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An Accurate Allowance for Initial and Final State Interactions in The Treatment of The alpha-alpha Bremsstrahlung

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One of motivations in studying the $\alpha + \alpha \rightarrow \alpha + \alpha + \gamma$ bremsstrahlung is to get a supplementary information on a strong part of the $\alpha - \alpha$ interaction [1]. We find some correlation function, in which one of the outgoing alphas is detected in coincidence with the emitted photon, depends considerably on the strong interaction in the entrance and exit channels (see Fig.1 for $d^5\sigma/dE_\gamma d\Omega_i d\Omega_f$ in the lab. frame and coplanar momenta disposal, where the photon momentum is directed along the Z-axis and the rest lie in the XZ-plane, viz., $\hat{k}_{1i} = (\theta_{1i}, 0)$, $\hat{k}_{1f} = (\theta_{1f}, \pi)$ at energies of the incident α -particle $E_i = 10$ MeV and photon $E_\gamma = 1$ MeV). As before, our departure point in describing electromagnetic (EM) interactions with nuclei is to use the Fock-Weyl criterion (see [2] and refs. therein). According to [3], the cross section can be expressed through the charge form factor of α -particle $F_{CH}(q)$ depending on the stretched photon momentum $q = \lambda k_\gamma$ ($0 \leq \lambda \leq 1$) and the overlap integral $I = \langle \chi_{k'}^{(-)} | e^{iq\rho} | \chi_k^{(+)} \rangle$, where the ingoing $\chi_k^{(+)}$ and out-going $\chi_{k'}^{(-)}$ solutions for the $\alpha - \alpha$ scattering induced with interaction $V = V_C + V_S$ that consists of the repulsive Coulomb potential V_C and its strong counterpart V_S . The Nordsieck-type integral I_C in the partition $I = I_C + I_{CS}$, which determines the purely Coulomb mechanism of the bremsstrahlung, is given by (10) in [6] while the radial integrals in fast-convergent series of the mix integral I_{CS} in partial waves have been calculated via the contour integration method [7]. When collision energy increasing the cross sections become more sensitive to distinctions between the two phase-equivalent $\alpha - \alpha$ potentials.

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