Physics of singular self-adjoint extension of one-dimensional Schrödinger and Pauli operators

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We consider boundary conditions (self-adjoint extensions) corresponding to point-like interactions for one-dimensional Schrödinger and Pauli operators. In the case of free spinless particle (Schrödinger operator) we demonstrate that non-standard singular self-adjoint extensions X_2 and X_4 considered by Pavel Kurasov in [1], can be described by the position-dependent mass Hamiltonian with a qualitatively different of the effective-mass profiles. In addition, these extensions also differ with respect to the time reversal symmetry. Namely, X_2 - case has quantized magnetic flux which was missed in previous works, while X_4 -case is of pure potential, i.e. "electrostatic" nature. Thus, according to the classification of singular self-adjoint extensions considered by us in [2], we have two extensions X_1, X_4 of the potential nature and two extensions X_2, X_3 where there is a magnetic field. In case of spin-1/2 (Pauli operator) we show that there are boundary conditions with spin-flip mechanism. We suggest the physical interpretation these point-like extensions in terms of the Rashba (spin-orbital) coupling.

The authors thank Prof. Vadim Adamyan for clarifying comments and discussions.

1. Kurasov P. Distribution Theory for Discontinuous Test Functions and Differential Operators with Generalized Coefficients. Journal of Mathematical Analysis and Applications, 1996, 201, 297-323.
2. Kulinskii V.L., Panchenko D.Yu. Physical structure of point-like interactions for one-dimensional Schrödinger operator and the gauge symmetry, 2015, 472, 78-83.