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Parallel MicPIC for first-principle analysis of light-matter interactions in solids CHARLES VARIN, GRAEME BART, University of Ottawa, CHRISTIAN PELTZ, THOMAS FENNEL, University of Rostock, THOMAS BRABEC, University of Ottawa — One of the main challenges in modeling laser-driven plasma physics is to properly resolve microscopic and macroscopic phenomena at the same time. For example, to resolve the propagation of a near-infrared pulse in a solid-density plasma, it is necessary to cover about four to five orders of magnitude in space—from Å to μm—to resolve both the atomic collision processes and light propagation. Here, traditional tools like molecular dynamics (MD) and particle-in-cell (PIC) fall short. With MD, light propagation is neglected. With PIC, microscopic interactions are limited to small-angle binary collisions, which restricts its use to the weakly coupled (low density) regime. To overcome the limitations of MD and PIC, we developed the MicPIC approach. It is actually being optimized for large-scale computations to effectively allow tracking 10^{10} particles with atomic-scale resolution, along with light propagation. Moreover, custom physical models are being integrated into MicPIC to include on the atomic level the different ionization channels (single and multiphoton ionization, tunnel ionization, and electron impact ionization) and the atomic polarization due to bound electrons. This promises new insight into the physics of strong-field light-matter interactions in solids.

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