KINEMATICS OF NEARBY AND DISTANT STARS

E. DROBITKO, V. VITYAZEV
The Sobolev Astronomical Institute of St.-Petersburg State University
198504, St.Petersburg, Petrodvoretz, Universitetsky pr., 28, Russia
e-mail: siggy@dorms.spbu.ru

ABSTRACT. The proper motions analysis of the main sequence stars and of the luminosity class III stars listed in the catalogue HIPPARCOS is presented. A new method based on representation of proper motions in coordinate systems whose poles are associated with each of the principal galactic axes is proposed. This method yields complete separation of all parameters of the Ogorodnikov-Milne model. The solutions for stars of different spectral classes are obtained. It was found that with respect to parallaxes the main sequence is splitted into two zones (distant and nearby stars) with rather sharp border at B-V = 0.5. It is shown that the Parenago's discontinuity may be connected with this effect.

1. INTRODUCTION

In 1950, Parenago [1] pointed out that parameters of the Solar motion and the dispersion of the stellar velocities show a certain dependence on spectral type with a sudden change at the F type. Later on this effect was named the *Parenago's discontinuity.*

The purpose of the present paper is looking at the Parenago's discontinuity from the standpoint of the newest astrometric data. The knowledge of parallaxes in HIPPARCOS catalogue gives us a possibility to separate the giants and dwarfs of the same spectral class and to localize them in 3D space. From 118 218 stars of HIPPARCOS catalogue we selected the stars which meet the following criteria: 1)only the single stars belonging to the 1.8^m-wide strips centered around the main sequence and the luminocity class III were used. The empirical lines of the main sequence and the luminocity class III have been taken according to [2]; 2)the only stars with the error of the parallax no more than 3σ, have been retained; 3)the fast stars with tangential velocities more than 80 km/sec have been excluded.

Samples of stars of the main sequence and of the giant stars were binned for different color indexes. For each bin we used the three-dimensional Ogorodnokov-Milne model [4] to get the kinematic parameters of thus formed star groups. This model was supplemented by the terms describing motion of the Sun with respect to chosen centroids. Such approach allows to determine the following parameters: U, V, W – the velocity components of the Solar motion in Galactic coordinate system; $M_{ij}^{+},\ i, j = 1, 2, 3$ – the elements of a matrix of local deformation of a velocity field; $\omega_i,\ i = 1, 2, 3$ – the components of the angular rate of rigid rotation of a stellar system with respect to the axes of the galactic trihedron.

The equations of conditions are defined by:

$$\mu_l \cos b = \sum_{i=1} L_i \ f_i(l, b, r), \tag{1}$$

$$\mu_b = \sum_{i=1} L'_i \ f'_i(l, b, r), \tag{2}$$

where L_i, L'_i are the described parameters; l, b, r are the galactic coordinates of a star with the proper motions $\mu_l \cos b$ and μ_b; $f_i(l, b, r)$, $f'_i(l, b, r)$ are known functions which determine the contribution of kinematic effects to the proper motions.

The unknown parameters of the model were derived from the least squares solution of the equation (1). The equation (2) was not used since for low latitude stars where the majority of the stars are concentrated it does not provide a reliable solution. The equation (1) allows us to obtain only 5 of 11 parameters of the Ogorodnikov-Milne model. To derive the remaining parameters the rotation algorithm proposed by V. V. Vityazev [3] was used.

2. RESULTS

In general, modern observational data confirm the results obtained by Parenago more than half a century ago. Still, from our solutions it follows that the Parenago's discontinuity is more complex phenomenon than it was thought before. The range of color index where the abrupt change of the kinematic parameters exists may be specified as $(0.3 < B - V < 0.75)$. More precisely our results may be formulated as follows: the parameters of the Ogorodnikov-Milne model may be derived from the proper motions of the main sequence stars rather reliably only for stars with $B - V < 0.5$. For the remaining segment of the main sequence $(B - V > 0.5)$ the reliability of determination of these parameters sharply falls down. This circumstance is tightly connected with distribution of stars of the main sequence in space. Namely, the stars with $(B - V > 0.5)$ being dwarfs are visible only at close distances (up to 100 pc). From theoretical reasons it follows, that within the limits of a volume with the radius 300 pc the Oort parameters should be determined correctly irrespective to distances. The found inconsistency means that the kinematics of the nearby stars does not follow the model of the Galaxy's flat rotation. Equally it is not compatible with more general Ogorodnikov-Milne model. Our analysis shows that the Parenago's discontinuity exists only for stars of the main sequence. It does not exist (or is too weak) for the giants of the luminocity class III, which have an uniform distribution in space at distances more than 100 pc. We see that the distance factor plays an important role in the study of the Parenago's discontinuity. In our opinion, the transition from the spectral types (color indexes) of the main sequence stars to their distances from the Sun may reduce the problem of the Parenago's discontinuity to pure kinematic nature. In this direction we are going to continue our activity.

The authors thank the RFFI (grant N 02-02-16570) and the Leading Scientific School program (grant 00-15-96775) for support.

3. REFERENCES

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