Singular optimal solutions of stochastic pumps

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The investigation of optimal processes has a long history in the field of thermodynamics. It is well known that finite-time processes that minimize dissipation often exhibit discontinuities. We use a combination of numerical and analytical approaches to study the driving cycle that maximizes the output in a simple model of a stochastic pump: a system driven out of equilibrium by a cyclic variation of external parameters. We find that this optimal solution is singular, with an infinite rate of switching between sets of parameters. The appearance of such a singular optimal solution in a thermodynamic process is surprising. Nevertheless, we argue that such solutions are expected to be quite common in models whose dynamics exhibit exponential relaxation, as long as the driving period is allowed to be arbitrarily short. Our results have implications to artificial molecular motors that are driven by a cyclic variation of parameters.