Kinetic modelling of the plasma-wall transition in magnetized fusion plasmas

Giovanni Manfredi

Institut de Physique et Chimie des Matériaux de Strasbourg
CNRS – Université de Strasbourg, France

The vast majority of plasmas produced in the laboratory are in contact with a material surface. In fusion devices, the surface can be either the material vessel that contains the plasma, or some *ad-hoc* device (limiter or divertor) specifically designed to optimize the interaction with the charged particles. These surfaces are eroded by ion and neutral bombardment and may thus see their lifetime considerably reduced. In addition, plasma-wall interactions also affect the outcome of probe measurements, as the probe's surface can disturb the plasma characteristics.

Perhaps the main feature of the physics of plasma-wall interactions is the formation of *sheaths*, i.e., boundary layers that form at the interface between the plasma and the surface. In a tokamak, the sheaths must support the main share of particles and heat fluxes directed towards the divertor.

In these seminars, I will review the basic theoretical and computational aspects of plasma-wall interactions. Some fundamental results will be derived analytically using a simple fluid model, and subsequently tested with kinetic simulations. The various regions composing the plasma-wall transition will be discussed in detail.

The structure of the plasma-wall transition is considerably modified by the presence of a magnetic field, particularly when the latter has a grazing incidence with respect to the surface. Here, I will describe the angular and energy distribution of the ions impinging on the surface, which is an important parameter to determine the level of wall erosion and sputtering.

Finally, I will discuss some transient (i.e., time-dependent) phenomena, such as the parallel transport of energetic charged particles in a tokamak edge following an ELM (edge-localized mode) event. Recent attempts to model these effects by means of kinetic equations will be illustrated and discussed.