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Criteria of Classification of Long Period Variables Based on their Light Curve Changes

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Abstract. Some numerical parameters of long-term changes of light curves in Long Period Variables (LPVs) are obtained. Results of analysis of the sample of 53 LPVs and classification of these stars are discussed.

The sample of 53 LPVs, which are actively observed by amateur astronomers, has been studied. Most of them (43) are Mira-type stars, according to GCVS (Kholopov et al., 1985), while the rest are semi-regular (SR) variables.

To study cycle-to-cycle changes in these variables, a dense series of data during a long time interval is needed. We used the AFOEV and VSOLJ databases for this research. We have obtained the following characteristics of each individual cycle: moments and magnitudes of extrema and the hump on the ascending branch; periods between maxima and minima; amplitudes of both branches; asymmetry; slopes of the ascending and descending branches and mean brightness of the branches. Analysis of variations of these characteristics with time and correlation analysis of them have been made. We also applied the periodogram, Fourier and wavelet analyses to study the periodicities and their stability. Parameters of the mean light curves such as period, amplitude and asymmetry have been obtained by using the trigonometric polynomial fit. (Below, these characteristics are referred to as "mean period", "mean amplitude", etc.) The method of our analysis has been described by Marsakova & Andronov (1998).

Also, we have analyzed the relations between numerical characteristics of the cycle-to-cycle changes and the parameters of the mean light curves (including the degree of the trigonometric polynomial fit) and the spectral class. For spectral class we have used a conditional scale from -5 (spectral class K5) to 29 (C9), where interval 0–9 corresponds to spectral classes M0–M9, 10–19 corresponds to S0–S9, 20–29 corresponds to C0–C9. For the cycle-to-cycle changes we have examined the following characteristics:

- relative quantity of humps on the ascending branch;
- scatter of the mean brightness;
- scatter of the amplitudes;
- scatter of the asymmetry;
- scatter of the individual periods between maxima;
- scatter of the individual periods between minima.

We have obtained a sequence of diagrams, such as spectral class versus arbitrary amplitude scatter, spectral class versus arbitrary mean brightness scatter, arbitrary period scatter versus arbitrary amplitude scatter, etc.

Several diagrams show that all values differ for different spectral classes in sequence C–M–S. They show no differences between Miras and semiregular variables in the sample. But the diagram of spectral class versus arbitrary scatter of the amplitudes shows that three stars (RU Cyg, V Boo, V CVn, all classified as semiregular in the GCVS) significantly differ by the value of arbitrary scatter of the amplitudes from other stars in group of spectral class M. Y Per (classified as a Mira, but with significant irregularity in last decade) also differs from the other stars in the group of spectral class C.

Almost all stars of spectral class C have amplitudes smaller than 2 magnitudes mentioned in GCVS as the limit for distinguishing Miras and SR variables. The diagram of mean amplitude versus scatter of the individual periods between maxima shows that the transition between small-amplitude and large-amplitude stars is very fluent. So the majority of stars in our sample of spectral class C may be classified as periodic carbon LPVs. There are no significant differences between Miras and SR variables.

Other diagrams also show that a few stars (both SRs and Miras) differ from majority by values of characteristics of the cycle-to-cycle changes.

The stars RU Cyg, V Boo and V CVn lie separately on the majority of diagrams, so these stars may be classified as semi-regular variables confidently.

The secular amplitude increase or decrease, except for the stars in the stage of helium shell flash (Wood & Zarro, 1981), probably also may serve for classification. For 5 stars (4 Miras and SS Vir, which was classified as SR in the GCVS) an amplitude increase has been found. For V Boo and V CVn we have found an amplitude decrease.

The analysis of the long-term light curve changes allows us to introduce new classification criteria for LPVs into Miras and semi-regular variables.

References

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