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On a New Cluster of H_2O Maser Spots in the Source ON2

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Abstract—We present the results of our observations of the H_2O maser emission toward the complex source ON2 associated with an active star-forming region. The observations were performed in a wide range of radial velocities, from −75 to 90 km s^{-1}. We have detected an emission with flux densities of 9.2, 4, and 26 Jy at radial velocities of −33.5, −24.4, and −18.8 km s^{-1}, respectively, at which no emission has been observed previously. The detected emission is most likely associated with a hitherto unknown cluster of maser spots located between the northern (N) and southern (S) components of the source ON2 (closer to the northern one). This cluster may be associated with one of the three CO molecular outflows in the ON2 region. We have also detected an emission at −22 and −14.5 km s^{-1} in N and at 12.6 km s^{-1} in S, which has extended significantly the velocity ranges of the maser emission in these sources and allowed their models to be improved.

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INTRODUCTION

The source ON2 is associated with an active star-forming region and is located in the intricate Cygnus X complex at a distance of 5.5 kpc (Wink et al. 1982). The northern molecular cloud of ON2 is also called ON2 N and ON2 C, i.e., the northern and central parts of the source. It contains the ultracompact H II region (UC H II) G75.78+0.34 with a cometary morphology that moves relative to the surrounding dense molecular gas. As a result, a ram shock wave emerges ahead of UC H II (Wood and Churchwell 1989). Shepherd and Churchwell (1996) observed a bipolar molecular outflow in the ^{12}CO line whose source may be an early B star. The outflow age is estimated to be $\sim(3–4) \times 10^4$ yr. Subsequently, Shepherd et al. (1997) found that ON2 hosts three molecular outflows and three sources of millimeter emission, one of which is G75.78+0.34, within a 1.5-pc region. Strong OH and H_2O masers are closely related to this UC H II region.

The VLBI observations of Hofner and Churchwell (1996) revealed three clusters of water-vapor maser spots in ON2. The emission from the main cluster lies within the radial velocity range from −3 to 15 km s^{-1} and is associated with G75.78+0.34. The cluster is located near the ram shock front and has a size of about $1'' \times 0''.4$. It is associated with a hot ($T > 100$ K), dense ($n(H_2) \approx 10^7$ cm^{-3}) molecular clump in the immediate vicinity of the UC H II region. Subsequently, Lekht et al. (2006) detected a maser emission in this region in the velocity range from −12 to −6 km s^{-1} and assumed that it could be associated with a cluster of maser spots that was absent on the map of Hofner and Churchwell (1996). Two other groups of spots whose emission was observed at negative velocities are compact and virtually coincide with the S component of ON2 (Genzel and Downes 1977).

Strong variability of the emission from the H_2O maser in ON2 in the entire radial velocity range has been observed since its first observations. Our long-term monitoring showed that the variability could include both slow variations with a period of more than 20 yr and flare-like variations with a period from 1.1 to 2.6 yr (Lekht et al. 1996, 2006).

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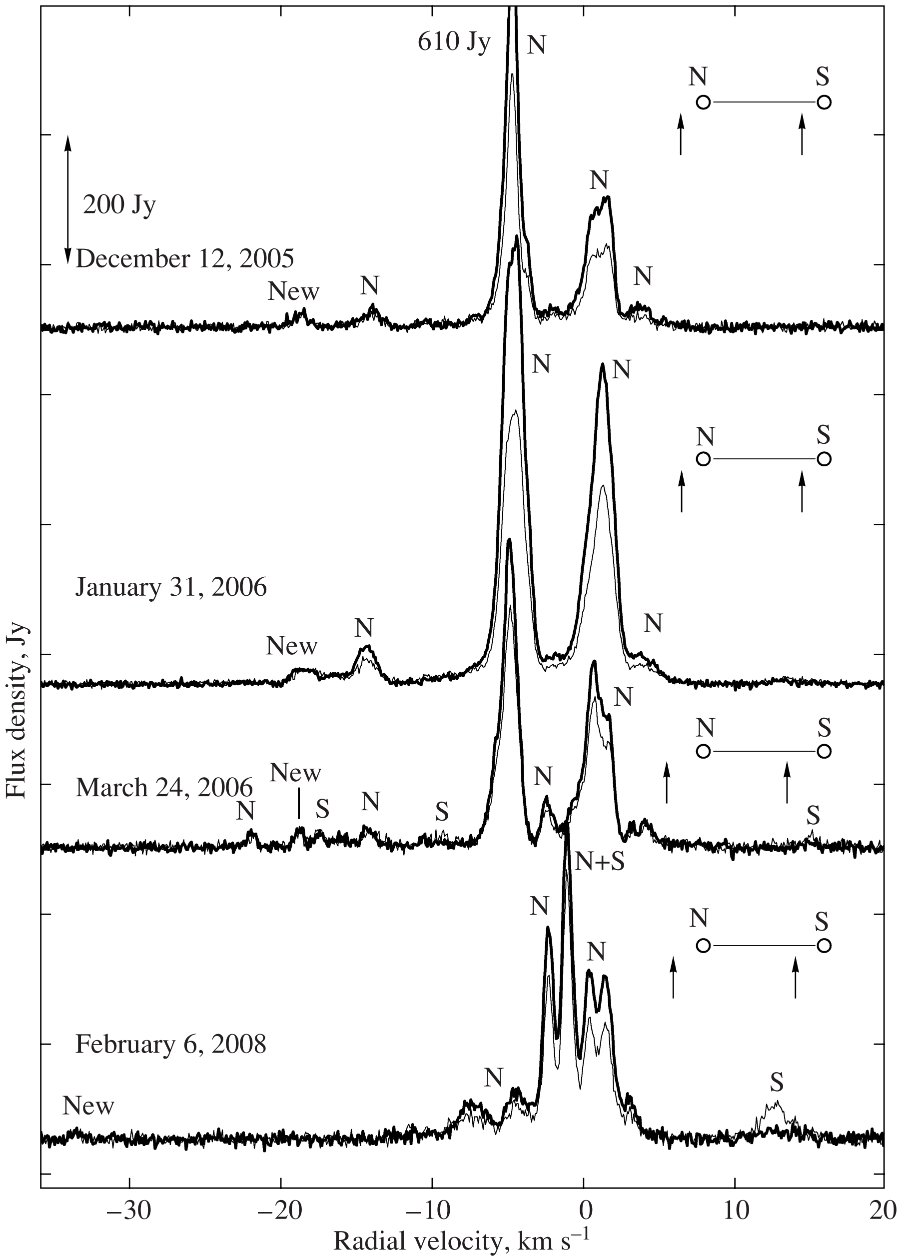

Fig. 1. Spectra of the H_2O maser emission toward the ON2 region. See the text for the notation.

OBSERVATIONS AND RESULTS

We observed the H_2O maser source toward the ON2 region with the 22-m telescope at the Pushchino Radio Astronomy Observatory.

The antenna beamwidth at 22 GHz is $2\farcm6$. The signal was analyzed by a 2048-channel autocorrelator with a spectral resolution of 6.1 kHz (0.082 km s^{-1}). An antenna temperature of 1 K corresponds to a flux density of 25 Jy. Using the autocorrelator allowed us to extend considerably the range of radial velocities under study (from −75 to 90 km s^{-1}) compared to the filter-bank spectrum analyzer.

The observations were performed in two directions:
$RA(1950) = 20^h19^m52^s$, $Dec(1950) = 37°17'00''$ and
$RA(1950) = 20^h19^m49^s$, $Dec(1950) = 37°15'58''$.

Figure 1 presents the spectra of the H_2O maser emission toward the ON2 region. The thick and thin lines indicate the spectra toward the northern (N) and southern (S) component of the source ON2, respectively. The dates of observations and the vertical scale (double arrow) are given on the left. The relative positions of the N and S components (open circles) and the antenna beam (arrows) for each epoch of observations are shown on the right. The indices N

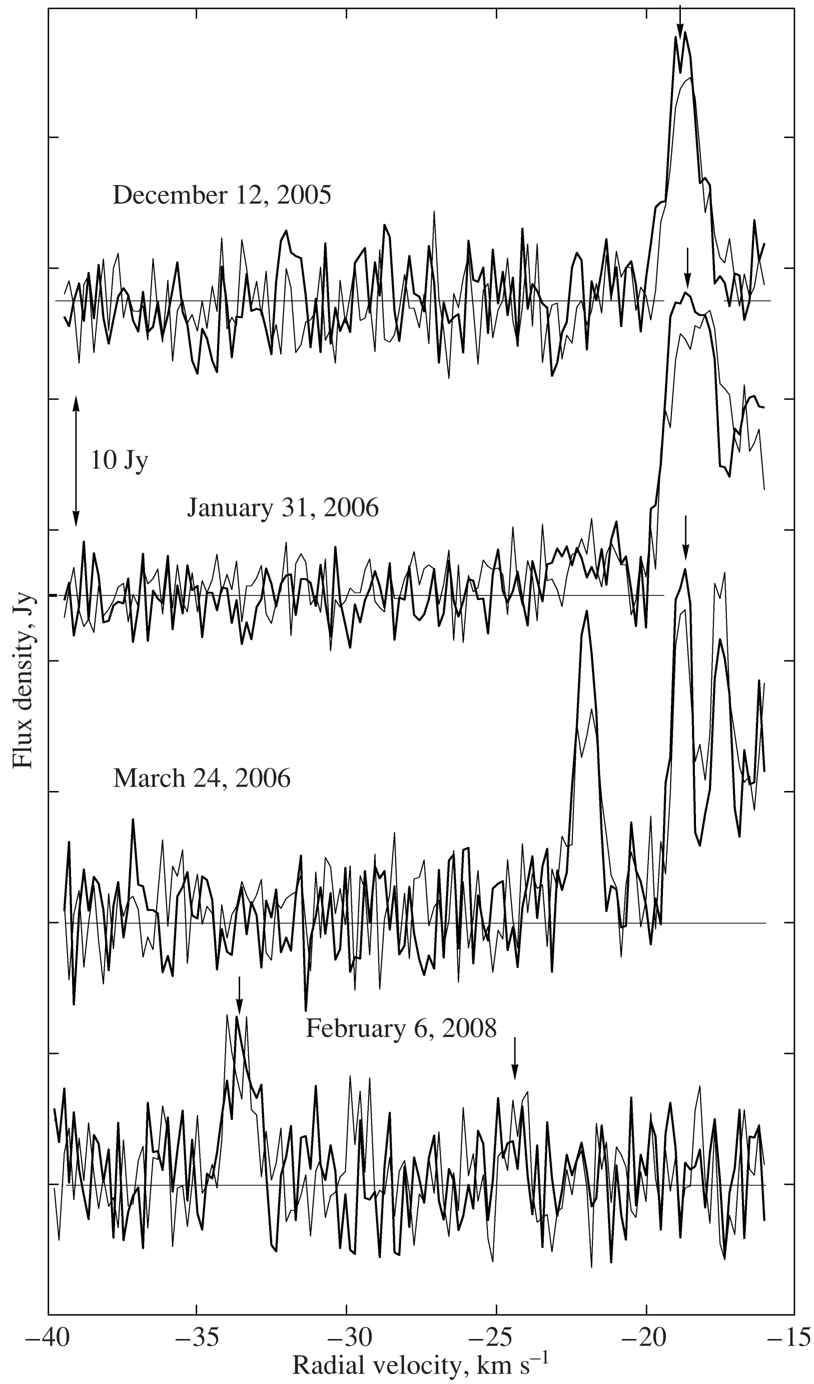

Fig. 2. Parts of the spectra presented in Fig. 1 on an enlarged scale. The arrows mark the emission features that are not identified with the N and S components.

and S denote the emission features that belong to the N and S components, respectively. The emission features whose flux densities turned out to be close when pointing the antenna to the sources N and S are identified neither with N nor with S. They are designated as New.

There are weak emission features at radial velocities from -35 to -8 km s^{-1}. To increase the sensitivity, we averaged the pairs of adjacent channels. Figure 2 shows parts of the spectra presented in Fig. 1 on an enlarged scale. The arrows mark the emission features designated as New in Fig. 1.

DISCUSSION

As follows from Figs. 1 and 2, there is an emission at new radial velocities toward the northern (N) and southern (S) components: −22, −14.5, −17.5, and 12.6 km s^{-1}. The first and last two emission features are identified with the N and S components, respectively. This extends considerably the V_{LSR} range of the maser emission from the source compared to what has been known previously. The emission features at −22 and −14.5 km s^{-1}, like all of the others in N, may be arranged along the ram shock front of UC H II G75.78+0.34 and may form a structure that is more elongated than $1'' \times 0''.4$.

The emission that we detected at −33.5, −24.4, and −18.8 km s^{-1} is not identified with the N and S components. The pattern of variation in the emission intensity as the telescope pointing changes suggests that this emission belongs neither to the northern component nor to the southern one. It most likely belongs to another, hitherto unobserved cluster of maser spots and is localized between N and S, but closer to N. The association of this cluster with one of the CO molecular outflows in ON2 N is not ruled out.

Owing to the observations in a wide radial velocity range, we have been able to detect an emission from the southern component at 12.6 km s^{-1} that probably appears seldom. Previously, our observations in this direction at such V_{LSR} were performed irregularly. Thus, the H_2O maser emission toward S was observed in the velocity range from −18 to 13 km s^{-1}. According to Hofner and Churchwell (1996), the projected separation between the two clusters of maser spots in S is about $9''$ (≈0.2 pc). This is too much for a shell-type structure but is not enough to admit the existence of two different activity centers. The maser emission toward S is most likely associated with the molecular outflow.

CONCLUSIONS

Analysis of the H_2O spectra obtained during our monitoring of the maser source ON2 with the 22-m radio telescope at the Pushchino Radio Astronomy Observatory (Russia) using a 2048-channel autocorrelation spectrum analyzer revealed a maser emission at radio velocities at which it was not observed previously. We identified these emission features.

The emission at −33.5, −24.4, and −18.8 km s^{-1} with flux densities of 9.2, 4, and 26 Jy, respectively, is most likely associated with a cluster of maser spots between the northern (N) and southern (S) components of the source ON2 (closer to the northern one). This cluster may be associated with one of the three CO molecular outflows in the ON2 region.

We also detected an emission at −22 and −14.5 km s^{-1} in N and at 12.6 km s^{-1} in S. This extended considerably the ranges of maser emission velocities in these sources and allowed their models to be improved: in the northern source, the emission features may be arranged along the ram shock front of UC H II G75.78+0.34 and may form a structure that is more elongated than $1'' \times 0''.4$. Since the masering region in the southern source has a large extent, the maser spots may be located in a molecular outflow.

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REFERENCES

1. R. Genzel and D. Downes, Astron. Astrophys. **30**, 145 (1977).
2. P. Hofner and E. Churchwell, Astron. Astrophys. Suppl. Ser. **120**, 283 (1996).
3. E. E. Lekht, A. Márquez, and J. E. Mendoza-Torres, Astron. Astrophys. Suppl. Ser. **120**, 415 (1996).
4. E. E. Lekht, M. A. Trinidad, J. E. Mendoza-Torres, et al., Astron. Astrophys. **456**, 145 (2006).
5. D. S. Shepherd and E. Churchwell, Astrophys. J. **472**, 225 (1996).
6. D. S. Shepherd, E. Churchwell, and D. J. Wilner, Astrophys. J. **482**, 355 (1997).
7. J. E. Wink, W. J. Altenhoff, and P. G. Mezger, Astron. Astrophys. **108**, 227 (1982).
8. D. O. S. Wood and E. Churchwell, Astrophys. J. Suppl. Ser. **69**, 831 (1989).

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