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Particle Identification by Pulse-Shape Analysis with Neural Network

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Recent cluster-model calculation predict that α condensed states emerge in self-conjugate $N = 4n$ nuclei. In the α condensed states, all of the α clusters are condensed in the lowest orbit, and their matter density is as low as 1/4–1/5 of normal nuclear states. Therefore, observation of the α condensed states is very important for clarifying physical properties of low-density nuclear matter.
Once nuclear nuclei in the α condensed states are excited, they are expected to decay with emitting 1–3 MeV α particles. However it difficult to identify such low-energy particles by $E - \Delta E$ telescope, one of the most conventional Particle identification (PID) method, because these particles cannot penetrate ΔE detectors. Thus, In order to search for α condensed states, it is necessary to establish a new PID method to identify low energy particles.
In the present study, we have attempted to identify particles by analyzing pulse shape output from Si detectors. This method has been somewhat successful mainly for high-energy heavy ions, but it has not been establish for low-energy light ions.
In addition, we applied neural networks to PID. In conventional pulse-shape analysis (PSA), PID was performed by defining some parameters and comparing them between different particles. On the other hand, neural networks enable to performed multi-dimensional analysis and it is expected to go beyond the limit of the conventional methods. We acquired pulse shape for known particles and used them to train the neural networks. As a result, we succeeded to develop the neural networks to separate to separate α particles with hydrogen with very high accuracy. We will report details of our study and PID ability of the neural networks.

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