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An Explanation for the High-β Runaway: the Non-Zonal Transition

M.J. PUESCHEL, University of Wisconsin-Madison

During the so-called high-β runaway, heat and particle fluxes grow to extremely large values after a transient saturation phase—this can occur well below the kinetic ballooning threshold. It is shown that this growth is driven by an ion temperature gradient mode which is no longer saturated by zonal flows; instead of *runaway*, this process is thus termed *non-zonal transition* [M.J. Pueschel et al., Phys. Rev. Lett. **110**, 155005 (2013)]. Changes in zonal flow drive and tertiary modifications of the driving gradients are excluded as potential causes; whereas zonal flow decay due to magnetic fluctuations is singled out as the responsible mechanism. An important contribution stems from field line decorrelation: magnetic field lines, on their way from the inboard to the outboard side, are displaced radially by a perturbed field B_x. This displacement can reach the radial correlation length of B_x, causing the non-resonant fluctuations to contribute to the magnetic stochasticity; suddenly subjecting the zonal flows to much stronger decay. The non-zonal transition provides a new critical β that, for sufficiently strong background pressure gradients, can be significantly more restrictive than the ballooning threshold.