EVOLUTION OF THE MAGNETIC FIELD ORIGINATED FROM THE KELVIN-HELMHOLTZ INSTABILITY

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The Kelvin-Helmholtz instability (KHI) is studied in ionized plasma focusing on the generation of the magnetic field via the Biermann battery (baroclinic) mechanism. The instability develops at the interface between two fluids (gases, plasmas), when one component is gliding along the other.

The interest in the KHI in laser plasmas arises from the Rayleigh-Taylor instability (RTI), which has been one of the most actively explored problems within the inertial confinement fusion (ICF) investigations for decades. At the nonlinear stage of the RTI, light and hot plasma forms bubbles rising “up” and spikes of heavy matter falling “down”. The relative motion of light and heavy components results in a secondary KHI with subsequent generation of turbulence and possible mixing of the two substances. Under extreme ICF conditions, plasma motion is expected to produce an ultra-high magnetic field, which may alter the plasma flow dynamics as well as influence background magnetic and electric fields.

We solve the problem using direct numerical simulations of two counter-directed flows in 2D geometry. In contrast to general believe and previous studies of the RTI we have found that the generated magnetic field has significantly different structure as compared with the vorticity, see Fig. 1. This distinction stems from intrinsically different initial conditions for these two quantities, which is expected to be rather common for the KH plasma experiments. At the initial time instant, the magnetic field is set to zero everywhere in the domain, while the two counter-flow velocity profile inevitably leads to a certain non-zero distribution of the vorticity field.

Another important finding of the present work is that the magnetic field continues to grow even after the largest vortex has been formed and started decaying.

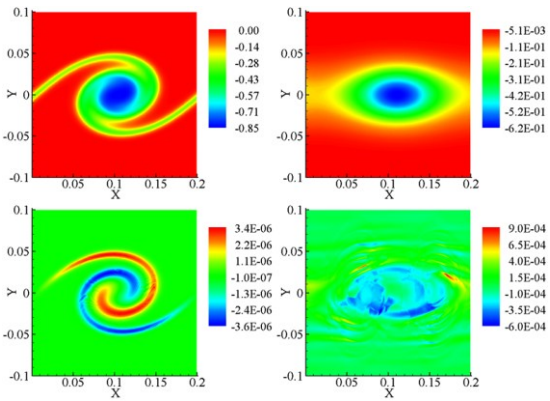

Fig. 1. Vorticity (top) and magnetic field (bottom) structures at intermediate and later stages of the KHI.