Microscopical Optical Calculations of the Nucleus-nucleus Scattering at intermediate Energies with Excitations of Nuclear Collective States

K.V. Lukyanov, E.V. Zemlyanaya, I.N. Kukhtina
Laboratory of Information Technologies, JINR
V.K. Lukyanov
Bogolybov Laboratory of Theoretical Physics, JINR
K.M. Hanna
Math. and Theor. Phys. Dept., NRC, Atomic Energy Authority, Cairo, Egypt
Z. Metawei
Physics Department, Faculty if Science, Cairo University, Giza, Egypt
B. Słowiński
Institute of Atomic Energy, Otwock-Swierk, Poland

Аннотация

Исследовано возбуждение низколежащих коллективных состояний ядер при рассеянии тяжелых ионов с энергиями в десятки МэВ/нуклон. Потенциал взаимодействия, приводящий к возбуждению, выбирается в виде производной от микроскопического ядро-ядерного оптического потенциала двойного фолдинга. Сечения упругого и неупругого рассеяния рассчитываются как с использованием метода связи каналов, так и в рамках высокоэнергетического приближения, где амплитуда неупругого рассеяния получена в первом порядке по параметру деформации. Сечения сравниваются с экспериментальными данными рассеяния ^{17}O на ряде ядер с возбуждением 2^+ уровня.

The double-folding (DF) microscopic model of the optical complex nucleus-nucleus potential was suggested, where dependence on the energy and atomic numbers of colliding nuclei was taken into account [1, 2, 3, 4]. Basing on this model the set of potentials $U_{opt} = N_r V^{DF} + iN_{im}W^{DF}$ was obtained in [1, 5], where only the pairs of strengths coefficients $N_r,\ N_{im}$ were fitted to experimental data [6, 7] on elastic scattering of the ^{16,17}O heavy ions at energies E about 100 Mev/nucleon on different target-nuclei. The obtained elastic scattering potentials were used to get the transition potentials in the form of derivatives of elastic optical potentials. When calculating the corresponding differential cross-sections, the high-energy approximation (HEA) method [3], developed for nucleus-nucleus scattering, was applied as well as the standard coupled-channel approximation [8]. The respective HEA amplitudes were constructed basing on the adiabatic approach and using the rotational wave functions [9] for excitations of low lying collective states with $E_{ex} << E$. The obtained results [10, 11] were compared to the experimental data from [7] and the adjusted deformation parameters were established.

As an example, in Figure, comparisons of our calculations to the experimental data are shown for excitations of the 2^+ rotational state in the target-nuclei.

In general, one concludes that the suggested model gives the fairly good agreements with experimental data with introducing no more than two normalization parameters of the microscopic optical potential and it has encouraging perspectives in applications to further analysis of experimental data.

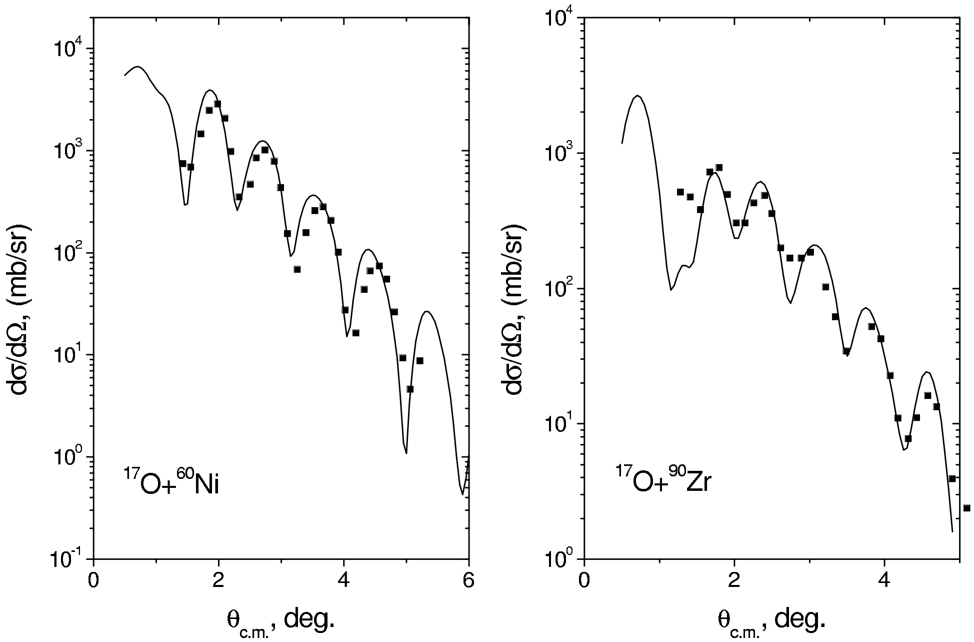

Fig. 1. Inelastic differential cross sections of scattering of ^{17}O+^{60}Ni,^{90}Zr at E_{lab}=1435 MeV calculated in [10]. The DF microscopic optical potentials include the strengths parameters N_r and N_{im} obtained as 0.6 and 0.6 for ^{60}Ni, and 0.6, 0.5 for ^{90}Zr with the nuclear deformations $\beta_n = 0.4$ (^{60}Ni) and $\beta_n = 0.16$ (^{90}Zr). Experimental data from [7]

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