THE UNIVERSITY OF CHICAGO

COMPUTATIONAL AND APPLIED MATHEMATICS STUDENT SEMINAR

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Transition Path Theory and Sudden Stratospheric Warming

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Jones 226, 5747 South Ellis Avenue

ABSTRACT

Many dynamical systems in nature exhibit bistability: they spend most of their time in a few stable regions of phase space, but intermittently travel from one state to another as a result of random perturbations, drifting background parameters, or inherent chaoticity. These transitions are the primary object of interest in (for example) molecular dynamics as a model for a protein undergoing conformational change. Transition path theory is a mathematical framework to characterize the statistics of such reaction paths. Through solutions of elliptic PDEs, transition path theory yields probability densities and currents, reaction rates, and 'committor' functions, which parametrize the progress from reactant to product. I will present a mathematical introduction to transition path theory as well as computational examples, both for a simple illustrative double-well potential and for a reduced atmospheric model of sudden stratospheric warming. The latter is an occasional violent transition in the stratospheric jet stream, which can induce extreme weather events in the troposphere. Our work is ongoing to apply transition path theory to sudden stratospheric warming to identify early warning signs and physical onset mechanisms.

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