Cosmic Masers - from OH to H_0
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Simultaneous observations of SiO and H_2O masers toward known stellar SiO and/or H_2O maser sources

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Abstract. We present the results of simultaneous observations of SiO $v = 1$, 2, ^{29}SiO $v = 0$, $J = 1$–0 and H_2O $6_{16} - 5_{23}$ maser lines toward 318 known stellar SiO and/or H_2O maser sources using the Yonsei 21-m radio telescope of the Korean VLBI Network. Toward 166 known SiO and H_2O maser sources, both SiO and H_2O maser emissions were detected from 112 sources giving a detection rate of 67.5 %. On the other hand, toward 152 known H_2O-only maser sources, both SiO and H_2O maser emissions were detected from 62 sources, giving a detection rate of 40.8 %. Characteristics of all observed sources in the IRAS two-color diagram is investigated including their evolutionary sequence and mutual relations between SiO and H_2O maser properties.

Keywords. circumstellar matter, masers, surveys, stars: AGB and post-AGB

1. Introduction

The SiO and H_2O masers, which display very compact structures and high brightness temperatures in oxygen-rich AGB stars, are good probes to study the physical conditions and dynamics in the circumstellar shells. In order to investigate mutual relations between SiO and H_2O maser properties, and the dynamical connection from the pulsating atmosphere to the inner circumstellar envelope through dust forming layers in relation with mass-loss processes, we have performed simultaneous observations of SiO and H_2O masers using the KVN single dish.

2. Observations

For 166 sources with both SiO and H_2O masers, which are selected from Cho *et al.* (1996) and Takaba *et al.* (2001), observations were performed in 2009 June. For 152 objects, which were previously detected only in H_2O maser lines (43 sources were detected only in the 22 GHz H_2O maser line in spite of SiO maser observations and 109 sources were not observed in the SiO masers), the observations were performed from 2009 June to 2011 January. The half power beam widths and aperture efficiencies were measured to be 122″, 0.65 (at 22 GHz) and 64″, 0.67 (at 43 GHz), respectively (Lee *et al.* 2011). The conversion factor from the antenna temperature, T_A^*, to the flux density is about 12.27 Jy K^{-1} at 22 GHz and 11.90 Jy K^{-1} at 43 GHz.

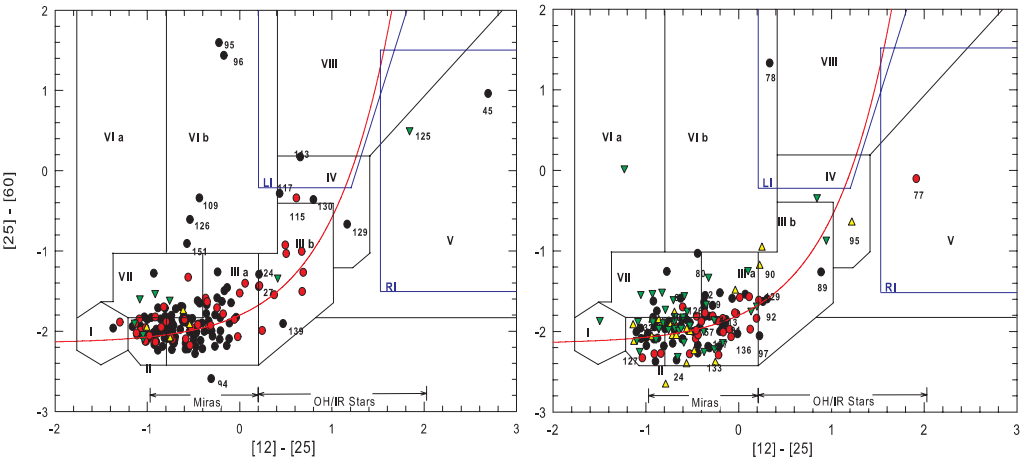

Figure 1. IRAS two-color diagram with the position of the observed sources in our observations toward 166 both SiO and H_2O maser sources (left) and 152 H_2O maser sources (right). The red line is the evolutionary track for AGB stars. The black circles indicate both SiO and H_2O maser detected sources, and the red circles and the yellow triangles indicate SiO-only and H_2O-only detected sources, respectively. Undetected sources are marked with the green inverted triangles. The numbers indicate identification numbers in Table 2 of Kim *et al.* (2010)

3. Results

Detailed observational results of the 166 known SiO and H_2O maser sources were described in Kim *et al.* (2010). Toward 152 H_2O-only maser sources, both SiO and H_2O masers were detected from 62 sources. Furthermore, we have identified 19 new detections of SiO maser emission for previously non-detected sources and 51 new detections of SiO maser for previously not observed sources. Most of the SiO maser emission peaks near the stellar velocity, while the peak of H_2O maser shows a wide spread compared with that of SiO. We examined the distribution of the sources with single, double, and multiple peaks of H_2O maser lines in the IRAS two-color diagram (Fig. 1) because they can be associated with an asymmetric wind and bipolar outflows commonly seen in PPNe and PNe (Engels 2002). These single and double peak sources are distributed in Regions IIIb, IV, V, and VIb with a relatively high percentage compared with those of Regions II, IIIa, and VII stars (Kim *et al.* 2010). The Regions IV and V are thought to be main areas of PPNe. However, candidates for young PPNe can be distributed in Region IIIb and the bipolar structure can already appear in the AGB stage (Zijlstra *et al.* 2001; Engels 2002) as an earliest transition phase from AGB stars to PPNe. The distribution of H_2O double peak sources, V1366 Aql and OH83.42−0.89 etc. in Region IIIb may support these facts. Statistical analyses based on these homogeneous data (intensity ratios, peak and mean velocities between SiO and H_2O masers etc.) are in progress.

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