

Towards inclusion of low-energy deuteron interactions with target nuclei in FLUKA

Friday, 15 June 2018 09:30 (30 minutes)

Deuteron interactions with nuclei at energies below ~ 100 MeV/n remain a topic of ongoing research, with eminent practical interest (among other) as sources of mostly forward-scattered neutrons and protons. The inclusion of these interaction mechanisms in a general-purpose Monte-Carlo code for the simulation of radiation transport is not straightforward due to the idiosyncrasies of the deuteron: its low binding energy and the predominantly direct nature of its interactions with target nuclei in the considered energy domain. In this contribution, an account will be given of recent efforts undertaken towards the inclusion of deuteron interactions in the FLUKA transport model, relying on distorted-wave Born approximation (DWBA) calculations.

Elastic deuteron break-up has been described within the zero-range post-form DWBA, accounting both for Coulomb and nuclear terms in the interaction potential, while disregarding spin-orbit coupling effects. The neutron, proton, and deuteron wavefunctions and phase shifts have been obtained using the RADIAL subroutine package to numerically solve the Schrödinger equation for effective nucleon-nucleus and deuteron-nucleus optical-potential models. Integrals of the highly oscillatory product of three unbound radial functions have been evaluated with Vincent et al.'s contour-integral approach. Reasonable overall agreement with earlier deuteron elastic break-up cross section calculations in the literature has been obtained. With minor changes and simplifications, the DWBA scheme for elastic break-up can be prospectively used to account for the contribution of (d,p) or (d,n) nucleon-transfer reactions to bound states.

State-of-the-art inclusive approaches to account for stripping to the continuum have been recently developed. However, it is not always easy to keep track of the final state of the target, as needed in a Monte Carlo simulation in view of phenomena like material activation. Effective modelling of the stripping to the continuum in a non-inclusive fashion is currently underway.

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Session Classification: Deuteron induced reactions

Track Classification: Deuteron induced reactions