Charged ions in magnetic field: Effects of the stochastic forces

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Ions are the most important components in biological systems other than deoxyribonucleic acid and proteins. They have an important role in signalling processes, are functional parts of the proteins, etc. Thus it is crucial to understand their behavior in various conditions. In this work, we consider a charged ion in a uniform magnetic field and confined potential. Also, it is coupled to a thermal bath, which will resemble the biological environment. To get non-trivial results we add colored (correlated) noise and add memory to the friction forces.

We write down the generalized Langevin equation (GLE) for the ion. The colored noise complicates things, and we derived approximate analytical results only for a limited set of potentials. However with the help of numerical methods we tested the validity of these results for more complicated nonlinear potentials.

It turns out that for a certain range of parameters of the model, the dynamics of the particle is deterministic despite high friction and stochastic forces from the environment. We tested this result by solving GLE numerically. These equations are stochastic differential equations, therefore advanced numerical methods were used.