SWIFT-UVOT-CALDB-02-R02
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Pages Changed: All
Comments:

SWIFT UVOT CALDB RELEASE NOTE

SWIFT-UVOT-CALDB-02-R02: Count Rate to Flux Ratio

0. Summary:

This product provides the in-orbit count rate to flux conversion for all 7 lenticular filters of the UVOT.

1. Component Files:

FILE NAME	VALID DATE	RELEASE DATE	VERSION

2. Scope of Document:

This document contains a description of the count rate to flux ratio calibration analysis performed to produce the count rate to flux ratio calibration product for the UVOT calibration database.

3. Changes:

This is the second release of the count rate to flux conversion ratios, replacing the first estimates. In the previous release the ratios were calculated using only model star spectra; for this release, ratios are also

calculated for model GRB spectra. Since the database can only take one set of ratios, the GRB ratios are given, since they are deemed more relevant for Swift than the ratios from star spectra.

4. Reason For Update:

An up-date was undertaken to base the count to flux ratios on full spectral simulations of GRBs using the in-orbit instrument effective area curves.

5. Expected Updates:

Further updates are expected with updates of the in-orbit effective area curves.

6. Caveat Emptor:

Due to the lack of faint spectroscopic standard stars, especially in the ultraviolet, the effective area curves have been calibrated with very few stars.

7. Data Used:

Observational data was used to obtain the in-orbit effective area curves, details of which can be seen in uvot_caldb_effectiveareas_02b.doc.

8. Description of Analysis:

The count rate to flux conversion ratio for each filter was calculated using Pickles model spectra (Pickles, 1998, PASP, 110, 863), and GRB power law spectral models with power law ranging from spectral energy index $-2.0 < \_ < 0.0$, SMC extinction ranging from $0.0 < A_v < 1.0$ and red shift ranging from $0.3 < z < 1.0$. e.g. see Figure 1.

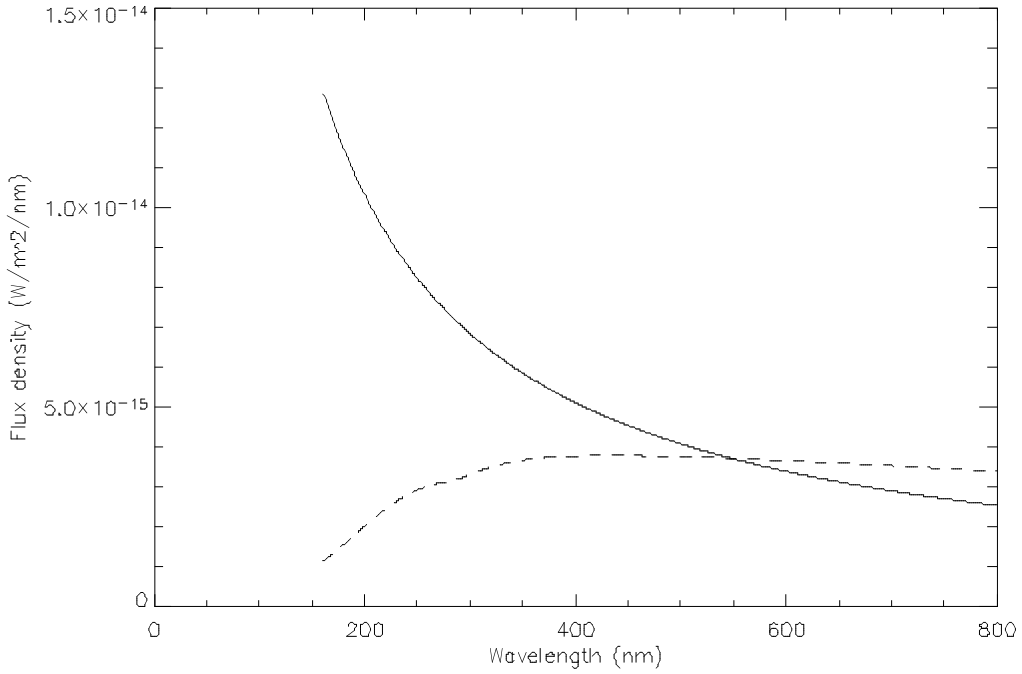

Figure 1 GRB model spectrum with solid line: _ = -2, z = 0.3 and A_v = 0; dashed line _ = -2, z = 0.3 and A_v = 1.0

To produce a count rate to flux conversion ratio in each filter, a UVOT count rate and flux value was obtained for each model spectrum, then averaged over each filter.

An expected in-orbit count rate for each model spectrum was obtained by folding the spectrum through the latest UVOT in-orbit effective area curves (uvot_caldb_effectiveareas_02b.doc).

To obtain flux values for each spectrum the effective wavelength (λ_{eff}) for each filter was calculated by convolving the Vega spectrum (Bohlin & Gilliland, 2004, ApJ, 127, 3508) with the in-orbit effective area curves, and then weighting the curves by this convolution using the following

$$\lambda_{eff} = \frac{\int F_{vega}(\lambda) E_{area}(\lambda) \lambda d\lambda}{\int F_{vega}(\lambda) E_{area}(\lambda) d\lambda},$$

where $F_{veg}(\lambda)$ is the Vega flux at a given wavelength, $E_{area}(\lambda)$ is the in-orbit effective area for a give filter at a given wavelength, and _ is the given wavelength across each filter. The resultant effective wavelength values for each filter are given in Column 2 of Table 1. Each model

spectrum was then smoothed to 10Å resolution to remove small spectral features, and then a flux value was obtained by interpolating over four points around the effective wavelength value for each filter.

The average count rate to flux ratios for the Pickles star models can be seen in Table 1. The RMS error on the average ratio (a measure of the data scatter) is also given in the table. The table also gives the range of UVOT b-v colours that the calculated ratios are applicable to (columns 6 and 7).

Filter	Wavelength (Å)	Ratio	RMS Error	Minimum b-v	Maximum b-v
V	5402	2.61×10^{-16}	2.4×10^{-18}	-0.36	1.09
B	4329	1.32×10^{-16}	9.2×10^{-18}	-0.36	1.09
U	3501	1.5×10^{-16}	1.4×10^{-17}	-0.36	1.09
UVW1	2634	4.3×10^{-16}	2.1×10^{-17}	-0.36	0.1
UVM2	2231	7.5×10^{-16}	1.1×10^{-16}	-0.36	0.1
UVW2	2030	6.0×10^{-16}	6.4×10^{-17}	-0.36	0.1
White	3471	2.7×10^{-17}	7.9×10^{-18}	-0.36	1.09

Table 1 - Average count rate to flux conversion ratio for Pickles star models for each UVOT filter. These ratios are NOT included in the CALDB file.

The average count rate to flux ratios for the GRB models can be seen in Table 2. The RMS error on the average ratio (a measure of the data scatter) is also given in the table. The table also give the range of UVOT b-v colours that the calculated ratios are applicable to (columns 6 and 7).

Filter	Wavelength (Å)	Ratio	RMS Error	Minimum b-v	Maximum b-v
V	5402	2.614×10^{-16}	8.7×10^{-19}	-0.12	0.73
B	4329	1.472×10^{-16}	5.7×10^{-19}	-0.12	0.73
U	3501	1.63×10^{-16}	2.5×10^{-18}	-0.12	0.73
UVW1	2634	4.00×10^{-16}	9.7×10^{-18}	-0.12	0.03
UVM2	2231	8.50×10^{-16}	5.6×10^{-18}	-0.12	0.03
UVW2	2030	6.2×10^{-16}	1.4×10^{-17}	-0.12	0.03
White	3471	3.7×10^{-17}	4.9×10^{-18}	-0.12	0.73

Table 2 - Average count rate to flux conversion ratio for Pickles star models for each UVOT filter. These ratios are included in the CALDB file.

We advice caution when using the count rate to flux conversion ratio for the white filter as it is such a broad filter (1600-8000Å). The large error in the white filter ratio is due to large differences between blue and red spectra across the white filter wavelength range. Figures 2 & 3 demonstrate this large scatter in conversion ratio. Figure 2 shows the

conversion ratio for the Pickles and GRB models across the UVOT colour b-v, and Figure 3 shows the conversion ratios for the same models across the UVOT colour uvw2-v. In both cases the stars represent the Pickles stars, and the triangles represent the GRB models.

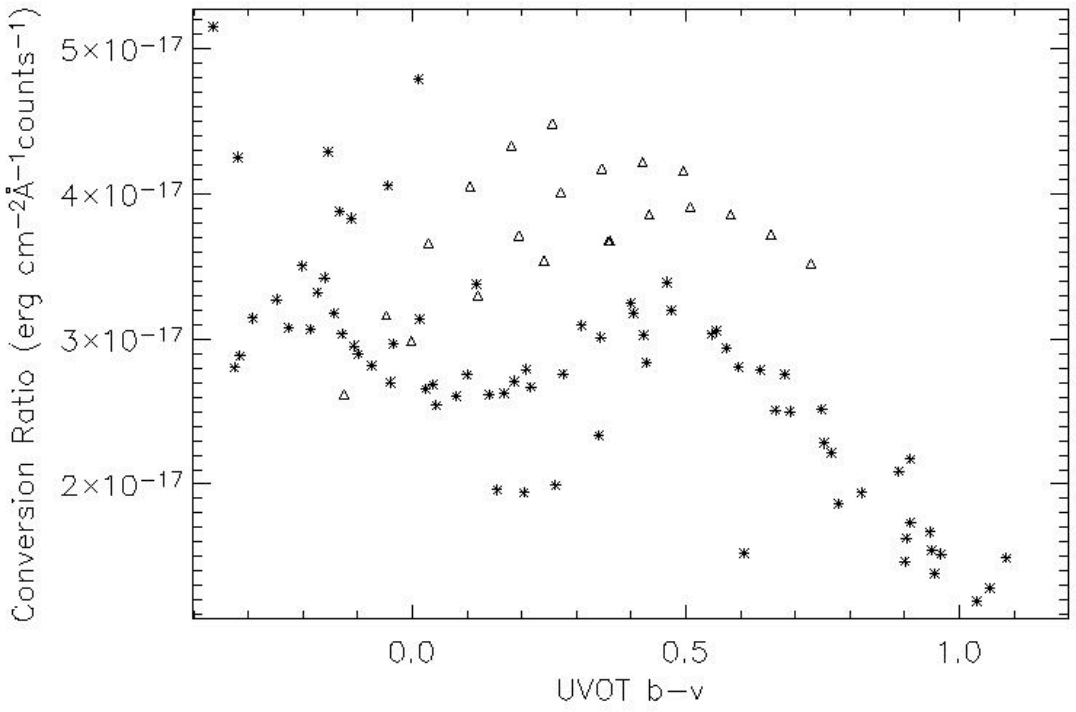

Figure 2 - Count rate to flux ratio for Pickles and GRB models in the white filter. Stars represent the Pickles models and triangles represent the GRB models.

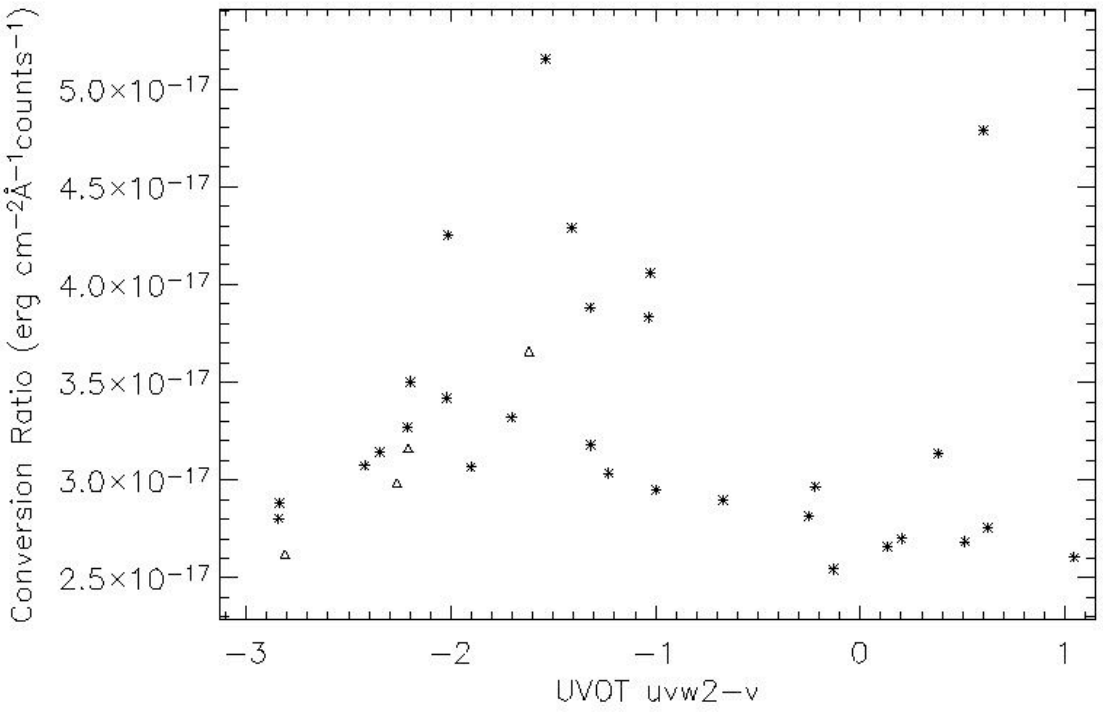

Figure 3 - Count rate to flux ratio for Pickles and GRB models in the white filter. Stars represent the Pickles models and triangles represent the GRB models.