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Carbon Recombination Lines at 34.5 MHz from the Galactic Plane

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Abstract.

We report the detection of carbon radio recombination lines (CRRLs) near 34.5 MHz ($n \sim 575$) and near 328 MHz ($n \sim 270$) from 6 positions with $l < 17°$, $b = 0°$. Modelling the data shows that the observed CRRLs can arise under a range of physical conditions which are found in atomic HI, molecular and photo-dissociation regions (PDRs) in the galactic disk.

1. Introduction

CRRLs which have been observed in absorption below 100 MHz and in emission above 200 MHz (Konovalenko and Sodin 1981, Payne, Anantharamaiah and Erickson 1989) provide good diagnostics of physical conditions in the cooler ($T \sim 20 - 200K$) and largely neutral, atomic and molecular clouds in the interstellar medium. During July-October 1995, we searched for these lines at 34.5 MHz in more than 30 directions in the Galactic plane using the EW arm of the T-shaped dipole array at Gauribidanur, near Bangalore. Unambiguous detection of lines in absorption were obtained from 6 of these directions (Fig 1(a)) - all of them with $l < 17°$. Followup observations with the Ooty Radio Telescope (ORT) resulted in detection of lines near 328 MHz in emission from all the 6 directions.

2. Properties of the Line Forming Regions

The observed radial velocities and widths indicated that the line-forming regions lie between Galactocentric distances of 4 and 7.5 kpc. Detection of lines with similar line strengths with two different beams ($2° \times 2°$ and $2° \times 6'$), used with the ORT, shows that the line-forming regions are $\geq 2°$ in extent. Width of the lines were found to be similar at the two frequencies indicating that pressure or radiation broadening is not significant and that the line widths (~ 30 km s^{-1}) probably arise due to galactic rotation.

Physical properties for the line-forming regions were derived by modelling the CRRL data at 34.5 MHz, 76 MHz (taken from Erickson et al 1995) & 328 MHz. Typical models, which include the effect of dielectronic-like recombination on the line optical depth are shown in Fig 1(b) for one position and the properties

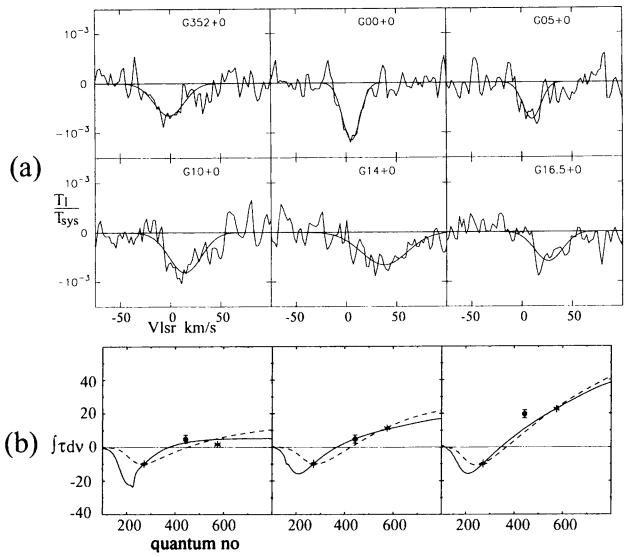

Figure 1. (a) Carbon recombination lines detected near 34.5 MHz. (b) Model fits to the observed CRRL data towards G05+00 for three assumed angular sizes listed in Table 1. Solid line is for the lower temperature.

are listed in Table 1. Models with similar parameters (Table 1) fit the data towards the other five positions. The derived parameters suggest a possible association with the neutral gas in the ISM; either atomic or molecular gas or PDRs (Tielens & Hollenbach 1985).

Size	$\mathbf{T_e}$	$\mathbf{n_e}$	**EM**	**Pathlength**	$\mathbf{n_H T_e}$
°	K	cm^{-3}	$pccm^{-6}$	pc	$cm^{-3}K$
$> 4°$	20	0.1	0.002	0.2	13340
	40	0.1	0.007	0.7	26680
4°	60	0.05	0.01	4.0	19980
	80	0.03	0.014	15.6	16000
2°	150	0.03	0.037	41.1	30000
	200	0.03	0.058	64.4	40000

Table 1. Model parameters for G05+00

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