A Statistical investigation of HI in the Magellanic Bridge

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Introduction:

High resolution observations (minimum ~98") of the HI in the Magellanic Bridge by Muller et al. (2003), have shown that the HI has a very complex structure. We present here analyses of the Spatial Power Spectrum (SPS) of the HI component. The outcomes suggest that the Magellanic Bridge (MB), historically considered to be a single coherent feature, may in fact be a projection of two kinematically and morphologically distinct structures, possibly representing two arms of the Small Magellanic Cloud (SMC).

We also probe the rate of variation of the HI spectra throughout the Bridge, measured by the Spectral Correlation (SCF) and highlight a tendency for the spectra of bright parts of the HI in the Bridge to have a more persistent correlation along a direction towards the Large Magellanic Cloud (LMC) and SMC..

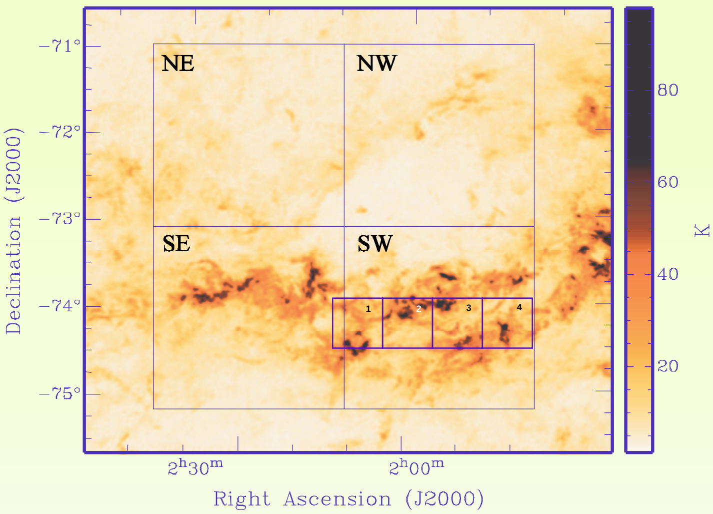


Figure 1: (Above) Peak pixel map of HI in the Magellanic Bridge (Muller et al. 2003) . The four squares indicate the four regions tested by the power spectrum analysis. The smaller regions in the SW are those tested with the SCF.

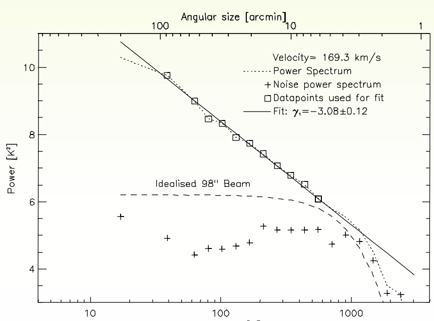
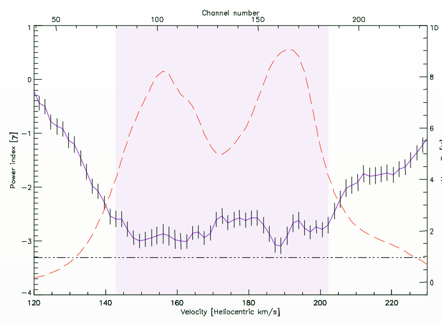
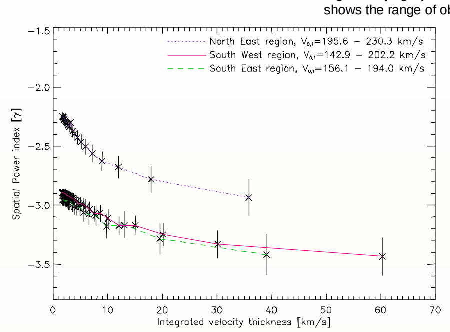


Figure 2 (Left): Typical power spectra of Bridge HI. This example is from the SE region. It is well fit with a single component.

Figure 3 (Left lower): The variation of γ and of mean HI brightness per channel as a function of velocity for the SW region. The index, γ appears to saturate at ~-3. Whereas the northern region saturate at ~-2 (not shown). The purple region shows the velocity range probed for measurements of γ(dv). Dot-Dash line shows RMS of the HI line emission.

Figure 4 (Lower): The variation of γ(dv) for each of the three subregions. The NE region is very distinct from those in the South.





Spatial Power Spectrum:

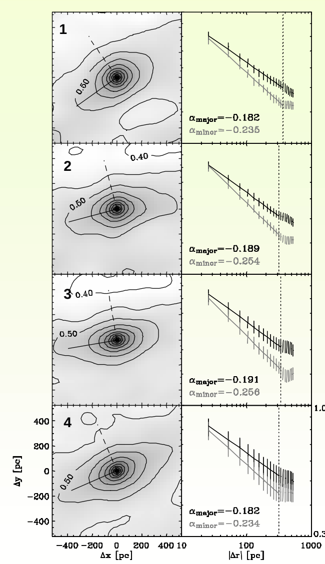
We apply the SPS in an effort to measure variations in the distribution of scale and power across this feature. We study the SPS for each of regions in the Bridge, as a function of velocity and of velocity integrated width.

γ(v): There is considerable variation in the HI structure throughout the MB. We probe the power spectra for four different regions in the Bridge (see Figure 1). An example power spectrum for each of the four regions is shown in Figure 2. An important result is the linear and featureless spectrum, consistent with results of studies of the power spectra of the SMC (e.g. Staveley-Smith et al. 1998). We find that the northern regions have a peak value of γ(v) which is very distinct from the southern regions.

γ(dv): The variation of the power spectrum index, as a function of velocity is shown in Figure 3. We have sub-selected velocity intervals over which the index appears to be constant , shown as the purple shaded region in Figure 2. We calculate the power spectrum index a s a function of velocity width in an attempt to remove a small-scale turbulent component, as shown in figure 4. Again, the Northern region has a clearly different turbulent component to the southern regions.

Spectral correlation Function:

The SCF measures the 'similarity' of spectra, as a function of spatial lag. The algorithm can be used to produce a map of the mean behavior of spectral similarity as a function of distance over a specific area. Four smaller regions, shown approximately by the purple squares in the SW region in Figure 1 were tested with the Spectral correlation Function. The generated maps are shown in Figure 5.



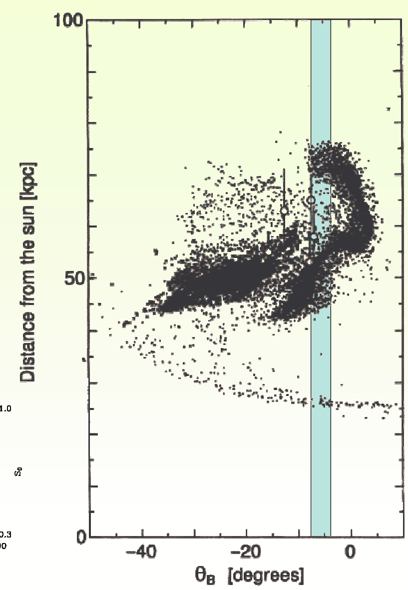


Figure 5 (Left): SCF maps of the purple squares marked in Figure 1. The plots adjacent to the maps show the logarithmic variation of the calculated value in the direction of minium variation, as well as the direction perpendicular to this. There are strong correlations with the direction of minimum variation of the tidal perturbation of the Cloud interaction.

Figure 6 (Right): Numerically Simulated Position-Distance map of the HI in the Magellanic system. The coloured bar shows the range of observations in Figure 1.

Discussions:

The distinct behaviour of the power spectra for the northern and southern regions suggest that these regions do not share a common morphology. Together with numerical simulations of the Magellanic System (Gardiner, Sawa & Fujimoto,1994), shown in Figure 6, this suggests that the Magellanic Bridge, is in fact a superposition of at least two, long and filamentary objects.

These results from the SCF shows that this technique is a useful test for locating tidally influenced, large-scale structures. It appears to be much more sensitive to small scale stucture than does the SPS. More work is necessary to fully understand the application of this algorithm.

Stanimirovic & Lazarian, 2001;

Gardiner, Sawa & Fijimoto, 1994, MNRAS, 226, 567

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