Physics of Resonant Magnetic Perturbations in Toroidal Plasmas

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Recent experiments on a variety of tokamaks and stellarators have demonstrated that 3D, resonant magnetic perturbation (RMP), fields can be beneficial for controlling the properties of high temperature plasmas. While these results may have important practical implications for mitigating or suppressing edge localized modes (ELMs) in ITER, they are also of significant intrinsic scientific interest for understanding the basic physics elements that define the confinement and stability properties of tororoidal plasmas. One rather interesting aspect of the experimental data from tokamaks is that applied RMP fields predominantly act on the particle confinement with relatively minor effects on the energy confinement, which is not consistent with predictions from a straightforward application of quasi-linear transport theory. This discrepancy suggests that the magnetic topology induced in the H-mode pedestal by the RMP fields is significantly different than that observed in Ohmic plasmas. Alternatively, other physics, such as neoclassical effects, may be significantly more important than parallel heat conduction along open stochastic field lines. In addition, RMP fields have been shown to either improve or degrade the particle confinement in tokamaks depending on the details of discharge parameters and have been associated with the formation of transport barriers during H-modes in stellarators. This talk will describe experimental measurements of changes in the plasma confinement and stability when RMP fields are present at the edge of the plasma and relate these changes to models of the physics that is thought to be responsible for various effects that are observed in experiments.

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