COMPARISON OF LIGHT VARIABILITY AND WATER MASER EMISSION IN T URSAE MAJORIS

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Abstract

We have observed the 22 GHz water maser emission for T UMa at Haystack Observatory[1] about once a month since December 14, 1986. The data have been compiled and graphed as a function of time and compared to the visual data compiled by the AAVSO. The variability between the maser emission and visual light is comparable, but the maser emission shows a phase lag of 0.35 phase with respect to the visible.

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We have monitored the water emission at 22 GHz in the Mira variable T Ursae Majoris (M4IIIe-M7e, P=256.6 days) regularly since December 14, 1986, with the goal of establishing the correlation between the water maser emission and the visible light curve. The observations were obtained approximately once a month at Haystack Observatory between December 14, 1986, and September 28, 1988, except for the time between June 1987 and October 1987 when the receiver was not available at Haystack.

The most prominent maser emission was observed at V_{LRS}=-88.3 km per second with FWHM usually 0.7 km per second. The water maser flux varied from <1 Jy to 31 Jy during this period. On a few occasions weaker components could be seen. A typical water maser spectrum is shown in Figure 1 where the antenna temperature is plotted against the radial velocity measured relative to the local standard of rest. This spectrum, taken March 19, 1988, shows the emission at its peak, with an antenna temperature of 3.08 K (=31 Jy). In Figure 2 we plot the Julian date versus the observed water maser flux. The dates of the observed visual maxima during this time period are indicated by short vertical lines. In Figure 3 we plot the visual observations of T UMa for the same time period as the maser observations. A comparison between Figures 2 and 3 shows that the maximum maser emission lags behind the visual maximum. The relationship is more clearly shown in Figure 3 where the water maser flux is plotted versus visual phase (phase = 0.0 at the time of visual maximum) which shows that the maximum maser flux lags the visual maximum by about 0.35 phase or about 90 days.

Hence, the observations of T UMa show that it takes approximately three months for the increase in visual energy output T UMa (P=256.6 days) to translate itself into larger water maser fluxes. This supports the theoretical prediction that the water masers in circumstellar shells are collisonally pumped as explained in Benson and Little-Marenin in a previous article in this issue.

We have observed T UMa during parts of three visual cycles

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(indicated by different symbols in Figure 4) and find that the cycle with the overall greatest maser flux appears to follow the cycle when T UMa had a bright maximum, m_V ~ 7, December 1987.

We thank Janet Mattei and Elizabeth Waagen for assistance in obtaining the AAVSO observational data and the members for their many observations.

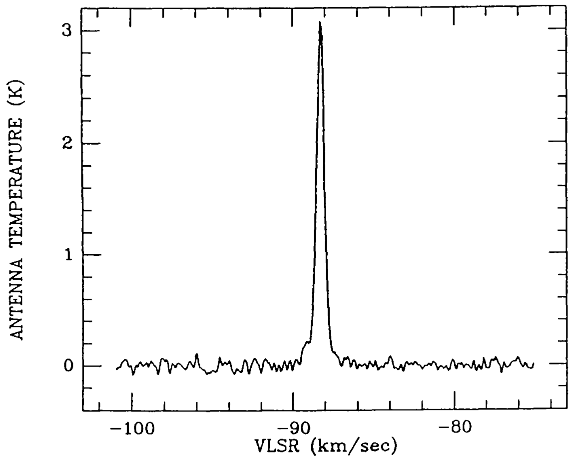

Figure 1. The water maser spectrum of T UMa on 19 March 1988 is shown. The y-axis gives the antenna temperature corrected for atmospheric effects and the gain of the telescope. The x-axis plots the radial velocity of the water maser source relative to the local standard of rest.

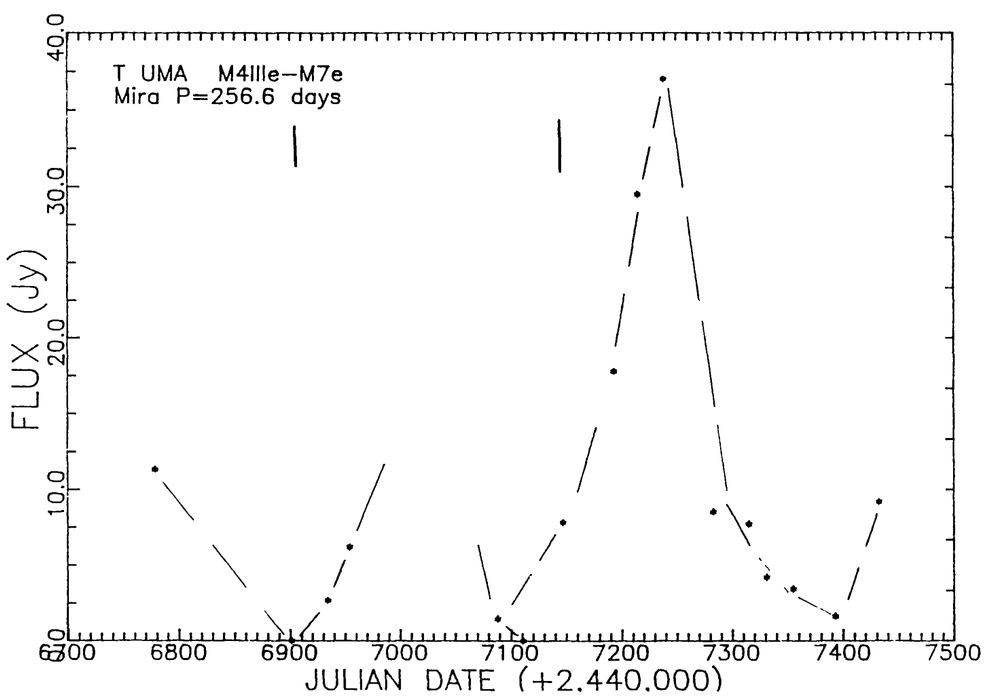

Figure 2. The water maser flux in Jy versus the Julian day number of the observation. The dates of the visual maximum are indicated by short vertical lines.

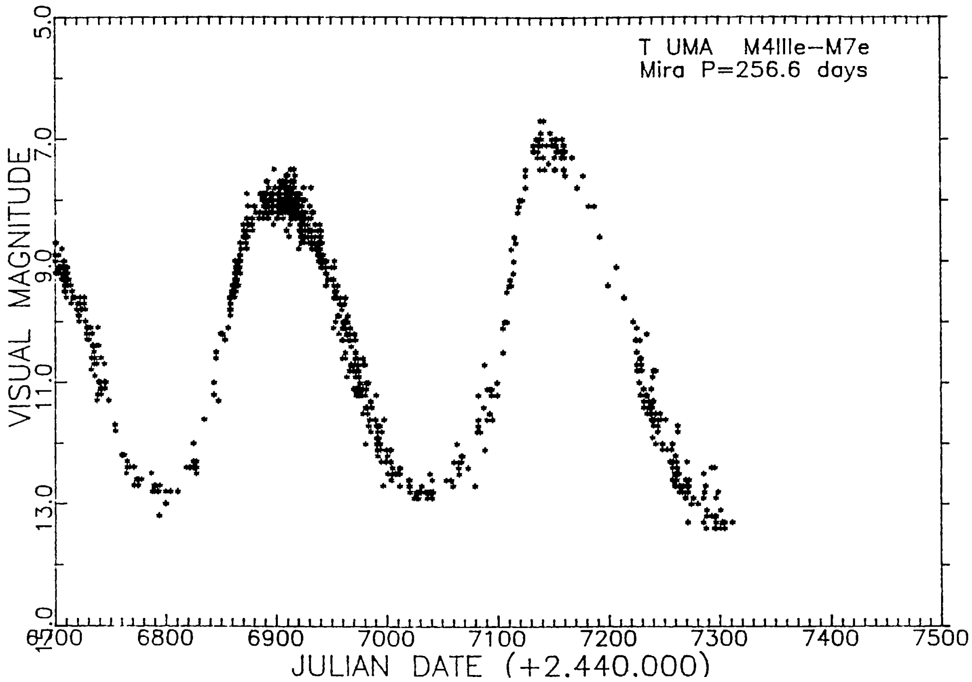

Figure 3. The visual light curve of T UMa for the same time period as the water maser observations.

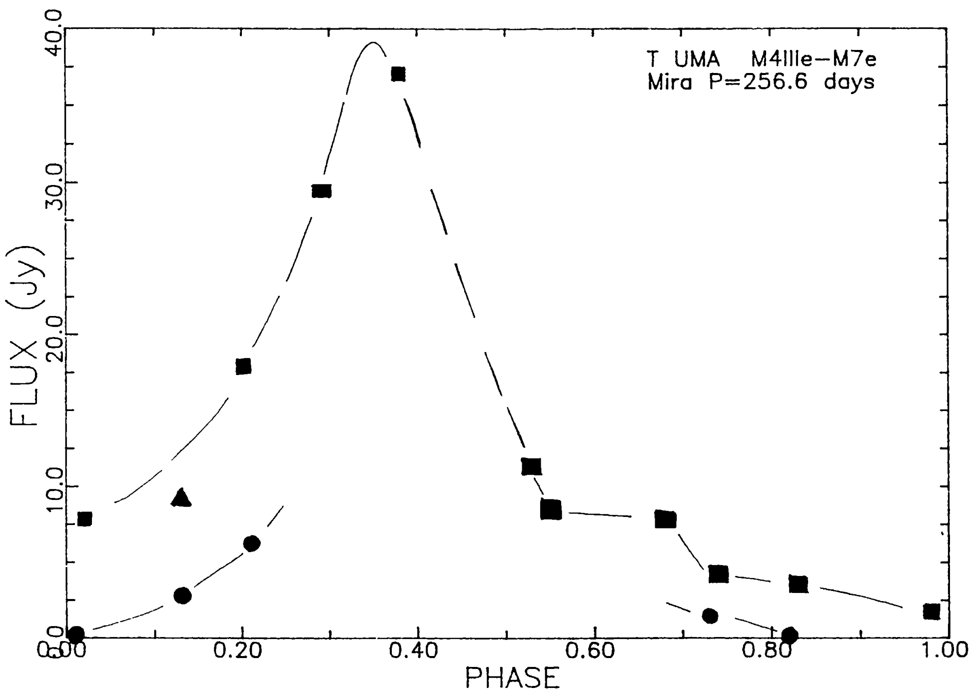

Figure 4. The water maser flux versus the phase of the visual light curve. The data from three different light cycles are indicated by different symbols.