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Simulating Complex Langevin at short real-times with stable implicit solvers

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We present recent results [1] in which we apply unconditionally stable stochastic partial differential equations solvers [2] to complex Langevin in real-time [3]. This allows us to avoid runaway solutions in principle and enables simulations at relatively large Langevin step size. We show that implicit schemes act as a regulator of the underlying path integral and give a heuristic estimate of the errors introduced by the discrete Langevin evolution. Due to the intrinsic regularization of the implicit scheme, we are able to simulate the quantum anharmonic oscillator on the canonical real-time contour (at short real-times). In turn, for the first time, we gain access to both the forward and backward correlators close to the real-time axis (D>, D<) required for the determination of the system spectral function. Concrete examples in and out-of thermal equilibrium are presented.

[1] D. Alvestad, R. Larsen, A. Rothkopf, arXiv:2105.02735

[2] P. Kloeden, E. Platen, Numerical Solution of Stochastic Differential Equations (1992).

[3] J. Berges, S. Borszanyi, D. Sexty, I.-O. Stamatescu, Phys.Rev.D 75 (2007) 045007

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