High Density Scrape-Off-Layer Absorption of Lower Hybrid Waves on the Alcator C-Mod Tokamak
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Abstract
The goal of the LHCD system on Alcator C-Mod is to investigate current profile control under plasma conditions relevant to burning plasma experiments. Bremstrahlung from fast electrons in the core plasma drops suddenly at a density below the density limit previously observed on other tokamaks ($\omega_c/\omega_{ce} \sim 2$). Electric currents in the SOL between the inner and outer divertors increase across the same density range that the core bremsstrahlung emission drops while SOL Lyman-$\alpha$ emissivity profiles shift outward, indicating absorption of LH waves in the SOL. The experimental x-ray data are compared to a ray tracing/Fokker-Planck model including collisional absorption in the SOL, which shows good agreement with the experiment across a wide range of densities.

High Density LH Operation\textsuperscript{[1]}
- Above densities $n_e \sim 1 \times 10^{20} \text{m}^{-3}$, HXR emission significantly drops with applied LH power.
- LH induced changes in loop voltage ($\Delta V$), diminish at higher density (indicating loss of current drive).
- HXR count rate decays at a rate faster than $\sim n^{-1}$.\textsuperscript{[1]}
- HXR reduction not dependent on $N_1$.
- Parametric Decay is not cause of loss ($\omega_{ce}/\omega < 3$).
- CQL3D/GENRAY codes better predict density dependence with addition of SOL

4.6 GHz Lower Hybrid System
The Lower Hybrid Current Drive (LHCD) system on Alcator C-Mod preferentially excites the lower hybrid slow wave. The launched spectrum is determined by the phased-waveguide array phasing.\textsuperscript{[3]} Wave coupling is maximized with a minimum distance to the plasma LCFS, minimizing the cutoff region. The old launch system was capable of $\sim 1.2$ MW net power for 500 ms, with an $N_1$ from 1.5-3.5. [New Launcher - See J.R. Wilson PO4.00003]

Lyman-$\alpha$ Emission Indicates Wave Absorption of LH in the SOL
- Lyman-$\alpha$ emissivity profile shifts outward radially with applied LH power in high density (shift into the SOL).
- Increased emissivity is also seen in higher density cases.
- Increase in emission and shift is indicative of increase of ionization in SOL.
- Emissivity profile shift is power dependent at high density.
- Increased emissivity is seen on fieldlines not tied to the launcher.

Lyman-$\alpha$ Measures SOL Ionization
- Detects the n=2 $\rightarrow$ 1 D transition (121.6 nm) light.
- Uses pinhole-collimated AXUV diodes and bandpass filters.\textsuperscript{[4]}
- Linear diode array resolves spatial Ly-$\alpha$ intensity.

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References

Conclusions and Future Work
- Lyman-$\alpha$ emissivity profile is modified during high density LH discharges.
- Results indicate that collisional absorption is ionizing the SOL.
- SOL currents arise from enhanced density in the SOL during high density LH discharges.
- Current drive efficiency drops with the onset of SOL phenomena.
- SOL absorption profile will be elucidated with planned experiments.

This work supported by the US DOE awards DE-FG02-99ER54512 and DE-AC02-76CH03110/73