# 1.6 Effects of Supersonic Beam and Pellet Injection on Edge Electric Field and Plasma Rotation in HL-1M

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Experimental measurements of edge electric field and plasma rotation have been carried out on both of SOL and the boundary region of HL-1M for Ohmic, Supersonic Beam Injection (SBI) and Multi-shot Pellet Injection (MPI) with a Mach/Langmuir probe array. The Mach/Langmuir probe array consists of five pins, four side pins acting as collecting electrodes of Mach probe to collect ion saturation currents, one center pin acting as a standard single probe to measure floating potential. This Mach probe array can measure not only parallel flows but the flow perpendicular to the magnetic field as well[1].

The effects of supersonic beam injection and multi-shot pellet injection on edge electric field, plasma rotation and fluctuation have been observed, as shown in Fig. 1. The results show that the change of radial electric field $E_r$ is generated at the edge and sheared poloidal flow relates to the reduction in fluctuation level.

The basic relation between the macroscopic drift velocity of a particle and a radial electric field $E_r$ is obtained from the radial component of the equation of motion for a particle. In the Tokamak plasma, the basic relation between the perpendicular fluid velocity of a particle $v_{i\perp}$ and $E_r$ is the radial force balance[2]

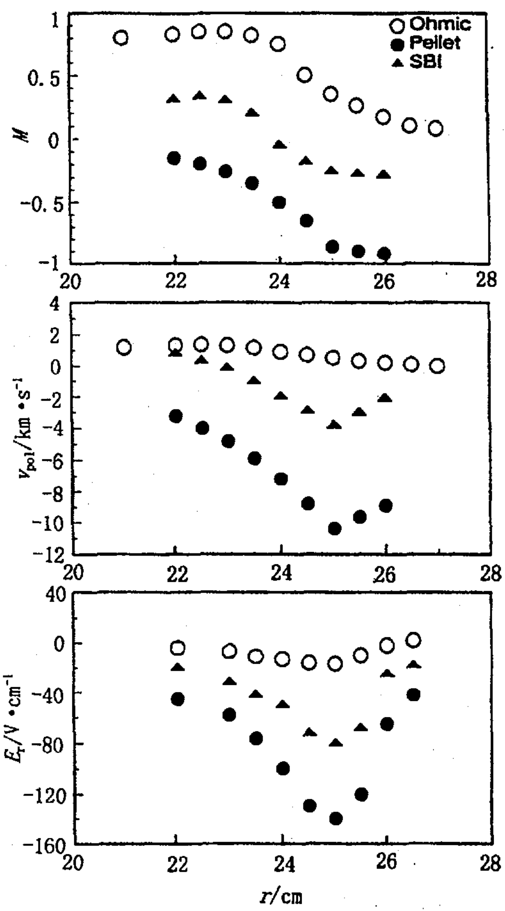


Fig. 1 The radial profiles of $M$, $v_{pol}$ and electric-field $E_r$ during Ohmic-heated discharge, MPI and SBI

$$eZ_in_i(E_r - v_{i\perp}B) = \frac{dp_i}{dt} \quad (1)$$

where $eZ_i$, $n_i$ and $p_i$ are the ion charge, density and pressure. In the Equ. (1), the perpendicular component of plasma flow velocity $v_{i\perp}$ is tangential to the magnetic surfaces and nearly in the direction of the poloidal flow velocity $v_{pol}$. if consider the poloidal projection of the plasma parallel flow: $\frac{B_{pol}}{B}v_t$ ($B_{pol}$ is the poloidal component of the toroidal magnetic field, $v_t$ is the plasma toroidal flow velocity) we can rewrite Eq. (1) as

$$v_{pol} \cong v_{i\perp} = \frac{E_r}{B} - \frac{1}{eZ_in_iB}\frac{dp_i}{dt} \quad (2)$$

The poloidal flow velocity of the edge plasma can write as

$$v_{pol} = \frac{E_r}{B} - \frac{1}{eZ_in_iB}\frac{dp_i}{dt} + \frac{B_{pol}}{B}v_t \quad (3)$$

It is clear that the poloidal velocity is determined by three factors: (1) the poloidal component of the $\boldsymbol{E}\times\boldsymbol{B}$ drift; (2) the plasma diamagnetic drift; and (3) the poloidal projection of the parallel flow.

In the experiment of the MPI and SBI on the HL-1M Tokamak, the changes of the radial electric field $E_r$ and the ion pressure gradient $dp/dt$, which is induced by the change of the local plasma potential and the generation of the high-density plasma, cause the change of the plasma poloidal rotation velocity $v_{pol}$. We can see from Fig. 1, that during MPI, the peak value of the radial electric field $E_r$ is of the order of $-14$ kV · $m^{-1}$ (at $B_t = 2.0$ T) and corresponding peak value of the poloidal velocity $v_{pol}$ is of the order of $-10$ km · $s^{-1}$, and during SBI, the peak value of the radial electric field $E_r$ is of the order of $-8$ kV · $m^{-1}$ (at $B_t = 2.5$ T) and corresponding peak value of the poloidal velocity $v_{pol}$ is of the order of $-3.8$ km · $s^{-1}$. It appears that the poloidal velocity is mainly dominated by the $\boldsymbol{E}\times\boldsymbol{B}$ drift. The increase of the poloidal rotation velocity decreases the level of the turbulent fluctuations, and the plasma confinement thereby improves.

In the experiment of the MPI and SBI, we found that the toroidal flow Mach number becomes negative, that is the direction of the local plasma toroidal flow is reversed. The mechanism that produces this phenomenon is in the study and discuss.

## REFERENCES


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