NUMERICAL SIMULATIONS IN A CURRENT SHEET

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Abstract. The present work focuses on some 2-D MHD numerical experiments, where the initial state is a current sheet, embedded in the solar hot corona. The gravitational effects and a complete energy equation are taken into account. The computations were made on an SGI - Challenge M supercomputer with the same code Alfven (see Forbes & Priest, 1982), based SHASTA method (see Weber, W., 1978). The computational grid covers a distance of one (or more) solar radius, placed in a meridional solar plane and the gravitation is directed along the *Ox* axis. Some numerical simulations were made for different scales (one or more solar radius) taking into account mass injections, continus or temporary, into the current sheet. Different solar features were obtained: flares, prominences, coronal streamers.

Key words: current sheet – corona – MHD numerical simulations.

1. INITIAL STATE AND BOUNDARY CONDITIONS

The present work focuses on four 2-D MHD numerical experiments, where the initial state is a current sheet, embedded in the solar hot corona. The gravitational effects and a complete energy equation are taken into account. The computations were made on an SGI - Challenge M supercomputer with the same code Alfven (see Forbes & Priest, 1982) based on SHASTA method (Weber, 1978). The computational grid covers a distance of one solar radius, placed in a meridional solar plane and the gravitation is directed along the *Ox* axis.

W consider a current sheet given by

$$B_x = \begin{cases} \sin(\pi/2w), |z| \le w \\ 1, |z| > w \end{cases} \tag{1}$$

$$B_z = 0 \tag{2}$$

and v_x=0, v_z=0, □=1 and p=□T, w=27.

The boundary conditions along the four sides of the computational box are:

- at the top (x=1)

$$\frac{\partial B_x}{\partial x} = \frac{\partial B_z}{\partial x} = 0 \qquad \frac{\partial B_z}{\partial x} = -\frac{\partial B_x}{\partial z} \tag{3}$$

- at the right-hand side (z=1)

$$\frac{\partial B_x}{\partial z} = \frac{\partial B_z}{\partial z} = 0 \qquad \frac{\partial B_z}{\partial z} = -\frac{\partial B_x}{\partial x} \tag{4}$$

- on the symmetry axis (z=0)

$$\frac{\partial B_x}{\partial z} = B_z = 0 \tag{5}$$

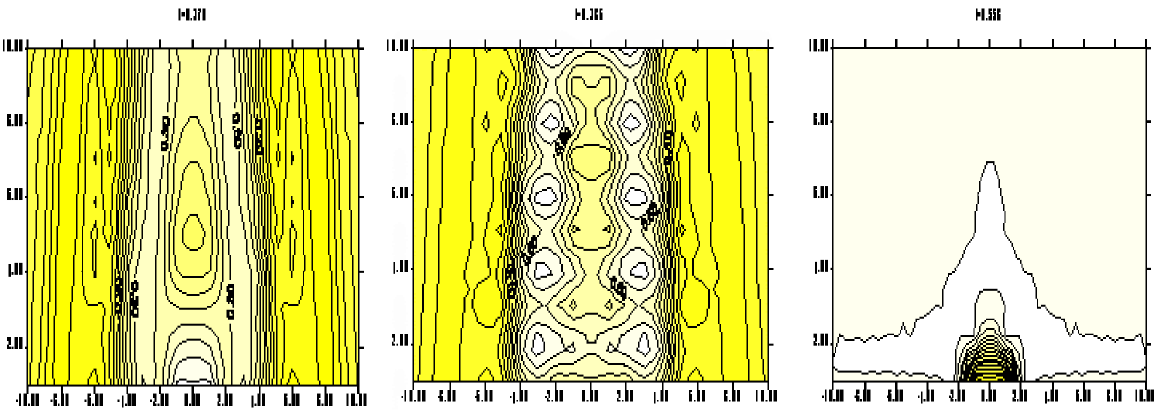
- at the bottom (x=0)

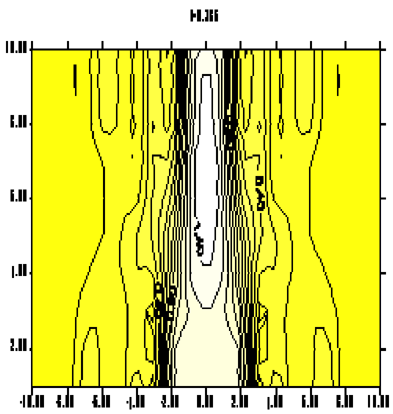
$$\frac{\partial B_z}{\partial x} = \frac{\partial B_x}{\partial x} = 0 \tag{6}$$

Additional conditions were made on density and gas pressure.

2. FLARE

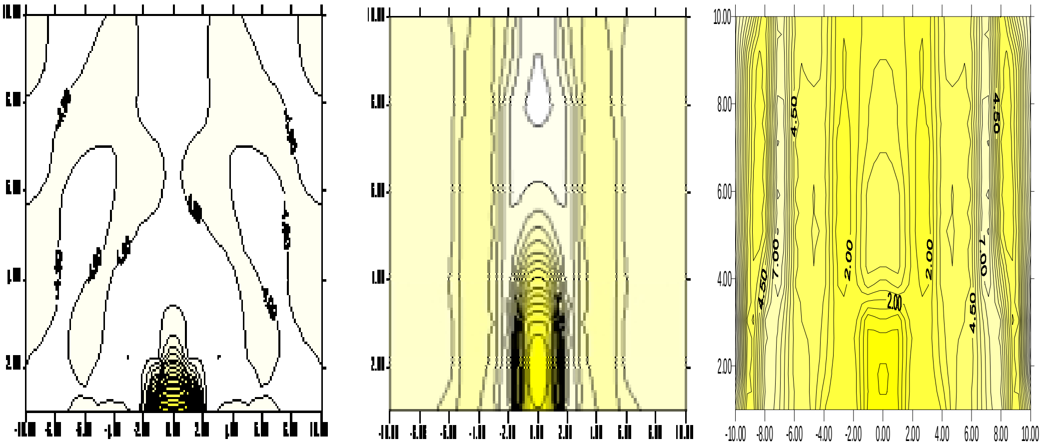
The current sheet, long of one solar radius, is embedded in the solar corona. No radiativ loss is considered and $=0.5$ and $=10^{13}$. After a Reynolds stress (□=*10^{-13}*), an Ohmic heating is added (□=*10^{-11}*). A mass injection is initiated at *t=0.323* (Alfven scale time), with an inflow speed rate equal to the sound velocity value and a density rate equal to 2. The pre-flare phase is at *t=0.370*, the flare rise at *t=0.386* and the maximum temperature is registered at *t=0.404*. Gravitational instabilities appears at the moment of the material expulsion. A post-flare loop forms starting with *t=0.439*, place of thermal instabilities and prominence formation. Figure 1 displays the magnetic field configuration at different moments. Figure 2 shows the density contour at the moment of the flare onset.





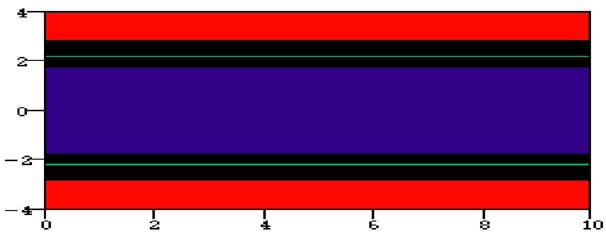
3. PROMINENCES

Few numerical experiments of prominence formation in a current sheet have been performed. We have taken into account the effect of gravity, the Ohmic heating, as well as a chromospheric mass injection (temporary or continuous). Magnetic reconnection and flare events accompany this process, before the condensation start, similar to the Kuperus - Tandberg-Hanssen scenario. Both types of prominence can be formed in this way: normal (first case) and inverse magnetic polarity configuration (second and third cases). Numeric instabilities have appeared when the plasma flow reached the sound speed. Both types of prominence could be obtained: normal and inverse polarity (Dumitrache, 1999).



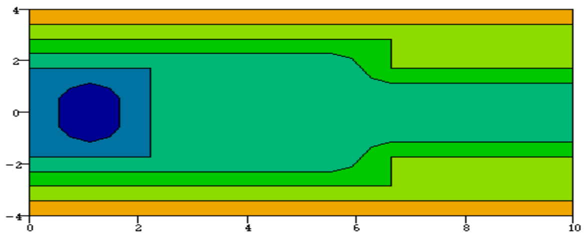
4. CORONAL STREAMER

A numerical experiment proceeded on a distance of $L=10\ R_O$, with $ß=1$ and $R_m=10^3$ has lead to a coronal streamer formation. Some stages of the magnetic field evolution and the density contours plotted at a final stage are presented below. The time is expressed in Alfven time units.



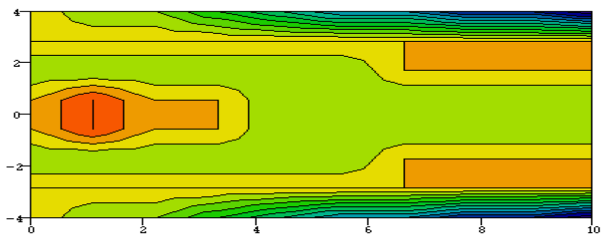
A

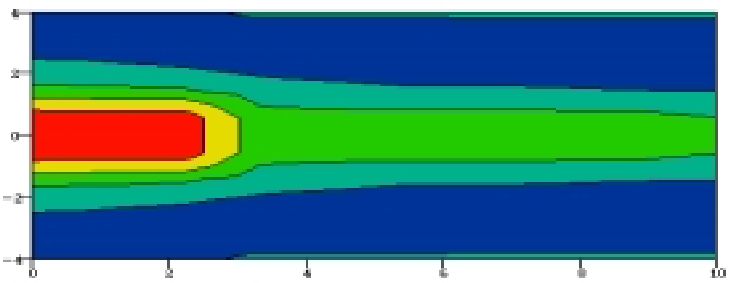
t = 0.392



A

t = 1.649





RO

t = 36.244

Acknowledgements: The Ministry of Research and Technology has supported this work under the grants 3016 GR/1997, 4038 GR/1998, 4067 GR/1998.

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