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High-order Foldy-Wouthuysen transformations of the Dirac and Dirac-Pauli Hamiltonians in the weak-field limit

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The low-energy and weak-field limit of the Dirac equation can be obtained by an order-by-order block diagonalization approach to any desired order in the parameter π/mc (π is the kinetic momentum and m is the mass of the particle). In previous work, it has been shown that, up to the order of (π/mc)^8, the Dirac-Pauli Hamiltonian in the Foldy-Wouthuysen (FW) representation may be expressed as a closed form and consistent with the classical Hamiltonian, which is the sum of the classical relativistic Hamiltonian for orbital motion and the Thomas-Bargmann-Michel-Telegdi Hamiltonian for spin precession. In order to investigate the exact validity of the correspondence between classical and Dirac-Pauli spinors, it is necessary to proceed to higher orders. In this paper, we investigate the FW representation of the Dirac and Dirac-Pauli Hamiltonians using Kutzelnigg's diagonalization method. We show that the Kutzelnigg's diagonalization method can be further simplified if non-linear effects of static and homogeneous electromagnetic fields are neglected (in the weak-field limit). Up to the order of (π/mc)14, we find that the FW transformation for both Dirac and Dirac-Pauli Hamiltonians is in agreement with the classical Hamiltonian with the gyromagnetic ratio given by g=2 and g≠2, respectively. Furthermore, with higher-order terms at hand, it is demonstrated that the unitary FW transformation admits a closed form in the low-energy and weak-field limit.

Biography

Tsung-Wei Chen has completed his PhD from National Taiwan University, Department of Physics. He is currently working as an Assistant Professor at National Sun-Yatsen University.

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