Complete Experimental and Theoretical study of the $^{16}O+^{64}Zn$ System*

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In a collision of two heavy nuclei their internal structure can be affected leading to intrinsic excitation, transfer of nucleons or particles between the nuclei. In the framework of coupled channel models this implies that different reaction channels can strongly couple with each other and interfere in the channel cross section distribution. Despite of being the focus of several studies for the last three decades, both experimental and theoretical studies, the quantum interference responsible for this phenomenon is not yet complete understood. The reaction channel interference replaces the single Coulomb barrier by a barrier distribution, which can be extracted directly from the experimental fusion excitation function. On the other hand, because the conservation of the reaction flux, an alternative representation of this barrier distribution can be obtained from the quasi-elastic excitation function [1, 2]

In the present work, we have measured the quasi-elastic barrier distribution for the $^{16}O+^{64}Zn$ system at energies around of the Coulomb barrier and at 161° degree. Coupled channel calculations were performed with the FRESCO [3] and CQUEL [4] code. Due to the quantum nature of the coupling channels, the cross sections of the different reaction channels are dependent on each other and therefore the ideal situation is to compare CCC with experimental data for all channels included in the coupling matrix [5]. Because this, we also compared the theoretical calculation with the elastic angular distributions [7] found in the Literature for energies of E_{LAB}= 42.5, 43.0, 43.5, 44.0, 48.0, 52.0 and 64.0 MeV. Moreover, the inelastic excitation function [9], inelastic angular distributions [7] and fusion excitation function [8] were compared too. In the calculations, the real part of the nucleus-nucleus interaction potential was described by the double-folding São Paulo Potential, SPP [6].

The quadrupole, octupole and hexadecapole states of the target were included in the matrix coupling. The result of these calculations was compared to our quasi-elastic, elastic and inelastic data [7, 9] and fusion excitation function [8]. We observed a striking importance of the first 2_1^+ quadrupole and 3_1^- octupole vibration states, in CQUEL and FRESCO code, of the target in the reaction mechanism of this system. A minor contribution of the 4_1^+ and 4_2^+ hexadecapole vibration, in FRESCO code, was also observed.

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