§2. Study on Momentum Transport via Fluctuations during L-H Transision on CHS

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Understanding of the mechanism that triggers the transition to high-confinement plasmas [1] is important for realizing fusion plasmas. In some tokamak operations, *H*-mode transitions are triggered by a sawtooth crash. However, such events have not been observed in *H*-mode transitions in helical plasmas. We have analyzed data obtained with the Hybrid Probe (HP) [2] in Compact Helical System (CHS) [3], and we present a direct observation of turbulent Reynolds stress (RS) preceding an *L-H* transition. Compression of RS could be a source of shear flows and is a candidate mechanism for the formation of a radial electric field, leading to *H*-mode plasmas [4].

We reconstituted the time evolution of two-dimensional maps of the RS shown in Ref. [5] (Fig. 1). Positive RS indicates radially outward transport of velocity in the electron diamagnetic drift direction. The maps are reconstituted from shot-by-shot scan data from the HP. Timings of the H_α drop are used as the reference to synchronize different shot data in the same time series in two-dimensional maps. The RS starts to increase at 78 ms, indicated by red square (1) in Fig. 1(a) of Ref. [5], has a maximum at 86 ms (2), and vanishes at 94 ms (3). We have discovered an increase in the RS preceding the H_α drop (the *L-H* transition). At the beginning of the increase, the RS is localized near the outermost surface of the plasma at $Z = 0$ m. However, around the period when the RS has a maximum (84 ms), a large RS is distributed along the plasma surface, and the radial gradient of the RS is strong. The RS can transfer poloidal momentum in the radial direction and/or radial momentum in the poloidal direction. The RS gradient is a source/sink for momentum. Therefore, the finite radial gradient observed here can drive poloidal shear flow.

The momentum balance equation determines the correspondence of negative electrostatic potential to positive RS in the coordinate used. We compare the waveforms of H_α, the floating potential, and the RS in detail in Fig. 1 (Quoted from Ref. [5]) to investigate the relationship between the potential and the RS. The waveforms were sampled simultaneously in a discharge. A positive spike in the RS, preceding the end of the H_α drop, is correlated with a negative jump in the floating potential.

Here, we discuss about the RS profile after the L-H transition. In Ref. [4], the RS maintains poloidal flows after the transition. However, in CHS, the radial gradient of the RS is poor after the transition. This observation suggests that the RS does not play significant roles on sustaining plasma rotation [6] after the transition. Further studies are necessary to clarify the existence of the radial electric field and edge structure of *H*-mode plasmas in CHS. In previous work, significant toroidal and/or poloidal asymmetry in electrostatic fluctuations were observed around the *L-H* transition in CHS [7]. The asymmetry may affect evaluation of flux surface averaged RS. We evaluated the RS at one toroidal location in this experiment. Simultaneous measurement of the RS at a number of toroidal/poloidal locations is necessary to evaluate the existence of zonal flows by which plasma confinement may be improved.

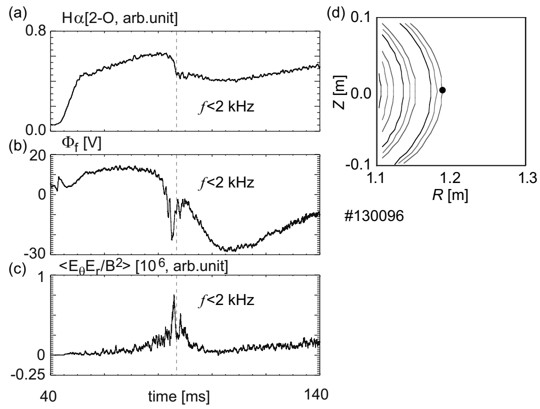

Fig. 1: Time evolutions of (a) emissivity of H_α, (b) floating potential, and (c) turbulent Reynolds stress. (d) Observation locations. In (a)–(c), vertical red lines mark the end of the H_α drop.

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