PIC simulations of resonant scattering–driven plasma loading in magnetar magnetospheres

Magnetars are highly magnetized neutron stars whose X-ray emission is thought to arise from resonant scattering in their magnetospheres. Unlike pulsars, the microphysics of magnetar magnetospheres remains largely unexplored numerically because the extreme surface magnetic field produces large separation between the relevant spatial and temporal scales. To study the kinetic aspects of these magnetospheres, global Particle-in-Cell simulations are an ideal tool; however, they require high resolutions and consequently significant computational resources. To make such simulations tractable, the usual practice is to employ rescaled parameters. Global simulations then suffer from artificially large plasma scales, eventually leading to the strong resonant scattering drag becoming unphysical. We then 1) developed a 1D simulation for which we can have a high resolution per one magnetic field line in order to probe the scale separation limits, and 2) developed a GPU-accelerated *Entity* version in 2D to include physical realism (pair production across field lines) at scale.
In this presentation, I will describe the numerical implementation of the resonant scattering and its application to a 1D simulation. I will also report on the ongoing development of the 2D version.