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Polarization of 6.0-GHz OH masers in W3(OH)

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Abstract. We present preliminary results of a MERLIN polarization study of 6.0-GHz OH masers in the W3(OH) region of massive star-formation. We have detected a small but significant amount of linear polarization in the 6031-MHz masers, as well as a much larger fraction of circular polarization. We have found many Zeeman pairs, the analysis of which (along with the results at 6035-MHz) will be presented elsewhere. MERLIN is well-suited to detecting all the single-dish maser flux in these regions, owing to its range of short baselines (tens of kilometers) and resulting sensitivity to extended emission. We have found core-halo structure in the 6031-MHz OH maser emission in the region of the highly extended 4.7-GHz OH and 6.7-GHz methanol maser filament found by Harvey-Smith & Cohen (2005, 2006).

1. Introduction

The W3(OH) star-forming region consists of an ultra-compact HII region containing one or more massive OB stars, surrounded by molecular gas. Projected on the nearside western face of the ultra-compact HII region are masers of OH and methanol from every transition known to occur in the interstellar medium. High-resolution polarization studies of these masers will allow us to make independent measurements of the radial velocities and magnetic field strength and direction in this young massive star-forming region.

2. Observations

W3(OH) was observed at 6031- and 6035-MHz in January 2005 using the Multi-Element Radio-Linked Interferometry Network (MERLIN). The maximum baseline was 217 km, giving an angular resolution of approximately 50 mas. Phase-referencing was used on a nearby compact source in order to ascertain maser spot positions to an absolute accuracy of 15 mas.

3. Linearly polarized masers in W3(OH)

We have produced the first images of linearly polarized 6031-MHz masers in W3(OH). Linear polarization was detected in the broadline and southern regions. Sample channel maps are shown in Figure 1. There was also a high degree of circular polarization and several Zeeman pairs were found. Full Zeeman analysis will be presented elsewhere (Harvey-Smith *et al.* (2007) *in prep.*) and compared with the results of Moran *et al.* (1978), Desmurs *et al.* (1998) and Etoka, Cohen & Gray (2005).

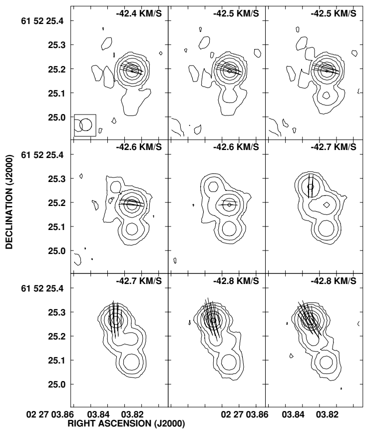

Figure 1. Sample channel maps in the broadline region of W3(OH) showing (contours) the OH flux density at 6031 MHz and (vectors) the linear polarization of the masers. The orientation of the linear polarization vectors varies significantly within this very compact region, as reported previously by Wright Gray & Diamond (2004) in ground-state OH, and Vlemmings, Harvey-Smith & Cohen (2006) in methanol masers.

4. Core-halo or extended maser structure

We have found that the excited OH 6031-MHz masers show extended structure in the form of halos and ordered structures extending far beyond the size of the restoring beam. High-resolution VLBI images of excited OH masers often miss a significant percentage of the flux observed with a single dish (e.g. Desmurs *et al.* 1998). In W3(OH), this missing flux has previously been found using MERLIN in OH at 4765-MHz (Harvey-Smith & Cohen 2005) and methanol at 6668-MHz (Harvey-Smith & Cohen 2006). When more examples of this phenomemon are known, it will be useful to compare co-spatial extended maser emission at different frequencies in order to assist parameter constraints on maser pumping models.

5. Summary

We have carried out a full linear and circular polarization study of excited OH 6.0-GHz masers in W3(OH), the full results of which will be published elsewhere. By comparing the linear polarization vectors with those of 6.7-GHz methanol masers, we remove the ambiguity in the magnetic field direction relative to the polarization vectors without encountering problems relating to (strongly frequency-dependent) Faraday rotation. The OH masers show extended structure beyond the compact VLBI-resolved 'spots'. Future work will involve comparing the relative positions of extended OH and methanol maser 'halo' emission at different frequencies between 1.7 and 6.7-GHz.

References

Desmurs J. F., Baudry A., Wilson T. L., Cohen, R. J., & Tofani G. 1998, *A&A*, 334, 1085
Etoka S., Cohen R. J. & Gray M. D. 2005, *MNRAS*, 360, 1162
Harvey-Smith L. & Cohen R. J. 2005, *MNRAS*, 356, 637
Harvey-Smith L. & Cohen R. J. 2006, *MNRAS*, 371, 1550
Moran J. M., Reid M. J., Lada C. J., Yen J. L., Johnston K. J., & Spencer J. H. 1978, *ApJ*, 224, L67
Vlemmings W. H. T., Harvey-Smith L. & Cohen R. J. 2006, *MNRAS*, 371, L26
Wright M. M., Gray M. D. & Diamond P. J. 2004, *MNRAS*, 350, 1253