Preparation Status of Decay Pion Spectroscopy Experiment on Double-Λ Hypernuclei

Hiroyuki Fujioka (Tokyo Tech)





本研究の位置付け





Hypernuclei with S = -2



 $\exists N-\Lambda\Lambda \text{ coupling} \qquad \qquad \forall decay \text{ width of } \exists \text{ hypernuclei} \\ \exists \text{ atomic level (shift, absorption width)} \\ \land \Lambda-bond \text{ energy of double-} \land hypernuclei \end{cases}$





$\Lambda\Lambda$, ΞN interaction



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K. Sasaki et al. (HAL-QCD Collaboration) NPA 998 (2020) 121737

light E hypernuclei

A=4 NNNE

A=10 ENaa



E. Hiyama et al., Phys. Rev. Lett. 124, 092501 (2020)

E. Hiyama et al., Phys. Rev. C 106, 064318 (2022)





Proposal for J-PARC 50 GeV Synchrotron

Decay Pion Spectroscopy of ${}^{5}_{\Lambda\Lambda}$ H Produced by Ξ -hypernuclear Decay

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December 14, 2018 http://j-parc.jp/researcher/Hadron/en/pac_1901/pdf/P75_2019-09.pdf



s-shell double-A hypernuclei

AABO AABO

31

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 Λ^{5}_{Λ}

13 14 ANH

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Many theoretical calculations supports the existence of the A = 5 isodoublet $\left({}_{\Lambda\Lambda}{}^{5}\text{H}-{}_{\Lambda\Lambda}{}^{5}\text{He} \right)$.

L. Contessi et al., Phys. Lett. B **797**, 134893 (2019) G. Meher and U. Raha, Phys. Rev. C **103**, 014001 (2021) and references therein

J-PARC E75 Experiment

will investigate ${}^{5}_{\Lambda\Lambda}$ H.

https://j-parc.jp/researcher/Hadron/en/pac_1901/pdf/P75_2019-09.pdf

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$\Lambda\Lambda$ -EN mixing in ${}_{\Lambda\Lambda}^{5}H$





$$V_{\Lambda\Lambda,\Xi N}(r)d^3r$$

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D. E. Lanskoy and Y. Yamamoto, Phys. Rev. C **69**, 014303 (2004)

 $\Delta B_{\Lambda\Lambda} \rightarrow$ strength of $\Lambda\Lambda$ - ΞN coupling potential



Production and Decay of ${}_{\Lambda\Lambda}^{5}H$

ANHO ANHO

31

1.54

3 ANH

Mass of ${}_{\Lambda\Lambda}{}^{5}$ H will be determined (decay pion spectroscopy)

 $p_{\pi^{-}} \approx 132 - 135 \,\mathrm{MeV/c}$ $\int_{\Lambda}^{5} \mathrm{H} \rightarrow \int_{\Lambda}^{5} \mathrm{He} + \pi^{-}$

 $^{4}_{\Lambda}H \rightarrow ^{4}He + \pi^{-}$

 $p_{\pi^-} \approx 132.9 \,\mathrm{MeV}/c$

Tag of a fast proton from NMWD of ${}_{\Lambda}^{5}$ He \Rightarrow distinction between ${}_{\Lambda\Lambda}^{5}$ H and ${}_{\Lambda}^{4}$ H 藤岡 宏之 第8回クラスター階層領域研究会 10/18 (大) 東京工業大学



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Production of ${}_{\Xi}^{7}H$





T. Koike, E. Hiyama, H. Fujioka, T. Fuukuda, in preparation

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d Phase-1 of the P75 experiment: Measurement of the formation cross section of ${}_{\Xi}^{7}$ H in the ⁷Li(K^{-} , K^{+}) reaction

Shuhei Ajimura¹, Hiroyuki Fujioka^{2*}, Tomokazu Fukuda^{3,4†}, Toshiyuki Gogami⁵, Emiko Hiyama^{6,4‡}, Yuhei Morino⁷, Toshio Motoba^{3,8}, Tomofumi Nagae⁵, Sho Nagao⁹, Akane Sakaue⁵, Toshiyuki Takahashi⁷, Yosuke Taki², Atsushi O. Tokiyasu¹⁰, Makoto Uchida², Masaru Yosoi¹

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December 9, 2019

http://j-parc.jp/researcher/Hadron/en/pac_2001/pdf/P75_2020-02.pdf



Cylindrical Detector System

 $^{5}_{\Lambda\Lambda}H \rightarrow ^{5}_{\Lambda}He + \pi^{-}$ (decay pion spectroscopy)

Solenoid magnet (SPring-8/LEPS)



TPC (SPring-8/LEPS→TokyoTech)



Inner counter (TokyoTech, RIKEN)







TPC signal readout (公募研究)

内田誠、田中智也、宇根千晶、霞千明、藤岡宏之(東工大) FADC card (developed for LEPS2-TPC)







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Display of cosmic-ray event

signal readout for 1 sector (14 FADC cards)

hit positions in cathode-pad plane







Performance evaluation of TPC



linear fitting for layer-2,3,5,6 → residual at layer-4



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Summary

- Spectroscopy of Ξ hypernuclei ${}_{\Xi}^{7}$ H and Double-A hypernuclei ${}_{\Lambda\Lambda}^{5}$ H at J-PARC E75 experiment
 - ► Strength of $\exists N-\Lambda\Lambda$ coupling → ${}_{\Xi}^{7}H$: decay width, ${}_{\Lambda\Lambda}{}^{5}H$: $\Lambda\Lambda$ -bond energy ($\Delta B_{\Lambda\Lambda}$)
- Signal readout of TPC for decay pion spectroscopy
 - readout system for 1 sector completed
 - Performance evaluation of TPC



