

SEARCH FOR INTERMEDIATE STRUCTURE IN ^{36}Ar ABOVE
THE COULOMB BARRIER VIA THE $^{24}\text{Mg}(^{12}\text{C},\alpha)^{32}\text{S}$ REACTION

R. Čaplar⁺, G. Vourvopoulos^{*}, X. Aslanoglou^{*}, D. Počanić⁺
⁺Rudjer Bošković Institute, 41000 Zagreb, Yugoslavia
^{*}NRC Demokritos, Aghia Paraskevi, Attikis, Greece

The $^{12}\text{C}+^{24}\text{Mg}$ entrance channel is the most favourable one for the observation of possible intermediate resonances in the ^{36}Ar composite system, as predicted e.g. by the orbiting-cluster model. For partial waves up to $\ell=15$, the $\alpha+^{32}\text{S}$ outgoing channel has a lower effective barrier than the $^{12}\text{C}+^{24}\text{Mg}$ elastic channel and is therefore suitable for testing structure effects and coupling with the $^{12}\text{C}+^{24}\text{Mg}$ incoming channel in the energy region studied in this work ($E_{\text{CM}}=11.9-19.4$ MeV).

We measured the $^{24}\text{Mg}(^{12}\text{C},\alpha)^{32}\text{S}$ reaction from the Coulomb barrier ($E_{\text{CM}}=11.9$ MeV) up to $E_{\text{CM}}=16.1$ MeV in steps of 200 keV and from $E_{\text{CM}}=15.7$ to $E_{\text{CM}}=19.4$ MeV in steps of 330 keV in two independent experiments. In the first experiment, the excitation functions of the α_0 and α_1 groups were measured at 4 angles ($\theta_L=10^\circ, 30^\circ, 50^\circ, 70^\circ$) and the angular distributions at $E_{\text{CM}}=12.3, 12.9$ and 14.3 MeV. In the second experiment, the excitation functions of both the α_0 and α_1 groups were measured at 16 angles ($\theta_L=10^\circ, \dots, 85^\circ$), yielding at the same time angular distributions. Very highly enriched ^{24}Mg targets were used since the α_1 group from the $^{25}\text{Mg}(^{12}\text{C},\alpha)^{33}\text{S}$ reaction can mask the α_0 peak from the $^{24}\text{Mg}(^{12}\text{C},\alpha)^{32}\text{S}$ reaction because of the Q-values and cross-section ratios.

The measured excitation functions of the $^{24}\text{Mg}(^{12}\text{C},\alpha)^{32}\text{S}$ reaction were analysed using the methods of statistical analysis. For this purpose, the summed absolute correlation function $C(E)$, the summed correlation function $C'(E)$, the summed absolute deviation function $D(E)$ and the summed deviation function $D'(E)$ were calculated and analysed (Fig. 1). The measured angular distributions of the $^{24}\text{Mg}(^{12}\text{C},\alpha)^{32}\text{S}$ reaction were fitted with squares of single Legendre polynomials and with squares of the coherent sums of pairs of Legendre polynomials ($\sigma(\theta)=k \cdot |P_\ell(\cos\theta) + \alpha e^{i\beta} P_{\ell'}(\cos\theta)|^2$), Fig. 2. For each angular distribution, ℓ and ℓ' ($\ell'=\ell+1$ or $\ell'=\ell+2$) as well as α and β were varied in order to

find the best fit to the data.

The present experiment and analysis show the following: (i) in most cases two-level fits to the angular distributions are satisfactory, (ii) single l -values, i.e. $l=5,4,7,9,11$ and 13 , are predominant ($\alpha < 0.5$ or $\alpha > 2$) in the angular distributions at $E_{CM}=12.3, 12.9, 14.3, 16.4, 18.1$ and 18.7 MeV, respectively, and (iii) maxima in the deviation functions appear at the same energies as above; however, none of them exceed the 1% probability limit. Thus, the data and the analysis indicate the presence of spin selectivity in the reaction and energy range studied. However, intermediate resonances in the ^{36}Ar composite system, if present, seem to be relatively weak and probably interfere strongly with the statistical background.

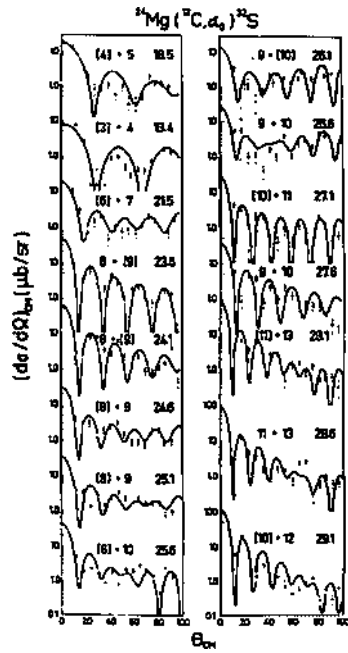
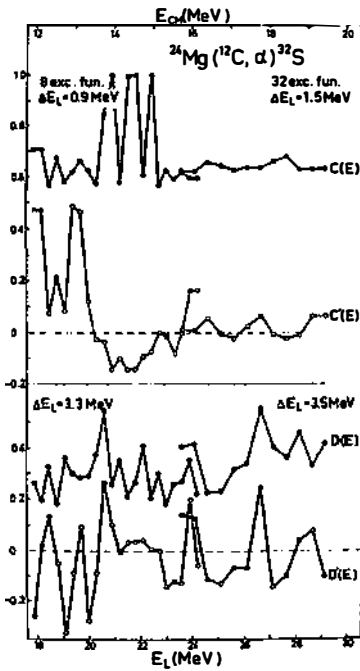


Fig. 1. Results of statistical analysis.

Fig. 2. Fits with coherent sums of pairs of Legendre polynomials at indicated laboratory energies; the values without parentheses denote the Legendre polynomials having larger amplitudes.