Contribution ID: **65** Type: **Poster**

Asymmetric Bethe Ansatz

Sunday, 10 September 2023 22:40 (20 minutes)

The recently proposed exact quantum solution for two δ-function-interacting particles with a mass-ratio 3:1 in a hard-wall box [Y. Liu, F. Qi, Y. Zhang and S. Chen, iScience 22, 181 (2019)] seemingly violates Gaudin's necessary condition for the Bethe Ansatz integrability of a system of semitransparent δ-function mirrors. This condition requires that if two mirrors cross at a dihedral angle π/(odd integer), they must be assigned equal coupling constants. In our article, we find a way to relax this condition. It turns out that one can take a conventional integrable system and replace some of its semi-transparent mirrors by a set of perfectly reflecting ones provided that it is represented by the mirrors of a reflection subgroup of the symmetry group of the original system. This subgroup is not required to be symmetric with respect to the symmetries original system, hence the proposed name for the method: Asymmetric Bethe Ansatz (ABA). We show that the exact solution of the Liu-Qi-Zhang-Chen problem is a particular instance of the ABA, where the symmetry of an infinite hexagonal lattice of δ-function plates is broken via superimposing it with a rectangular chamber of perfect mirrors.

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Session Classification: Poster Session I

Track Classification: Quantum Gases in Low Dimensions