Discovery of a μs isomer of ^{76}Co†

P.-A. Söderström,[*1] S. Nishimura,[*1] Z. Y. Xu,[*2] K. Sieja,[*3] V. Werner,[*4,*5] P. Doornenbal,[*1] G. Lorusso,[*1] F. Browne,[*1,*6] G. Gey,[*1,*7,*8] H. S. Jung,[*9] T. Sumikama,[*10] J. Taprogge,[*1,*11,*12] Zs. Vajta,[*1,*13] H. Watanabe,[*1,*14] J. Wu,[*1,*15] H. Baba,[*1] Zs. Dombradi,[*13] S. Franchoo,[*16] T. Isobe,[*1] P. R. John,[*17,*18] Y.-K. Kim,[*19] I. Kojouharov,[*20] N. Kurz,[*20] Y. K. Kwon,[*19] Z. Li,[*15] I. Matea,[*16] K. Matsui,[*2] G. Martnez-Pinedo,[*5] D. Mengoni,[*17,*18] P. Morfouace,[*16] D. R. Napoli,[*21] M. Niikura,[*2] H. Nishibata,[*22] A. Odahara,[*22] K. Ogawa,[*1] N. Pietralla,[*5] E. Şahin,[*23] H. Sakurai,[*1,*2] H. Schaffner,[*20] D. Sohler,[*13] I. G. Stefan,[*16] D. Suzuki,[*16] R. Taniuchi,[*2] A. Yagi,[*22] and K. Yoshinaga[*24]

Changes in nuclear shell structure far from stability are largely associated with the monopole component of the proton-neutron interaction. Thus, there is a large ongoing experimental effort aiming to investigate how these shell and sub-shell closures evolve for very exotic nuclei at and below ^{78}Ni. The study of single neutron and proton particle and hole states outside ^{78}Ni is one important way to gain information on this topic. In a recent paper new experimental results on ^{76}Co, one neutron-hole and one proton-hole in ^{78}Ni, were presented. Due to the purity of the excited states, this is a unique case to study the neutron-proton interaction in a region with sparse experimental information.

The ^{76}Co nuclei were produced by in-flight fission of a 345 MeV/u ^{238}U beam on a 3 mm beryllium target and then separated using the BigRIPS fragment separator and the ZeroDegree spectrometer. At F11 the WAS3ABi[1)] silicon detector stack was used for implantation and β-decay correlation measurements and the EURICA spectrometer was used for measuring the energy and time of the γ rays. In total, approximately 1000 ^{76}Co ions were implanted in WAS3ABi during 10 days of measurement.

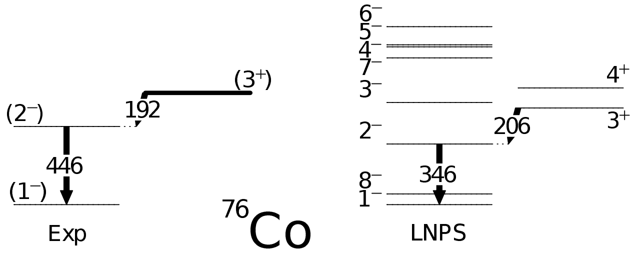

Fig. 1. Proposed experimental level scheme of ^{76}Co compared to shell model calculations using a modified LNPS interaction.

In the experiment, two coincident γ rays of 192 and 446 keV from the decay of a $t_{1/2} = 3$ μs isomeric state of ^{76}Co were observed. The decay of the isomer was assigned to an E1 transition with a reduced transition probability of $B(\mathrm{E1}; 3^+ \rightarrow 2^-) = 1.79 \times 10^{-8}$ W.u. Shell model calculations carried out with an up-to-date LNPS interaction[2,3)] including monopole changes to assure the correct propagation of proton single-particles energies showed the states to be about 70% pure structures of $\pi f_{7/2}^{-1} \otimes \nu g_{9/2}^{-1}$ or $\pi f_{7/2}^{-1} \otimes \nu p_{1/2}^{-1}$ hole configurations for negative and positive parity states, respectively. Thus, the relative $\nu g_{9/2}^{-1}$ and $\nu p_{1/2}^{-1}$ positions could be fine tuned by changing the strength of the $\pi f_{7/2}^{-1} \otimes \nu p_{1/2}^{-1}$ monopole. The results of these calculations are shown in Fig. 1.

Furthermore, a β decaying 8^- state was also observed in the data, consistent with the LNPS shell model calculations. These results will help constrain further developments of theoretical models in the $\pi f_{7/2} \otimes \nu g_{9/2}$ region between ^{60}Ca and ^{78}Ni, where scarce experimental data are available.

References
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*1 RIKEN Nishina Center
*2 Department of Physics, University of Tokyo
*3 Université de Strasbourg, IPHC
*4 Wright Nuclear Structure Laboratory, Yale University
*5 Institut für Kernphysik, TU Darmstadt
*6 School of Computing, Engineering and Mathematics, University of Brighton
*7 LPSC, Université Grenoble-Alpes, CNRS/IN2P3
*8 ILL
*9 Department of Physics, Chung-Ang University
*10 Department of Physics, Tohoku University
*11 Departamento de Física Teórica, Universidad Autónoma de Madrid
*12 Instituto de Estructura de la Materia, CSIC
*13 Institute for Nuclear Research, Hungarian Academy of Sciences
*14 School of Physics and Nuclear Energy Engineering, Beihang University
*15 School of Physics and State key Laboratory of Nuclear Physics and Technology, Peking University
*16 Institut de Physique Nucléaire, CNRS-IN2P3
*17 INFN Sezione di Padova
*18 Dipartimento di Fisica e Astronomia, Università di Padova
*19 Institute for Basic Science, Rare Isotope Science Project
*20 GSI
*21 INFN, LNL
*22 Department of Physics, Osaka University
*23 Department of Physics, University of Oslo
*24 Department of Physics, Tokyo University of Science