Radio Spectroscopy of Circumstellar Molecular Masers

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Results of observations of circumstellar maser sources in long-period variable stars are reported. We have monitored a sample of Mira-type and semiregular variables in the H_2O (wavelength 1.35 cm) and OH (wavelength 18 cm) radio lines. A comparison with data of optical photometry and spectroscopy has been done.

WATER VAPOUR

The observations in the H_2O line at 1.35 cm were carried out on the RT-22 radio telescope of the Pushchino Radio Astronomy Observatory in 1980-2011. Sensitivity is ~10^-15 Jy, velocity resolution 0.082 km/s. The sample included sixty late-type variable stars with circumstellar envelopes and sixty-five star-forming regions. For most stars twenty to thirty variability cycles (lasting about a year) were covered. There is a correlation of the H_2O line flux density with the light variations: in general, the maser intensity follows the optical variability with a certain phase lag.

A model, in which the maser variability is caused by the joint influence of a shock wave propagating in the circumstellar envelope and of the variable radio continuum of the stellar photosphere, is considered. There are indications for a quasiperiodic character of the variations of the integrated H_2O line flux and mean radial velocity of the maser emission at a timescale of 14-15 years.

HYDROXYL

Polarimetry of the OH maser emission has allowed us to draw conclusions about circumstellar magnetic field. The observations of OH masers were carried out at a wavelength of 18 cm on the radio telescope of the Nançay Radio Astronomy Observatory (France). The recent upgrade of the telescope allows us to measure simultaneously all four Stokes parameters of the OH maser emission. In 2007-2011 seventy late-type stars (including Mira-type and semiregular variables) were observed as well as some OH masers in star-forming regions. The sample largely overlaps with that of the sources observed in the H_2O line.

For 53 of the late-type stars the emission in at least one of three OH lines (1612, 1665, or 1667 MHz) was detected and all four Stokes parameters were measured. The emission of T Lep in the 1665 and 1667 MHz OH lines was observed for the first time. In the Stokes profiles of several stars (including T Lep) features probably due to Zeeman splitting were detected. Estimates of the magnetic intensity in the maser sources (0.46-2.32 mG) were obtained.

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References
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