THE SIGNIFICANCE OF USING HIGHER ORDER POLYNOMIALS TO DESCRIBE THE (O-C) DIAGRAMS OF ECLIPSING BINARIES

H. Rovithis-Livaniou[1], P. Rovithis[2], A. Kalimeris[1,2]
[1] Section of Astrophysics, Astronomy & Mechanics, Physics Dept., University of Athens, GR-15784 Zografos, Greece.
[2] Astronomical Institute, The National Observatory of Athens, P.O. Box 20048, GR-11810 Athens, Greece.

ABSTRACT. The principal aim of the present study is to underline the significance of using higher order polynomials to describe the (O-C) diagrams of eclipsing binary systems.

Key words: Stars: Binaries: Eclipsing: RT And, GO Cyg, AH Vir.

Introduction

In a recent paper (Kalimeris et al., 1994a;) we proposed a new method for the (O-C) diagram analysis of eclipsing binary systems: that is to describe an (O-C) diagram using a higher order polynomial and not to be limited to a second order one (the well-known and widely used parabola). Do ing so, we were also able to compute in a very simple and accurate way the orbital period changes of the system and its rate of variation. The choice of the appropriate polynomial depends mainly on its RMS error, which reflects to the accuracy with which the description of an (O-C) diagram is made. The latter will in consequence affect the accuracy of determination of the orbital period variations. So it is of great importance to make the right choice. In the present paper we shall show how significant information of the orbital period changes of a system is coming out applying our method, or might be lost using the old way.

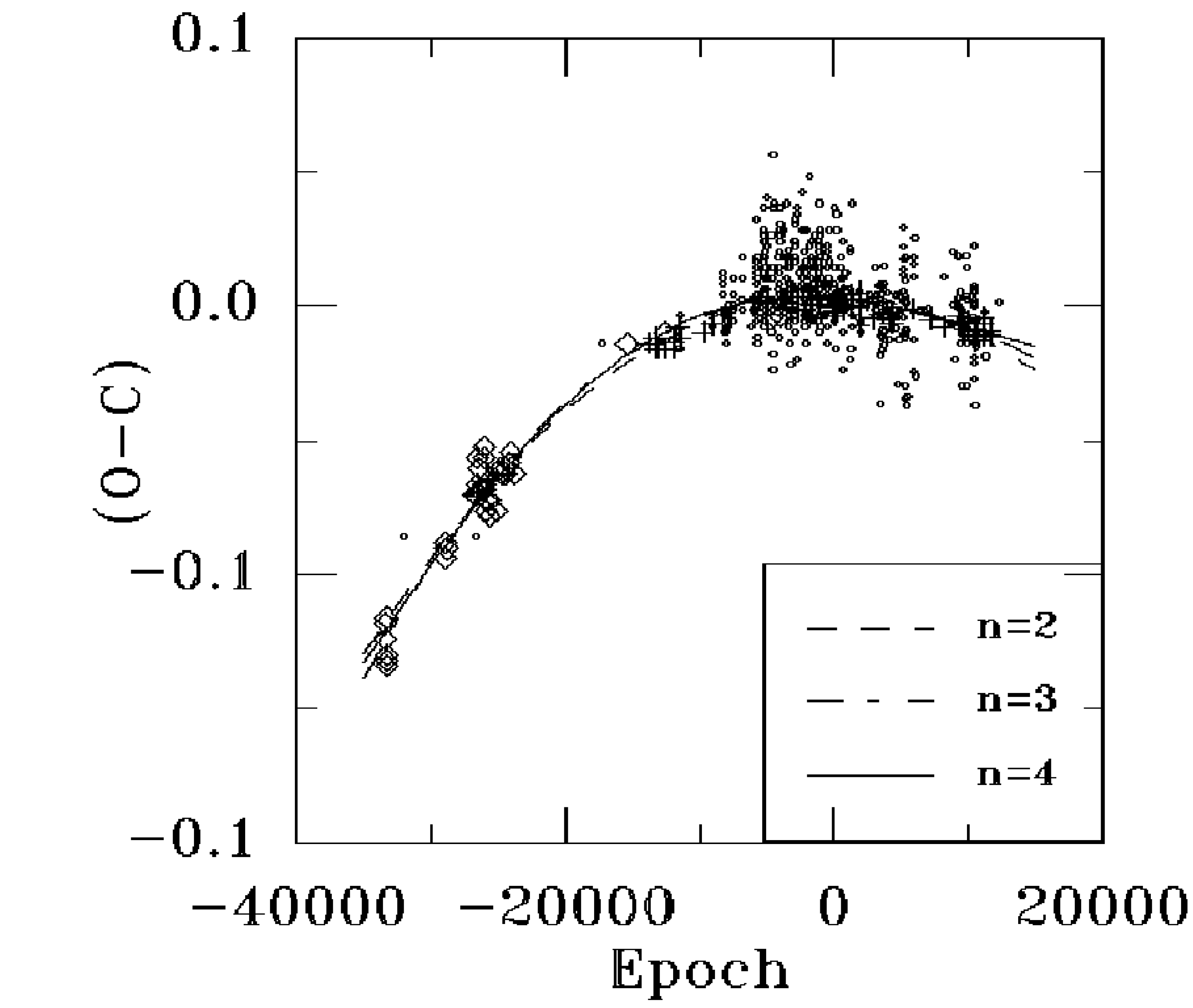
The data and their analysis

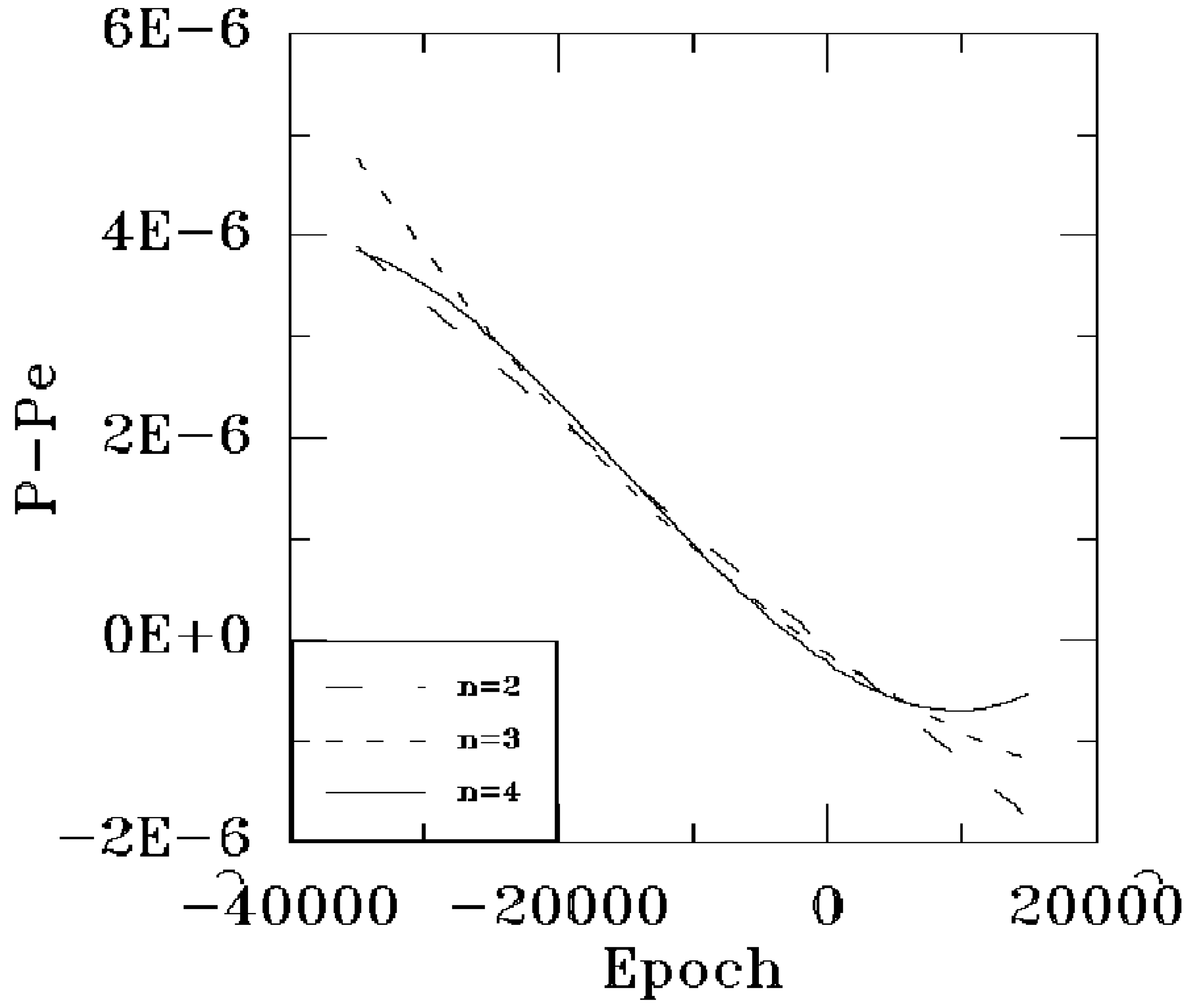
The eclipsing binaries RT And (HD 218915, of RS CVn's type) and AH Vir (a contact star) are the systems, which we select as examples in the present study. One can find the data for their construction in Rovithis-Livaniou et al. (1994) and Demircan et al. (1991), respectively. Applying our new method to RT And, we described its (O-C) diagram by a second, a third and a fourth order polyno mial presented in Fig.1. Table I lists their corresponding coefficients and RMS errors of approximation. For AH Vir (Fig.2), the description is rather complicated, since one has to apply three different least-squares polynomials connected by two spline interpolants to achieve a good fit (Kalimeris et al., 1994a). The orbital period variations and their rates of change for both systems were computed (applying Eqs. 5 and 6 of Kalimeris et al., 1994a) and are presented in Figs. 3, 4 and 5. In both cases we have adopted the same weights: 0.1 for visual , 0.3 for photographic and 1.0 for photoelectric observations.

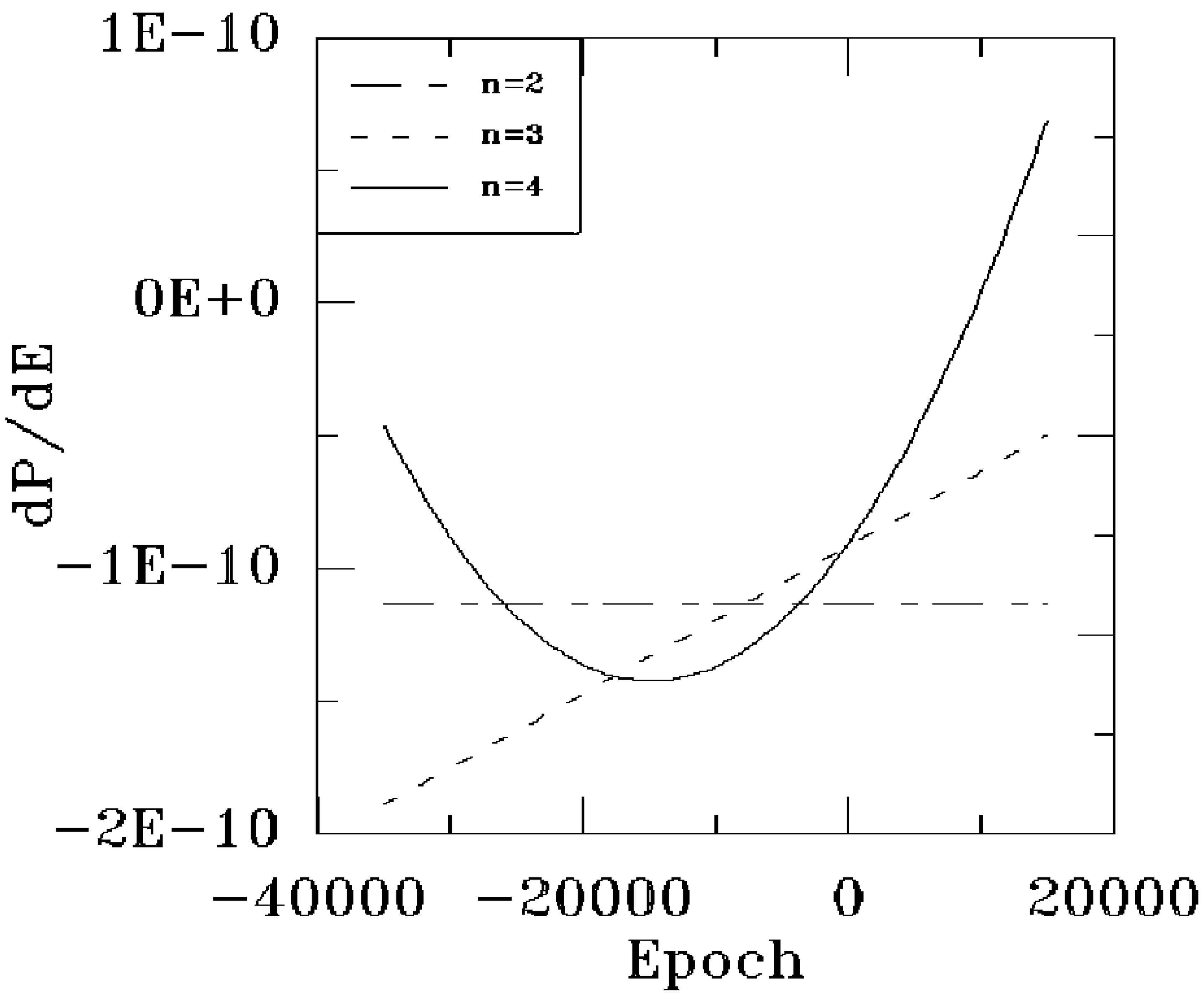
Discussion

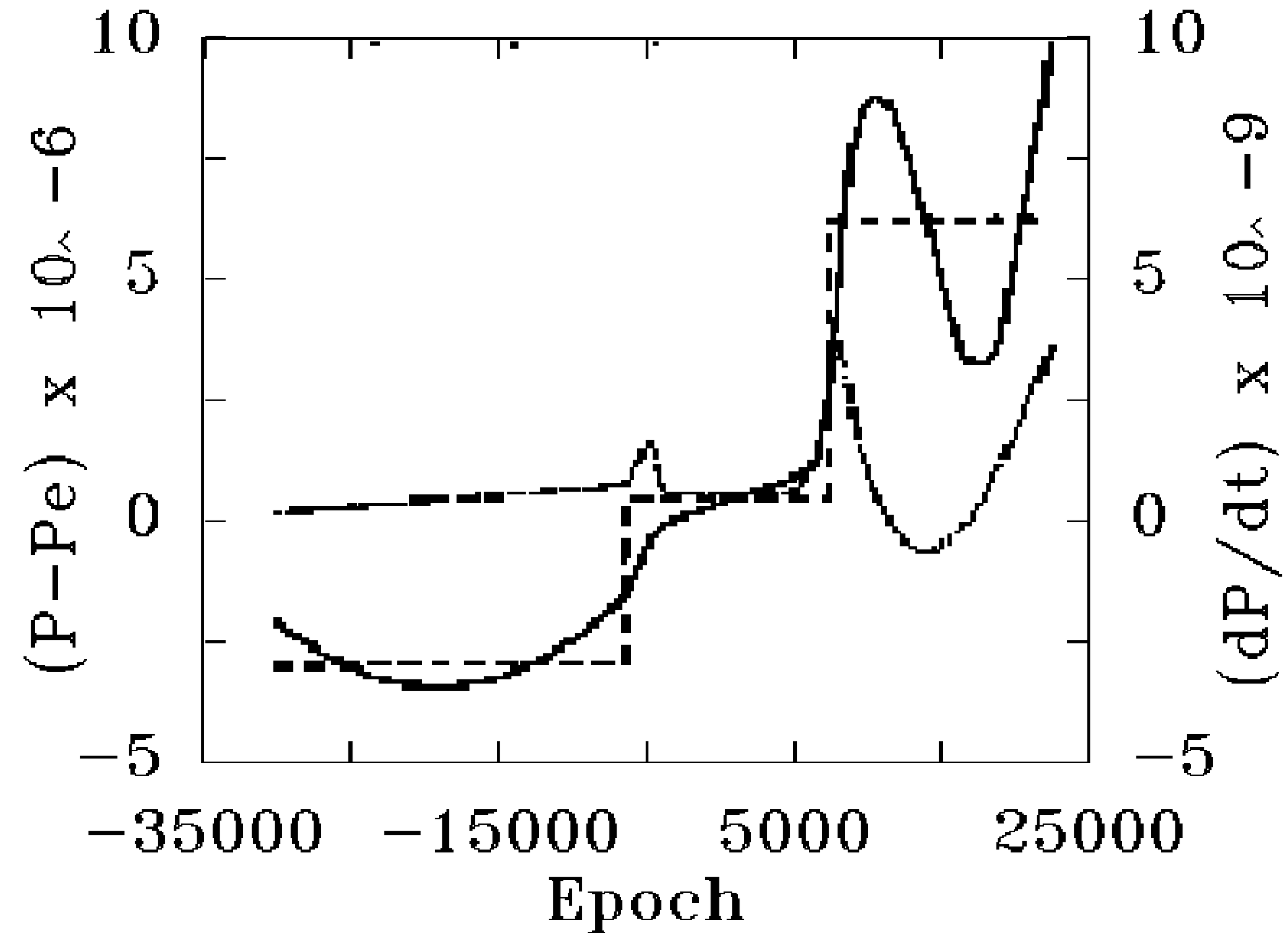
From Fig. 1, where a second, a third and a fourth order polynomial have been employed to fit the (O-C) diagram of RT And, one could say that all of them are describing it quite well. This is directly coming from the values of their coeffi cients and RMS errors, which are very close to each other. However, if one pays attention to RMS errors of approximation, will choice the fourth-order polynomial as the most appropriate one. It does not only describe better the (O-C) diagram, but it must be recruited to compute the orbital period changes of RT And (continuous line in Fig. 3). As regards the contact binary AH Vir, three different polynomials (connected by spline) have been adopted to describe its (O-C) diagram. Therefore, we do not give separate coeffi cients as we did before. In Fig.5, where its orbital period variations are presented by a continuous line with what we should have if the old method was used (long dashed line), one can see how much valuable information can be lost.

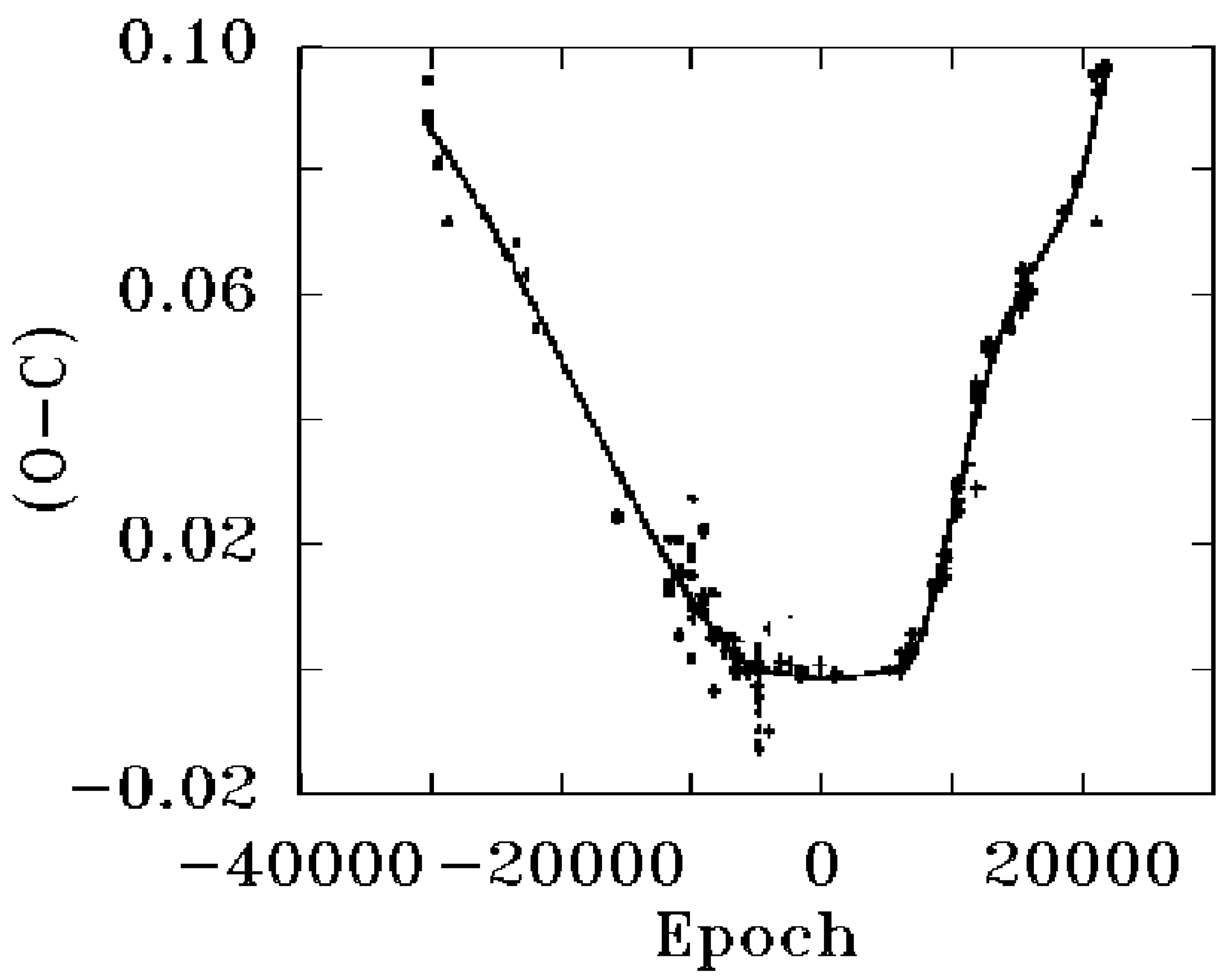
The same is true for the period changes of other systems as well (Kalimeris et al 1994a; 1994b; 1995). And although the (O-C) diagram of RT And for instance could be described well enough by a parabola, from the point of view of RMS errors obviously a fourth-order polynomial must be employed for it, respectively.











Figs.1–5. (O–C) & P–Pe diagrams (up), dP/dE for RT And & P–Pe for AH Vir (center), (O–C) for AH Vir (bottom).

Table 1.

	$n=2$	$n=3$	$n=4$
a_0	+0.00193	+0.00145	+0.00138
a_1	−0.00742	−0.01420	−0.02306
a_2	−0.56600	−0.45660	−0.45060
a_3		+0.46589	+1.17348
a_4			+1.97352
RMS	+0.00214	+0.00212	+0.00211
Sc. f.	+100000	+100000	+100000

Doing so, different pictures for their period changes are found, as one can notice from Figs. 3 and 4, where the P-Pe is presented for different order approximations.

Acknowledgements. This work was partly supported by Athens University (grant No. 70/4/2448).

References

Demircan O., Derman E., Akalin A.: 1991, *AJ*, **101**, 201.

Kalimeris A., Rovithis-Linaviou H., Rovithis P.: 1994a, *As. Ap.*, **282**, 775.

Kalimeris A., Rovithis-Linaviou H., Rovithis P., Oprescu G., Dumitrescu A., Suran D.M.: 1994b, *As. Ap.*, **291**, 765.

Kalimeris A., Mitrou C.K., Doyle J.K., Antonopoulou E., Rovithis-Livaniou H.: 1995, *As. Ap.*, **293**, 371.

Rovithis-Livaniou H., Rovithis P., Kalimeris A., Oprescu G., Dumitrescu A., Suran D.M.: 1994, *Rom.Astron.J.*, **4**, 135.