The advent of nano-instrumentation has led to a surge of "single particle tracking" experiments, wherein the dynamics of one or more observables of a biophysical system are recorded at extremely high accuracy and resolution. Central to the modeling of such experiments is the Generalized Langevin Equation (GLE), a stochastic model for interacting particle systems encoding the fundamental laws of motion.

Alas, the GLE is a stochastic integro-differential equation, all but invariably lacking a closed-form solution. I will discuss two ongoing efforts to render the GLE more tractable: (i) the explicit representation of any continuous stationary-increments Gaussian process as a linear GLE, and (ii) the approximate simulation of nonlinear GLEs to arbitrary accuracy. These results are motivated by recent analyses of subdiffusive pathogen dynamics in pulmonary mucus, and of the curious behavior of water molecules in the vicinity of a protein.