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On the self-consistent evolution of the zonal state*

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The zonal state represents a portrait of nonlinearly evolving magnetized tokamak plasmas [1,2]. It consists of phase space zonal structures (PSZS) [3,4], which are undamped by fast collisionless processes and reflect the meso- and macro-scale toroidally symmetric particle distributions, of their fast-varying spatiotemporal counterpart, of zonal field structures (ZFS) [2], and of a finite level of toroidal symmetry breaking fluctuations. In this work [5], the self-consistent evolution of the zonal state will be analyzed in the absence of toroidal symmetry breaking fluctuations, although it is possible to straightforwardly generalize the present approach to a scenario where a given $n\neq0$ spectrum is assumed. The equations obtained can be used, in particular, to describe geodesic acoustic modes (GAM) and energetic particle induced GAM (EGAM) physics. As illustrative application of the present approach, zonal flow generation by GAM for general geometry and distribution functions will be presented. The EGAM nonlinear dynamics will also be discussed, with emphasis on the prediction of the chirping rate in the strongly nonlinear regime.

References

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