The H I size-mass relation of galaxies

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Abstract. We revisit the well known H I size-mass relation of galaxies with an unprecedented large sample of over 500 galaxies (Wang *et al.* 2016). We find that the relation and the scatter about the relation do not depend on the galaxy type, optical luminosity or H I richness. It indicates a fundamental unrecognised mechanism that drives the distribution of H I in different galaxies.

Keywords. radio lines: galaxies, galaxies: ISM, galaxies: galaxy formation

The relation between the diameter where the H I surface density reaches 1 $M_\odot$ pc^2 (D_{HI}) and total H I mass (M_{HI}) was first investigated in Broeils & Rhee (1997). We revisit this relation by collecting interferometric H I data for over 500 galaxies from 14 different surveys, including the Bluedisk survey (Wang *et al.* 2013) and Local Volume HI Survey (LVHIS; Koribalski 2008). We confirm a remarkably tight D_{HI}-M_{HI} relation, with a scatter of only 0.06 dex or 14%. For the first time we show that the scatter around the best-fit relation does not depend on the H I mass, the B band magnitude, the H I to optical light ratio and the H I to optical size ratio. This result is very interesting because H I surface density in a galaxy is regulated by the atomic-to-molecular gas conversion process and further regulated by the star formation process. Then we would expect the dwarf galaxies to have a shift and large scatter from the D_{HI}-M_{HI} relation compared to other galaxies for their lower star forming efficiency and more bursty star formation history. This is not observed, suggesting that some fundamental mechanisms besides star formation drives the distribution of H I in the same way in different galaxies. We refer the readers to Wang *et al.* (2016) for more details.

This relation also has useful applications in future projects. For example, WALLABY (the ASKAP HI survey, Koribalski 2012) will detect the H I in over 500 000 galaxies. With the H I size-mass relation, we can predict the distribution of H I diameter for the bright (well resolved) galaxies based on the HIPASS (the H I Parkes All-Sky Survey) catalogs (e.g. Koribalski *et al.* 2004, Meyer *et al.* 2004) before WALLABY is fully launched, and estimate the H I diameters of the unresolved galaxies based on the H I masses to be detected by WALLABY.

References

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