NEW TECHNIQUE TO COMPUTE THE GEOMETRICAL ELEMENTS OF THE ECLIPSING OF W UMa-TYPE

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Abstract. The aim of this paper is to present a general method for computation of the geometrical elements of totally eclipsing W UMa (close, or in actual contact) binary systems in the frequency-domain. This method has been done using a new technique (two minima with the improved values of the photometric perturbation effects). The results are compared with the results calculated by different methods, that have used the same observation references. The improved photometric perturbation terms have been discussed and its effects are computed for both (primary and secondary) minima.

1. Introduction

A new method to analyze the light changes of eclipsing binary systems was introduced by Kopal in 1975 (cf. Kopal, 1975a, b, c, d), using the Fourier analysis in the frequency-domain, where the eclipsing system consists of two spherical stars revolving about their common centre of gravity in circular orbits.

Kopal's method was generalized for stellar eclipses that might be distorted by axial rotation and mutual interaction (Kopal, 1975e). This method has been discussed and applied to all types of eclipses (Kopal, 1976a, b; 1977a, b, c; 1978a, b; 1979a, b; Kopal et al., 1976; Kopal and Al-Naimiy, 1978; Kopal and Demircan, 1978), to determine the geometrical elements of the close eclipsing spherical and distorted binary systems.

The generalized method was studied and developed in 1982 and 1983 (by adding the values of perturbation terms to the minimum under occultation) to compute the geometrical elements of distorted eclipsing binary systems (Kopal, 1982a, b; Jabbar and Kopal, 1983; hereafter referred to as Paper I; and Jabbar, 1983).

The present work introduces a general method based on using a new technique through the employment of two minima and improved photometric perturbation values to compute the geometrical elements of totally eclipsing W UMa (actual and non-actual contact) close binary systems.

This new technique was applied to seventeen selected W UMa eclipsing binary systems (ten of which were treated by Paper I) in Johnson's standard yellow and blue filters.

The results of the study of the stars selected in Paper I, will not be mentioned in the present work because of the similarity of the final results of the present work to that listed in Paper I.
2. Source of Observations

In this paper we shall select the data of the eclipsing binary W UMa systems (Table I) based on the following criteria:

1. The photometric evidence based on photoelectric observations.
2. The light curves (at least, at the time of observation) should be symmetrical with respect to the conjunctions.
3. The minima of light are produced by alternation of the total and annular eclipses.

<table>
<thead>
<tr>
<th>System</th>
<th>J.D. Hel.</th>
<th>Period (day)</th>
<th>$T_{\text{eff}}$ (K)</th>
<th>Sp. type</th>
</tr>
</thead>
<tbody>
<tr>
<td>TZ Boo</td>
<td>2439632.8418</td>
<td>0.29716070</td>
<td>4900</td>
<td>K0</td>
</tr>
<tr>
<td>RR Cen</td>
<td>2424231.0981</td>
<td>0.60569029</td>
<td>7250</td>
<td>F5</td>
</tr>
<tr>
<td>CC Com</td>
<td>2442467.3307</td>
<td>0.22068420</td>
<td>4300</td>
<td>K4</td>
</tr>
<tr>
<td>FG Hya</td>
<td>2436968.7067</td>
<td>0.32783546</td>
<td>6030</td>
<td>G0</td>
</tr>
<tr>
<td>UZ Leo</td>
<td>2434041.4777</td>
<td>0.61803930</td>
<td>8500</td>
<td>A7</td>
</tr>
<tr>
<td>V566 Oph</td>
<td>2436744.4200</td>
<td>0.40964091</td>
<td>6700</td>
<td>F5</td>
</tr>
<tr>
<td>AE Phe</td>
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<td>0.36237459</td>
<td>6030</td>
<td>G0</td>
</tr>
</tbody>
</table>

The foregoing criteria have been used to select the following systems:

1. **TZ Boo**
   Discovered by Guthnick and Prager (1927). The photoelectric observations were made by Binnendijk (1969), using the 36-inch No. 2 reflector at the Kitt Peak National Observatory.

2. **RR Cen**
   Discovered as a variable by Roberts (1896). Knipe (1965) made the first photoelectric study of the system. Chambliss (1971) observed the system photoelectrically at the Cerro Tololo Inter-American Observatory in Chile.

3. **CC Com**
   Discovered by Hoffmeister and subsequently observed photoelectrically by Wenzel (1967). The photometric observations were made by Rucinski (1976), using No. 1, 91-cm and No. 3, 41-cm telescopes of the Kitt Peak National Observatory.

4. **FG Hya**
   Discovered by Hoffmeister (1934). Smith (1955, 1963) observed the system photoelectrically and classified it as W UMa type. The observations of the variable were made by Binnendijk (1963). Recently the system was observed photoelectrically by Mahdy \textit{et al.} (1985), using 74-inch reflecting telescope of the Kottamia Observatory.