BETA-DECAY ENERGY MEASUREMENTS USING TOTAL GAMMA-ABSORPTION SPECTROSCOPY

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We have developed a new method for deternination of Q-values of nuclei far from stability with the help of a total gamma absorption (TGA) spectrometer. The essence of this method is to sum up energies of the cascade quanta arising in β-decay. This is done in a large γ-detector of a 4π-geometry. In our spectrometer [1] the NaI-crystal of 200 *mm* diameter and 200 *mm* length with an axial well of 40 *mm* diameter and 100 *mm* depth is used. Radioactive samples are positioned inside the well by means of a tape transportation system. The solid angle of the spectrometer is 98% of 4π. The full energy peak efficiency is about 20% at 7.5 *MeV*. The energy resolution of the spectrometer is about 9% at 1 *MeV*.

The Q_ε-values are determined from the γ-ray end-points obtained from plots of square root of the number of events in TGA spectra. This approach could yield very accurate values of Q_ε provided $S_\beta(E)$ were constant in the energy range used for the analysis of the data. However $S_\beta(E)$ is not known apriori and resonances lose to Q may exist in $S_\beta(E)$. The deviation of the β-strength function from a constant is the main source of systematical error of this method. According to our consideration of the problem this error is about 60 *keV*.

A thin β-detector placed in front of the source registers β-particles. Measuring the TGA-spectrum and TGA-spectrum in coincidence with the β-detector allowed us to determine the electron-capture to positron decay ratio and from these values it was also possible to obtain Q-values in an independent way.

Measurements of Q-values for a number of nuclei, for which the Q-values were measured before with rather high accuracy confirmed that the systematic error of the proposed method is within 60 *keV* [2]. Table presents the results of our measurements of Q-values for nuclei in the cases where the Q-values were not measured before or were measured with a low accuracy.

The present work demonstrates that the TGA spectroscopy is a convenient and rather powerful tool for measuring nuclear masses of nuclei far from stability.

Table

β-decay energies of proton-rich nuclei

Isotopes	Q_e,*Mev*	Isotopes	Q_e,*MeV*
^{122m}Cs	7.30(15)	^{154m}Ho	6.07(8)
^{129}Ce	5.60(20)	^{157}Tm	4.48(10)
^{131}Nd	6.56(15)	^{158}Tm	6.53(10)
^{131}Pr	5.25(15)	^{159}Lu	5.85(15)
^{143}Gd	6.16(20)	^{159}Yb	5.05(20)
^{145}Dy	7.30(20)	^{159}Tm	3.85(10)
^{145}Tb	6.40(15)	^{160}Lu	7.30(10)
^{146}Dy	5.16(10)	^{160}Tm	5.89(10)
^{147m}Dy	7.18(10)	^{161}Lu	5.30(10)
^{148}Ho	9.40(25)	^{161}Tm	3.18(10)
^{148m}Tb	5.91(8)	^{161}Tm	6.96(10)
^{149}Dy	3.95(10)	^{162}Lu	4.90(10)
^{150q}Ho	6.56(10)	^{162}Tm	4.60(20)
^{150m}Ho	7.06(8)	^{163}Lu	6.25(9)
^{150m}Tb	5.04(10)	^{164}Lu	3.92(8)
^{152m}Ho	6.33(10)	^{165}Lu	

References

1. Alkhazov G.D. et al. //Nucl.Phys., 1985. V.A438. 482.
2. Alkhazov G.D. et al. Preprint LNPI-1620. Leningrad. 1990. 22 p.