Improved Capture Gamma-Ray Libraries for Nuclear Applications

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The neutron capture reaction is of fundamental use in identifying and analyzing the gamma-ray spectrum from an unknown object as it gives unambiguous information on exactly what isotopes are absorbing the neutrons. There are many applications where this can be used passively (nonproliferation), or actively where an external neutron source is used to probe an unknown mass (planetary studies). There are known capture gamma data gaps in the ENDF libraries used by transport codes for various nuclear applications. The Evaluated Gamma-ray Activation file (EGAF) is a new thermal neutron capture database of discrete line spectra and cross sections for over 260 isotopes. This database is used to improve the capture gamma production in ENDF libraries. For medium to heavy nuclei the unresolved quasi continuum part of the gamma cascades are not experimentally available. This continuum can contain up to 90\% of all the decay energy, in this work it is modeled with the statistical nuclear structure code Dicebox. This code is also used as a consistency check to improve the level scheme evaluation. The resulting unresolved continuum is sufficiently accurate for inclusion in the ENDF libraries. This process also predicts new total thermal capture cross sections and allows for improvements in the RIPL database. For the capture of higher energy neutrons there is little experimental data available making evaluation of modeling codes problematic. We plan to continue the Dicebox approach through the resolved resonance region where spin and parity information is partially known. In the unresolved resonance region we are applying Hauser Feshbach models to predict the cross sections of discrete transitions. This is used to simulate the capture gamma spectrum from neutrons at higher incident energies up to 20 MeV in order to improve the neutron data libraries used for transport modeling of unknown objects. This work was performed under the auspices of the United States Department of Energy (DOE).