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Mitigation of Runaway Current with Supersonic Molecular Beam Injection on HL-2A Tokamak

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Disruption mitigation experiments with MGI have been carried out on HL-2A with a rapid (˜1 ms), massive (˜1021 particles) injection of helium/neon/argon to study various injection scenarios. The behaviors of runaway currents in MGI induced disruptions have been investigated. A long-lasting RE plateau is achieved after argon injection by MGI even at Bt = 1.28 T, much lower than previous Bt threshold found in other tokamaks. It was found that argon injection can cause the generation of runaways carrying up to 30% of the initial plasma current, while disruptions triggered by injection of helium or neon are runaway free.
Furthermore, the runaway current caused by argon injection with MGI was successfully suppressed by SMBI with a number of injected atoms of about 1.0×1021. Light gases, such as helium, are selected in this experiment for its high efficiency in increasing the density.These experiments suggest that SMBI might be viable for runaway suppression in future tokamaks even though core penetration of jet neutrals is not achieved. An understanding of this paradox is obtained by modeling, which shows that the initial cooling of the plasma periphery triggers a very rapid growth of low-order tearing mode, resulting in a strochastic region over much of the plasma. This allows rapid transport across the entire plasma, and could explain the effectiveness of SMBI mitigation in HL-2A in spite of the shallow penetration of the neutral gas jet.
In addition, a toroidal alfvén eignmode (TAE) was observed during disruptions deliberately triggered by the massive gas injection (MGI) of argon. This mode occurs at the beginning of the current quench and lasts about 1-2 ms. These instabilities appears to be favorable in limiting the RE beam formation. It has been found that the runaway plateau is easy to obtain on the condition of high normalized magnetic fluctuation level(⊠B/BT), the runaway plateau is even invisible when ⊠B/BT the exceeds the threshold of about 7.8×10-4, incdicating that this magnetic mode plays a scattering role on the RE beam strength.

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