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Observation of large filaments during the disruptive phase of Aditya tokamak plasma

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Study of the plasma dynamics during the termination phase of a tokamak discharge, particularly during a major disruption, is extremely important for gaining an understanding of essential processes that impact operation limits (e.g. the β limit), outward heat and particle flux and plasma control. Behavior of the edge and scrape off layer plasma during such an event is also vital since this region bridges the hot core plasma and the material wall of the device. We report on a detailed investigation of the edge dynamics during the discharge termination phase in Aditya tokamak using fast visible imaging diagnostics and Langmuir probes.

A frequent observation during disruptions on the Aditya tokamak is the occurrence of large filaments predominantly on the low field side. These filaments follow the enhanced interaction of the plasma column with the high field side (HFS) limiter surface almost at the end of the discharge. Just prior to the disruption, the plasma column shrinks considerably towards the HFS and the filaments evolve on a resistive diffusion time scale (˜1 ms). In Aditya, enhanced oscillations in the signals are observed just prior to the thermal quench. Oscillation amplitude peaks at the thermal quench. Similar phase chronology is observed during high and intermediate β disruptions in TFTR. Studies on gas puff induced disruptions followed by disruption mitigation using biased electrodes in Aditya, had shown that the m/n = 2/1, 3/1 tearing modes were destabilized prior to the disruption sequence. These modes tend to lock and lead to field ergodization and subsequently cause a thermal quench, followed by the final current quench. For the TFTR observations resistive MHD simulations had concluded that the growth rate of plasma filaments did not depend on resistivity eta_d but were influenced by the plasma β. Further, the number of fingers were shown to be inversely proportional to eta_d. In contrast, our experimental observations show that the number of fingers is proportional to eta_d in Aditya. We will discuss the underlying physics of the formation of such filaments during disruptions in Aditya and present model calculations supported by MHD simulations that are based on the growth of tearing modes and the mode locking scenario and that are consistent with the observed filament growth rates and the scaling of the number of filaments with eta_d.

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