CORONAL HEATING MECHANISM IN THE PRESENCE OF A FLOW: A NUMERICAL APPROACH

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Introduction

The solar corona is a hot, tenuous plasma permeated with the structured magnetic fields. A variety of waves is generated in the corona due to the convective upwelling motion in the photosphere. The excitation of MHD fluctuations is generated by the footpoint motion of the field lines in the photosphere. Resonant absorption of the Alfvén waves in an inhomogeneous plasma has been suggested as a means of driving current and plasma heating in the corona (Sakurai *et al.*, 1991). We study this problem in the presence of flow.

Simulation Model

The coronal plasma in cartesian geometry obeys the usual compressible, time-dependent and resistive equations. The y direction is along the height of the loop, the z direction corresponds to the azimuthal direction and the inhomogeneity occurs in the x direction. Rigid wall and free-slip boundary conditions are considered at the top and bottom of the simulation regions: $V_y = 0$ and $\partial f/\partial y = 0$ for $f = \rho, p, \mathbf{B}$, V_x, and V_z. At the remaining (x) boundaries open (zero gradient) conditions for all of the variables are considered (Murawski *et al.*, 1996; Parhi *et al.*, 1996).

We present all our numerical results for the Lundquist number $aV_a/\eta = 10^4$ and plasma β of 0.04 far outside the slab. The equilibrium density $\rho_0(x) = 1 + sech^3(x/5)$ and the magnetic field $B_{0y}(x) = 1 - sech^3(x/5)$. The only flow $V_{0y}(x)$ has similar structure as density. The magnetic field $B_{0z}(x)$ along the z direction is taken as $B_{0z}(x) = cxe^{-x^2}$, where c is an amplitude factor to be chosen. The plasma undergoes twist due to this magnetic field. At the bottom of the simulation region we superimpose on V_z the perturbation $F_z(x, y, t) = F_d(x)sin(\omega_d t)$, where $F_d(x) = sech^3(x/5)$. The following is considered: $F_d = 0.01\ \rho_e V_{ae}^2/a$, $c = 0.05\ V_{ae}\sqrt{\mu\rho_e}$, $\omega_d = 0.9\ V_{ae}/a$ and $V_{0y} = 0.1\ V_{ae}$.

Simulation Results

We see some signature of kink instability and traces of logarithmic singularities at early stage of evolution. Further temporal evolution completely

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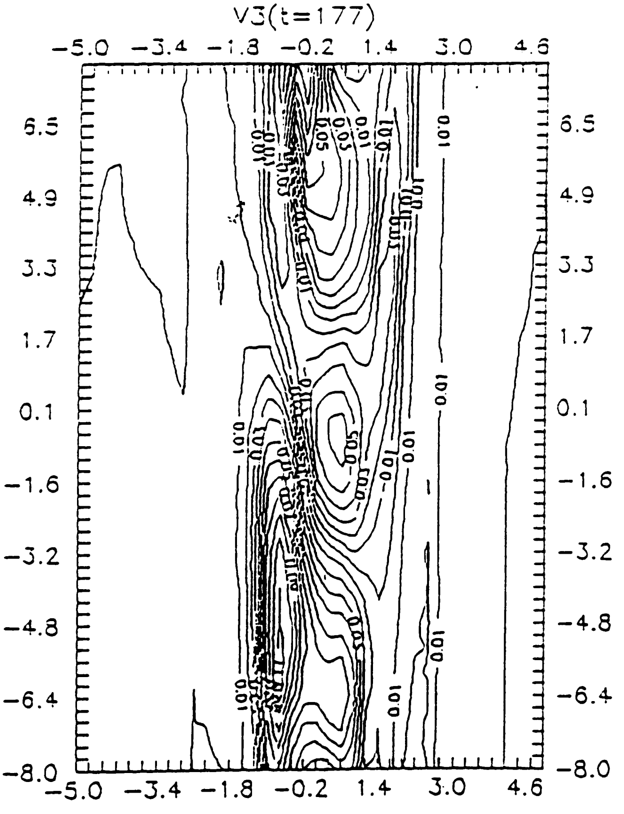
removes the singularity. We infer that the flow inhibits the development of kink instability. We see that the presence of flow facilitates heating. The inclusion of a small non-zero V_y has tremendous effect on resonance absorption manifested in the large change of the vortex structures. The center of the simulation loop appears consisting of elongated plasma vortices (the following figure at $t = 177\ a/V_{ae}$) which break down on further evoluion. The microstructures thus formed are the possible signatures of the direct cascade of energy. The flow brings more or less symmetric distribution of heating. Attempt is made to correlate vortex formation and heating pattern.



References

Murawski, K., DeVore, C. R., Parhi, S. and Goossens, M.: 1996, *Planet Space Sci.* **44**, 253.

Parhi, S., De Bruyne P., Murawski, K., Goossens, M. and DeVore, C. R.: 1996, *Solar phys.* **167**, 181.

Sakurai, T., Goossens, M. and Hollweg, J. V.: 1991, *Solar Phys.* **133**, 227.