1. Photometric Zero Points

When combining our high-z CSP data with the data from other groups with the purpose of deriving a color (to constrain reddening, for example), care must be taken to ensure that the photometric zero-points are consistent. These zero-points enter our analysis in the cross-filter k-corrections:

$$K_{XY} = -2.5\log\left[1+z\right] + 2.5\log\left[\frac{\int S_X\left(\lambda\right)\Phi\left(\lambda\right)\lambda d\lambda}{\int S_Y\left(\lambda/\left(1+z\right)\right)\Phi\left(\lambda\right)\lambda d\lambda}\right] - ZP_X + ZP_Y$$

where K_{XY} is the k-correction from rest-frame filter X to observed filter Y, S_X and S_Y are the transmission functions for filters X and Y, respectively, Φ is the SED of the observed object (type Ia supernova), and ZP_X and ZP_Y are the photometric zero-points of filters X and Y, respectively.

If one wishes to construct a color (say $B-V$) from observed filters X and Y, then due to the cross-filter k-corrections, one must compute the following term: $(ZP_B - ZP_X) - (ZP_V - ZP_Y)$. These zero points can be derived as:

$$ZP_X = 2.5\log\left[\int S_X\left(\lambda\right)F_o\left(\lambda\right)\lambda d\lambda\right] + m_o$$

where F_o is the SED of a fiducial source and m_o is the observed magnitude of this source through filter X. In the case of the Landolt system, the fiducial source is Vega, whereas in the SDSS system, there are 4 fiducial WD stars. It is evident from these formulae that the absolute flux level of the fiducial source is not important, as we are only dealing with differences in zero-points: only the color matters. However, this is only true if both photometric systems use the same fiducial sources. Unfortunately, when combining our NIR data (for which the ficucial source is Vega) with SDSS data (which is tied to the AB system), the absolute fluxes of the fiducial sources *do* matter.

For the purposes of computing photometric zero-points, we have adopted the SED of Vega as presented in Bohlin & Gilliland (2004). In the following subsections, we outline how the zero-points were derived for each photometric system. Table 1 shows the final zero-points adopted.

1.1. CSP NIR Photometry

Our YJ photometry uses the standards of Persson et al. (1998), which are tied to the Elias et al. (1982) standards. In turn, the Elias standards are ultimately tied to Vega. We are therefore on a Vega system and use the Bohlin et al. (2004) SED. We assume $J_{vega} = -0.001$ and $Y_{vega} = 0.000$ (Stritzinger et al. 2005).

1.2. Johnson Kron/Cousins BVRI

Our light-curve templates are based on BVRI photometry as outlined in Prieto et al. (2006). These templates and calibration of the low-z sample are based on BVRI photometry from various sources. Still, all these data are transformed to the standard BVRI system and are therefore Vega-based. We adopt the following for Vega: $B_{vega} = 0.0210$, $V_{vega} = 0.0230$, $R_{vega} = 0.0290$, and $I_{vega} = 0.0230$.

1.3. SNLS griz

SNLS uses the SDSS filter set, yet they use the Landolt standards, so are also on a Vega system. Again, we use the Bohlin et al. (2004) SED and adopt the following magnitudes for Vega: $g_{vega} = 0.0220$, $r_{vega} = 0.0281$, $i_{vega} = 0.0241$, $z_{vega} = 0.0214$ (Alex Conley, private communication).

1.4. ESSENCE RI

Essence uses the Landolt stars as standards and are therefore on a Vega system. We adopt the same magnitudes for Vega as in the case of the Johnson filters: $R_{vega} = 0.0290$ and $I_{vega} = 0.0230$.

1.5. SDSS II gri

Unlike all the previous datasets, Sloan uses an AB system that is tied to the SED of 4 F sub-dwarf stars (Fukugita et al. 1996) whose absolute fluxes are calibrated by the absolute flux of Vega's continuum. In order to compute the zero-points, we use the transmission functions for the APO 2.5m telescope. We then use the transformation equations from the SDSS website to transform the u'g'r'i'z' magnitudes of the 4 sub-dwarfs to ugriz (2.5 m) values. We also re-calibrate the SEDs of these 4 sub-dwarfs so that they are consistent with the Bohlin et al. (2004) SED. We do this by re-binning the Bohlin SED to match the SED of Vega given by Fukugita et al. (1996), dividing one by the other, and then multiplying each sub-dwarf SED by the resulting normalization function. Once this is done, we use the transformed sub-dwarf magnitudes to compute the zero-points of the filter set.

Filter	Survey	Zero-point
Y	CSP	12.687
J	CSP	12.853
B	Johnson	15.289
V	Johnson	14.860
R	Johnson	15.046
I	Johnson	14.546
g	SNLS	15.536
r	SNLS	14.806
i	SNLS	14.554
z	SNLS	14.000
g	SDSS	14.192
r	SDSS	14.220
i	SDSS	13.779
R	Essence	15.182
I	Essence	14.458

Table 1: Photometric zero-points of filter sets used by the high-z CSP.