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Progress in full-F gyro-fluid theory

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We report on the latest developments in full-F gyro-fluid theory. First we focus on a major and long-standing theoretical problem of current full-F gyro-fluid but also gyro-kinetic models, which is the treatment of polarization effects within a long wavelength approximation. This fundamental issue dates back to the beginning of gyro-kinetic theory. We present a solution by combining gyro-kinetic field theory with Padé-approximations in order to deduce novel non-linear and conservative full-F gyro-fluid closures for polarization effects at arbitrary wavelengths [1]. The proposed polarization closures constitute the full-F analogue of the widely used delta-f gyro-fluid Padé-model and enable new predictive capabilities in full-F gyro-fluid and gyro-kinetic modeling of for example fusion edge plasmas.

Secondly, we introduce the Favre averaging technique [2] in full-F gyro-fluid (or -kinetic) theory to disentangle effects of large relative density fluctuations and steep background density gradients on the mean flow dynamics in toroidal not necessarily axisymmetric magnetic field equilibria [3]. In particular, we derive all relevant stress tensors, torques and source terms for the poloidal and toroidal components of the Favre averaged angular momentum density. Our results encompass most importantly the Favre stress generalizations of previously found Reynolds stresses, like the diamagnetic or parallel E×B stress, and the generalization of the background density gradient drive.

References:

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