# Particle in Cell Simulation of the Weibel Instability Driven by Spatially Anisotropic Structures

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## *Abstract*

The Weibel instability occurs in collisionless plasma with the temperature anisotropy. It is thought to be important for particle acceleration and generation of magnetic fields in relativistic shocks. Observations of afterglows of gamma ray bursts (GRBs) suggest that magnetic fields are amplified in the large downstream regions of relativistic shocks. However the magnetic field produced by the Weibel Instability decays rapidly, which cannot explain observed properties of afterglows of GRBs. The nonlinear evolution of the Weibel instability has been studied in uniform plasma or shocks in uniform plasmas so far. However there are density fluctuations in the interstellar medium. For relativistic shocks propagating into the inhomogeneous plasmas, it is expected that anisotropic density structures are generated by the shock compression in the downstream regions of the shocks. We investigate the nonlinear evolution of the Weibel instability in inhomogeneous plasmas by means of two-dimensional PIC simulations. We find that spatially anisotropic density structures produce anisotropic velocity distributions. It causes that the magnetic fields are amplified by the Weibel instability. Furthermore we find that growth and damping timescales of the Weibel instability are proportional to the lengthscale of density structures. This means that magnetic fields produced by the Weibel instability can occupy larger regions than previously thought. Therefore our results can be important for the generation of magnetic fields in the afterglow of the GRBs.