SWIFT-UVOT-CALDB-05-R03
Date Original Submitted: 7th November 2005
Prepared by: Tracey Poole
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Revised by: Alice Breeveld
Pages Changed: All
Comments:
Updated effective area curve for the UVOT UV filters (uvw1, uvm2 and uvw2)

SWIFT UVOT CALDB RELEASE NOTE

SWIFT-UVOT-CALDB-05-R03: Effective Area Curves

1. Summary:

This product provides the in-orbit effective area curves for the 7 lenticular filters of the UVOT.

2. Component Files:

FILE NAME	VALID DATE	RELEASE DATE	VERSION

3. Scope of Document:

This document contains a description of the effective area curve calibration analysis performed to produce the effective area curve calibration products for the UVOT calibration database.

4. Changes:

This is the third release of the in-orbit effective area curves, updating the ultraviolet (UV) effective area curves. This version (10wa) includes the following changes in the UV filters:

- The effective areas have been adjusted to better predict the count rates from stars of a range of colours.

- More standard stars have been used to test the effective area curves.
- Many more measurements of the original white dwarf standard stars have been used, with corrections for changes in sensitivity with time and position on the detector (LSS).

5. Reason For Update:

An update (to version 03) was undertaken to improve the effective area curve calibration by increasing the number and colour range of standard stars used, and also by using more observations for each star. The UV effective area curves have been adjusted particularly at the red end.

6. Expected Updates:

Further updates may follow with the addition of new observations.

7. Caveat Emptor:

The ***original*** ground-based effective area curves (SWIFT UVOTA calibration files: 20041116) were calculated incorrectly, therefore a comparison between these (third version) in-orbit curves and the ground-based curves in the original (first) versions of the CALDB is meaningless.

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

8. Data Used:

This update only concerns the UV filters. Observations of 3 faint white dwarf stars and 5 other HST standard stars with known ultraviolet spectra were used for the new UV filter analysis (see Table 1). Where multiple observations were taken, the individual count rate measurements were corrected for positional and time sensitivity variations, and then averaged.

Object name	Origin	Filter	Target ID	V mag	B mag	Type
WD1121+145	IUE	uvw1, uvm2	55250	16.9	16.6	DA D
WD1026+453	CALSPEC	uvw1, uvm2, uvw2	55761	16.1	15.9	DA D
WD1657+343	CALSPEC	uvw1, uvm2, uvw2	55900	16.4	16.2	DA D
LDS749B	CALSPEC	uvw1, uvm2, uvw2	57350	14.67	14.71	DBQ4
HZ4	CALSPEC	uvw1, uvm2, uvw2	57300	14.51	14.6	DA4
MMJ6476	NGSL	uvw1, uvm2, uvw2	57450	10.9	11.5	A7.2:m
P041C	CALSPEC	uvw1	57950	12.00	12.62	G0V
P330E	CALSPEC	uvw1, uvm2, uvw2	56770	12.92	13.64	G0V
P177D	CALSPEC	uvw1, uvw2	56760	13.47	14.13	G0V
HD118055	NGSL		57200	8.89	10.1	K0w
BD+442051	NGSL		57050	8.68	10.22	M2V
HD102780	NGSL		57150	8.18	9.8	D2D

Table 1 Standard stars used for UV effective area analysis and zeropoint calculation. The third column lists the filters for which the objects were used for the zeropoint calculation. The second column gives the origin of the calibrated spectra. The CALSPEC spectra were obtained from ftp://ftp.stsci.edu/cdbs/current_calspec/; NGSL from http://archive.stsci.edu/prepds/stisngsl/; IUE from Holberg et al. (2003). The spectrum of MMJ6476 has a model atmosphere added below 1700Å. The HD118055 spectrum has had the stellar radial velocity of -101km/s put back in since NGSL subtracts it out.

9. Description of Analysis:

The first step to calculating the in-orbit effective area curves was to produce the in-orbit instrument response curve using the UVOT ground-based instrument response and in-orbit observations. The in-orbit effective area curves were then calculated using in-orbit instrument response and the ground-based filter transmission curves. The detailed description for this process was given in the previous version of this document (SWIFT-UVOT-CALDB-05-R02). Here we will describe the new work undertaken for this version, which only concerns the UV filters.

Count rates for the stars listed in Table 1 were obtained using UVOTSOURCE, for the standard aperture of 5 arcsecs. The background region was in most cases set to an annulus with an inner radius of 55 pixels (27.5 arcsec), and an outer radius of 70 pixels (35 arcsec). All the default corrections were applied and in addition we corrected for LSS and sensitivity changes with time (lssfile = CALDB sensfile = $CALDB/swusenscorr20041120v001.fits). Outlying values were

discarded and the rest were averaged, using a weighting depending on the exposure time.

The expected count rate of each observed standard star for each filter was calculated by convolving the known spectra (see second column of Table 1) of the observed stars with the effective area curve. Comparison of the expected with the measured count rates for the range of stars of different colours showed that there was a problem with the shape of the effective area curves, particularly at the red end for uvm2 and uvw2 and more generally for uvw1. Therefore, in 2009, P. Roming and W. Landsman adjusted the shapes of UV filter curves to better match the photometry of stars with different colours. To minimize changes from the ground-based measurements, the uvm2 filter was only modified longward of 3950 Å, and the uvw2 filter only modified longward of 2600 Å. The uvw2 filter also required a tiny contribution at long (>7000 A) wavelengths to predict the photometry of the very red stars. However, the uvw1 filter required modifications across the entire wavelength range in order to match the photometry of stars of all colours. A comparison of the shapes of the previous and filter response curves is given in Figure 1 and Figure 2. Table 2, Table 3 and Table 4 give the predicted and measured count rates for all sources for the three UV filters.

For each source in each filter we calculated a ratio of measured count rate to expected count rate. Excluding the reddest stars (see column 2 in Table 1 for exact list of stars used), the ratios were averaged over each filter and these average ratios were used to renormalise the effective area curves by a small factor.

Object name	**Meas. c/r**	**Previous version (03)**		**New version (10wa)**	
		Pred. c/r	Ratio	Pred. c/r	Ratio
WD1121+145	27.71	27.88	0.99	28.28	0.98
WD1026+453	40.85	41.04	0.99	41.64	0.98
WD1657+343	33.84	33.99	0.99	34.59	0.98
LDS749B	53.91	55.05	0.98	53.01	1.02
HZ4	58.53	58.49	1.00	57.95	1.01
MMJ6476	92.15	97.14	0.95	91.08	1.01
P041C	22.19	24.56	0.90	21.90	1.01
P330E	9.17	10.40	0.88	9.28	0.99
P177D	5.07	5.69	0.89	5.08	1.00
HD118055	71.24	73.99	0.96	73.39	0.97
BD+442051	57.20	61.47	0.93	60.36	0.95
HD102780	74.93	76.27	0.98	77.59	0.97

Table 2 uvw1 predicted and measured count rates for previous and current versions. The ratio is measured/observed c/r.

Object name	Meas. c/r	Previous version (03)		New version (10wa)	
		Pred. c/r	Ratio	Pred. c/r	Ratio
WD1121+145	22.42	23.78	0.94	23.96	0.94
WD1026+453	33.19	32.84	1.01	33.10	1.00
WD1657+343	27.29	27.56	0.99	27.77	0.98
LDS749B	32.75	32.08	1.02	32.32	1.01
HZ4	42.26	40.65	1.04	40.96	1.03
MMJ6476	31.61	30.41	1.04	30.48	1.04
P330E	1.08	1.10	0.98	1.08	1.00
P177D	0.51	0.43	1.19	0.41	1.23
HD118055	0.98	2.21	0.44	0.99	0.99
BD+442051	0.49	1.91	0.25	0.55	0.88
HD102780	0.70	2.87	0.24	0.68	1.03

Table 3 uvm2 predicted and measured count rates for previous and current versions. The ratio is measured/observed c/r.

Object name	Meas. c/r	Previous version (03)		New version (10wa)	
		Pred. c/r	Ratio	Pred. c/r	Ratio
WD1121+145	42.12	42.89	0.98	44.39	0.95
WD1026+453	64.81	62.72	0.99	64.90	1.00
WD1657+343	55.20	53.41	1.03	55.25	1.00
LDS749B	46.08	44.57	1.03	46.49	0.99
HZ4	71.93	68.85	1.04	71.43	1.01
MMJ6476	42.67	41.88	1.02	43.45	0.98
P330E	1.959	2.01	0.97	2.03	0.97
P177D	1.09	1.04	1.05	1.04	1.05
HD118055	19.68	22.90	0.86	19.82	0.99
BD+442051	17.26	20.81	0.83	18.39	0.94
HD102780	24.84	29.03	0.86	25.89	0.96

Table 4 uvw2 predicted and measured count rates for previous and current versions. The ratio is measured/observed c/r.

9.1. Effective Area curves:

Figure 1 shows the comparison between the new effective areas curves and the previous version. The detail can better be seen in a log plot Figure 2.

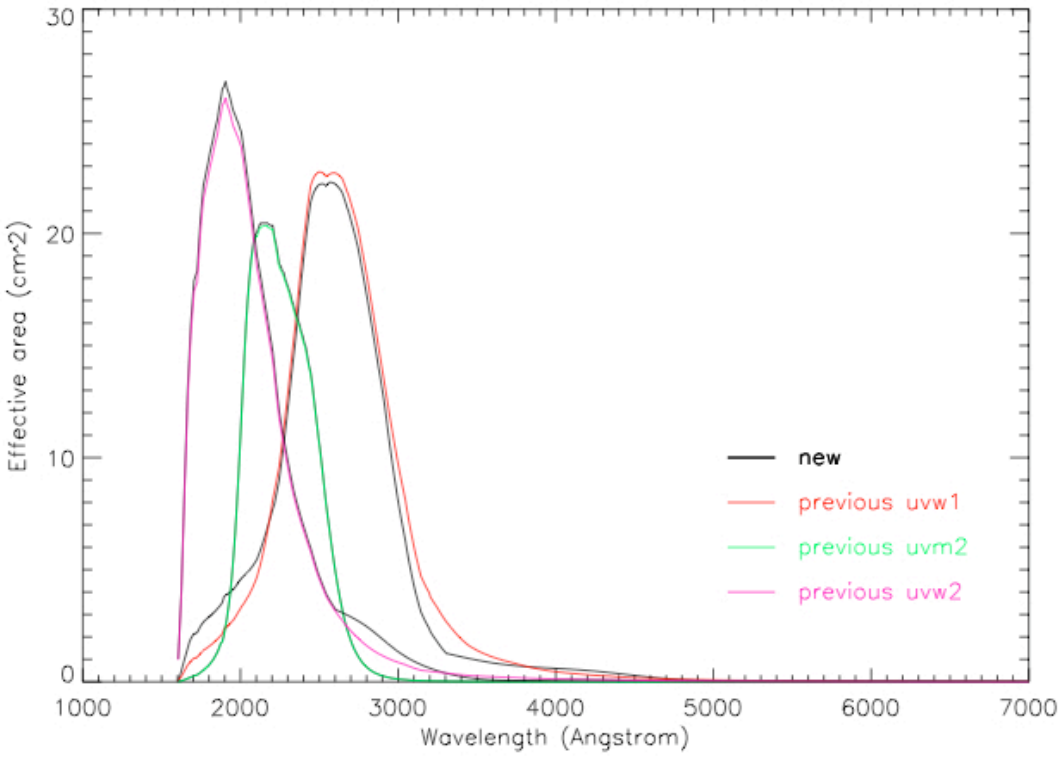

Figure 1 Comparing previous in-orbit uv effective area curves with new ones from this version.

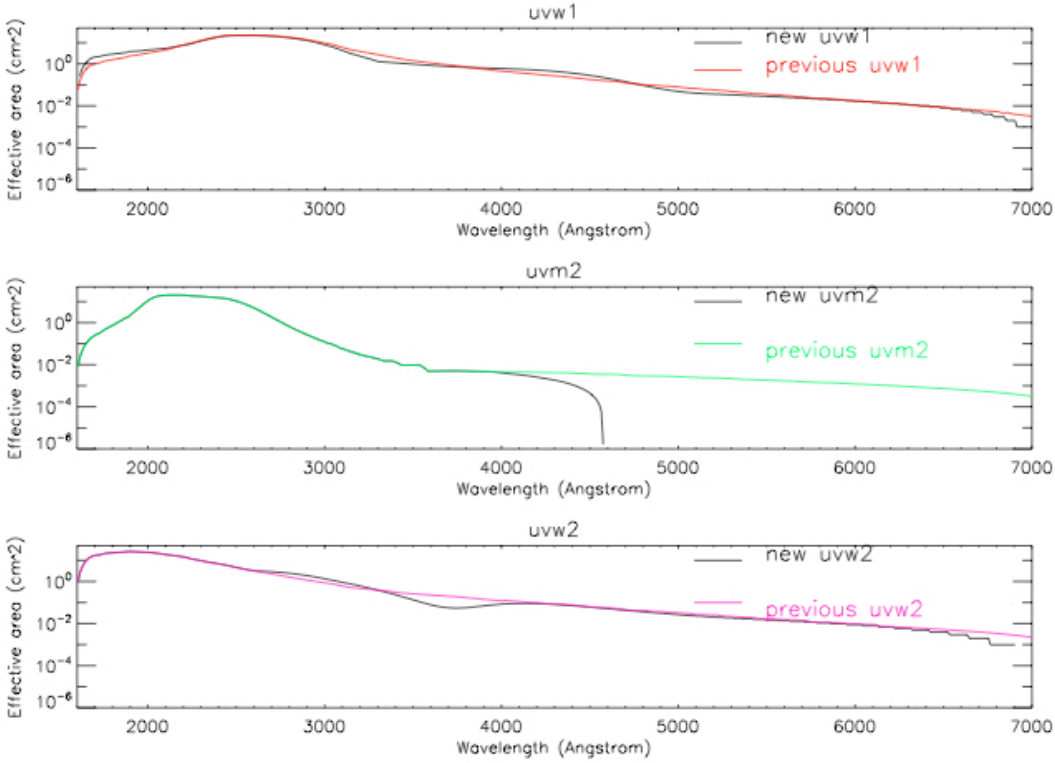

Figure 2 Same curves as in previous figure but plotted on a log scale to show changes in red tails more clearly.