II.B.1.d. External R-function

When generating cross sections via R-matrix theory, it is important to include contributions from *all* resonances, even those outside the energy range of the data. Tails from negative-energy resonances (which may correspond to bound states) and from higher-lying resonances can contribute significantly to the "background" of the R-matrix and must therefore not be omitted. There are infinitely many of these resonances, so approximations must be made.

The usual approximation is to use pseudo or dummy resonances to approximate the effect of the infinite number of outlying resonances. The energy associated with a dummy resonance must be outside the energy region for which the analysis is valid.

For discussion regarding two different philosophies for determining appropriate choices of dummy resonances, see Leal et al. [LL99] and Fröhner and Bouland [FF01].

Any number of additional possibilities exist for approximating the contribution of the external resonances to the tail of the R-matrix. A logarithmic parameterization of the R-function is implemented in SAMMY; note that this is properly denoted as a *function* rather than *a matrix*, because it is diagonal with respect to the channels. The form used in the code is

$$R_c^{ext}(E) = \overline{R}_{con,c} + \overline{R}_{lin,c} E + \overline{R}_{q,c} E^2 - s_{lin,c}\left(E_c^{up} - E_c^{down}\right) - \left(s_{con,c} + s_{lin,c} E\right) \ln\left[\frac{E_c^{up} - E}{E - E_c^{down}}\right] \quad . \qquad \text{(II B1 d.1)}$$

Any or all of the seven free parameters may be varied during a SAMMY analysis (see Table VI B.2, card set 3, and card set 3a). Note that R_c^{ext} is strictly real in this parameterization.

The *u*-parameters (i.e., the parameters on which Bayes' equations will operate, as described in Section IV.C) associated with the external R-function are given by

$$\begin{array}{lll} u\left(E_c^{down}\right) = E_c^{down} & u\left(E_c^{up}\right) = E_c^{up} & \\ u\left(\overline{R}_{con,c}\right) = \overline{R}_{con,c} & u\left(\overline{R}_{lin,c}\right) = \overline{R}_{lin,c} & u\left(\overline{R}_{q,c}\right) = \overline{R}_{q,c} \\ u\left(s_{con,c}\right) = \sqrt{s_{con,c}} & u\left(s_{lin,c}\right) = s_{lin,c} & \end{array} \quad . \qquad \text{(II B1 d.2)}$$

Of the current ENDF formats [ENDF-102], only new LRF = 7 format permits this type of parameterization of the R-function. The more commonly used LRF = 3 format (the so-called Reich Moore format) allows only the dummy-resonance option.