

Second JLab Hypernuclear Workshop

(Hypernuclear 2016, 15 March 2016)

(Summary Note by S.N.Nakamura)

The second hypernuclear workshop was held on the 15th of March 2016 at Jefferson Lab (organizers: S.N. Nakamura, L. Tang and F. Garibaldi). In the previous JLab PAC43, the part of new hypernuclear proposal C12-15-008 with Ca40 and 48 targets was conditionally approved (with requirement of becoming a stand alone proposal, i.e. separated from other parts). Recently, new experimental results about the charge symmetry breaking of the Lambda-N interaction are getting obtained at Mainz and J-PARC. These developments affect our strategies in establishing the future hypernuclear physics research at JLab.

In the workshop, we discussed what kind of hypernuclear program should be carried out at JLab in timely manner with recent theoretical progresses including experts out of the JLab hypernuclear collaboration. Many progresses of hypernuclear study theoretically as well as experimentally were discussed at the workshop with active discussions and exchange of opinions.

Brief summary of the presentations are follows:

Nakamura welcomed participants and summarized what we had discussed at the first hypernuclear workshop and proposal submitted to PAC43. He also explained highlights of JLab hypernuclear experiments carried out in the last decade.

Isaka presented about hyperon puzzle and pointed out three-body repulsive force is a key to solve it. He discussed recent theoretical calculation of Hyper-AMD with ESC08c+MPP+TBA potentials.

Pederiva explained about Quantum Monte Carlo method and how QMC can be used to solve the hyperon puzzle. He described how non-trivial isospin

dependence is in the three-body sector and pointed out importance of gravitational wave observation to the neutron star study.

Lonardoni explained detail of AFDMC and presented recent results on various hypernuclei. He pointed out that accuracy of experimental inputs of B_Λ is essentially important to constraint the model. He showed latest results of isospin dependence of B_Λ for $^{40}_\Lambda\text{K}$ and $^{48}_\Lambda\text{K}$.

During discussion, he was asked to make a plot which shows how radius-maximum mass relation of neutron stars can be constrained by 100 keV precision B_Λ information and his answer was "It is possible."

Nakamura outlined the idea of proposal of $^{40}_\Lambda\text{K}$ and $^{48}_\Lambda\text{K}$ spectroscopy and how the measurements can contribute to solve the hyperon puzzle. He also discussed about availability of ^{40}Ca , ^{48}Ca targets and possible isospin study with Sn isotope targets.

Hiyama explained charge symmetry breaking of the Lambda-N interaction and recent progresses about spectroscopy of A=4 Lambda hypernuclei. She discussed possible $nn\Lambda$ bound/resonance system and observation of tetra-neutron system at RIBF. She also discussed detailed spectroscopy of $^7_\Lambda\text{He}$ excited states and concluded that Lambda hypernuclear study can contribute to unstable nuclear physics.

Gibson explained the non-existence of n-Lambda scattering measurement that may hold the key clue on Charge-Symmetry-Breaking and possible extraction from the measurement of the $nn\Lambda$ resonance. He discussed about a theoretical analysis of the n-Lambda interaction according to the mass and decay width of the $nn\Lambda$ resonance. He stressed the importance of $n\Lambda$ data and suggested an experiment with tritium target through the $(T(e,e'\text{K}^+)(nn\Lambda))$ reaction at JLab.

Tamura reported present status of hypernuclear physics at J-PARC. He noted that systematic study of p-shell Lambda hypernuclei with excellent precision is quite important to understand Lambda's behavior in nuclear matter. Recent progresses of ΛN CSB study for A=4 systems were summarized. J-PARC Hadron Hall Extension plan was also introduced. High-resolution spectroscopy of various Lambda hypernuclei is a key

program at High-Intensity High-Resolution beamline (HIHR) at the J-PARC Extended Hadron Hall.

Motoba discussed theoretical framework of photo/electro-production of Lambda hypernuclei. He emphasized detailed comparison of $^{12}_{\Lambda}\text{B}$ spectrum and theoretical prediction disclosed a new feature of hypernuclear structure, namely parity-mixing states mediated by Lambda. He demonstrated DWIA predictions for p-shell hypernuclei as well as $^{40}_{\Lambda}\text{K}$ and $^{208}_{\Lambda}\text{Tl}$.

Benhar discussed the interpretation of the $(e,e'K^+)$ cross section, and its relation to the Lambda binding energies. He also explained that lead is expected to be the best target to study hyperon properties in nuclear matter based on its charge-density distribution showing results of theoretical calculations and the $^{208}\text{Pb}(e,e'p)$ data from NIKHEF.

Markowitz proposed an experiment of electro-production of hyperons via the $\text{H}(e,e'K^+)\Lambda/\Sigma^0$ reactions to study unsolved problems about elementary processes. He discussed a possibility of $nn\Lambda$ bound state/resonance study with a tritium target. He stressed that observation of even a resonance of $^3_{\Lambda}\text{n}$ would teach us many things. Experimental progresses of CSB for $A=4$ hypernuclei were also discussed.

Tang proposed a new experiment to measure Λ -p scattering and a possibility to investigate Λ -n interaction. CLAS data were introduced to show that Λ -p scattering experiment is promising experiment at JLab. Possibility of usage of Hall-D to study Λ -p is discussed during Q&A time. Significance of Λ -n study with a tritium target was again noted in his talk.

Garibaldi explained merits of the $(e,e'K^+)$ reaction spectroscopy over the (π^+,K^+) reaction for heavy hypernuclei from a view point of good resolution and pointed out that Pb would be the best target to study hyperon properties in nuclear matter. He introduced progresses of RICH detector which might be used in a future experiment at JLab. Jointly, Dusa discussed a design of a 0.1 mm thick Pb rotating target and proposed possible test plan for feasibility of the target.

Mckeown presented his positive impression about the active discussions at

the workshop on the hypernuclear physics topics and progresses that are related to the possible experiments at JLab and encouraged the collaboration to put further efforts to polish up a new proposal of ^{40}Ca , ^{48}Ca targets to study isospin dependence of Lambda binding energies for the next PAC.