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Adiabatic eigenstate deformations and weak integrability breaking of Heisenberg chain

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We consider the spin-1/2 XXX chain weakly perturbed away from integrability by an isotropic next-to-nearest neighbor exchange interaction. Recently, it was conjectured that this model possesses an infinite tower of quasiconserved integrals of motion (charges) [D. Kurlov et al., Phys. Rev. B 105, 104302 (2022)]. In this work we first test this conjecture by investigating how the norm of the adiabatic gauge potential (AGP) scales with the system size, which is known to be a remarkably accurate measure of chaos. We find that for the perturbed XXX chain the behavior of the AGP norm corresponds to neither an integrable nor a chaotic regime, which supports the conjectured quasi-integrability of the model. We then prove the conjecture and explicitly construct the infinite set of quasiconserved charges. Our proof relies on the fact that the XXX chain perturbed by next-to-nearest exchange interaction can be viewed as a truncation of an integrable long-range deformation of the Heisenberg spin chain.

Primary author: TIUTIAKINA, Anastasiia (Laboratoire de Physique Théorique et Modélisation)

Presenter: TIUTIAKINA, Anastasiia (Laboratoire de Physique Théorique et Modélisation)

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