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Magnetic field amplification driven by the relativistic shock-clump interaction

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Magnetic field amplification in collisionless shocks is required for particle acceleration and high-energy synchrotron emission in high-energy astrophysical phenomena. Recent magnetohydrodynamics (MHD) simulations of shocks propagating into inhomogeneous media show that the ambient magnetic field is amplified by turbulent dynamo in the downstream region. However, post-shock density fluctuations could easily decline in a collisionless shock due to particle diffusion, so that it is not clear whether the turbulent dynamo is driven. We investigate the interaction between a relativistic magnetized collisionless shock and a dense clump by means of Particle-in-Cell (PIC) simulation for the first time. We also perform MHD simulations for the same physical condition as the PIC simulation. The PIC simulation shows that particles escape from the dense clump along the magnetic field line. As a result, the vorticity around the shocked clump is smaller than that in the MHD simulations. Moreover, in both PIC and MHD simulations, it is found that the shocked clump quickly decelerates. Because of the escape and the deceleration, the turbulent dynamo driven by the shock-clump interaction is not efficient for relativistic collisionless shocks.

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