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The School of Physics
The University of Melbourne
PARKVILLE 3052
AUSTRALIA

Population of States in ^{15}O following the $^{16}O(\gamma,n)$ Reaction

J. R. M. Annand, G. I. Crawford, D. G. Ireland, K.Livinsgton, I. J. D. MacGregor, J.C. McGeorge and R. O. Owens
Department of Physics and Astronomy, University of Glasgow, Glasgow G12 8QQ, SCOTLAND

J-O Adler, K. Hansen, M. Lundin, L. Isaksson, B. Nilsson, A. Sandell, and B.Schroeder
Institute of Physics, Lund University, Lund S-223 62, SWEDEN

M. J. Boland, R. P. Rassool and M. N. Thompson
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Introduction

This measurement forms part of a series of experiments designed to resolve the nature of the reaction mechanism involved between high-energy photons and the nucleus. Of the several theoretical models currently available, microscopic calculations, such as those of Gari and Hebach[1], and more recently Ryckebusch[2] seem to better describe the experimental observations.

These models include multi-particle effects by specific reference to short range correlations between the nucleons, meson-exchange effects and ground state correlations. Measurement of the population of excited residual states following photonuclear reactions, severely constrains the model parameters. This is particularly true for residual states with configurations involving terms with multiple holes.

A study of the population of residual states in ^{11}B following the $^{12}C(\gamma,p)$ reaction, has provided compelling data that has helped to refine the model parameters[3]. This measurement exploited a technique where γ-rays from residual excited states are used to provide better resolution of the relative population of these states[4]. This de-excitation γ-ray technique is used in the present experiment, so as to provide a measure of the population strength to the +ve-parity doublet of states in ^{15}O near 5.2 MeV. These states have a predominant *2p-1h* structure, and hence provide an important test of the theoretical models. Without access to the de-excitation γ-ray spectrum it would not be possible to resolve population of these states from the –ve parity state at 6.2 MeV.

Experimental Method

Tagged photons between 50 and 70 MeV were incident on a 15-cm-long target of water, contained in a thin-walled metal cylinder. Neutrons were detected at five angles ranging from 45° to 105° in 15° steps, using large (60 x 60x10 cm) liquid scintillator detectors. The detector design, and the PSD techniques used in this measurement are described in a recent publication[5].

The associated de-excitation γ-rays were detected using three 25-cm-diameter NaI scintillators placed above, below, and at 90° horizontally to the beam. The event-by-event data acquisition was designed so that off-line analysis could determine the de-excitation γ-ray spectrum following neutron emission from ^{16}O by tagged photons of known energy.

Analysis

Neutrons were identified from the PSD data, and their energies determined from the TOF record. After correction for reaction energetics, and centre-of-mass effects, it is possible to sum the neutron TOF spectra for all tagger channels, and this is shown in Figure 1 for data obtained at 60°.

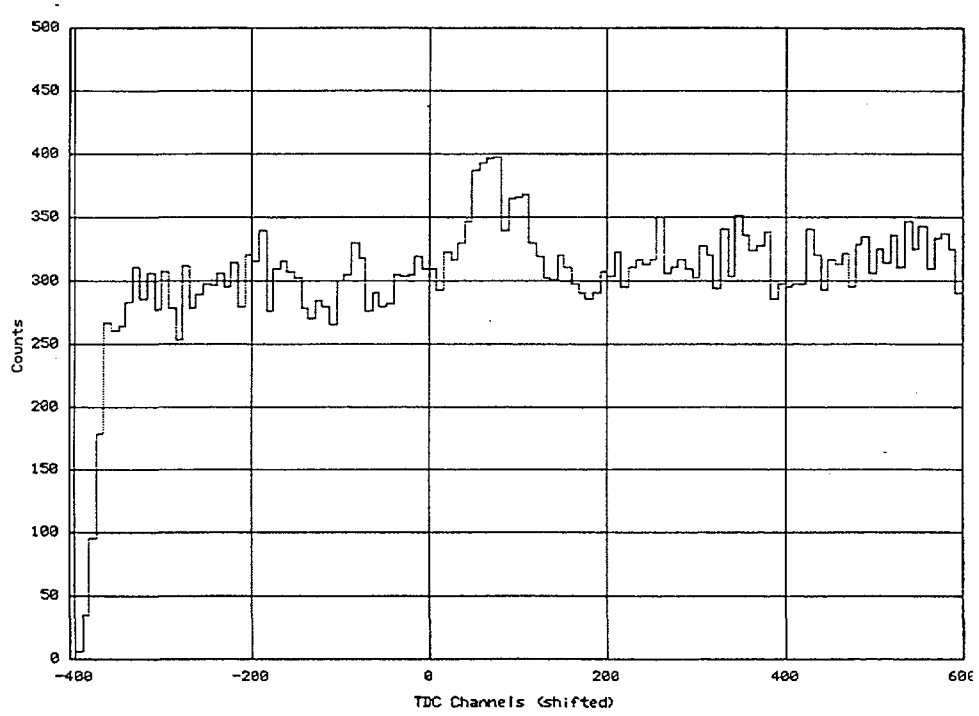

Figure 1 The sum of neutron TOF spectra for all tagger channels.

The next step in the analysis is to identify the de-excitation γ-rays associated with each neutron-energy group. Figure 2 shows the spectrum of γ-ray associated with neutrons emitted at 60°, which lead to the +ve-parity doublet at 5.2 MeV, and the 3/2$^-$ state at 6.3-MeV in ^{15}O. These γ-rays can be clearly identified in this preliminary spectrum. The absence of a de-excitation γ-ray from the 7.5MeV state in ^{15}O, which is known to be populated following the $^{16}O(\gamma,n)$ reaction, results from its predominant decay via the ½$^+$ state at 5.18 MeV.

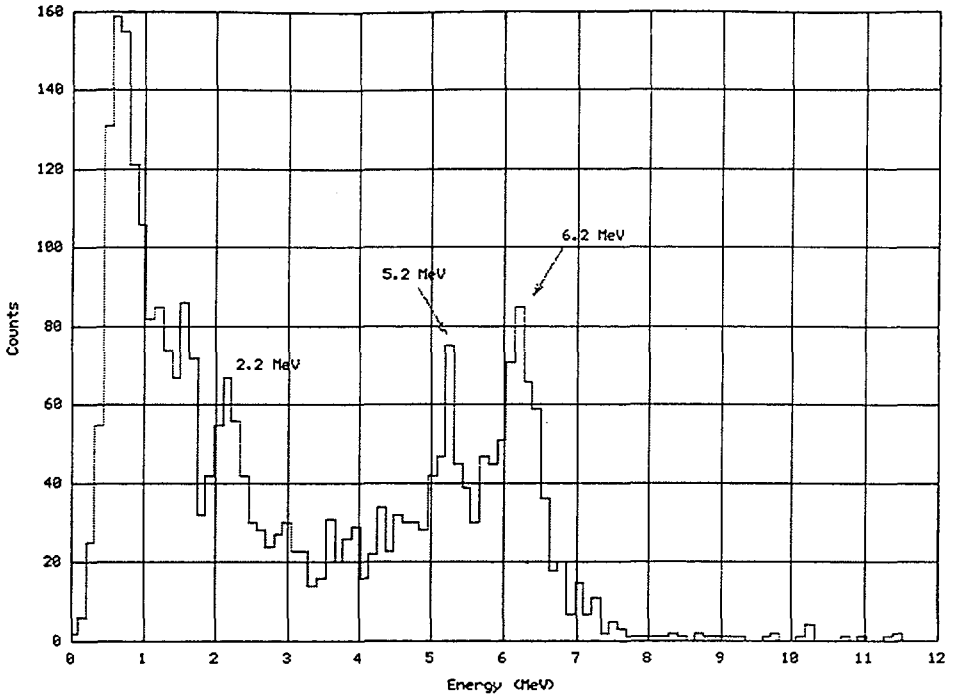

Figure 2 The de-excitation γ-ray spectrum from residual states in ^{15}O, following emission of neutrons at 60° in the $^{15}O(\gamma,n)$ reaction. The data is summed for tagged photons with energies ranging from 50 to 70 MeV

Analysis of the data at the remaining angles is proceeding, and it is anticipated that the differential cross sections for population of the low-lying states in ^{15}O will be available shortly.

References

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See also MAX-Lab Report (1996) Page 233

4 A. Kuzin, *et al.* Aust. J. Phys. **49**, 1075-1080 (1996)

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