Poincaré Invariant Three-Body Scattering

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Traditionally three-nucleon calculations are carried out by solving Faddeev equations in a partial wave truncated basis, working either in momentum or in coordinate space. In Ref. [1] the Faddeev equations were solved directly as function of vector variables for scattering at intermediate energies. The key advantage of this formulation lies in its applicability at higher energies, where special relativity is expected to become relevant. We investigate relativistic three-boson scattering in the framework of Poincaré invariant quantum mechanics [2]. The main points are the construction of unitary irreducible representations of the Poincaré group, both for noninteracting and interacting particles. The application to three-body scattering is based on the Faddeev scheme, which is reformulated relativistically. The usage of Poincaré-Jacobi momenta leads to various algebraic modifications of corresponding standard nonrelativistic expressions. Due to its dependence on the total momentum, the two-body off-shell t-operator entering the Faddeev equation acquires additional momentum dependence beyond the usual energy shift which is characteristic in nonrelativistic calculations. We handle this by using a first resolvent method [3] and thus can exactly solve for the relativistic two-body operator embedded in the three-body system [4].

Comparison of the relativistic and non-relativistic calculations lead to observations the should be also relevant for realistic interactions [5, 6]. This comparison does not involve a non-relativistic limit, instead relativistic and non-relativistic three-body calculations with interactions fitted to the same two-body data are compared. All of the differences result from the different ways in which the two-body dynamics appears in the three-body problem.

References

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