GAMOW VECTORS IN THE BAKAMJIAN-THOMAS CONSTRUCTION

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Abstract.   We show that the Bakamjian-Thomas construction for relativistic direct interactions can be extended to describe resonances by irreducible representations of the causal Poincaré semigroup. These representations are generated by a Poincaré algebra that incorporates interactions and are characterized by the complex pole position and spin of the resonance.

1. Inroduction

Unitary representations of the Poincaré group $\mathcal{P}$ underlie all physical theories that obey the principles of special relativity and quantum mechanics. The Poincaré group is also fundamental to classical relativistic physics. In this context, Dirac considered the problem of describing interactions between classical relativistic particles [4]. He worked within the framework of a Poincaré algebra realized by Poisson brackets of dynamical variables and did not make ancillary assumptions such as the existence of fields that mediate the interactions. In classical relativistic mechanics, Dirac's problem does not have a non-trivial solution if the particles are subjected to the (unphysical) constraint of having covariant world-lines. World-line constraints do not certainly hold in the quantum setting, and Bakamjian and Thomas (BT) gave the first explicit construction of a class of relativistic quantum direct interaction theories for two particles [2]. The key theoretical idea of this work, which we will refer to as the BT construction, is that interactions can be introduced as a perturbation to the invariant mass operator $M = M_0 + \Delta M$, much like in the non-relativistic case where the Hamiltonian absorbs the interactions, $H = H_0 + V$. Interaction incorporating self-adjoint operators that furnish a realization of the Poincaré algebra can be induced from this interacting mass operator M and the interaction-free two particle generators of the Poincaré transformations. Here, it is possible to choose a kinematic subalgebra that remains unaffected by the interactions, leading to different forms of dynamics [4]. Sokolov