# CHARGE SEPARATION ELECTRIC FIELD INSIDE A PLASMOID PENETRATING THROUGH A MAGNETIC FIELD DISTRIBUTION LIKE THAT OBSERVED IN THE MAGNETOPAUSE REGION: PARTICLE-IN-CELL SIMULATIONS, KINETIC AND MAGNETOHYDRODYNAMIC APPROXIMATIONS

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## KEYWORDS

electric field, Polarization, Plasmoid, Tangential discontinuity, Kinetic theory, Magnetohydrodynamic approximation, Particle-in-cell simulations

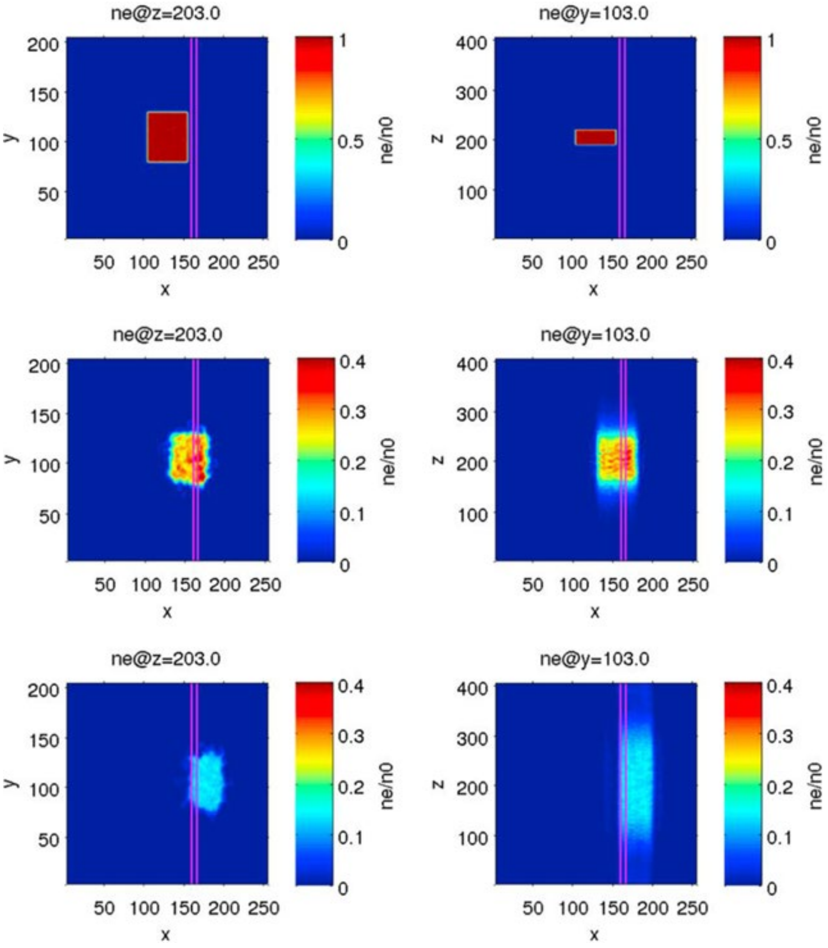


**fig. 1.** Time evolution of a plasmoid penetrating a tangential discontinuity. The figure shows the number density of electrons in the plane perpendicular to the background magnetic field (left column), and in the plane determined by the bulk velocity and the background B-field (right column). Each row corresponds to a different time step (t=0, t=0.75 $T_{Li}$, t=1.5 $T_{Li}$, given in proton Larmor periods); from Voitcu and Echim (2016)

## INTRODUCTION

The kinetic mechanism that builds up a *charge separation electric field*, or *polarization density*, and a *polarization electric charge density* within and along the surface of plasmas inhomogenities, streams or plasmoids which are moving through a uniform magnetic field had been identified and described by *Schmidt* (1960)[1]. In our presentation we first recall Schmidt's kinetic theory and its extension (i) for the cases of plasmoids which are either stopped by non-uniform magnetic fields distributions – alike the Tangential Discontinuity (TD) corresponding to Chapman-Ferraro layers – or else (ii) for the cases of plasmoids which have enough momentum flux density to pass through such a TD, as developed by *Lemaire* (1985)[2]. Particle-In-Cell (PIC) simulations of the electromagnetic interaction mechanism taking place in a collision-less magnetized plasma have been developed by *Voitcu and Echim* (2016, 2017)[3,4]. Their numerical PIC simulations describe the motion - as well as the change of their morphology – of simple (initially box-shaped) plasmoids that are either (i) stopped in front of a Tangential Discontinuity, or else (ii) that can pass through the TD and continue an adiabatic motion on the opposite side by conserving the total magnetic momentum as well as the total kinetic energy (drift + gyro-energies of all charged particles forming the moving plasmoids). We will illustrate the results of such PIC simulations and compare them to the predictions of the Schmidt-Lemaire kinetic theory. Finally, we will compare these theoretical and numerical simulations to results from laboratory experiments, and magnetospheric observations.

## REFERENCES


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