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Guiding of Ar^{7+} ions through a glass microcapillary array

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Synopsis: We studied the guiding effect in a glass microcapillary array with similar dimensions as for a Multi Channel Plate (MCP) detector. Unexpected irregularities were found in the angular distribution of the transmitted ions during the time evolution.

The guiding of highly charged ions through tilted nano- and microcapillaries were intensively studied in recent years. The guiding effect is due to the electrostatic charging up of the capillary wall by the incident ions, which deflects other ions to the capillary exit. The transmission develops in a self-organizing manner [1,2].

In this work we present the observed behavior of 21 keV Ar^{7+} ions guided through glass microcapillary array.

The experiment was performed at the ECR ion source of Atomki. We used a piece of not fully manufactured MCP as target, which was not covered with electron emission layer. The length of the capillaries was 1 mm and their diameter was 5 μm with an opening of ~50%. In order to avoid macroscopic charge up, both sides of the sample were covered with thin gold layer. The typically 700 pA beam current was collimated to a diameter of 0.5 mm. Two dimensional distributions of the transmitted particles were measured by a position sensitive detector. Images were acquired for 9 seconds with 1 second breaks. Ions and neutrals were electrostatically separated in front of the detector.

The neutrals immediately appeared on the detector as the beam was switched on. After a short delay ions also appeared, but in a very irregular pattern (see figure 1.). The distribution of ions changed very dynamically. Multiple patches were popped up and completely changed almost on a picture to picture basis. After a while these patches merged and the transmission became regular. The total integrated intensity continuously increased (see figure 2). Unfortunately the detector got overloaded, when the intensity was not yet saturated. In order to observe the full time development we plan to repeat the measurement with different detection technique.

The reason of the stochastic transmission is still a puzzle. Earlier, similar behavior was observed for single glass capillary too [3], but not for tapered glass capillaries [4].

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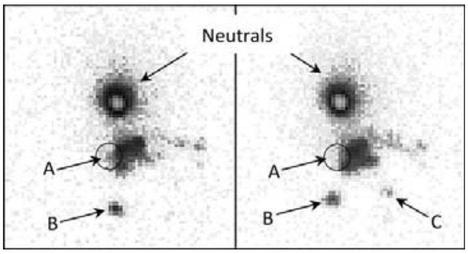

Figure 1. Typical changes in the patterns of the transmitted ions (lower half of the panels) in two consecutive frames. Spot A disappears, B moves up and left. A just appeared new spot is denoted by C. The tilt angle was 5° relative to the beam.

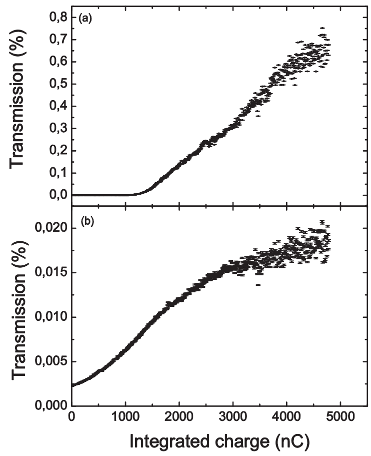

Figure 2. The transmitted intensity of ions (a) and neutrals (b) as a function of the deposited charge on the sample.

References

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