DETERMINATION OF RESONANCE PARAMETERS OF THE $^{12}C(^{12}C,\alpha_o)^{20}Ne$ REACTION AT COULOMB-BARRIER ENERGIES

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Previous measurements of the $^{12}C(^{12}C,\alpha)^{20}Ne$ reaction at Coulomb barrier energies did not reveal all quasimolecular-type resonances known from the $^{12}C+^{12}C$ total reaction cross section[1]. We have therefore performed a high-resolution study of the $^{12}C+^{12}C$ system from 5.68-6.10 MeV(c.m.) with emphasis on the $\alpha_o+^{20}Ne_{g.s.}$ exit channel. For this purpose, we used a very thin windowless gas target (propan gas with 2.5 μg cm^{-2} carbon content), small energy steps (25 and 12.5 keV) and simultaneous detection of the reaction products at 20 angles with reasonably good counting statistics.

For the reaction involving zero-spin particles only, the scattering matrix S can be determined from the measured angular distribution

$$\frac{d\sigma}{d\Omega}(\theta) = \left|\frac{1}{2ik}\sum_{\ell=0}^{L}(2\ell+1)S_\ell P_\ell(\cos\theta)\right|^2 ,$$

with all $2^{L/2}$ ambiguous solutions by means of zeros in the complex cos θ plane of the associated equation $d\sigma(\theta)/d\Omega = 0$[2].

Since the acceptable fits of the data could be obtained with partial waves ℓ = 0, 2 and 4, the S matrix can have four solutions at each energy. As the amplitude $|S_\ell|$ has half the ambiguity of S_ℓ itself, the moduli of the S matrix have twofold ambiguity and these solutions are represented by open and full circles in Fig. 1. The absolute values $|S_\ell|$ exhibit pronounced structures concentrated at c.m. energies of 5.8, 5.9 and 6.0 MeV, where the total reaction experiment confirms that quasimolecular resonances exist in the angle-integrated α-particle data. Both solutions happen to have a very similar energy dependence. If we assume that the solution denoted by open circles represents the physical reality, we find the resonance energies E_R and J^π values listed in Table I. Obviously, the resonance at 5.8 MeV is a resonance triplet with J^π values 4^+, 2^+ and 0^+ and the one at 6.0 MeV seems to be a resonance doublet with J^π values 0^+ and 2^+.

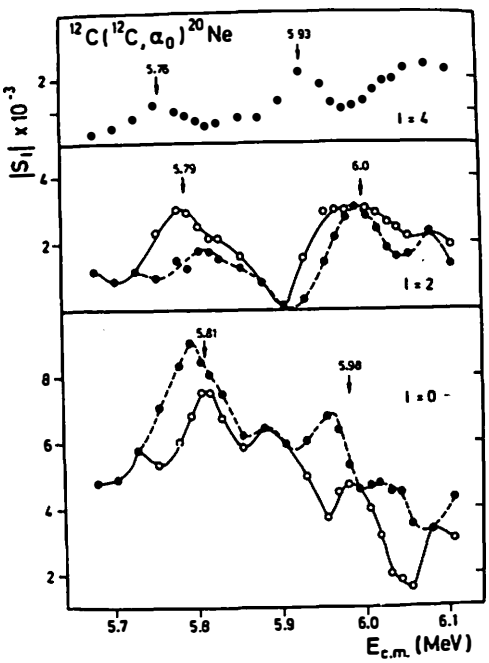

Fig. 1. Absolute values $|S_\ell|$ of the S-matrix elements. Two solutions are represented by open and full circles. The lines are to guide the eye. Numbers on the arrows indicate resonance energies.

Table I. Resonance energies E_R and J^π values for resonances deduced from the $|S_\ell|$ data

E_R (MeV)	5.76	5.79	5.81	5.93	5.98	6.00
J^π	4^+	2^+	0^+	4^+	0^+	2^+

1. W. Treu, H. Fröhlich, W. Galster, P. Dück and H. Voit, Phys. Rev. C22 (1980) 2462.
2. Z. Basrak, F. Auger, P. Charles, W. Tiereth and H. Voit, Contribution to the Bielefeld Encounters in Physics and Mathematics VI: Resonances - Models and Phenomena, Bielefeld (1984), F.R. Germany, and to be published.