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Modeling propagating heat pulses in the Large Helical Device

HAO ZHU, Centre for Fusion, Space and Astrophysics, Department of Physics, University of Warwick, Coventry CV4 7AL, United Kingdom, RICHARD DENDY, Euratom/CCFE Fusion Association, Culham Science Centre, Abingdon, Oxfordshire OX14 3DB, United Kingdom, SANDRA CHAPMAN, Centre for Fusion, Space and Astrophysics, Department of Physics, University of Warwick, Coventry CV4 7AL, United Kingdom, SHIGERU INAGAKI, Research Institute for Applied Mechanics, Kyushu University, Fukuoka 816-8580, Japan — Rapid edge cooling induced by pellet injection in Large Helical Device plasmas generates inward propagating pulses with either large positive or negative deviations of the electron temperature at the core [Inagaki et al, Plasma Phys. Control. Fusion 52 (2010) 075002]. By applying a traveling wave transformation, we extend a recent model [Dendy et al, Plasma Phys. Control. Fusion 55 (2013) 115009] for local temporal evolution, to include also spatial dependence. The extended model comprises two coupled nonlinear first order differential equations for the (x,t) evolution of the deviation from steady state of two variables, the temperature gradient and heat flux. It also defines the pulse velocity in terms of plasma quantities. This enables us to model spatiotemporal pulse evolution, from first principles, in terms of the electron temperature. We have tested the model against LHD datasets using appropriate initial and boundary conditions. We find that this model can match experimental data for pulse peaks, shapes and propagation velocities within a broad radial range from plasma edge to core.

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