Notes on ^{nat}Tl (thallium) interpolation law in JEFF-3.1

The comparison of JEFF-3.1 processing[1] using NJOY-99 and PREPRO-2004 has shown differences at low neutron energy for the thallium file. This inconsistency is due to the lin-lin interpolation law given in the evaluation itself and used to process MF3 cross sections.

Figure 1 shows low neutron energy (below 100 eV) JEFF-3.1 thallium pointwise cross sections processed with NJOY. Both the total and the capture cross sections show an odd shape below 1 eV.

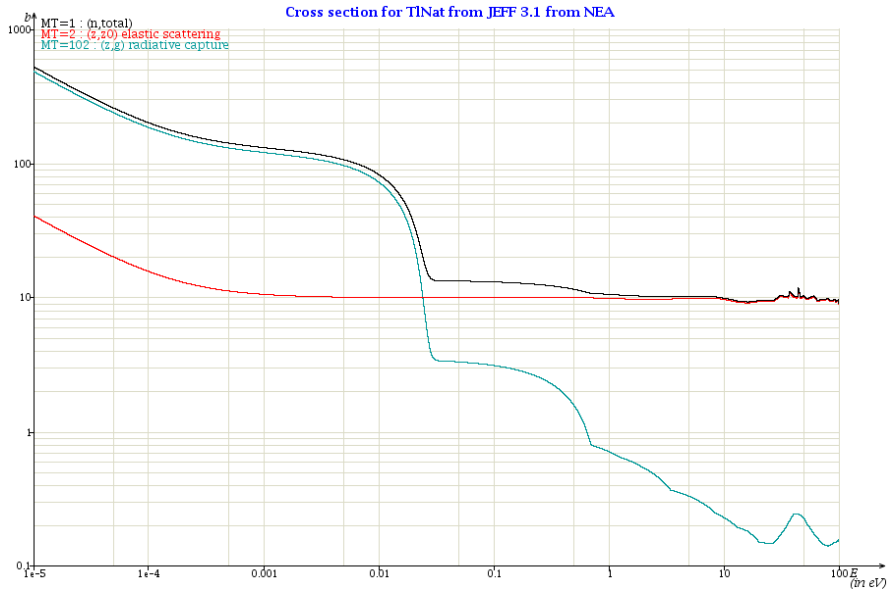

Figure 1: JEFF-3.1/GP thallium cross sections (NJOY processing)

Figure 2 displays thallium capture cross section (pointwise) for JEFF-3.1/GP and JEFF-3/A (EAF-2003) together with measurements available in the EXFOR database. Both JEFF-3.1/GP and EAF-2003 are in rather good agreement with experimental data. However, unlike EAF-2003, JEFF-3.1/GP clearly departs from the well established 1/v behaviour.

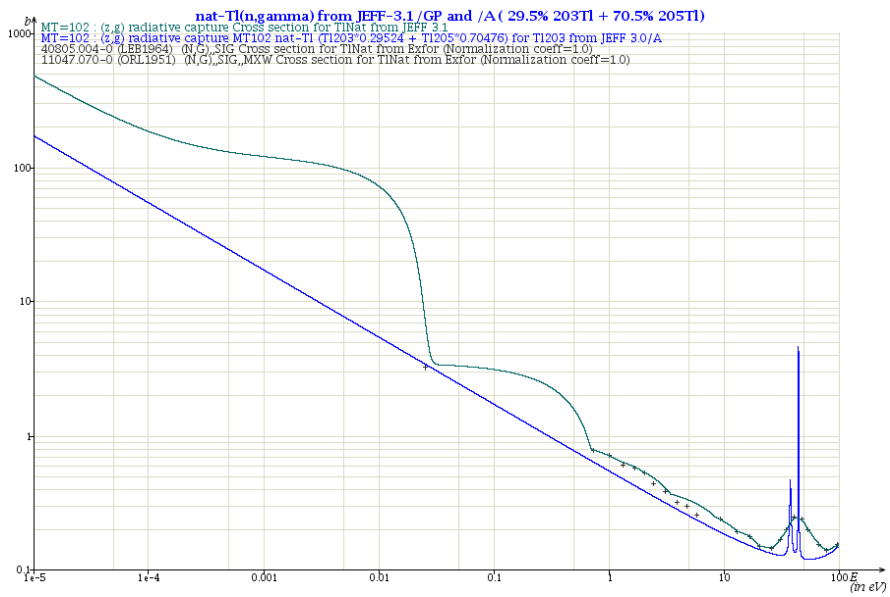

Figure 2: Thallium capture cross sections of JEFF-3.1/GP and JEFF-3/A (NJOY processing)

[1] *Processing of the JEFF-3.1 Cross Section Library*, OECD/NEA Data Bank, NEA/NSC/DOC(2006)18, p. 49

NB: in the following plots (Figure 3 to Figure 5), JANIS uses the interpolation law given in the ENDF file when plotting cross sections between evaluated points.

Figure 3 shows the raw MF3 cross-sections available in the JEFF-3.1/GP evaluated file. The gap between 100 eV and 50 keV, where the background cross section is zero, corresponds to the resolved resonance range. At low neutron energy, below 1 eV, cross section values are given for three energies only: 10^{-5} eV, 0.0253 eV and 0.7 eV. As already mentioned, the lin-lin law used to interpolate over decades between these few points is not appropriate.

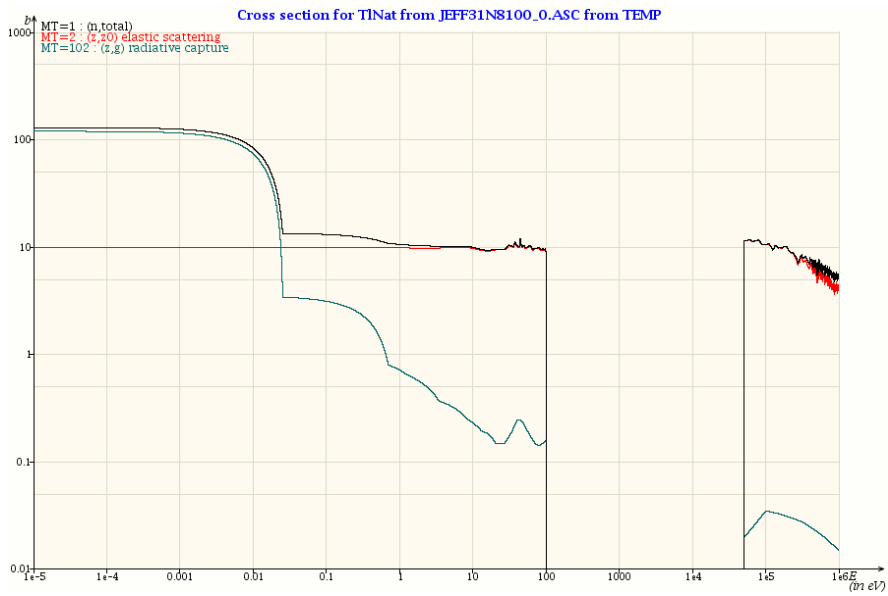

Figure 3: JEFF-3.1 Thallium cross sections (ENDF file)

There are different ways to correct the thallium evaluation: either (1) increase the number of points or (2) use a log-log interpolation law. A new evaluated file was produced by applying option (2) to MF3/MT1 (total), MF3/MT2 (elastic scattering), and MF3/MT102 (radiative capture). The differences between JEFF-3.1/GP (JEFF31N8100_0.ASC) and this new file (JEFF31N8100_1.ASC) are shown below.

```
MF3/MT1      JEFF31N8100_0.ASC (<) vs. JEFF31N8100_1.ASC (>)

<  0.000000+0 0.000000+0          0          0          1        7238100 3  1    2
<         723          2                                            8100 3  1    3
---
>  0.000000+0 0.000000+0          0          0          3        7238100 3  1    2
>          42          5         46          2        723          58100 3  1    3

MF3/MT2      JEFF31N8100_0.ASC (<) vs. JEFF31N8100_1.ASC (>)

<  0.000000+0 0.000000+0          0          0          1        7238100 3  2    2
<         723          2                                            8100 3  2    3
---
>  0.000000+0 0.000000+0          0          0          3        7238100 3  2    2
>          42          5         46          2        723          58100 3  2    3

MF3/MT102    JEFF31N8100_0.ASC (<) vs. JEFF31N8100_1.ASC (>)

<  6.655800+6 6.655800+6          0          0          1         678100 3102    2
<          67          2                                            8100 3102    3
---
>  6.655800+6 6.655800+6          0          0          3         678100 3102    2
>          42          5         44          2         67          58100 3102    3
```

In MT1, MT2, and MT102 sections the lin-lin interpolation law (INT=2) was replaced by a log-log interpolation law (INT=5) except for the points between 100 eV and 50 keV, where the background cross section is zero.

A graphical comparison between present JEFF-3.1/GP (JEFF31N8100_0.ASC) and the new file (JEFF31N8100_1.ASC) is given in Figure 4 for the capture cross section and in Figure 5 for the total cross section. There is no visible change in the elastic scattering case since the cross section is constant at low neutron energy (cf. Figure 3).

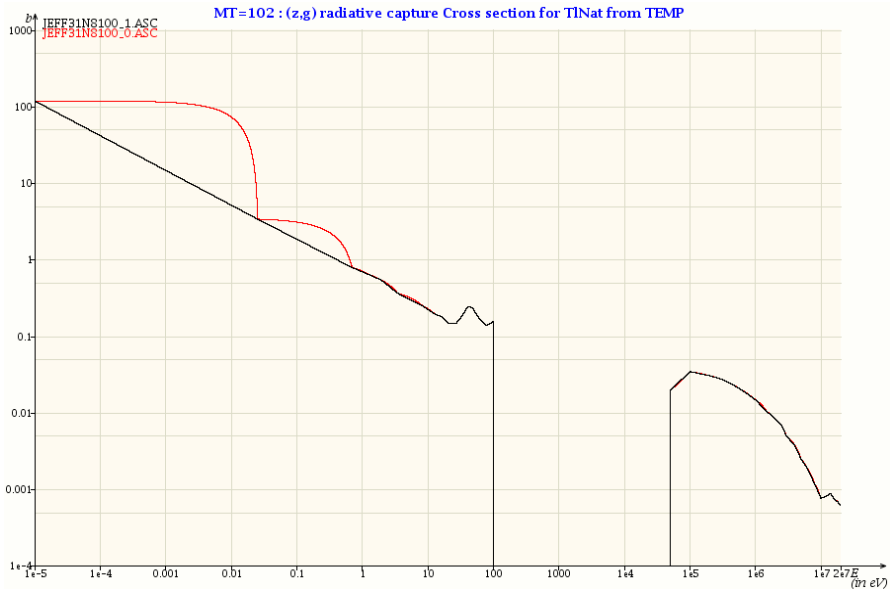

Figure 4: Capture cross sections before and after correction of JEFF-3.1/GP (ENDF file)

Figure 5: Total cross sections before and after correction of JEFF-3.1/GP (ENDF file)

Conclusion

The lin-lin interpolation law used in the JEFF-3.1/GP thallium evaluation has been modified to a log-log interpolation law to correctly reproduce the 1/v behaviour of the radiative capture cross section. The new file is available as JEFF31N8100_1.ASC and should be tested again with PREPRO-2004 and NJOY-99.