

Collisionless dynamics of zonal flows in stellarators

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The collisionless time evolution of zonal flows in stellarator systems is investigated. An analytical solution of the kinetic and quasineutrality equations describing the residual zonal flow is derived for arbitrary three-dimensional systems without approximations in the magnetic geometry. The theory allows for an arbitrary number of particle species. It has been found that in stellarators the residual zonal flows are not in general steady but oscillate with a certain frequency. This frequency is determined by the speed of the bounce-averaged radial drifts of the particles trapped in the magnetic field and vanishes in tokamaks, where such net drifts are absent. A reduction of the bounce-averaged radial drifts in configurations optimized with respect to neoclassical transport results in a smaller zonal-flow frequency.