The gamma rays of $^{99}$Tc excited through negatron decay of $^{99}$Mo have been studied by internal conversion spectroscopy, using a high resolution double focusing beta-ray spectrometer. Conversion electrons were observed for all transitions reported before. In addition a new gamma ray of energy $989.37 \pm 1.02$ keV could be identified and ascribed for the first time to the decay of $^{99}$Mo. Gamma-ray energies have been determined with high precision. Multipolarity data, obtained from the measurements of absolute or ratio of conversion coefficients of gamma rays, were utilized for assigning possible spins and parities to the levels of $^{99}$Tc.

From our present data combined with other studies spins and parities; $7/2^+, 1/2^-, 5/2^+, 3/2^-, 3/2^+$ and $5/2^-$ have been given to the 140, 142, 181, 514, 922 and 1131 keV levels respectively. The experimental level scheme is discussed in terms of theoretical predictions.

1. Introduction

The decay of 67 h $^{99}$Mo to $^{99}$Tc has been investigated by many workers$^{1-6}$ and the level scheme of $^{99}$Tc has been regarded as known. In most of the previous studies a scintillation either single or coincidence spectrum was determined and used in the elucidation of the decay scheme of $^{99}$Tc. The spins and parities of most of the levels in $^{99}$Tc were assigned from the study of $\log f t$ values of the beta branches populating them. The properties of low lying levels could be considered as certain, however those of high lying levels are not fully identified. RAVIOR et al.$^1$ studied the nuclear character of low energy $\gamma$-transitions by internal and external conversion techniques. Their conversion coefficients results confirmed the $5/2^+$ assignment for the 181 keV level in $^{99}$Tc. Recently, DOUKENS et al.$^6$ studied carefully the decay of $^{99}$Mo by means of $\gamma-\gamma$ and $\beta-\gamma$ coincidence techniques, however no definite conclusion concerning the properties of high lying levels in $^{99}$Tc could be given.

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In view of the inconclusive nature of the results concerning exact γ-energies as well as the properties of high lying levels in $^{99}$Tc, it was considered that further investigations of this nucleus are of great interest and may yield useful information regarding the properties of various energy levels and the cascade modes of decay. In the present investigation a high resolution double focusing beta-ray spectrometer was employed to study carefully the internal conversion electrons of gamma transition in $^{99}$Tc.

2. Experimental Procedures

The conversion electron spectrum studied has been obtained by the use of an iron yoke ($\rho_0 = 22.5$ cm) double focusing spectrometer*. The baffle has been set to give resolutions $\sim 0.3\%$. It was not practical to operate at better resolution due to the low specific activity of the source. Fortunately, improved resolution was not required to resolve any closely line groups. As detector a G.M. counter with end window of $\sim 2$ mg/cm$^2$ mica has been used. When necessary, corrections for absorption in the G.M. window and for the counter dead-time have been made.

Sources were produced by sputtering molybdenium oxide (enriched to $\sim 99\%$ $^{98}$Mo), onto aluminium foils of thickness 0.7 mg/cm$^2$, which then were irradiated in a thermal neutron flux of $\sim 10^{14}$ n/cm$^2$. s for about 12 days. The thickness of the material deposited was estimated to be $\sim 80$ $\mu$g/cm$^2$ and of dimension $1.5 \times 0.2$ cm$^2$. Before the measurements were started, the activity was allowed to decay for a necessary period so that the short lived activities, which may be produced would not disturb the measurements.

2.1. Conversion Electron Measurements

The internal conversion electron spectrum between 10 keV and 1.3 MeV has been studied, and the measurements were followed up in a repetitive way to scan the various line groups corresponding to gamma-rays previously reported. Each source was counted for more than three half-lives, which was as long as the majority of the sources were counted. No line with a half-life which could not be ascribed to the decay of $^{99}$Mo was observed. Energy calibrations were performed using $^{170}$Tm, $^{198}$Au and $^{137}$Cs as standard sources. Possible source asymmetry was compensated for. The precision conversion electron energies were observed for several transitions all ascribed to the decay of 67 h $^{99}$Mo, as shown in Table I.

* β-ray spectrometer type БПМ-2 (Moscow, 1957).