PHYSICS

B.Sc Part-III (H) Paper-V Gr-C

By :- Dr. Mirza Abbas Hussain

SYMETRIC AND ANTISYMMETRIC WAVE FUNCTIONS

PAULI EXCLUSION PRINCIPLE

Symmetric and Antisymmetric wave function

Let us consid an atom having two electrons. one is in quantum state 'a' and the second in the quantum state b. When first particle in the quantum state a and second particle in the quantum state 'b' then.

$$\psi(1,2) = \psi_a(1)\,\psi_b(2) \quad \text{--- (1)}$$

If the second particle in the quantum state (a) and 1st particle in the quantum state (b) then.

$$\psi(2,1) = \psi_a(2)\,\psi_b(1) \quad \text{--- (2)}$$

The wave function may be interchanged by the phase factor $e^{i\alpha}$

$$\psi(2,1) = e^{i\alpha}\,\psi(1,2) \quad \text{--- (3)}$$

Where α is real constant

The wave function may be again interchanged to the original wave function when it is multiplied by the phase factor $e^{2i\alpha}$, Hence this implies that

$$e^{2i\alpha} = 1$$

$$\& \quad e^{i\alpha} = 1^{2} = \pm 1$$

From equ^n (3) $\psi(1,2) = \pm\,\psi(2,1)$.

If a wave function changes sign on interchanging the particle, it is said to be an antisymmetric function. For such function

$$\psi(1,2) = -\psi(2,1)$$

The particle that are described by the antisymmetric wave function are terms "fermion" They obey "Fermi-dirac Statistics"

If a wave function remains unchange on interchanging the particle it is said to be Symmetric wave function

$$\psi(1,2) = \psi(2,1)$$

The particle that are described by Symmetric functions are called "Bosons" They obey "Bose-Einstein Statistics"

Pauli Exclusion Principle

Statement:- The wavefunction of a many electron system is antisymmetric to exchange of co-ordinate of any two electron.

There are four quantum number of the electron

① Principal quantum number (n) → This gives total energy

② Orbital quantum number (l):- This gives orbital angular momentum and magnetic moment of electron.

③ Magnetic quantum number (m_l):- This gives the spatial quantisation of the angular momentum and magnetic moment of electron in applied mag. field.

④ Spin magnetic quantum number (m_s):- This gives the spin angular momentum and magnetic moment due to the spin of electron.

$$m_l = \pm l, \pm(l-1), \pm(l-2), \text{---} 0$$

$$m_s = \pm 1$$

In an electron having more than one electron, the electrons may arrange themselves in different quantum state. The wave function of the electron should be antisymmetric. They obey Fermi-dirac statistics.

The antisymmetric combination of N function corresponding to the N! Permutation of the particle can be expressed in the slater determinant

$$\psi(1,2,3 \text{---} N) = \frac{1}{\sqrt{N}} \begin{vmatrix} \psi_1(1) & \psi_1(2) & \psi_1(3) & \text{----} & \psi_1(N) \\ \psi_2(1) & \psi_2(2) & \psi_2(3) & \text{----} & \psi_2(N) \\ \vdots & \vdots & \vdots & & \vdots \\ \psi_N(1) & \psi_N(2) & \psi_N(3) & \text{---} & \psi_N(N) \end{vmatrix}$$

When ever two or more rows of the determinant are identical, the determinant vanishes. So that two or more fermions of a system can't occupy the same state. This principle is K/a Pauli's exclusion Principle.

The end.

कल starting का Topic भेजेगा।