Magnetic Field Generation via the Kelvin-Helmholtz Instability

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Collisionless plasma instabilities have been proposed as candidates to explain the strong magnetic fields required by models for non-thermal radiation emission in GRBs. Since these extreme scenarios are usually associated with strong and rapid variability of the ejecta, it is likely that strong velocity shears are present, and thus the collisionless Kelvin-Helmholtz Instability (KHI) can operate [1], even in the absence of an external magnetic field, and the KHI generated fields can then be amplified by the dynamo effect.
In this work we generalize the relativistic collisionless KHI calculations [1] to include arbitrary density jumps/flows and pressure effects. The growth rates, the fastest growing modes, dependencies on density ratios and pressure effects, as predicted by the linear theory, are explored and compared with 2D PIC simulations. 3D PIC simulation results are also presented, and our results are compared with the previously published MHD simulations [2]. Finally, we discuss possible experimental set-ups to explore these mechanisms in the laboratory.

References

[1] A. Gruzinov, *GRB: Magnetic Fields, Cosmic Rays, and Emission from First Principles?*, arXiv:0803.1182, 2008
[2] W. Zhang, et al., *Three-Dimensional Relativistic MHD Simulations of the Kelvin-Helmholtz Instability: Magnetic Field Amplification by a Turbulent Dynamo*, ApJ 692 L40-L44, 2009

8th International Conference on High Energy Density Laboratory Astrophysics
March 15-18, 2010
California Institute of Technology
Pasadena, California, USA
http://hedla2010.caltech.edu/