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Noether’s theorem and its complement in multi-particle systems. (English) Zbl 1406.70018


Summary: Noether’s theorem has gained outstanding importance in theoretical particle physics, because it leads to basic conservation laws, such as the conservation of momentum and of angular momentum. Closely related to this theorem, but unnoticed so far, is a complementary law, which requires the (virtual) exchange of momentum between the particles of an isolated multi-particle system. This exchange of momentum determines an interaction. For a two-particle system defined by an irreducible representation of the Poincaré group, this interaction is identified as the electromagnetic interaction. This sheds new light on the particle interactions described by the Standard model. It resolves long-standing questions about the value of the electromagnetic coupling constant, and about divergent integrals in quantum electrodynamics.

For the entire collection see Zbl 1403.81002.

MSC:

70F10 n-body problems
70H33 Symmetries and conservation laws, reverse symmetries, invariant manifolds and their bifurcations, reduction for problems in Hamiltonian and Lagrangian mechanics
22E43 Structure and representation of the Lorentz group
81V10 Electromagnetic interaction; quantum electrodynamics
81V22 Unified quantum theories
81V45 Atomic physics

Keywords:
Noether’s theorem; multi-particle systems; Poincaré group; momentum entanglement; electromagnetic interaction; fine-structure constant

Full Text: DOI