INTERMEDIATE STRUCTURE IN THE $^{16}O+^{16}O$ SYSTEM OBSERVED VIA THE α EXIT CHANNEL

D. Počanić
Rudjer Bošković Institute, 41001 Zagreb, Croatia, Yugoslavia

K. Van Bibber, W.A. Seale[+], J. Dunham, J.L. Thornton and S.S. Hanna
Physics Department, Stanford University, Stanford, California 94305

In an attempt to obtain more definite information concerning the existence of quasimolecular resonances in the $^{16}O+^{16}O$ system, a study of the $^{16}O(^{16}O,\alpha_{o,1})$ reactions was performed at the Stanford University tandem Van de Graaff Laboratory. Eight excitation functions of both α_o and α_1 were measured in the energy range $E_{lab}\approx 20-45$ MeV (detector angles: $\theta_{lab}=10$, 16.7, 23.3, 30, 50, 56.7, 63.8 and 70^o) using a 35 $\mu g/cm^2$ SiO_2 target on a gold backing 70 $\mu g/cm^2$ thick. An array of 4-5 large-area solid state detectors shielded with thin Al foils was used to detect the α_o and α_1 events.

The excitation functions of α_o and α_1 cross sections, summed over the eight angles, are shown in Fig. 1. Two features strike the eye: (i) the overall presence of intermediate structure ($\Gamma\sim 0.5-1$ MeV_{cm}) in both curves and (ii) the anomalously high increase in cross section in both channels in the region $E_{lab}\approx 30-33$ MeV.

Statistical analysis of the data by means of correlation and deviation functions revealed highly nonstatistical behaviour in the region above $E_{lab}\approx 29$ MeV. The strongest anomaly is at $E_{lab}\approx 32.1$ MeV; also pronounced are the anomalies around $E_{lab}\approx 30$, 36, 38 and 40 MeV. However, the behaviour below E_{lab} ≈ 29 MeV was found to be in agreement with statistical predictions.

Angular distributions of both α_o and α_1 were measured on top of four peaks in the summed α_o cross section ($E_{lab}=27.65$, 30.4, 31.9 and 37.9 MeV) as well as one off-peak ($E_{lab}=29.15$ MeV). Minimum-χ^2 analyses of the shapes of α_o distributions (shown in Fig. 2) with coherently summed pairs of Legendre polynomials reveal: (i) strong mixing of $\ell=10$ and 8 at $E_{lab}=27.65$ MeV, (ii) dominance of $\ell=10$ at $E_{lab}=29.15$ and 30.4 MeV, and (iii) strong mixing of $\ell=10$ and 12 at $E_{lab}=31.9$ and 37.4 MeV.

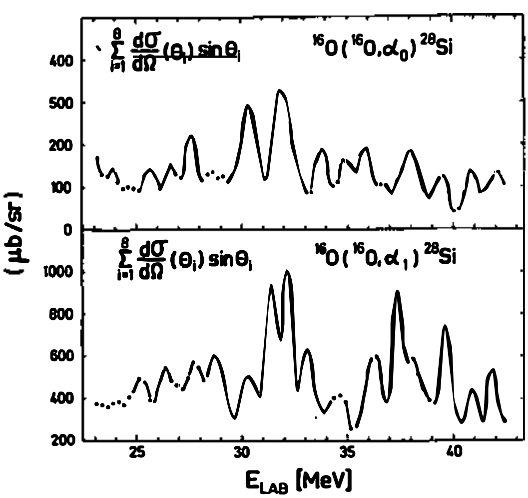
[+]On leave from Instituto de Fisica, Universidade de São Paulo, São Paulo, Brazil

The present results may be summarized as follows. The experiment and analysis reveal a strong presence of intermediate structure which displays nonstatistical behaviour in the region $E_{lab} \gtrsim 29$ MeV, a fact consistent with previous studies of the $^{16}O+^{16}O$ system. Thus, several good candidates for resonance observation are found. However, if they are indeed resonances, they either overlap strongly or interfere nonnegligibly with the statistical background. It is therefore important to compare the present data with Hauser-Feshbach calculations before any definite resonance identifications are made.

It is worth mentioning that the energies and dominant spins of anomalies observed in this work coincide well with the resonant band predicted for the $^{16}O+^{16}O$ system by the orbiting-cluster model[1].

References

1) N. Cindro and D. Počanić, J. Phys. G: Nuclear Physics 6 (1980) 359



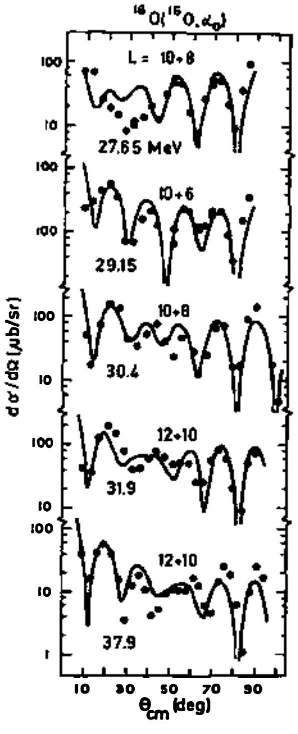


Fig.1. Summed excitation functions.

Fig.2. Measured α_o angular distributions.