Publ. Astron. Obs. Belgrade No. 54 (1996), 157 – 158 *Contributed paper*

COMPARISON OF DIFFERENT TYPES OF EQUATIONS OF CONDITION IN ORBIT CALCULATION OF VISUAL BINARY STARS

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1. INTRODUCTION

Growing number and improving quality of visual double star observations (Dommanget, J. Lampens, P. 1993.) makes the problem of calculation of their orbits still topical. Great number of methods are at disposal, and in use by practitioners. In precomputer age astronomers were resolving orbits on basis of more or less heuristic algorithms. After appearance of computers, the method of least squares as an objective mathematical tool for resolving orbits from input data (relative positions) attracts attention. Eichorn and Xu (Eichorn, Xu, 1990.) worked out method for calculation of orbits by means of nonlinear least squares method. Equations of condition were designed by geometrical and dynamical conditions simoultaneously. Ćatović and Olević, (Ćatović, Olević, 1992.) proposed a method of falsified observation (FO) whereby linear least squares were applied twice. First to solve geometrical equations of condition, and second to solve dynamical equations of condition. Some possible approaches based on idea of FO were discussed in (Ćatović, Olević, 1995.). In this paper we present results based on analysis of equations of condition given there.

2. MAIN RESULT

In the first version of algorithm FO was introduced as regular observation, but with weight equal to the sum of all other weights. Geometrical equation of condition was:

$$z_1 x_i^2 + z_2 y_i^2 + z_3 y_i x_i + z_4 x_i + z_5 y_i + 1 = 0; \quad i = 1, ..., N. \tag{1}$$

where N is the number of observations; $(x_i = \varrho_i \cos\theta_i, y_i = \varrho_i \sin\theta)$ are observed apparent positions and $z_1, ..., z_5$ are unknown coeficients - geometrical elements of the orbit.

The number of unknown coefficients can be reduced by one, if we demand that conical section to be determined, passes throught FO with coordinates (x_f, y_f). We can eliminate one of the coefficients by putting (x_f, y_f) in equation (1). In previous paper (Ćatović, Olević, 1995.) we gave five additional types of equations of condition. Here, as an example, we give equation of condition with z_3 expressed via other coefficients, and position of FO.

$$z_1\left[x_i(x_i - \frac{x_f}{y_f}y_i)\right] + z_2\left[y_i(y_i - \frac{y_f}{x_f}x_i)\right] + z_4\left[y_i(1 - \frac{x_i}{x_f})\right] +$$

$$+z_5\left[y_i(1 - \frac{y_i}{y_f})\right] + \left(1 - \frac{x_i y_i}{x_f y_f}\right) = 0; \quad i = 1, ..., N, \tag{2}$$

and z_3 directly from:

$$z_3 = -z_1\left(\frac{x_f}{y_f}\right) - z_2\left(\frac{y_f}{x_f}\right) - z_4\left(\frac{1}{y_f}\right) - z_5\left(\frac{1}{x_f}\right) - \left(\frac{1}{x_f y_f}\right). \tag{3}$$

We checked all five types of geometrical equations, by direct calculations and found that **all five types of geometrical equations of condition, in spite of their different form, give the same result for the same FO**. This result is obtained by direct calculation but the same thing could probablly be shown by direct calculation of solution of normal equations with the help of some computer algebaic manipulator. From practical point of view, unfortunatelly, we can not say that new appoach gives more accurate results. But it gives results of the same accuracy as the approach previously checked.

In dynamical equations of condition

$$nt_i - \beta = M_i; \quad i = 1, ..., N, \tag{4}$$

where $\beta = n\tau$, were analysed too. The idea was to take some point from the apparent orbit, instead of the observed position wich is not exactly on that orbit in general case. By direct calculation we took into calculations in (4), point - intersection of apparent orbit and line AB (primary-secondary). It seems that this approach, although theoreticaly more justified, did not give better accuracy in practice.

3. CONCLUSION

"Different types" of geometrical equations of condition presented in Ćatović, Olević, (1995.) were in fact one and the same equation in different forms. From the point of view of accuracy, there is not big difference in appplying geometrical equations (1) or (2). The same can be said of differences connected with the dynamical equations of condition (4).

References

Dommanget, J. and Lampens, P.: 1993, *Astrophys. and Sp. Sci.* **Vol 200**, pp. 221-238

Eichorn, R. and Xu, X.: 1990, *Astrophys. J.* **Vol 358**, pp. 575

Ćatović, Z. and Olević, D.: 1992, *in Astro. Soc. of the Pacific, Conference Series*, **Vol 32**, Atlanta. pp. 231

Ćatović, Z. and Olević, D.: 1995, *Bull. Astron. Belgrade*, **152**, pp. 65-69