Contribution ID: **139** Type: **Talk**

Supernova-like Collisionless Shock in the Laboratory

Friday 18 July 2025 14:35 (15 minutes)

The study of collisionless shocks and their role in cosmic ray acceleration has gained importance through observations and simulations, driving interest in reproducing these conditions in laboratory experiments using high-power lasers. In this work, we examine the role of three-dimensional (3D) effects in ion acceleration at quasi-perpendicular shocks under laboratory-relevant conditions. Using hybrid particle-in-cell simulations (kinetic ions and fluid electrons), we explore how the Alfvénic and sonic Mach numbers influence ion energization and establish scaling criteria for when 3D simulations are necessary. Our results show that while 2D simulations suffice for most laboratory-accessible shocks, 3D effects become crucial for shock velocities exceeding 1000 km/s and experiments sustaining the shock for at least 10 ns. We surveyed previous laboratory experiments on collisionless shocks and found that 3D effects are unimportant under those conditions, implying that 1D and 2D simulations should be enough to model the accelerated ion spectra. However, we do find that these experiments are realistically close to accessing the regime relevant to 3D effects, an exciting prospect for future laboratory efforts.

Collaboration(s)

Authors: ORUSA, Luca (Princeton University); Dr VALENZUELA-VILLASECA, Vicente (Princeton University)

Presenter: ORUSA, Luca (Princeton University)

Session Classification: CRD

Track Classification: Cosmic-Ray Direct & Acceleration