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Quantum Description of Impurities - Heavy Quarks and Quarkonia

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Single heavy quark system has been considered as a hard probe for dynamical information of quark-gluon plasma (QGP), namely drag force, while heavy quarkonium has been thought to probe static information, such as heavy quark potential. However, this intuitive picture is not correct, in particular for the latter. Recent theoretical developments have shown that dynamical feature is also important in the physics of heavy quarkonia through complex heavy quark potential [1]. This complex potential can be understood as stochastic process in the medium [2]. However, as pointed out in [2], complete description must also explain the irreversible process, which results in drag force in the classical limit. In other words, a unified description of heavy quark systems is required.

In this presentation, I will develop such a quantum description for heavy quark systems in QGP on the basis of closed-time formalism in non-equilibrium field theory. In this description, I will explain how we can obtain the stochastic process and the drag force from the first principle and derive the master equation for quantum evolution of the heavy quark systems.

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Primary author: AKAMATSU, Yukinao (Nagoya University)

Presenter: AKAMATSU, Yukinao (Nagoya University)

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