DPP12-2012-000456

Abstract for an Invited Paper
for the DPP12 Meeting of
the American Physical Society

The structure of a magnetic field propagating through low-resistivity, multi-ion species plasma[1]

RAMY DORON, Faculty of Physics, Weizmann Institute of Science

The study of low-resistivity plasmas interacting with transient electromagnetic fields is important for the understanding of a variety of fundamental phenomena. Previous research revealed rich physics and intriguing phenomena, including the long-standing problem of rapid magnetic-field penetration into low-resistivity plasmas. Inconsistencies between observations and theories invoked the possibility that unexplored processes, occurring in scales that are beyond the experimental resolution, play a significant role in the interaction. In the present study, significantly improved diagnostic capabilities of the plasma and magnetic-fields are developed and employed. In the configuration studied, a pulsed current (rise-time 350 ns) generating the magnetic field ($\sim$ 1 T), is driven through a plasma that prefills the volume between two electrodes. The structure of the propagating magnetic-field front is reconstructed and its width is used for estimating the plasma conductivity. The magnetic-field front structure and velocity are found to remain nearly constant when the field propagates over a length scale of the order of the front width. This observation allows for treating the magnetic-field front as an electric potential hill in the moving frame of the field. Using the properties of the potential hill, derived are the details of the ion dynamics according to their charge-to-mass ratios (Z/m). Ions of relatively low Z/m are penetrated by the magnetic-field, whereas ions of high Z/m are reflected off the magnetic-field at different field magnitudes. The inferred ion dynamics are used to predict the electron density evolution, which is found to agree with the observed density evolution.

[1]This work is done in collaboration with B. Rubinstein, A. Fruchtman, and Y. Maron and is supported by the Minerva Foundation with funding from the Federal German Ministry for Education and Research and by the U.S.-Israel Bi-national Science Foundation.