§21. MHD Instability of a Magnetic Loop with Reversed Current

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We investigate the MHD instability of a magnetic loop with a reversed current using by a three dimensional resistive MHD code. Semi-implicit numerical method is used to trace the dynamics of the magnetic loop for long time. Potential magnetic field whose root is located on the photosphere spreads in the solar corona. The magnetic loop is twisted by the horizontal motion of the plasma in the photosphere. In this case, reversed current is always formed. First we investigate the linear instability of the magnetic loop within the cylindrical geometory. The majority of MHD instabilities observed in the present simulation are identified as 'tearing' instability. These instabilities make the current shell split into many current filaments. We found that the number of the current filament depends on the current density. The growth rate of the instability also depends on the current density. Higher current density shell spreads into much current filaments more rapidly.

We performed the nonlinear calculation of the dynamics of the magnetic loop with reversed current. Figures show the isosurfaces of pressure and the contour map of current density along the loop. Figure 1 shows the isosurfaces of pressure in this linear phase at 40 Alfven transit time. Alfven transit time is defined by the transit time of Alfven wave from center of the calculation region to the boundary. We can see the helical structure of the pressure. The structure of the current density is also helical. These helical structure is located along the magnetic line of force. Figure 2 shows the isosurface of pressure and the contour map of current density at 60 Alfven transit time. We found that the two pressure filament collide into one filament just at x axis. This is collapse of current filaments. At the 70 Alfven transit time, the collisional part spreads along the helical structure of the pressure or current density. Finally, one large pressure filament appear at 80 Alfven transit time as shown in figure 4. We can see the many waves are formed around the interacting region. If the current of the filaments is strong enough, shock waves may be formed. This is the typical case which the magnetic energy release into kinetic energy. This process is important for the coronal heating or solar flare.
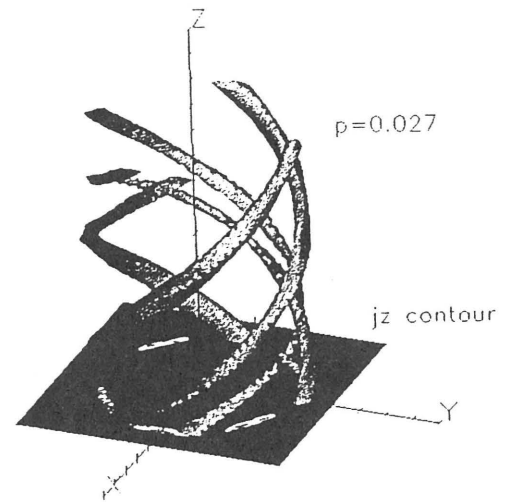

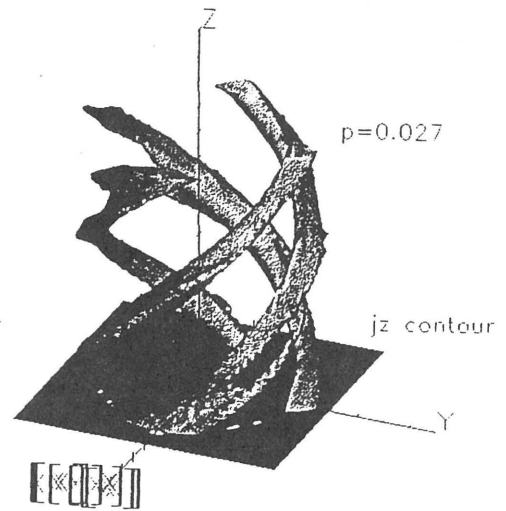Fig. 1. The isosurface of pressure p=0.0027 and contour map of current at 40 Alfven transit time.

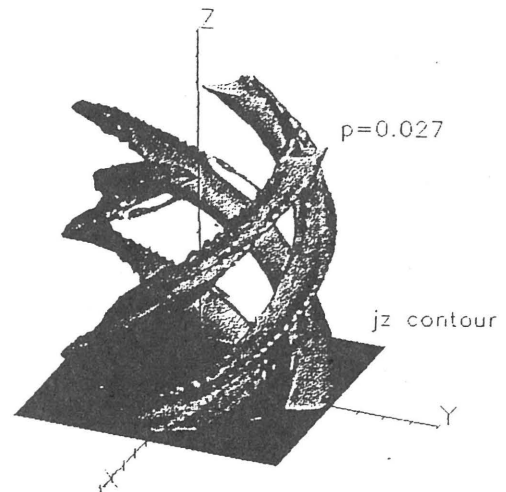Fig. 2. The isosurface of pressure p=0.0027 and contour map of current at 60 Alfven transit time.

Fig. 3. The isosurface of pressure p=0.0027 and contour map of current at 80 Alfven transit time.

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