VLBI OBSERVATIONS OF THE V=1 AND V=2 SiO MASERS IN W HYDRA AND VX SAGITTARIUS

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Our previous observations[1] established the small angular size and high brightness temperature of emission from the v=1, J=1-0 transition of SiO from the circumstellar envelopes of the supergiant VX Sgr and the Mira variable R Cas. We performed a second VLBI experiment on the SiO masers in several late type stars on 31 Oct.-2 Nov. 1978 to compare the physical characteristics of the SiO masers in the v=1 and v=2 states. With an energy separation of 1258 cm^{-1} (an equivalent temperature of 1753 K) between the two vibrational states, differences in excitation and pumping of the maser states may lead to different maser properties.

The interferometer elements were the 13.7 m antenna of the Five College Radio Astronomy Observatory and the 36.6 m antenna of the Haystack Observatory. The 75 km baseline provides a fringe spacing of 0".02-0".03. Instrumental setup and observational procedures are discussed in detail by Genzel et al.[2] The data were recorded on the Mark II VLBI system and processed at the National Radio Astronomy Observatory.

We present in Fig. 1 the total-power and cross-power spectra of the v=1 and v=2 lines observed toward VX Sgr and W Hya. The cross-power spectra were calculated from the data by coherently averaging for 45 minutes using a strong spectral feature as a phase reference. The total bandwidth was 2 MHz (14 km s^{-1}) and the velocity resolution (with Hanning weighting) was 0.30 km s^{-1}.

We find a remarkable agreement between the v=1 and v=2 masers toward VX Sgr in their cross power spectra. The fringe visibilities of the strongest features are about 0.4 in both transitions. Assuming a Gaussian source model for individual features, we estimate an angular size of 0".010 for the maser spots, corresponding to a linear apparent size of 2 x 10^{14} cm at a distance of 1500 pc. The implication is that both the v=1 and v=2 masers are at the same distance from the star with similar excitation. Velocity structure across the spectrum is complex with blending of many narrow components of width a few times 0.1 km s^{-1}.

In the case of W Hya, differences between the two vibrational states are evident in the velocities of partially resolved features.

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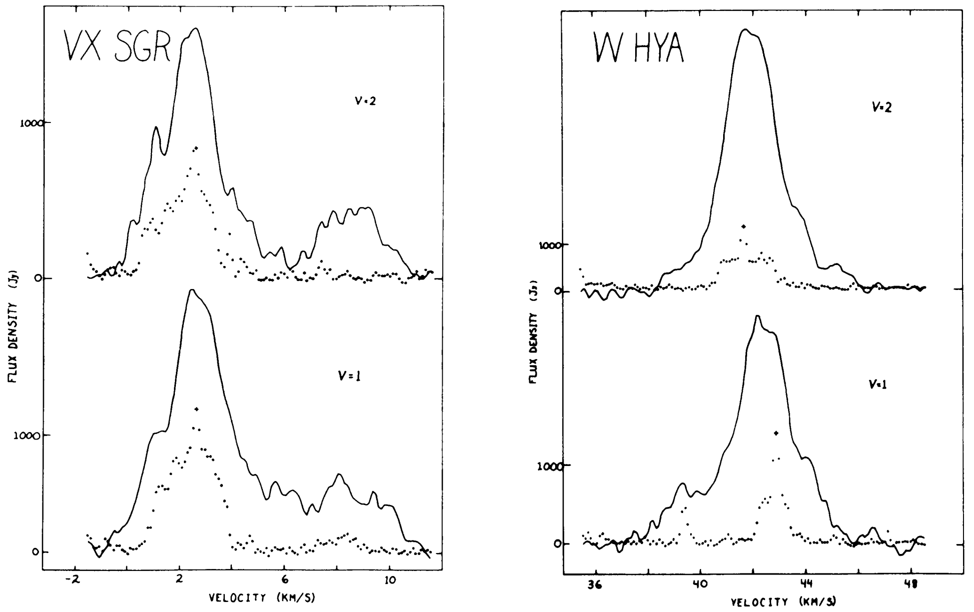

Figure 1: Total-power (solid line) and cross-power (dotted line) spectra for VX Sgr and W Hya. Velocity is relative to the local standard of rest. The upper spectrum for each source is the v=2, J=1-0 transition (rest frequency 42.820510 GHz); lower spectra are v=1, J=1-0 (rest frequency 43.122027 GHz). The v=1 and v=2 spectra for each source were taken on consecutive days at similar hour angles. Phase referencing overestimates the amplitude of the reference feature (plotted as +).

Peak visibilities, however, are comparable, $\sim$0.2, implying an angular size of 0".016 and a linear size of 4 X 10^{13} cm at a distance of 154 pc. One may conclude in this case that the masering clouds are probably distinct objects in the two vibrational lines. This may be related to the fact that the W Hya masers appear to be smaller by a factor of five than the VX Sgr masers, which in an expanding (or contracting) shell model implies a smaller distance from the central exciting source.

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REFERENCES

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