Transport of energetic alpha particles in reconnecting magnetic fields

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Future burning plasma experiments like ITER will rely on the heating from the energy excess of fusion born alphas as well as fast ions produced by auxiliary heating systems. Good confinement of these energetic particles (EPs) must be assured to sustain feasible fusion reactor conditions. Likewise space plasmas, laboratory magnetized plasmas naturally develop MHD activity which usually involve magnetic reconnection leading to island formation and sudden topological changes of the magnetic structure, among other effects. Sawtooth oscillations and tearing modes in tokamaks are typical examples of these phenomena. These processes produce significant transport of EPs and constitute a potential threat for ITER because, despite they can be controlled, they can not be completely avoided. In this work, an existing technique for the reconstruction of MHD fluctuations [1] is extended to describe evolving fields with reconnection and employed to study the redistribution of EPs caused during the crash phase of the sawtooth instability. It is shown that the evolution of the magnetic field during this process can significantly redistribute particles even if the contribution of the electric field is neglected. Moreover, when the characteristic time of the instability is small compared to the particle turn-over time, the particles follow the flux surfaces, provided the magnetic shear is not too low. In low shear cases, particles may drift across magnetic flux surfaces.

[1] Farengo, R., Plasma Phys. Controlled Fusion **54** 025007 (2012)