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"Chebyshev methods with discrete noise: the tau-rock methods"

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Review

The motivation for this work comes from computational considerations for models in chemical kinetics. The models in question can be formulated as stochastic differential equations (SDEs) with discrete (Poissonian) noise and very often contain multiple timescales. To mitigate the efficiency issues involved in resolving these timescales, semi-implicit methods have been designed previously. However, for stochastic problems, multiscale behavior cannot generally be handled efficiently by turning to implicit methods.

In this paper so called tau-ROCK methods are introduced as time-stepping methods for these processes. The basic idea behind ROCK methods is to exploit properties of the Chebyshev polynomials and construct explicit methods of arbitrary orders and yet good stability properties. The order is controlled by varying the number of stages and, in turn, the stability doman depends on a certain damping parameter.

After stating the new methods, a simple linear scalar problem is considered as a test equation. Stability conditions and errors in the first two moments at equilibrium are obtained explicitly. Three models are examined numerically and it is seen that for nonlinear terms and a sufficient large variance at equilibrium, the efficiency unfortunately deteriorates.

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