Generating nucleon-nucleus scattering data by Gaussian process regression

Shoto Watanabe[1], Futoshi Minato[2], Masaaki Kimura[1,3,4] and Nobuyuki Iwamoto[2,3]

1. Department of Physics, Hokkaido University, Sapporo 060-0810, Japan
2. Japan Atomic Energy Agency, Tokai, Ibaraki 319-1195, Japan
3. Nuclear Reaction Data Centre, Hokkaido University, Sapporo 060-0810, Japan
4. RIKEN Nishina Center, Wako, Saitama 351-0198, Japan

Recent progresses in the data science have greatly impacted the study of nuclear data evaluation. The AI-technologies have a possibility to improve the accuracy of nuclear data and reduce the human and time resources required to construct the database. In fact, the AI technologies have already been tested for fission yield evaluation [1] and proton-induced reactions [2], showing promising results.

As one of such challenges, we are building a machine learning system that optimizes and estimates parameters of the nucleon-nucleus scattering models to generate an AI-based nuclear database. In this contribution, we will explain how our system is designed and works effectively.

Our system combines the Gaussian process regression with the CCONE code system [3], an assembly of various nuclear reaction models. By fitting measured cross sections, it optimizes the parameters of the nuclear reaction models, such as the optical potential parameter and the structural parameters of the target nucleus. It also estimates unknown energy dependences of the model parameters from experimental data. Figure 1 shows one such example, where the optical potential parameters are optimized to reproduce the angular

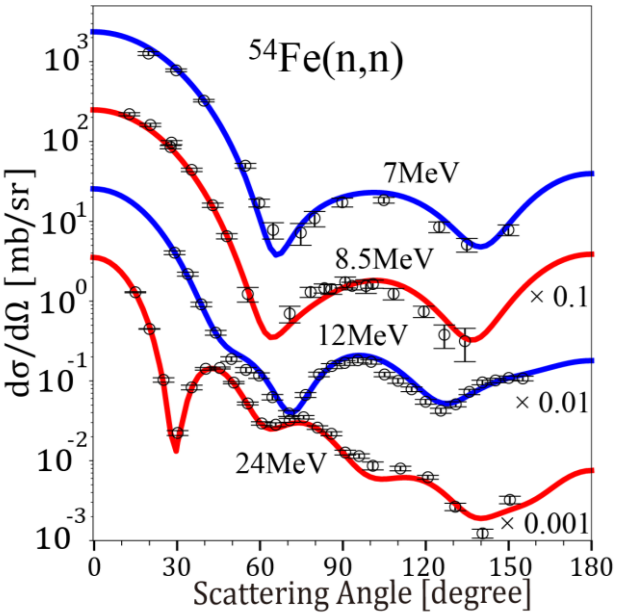

Fig.1: The angular distribution of the neutron elastic scattering on ^{54}Fe target at 7, 8.5, 12 and 24 MeV. The nuclear model parameters are fitted to reproduce the 7 and 12 MeV data (blue line). From these results, our system estimates the model parameters at other incident energies and predicts the angular distributions at 8.5 and 24 MeV (red line). Experimental data are taken from Ref. [4-7].

distributions measured at incident energies of 7 and 12 MeV, and then the angular distributions at other energies (8.5 and 24 MeV) are predicted based on the estimated energy dependence of the parameters.

In our presentation, we will also show other examples to demonstrate the performance of our system and how it helps in creating nuclear reaction databases.

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