

$(^{12}\text{C} + ^{28}\text{Si})$ REACTIONS LEADING TO ^{32}S FINAL STATES

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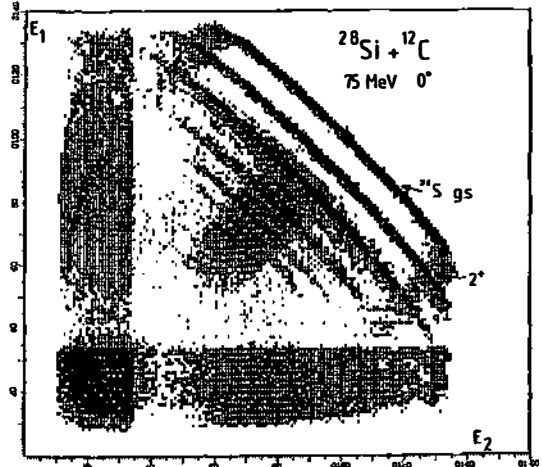
Elastic scattering of ^{12}C and ^{16}O on ^{24}Mg , ^{28}Si and ^{40}Ca has been extensively studied these last years in order to understand the origin of the gross-structures observed in 180° excitation functions, in general correlated with oscillating angular distributions compatible with the contribution of a single l value. These features have been interpreted by various theoretical approaches, both quantal and semi-classical and particularly with the underlying concept of quasi-molecular states. These approaches had individual successes but no clear over all picture emerged.

The system $^{12}\text{C} + ^{28}\text{Si}$ is of special interest since in addition to the gross-structure of ~ 3 MeV width a fine structure of ~ 0.5 MeV width is observed. In order to get some insight on the contribution of the compound nucleus ^{40}Ca to the "resonant" behaviour we choose to investigate reaction channels of this system. Since alpha particle transfer channels are the most suitable for angular momentum determinations we focused our attention to the channels leading to discrete states of ^{32}S . We used the ^{28}Si beam of the Saclay Tandem accelerator and measured with position sensitive detectors the coincidences of two α particles around zero degree ($\Delta\theta = \pm 5^\circ$). The matrix of the coincidence events in function of the energies E_1 and E_2

(Fig. 1) shows that the transfer reaction $^{28}\text{Si}(^{12}\text{C}, ^8\text{Be})^{32}\text{S}$ (localized near identical energies) is clearly distinguishable from the sequential emission of two alpha particles $^{28}\text{Si} + ^{12}\text{C} \rightarrow ^{40}\text{Ca}^* \rightarrow ^{36}\text{Ar}^* + \alpha_1 \rightarrow ^{32}\text{S} + \alpha_2 + \alpha_4$

Fig. 1

One sees that the relative strength of the two reactions



depends strongly on the final state. Excitation functions measured between 68 MeV and 80 MeV exhibit structures less pronounced for the first excited states. The strongest resonance is observed for a state at (7.0 ± 0.2) MeV in ^{32}S .

The spectrum of Fig. 2 (projection for ^{32}S g.s.) is related to ^{36}Ar excitation ; it is symmetric since the detector does not distinguish between α_1 and α_2 . In order to get separate information on α_1 and α_2 (using the different kinematics of the two decays), one detector has been replaced by the QD3 spectrometer, and further angular correlations ($\theta_1 = 0^\circ, \theta_2$ from 0° to 30°) have been measured.

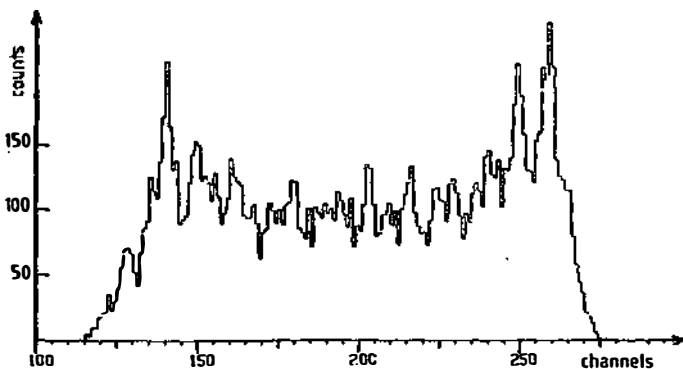


Fig. 2 - Projection of the α - α coincident events leading to ^{32}S g.s. ($E_{\text{inc}} = 75$ MeV).

The present overall CONCLUSIONS are the following :

- 1) Strong structures have been observed in ^{36}Ar around 20 MeV excitation in the sequential reaction $^{12}\text{C}(^{28}\text{Si}, \alpha\alpha)^{32}\text{S}$ at 180° with widths of ~ 130 keV. The high α energies correspond essentially to $\alpha_2(^{36}\text{Ar} \rightarrow ^{32}\text{S})$.
- 2) The angular correlations and the energy spectra of the sequential decay compared with statistical model calculations show i) selectivity for high angular momenta in the entrance channel ; ii) that the intermediate levels populated in ^{36}Ar lie near the Yrast line.
- 3) Some high lying levels of ^{32}S are stronger populated than statistical model predicts ; these levels are those also strong in the transfer reaction ($^{12}\text{C}, ^8\text{Be}$).
- 4) The excitation functions of the transfer reaction show more structure than those of the sequential decay.