New spectroscopy of 10-Lambda-Be hypernucleus redefines the reference data of Lambda hypernuclei

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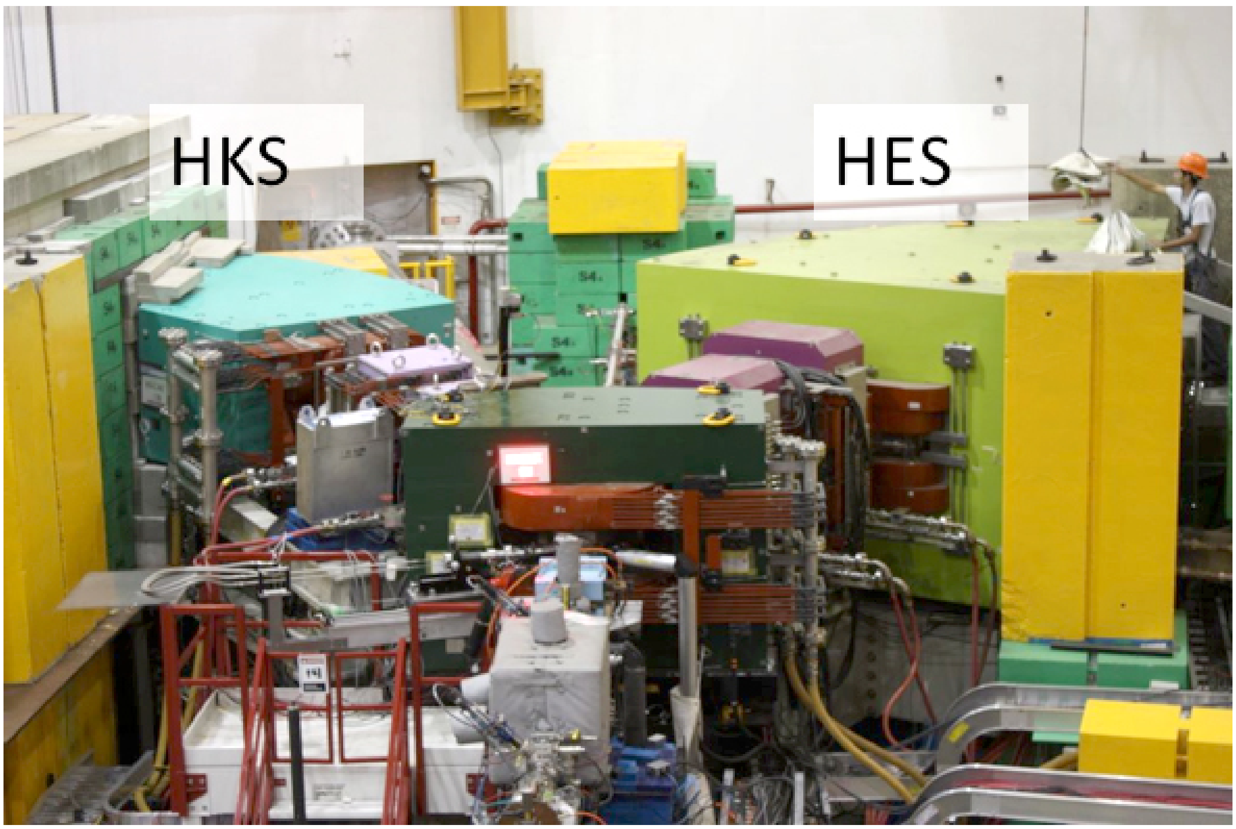


The magnetic spectrometers, HKS (High resolution Kaon Spectrometer) and HES (High resolution Electron spectrometer) used for the experiment. These spectrometers were constructed and tested in Japan and then shipped to JLab. Credit: Tohoku University

A team of international researchers has successfully measured precise binding energy of a 10ΛBe hypernucleus made of four protons (ρ), five neutrons (n) and and a Lambda (Λ) particle, at Thomas Jefferson National Accelerator Facility (JLab).

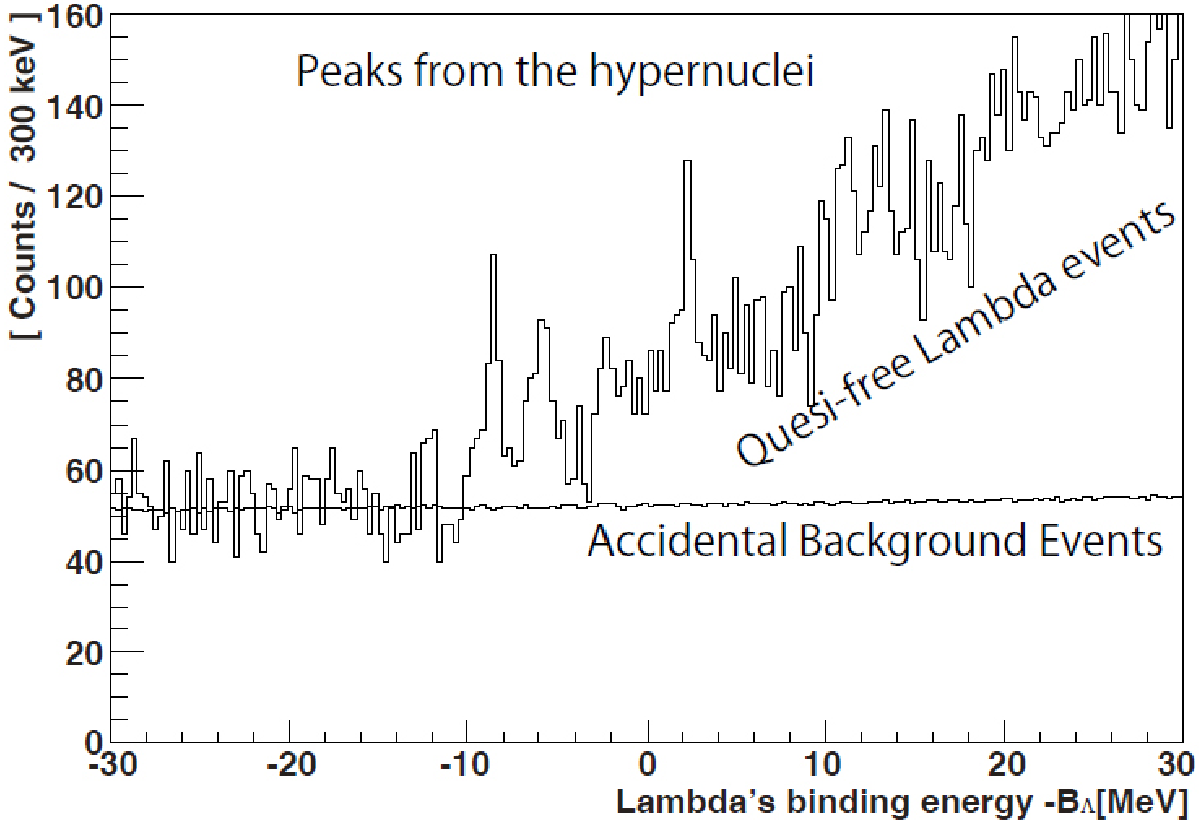
The research team, known as HKS Collaboration, consists of 76 members from 21 institutes led by Tohoku University, Hampton University and Florida International University.

All materials are made of small charged particles: nuclei and electrons. A nucleus consists of protons and neutrons that are bound by the nuclear force against Coulomb repulsion.

Without the nuclear force, no material can exist stably. Therefore, understanding it is essential to knowing how our material world was created.

A proton has positive charge and a neutron has no charge. Therefore the Coulomb force between proton-proton is repulsive and the Coulomb force does not work between neutron-neutron. However, it is widely known that the nuclear forces between proton-proton and neutron-neutron are almost the same and this is one of most basic features of the nuclear force. This is called as the charge symmetry of the nuclear force.

Modern physics is trying to understand the nuclear force as a part of a more general "baryonic force." A Lambda hypernucleus consists of a Lambda particle, the lightest baryon with strangeness, in addition to protons and neutrons, so the study of Lambda hypernuclei extends our knowledge of the nuclear force to the more general "baryonic force".



Sharp peaks originating from hypernuclei are clearly observed on accidental coincidence background and quasi-freely produced Lambda events. Credit: Tohoku University

There have been long discussions about whether the charge symmetry is also satisfied between Lambda-proton (Λρ) and Lambda-neutron (Λn) systems. Recent experimental studies have revealed that the charge symmetry is largely broken for light hypernuclei, 4ΛH and 4ΛHe [1,2].

Though its origin is still under debate, comparison of the newly measured 10ΛBe binding energy with that of its mirror hypernucleus 10ΛB shows small charge symmetry breaking for heavier hypernuclei. Small charge symmetry breaking for 10ΛBe – 10ΛB will shed light on the source of charge symmetry breaking of the ΛN interaction. Furthermore, the existence of 0.54 MeV shift is suggested for the reported binding energies of 12ΛC which has been serving as the mass reference for various hypernuclei.

This shift would affect all reported hypernuclear binding energies calibrated with 12ΛC and it has great impact on hypernuclear study.

More information: T. Gogami et al. High resolution spectroscopic study of , *Physical Review C* (2016). DOI: 10.1103/PhysRevC.93.034314

[1] Recent experimental result on �ΛH performed at MAMI by international collaboration of Tohoku University, Mainz University and others. A.Esser, S.Nagao, et al., *Physical Review Letters* 114, 232501 (2015).

[2] Recent experimental result on �ΛHe performed at J-PARC by international collaboration of Tohoku University, KEK, JAEA and others. T.O.Yamamoto, et al. *Physical Review Letters* 115, 222501 (2015).

Provided by Tohoku University