FK5-HIPPARCOS: SYSTEMATIC DIFFERENCES WITHOUT ASSUMPTION OF RIGID MUTUAL ROTATION OF THE FRAMES

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ABSTRACT. The first attempt to connect the FK5 and HIPPARCOS frames resulted in deriving six parameters describing the orientation and spin of the FK5 with respect to HIPPARCOS [1]. An extensive study of the rigid body rotaion (RBR) model [2] gave evidence that this model is not compatible with the real differences FK5-HIPPARCOS.

In 2000, Mignard et al.,[3] published tables of the differences FK5-HIPPARCOS smoothed out over the areas of about 230 square degrees. Thus obtained differences include the overall rotation and spin. On the contrary, H. Schwan [4] used strict analytical representation of the differences FK5-HIPPARCOS but eliminated the global rotation and spin from initial data. Both approaches are not free from drawbacks: in case [3] one has not good representation of good data, in case [4] – one has good representation of not good data.

To our mind, to connect the FK5 and HIPPARCOS correctly the RBR model must be discarded. In our paper we present the approximation of systematic differences FK5-HIPPARCOS over a set of orthogonal functions "Legendre-Hermite-Fourier" [5]. No RBR correction were applied to initial differences.

1. RESULTS

We have calculated the differences FK5-HIPPARCOS for positions and proper motions of 1232 stars at the epoch 1991.25 and decomposed them on products of Legendre, Hermite, Fourier polynomials. The coefficients of decomposition (B_j) are given in table 1, where j, p, n, k, l - indexes of decomposition (limiting values p=2, n=10, k=6). The separation of noise from systematic component was made with the probability more than 0.95. The magnitude equation was determined reliably only for $\Delta\alpha\cos\delta$ – (7 harmonics) and for $\Delta\mu_\alpha\cos\delta$ – (2 harmonics). Using our coefficients we calculated the systematic differences for all 1232 selected stars of the FK5.

Analyzing the systematic differences of declinations of stars of FK5 and HIPPARCOS catalogues, we can conclude that equatorial plane of FK5 constitutes a small circle parallel to equator of HIPPARCOS catalogue and displaced by 49.23 ± 2.23 mas in direction to the North Pole. This fact was first stated in [3], the value of displacement being estimated to be ≈ 60 mas. The method of orthogonal decomposition, we used, confirms this estimate.

Table 1: Analytical representation of the FK5-HIPPARCOS systematic difference

Right ascension. Units [mas]																		
j	p	n	k	l	B_j	σ_{B_j}	j	p	n	k	l	B_j	σ_{B_j}	j	p	n	k	l	B_j	σ_{B_j}
1	0	2	0	-1	-25.78	1.99	12	0	5	2	1	-6.72	1.89	23	0	8	4	-1	5.14	1.93
2	0	3	0	-1	21.90	1.93	13	0	7	2	-1	7.33	1.88	24	0	3	5	1	-5.85	1.87
3	0	4	0	-1	-17.87	1.89	14	0	0	3	1	6.33	2.08	25	0	0	6	-1	4.87	2.02
4	0	7	0	-1	-6.13	1.95	15	0	1	3	-1	-8.44	1.96	26	0	2	6	-1	5.79	1.89
5	0	0	1	-1	-16.56	2.03	16	0	1	3	1	-3.57	2.00	27	1	5	0	-1	-10.60	2.11
6	0	1	1	-1	-7.20	2.01	17	0	3	3	1	-8.27	1.96	28	1	6	0	-1	4.95	2.18
7	0	2	1	-1	24.15	1.98	18	0	0	4	-1	-13.21	2.06	29	1	3	1	1	7.14	2.34
8	0	7	1	-1	-6.21	1.88	19	0	1	4	1	8.75	1.95	30	1	7	1	1	4.20	2.23
9	0	7	1	1	6.29	1.94	20	0	3	4	-1	-4.83	1.93	31	1	5	3	1	-4.41	2.41
10	0	0	2	1	11.54	2.13	21	0	4	4	-1	8.79	2.04	32	2	7	4	-1	14.34	4.75
11	0	2	2	1	-7.58	2.03	22	0	5	4	1	-5.79	1.88	33	2	6	5	-1	12.92	4.95
Declination. Units [mas]																		
j	p	n	k	l	B_j	σ_{B_j}	j	p	n	k	l	B_j	σ_{B_j}	j	p	n	k	l	B_j	σ_{B_j}
1	0	0	0	-1	-49.23	2.23	8	0	9	0	-1	10.92	2.02	15	0	5	1	1	6.22	2.07
2	0	1	0	-1	29.74	2.19	9	0	0	1	-1	-17.85	2.23	16	0	0	2	1	-8.04	2.23
3	0	2	0	-1	18.42	2.06	10	0	0	1	1	16.11	2.24	17	0	2	2	1	6.47	2.07
4	0	3	0	-1	-6.92	2.10	11	0	2	1	-1	5.88	2.10	18	0	7	2	1	6.97	2.05
5	0	5	0	-1	-22.36	2.12	12	0	2	1	1	-6.55	2.05	19	0	2	4	-1	7.03	2.10
6	0	7	0	-1	5.90	2.08	13	0	3	1	1	5.58	2.09	20	0	0	6	1	6.16	2.27
7	0	8	0	-1	-6.40	2.05	14	0	4	1	-1	5.16	2.00							
Proper motion in right ascension. Units [mas/y]																		
j	p	n	k	l	B_j	σ_{B_j}	j	p	n	k	l	B_j	σ_{B_j}	j	p	n	k	l	B_j	σ_{B_j}
1	0	0	0	-1	0.46	0.08	7	0	0	1	1	0.24	0.08	13	0	3	5	1	-0.24	0.07
2	0	2	0	-1	-0.67	0.08	8	0	1	1	-1	-0.46	0.08	14	0	9	5	-1	-0.18	0.07
3	0	3	0	-1	0.79	0.07	9	0	2	1	-1	0.41	0.07	15	1	5	0	-1	-0.25	0.08
4	0	4	0	-1	-0.68	0.07	10	0	0	3	-1	0.24	0.08	16	1	3	1	1	0.30	0.09
5	0	6	0	-1	-0.23	0.07	11	0	0	3	1	0.23	0.08							
6	0	7	0	-1	-0.16	0.07	12	0	8	4	-1	0.18	0.08							
Proper motion in declination. Units [mas/y]																		
j	p	n	k	l	B_j	σ_{B_j}	j	p	n	k	l	B_j	σ_{B_j}	j	p	n	k	l	B_j	σ_{B_j}
1	0	0	0	-1	-0.32	0.07	4	0	5	0	-1	-0.53	0.07	7	0	0	1	-1	-0.40	0.07
2	0	1	0	-1	0.50	0.07	5	0	8	0	-1	-0.18	0.07	8	0	0	1	1	-0.30	0.07
3	0	4	0	-1	0.29	0.07	6	0	9	0	-1	0.20	0.06	9	0	2	1	1	-0.28	0.07

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