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Automated Classification of Variable Stars for ASAS Data

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Abstract. With the advent of surveys generating multi-epoch photometry and their discoveries of large numbers of variable stars, the classification of the obtained time series has to be automated. We have developed a classification algorithm for the periodic variable stars using a Bayesian classifier on a Fourier decomposition of the light curve. This algorithm is applied to ASAS (All Sky Automated Survey, Pojmanski, 2000). In ASAS 85% of the variables are red giants. A remarkable relation between their period and amplitude is found for a large fraction of those stars.

1. Introduction

In its test-implementation, the ASAS project measured 50 fields (2×3 deg^2 each) in the I-band with a 135 mm f/1.8 telephoto lens during 1997-2000. Pojmanski (2000) detected about 3900 variables, among which 380 periodic variables. We propose an automated method which classifies a subsample of 458 ASAS stars in a two step procedure: 1) find a satisfactory Fourier decomposition for the light curve, 2) apply Autoclass (Cheesemen, 1996), a Bayesian classifier, on the parameters obtained for each light curve. Several tests were done and the best classification was obtained when Period, Amplitude, Skewness and Amplitude ratio (first overtone/fundamental amplitudes of the Fourier decomposition) were used as the input parameters. The stars in the subsample have a fairly periodic behaviour. Time series with aliasing periods have been removed.

2. Results

For a fraction of red giants, a clear relation between period and amplitude can be seen (Fig. 1, left). This relation is also seen in infrared photometry (van Loon, these proceedings). The classes found are (Fig. 1, right): small amplitude and sinusoidal curves (~100), eclipsing binaries (~144), Cepheids (~48), SARV (~40), SR (~81), Mira (~45). The RR Lyrae stars are too few (too faint) to form a group, so they might be recovered as extreme objects in some classes. Some classes are divided in subgroups. For instance, the eclipsing binaries are classified in three subgroups, which correspond approximately to EA, EB and EW, but with some mixture. The decomposition in Fourier series is not optimal for such a separation. Principal components analysis will be applied to separate the different types of eclipsing systems. The subgroups of SRs will be studied to see if they correspond to real physical distinctions.

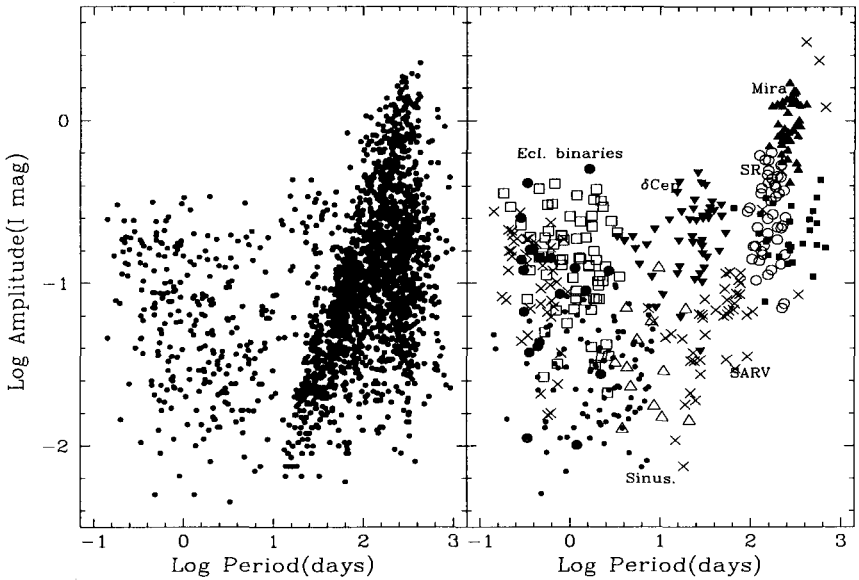

Figure 1. Amplitudes versus periods. Left: raw diagram of the whole sample, except the stars with alias problems (periods from the Lomb algorithm). Right: result after modeling of the Fourier decomposition. The main classes are written next to the symbols.

3. Conclusion

With the method we propose for the ASAS sample, we show that an automated classification can be reached with a level of incorrect classification of about 5%. This rate has to be reduced when very large datasets will be considered. There are, of course, irreducible classification ambiguities from the light curve alone (e.g. RRc and eclipsing binaries of EW type unless measured with very accurate photometry), but multi-colour photometry and/or spectroscopy can help resolve these ambiguities.

Internet Links :
ASAS Home Page: http://archive.princeton.edu/~asas/
For this work: http://www.astro.princeton.edu/~leyer/ASAS/
See also HAT Home Page: http://www.astro.princeton.edu/~bakos/HAT

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Pojmanski, G. 2000, AcA 50, 177