7. Comparison of results and conclusions

In this energy region there is very little spectroscopic information on ^{33}S states. Excitation functions for ^{29}Si(α, n_0)^{33}S measured by Balakrishnan *et al.* [3]) in the region from E_x = 3.0–5.4 MeV, yielded level width and spacing information referred to earlier. Resonance energies are in good agreement with our results. Resonance energies and spin values for 14 resonance levels in the compound nucleus ^{33}S have been reported by McMurray *et al.* [16]) in the region from E_x = 3.0–4.8 MeV, overlapping our energy region in the range from 3.5–4.8 MeV. In the lower region ($E^* \leqq$ 10.0 MeV) spins and parities have been assigned by several investigators [17–19]), mainly by either analysis of γ-ray angular distributions in the ^{30}Si(α, nγ)^{33}S reaction or angular distributions of protons from the ^{31}P(^{3}He, p)^{33}S reaction. Also in the same energy region, elastic and inelastic scattering of protons on ^{33}S has provided spin and parity assignments by means of a DWBA analysis of angular distributions of protons from the ^{33}S(p, p)^{33}S reactions.

The previous work by McMurray *et al.* [16]) was measured with somewhat better energy resolution than the present work. Our resonance energies of E_x = 3.675, 4.090, 4.245, 4.300, 4.425, 4.555, 4.595, 4.635 and 4.745 MeV are in excellent agreement with the corresponding resonances reported earlier. The remaining energies at which angular distributions were measured correspond only approximately with their energies, due primarily to the differing energy resolutions. Spin information was extracted by McMurray *et al.* employing a shape analysis of angular distributions measured for θ = 10°–120° in 15° steps. Table 4 compares the results of the two experiments which agree in only an approximate manner. This fair agreement arises

TABLE 4

A comparison of the results of this experiment with previous work

McMurray *et al.*		Present work	
E_x (MeV)	J	E_x (MeV)	J^π
3.759	$\frac{3}{2}$	3.755	$\frac{1}{2}^-$, $\frac{3}{2}^+$
		3.765	$\frac{1}{2}^-$, $\frac{5}{2}^-$
3.803	$\frac{3}{2}$		
3.844	$\frac{3}{2}$	3.860	$\frac{3}{2}^\pm$
4.011	$\frac{3}{2}$	4.020	$\frac{1}{2}^-$, $\frac{3}{2}^+$
4.064	$(\frac{3}{2})$	4.070	$\frac{1}{2}^+$, $\frac{5}{2}^-$
4.351	$\frac{7}{2}$	4.325	$\frac{1}{2}^-$, $\frac{5}{2}^+$
		4.370	$\frac{3}{2}^+$, $\frac{5}{2}^-$
4.407	$(\frac{3}{2}, \frac{5}{2})$	4.400	$\frac{7}{2}^-$
		4.425	$\frac{3}{2}^+$, $\frac{7}{2}^-$
4.424	$(\frac{3}{2}, \frac{5}{2})$	4.425	$\frac{3}{2}^+$, $\frac{7}{2}^-$
4.502	$(\frac{5}{2})$	4.495	$\frac{3}{2}^+$, $\frac{5}{2}^+$
		4.520	$\frac{3}{2}^+$, $\frac{5}{2}^+$
4.614	$\frac{5}{2}$	4.605	$\frac{1}{2}^-$, $\frac{3}{2}^+$
		4.635	$\frac{3}{2}^-$

not only from the differing energy resolution but more importantly from shortcomings in the measurement of the angular distributions which were not made over the full angular range and which were taken in very coarse angular increments. In the present work, it has been our experience that a full angular distribution ($\theta = 0° - 169°$) measured in fine steps ($\Delta\theta = 5°$) is required for a truly comprehensive analysis. Often one-half the angular distribution has nearly a pure J-shape only to markedly deviate from it in the second half of the angular range. Furthermore, the present analysis attempts also to make parity assignments and is not restricted to single-spin resonances. We submit that the present results should be accepted with considerable confidence and should provide the major source of spin-parity information in ^{33}S at $E^* = 10$–12 MeV.

This special method that was invoked in the present analysis to assign spins and parities can be applied to any reaction with channel spin restricted to either 0 or $\frac{1}{2}$, such as (α, p) reactions on odd-A nuclei of ground-state spin $\frac{1}{2}$ or (p, α) reactions on even-A nuclei of spin zero. Such an analysis has been recently completed for the ^{19}F$(\alpha, p_0)^{22}$Na and ^{31}P$(\alpha, p_0)^{34}$S reactions, and publication of these results will soon follow. Preparations for the study of the ^{57}Fe$(\alpha, n)^{60}$Ni reaction are underway. It should be noted that in all such reactions at low α-energies there is an artificial reduction of the level density in the compound nucleus due to barrier-penetrability considerations. Particularly in the proposed ^{57}Fe$(\alpha, n)^{60}$Ni reaction it is expected that only low-spin states will be excited, thus making a resonance study feasible.

The authors gratefully acknowledge assistance in the experimental phase of this project by Drs. J. Correia, D. Donati, R. LeClaire, S. C. Mathur, D. Pullen, and F. Prevo and by C. Connolly, T. Marcella, P. Quinn, N. Sullivan and S. Traiforos. We also thank Drs. L. Beghian and G. Kegel for their encouragement throughout this program.

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