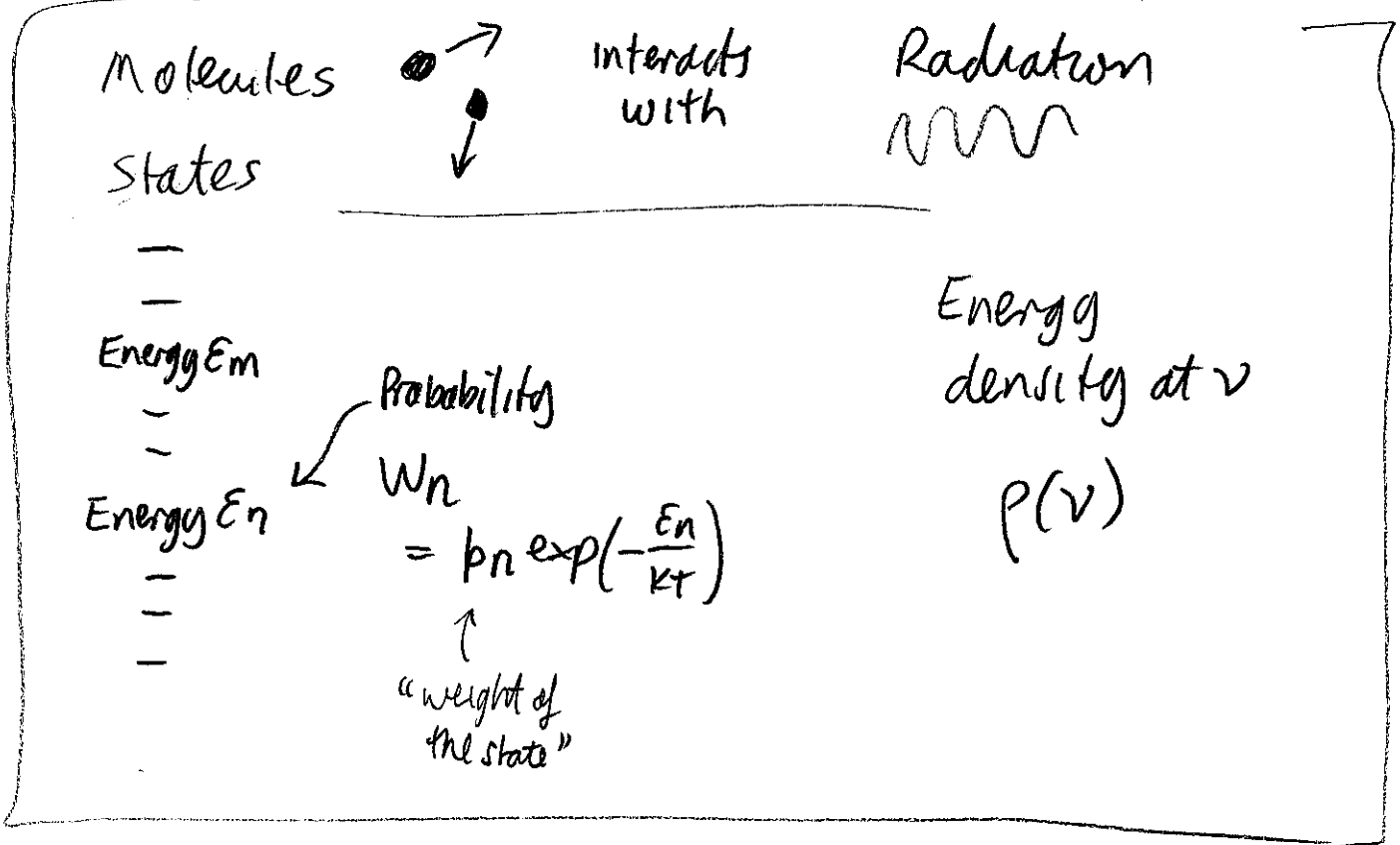


Einstein's A & B coefficient derivation of the Blackbody radiation law

I Derivation based on a non-classical, probabilistic treatment of energy transfers between matter & radiation

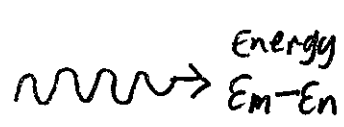
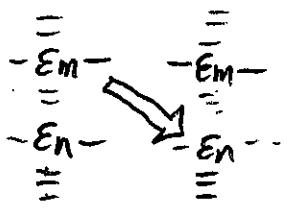
To be treated here

II Demonstrates that emission/absorption of radiant energy $h\nu$ by matter is accompanied by a momentum gain/loss of $h\nu/c$



Processes

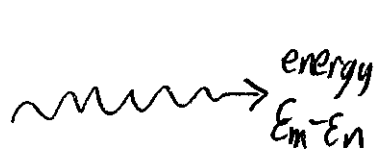
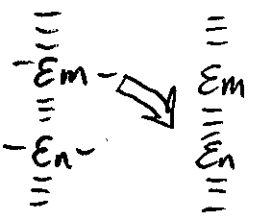
spontaneous emission



Probability in time
↓

$$dW = A_m^n dt$$

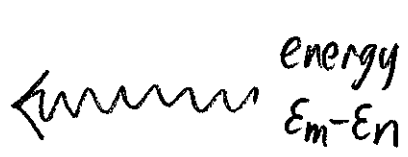
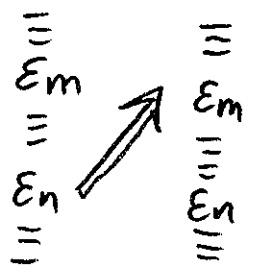
stimulated emission



Probability in time
↓

$$dW = B_m^n \rho dt$$

Absorption



$$dW = B_n^m \rho dt$$

Notation: Since $E_m > E_n$,
 B_m^n and B_n^m represent
very different processes
Beware!

Condition for Equilibrium

Rate transitions

$n \rightarrow m$

In time dt

$$W_n \cdot B_{n \rightarrow m}^m \rho$$

=

Rate transitions

$m \rightarrow n$

In time dt

$$W_m (B_{m \rightarrow n}^n \rho + A_m^n)$$

$$\therefore p_n \left(\exp\left(-\frac{E_n}{kT}\right) \right) B_{n \rightarrow m}^m \rho = p_m \exp\left(-\frac{E_m}{kT}\right) (B_{m \rightarrow n}^n \rho + A_m^n)$$

a little manipulation



At high T , $\rho \rightarrow \infty$, $\exp\left(-\frac{E_m}{kT}\right) \rightarrow 1$

\therefore Equality requires $p_n B_n^m = p_m B_m^n$

$$\rho = \frac{A_m^n / B_m^n}{\exp\left[\frac{E_m - E_n}{kT}\right] - 1} \propto \nu^3 \text{ some constant } \alpha$$

$E_m - E_n = h\nu$
some constant h

Wien displacement law

$$P(\nu) = \nu^3 f\left(\frac{\nu}{T}\right)$$