Optimal shape and location of actuators or sensors in PDE models

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We investigate the problem of optimizing the shape and location of actuators or sensors for evolution systems driven by a partial differential equation, like for instance a wave equation, a Schrödinger equation, or a parabolic system, on an arbitrary domain Omega, in arbitrary dimension, with boundary conditions if there is a boundary, which can be of Dirichlet, Neumann, mixed or Robin. This kind of problem is frequently encountered in applications where one aims, for instance, at maximizing the quality of reconstruction of the solution, using only a partial observation. From the mathematical point of view, using probabilistic considerations we model this problem as the problem of maximizing what we call a randomized observability constant, over all possible subdomains of Omega having a prescribed measure. The spectral analysis of this problem reveals intimate connections with the theory of quantum chaos. More precisely, if the domain Omega satisfies some quantum ergodic assumptions then we provide a solution to this problem. These works are in collaboration with Emmanuel Trélat (Univ. Paris 6) and Enrique Zuazua (BCAM Bilbao, Spain).