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BEPI-COLOMBO filters (using zeros)

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Abstract

Key words: spectral libraries — flux calibration — filters

1 Filter profiles

The filter profiles are shown in Fig. 1.

2 Determination of AB magnitudes

AB magnitudes were obtained by integrating over the spectra convolved with the filter response. Two codes were used for obtaining and testing the magnitudes: the pyphot code by Dr. Feausneau and Maria's IDL code.

By definition

$$mag_{AB} = -2.5log_{10}(\bar{f_\nu}) - 48.60 \quad (1)$$

2.1 Calculation in IDL

AB magnitudes were obtained by integrating over the spectra convolved with the filter response.

By definition

$$mag_{AB} = -2.5log_{10}(\bar{f_\nu}) - 48.60 \quad (2)$$

In the IDL code the formulation by Bessell & Murphy (2012) was implemented.

$$mag_{AB} = -2.5log_{10}\frac{\int f_\lambda(\lambda)S(\lambda)\lambda\delta\lambda}{\int S(\lambda)c\delta\lambda/\lambda} - 48.60 \quad (3)$$

$f_\lambda(\lambda)$ is in erg cm^{-2} s^{-1} Å^{-1}, λ is in Å, and the light speed c is in Å s^{-1}

The integration is performed with the trapezoidal method in IDL.

2.2 pyphot code

The AB magnitudes are obtained using the formulation by Koornneef et al. (pythot link).

$$mag_{AB} = -2.5log_{10}(\bar{f_\lambda}) - 2.5log_{10}(\lambda_p^2/c) - 48.60 \quad (4)$$

$$\bar{f_\lambda} = \frac{\int f_\lambda(\lambda)S(\lambda)\lambda\delta\lambda}{\int S(\lambda)\lambda\delta\lambda} \quad (5)$$

$$\lambda_p^2 = \frac{\int S(\lambda)\lambda\delta\lambda}{\int S(\lambda)\delta\lambda/\lambda} \quad (6)$$

The speed of light c and λ_p must be expressed in matching units. The program pyphot is able to automatically transform the units, as long as they are indicated.

λ is the wavelength, $f_\lambda(\lambda)$ is the observed flux density, and $S(\lambda)$ is the photonic passband (response function).

The integration is performed with the numpy trapz (np.trapz) function.

3 Datasets

The synthetic magnitudes were measured on a subsample of 133 SPSSv3.4 stars, results are in Figs. 2 and 3.

The 61 PVL stars are shown in Figs. 4 and 5.

The CALSPEC stars are shown in Figs. 6 and 7.

3.1 Code differences

Using the 133 SPSSv3.4 stars and the results from python and IDL, the measured differences are listed in Table 1.

For the PVL, 62 stars are used and the differences are in Table 2.

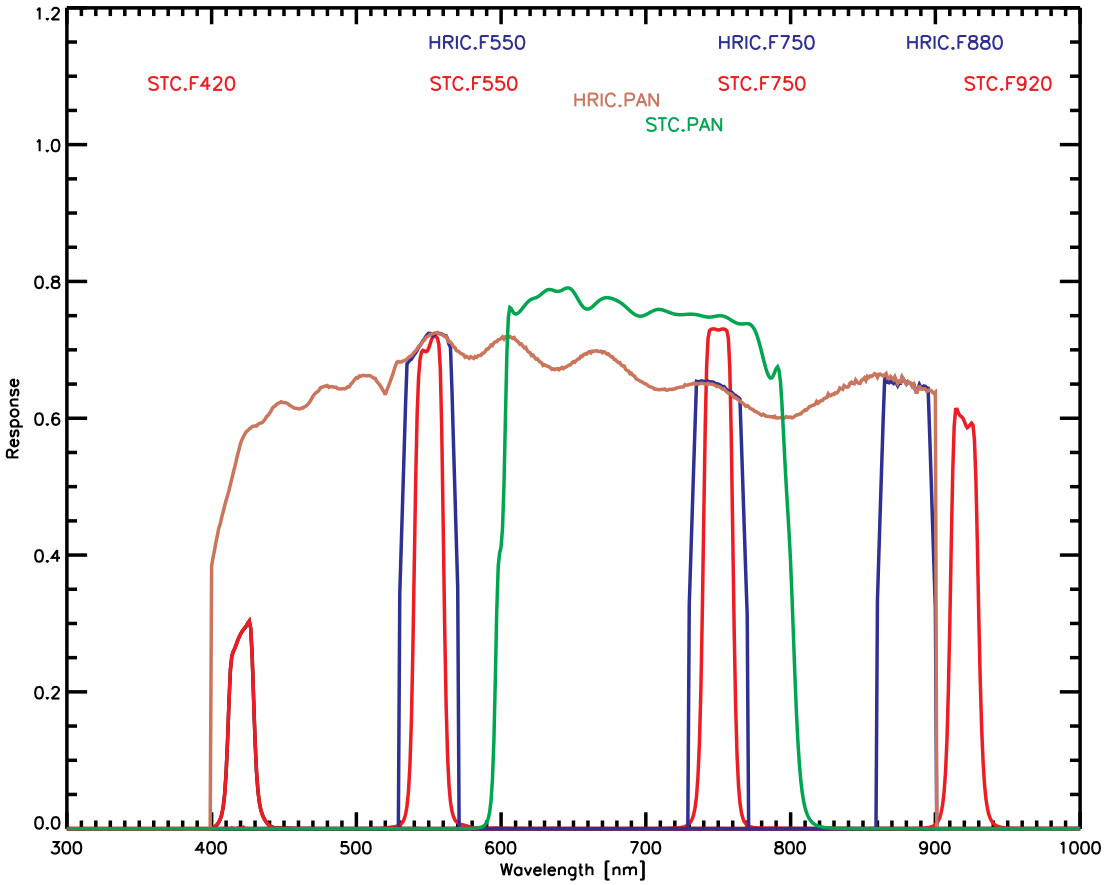

Fig. 1. BEPI-COLOMBO filter profiles.

For the CALSPEC, the differences are listed in Table 4. Now, the table looks nice; the problem was coming from some negative fluxes present in some spectra. A python script was made to counts exactly the number of negative numbers. The following spectra were removed 2MASSJ00361617+1821104, ;ok 31, ¿ 5000 2MASSJ05591914-1404488, ;ok 203 negative, ¿ 5000 hz43b8, and ;ok, ¿ 5000 VB8. ;ok 71 negative Three spectra starting at wave > 500 nm and one with 71 negative points in the blue side (VB8). ;BD-11_3759, ;ok 7 negative ;2MASSJ17583798+6646522, ; 4 negative, but not in range ;SF1615+001A, ; 9 negative, but not in range ;WD1057+719, ; fits ok, weird rebin figure ;LDS749B. ; fits ok, weird rebin figure Now, only 103 CALSPEC spectra are used, and 98 of them have BP/RP spectra.

Two changes were implemented:

- Added a dot in the HRIC-PAN filter.
- The codes was modified to consider flux > 0 (rather than flux ! = 0).
- Four CALSPEC spectra were removed.

Table 1. SPSSv3.4: Differences between the magnitudes from the IDL code and those from the python code.

Δ	mean	sigma
H550mag_idl-H550mag_py	3.8720611e-06	2.7911181e-05
H750mag_idl-H750mag_py	-1.3695624e-06	2.9024191e-05
H880mag_idl-H880mag_py	4.6751553e-06	3.0232872e-05
Hpanmag_idl-Hpanmag_py	3.3199339e-06	3.0651081e-05
S420mag_idl-S420mag_py	1.4627787e-06	2.7303664e-05
S550mag_idl-S550mag_py	7.4142800e-06	3.0941043e-05
S750mag_idl-S750mag_py	3.3414453e-06	2.8009717e-05
S920mag_idl-S920mag_py	2.3555039e-06	2.9032638e-05
Spanmag_idl-Spanmag_py	2.3375776e-06	2.9760063e-05

sectionReferences

Bessell, M. & Murphy, S. 2012, PASP, 124, 140

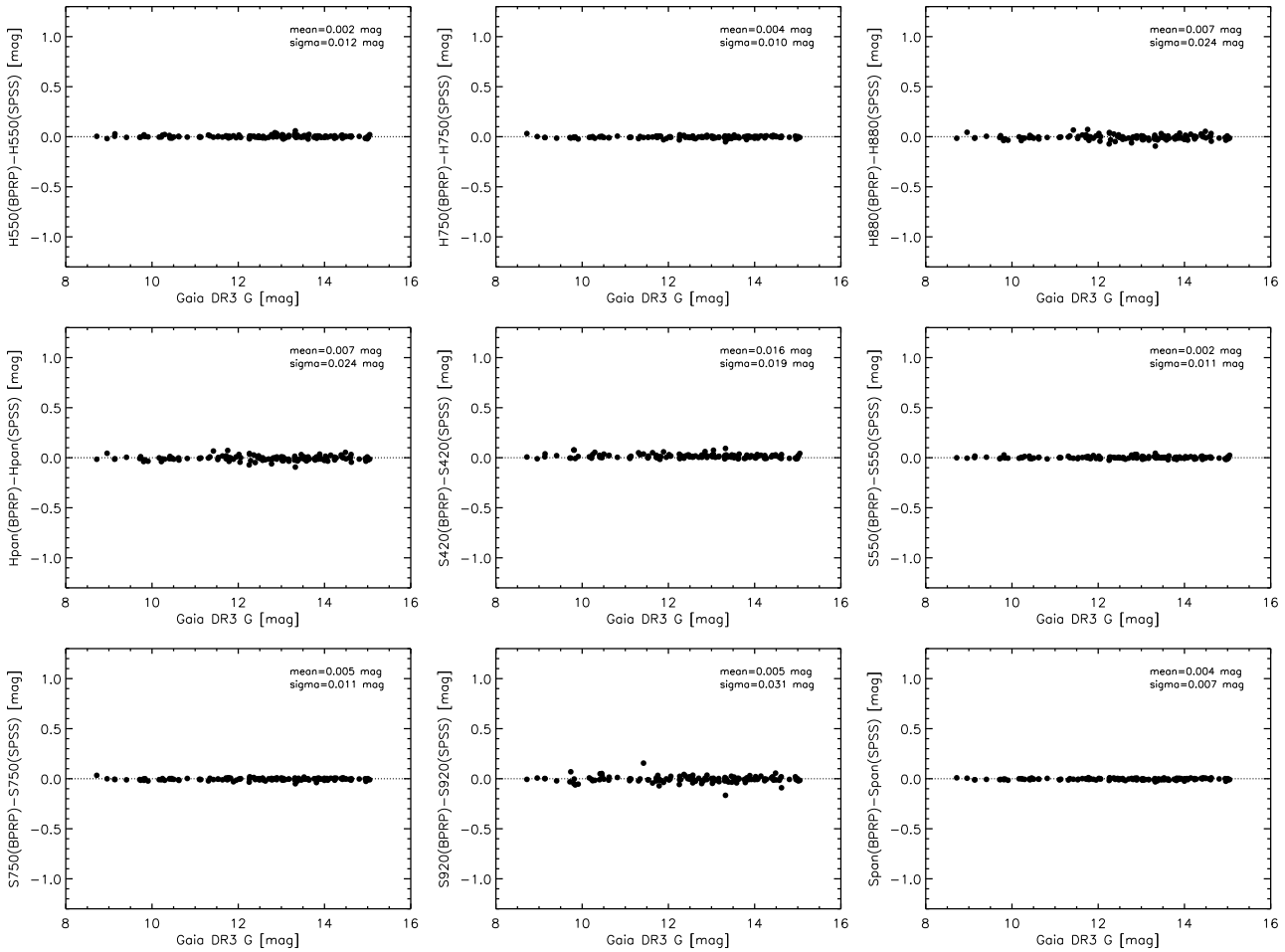

Fig. 2. Synth_mag(BPRP)-Synth_mag(SPSSv3.4) vs. G magnitudes.

Table 2. PVL: Differences between the magnitudes from the IDL code and those from the python code.

Δ	mean	sigma
H550mag_idl-H550mag_py	5.7142289e-06	3.0973316e-05
H750mag_idl-H750mag_py	-1.6884726e-06	2.4715253e-05
H880mag_idl-H880mag_py	5.2217577e-06	2.9494788e-05
Hpanmag_idl-Hpanmag_py	-3.2987751e-06	2.7367614e-05
S420mag_idl-S420mag_py	1.9229826e-06	2.9486762e-05
S550mag_idl-S550mag_py	1.4539625e-06	2.7562181e-05
S750mag_idl-S750mag_py	6.0972620e-07	3.0204931e-05
S920mag_idl-S920mag_py	-2.3685518e-06	2.7386809e-05
Spanmag_idl-Spanmag_py	7.5746755e-06	2.9346748e-05

Table 3. CALSPEC good (now): Differences between the magnitudes from the IDL code and those from the python code.

Δ	mean	sigma
H550mag_idl-H550mag_py	1.1121185e-05	2.9679948e-05
H750mag_idl-H750mag_py	1.2823679e-06	2.7006031e-05
H880mag_idl-H880mag_py	-2.5994569e-06	4.1560965e-05
Hpanmag_idl-Hpanmag_py	-6.4581343e-06	7.9265793e-05
S420mag_idl-S420mag_py	4.6966145e-06	2.7334101e-05
S550mag_idl-S550mag_py	5.7579244e-06	2.9689256e-05
S750mag_idl-S750mag_py	2.1990063e-06	2.9840780e-05
S920mag_idl-S920mag_py	8.0159567e-06	3.1629783e-05
Spanmag_idl-Spanmag_py	9.4673009e-07	2.8698807e-05

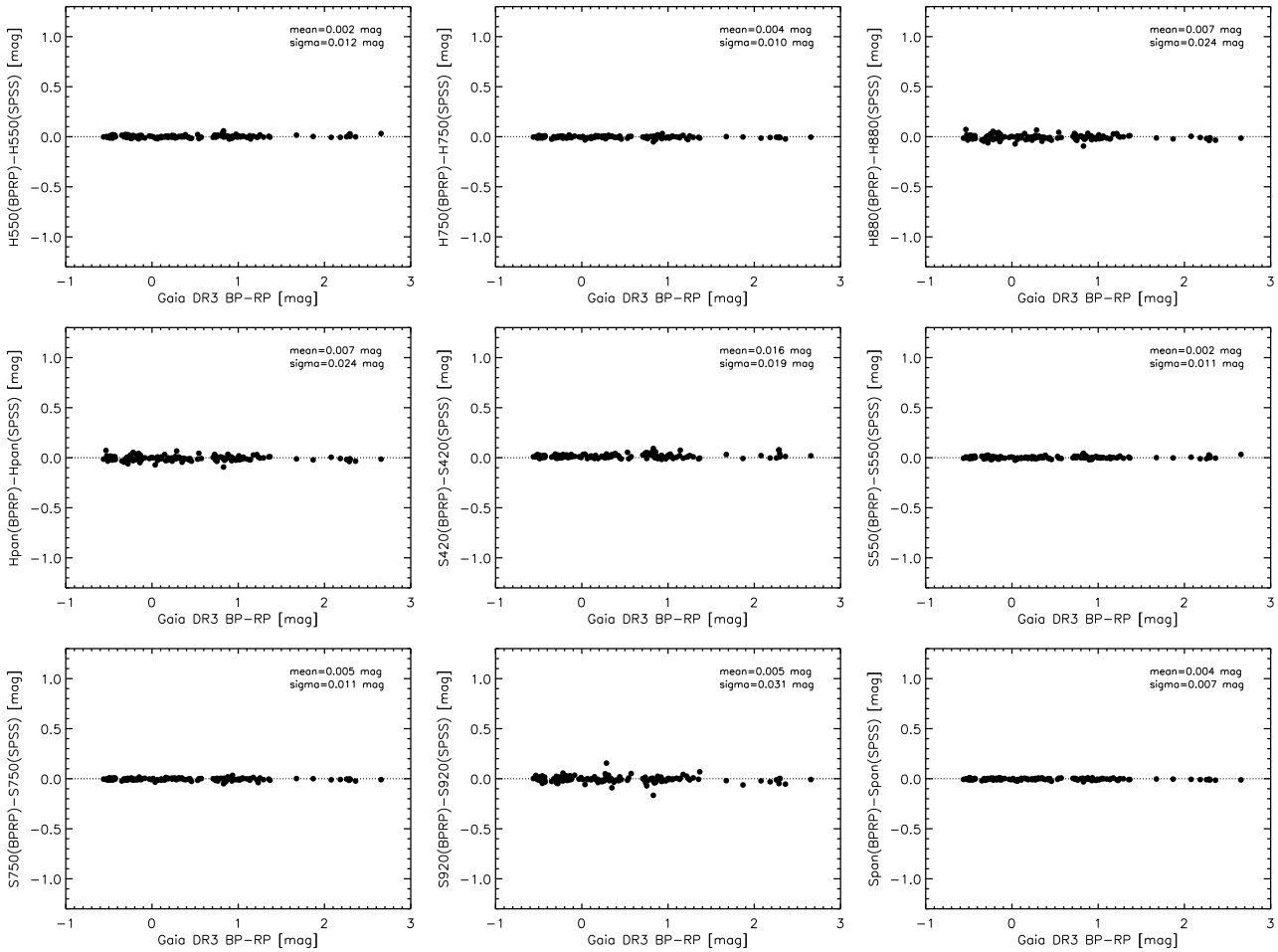

Fig. 3. Synth_mag(BPRP)-Synth_mag(SPSSv3.4) vs. BP-RP colors.

Table 4. CALSPEC wrong (15 April 2024): Differences between the magnitudes from the IDL code and those from the python code.

Δ	mean	sigma
H550mag_idl-H550mag_py	-0.00017976204	0.0017897086
H750mag_idl-H750mag_py	1.4483372e-06	2.6841885e-05
H880mag_idl-H880mag_py	-2.3775012e-06	4.1028370e-05
Hpanmag_idl-Hpanmag_py	-0.0061440468	0.036308337
S420mag_idl-S420mag_py	-0.027143298	0.16059711
S550mag_idl-S550mag_py	-6.7927013e-06	8.8693805e-05
S740mag_idl-S740mag_py	-1.8115356e-05	0.00012183801
S920mag_idl-S920mag_py	6.1921984e-06	3.3495716e-05
Spanmag_idl-Spanmag_py	1.1430723e-06	2.8310121e-05

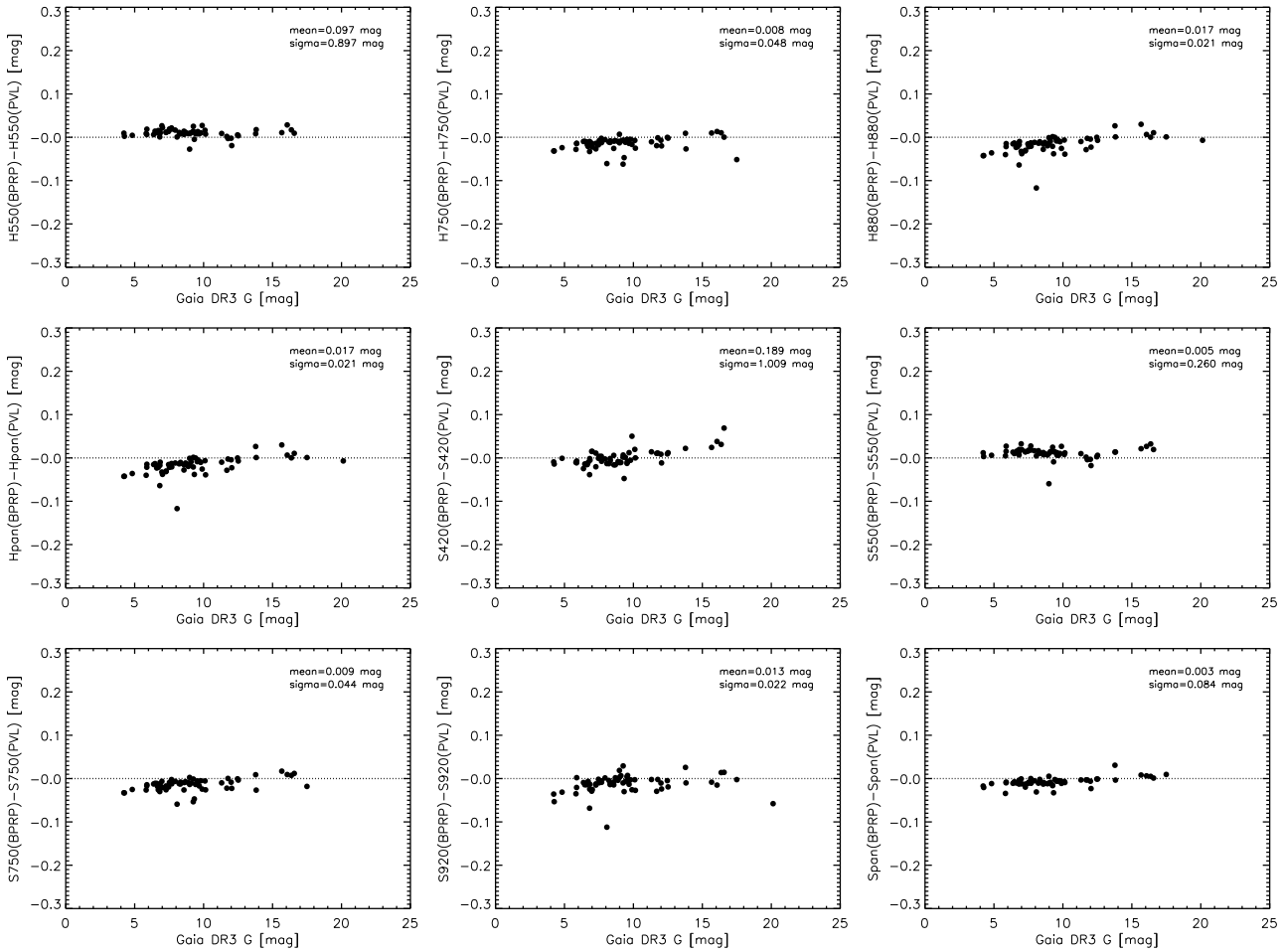

Fig. 4. Synth_mag(BPRP)-Synth_mag(PVL) vs. G magnitudes.

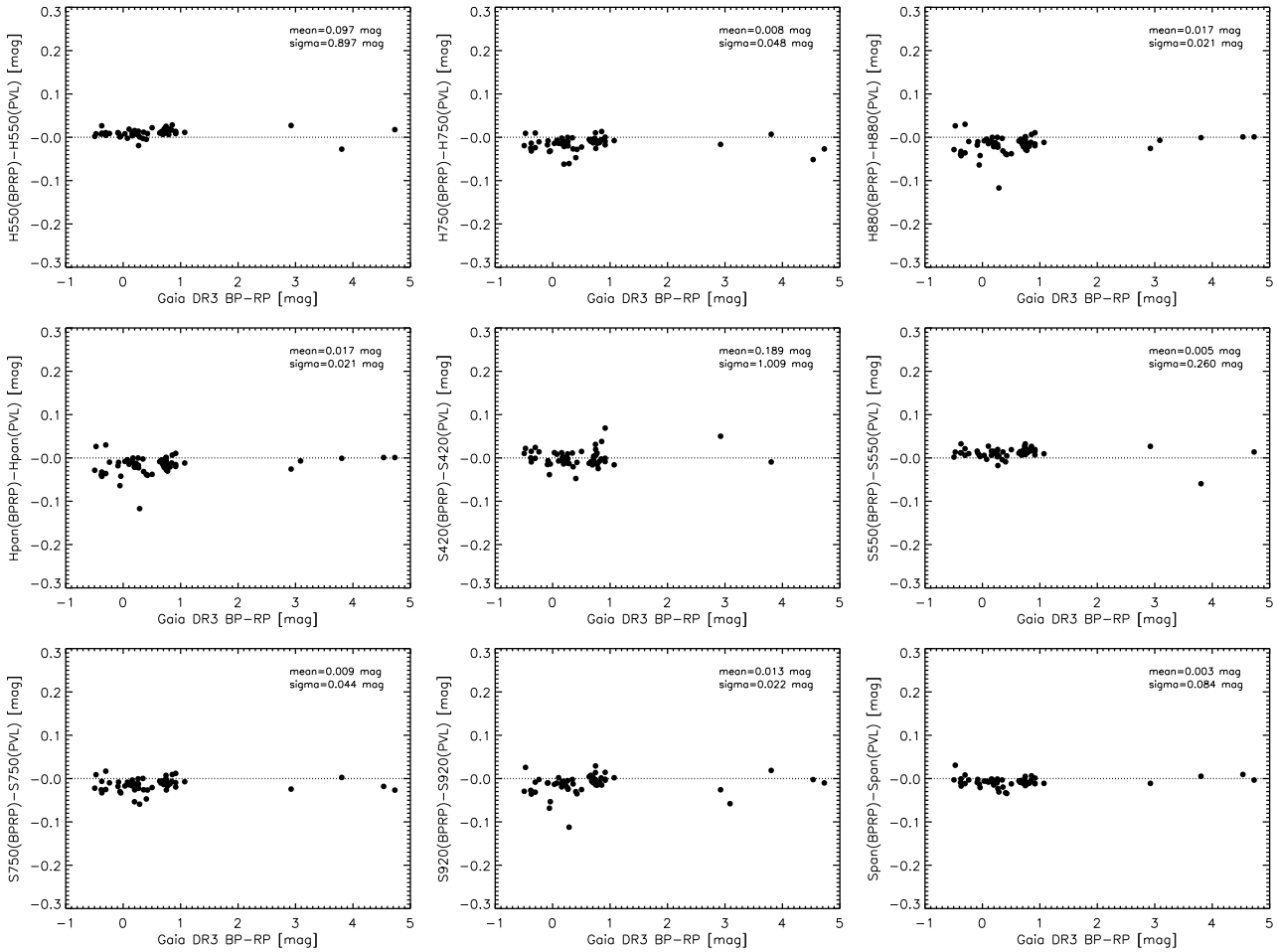

Fig. 5. Synth_mag(BPRP)-Synth_mag(PVL) vs. BP-RP colors.

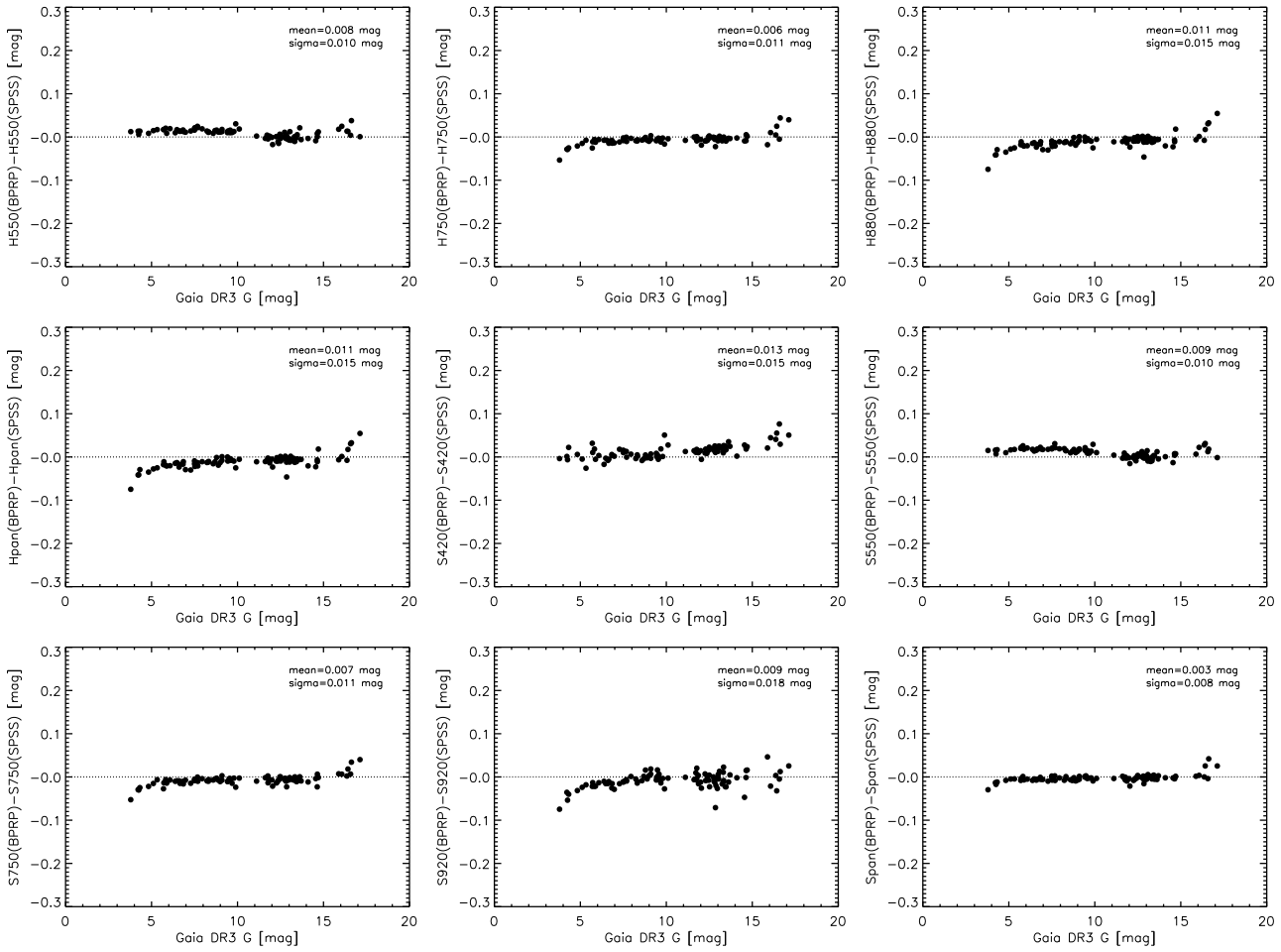

Fig. 6. Synth_mag(BPRP)-Synth_mag(CALSPEC) vs. G magnitudes.

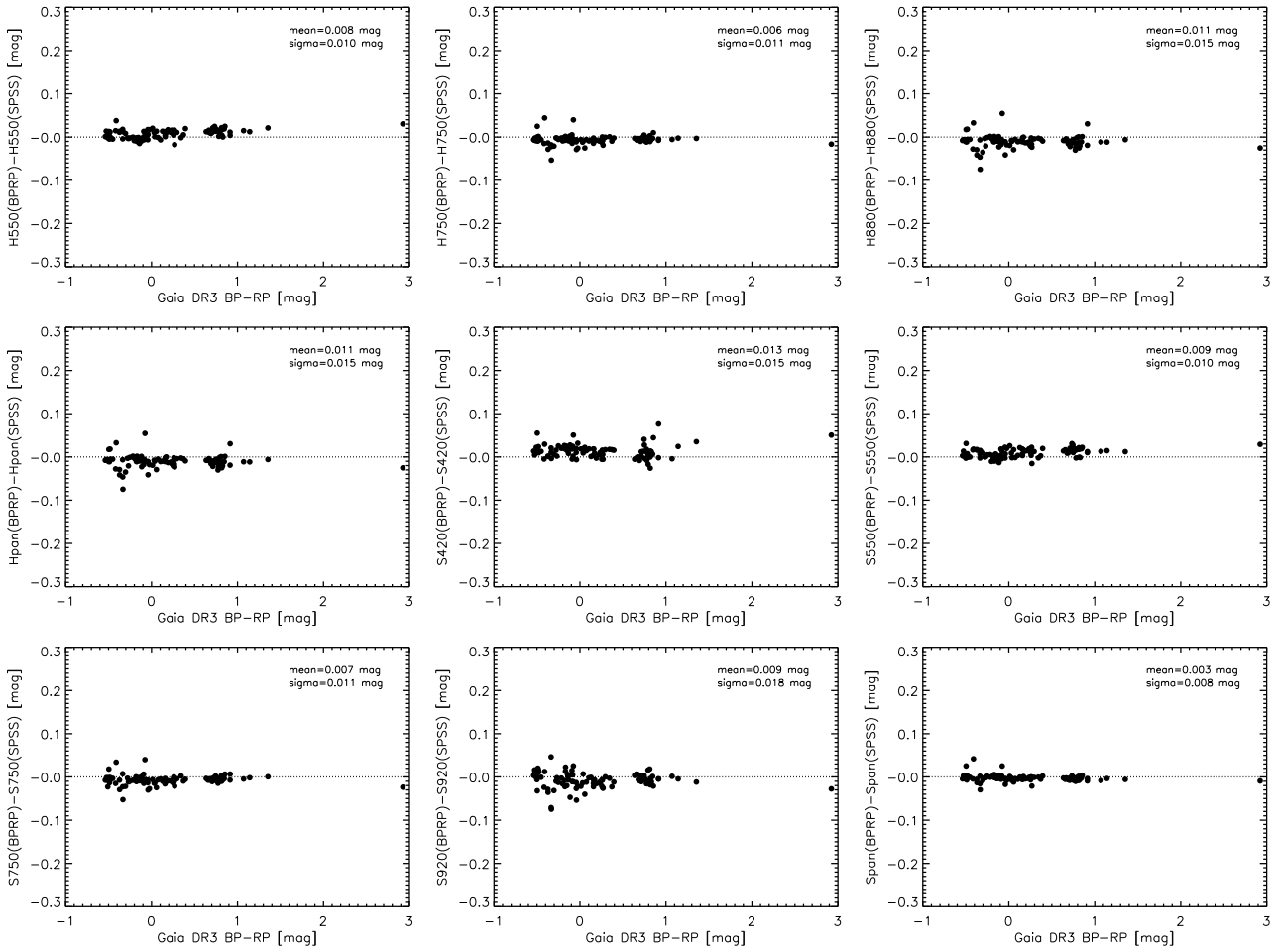

Fig. 7. Synth_mag(BPRP)-Synth_mag(CALSPEC) vs. BP-RP colors.