Observation of thermal deuteron-deuteron fusion in accelerator experiments at sub-keV energies

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A direct observation of the deuteron-deuteron (DD) fusion reaction at thermal meV energies by emission of its nuclear products, although theoretically possible, was not succeeded up to now. The electron screening effect that reduces the repulsive Coulomb barrier between reacting nuclei in metallic environments by several hundreds of eV and is additionally increased by crystal lattice defects in the hosting material, leads to strongly enhanced cross sections which means that this effect might be studied in laboratories. Here, the results of the $^{2}H(d,p)^{3}H$ reaction measurements performed on different deuterated metallic targets at sub-keV energies, using an ultra-high vacuum accelerator system will be presented. The experimentally determined thick target yield, decreasing over many orders of magnitude for lowering beam energies, could be well described by the electron screening effect and the $J^{\pi} = 0^{+}$ threshold resonance in ^{4}He. At the lowest energies of several keV, a constant plateau yield value could be observed for different metallic targets used. As indicated by significantly increased energies of emitted protons, this effect can be associated with the thermal DD fusion. A theoretical model explains the experimental observations by creation of ion tracks, induced in the target by projectiles, and a high phonon density which locally increases temperature above the melting point. The nuclear reaction rates taking into account the enhanced electron screening effect for different target materials and DD threshold resonance agrees very well with the experimental data.