Magnetic Reconnection Events in Weakly Collisional Regimes

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There are two kinds of mode that can lead to the formation of macroscopic magnetic islands in weakly collisional plasmas, one related to the so-called drift tearing mode\cite{1} and another with phase velocity in the ion diamagnetic drift direction. In the first case large ratios of the longitudinal to the transverse electron thermal conductivity do not allow the existence of normal modes that can support linear instability. In the second case the presence of a high energy particle population\cite{2} is required.

We note that observation of islands, that suddenly appear at finite amplitude during a trigger event (like a sawtooth crash) led to the concept of metastable resistive tearing modes. However, the fact that islands growing from very small amplitude without any trigger event can be observed\cite{3} even in weakly collisional regimes left open the question of the existence of appropriate unstable modes. This difficulty can be solved by requiring the prior excitation of other linearly unstable modes.

The considered precursor for the drift-tearing mode is the microreconnecting mode, which has transverse scale of the order of the collisionless skin depth and is driven unstable by the electron temperature gradient. This mode leads to the instability of the drift-tearing mode by decreasing the ratio of the longitudinal to the transverse thermal conductivities\cite{4}. The instability of modes that have a phase velocity about equal to the ion diamagnetic velocity\cite{5} and produce magnetic reconnection is associated with a finite “inductivity” (equivalent to an enhanced electron inertia) that is attributed to the pre-excitation of macroscopic modes that do not involve reconnection and have similar phase velocity. Internal MHD ballooning modes, which are driven by the combined effects of the plasma pressure gradient and magnetic field curvature, and close to marginal stability become purely oscillatory as a result of finite ion Larmor radius effects, have this characteristic. *Sponsored in part by the U.S. Department of Energy.

\begin{itemize}
  \item \textsuperscript{1} B. Coppi, \textit{Phys. Fluids} \textbf{8}, 2273 (1965)
  \item \textsuperscript{3} P. Buratti \textit{et al.}, 34th EPS Conf. on Plasma Phys., Warsaw, July 2-6 2007 ECA \textbf{31F} O-4.018 (2007)
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