Using 3D shaping to manipulate ITG turbulent saturation in stellarators*

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Abstract

A three field fluid model is developed to describe ion temperature gradient turbulent saturation processes in stellarators. The theory relies on the paradigm of zonal flow catalyzed transfer of energy from unstable to damped modes as the dominant saturation mechanism. The model allows for generally 3D equilibrium geometry. The nonlinear saturation process is controlled by a triplet correlation lifetime that is determined by a three-wave frequency mismatch associated with an instability, a stable mode and a zonal flow. This triplet correlation time can be used as a proxy in optimization procedures for improving turbulent transport in stellarators. Preliminary estimates indicate that quasi-helically symmetric devices have an advantage with regard to turbulent saturation physics relative to other stellarator configurations

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