Research Group for Hadron Nuclear Physics

Group Leader : Makoto Oka
Members : Hiroyuki Sako, Toshiki Maruyama, Shoichi Hasegawa, Susumu Sato, Kiyoshi Tanida, Hitoshi Sugimura, Yudai Ichikawa, Takayasu Sekihara, Hiroyuki Ekawa, Shuhei Hayakawa, Shinji Kinbara, Yoshiyuki Nakada, KenIchi Imai, Shoji Nagamiya, Atsushi Hosaka, Emiko Hiyama

Our group has performed 1) experimental studies of exotic hadrons and nuclei with strangeness and charm, high-density matter at J-PARC and BNL-RHIC, and 2) theoretical studies of nuclear matter at low and high densities, and the roles of strangeness and charm in nuclear matter and neutron stars. Through these topics, we study many-body problems of quarks and hadrons in relation with quantum chromodynamics (QCD).

Hadron physics experiments at J-PARC and Belle

We performed the first run of J-PARC E07 experiment to measure double Λ hypernuclei in stopped Ξ^- reactions using the hybrid-emulsions-SSD method, where we associate tracks from SSD (Silicon Strip Detectors) with hits in emulsions. We irradiated 18 out of 100 emulsions stacks with K^- beam from the K1.8 beam line at the hadron hall of J-PARC. We have confirmed that the hybrid-emulsion-SSD method works as planned, and expect 10000 Ξ^- stopped events in these data [1,2]. We also analysed the E05 pilot run data. We observed a peak which can be identified as ${}^{12}_{\Xi}$Be in $K^-\,{}^{12}\mathrm{C} \to K^+X$ reaction. We also measured $K^-\,{}^{12}\mathrm{C} \to pX$ reaction to study $\bar{K}$-nucleus interaction, and the result of the analysis is shown in Fig. 1 [3].
As a preparation of the Hyperon spectrometer for the H-dibaryon search experiment (J-PARC E42), we perform excitation tests of the Helmholtz-type superconducting magnet at KEK. The Stage-II request of the E42 experiment will be approved after our update of the technical design review (TDR).
Results of the E15 experiment of $K^-\,{}^3\mathrm{He} \to \Lambda pn$ reactions [4], and a theoretical analysis [5] for possible K^-pp bound states are given in a separate report.
At the Belle detector of the KEK B-factory, we analyzed spectrum of charm baryon excited states and weak decays of charmed baryons. We observed $\Lambda_c^+ \to pK^+\pi^-$ decay in e^+e^- collisions [6], which is the first observation of a double Cabibbo-suppressed decay of charmed baryons.

High energy heavy-ion physics at RHIC and J-PARC

The RHIC-PHENIX experiment aims at studies of quark-gluon plasma. In the 2015-2016 run, we investigated the reactions Au + Au at nucleon-nucleon center-of-mass energy $\sqrt{s_{NN}}$ of 200 GeV, d + Au at $\sqrt{s_{NN}}$ of 20, 39, 52, and 200 GeV. It was the last run of PHENIX. It will be upgraded into sPHENIX experiment which is to measure jets in 2019.
The J-PARC Heavy-Ion project (J-PARC-HI) aims to explore QCD phase structures at extremely high baryon density with the world's most intense heavy-ion beam. Detailed design of the dilepton spectrometer and the hypernuclear spectrometer and their expected physics performance has been discussed [7]. We have submitted the Letter-Of-Intent of J-PARC-HI to the J-PARC PAC (Program Advisory Committee) in June 2016.

Hadron Theory Research and Theoretical Physics Institute

The J-PARC experimental programs are quite competitive and highly regarded internationally, and they rely on strong theoretical supports. Our theorists benefit from working closely with experimentalists and have established collaborative research in multi-strange hadron/nuclear physics, charm hadron physics, and properties of dense hadronic matter. Much efforts have been devoted to promote theoretical researches to support J-PARC experiments. For example, we started the Theoretical Physics Institute (TPI) at ASRC, aiming to promote international collaborations related to the J-PARC hadron physics. It is also intended to host cross-disciplinary collaborations among the theorists in ASRC. We held a series of TPI Lectures, for which we invited several guest speakers covering hadron physics, nuclear structure and reactions and condensed-matter physics.

The Reimei Program and International Collaborations

A Reimei Program on "Advanced Study of New Exotic Hadron Matter at J-PARC" was successfully carried out with Prof. Hyun-Chul Kim (Inha Univ., Korea) as the PI. We had a fruitful research collaboration to study heavy quark hadrons and dense matter physics with heavy-ion collisions. We held three Reimei workshops: the J-PARC Workshop 2016 "From Exotic Hadrons to QGP" at Inha University in June with 50 participants, the Reimei Workshop "Physics of Heavy-ion Collisions at J-PARC" at ASRC in August with 50 participants, and the Reimei Workshop "New Exotic Hadron Matter at J-PARC" at Inha University in October with 57 participants.

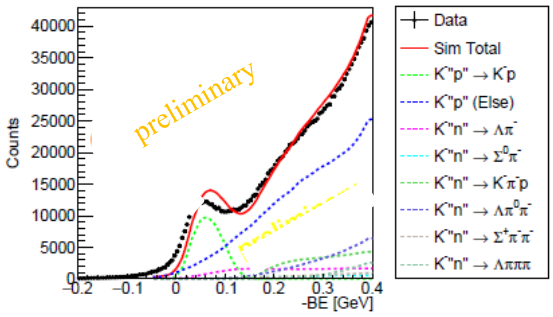

Fig.1 Missing mass spectrum for the $K^-\,{}^{12}\mathrm{C} \to pX$ reaction at 1.8 GeV/*c*. Experimental data are shown by black points. Fitting results are indicated with different colors [3].

References

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