Progress in the study of energy tunable Ps beams employing the Ps^- photodetachment technique

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In 2012, an energy-tunable Ps beam employing the Ps^- photodetachment technique was developed [1]. An efficient method to produce Ps^- ions using a Na-coated tungsten surface enabled this development [2]. The beam provided an energy range that extended to a few keV, which was a hitherto unrealized range and complementary to that of the beams produced using the charge-exchange reaction with gas molecules [3]. This system has enabled the observation of the shape resonance of Ps^- [4]. However, further applications were limited because Ps^- ions were emitted from the thick tungsten target in reflection geometry and the trajectory of the Ps beam overlapped with the incident positrons.

In order to obtain Ps beams available for many applications, we have investigated the Ps^- production using a thin tungsten film in transmission geometry. When low-energy positrons impinge on a tungsten film, they lose their energy until they are thermalized in the bulk and then diffuse back to the surface. We found that the thermalized positrons which diffuse to the opposite surface also contribute to the Ps^- production if the film thickness is on the order of 100 nm.

Recently, we have completed a new Ps beam apparatus using this geometry at Tokyo University of Science [5]. Slow positrons from a ^{22}Na source capsule and a solid Ne moderator are pulsed using a buffer gas positron trap (Surko trap) and then focused onto a tungsten film of 100 nm thickness with a magnetic lens. A fraction of the positrons are emitted as Ps^- from the opposite surface coated with Na. The Ps^- ions are accelerated and photodetached by a pulsed laser light. The Ps beam energy range is 0.2 – 3.3 keV. The size of the Ps beam spot observed using a MCP located 419 mm downstream from the photodetachment point is 9 mm. It can be reduced further using a narrow aperture.

Using this beam, new experiments have started. In this talk, the details of the beam will be presented and the experiments will be discussed.

References

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