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Energy dependency of runaway-electron transport in perturbed fields

The widely used estimate for particle transport in a toroid with broken flux surfaces is that the transport is diffusive and scales as a square of perturbation amplitude δB:
\begin{equation}
D \approx v_\parallel\left(\frac{\delta B}{B}\right)^2,
\end{equation}
where $v_{||}$ is the velocity particles are moving along the chaotic field lines. However, this estimate neglects finite orbit width effects that become increasingly more important for more energetic particles. For runaway electrons, theoretical work predicts that the transport decreases as γ^{-1}, where γ is the Lorentz factor, or even as γ^{-2} if certain conditions are met.

Understanding the energy dependency of the transport is needed for reduced kinetic models as the losses induced by the magnetic field stochasticity might reduce the runaway electron avalanche, but the models lack the 3D magnetic field necessary to study the issue.

In this contribution, we study the transport in perturbed magnetic fields using an orbit-following Monte Carlo method to calculate the energy-dependent transport coefficients. The orbit-following calculations are done with ASCOT5 code. By using an ITER magnetic field with artificial perturbations, we find an agreement between the theory and simulations. The transport is found to depend on the magnetic field autocorrelation lengths, the electron gyroradius and the poloidal orbit width as expected.

Additional orbit-following simulations are carried out for more realistic magnetic fields that are relevant for runaway electron mitigation (Fig. 1). These consist of ITER field perturbed with ELM control coils and two post-disruption JET fields computed with MHD code JOREK~\cite{nardon2016progress}: one at the end of the thermal quench where the field is completely stochastic, and one where only the edge is stochastic. While the ITER case has reduced transport with increased electron energy, the relationship is weaker than γ^{-1}. The two JET cases show no finite orbit width effects at all as these are dominated by the presence of magnetic islands and radially non-uniform δB.

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T. Hauff and F. Jenko, “Runaway electron transport via tokamak microturbulence”, Physics of Plasmas, 2009.

J.R. Myra and P. J. Catto, “Effect of drifts on the diffusion of runawau electrons in tokamak stochastic magnetic fields”, Physics of Fluids B: Plasma Physics, 1992.

P. Helander, L.-G. Eriksson, and F. Andersson, “Suppression of runaway electron avalanches by radial diffusion”, Physics of Plasmas, 2000.

K. Särkimäki, et al., “An advection-diffusion model for cross-field runaway electron transport in perturbed magnetic fields”, Plasma Physics and Controlled Fusion, 2016.

J. Varje, et al., “High-performance orbit-following code ASCOT5 for Monte Carlo simulations in fusion plasmas”, submitted to Computer Physics Communications, 2019.

E Nardon, et al., “Progress in understanding disruptions triggered by massive gas injection via 3D non-linear MHD modelling with JOREK”, Plasma Physics and Controlled Fusion, 2016.

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