THE VLA GALACTIC PLANE SURVEY

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ABSTRACT

The VLA Galactic Plane Survey (VGPS) maps the first Galactic quadrant between longitudes 18 degrees and 67 degrees in 21-cm radio continuum and the HI 21-cm line at a resolution of 1 arcminute. The survey consists of a mosaic of 990 pointings of the Very Large Array (VLA) supplemented with short spacing information from the NRAO 140-foot telescope. The VGPS is expected to be very valuable for a better understanding of the spatial, dynamical and thermal structure of Galactic atomic hydrogen, and for the disk-halo interaction.

INTRODUCTION

The VLA Galactic Plane survey (VGPS) is a part of the International Galactic Plane Survey (IGPS), an international effort to map our Galaxy in the 21-cm line of HI and continuum at a resolution of one arcminute. The sensitivity in the HI line is 2 Kelvin (r.m.s.) for channels of width 1.3 km/s. Apart from the HI line, images of radio continuum intensity at 21-cm will be created. The area covered by the VGPS extends about 50 degrees longitude in the first quadrant (Fig. 1.). This includes a large part of the Galaxy inside the sun's orbit around the Galactic centre (solar circle). Observations with radio interferometers and single-dish radio telescopes are combined to provide information on all spatial scales down to the resolution limit of 1 arcminute. The three major areas of the IGPS are the Canadian Galactic Plane Survey (CGPS; [1]) in the north, the Southern Galactic Plane Survey (SGPS; [2]) in the south and the VGPS near the celestial equator.
The VGPS survey area contains a total of 990 pointings that were observed with the VLA at three different hour angles in 3 minute snapshots. The spacing between pointing centres is 25 arcminutes. The latitude coverage increases with longitude from a minimum –1.3 degrees to +1.3 degrees (six latitude pointings) through an intermediate –1.7 degreed to +1.7 degrees (eight latitude pointings) to –2.1 degreed to +2.1 degrees (ten latitude pointings).

SCIENTIFIC OBJECTIVES

Fig 1. demonstrates the importance of high-resolution HI surveys to obtain a description of the spatial, dynamical and thermal structure of HI. The survey covers areas of intense activity, as well as quiescent areas.

An important aspect is the mass and energy exchange between the disk and the halo of the Galaxy. The Galactic Chimney [3], and the Galactic Mushroom [4] are spectacular discoveries from the CGPS. The VGPS covers much more of the inner galaxy, where star formation is on average more intense. A good impression of what can be expected from the VGPS is the discovery of two large (400 to 600 parsec diameter) HI shells in the SGPS [5]. Fig. 2 shows a much smaller shell discovered in the VGPS (Rothwell et al., in preparation). This shell has an estimated diameter of only 30 parsec, illustrating the large range in scale that becomes accessible through high-resolution HI surveys. HI shells can be found in – a priori – unexpected places such as the far outer Galaxy [6]. These HI shells can have no detectable counterpart in radio continuum or in the infrared. The HI surveys therefore contribute to a complete inventory of energetic processes in the disk of the Milky Way.

Absorption of radio continuum emission allows distance determinations for galactic continuum sources such as HII regions and supernova remnants. Absorption also provides information on the spin temperature of atomic hydrogen. Cold HI clouds may be detected as dark silhouettes against warm HI clouds in the background, if both clouds have the same velocity, a process known as HI self-absorption. At a resolution of 1 arcminute many filamentary clouds are seen, that are heavily diluted by the large beams of single-dish surveys. Most of these cold HI clouds remain undetected in CO or dust emission [7]. An important advantage of this approach is that one does not have to rely on specific lines of sight towards radio continuum sources as long as a bright background of HI with the same velocity is available. This allows the detection of extended structures of cold atomic hydrogen that can be very large [8]. The double-valued velocity of HI in the inner Galaxy ensures background HI emission at virtually all positive velocities in the first Galactic quadrant. This provides a particularly good opportunity to study obtain a complete view of the distribution of cold HI.

Many other projects are being pursued. The data will be made available for the astronomical community as soon as possible.

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REFERENCES

[1] Taylor, A. R., Gibson, S. J., Peracaula, M., Martin, P. G., Landecker, T. L., Brunt, C. M., Dewdney, P. E., Dougherty, S. M., Gray, A. D., Higgs, L. A., Kerton, C. R., Knee, L. B. G., Kothes, R., Purton, C. R., Uyaniker, B., Wallace, B. J., Willis, A. G., & Durand, D., 2002, ApJ, submitted

[2] McClure-Griffiths, N.M., Green, A. J., Dickey, J. M., Gaensler, B.M., Haynes, R.F., & Wieringa, M.H., 2001, ApJ 551,394

[3] Normandeau, M., Taylor, A. R., & Dewdney, P. E., 1996, Nature 380,687

[4] English, J., Taylor, A. R., Mashchenko, S. Y., Irwin, J. A., Basu, S., & Johnstone, D., 2000, ApJL 533,25

[5] McClure-Griffiths, N.M., Dickey, J. M., Gaensler, B.M., Green, A. J., Haynes, R.F., & Wieringa, M.H., 2000, AJ 119,2828

[6] Stil, J. M., & Irwin J. A., 2001, ApJ 563,816

[7] Gibson, S. J., Taylor, A. R., Higgs, L. A., & Dewdney, P. E., 2000, ApJ 540,851

[8] Knee, L. B. G., & Brunt, C. M., 2001, Nature 412,308

[9] Hartmann, D., & Burton W. B., 1997, Atlas of Galactic Neutral Hydrogen, Cambridge University Press

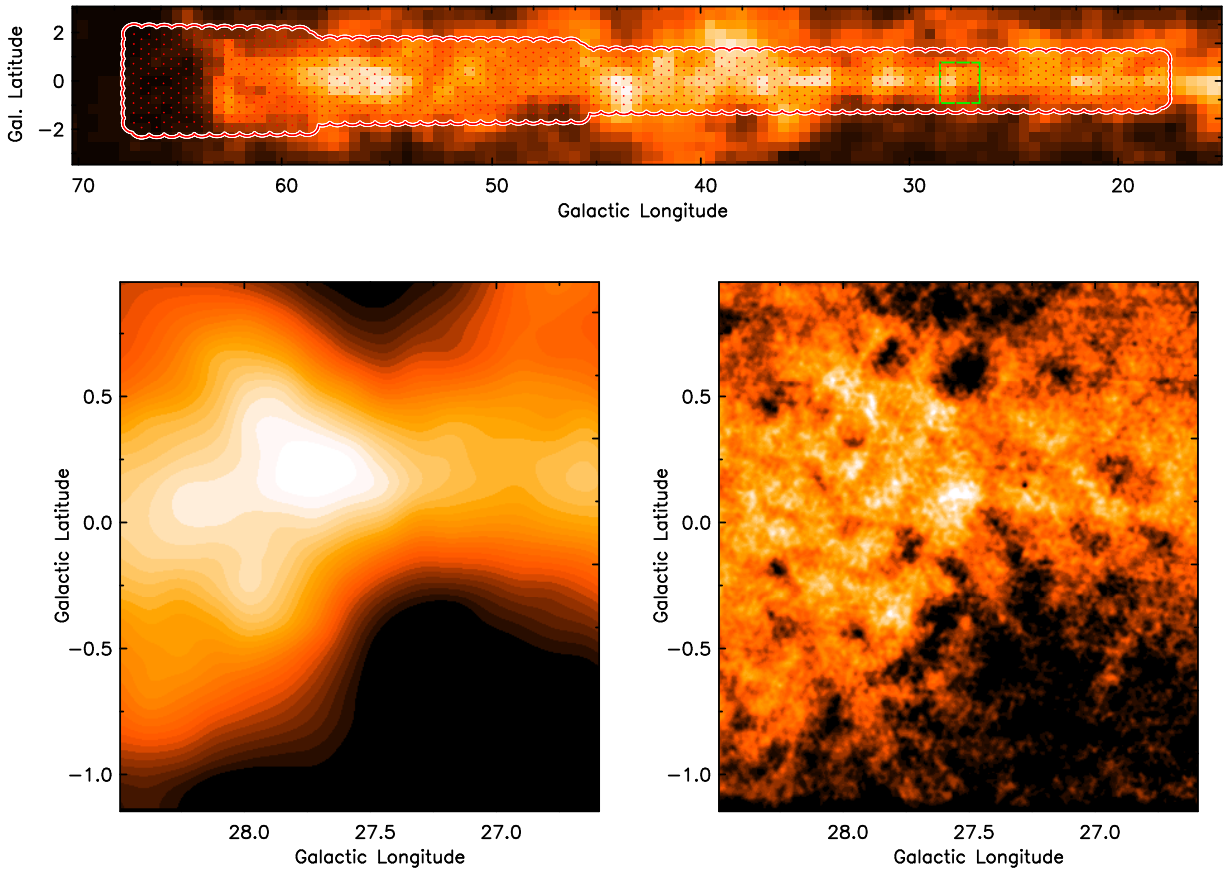

Fig. 1. Top: Area covered by the VGPS drawn on top of a the HI brightness at LSR velocity 36 km/s from the Leiden/Dwingeloo Survey [9]. Intensity increases from black to orange to white. Dots indicate the pointing centres and the red curve marks the approximate boundary of the survey area. The green rectangle indicates the area shown in the lower plots. Bottom left: HI brightness at 36 km/s observed with the NRAO 140-foot telescope (FWHM beamsize 21 arcminutes). Bottom right: Combined VLA/140-foot image containing all spatial scales down to 1 arcminute.

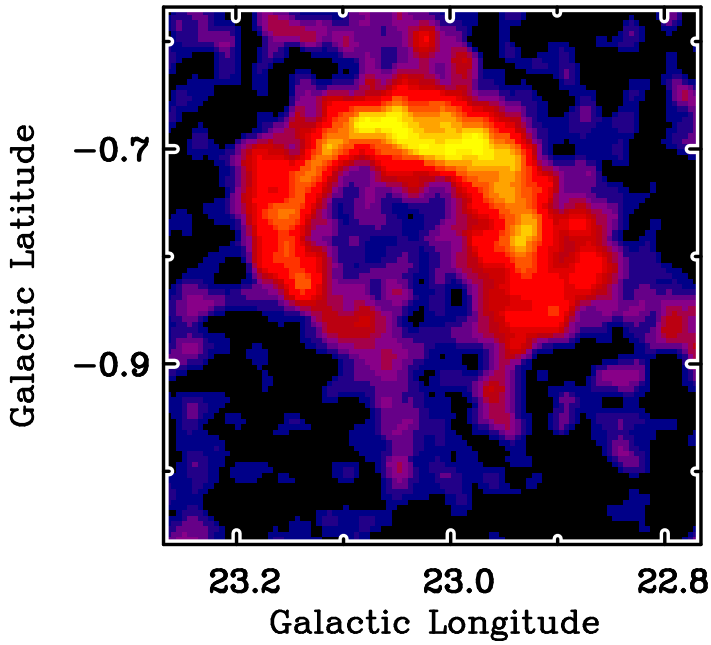

Fig. 2. HI shell discovered in the VGPS.