Measurement of the neutron-decay lifetime of the ^{26}O ground state at the SAMURAI setup at RIBF

C. Caesar,[*1,*2] J. Kahlbow,[*3,*2] V. Panin,[*2] D. S. Ahn,[*2] L. Atar,[*3,*2] T. Aumann,[*3] H. Baba,[*2] K. Boretzky,[*1,*2] H. Chae,[*4] N. Chiga,[*2] S. Choi,[*4] M. L. Cortes Sua,[*2] D. Cortina-Gil,[*5] Q. Deshayes,[*6] P. Doornenbal,[*2] Z. Elekes,[*2,*7] N. Fukuda,[*2] I. Gašparić,[*8,*2] K. I. Hahn,[*9] Z. Halász,[*7] A. Hirayama,[*11] J. Hwang,[*4] N. Inabe,[*2] T. Isobe,[*2] S. Kim,[*4] T. Kobayashi,[*10,*2] D. Körper,[*1] Y. Kondo,[*11,*2] Y. Kubota,[*2] I. Kuti,[*7] C. Lehr,[*3,*2] S. Lindberg,[*12,*2] M. Marques,[*6] M. Matsumoto,[*11] T. Murakami,[*13,*2] I. Murray,[*2] T. Nakamura,[*11,*2] T. Nilsson,[*12] H. Otsu,[*2] S. Paschalis,[*14] M. Parlog,[*6] M. Petri,[*14] D. Rossi,[*3] A. Saito,[*11] M. Sasano,[*2] H. Scheit,[*3] P. Schrock,[*15] Y. Shimizu,[*2] H. Simon,[*1] D. Sohler,[*7] S. Storck,[*3,*2] L. Stuhl,[*15] H. Suzuki,[*2] I. Syndikus,[*3] H. Takeda,[*2] H. Törnqvist,[*3,*2] T. Togano,[*11,*2] T. Tomai,[*11] T. Uesaka,[*2] H. Yamada,[*11] Z. Yang,[*2] M. Yasuda,[*11] K. I. Yoneda,[*2] for the SAMURAI20 Collaboration

In December 2016, the NP1306-SAMURAI20 experiment was conducted. A new technique to measure lifetimes of possible neutron-radioactive nuclei[1)] was applied for the first time to study ^{26}O. The technique is based on the production of the neutron-unbound nucleus of interest in a target with large Z and high density that slows down the produced nucleus and the residual nucleus after (multi-) neutron emission. The spectrum of the velocity difference between neutron(s) and the residual nucleus has a characteristic shape that allows to extract the lifetime.

The experiment was carried out at the SAMURAI[2)] setup with an invariant-mass configuration together with an experiment specific target region. Secondary beams of ^{27}F and ^{26}F were produced in BigRIPS by projectile fragmentation of a ^{48}Ca primary beam at 345 MeV/nucleon on a 20 mm thick beryllium production target. The combination of the incoming energy of the secondary beam and the reaction-target thickness is crucial for the sensitivity to a specific lifetime region. For this reason, the beam energy was reduced with degraders. At the first (second) momentum dispersive focal plane F1 (F5) of BigRIPS, a 15 mm (10 mm) thick aluminum wedge was installed. In addition, a ^{24}O beam with a very narrow energy spread has been used for calibration purposes to emulate the fragments of interest in the analysis.

At the SAMURAI setup, incoming beam particles were identified by two 1 mm thick plastic scintillators (SBTs), two drift chambers (BDC1 and BDC2), and one ionization chamber (ICB). In addition, one silicon pin diode was mounted in front of the target stack and two behind it for energy loss measurements.

Unbound ^{26}O was produced by proton removal from the ^{27}F beam in a target stack consisting of 6 foils separated by 0.8 mm, with decreasing thickness in the beam direction. The foils of thickness 2.04 mm, 1.59 mm, 1.35 mm, and 1.06 mm were made of tungsten. The two foils of lower thickness were platinum foils of thickness 0.77 mm and 0.61 mm. The total area density of the target amounted to 14.6 g/cm^2. The heavy target material causes a broad neutron-fragment velocity-difference distribution for prompt decays, due to the large energy loss of the fragments. In contrast, a sharp peak will be observed for out-of target decays, which allows to distinguish between these two types of events.

The decay products ^{24}O and the two neutrons were separated by the SAMURAI dipole magnet. Multi-wire drift chambers (FDC1 and FDC2) in front of the magnet and behind it and the plastic scintillator hodoscope (HODF24) were used for the detection and tracking of charged fragments. For neutron detection, the NeuLAND demonstrator in conjunction with NEBULA was used. The energy loss measurements in the silicon pin diodes can be used to select events with Z=9 (8) directly in front (behind) the target to exclude possible background contributions. The remaining 'background' was estimated in a 'null' measurement. For this purpose, the one-neutron decay of ^{25}O produced by proton removal from ^{26}F as a reference was measured. The ground state resonance of ^{25}O has a width of around 88 keV[3)] corresponding to an extremely short lifetime. The analysis of the SAMURAI20 data is currently in progress.

*1 GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt
*2 RIKEN Nishina Center
*3 Institut für Kernphysik, TU Darmstadt
*4 Department of Physics, Seoul National University
*5 Departamento de Fìsica de Partìculas, Universidade de Santiago de Compostela
*6 LPC, Caen
*7 ATOMKI, Debrecen
*8 Ruđer Bošković Institute, Zagreb
*9 Department of Physics, Ewha Womens University
*10 Department of Physics, Tohoku University
*11 Department of Physics, Tokyo Institute of Technology
*12 Department of Physics, Chalmers University of Technology
*13 Department of Physics, Kyoto University
*14 Department of Physics, University of York
*15 Center for Nuclear Studies (CNS), University of Tokyo

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