Conversion between the formal and observed parameters in R-matrix theory

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The low-energy reactions are usually thought to be governed by the complicated process of nucleus reactions. So, the phenomenological R-matrix method [1-5] can be applied to evaluate the experimental cross section data. In the evaluation, it should be noted that the resonance parameters in the R-matrix are different from the observed experimental values.

In XII-3 of [1], the observed parameters are defined as the experimental quantities of Breit-Wigner form, and the formal parameters are the model parameters in R-matrix theory. The conversion between the formal and observed parameters can be obtained from the phase (S-matrix) equivalence in the R-matrix and Breit-Wigner formula, and it ensures that the calculations correspond to the experimental width and cross sections. If the reduced width is narrow $\gamma_{nL}^2 \ll 1$, the formal parameters are almost equivalent to the observed experimental width and resonance energy. However, the difference might have to be considered accurately when the reduced width is a value close to the single-particle limit which represents the well-developed cluster state.

In this presentation, I will show the conversion between the resonance parameters by using an example of the α+^{12}C system. After the conversion, the collision matrix and cross sections can be calculated independent of the boundary condition parameter $\tilde{b}_c$. I also discuss this transformation. The second transformation is the conversion between two formal parameter sets, and it is performed using an orthogonal matrix. As a result, I show that any choice of $\tilde{b}_c$ leads to the same cross sections.

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