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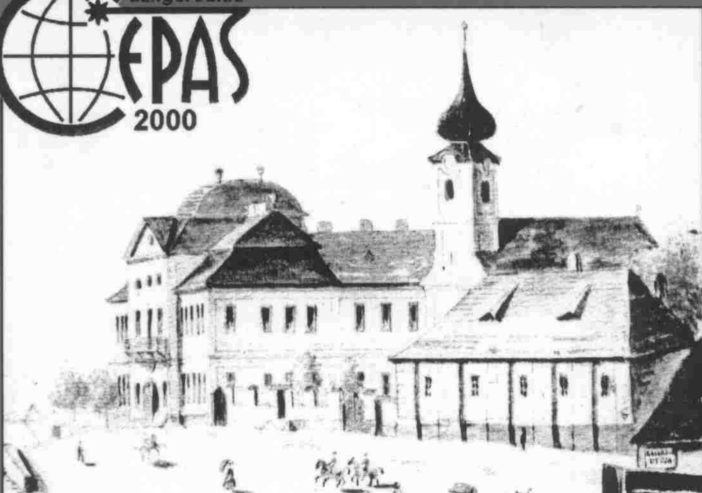

WKB-METHOD IN THE TWO-CENTER PROBLEM FOR THE DIRAC EQUATION

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The modern achievements in heavy ion acceleration technology made it possible of experimental studies of heavy ion collision processes and in particular the one-electron capture process of highly charged ions:

$$A^{(Z_1-1)+} + B^{Z_2+} \to A^{Z_1+} + B^{(Z_1-1)+}, \; Z_1, Z_2 >> 1 \qquad (1)$$

The theoretical description of such kind of processes reduces to correct determination exchange splitting $\Delta E = E_I - E_{II}$ of quasi-molecular terms of the system $(AB)^{(Z_1+Z_2-1)+}$, which correspond to the entrance and exit channels of the reaction (1). When Z_1 and Z_2 are very large, the relativistic effects on the motion of the active electron are not negligible and the determination of ΔE requires knowledge of the relativistic electron wavefunction. Since the Dirac equation with the potential of two Coulomb centers does not permit a complete separation of variables at any system of coordinates, the given problem does not have exact analytical solution. At the present paper we applied quasi-classical approach (WKB-method) for solving the two-Coulomb-center Dirac problem in a narrow region near the internuclear axis at asymptotically large internuclear distances R. Using this function we have derived several analytic formulae for the exchange splitting of the adiabatic potential curves $\Delta E(R)$ in the limit of long distances between interacting partners in all versions, ΔE is expressed through the known characteristics of disconnected atoms: charges of atomic (ion) cores Z_1, Z_2, asymptotic coefficients $A_{1,2}$, binding energies $\lambda_{1,2}^2/2$, and quantum numbers of the electron in the considered states of atoms (ions).

The results of the relativistic ΔE and analogous non-relativistic $\Delta E^{(n)}$ versions of the calculation of the exchange splitting between potential curves of the system (Z,e,Z) show that the relative contribution of relativistic effects amounts to about 50%, even at Z=48.