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Executive Summary

New perspectives on the Orbital Angular Momentum Operator's Eigenvalue Problem

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The rules of quantum theory are not in conflict with non-integer angular momentum values, which have been considered on a few occasions from various angles. Majorana pointed out in 1932 that the theory of infinite dimensional representations of the Lorentz group's general formulation of a one-particle problem enables a solution with any angular momentum within the context of relativistic quantum mechanics. This paper reports a solution to the eigenvalue problem for the quantum-mechanical orbital angular momentum operator (hereafter referred to as angular momentum operator) obtained when only the physical requirement is imposed on the eigenfunction and demonstrates that the eigenfunctions with both integer and non-integer eigenvalues are permitted within the framework of theoretical quantum mechanics. In the context of nonrelativistic quantum physics, the eigenvalue problem for the operator of angular momentum is examined in this research. The spectrum is discrete as a general conclusion; specifically, |m|=Lk with k being integer, k=0, 1, ..., [L], where [L] is the integer fraction of L. No physical principle is violated because L and m can both be integer and non-integer. This stands in stark contrast to the well-known statement that m and L can only be integers or half-integers because of theoretical quantum physics. The result reached here does not impose any non-physical constraints of either periodicity of the wave function or postulating that moving with the step size 1 and starting from a state with m=−L, one should arrive at the state with m=+L and vice versa, which explains the conflict. In the general case, there is no restriction on L and m to be integer only when the only requirement imposed on a wave function is the physical requirement of the normalizability, i.e., when the periodicity requirement for a wave function is lifted or when a different pair of linearly independent functions is chosen. The problem can only be considered from a physics perspective if all non-physical conditions are dropped and only the physical needs are present. The eigenvalue problem for the angular momentum operator thus has a fresh quantum-mechanical solution. The fundamental finding of this research, to sum up, is that it does not follow from the framework of theoretical quantum mechanics that the eigenvalues of the angular momentum operator should only be an integer.

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KEYWORDS

nonrelativistic, quantum mechanics, angular momentum, power of a complex number