6 - 23 Research Activities of Nuclear Data Research Group in 2018

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In 2018 the main research activities of Nuclear Data Research Group were focused on nuclear data measurements, calculations and fundamental research in heavy ion reactions. Some important results have been obtained.

In order to validate nuclear data and the neutron transportation performance of the materials related to the accelerator driven subcritical system (ADS), we measured the leakage neutron spectra from multiple-slab sample assemblies using 14.8 MeV D-T neutrons[1]. The measurement was performed at China Institute of Atomic Energy using time-of-flight method. Two types of assemblies comprising A-1 (W+U+C+CH2) and A-2 (U+C+CH2) were both built up gradually starting with the first wall. The measured spectra were compared with the MCNP simulations with ENDF/B-VII.1, JENDL-4.0 and CENDL-3.1 libraries. The results show that the experimental leakage neutron spectra for both A-1 or A-2 were reproduced well by the three evaluated nuclear data libraries with discrepancies of less than 15% (A-1) and 12% (A-2), 2), except when below 3 MeV. For 2 cm and 5 cm uranium samples, the CENDL-3.1 calculations exhibited large discrepancies in the energy range of 2∼8 MeV and above 13 MeV.

In order to validate JEFF-3.2, FENDL-3.0 and TENDL-2015 nuclear data libraries, some integral experiments have been conducted with TOF method on the D-T neutron source facility at China Institute of Atomic Energy (CIAE). The measured neutron spectra for Silicon Carbide, Graphite, Uranium and multi-slab sample assemblies were compared with the leakage neutron spectra simulated using the MCNP-4C code with the evaluated nuclear data libraries[2]. The comparison was made by the spectrum shape and the C/E values in five energy regions. From the results we can conclude that all the calculations reproduce well the measurements except at a few neutron energy ranges.

The leakage neutron spectrum from granular tungsten samples was measured by a TOF technique at 60°. The neutron transport and benchmark on granular tungsten samples were investigated using MCNP-4C simulations with the ENDF/B-VII.1, CENDL-3.1, JEFF-3.2, JENDL-4.0 and TENDL-2015 evaluated nuclear data libraries[3]. And four different geometry lattices (FCC, BCC, CHPOP and SC) were considered for the granular tungsten target. The simulated results show that the leakage neutron spectrum mainly depends on the filling factor of granular tungsten. The general trend of the experimental leakage neutron spectrum is well reproduced by MCNP simulation with the ENDF/B-VII.1 library within 15% error.

The impact of cluster correlations has been studied in the intermediate mass fragment (IMF) emission in ^{12}C + ^{12}C at 95 MeV/u, using antisymmetrized molecular dynamics (AMD) model simulations[4]. This version of AMD, combined with GEMINI to calculate the decay of primary fragments, reproduces the experimental energy spectra of IMFs well overall with reasonable reproduction of light charged particles when we carefully analyze the excitation energies of primary fragments produced by AMD and their secondary decays. The results indicate that the cluster correlation plays a crucial role for producing fragments at relatively low excitation energies in the intermediate-energy heavy-ion collisions.

References

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6 - 24 Effects of Cluster Correlations on Fragments Emission in ^{12}C+^{12}C at 50 MeV/u

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Effects of cluster correlations on fragments emission in ^{12}C+^{12}C at 50 MeV/u are studied with the antisymmetrized molecular dynamics (AMD) and an extended version of AMD, which has introduced cluster correlation based on the original AMD version (AMD-cluster). For the simulations, AMD model contains no effects of cluster correlations. The experimental data are well reproduced by the AMD-cluster calculations for light charged particles with $Z \leq 2$ (LCPs). The angle distributions of isotopes with $Z > 2$ (IMFs) are reproduced reasonably well by the AMD-cluster calculations. But the yields of ^{8}B, ^{10}Be, ^{10}C and ^{12}C do not improve.

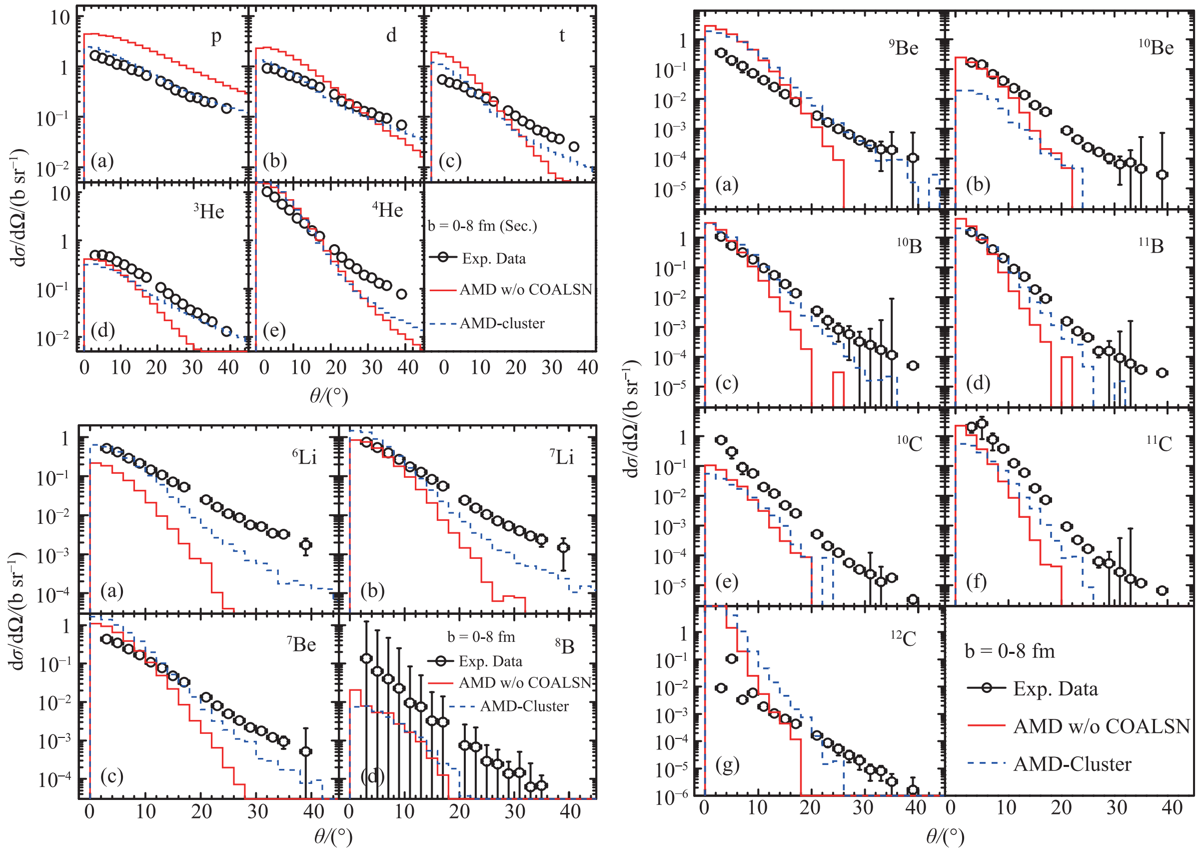

Fig. 1 (color online) Compares for LCPs and IMFs angular distributions with impact parameter $b = 0 \sim 8$ fm. The experimental data from Ref. [1].

In Fig. 1, the angular distributions of LCPs and IMFs from two transport models and the experimental data are compared. The experimental data are shown by open symbols. The calculated results of AMD and AMD-cluster are shown by red solid line and blue dash line, respectively. For LCPs, AMD-cluster calculated results were obviously improved compared with the AMD results. For IMFs, the improvement of AMD-cluster calculated results mainly reflected in the large angle range, except for ^{8}B, ^{10}Be, ^{10}C and ^{12}C isotopes. We have found that the cluster correlation plays a key role for the angular distributions of LCPs and IMFs.

Reference

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6 - 25 Benchmarking of Evaluated Neutron Nuclear Data for Multiple-slab Sample Assemblies Comprising W,U,C, and CH_2

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In order to validate nuclear data and the neutron transportation performance of the materials related to ADS, we measured the leakage neutron spectra from multiple-slab sample assemblies using 14.8 MeV D-T neutrons. Two types of assemblies comprising A-1 (W+U+C+CH_2, the thickness of W is 3.5 cm, the others are 2 cm.) and A-2 (U+C+CH_2, the thickness of U is 5 cm, the others are 10 cm.) were both built up gradually starting with the first wall. The measured spectra were compared with those calculated using the Monte Carlo code neutron transport coed (MCNP)-4C with evaluated nuclear data of the ENDF/B-VII.1, CENDL-3.1, JENDL-4.0, JEFF-3.2, FENDL-3.0 andTENDL-2015 libraries. A comparison of the results showed that the experimental leakage neutron spectra for both A-1 or A-2 were reproduced well by all the evaluated nuclear data libraries with discrepancies of less than 15% (A-1) and 12% (A-2), except when below 3 MeV. For 2 and 5 cm uranium samples, the CENDL-3.1 calculations