Chapter 5 Conclusions and future scope of the work

We have formed hydrogen plasma using ECR method. Plasma is formed with a peak density of $3 \times 10^{16}$ cm$^{-3}$. Electron temperature is in the range of 4-7 eV. Density and floating potential exhibit slab nature of the plasma in the vertical direction of the poloidal cross-section. Our measurements reveal that X-mode wave converted to electrostatic modes near UHR, which propagates close to ECR region, where entire energy of the waves are deposited. Thus, we observe plasma profiles becoming broadened towards the weaker magnetic field region upto the UHR region, with an inner boundary near ECR region. This is further supported by numerical calculation.

In ECR formed plasma, both turbulent and coherent spectra are observed. LF fluctuations are observed and identified as flute type and drift type of instabilities. The LF modes identified in this plasma are highly localised. Turbulent spectra is observed where the condition $V_n . V_B < 0$. In this region, we also observe large density gradient and moderate electric field. LF coherent fluctuating modes are observed in the region where $V_n . V_B > 0$. Both RT mode and collisional drift mode are observed in these regions. Drift mode is observed where electric field is large, with moderate density gradient or in the region where electric field is moderate and positive in nature but density gradient is weak. Flute
modes are observed in the region where electric field is small and positive. Also, density gradient is moderate and antiparallel to ‘g’. Our measurements suggest that collisional drift modes could be excited when $\eta_r < 0$ whereas R-T modes could be excited when $\eta_r > 0$ and density gradient is antiparallel to ‘g’.

Plasma is also formed with filament at the minor axis. Bi-direction gradients in density and potential are observed. Our measurement confirms the fact that the slab plasma is formed, away from the filament location. The slab nature of the plasma in the vertical direction could be adjusted using the appropriate length of the filament. The contours suggest that the condition $\nabla n$ is parallel (antiparallel) to the structure vectors in the good (bad) curvature region is satisfied in the vertical direction, when the axisode is placed vertically at the minor axis. The slab nature of the contour is confirmed. The contours are elliptical for an extended source and confirm that, for Bi-directional plasma, oblique to the observation of the R-T modes, in the good curvature region. The contours exhibit parallel isocontours exhibit similar behaviour even in the presence of a weak vertical magnetic field. With the help of a weak vertical magnetic field, however, the modes in the slab are suppressed. The vanishing divergence of the current is responsible for the occurrence of equilibrium of the plasma and our results indicate that this growth. The fluctuations in the parallel direction provides an excellent path to get rid of excess current in addition to the filament.

Coherent fluctuations of density and floating potential, observed around 3 kHz, gets suppressed in the presence of a weak vertical magnetic field. Significant suppression is observed in the good curvature region than in the bad curvature region. Accommodation of larger $k_B$ tends the coherent mode to evolve into a turbulent one with a shift in the frequency to a higher side.

The plasma in first experiment and second experiment, exhibits interesting observations. The modes are highly localised in the former case whereas they are global in the latter case. In the first case, both turbulent and coherent modes, showing flute and drift nature of instabilities are observed, whereas in the second case flute modes are the dominant
modes. The electric field profiles are also different in the two cases. In the first case it varies locally, whereas in the other case it changes its sign, once we cross the filament location, as we go from bad curvature region to good curvature region. Thus, biasing of filament and filament presence do play an important role in the behaviour of low frequency fluctuations in filament plasmas.

The present work offers a good scope for the future work. The differences observed in the fluctuating component of ECR produced plasma and the filament-produced plasma varies significantly. Proper modeling of the above plasma fluctuations is desired and could be the future work. The same could be studied through numerical studies. One could also form toroidal plasma using rf source and study plasma fluctuations.