defined by:

$$\frac{d\sigma^{exp}}{d\Omega}(\theta_{cm}, E_x) = \sum_{L=0}^{7} a_L(E_x) \times \frac{d\sigma_L^{cal}}{d\Omega}(\theta_{cm}, E_x) \quad (1)$$

where $\frac{d\sigma_L^{cal}}{d\Omega}(\theta_{cm}, E_x)$ is the calculated distorted-wave Born approximation (DWBA) cross section corresponding to 100% energy-weighted sum rule (EWSR) for the L-th multipole. The fractions of the EWSR, $a_L(E_x)$, for various multipole components were determined by minimizing χ^2. This procedure is justified since the angular distributions are well characterized by the transferred angular momentum L, according to the DWBA calculations for α scattering. It was confirmed that the MDA fits were not affected by including $L >7$.

The DWBA calculations were performed following the method of Satchler and Khoa [45], using the density-dependent single-folding model for the real part, obtained with a Gaussian α-nucleon potential, and a phenomenological Woods-Saxon potential for the imaginary term. Therefore, the α-nucleus interaction is given by:

$$U(r) = V_F(r) + iW/(1 + exp((r - R_I)/a_I)) \quad (2)$$

where $V_F(R)$ is the real single-folding potential obtained by folding the ground-state density with the density-dependent α-nucleon interaction:

$$v_{DDG}(r, r', \rho) = -v(1 - \beta\rho(r')^{2/3})exp(-|r - r'|^2/t^2)) \quad (3)$$

where $v_{DDG}(r, r', \rho)$ is the density-dependent α-nucleon interaction, $|r - r'|$ is the distance between the center of mass of the α particle and a target nucleon, $\rho(r')$ is the ground-state density of the target nucleus at the position r' of the target nucleon, β=1.9 fm^2, and t=1.88 fm. W is the depth of the Woods-Saxon type imaginary part of the potential, with the reduced radius R_I and diffuseness a_I.

These calculations were performed with the computer code PTOLEMY [46, 47], with the input values modified [48] to take into account the correct relativistic kinematics. The shape of the real part of the potential and the form factor for PTOLEMY were obtained using the codes SDOLFIN and DOLFIN [49]. We use the transition densities and sum rules for various multipolarities described in Refs. [13, 50, 51]. The radial moments were obtained by numerical integration of the Fermi mass distribution with the parameter values from Ref. [52] (listed in Table I).