Table I. Experimental single-particle level spacings.

Levels	ΔE (Mev) (present work)	ΔE (Mev) (reference 3)
$1f_{5/2}-1f_{7/2}$	6.4	$\geqslant 4$
$2p_{1/2}-2p_{3/2}$	2.2	~ 1.8
$2p_{3/2}-1f_{5/2}$	4.5	$\geqslant 1$
$1g_{9/2}-2p_{1/2}$	1.5	...
$2d_{5/2}-2p_{1/2}$	1.9	...

the spectra of protons from (d,p) reactions for this region of nuclei as due to the influence of single-particle states on the level structure.[14]

(3) If one assumes that the groups of states according to $l\,(j)$ value are in fact identifiable with the appropriate single-particle states, then the mean energy spacings of these states are of interest in connection with theories of the origin and magnitude of the spin-orbit force. The spacings observed in our measurements are summarized in Table I, and for comparison previous estimates of these spacings are included when available.

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ENERGY SPECTRUM OF PHOTONEUTRONS FROM OXYGEN

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The energy spectrum of the photoneutrons from oxygen has been studied by irradiation of a water target with a 31-Mev collimated bremsstrahlung beam from the Brown Boveri betatron of Torino University.

Photoneutrons emitted at about 90° with the γ-ray beam have been recorded by means of the proton recoil tracks in Ilford L_4 plates 400 μ thick. A water wall 60 cm thick screened the plates against the spurious neutrons coming directly from the betatron, as in a previous work.[1]

Plates were scanned and proton recoil tracks were selected following the method used previously.[1]

The neutron spectrum is deduced from the proton recoil spectrum taking into account the cross section for (n,p) collisions in the hydrogen of the emulsion. The relation $E_n = E_p/\cos^2\theta$ was introduced only for $\theta > 10°$. Small corrections are due to the probability of escape of the tracks from the emulsion[2] and to the absorption and scattering of neutrons in the target. The experimental energy spectrum is given in Fig. 1(a).

Under the restrictive assumption that only the direct $O(\gamma,n)$ process is effective and that the residual O^{15} nucleus is left in the ground state, the expected neutron spectrum may easily be inferred from the $O(\gamma,n)$ cross section,[3] taking

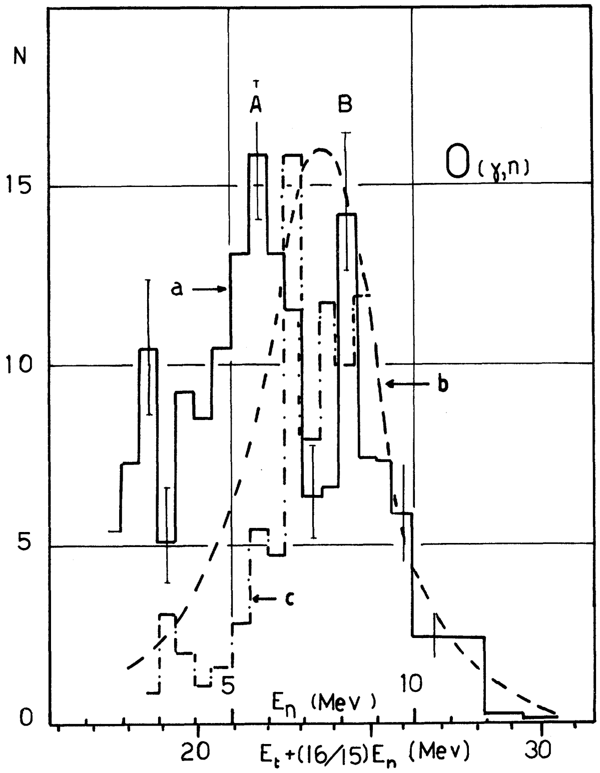

FIG. 1. (a) Experimental photoneutron spectrum. N = neutrons per $\Delta E_n = 0.5$ Mev (arbitrary units). (b) and (c) Spectra calculated from the O(γ, n) cross sections.

account of the bremsstrahlung spectrum. The behavior of the neutron spectrum thus inferred is given in Fig. 1(b).

Although the above assumption is very restrictive and the O(γ, n) cross section[3] is available only in large energy steps, a rough agreement may be observed in the high-energy region between the experimental and calculated spectra. This gives evidence of a large contribution of direct process in the O(γ, n) reaction. On the other hand, for all elements previously investigated,[4] evaporation accounts for the greater part of the emitted neutrons. A more detailed comparison between the experimental and the calculated spectra in the high-energy region may be made up to $E_\gamma = 25.1$ Mev taking into account Spicer's cross section[5] calculated in 0.5-Mev steps. The spectrum (c) in Fig. 1 inferred from Spicer's cross section in the giant resonance region shows a fine structure as the experimental spectrum.

In the low-energy region a contribution of the evaporative process may account for the difference between the experimental and calculated spectra.

The neutron peak around 2.5-3 Mev may be due to neutrons leaving O^{15} in excited states. The two neutrons peaks A and B are to be attributed to photons of energy E_γ around 22 and 24 Mev, respectively. Indeed, taking into account (*i*) the $O^{16}(\gamma, n)$ threshold energy ($E_t = 15.6$ Mev), (*ii*) the energy of the first excited level in O^{15}($E_1 = 5.3$ Mev), and (*iii*) the behavior of the O(γ, n) cross section beyond 27 Mev,[3] it appears that after the emission of the neutron groups A and B the O^{15} must be left in its ground state. In this particular case $E_\gamma = 15.6 + (16/15)E_n$.

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