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Dynamics of Runaway Electron Generation and Loss in Tokamaks

T. Tang[1], L. Zeng[1, 2], X. Zhu[3], D. Chen[1], S. Lin[1], Y. Sun[1], Y. Duan[1], H. Zhao[1], C. Luo[1], H. Liu[1], J. Qian[1], Y. Jie[1], Y. Liang[4], X. Gao[1]

[1]Institute of Plasma Physics, Chinese Academy of Sciences, 230031 Hefei, China
[2] Department of Engineering Physics, Tsinghua University, Beijing 100084, China
[3]Advanced Energy Research Center, Shenzhen University, Shenzhen 518060, China
[4]ForschungszentrumJülich GmbH, Institute of Energy and Climate Research - Plasma Physics, 52425 Jülich, Germany

e-mail: tian.tang@ipp.ac.cn

Runaway electrons (REs) have been observed in EAST un-intended and intended disruptions with circular plasma. RE plateau can carry up to 70% pre-disruption plasma current and last up to 400 ms, larger RE plateau current is found with more RE seeds.

In the un-intended disruptions, the higher loop voltage corresponds to a lower runaway current, which is contrary to the observations made in most tokamaks. A loop voltage threshold is further observed over which no RE plateau can be obtained. This anomalous behavior is attributed to the pre-existing wave resonant suprathermal electrons by lower hybrid waves[1]. These suprathermal electrons remain confined during the TQ and then are accelerated into RE regime during the current decay phase. Moreover, in ohmic disruptions triggered by MGI, RE plateau can be more often observed with lower pre-disruption electron density (0.2-0.3×10^{19} m^{-3}); on the contrary, much higher density (~1×10^{19} m^{-3}) leads to failure of RE plateau formation. A same mechanism can be applied to resolve enhanced RE production that higher RE fraction is previously generated during flattop phase and eventually provides more RE seeds after TQ.

Besides, a 0-D RE generation model is developed to characterize the evolution of runaway current, and results matches experimental data well with residual RE seeds taken into consideration. These results will further deepen the understanding of RE generation in EAST and be an important part of RE mitigation or avoidance research in future.

References

[1] T. Tang, et al., Runaway electron generation and loss in EAST disruptions, Nucl. Fusion, 61 (2021) 076003

Note: Abstract should be in (full) double-columned one page.