A Study of the $^{51}$V($n, n'\gamma$)$^{51}$V Reaction.

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Summary. -- The results of a measurement of the $^{51}$V($n, n'\gamma$)$^{51}$V reaction are presented for incident-neutron energies ranging from 1.3 MeV to 3.9 MeV. The pulsed-beam time-of-flight technique was used to obtain a good discrimination between neutrons and de-excitation $\gamma$-rays, which were collected by means of a true coaxial Ge(Li) detector. In this way the levels and the decay scheme of the $^{51}$V nucleus were determined and, through the comparison of the measured excitation functions with the predictions of the statistical theory of the compound nucleus, $J^\pi$ assignments were proposed and compared with the results reported in the literature.

1. - Introduction.

The spectroscopic properties of nuclear energy levels may be investigated accurately, but at the same time in a fairly simple way, through the study of the de-excitation $\gamma$-rays following the inelastic scattering of neutrons from light- and medium-weight nuclei. The main advantage of this method lies in the absence of the Coulomb barrier for the incident particles, so that even low-energy neutrons are able to excite low-lying states of the investigated nuclei. When charged particles are employed as projectiles, the higher energy needed to overcome the Coulomb barrier leads to the opening of a certain number of competitive reactions that may render the $\gamma$-spectra difficult to unfold. Moreover, the absence of selection rules allows the incident neutrons to excite all nuclear states, regardless of their nature. On the other hand, from the experimental point of view, new interest in the ($n, n'\gamma$) measurements was aroused.
by the availability of high-resolution large-volume true coaxial Ge(Li) detectors with good timing characteristics.

From these measurements, nuclear information is extracted by means of the extensive comparison of experimental data with the results of theoretical calculations. The experimental data one looks for are typically the absolute cross-section values of the excitation functions for the production of the observed γ-rays. The corresponding theoretical calculations are then carried out by means of the statistical theory of the compound nucleus, in the classical formulation of Hauser and Feshbach (1), as revised by Moldauer (2), and applied to γ-ray angular distributions by Satchler (3) and Sheldon and Van Patter (4). Besides being invaluable in assessing the knowledge of the spectroscopic properties of the nuclear energy levels, in some cases, these comparisons may also be useful to check some characteristics of the theoretical models themselves. Two examples are the variation of the choice of the optical-model parameters, which ought to generate the best set of transmission coefficients, and the study of the limits within which spin assignments may be reasonably proposed on the basis of this method of investigation.

This paper is a part of a research programme on the study of some medium and heavy nuclei via the (n, n'γ) reaction (5-7). The study of the 51V(n, n'γ)51V reaction is presented for incident-neutron energies ranging from 1.3 MeV to 3.9 MeV. The results of our work are then compared with the previous results available in the literature, which are well exhibited in the recent compilation of Auble (9).

2. - Experimental set-up and data analysis.

All the measurements described in this paper were made at the Laboratori Nazionali di Legnaro (LNL, Padua), by using its 7 MV Van de Graaff accelerator. A proton current of about 1.5 μA, with a pulse width of 3 ns, impinged on the target and the reactions of interest were monitored by means of the available large-volume true coaxial Ge(Li) detectors.