Analysis of ^{4}He Elastic Scattering on ^{208}Pb and ^{58}Ni Nuclei at High Energies by the S-Matrix Approach

P.E. Kuznietsov, **Yu.A. Berezhnoy**, **G.M. Onyshchenko**, **A.V. Anataichuk**

V.N. Karazin Kharkiv National University, 61022, Kharkiv, Ukraine

Investigation of hadron interaction with nuclei is an important source of information about nuclear structure and mechanisms of nuclear interaction. Approaches based on complex potentials (optical model) or scattering matrix (S-matrix) are typically used for theoretical description of investigated experimental data. We present analysis of the elastic scattering of α-particles on intermediate ^{58}Ni and heavy ^{208}Pb nuclei at energies 26175 MeV/nucleon using the original six-parameter S-matrix model accounting effects of strong absorption and pronounced refraction properties of scattered waves. Worth attention that selected model parameters have clear physical meaning: L_0 and Δ_0 correspond to linear size and diffuseness of the strong absorption region, L_1 and Δ_1 correspond to linear size and diffuseness of the nuclear refraction region, δ_0 is interpreted as the magnitude of nuclear refraction and ε is the transparency of nuclear matter. The diffraction and refractive patterns of scattering were investigated by fitting experimental data measured for a wide range of high energetic α-particles (104, 139, 166, 172, 240, 288, 340, 386, 480 and 699 MeV) applying the gradient method. Smooth behavior of the quantum deflection function and the S-matrix modulus demonstrates the reliability of obtained parameters. We present energy dependence of differential cross-sections and their decomposition into the near and far components of the scattering amplitudes via the Fuller procedure. The differential cross-section oscillations in the region of small scattering angles are explained by the intersection rapidity of this amplitudes (Fraunhofer crossover). Further, we obtain broad maximum of the cross section, after which it decreases smoothly in the region of large scattering angles. Such a cross-section behavior is typically interpreted as a rainbow scattering. The set of total cross-section values is in a good accordance to the ones obtained from optical models. The consistency of the selected S-matrix parameterization is confirmed by the lower values of χ^2N obtained from the data analysis for the investigated energy region.