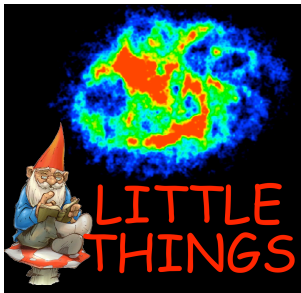

The Relationship between Gas, Star Formation, and the Stellar Disk in LITTLE THINGS Dwarf Galaxies

D. Hunter (Lowell Observatory), B. Elmegreen (IBM T. J. Watson Research Center), and the LITTLE THINGS team

ABSTRACT

To address the question of what role gas plays in determining the structure of the stellar disk in dwarf galaxies, we have parameterized the HI surface density profiles of the sample of dwarf galaxies that are part of the LITTLE THINGS Survey. We then compare the characteristics of the HI surface density profiles with the properties of the stellar disk.

LITTLE THINGS

LITTLE THINGS (Local Irregulars That Trace Luminosity Extremes - The HI Nearby Galaxy Survey) is a multi-wavelength survey that is aimed at determining what drives star formation in dwarf galaxies (Hunter et al., in preparation). The LITTLE THINGS sample includes 37 dwarf irregular (dIm) and 4 Blue Compact Dwarf (BCD) galaxies, and is centered around HI-emission data obtained with the VLA. The HI-line data are characterized by high sensitivity (≤1.1 Jy beam^{-1} per channel), high spectral resolution (≤2.6 km s^{-1}), and high angular resolution (≈6"). The LITTLE THINGS sample contains dwarf galaxies that are relatively nearby (≤10.3 Mpc; 6" is ≤300 pc), that contain gas, and that cover a large range in dwarf galactic properties. Here we use *GALEX* FUV to trace recent star formation.

The Sersic Fits

We performed a multi-variable least squares fit of a Sersic (1982) profile to the HI surface density distributions measured from velocity-integrated ROBUST-weighted maps. The Sersic profile, as used here, is

$$\log \Sigma_{HI}(R) = \log\Sigma_{HI}^0 - 0.434(R/R_0)^{1/n},$$

$\log \Sigma_{HI}^0$ is the central surface gas density,
R_0 is a characteristic radius, and
n is an index that controls the curvature.

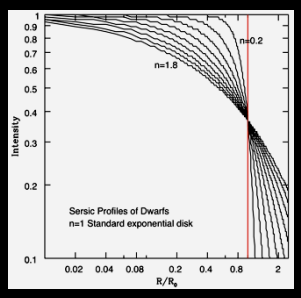

Figure 1: Family of curves that define dwarfs.

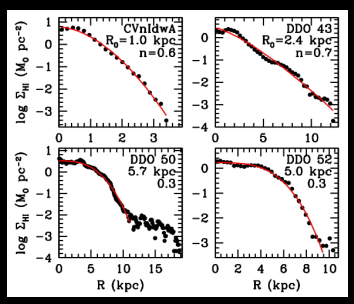

Figure 2: Examples of Sersic fits to the HI surface density profiles.

References

Hunter et al. 2010, AJ, 139, 447
Sersic 1982, Extragalactic Astronomy (Dordrecht: Reidel)
Zhang, H.-X., et al. 2012, AJ, 143, 47.

SFR and $\log\Sigma_{HI}^0$

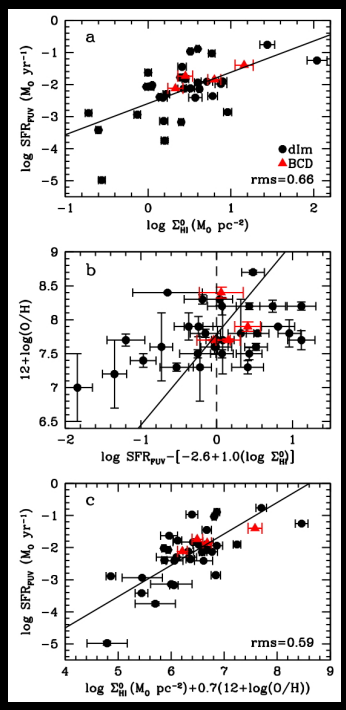

Figure 3:
a) Integrated SFR measured from the FUV (Hunter et al. 2010) correlates with $\log\Sigma_{HI}^0$.
b) Deviations from the fit in (a) plotted against oxygen abundance.
c) SFR plotted against a combination of Σ_{HI}^0 and oxygen abundance determined from the fit in (b). The scatter decreases.

If we write metallicity in units of the solar metallicity, then the relationship shown in (c) becomes $SFR \approx 0.003\Sigma_{HI}^0 (Z/Z_\odot)^{0.7}$. The integrated SFR depends linearly on the central gas surface density and on metallicity to the 0.7 power.

n as a measure of the HI concentration

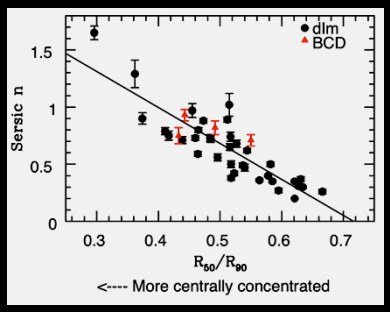

Figure 4: R_{50} and R_{90} are radii containing 50% and 90% of the total HI mass. This shows that n is a measure of the central concentration of HI.

n and the central concentrations of stars

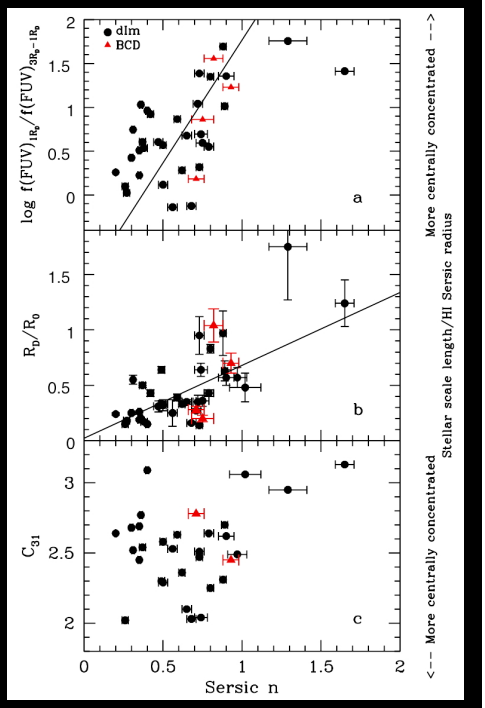

Figure 5:
a) $FUV_{1RD}/FUV_{3RD-1RD}$ is the ratio of integrated FUV emission within a radius of one disk scale length to that in the annulus of 1 to 3 disk scale lengths. This is an indicator of the central concentration of FUV emission, a tracer of young stars. It is plotted against the Sersic n parameter, a measure of the HI concentration. The more centrally concentrated the HI is, the more centrally concentrated the FUV emission is.
b) Ratio of stellar disk scale length to HI Sersic R_0. The stellar disk scale length approaches the HI R_0 as the HI becomes more centrally concentrated.
c) A measure of the central concentration of the stellar mass distribution (Zhang et al. 2012). No correlation is seen with HI concentration.

Summary

We find the following relationships between the HI surface density profiles and the stars:

1. Dwarf HI surface density profiles are fit by the Sersic family of curves with n=0.2-1.8.
2. The integrated SFR, measured from the FUV luminosity, depends linearly on the central gas surface density and on the metallicity to the 0.7 power.
3. The more centrally concentrated the HI, the more centrally concentrated is the star formation activity.
3. The more centrally concentrated the HI, the more the stellar disk scale length approaches the HI characteristic radius R_0.
4. The degree of central concentration of the stellar mass, does not seem to correlate with the degree of HI central concentration.

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