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Novel Microwave Cavity for Resonant Cooling of a Lepton Plasma

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A novel microwave cavity is described which can be used to cool lepton plasmas for potential use in creation of mono-energetic beams, and synthesis of antihydrogen. The cooling scheme represents an incarnation of the Purcell Effect; When plasmas are coupled to a microwave cavity, the plasma cooling rate is resonantly enhanced through increased spontaneous emission of cyclotron radiation. Geometric design considerations for a cavity with strong cooling power and low equilibrium plasma temperatures are discussed. A three electrode cavity forms a section of a Penning-Malmberg trap. It has a bulged cylindrical geometry with open ends aligned with the magnetic trapping axis. This allows plasmas to be injected and removed from the cavity without the need for moving parts while maintaining high quality factors for resonant modes. The cavity includes unique surface preparations for tuning the cavity quality factor and achieving anti-static shielding using thin layers of nichrome and colloidal graphite respectively. Preliminary data suggests that temperatures and cooling rates for these plasmas can be improved by at least a factor of 10 as described in an adjacent poster. This work is supported by DoE, Grant DE-FG02-06ER54904, and NSERC.

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