

Investigation of a Sample of Long-Period Variable Stars Possessing Maser Emission

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An investigation of parameters of a sample of more than two hundred late-type long-period variable stars (LPVs) has been carried out. In more detail were studied 13 giants (Mira Ceti-type variables R Aql, RR Aql, RT Aql, R Leo, U Ori, U Her, R Cas, R Tau, Z Cyg, R Peg, U Aur and semiregular variables RT Vir and RX Boo) and 2 supergiants (S Per, PZ Cas). A considerable fraction of the sample stars (about one third) possess circumstellar maser emission in molecular spectral lines (OH, H₂O, SiO). Our aim was to elucidate the particularities of photometric characteristics of maser stars, such as period P, amplitude A, light curve asymmetry $f = (M-m)/P$, and, in prospect, to determine their status in course of their evolution on the asymptotic giant branch. An extensive comparison with non-maser LPVs was made.

New linear and parabolic light elements for six miras have been derived for the time interval 1957-1984. The study of photometric periods of PZ Cas, RT Vir, and RX Boo indicates the presence of multiperiodicity in these stars. The individual LPVs' light curves were also compared with the curves of variability of the flux density of maser radio emission in the 1.35-cm H₂O line. The correlation is noted between the H₂O-line flux rise and the brightness maximum height for the miras R Aql, R Leo, U Her, and U Ori. The mean cycle of appearance of a "high" optical maximum varies from 800 d to 1600 d for R Leo, U Her and U Ori, and ~600-800 d for R Aql. The "long" H₂O variability cycle has approximately the same length.

Dependences between P, A, f, and Sp have been analysed for the sample stars. The conclusion is confirmed that maser LPVs have smaller f values than non-maser ones; the lower the value of f, the higher the shock-wave velocity in the circumstellar shell. Thus, the presence of a maser is related to the strength of the shocks. The histogram of Sp-f shows that the fraction of maser stars increases gradually from M4 and reaches a maximum by M9, whereas the number of non-masers is maximum at M6 and decreases laterwards. It may be concluded that masers arise at a later evolutionary stage of an LPV.