3D Study of the MHD Kelvin-Helmholtz Instability

Dongsu Ryu
Chungnam National University

Through high resolution 3D simulations, the nonlinear evolution of compressible magneto- hydrodynamic flows subject to the Kelvin-Helmholtz instability has been investigated. Periodic sections of flows that contain a thin, trans-sonic shear layer, but are otherwise uniform, have been investigated. The initially uniform magnetic field is parallel to the shear plane, but oblique to the flow itself. The most important result is that even apparently weak magnetic fields embedded in Kelvin-Helmholtz unstable plasma flows can be fundamentally important to nonlinear evolution of the instability. In our simulations twisting of the field may increase the field strength significantly. If the Alfven Mach number of flows around the Cat's Eye drops to unity or less, our simulations suggest magnetic stresses will eventually destroy the Cat's Eye and cause the plasma flow to self-organize into a relatively smooth and apparently stable flow that retains memory of the original shear. When the initial field is strong, either the flow is linearly stable, or becomes stabilized by enhanced magnetic tension due to the corrugated field along the shear layer before the Cat's Eye forms. For very weak fields the instability remains essentially hydrodynamic in early stages, and the Cat's Eye is destroyed by the hydrodynamic secondary instabilities of a 3D nature. Then, the flows evolve into chaotic structures that approach decaying isotropic turbulence.