Running away and radiating

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Tokamak discharges are frequently terminated by a disruptive instability, whereupon the plasma interacts with the wall and impurity ions enter the plasma, causing a catastrophic loss of energy due to the excitation and ionization of these ions. As the plasma cools down quickly in a disruption, a large toroidal electric field is induced. This electric field can detach a fraction of the electrons (in velocity space) from the bulk of the plasma and accelerate them to very high energies (tens of MeV). The detached electrons are normally referred to as runaway electrons. In the end, the beam of runaway electrons will intersect material surfaces of the mechanical structure of the tokamak and can potentially cause severe damage to vital parts.

In this talk we review the current status of theoretical modelling of runaway avalanches in fusion plasmas. We will describe possible techniques for obtaining information about them by characterizing the synchrotron radiation they emit and the kinetic instabilities they excite. We will also adress possibilities to mitigate their harmful effects through e.g. massive gas injection or resonant magnetic perturbations. Finally, we will describe the phenomena of ion runaway and its role in neutron production through fusion reactions in lightning discharges.