AOGS 2005

Role of Electrostatic Instability in Initiating Magnetic Reconnection in Thin Current Sheets

NAGENDRA SINGH and C. DEVERAPALLI

Department of Electrical and Computer Engineering and CSPAR
University of Alabama, Huntsville, AL 35899, USA

Just a few years ago it was commonly questioned that thin current sheets (CSs) with thickness as small as electron skin depth could form in space plasmas. There is observational evidence now that such thin CSs do form. IT appears that as the measurements in space are progressively refined, observation of such thin CSs could be a norm not an exception. Using three-dimensional electromagnetic particle-in-cell (EMPIC) simulations of a thin CS, we recently reported that electrostatic instabilities consisting of Buneman and inflectional shear instabilities trigger an explosive magnetic reconnection event at time scales much faster than that for the electromagnetic instabilities. The simulation reported previously was based on an artificial ion to electron mass ratio M/m=25. We have repeated the simulation with the real mass ratio for H^+ ions (M/m=1836) and performed a systematic set of study by varying the CS thickness. We have found that a combination of the electrostatic instabilities, one of which is the inflectional shear instability, plays the crucial role in triggering the explosive magnetic reconnection process. We will report the initial electrostatic instabilities depending on the CS thickness; such instabilities begin the process of current disruption in the central part of the CS. Once the process of current disruption begins, causing shear in the electron flow velocity, inflectional instability sets in leading to the explosion. One significant consequence of the explosion is the bifurcation of the original CS with nearly total current disruption in the central region. Another equally significant consequence is the large acceleration of both electrons and ions in the central region of the CS. Our simulations show that the primary cause of the magnetic reconnection is the fragmentation of the current by the electrostatic instabilities.