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Fast-Sweeping Langmuir probes: What happens to the I-V trace when sweeping frequency is higher than the ion plasma frequency?

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A rising demand of fast sweeping Langmuir probe has been spurred due to its implement simplicity with increasing interest in studying turbulent fluctuations and transient phenomenon[1,2]. However, when a Langmuir probe sweeps much faster than the ion sheath transit time, typically the ion plasma frequency ω_{pi}, an equilibrium sheath cannot truly form resulting in a time-averaged current of a non-equilibrium sheath[3]. Such influence of improper ion current on I-V traces is undetermined. Therefore, I-V characteristics of fast-sweeping planar Langmuir probe with $f_{sweep} >> \omega_{pi}$ has been investigated in a multi-dipole filament discharge. A fast-sweeping dual Langmuir probe system has been constructed with a 30 mm in diameter tantalum probe tip and a maximum available sweeping frequency of 500 KHz is achieved. The experiments were conducted at a low-density plasma with ion plasma frequency ω_{pi} ~50KHz, allowing sweeping frequency $f_{sweep} >> \omega_{pi}$. Preliminary results indicate incorrect ion current is insignificant to the determination of Te and an overestimated electron density ne is observed as expected when a planar Langmuir probe sweeping at frequency higher than ω_{pi}. The relative errors of probe data between fast sweeping Langmuir probe and typical one is less than 30%, which is acceptable for Langmuir probe. And the methods compensating capacitive effect are briefly discussed.

References

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