Zero magnitude conversion for the PACS Photometer

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1 Introduction

There are potential scientific applications, in which a conversion from monochromatic flux densities to a magnitude system would be desirable. Like in previous far-infrared (FIR) missions, this can be done by using a theoretical photospheric model spectrum of Vega (Cohen et al. 1992; Rieke et al. 2008). From this, one can extract the flux densities at 70, 100 and 160 μm and define them as 0 mag. Different approaches for deriving model fluxes have been used in the literature. For a general discussion on zero points, see Glass (1999).

2 Stellar model

We employed the framework of the ISOPHOT (Lemke et al. 1993) zero point calibration programme[1] that used a theoretical model spectrum of Vega, based on a Kurucz 1993 model spectrum of an A0 star with properties $T_{\rm eff}$ = 9400 K, $\log g = 3.9$, $\log z = -0.5$. The total uncertainty was specified to amount to 1.46%. The model spectrum was extrapolated into the FIR range (Cohen et al. 1992, 1995). Later, Rieke et al. (2008) re-investigated this approach with slightly different stellar parameters. Especially in the IR, the differences are insignificant. This latter analysis was restricted to the spectral range up to $\lambda = 30\,\mu$m. When extapolating these data to the FIR via fitting a suitable black-body SED, the results are comparable to those of Cohen et al. (1992, 1995) and Laureijs et al. (2003).

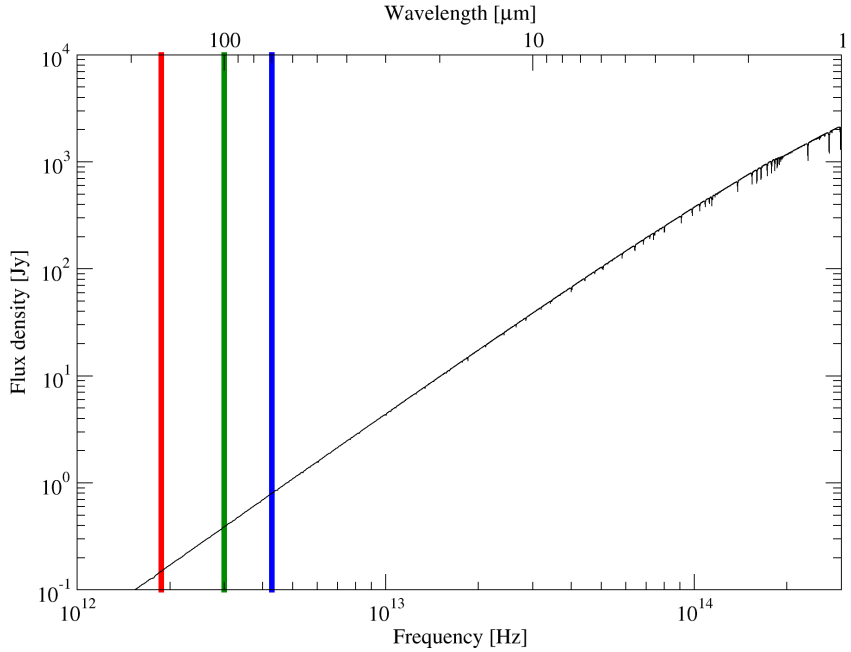

Figure 1: Theoretical photospheric spectrum of Vega derived from a Kurucz model of an A0V star with $T_{\rm eff}$ = 9400 K, $\log g = 3.9$, $\log z = -0.5$ (Laureijs et al. 2003). The three PACS photometric bands at 70, 100, and 160 μm are indicated as blue, green, and red vertical bars, respectively.

The PACS photometer calibration is based on stellar models of five fiducial stars (Dehaes et al. 2011) that are based on the MARCS models (Gustafsson et al. 2008). It would be desirable to determine the photospheric model spectra of Vega using the same procedure as applied for the five standard stars on which the flux calibration is based. However, the differences between the MARCS and Kurucz models for the covered parameter range are insignificant (Blommaert, priv. comm.).

[1] http://iso.esac.esa.int/users/expl_lib/ISO/wwwcal/#zero

We converted the model spectrum from wavelength to frequency and the flux density values from W/m^2/μm to Jy (Fig. 1). By interpolating the model SED in the far-infrared range, we were able to extract the monochromatic flux densities for the three PACS photometer bands. The results are given in Tab. 1. These values are in good agreement with the results for the corresponding ISOPHOT filter bands (Laureijs et al. 2003).

Table 1: Monochromatic flux densities at 70, 100 and 160 μm determined for a theoretical photospheric model spectrum of Vega according to a Kurucz model of an A0V star with $T_{\rm eff}$ = 9400 K, $\log g$ = 3.9, $\log z$ = −0.5 and extrapolated into the FIR.

PACS band	$F_{\nu,0}$ [Jy]	$F_{\lambda,0}$ [W m^{-2} μm^{-1}]
70 μm	0.7961	4.8707×10^{-16}
100 μm	0.3868	1.1595×10^{-16}
160 μm	0.1500	1.7449×10^{-17}

The magnitude in a given filter band can be calculated by applying Eq. (1).

$$m_\lambda = -2.5 \log \frac{F_{\nu,\rm obs}}{F_{\nu,0}} = -2.5 \log \frac{F_{\lambda,\rm obs}}{F_{\lambda,0}} \quad (1)$$

3 Conclusions

We have derived a flux-to-magnitude conversion for the three PACS photometer bands. It is based on an extrapolation of a theoretical photospheric spectrum of the A0 star Vega, which was derived from Kurucz models. We find a good agreement with the ISOPHOT conversion.

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