From Justin Wark
Clarendon Lab, Oxford

Assume we have an assembly of $N$ identical, weakly interacting particles in a volume $V$, in thermal equilibrium at a temperature $T$.

↓

**Are the particles gaseous?**

Yes ↓ ↓ No

**No →** Use Boltzmann Statistics

$$\frac{n_i}{g_i} = \frac{N}{Z_{sp}} exp(-\frac{\epsilon_i}{k_B T})$$

$$Z_{sp} = \sum_i g_i exp(-\frac{\epsilon_i}{k_B T})$$

$$Z_N = (Z_{sp})^N$$

**Yes →** Do the particles obey classical or quantum statistics? i.e. is

$$\frac{V}{N}\left(\frac{2\pi m k_B T}{h^2}\right)^{3/2} \gg 1$$

No ↓ Yes ↓

**No →** Fermions?

- No ↓ You need to know about photons - i.e. variable numbers of Bosons

$$\frac{n_i}{g_i} = \frac{1}{exp(\frac{\epsilon_i}{k_B T}) - 1}$$

- Yes ↘ Use Fermi-Dirac statistics - i.e.

$$\frac{n_i}{g_i} = \frac{1}{exp(\frac{(\epsilon_i - \mu)}{k_B T}) + 1}$$

**Yes ↘** Use Boltzmann Statistics for indistinguishable particles

$$\frac{n_i}{g_i} = \frac{N}{Z_{sp}} exp(-\frac{\epsilon_i}{k_B T})$$

$$Z_{sp} = \sum_i g_i exp(-\frac{\epsilon_i}{k_B T})$$

$$Z_N = \frac{(Z_{sp})^N}{N!}$$