High-resolution decay-pion spectroscopy of $^{4}_{\Lambda}$H hypernuclei

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The structure of light Λ-hypernuclei and the precise determination of Λ binding (separation) energies has been in the focus of recent experimental and theoretical programs. In 2012, the first high-resolution spectroscopy of pions from decays of stopped $^{4}_{\Lambda}$H hypernuclei was performed by the A1 Collaboration at the Mainz Microtron MAMI, Germany [1]. The binding energy of $^{4}_{\Lambda}$H was deduced from the two-body decay mode $^{4}_{\Lambda}\mathrm{H} \to \pi^{-}+{}^{4}\mathrm{He}$ to be $B_\Lambda = 2.12 \pm 0.01$ (stat.) $\pm$ 0.09 (syst.) MeV with respect to the ^{3}H+Λ mass. This value is 0.08 MeV different from emulsion data, for which the most complete compilation found $B_\Lambda = 2.04 \pm 0.04$ MeV using only three-body decay modes [2].

In the year 2014 the A1 experiment was continued with a better control of the systematic uncertainties, with better background suppression, and with higher luminosities. Energy-loss fluctuations in the target chamber windows could be eliminated by directly coupling the spectrometers to the chamber. A tungsten alloy collimator was placed behind the Be target to reduce the background from quasi-free produced Σ^- decays in flight. In order to check systematic momentum uncertainties the acceptance of two spectrometers covered the $^{4}_{\Lambda}$H decay-momentum region simultaneously. Variations of the magnetic fields of the spectrometers contributed only $\delta p_{stabil.} < 0.004\,\mathrm{MeV}/c$ as compared to $0.04\,\mathrm{MeV}/c$ in 2012. Different calibration measurements with thin tantalum targets over a time of two days confirmed a calibration stability within $\delta p_{stabil.} < 0.02\,\mathrm{MeV}/c$. A preliminary analysis of these data confirmed in both spectrometers the mono-energetic line from pionic $^{4}_{\Lambda}$H decays stopped in Be targets of two different thicknesses. A systematic study of the measured binding energy of $^{4}_{\Lambda}$H hypernuclei is presented.

[1] A. Esser et al. (A1 Collaboration), Phys. Rev. Lett. **114**, 232501 (2015)

[2] Jurić, M. et al., Nucl. Phys. **B52**, 1 (1973)

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