SWIFT-UVOT-CALDB-02-R03
Date Original Submitted: 28th October 2005
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Date Revised: 23rd September 2010
Revision #03
Revised by: Alice Breeveld
Pages Changed: All
Comments: Changed to match updated effective area curves and zero points in the UV.

SWIFT UVOT CALDB RELEASE NOTE

SWIFT-UVOT-CALDB-02-R03: 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 third release of the count rate to flux conversion ratios, replacing the second in-orbit calibration. As in the previous release ratios were calculated using model star spectra and 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 because the effective area curves and zero points have been updated.

5. Expected Updates:

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

6. Caveat Emptor:

To compute an accurate flux density it is necessary to fold the source spectrum through the effective area curves. However, we have found for all but the white filter that there is not a strong dependency on spectral shape across a wide range of classes. Nevertheless, particular care should be taken where there may be significant absorption or emission features in the wavelength range of the filter and especially with the conversion factor of the white filter, which depends strongly on spectral shape because of the wide wavelength range (1600–8000Å).

7. Data Used:

Observational data was used to obtain the in-orbit effective area curves, details of which can be found in uvot_caldb_effectiveareas_02b.doc and for the uv filters uvot_caldb_effectiveareas_10wa.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 $-2.0 < \beta < 0.0$, 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.

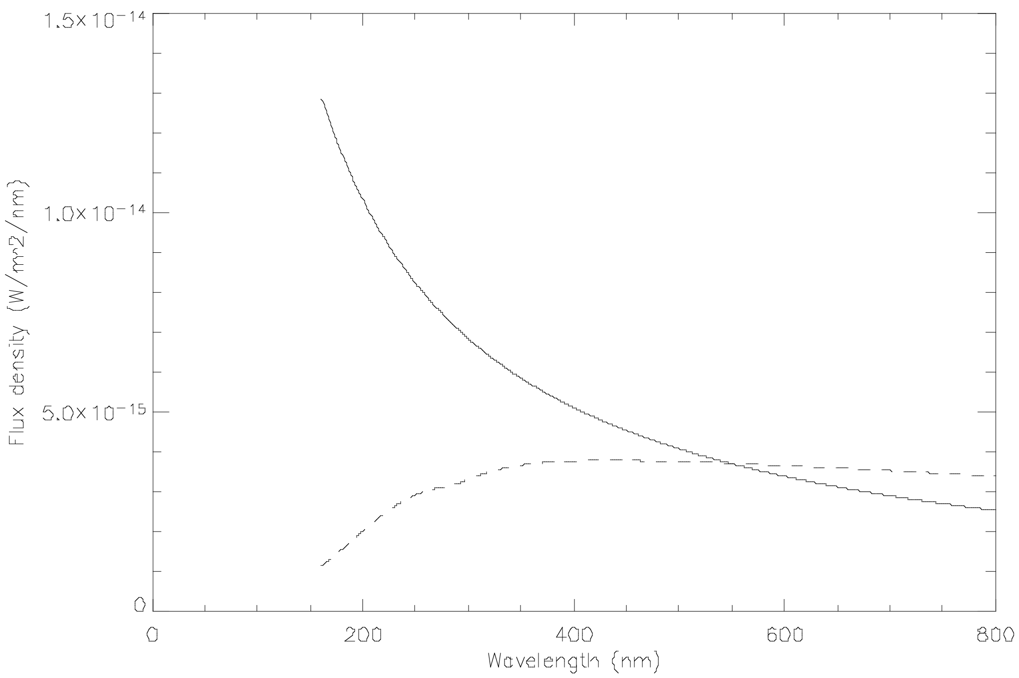

Figure 1 GRB model spectrum with solid line: β = -2, z = 0.3 and A_v = 0; dashed line β = -2, z = 0.3 and A_v = 1.0

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 and uvot_caldb_effectiveareas_10wa.doc).

To obtain flux values for each spectrum the effective wavelength (λ_{eff}) for each filter was calculated by convolving the Vega spectrum (ftp://ftp.stsci.edu/cdbs/current_calspec/alpha_lyr_stis_005.fits) 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 λ 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	2.608×10^{-16}	2.4×10^{-18}	-0.36	1.09
B	4329	1.313×10^{-16}	9.7×10^{-18}	-0.36	1.09
U	3501	1.530×10^{-16}	1.4×10^{-17}	-0.36	1.09
UVW1	2591	4.055×10^{-16}	2.6×10^{-17}	-0.36	0.1
UVM2	2229	7.470×10^{-16}	1.1×10^{-16}	-0.36	0.1
UVW2	2033	5.770×10^{-16}	6.5×10^{-17}	-0.36	0.1
White	3470	2.728×10^{-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	2.613×10^{-16}	8.7×10^{-19}	-0.12	0.73
B	4329	1.471×10^{-16}	5.6×10^{-19}	-0.12	0.73
U	3501	1.628×10^{-16}	2.5×10^{-18}	-0.12	0.73
UVW1	2591	4.209×10^{-16}	1.3×10^{-17}	-0.12	0.03
UVM2	2229	8.446×10^{-16}	5.3×10^{-18}	-0.12	0.03
UVW2	2033	5.976×10^{-16}	1.3×10^{-17}	-0.12	0.03
White	3470	3.677×10^{-17}	4.9×10^{-18}	-0.12	0.73

Table 2 - Average count rate to flux conversion ratio for GRB 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.

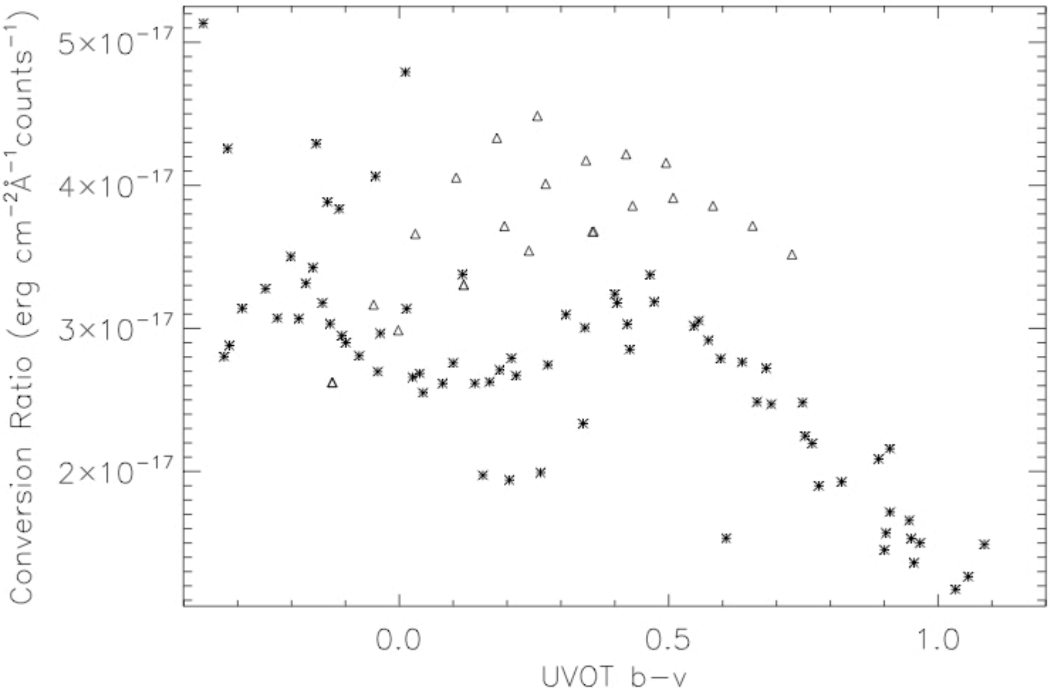

Figure 2 - Count rate to flux ratio for Pickles and GRB models in the white filter. Stars represent the Pickles models and triangles represent the GRB models.

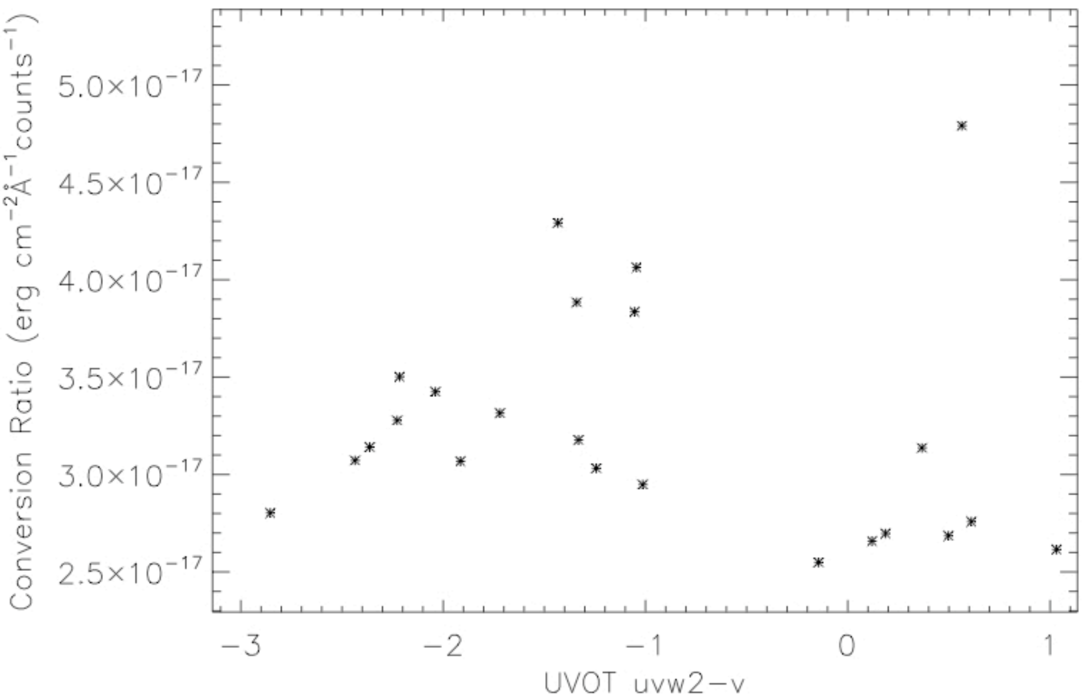

Figure 3 - Count rate to flux ratio for Pickles and GRB models in the white filter. Stars represent the Pickles models and triangles represent the GRB models.