Spin: Nonlinear zero dynamics of orbital motion

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Abstract

A formal proof is given to show that the prevailing historical view of treating the Schrödinger's wave mechanics as a spinless theory is a great misunderstanding and that finding the fourth quantum number outside the Schrödinger equation is indeed superfluous. The spin dynamics inherent in the Schrödinger equation has long been overlooked since the inception of wave mechanics. We point out that from the original viewpoint of the Schrödinger equation without any additional interpretation, spin is not a motion with new degree of freedom beyond orbital motion; instead, it is the zero dynamics of orbital angular momentum. To manifest this point, the experiment performed in 1927 by Phipps and Taylor about the beam deflection of hydrogen atoms is revisited here to show how the Schrödinger equation correctly predicts the existence of the spin angular momentum $\pm\hbar/2$ when the orbital quantum number l is zero. Apart from spin angular momentum, the Schrödinger equation also provides us with the nonlinear dynamics describing both the spin and orbital motion, from which spin quantization can be derived and the interaction between spin and orbital motions can be clearly demonstrated. This discovery allows us to include and analyze spin effect in any non-relativistic

quantum mechanical systems by merely using the nonlinear dynamics derived from the Schrödinger equation.