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Cavity-cooled electron plasmas[1]

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Cooling non-neutral plasmas to cryogenic temperature is a long standing challenge. With standard Penning-Malmberg trap geometry these temperatures can be difficult to achieve for lepton plasmas even in strong (>1 T) magnetic fields. By incorporating a high-Q microwave cavity into the plasma confinement region [1], we observed significantly enhanced cooling rates when the cyclotron frequency, controlled by scanning the axial magnetic field, is near a cavity resonance [2]. With improved cavity design and control over the axial magnetic field gradient, we now obtain resonant cooling for plasmas containing millions of electrons, which approach equilibrium with trap walls at 10 K, remarkably, at fields lower than 0.2 T. The dependence of the cooling rate and final temperature has been investigated over a wide range of system parameters, including plasma length (∼1 mm to ∼10 cm), number of electrons ($<10^3$ to $>10^8$), field gradient, and microwave cavity realizations. — [1] N. Evetts et al. "Open microwave cavity for use in a Purcell enhancement cooling scheme." Review of Scientific Instruments 87.10 (2016). [2] A.P. Povilus et al. "Electron plasmas cooled by cyclotron-cavity resonance." Physical review letters 117.17 (2016).

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