The MHD Kelvin-Helmholtz Instability III: The roles of rotating magnetic field in a planar flows

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We have carried out simulations with respect to the nonlinear evolution of the MHD Kelvin-Helmholtz (KH) instability for compressible fluid in $2\frac{1}{2}$ dimensions. Already Frank *etal* (1996) (Paper I) have executed simulations of the MHD KH instability for compressible flow which include uniform magnetic field (M_a = 2.5 & M_a = 5) parallel to a planar flow in 2 dimensions. Continuously Jones *etal* (1997)(Paper II) have presented the nonlinear evolution of the MHD KH instability for flow containing the magnetic field which is oblique in a planar flow ($2\frac{1}{2}$D). We have extended work by Frank *etal* (1996)(Paper I) and Jones *etal* (1997)(Paper II) and performed the MHD simulations for flow including the magnetic field which smoothly rotates from z direction to x direction within a shear layer of full width 2a (a≈L/25), where L is length of computation domain, directing along the x direction in regions, $\frac{L}{2}+a$ < y < L and along the z direction in regions, 0 < y < $\frac{L}{2}-a$ we extended our work into much wide range of magnetic field strength from extremely weak magnetic field (M_a (U_0/c_a)=142.9) to even critical value (M_a = 2) stabilizing the instability in the case including parallel the magnetic field a planar flow.

In our case the result is different from that of case including parallel magnetic field on a planar flow in evolution of vortex structure, mixing of fluid, kinetic energy dissipation, and magnetic field amplification although the z direction magnetic field oblique in the planar flow didn't affect the nonlinear evolution of the MHD KH instability. Particularly structure of vortex, which is similar to cat's eye vortex showed in the hydrodynamics, is formated even in critical value required to stability and the results is due to absence of magnetic tension in the region, 0 < y < $\frac{L}{2}-a$. In disruption case of vortex, after the vortex is disrupted by magnetic tension the structure of low velocity is reformatted which is rather crump of high density than vortex and strongly wined by magnetic field.

We found that mixing of the fluid between two layers is closely connected to magnetic field strength and adequate field strength to affect mixing of fluid exists, which isn't too weak to disrupt the vortex and sufficient strong to stabilize instability. The mixing of fluid is actively developed by disruption of vortex by magnetic tension and local turbulence motion by the transient reconnection event which leads to a cascade of energy to smaller scales.