GEC10-2010-000485

Abstract for an Invited Paper
for the GEC10 Meeting of
the American Physical Society

The effect of neutral-gas depletion on the plasma density and momentum[1]

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Space and laboratory plasmas can be significantly affected when ionization is so intense that the neutral-gas density is modified. Our study of the coupled dynamics of plasma and neutral-gas has predicted previously-unexpected phenomena. Such are the decrease of plasma density due to neutral-gas depletion; despite the increase in plasma production as deposited power is increased [1], and the transition from neutral-gas depletion to neutral-gas repletion as neutral-gas collisionality with ions is reduced [2]. Two new theoretical predictions related to neutral-gas depletion will be described in the talk. First, it has been recently shown that the 2D plasma transport along and across magnetic field in the presence of neutral-gas depletion may result in a hollow cylindrical profile of the plasma density, in which the plasma density has a minimum at the cylinder axis [3]. We examine further the possibility of two different steady-states of the plasma and neutral-gas in the presence of a magnetic field and neutral-gas depletion, for the same input parameters. A second issue is related to the amount of momentum carried by plasma flowing out of a plasma source, which determines the efficiency of such a source as a thruster. We have recently calculated that momentum when the plasma is collisionless [4]. Taking into account the neutral-gas dynamics, we show that the carried momentum when the plasma is collisional is larger.

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[1]This research has been supported by the Israel Science Foundation Grant No. 864/07.