Triggered Star Formation in a Turbulent ISM
Proceedings IAU Symposium No. 237, 2006
B. G. Elmegreen & J. Palouš, eds.

doi:10.1017/S1743921307002578

High-frequency carbon recombination line as a probe to study the environment of Ultra-compact H II regions

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Abstract. The far-ultra violet (6 – 13.6 eV) photons from the OB stars in Ultra-compact H II regions (UCHs) produce photo-dissociation regions (PDRs) at the interface between the ionized and the natal molecular material. In this paper, we show that carbon recombination lines (CRLs) at frequencies greater than a few GHz are detectable from these PDRs and such observations can be used to : (1) estimate the physical properties of the PDR material; (2) study the kinematics of the PDR material relative to the H II region gas; (3) constrain the magnetic fields in the vicinity of UCHs and (4) address the lifetime problem of UCHs.

Keywords. H II regions, ISM: magnetic fields, radio lines: ISM, stars: formation

H II regions with size less than ~ 0.1 pc are called UCHs. UCHs are associated with newly born OB stars and are embedded in dense molecular material. With the aim to detect CRLs from the interface between UCHs and their natal molecular cloud, we made a survey near 9 GHz with the Arecibo telescope toward 17 sources (Roshi *et al.* 2005a). CRLs were detected in 11 directions (65% detection rate). The detection of CRLs toward a large number of UCHs indicates that a majority of these H II regions have associated dense PDRs. We made high angular resolution ($14''$ to $2''$), multi-frequency (6, 3.6, 2 & 0.7 cm) CRL observations toward the UCH W48A with the VLA. The C76α (near 2 cm) and C53α (near 0.7 cm) transitions were detected toward W48A (Roshi *et al.* 2005b).

Models for CRL emission toward W48A were constructed using the PDR model developed by Le Bourlot *et al.* (1993). The neutral density in the PDR inferred from our modeling is a few times 10^7 cm^{-3} . Modeling also shows that the line emission at frequencies $\lesssim$ 25 GHz is dominated by stimulated emission due to the background continuum radiation arising from the UCH. This dominance of stimulated emission is made use to study the relative motion between the PDRs and the H II regions in our Arecibo data. The RMS radial velocity difference between the PDR and UCH is found to be 3.3 km s^{-1}. The observed non-thermal width of CRLs is likely to be due to Alfvén waves in the interface region. Based on this consideration we estimated magnetic field strength from the non-thermal line width. The estimated values compare well with those obtained from Zeeman observations of molecular lines. The derived physical properties and magnetic fields in the PDR indicate that the ambient pressure is high enough to pressure confine the UCHs thus increasing their lifetime.

References

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