ON THE ACCURACY OF GAIA PHOTOMETRY

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Abstract. The errors of *Gaia* photometry originating from tolerances of the light filter mean wavelengths and half-widths are investigated.

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The *Gaia* medium-band photometric system (MBP) will play a major role in determination of the astrophysical parameters for about a billion of stars in our Galaxy. Since the variation of the filter characteristics (the central wavelength λ_0 and the bandwidth $\Delta\lambda$) across the filter area are expected to be one of the main sources of the final photometric errors, two questions are of extreme importance for the filter design: (a) how large photometric errors are expected in the case of the λ_0 and $\Delta\lambda$ tolerances of 2 nm?; (b) how small should be the filter transmittance tolerances, in order to achieve the millimagnitude accuracy level.

Using the software TFCalc we have designed two filters: F390 and F510 ($\lambda_0 = 390$ and 510 nm, $\Delta\lambda = 10$ nm). Their transmittance curves are similar to the 3X filters of the *Gaia* MBP system (Vansevičius, in preparation). Photometric observations were modeled by using BaSeL 2.2 (Lejeune et al. 1998) synthetic stellar spectra ($[M/H] = 0, -1, -2$; $2\,000 \leq T_{\text{eff}} \leq 50\,000$ K; $-1 \leq \log g \leq 5$). Modeling was performed using the standard ($\delta\lambda_0 = \delta(\Delta\lambda) = 0$) and the modified ($\delta\lambda_0, \delta(\Delta\lambda) = 0.5, 1, 1.5, 2$ nm) filter transmittance curves.

The instrumental magnitudes were converted to the standard system iteratively by equations of the type: $m_{\text{std}} = a + b \cdot m_{\text{instr}} + c \cdot (B - V)$.

The main results obtained for the filter F390 (errors for the filter F510 are slightly smaller) are shown in Figure 1 and may be summarized as follows: (a) a millimagnitude level photometric accuracy cannot be achieved when the filter transmittance curve tolerances $\delta\lambda_0$ and $\delta(\Delta\lambda)$ of 2 nm are assumed; (b) the filter transmittance curve tolerances $\delta\lambda_0$ and $\delta(\Delta\lambda)$ of ~ 0.5 nm and ~ 1 nm, respectively, are the upper allowed limits in order to achieve the millimagnitude photometric accuracy; (c) the required tolerances for the *Gaia* MBP filters may be slightly increased if the MBP bands in transformation color equations are used (see Kazlauskas et al. 2002).

Fig. 1. Accuracy of the magnitude F390 versus effective temperature. Transformation to the standard system were based on the following stars: all stars (squares); dwarfs (circles); giants (triangles up); supergiants (triangles down). $\delta\lambda_0$ and $\delta(\Delta\lambda)$ are 2 nm (left panel) and 0.5 nm (right panel).

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