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A hybrid model for computing nonthermal ion distributions in a long mean-free-path plasma[1] XIANZHU TANG, CHRIS MCDEVITT, ZEHUA GUO, Los Alamos National Laboratory, HERB BERK, University of Texas at Austin — Non-thermal ions, especially the suprathermal ones, are known to make a dominant contribution to a number of important physics such as the fusion reactivity in controlled fusion, the ion heat flux, and in the case of a tokamak, the ion bootstrap current. Evaluating the deviation from a local Maxwellian distribution of these non-thermal ions can be a challenging task in the context of a global plasma fluid model that evolves the plasma density, flow, and temperature. Here we describe a hybrid model for coupling such constrained kinetic calculation to global plasma fluid models. The key ingredient is a non-perturbative treatment of the tail ions where the ion Knudsen number approaches or surpasses order unity. This can be sharply constrasted with the standard Chapman-Enskog approach which relies on a perturbative treatment that is frequently invalidated. The accuracy of our coupling scheme is controlled by the precise criteria for matching the non-perturbative kinetic model to perturbative solutions in both configuration space and velocity space. Although our specific application examples will be drawn from laboratory controlled fusion experiments, the general approach is applicable to space and astrophysical plasmas as well.

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