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Structures in the interstellar medium of galaxies

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Abstract. Interstellar medium of spiral galaxies are seen to have scale free structures. We report measurements of power spectra of these HI structures by observing them in emission using radio interferometers. Power spectra are found to be power law indicating existence of a scale free driving process operational at these large range of length scales.

Keywords : ISM: structures, HI — physical process: turbulence

1. Introduction

Interstellar medium in our galaxy and nearby dwarf galaxies is found to have hierarchy of structures- believed to be created by supernovae driven turbulence (see Elmegreen & Scalo (2004)). Here we report our result of power spectrum estimation of the external spiral galaxies. We use radio interferometric archival VLA data as well as data taken from THINGS sample of galaxies (Walter et al. 2008). Power spectrum of the HI intensity fluctuation $P_{HI}(U)$ as a function of the inverse angular scale U can be written as $P_{HI}(U) = \langle V^*(U)V(U)\rangle$, where $V(U)$ is the visibility measured by an interferometer. Details about this estimator and actual considerations for making it bias free is discussed in detail in Dutta et al. (2008).

We estimated the power spectrum of 18 spiral galaxies in THINGS sample. For all cases the power spectra are well fit by a single power law over a length scale ranging between $\sim$ 500 pc to $\sim$ 15 kpc considering all the galaxies. Figure 1 (left panel) shoes the histogram of the value of the best fit slope. Clearly, for most of the galaxies the power spectrum have a slope of -1.5 to -1.8, about one higher than

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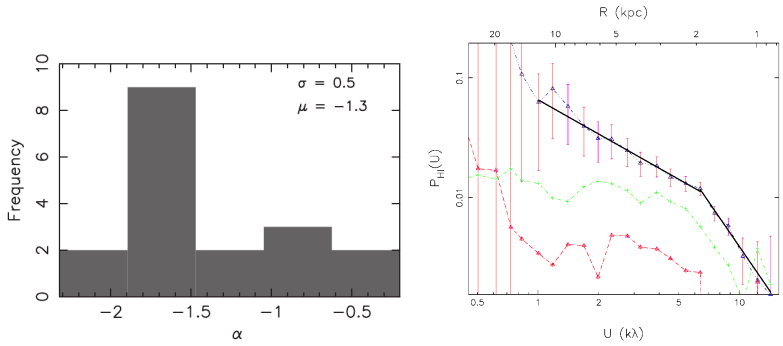

Figure 1. Left panel shows the histogram of the best fit slope of the 18 galaxies from the THINGS sample. This figure is reproduced from Dutta et al. (2013). Right panel shows the power spectrum estimated for the galaxy NGC 1058 (blue line with error bars). This figure is reproduced from Dutta et al. (2009)

the slope of the HI power spectra measured at much smaller length scales of $\sim$ 1 to $\sim$ 200 pc in our Galaxy. This we explained arising because of the fact that at small scales the structures we probe are 3 dimensional, while at the scale of the galactic disk, we are mostly looking at 2 dimensional fluctuations. This was found to manifest in the power spectrum of the galaxy NGC 1058 (see Figure 1 right panel), where based on the angular scale of the break, we could estimate the average HI scale height of this face on galaxy to be $\sim$ 500 pc. We found the amplitude of the HI column density fluctuations at the largest scales probed is about one order of magnitude less than the mean column density of these galaxies. These inputs would be useful for the theoretical investigation that need to follow to explain these large scale coherent structures.

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