MAGNETIC FIELD STRUCTURE OF STAR FORMING REGIONS: VLBI SPECTRAL LINE RESULTS

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I. INTRODUCTION

Magnetic fields play a major role in the general dynamics of astronomical phenomena and particularly in the process of star formation. The magnetic field strength in galactic molecular clouds is of the order of few tens of μG [6]. On a smaller scale, OH masers exhibit fields of the order of mG [7, 9] and these can probably be taken as representative of the magnetic field in the dense regions surrounding protostars. The OH molecule has been shown to emit highly circular and linearly polarized radiation [11, 2]. That it was indeed the action of the magnetic field that would give rise to the highly polarized spectrum of OH has been shown by the VLBI observations of Zeeman pairs of the 1720 and 6035 MHz by Lo et. al. [7] and Moran et. al. [9]. VLBI observations of W3(OH) revealed that the OH emission was coming from numerous discrete locations [8] and that all spots fell within the continuum contours of the compact HII region [1, 3]. The most detailed VLBI aperture synthesis experiment of the 1665 MHz emission from W3(OH) was carried out by Reid et. al.[10] who found several Zeeman pairs and a characteristic maser clump size of 30 mas. In this work, we report the results of a 5 station VLBI aperture synthesis experiment of the 1665 MHz OH emission from W3(OH) with full polarization information. We produced VLBI synthesis maps of all Stokes parameters of 16 spectral features that showed elliptical polarization. The magnitude and direction of the magnetic field have been obtained by the detection of 7 Zeeman pairs. The three dimensional orientation of the magnetic field can be obtained, following the theoretical arguments of Goldreich et. al. [4, 5], from the observation of π and σ components.

II. RESULTS

Reid et. al. [10] showed, more recently, that in the case of W3(OH) the OH maser radiation was coming from different subregions within the OH emission complex. We detected maser emission from 17 subregions. In five of these, labeled 1, 2, 4, 5 and 8 we detected 16 elliptically polarized components. They showed a percent of linear polarization in

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the range from 6 to 44% and polarization position angles in the range from 97 to 210° (E of N) depending on the particular feature. The percent of total polarization was found to be in the range from 23 to 99%. We were able to detect 7 Zeeman pairs which appeared in subregions 2, 3, 5, 6, 7, 8 and 9. The field strength of about 5.5 mG was remarkably uniform and in all cases it was pointing away from Earth. In subregion 5, there is a RCP σ, an elliptically polarized feature(assumed to be a π component) but the companion LCP σ feature was not reliable identified since it was at the same frequency as a strong LCP σ line in subregion 7. It is worth noting that the velocity of the LCP σ feature in subregion 5 completely agrees with the expected velocity given the values found for the magnetic field from other Zeeman pairs. All 3 components are observed to belong to the same maser clump and they may be the first complete Zeeman pattern being detected. The projection of the magnetic field on the plane of the sky may be obtained from the polarization position angles of the features that showed elliptical polarization, while the angle that the magnetic field makes with respect to the line of sight can be deduced from the observation of π and σ components. This experiment has been the first attempt to do so and for this reason we have conducted another VLBI experiment designed to observe other maser sources which will provide us with more information on the 3 dimensional orientation of the magnetic field in other regions of recent star formation.

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III. REFERENCES

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