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Plasma sheath effects in the sampler and skimmer cones of the ICP-MS MATTHEW ZACHRESON, ROSS SPENCER, Brigham Young University — In the ICP-MS, plasma neutrality and the associated issue of the plasma potential are governed by what happens in the plasma sheath. Plasma sheaths can generally be described by two model types: collisional, where the Debye length is long compared to the mean free path; and collisionless, where the mean free path is long compared to the Debye length. In the sampler cone, the Debye length is .3 micrometers, while the ion mean free path is 5 micrometers, nearly in the collisionless regime. In the skimmer cone, the Debye length is 2 micrometers, while the ion mean free path is 400 micrometers, well into the collisionless regime. Doing a full calculation with the Direct Simulation Monte Carlo algorithm, FENIX, would involve simulating electron physics, performing electrostatic field calculations, and resolving the small Debye length, all of which are computationally expensive. To approximate sheath formation in the sampler and skimmer, a forced ion flux model is made by first estimating the number of ions per second that should recombine at the wall using a simple, planar, collisionless sheath model, and then forcing the ions near the wall to have that flux by modifying their velocities each time step. The ion loss through the sheath results in a steep drop in the ion density at the nozzle wall which both diffuses and is sheared by the nozzle flow. Another plasma effect is that the sheath inhibits electron flow to the wall, greatly reducing thermal conduction to the wall. This means that the electron temperature of the plasma in the nozzle is hardly affected by the presence of the metal wall. In particular, setting the electron temperature equal to the wall temperature at the wall is inappropriate.

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