凝縮系物理学ゼミナール
Condensed Matter Seminar

Date: 13:30-15:00, Wednesday, 26 October 2022

Title: Universal properties of dissipative Tomonaga-Luttinger liquids with and without internal symmetry

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Abstract:

In recent years, open quantum systems have been actively studied both experimentally and theoretically, as exemplified by driven-dissipative many-body systems and non-Hermitian (NH) quantum systems. In particular, high controllability of ultracold atoms has facilitated investigations of NH quantum systems [1].

In this seminar, we demonstrate universal properties of dissipative Tomonaga-Luttinger (TL) liquids with and without internal symmetry by deriving correlation functions and performing finite-size scaling analysis. We first analyze a NH XXZ spin chain as a prototypical correlated model in one-dimensional (1D) open quantum systems [2]. Our calculation is based analytically on the field theory with bosonization, the finite-size scaling approach in conformal field theory (CFT), and the Bethe-ansatz (BA), and numerically on the density-matrix renormalization group analysis generalized to non-Hermitian systems. Importantly, we uncover that the model belongs to the universality class characterized by the complex-valued TL parameter in the massless regime.

Then, time permitting, we generalize the above results to the one with SU(N) spin symmetry, by using asymptotic BA and CFT [3]. We uncover that the spectrum is described by the sum of one charge mode characterized by a complex generalization of c = 1 U(1) Gaussian CFT, and N −1 spin modes characterized by level-1 SU(N) Kac-Moody algebra with the conformal anomaly c = N −1, and thereby dissipation only affects the charge mode as a result of spin-charge separation. The derivation is based on a complex generalization of Haldane's ideal-gas description, which is implemented by the SU(N) Calogero-Sutherland model with inverse-square long-range interactions.

Reference:

[1] K. Yamamoto, M. Nakagawa, K. Adachi, K. Takasan, M. Ueda, and N. Kawakami, Phys. Rev. Lett. **123**, 123601 (2019).

[2] K. Yamamoto, M. Nakagawa, M. Tezuka, M. Ueda, and N. Kawakami, Phys. Rev. B **105**, 205125 (2022).

[3] K. Yamamoto and N. Kawakami, arXiv:2207.04395