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Atomic Physics with Positronium

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Positronium, the metastable hydrogen-like bound state between an electron and its antiparticle, the positron, is a leptonic atomic system whose properties may be studied using laser spectroscopy in much the same way as for any other atomic system. However, such measurements are complicated by the difficulties associated with producing these short-lived atoms in sufficient quantities. The introduction of positron trapping techniques [1] has made it possible to produce intense bursts of slow positrons with spatiotemporal densities approaching $\sim 10^{20}$ $e^{+}cm^{-2}s^{-1}$ [2]. By implanting these positrons into various materials we may produce short bursts of positronium atoms that are well suited to pulsed laser spectroscopy, and that we have used to perform a variety of laser-Ps experiments [3] as well as measurements of Ps-Ps interactions [4]. In this presentation I shall outline the techniques we have used to do so, and describe how this work fits into our long-term goal of producing a Bose-Einstein condensate of positronium [5]. A condensate of this sort would provide a nearly ideal weakly interacting system of fundamental interest that could be used for precision spectroscopy, and may one day form the basis of a positronium annihilation gamma ray laser [6].

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