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トロイダル乱流における E×B 階段構造の動的発展と輸送特性
Dynamical evolution and transport characteristics of E×B staircase structure on toroidal turbulence

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Profile stiffness and intermittent bursts are the basis in understanding L-mode plasmas. However, why and how these different processes coexist and regulate the transport have not been clarified. Here, we have presented an overall picture of flux-driven ITG turbulent transport [1] which reveals *profile stiffness with self-similarity* and *SOC type intermittent bursts* [2]. We study a circular plasma of $a/R_0 = 0.36$, $a/\rho_i = 150$, $\nu_* = 0.066$, safety factor $q(r)$ and input power $P_{in} = 16$M shown in Fig.1. Figure 1 also shows the turbulent heat flux (a) $\langle Q_{tub}(t) \rangle$ and (b) $Q_{tub}(r,t)$, and (c) radial electric field $E_r(r,t)$ in quasi-steady state. The ion tem-perature profile $T_i(r)$ is suffered from a constraint keeping the exponential function form while only the scale length L_T is changed at $r/a \sim 90$, exhibiting weak confinement improvement [2].

From the results, the transport is found to be regulated by four non-diffusive processes, (1) *radially localized fast time scale avalanche*, (2) *radially extended global burst*, (3) s*low time scale avalanche with* $E \times B$ *stair- case*, (4) *transport with long range time correlation.* Among them, the process (2) is the key, which results from instantaneous formation of radially extended ballooning modes ranging from meso- to macro-scale. The repetitive occurrence of such global modes provides a strong constraint on the profile causing stiffness.

The $E \times B$ staircase originates from zonal flows produced by such global modes while it dynamically evolves causing long time scale breathing in transport (*process* (3)) as seen Fig.1(c), referred to as $E \times B$ staircase [3]. Since they are excited near both edges of global mode, the interspace is determined approximately by the radial correlation length. Meanwhile, the staircase is found to evolve dynamically coupled with successive excitation of global mode as seen Fig.1 (b). This process causes a long time scale breathing in transport and plays a role in sweeping out corrugations appeared on the self-organized stiff profile.

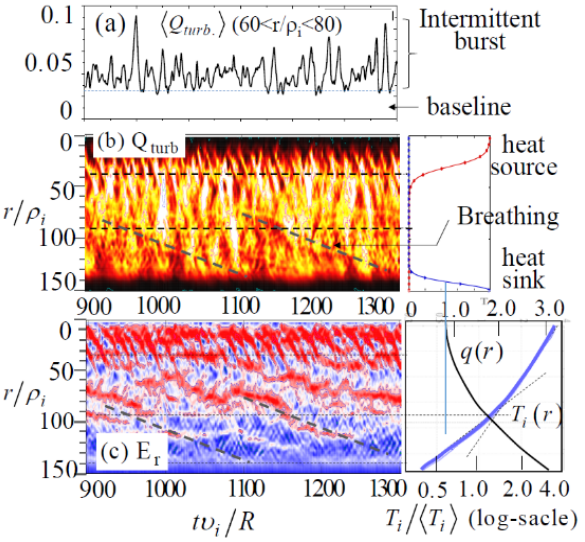

Fig. 1: Fig.1. (a) Evolution of averaged heat flux $\langle Q_{turb} \rangle$ in $60<r/\rho_i<80$, (b) spatio-temporal evolutions of heat flux $Q_{turb.}(r,t)$ and (c) radial electric field $E_r(r,t)$. Ion temperature profile (log-scale) and $q(r)$ are shown.

Reference
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