ALFALFA Follow–up: First Campaign

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Scientific Background:

ALFALFA is an ongoing legacy survey at the Arecibo Observatory. It aims to cover 7000 square degrees of sky, in the 21cm HI line covering the frequency range 1330-1430 MHz. It uses the ALFA array in transit mode, sweeping over each part of the sky twice, at different phases of Earth's solar orbit, for an effective integration time per beam of about 40 sec.

ALFALFA is an open collaboration involving several dozen participants from more than 30 institutions. A number of spinoff projects are currently underway and a significant effort has been made to involve undergraduate students and representatives from undergraduate institutions. In addition to 2 ALFALFA science worskshops each year (one in the US and one in Europe, 4 in total so far), an annual undergraduate workshop is held each year (two in total so far) at Union College. Undergraduate and graduate thesis projects are discussed in the ALFALFA website and in the proposal report submitted in parallel with this one.

In mid-2006, several regions of the sky were completely mapped, so that catalogs of sources could start being extracted. As of the end of January, sources have been extracted from about 600 square degrees of sky - just below 10% of the survey goals. The source extraction method is very effective and it has been described in Saintonge (2007, AJ, in press), where an analysis of the noise characteristics of ALFALFA has been presented. Previous reviewers of the ALFALFA proposals have indicated that priority should be given to the production of source catalogs. We have done so and the first source catalog release has been submitted for publication in December (2007 AJ, in press). Note that source extraction was not possible until Summer 2006, given the need for full coverage of large contiguous regions of sky in double pass mode and the vagaries of telescope time allocation. The ALFALFA web site (http://egg.astro.cornell.edu/alfalfa/) can be consulted for details of the sky coverage, progress and plans with the observations, among other things. Several papers, including additional source catalogs, are currently in preparation and will be submitted during Winter-Spring 2007.

In catalogs, we qualify sources with a code that depends on S/N, polarization and beam match, local (i.e by time and frequency) rfi conditions, existence of priors (e.g. positional coincidence with optical counterparts of known redshift, etc.). Approximately 3000 sources of high reliability are cataloged by the end of Jan. 2007, typically of signal to noise ratio greater than 6.5. We believe such set of candidate sources to be real cosmic sources to better than 95% reliability. In addition to those, a comparable sample of marginal candidate detections will be available, typically of S/N between 4.5 and 6.5 but already passed through a polarization/beam match and recurrent rfi filter. It is necessary to assess the fraction of those sources that will be confirmed as real, in order to plan future follow-up activities, as significant additional gains can be drawn from the survey. Assume for example, that this "sample of marginals" (SOM) contains a fraction F of real sources, (1-F) being spurious (i.e. due to noise, rfi, etc.). ALFALFA detects on order of 5-8 sources per hour; corroborating single pixel observations of SOM candidate sources can be done at the rate of 2 min of telescope time per source; thus, "mining" SOM can deliver a comparable or better harvest (per unit of telescope time) of corroborated detections if F>0.20.

Figures 1–2 illustrate examples of SOM candidates of differing S/N, for a visual reference.

We propose to observe in single pixel mode a statistically significant sample of SOM candidate sources of varying S/N, in order to obtain a characterization of the S/N dependence of F. This experiment has been statistically described in the initial submission of ALFALFA and in Giovanelli et al. (2005, AJ 130, 2598: A1); we point the reader to those sources for details. Observations will be made in "ON only", total power mode. The high spatial density of SOM candidates (several per square degree) guarantees that a small fraction of time will be lost to motions other than source tracking and that effective bandpass correction will be possible. This observing technique was successfully used in 2005 (see Giovanelli et al. 2005, AJ 130, 2613: A2). We intend to devote approximately 35 hours of telescope time with the single pixel HI system, to carry out this experiment.

Previous reviewers of ALFALFA proposals have specifically requested that the issue of obtaining an adequate characterization of detection threshholds be addressed early in the survey. We have done so in a preliminary, formal manner in paper A1, and ALFALFA precursor observations helped set a first order threshhold in paper A2. Now that a large body of marginal detection candidates exists, this proposal will deliver a detailed estimate of detection reliability at lower levels of S/N.

We do not ask for any specific allocation of telescope time for this proposal. Rather, we request that we be allowed to use the 21cm single pixel system for approximately 35 hours of time that would otherwise be allocated to the main ALFALFA survey program A2010. Given the rapidly increasing SOM, we would observe SOM candidates whenever the scheduling circumstances are most favorable, e.g. when time is allocated in LST slots already well covered by ALFALFA and the impact to survey work is minimized. The vagaries of telescope scheduling are naturally responsible for uneven sky coverage, especially when data are taken with the telescope parked at meridian, as is the case with ALFALFA. Carrying out the described tests within the time allocation to ALFALFA (A2010) will allow most efficient use of telescope time.

References

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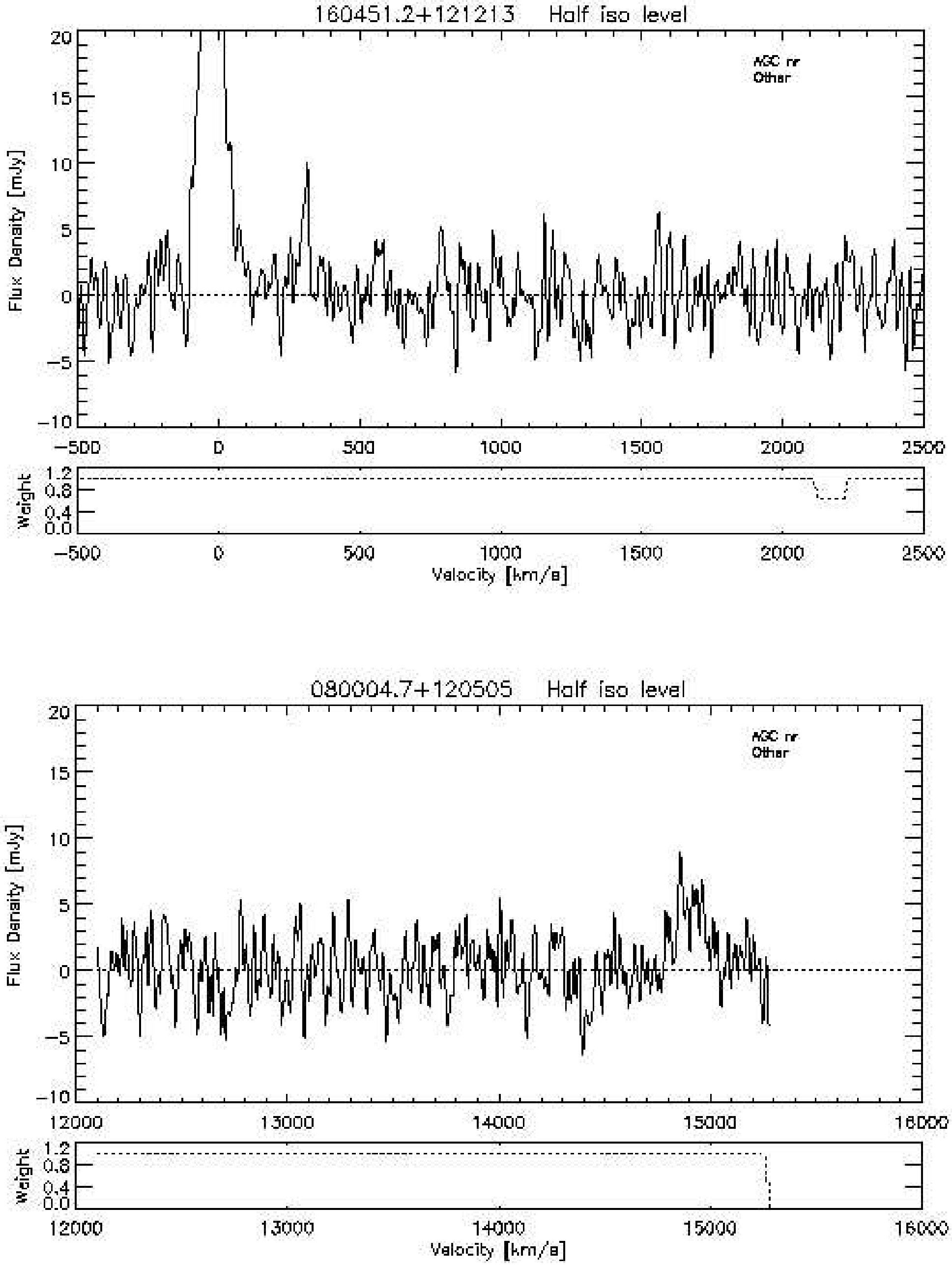

Figure 1: Examples of SOM candidates. The top feature has S/N=5.0; it is at a velocity of 308 km s^{-1} , with an estimated velocity width of 25 km s^{-1} . Were it to be confirmed as an extragalactic source, it would have an HI mass of about 10^6 M$_\odot$. The bottom panel is at a velocity of 14910 km s^{-1} , with an estimated velocity width of 130 km s^{-1} . It is at the limit of what we'd refer to as a solid detection, at S/N=6.4. It is positionally matched by an optical counterpart.