DETERMINATION OF NUCLEAR MATTER RADII USING S-MATRIX FOR ELASTIC SCATTERING OF IDENTICAL NUCLEI

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New approach based on combination of the optical model with the modified optical potential and the classical trajectories is proposed for calculations of the effective matter radii of the identical colliding nuclei. The example of the angular distribution for ^{6}Li + ^{6}Li elastic scattering is shown in Fig. 1a. The plot of the value $1-|S_l|^2$, where S_l is the diagonal element of the S-matrix, is shown in Fig. 1b. The quantum partial reaction probability $1 - |S_l|^2$ can be transformed into the semiclassical partial reaction probability

$$P_R(R_{\min}) = \left\{1 + \exp\left[\frac{R_{\min} - R_{\rm R}}{a_{\rm R}}\right]\right\}^{-1}$$

as a function of the minimum distance between the centers of the colliding nuclei $R_{\min}$ depended on energy E and impact parameter b taking into account the relation: $l \sim kb$. For ^{6}Li + ^{6}Li elastic scattering at $E_{\rm lab}$ = 40 MeV the results of calculations are $R_{\rm R}$ = 5.76 fm and $a_m athrm R$ = 0.47 fm. The quantity $R_{\rm R}$ may be interpreted as the sum of the effective matter radii $R_{\rm m}$ of the identical nuclei $R_{\rm R} = 2R_{\rm m}$. So the determined effective matter radius of the ^{6}Li nucleus is $R_{\rm m}$ = 2.88 fm, the experimental rms charge radii is 2.589 fm [2]. Similarly, the effective matter radii of the ^{9}Be, ^{11}B, ^{12}C and ^{16}O nuclei were calculated using data from [2], they are 4.0 ± 0.05, 3.3 ± 0.05, 4.0 ± 0.05 and 3.3 ± 0.05 fm, accordingly.

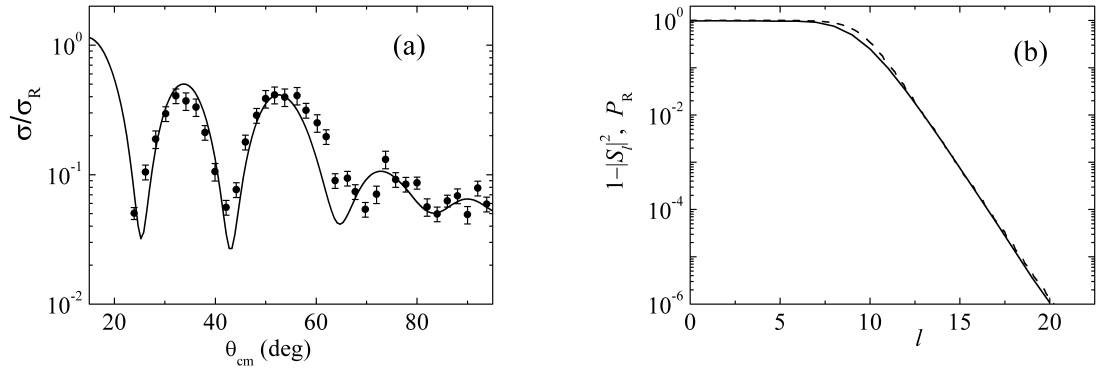

Fig.1. (a) The experimental angular distributions (points) for elastic scattering of ^{6}Li + ^{6}Li at Elab = 40 MeV [1] and the results of calculations in the optical model with modified real part of the optical potential (curve). (b) Comparison of the dependences of the quantum partial reaction probability $1 - |S_l|^2$ (solid curve) on the orbital angular momentum l for elastic scattering ^{6}Li + ^{6}Li at $E_{\rm lab}$ = 40 MeV with the semiclassical partial reaction probability $P_{\rm R}\,[R_{\min}(1/k, E)]$ (dashed curve).

1. K.W. Potthast, H. Brand, H. Freiesleben, et al, Nucl. Phys., A. 1997, V. 614 P. 95.
2. NRV Web Knowledge Base on Low-Energy Nuclear Physics, http://nrv.jinr.ru/.