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Corrections to the higher moments of the heavy ion energy-loss distribution beyond the Born approximation: β dependence of Mott's corrections

Olga Voskresenskaya
JINR, Russia

The first-order Born approximation, upon which Bethe's stopping power formula is based, is inadequate to the task of accurately describing the energy-loss distribution of highly charged particles. It was pointed the importance of the Mott higher-order-correction (MC) to the relativistic version of this formula in various works. However, most of the known expressions are inconvenient for the practical calculations of MCs. In this regard, obtaining convenient and accurate representations for the MCs become significant. In previous work, we have obtained an exact analytical expression for the Mott correction to the Bethe-Bloch formula in the form of a rather fast converging series of the quantities bilinear in the Mott partial amplitudes, which can be quite simply calculated. The aim of the present work is to obtain similar expressions for the MCs to the first-order Born central moments μ_(n,B) (n = 2,3,4) and normalized central moments ρ_(k,B) (k=3,4) of the energy-loss distribution (ELD) for heavy ions and estimate them in a wide range of the relative ion velocity β. Based on our previous result, we have obtained in this work analytical expressions for the higher moments that reduce their calculations to the summation of rapidly convergent infinite series with a specified accuracy. As a result, we managed to estimate the most common ELD characteristics in the Mott and Born approximations and show that whereas the relative corrections to the moments ρ_(k,B) can reach several tens of percent over the range 0.05≤β≤0.95, these corrections achieve several hundred percent for μ_(n,B) over β range considered (Figure 1). The obtained results mean the dominant contribution of close collisions to the higher moments of ELD. They also mean that ELDs which are calculated taking into account MCs are always less asymmetric and closer to Gaussian than those in the Born approximation.

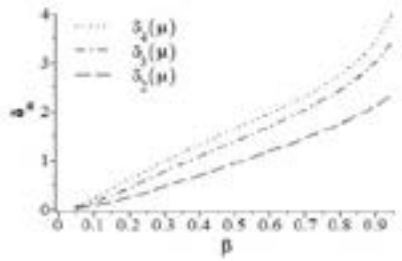

Figure 1: Relative corrections δ_n (n = 2,3,4) to the first-order Born central moments of ELD depending on the relative particle velocity for Z = 92.

Recent Publications:

1. Afanasyev LG, Gevorkyan SR, Voskresenskaya OO (2017) Production of dimeson atoms in high-energy collisions. European Physical Journal A 53:78 1-7.
2. Kuraev EA, Voskresenskaya OO, Tarasov AV (2014) Coulomb corrections to the parameters of the Molière multiple scattering theory. Physical Review D 86: 116016, 1-9.
3. Kuraev EA, Voskresenskaya OO, Torosyan HT (2014) Coulomb corrections to the parameters of the Landau–Pomeranchuck–Migdal Effect Theory. Physics of Particles and Nuclei Letters 11(4):366-380.
4. Torosyan H, Voskresenskaya O (2014) Application of a Revised Molière Theory to the Description of the Landau-Pomeranchuk Effect. Universal Journal of Physics and Application 2(4): 226-235.
5. Voskresenskaya O, Tarasov A (2013) A Complete Version of the Glauber Theory for Elementary Atom – Target Atom Scattering and Its Approximations. Journal of Physics G 40:095106, 1-9

Biography

Olga Voskresenskaya is a Senior Researcher at the Joint Institute for Nuclear Research (JINR) in Dubna, Russia. She received a Ph.D. in Theoretical Physics from the Bogoliubov Laboratory of Theoretical Physics at the Joint Institute for Nuclear Research, where she has been staff member since 1994. Dr. O. Voskresenskaya is the author and co-author of more than 130 scientific papers and the winner of two awards (Second Prize of JINR in 2007 and the TSU Award for High Scientific Achievements in 2013).

voskr@jinr.ru

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