Numerical Solution of two-dimensional parabolic SPDEs using a Galerkin exponential time differencing scheme combined with a boundary integral formulation

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In this talk, we consider the numerical solution of two-dimensional parabolic stochastic partial differential equations (SPDEs). While the research on theory as well as numerics of SPDEs is growing rapidly, little to no effort has been made to solve SPDEs on two-dimensional domains that are more general than a rectangle. In this work, we aim to solve SPDEs on the much more general class of star-shaped domains by using a numerical Galerkin scheme developed by Jentzen and Kloeden in 2008. The scheme approximates the solution as a truncated Fourier sum with coefficients that vary in time, with a suitable orthonormal basis of the space of square integrable functions on the domain under Dirichlet boundary conditions. We use the Dirichlet eigenfunctions as a basis, which we find via translating the problem into a boundary integral formulation involving a double layer potential. The density in this layer potential as well as the boundary of the domain are approximated piecewise using quadratic Lagrange polynomials. The resulting discretized nonlinear eigenvalue problem can be reduced to a linear eigenvalue problem and then solved using Beyn's integral algorithm. We will present examples for the numerical solution of an SPDE on two-dimensional domains, as well as an outline of an error analysis and possible applications.