RELATIONSHIP OF OH AND H_2O MASERS

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ABSTRACT. Detailed maps of 70 OH and H_2O masers associated with star-forming regions have been made with the VLA at an angular resolution of ~2" arc. The absolute position accuracy is 0".5 for both the OH and H_2O observations, and the relative position accuracy of maser spots within a group is 0".1 for each species. For about half of the sources compact HII regions are detected at 22 GHz with 0".1 positional accuracy relative to the strongest H_2O maser. Preliminary results are presented, with emphasis on the spatial relationship between the OH and H_2O masers and compact HII regions.

1. INTRODUCTION

Main-line OH and H_2O masers are accepted signposts of star formation. There is a good correlation between OH and H_2O masers and various indicators of active star formation. However, the nature of the relationship between OH and H_2O masers, compact HII regions and IR sources is not well understood. In order to investigate the spatial relationship between OH and H_2O masers in star-forming regions we have observed 70 OH/H_2O maser associations with the VLA.* These associations form a complete and unbiased sample of OH and H_2O masers with angular separation less than 15" arc (see series of papers by Caswell et al. 1983, Aust. J. Phys., Vol. 36, pp. 361-451).

2. RESULTS

The data analysis is not yet final; nevertheless it is possible to summarize our results so far and to make some preliminary generalizations.

2.1 Overall spatial distribution of OH and H_2O masers

The OH and H_2O masers appear as unresolved spots when observed in a single velocity channel (~1 km s^{-1}) with the 2" arc resolution of the VLA. The maser spots tend to occur in fairly compact groups, and two or more well-separated groups are sometimes found in the same general vicinity. There is seldom more than one OH group in a cluster, whereas two or more H_2O groups are often present. The size of an individual OH

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or H_2O group is typically 30 mpc, although they range from 10 to 100 mpc in diameter (1 mpc = 3×10^{15} cm). The average separation between groups in a cluster is about 250 mpc and can be as large as 1 pc (corresponding to 1' arc in some nearby sources).

2.2 Spatial relationship of OH and H_2O masers

Of the 51 fields analysed which contain both OH and H_2O masers there are 15 cases (29%) in which the two species are clearly separated (>2"). The average separation is 60 mpc for these sources. The remaining fields contain OH and H_2O groups separated by less than 1", which is about the combined error in positioning the groups. For these sources the two species occupy overlapping volumes of space about 60 mpc in diameter. When a compact HII region is present the masers extend over a larger area, 100-150 mpc.

2.3 Relation of OH/H_2O masers with compact HII regions

Of the 20 compact HII regions detected in the 51 fields analysed so far only two have no masers within 100 mpc of the continuum peak. In four cases there is a nearby OH maser but no H_2O maser. For the remaining 14 HII regions both OH and H_2O masers are found within 100 mpc of the peak continuum emission. For the resolved HII regions the OH and H_2O masers are distributed over the full extent of the continuum source, with a tendency for the H_2O masers to extend further than the OH masers. In all cases the resolved HII regions fall to less than 10% of their peak 22 GHz intensity within a radius of 100 mpc.

3. SUMMARY OF RESULTS

The OH and H_2O masers in our sample most often occur in closely associated groups with separations less than about 60 mpc. When a compact HII region is present the overall size of the association is larger. In some cases several distinct OH and H_2O maser groups are found in the same field with separations of typically 250 mpc and ranging up to about 1 pc.

There is a close association between compact HII regions and both OH and H_2O masers. The OH masers are generally confined to a smaller area around the HII region than the H_2O masers. It is not unusual to find isolated H_2O masers a few HII radii from the HII region, whereas OH masers are rarely seen unaccompanied by either an HII region or an H_2O maser.

The observed distribution of OH and H_2O masers and compact HII regions suggests that the masers arise in the dense molecular regions around individual newly formed stars. The maser emission is initially confined to ~30 mpc diameter expanding to about 100 mpc as a compact HII region develops. Although the H_2O and OH masers are usually confined to a radius of 100 mpc around the HII region, isolated H_2O masers are sometimes seen at greater distances. It is not clear whether those masers are ejected from the HII region or whether they mark the site of yet another young star.