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Analytical approximations for double Compton backscattering

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Gamma-ray Compton backscattering has proven to be of interest for technical applications, one example being an imaging device [1] able of getting the shape of objects behind material obstacles. A big deal of work has been performed in order to characterize the process, which, given the huge mathematical difficulties of an intrinsically random, non-lineal process, numerical simulation is preferred [2]. However, since having an analytical approximation is a powerful prediction and evaluation tool, the analytical path deserves also exploration. An attempt to understand the difference in capacity to backscatter photons by different materials, and for the same material, for different thicknesses and densities produced an analytical expression for the single-backscattered intensity [3].
Obtaining a collective expression for higher scattering orders is a dauting task. A rather ambitious method in that direction uses transport theory to obtain both intensity and spectral shape of the scattered radiation [4]. This method, although offering completeness in the solution is rather difficult to implement in practical cases and simplified approaches might be needed. One example in that direction is the mixed analytical-numerical algorithm in Ref. [5]. Following this approach of incremental theoretical improvement we present a method and several theoretical and numerical results for only-double Compton scattering. These results may prove useful in practice since according to numerical simulations double Compton backscattering events may be responsible in some materials for more than 30% of the total number of multiple scattering events whereas both together, single and double scattering, add up to more than 60% of the total backscattered intensity.

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