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Torque-balanced Steady States of Single-component Plasmas[1]

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Penning-Malmberg traps provide an excellent method to confine single-component plasmas. Specially tailored, high-density plasmas can be created in these devices by the application of azimuthally phased rf fields [i.e., the so-called "rotating wall" (RW) technique]. Recently, we reported a new regime of RW compression of electron (or positron) plasmas [3]. In this "strong-drive" regime, plasmas are compressed until the E × B rotation frequency, ω_E (with $\omega_E \propto$ plasma density) approaches the applied frequency, ω_{RW}. Good compression is achieved over a broad range of RW frequencies, without the need to tune to a mode in the plasma. The resulting steady-state density is found to be only weakly dependent on the applied RW amplitude. A simple nonlinear dynamical model explains these observations as convergence to an attracting fixed point - the torque-balanced steady state. The applied RW torque, τ_{RW}, can be understood as a generic, linear coupling between the plasma and the Debye- shielded RW electric field. The thermodynamic equations [4] governing the evolution will be discussed and compared to the experiments. This new regime facilitates improved compression and colder plasmas (since less transport means less plasma heating). Factors limiting the utility of the technique and applications will be discussed, including the development of a multicell trap to confine large numbers (i.e., $N \geq 10^{12}$) of positrons [5].

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[2]In collaboration with C. M. Surko and T. M. O'Neil.
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