

Supplement to Lecture 1: Nuclear Data Compilation and Evaluation

As an addendum to our brief overview of basic nuclear concepts (Lec 1) we call attention to an important aspect of the study of nuclear phenomena that does not get much emphasis in the class room, or at examinations. This is the topic of how information on nuclear data is gathered, analyzed, and made available to users on a world-wide basis. Data compilation and evaluation are continuously on-going activities in the development and applications of nuclear science and engineering. Their importance can never be overestimated in view of the critical need for accurate cross sections and other data in a nuclear calculation of any practical consequence. It is not surprising that an entire industry has evolved on nuclear data technology which continues to play a vital role in the maintenance and improvement of a huge existing database which is also expanding. It is beyond the scope of this class to go into any kind of detail on nuclear data beyond a general understanding of what types of data are available.

We confine our discussion to two sources of nuclear data, the *Chart of Nuclides* and the *Table of Isotopes*. The former used to be familiar and commonly available to students and faculty as a fold-out insert in a nuclear physics text, or as a wall chart. The latter contains much more voluminous data, the seventh (and the last) edition of which has grown by 1978 into a large volume too cumbersome to be carried around. For the purposes of this class the relevant information can be obtained from an on-line versions of the Chart of Nuclides, a convenient source being the Table of Nuclides that is maintained by the Korean Atomic Energy Research Institute (KAERI) – <http://atom.kaeri.re.kr/>. This Table provides the basic data on nuclides – mass, half life, decay schemes and cross sections. For special data not available in the Table of Nuclides, the student may wish to consult the Table of Isotopes which is admittedly a less than convenient reference source.

In addition, there are many sources of cross section data that have compiled and evaluated. Compilation and evaluation of nuclear data are carried out at many national laboratories and research centers all over the world. In the U.S. the focal point of this activity has been the National Neutron Cross Section Center at the Brookhaven National Laboratory. Going back about 20 to 30 years, perhaps the most significant contribution of this Center was a library of evaluated nuclear data, known as the Evaluated Nuclear

Data File (**ENDF**), which was developed for the storage and retrieval of nuclear data needed for neutronic and photonic calculations. At one time there were two libraries. ENDF/A was a collection of useful evaluated data sets. **ENDF/B** contained the reference data sets recommended by the Cross Section Evaluation Working Group. At any given time there was only evaluated data set for a particular material. Most users were concerned only with the B version.

Evaluation of nuclear data means the assignment of the most credible value after consideration of all the pertinent information. The evaluation was supported by documentation giving a description of how the value was determined and an estimate of its uncertainty. As of 1975 the information contained in ENDF consisted of: Resonance parameters, cross section tables, angular distributions, energy distributions, double differential data in angle and energy, scattering law data, and fission parameters.

For a brief look at the contents of ENDF/B library, we note that ENDF/B-II contained 3 basic types of data stored on 13 magnetic tapes.

1. Scattering law data for 12 moderator materials. For example, $s(\alpha, \beta)$ for a series of temperatures, 10 temperatures between 296°K and 2000°K in the case of graphite.
2. Neutron cross sections for 78 fissile, fertile, structural, and other materials, each being an element or an isotope -- total and any significant partial cross sections, reactions producing outgoing neutrons, angular and energy distributions, radioactive decay chain data, fission product yield, $\nu(E)$.
3. Photon interaction cross sections for 87 elements from $Z = 1$ to 94 -- photon cross sections, angular and energy distributions of secondary photons.

Over the years a number of active compilation groups have issued library files: **KEDAK** from Karlsruhe, Germany, **JAERI** (Japan), **UKNDL** from England, and various libraries from U.S. national laboratories such as Oak Ridge, Los Alamos, and Lawrence Livermore.