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Advances in astrophysical relevant particle acceleration using simulations and laser plasma experiments

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Astrophysical plasmas are efficient particle accelerators, from keV electrons in terrestrial aurorae to > 10^{20} eV Ultra High Energy Cosmic Rays of unknown provenance. The mechanisms behind these cosmic accelerators remain a long-standing mystery. Collisionless shocks and magnetic reconnection are often invoked as the dominant acceleration mechanisms, depending on whether the system energy is stored in flows or magnetic fields, respectively; however the microphysics underlying these processes and their ability to efficiently accelerate particles is not yet fully understood. The combination of first principles simulations and high-energy-density (HED) plasma experiments can play an important role in the exploration of the microphysics of particle acceleration in collisionless plasmas.
I will review how the fast progress in HED facilities and computational capabilities is creating a unique window of opportunity to push the boundaries of our understanding of particle acceleration in plasmas. In particular, I will discuss recent results from fully-kinetic 3D simulations and HED experiments that bring novel insights into the physics of energy dissipation and particle acceleration in plasmas, including collisionless shocks [1-2], jets [3], and magnetic reconnection [4-5].

References

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