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Dynamics of High-Intermediate-High Confinement Transitions on the HL-2A Tokamak

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It is essential to understand L-H transition mechanisms to provide a predictable power threshold for a successful operation in fusion reactors. Early theoretical and experimental studies have shown that plasma may pass an intermediate phase (I-phase) when the heating power gradually increases, approaching the H-mode power threshold. This extended time scale provides opportunity to study the L-H transition mechanism. Recently, this phenomenon accompanying with limit cycle oscillations was studied using a Langmiur probe array on the HL-2A in detail. Here, we report extended observations of dynamics in high-intermediate-high (H-I-H) confinement transitions on this device. The H-I transition was stimulated by the supersonic molecular beam injection (SMBI) with gas pressure⊠2.5 MPa and pulse width⊠2.0 ms. The Lissajous diagram between the normalized radial electric field X=e\rho_\theta|E_r|/T_e and the envelope of density fluctuations in the I-phase shows that all cycles rotate in the counterclockwise (CCW) direction, which means that the increase of the turbulence causes the reduction of radial electric field while the increase of the radial electric field induces decrease of turbulence. It seems that once the system enters such CCW LCO state the plasma may be able to enter a positive feedback loop which triggers the I-H transition. Another interesting finding is a coherent mode with 11.7 kHz appearing just prior to the I-H transition (lasting about 1.0 ms). The mode numbers of the magnetic fluctuations are identified to be m/n=3/1. It was found that the amplitude of magnetic fluctuations rapidly increases while that of LCOs significantly reduces. This contrast indicates that there is a possible interaction between the coherent mode and the turbulence, which is also favorable for the I-H transition. Detailed results will be presented.

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