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Covariance and noncovariance of relativistic spin equations

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To solve difficult problems of nuclear spin physics like the proton spin crisis physicists should perfectly understand what spin is. There are a few correct definitions of the relativistic spin operators [1]: Dirac spin definition and two Foldy-Wouthuysen spin definitions coupled with the center-of-charge and center-of-mass position operators. The conventional definition explicitly or implicitly uses the Foldy-Wouthuysen representation and presents the total angular momentum as a sum of the orbital angular momentum defined in the laboratory frame and the spin defined in the particle rest frame. It has been proven [2] that this definition leads to noncovariant spin equations. Two other definitions result in covariant spin equations but are not convenient.

[1] Liping Zou, Pengming Zhang, and A. J. Silenko, Position and spin in relativistic quantum mechanics, Phys. Rev. A 101, 032117 (2020).

[2] A. A. Pomeransky, R. A. Senkov, and I. B. Khriplovich, Spinning relativistic particles in external fields, Usp. Fiz. Nauk 43, 1129 (2000) [Phys. Usp. 43, 1055 (2000)].

Section

Nuclear structure: theory and experiment

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