

# An OH maser flare with a strong magnetic field in W75N

V. I. Slysh<sup>1</sup> and V. Migenes<sup>2</sup>

<sup>1</sup>Astro Space Center, Lebedev Physical Institute, 84/32 Profsoyuznaya, Moscow, 117997  
email: vslysh@asc.rssi.ru

<sup>2</sup>Department of Astronomy, University of Guanajuato, P.O. Box 144, Guanajuato, GTO.  
Mexico 36000,  
email: vmigenes@astro.ugto.mx

**Abstract.** A flare of OH maser emission was discovered in W75N in 2000. Its location was determined with the VLBA to be within 110 AU from one of the ultra-compact HII regions, VLA2. The flare consisted of several maser spots. Four of the spots were found to form Zeeman pairs, all of them with a magnetic field strength of about 40 mG. This is the highest ever magnetic field strength found in OH masers, an order of magnitude higher than in typical OH masers. We discuss the possible source for the enhanced magnetic field and its relation to the flare event.

**Keywords.** ISM:magnetic fields, stars: flare, maser

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## 1. Observations

The new observations of the OH maser emission in W75N were conducted on 2001 January 01 with the VLBA in a snapshot mode of 6-min duration. The velocity resolution was  $0.176 \text{ km s}^{-1}$  covering  $45 \text{ km s}^{-1}$  in each of the OH main lines at 1665 MHz and 1667 MHz. In addition, we reduced and analyzed archived observations from the EVN and VLBA for 2000 September 27 and 2000 November 22 and 2001 January 6, respectively. Both data sets had the same velocity resolution though different velocity coverage.

All three sets of data have been obtained during the maximum phase of the OH maser flare. The data were reduced in the standard way using NRAO AIPS package. Most of the maser spots were unresolved by the synthesized beam. The absolute position given in Table 1 was measured through fringe rates using AIPS task FRMAP.

## 2. Discussion: Flare and magnetic field

Two new strong spectral features have appeared since the 1998 observations, at the low-velocity side of the spectrum. On the other hand, two relatively strong spectral features from the 1998 spectrum became a factor of three weaker in the 2000–2001 spectra. It is also evident from the spectra that the new “flare” features were rapidly evolving in about a three months time interval, between 2000 September 27 (EVN) and 2001 January 1 (VLBA). Four months later, on 2001 April 12, these features had become considerably weaker as observed with the Bear Lake 64-m single dish telescope (Alakoz *et al.* 2005). In the same time interval the rest of the spectral features remained unchanged. All constant features are connected with the ultra-compact HII region VLA1 while the variable features are connected with VLA2.

Compared to the 1998 map (Slysh *et al.* 2002) several additional spots have been detected, partly due to a higher sensitivity of the new observations. The other features

**Table 1.** OH Zeeman pairs in W75N

Zeeman Pairs	$\Delta$ RA RCP	$\Delta$ DEC RCP	Velocity (km/s)	$\Delta$ RA LCP	$\Delta$ DEC LCP	Velocity (km/s)	B-field Strength (mG)	Separation (mas)	Associate HII Region
Z1 <sup>a</sup>	0.0	0.0	12.45	0.16	0.03	9.28	5.4	0.2	VLA1
Z2	205.42	666.92	8.07	206.91	668.90	5.43	7.5 <sup>b</sup>	2.5	VLA1
Z3	488.80	1345.93	7.24	489.13	1345.29	5.13	3.6	0.7	VLA1
Z4	765.77	-178.12	24.40	766.15	-177.75	-0.48	42.2	1.6	VLA2
Z5	768.89	-135.24	19.80	767.59	-132.00	4.76	42.5 <sup>c</sup>	3.5	VLA2
Z6	770.30	-122.33	29.27	770.89	-125.00	4.71	41.6 <sup>d</sup>	2.7	VLA2
Z7	770.41	-129.98	21.17	772.36	-128.62	8.42	36.3 <sup>b</sup>	2.4	VLA2

<sup>a</sup>Z1 is spot A: with a measured absolute position of RA = 20h38m36s.416; DEC = 4237'34".42 (0".01) (J2000). <sup>b</sup>1667 MHz. <sup>c</sup>1667 MHz (Fish *et al.* 2005, table 15). This Zeeman pair was probably overlooked by the authors, or dismissed as showing too large a velocity separation. <sup>d</sup>From EVN data.

are really new as they are related to the flare which took place between 1998 and 2000. Also, more accurate absolute positions of OH spots were obtained and are given in Table 1, as well as the positions of the 1667 MHz spots relative to the 1665 MHz spots.

H<sub>2</sub>O-masers have also been found near the OH masers in W75N, located in two clusters around VLA1 and VLA2. Torrelles *et al.* (2003) have found a shell of water masers around the ultra-compact HII region VLA2 with a radius of 160 AU. The shell is expanding with a velocity of 28 km s<sup>-1</sup>, perhaps episodically as in a recurrent outflow. The high magnetic field OH maser spots Z4-Z7 are located very close to VLA2, at a distance of 55 mas ( $\pm 40$  mas), or at the projected distance of 110 AU ( $\pm 80$  AU). Therefore, the OH masers may well be located in the same shell as the water masers. The magnetic field in water masers associated with star-forming regions is typically around 100 mG, which is about the same order of magnitude as in the OH maser flare reported here.

The appearance of new strong maser features and the simultaneous dimming of nearby features can be interpreted as originating from the passage of a magnetohydrodynamic (MHD) shock (Alakoz *et al.* 2005). The shock was probably generated by the exciting star of VLA2 and propagated in the gas of the stellar wind.

### 3. Conclusions

A very strong magnetic field of 40 mG has been detected in several OH masers spots which have appeared during a flare of OH maser emission in 2000, within 110 AU from the ultra-compact HII region. The magnetic field probably originates in the exciting star where its intensity is about 500 G, or from the compression of interstellar gas by MHD shock, or in icy planetary bodies serving as nuclei for the maser spot emission. More frequent high angular resolution observations of future flares may help to distinguish between these models.

### References

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