Linear and Nonlinear Physics of Tenuous Beam-Plasmas Instabilities

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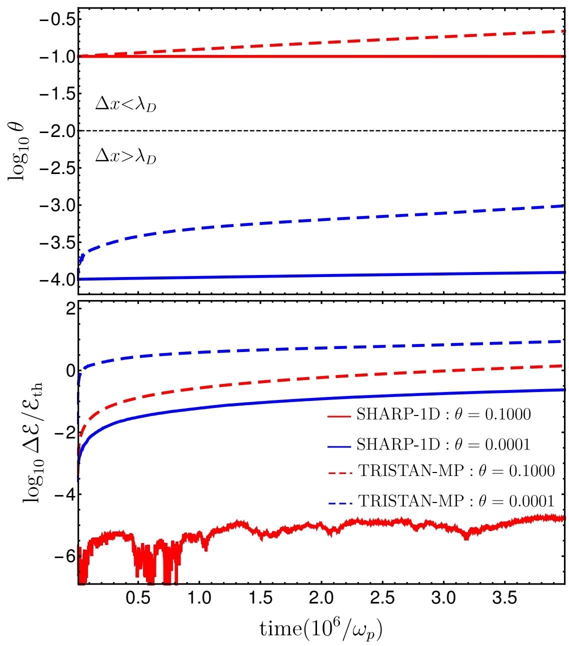
Astrophysical plasmas are ubiquitous and differ from laboratory plasmas in key aspects. They are typically cold ($k_BT \ll m_ec^2$), collisionless, and usually contain relativistic sub-populations. To study the evolution of such plasmas, it is necessary to employ a fully kinetic treatment. Particle-in-cell (PIC) algorithms combine Eulerian and Lagrangian methods to efficiently solve for the full evolution of plasmas. Due to numerical heating in PIC algorithms, exploring non-linear and long term (e.g., millions of ω_p^{-1}) evolution is inaccurate and unreliable.

We developed the SHARP algorithms [1] (1D, 1D3V, and 2D3V), which uses higher-order interpolation to great improve energy conservation while exactly conserving both the charge and the total momentum. This enables reliable explorations of the nonlinear evolution of astrophysical plasmas. The talk will prominently features this novel PIC simulations of the linear and nonlinear evolution of tenuous beam-plasmas instabilities (within inhomogeneous [2] and homogeneous [3] background plasmas) driven by pair beams that result from the propagation of TeV photons from Blazars [4].



References

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