Shape uncertainty quantification for scattering transmission problems

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In this talk we address the issue of quantifying how shape variations affect the optical response of a nano-sized scatterer to some electromagnetic excitation. We illustrate the method on the *Helmholtz transmission problem* with an incoming plane wave, focusing on the case of a particle in free space. In the framework of the so-called deterministic approach, we provide a high-dimensional parametrization for the interface. Each domain configuration is mapped to a nominal configuration, obtaining a problem on a fixed domain with stochastic coefficients. For the discretization of the parameter space, we present an adaptive Smolyak algorithm for sparse stochastic collocation. Realizations of the quantity of interest at the selected collocation points are then computed via a finite element discretization. The sparse adaptive Smolyak algorithm allows to achieve high order convergence rates independent of the parameter space dimension, under some smooth parameter-dependence of the quantity of interest. We discuss the fulfillment of these smoothness assumptions in our framework. In particular, such requirements do not hold for values of the solution at points not on the nominal spatial domain but on the physical domain if these points are crossed by the interface for some parameter realizations. In this case, we present numerical experiments where high order methods such as sparse stochastic collocation fail to converge, while the multilevel Monte Carlo (MLMC) algorithm still exhibits the convergent behavior predicted by the theory.