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The Weibel Mediated Shocks Propagating into the Inhomogeneous Plasmas

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The Weibel instability driven by plasmas with anisotropic temperature is thought to have a crucial role for magnetic fields generation and particle acceleration in relativistic shocks. Observations of afterglows of Gamma-ray bursts (GRBs) suggest that magnetic fields are amplified to about 100 times the shock-compressed value in the large downstream region of the relativistic shock. However simulations of collisionless shocks in homogeneous plasmas show that the magnetic fields generated by the Weibel instability decay rapidly. It means that the observed properties of afterglows of GRBs cannot be explained. In reality, there are density fluctuations in the interstellar medium. We proposed a new model for the generation of magnetic fields in the far downstream regions of relativistic collisionless shocks. Our model expects that relativistic shocks propagating into the inhomogeneous media make an anisotropic density structure in the downstream region. Then an anisotropic velocity distribution is generated, which generates the magnetic field by the Weibel instability [1, 2]. In this study, we perform Particle-In-Cell simulation of relativistic unmagnetized collisionless shocks propagating into the inhomogeneous plasma to confirm whether or not our model actually works. As a result, the Weibel instability is excited in the downstream region as predicted by our model and the magnetic fields are amplified in the far downstream region. In addition, we find that strong sonic waves are excited in the downstream region. Therefore the magnetic fields in the Weibel mediated shocks propagating into inhomogeneous media can occupy larger downstream regions than previously thought.

References

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