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**Interest on high quality evaluation of Zr isotopes for LWRs**

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The power maps of commercial nuclear reactor cores are calculated by solving neutron transport equation, *i.e.* Boltzmann equation. The latter has to be considered here as an eigenvalue equation giving different multiplication factor values (aka, keff). The so-called “fundamental mode”, *i.e.* the first eigen-vector for the neutron flux is not sensitive to any nuclear data whatever the core size. The proof that the sensitivity of 2-dimension power maps to inelastic scattering cross section off 238U is almost null is done during the presentation for a homogeneous UO2+H2O core whatever its radius from 10cm to 4m. To excite flux harmonics (degenerated eigen-function or flux), the core has to be heterogeneous as commercial cores are (alternating various 235U enriched assemblies for the loading for instance). In this case, the Eigen Value Separation can reach 400, *i.e.*, the first fundamental mode and the first harmonics are living not so far together.

The toy model in the presentation is a typical French 1450MWé reactor called “palier N4” loaded with 205 typical 17x17 fresh assemblies with different 235U enrichments. The heterogeneous loading of this core leads to excite harmonics and the power map becomes then sensitive to nuclear data. The sandwich formula uncertainty propagation gives the main following components of uncertainty of 2D radial power maps: 238U(n,ncont’), p(n,p) and Zr inelastic scattering, Zr radiative capture… The order of magnitude for the power map uncertainty of Zr nuclear data is about ±0.7% by using COMAC covariance matrices. This has a consequence on the control rod worth as twice of 0.7, *i.e.* ±1.4%.

A pragmatic “validation” of this 0.7% uncertainty is done by comparing different evaluations of 90Zr only: the use of 4 nuclear data libraries (JEFF-3.1.1, JEFF-3.3, JEFF-4T3 and ENDF/B-VIII.0) shows a 1 dispersion of 0.3%. But the simple difference between ENDF/B-VIII.0 and JEFF-3.1.1 shows a difference of the power map distribution of +0.23% in the center of the core and about -0.25% in the peripheral assemblies.

We suspect that the difference in the description of inelastic cross-sections is responsible of this modification. Indeed, the number of discrete level is only 7 for JEFF-3.1.1, 20 for JEFF-3.3, 16 for JEFF-4T3 and 9 for ENDF/B-VIII.0. Then, the threshold of continuum inelastic cross section is different between evaluation and this could play a crucial role in the neutron slowing down and then on the neutronic coupling between adjacent assemblies and then on the power map calculation.

The open question for Zr nuclear data is the following: do transition between MF4 (discrete inelastic scattering angular distribution) and MF6 (double differential distribution -angle+outgoing energy- for continuum inelastic scattering) smooth enough? Nuclear reaction codes such as TALYS, EMPIRE, handle the total cross section as the sum of partial, but is it the same for differential cross sections?

The plot showing the probability distribution of the neutron outgoing distribution (Legender polynomial P0) at 4.5 MeV-incident neutron shows a different behavior for 90Zr(n,inelastic scattering) between JEFF-3.1.1 (7 discrete levels) and JEFF-4T3 (20 discrete levels) probably because of the non-continuity between MF4 and MF6.

As a conclusion, the recommendation for Zr nuclear data evaluation files would be:

* to ensure a good evaluation for an accurate calculation of radial power maps for large commercial reactor core.
* to find a way to impose a continuity between MF4 (discrete inelastic levels) and MF6 (continuum inelastic level).