Sheaths – Where Plasma Meets a Surface

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A sheath occurs at the walls bounding plasma and adjacent to objects inserted into plasma. Textbook discussions of sheaths usually omit mathematical development because the potential profile cannot easily be expressed in terms of tabulated functions. The sheath region is not quasineutral and numerical solutions to Poisson's equation are needed to find the sheath characteristics. The personal computer makes it possible to find the sheath profile with relatively little effort given appropriate boundary conditions and expressions for the electron and ion densities. This tutorial will discuss fluid and kinetic models for the densities of electrons and ions near boundaries and desktop methods for integrating Poisson's equation to find solutions for the spatial variation of the potential, electric field, and particle densities as well as particle flux and energy flux. These solutions can describe the interior region of the plasma (the presheath) as well as the sheath itself. Active areas of research include sheaths at emitting surfaces and sheaths at boundaries for plasmas with several populations of electrons or with several species of ion.