Hess (G)
- **U. of Wisconsin, Stevens Pt.:** Katherine Jore + U

- **Arcetri Astrophysical Observatory, Italy:** Edvige Corbelli, Carlo Giovanardi, Marco Grossi, Leslie Hunt, Sperello di Serego Alighieri
- **Observatory of Brera/Milan:** Ginevra Trinchieri
- **U. of Barcelona, Spain:** José-M. Solanes
- **U. of Bonn, Germany:** Uli Klein, Jozsa Gyula
- **Cambridge U., UK:** Ayesha Begum
- **Cardiff University, UK:** Jon Davies
- **U. of Cordoba, Argentina:** Diego Garcia–Lambas, Carlos Valotto
- **U. of Crete, Greece:** Vassilis Charmandaris
- **U. of Kiev, Ukraine:** Valentina Karachentseva
- **INAF, Milan, Italy:** Marco Scodeggio
- **Lab. d'Astrophysique, Marseille, France:** Alessandro Boselli
- **U. of Milan-Bicocca, Italy:** Giuseppe Gavazzi
- **Max–Planck–Institut f. Ap., Germany:** Guinevere Kaufman, Barbara Catinella (prev. at NAIC)
- **NCRS/GMRT, India:** Jayaram Chengalur
- **U. of Provence, Marseille, France:** Chris Marinoni
- **U. of Rome, Italy:** Roberto Scaramella, Sabina Sabatini
- **SISSA, Trieste, Italy:** Paolo Salucci, Irina Yegorova (G) , Christiane Martins Frigerio (G)
- **Special Astrophysical Observatory, Russia:** Igor Karachentsev
- **U. of Tel–Aviv, Israel:** Noah Brosch (OC), Oded Spector (G)
- **U. of Zurich, Switzerland:** Amélie Saintonge (Cornell Ph.D. 2007)