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Grey solitons in the ultracold fermions at the full spin polarization

© Pavel A. Andreev

Faculty of physics, Lomonosov Moscow State University,
Moscow, Russian Federation

E-mail: andreevpa@physics.msu.ru

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A minimal coupling quantum hydrodynamic model of spin-1/2 fermions at the full spin polarization corresponding to a nonlinear Schrödinger equation is considered. The nonlinearity is primarily caused by the Fermi pressure. It provides an effective repulsion between fermions. However, there is the additional contribution of the short-range interaction appearing in the third order by the interaction radius. It leads to the modification of the pressure contribution. Solitons are considered for the infinite medium with no restriction on the amplitude of the wave. The Fermi pressure leads to the soliton in form of the area of decreased concentration. However, the center of solution corresponding to the area of minimal concentration has nonzero value of concentration. Therefore, the grey soliton is found. Soliton exist if the speed of its propagation is below the Fermi velocity.

Keywords: degenerate fermions, hydrodynamics, non-linear Schrödinger equation, dark soliton, Fermi pressure.