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Simulation of ultracold plasmas using the Monte Carlo method
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After creation of the ultracold plasma, the system is far from equilibrium. The electrons equilibrate among themselves and achieve local-thermal equilibrium on a time scale of few nano-seconds. The ions on the other hand expand radially due to the thermal pressure exerted by the electrons, on a much slower time scale (microseconds). Molecular dynamics simulation can be used to study the expansion and equilibration of ultracold plasmas, however a full micro second simulation are computationally exorbitant. We propose a novel method using Monte Carlo method for simulating long timescale dynamics of a spherically symmetric ultracold plasma cloud [1]. Results from our method for the expansion of ion plasma size, and electron density distributions show good agreement with the molecular dynamics simulations. Our results for the collisionless plasma are in good agreement with the Vlasov equation. Our method is very computationally efficient, and takes a few minutes on a desktop to simulate tens of nanoseconds of dynamics of millions of particles.

[1] D. Vrinceanu, G. S. Balaraman and L. Collins, "The King model for electrons in a finite-size ultracold plasma," J. Phys. A, 41 425501 (2008)

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