Photometric study of FU Orionis and EX Lupi type stars

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The studies of the photometrical variability of Pre-Main Sequence stars (PMS) stars are very important for the understanding of the stellar evolution. The main purpose of the dissertation is investigation of the relationship between photometric variability of FU Orionis and EX Lupi type stars and processes of interaction of PMS stars with circumstellar environments and circumstellar disks. Because only a small number of FUors and EXors have been detected so far, photometric and spectral studies of these variables are of a great interest.

Four objects of that type - namely: V733 Cep,V1735 Cyg, Parsamian 21 and GM Cep were selected for photometric monitoring. Their historical $BVRI$ light curves were constructed using new data from CCD observations supplemented with data from the photographic plates archives.

Our photometric observations were performed at two observatories with three telescopes: the 2-m Ritchey-Chretien-Coude and 50/70/172 cm Schmidt telescopes of the Rozhen National Astronomical Observatory (Bulgaria) and the 1.3-m Ritchey-Chretien telescope of the Skinakas Observatory of the Institute of Astronomy, University of Crete (Greece). The photometric $BVRI$ data that we present were collected from 2002 to 2011. Aperture photometry was performed using DAOPHOT routines. In order to facilitate transformation from instrumental measurement to the standard Johnson-Cousins system at least 15 stars in the field of each studied object were calibrated in $BVRI$ bands. Calibration frames were obtained during fourteen clear nights with the 1.3-m RC telescope of the Skinakas Observatory. Standard stars from Landolt (1992) were used as reference.

To construct the long-time light curves of the objects, a search for archival photographic observations in the photographic plate collections all over the world was made using the Wide-Field Plate Database. The digitized plates from the Palomar Schmidt telescope, available via the website of the Space Telescope Science Institute, are also used. Aperture photometry of the digitized plates was performed with DAOPHOT routines.

Our photometric study has allowed us to classify V733 Cep as a FUor variable. The long-time light curve of V733 Cep is similar to the light curves of other FU Orionis objects. An outburst in the optical light and a slow rise in brightness during the period 1971-1993 are well documented. During the period 1993-2004, V733 Cep exhibited its maximum brightness and the amplitude of the observed outburst exceeded $4\overset{\mathrm{m}}{.}5$ (R). The $BVRI$ photometric data imply that from February 2007 to October 2009, a slow decrease in brightness of the star was observed. The observed evolution of $V-I$ color index also suggests that V733 Cep is currently fading. V733 Cep is presently the FUor object with the longest time of increase in brightness and probably the first found to have an approximately symmetrical light curve.

The available photometric data for V1735 Cyg are not enough at present to determine the time of rise to the maximum brightness, but the rate of decrease in brightness is definitely similar to that observed in other FUors. The data from photographic observations of V1735 Cyg from 1986 to 1992 show a strong light variability. Such change of the photometric activity during the period of setting of the brightness was not observed in the other FUor objects. The analysis of existing photometric data shows a very slow decrease in star brightness – $1\overset{m}{.}8$ (R) for 44 years period.

The data from our photometric observations show that V1735 Cyg and Parsamian 21 must be added to the group of long-lived FUors and that the time-scale of the FUor phenomenon must be much longer than the assumed in previous studies.

Our photometric observations of GM Cep during 2.5 years period show that the star spends much more time in high-brightness level than in low-brightness level. A high amplitude variations $2\overset{m}{.}3$ (V), typical for the Classical T Tauri and two deep minimums in brightness are observed. The analysis of collected multicolor photometric data shows the typical of UX Ori variables color reversal during the minimums in brightness. Comparing our results with results published in the literature, we conclude that changes in brightness of GM Cep are caused by superposition of both: (1) magnetically channeled accretion from the circumstellar disk, and (2) occultation from circumstellar clouds of dust.

During the photometric monitoring of V733 Cep and V1735 Cyg we found three variable stars unknown to the present. $BVRI$ light curves and color-magnitude diagrams of the newly discovered variables are constructed.

References

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