Abstract for an Invited Paper
for the DPP07 Meeting of
The American Physical Society

Neutral depletion and transport in low temperature plasmas

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Space and laboratory plasmas can be dramatically affected by neutral depletion. We describe the effect of neutral depletion on low temperature laboratory plasmas in which the plasma is either collisional or collisionless and neutrals are either thermalized or move ballistically. In all these cases the total number of neutrals is shown to be the similarity variable that determines the electron temperature. For collisional plasma that is in pressure balance with the neutral gas it has been shown that because of the inherent coupling of ionization and transport, an increase of the energy invested in ionization can nonlinearly enhance the transport process. Such an enhancement of the plasma transport due to neutral depletion was shown to result in an unexpected *decrease* of the plasma density when power is *increased;* despite the *increase* of the flux of generated plasma.[1] Unexpected steady-state has also been found for collisionless plasma due to neutral depletion. For ballistically-moving neutral-gas the strong ionization results in an expected neutral-gas minimum at the center of the chamber.[2] However, Raimbault *et al.* have shown that in the case of thermalized neutral-gas (in which the pressure increases with density) a strong ionization results in a maximum of the neutral-gas density surprisingly located at the center of the chamber.[3] The effects of neutral depletion due to a noticeable neutral gas heating will also be discussed. When collisions with electrons are the dominant source of neutral heating, that heating is larger at the center of the discharge,[4] while when collisions with ions are the dominant source, the heating is larger near the wall. It will be shown that, interestingly, the partitioning of power between plasma and neutral-gas is a function of the electron temperature only and not of the power level.

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3. J.-L. Raimbault, L. Liard, J.-M. Rax, P. Chabert, A. Fruchtman, and G. Makrinich, Phys. Plasmas **14**, 013503 (2007).

4. L. Liard, J.-L. Raimbault, J.-M. Rax, and P. Chabert, "Plasma transport under neutral gas depletion conditions", submitted to J. Phys. D.

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