WP2025-10

Revision of LEXFOR “Transmission and Reaction Yield”

(N. Otsuka, 2025-05-12, Memo CP-D/1137)

In the current LEXFOR “Transmission and Reaction Yield”, the transmission $T(E)$ and the reaction yield $Y_x(E)$ are defined in terms of the total cross section $\sigma_T(E)$ and reaction cross section σ_x(E) by the following equations:

$$T(E) = \exp[-n_T \sigma_T(E)]$$
$$Y_x(E) = \left[1 - \exp\left(-n_T \sigma_T(E)\right)\right] \frac{\sigma_x(E)}{\sigma_T(E)}$$

(Note that the second equation is valid only when the multiple scattering is negligible.)

These equations could be useful to understand the relationship with the cross sections. However, it would be more practical for compilers if they are introduced in terms of the measurables (i.e., counts). We also had long discussion in the past NRDC meetings on (1) compilation of the supplemental information including resolution (response) function under SUPPL-INF and (2) treatment of the reaction yield divided by the sample areal density (“cross section in thin target approximation” `,SIG,,TTA`).

I would like to propose reformulation of the introduction of these quantities in LEXFOR as appended to this memo.

<u>Transmission and Reaction Yields</u>

Transmission T and reaction yield Y_x (x = capture, fission etc.) are related with the count C and background count B by

$$T = N_T \frac{C_{\text{in}} - B_{\text{in}}}{C_{\text{out}} - B_{\text{out}}}$$

$$Y_x = N_x \frac{C_x - B_x}{C_\varphi - B_\varphi}$$

where in, out, x and φ stand for sample-in, sample-out, reaction channel and beam flux measurement, respectively. N_T and N_x are normalization factors.

REACTION coding: `TRN` (transmission) or `RYL` (reaction yield) in SF6.

Independent variables:

Incident energy (e.g., `EN`)
Sample thickness (`THICKNESS`)

Units: `NO-DIM`.

Examples:

`(…(N,TOT),,TRN)`	Transmission
`(…(N,G)…,,RYL)`	Capture yield

In a time-of-flight measurement, Z (= T or Y_x) is measured in the time-of-flight domain $Z(t)$, which is related with the same quantity in the energy domain Z'(E) by

$$Z(t) = N_Z \frac{\int \mathrm{d}E\ R(t,E) Z'(E)}{\int \mathrm{d}E\ R(t,E)}$$

where t is the time-of-flight, E is the incident neutron energy and R (T, E) is the resolution (response) function. When the function is available in a numerical form, it is entered with the code `RESFN` under the keyword SUPPL-INF. See LEXFOR **Supplemental Information**.

<u>Relation with Cross Sections</u>

The transmission T and reaction yield Y_x are related with the total cross section σ_T and reaction cross section σ_x by

$$T = \exp[-n_T \sigma_T]$$
$$Y_x = [1 - \exp(-n_T \sigma_T)] \frac{\sigma_x}{\sigma_T} + \sum_i Y_{xi}$$

where n_T is the number of the atoms in area (e.g., atoms/barn). Y_{xi} is the reaction yield due to interaction with a particle scattered i times in the sample.

The cross section determined as the ratio of the reaction yield to the areal sample number density (atoms/barn) is compiled as the cross section in thin target approximation.

REACTION coding: `SIG` in SF6, `TTA` in SF8.

Example:

`(26-FE-56(N,G)26-FE-57,,SIG,,TTA)`

When the sample effect (e.g., self-shielding, multiple scattering effect) is negligible (e.g., fission) or correction is done for the sample effects, the modifier `TTA` is omitted.