On the Pekar process and its connection with the polaron problem

The polaron describes an electron coupled to a polar crystal. A particular Hamiltonian was proposed by Herbert Froehlich. Already Feynman formulated the problem in terms of path integrals which leads to a three dimensional Brownian motion with a singular, and attractive, interaction kernel. By a simple rescaling, this can be viewed as one-dimensional statistical mechanics model with a Kac-type interaction. A long-standing open problem is the asymptotics of the effective mass for the Froehlich polaron in the strong coupling limit. In the celebrated paper by Donsker and Varadhan (Comm Pure Appl Math, 1983), the asymptotics of the ground state energy is considered. The effective mass is however more delicate, and is closely tied to the path behavior. In a heuristic derivation by Spohn (Phys Rev B, 1986), this problem is related to the behavior of a stochastic process that Spohn called the “Pekar process.”

The problem about the asymptotics of the effective mass is mathematically still open. In work with Koenig and Mukherjee (Comm Pure Appl Math, 2017), we construct rigorously the Pekar process as the asymptotic limit of the Brownian motion with the singular pair interaction. I will also discuss the conjectured relation with the original problem.

Lecture 1:  Thursday, April 5, 4:30pm – Sloan Center Room 380W
Lecture 2:  Monday, April 16, 4:00pm – Sequoia Hall Room 200