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# Interactions of two opposite moving pellets in the poloidal plane

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## Introduction

A time-dependent 2D computational model has been developed in which the complete set of resistive MHD conservation equations, consisting of mass momentum and energy, supplemented by Maxwell's equations, are solved for the poloidal plane. In this system, the pellet represents a neutral particle source whose strength is given, or computed in a self-consistent manner, as a function of the background plasma- and ablatant parameters. Since the neutral particle source is only allowed to move in the poloidal plane, the poloidal plane is considered to be a plane of symmetry. To this 2D computational model Lagrangian modules have been coupled, which take into account the expansion of ablated substance along the magnetic field lines(the 3rd direction). Hence a '2D+1' model is being used. This '2D+1' model implies that the 2-D space, representing the poloidal plane in which the 2D calculations are performed, has a constant thickness (length) in the 3rd direction(a free parameter), and that this length defines the initial length of of the Lagrangian modules in the 3rd direction. The relatively cold and high-density clouds evolving around the ablating pellets represent massive disturbances for the recipient plasmas. The ablated substance is heated by the energy fluxes carried by the background plasma particles along the magnetic field lines and by thermal diffusion both in the poloidal plane and along the field lines. The partially or fully ionized pellet material becomes magnetically confined in the poloidal plane but expands freely along the magnetic field lines. In this series of test calculations, we consider the interaction of two particle clouds generated by two neutral particle sources moving along parallel lines but in opposite directions in a magnetized recipient plasma. The sources approach each other each and then move away from each other, similarly to two meteorites moving along parallel trajectories.

## The Scenario

Two identical neutral particle sources are placed in the poloidal plane at some distance apart( in both R and Z directions) and are allowed to have parallel but opposite trajectories, the sources being injected with constant and opposite velocities. The velocities of the two sources have components only in the x-direction. The initial recipient plasma is assumed to be uniform and placed into an initial uniform magnetic field in the toroidal direction. Here the poloidal plane is represented by a rectangular x-y plane of dimensions ($0.601m$ , $0.401m$). The initial length of the

Lagrangian cells in the 3rd direction is 0.04m. The neutral particle sources are represented by circles (of radius 0.002m) and are depositing particles proportionally to the area that is mapped on the rectangular grid that represents the poloidal plane.

**The parameter of the two neutral sources :**

| | | |
|---|---|---|
| Initial positions(x,y)m | (0.201,0.191) | (0.281,0.211) |
| Velocities | 1000 m/s | -1000 m/s |
| Ablation rates | $1 \times 10^{24}$ | $1 \times 10^{24}$ |
| Temperature of neutral particles | $450\ ^0K$ | $450^0K$ |

**Initial parameters of the recipient plasma :**

| | |
|---|---|
| Electron Density | $N_e = 1 \times 10^{20}\ m^{-3}$. |
| Electron Temperature | $T_e = 1.0$ keV. |
| Toroidal Magnetic field | $B_z = 1.5$ Tesla. |

## Results and Conclusions

All the Figures shown here are zoomed and they display only the regions in which the the various plasma parameters became disturbed. The two circles shown in all Figures represent the location of the neutral particle sources at the respective times. The contours of the density profiles at $6.6,\ 24.6,\ 41,$ and 65.6 $\mu s$ are shown in Figures 1.a to 1.d respectively. From Figures 1.b and 1.c we see that particle density profile have higher maxima when the two source are close to each other. Figure 2.a shows the contours of the pressure profile after $6.6\mu s$ interaction of the two pellets with the recipient plasma. At this time the two pellets have transversed a distance of 0.66cm, and the disturbance on the pressure profile has an almost circular shape of radius 1cm. The density profile, Figure 1.a, also shows a similar disturbance shape. The contour lines of the temperature distribution at $24.6\mu s$ are displayed in Figure 2.b. At this time, the disturbances on the plasma parameters have no longer circular shape. Figure 2.c shows the contours of the magnetic field ($B_z$) distribution at $41\mu s$. Figure 2.d shows the contours of pressure profile at $65.6\mu s$. From Figures 2.c and 2,d we see that the minuma in the magnetic field and the maxima in the pressure are at some distance behind the respective positions of the two neutral sources. At these time instances, the two neutral particle sources move away from each other. From the calculations shown here, we see that with two pellets injected with different trajectories, local modifications to the recipient plasma parameters can be instigated. The disturbance on the parameters of the recipient plasma are more pronounced when the two pellets are close to each other: higher maxima for pressure and density, and lower minum for magnetic field were obtained

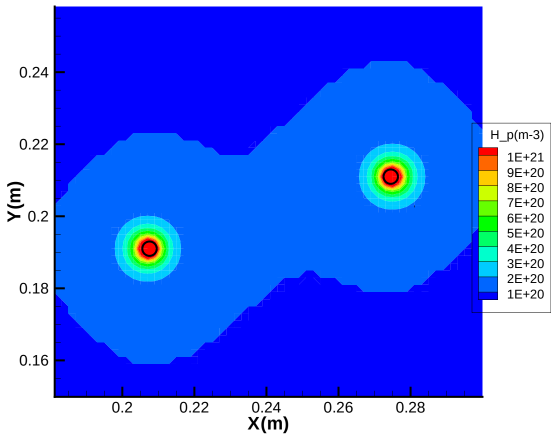


**Figure 1.a** Contours of density profile at 6.6$\mu s$.

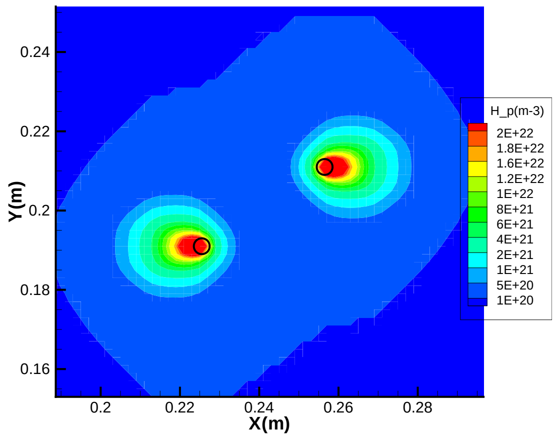


**Figure 1.b** Contours of density profile at 24.6$\mu s$.

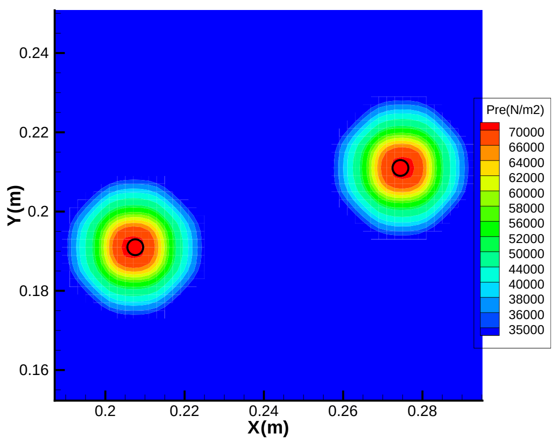


**Figure 2.a** Contours of pressure profile at 6.6$\mu s$.

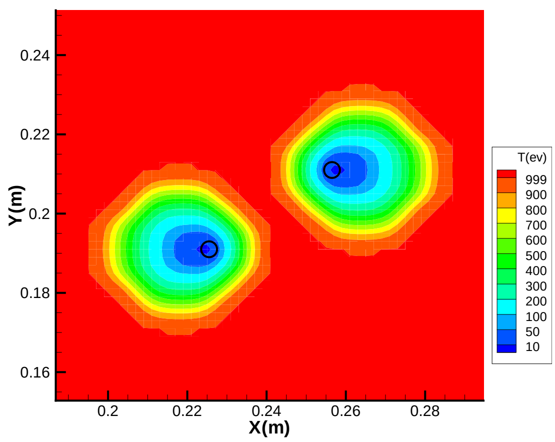


**Figure 2.b** Contours of temperature profile at 24.6$\mu s$.

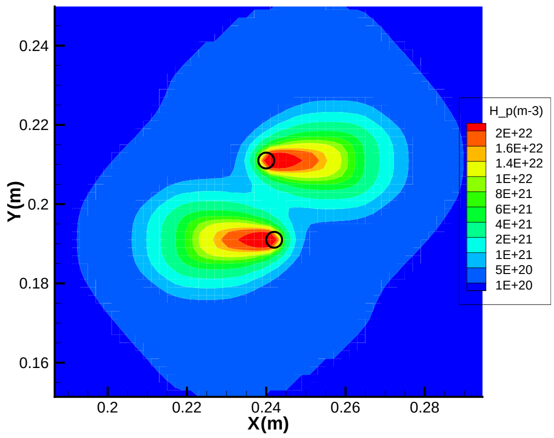


**Figure 1.c** Contours of density profile at 41$\mu s$.

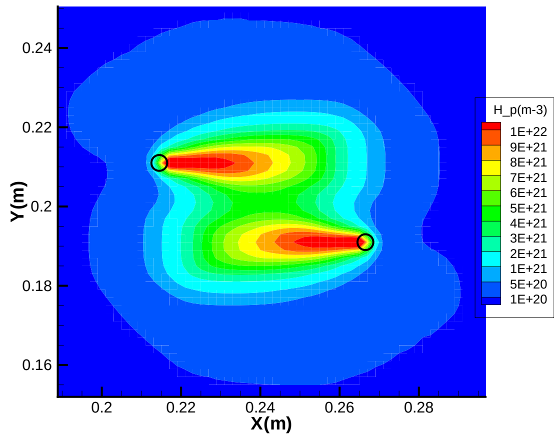


**Figure 1.d** Contours of density profile at 65.6$\mu s$.

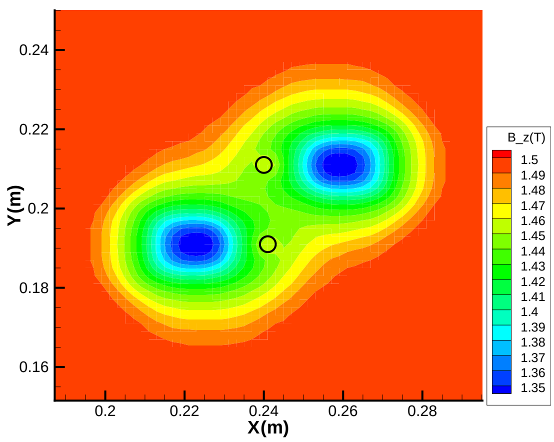


**Figure 2.c** Contours of magnetic field ($B_z$) at 41$\mu s$.

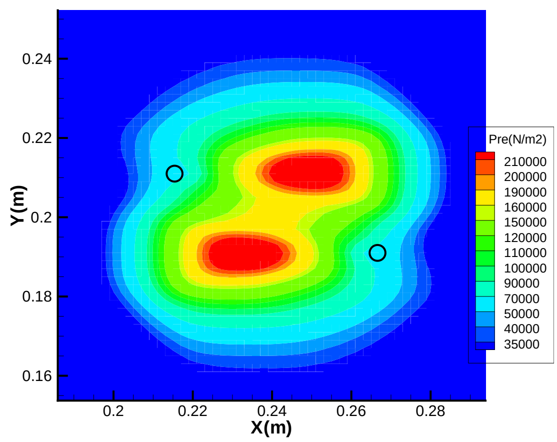


**Figure 2.d** Contours of pressure profile at 65.6$\mu s$.

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