

### IV.E.5. Calculating Average Values and Uncertainties for Resonance Widths

In the SAMMY.LPT file (discussed in Section VII.A), the average value and uncertainty are reported for the various channel widths for every spin group. These averages are generated from the  $p$ -parameter covariance matrix by invoking Bayes' equations over a different set of variables from those used in earlier sections of this manual.

To calculate an average over a set of correlated parameters, we recognize that “average” can be interpreted as “most likely value for a group of numbers.” Bayes' equations therefore are applicable, where the theoretical model is a simple function equal to the average whose value is needed. Explicitly, we can rewrite Bayes' equations [see, for example, Eq. (IV A 1.1)] into the form

$$A' = K' G' M^{-1} \Gamma \quad (\text{IV E5.1})$$

and

$$K' = (G' M^{-1} G)^{-1} . \quad (\text{IV E5.2})$$

Here  $A'$  represents the needed average (for example, for the neutron widths for spin group number 3), and  $\Gamma$  represents the individual values (for each of those widths). The prior value for the average is set to zero.  $K'$  is the needed variance for the average, and the prior variance is set to infinity.  $M$  represents that portion of the parameter covariance matrix which corresponds to this set of widths. Finally,  $G$  is the partial derivative of the function to be fitted with respect to the average  $A$ , so that  $G$  is 1 for parameters in the set of interest and 0 for all other parameters. With these definitions, Eq. (IV E5.2) reduces to

$$K' = \left[ \sum_{ij} (M^{-1})_{ij} \right]^{-1} , \quad (\text{IV E5.3})$$

in which the summation includes all parameters within the set to be averaged. The average value from Eq. (IV E5.1) then becomes

$$A' = K' \sum_{ij} (M^{-1})_{ij} \Gamma_j , \quad (\text{IV E5.4})$$

again summing over only the relevant parameters.

In the SAMMY.LPT file, two different average values and uncertainties are reported for each channel width for each spin group:

The first is labeled “Expected Value” in the LPT file and includes all varied widths in the summations in Eqs. (IV E5.3) and (IV E5.4).

The second is labeled “EV changed parameters” and attempts to include only those widths whose values have been affected (changed) by the data analysis. However, the criterion used to determine which parameters are to be included is rather naive: the uncertainty on the individual widths must be less than 9% of the value of the parameter.

In either case, if there are no parameters fitting the requirements, the printed average and uncertainty are zero.