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Momentum balance and radial electric fields in axisymmetric and nonaxisymmetric toroidal plasmas HIDEO SUGAMA, TOMOHIKO WATANABE, MASANORI NUNAMI, SHIN NISHIMURA, National Institute for Fusion Science — It is investigated how symmetry properties of toroidal magnetic configurations influence mechanisms of determining the radial electric field such as the momentum balance and the ambipolar particle transport. Both neoclassical and anomalous transport of particles, heat, and momentum in axisymmetric and nonaxisymmetric toroidal systems are taken into account. Generally, in nonaxisymmetric systems, the radial electric field is determined by the neoclassical ambipolarity condition. For axisymmetric systems with up-down symmetry and quasisymmetric systems with stellarator symmetry, it is shown by using a novel parity transformation that the particle fluxes are automatically ambipolar up to $O(\delta^2)$ and the determination of the radial electric field E_s requires solving the $O(\delta^3)$ momentum balance equations, where δ denotes the ratio of the thermal gyroradius to the characteristic equilibrium scale length. In axisymmetric systems with large ExB flows on the order of the ion thermal velocity v_{Ti}, the radial fluxes of particles, heat, and toroidal momentum are dependent on E_s and its radial derivative while the time evolution of the E_s profile is governed by the $O(\delta^2)$ toroidal momentum balance equation.

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