# 23. FILE 23. "SMOOTH" PHOTON INTERACTION CROSS SECTIONS

## 23.1. General Comments on Photon Interaction

Photon interaction data are divided into two files. File 23 is analogous to File 3 and contains the "smooth" cross sections. File 27 contains the coherent scattering form factors and incoherent scattering functions (see Chapter 27).

Electron interaction data are divided into two different files. The smooth cross sections for elastic scattering, bremsstrahlung, excitation, and the ionization of different atomic subshells are given in File 23. File 26 is used to give the angular distribution for elastically scattered electrons, the outgoing photon spectra and energy loss for bremsstrahlung, the energy transfer for excitation, and the spectra of the scattered and recoil electrons associated with subshell ionization.

Both photo-atomic and electro-atomic reactions can leave the atom in an ionized state. See Section 28 for a description of the atomic relaxation data needed to compute the outgoing X-ray and electron spectra as an ionized atom relaxes back to neutrality.

## 23.2. General Description

This file is for the integrated photon and electron interaction cross-sections. The reaction type (MT) numbers for photon and electron interaction are in the 500 series. Several common photon and electron interactions have been assigned MT numbers:

| MT | Reaction Description |
|---|---|
| 523 | Photo-excitation cross sections |
| 526 | Electro-atomic elastic scattering |
| 527 | Electro-atomic bremsstrahlung |
| 528 | Electro-atomic excitation cross section |
| 533 | Atomic relaxation data (see Section 28) |
| 534-572 | Photo-electric or electro-atomic subshell ionization |

Photon cross sections, such as the total cross section, coherent elastic scattering cross section, and incoherent (Compton) cross section, are given in File 23, which has essentially the same structure as File 3. These data are given as a function of energy, $E_\gamma$, where $E_\gamma$ is the energy of the incident photon (in eV). The data are given as energy-cross section pairs.

Similarly, electron cross sections, such as elastic scattering, bremsstrahlung, ionization, and excitation, are given in File 23. These data are given as a function of the electron energy in eV, and they are also given as energy-cross section pairs.

Each section in File 23 contains the data for a particular reaction type (MT number). The sections are ordered by increasing MT number.

## 23.3. Formats

The following quantities are defined:

| | |
|---|---|
| **ZA,AWR** | Standard material charge and mass parameters. |
| **EPE** | Subshell binding energy (equal to the photoelectric edge energy) in eV. The value is zero if MT is not in 534-599. |
| **EFL** | Fluorescence yield (eV/photoionization). Value is zero if not a photoelectric subshell ionization cross section. |
| **NR,NP,$E_{int}$** | Standard TAB1 parameters (see Section 1.3.1). |
| **σ(E)** | Cross section (barns) for a photon or electron of energy E given as a table of NP energy-cross section pairs. |

The structure of a section is

```
[MAT, 23, MT/  ZA,  AWR,   0,   0,   0,   0] HEAD
[MAT, 23, MT/ EPE,  EFL,   0,   0,  NR,  NP/ E_int / σ(E)] TAB1
[MAT, 23,  0/ 0.0,  0.0,   0,   0,   0,   0] SEND
```

## 23.4. Procedures

1. Values are usually for elements; hence, except for mono-isotopic elements, ZA=Z × 1000.0; also, AWR should be for the naturally occurring element.
2. Photoelectric edges will not be multi-valued. The edge will be defined by two energies differing in the fourth or fifth significant figure.
3. Interpolation is normally log-log (INT=5).
4. Kerma factor (energy deposition coefficients) libraries will normally be local because there is no universal definition. The application will determine whether annihilation or other radiation fractions are subtracted.