Astronomy 730

Magnitudes

Flux Units in Astronomy

- Flux (f_ν): measured in Janskys
  - 1 Jy = 10^{-26} W m^{-2} Hz^{-1}= 10^{-23} erg sec^{-1} cm^{-2} Hz^{-1}
- Flux (f_λ): measured in ergs s^{-1} cm^{-2} A^{-1} (cgs units)
- Photon flux (f_γ) is useful for calculating signal-to-noise (counting statistics):
  - Define *neper* = $\Delta\lambda/\lambda = \Delta\nu/\nu = \Delta\ln\nu$
  - The photon flux is:
    - photons sec^{-1} cm^{-2} neper-1 = f_ν/h
    - where h=6.6256 x 10^{-27} erg sec
  - Useful identify:

1 microJy = μJy = 15.1 photons sec^{-1} m^{-2} neper^{-1}

Apparent magnitudes

$$m_1 - m_2 = -2.5\log_{10}\left(\frac{f_1}{f_2}\right) = -a\ln\left(\frac{f_1}{f_2}\right)$$

$$a = 2.5\log_{10} e = 1.08574$$

$$m = -2.5\log_{10}\left(\frac{f_1}{f_0}\right) + m_0$$

f_n: the apparent flux of object *n*.

Pogson's ratio (MNRAS, 1856, 17, 12)

Will drop "10" here on out.

m_0 : zeropoint of the magnitude system

$f = f_0$ dexp[-0.4(m-m_0)] ← how to get your money back

Absolute Magnitudes

$$m_\lambda - M_\lambda = 5\log_{10} d - 5 + A_\lambda$$

$$\therefore \quad \frac{f_1}{f_2} = \left(\frac{d_2}{d_1}\right)^2$$

- Absolute magnitude is the apparent magnitude that would be observed if the object were at a distance, *d*, of 10 pc.
- A_λ is the total extinction due to interstellar dust, in magnitudes, typically take to be only the Galactic foreground screen (Burstein & Heiles 1982, AJ, 87, 1165; Schlegel et al. 1998, ApJ, 500, 525):

HI

IRAS

  - $f = f_0 \exp(-\tau_\lambda)$,
  - $A_\lambda = 1.086\ \tau_\lambda = -2.5 \log(f/f_0)$

See nedwww.ipac.caltech.edu/help/extinction_law_calc.html

Absolute Magnitudes

- For extragalactic observers: d in Mpc, plus the so-called k-correction, κ, which accounts for effects of the cosmological expansion
  1) effects of redshifting the rest-frame spectrum in the observed band-pass; and
  2) photon dilution.

$$\boxed{m_\lambda - M_\lambda = 5\log_{10} d + 25 + A_\lambda + \kappa_\lambda}$$

See, e.g.: Schneider, Gunn & Hoessel (1983, ApJ, 264, 337)

Astronomical Magnitude Systems

Table 3.1: Fluxes for m = 0

How are these determined?

Band	λ_c (μ)	$\Delta\lambda/\lambda$	Jy	Reference
U	0.36	0.15	1810	Bessell (1979)
B	0.44	0.22	4260	"
V	0.55	0.16	3640	"
R	0.64	0.23	3080	"
I	0.79	0.19	2550	"
J	1.26	0.16	1600	Campins, Rieke & Lebofsky (1985)
H	1.60	0.23	1080	"
K	2.22	0.23	670	"
g	0.52	0.14	3730	Schneider, Gunn & Hoessel (1983)
r	0.67	0.14	4490	"
i	0.79	0.16	4760	"
z	0.91	0.13	4810	"
u'	0.35	0.18	3631	Fukugita et al. (1996)
g'	0.48	0.29	3631	"
r'	0.63	0.22	3631	"
i'	0.77	0.29	3631	"
z'	0.91	0.16	3631	"

Johnson

griz

SDSS AB_{95}

Note uniformity in $\Delta\lambda/\lambda$

nepers