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Overview of Recent Experiments on HL-2A Tokamak

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Recent experiments on the HL-2A tokamak have been aimed at the major challenges relevant to ITER operation and fusion energy development. Significant progress has been achieved in many areas, including the first demonstration of high coupling efficiency of LHCD passive-active multi-junction (PAM) antenna in H-mode discharges, pedestal instability and dynamics, ITB formation mechanism, energetic particle physics, ELM and disruption mitigation, real-time control of tearing modes with ECRH, etc..
A new PAM antenna as an LHCD launcher was designed and installed on the HL-2A tokamak. A high coupling efficiency was demonstrated under NBI heated ELMy H-mode plasmas. This was the first time that PAM antenna was applied in H-mode. The effects of LHCD on ELM mitigation and control of heat load on divertor plate were also observed. It was found that impurity accumulation and relaxation in the edge could trigger a series of I-H-I transitions through the excitation of a broadband (50-150 kHz) electromagnetic (EM) turbulence. EM turbulence could also be excited by impurity injection via laser blow-off. An improved confinement with complete suppression of ELMs was achieved by this technique. These findings reveal the underlying physics of how impurity affects the pedestal evolution, and suggest an important method to actively control pedestal via impurity-excited EM turbulence. An inward particle flux induced by a quasi-coherent mode at frequency 40-60 kHz was found to be responsible for the dramatic changes of the gradients in pedestal and the triggering of ELMs. Dependence of the correlation of resistive ballooning modes and trapped electron modes on electron temperature increase was observed experimentally. Formation of the ion ITB was found to be closely related to the Te/Ti ratio. A new nonlocal transport phenomenon triggered by the fishbone was observed and demonstrated to be caused by electromagnetic fluctuations. High-frequency RSAE and resonant kinetic ballooning mode were confirmed in experiments, and found to cause energetic ions losses. Low-n Alfvenic ITG were observed and identified in Ohmic and NBI plasmas. For the first time non-resonant internal kink modes destabilized by energetic electrons with ECRH+ECCD were found in current ramp-up phases.

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