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An Imaging Survey of Northern Galactic Hα Emission with Arcminute Resolution

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Abstract: We present preliminary results from a high-resolution, high-sensitivity imaging survey of the northern galactic Hα emission. The survey is carried out using the Spectral Line Imaging Camera (SLIC) which incorporates a fast (f/1·2) lens attached to a cryogenic CCD in combination with a narrowband interference filter. The pixel size is 1·6 arcminutes and the diameter of each field is 10°. The fast optics, narrow bandpass (1·7 nm) filter, and high quantum-efficiency, low-noise CCD yield a high brightness sensitivity to Hα emission on arcminute scales. This gives an equivalent sensitivity to emission measure structure below 1 pc cm^{-6}. Some faint features detected include a supershell connected with the star forming region W4 extending 7° above the galactic plane, and filaments possibly related to galactic loops II and III. In addition, we have carried out deep observations of fields in which anisotropies in the cosmic microwave background radiation have been detected. Our observations place stringent limits upon the contribution to the apparent microwave fluctuations from free–free emission in the galactic foreground.

Keywords: surveys — ISM: bubbles — ISM: clouds — ISM: HII regions — ISM: structure — ISM: supernova remnants

1 Introduction

We are presently carrying out an imaging survey of the Galactic Hα emission in the northern hemisphere. Our instrument, the Virginia Tech Spectral Line Imaging Camera (SLIC) utilises a fast objective lens (f/1·2, 58 mm focal length) with a cryogenically-cooled TK 512×512 CCD. The CCD is back-illuminated and has a quantum efficiency of 80% at 650 nm. A filter wheel in front of the lens allows us to select interference filters, including a narrowband (1·75 nm) Hα filter and a broader bandpass continuum filter in a line free part of the spectrum. The fast optics in combination with the low noise CCD result in sub-Rayleigh sensitivity at confusion limited levels (1 Rayleigh $= 10^6/4\pi$ photons cm^{-2} s^{-1} sr^{-1}). This corresponds to an emission measure sensitivity of ≈1 pc cm^{-6}.

Our survey with its 1′·6 resolution is complementary to the WHAM (Wisconsin Hα Mapper) survey of Reynolds et al. (1988, present issue p. 14) which collects detailed spectral information with approximately 50′ resolution. Other efforts in the southern hemisphere are also complementary to ours. These include a similar survey by J. Gausted, P. McCullough and D. Van Buren, a galactic plane Schmidt survey by Parker & Phillipps (1998, present issue p. 28) and Fabry–Perot observations at Marseille by Russeil et al. (1998, present issue p. 9).

2 Survey

We have currently covered a major fraction of the northern sky. The survey already reveals a wealth of structure including very faint filaments away from the galactic plane. Because the survey is CCD based, it contains the full range of surface brightness from sub-Rayleigh structures to 10^3 Rayleigh features (and brighter) near the plane, without saturation of the brighter features. The resolution of the survey makes it ideal for comparison with IRAS maps and X-ray observations, as well as HI observations in order to study the relationship between the various phases of the ISM and the warm ionised medium.

We are calibrating the existing observations and shall make them available as FITS images at our web site:

`http://www.phys.vt.edu/ astrophy/halpha.html`

We have also constructed mosaics of several extended regions near the galactic plane. These are available as GIF and JPEG images at our web site. The mosaics are presented in a nonlinear display to show qualitatively the detailed structure.

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3 Early Scientific Results

We have carried out deep Hα observations of fields in which other groups have observed apparent anisotropies in the cosmic microwave background. Our results rule out any significant contribution from foreground galactic free–free emission (Simonetti, Dennison & Topasna 1996).

We have also discovered a supershell inflated by stellar winds from young stars associated with the HII region W4. This structure was previously thought to be an open galactic chimney. Our Hα image reveals a large, elongated ionised shell which appears to close at a galactic latitude of 7° above the W4 HII region. Stellar winds from the very young star cluster OCl352 have evidently produced this superbubble. The H II shell is maintained by ionising radiation from the star cluster. For further details see Dennison, Topasna & Simonetti (1997).

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