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Master equations of quarkonia in the Lindblad form

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Understanding the quantum dynamics of quarkonia is essential in the description of bottomonia and charmonia in the quark-gluon plasma. So far, it has been quite naively assumed that their dynamics can be described by the Schrödinger equation with in-medium, screened potential. Such a naïve approach is not correct anymore, in particular if one wants to study their time-evolution. After the discovery of imaginary part in the in-medium potential [1], it must be recognized that quarkonia should be viewed as open quantum systems in the environment of quark-gluon plasma [2].

In the open quantum system, master equation instead of the Schrödinger equation describes the quantum dynamics of quarkonia. Open quantum system techniques, such as influence functional approach, have been applied to quarkonia [3]. In this presentation, I will summarize developments in this approach and show an additional step toward a more complete description. In particular, I will show how to obtain the Lindblad-form master equation, which preserves the complete positivity of the density matrix of the system [4].

References:

[1] M. Laine et al., JHEP 0703 (2007) 054; JHEP 0705, 028(2007); A. Beraudo, J. P. Blaizot and C. Ratti, Nucl. Phys. A806, 312 (2008); N. Brambilla, J. Ghiglieri, A. Vairo and P. Petreczky, Phys. Rev. D 78, 014017 (2008); A. Rothkopf, T. Hatsuda and S. Sasaki, Phys.Rev.Lett. 108 (2012) 162001.

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[3] Y. Akamatsu, Phys.Rev. D87 (2013) 045016.

[4] Y. Akamatsu, in preparation.

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