



Contribution ID: 49

Type: Oral Presentation

## Experimental progress towards positronium Bose-Einstein condensation

Monday 26 August 2019 15:20 (20 minutes)

Positronium (Ps), the bound state of an electron and a positron, is one of the best candidates for the first Bose-Einstein condensation (BEC) of antimatter system. Ps-BEC can be regarded as an “antimatter laser”, which has rich potential for applications to both fundamental and applied physics. For example, the gravitational effect on antimatter can be studied by constructing a Mach-Zehnder interferometer of Ps-BEC. Gamma-ray laser can also be realized using annihilation gamma-rays from Ps-BEC.

The challenge to realize Ps-BEC is to create dense ( $> 10^{17} \text{ cm}^{-3}$ ) and cold ( $< 10 \text{ K}$ ) Ps atoms in a short lifetime of Ps (142 ns). To achieve these target values, we proposed the following new scheme. Firstly, dense Ps atoms are formed in small ( $\sim 10^6 \text{ nm}^3$ ) pores in a silica ( $\text{SiO}_2$ ) target by bombarding focused and bunched positron beams. Then, Ps atoms are rapidly cooled to  $\sim 300 \text{ K}$  by thermalization caused by collisions with pore walls. Finally, Ps are cooled to less than 10 K by laser cooling which uses 243 nm 1S-2P transitions. Monte Carlo simulation shows that this method can realize Ps-BEC in  $\sim 300 \text{ ns}$  after Ps formation.

We are currently trying laser cooling of Ps at KEK slow positron facility (SPF). In this presentation, I will show the overall development status and future prospects of our experiment, especially about the following topics: positron fusing system using multi-stage brightness enhancement system, Ps generator/condenser/cooler target material, and special home-made 243 nm pulsed laser system for Ps cooling.

This work is supported by JSPS KAKENHI Grant Numbers JP16H04526, JP17H02820, JP17H06205, JP17J03691, JP18H03855, JP19H01923, MATSUO FOUNDATION, Mitutoyo Association for Science and Technology (MAST), Research Foundation for Opto-Science and Technology, and TIA Kakehashi TK17-046.

**Primary author:** ISHIDA, Akira (University of Tokyo (JP))

**Co-authors:** SHU, Kenji; Mr YAMADA, Kyohei (The University of Tokyo); Ms HASHIDATE, Kaori (The University of Tokyo); Dr NAMBA, Toshio (The University of Tokyo); ASAI, Shoji (University of Tokyo (JP)); Prof. KUWATA-GONOKAMI, Makoto (The University of Tokyo); Mr TAJIMA, Yohei (The University of Tokyo); Dr CHAE, Eunmi (The University of Tokyo); Prof. YOSHIOKA, Kosuke (The University of Tokyo); Dr OSHIMA, Nagayasu (National Institute of Advanced Industrial Science and Technology (AIST)); Dr O'ROURKE, Brian E. (National Institute of Advanced Industrial Science and Technology (AIST)); MICHISHIO, Koji (I); Dr ITO, Kenji (National Institute of Advanced Industrial Science and Technology (AIST)); Dr KUMAGAI, Kazuhiro (National Institute of Advanced Industrial Science and Technology (AIST)); Dr SUZUKI, Ryoichi (National Institute of Advanced Industrial Science and Technology (AIST)); Prof. FUJINO, Shigeru (Kyushu University); Dr HYODO, Toshio (High Energy Accelerator Research Organization (KEK)); Dr MOCHIZUKI, Izumi (High Energy Accelerator Research Organization (KEK)); Dr WADA, Ken (National Institutes for Quantum and Radiological Science and Technology (QST)); Dr KAI, Takeshi (Japan Atomic Energy Agency (JAEA))

**Presenter:** ISHIDA, Akira (University of Tokyo (JP))

**Session Classification:** Parallel Session