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Full-f gyrokinetic simulation including kinetic electrons

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A new hybrid kinetic trapped electron model [Y. Idomura, J. Comput. Phys. 313, 511 (2016)] is developed for electrostatic full-f gyrokinetic simulations. The model is verified by computing the ion and electron neo-classical transport and the linear ion temperature gradient driven trapped electron mode (ITG-TEM) stability, in which collisional TEM stabilization shows an isotope effect. An impact of kinetic electrons on the ITG turbulence is investigated by comparing ITG turbulence simulations with adiabatic electrons and with kinetic electrons. It is found that in the kinetic electron case, resonant passing electrons transport at mode rational surfaces generates corrugated density profiles, and the resulting microscopic radial electric field Er sustains nonlinear critical temperature gradients above linear ones. This is qualitatively different from the so-called Dimits shift sustained by turbulence driven zonal flows in the adiabatic electron case. In the toroidal angular momentum balance, kinetic trapped electrons enhance the field term stress, which is characterized by the phase difference between the perturbed distribution and the toroidal electric field, and thus reversed between the adiabatic and kinetic electron cases. It is also found that the field term stress and the resulting intrinsic rotation is reversed between the ITG turbulence and the TEM turbulence.

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Japan

Primary author: Dr IDOMURA, Yasuhiro (Japan Atomic Energy Agency)

Co-authors: Dr URANO, Hajime (JAEA); Dr HAYASHI, Nobuhiko (Japan Atomic Energy Agency); Dr ASAHI, Yuichi (Japan Atomic Energy Agency)

Presenter: Dr IDOMURA, Yasuhiro (Japan Atomic Energy Agency)

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