Ion Acceleration in Driven Magnetic Reconnection during High-energy–Density Plasma Interaction

การเร่งไอออนโดยการต่อใหม่ของเส้นสนามแม่เหล็กที่ขับเคลื่อนโดยอันตรกิริยาระหว่างพลาสมาความหนาแน่นพลังงานสูง

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Understanding the mechanism for particle acceleration would provide crucial information concerning extreme astrophysical events as probed by X-rays or γ-rays. One of the promising mechanisms involves magnetic reconnection that converts magnetic energy into kinetic energy of particles. In the present work, we performed particle-in-cell (PIC) simulations of strongly driven collisions of magnetized plasmas to generate driven magnetic reconnection in a configuration more closely related to violent astrophysical collisions, and yet also closely related to present-day laboratory experiments that irradiate targets with high-intensity lasers to produce high-energy-density plasma. We find that the ion acceleration along the reconnection outflow becomes significant when there is sufficient magnetic flux embedded in low-density plasmas to set up a high-speed reconnection outflow. Additional acceleration can come from a plasmoid accelerated during the driven reconnection. This effect should be measurable in the laboratory when experiments are developed to use stronger magnetic fields.

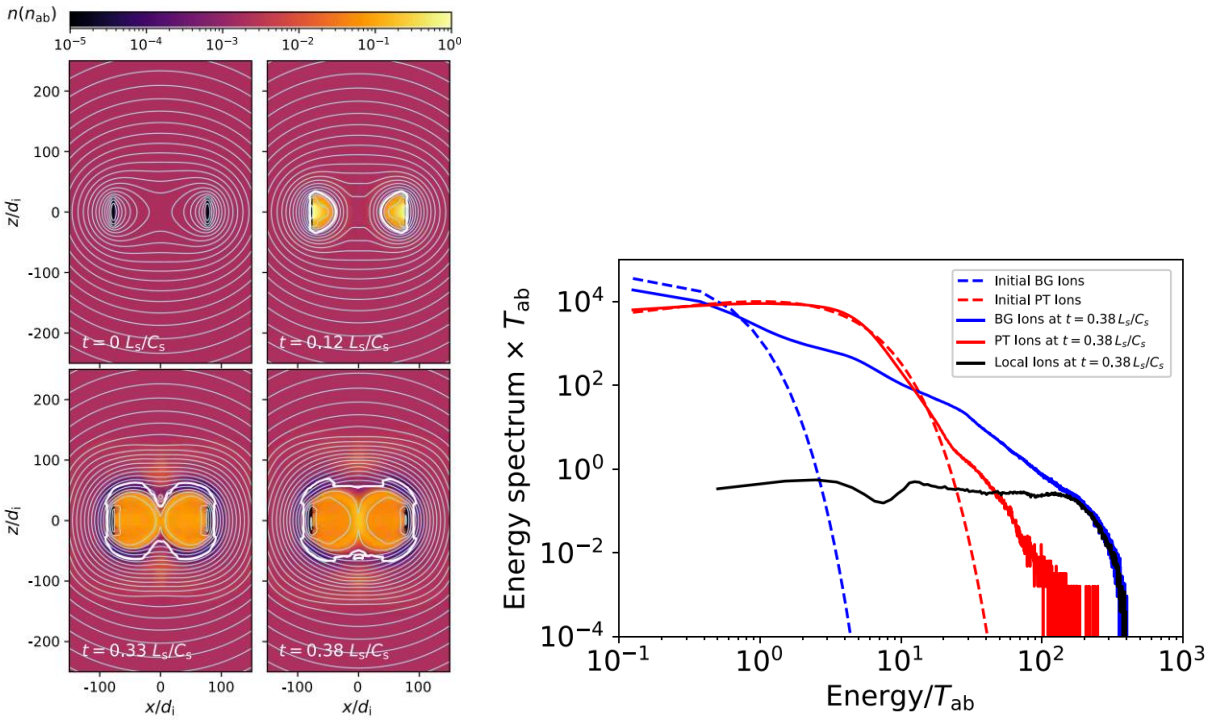

Figure: (Left) A 2.5D simulation of the interaction between piston (PT) high-energy-density plasma released from two targets (e.g., as produced by laser irradiation). The colors show the total density of plasma at various times. The blue curves represent the 2D magnetic field lines. The white curves mark the locations where PT density is equal to the background (BG) density. (Right) Energy spectra of BG ions (blue curves) and PT ions (red curves) integrated over the full simulation domain, initially (dashed) and after substantial particle acceleration (solid).