Introduction

The use of mesoporous silica films for the production of positronium has become widespread in recent years [1]. In some applications it may be desirable to use such materials in a cryogenic environment, for example in the cold bore of a superconducting magnet for antihydrogen experiments [2]. We have observed a drastic reduction in the positronium formation efficiency of a porous SiO$_2$ sample [1] following UV laser irradiation at 12 K.

Laser irradiation at room temperature allows us to study Ps atoms within the bulk of the sample and does not induce the same Ps quenching effects. 

Ps Production

Slow positrons from a neon moderated positron beam are magnetically guided into a two-stage, Surko-type positron trap [3] which produces 6 ns wide pulses at 1 Hz. The bunched output of the trap is implanted into a porous SiO$_2$ target which is mounted on a cryogenic cold head with a base temperature of 12 K.

Detection of $o$-Ps annihilation

The positron lifetime spectrum is obtained with ‘single shot positron annihilation lifetime spectroscopy’ (SSPALS) [4]. This technique allows us to distinguish between gamma rays originating from prompt annihilations and those that are delayed, which we attribute to ortho-positronium decay.

Cooling silica samples

The positronium conversion efficiency of a porous SiO$_2$ target is reduced if the sample surface is contaminated with residual gas at low temperatures.

Laser Irradiation of samples at room temperature

We have performed laser spectroscopy of positronium at room temperature for both geometries shown in figure 1. We use 6 ns, 243 nm (UV) pulses (~ 1 mJ) to drive the 1s-2p transition in Ps. Atoms in the 2p state are then photo-ionised with 532 nm (visible, green) light (~ 20 mJ).

Summary

We have observed a drastic reduction in the positronium formation efficiency of a porous SiO$_2$ sample following UV laser irradiation at 12 K. With the sample at room temperature the observed Ps fraction was stable . At 12 K the positronium formation efficiency was slightly reduced due to the adsorption of residual gas by approximately 2% per day. However, following irradiation with UV light (243 nm) at 12 K the Ps fraction dropped significantly, as shown in figure 5. No effects from laser irradiation were observed at room temperature and the low temperature laser induced damage was fully annealed out after warming the target to room temperature. These observations are consistent with the formation of paramagnetic centers, as observed by Saito et al [5], who observed quenching of ground state Ps atoms by surface paramagnetic centers in silica aerogels. The authors would like to thank L. Liskay for providing the porous silica samples.

This poster can be downloaded from www.antimattergravity.com

References