Spin 3/2 Particle: Fradkin Theory, Non-Relativistic Approximation

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Abstract: It is well-known the relativistic wave equation for a spin 3/2 particle proposed by Pauli and Fierz and based on the use of the wave function with transformation properties of vector-bispinor. Less known is the Fradkin theory based of the vector-bispinor wave function as well. At vanishing additional Fradkin parameter Λ this equation reduces to the Pauli - Fierz theory. To clarify the physical meaning of additional parameter Λ, in the present paper the nonrelativistic approximation in Fradkin theory is studied, at this we take into account the presence of external electromagnetic fields. With the use of the technique of projective operators, we decompose the wave function into big and small constituents, and then derive a generalized nonrelativistic equation for a 4-component wave function. It is shown that when preserving only the terms of the first order in Fradkin parameter Λ there arises the ordinary nonrelativistic equation for Pauli - Fierz theory without any additional interaction terms with electromagnetic elds. When preserving the terms of the second order in parameter Λ, we obtain nonrelativistic equation with additional interaction, however only with magnetic field. This interaction is quadratic in magnetic field components and is governed by six 4-dimensional matrices. So the Fradkin theory may be understood as relevant to a particle whether with magnetic polarisability or magnetic quadrupole moment.

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