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1) Consider a total energy operator:

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$H = H0 + H'$

Where H' is some small perturbation operator. We are interested in a problem:

$H\psi = E\psi$

In general, the degeneracy of states is connected to some symmetries, but perturbation usually has no such symmetry and for that reason the symmetry is broken and it leads to the splitting of energy levels E_n^0 and we get some set of closely laying energy levels

$E_n^0 + \Delta E_n$

Как эти два параметра связаны?

Next, we analyze how the energies E_n^0 are splatted. We restrict ourselves to the first order approximation:

$(H_0 - E_n^0)\psi_n^1 = (E_n^1 - H')\psi_n^0$

Where ψ_n^1 and E_n^1 are the first order improvements to the wave equation and energy eigenvalues. Since we operate in the subspace, corresponding to E_n^0, we take zeroth order wave function ψ_n^0 as an arbitrary linear combination of functions ψ_{nr}. Therefore, we analyze the equation:

$(H_0 - E_n^0)\psi_n^1 = \sum_{j=1}^r c_j (E_n^1 - H')\psi_{nj}$

Это какая-то новая функция или это вот эта?

Multiplying from left to ψ_{ni}^*, then integrate by $\int dV$:

$\int \psi_{ni}^*(H_0 - E_n^0)\psi_n^1 \, dV = 0$

А откуда это, почему 0?

$\sum_{j=1}^r c_j \int \psi_{ni}^*(E_n^1 - H')\psi_{nj} \, dV = 0$

Both left and right side of the previous equation is equal to zero. If follows from the fact that H_0 is a Hermitian operator.

Introducing matrix elements:

$H'_{ij} = \int \psi_{ni}^* H' \psi_{nj} \, dV$

(matrix elements in the subspace of functions ψ_{nr}, $r = 0,1\ldots r$)

By doing so we get following equations:

$\sum_{j=1}^r c_j (E_n^1 \delta_{ij} - H'_{ij}) = 0, \; i = 0,1\ldots r$

10) $A_{nm} = (\omega^3 2\pi\hbar / c^2) B_{nm}$ 0 No comments!

$\omega = (E_m - E_n) / \hbar$

$B_{nm} \approx |z_{nm}|^2$

17) The Dirac equation for a free electron can be improved by including the interaction with an external electromagnetic field. This gives the so-called Schrödinger-Pauli equation. But in this new equation, an additional potential energy appears, which looks like this $-q/(2m)\, \vec{\sigma}\vec{B}$. It is important to emphasize that the particle moves translationally in an external electromagnetic field. This means that this additional energy is associated with the interaction of an external electromagnetic field with additional internal degrees of freedom of particle related to the its own internal magnetic field - the Spin.

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