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BEPI-COLOMBO filters

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Abstract

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1 Filter profiles

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 pyphot code

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

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

$$\bar{f_\lambda} = \frac{\int f_\lambda(\lambda)S(\lambda)\lambda\delta\lambda}{\int S(\lambda)\lambda\delta\lambda} \quad (3)$$

$$\lambda_p^2 = \frac{\int S(\lambda)\lambda\delta\lambda}{\int S(\lambda)\delta\lambda/\lambda} \quad (4)$$

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.

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

Δ	mean	sigma
H550mag_idl-H550mag_py	-4.61923e-05	0.000332099
H750mag_idl-H750mag_py	-1.63057e-05	0.000117897
H880mag_idl-H880mag_py	-3.74550e-05	0.000168548
Hpanmag_idl-Hpanmag_py	3.58524e-06	3.51273e-05
S420mag_idl-S420mag_py	-0.000638058	0.00197576
S550mag_idl-S550mag_py	-1.75462e-05	0.000270972
S740mag_idl-S740mag_py	-2.85744e-05	0.000216341
S920mag_idl-S920mag_py	-0.00528677	**0.0135041**
Spanmag_idl-Spanmag_py	7.57920e-06	0.000156828

2.2 Maria's IDL code

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

$$mag_{AB} = -2.5log_{10}\frac{\int f_\lambda(\lambda)S(\lambda)\lambda\delta\lambda}{\int S(\lambda)c\delta\lambda/\lambda} - 48.60 \quad (5)$$

$f_\lambda(\lambda)$ 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, see Fig. 2.

2.3 Code differences

Using the 133 SPSSv3.3 stars and the results from python and IDL, the measured differences are listed in Table 1.

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Fig. 1. BEPI-COLOMBO filter profiles.

3 Datasets

The synthetic magnitudes were measured on a subsample of 133 SPSSv3.3 stars and are shown in Figs. 3 and 4. For the SPSSv3.4, results are in Figs. 5 and 6.

For the 256 selected NGSL stars, the synthetic magnitudes are plotted in Figs. 7 and 8.

The 61 PVL stars are shown in Figs. 9 and 10.

The CALSPEC stars are shown in Figs. 11 and 12.

section**References**

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

```
bin=dblarr(n_elements(wave))

for jj=1L, n_elements(wave)-2 do begin
  bin[jj]=(wave[jj+1]-wave[jj])
  funcH550[jj]=((flux[jj+1]*restransH550[jj+1]*wave[jj+1])+(flux[jj]*restransH550[jj]*wave[jj]))*0.5
  funcH750[jj]=((flux[jj+1]*restransH750[jj+1]*wave[jj+1])+(flux[jj]*restransH750[jj]*wave[jj]))*0.5
  funcH880[jj]=((flux[jj+1]*restransH880[jj+1]*wave[jj+1])+(flux[jj]*restransH880[jj]*wave[jj]))*0.5
  funcHpan[jj]=((flux[jj+1]*restransHpan[jj+1]*wave[jj+1])+(flux[jj]*restransHpan[jj]*wave[jj]))*0.5
  funcS420[jj]=((flux[jj+1]*restransS420[jj+1]*wave[jj+1])+(flux[jj]*restransS420[jj]*wave[jj]))*0.5
  funcS550[jj]=((flux[jj+1]*restransS550[jj+1]*wave[jj+1])+(flux[jj]*restransS550[jj]*wave[jj]))*0.5
  funcS740[jj]=((flux[jj+1]*restransS740[jj+1]*wave[jj+1])+(flux[jj]*restransS740[jj]*wave[jj]))*0.5
  funcS920[jj]=((flux[jj+1]*restransS920[jj+1]*wave[jj+1])+(flux[jj]*restransS920[jj]*wave[jj]))*0.5
  funcSpan[jj]=((flux[jj+1]*restransSpan[jj+1]*wave[jj+1])+(flux[jj]*restransSpan[jj]*wave[jj]))*0.5

  denH550[jj] =((restransH550[jj+1]/wave[jj+1])+(restransH550[jj]/wave[jj]))*0.5
  denH750[jj] =((restransH750[jj+1]/wave[jj+1])+(restransH750[jj]/wave[jj]))*0.5
  denH880[jj] =((restransH880[jj+1]/wave[jj+1])+(restransH880[jj]/wave[jj]))*0.5
  denHpan[jj] =((restransHpan[jj+1]/wave[jj+1])+(restransHpan[jj]/wave[jj]))*0.5
  denS420[jj] =((restransS420[jj+1]/wave[jj+1])+(restransS420[jj]/wave[jj]))*0.5
  denS550[jj] =((restransS550[jj+1]/wave[jj+1])+(restransS550[jj]/wave[jj]))*0.5
  denS740[jj] =((restransS740[jj+1]/wave[jj+1])+(restransS740[jj]/wave[jj]))*0.5
  denS920[jj] =((restransS920[jj+1]/wave[jj+1])+(restransS920[jj]/wave[jj]))*0.5
  denSpan[jj] =((restransSpan[jj+1]/wave[jj+1])+(restransSpan[jj]/wave[jj]))*0.5
endfor
bin[0]=bin[1]
bin[n_elements(wave)-1]=bin[n_elements(wave)-2]


totH550=total(funcH550*bin, /NaN)                          ; erg/(s*cm2*A) *nm *nm = erg/(s*cm2*A) *nm^2
tot_denH550=total(denH550*bin,1, /NaN)*light                          ; (1/nm)*nm * nm/s= nm/s
H550mag=-2.5d0*alog10(totH550/tot_denH550*10.0d0*1e20)+ZP+2.5d0*20d0      ; erg/(cm2/A)*A

totH750=total(funcH750*bin, /NaN)         ;
tot_denH750=total(denH750*bin,1, /NaN)*light ;
H750mag=-2.5d0*alog10(totH750/tot_denH750*10.0d0*1e20)+ZP+2.5d0*20d0
```

Fig. 2. Trapezoidal integration in the IDL code.

Fig. 3. Synth_mag(BPRP)-Synth_mag(SPSSv3.3) vs. G magnitudes.

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

Fig. 5. Synth_mag(BPRP)-Synth_mag(SPSSv3.4) vs. G magnitudes.

Fig. 6. Synth_mag(BPRP)-Synth_mag(SPSSv3.4) vs. BP-RP colors.

Fig. 7. Synth_mag(BPRP)-Synth_mag(NGSL) vs. G magnitudes.

Fig. 8. Synth_mag(BPRP)-Synth_mag(NGSL) vs. BP-RP colors.

Fig. 9. Synth_mag(BPRP)-Synth_mag(PVL) vs. G magnitudes.

Fig. 10. Synth_mag(BPRP)-Synth_mag(PVL) vs. BP-RP colors.

Fig. 11. Synth_mag(BPRP)-Synth_mag(CALSPEC) vs. G magnitudes.

Fig. 12. Synth_mag(BPRP)-Synth_mag(CALSPEC) vs. BP-RP colors.