VLBI OBSERVATIONS OF AMMONIA (9,6) MASERS

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ABSTRACT We present the first VLBI measurement of interstellar ammonia (NH_3) masers. Two masers were found toward the ultracompact HII regions, W51-e1 and e2. The masers are unresolved in angle and smaller than 0.1 milliarcseconds. Unless these masers are highly beamed, they appear to be saturated.

Maser emission in the (J,K) = (9,6) transition of NH_3 was first detected by Madden *et al.* (1986) toward several star-forming regions. One of the strongest masers was found to arise from near the ultracompact HII regions W51 e1/e2 and the prominent H_2O maser sources W51S and W51M. NH_3 masers are found to be strongly variable like H_2O masers but unlike OH and CH_3OH masers. NH_3 maser emission covers the same velocity range as the low-velocity H_2O masers but in general have fewer spectral features. If the NH_3 masers are coincident with the H_2O masers, they could provide information about the physical conditions in the maser region. Accurate position determinations of these masers are necessary in order to obtain such information.

The VLBI observations were obtained using the Haystack 37m antenna, the NRAO 43m antenna, the Caltech 40m antenna and the Bonn 100m antenna. The minimum fringe spacing on the longest baseline (Bonn-OVRO) was 0.4 milliarcseconds. The 2 MHz band was centered at a velocity of 60 km s^{-1} based on a rest frequency of 18499.393 MHz for the (9,6) line of NH_3. The total power spectrum of the maser shows that there is a strong component at 55.0 km s^{-1} and a weaker component at 64 km s^{-1}. The lower limit for the 55 km s^{-1} feature is found to be 1.2×10^{13}K for a gaussian source model. The saturation temperature for this transition is found to be 10^{10}K which implies that the maser feature is saturated unless the beaming angle is less than 10^{-5} sr. The strong feature was found to be at $\alpha(1950) = 19^h21^m26\overset{s}{.}216 \pm 0.007, \delta(1950) = 14°24'42\overset{''}{.}7 \pm 0.1$. The weak feature was found to be offset by $0\overset{s}{.}0088780 \pm 0\overset{s}{.}0000027$ to the east and $-8\overset{''}{.}41700 \pm 0\overset{''}{.}00010$ to the south of the strong one. The spots are very compact and are smaller than 0.1 millarcseconds.

Figure 1 shows the positions of both the NH_3 maser features, along with the OH and H_2O masers, the thermal NH_3 peaks and the continuum source, W51 e1 and e2. It is evident from the figure that the NH_3 masers are not situated in front of the continuum source and are offset from the thermal peaks. Within the joint positional errors,

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the NH_3 and H_2O masers may be coincident.

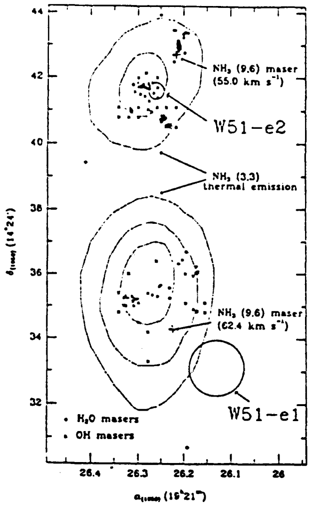

Figure 1. Map of the W51 e1/e2 region showing the positions of the two NH_3 masers with the positions of the OH masers (crosses - Gaume and Mutel 1987) and H_2O masers (dots - Genzel *et al.* 1978). The absolute position uncertainties of the OH and H_2O masers are 0".4 and 0".1 respectively. The two circles correspond to the sizes of the two continuum sources measured by Scott (1978). The positions of the continuum sources was taken from Ho *et al.* (1983). The dotted contours indicate the peaks of thermal emission as traced by the NH_3 (3,3) line (Ho *et al.* 1983).

There appear to be differences between the immediate molecular environments of the two compact continuum sources, W51-e1 and W51-e2. The northern OH masers are located close to the W51-e2 continuum peak while the H_2O masers are definitely offset. In contrast, the southern OH and H_2O masers overlap and are offset from W51-e1. Ho *et al.* (1983) suggest that this difference may be caused by outflows from the continuum sources creating adjacent density enhancements. As noted in Pratap *et al.* (1991), the velocity structure of the NH_3 masers appears to be strikingly different from that of the OH and H_2O masers. The centroid of the OH masers toward W51-e2 is about 58 km s^{-1} , with the masers distributed in two groups - the northeastern group having redshifted velocities and the southwestern group having blueshifted velocities (Gaume and Mutel 1987). The centroid of the OH masers toward W51-e2 is about 57 km s^{-1} . The H_2O masers in this region have velocities ranging from 41 km s^{-1} to 66 km s^{-1} . In contrast the NH_3 masers have a single component toward each source, the velocities of which correspond to the ambient molecular cloud velocity.

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