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Machine learning techniques applied to study light hypernuclei

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Machine learning techniques have become very powerful and practical tools not only in our daily life but also in scientific research. We have performed several developments of machine learning models to study light hypernuclei, especially hypertriton, ${}^{4}_{\Lambda}\mathrm{H}$ and an nnΛ state. We have developed a complex of analysis methods for analyzing the J-PARC E07 nuclear emulsion data to determine precisely the binding energy of hypertriton and ${}^{4}_{\Lambda}\mathrm{H}$ by employing Mask-R CNN and the Generative Adversarial Network (GAN) together with Monte Carlo simulations. Determination of their binding energies are currently in progress. The developed models are being applied and improved for searching double-strangeness hypernuclear events as well as single-strangeness hypernuclear events with multi-body decay modes. We have also developed a new track finding model with the Graph Neural Network (GNN) for the WASA-FRS experiment to study the lifetime of hypertriton and ${}^{4}_{\Lambda}\mathrm{H}$ and whether or not an nnΛ bound state can exist. It has demonstrated that the efficiency and purity in track finding have been significantly improved. In the presentation, details of machine learning developments for the nuclear emulsion data will be discussed, and the development with the GNN will also be briefly discussed.

Primary author: SAITO, Takehiko (High Energy Nuclear Physics Laboratory, RIKEN and GSI)

Presenter: SAITO, Takehiko (High Energy Nuclear Physics Laboratory, RIKEN and GSI)

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