Measurement and development of muonic helium hyperfine structure at J-PARC

Authors: **Seiso Fukumura**, Patrick Strasser[1], Takashi Ino[1], Takayuki Oku[2], Takuya Okudaira[3], Sohtaro Kanda[1], Masaaki Kitaguchi[3], Koichiro Shimomura[1], Hirohiko Shimizu[3], Shoichiro Nishimura[1]

[1] *KEK*
[2] *JAEA*
[3] *Nagoya University*

The muonic helium atom is an atom in which one of the electrons has been replaced by a negative muon. Muonic helium can be treated as a hydrogen-like atom with a pseudo nucleus which has an equivalent effective charge and a magnetic moment similar to that of a negative muon because the orbital radius of the negative muon is about 400 times smaller. The measurement of the hyperfine structure of muonic helium has the potential to improve the precision of the mass of the negative muon by a factor of 50 or more, which is presently determined to 3.1 ppm by precise spectroscopy of the characteristic X-rays of muonic silicon [1]. The mass of the negative muon is very important because it is a parameter of the Standard Model. We aim to measure the hyperfine structure of muonic helium with a precision 1000 times higher than previous experiments [2,3] using the high-intensity muon beam at J-PARC, and have already obtained results better than the current precision in zero-field measurements in a test experiment in March 2021. To further improve the accuracy, we plan to measure in a high magnetic field and incorporate the SEOP technique that can produce highly polarized muonic helium atom [4]. In this talk, we will report on these developments and preparations.

[1] I. Beltrami, et al., Nucl. Phys. A 451, 679 (1986)
[2] H. Orth, et al., Phys. Rev. Lett. 45, 1483 (1980)
[3] C. J. Gardner, et al., Phys. Rev. Lett. 48, 1168 (1982)
[4] A. S. Barton, et al., Phys. Rev. Lett 70, 758 (1993)