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Measurement and analysis of the excitation function and isomeric cross section ratios for α-induced reaction on Ir, Au, Re and Ta nuclei

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Abstract. Excitation functions and a few isomeric cross-section ratios for production of (1) ^{192}Au, ^{193}Au, ^{194}Au, ^{195}Au and ^{192}Ir nuclides in α-induced reactions on ^{191,193}Ir, (2) ^{197}Tl, ^{197m}Hg, ^{198m,g}Tl, ^{199}Tl and ^{200}Tl nuclides in α-induced reaction in ^{197}Au and (3) ^{183}Re and ^{184m,g}Re nuclides in α-induced reaction in ^{181}Ta and ^{185}Re are obtained from the measurements of the residual activities by the conventional stacked-foils technique from threshold to 50 MeV. The excitation function and isomeric cross-section ratios for nuclear reaction ^{181}Ta$(\alpha, n)^{184m,g}$Re are compared with the theoretical calculation using the code Stapre which is based on exciton model for pre-equilibrium phase and Hauser–Feshbach formalism taking angular momentum and parity into account for the equilibrium phase of the nuclear reaction. All other experimental excitation functions are compared with the calculations considering equilibrium as well as pre-equilibrium reaction mechanism according to the geometry dependent hybrid (GDH) model and hybrid model of Blann using the code Alice/91. The high energy part of the excitation functions are dominated by pre-equilibrium reaction mechanism whereas the low energy parts are dominated by equilibrium evaporation with its characteristic peak. The GDH model provides a potentially better description of the physical process (i.e., a higher probability for peripheral collisions to undergo precompound decay than for central collisions) compared to hybrid model. However in the energy range of present measurement most of the excitation functions are fitted reasonably well by both GDH model and hybrid model with initial exciton number $N_0 = 4(N_n = 2, N_p = 2, N_h = 0)$. Barring a few reactions we have found the overall agreement between theory and experiment is reasonably good taking the limitations of the theory into account.

Keywords. α-induced reactions on Ir, Au, Re and Ta; stacked foil technique; isotope production; equilibrium and pre-equilibrium decays; Stapre and Alice/91 codes.

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1. Introduction

It is well known that the compound statistical model coupled with the exciton model gives a correct overall description of the excitation functions and particle energy spectra in nuclear reactions at medium energies. However, the calculations partially fail to account for details such as the exact position of the maximum or the slope of the ascending and descending part of the excitation functions. The high energy parts of the excitation functions are dominated by pre-equilibrium reaction mechanism whereas the low energy parts are dominated by evaporation with its characteristic peak. The pre-equilibrium