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Fractal Structure in the Interstellar Medium of the Small Magellanic Cloud?

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Abstract. We use the spatial power spectrum for a statistical study of HI in the SMC in order to probe the intrinsic topology of the ISM. A remarkable power-law fit to the spatial power spectrum was found, supporting an alternative ISM model having a fractal nature resulting from interstellar turbulence.

1. 2-D HI Spatial Power Spectrum

We have recently combined an ATCA HI mosaic of the SMC with the 'zero-spacing' Parkes data to obtain images sensitive to all spatial scales between 30 pc and 4 kpc (Stanimirović et al. 1999). This allows us to undertake a statistical study of HI in the SMC using the spatial power spectrum (e.g., Crovisier & Dickey 1983; Green 1993).

The 2-D spatial power spectrum of the whole SMC was derived by Fourier transforming images for each velocity channel and measuring the average value of the square of the modulus of the transform, $< \Re^2 + \Im^2 >$, in annuli of equal width in $\log \sqrt{u^2 + v^2}$ (u and v are measured in wavelengths, λ). We derive the following results:

- For all velocity channels, over the whole linear size range, the power spectra are remarkably well fitted by a power law (see Fig. 1), $P(k) \propto k^{\gamma}$ (k is in units of λ), with $< \gamma >= -3.04 \pm 0.02$.
- The power law slope (γ) is very similar to the ones derived previously for our own Galaxy (Crovisier & Dickey 1983; Green 1993), suggesting

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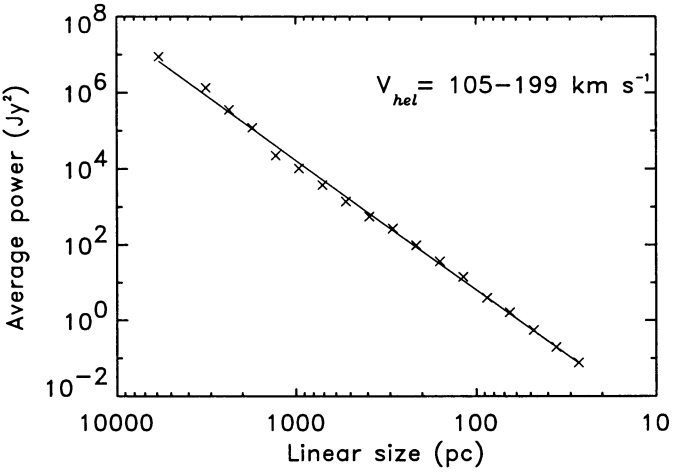

Figure 1. An average 2-D spatial power spectrum of the SMC. A least-squares fit is overlaid.

that similar processes are responsible for structure formation in both the Galaxy and the SMC.

- $P(k) \propto k^{\gamma}$ shows that the IS turbulence may play a significant role in the ISM of the SMC. However, in a compressible, self-gravitating environment, the situation is much more complex than the Kolmogorov's one which applies to incompressible fluids.

2. The ISM as a Fractal?

The observed HI power spectrum in the SMC could be a manifestation of a fractal structure created by the IS turbulence (Falconer 1997). The projected fractal dimension is $D_p = 1.5$, and the volume fractal dimension is $D = 2.5$. D_p is very similar to the ones obtained for molecular clouds, suggesting that fractal structure is pervasive in the ISM. This alternative fractal model of the ISM consists of a hierarchy of HI clouds, clustered and clumped into dense interstellar regions, while the bulk of the ISM has low density.

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References

Crovisier, J., & Dickey, J.M. 1983, A&A, 122, 282

Falconer, K. 1997, in: *Fractal Geometry*, J. Wiley & Sons Ltd: Baffine Lane, England

Green, D.A. 1993, MNRAS, 262, 327

Stanimirović, S., Staveley-Smith, L., Dickey, J.M., Sault, R.J., & Snowden, S.L. 1999, MNRAS, 302, 417

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Discussion

Sally Oey: I just want to suggest that the fractal dimension and turbulence may result from energy input from supernovae and stellar winds, rather than in opposition to this model.

Stanimirovic: Supernovae and stellar winds certainly contribute a lot to the IS turbulence, especially on intermedidate spatial scales, but they are not enough to explain the hierarchy of clouds going up to 4 kpc (the physical size of the SMC).

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