Collisionless axisymmetric equilibrium with diamagnetic flows*

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A recently derived system of finite-Larmor-radius collisionless two-fluid equations is used to obtain stationary flow equilibrium relations in axisymmetric toroidal geometry. This model contains a general treatment of the gyroviscous stress, the pressure anisotropy and the anisotropic heat fluxes. The analysis is based on a perturbative expansion in powers of the small ratio between the ion gyroradius and any other characteristic length, $\epsilon \sim \rho_i/l \ll 1$. The flow velocities are assumed to be of the order of the diamagnetic drifts, and therefore are taken to be comparable to the ratio between heat fluxes and pressures and first order relative to the ion thermal speed, $u \sim q/p \sim \epsilon v_{thi}$. Under this ordering, the gyroviscous stress tensor is second order relative to the mean scalar pressure, and includes the gradients of the collisionless parallel heat flux and the diamagnetic perpendicular heat flux together with the more familiar terms proportional to the product of the pressure and the gradient of the flow velocity. In first order, one obtains a generalized Grad-Shafranov equation and specific expressions for the pressures, the density, the electric potential, the flow velocities and the heat fluxes, up to a number of free flux functions. These free flux funcions are determined by the solubility constraints in second order.

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