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Discovery of polarized 6.7-GHz methanol masers in DR21/W75

L. Harvey-Smith[1], R. Soria-Ruiz[1], A. Duarte-Cabral[1,2] and R. J. Cohen[3]

[1]Joint Institute for VLBI in Europe, Postbus 2, 7990 AA, The Netherlands.
[2]University of Porto, Rua Campo Alegre 687, 4169-007 Porto, Portugal.
[3]Jodrell Bank Observatory, Macclesfield, Cheshire, SK11 9DL, UK. (Deceased)

Abstract. We present the first images of 6.7 GHz methanol masers in the DR21 star-forming complex. We have discovered two sites of Class II methanol maser emission; in DR21(OH) and DR21(OH)N. The emission comprises clusters of linearly extended masers which have velocity gradients along their length. There are four maser spots in DR21(OH)N, some of which show a small fraction of linear polarization. The twelve masers in DR21(OH) lie in a linear arrangement stretching approximately 0.7 arcseconds and show no significant linear polarization. We were not able to detect any circular polarization in the masers.

Keywords. masers, (ISM:) HII regions, ISM: molecules, radio lines: ISM, stars: formation

Dedication

This work was conceived by the late Jim Cohen. The authors acknowledge the leading role he had in the early stages of this project. His contribution to maser physics and his friendship will be greatly missed.

1. Introduction and observations

Despite playing a vital and dominant role in feedback processes in the interstellar medium, massive stars are still not understood in terms of their formative accretion processes. Methanol masers at 6.7 GHz are bright and widespread tracers of massive star-formation. High-resolution study of methanol masers, including polarization measurements, is the best way to characterise these environments.

The DR21 star-forming complex was observed using the Multi-Element Radio-Linked Interferometry Network (MERLIN) at 6.7 GHz in January 2005. The maximum baseline of MERLIN was 217 km, giving an angular resolution of approximately 50 mas at 6.7 GHz. Phase-referencing was used to ascertain positions to an absolute accuracy of 15 mas.

2. Results

We have found a cluster of four methanol masers in DR21(OH)N (also known as W75) with radial velocities ranging from +3.2 to +4.6 km s^{-1}. They lie very close both spatially and in velocity to the OH 4765-MHz masers reported in the region by Harvey-Smith & Cohen (2005). Assuming that we are seeing elliptical polarization of the σ components, the magnetic field runs *perpendicular* to the linear polarization vectors (shown in Figure 1, left). The resulting magnetic field direction is then broadly consistent with measurements

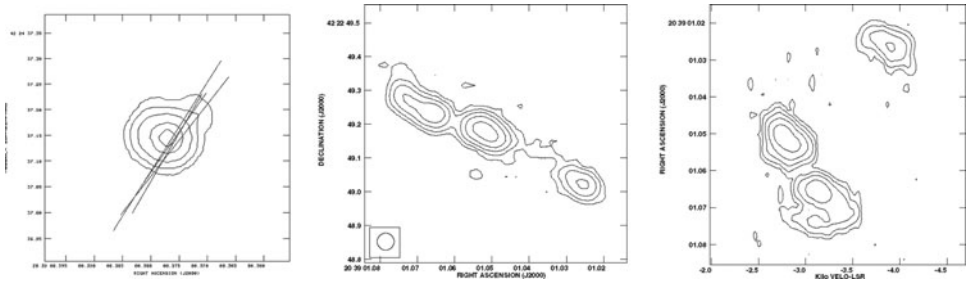

Figure 1. Left: Image of the 6.7 GHz methanol maser emission in DR21(OH)N, integrated between +3.0 and +5.0 km s^{-1}. We found four individual maser spots (corresponding to four distinct spectral peaks), but these were very closely spaced. The linear polarization vectors are shown. Middle: The 6.7 GHz methanol masers in DR21(OH), integrated between −2.5 and −4.0 km s^{-1}. A total of twelve individual spectral peaks make up this filamentary maser. Right: The R.A. – radial velocity plot of DR21(OH), showing that the methanol maser filament is composed of two distinct parts, separated in velocity. The longer section stretches some 780 AU and has a velocity gradient of 2.5 km s^{-1} $arcsec^{-1}$.

of the large-scale magnetic field direction perpendicular to the DR21 molecular ridge by Curran *et al.* (2006).

We have discovered a line of 6.7 GHz methanol masers in DR21(OH) (also known as W75S) close to the continuum source and the 1.7 GHz OH masers (Fish *et al.* 2005). Figure 1 (middle) shows the total intensity image, integrated over the full velocity range of the maser emission. Figure 1 (right) shows the velocity profile of the filament. Although the methanol masers in this region have no measurable polarization, the magnetic field direction has been extrapolated by measurements of CO and dust polarization (Lai *et al.* 2003, Curran *et al.* 2006), suggesting that the magnetic field runs along the major axis of the methanol maser filament, as is the case in W3(OH) (Vlemmings, Harvey-Smith & Cohen 2006).

3. Summary

We have detected a 1200 AU filament of unpolarized 6.7 GHz methanol masers in DR21(OH) using MERLIN. In DR21(OH)N we detected a small group of linearly polarized methanol masers, where the degree of linear polarization was 4.5%. Linear polarization measurements of other maser transitions in this region will enable us to make a physical interpretation of the maser polarization in terms of the direction of the magnetic field and its influence on the gas structures.

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