Drift Ordered Short Mean Free Path Fluid Equations

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Abstract

Short mean free path descriptions of magnetized plasmas have existed for almost 50 years. The earliest work by Braginskii [1] in 1957 assumes an ordering in which the ion mean flow is on the order of the ion thermal speed. Mikhailovskii and Tsypin [2] realized that this ordering is not the one of most interest in many practical situations in which the flow is weaker and on the order of the ion heat flux divided by the pressure. In their ordering the ion flow velocity is allowed to be on the order of the diamagnetic drift velocity - the case of interest for most fusion devices in general, and the edge of many tokamaks in particular. Their drift ordering is required to properly retain the temperature gradient terms in the viscosity as well as the terms found by Braginskii. Our treatment [3] corrects the expressions for the ion parallel and perpendicular collisional viscosities found in these later treatments [2] which used an approximate truncated polynomial expression for the distribution function and neglected quadratic heat flow terms associated with the non-linear form of the collision operator. The modifications to the pressure anisotropy and perpendicular collisional viscosity that we evaluate are valid for turbulent and collisional transport, and also allow stronger poloidal density, temperature, and electrostatic potential variation in a tokamak than the standard Pfirsch-Schlüter ordering. We have also evaluated the electron pressure anisotropy and gyroviscosity, and then used the ion and electron equations to obtain a reduced system of equations suitable for edge plasma modelling [4].

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2 A. B. Mikhailovskii and V. S. Tsypin, Beitr. Plasmaphys. **24**, 335 (1984) references therein.

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