Ion velocity distributions in front of a ceramic surface: an inverse sheath ?

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Plasma-wall interaction is a fundamental field of research in plasma physics for numerous applications. In Hall thrusters, it is known that the wall properties may influence the discharge, mainly through electron emission and sputtering. The sheath and pre-sheath in front of an insulator ceramic sample (BNSi02, used in the aforementioned thruster), immersed in the low temperature Argon plasma of a multipolar device are studied experimentally using an emissive probe and the laser-induced fluorescence diagnostic. Firstly obtained ion velocity distribution functions exhibited an unexpected flow of ions directed away from the wall toward the bulk plasma, and an other one toward the wall. But later experiments involving the laser beam propagation through a 0.8mm drilled hole (slightly smaller than the Debye length $\lambda_D \simeq 1$cm), see Fig.1, discarded the wall-directed ion flow. Despite the diffuse laser beam reflection at the ceramic surface, and small detection solid angle of sight, fluorescence transition saturation may explain the presence of the wall-directed flow in the first measurements.

It seems that the BNSi02 secondary electron emission[1] and/or electrons reflected from an insulator surface [2] could be the cause of this phenomenon, which would correspond to an inverse sheath [3]. The ionizing energetic electrons present in the multipolar discharge are suspected to play a major role.

Emissive probe measurements did not show this probable inverse sheath but a monotonic potential drop. It seems that emissive probes could be too intrusive to measure potential in this thin high gradient region, especially if electron emission/reflection at the wall is present, leading biased measurements. Experimental artifacts removal and theoretical modeling (involving the Campanell's model [3]) are currently performed in order to confirm the formation of an inverse sheath in front of the ceramic.

References

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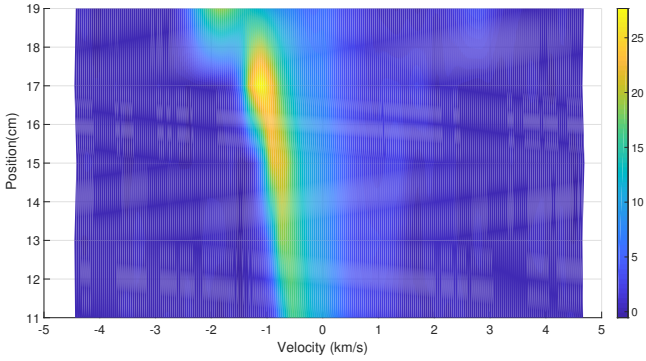

Figure 1: *2D ion velocity distributions in front of the drilled ceramic. Wall is at* 23*cm. Negative velocities are oriented toward the bulk plasma.*