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PT and CPT Symmetry as a Dynamics

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Interest in discrete symmetries in particle physics is concentrated primarily in determining the degree to which they may or may not be obeyed by nature. However, with the advent of the non-Hermitian, antilinear PT-symmetry program of Bender and collaborators it has become apparent that quantum theory is richer than the standard Dirac Hermitian approach, to thereby increase the number of options available to quantum theory. Moreover, antilinear symmetry can be used as a dynamics that constrains what is allowed in physics. While interest has focused on PT itself, here we show that the fundamental antilinear symmetry is CPT. Specifically we show that if one imposes only two requirements, namely the time independence of inner products and invariance under the complex Lorentz group, it follows that the Hamiltonian must be CPT invariant. Since no Hermiticity requirement is imposed the CPT theorem is thus extended to non-Hermitian theories. We present some examples of theories that are not Hermitian but are CPT invariant. Since charge conjugation plays no role in non-relativistic physics where one is below the threshold for particle production, CPT then defaults to PT, to thus put the PT-symmetry program on a quite secure theoretical foundation.
References: P. D. Mannheim, Extension of the CPT Theorem to non-Hermitian Hamiltonians and unstable states, Phys. Lett. B 753, 288 (2016). (arXiv:1512.03736 [quant-ph]).
P. D. Mannheim, Antilinearity rather than Hermiticity as a guiding principle for quantum theory, J. Phys. A 51, 315302 (2018). (arXiv:1512.04915 [hep-th]).

Content of the contribution

Theory

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