International Conference on

Mathematical Modeling and Computational Physics

MMCP 2015

Book of Abstracts

July 13 – 17, 2015
Stará Lesná, Slovakia

Joint Institute for Nuclear Research, Dubna

Institute of Experimental Physics SAS, Košice

Slovak Physical Society

University of Pavol Jozef Šafárik, Košice

Technical University, Košice

IFIN-HH, Bucharest, Romania

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Quasiclassical Approximation in the Non-Relativistic and Relativistic Problems of Tunnel Ionization of H-Like Atom by the Uniform Electric Field

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The recurrent scheme of finding the quasiclassical solutions of the one-dimensional equation obtained at separation of the Schrödinger equation in the parabolic coordinates is elaborated. By means of this scheme of WKB expansions the wavefunctions in the problem of the hydrogen-like atom in the constant uniform electric field are constructed in the classically forbidden and allowed regions. This has allowed to calculate the leading term of the asymptotic (at small intensity of electric field F) formula of probability of tunneling ionization of the H-like atom and negative ion in this field. The results of calculations show high accuracy of these formulae.

Within the paraxial Fock-Leontovich approximation, the three-dimensional version of WKB method is developed for the Dirac equation with arbitrary axially symmetrical potential of barrier type which do not permit the complete separation of variables. By means of the elaborated quasiclassical method the relativistic wave functions for H-like atom in the external constant uniform electric field are constructed in the below-barrier and classically allowed regions. The general analytical expression for leading term of the asymptotic (at small F) behaviour of ionization rate of highly charged H-like atom in the constant uniform electric field is obtained.

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