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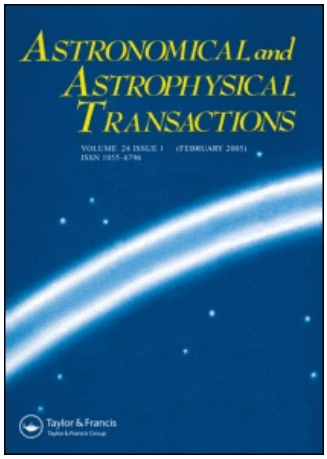

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Radial velocities of 35 495 Hipparcos stars in a common system

G. A. Gontcharov [a]
[a] Pulkovo Observatory, St Petersburg, Russia

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Radial velocities of 35 495 Hipparcos stars in a common system

G. A. GONTCHAROV*

Pulkovo Observatory, St Petersburg 196140, Russia

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The Pulkovo Compilation of Radial Velocities (PCRV) catalogue has been produced to study stellar kinematics in the local spiral arm. The PCRV contains the mean weighted absolute radial velocities of 35 495 Hipparcos stars of various spectral types and luminosity classes over the whole celestial sphere mainly within the radius of 500 pc from the Sun. The median precision of the obtained radial velocities is 0.7 km s^{-1}. The results from 203 publications have been used in the catalogue. They are linked to the system of IAU standard stars or a list of secondary standards by means of the analysis of zero-point deviations and systematic dependences of the radial velocity differences 'new observations minus standards' on the radial velocity, colour index $B - V$, right ascension and declination.

Keywords: Radial velocity; Galaxy; Stellar kinematics

The Orion Spiral Arm Catalogue (OSACA) project (http://www.geocities.com/orionspiral/) by Pulkovo Observatory and the Astronomical Institute of St Petersburg State University is aimed at investigating stellar kinematics via the three-dimensional positions and motions of stars, α, δ, π, μ_α, μ_δ and V_r, converted into the standard Galactic coordinate and velocity components, X, Y, Z, U, V and W [1].

So far the WEB catalogue [2] as well as the catalogue by Barbier-Brossat and Figon (BBF) [3] have been the largest compilations of radial velocities. They include about 20 000 stars for which the accuracy of V_r is better than 5 km s^{-1}. Many observed V_r values have been published since these compilations, *e.g.* for about 140 00 main sequence stars of the Geneva–Copenhagen survey of the Solar neighbourhood (GCS) [4] and about 6000 K and M giants (KMG) [5] (both surveys were made with CORAVEL), as well as hundreds of other publications. Therefore, a new compilation of V_r is timely. This is presented here as the Pulkovo Compilation of Radial Velocities (PCRV) catalogue of 35 495 Hipparcos stars of various spectral types and luminosity classes over the whole celestial sphere mainly within the radius of 500 pc from the Sun. Some kinematics studies made with the PCRV together with α, δ, π, μ_α, μ_δ and other data in the framework of the OSACA project have been presented elsewhere e.g. the major galactic structures within 400 pc (the Local Bubble, Great Tunnel and Gould Belt)

*Email: georgegontcharov@yahoo.com

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containing stars of various ages up to gigayears seem to be formed not earlier than 20 Myears ago in some processes related to Orion and Sirius streams [6]; the Ogorodnikov–Milne model applied to our data shows noticeable distinctions in the kinematics of the nearby single and non-single main sequence stars [7].

In theory, the systematic errors in the modern absolute V_r measurements being less than a few kilometres per second in amplitude [8], should depend on the colour index and V_r itself, the celestial coordinates. In practice, such dependences have been found in the differences of V_r of some standard stars in the form of 'new observations minus known V_r'. For decades the IAU list of standard stars lost newly discovered spectroscopic binaries. Finally, our comparison of recent re-observations leaves only 155 IAU standard stars with V_r constant within 0.3 km s^{-1}. Of course, these stars neither cover the sky evenly nor represent major spectral types and luminosity classes.

Only WEB, BBF, GCS, KMG and another eight publications presented in table 1 contain sufficient results of the observations of standard stars that the systematic errors in the publications can be evaluated and accounted for. These 12 publications provide about 80% of the data used in the PCRV. The table lists the following: identification of the publication; N, the number of stars used in the PCRV; n, the number of standard stars; ΔV_r (km s^{-1}), the mean difference of V_r of the standard stars in the form of 'new observations minus known V_r', which should be considered as zero-point mismatch; σ (km s^{-1}), the standard deviation of the differences, which can be considered as an estimation of the mean accuracy of the published value; σ' (km s^{-1}), the value of σ after accounting for the systematic dependences of the V_r differences on some parameters.

We have considered the dependences on the equatorial and Galactic coordinates, parallax, magnitude of V, colour index $B - V$ taken from the *Hipparcos and Tycho Catalogues* [16] as well as $v \sin i$, [Fe/H], age, $T_{\rm eff}$ and some indices taken from the GCS, V_r and absolute magnitude M_V calculated from the Hipparcos data with extinction calculated from [17]. Some small dependences on $v \sin i$, [Fe/H] and age cannot be taken into account because these parameters were not known for all the stars. Also strong correlations have been found between various colour indices and $T_{\rm eff}$. Moreover, they correlate with M_V if the publication contains main sequence stars or red giants only. Finally, we have approximated and taken into account the dependences on V_r, $B - V$, α and δ (although no noticeable dependences were recorded in WEB, BBF and KMG). Some systematic dependences on V_r, $B - V$ and α, which were found to be similar for GCS and red giants by CORAVEL [10], have been presented elsewhere [18]. The dependences of the difference of V_r of the standard stars in the form of 'new observations minus known V_r' for some other mentioned publications are shown in figure 1: on δ for

Table 1. Major V_r publications with a sufficient number of IAU standard stars.

Publication	N	n	ΔV_r	σ	σ'
GCS [4]	11 545	59	−0.2	0.3	0.1
WEB [2]	11 291	58	+0.3	0.9	0.9
BBF [3]	11 193	86	+0.0	1.7	1.7
KMG [5]	5 406	8	+0.0	0.2	0.2
B2–F5 stars by the Marly spectrograph [9]	2 876	9	+0.7	4.2	2.0
Red giants by CORAVEL [10]	1 414	29	−0.3	0.2	0.1
ELODIE [11]	1 248	65	+0.0	0.5	0.4
G–K stars by the coudé spectrograph at Kitt Peak [12]	1 087	11	+0.3	0.7	0.6
F–M stars by the HIRES and 'Hamilton' spectrometers [8]	849	54	+0.1	0.1	0.1
Proper motion stars by the CfA speedometers [13]	773	8	−0.2	0.5	0.2
O–B stars by the coudé spectrograph at Kitt Peak [14]	61	10	−0.6	1.2	1.0
F–M stars by the fibre-fed spectrograph at Mount John [15]	25	14	+0.1	0.2	0.1

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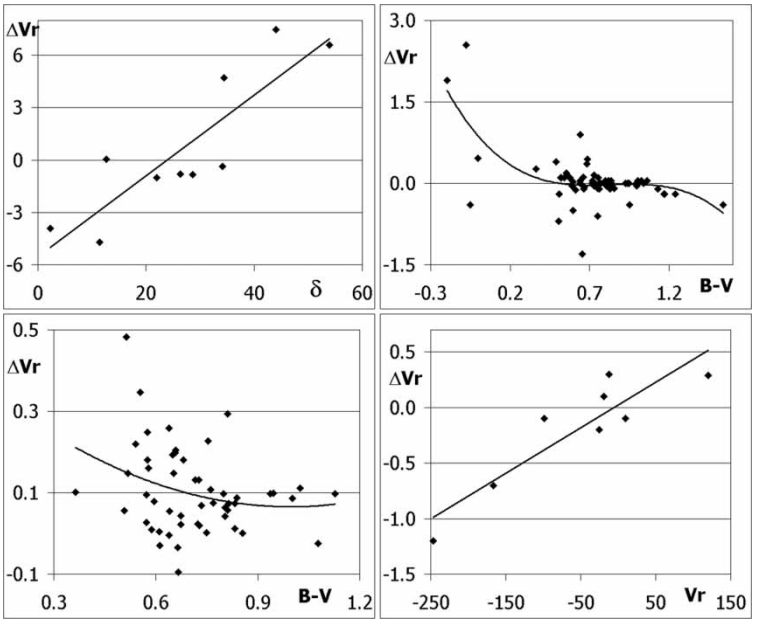

Figure 1. The difference of V_r of the standard stars in the form of 'new observations minus known V_r' versus δ for the Marly spectrograph results [9] (upper left), $B - V$ for the ELODIE results [11] (upper right), $B - V$ for the HIRES and 'Hamilton' spectrometers results [8] (lower left) and V_r for the CfA speedometer results [13] (lower right).

the Marly spectrograph, on $B - V$ for ELODIE, on $B - V$ for the HIRES and 'Hamilton' spectrometers and on V_r for the CfA speedometers.

After accounting for the dependences these publications have been used to form a working list of 1128 secondary standard stars. The selection criteria are as follows: the stars are presented in at least three of the publications; the accuracy of the mean weighted V_r is less than $1\,\mathrm{km\,s^{-1}}$; the scatter of the results in the publications is less than $3\,\mathrm{km\,s^{-1}}$; the stars do not have orbital V_r variations more than $0.5\,\mathrm{km\,s^{-1}}$ according to the SB9 catalogue [19]; the stars are not Hipparcos O, X or G binaries; the stars are not visual binaries with separation less than 20 AU according to Hipparcos. The secondary standards cover the celestial sphere much more evenly than the IAU standards. In contrast with the IAU standards, the secondaries include red dwarfs, subgiants, subdwarfs and A5V–F5V, although this gap with many fast rotators and peculiar stars is still a problem in V_r measurements. No supergiants, white dwarfs and O stars are among the secondaries. Additional standard stars are much needed.

Both 155 IAU and 1128 secondary standard stars have been used for similar processing of more 33 publications with about 13% of the data used in the PCRV. The results from another 154 'good' publications have been taken 'as is' (about 7% of the data used in the PCRV).

Finally, we have processed 60 207 mean observed V_r values of 40 825 stars. In the calculation of the mean weighted V_r values, some 5000 spectroscopic binaries without a systemic velocity appear to be problem stars. They will be processed separately.

The PCRV contains the following: the Hipparcos and the Henry Draper (HD) catalogue numbers; the mean weighted V_r and its weighted accuracy; the number of publications used; the 'external' accuracy calculated from the scatter of the results in the publications; the approximated α, δ and magnitude of V. The mean weighted accuracy of V_r is $0.7\,\mathrm{km\,s^{-1}}$.

The PCRV stars are evenly distributed over the sky, slightly dominating in the northern celestial sphere, along the Galactic equator and near the northern Galactic pole.

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Their Hertzsprung–Russell (M_V versus $B-V$) distribution is similar to those of all Hipparcos stars. About 85% of the PCRV stars are between 30 and 500 pc. Unfortunately, 24 437 stars (69%) are presented in one publication.

With the increasing number of current V_r measurements we intend to provide a permanent collection and recompilation of them within the framework of the OSACA project. Everyone is welcome to supply results of V_r observations as well as to use the mean weighted results. Consequently some new versions of the PCRV will be produced in future. The version of 15 May 2006 is presented here.

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