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Exploring 9x9 Integrable Hermitian Hamiltonians via the Boost Operator Method

Quantum integrable models possess a sufficiently large number of conserved quantities in involution. As a result, these models often admit mathematical methods that enable the construction of exact solutions, even in the presence of complex physical properties such as nonlinearity and dispersion. Consequently, they are of great interest across various areas of theoretical and mathematical physics. In this context, the discovery and classification of new integrable models constitute a significant and active research field.

Among the various approaches, the Boost Operator Method is a novel technique used to identify integrable spin chain models. The core of this method lies in finding the R-matrix, the mathematical entity that characterizes integrable models, associated with a given Hamiltonian. This is achieved by employing an operator capable of generating the hierarchy of conserved charges starting from the Hamiltonian.

In this work, we discuss this method and present results concerning the classification of 9×9 Hermitian Hamiltonian models. These models can be physically interpreted as a system with two-site interactions, where each site can occupy three distinct states. Considering the basis $\mathcal{V} = \{|0>, |->, |+>\}$, the states $|\pm>$ represent the presence of a particle at a site, while $|0>$ denotes an empty site, leading to a 9×9 Hamiltonian matrix. The imposed Hermitian condition ensures a real energy spectrum.

Specifically, we analyze a model that allows for the creation and annihilation of $|->$ particles at the sites, in addition to particle swapping, resulting in a 29-vertex Hermitian Hamiltonian model. Through this classification, we identify a new family of integrable models.

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