Observation of large-scale coherent structures under strong $E \times B$ shear

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Transitions from a low-confinement to a high-confinement regime are accompanied by the formation of a transport barrier at the plasma edge. $E \times B$ shear flows have been considered as a candidate for triggering the transport barrier. They are assumed to limit the radial correlation length of turbulent structures and, thus, reduce radial turbulent transport.

In order to study the influence of shear flows on the spatio-temporal structure of turbulence and turbulent transport, strong $E \times B$ shear flows have been generated by core biasing of the low-temperature plasma in the torsatron TJ-K. Since the plasma in TJ-K is throughout accessible for probe diagnostics, different types of multiprobe arrays were employed for the detection of turbulent structures. In particular, the spatial structure of turbulence under strong shear will be presented in high detail. Poloidal $E \times B$ flows with velocities of up to 16 km/s and maximum shearing rates of 400 kHz were achieved. The decorrelation rate of the order of 50 kHz was exceeded by the shearing rate in almost the entire plasma. The density gradient was steepened and the particle confinement improved. Measurements with an 8×8 probe matrix showed that under strong shear, the fluctuations are dominated by large-scale coherent structures, which reveal increased correlation lengths. Also the characteristic poloidal wavelength as measured with a poloidal probe array increased. The wavenumber decreased from $m = 4$ to $m = 3$, which corresponds to a single helical structure. This structure could be associated with inward transport due to a modification of the cross-phase between density and radial velocity fluctuations and, therefore, contributes to improved confinement.