

Fig. 3. Energy dependence of the reaction channel amplitudes $S_{ll'j}$, for the indicated J^π values, as a function of proton bombarding energy. The results were determined by two methods: (a) an independent fit to each differential cross section, and (b) parameters found at one energy being used as starting parameters for the search at the next energy.

The two fitting methods produced differences in detail in the reaction amplitudes $S_{ll'J}$; however, the dominant features are the substantial peaks in the $J^\pi = 1/2^+$ and $1/2^-$ reaction amplitudes near 7.2 MeV. The differences in detail are due to inherent ambiguities in this method of analysis (Jolivette and Richards 1969). The results indicate that the peak observed in the excitation function is due to two overlapping states which interfere. The energy dependences of the $1/2^+$ and $1/2^-$ reaction amplitudes were fitted with Breit-Wigner resonance shapes, and these fits resulted in the resonance parameters given in Table 1.

Table 1. Resonance parameters in $^{18}\text{O}(p, \alpha_0)^{15}\text{N}$ cross section

Resonance J^π	Proton energy (c.m.) E_p (MeV)	^{19}F excitation energy (MeV)	Width (lab.) (keV)
$1/2^-$	6.72 ± 0.07	14.71 ± 0.07	270 ± 70
$1/2^+$	6.80 ± 0.07	14.80 ± 0.07	400 ± 100

To attempt to confirm the resonance nature of the two peaks in the reaction amplitudes, attention was turned to the phases deduced for the $S_{ll'J}$ channel amplitudes from the least-squares fitting of the data to equation (4). As noted in Section 2 above, the work of McVoy (1967) indicates that the trajectory of the complex amplitude, for an isolated resonance, is a circle traced in the counter-clockwise direction. The plots of the two peaks are shown in Fig. 4.

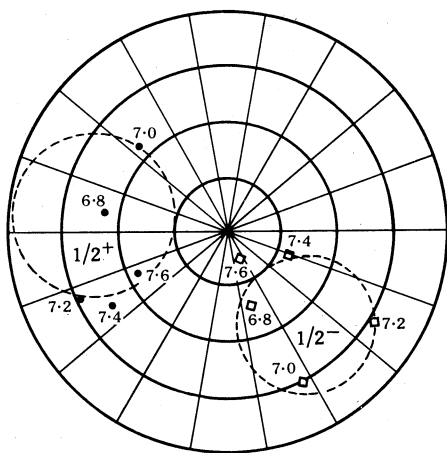


Fig. 4. Resonance 'circles' for the $1/2^+$ and $1/2^-$ states of ^{19}F (following McVoy 1967).

The present attempt to demonstrate the resonance circles from actual data suffers from several disadvantages. Firstly, the differential cross sections were measured at intervals of 200 keV, which are larger than is desirable for such resonances. Secondly, Fig. 3 shows substantial background beneath these two states. The lack of data below 6.6 MeV bombarding energy precludes any estimate of the energy dependence of this nonresonant background. Thirdly, there is known to be an inherent ambiguity in the phase determination in this method of resonance study (Jolivette and Richards 1969), and the present data do not contain enough information to remove this. We have attempted to minimize the ambiguity problem by plotting

the phases determined in the second (sequential) method; it was felt that this procedure was more likely to lead to a consistent set of amplitudes and phases. Fig. 4 shows that this expectation was in fact borne out.

In spite of the above problems, Fig. 4 does show that resonance 'circles' are obtained, and this is taken as confirmation of the resonance nature of the peaks. Analysis of the differential cross sections therefore leads to the identification of two states in the compound nucleus ^{19}F , whose parameters are given in Table 1. The $1/2^-$ state appears to be a new state of ^{19}F , provided that the 14.80 MeV state ($1/2^+$) is identified with the resonance observed in the $^{18}\text{O}(p, n)^{18}\text{F}$ reaction by Bair *et al.* (1964), who give the excitation energy as 14.78 ± 0.02 MeV. The widths (laboratory system) also compare well: Bair *et al.* give 300 keV and our value is 400 ± 100 keV.

References

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