Track tracing of charged particles with simultaneous distribution between the deflection angle and the spatial displacement

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A sampling method for multiple Coulomb scattering is presented. The method is constructed by dividing the differential scattering cross section into the moderate and large angle scattering, and exploiting the central limit theorem. That is, the sum of many small angle deflections is simulated by a Gaussian random number and the large angle scattering is directly sampled from the differential scattering cross section. It is found that the appropriate selection of the dividing angle makes the Gaussian approximation of the moderate scattering good while keeping the sampling frequency of large angle scattering low.

If we use the screened Rutherford cross section with the small angle approximation, our method yields the Moliere distribution, however, it doesn't require auxiliary numerical tables. Therefore, it can be implemented as simple as, and as fast as Gaussian approximation methods.

The most important feature of our new method is the simultaneous sampling of the deflection angle and the lateral displacement. A correction to take a constant energy loss per unit length into account is also presented.