Role of E×B shear and magnetic shear in the formation of transport barriers in DIII-D

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Abstract. Development of the E×B shear stabilization model to explain the formation of transport barriers in magnetic confinement devices is a major achievement of fusion research. This concept has the universality needed to explain the H-mode edge transport barriers seen in limiter and divertor tokamaks, stellarators and mirror machines; the broader edge transport barrier seen in VH-mode plasmas; and the core transport barriers formed in tokamaks with low or negative magnetic shear. These examples of confinement improvement are of considerable physical interest; it is not often that a system self-organizes to reduce transport when an additional source of free energy is applied to it. The transport decrease associated with E×B velocity shear also is of great practical benefit to fusion research. The fundamental physics involved in transport reduction is the effect of E×B shear on the growth, radial extent and phase correlation of turbulent eddies in the plasma. The same basic transport reduction process can be operational in various portions of the plasma because there are a number ways to change

the radial electric field E_r. An important theme in this area is the synergistic effect of E×B velocity shear and magnetic shear. Although the E×B velocity shear appears to have an effect on broader classes of microturbulence, magnetic shear can mitigate some potentially harmful effects of E×B velocity shear and facilitate turbulence stabilization. The experimental results on DIII-D and other devices are generally consistent with the basic theoretical models.

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