COPYRIGHT & LICENSE *Copyright © 2007 Jason Underdown* *Some rights reserved.* QUANTUM STATISTICAL MECHANICS	DEFINITION *spin excess* QUANTUM STATISTICAL MECHANICS
FORMULA *multiplicity function* QUANTUM STATISTICAL MECHANICS	FORMULA *Stirling's approximation* QUANTUM STATISTICAL MECHANICS
FORMULA *approximate multiplicity function* QUANTUM STATISTICAL MECHANICS	ASSUMPTION *fundamental assumption* QUANTUM STATISTICAL MECHANICS
DEFINITION *probability of states* QUANTUM STATISTICAL MECHANICS	DEFINITION *expectation* *average value* QUANTUM STATISTICAL MECHANICS
DEFINITION *entropy* QUANTUM STATISTICAL MECHANICS	EQUATION *condition for thermal equilibrium* QUANTUM STATISTICAL MECHANICS

Assuming N is even, then we define the *spin excess* by

$$N_\uparrow - N_\downarrow = 2s$$

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$$N! \approx (2\pi N)^{1/2} N^N \exp(-N + (1/12)N + \cdots)$$

$$g(N,s) = \frac{N!}{(\frac{1}{2}N + s)!\,(\frac{1}{2}N - s)!} = \frac{N!}{N_\uparrow!\,N_\downarrow!}$$

The fundamental assumption of statistical mechanics is that in a closed system, each of its *accessible* states is *equally likely*.

$$G(N,s) \approx (2/\pi N)^{1/2} 2^N \exp(-2s^2/N)$$

Suppose that a system has some physical property $X = X(s)$ when the system is in state s. The *expected* or *average value* of X is defined by:

$$\langle X \rangle = \sum_s X(s) P(s)$$

If s is a state of a system, then the probability of that state is given by:

$$P(s) = \begin{cases} 1/g & \text{if } s \text{ is an accessible state} \\ 0 & \text{otherwise} \end{cases}$$

The sum of the probabilities over all states is unity.

$$\sum_s P(s) = 1$$

If two systems are in thermal contact, the condition for them to be in *thermal equilibrium* is the following:

$$\left(\frac{\partial \sigma_1}{\partial U_1}\right)_{N_1} = \left(\frac{\partial \sigma_2}{\partial U_1}\right)_{N_2}$$

$$\sigma(N,U) \equiv \ln g(N,U)$$

Definition

fundamental temperature
Kelvin temperature
Boltzmann constant

Quantum Statistical Mechanics

Definition

relationship between entropy and classical thermodynamic entropy

Quantum Statistical Mechanics

Equation

multiplicity function for the Hydrogen atom

Quantum Statistical Mechanics

Equation

multiplicity function for 3D harmonic oscillator

Quantum Statistical Mechanics

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$$\frac{1}{T} = \left(\frac{\partial S}{\partial U}\right)_N$$

$$S = k_B \sigma$$

$$\frac{1}{\tau} \equiv \left(\frac{\partial \sigma}{\partial U}\right)_N$$

$$\tau = k_B T$$

$$k_B = 1.381 \times 10^{-23} \text{ J/K}$$

The multiplicity function for a simple harmonic oscillator with three degrees of freedom with energy E_n is given by

$$g(n) = \frac{1}{2}(n+1)(n+2)$$

where $n = n_x + n_y + n_z$.

The multiplicity function for a Hydrogen atom with energy E_n, is given by

$$g(n) = \sum_{l=0}^{n-1}(2l+1) = n^2$$

where n is the principal quantum number, and l is the orbital quantum number.