Phase-space approach to strong field multi-electron dynamics

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We present a novel method of simulating the dynamics of a quantum system which has the unique advantage of requiring memory and a time-complexity which is only dependent on the volume of phase-space which is actively occupied by the system. By utilizing a basis which is bi-orthogonal to phase-space localized Gaussians, we derive a sparse representation of the state, allowing for huge savings in both storage and computation. This approach allows, for example, the simulation of concerted and sequential ionization of Helium-like atoms by very strong atto-second fields. Moreover, it is extendible to eigenstate calculations, and directly parallelizable to cluster-scale computation.