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Next-Generation Realism in Extreme Astrophysical Plasma Simulations with Entity

In this talk, I will introduce Entity, a community-developed, open-source, GPU-accelerated particle-in-cell framework for large-scale simulations of collisionless plasmas. Entity's grid-agnostic architecture and use of the Kokkos performance portability library enable efficient execution across CPU and GPU platforms, making it a versatile tool for studying plasma environments from laboratory to astrophysical scales. To illustrate its capabilities, I will present recent applications to the study of magnetars—neutron stars with ultrastrong magnetic fields. We model the dissipation of magnetic energy and the resulting radiative plasma dynamics that likely power their X-ray emission. These simulations offer new insights into plasma composition, emission spectra, and temporal evolution that can be directly compared to high-energy observations.

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