The LITTLE THINGS Survey of Nearby Dwarf Galaxies

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LITTLE: Local Irregulars That Trace Luminosity Extremes

THINGS: The HI Nearby Galaxy Survey

http://www.lowell.edu/users/dah/littlethings/

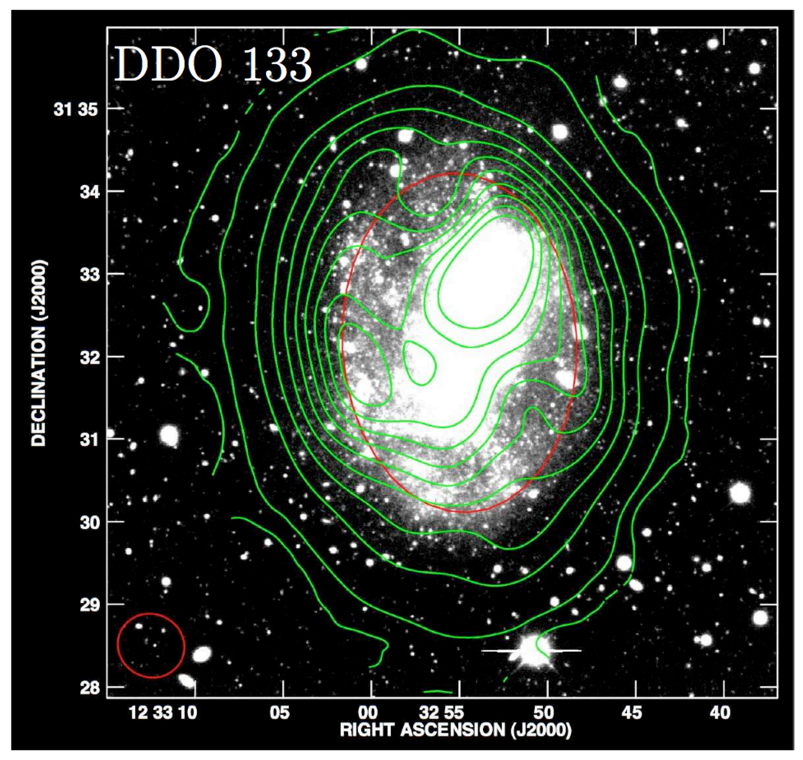
Synopsis

The LITTLE THINGS Survey has been granted close to 376 hours with the VLA in the current B, C, and D array configurations (December 2007 to fall 2008) to obtain deep HI-line maps of dwarf galaxies. The purpose is to determine how tiny galaxies form stars. We will observe 21 dwarf irregular (dIm) and Blue Compact Dwarf (BCD) galaxies, and add another 21 dwarfs from the archives. The new observations consist of 12 hrs in B-array, 6 hrs in C-array, and 2 hrs in D-array for each galaxy. The channel separation is 2.6 km/s for 31 galaxies and 1.3 km/s for 11 galaxies.

The combined B/C/D arrays will sample the galaxies at 6 arcseconds, which is 110 pc at 3.7 Mpc, the average distance of our sample. This resolution will show clouds, shells, and turbulent structures that are important for star formation. We will also produce maps at lower resolution (30 arcseconds, 540 pc at 3.7 Mpc). These maps will reveal the extended, low-density gas around star formation structures and trace the low density HI far beyond the stellar disks.

The Science

Dwarf galaxies are the closest analogs in the nearby universe to the low mass dark matter haloes that formed after the Big Bang and in which the first stars formed. Yet, we do not understand the processes that lead to star formation even in simple dwarfs. We are assembling a complete dataset on a sample of nearby dwarf galaxies, tracing their current star formation, older stellar populations, gas content, and dynamics, and using these data to test and modify star formation models. The HI-line maps will reveal the gas from which star-forming clouds are created and their kinematical context. We will combine the HI data with our optical, UV, and IR data to answer the following quesitons:



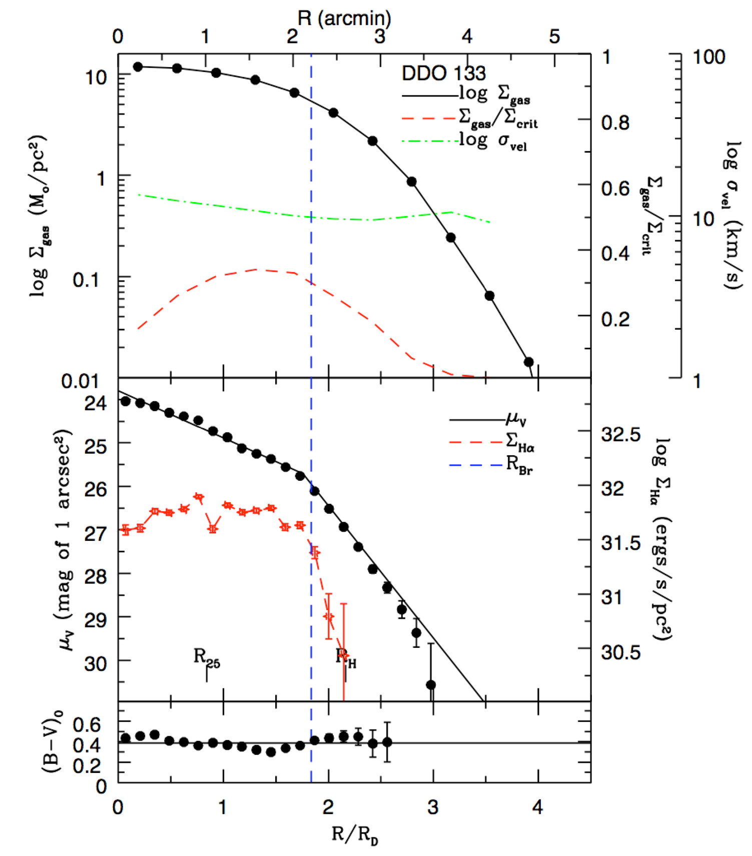


Figure 1: Example of a LITTLE THINGS galaxy. Left: Integrated HI D-array contours superposed on a V-band image. B and C array observations are pending. Right: HI (top) and optical (bottom) surface photometry. The vertical dashed line marks the V-band profile break. There the average gas density drops to 0.3 of the critical gas density, and it drops to 0.02 in the outer stellar disk, indicating a gravitationally stable gas.

What regulates star formation in small galaxies?

The standard large-scale gravitational instability model does not work in dwarfs or the outer disks of spirals where the gas density is below the critical threshold and is stable to spontaneous perturbations. Why do cloud complexes and stars form at all in sub-critical gas?

What is the relative importance of sequential triggering for star formation in small galaxies?

One generation of stars can trigger the formation of the next by rearranging the gas through winds and supernovae explosions, but how important is this process? HI and optical observations of dwarfs show a better correlation between the star formation rate and the V-band surface brightness, which emphasizes Gyr old stars, than any other measure. This suggests that the existing stars are somehow important for triggering new stars.

What is the relative importance of triggering by random turbulence compression in dwarf galaxies?

Turbulence can account for various phenomena that are indirectly related to star formation. Is turbulence the key to allowing star formation to proceed in a normal fashion in dwarfs even though the gas density is sub-critical?

What happens to the star formation process in the outer parts of disks?

We find exponential stellar surface brightness profiles with a break and a steeper profile extending beyond that for several more scale lengths. These breaks are similar to what are seen in the outer parts of spirals. The break implies a change in the star formation process there.

The Sample

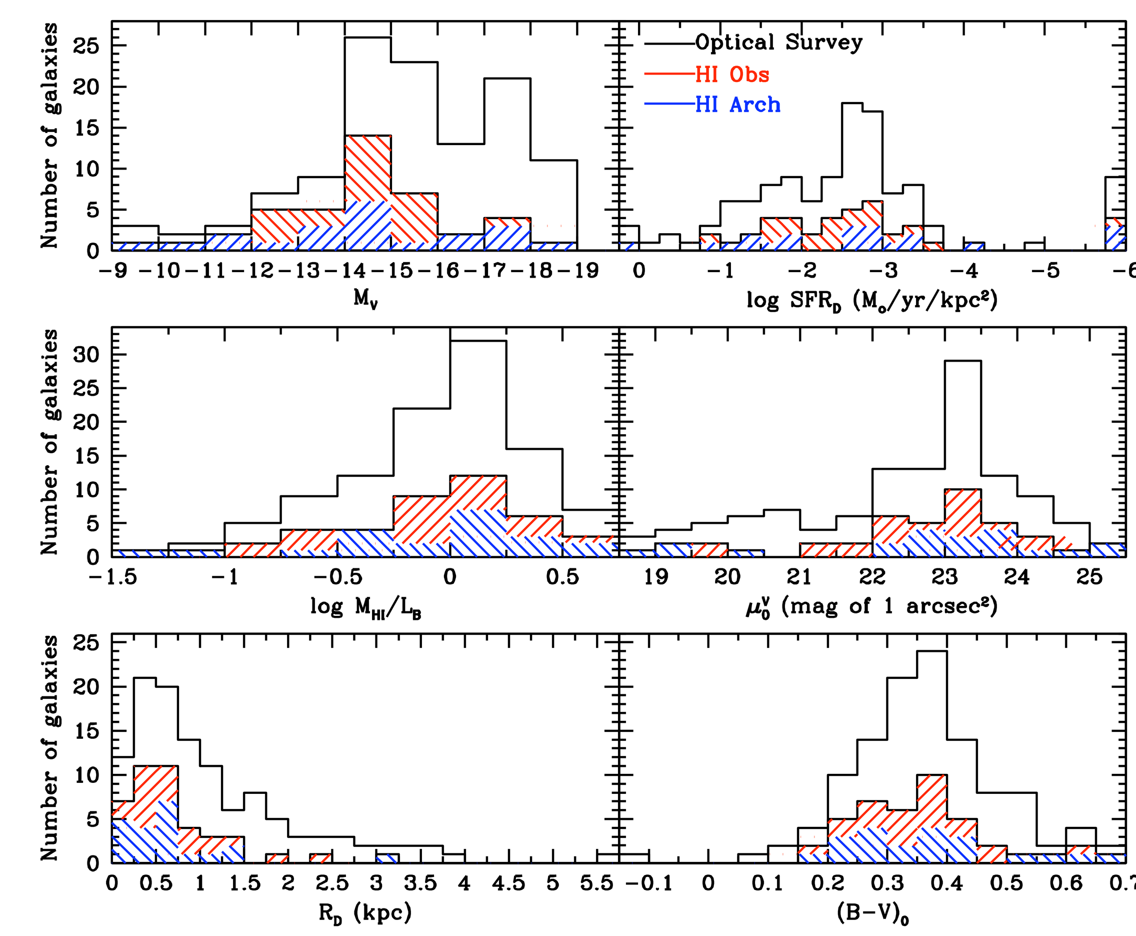


Figure 2: Properties of the LITTLE THINGS HI sample (new observations, archives) compared to the entire optical survey (open) of Hunter & Elmegreen (2004, 2006). The HI sample covers the range of parameters of the full sruvey. A star formation rate (SFR) of 0 is plotted as a log of -6. SFR_D is the SFR normalized to πR_D^2, where R_D is the disk scale length.

Table 1: The Data Sets

Data set	# Gal.	Purpose	Status
VLA HI maps		Trace cloud formation	
Archives (1.3 km/s)	9		Data in archives
(2.6 km/s)	12		Data in archives
New Obs (1.3 km/s)	11		Observations pending
(2.6 km/s)	10		Observations pending
Hα images	42	Trace current star formation	Published
GALEX UV		Trace star formation into outer disk	
Archives	29		Partially anlayzed
New Obs	11		Proposal pending
UBV images	42	Trace star formation over past Gyr	Published
JHK images J	8	Trace star formation over galaxy lifetime	Published
JH	3		
JHK	7		
Spitzer IRAC images	24	Trace stars, hot dust, PAHs	Most published
Spitzer MIPS images	16	Trace embedded star formation	In archives
Spitzer IRS spectra	14	Characteristics of HII regions, PDRs	Published
Molecular clouds		Star-forming clouds, ISM energy budget	
Herschel	42		Proposed
IRAM	?		Will propose

Acknowledgements

We are grateful to NRAO for time on the VLA and the people at the VLA who make things run. The VLA is a facility of the NRAO, itself a facility of the National Science Foundation that is operated by Associated Universities, Inc.

We are also grateful to the NSF for funding the LITTLE THINGS project with grants to Hunter (AST-0707563), Elmegreen (AST-0707426), Simpson (AST-0707468), and Young (AST-0707835).