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DETECTION OF BE^7 GROUND STATE DECAY BY MEANS OF A CRYOGENIC μ-CALORIMETER

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Abstract

The detection of Be7 ground state decay by means of a cryogenic μ-calorimeter has been demonstrated. This kind of detector could have an important application in the environment of a lithium radio-chemical solar neutrino experiment which is in progress in Moscow [1].
The detector has been realised using a Beryllium metal foil containing Be7 isotope as absorber, and a NTD Ge as thermistor. A low energy spectral line at 112 eV has been successfully detected with an energy resolution of 66 eV FWHM.

1. Introduction

The Cryogenic Detectors Group of Genova is carrying on a line of investigation on electron capture processes [2]. Within this program the possibility of doing the counting of Be7 atoms by means of a micro-calorimeter has been investigated in collaboration with the group of Moscow. We are interested in the detection of ground state Be^7 decay because it can be useful in the solar neutrinos lithium radiochemical experiment which is in progress in Moscow [1].
Prof. Kopylov from INR of Moscow, prepared for us a source of Be7 in the form of a beryllium metal foil. This sample would be the final form of the beryllium extracted from the tanks of the lithium radiochemical experiment.
A prototype of the detector has been developed using this source, and the preliminary results obtained are reported in this paper.

2. Preliminary results

The schematic of the prototype Be7 counter is illustrated in Fig. 1.
The micro-calorimeter comprises a NTD-Germanium thermistor (100x200x200 μm) coupled to the Beryllium metal foil (100x80x200 μm) using epoxy. The detectors operate at a temperature of 50-60mK. An external x-ray source of Fe55 has been used as a calibration source.
The technique used in the detector mounting and in the signal processing and analysis is the same one applied to the cryogenic detectors developed by the Genova group for the study of Beta decay processes, and is reported in details elsewhere [2] [3],[4].
In Fig. 2 the preliminary spectrum of the electron capture K-line at 112 eV has been reported. The energy resolution of the Be7-line is 66 eV (FWHM).

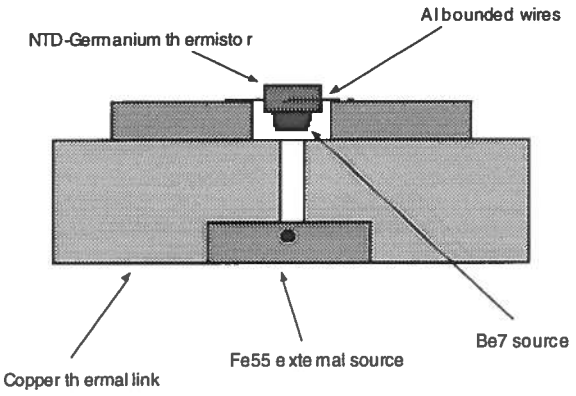

Fig. 1 Schematic of the prototype Be7 counter.

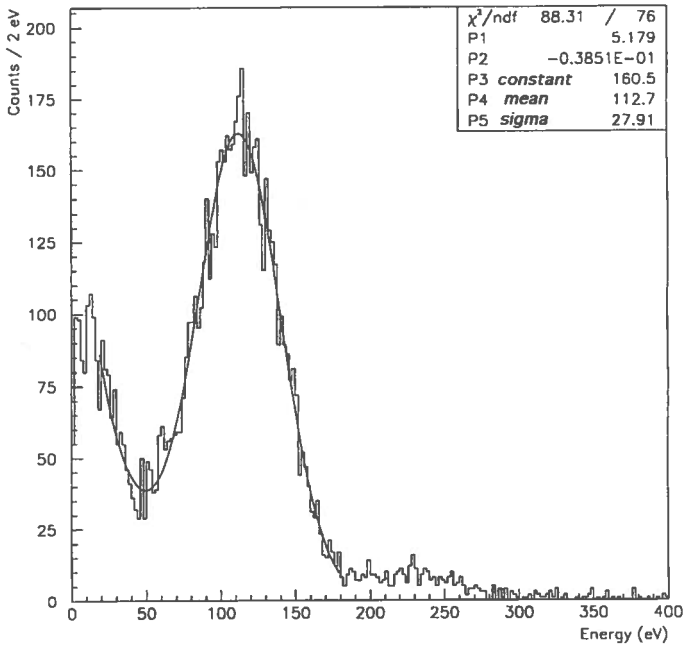

Fig. 2 Spectrum of the Be7 electron capture K-line at 112 eV.

The observed energy resolution is full compatible with the signal to noise ratio. The signal amplitude is limited by the detector heat capacity, mainly due to the Be metal foil contribution. Indeed a metal absorber is not the optimal choice for a micro-calorimetric detector, because of the high heat capacity of a metal with respect to a superconductive or a dielectric absorber. Nevertheless this is the optimal form to extract beryllium from the Lithium tank of the Moscow experiment; the extracted Beryllium metal powder can be easily compressed and a metal foil prepared[5].

The measured activity of the Be7 source at the measurement date is (2.3 ± 0.2) Bq. The activity error is quite large as it takes into account the uncertainty in the pile-up discrimination because for this preliminary test we used a relatively intense activity in order to be sure to single out the Be^7 signal with respect to background.
In order to check the attribuition of the observed 112 eV peak to the Be^7 K-electron capture decay, the same source has been measured again after 41 days. The activity at the measurement date in this second run is (1.4 ± 0.1) Bq, which is in agreement with the expected value calculated from the Be^7 half life [6].

3. Conclusion

The feasibility of a micro-calorimeter to detect the Be^7 decay in the Li^7 ground state has been proved.
We used as calorimeter absorber a Beryllium metal foil with an enclosed Be^7 source as this is the easier form for the Beryllium sample preparation in the radio-chemical solar neutrinos experiment. Although a metallic absorber is not the optimal choice for a cryogenic detector, a line at 112 eV has been successfully detected with an energy resolution of 66 eV FWHM. The variation of the measured activity of the Be^7 source ranged in a month is compatible with the theoretical one, and therefore we can identify the 112 eV line with the Be^7 K-electron capture line.

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