III.C.2. Oak Ridge Resolution Function (ORR)

For ORELA data, the resolution-broadening functions described in Section III.C.1 are not especially accurate approximations. We have therefore developed a more realistic mathematical description of the experimental situation at ORELA, based on concepts described by D. C. Larson et al. [DL84] and initially derived by F. G. Perey [FP89].

The resolution function has four components: the electron burst, the ORELA moderator, the neutron detector, and the time-of-flight channel width. Experimentally, the resolution-broadened cross section $\bar{\sigma}(E)$ is formed when each contributing feature provides its own broadening; the combined effect of the several components is all that is actually noticed. Mathematically, this may be viewed as follows: Each component is modeled separately as a function of flight time (rather than energy), and then each is convoluted in turn with the unbroadened (or partially broadened) cross section; the convolution process is performed analytically where possible and numerically where necessary. That is, the resolution-broadened cross section $\bar{\sigma}(t)$ may be expressed as

$$\bar{\sigma}(t) = \int I_1(t-t_1)\,dt_1 \int I_2(t_1-t_2)\,dt_2 \int I_3(t_2-t_3)\,dt_3 \int I_4(t_3-t_4)\,dt_4\ \sigma(t_4) \quad , \qquad \text{(III C2.1)}$$

where I_i is our mathematical model for the ith component. This expression may then be rearranged into the form

$$\bar{\sigma}(t) = \int I(t-t')\sigma(t')\,dt' \quad , \qquad \text{(III C2.2)}$$

where the resolution function $I(t-t')$ is defined as

$$I(t-t') = \int I_1(t-t_1)\,dt_1 \int I_2(t_1-t_2)\,dt_2 \int I_3(t_2-t_3)\,dt_3\ \ I_4(t_3-t') \quad . \qquad \text{(III C2.3)}$$

Because SAMMY deals with cross sections as functions of energy, rather than time, the relationship

$$E = \frac{1}{2}mv^2 = \frac{1}{2}m\frac{L^2}{t^2} \qquad \text{(III C2.4)}$$

is used to convert from energy to time (or time to energy) in Eq. (III C2.2), yielding

$$\bar{\sigma}(E) = \int I'\big(t(E)-t'\big)\sigma\big(E'(t')\big)\,dt' \quad . \qquad \text{(III C2.5)}$$

In the following sections we describe the components I_i and the convolution procedure. Input for using this resolution function is described in card set 9, Table VI B.2. See also Section X.H, which describes program SAMORT, used for plotting the individual pieces and the complete ORR function at a specified energy.