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Measurement of the ^{123}I Mass

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The mass of ^{123}I has been determined by measuring the ground state *Q*-value of the ^{122}Te(^{3}He,d)^{123}I reaction.

A massa do ^{123}I foi determinada medindo-se o valor de "*Q*" para o estado fundamental da reação ^{122}Te(^{3}He,d)^{123}I.

1. INTRODUCTION

The mass-excess *(M-A)* of ^{123}I is known to be -87960 ± 100 keV. This large uncertainty is reflected in the ground state Q-value for the reaction ^{122}Te(^{3}He,d)^{123}I, the presently accepted value being -550 ± 100 keV. As part of a systematic study of the odd-iodine nuclei by means of the (^{3}He,d) reactions on the even tellurium isotopes[2], we have investigated the ^{122}Te(^{3}He,d)^{123}I reaction and measured the ground state Q-value within an uncertainty of ± 8 keV. A ground state Q-value of 712.0 ± 3.9 keV for the ^{126}Te(^{3}He,d)^{127}I reaction was used as a reference for our measurement.

2. EXPERIMENTAL PROCEDURE

Targets of ^{122}Te and ^{126}Te were prepared by vacuum evaporation of isotopically enriched (> 96%) metallic tellurium onto 20μg/cm^2 carbon foils. The target material was obtained from the Stable Isotopes Division, Union Carbide Corporation, Oak-Ridge, Tennessee, U.S.A..

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The target thicknesses were measured assuming that, at the low incident energy utilized, the elastic scattering in the forward angles is purely Rutherford. The measured thicknesses of the ^{122}Te and ^{126}Te targets were 195 $\mu g/cm^2$ and 170 $\mu g/cm^2$, respectively.

An incident ^3He beam of 14.35 MeV, from the Pelletron tandem accelerator of the University of São Paulo[3], was utilized to bombard the tellurium targets, mounted in a 1 m. diameter scattering chamber[4].

Due to the fact that for the (^3He,d) reactions $|Q| \leq 1$ MeV, the deuteron groups of interest appear in the region of the elastically scattered ^3He particles, and thus a particle identification system becomes necessary.

In the present measurement, two AE-E solid state detector telescopes and analog particle identifiers[5] were used. The method requires that the incident particle lose a part (ΔE) of its energy in the first detector and the rest (E) in the second one, where it stops. The principle of operation (Fig. 1) is based on the power law relationship between the range R and energy loss for light particles, $R = a E_T^b$, where a ($\propto MZ^2$) is a constant depending on the incident particle, b (= 1.73) is an empirically determined constant[5], and $E_T = E + \Delta E$ is the incident particle energy. The identification function is given by

$$T/a = (E + \Delta E)^{1.73} - E^{1.73} .$$

Each event is thus characterized by two signals proportional to ΔE and E. A coincidence circuit guarantees that these two signals correspond to the same incident particle.

The block diagram of the electronics circuit is shown in Fig. 2. The particle identifier provides two output signals; one related to the identification function T/a, and the other proportional to the total energy of the particle. The energy spectra are obtained from the (E + ΔE) output gated with the signals from the deuteron identification function, and are stored in a Honeywell DDP/516 computer memory with the aid of analog to digital converters.

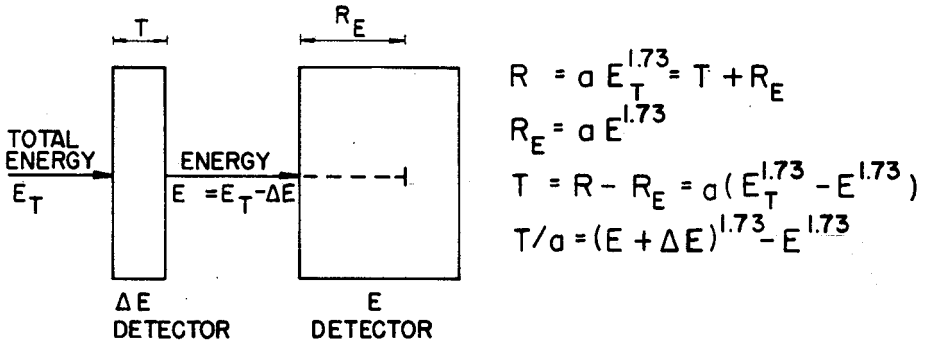

Fig. 1 - Identification function characterising the incident particle.

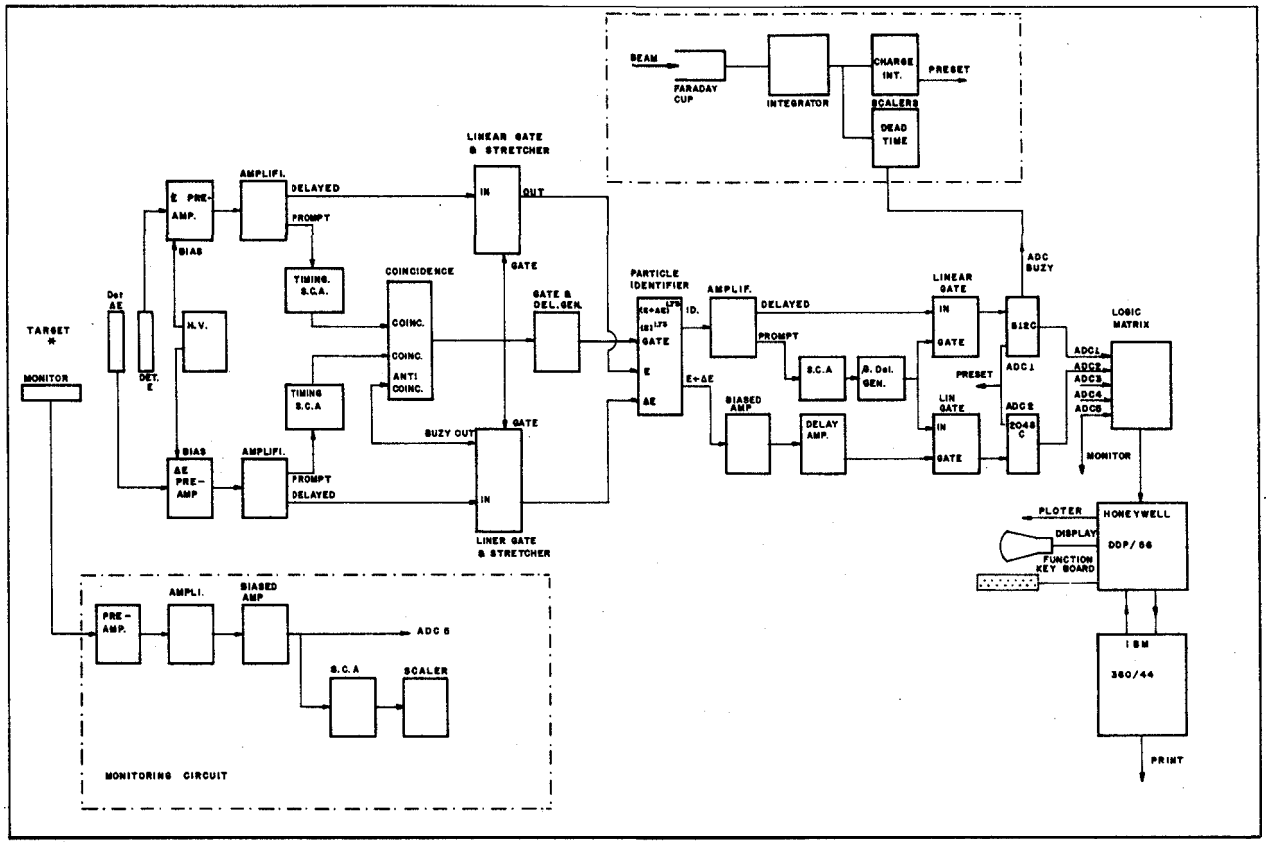

Fig. 2 - Diagram of the electronic circuit.

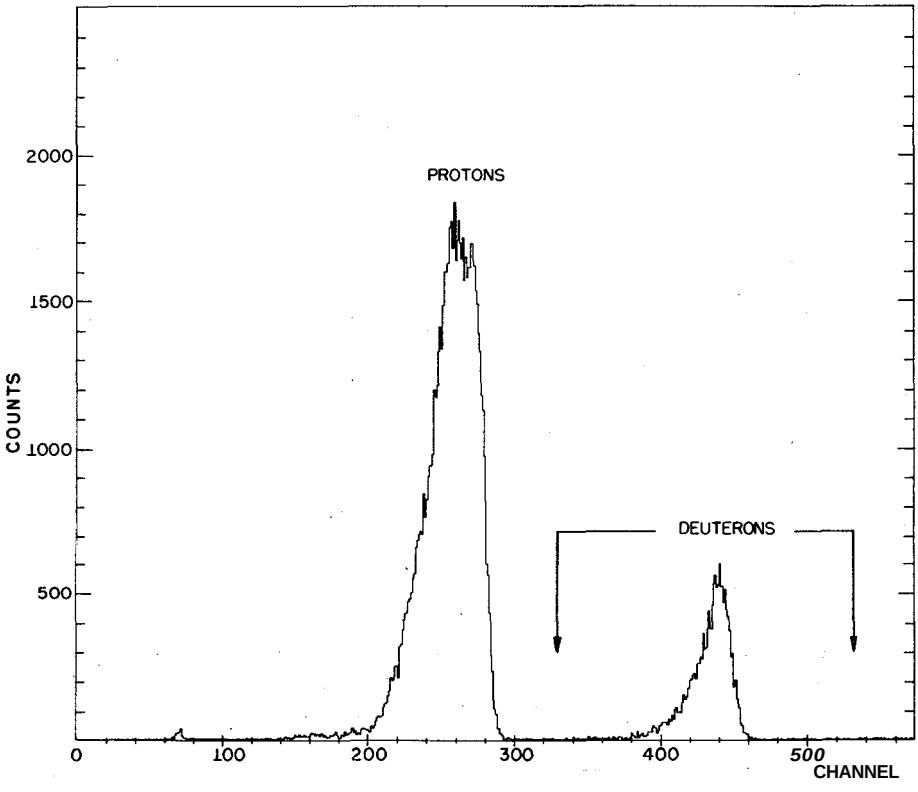

Fig. 3 - Typical identification spectrum.

A typical spectrum of the identification output is shown in Fig. 3 and the energy spectrum of the deuteron groups at a laboratory angle of 70° is presented in Fig. 4.

The energy loss of the incident ^3He particles in the target (~135 keV cm^2/mg), the spread in the energy of the deuterons due to kinematic broadening ($\leq$ 12 keV/deg) and the intrinsic energy resolution of the detectors and electronic circuits (~25 keV) are the main contributions to the resulting overall energy resolution of ~35 keV obtained.

An improvement in the energy resolution of the order of 30% was achieved applying a +3 kV bias to the target support.

3. RESULTS

Relevant portions of the observed deuteron spectra from the two targets are shown in Fig. 5.

With a precise energy calibration of the spectrum of the deuterons from the $^{126}Te(^3He,d)^{127}I$ reaction, the centre of gravity of the deuteron peak corresponding to the ground state transition was first determined. The target was then substituted by the ^{122}Te target and the centre of gravity of the peak corresponding to the ground state deuteron group was again obtained with the same energy calibration. The channel difference of 118.35 ± 0.50 between the centres of gravity of the two ground state peaks was then converted into difference in energy.

Using a setting of 10.90 ± 0.04 keV/channel, a difference in energy of 1290 ± 8 keV was obtained between the two ground state peaks. With the known value of 712.0 ± 3.9 keV for the $^{126}Te(^3He,d)^{127}I$ ground state Q-value, this result, after an estimated correction of 1.5 keV for the difference in target thicknesses, yields a value of 577 ± 8 keV for the ground state Q-value of the $^{122}Te(^3He,d)^{123}I$ reaction.

The measured Q-value corresponds to a mass-excess of - 87932 ± 9 keV for ^{123}I.

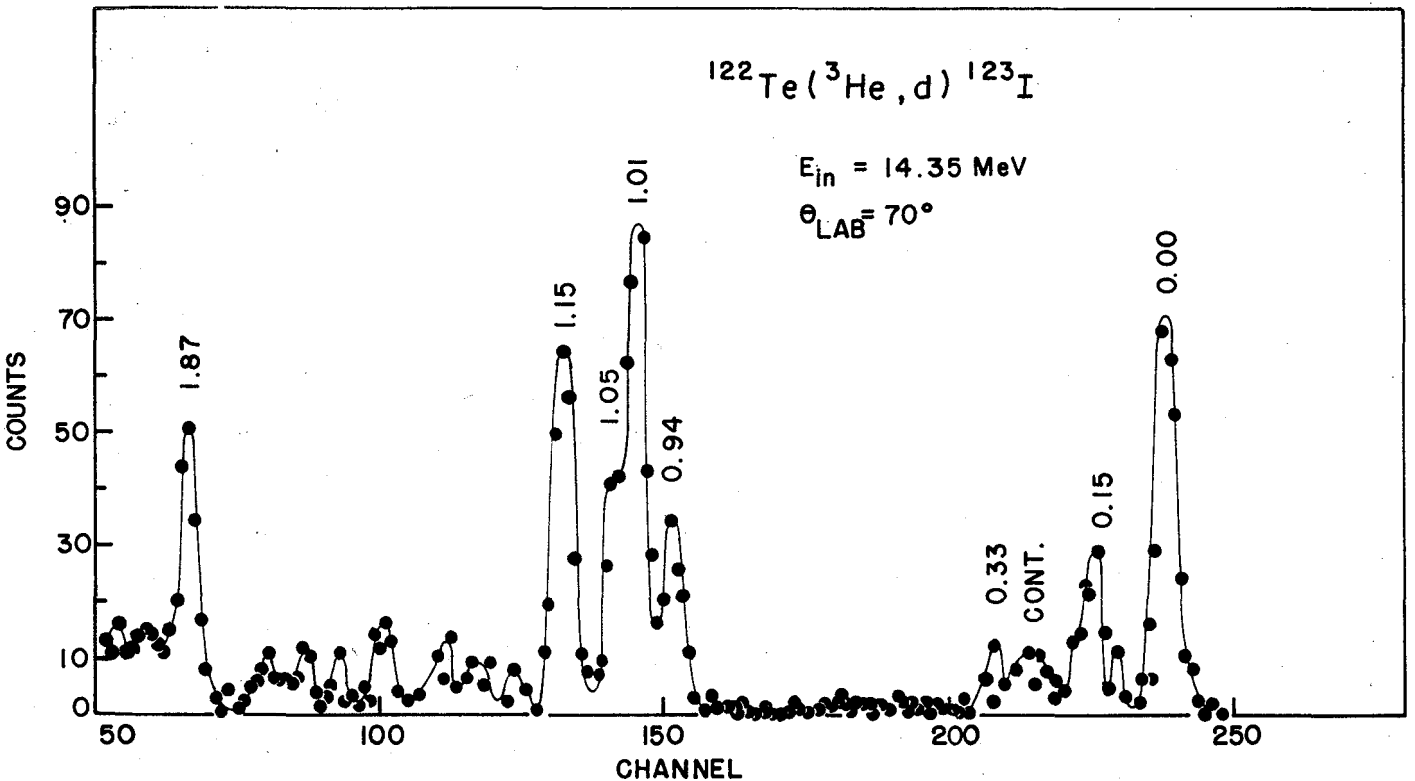

Fig. 4 - Typical deuteron spectrum.

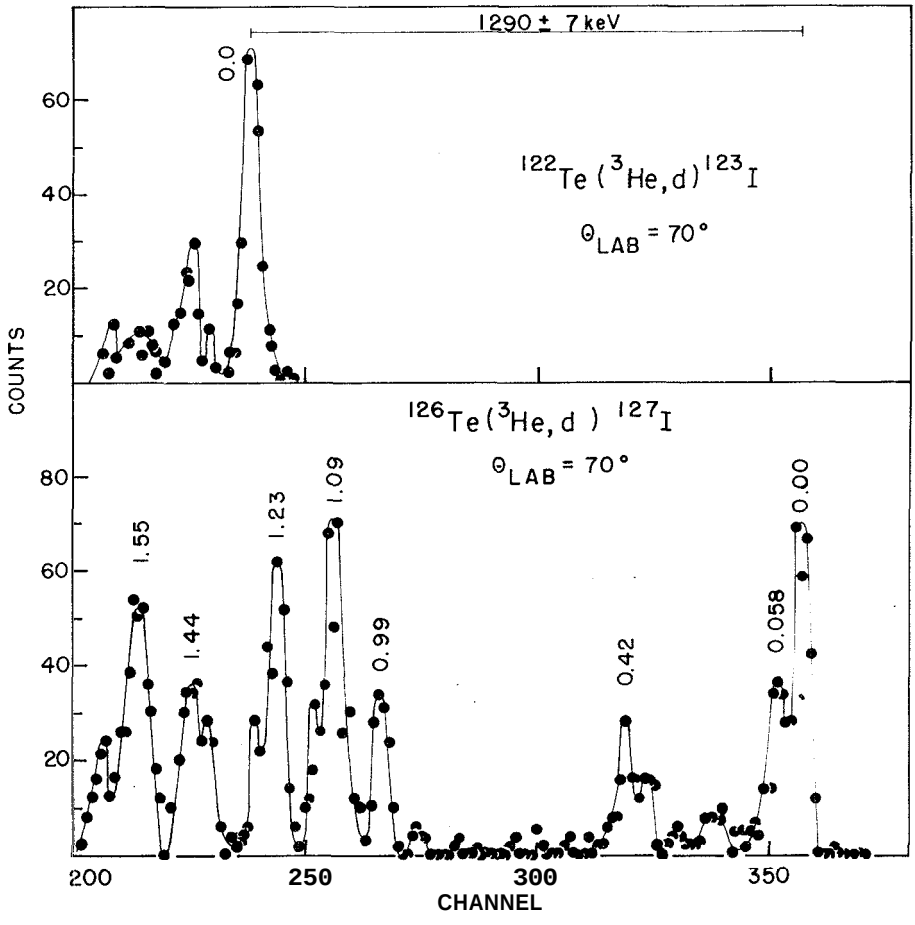

Fig. 5 - Relevant portions of the observed deuteron spectra from ^{122}Te and ^{126}Te targets.

REFERENCES

1. A.H. Wapstra and N.B. Gove, Nucl. Data Tables 9, 286 (1971).
2. A. Szanto de Toledo, M.N. Rao, N. Ueta and O. Sala (to be published).
3. O. Sala and G. Spalek, Nucl. Inst. & Meth. 122, 213 (1974).
4. A.T.M. Mendes, N. Ueta and M.N. Rao, Rev. Bras. Física 6, 139 (1976).
5. F.S. Goulding, D.A. Landis, J. Cerny and R.H. Pehl, Nucl. Inst. & Meth. *31,* 1 (1964).