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Realisation of constraints in stochastic Langevin and port-Hamiltonian dynamics

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The realisation of constraints by strong confining forces is a classical theme in mechanics. Constraining a mechanical system typically leads to a differential algebraic equation of differential index 3. Recently, there has been a growing interest in studying constrained stochastic differential equations, due to their relevance in molecular dynamics, material science, computational statistics, or machine learning.

In this talk, I will discuss the realisation of algebraic constraints on stochastic differential equations with degenerate noise, specifically, Langevin-type systems and closely related port-Hamiltonian systems. The constraints are realised by adding stiff confinement terms that penalise deviations of the stochastic dynamics from the constraint surface. In doing so, we focus on two aspects: (1) the pathwise approximation of the constrained dynamics by an unconstrained one with a strong confining force, (2) the preservation of structural properties, such as stability or invariant measures.

This is joint work with Lara Neureither (Cottbus) and Upanshu Sharma (Sydney).

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