Convergence analysis of a finite volume scheme for a stochastic Allen-Cahn problem

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We address the convergence analysis of a numerical scheme for an Allen-Cahn problem with constraint and with a stochastic external force given by a multiplicative noise of Itô type. The problem is set up in a bounded spatial domain of dimension 2 or 3 and homogeneous Neumann boundary conditions are considered.
We propose a time-space discretization, of semi-implicit Euler-Maruyama type with respect to time and a Two-Point Flux Approximation (TPFA) with respect to space for a regularized version of the constrained problem. Under the assumption $\Delta t = \mathcal{O}(\epsilon^{2+\theta})$ for a positive θ on the time parameter Δt and the regularization parameter ϵ we show the convergence our scheme towards the unique variational solution of the problem.