Statistical investigation of physical and geometrical parameters in close binaries using ASAS database

J. Nedoroščík[1], M. Vaňko[2], Š. Parimucha[1]

[1]*Faculty of Natural Science, Pavol Jozef Šafárik University, 040 01, Košice, Slovakia*
[2] *Astronomical Institute of the Slovak Academy of Sciences, 059 60 Tatranská Lomnica, Slovakia*

Abstract: The main goal of this work was to find dependencies between fourier coefficients, which were developed by light curve fitting with fourier polynomial. The light curves were acquired from ASAS database (All Sky Automated Survey). In this statistical research it was necessary to sort and modify these data, because light curves of eclipsing binaries are just part of bigger database, which contains the light curves of pulsating variable stars, novas etc. It was required to phase and normalize all of our light curves, that it could be possible to use program to fit light curves with fourier coefficients. Thereafter, we were looking for relations between fourier coefficients.

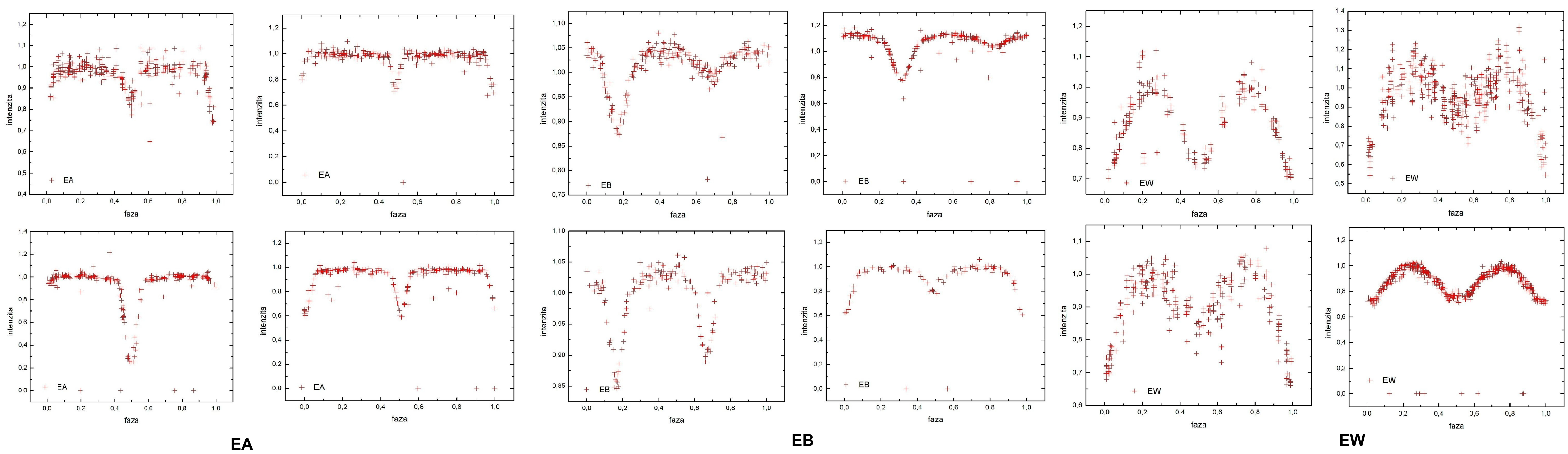

Fig. 1 Real systems from ASAS database representing EA, EB and EW binaries

Light curves expansion to polynomial according to Fourier coefficients

In ASAS[1] database is about 11 240 eclipsing binaries or candidates for eclipsing binaries. Light curves of these systems had to be phased and normalized, that we can use program, which expands light curves to polynomial according to Fourier coefficients. We used this expression to find Fourier coefficients:

$$S(x) = \frac{a_0}{2} + \sum_{n=1}^{N} \left[a_n \cos(nx) + b_n \sin(nx) \right]$$

For all light curves we obtained file with eleven Fourier coefficients.

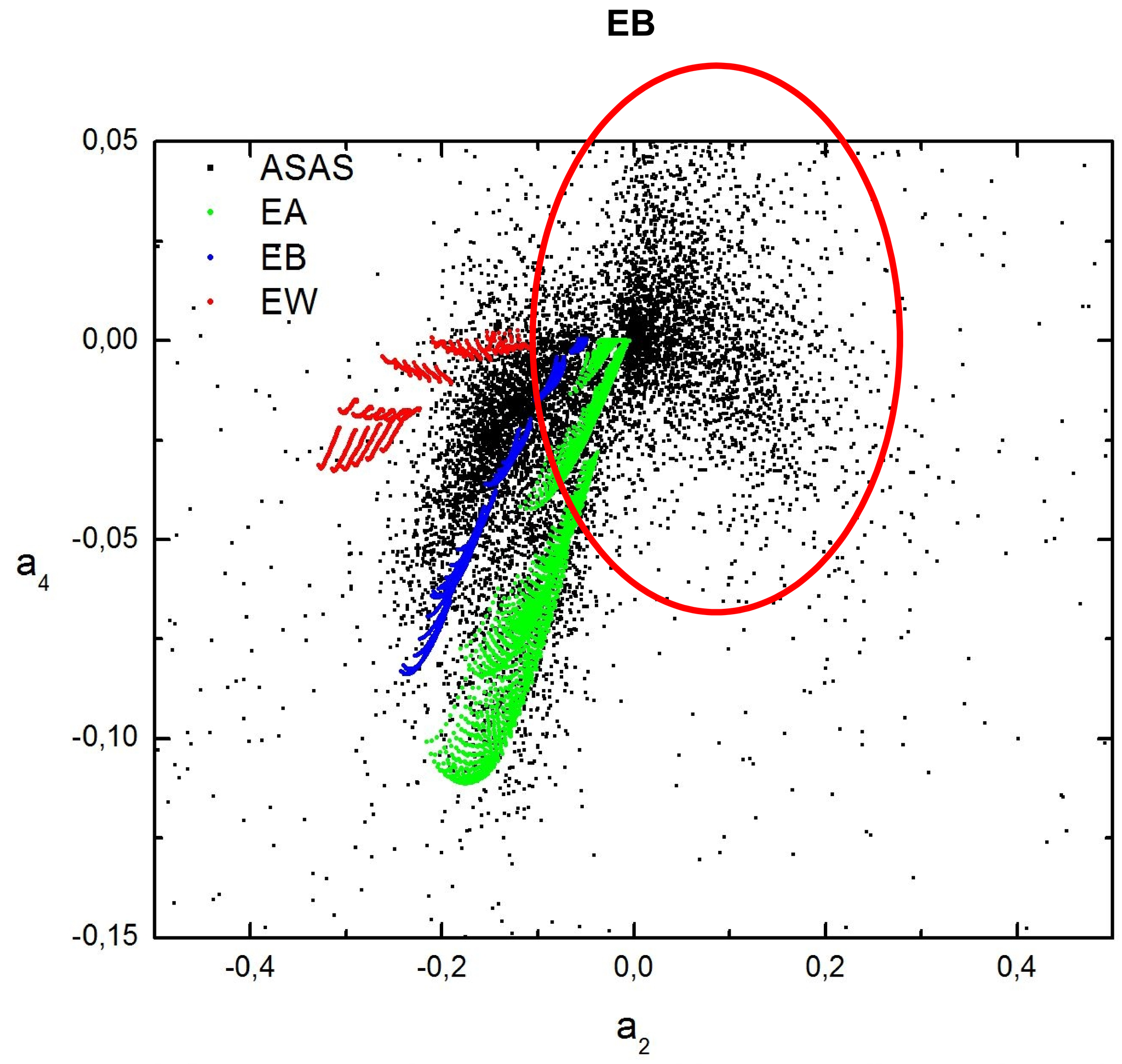

Fig. 3 Comparison of dependences of fourier coefficients for real (black) and model (color) light curves.

Results

Some of these Fourier coefficients represent directly physical or geometrical parameters (Hambálek, 2006). We were interested in relation between a_2 and a_4 and thereafter we were looking for boundary, which determines detached systems from semi-contact and contact systems for model light curves (see Fig. 2, right) and light curves for real systems (see Fig. 2, left). Selam (2004) published his equation for this boundary

$$a_4 = a_2(0.125 - a_2)$$

This equation was not correct for our model light curves – we needed to derive own boundary:

$$a_4 = -1.06011 a_2^2 + 0.21635 a_2 + 0.01229$$

By these boundaries we can determine types of eclipsing binaries. When we compare dependences of these two Fourier coefficients for model and real light curves (see Fig. 3), we can estimate some physical (e.g. mass ratio) or geometrical (e.g. inclination) parameters. It is necessary to model light curves with high precision to obtain correct estimation of physical and geometrical parameters of binary systems. Interesting is the area in red circle. We do not know, what kind of binaries represents this area These stars can represents close binaries with a lot of spots, pulsating stars or it could be systems with exoplanets.

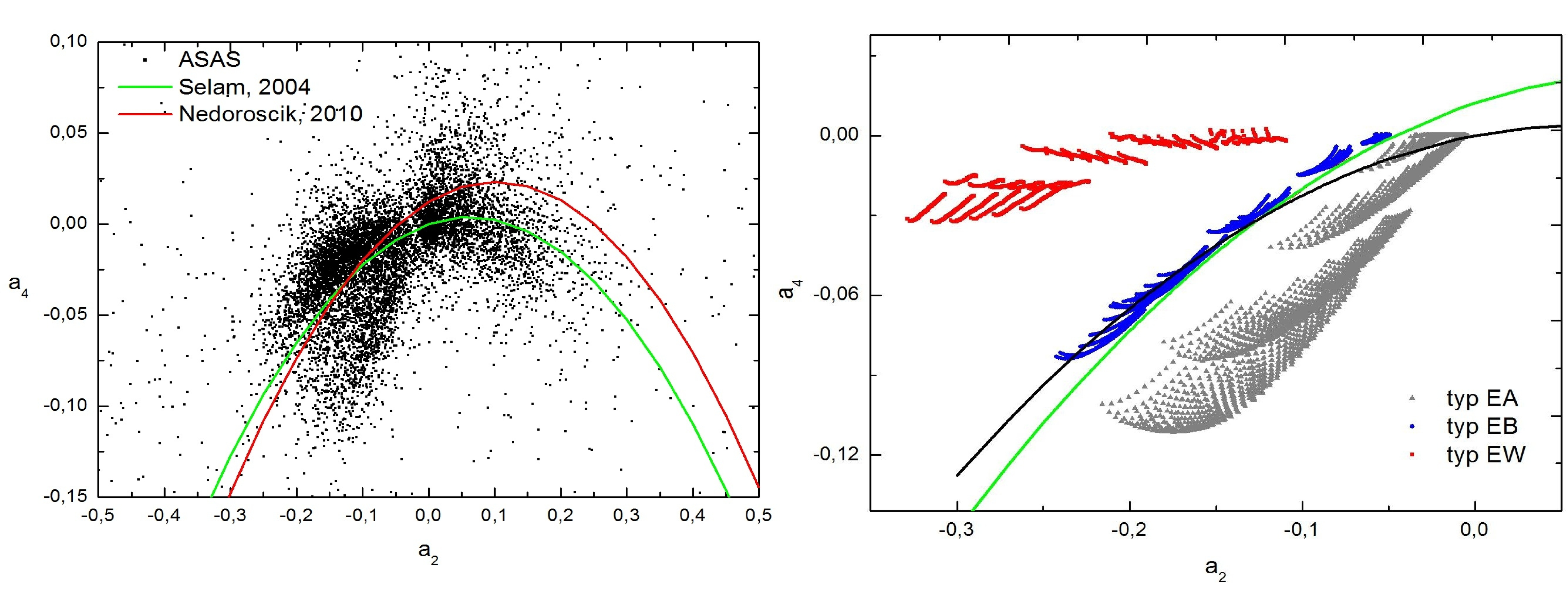

Fig. 2 Boundary determination between EA types and EB, EW types (left figure represents real systems from ASAS database, right model light curves)

References:

Hambalek, L.: 2006: Diploma thesis
Selam, S.O.: 2004, *A&A* **416**, 1097

[1]*http://www.astrouw.edu.pl/asas/*