Supplement to *J. Astrophys. Astr.* (1995) **16**, 269–271

Ionized Gas in the Inner Galaxy

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Abstract. We present 90 and 20 cm radio recombination line observations of six regions in the inner galactic plane which are devoid of any discrete continuum sources.

Key words: Galaxy: Recombination lines, galactic plane—HII regions.

1. Introduction

It has been known for about 20 years now that radio recombination lines can be observed in the inner Galaxy even from regions where there are no discrete continuum sources. The origin of these lines has been a matter of debate. It is thought that these lines could be coming from old diffuse HII regions in the inner galaxy (Shaver 1976) which cannot be identified as discrete sources in the continuum surveys or from outer envelopes of known discrete HII regions (Lockman 1979; Anantharamaiah 1986).

Anantharamaiah (1985) had detected the H272α (324.99 MHz) recombination line from six 'blank' regions which were chosen to be devoid of any discrete continuum sources within the Ooty radio telescope beam of $2^\circ \times 6'$. Example of one such blank region is shown in Fig. 1a. We have now observed these six blank regions in the H168α (1.37 GHz) line using the NRAO[1] 43 m telescope at Green Bank. Since the beam size of the 43 m telescope is about 21′, observations were made at several positions within the Ooty beam area and the profiles were averaged with appropriate weighting to simulate the Ooty beam for the H168α observations. Three of the blank regions were similarly observed in the H128α line (3.1 GHz). In four of the six blank regions there is good agreement in the velocity and width of the H272α and H168α lines (see Fig. 1b) suggesting that the two lines originate in the same gas. In the other two cases the higher frequency line has additional components.

2. Properties of the ionized gas in blank regions

Using the theory of recombination line formation and taking into account possible departure from local thermodynamic equilibrium (LTE), we have constrained the

[1]NRAO is operated by Associated Univ. Inc. under a co-operative agreement with the NSF.

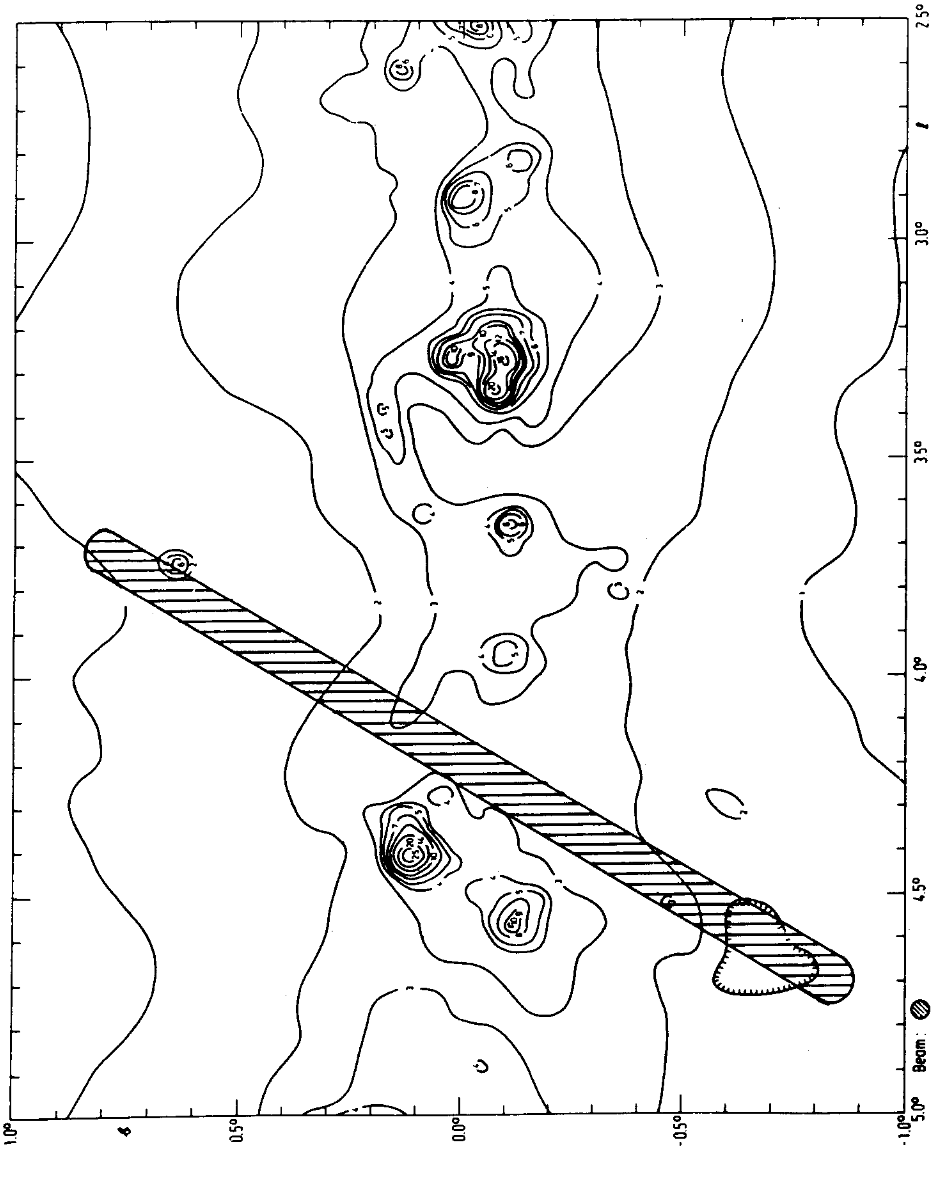

Figure 1a. A typical 'blank region' chosen from the 5 GHz continuum map of Altenhoff *et al.* (1978). The position of the Ooty telescope beam is shown by the hatched area.

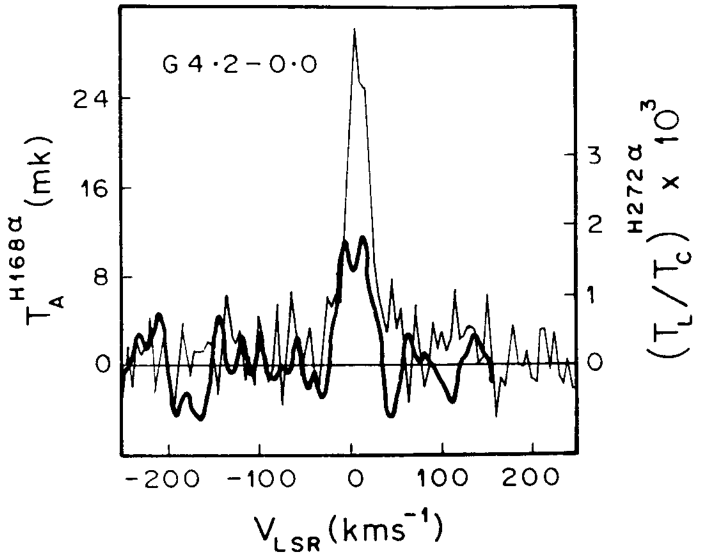

Figure 1b. H272α (thick line) and H168α (thin line) recombination lines observed from the blank region shown in (a).

electron density (n_e), electron temperature (T_e) and emission measure ($n_e^2 . l$) of the line emitting regions. Because of the very different dependence of H272α and H168α line intensities on electron density, the value of n_e is remarkably well constrained in all the cases irrespective of the values of l and T_e. On the other hand T_e and l are not well constrained although some handle is obtained for those cases where the H128α line is also observed. In all the blank regions the electron density of the ionized gas is $< 5\,\mathrm{cm}^{-3}$. If $T_e = 5000\,\mathrm{K}$, then the pathlength through the gas is a few hundred parsecs except for G2.1−0.0 for which the pathlength could be several kilo parsecs. The emission measure of the gas is between a few 100 to a few $1000\,\mathrm{pc\,cm}^{-6}$.

We have also compared the radial velocity of the ionized gas observed towards the blank regions and a nearby HII region closest in velocity and seen in the 5 GHz continuum map. In three out of the 5 cases there is an HII region within $4\,\mathrm{km\,s}^{-1}$ of the central velocity observed in H272α. But then, for all these three cases the derived pathlength is very large ($> 0.5\,\mathrm{kpc}$) and therefore the agreement may not suggest a physical association. We conclude, from the available evidence, that the ionized gas observed towards the blank regions is unlikely to be associated with any of the HII regions seen in the continuum surveys.

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