A FLEXIBLE PARAMETRIZATION OF THE ELECTRONIC STOPPING CROSS SECTION

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To accurately describe and predict experiments involving ion-beam modification or ion-beam analysis, it is essential to have reliable knowledge of fundamental physical parameters such as the scattering cross section, the nuclear reaction cross section, and the stopping cross section. Continuous improvements in these quantities are being realized through many experimental and theoretical contributions. The experimental data are accessible on the web through the Nuclear Data Section of the International Atomic Energy Agency [1].
The stopping cross section describes the rate of energy loss of an ion per unit path, normalized to the atomic density, and is often expressed in units of eV/(10^{15} atoms/cm^2). Its value depends on the type and velocity of the moving ion and on the target atoms. For practical use, empirical parametrization is needed because theoretical models cannot yet describe the stopping cross section with the required accuracy.
However, widely used stopping-data implementations such as ASTAR [1] and SRIM [2] have not been updated beyond 2003 [3]. At the same time, alternative modern implementations appear difficult to adopt in practical applications because they lack a standardized representation [4 - 6]. Therefore, we present a new analytical parametrization for the stopping cross section, called the double-Konac (dK) parametrization, and propose expressing its parameters in a uniform, open JSON format. In this way, parametrizations become traceable and facilitate intercomparison between different versions. This approach also enables swift adoption of new results as they become available.
We first demonstrate compatibility with existing work by presenting the parametrization for ASTAR, SRIM, and ESPNN. We then discuss the fidelity of the parametrization quantitatively in terms of the absolute percentage error.
To illustrate how the dK representation can incorporate new results, we present a version that accounts for experimental stopping-power data published between 2003 and 2025. As an example, Fig. 1 shows the stopping cross section for He in Si. The data points are taken from the IAEA database. The green dashed curve shows the SRIM-2003 output, while the red solid curve shows a fit that includes the experimental data published between 2003 and 2025. The various parameter sets are shared as open data [7] and can be downloaded from the web [8]. Each JSON file contains a complete set of parameters for estimating the stopping cross section for all ions in all elementary matrices. The new dK representation has been adopted in several simulation and data-analysis software programs, including software for the analysis of RBS spectra [9]. The importance of using an up-to-date parametrization of the stopping cross section will be discussed.

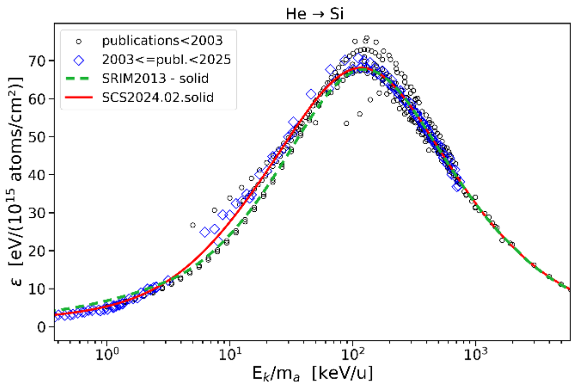

Fig. 1. Stopping cross section for He in Si as a function of the reduced energy. The data points are extracted from the IAEA database. The green dashed and red solid lines are two versions of the parametrization.

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