Positronium molecules and many-positron systems

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The ability to accumulate and store large numbers of positrons in Penning-Malmberg traps [1] has proved to be of great utility in a number of experimental endeavours, most notably the production of Antihydrogen [2] and measurements of positron scattering from atoms and molecules at very low energies [3]. By rapidly dumping positron plasmas stored in such a trap we have been able to produce intense, sub-ns, positron bursts with instantaneous currents of more than 10 mA [4]. By implanting these positron bursts into suitable targets, positronium atoms may be created that have a chance of interacting with each other, and in this way we have begun to study systems containing more than one positronium atom, and in particular interactions between positronium atoms. So far we have observed the formation of molecular positronium (Ps_2) on the internal surfaces of porous silica [5] and on a clean Al(111) surface [6] as well as spin exchange quenching between (oppositely polarized) ortho-positronium atoms [7]. The main objective of our research, however, is to produce an ensemble of spin polarised positronium atoms at a much higher density, where they might undergo a phase transition and form a Bose-Einstein condensate at an experimentally realistic temperature (i.e., over ~ 10K) [8]. Here we shall discuss the methods used to perform our experiments, the results we have obtained so far, and what we intend to do next.

References

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