**Understanding the Physical Processes Prevailing in the Edge Plasma Region of ADITYA-U Tokamak using Spectroscopic Measurements**

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***Abstract***

The edge region of any tokamak plasma controls both the core plasma confinement as well as the particle and heat flux to the plasma facing components and vessel wall. The ADITYA-U tokamak edge plasma has been extensively explored using spectroscopy diagnostic to understand the prevailing physical phenomena in this region. The ion and neutral temperature, recycling influx from limiter and wall and impurity particle transport are deduced from spectroscopic measurements of emission intensities and spectral line profiles of fuel and impurity neutral and ions, emissions in ADITYA-U tokamak plasma. Along with this to develop the characterization technique for divertor plasma for future ADITYA-U experiments, molecular bands are identified and analyzed through molecular band modelling.

While deducing the ion and neutral temperatures, an anomaly arising due to Zeeman effect has been removed and real temperature are estimated. As the tokamak plasma is suspended in high-magnetic fields, Zeeman effects are important to be included in the line-shape profile analysis. By including the Zeeman effect in the line shape analysis of fuel neutral and , impurity ions it has observed that there exists a poloidal asymmetry in neutral temperature, which is reported for very first time. The anomaly has been resolved through modelling of spectral line shape profile with by incorporating the Zeeman influenced components in simulation. The analysis also showed that there exists two components of neutral temperature (warm and hot) in ADITYA-U tokamak plasma, corresponding to different atomic and molecular processes. The corrected temperatures of and ions and their radial profiles indicated that presence of magnetic islands significantly influence the impurity temperatures. *In the novel Inductive Pellet Injection (IPI) experiments, self-absorption phenomenon in spectral line emission has been identified and thoroughly analysed.*

For recycling and influx estimations emissions from stainless-stell wall and graphite limiter with and without Li coating are collected and analysed. Using this the temporal evolution of , and emissions, the recycling from these surfaces is quantified. To further decipher the edge plasma physical processes, The Diffusion coefficient is estimated for C, O, Ne, Ar, and Fe with an in-house developed SITA code (Study of Impurity Transport in ADITYA-U tokamak). Using the code, it has been observed that with increasing Z value the diffusion coefficient decreases. The observed mass dependency of diffusivity coefficient throws a new light towards understanding the impurity transport in tokamaks. Due to very low plasma temperatures near the wall, molecular processes become very important. The presence of different impurities in this region further complicates the molecular band identification. The overlapping of bands is studied in a RF produced plasma and correct impurity ion temperatures are estimated. A elaborated edge plasma diagnosis through spectroscopic technique and understanding of physics basis for the events occurring there will be presented in this paper.

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