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Formation of radially elongated flow in HL-2A H mode plasmas

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The dynamical evolution of turbulence and transport in structural transitions in magnetically confined plasmas, and even in fluids, is a long lasting important and interesting subject with many challenges remaining unsolved in laboratories and the nature. In particular, it is well known that there are two important kinds of mesoscale structures resulting from turbulence in magnetically confined plasmas. One is zonal flows, including low/zero frequency zonal flow and GAM, which suppress turbulence and induce improvement of plasma confinement [1]. The other is radially elongated flow (REF), i.e., streamers [2], which are localized in poloidal direction while elongated in radial direction and, therefore, enhance cross-field transport. Experimental investigation on REF is rather rare, in contrast to the abundant achievement on zonal flows, although systematic theoretical investigation on streamer has been performed and significant progress has been made in recent years [3-4].

Here we report an experimental observation of REF formation in edge plasmas during inter-ELM phases of high confinement discharges on HL-2A tokamak [5]. A quasi-coherent mode at the frequency of 40-70 kHz which gains energy from and modulates ambient turbulence and induces inward particle flux and increases of density, pressure and their gradients was observed prior to each type-III ELM onset in a series. The mode stretches inward in the radial direction, bunches in the poloidal direction near the mid-plane at the low field side, and transits into streamers finally in a time scale of 10-20 μs. The REF induces almost instantaneous collapse of plasma energy in the outer region ~ 0.3 of the plasma column within a few tens of microseconds without global MHD instabilities. Detailed dynamic features of the REF are described and the possible influence on pedestal collapse is discussed.

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