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Time-Reversal Symmetry in Non-Hermitian Systems

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For ordinary hermitian Hamiltonians, the states show the Kramers degeneracy when the system has a half-odd-integer spin and the time reversal operator obeys \Theta^2=-1, but no such a degeneracy exists when \Theta^2=+1. Here we point out that for non-hermitian systems, there exists a degeneracy similar to Kramers even when \Theta^2=+1. It is found that the new degeneracy follows from the mathematical structure of split-quaternion, instead of quaternion from which the Kramers degeneracy follows in the usual hermitian cases. Furthermore, we also show that particle/hole symmetry gives rise to a pair of states with opposite energies on the basis of the split quaternion in a class of non-hermitian Hamiltonians. As concrete examples, we examine in detail NxN Hamiltonians with N=2 and 4 which are non-hermitian generalizations of spin 1/2 Hamiltonian and quadrupole Hamiltonian of spin 3/2, respectively.

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