Observational Techniques in Astrophysics — Exercise

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1 Conversion between Vega and AB magnitudes

The Vega and AB magnitudes in a given filter are defined as follows (e.g., Fukugita, Shimasaku, & Ichikawa 1995, PASP, 107, 945):

$$m_{\rm Vega} = -2.5 \log \frac{\int d\nu\, f_\nu R_\nu/\nu}{\int d\nu\, f_\nu^{\rm Vega} R_\nu/\nu} \tag{1}$$

$$m_{\rm AB} = -2.5 \log \frac{\int d\nu\, f_\nu R_\nu/\nu}{\int d\nu\, R_\nu/\nu} - 48.6. \tag{2}$$

where f_ν is the flux density and R_ν is the filter response curve. From these definitions it follows that a) the zeropoint of the AB magnitude is $f_\nu = 3.63 \times 10^{-20}$ erg s^{-1} cm^{-2} Hz^{-1}, and b) the AB magnitude of Vega in the V-band is zero.

1. Plot the spectrum of Vega together with the arbitrarily scaled filter response curves of the ($UBVIRIJHK$) bands. This will show you which part of the spectrum is sampled in each filter.
2. Normalise the given (arbitrary scaled) spectrum of Vega so that a) and b) are true.
3. Derive the offsets between the Vega magnitude and AB magnitude, $\Delta m = m_{\rm AB} - m_{\rm Vega}$, in the $UBVRIJHK$ bands.
4. What can you say about the Vega magnitude of Vega in the different bands?

The spectrum of Vega (arbitrarily normalised) and the filter response curves can be downloaded from `https://github.com/liasartori/ObsAstro_HS14`.

2 Stellar mass function

The galaxy stellar mass function is known to be better expressed by the so-called the *double-Schechter function* (e.g., Baldry et al. 2008, MNRAS, 388, 945) with 5 free parameters, (M^*, ϕ_1^*, α_1, ϕ_2^*, α_2),

$$\Phi(M)\, dM = e^{-M/M^*} \left[\phi_1^* \left(\frac{M}{M^*}\right)^{\alpha_1} + \phi_2^* \left(\frac{M}{M^*}\right)^{\alpha_2} \right] \frac{dM}{M^*}, \tag{3}$$

where $\Phi(M)\, dM$ is the number density of galaxies with mass between M and $M + dM$. Here, α_1 should be larger than α_2 so that the first term dominates at the high mass part of the mass function and the second term dominates at the low-mass end.

1. Plot the galaxy stellar mass function observed locally by the *Galaxy And Mass Assembly (GAMA)* survey (Baldry et al. 2012, MNRAS, 421, 621) with the error bars. The data can be downloaded from `https://github.com/liasartori/ObsAstro_HS14`.

2. Fit the observed mass function with Equation 3 and overplot the best-fit curve on the observed data (total double-Schechter function, as well as the two single components separately).

   As initial parameters for the fit you can assume:

   $(M^*,\ \phi_1^*,\ \alpha_1,\ \phi_2^*,\ \alpha_2)$ = (5.e10, 4e-3, -0.4, 1e-3, -1.4).

3. Report the best-fit parameters.

4. What is the (astro)physical reason for the two different components?