

Magnetic field amplification at planetary and astrophysical high Mach-number shocks

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Collisionless shocks are present everywhere in the universe, from the solar environment to distant supernovae. They are often associated with strong magnetic fields due to strong nonthermal radiation. However, it is still not well understood how magnetic fields are amplified at scales of the shock thickness. Here we use a set of large-scale Particle-In-Cell (PIC) simulations of non-relativistic perpendicular shocks in the high Mach number regime to clarify this issue. These shocks are Weibel mediated and we present evidence that the magnetic field is amplified at the shock transition due to the Weibel instability and the magnetic field strength strongly correlates with the Alfvénic Mach number. We propose a new explanation for this correlation. PIC simulation results can explain in-situ magnetic field measurements of Saturn's bow shock performed by the Cassini spacecraft.

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Collaboration

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Theoretical Results

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