AN INTERPRETATION OF GROSS STRUCTURES IN THE ENERGY SPECTRA OF THE $^{12}C(^{16}O,\alpha)^{24}Mg$ REACTIONS†

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Recent studies[1] of the $^{12}C(^{16}O,\alpha)^{24}Mg$ reaction at $E(^{16}O)$=145 MeV have revealed the existence of several broad states with $E_x(^{24}Mg)$ = 20 to 60 MeV. The energies of these states have been taken as evidence that they are members of the ^{12}C + ^{12}C molecular band J^{π} = (10^+) through J^{π} = (18^+). Subsequent investigation[2] of the properties of these states, however, has failed to reveal the expected partial width for $^{24}Mg^* \rightarrow {}^{12}C$ + ^{12}C.[3]

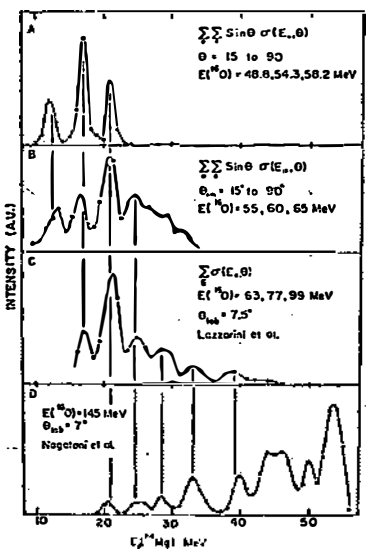

Fig. 1 - Background-subtracted energy spectra (A,B) present work - (C,D) Ref. 1.

The recognition that the broad bumps observed at high energies are also visible at much lower energy has promped us to extend these measurements to even lower energies. Complete angular distributions were measured at $E(^{12}O)$ = 48.8, 54.2, 58.6, 55.0, and 65 MeV. Measurements were made on the University of São Paulo Pelletron, and the University of Rochester MP tandem.

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Gross structures are also observed around $E_x(^{24}Mg)$ = 13, 17 and 21 MeV. Beam energy averaged, angle integrated, background subtracted α particle spectra are depicted in Fig.1. It is known that the component levels are not molecular in nature below $E_x(^{24}Mg) \simeq 27$ MeV and that they are, at least at low bombarding energies, selectively populated by a compound nucleus mechanism as a result from angular momentum matching.

Thus, a consistent interpretation of the broad structures seen at $E(^{16}O)$ = 145 MeV can be given relating them to similar structures observed at much lower bombarding energies where the reaction mechanism is well understood.

The spacing of the broad structures suggests a $\Delta J=1$ sequence (E_x vs (J(J+1)) beginning with J=8 at E_x = 13 MeV, that overlaps with the ^{24}Mg ground state band. Of course, the $K^{\pi}= 0^+$ ground state band contains only even spin, but the odd spin yrast states, apparently lie very close to this trajectory (E_x = 16.55 MeV for the lowest 9^- state).

Based on the statistical model, these broad structures are understood as arising from angular momentum matching conditions which creates narrow windows of excitation energy whithin which yrast levels or "yrast clusters" are selectively populated.

References

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