Gas, Stars and Star Formation in ALFALFA Dwarf Galaxies

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The ALFALFA survey
- The Arecibo Legacy Fast ALFA (ALFALFA) survey is a blind HI-line survey conducted with the ALFA feed array on the 305m telescope (Giovanelli+ 2005).
- It is expected to detect ~30,000 galaxies out to z<0.06, over ~7000 deg² of sky.
- The superior sensitivity, spectral and angular resolution of ALFALFA compared with previous blind HI surveys, allow it to detect the smallest HI-bearing galaxies in significant numbers over a cosmologically significant volume.

HI dwarf sample and data
- Based on the a.40 catalog, covering ~40% of the final area (Haynes+ 2010).
- A complete HI-selected dwarf sample (176 galaxies; filled symbols in all plots).
  (i) extragalactic with optical counterpart;
  (ii) logM_HI < 7.7; (iii) HI line width < 80 km/s;
  (iv) not massive but HI deficient galaxies.
- Supplementary dwarfs with GALEX data (53 galaxies; open symbols in all plots).
  (i) all have logM_HI > 7.7;
  (ii) only a small subset of a.40.
- Photometry on GALEX M16 images and good SDSS.
- Only one galaxy not detect in UV.
- M. and SFR derived from SED fitting the 7 bands (FUV, NUV, u, g, r, i, z).
- ALFALFA provides a statistically rich sample of global measures to lower HI masses than previous surveys, serving as the basis for further studies, e.g., survey of HI in the extremely low-mass dwarfs (SHIELD, Cannon+ 2010).

The HI selected galaxy population
- The ALFALFA dwarfs (circles and squares in all plots) probe lower HI fraction (f_gas=M_HI/M*) range relative to the overall ALFALFA population in the same M. range, because of the M_HI upper limit.
- Less massive and bluer galaxies are more gas-rich on average, i.e., with higher f_gas.
- M_HI equivalent or exceed M. in the low mass regime.
- ALFALFA galaxies are biased towards gas-rich populations. They may reside in dark matter halos with high spin parameters and have longer gas-accretion and SF timescales (Boissier+ 2000).

Color-Magnitude Diagram and f_gas
- HI dwarfs are also faint and LSB in the optical; only 56% of those within the SDSS footprint have a counterpart in the spectroscopic survey.
- Almost all of the ALFALFA dwarfs lie in the blue cloud in a CMD (NUV-r < 4).
- SDSS spectra confirm that they are star-forming galaxies.
- At fixed M., galaxies with lower f_gas have on average redder colors. Such variation is more evident among the low mass galaxies.

SFR estimates of dwarf galaxies
- The construction of SED fitting models has reasonably incorporated the effects of stochastic star formation, which is important for low mass galaxies with high specific SFRs (SSFR = SFR/M*).
- The Standard conversion from the f_*UV, e.g., Kennicutt (1998), assuming constant SFH, systematically overestimates SFR in dwarfs.

Star-forming sequence and f_gas
- The increased dispersion of the SSFR distribution below logM_*~8 is driven by a set of dwarf galaxies which have low gas fractions and SSFRs. Some of these are dE/dSphs in the Virgo Cluster (Hallenbeck+ 2012).
- At fixed M., galaxies with higher SSFR have higher f_gas. The trend is less evident for galaxies with logM_* > 9.5.
- As galaxies assemble their stellar mass and evolve along the SF sequence, their f_gas decreases.

Star formation efficiency and f_gas
- Many of the ALFALFA dwarfs, particularly the Virgo members, have HI depletion timescales (t_H = 1/SFE = M_HI/SFR) shorter than the t_Hubble.
- HI-selected galaxies have lower SFR than do optically selected ones (Schiminovich+ 2010).
- SFE increases gradually with M., with a steeper slope below logM_*~ 9.5. Notice the similar transition of slope in the f_gas or SFR vs. M. plots, which is below the frequently studied transition mass of logM_*~ 10.5.

- Despite the low SFEs, HI-selected galaxies have systematically higher SFRs. They may be in an earlier stage of the evolution than the optically-selected ones.

Main references
Huang et al. 2012, submitted
Huang et al. 2012, in preparation
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Kennicutt 1998, ARAA, 36, 189

Acknowledgements
The research presented in this poster is funded by National Science Foundation Grant (AST-0607007 and AST-1107390), Brinson Foundation, GALEX GI program under NASA grants NNX07Al22G, NNX08Al67G and NNX09AF79G.

Attendance of this conference is funded by the Brinson Foundation and the Cornell Graduate School.