RMP reduces effective particle confinement time during RMP application at MAST

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The application of resonant magnetic perturbations (RMPs) on plasma discharges at MAST leads, in many cases, to reduced particle confinement of the core plasma, known as density pump-out. This can be described by the characteristic particle confinement time τ_p obtained from a global, single reservoir particle balance analysis. During all discharges with pump-out, the ionization source increased as the RMPs are turned on, but the confinement time decreased substantially enough to cause an overall density decrease. In L-mode plasma, up to a 15% reduction in τ_p is measured, and in H-mode plasma, a similar level of τ_p reduction is seen, however, the exact value depends on the RMP mode number and phasing.

The results presented in this paper relate this pump out for the first time for MAST to the neutral fueling and exhaust fluxes using a single reservoir, global particle balance. This particle balance was assembled using the plasma density and D_α emission measured by filter-scopes and a calibrated 1-D camera, as well as local values of S/XB coefficients determined by edge plasma parameter measurements, to infer the particle flux loss from the plasma and the incoming neutral recycling flux maintaining the plasma density.

In order to resolve the underlying effects in the neutral fueling and exhaust household inside the recycling and ionization layer, a multi-reservoir particle balance model [1] was revived, which includes both molecular and atomic species as well as the plasma and wall inventory. This model allows for experimental inputs such as fueling from gas puffing and neutral beam injection and estimates of parameters like the probability of particles adsorbing on the wall and the efficiency with which ionized particles are confined. Using the previously determined confinement time τ_p, the model is able to accurately reproduce the time evolution of the plasma density, vacuum vessel neutral pressure, and D_α emission that would be measured by the filterscope. The results from this experimental analysis with both particle balance models are compared to results from numerical analysis with the EMC3-EIRENE code. Initial results from this comparison supports increased fueling efficiencies and reduced particle confinement times as a reason for the observed particle pump out.

[1] G.P. Maddison, et al., Plas. Phys. & Contr. Fus. 48 (2006) 71-107

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