**Fuelling efficiency and penetration of supersonic molecular beam injection in HL-2A tokamak plasmas**

Southwestern Institute of Physics, Chengdu, China

*Email: yudl@swip.ac.cn

**Abstract**

The fuelling efficiency and penetration characteristics of supersonic molecular beam injection (SMBI) have been studied on HL-2A tokamak. The signals from the tangential $D_\alpha$ array and CCD camera clearly show that the SMBI from low field side (LFS) consists of a slow component (SC) and a fast component (FC). The FC can penetrate more deeply than the SC, such as 8.5 cm inside the last closed flux surface (LCFS), while the SC is around 4 cm. The penetration depth of the SC is weakly dependent on the line-averaged plasma density before injection and the backing pressure. Typical fuelling efficiency of LFS SMBI is 30–60% for the limiter configuration. It is more the variation of the decay time of the post-SMBI electron density than the different injection depth that is responsible for the large scatter of the measured fuelling efficiencies. The fuelling efficiency from high field side (HFS) is higher than that from LFS for the ohmic heating discharges; moreover, with ECRH power of 1.3MW, this trend becomes much more distinct indicating it is better for SMBI to fuel from HFS.

Keywords: Fuelling depth, $D_\alpha$ emission, fuelling efficiency, supersonic molecular beam injection

PACS Number: 28.52.Cx, 52.25.Ya

**1. Introduction**

Supersonic molecular beam injection (SMBI), as an effective fuelling method, was first successfully developed on HL-1M tokamak [1] and then widely adopted by other devices such as HL-2A, Tore Supra [2] and ASDEX-U [3] due to its high fuelling efficiency, simplicity of structure and low cost. It is reported that the fuelling efficiency ranges from 30–60% on Tore Supra [2]; and on ASDEX-U, fuelling efficiency is about 30% for L-mode and low density H-mode plasmas and is reduced to less than 15% in high density H-mode discharges[4].

On HL-2A, the SMBI can fuel plasma from both the low field side (LFS) with an electro-magnetic valve and the high field side (HFS) with a pneumatic valve, as shown in figure 1. The distance from plasma to HFS nozzle is several centimeters only, whereas the LFS is about 1.28 m. The relevant diagnostics around the SMBI are $D_\alpha$ arrays and CCD cameras. Two $D_\alpha$ arrays and a CCD camera are installed in the same cross-section with respect to the SMBI port. Besides, a 46-channel tangential $D_\alpha$ array monitors the half cross-section on the LFS with 0.9 cm spatial resolution and typical acquisition frequency of