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VIBRATIONS AND STRENGTH FUNCTIONS IN Ar^{37}

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Rosner and Schneid[1] have recently determined the distribution of single particle strength in Ar^{37} by (d,p) reactions on Ar^{36}. Some $\ell = 2$ and 0 stripping was observed into the ground and first excited states, while only $\ell = 1$ and 3 stripping was observed into the higher excited states. Level assignments were then completed on the basis of j-dependence in the angular distributions and from shell model considerations. Their results are shown in fig. 1.

In this note we consider a one parameter model for Ar^{37}. Since the details have been presented elsewhere[2] we shall merely outline the features which are of importance here. It is assumed that Ar^{37} may be described in terms of coupling between quadrupole oscillations of the even core and a neutron in the nearby empty single particle levels,

$$H = H_C + H_{SP} + K_2 \left(\frac{m\omega_2}{\hbar} r^2\right) \sum_{\mu=-2}^{2} (-1)^{-\mu} \alpha^+_{2\mu} Y_{2\ -\mu}(\theta_n,\phi_n) \qquad (1)$$

$$\alpha^+_{2\mu} = \sqrt{\frac{\hbar}{2m\omega_2}} \left[a^+_{2\mu} + (-)^{-\mu} a_{2\ -\mu}\right] \qquad (2)$$

$$\left[H_C, a^+_{2\mu}\right] = \hbar\omega_2 a^+_{2\mu} \qquad (3)$$

where $a^{+}_{2\mu}$ is the creation operator for a quadrupole phonon of energy $\hbar\omega_2 = 1.97$ MeV (Ar^{36}, see Ref. 3). The eigenfunctions of Ar^{37} may be written as follows,

$$\Psi^{J^\pi}_M = \sqrt{S_{\ell J}}\,\left[\phi_{00}(C)\,\Psi_{\ell J}\right]^J_M + \sum_{(N\bar{v}L),(\ell' j')} C_{N\bar{v}L,\ell' j'}\left[\phi_{N\bar{v}L}(C)\,\Psi_{\ell' j'}\right]^J_M \tag{4}$$

in which the sum is over the excited states of the core $\phi_{N\bar{v}L}(C)$ with N (here ≤ 4) phonons coupled to angular momentum L (v = seniority where necessary) which, in turn, is coupled with the single particle j' to J^π, $\pi = (-1)^\ell$.

The (d,p) cross section,

$$\frac{d\sigma}{d\Omega} = \frac{(2J+1)}{(2I+1)}\,S_k(\ell,J)\;\sigma(\ell,\theta,Q) \tag{5}$$

determines the probability $S_k(\ell,J)$ for stripping into the k-th state of J^π. The single neutron energy levels may be determined, to within an additive constant, from the relation

$$\epsilon_{\ell J} = \frac{\sum_k S_k(\ell,J)\,E_k(J^\pi)}{\sum_k S_k(\ell,J)} \tag{6}$$

which follows from eq. (1) and the completeness of the wave functions (4).

The thin lines in fig. 1 give the results of diagonalizing the Hamiltonian (1) with a coupling strength $X_2 = K_2 = \sqrt{\frac{5\hbar}{2\pi m\omega_2}} = .60$ MeV and neutron levels at $\epsilon_{f_{7/2}} = 1.91$, $\epsilon(p_{3/2}) = 3.31$, and $\epsilon(p_{1/2}) = 5.31$ MeV. The best fit is obtained by shifting them uniformly 0.31 MeV above the

values quoted in Ref. 1, consistent with the fact that the effect of unobserved strength at higher excitations was not included there.

This model cannot, of course, be applied directly to the ground and first excited states. The $\ell = 2$ and 0 stripping into them involves the s and d neutron levels which evidently are not entirely filled. To incorporate them into such a model would require quenching their matrix elements by quantities like u^2 of pairing theory.

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3. J. C. Lisle and P. F. D. Shaw, Proc. Roy. Soc. 76 (1960) 929

FIGURE CAPTION

Fig. 1. Excitation energies and spectroscopic factors for (d,p) stripping into Ar^{37}. The thick lines are from experiments reported in Ref. 1. The thin lines refer to the vibrational-core plus single-particle model with coupling strength $X_2 = 0.60$ MeV; for Ar^{36} energy we assume $\hbar\omega_2 = 1.97$ MeV.

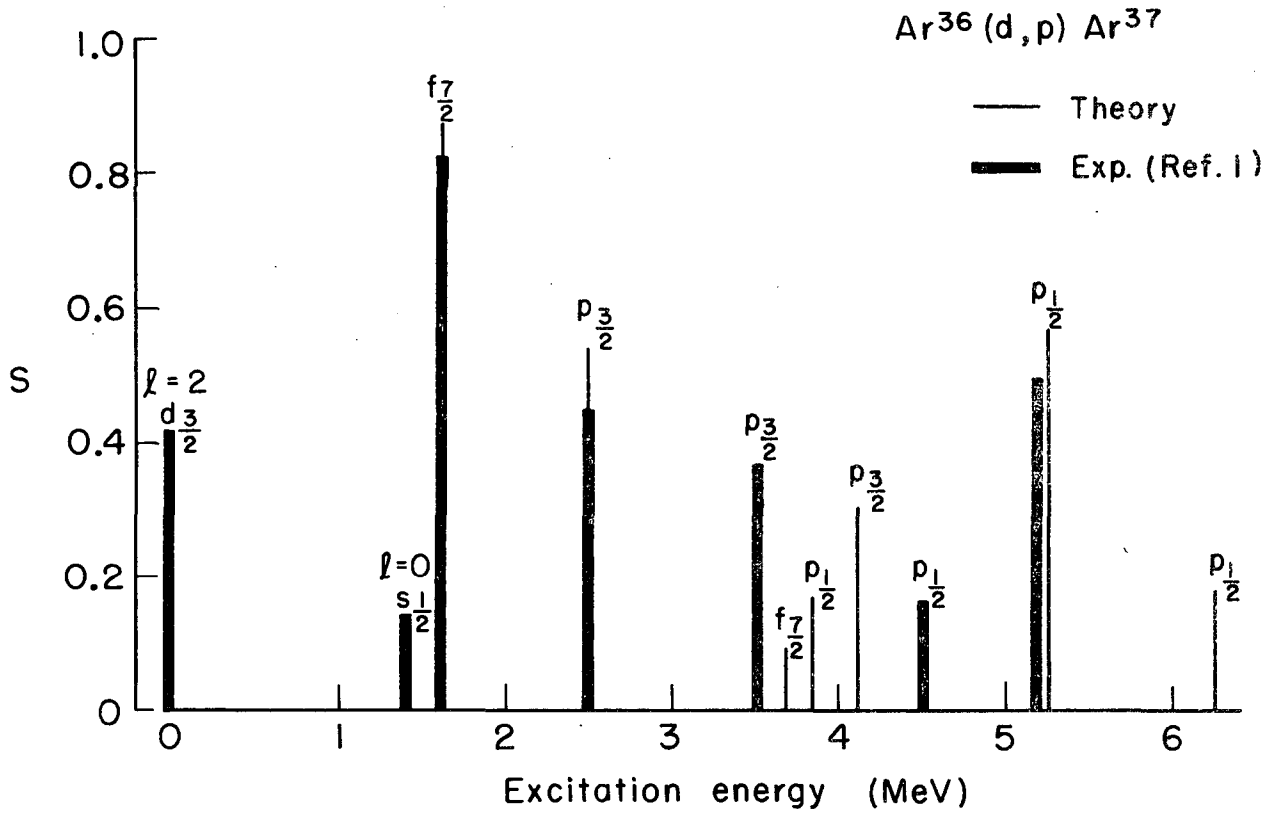

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Fig. 1

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