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Marginal Stability Dynamics for Energetic Particles[1]

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Marginal stability in plasmas characteristically sets a stiff limit to the range of that can be achieved. Below this limit, the system is governed by classical. Near marginal stability, however, plasmas may be subject to rapid processes, resulting in a system that hovers near marginality. This scenario emerged from nonlinear studies of energetic particle relaxation and may be to more general plasma transport. We describe results from several such which include. [1] Avalanches—Near marginal stability, an important point is whether an instability driven by resonant particles where the distribution function has "free energy" will cause global radial diffusion. For that,modes need to overlap. This process can be continuous or bursty, the latter having been recently observed in NSTX and DIII-D. [2] Frequency chirping—Recent simulations by Vann showed that marginal stability can be sustained when there is only one unstable linear mode, due to the mechanism of spontaneous frequency sweeping. Although a single mode near stability should not cause dramatic relaxation, nevertheless in the Vann simulations, the achievement of marginal stability induced a continual chirping of that had removed energy from the bulk of the region where the external beam to deposit free energy. The distribution was then found to hover near stability. This mechanism may apply to the n=0 GAM where frequency sweeping might be a mechanism for extracting energy from alpha particles in a burning plasma, thereby reducing the stored alpha particle pressure. One way to implement this is to have the n=0 geodesic acoustic modes (GAM) be preferentially excited, since energy rather than momentum (leading to spatial diffusion) is then primarily extracted from alpha particles.

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