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Interactions of runaway electrons with Alfvén and whistler waves

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Runaway electrons are of significant interest in tokamaks due to their potential for damage to plasma facing components. Runaways are of particular concern following disruptions when the plasma undergoes a thermal quench and a subsequent current quench; these lead to large loop voltages that can rapidly create runaways. Due to the risks of performing intense runaway experiments, the generation of runaways and the rate at which they can be suppressed is a crucial issue for modeling. Comparison of electric field thresholds from a range of tokamaks with theoretical predictions has shown that the observed thresholds have generally been higher than predictions [R. S. Granetz, B. Esposito, J. H. Kim, R. Koslowski, et al., Physics of Plasmas **21**, 072506 (2014)]. This discrepancy can exist for a variety of reasons, but runaway-driven instabilities and scattering from plasma waves are mechanisms not taken into account in the existing predictions. In this paper, examples of both resonant and non-resonant runaway interactions with Alfvén and whistler waves are analyzed and compared with recent DIII-D experiments [D. A. Spong, W.W. Heidbrink, C. Paz-Soldan, et al., submitted to PRL (2018)]. The analysis is based on relativistic Monte Carlo models that include runaway/partially ionized impurity collisions, synchrotron radiation, and wave mode structures. The mode structures are calculated using the TAEFL/FAR3D gyrofluid models (for Alfvén instabilities) and the AORSA all orders full-wave RF model (for whistler instabilities). In addition to an improved understanding of runaway generation, this can also lead to new methods for runaway control.

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Author: Dr SPONG, Donald (Oak Ridge National Laboratory)

Co-authors: Dr LVOVSKIY, Andrey (Oak Ridge Associated Universities); Dr COLLINS, Cami (General Atomics); Dr PAZ-SOLDAN, Carlos (General Atomics); LIU, Chang (Princeton Plasma Physics Laboratory); Dr LAU, Cornwall (Oak Ridge National Laboratory); DEL-CASTILLO-NEGRETE, Diego (Fusion Energy Division. Oak Ridge National Laboratory); Dr BRENNAN, Dylan (Princeton University); Dr JAEGER, Erwin F. (XCEL Engineering); Dr THOME, Kathreen (Oak Ridge Associated Universities); Dr CARBAJAL GOMEZ, Leopoldo (Oak Ridge National Laboratory); Dr VAN ZEELAND, Michael (General Atomics); Dr MOYER, Richard (University of California San Diego); Prof. HEIDBRINK, William W. (University of California Irvine); DU, xiaodi (University of California - Irvine)

Presenter: Dr SPONG, Donald (Oak Ridge National Laboratory)

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