PROCEEDINGS OF SCIENCE

The magnetic field of the evolved star W43A

Nikta Amiri,[a,c] **Wouter Vlemmings**[b] **and Huib Jan van Langevelde**[a,c]
[a] *Joint Institute for VLBI in Europe (JIVE)*
The Netherlands
[b] *Argelander Institute for Astronomy, University of Bonn*
Germany
[c] *Leiden Observatory, Leiden University*
The Netherlands
E-mail: amiri@jive.nl, wouter@astro.uni-bonn.de, langevelde@jive.nl

Planetary nebulae (PNe) often show large departures from spherical symmetry. The origin and development of these asymmetries is not clearly understood. The most striking structures are the highly collimated jets that are already observed in a number of evolved stars before they enter the PN phase. The aim of this project is to observe the Zeeman splitting of the OH maser of the W43A star and determine the magnetic field strength in the low density region. The 1612 MHz OH masers of W43A were observed with MERLIN to measure the circular polarization due to the Zeeman splitting of 1612 OH masers in the envelope of the evolved star W43A. We measured the circular polarization of the strongest 1612 OH masers of W43A and found a magnetic field strength of $\sim 100\mu G$. The magnetic field measured at the location of W43A OH masers confirms that a large scale magnetic field is present in W43A, which likely plays a role in collimating the jet.

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1. Introduction

Planetary nebulae (PNe), supposedly formed out of the ejected outer envelopes of AGB stars, often show large departures from spherical symmetry. The origin and development of these asymmetries is not clearly understood. The most striking structures are the highly collimated jets that are already observed in a number of evolved stars before they enter the PN phase. However, the origin of the collimation of the jet is still puzzling. Theoretical models have shown that collimated jets can be caused by magnetic field in evolved stars [1]. Studying the large scale magnetic field through polarization observations of different maser species in the circumstellar envelope (CSE) of these stars provides a unique tool to understand the role of the magnetic field in the process of jet collimation. The aim of this project is to observe Zeeman splitting of the OH maser of W43A and determine the magnetic field strength in the low density region. H_2O maser polarization observations have revealed that the jet of W43A is likely magnetically collimated [3]. OH masers arising from the material surrounding the jet are predicted to also have a detectable magnetic field and our observation will thus be able to confirm the role of the magnetic field in collimating the jet in proto-PNe.

The 1612 MHz OH masers of W43A were observed with MERLIN in June 2007. The observations were done with maximum possible 256 spectral resolution since all 4 polarization channels were required. The source 3C84 was used for bandpass and polarization calibration. The resulting noise in the emission free channel was 65 mJy / Beam.

2. Results

From the image plane we have obtained the typical double peak spectrum of the OH maser region of W43A. Figure 1 shows the velocity profile of the integrated flux of each channel in the I, V and P (polarization intensity) data cubes. The velocity spectrum of the total intensity data cube is a typical double peak profile with velocity in the range 27-43 Km/s; despite the fact that W43A is a water fountain source and has much higher velocities in the H_2O maser region (in the range -53 to 126 km/s). The brightest peak is red-shifted and the blue-shifted peak has a much lower brightness; only 3 % of the red-shifted brightness. The peaks in the polarization intensity and circular polarization spectra are 10% linearly and 12% circularly polarized. The relatively low level of linear polarization excludes most non-Zeeman interpretations of the circular polarization [2].

Figure 2 shows the spatial distribution of the OH maser features of W43A together with H_2O maser positions [3]. The offset positions are with respect to the reference feature. H_2O maser features are indicated by filled circles. OH maser features are shown as triangles. Red and blue colors show the red-shifted and blue-shifted features. This map clearly shows that H_2O maser occurs at the tips of a jet and the OH maser has a projected distance much closer to the star.

The actual measurement of the magnetic field strength may depend on a number of conditions, but is estimated to be 100 μG. This value is consistent with the expected magnetic field strength of 70 μG extrapolated from H_2O maser observations [3]. A lower OH magnetic field is expected compared to H_2O (85$\pm$33 mG) due to the higher density and shocked nature of the H_2O masers at the tips of the jet.

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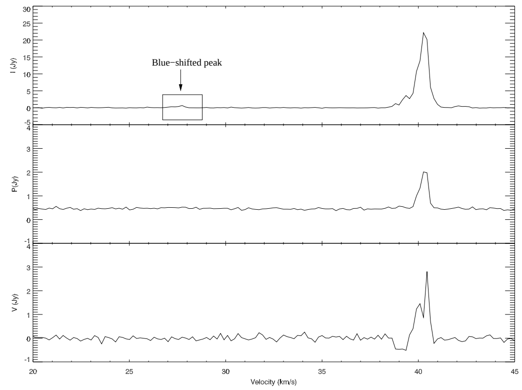

Figure 1: The 1612 MHz spectra of W43A.

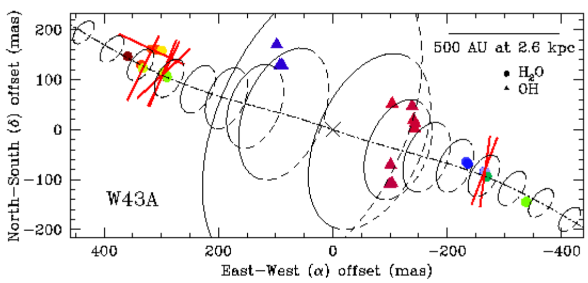

Figure 2: The spatial distribution of the OH and H_2O maser features of W43A. OH maser positions are overlaid on H_2O maser features [3].

3. Conclusions

The magnetic field and jet characteristics of W43A have previously been reported from H_2O maser polarization observations in relation to the formation of non-spherical planetary nebulae. Here we present the detection of the magnetic field of $\sim 100\ \mu G$ in the OH maser region surrounding the collimated jet. This confirms that a large scale magnetic field is present in W43A, which likely plays a role in collimating the jet.

References

[1] Blackman, E. G. & Frank, A.& Markiel, J. A.& Thomas, J.H. & Van Horn, H. M., 2001, Nature 409, 485

[2] Fish, V. L. & Reid, M. J. 2006,ApJ, 164, 99

[3] Vlemmings, W. H. T. & Diamond, P. J. & Imai, H., 2006, Nature, 440, 58

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