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Spectrum of electron states in a charged atomic chain within the Dirac description

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It is demonstrated that the description of electron states in a one-dimensional crystal with account of electron spin should be based on the Dirac theory. Electron spin states are determined by the eigen states of the spinor invariants with their free parameters.

It is shown that in the case of atomic chain with the cylindric symmetry integrals of motion include a set of spinor operators corresponding to different spin states. Electrons bound by a charged atomic chain, are shown to attain one-dimensional character of motion and can have arbitrary spin orientation corresponding to the particular chosen spinor invariant. The general solution of the Dirac equation for a one-dimensional crystal is obtained analytically and is shown to be independent of the choice of the spinor invariant(s). It includes free parameters which have the meaning of spin variables and can be fixed corresponding to the concrete spinor invariants determined by the symmetry of the system and experiment conditions.

The spectrum of bound electrons in atomic chain is calculated. The electron band structure is shown to be characterized by the principal quantum number n so that the corresponding energy bands are split into n subbands describing their fine structure.

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