§3. Development of Supersonic Molecular Beam Source for Fueling

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A piezoelectric valve, which is same as the valves used for gas-puffing in LHD, has been modified as a supersonic molecular source. The modification was just the removal of the pipe at the downstream side of the valve in order to avoid the hitting of the beam to it, as a first step of the test.

In the modified valve, there is a narrow channel, 2 mm in diameter and about 20 mm in length, after a valve head. Figure 1 shows two examples of the computer simulation of the plume from such a narrow channel. One is a plume from 2 atom to 1 atom and the other 2 atom to 0.5 atom. As the downstream pressure decreases, the length of the plume extends. Further decrease of the downstream pressure resulted in numerical difficulty at present.

Figure 2 shows the experimental result, showing the plume from the valve. In order to visualize the plume, a pair of transparent, parallel electrodes, which are energized by an inverter originally for a cold-cathode fluorescent lamp, are set at the exit of the narrow channel. The plume seems to spread more widely than the simulations. This is probably because the flow rate is determined by the gap between the valve element and the upstream of the narrow channel, not by the conductance of the narrow channel itself, and therefore the supersonic molecular beam is not formed at the exit of the channel. A narrower channel is being prepared to confirm this assumption and get a high-directional, supersonic molecular beam.

Figure 3 shows an insertion system of the supersonic molecular beam source installed in LHD. One of the upper ports of LHD is used. The vertical position of the valve is adjustable. An improved valve will be attached to the system and used for plasma experiments in 2002.

One of the authors (MM) visited Southwestern Institute of Physics, Chengdu, China. Purpose of the visit was information exchange on the technology and physics of supersonic molecular beams for fueling as well as a discussion on the possibility of the future collaboration for supersonic molecular beam experiments in LHD, as one of the subjects of the collaboration program on the development of diagnostic and control methods for high-performance plasma confinement. We agreed that development of supersonic molecular beam sources, plasma experiments using them, and physics understanding of those experimental results are just started and that further collaborations between China and Japan will be quite useful for efficient progress.

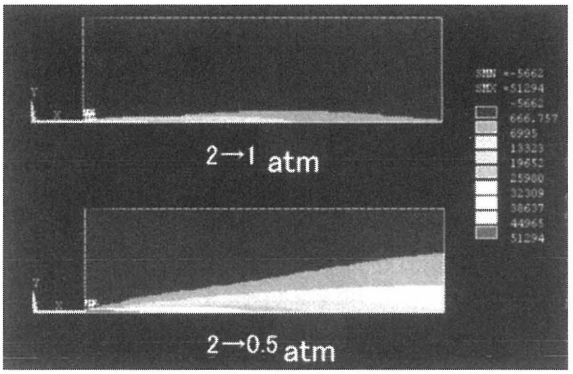

Fig. 1 Simulation of plume.

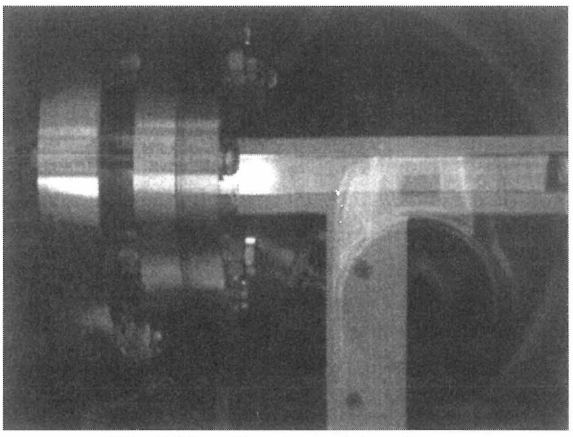

Fig.2 Visualization of the plume.

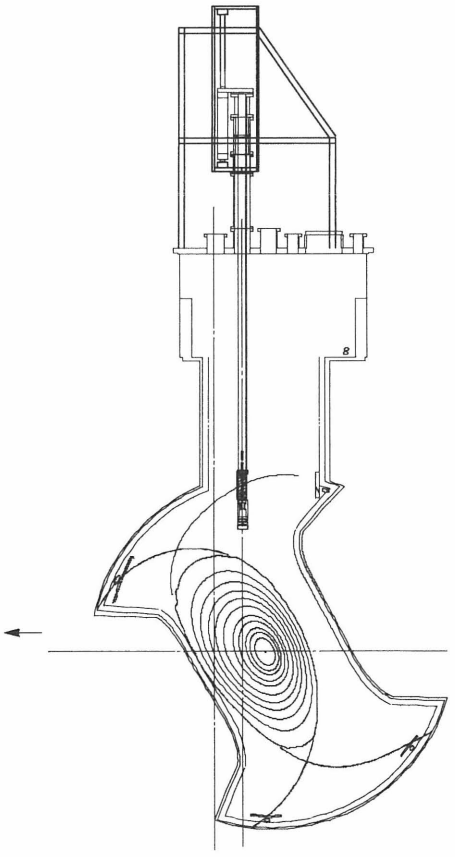

Fig. 3 Insertion system of the valve.