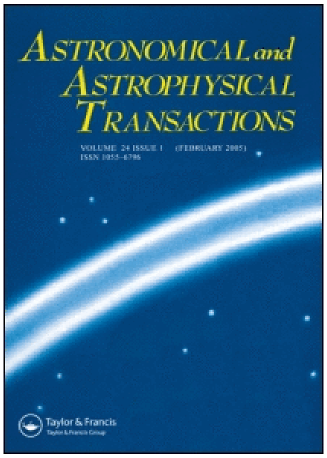

Astronomical & Astrophysical Transactions

The Journal of the Eurasian Astronomical Society

Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

Investigation of the negative **K** effect using the Orion Spiral Arm Catalogue

V. V. Bobylev [a]; A. T. Bajkova [a]; G. A. Gontcharov [a]
[a] Main (Pulkovo) Astronomical Observatory of the Russian Academy of Sciences, Pulkovskoye Chaussee 65/1, St Petersburg, Russia

Online Publication Date: 01 April 2006
To cite this Article: Bobylev, V. V., Bajkova, A. T. and Gontcharov, G. A. (2006) 'Investigation of the negative **K** effect using the Orion Spiral Arm Catalogue', Astronomical & Astrophysical Transactions, 25:2, 143 - 144
To link to this article: DOI: 10.1080/10556790600893104
URL: http://dx.doi.org/10.1080/10556790600893104

Astronomical and Astrophysical Transactions
Vol. 25, Nos. 2–3, April–June 2006, 143–144

Investigation of the negative *K* effect using the Orion Spiral Arm Catalogue

V. V. BOBYLEV*, A. T. BAJKOVA and G. A. GONTCHAROV

Main (Pulkovo) Astronomical Observatory of the Russian Academy of Sciences,
Pulkovskoye Chaussee 65/1, St Petersburg 196140, Russia

(Received 29 June 2006)

We created and are constantly updating the Orion Spiral Arm Catalogue for stars with known coordinates, parallaxes, proper motions and radial velocities. It is shown that there is an effect of contraction appearing in the motion of giants of A0–A5 spectral classes which attains a value of $K = -13 \pm 2\,\mathrm{km\,s^{-1}\,kpc^{-1}}$. We try to link this effect to the periodic structure of the residual velocity field of stars in the solar neighbourhood, which is caused by spiral density waves.

Keywords: Milky Way; Structure; Kinematics; *K* effect

In the framework of the Ogorodnikov–Milne model, the presence of a negative K effect means that the star system being considered is found in the state of contraction. The negative K effect of value –(1–7) $\mathrm{km^{-1}\,kpc^{-1}}$ was found in the motion of OB stars by Fernández *et al.* [1], Bobylev [2] and Rybka [3]. At present, the nature of this phenomenon is not completely clear. There are different hypotheses; this effect is connected with specific measurements of star radial velocities [4], or with the influence of the bar in the Galactic centre [4], or with the influence of the spiral structure [5].

The goal of this work is to establish the connection of the negative K effect with the periodicity of star's velocity field caused by the spiral structure.

The database used here represents the radial velocities of stars collected from more than 1400 bibliographical sources. They are reduced to a single system of radial velocities of 854 standard stars from the list formed by us. This allowed us to calculate the weighted-mean radial velocities with a median accuracy of $\pm 1\,\mathrm{km\,s^{-1}}$ for more than 25 000 Hipparcos stars located in the Orion Arm region. Together with other characteristics, these values are represented in the form of a constantly updated database and the Orion Spiral Arm Catalogue (OSACA) [6, 7]. We used 1269 stars of A0–A5 spectral classes with $B - V \leq 0.2$. Stars of only I, II and III luminosity classes are included into this sample. However, the basic part of the sample consists of OSACA stars, without any notification of the luminosity class. All selected stars belong to the distance interval $r = 0.1{-}0.6$ kpc. The velocities of the stars were

*Corresponding author. Email: vbobylev@gao.spb.ru

Astronomical and Astrophysical Transactions
ISSN 1055-6796 print/ISSN 1476-3540 online
http://www.tandf.co.uk/journals
DOI: 10.1080/10556790600893104

corrected for the common Galactic rotation with the Oort constants $A = 13.7\,\mathrm{km\,s^{-1}\,kpc^{-1}}$ and $B = -12.9\,\mathrm{km\,s^{-1}\,kpc^{-1}}$ [2]. As a result, the following values of the solar peculiar velocity were found: $u_\odot = 10.2 \pm 0.4\,\mathrm{km\,s^{-1}}$, $v_\odot = 10.9 \pm 0.4\,\mathrm{km\,s^{-1}}$ and $w_\odot = 6.6 \pm 0.4\,\mathrm{km\,s^{-1}}$. The roots of the deformation tensor are $(\lambda_1, \lambda_2, \lambda_3) = (3.5, -29.3, -3.5)\,\mathrm{km\,s^{-1}\,kpc^{-1}}$, and their errors are approximately $3\,\mathrm{km\,s^{-1}\,kpc^{-1}}$. Let one of the roots ($\lambda_3$) be zero, and consider only the x–y plane. We take into account that $(\partial V_R/\partial R)_{R_0} = \lambda_1$ and $(V_R/R)_{R_0} = \lambda_2$, where R is the distance from the kinematic centre, which is unknown. Using the relations $K + C = 4 \pm 3\,\mathrm{km\,s^{-1}\,kpc^{-1}}$ and $K - C = -29 \pm 3\,\mathrm{km\,s^{-1}\,kpc^{-1}}$, we can evaluate the typical residual velocity of stars as $(K - C)\bar{r} = -5.4 \pm 0.6\,\mathrm{km\,s^{-1}}$. Contraction takes place along the axis in the direction 12–192°.

To take into account the spiral structure, we have used the following parameters found in work by Mel'nik *et al.* [8]: $f_R = 6.6\,\mathrm{km\,s^{-1}}$, $f_\theta = 1.8\,\mathrm{km\,s^{-1}}$, $\phi_R = 38°$, $\phi_\theta = -33°$ and $\lambda = 2\,\mathrm{kpc}$, at $R_0 = 7.1\,\mathrm{kpc}$ and $i = 6°$. For these parameters we found that $u_\odot = 4.2 \pm 0.5\,\mathrm{km\,s^{-1}}$, $v_\odot = 11.0 \pm 0.5\,\mathrm{km\,s^{-1}}$ and $w_\odot = 6.7 \pm 0.5\,\mathrm{km\,s^{-1}}$. The roots of the deformation tensor are $(\lambda_1, \lambda_2, \lambda_3) = (2.0, -33.5, -3.9)\,\mathrm{km\,s^{-1}\,kpc^{-1}}$, and $K = -15.9 \pm 2.2\,\mathrm{km\,s^{-1}\,kpc^{-1}}$. For the second case we have used the spiral structure parameters found in the work by Popova and Loktin [9]: $f_R = -3.97\,\mathrm{km\,s^{-1}}$ and $f_\theta = 13.27\,\mathrm{km\,s^{-1}}$, at $R_0 = 8.3\,\mathrm{kpc}$ and $i = 21.5°$. Our results are as follows: $u_\odot = 8.6 \pm 0.5\,\mathrm{km\,s^{-1}}$, $v_\odot = -1.3 \pm 0.5\cos^{-1}\,\mathrm{km\,s^{-1}}$ and $w_\odot = 6.7 \pm 0.5\,\mathrm{km\,s^{-1}}$. The roots of the deformation tensor are $(\lambda_1, \lambda_2, \lambda_3) = (5.4, -29.8, -3.5)\,\mathrm{km\,s^{-1}\,kpc^{-1}}$, and $K = -12.1 \pm 2.2\,\mathrm{km\,s^{-1}\,kpc^{-1}}$. A comparison of these two results shows that the negative K effect exists in both the cases considered.

Acknowledgement

This work is supported by the Russian Fund for Basic Research (grant 05-02-17047).

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