BETA DECAY OF ^{56}Cu TO EXCITED STATES OF ^{56}Ni

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Nuclei having *N* close to *Z* serve as a perfect laboratory for the study of nuclear properties dependent on residual proton-neutron interactions, since these interactions are expected to have their maximum when $N = Z$. We have completed a study of the ^{56}Cu β-decay to excited states of ^{56}Ni in order to measure the half-life and decay properties of this $T_Z = -1$ nucleus.

A ^{58}Ni^{15+} beam was extracted from the superconducting ECR source and accelerated to 70 MeV/nucleon using the K1200 cyclotron. The maximum beam intensity of ^{58}Ni measured before the A1200 production target was 1.6 pnA. The beam was made incident on a 202 mg/cm^2 Be target at the entrance of A1200 fragment separator. The momentum acceptance of A1200 was set to 3% using a slit at the first dispersive image. An Al wedge at the second dispersive image was used to separate the nuclei of interests from other fragmentation products. Further *M/q* separation was achieved using the Reaction Product Mass Separator (RPMS). Fragments were identified using their energy loss in a 300 μm Si PIN detector and the fragment time-of-flight measured between the K1200 cyclotron radiofrequency and Si PIN detector. An implantation detector telescope consisting of three Si detectors with thickness of 300, 150, and 1000 μm, respectively, was placed at RPMS tail. The implantation point was viewed by two Ge-detectors with relative efficiencies of 80% and 120% and a cylindrical β detector with a geometrical efficiency 80% of 4π.

The RPMS was tuned using stronger secondary beams of ^{55}Ni and ^{54}Co. After this, the magnetic field value of RPMS was tuned to be optimum at ^{56}Cu. Due to low count rates and scattered beam, the identification of ^{56}Cu was difficult. Clear evidence of the beta decay of ^{56}Cu to excited states of ^{56}Ni was seen with continuous beam implantation. The total collection time during this continuous beam was 4 1/2 hours and the resulting gamma spectrum is shown in Figure 1. A preliminary beta half-life has been determined by using the ratios of the growth-in (I_1) and decay period (I_2). If X is the length of the in-growth period and Y is the length of the decay period then the number of the observed decay events at in-growth and decay periods can be written as [1]:

$$I_1 = \int_0^X N(1-\exp(-\lambda t)dt = NX + \frac{N}{\lambda}(\exp(-\lambda X)-1)$$

$$I_2 = \int_0^Y N_0 \exp(-\lambda t)dt = \frac{N}{\lambda}(\exp(-\lambda X-1)(\exp(-\lambda Y)-1)$$

The ratio between integrals is

$$\frac{I_1}{I_2} = \frac{\lambda X + \exp(-\lambda X)-1}{(\exp(-\lambda X)-1)(\exp(-\lambda Y)-1)}$$

Using this information the value of λ can be obtained from the above equations by iteration. The data used for the in-growth period was the continuous beam implantation data (saturated source) and the data used for the decay period included all runs collected using a 100 ms beam off time. The total collection time during the decay period runs was 10 hours. Using the counts in the ^{56}Ni γ-peaks with energies of 1223, 2700, and 3700 keV, we extract a preliminary half-life of 0.2 +0.3/-0.1 s.

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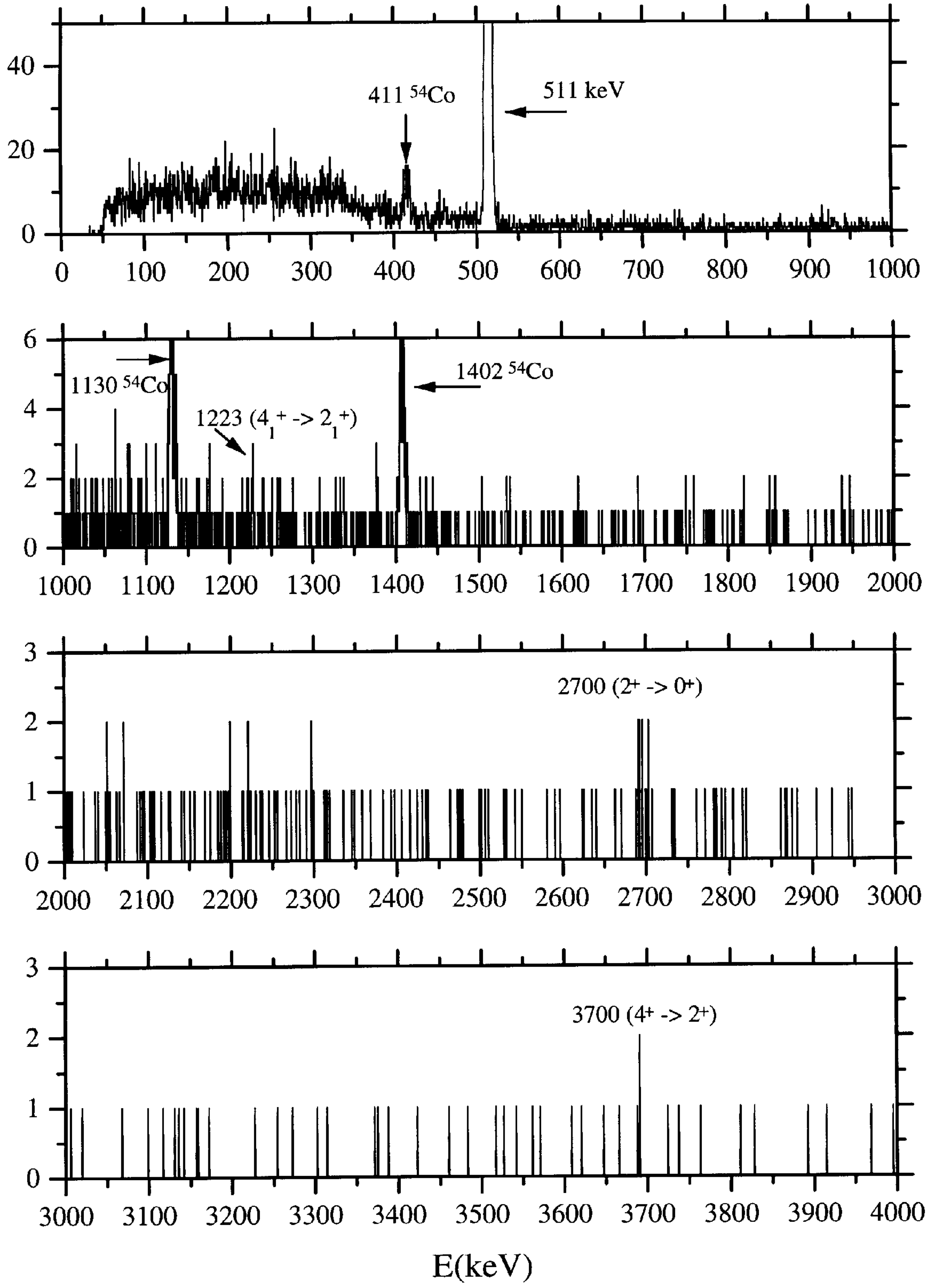

Figure 1. Partial gamma-ray spectrum showing transitions observed following the beta decay of ^{56}Cu.

References

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