H76α EMISSION FROM THE SGR A 15 KM S^{-1} CLOUD

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ABSTRACT. We report VLA observations of H76α emission from the H II region in M$-0.13-0.08$, the Sgr A "15 km s^{-1} cloud." The line to continuum flux ratio implies an electron temperature $T_e \sim 7500$ K, slightly lower than measurements of T_e in Sgr B2. The deduced number of early stars and the infrared luminosity are consistent with a normal IMF in this cloud.

1. Introduction

The "15 km s^{-1} cloud," M$-0.13-0.08$, has large molecular linewidths and moderately high temperatures, and a substantial IR luminosity. However, the Sgr A clouds, and M$-0.13-0.08$ in particular, have no obvious counterparts to the cluster of massive star-forming H II regions observed in Sgr B2 (*e.g.*, Benson and Johnston 1984). VLA continuum observations at 18, 6, and 2 cm by Ho *et al.* (1985) show three continuum sources. Only one of them, source G, is a thermal source; the others show polarized emission with negative spectral indices. Source G corresponds to source 6 of Downes *et al.* (1978) and appears to be an H II region with a flux corresponding to excitation by one O9 star or five B0 stars (Ho *et al.* 1985). Its position is also coincident with the H_2O maser found by Güsten and Downes (1983).

We have observed the H76α recombination line in the direction of M$-0.13-0.08$ with the NRAO[1] VLA in order to confirm the nature of the three continuum sources, and for source G, to confirm its association with M$-0.13-0.08$.

[1]The National Radio Astronomy Observatory is operated by Associated Universities, Inc., under contract to the National Science Foundation.

M. Morris (ed.), The Center of the Galaxy, 389–391.

https://doi.org/10.1017/S0074180900186796 Published online by Cambridge University Press

2. Observations and Results

We used 25 antennas of the VLA in C/D configuration on 15 July 1984 to observe the H76α recombination line (ν = 14.68999 GHz) at the peak of M−0.13−0.08 ($\alpha, \delta = 17^{\rm h}42^{\rm m}28\overset{\rm s}{.}0, -29°04'01''$ [1950]). A 30 kλ taper applied later gave a $7\overset{''}{.}1$ circular beam. We used 32 spectral line channels separated by 7.97 km s^{-1}. The channel width after Hanning smoothing was 15.9 km s^{-1}. The data were processed with the usual VLA DEC-10 editing and calibration programs, and with the AIPS package. We self-calibrated the data (phase only) (Schwab 1980) using the CLEANed continuum channel as the source model.

We detected H76α emission from the H II region G of Ho *et al.* (1985), about 30″ south of the molecular line peak. The LSR radial velocity of 14.0 ± 2.0 km s^{-1} confirms its association and that of region G with the molecular cloud. The continuum flux in a 14″ beam is 57.9 ± 0.6 mJy beam^{-1}, while the peak brightness of H76α in excess of the continuum is 13.2 ± 2.5 mJy beam^{-1}. The linewidth is 21.8 km s^{-1}, somewhat more than the NH_3 linewidth of 14 km s^{-1}.

3. Discussion

3.1. ELECTRON TEMPERATURE

We use the results of Lockman and Brown (1976), but neglect geometric effects, to estimate the electron temperature T_e to be ~7500 K, which is somewhat lower than the ~8800 K derived from H86α observations of Sgr B2 by Lichten, Rodriguez, and Chaisson (1979), but somewhat higher than the temperature of ~5000 K derived for the nearby Sgr A (West) by Rodriguez and Chaisson (1979). Chaisson and Dopita (1977) point out that the Brown and Lockman results should give a good estimate of the true electron temperature if $\tau_c n(kT_e/h\nu)(d\ln b_n/dn) < 1$. For the values we have derived, this quantity is 0.08. Here, n is the principal quantum number, b_n is the departure coefficient, and τ_c is the continuum optical depth.

Using this excitation temperature, we estimate the continuum optical depth of the H II region following Turner and Matthews (1984) to be τ(2 cm) = 0.004, which corresponds to an emission measure $EM = 2.3 \times 10^6$ pc cm^{-6}. If the electron density distribution is not clumpy, $\langle N_e \rangle = 2500$ cm^{-3}.

3.2. IS THERE A DEFICIT OF MASSIVE STAR FORMATION?

The thermal radio continuum from the region within 200 pc of the Galactic Center (Mezger and Pauls 1979) implies a high rate of star formation (Güsten 1981), but the number of H_2O masers, which are normally associated with young OB stars, expected from such a high star formation rate is not seen (*e.g.*, Downes and Genzel 1980). Is it true of M−0.13 − 0.08 in particular that there appears to be a deficit of high-mass star formation? From the estimate from Ho *et al.* (1985) that one O9 or five B0 stars are needed to power the H II region and from an assumed initial mass function $\Phi = \text{const.} \times M^{-2}$, we can estimate the total luminosity of all the stars in the cloud and compare this to the infrared luminosity. The interval of stellar masses represented by five B0 stars runs from about 25 $M_\odot$ to 50 $M_\odot$. The constant of proportionality for Φ is then $\sim 9000\ M_\odot^2$. Using a simple mass-luminosity relation $L \propto M^{3.3}$ yields a total luminosity of $10^6 (M_u/50 M_\odot)^{1.6} L_\odot$, where M_u is the upper mass cutoff of the mass function.

Hildebrand *et al.* (1978) measured a flux of 530 ± 200 Jy in an $80''$ beam at 540 μm, which implies a luminosity of $\sim 10^6\ L_\odot$ for a dust temperature of 40 K and dust emissivity proportional to λ^{-1} to λ^{-2}, while Gatley *et al.* (1977) measured an integrated flux of $\sim 7 \times 10^{-10}$ W m^{-2} in a 1 arcmin beam over the range from 25 μm to 130 μm, corresponding to a luminosity of $1.6 \times 10^6\ L_\odot$. These two estimates are in reasonable agreement with the total luminosity we infer here. We conclude that the IMF in this cloud is not radically different from a normal IMF.

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https://doi.org/10.1017/S0074180900186796 Published online by Cambridge University Press