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Nonlinear dynamics of the tokamak edge plasmas[1]

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Transport in the edge appears to be mostly convective and intermittent. Ubiquitous coherent structures referred to as blobs that form in the steep-gradient region lead to cross-field transport that greatly enhances the SOL widths beyond those expected from simple diffusion models. In H-mode discharges, in addition to this background of blobby transport, filamentary structures, associated mostly with Type I ELMs, are observed to convectively transport significant portion of the stored energy in the pedestal to the far SOL. Blobs and ELM-generated filaments share many dynamical features, the most significant being their rapid radial propagation and interaction with the plasma facing components first, before their effects are felt in the divertor chamber. Here the nonlinear dynamics of both blob and ELM-generated filaments are examined with fluid models. An earlier study of blobs with a reduced 2D model showed how interchange-driven turbulence and the associated blobby transport can account for the observed SOL widths and their sometimes seen two-tier structure. A more recent 3D effort using the MHD code CTD shows that the ballooning/peeling mode generated fingers in the pedestal are quite similar to those of the blob studies: they rapidly convect plasma from the pedestal to the far SOL, while the holes between the fingers move inward, thus also affecting core confinement in some circumstances. An externally-imposed shear flow in the pedestal has a stabilizing influence on the linear modes involved; however, the modes in turn affect the flow, leading to a complex nonlinear coupling that is being investigated. Another effect under study is the role of resonant magnetic perturbations in ameliorating the effects of Type I ELMs.

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