

VLBI Observations of the 22 GHz H₂O Maser in Late Type Stars

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Abstract. The results of the VLBI observations between Kashima 34 m and Nobeyama 45 m are reported. H₂O maser sources at 22.235 GHz around some late type stars are observed. Beaming model around the star and a blocking model of H₂O maser were investigated.

1. Introduction

From the single dish observations by using Kashima's 34 m telescope, we found that the H₂O maser sources in oxygen-rich late type stars change their spectra (see Fig. 1) while the star evolves (TAKABA, 1992). The systematic changes of maser spectra can be explained by the beaming model.

Far-infrared observations by IRAS and radio observations of circumstellar molecular lines revealed that the mass loss rate increases as the stars evolve and the dust/gas envelopes become thick. COOKE and ELITZUR (1985) showed that the excitation of H₂O maser quenches when the gas density becomes large because of the radiative processes. Then H₂O maser emissions are from the shell around the star and the radius of the shell expands as the mass loss rate increases.

In visible Mira variables, the masers are emitted from the nearest region of the star. The gas motion must be highly random because of the supersonic gas outflow from the surface, then maser emissions are beamed toward the rim direction because the column density becomes maximum, and the velocity coincided with the stellar systemic velocity. The 43 GHz SiO masers need high temperature, then the maser emitting region is always close to the star. Then the spectra always show single peak. As the stars evolve and when the maser's emitting regions lie at more than 10 times of the stellar radius, the masing gas/dust complex is subject to expansion by the radiation pressure. In these cases, maser emissions are beamed toward the line of sight and they splits into two peaks.

We also found that in stars which have separated double peaks, red shifted components are weak compared to blue shifted components in about 2/3 sources. This fact is explained by a blocking model by the central star considering that the maser emissions are highly beamed and the red shifted components are passing through the surface of the earth-orbital sized red giant star.

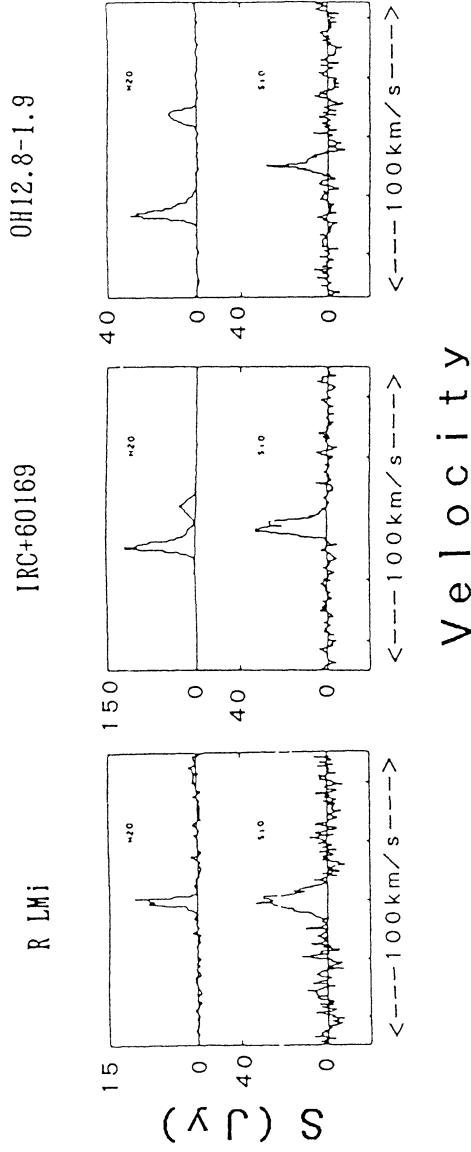


Fig. 1. SiO and H₂O maser spectra in late type stars.

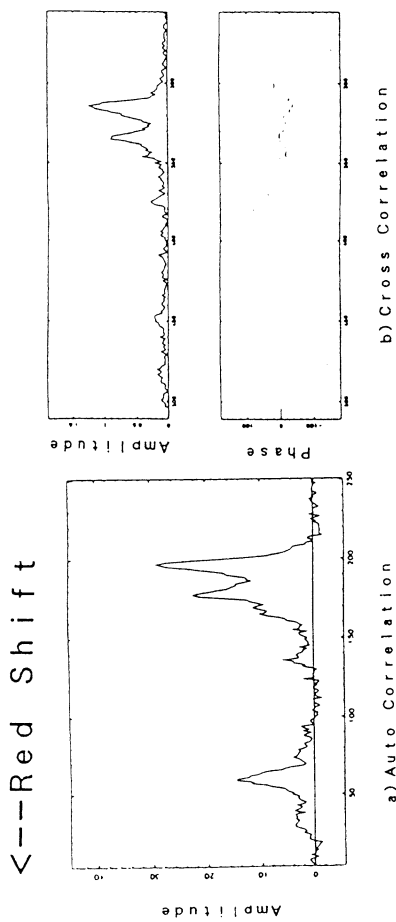


Fig. 2. H₂O maser spectra of IRC+60169. Autocorrelation (left) and crosscorrelation (right).

2. Observations

Observations were made among 4–7 June 1992. The system noise temperature at 22 GHz were about 200 K including sky noise in both stations. We used K-4 type data recorders developed in CRL. The correlation was done by using the NAOCCO (New Advanced One-unit Correlator, see Shibata *et al.*, in these Proceedings), which is able to process 512 lags for each of 16 channels.

3. Results and Discussion

Figure 2 shows an auto-correlation spectrum (left) and a cross correlation spectrum (right) in IRC+60169. The red shifted components are highly resolved out by the VLBI. This result strongly suggest that the red shifted components are not so compact compared to the blue shifted components, we think that it is caused by the blocking of the star. Another explanation is the amplification of the radio continuum from the star in blue shifted emission.

If the blocking model is correct, we will be able to obtain the physical parameters such as the stellar radius, pulsation and the mass loss phenomena by more detailed VLBI observations and the single dish time variation monitoring observations.

REFERENCES

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