URSI AP-RASC 2019, New Delhi, India, 09 - 15 March 2019

Harmonics Of Drift Tearing Modes In ADITYA Tokamak

Joydeep Ghosh[1,2], Harshita Raj[1,2], R. L. Tanna[1], Tanmay Macwan[1,2], R. Kumar[1], S. Aich[1], P. K. Chattopadhyay[1,2], K. A. Jadeja[1], K. Patel[1], D. Raju[1], S. Jha[1], P. K. Atrey[1], U. Nagora[1], A. Sen[1,2], N. Bisai[1], R. Pal[3] and ADITYA Team[1]
(1)Institute for Plasma Research, Bhat, Gandhinagar, India, email: jghosh@ipr.res.in
(2)Homi Bhabha National Institute, Mumbai, India
(3)Saha Institute of Nuclear Physics, Kolkata, India

Tearing modes are the resistive magnetohydrodynamic (MHD) modes, which occur in all conventional tokamaks. They are known to degrade plasma confinement by creating magnetic islands which often lead to plasma disruption if their growth is not controlled. They have been extensively studied both theoretically and experimentally, as controlling them is foremost priority for every tokamak, including ITER and future large size tokamaks. In the high diamagnetic-drift frequency regime, the drift mode couple to tearing modes resulting in drift-tearing modes. The growth rate of Drift-Tearing modes decreases as its real frequency increases. In ADITYA as well as in ADITYA Upgrade tokamak, the frequency spectra of Mirnov signal show multiple frequency bands identified as drift tearing modes. Interestingly, the higher frequencies have precisely been found to be the integral multiples of the fundamental frequency. Further analysis reveals that these frequencies do not belong to different modes but harmonics of a single mode. These harmonics are also observed in the density as well as impurity emission. It has been observed that the harmonics generation is strongly correlated with the presence of high energetic electrons, known as runaway electrons, in the plasma. When the magnetic island grows in size, the runaway electrons get trap in these islands. And as the linear growth rate of tearing modes increases in presence of REs, the island size increases further due to the presence of runaway electrons, leading to harmonics generation.

ADITYA, a medium size, Ohmically heated limiter tokamak, has been upgraded to ADITYA-Upgrade tokamak with diverter configuration. This paper includes observation of discharges from both ADITYA and ADITYA-U which fall in category of drift-tearing modes, in limiter operation/mode. Both the machines have major radius, R~75 cm and minor radius, a ~25 cm. Typical plasma parameters of the discharge used for study presented in this paper are : plasma current, Ip ~80-120 kA, chord average plasma density, n_e ~ 1.5 - 3 x 10^{19} m^{-3}, electron temperature, T_e ~300 - 700 eV characteristics, current flat-top duration, 50- 200 ms, toroidal field, B_T ~ 0.8-1.2 T and pre-fill pressure ~ 10^{-5} (ADITYA) and 10^{-4} Torr (ADITYA-U). To understand the evolution of MHD modes in ADITYA and ADITYA-U discharges, systematic spectral analysis of poloidal magnetic fluctuation ($\dot{B}_\theta$) acquired by 16 Mirnov coils has been carried out for a large number of discharges. The power spectra of these fluctuations show distinct peaks at ~6.5 kHz, 13 kHz and 19.5 kHz respectively in both plasma density and MHD.

Parametric coupling may lead to the observation of harmonics of drift tearing mode when the magnetic field fluctuations rise above certain threshold. The bi-coherence analysis of the fluctuations shows clear signature of non-linear self-interaction. Sudden growth of the magnetic field fluctuations is observed to be related to the trapping of runaway electrons in the magnetic islands formed within the plasma.