A High-Performance Framework for N-body Simulations of Galaxy-Galaxy Lensing

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Large-scale high-resolution N-body simulations provide a means for simulating the effects of gravitational lensing in the Universe. The large volume and high mass resolution of state-of-the-art simulations pose major computational challenges as they increase the total number of lenses and the computational cost per lens. Here, we report on developing a galaxy-galaxy lensing simulation framework capable of scaling to some of the largest N-body simulations. At these scales, millions of lenses are computed - each of which may require millions of particles in the computation. We have developed a fast thread-parallel algorithm for computing the optimal surface mass density - an essential component for lensing - when using the Delaunay tessellation field estimator, and introduce a technique for reducing Poisson noise. The complete lensing simulation is implemented as an OpenMP/MPI hybrid application that implements load balancing to address the highly clustered computational workload.