Reaction mechanisms involved in the deuteron interaction with medium mass nuclei

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An extended analysis of the reaction mechanisms involved within deuteron interaction with target nuclei from ^{27}Al to ^{231}Pa, *i.e.*, the breakup (BU), stripping, pick-up, pre–equilibrium emission (PE) and evaporation from fully equilibrated compound nucleus (CN), is presented. An increased attention is devoted to the BU mechanism [1-3] including all its components, namely the elastic (BE), inelastic (fusion) (BF), and total breakup (BU). An extension of the empirical parameterization of the BE cross sections beyond the energies considered in this respect, checked by microscopical calculations in the frame of Continuum-Discretized Coupled-Channels (CDCC) formalism [4], should be completed. Concerning the deuteron BU importance, regardless the differences between various parametrizations [1,5], its enhanced role with the target–nucleus mass/charge increase is predicted, as well as the BU dominance around the Coulomb barrier for heavy nuclei as, *e.g.*, ^{231}Pa. Furthermore, the consideration of the deuteron BU contribution to the activation cross section has to take into account two opposite effects, namely the important BU leakage of initial flux as well as the BF enhancement brought by the BU–nucleon interactions with the target nucleus [1-3].

On the other hand, the stripping (d,p) and (d,n), as well as the pick-up (d,t) reactions, usually neglected or very poorly taken into account, that have been proved to be important at low incident energies [2], are appropriately analyzed through the Coupled-Reaction Channels formalism using the FRESCO code[6]. A particular note should concern the (d,t) pick-up contribution to the total (d,t) activation cross section at low energies, leading to the same residual nucleus, between its threshold and the (d,dn) and (d,p2n) reaction thresholds. All these BU and direct processes are also taken into account above the Coulomb barrier, where the PE and CN reaction mechanisms described by using, *e.g.*, the codes TALYS [7] and STAPRE-H [8], become important. Particularly, a consistent local parameter set was involved within the detailed analysis carried out using the code STAPRE-H.

The overall agreement between the measured data and model calculations validates the theoretical approach of the various deuteron interactions while the comparison to the global predictions [9] underlines the effects of overlooking the BF enhancement as well as the stripping and pick-up processes. However, while the theoretical framework is already settled for the stripping, pick-up, PE, and CN, an increased attention should be paid to the BU description, and especially to its inelastic component. The complementary experimental studies requested by the improvement of this issue are pointed out too.

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