Ay 20 # 3 - Measures of radiation

	RADIO	MM / SUB-MM	FAR-IR	MID-IR	NEAR-IR	OPTICAL
Frequency (Hz)	$\sim 300 - 5\times10^{10}$	$\sim 8\times10^{10} - 8.6\times10^{11}$	$8.6\times10^{11} - 1.2\times10^{13}$	$1.2\times10^{13} - 3.8\times10^{13}$	$3.8\times10^{13} - 4\times10^{14}$	$4\times10^{14} - 8\times10^{14}$
Wavelength (cm)	$1000\ km - 0.6$	$0.375 - 3.5\times10^{-2}$	$3.5\times10^{-2} - 2.5\times10^{-3}$	$2.5\times10^{-3} - 8\times10^{-4}$	$8\times10^{-4} - 7.5\times10^{-5}$	$7.5\times10^{-5} - 3.8\times10^{-5}$
Energy (eV)	$10^{-12} - 2\times10^{-4}$	$3\times10^{-4} - 4\times10^{-3}$	$4\times10^{-3} - 5\times10^{-2}$	$5\times10^{-2} - 2\times10^{-1}$	$2\times10^{-1} - 2\times10^{0}$	$2\times10^{0} - 4\times10^{0}$

Typical measures

* Jansky (Jy)

$1\ Jy = 10^{-26}\ W m^{-2} Hz^{-1}$

$= 10^{-23}\ erg\ cm^{-2} s^{-1} Hz^{-1}$

* Kelvin (K) - surface brightness temperature (Rayleigh-Jeans law)

Gives a flux density F in erg $cm^{-2} s^{-1} Hz^{-1}$ (for eg.),

$$T = \frac{F c^2}{2\nu^2 k_B \Omega}$$ ← solid angle of source.

* Apparent magnitude (mag).

0 mag ≡ 3631 Jy.

Gives F_J in Jy, the magnitude is

$$m = -2.5 \log_{10}\left(\frac{F_J}{3631}\right).$$

UV (NEAR, MID, FAR, EXTREME)	X-RAYS (SOFT, HARD)	GAMMA-RAYS
8×10^{14} – 3×10^{16}	3×10^{16} – 3×10^{19}	3×10^{19} – ?
3.8×10^{-5} – 10^{-8}	10^{-8} – 10^{-11}	10^{-11} – ?
4 – 100	100 – 10^{5}	10^{5} – ?

* High-energy detectors often work in "counts/s", which can be translated to a flux: erg s^{-1} cm^{-2}.
* Need knowledge of the instrument response.
* 1 "Crab" = (2-10 keV) 2.4×10^{-8} erg s^{-1} cm^{-2} ≈ 1 mJy!

(There is a lot of astrophysics in this statement.).

Key concepts: (RADIO/MM) (OPTICAL/IR) (HIGH-ENERGY)

* Flux density: Jy, erg s^{-1} cm^{-2} Hz^{-1}, erg s^{-1} cm^{-2} $Å^{-1}$
* Flux: erg s^{-1} cm^{-2}
* Surface brightness: e.g., Jy arcsec^{-2}, mag arcsec^{-2}
* Brightness temperature: K from R-J tail.
* Magnitudes: $m - M = 5\log_{10}\left(\frac{d}{10\,pc}\right)$
  - Apparent ← Absolute
  - r^{-2} law
  - Ref. distance of 10 pc.