Relativistic few-body physics

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I discuss various aspects of the relativistic few-body problem with an emphasis on differences with the non-relativistic few-body problem and the relationship of different formulations of relativistic quantum mechanics. A relativistic treatment is needed to consistently describe GeV-scale reactions where kinetic energies are of comparable size or greater than particle massses, reactions where particles can be produced, or reactions that involve strong binding. There are many different approaches to relativistic quantum mechanics. In this talk I discuss the relation between different approaches, emphasizing the similarities between methods that at first sight seem unrelated. Specifically I discuss the relation between field theoretic treatments, Euclidean treatments (Schwinger-Dyson, Lattice), covariant constraint dynamics treatments, quasipotential treatments, and particle-interaction treatments.

The unifying principle behind all of these treatments is the quantum-mechanical formulation of the principle of special relativity given by Wigner in 1939. I discuss the conceptual differences with Wigner's formulation of special relativtiy in quantum theories from the historical assumptions that predated Wigner's work.

I discuss a number of properties of relativistic quantum mechanics that are different from non-relativistic quantum mechanics, including the requirement that relativistic theories have more than one "Hamiltonian", the large number of possible definitions and relations between relativistic spin operators, two vs. four-component spinors, the difficulties in defining position operators, Lorentz covariance vs. Poincaré invariance, the difficulties with satisfying cluster properties, and the dynamical nature of spinor and tensor operators.

In the last part of the talk I discuss Poincaré-invariant particle-interaction methods, which have the closest connection to non-relativistic Faddeev methods, and discuss the nature of relativistic corrections in the context of this framework. I conclude with some representative examples.

[1] E. P. Wigner, Ann. Math., **40**,1939,1.

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