# A method of calibrating spectra in absolute flux using V magnitudes

This method of calibrating spectra in absolute flux relies on knowing the V magnitude of the target at the time its spectrum was recorded together with the transmission profile of the V filter used to measure this magnitude. In most cases the filter profile can be found from the filter manufacturer.
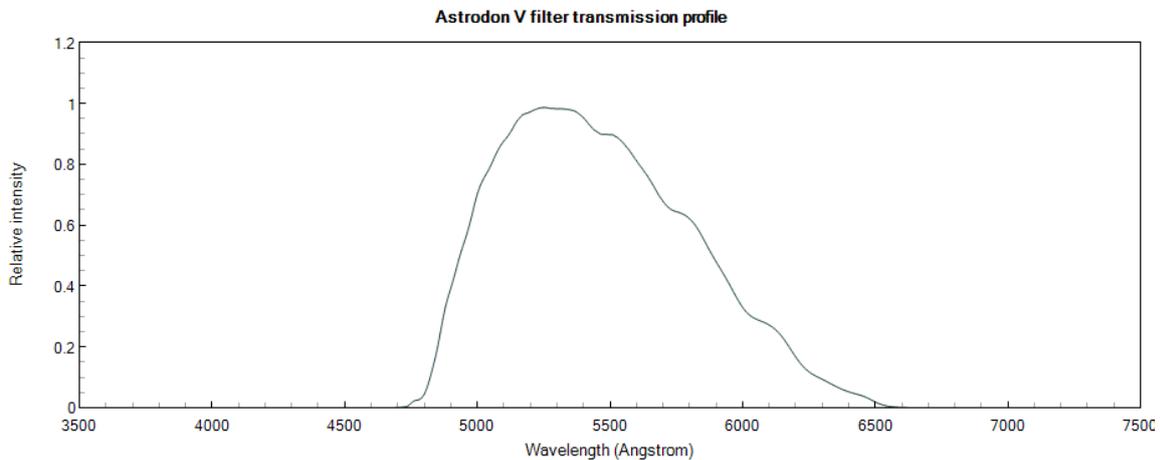

Failing that, a standard V filter profile can be used. Ideally the V magnitude should have been transformed to the photometric standard magnitude system but failing that the method will still give an acceptable result. The method is straightforward to implement using most spectral analysis software. Note that this method will only work for spectra which fully cover the V filter passband from 4600 to 7000 Å.

First you need to find the spectroscopic zero point of your magnitude measurements. This enables you to relate a V magnitude you measure to the absolute flux transmitted by your V filter. One way to do this is to use spectra calibrated in absolute flux from the HST CALSPEC archive:

http://www.stsci.edu/hst/instrumentation/reference-data-for-calibration-and-tools/astronomical-catalogs/calspec

These are in flux units of ergs/cm^2/sec/Å. Select a star from the archive (eg BD+25 4655) and multiply its profile by the transmission profile of your V filter.

Absolute flux of BD+25 4655 transmitted by V filter
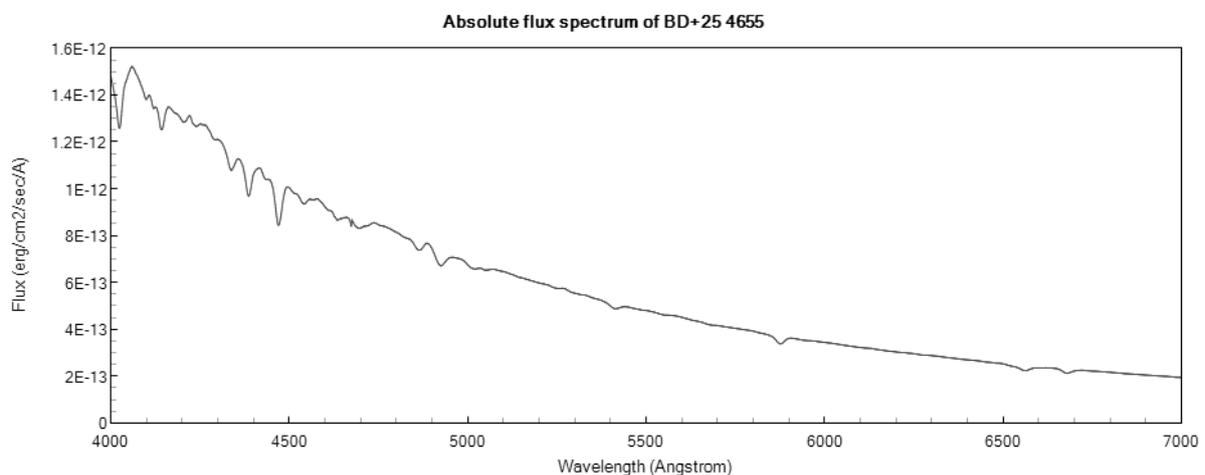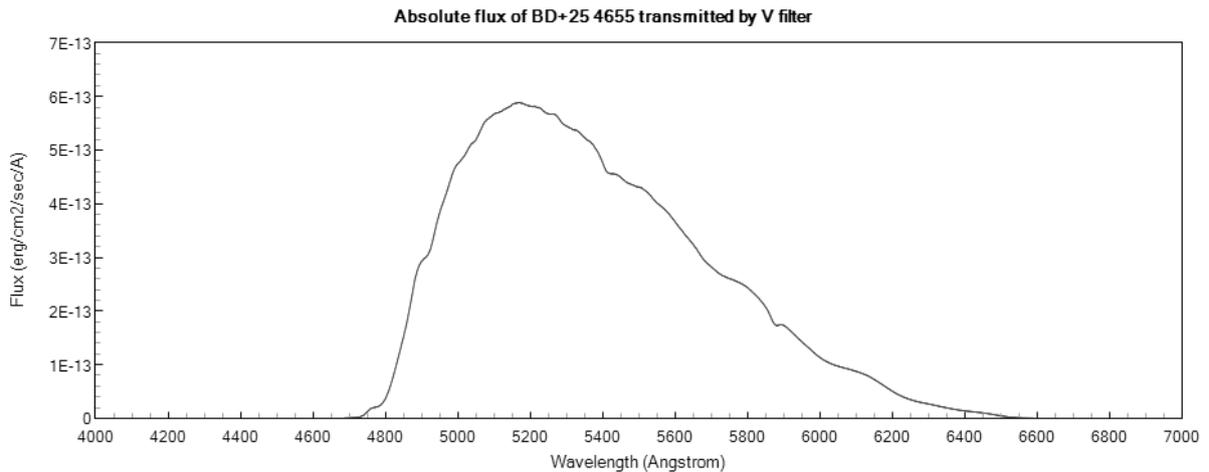
Measure the integrated flux in the transmitted profile to get the total flux, F, transmitted by the filter for this star. In this example F = 4.767×10^{-10} erg/cm^2/sec. The CALSPEC archive says that the magnitude of this star is V = 9.69. The zero point, ZP, for this star is given by the formula

$$ZP = -V - 2.5 \cdot \log_{10}(F)$$

Repeat this for about a dozen stars from the CALSPEC archive and calculate the mean value of the zero point. In my case this was ZP = 13.629 magnitudes with a standard deviation of 0.014. This value is used for all subsequent flux calibrations.

Knowing the V magnitude, V_T, of your target measured at the same time as the spectrum, you can calculate the absolute flux, A, of your target which will be transmitted by the V filter using the formula

$$A = 10^{[-0.4 \cdot (V_T + ZP)]}$$

You are now ready to convert your spectrum into absolute flux units. The starting point is a spectrum of your target in relative flux units corrected for atmospheric extinction and instrument response in the normal way. We will use a spectrum of AG Peg as an example. Multiply this spectrum by the transmission profile of the V filter as described above.

Relative flux spectrum of AG Peg

Relative flux of AG Peg transmitted by V filter
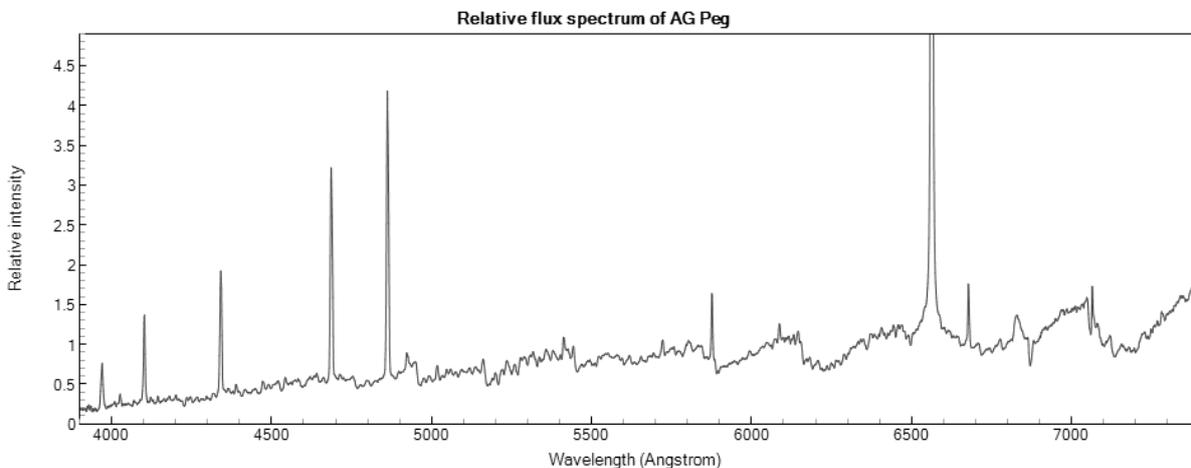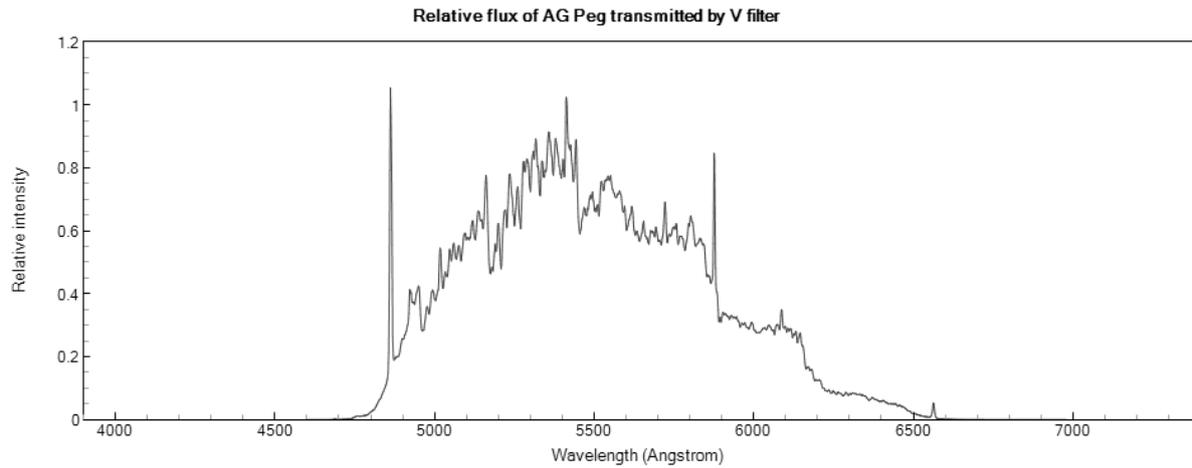
The V magnitude of AG Peg obtained at the same time as this spectrum was V = 8.62. The absolute flux transmitted by the V filter is therefore A = 1.259×10^{-9} ergs/cm^2/sec. Measure the integrated flux in the transmitted profile of the relative flux spectrum to get the total relative flux, R, transmitted by the filter in units of relative flux. In the above case R = 736.99 relative flux units.

Now multiply the relative flux spectrum of the target by A and divide by R. The spectrum is now calibrated in absolute flux units of ergs/cm^2/sec/Å.

Absolute flux spectrum of AG Peg
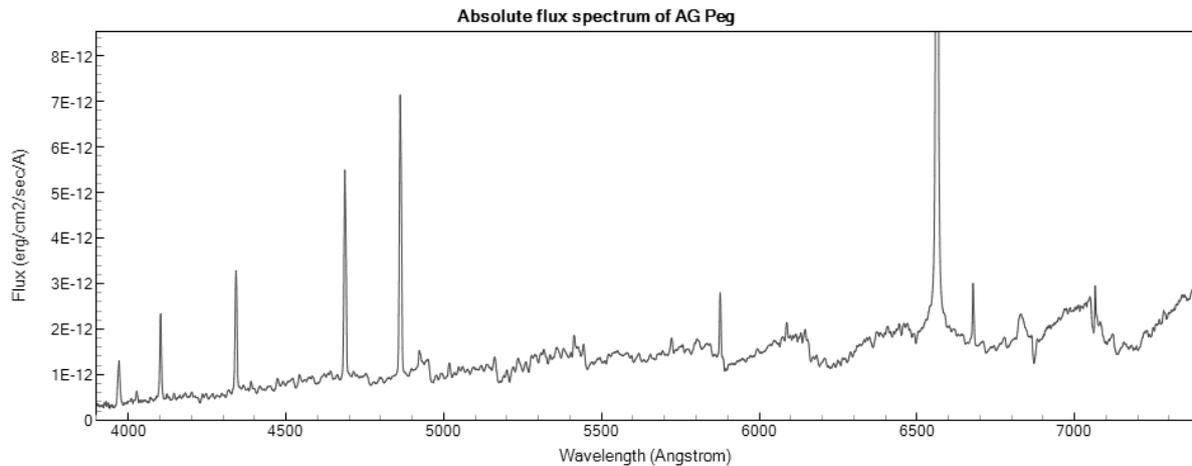
Finally, as a check that everything is working properly, you can record the relative flux spectrum of a spectrophotometric standard star with a known absolute flux spectrum, for example one from the CALSPEC archive, in the normal way and calibrate it in absolute flux as described above. You should find that your calibrated spectrum agrees closely with the standard spectrum.

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