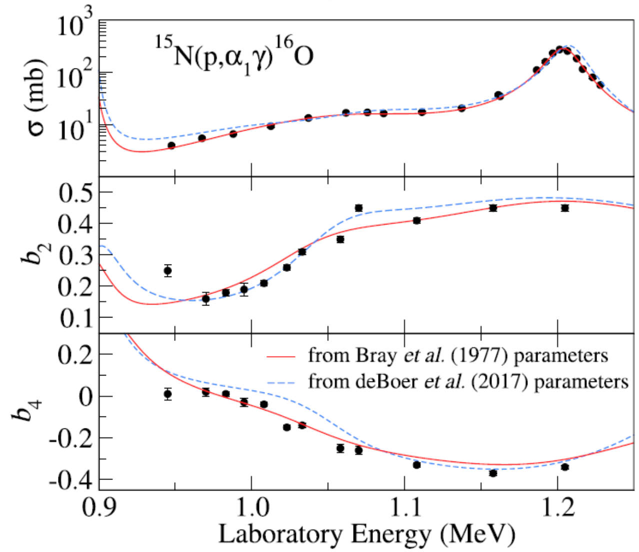
Secondary γ-ray decays from partial-wave T matrix with R-matrix applications to $^{15}N(p,\alpha_1\gamma)^{12}C$

The secondary γ rays emitted following a nuclear reaction are often relatively straightforward to detect experimentally. Despite the large volume of such data, a practical formalism for describing these γ rays in terms of partial-wave T-matrix elements has never been given.



$$\frac{d\sigma}{d\Omega_\gamma} = \frac{1}{(2I_A+1)(2I_a+1)}\frac{\pi}{k_{aA}^2}\sum_k (2k+1)^{1/2} R_k \frac{P_k(\cos\theta_\gamma)}{4\pi} H_k,$$

$$H_k = \sum_{J_1 J_2 \ell_1 \ell_2 \ell' s s'_1 s'_2} (-1)^{k+s'_2-s'_1}(2J_1+1)(2J_2+1)[(2\ell_1+1)(2I_B+1)(2s'_1+1)(2s'_2+1)]^{1/2} \times (k\ell_1 00|\ell_2 0)\, W(kI_B s'_2 I_b; I_B s'_1)\, W(k s'_1 J_2 \ell'; s'_2 J_1)\, W(k J_1 \ell_2 s; J_2 \ell_1)\, T^{J_1 *}_{bBs'_1\ell':aAs\ell_1} T^{J_2}_{bBs'_2\ell':aAs\ell_2}.$$

$$R_k(LL'I_BI_C) = (2I_B+1)^{1/2}(2L+1)^{1/2} \times (2L'+1)^{1/2} \times (-1)^{I_B-I_C+L-L'+k+1} \times (L'L1-1|k0)\, W(LL'I_BI_B; kI_C).$$

The partial-wave formalism is applicable when R-matrix methods are used to describe the reaction in question. We have supplied the needed framework, and it is demonstrated by the application to the $^{15}N(p,\alpha_1\gamma)^{12}C$ reaction through the JINA R-matrix code AZURE2.

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