Preface

The importance of an accurate prediction of all what happens when a nuclear interaction takes place can be estimated from the point of view of both basic and applied knowledge and the possible use of nuclear physics in interdisciplinary fields and applications useful to mankind such as medical diagnostics and therapy, dosimetry, environmental control, space physics, and industrial research. Much work is in progress or has recently been published concerning the problem of fusion in heavy ion reactions and properties of the decaying compound nuclei. It can be shown that the compound and pre-compound or pre-equilibrium mechanisms may provide an important mode of de-excitation during the fusion process and that some experimental results which are difficult to understand may be explained by this process. There is an increasing need for information on inclusive nuclear reactions induced both by light particles and heavy ions due to their relevance in interdisciplinary fields and applications. Reactions induced by light particles are better known, both from an experimental and a theoretical point of view. The knowledge in the case of heavy-ion reactions is much less systematic and often essential experimental information is lacking. In recent years quantum mechanical theories have been developed to describe the pre-equilibrium nuclear reaction mechanism and the advent of fast computers has enabled numerical computations of these cross-sections.

Recently, many experimental techniques have been developed to obtain and detect neutrons and charged particles of different energies and to measure the cross-sections of different particle-induced reactions. Nuclear reaction models are frequently needed to provide estimates of the particle-induced reaction cross-sections, especially if the experimental data are not available or unable to measure the cross-sections due to experimental difficulties. Therefore, nuclear reaction model calculations play an important role in nuclear data evaluation. Besides, these measurements are necessary to improve theoretical models in order to understand nuclear reaction mechanisms and the properties of the excited states in different energy ranges. Pre-equilibrium emission takes place after the first stage of the reaction but long before statistical equilibrium of the compound nucleus is attained. It is imagined that the incident particle step-by-step creates more complex states of the compound system and gradually the memory of the initial energy and direction is lost. Pre-equilibrium processes provide a sizeable part of the reaction cross section for incident energies between 10-200 MeV and higher.

Study of equilibrium and pre-equilibrium particle emissions during the decay process of a compound nucleus are very important for a better understanding of the nuclear reaction mechanism induced by medium energy particles. The highly excited nuclear system produced by charged particles first decays by emitting fast nucleons at the pre-equilibrium (PE) stage and later on by the emission of low-energy nucleons at the equilibrium (EQ) stage. The excitation functions for pre-equilibrium calculations can be calculated using hybrid Monte-Carlo (HMS) code which is based on hybrid model. This code can be applied for the calculation of excitation functions, energy and angular distribution of secondary particles in nuclear reactions induced by nucleons and nuclei up to an energy range of 300 MeV.

The hybrid model of pre-equilibrium decay was the first formulation to consider the importance of multiple pre-equilibrium decay. But, "multiple" pre-equilibrium decay was restricted to the emission of two or fewer pre-equilibrium nucleons from each nuclide. As pre-equilibrium models have been extended to higher energies, this constraint has become an ever more serious limitation. To overcome these problems, the new HMS model (2014) is introduced which uses only the kinematically justified two and three exciton densities and which allows unlimited pre-equilibrium emission from each nuclei. The formulation otherwise follows the philosophy of the hybrid model of pre-equilibrium decay. We aim to study such pre-equilibrium decays in heavy-ion reactions by measuring emission of neutrons, charged particles and excitation functions of the residues produced in such reactions. Also we want to put this new HMS model to test and see its capability in predicting contribution from this type of reaction mechanism.

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