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HI gas component in dwarf and disk galaxies in the view of semi-analytic models†

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Abstract. We show our recent progress on the L-Galaxies semi-analytic models of galaxy formation, which focuses on the HI gas in low mass galaxies. We find that the model based on ELUCID haloes can reproduce the HI mass function from ALFALFA 100 at low mass end. On the other hand, our models predict some gas rich low mass galaxies around the Milky Way, which may offer opportunities for future HI 21cm survey in nearby universe by FAST and SKA-1.

Keywords. galaxies: formation, galaxies: ISM, ISM: atoms.

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1. Model Introduction

In the recent version of Munich group L-Galaxies semi-analytic models of galaxy formation, we combine the previous models (Henriques *et al.* 2015) with two branches. One is the model prescriptions by Fu *et al.* (2013), which can study the HI and H_2 gas in a radial resolved galaxies disks. The other is the model prescriptions by Yates & Kauffmann (2014), which helps to study the chemical enrichment processes for different elements produced by AGB, SN-Ia and SN-II. The current model can give the radial distribution of HI gas, H_2 gas, and also the radial chemical gradients of 11 elements. Our model runs not only on Millennium and Millennium-II haloes, but also on Aquarius and ELUCID haloes. Aquarius haloes is mainly used to study the Milky Way and its satellite galaxies. ELUCID (Wang *et al.* 2014) is the halo based on the reconstruction of the initial density field according to local observations from SDSS, which offers opportunities to compare the simulation directly to the local universe.

2. Model Results

In Fig. 1, we show the HI mass function based on both Millennium and ELUCID haloes compared to the observational results from HIPASS and ALFALFA 100 percent. We can see that the model results based on ELUCID haloes can fit the HI mass function in quite wide mass range, especially at low mass end ($M_{\rm HI} \sim 10^7 M_\odot$), which means the ELUCID haloes may be more helpful to study the gas properties in low mass galaxies. Fig. 2 shows that the model results of $M_{\rm HI}/M_*$ and $M_{\rm H_2}/M_*$ vs M_* for local disk and dwarf galaxies can fit the recent XGASS and XCOLD GASS results, in which the selection criterion of model samples are same to the observations. In Fig. 3, we show the HI gas in the Milky Way and its satellite galaxies, which are based on the Aquarius haloes. The model predicts 7 satellite galaxies with HI gas detection, which is more than HIPASS (only 4 satellites with HI detection). Future HI survey in nearby universe by SKA or FAST may help to test these model results and the validity of cold dark matter.

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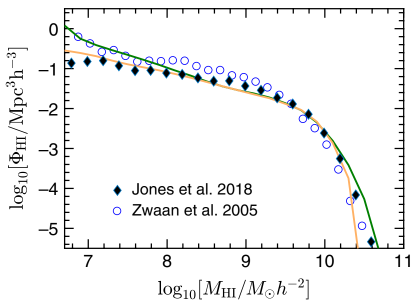

Figure 1. Model results of HI mass functions at z=0. Orange curve is based on ELUCID haloes and green curve is based on Millennium haloes. The observational HIMFs are based on HIPASS and ALFALFA.100.

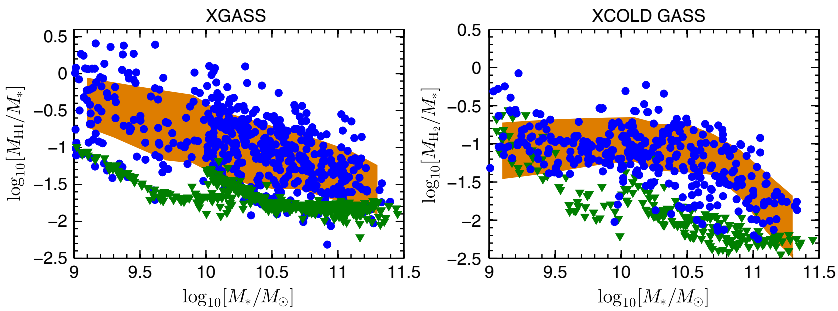

Figure 2. The model samples based on ELUCID haloes (orange areas, $\pm 1\sigma$ to the average values) compared to XGASS (left panel) and XCOLD GASS (right panel) results. In each panel, the blue dots are observational sample with certain values and the green triangles are the up limits of observations.

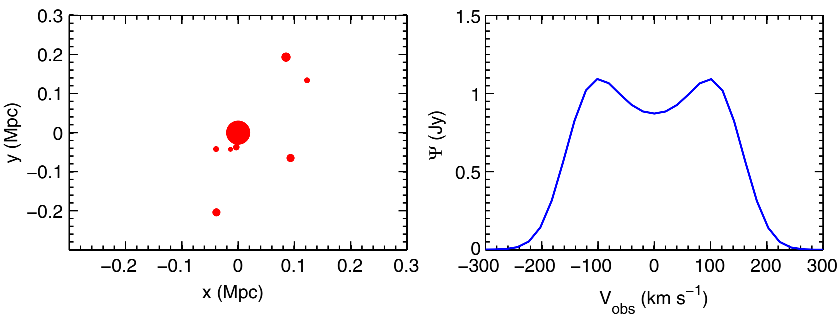

Figure 3. The synthetic observation of HI gas for the Milky Way and it satellites. The left panel shows the HI mass spacial distribution in each galaxy, and the size of each dot represents the HI mass in each galaxy. The right panel shows synthetic 21 cm flux line profile from the HI gas in the model galaxy group.

References

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