Abstract for an Invited Paper
for the APR06 Meeting of
The American Physical Society

Spontaneous Double Layer Formation in Expanding Plasmas[1]

XUAN SUN, West Virginia University

A double layer (DL) is a localized region of electric field characterized by a strong potential gradient. Particle acceleration in DLs has been proposed as a mechanism for astrophysical phenomena such as energetic electrons in the auroral zone and energetic ions emitted by the Sun during solar flares. In laboratory plasmas, DLs are typically created at the interface of two different plasmas or by driving a current in a single plasma. Recently, DLs have been observed to spontaneously develop in three different, current-free, expanding helicon plasmas: Chi-Kung at ANU, MNX at PPPL, and HELIX at WVU. We will present measurements of the DL structure in HELIX and MNX. Both DLs have a total potential drop of 3-4 kT_e and length scales smaller than ion-neutral mean-free-path. The spatial structure of the DL and ion acceleration in the DL is consistent with the predictions of Monte-Carlo, Particle-in-Cell simulation. Based on the experimental parameters, we hypothesize that DL formation is triggered when the ion-neutral collisional mean free path exceeds the magnetic field gradient scale length. Similar to the DLs occurring in nature, those two helicon DLs, as well as the DL in Chi-Kung, occur in the region of strong magnetic field gradient. We will also present measurements of the effect of magnetic field strength on DL structure and show that the DL continues to strengthen after many tens of ms in a pulsed helicon plasma.

[1]In collaboration with Costel Biloiu and Earl Scime, West Virginia University; and Sam Cohen, Princeton Plasma Physics Laboratory.