Comparing experimental stopping power data for positive ions with stopping tables, using statistical analysis.

Helmut Paul

Atomic and Surface Physics, Institute for Experimental Physics, Johannes Kepler University, Altenbergerstrasse 69, A-4040 Linz, Austria

Statistical analysis is used to compare the files in my large collection of experimental data for the stopping of positive ions, to various stopping programs and tables. (Note that this collection contains many unpublished stopping power files for ions from Ar to U, for solid and gaseous targets, measured by H. Geissel at UNILAC 1977-81).

The results are shown both numerically (separately in various regions of reduced energy) and graphically.

SRIM2008 describes all ions and all targets and is best in most cases.

For protons and alphas in elemental targets, the tables ICRU 49 and SRIM give best overall agreement with experimental data; for compounds, ICRU 49 is better (but it does not treat as many targets as SRIM).

For medium heavy ions (\(3\)Li to \(18\)Ar), SRIM and MSTAR are about equally good (except that SRIM is too high for low energy helium ions); the ICRU 73 table is good at high energy, but too high at low energy, especially for gas targets.

For heavy ions (\(19\)K to \(92\)U) in solid elemental targets, Lindhard-Sørensen is best above 100 MeV/nucleon. Between 30 and 100 MeV/n, SRIM and the Hubert table are slightly better. In the region of the maximum (2.5 to 30 MeV/n), SRIM is, on the average, 6 % high for heavy solid targets, 5 % low for light solid targets; in that energy range, Hubert is better than SRIM.

Only SRIM and CasP can be used for heavy ions in gases.

For fast heavy ions in elements, CasP 4.0 describes the positive solid-gas difference (due to the high collision frequency of fast ions in solids), since it uses different ionic charges for solids and gases. SRIM does not describe it: it is too high for gases. But SRIM does describe the small negative solid-gas difference (due to polarization screening in the solid) below 1 MeV/n.

For heavy ions in solid compounds, SRIM gives larger deviations than for elements.

A remarkable discrepancy between stopping and range results for Au ions in SiC by Zhang et al. will be discussed.