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New Lessons from the HI Size-Mass Relation of Galaxies

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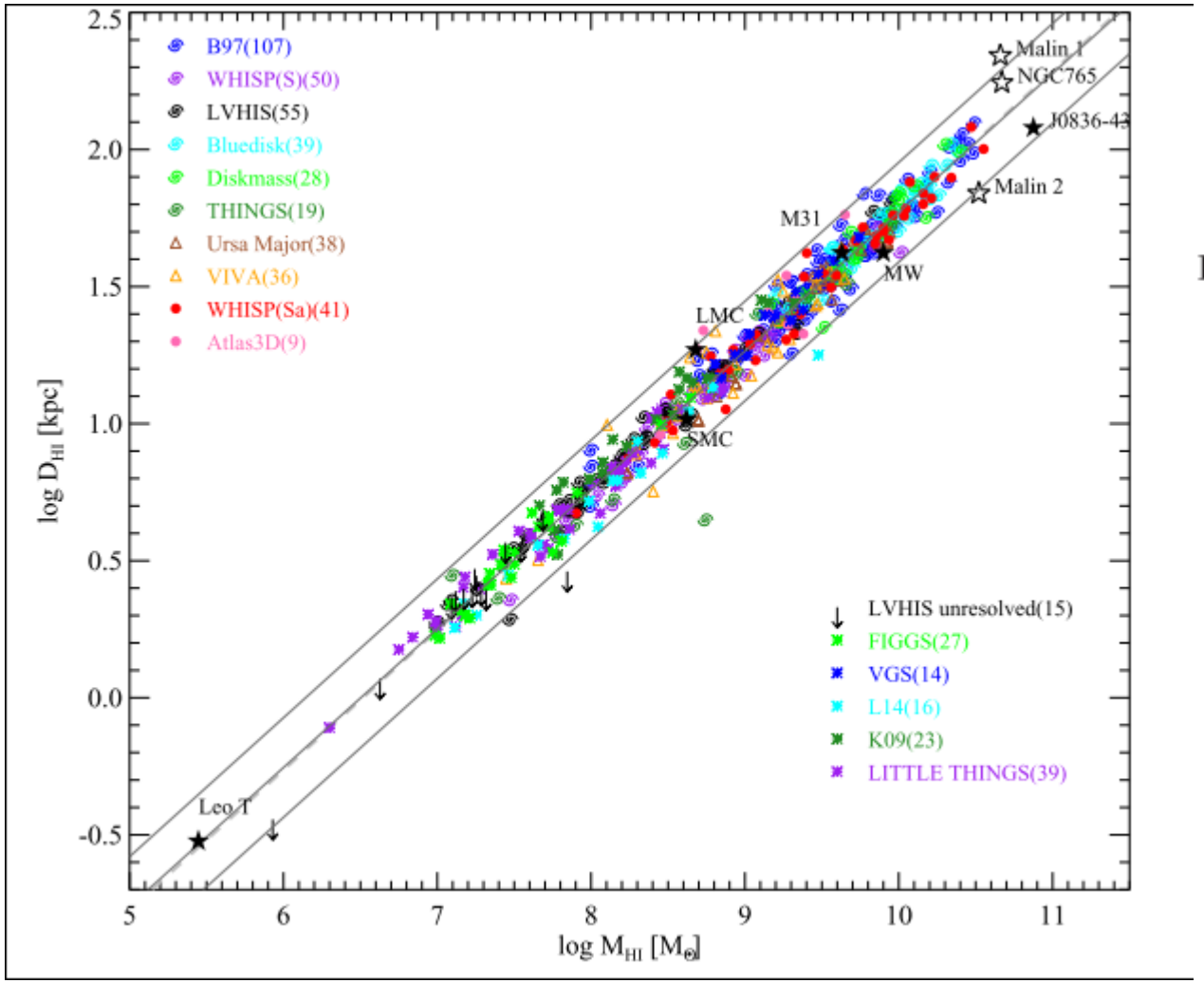
ABSTRACT

We revisit the HI size-mass (D_{HI}-M_{HI}) relation of galaxies with a sample of more than 500 nearby galaxies covering over five orders of magnitude in HI mass and more than ten B-band magnitudes. The relation is remarkably tight with a scatter σ ∼0.06 dex, or 14%. The scatter does not change as a function of galaxy luminosity, HI richness or morphological type. The relation is linked to the fact that dwarf and spiral galaxies have a homogenous radial profile of HI surface density in the outer regions when the radius is normalised by D_{HI}. The early-type disk galaxies typically have shallower HI radial profiles, indicating a different gas accretion history. We argue that the process of atomic-to-molecular gas conversion or star formation cannot explain the tightness of the D_{HI}-M_{HI} relation. This simple relation puts strong constraints on simulation models for galaxy formation.

Key words: intergalactic medium; galaxies



D_HI и M_HI — до 1M_sun/pc^2

$$D_{HI} = (0.506 \pm 0.003) \log M_{HI} - (3.293 \pm 0.009),$$

$$\Sigma_{HI,c} = 4\frac{M_{HI}}{\pi {D_{HI}}^2} = 5.07\ M_\odot\ pc^{-2}$$

→ схожее распределение пов. плотности HI в галактиках разных типов
Это верно для карликовых и спиральных галактик

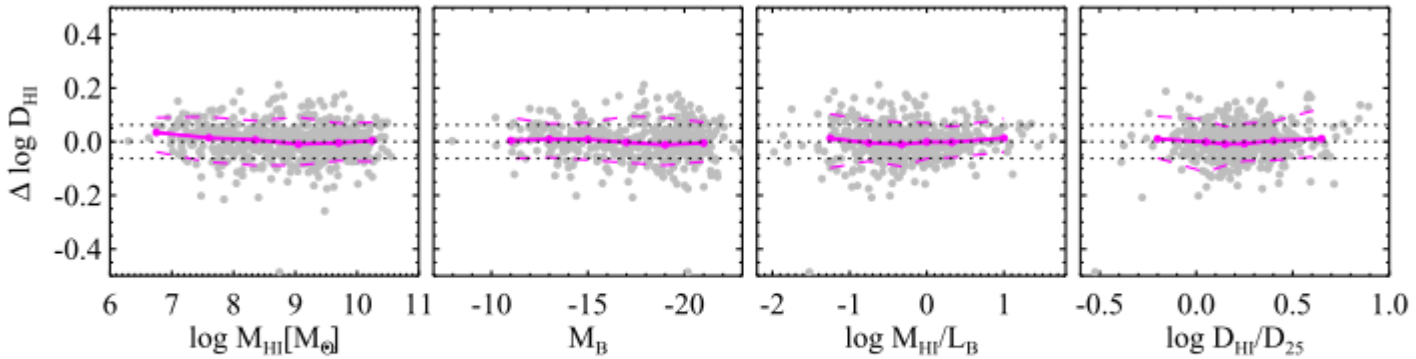


Figure 3. Vertical offset of galaxies from the D_{HI}-M_{HI} relation as a function of M_{HI}, M_B, M_{HI}/L_B, and D_{HI}/D_{25}. The solid magenta lines show the median, and the dashed magenta lines show the 10 and 90 percentiles of the distribution . The dotted black lines mark the position of 0 and 1σ scatter measured in Figure 1. The optical properties are taken from the Simbad astronomical database and are inhomogeneous.

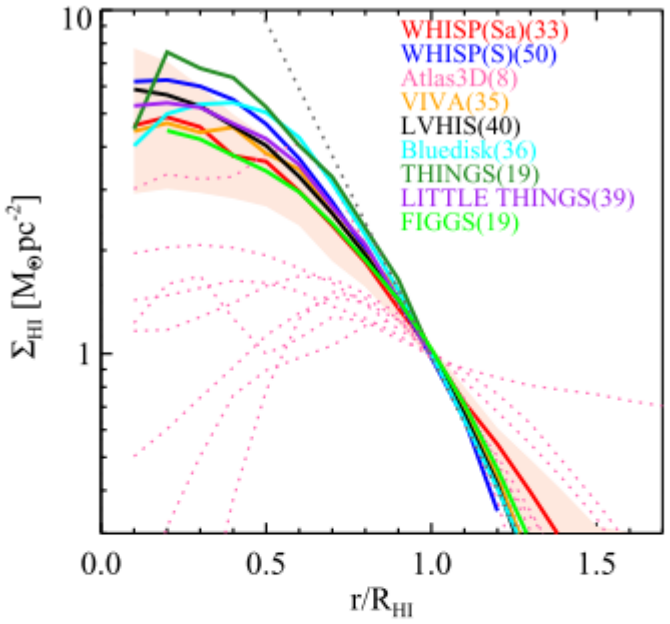


Figure 2. Σ_{HI} radial profiles for nine samples; only galaxies 3 times larger than the respective interferometric beam are included here. We display the median profile for each sample, except for Atlas3D where we show the individual profiles. We also show the 25 and 75 percentile of profiles for the WHISP (Sa) sample (the red shaded region). The dotted black line is an exponential fit to the homogeneous outer profiles of the samples excluding the Atlas3D and WHISP (Sa) samples. The VGS sample is not present because only 5 galaxies are large enough for measuring the profile.

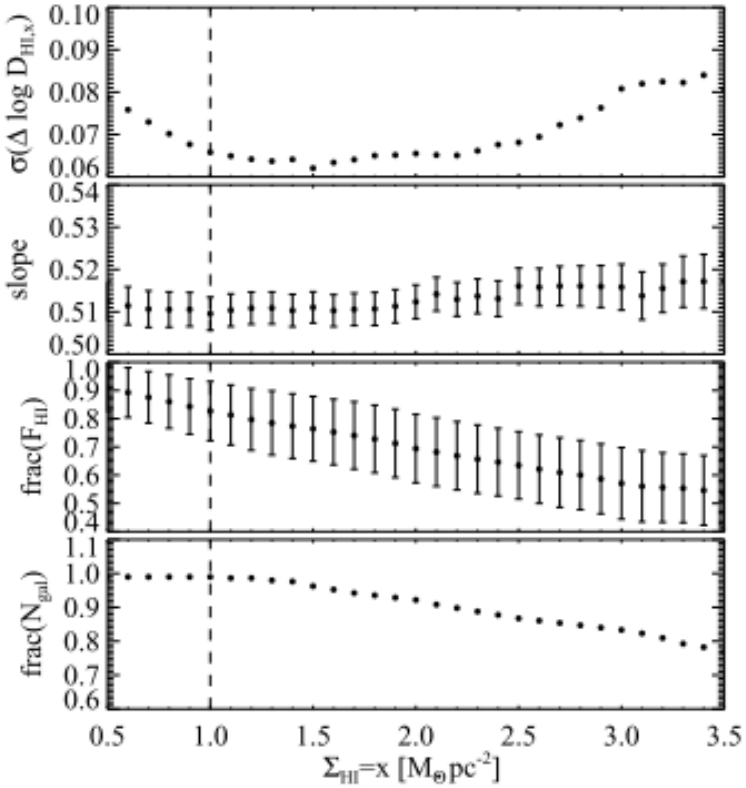


Figure 4. Comparison of different D_{HI}-M_{HI} relations with D_{HI} defined at a range of HI surface brightness densities. The measurements are based on the 10 samples where we have HI maps. From top to bottom: the scatters and slopes of the relations, the fraction of total fluxes enclosed in D_{HI} and the fraction of galaxies with measurable D_{HI} are shown.

Чем обусловлена зависимость?

Переход HI-> H2. Можно ожидать изменения наклона зависимости при переходе от карликов к большим спиралям — этого не наблюдается
ЗО. Можно ожидать большего разброса для карликов. Тоже не наблюдается.

Процесс перехода HI в H2 или ЗО, похоже, не являются главными или единственными причинами зависимости M_HI-D_HI