**Comparing two mapping formalisms for mixed quantum-classical simulations of complex systems**

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Molecular dynamics simulations on multiple electronic states are important in understanding photochemical processes in complex systems. One of widely studied examples is the excited-state proton transfer in solvated pigment molecules. In this example, there are many degrees of freedom in pigment and solvent molecules which are intractable for full quantum mechanical descriptions. Instead, by combining quantum mechanical and classical mechanical treatments, one can carry out quantum dynamics simulations for important degrees of freedom and classical simulations for remaining ones. These hybrid methods are called as mixed quantum-classical (MQC) approaches. Several MQC algorithms were developed under mapping formalisms, which relate the dynamics in many electronic states to that of fictitious harmonic oscillators. These algorithms can be applied to all-atom molecular dynamics simulations of electronically excited systems. However, there is still a constant need for improving existing algorithms suitable for describing more complex systems in more efficient manner. To this end, I will present the analyses of two MQC approaches based on mapping formalisms, Poisson bracket mapping equation (PBME) and forward-backward trajectory solution (FBTS) of quantum-classical Liouville equation (QCLE). First of all, I will focus on the error of approximate PBME and FBTS of QCLE which should be accumulated in the long-time simulations. With our simulation results for two-state models, I will discuss how approximations made in deriving these approaches affect the population dynamics.