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Physics and latest results of pellet core fueling for fusion devices : Tokamaks, stellarators, and reversed field pinches

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In a reactor grade device, the role of core fueling is to replace the D and T consumed in the fusion reactions (almost negligible) and to compensate the plasma losses through the separatrix - including the material expelled out by the ELMs. For this purpose, deep material deposition is an advantage and pellet injection the best candidate for fueling the future machines. Indeed, in a large-scale device, the screening of the neutrals is important and a simple gas injection from the edge is not efficient enough for feeding the plasma at the required level [1]. Fueling by pellet injection consists in two phases: First, the pellet ablation itself then, the ablated material homogenization and drift in the discharge. The former is a self-regulated local process, which depends only of the local plasma characteristics. The second is a global phenomenon, which depends on the whole magnetic configuration ([2], [3]). In this presentation, we discuss first the basics of the ablation physics, emphasizing the role of the fast particles – ions and electrons – resulting from NBI or wave heating; then we describe the homogenization process and associated ∇B-induced drift.

The drift acceleration and damping processes are described as well as the influence of the magnetic configuration (tokamak, stellarator and reversed field pinch) on the predominance of a given damping process and its consequence on the resulting deposition profile. We will illustrate this with several results of experiments made on:

- Tokamaks such as Tore Supra [4], ASDEX [5], DIII-D [6]
- Stellarator like W7-X ([7], [8]), LHD ([9], [10])
- Reversed Field Pinches RFX ([11], [12]).

We finally review the last results relative to pellet fuelling in these different kind of devices ([13] to [17]) and present the ongoing projects for future large-scale machines.

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