Abstract. Some properties of the quantities $B_{2m}$ (Smith, 1977) inherent in the frequency-domain approach have been deduced, and a general expression for them in terms of the eclipse elements $r_{1,2}$, $i$ and $L_1$ of the basic model has been presented (Section 2).

An expansion for the loss of light $(1 - l)$ into a Fourier sine series alone have been introduced, and its coefficients $b_m$ presented (Section 3) in terms of the same eclipse elements. A method of increasing the rate of convergence of this series has been given in Section 4. The methods for obtaining the elements of eclipsing binaries by making use of all these quantities in the frequency-domain can likewise be generalized to cover the photometric effects of gravitational and radiative interaction between the components.

1. Introduction

A number of alternative quantities can likewise be used as a basis for the solution of the elements of eclipsing systems in the frequency-domain. In a series of previous communications (which have been referred to as Papers I–XXI, respectively) methods have gradually been developed for an analysis of the light curves where the quantities $A_{2m}$ (see for definition Equation (3.1) in Kopal (1975, Paper I)), so called ‘the moments of the light curves’, have been used as basic quantities. For a general survey of the procedures, the reader may be referred to Kopal and Demircan (1978, Paper XIV). Different procedures have been considered in Section 4 of Demircan (1978b, Paper XVI) for the solution of the problem with the same basic quantities $A_{2m}$.

Alternatively, a slightly different class of quantities have been introduced by Smith (1977, Chapter V). These alternative quantities for the analysis defined by

\[ B_{2m} = \int_0^{\pi} (1 - l)d(\cos^{2m}\theta) \]  

\[ (1.1) \]

differ from the conventional moments $A_{2m}$ by only the cosine term. Thus, obviously, these two types of moments are correlated for non-negative integral $m$'s by

\[ B_{2m} = \sum_{j=0}^{m} (-1)^j \frac{m!}{j!(m-j)!} A_{2j}; \quad m = 0, 1, 2, \ldots \]  

\[ (1.2) \]

or inversely,

\[ A_{2m} = \sum_{j=0}^{m} (-1)^j \frac{m!}{j!(m-j)!} B_{2j}; \quad m = 0, 1, 2, \ldots . \]  

\[ (1.3) \]
Hence, many alternative expressions are obtainable for the quantities $B_{2m}$ by simply inserting the expressions for the moments $A_{2m}$ from Kopal (1977b, Paper XII) and Demircan (1978a, Paper XV; 1978c, Paper XXI) into Equation (1.2). For the sake of an illustration let us consider, for example, Equation (2.8) from Demircan (1978a, Paper XV) which holds good for any non-negative $m$-integral or fractional – and which can be alternatively rewritten as

\[
A_{2m} = \frac{4}{\sqrt{\pi}} \Gamma(m + 1)L_1(1 - a)^2 \sin^2 \theta \sum_{i=0}^{A} C^{(i)} \Gamma(n)(1 - c_0)^{\nu + 1/2} \times \\
\times \sum_{n=0}^{\infty} \frac{(2n + \nu + 3\frac{1}{2})\Gamma(n + \nu + 3\frac{1}{2})\Gamma(n + \nu + 1)}{(2n + 1)(2n + 2)\Gamma(n + \nu + 1)} \times \\
\times R_{2\nu}^{(2,2\nu)}(a)R_{m+\nu+1/2,-m}(c_0^2),
\]

with the same notations as used before in previous communications (cf., e.g., Demircan, 1979). If we now substitute for the moments $A_{2j}$ in Equation (1.2) directly from (1.4), a general series expansion for the quantities $B_{2m}$ can be obtained in the form

\[
B_{2m} = \frac{4}{\sqrt{\pi}} m!L_1(1 - a)^2 \sum_{i=0}^{A} C^{(i)} \Gamma(n)(1 - c_0)^{\nu + 1/2} \times \\
\times \sum_{n=0}^{\infty} \frac{(\nu + 2n + 3\frac{1}{2})\Gamma(n + 3\frac{1}{2})\Gamma(n + \nu + 3\frac{1}{2})}{(2n + 1)(2n + 2)\Gamma(n + \nu + 1)} \times \\
\times R_{2\nu}^{(2,2\nu)}(a) \times \\
\times \sum_{j=0}^{m} (-1)^j \frac{\sin^2 \theta_x}{(m - j)!\Gamma(n + j + \nu + 3\frac{1}{2})} \times \\
\times R_{2\nu+1/2,-j}(c_0^2).
\]

This equation represents a general expression between the observed quantities $B_{2m}$ (see Definition (1.1)) and the eclipse elements $r_{1,2}, i$ and $L_1$ of the basic model. It is valid for any type of eclipse, for any arbitrary degree $\Lambda$ of the adopted law of limb-darkening but for only positive integral values of $m$. A more general expression for these quantities in terms of the same eclipse elements for the basic model will be developed in the following section.

One other class of quantities which may be used as a basis for an analysis of the eclipsing binary light curves are the Fourier transforms $F$, or rather their local values $a_m$ and $b_m$ of the light curves. For $a_m$'s a general expression has already been deduced (Demircan, 1979) in a preceding paper. The use of the continuous Fourier transforms $F$ or, alternatively, their local values $a_m$ and $b_m$ has a remarkable advantage that their empirical values can be found exactly (except for round-off) by a least-squares solution of the respective finite Fourier series instead of approximately from the integral definitions by a numerical integration. In the respective Fourier series of the loss of light $(1 - l)$ worked out by Kopal (1977a) and Demircan (1979) the sine coefficients have been taken to be zero – an assumption implying symmetry of the light curves with respect to the moments $\theta = 0$ of conjunctions. We shall justify this statement here.