3 Interstellar Medium Physics

The Queen's University Belfast–Jodrell Bank optical–IR programme addresses questions about physical conditions in the ISM. H I emission data are taken along lines of sight to stars whose absorption spectra are of particular interest, for example lying in the direction of intermediate velocity clouds (IVCs) or high velocity clouds (HVCs). The $-71\ \mathrm{km\,s^{-1}}$ IVC/HVC lying in front of the globular cluster M13 has been investigated in this way using Echelle spectra from the NaI D line and CaII K line observations of stars in M13 along with 12′ resolution H I spectra taken with the Lovell Telescope (Shaw et al. 1996). N(NaI)/N(H I) ratios in the clouds lying in front of M13 lie in the range $1\text{–}4 \times 10^{-8}$, while the N(CaII)/N(H I) ratios are $\geq 10^{-7}$. Temperatures in the compact clouds are a few hundred Kelvin while the warmer, more extensive, gas is at $\sim 10^4$ K. Ionisation conditions can be determined for the clouds.

Similar investigations have been made of the conditions in the large gas concentration (1300 $M_{\odot}$), in the direction of Perseus at $l = 150°$, $b = -10°$ (Trapero et al. 1995). H I temperatures in this cloud reach as low as 30 K. Systematic velocity changes across its surface of several $\mathrm{km\,s^{-1}}$ are found. A distance for the cloud of ~100 pc was determined from the presence or not of corresponding absorption features in the spectra of stars lying this direction.

4 Angular Structure in H I

Structure in Galactic H I is found on all scales accessible to observation. A good example of this range of structure may be found in the study of the M13 region by Shaw et al. (1996). Features are seen with the Lovell Telescope on scales of 12 arcmin and greater. Observations at 2 arcmin resolution with the DRAO Synthesis Telescope show structure on that scale while optical evidence from NaI and CaII spectra, and by implication H I, indicates significant differences in the line of sight to stars ~ 10 arcsec apart. This interstellar material is believed to be at a distance of ~ 100 pc where 1 arcmin corresponds to 0·03 pc.

Radio interferometer data on H I clouds seen in absorption against extragalactic radio sources show structure down to 0·1 arcsec. Davis, Diamond & Goss (1996) find 10–30% changes in optical depth over 0·1 arcsec in galactic H I lying in front of the sources 3C138 and 3C147.

5 Conclusions

The evidence presented above shows that Galactic H I occurs on all angular scales down to arcseconds. An all-sky survey of H I at an angular scale of ~10 arcmin would provide a rich source of data for many current areas of interest. These include the distribution and kinematics of H I in the Galactic disk, the structure of the nearby ISM from studies of intermediate and high latitude H I, HVCs and IVCs as well as tidal tails of our own Galaxy and the Magellanic Clouds. The imminent availability of multibeam systems for H I observations makes such large-area surveys a realistic possibility.

The Jodrell Bank multibeam system at present under construction consists of four dual-polarised horns at the prime focus of the Lovell Telescope. Each of the eight receiver systems will operate with a system noise of 25 K and feed into a 1024 channel two-level correlator spectrometer. The system will be used for Galactic and extragalactic studies.

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An H I Mosaic of the Large Magellanic Cloud

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Abstract: The parameters of a new Australia Telescope Compact Array (ATCA) mosaic of the Large Magellanic Cloud (LMC) in the 21-cm line of neutral hydrogen are described. A preliminary peak-brightness-temperature image of the whole of the LMC, and a detailed image of the region around the supergiant shells LMC 4 and 5 is shown.

1 Introduction

The LMC is the nearest internally bound galaxy to the Milky Way, and is an important laboratory for the study of gas dynamics and star formation in young galaxies. Previous H I observations (e.g. Luks & Rohlfs 1992) have been limited by the spatial resolution of the Parkes telescope at 21 cm (220 pc at the distance of the LMC). However, the ATCA permits much higher spatial resolution to be

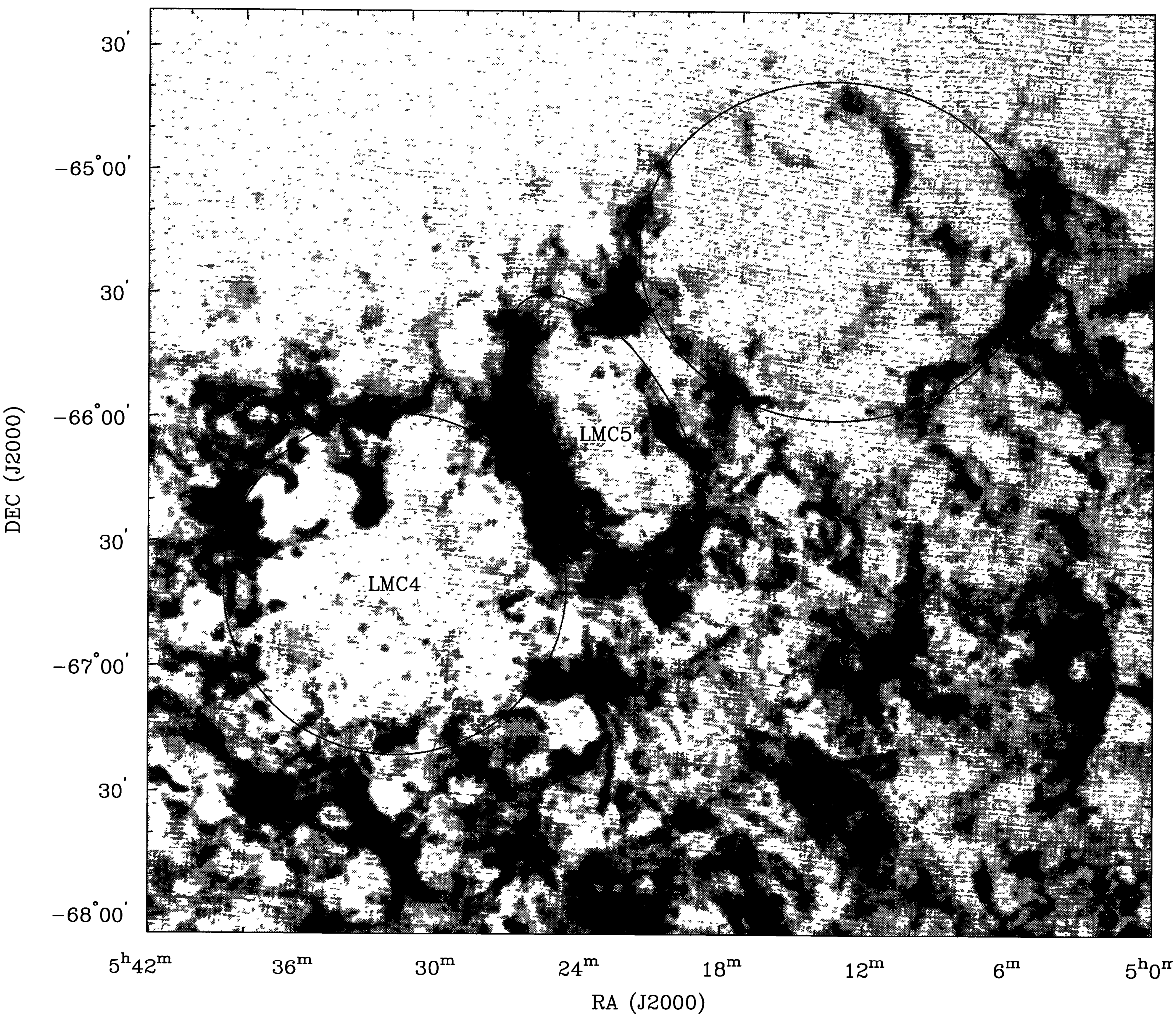

Figure 1—Peak H I brightness temperature around the supergiant shells, LMC 4 and 5 (see Meaburn 1980). The newly found supershell next to the LMC 5 has a diameter of about 1·4 kpc.

obtained. In this paper, we describe the very first results of a new survey.

2 Observations

The Large Magellanic Cloud has been surveyed in neutral hydrogen emission with the ATCA. The mosaic consists of 1344 separate pointings of the 750-m array (four configurations) covering a field of $10° \times 12°$ with an angular resolution of $60''$ (~15 pc) and a velocity resolution of $1 \cdot 6$ km s^{-1}. The images show the detailed spatial structure of the neutral interstellar gas in the LMC for the first time. Figure 1 is a close-up of the H I in a 10 square-degree region in the north of the LMC containing the supergiant shells LMC 4 and 5 (Meaburn 1980). Figure 2 is an H I image of the whole LMC. Both figures are peak-brightness-temperature images. On small-to-medium scales, the combined action of numerous shells and supershells dominates the structures and motions of the H I in the LMC. On large scales, the LMC is remarkably symmetric in appearance compared with at other wavelengths and shows a pronounced spiral pattern. A southern spiral arm is seen for the first time. This arm extends out from the 'B3' stub tentatively identified by de Vaucouleurs and Freeman (1972).

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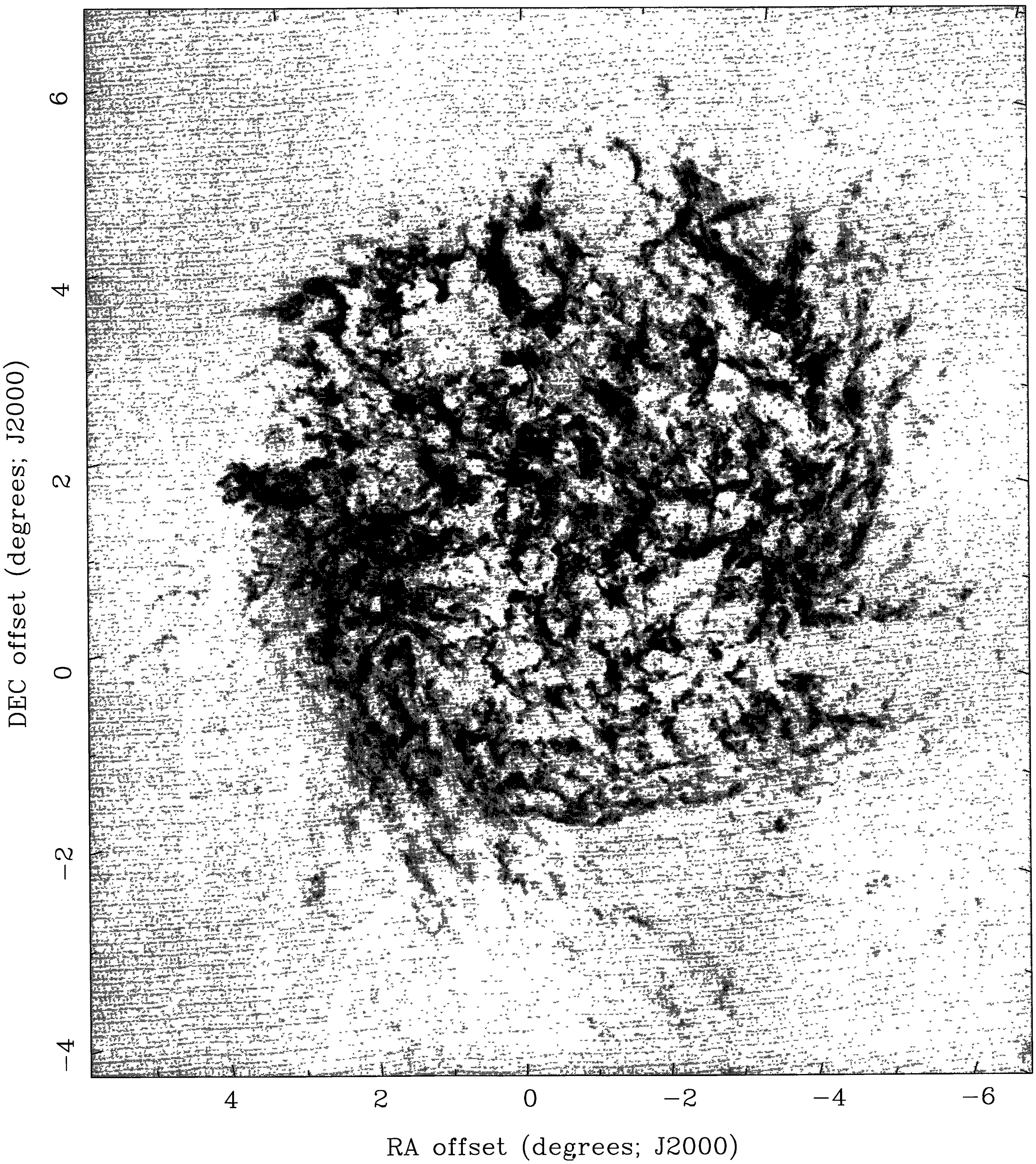

Figure 2—The peak H I brightness temperature image from the ATCA survey of the LMC. On the largest scales, the LMC shows remarkable symmetry in its structure compared with at other wavelengths. On smaller scales, the effect of numerous wind and supernova-blown shells is apparent. The highest brightness temperature in this image is 109 K.