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L-H Transitions Triggered by SMBI: Experiment and Theory

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Recent understanding of the L-H transition phenomena developed a possible explanation that a gas-induced density profile change can trigger a "Stimulated edge transport barrier (ETB)"state, which can be used to reduce the required power threshold relative to the known power threshold scalings for standard fueling.
Experimental investigations on these stimulated transitions were carried in KSTAR using an SMBI (supersonic molecular beam injection) system. Available edge profile measurements show that the SMBI drives a localized edge density increase, accompanied by strong edge cooling. The density gradient driven by SMBI is not as steep as what is seen in the H-mode, but formed gradient is sustainable because it can alter the edge required to enhance the particle confinement. Behavior induced by an SMBI strongly depends on the baseline density of the plasma at the moment of injection. The known density rollover, nmin = 2.0e19 m-3 for KSTAR1, seems to play a role as an important parameter.
The non-trivial "stimulated ETB"occurs only on the higher branch of Pthr vs ne in KSTAR. A reproducible gas-stimulated ETB state occurs for a certain amount of SMBI particles with 30-50 percent reductions in the total absorbed power (Pabs = Pinj –dW/dt - Prad). These stimulated transitions are always limited in duration, but the transition state is sustained by repeated injections in the experiment.
A spatial-temporal evolution of the edge electron density/temperature is also obtained by KSTAR Thomson scattering during the SMBI-stimulated ETB period. During that period, it is observed that the edge density level decreases steadily, hence the corresponding electron pressure becomes lower. The electron temperature, however, does not change much after the stimulated ETB is achieved (t > 6.52s).
A reduced model of the L⟶H transition has been used to study injection-stimulated transitions2. Results demonstrate: 1) shallow injection is optimal, and superior to strong puffing, 2) transient improved confinement states can be maintained by repetitive injection, 3) the principle means of accessing enhanced confinement is via stronger edge ExB shear, 4) in contrast to standard transitions, a burst of zonal flow growth does not lead stimulated transition events. Ongoing work is concerned with detailed comparison with experiment.

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