β-decay of ^{78}Cu produced with the ISOLDE resonance ionization laser ion source

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PACS. 21.10.-k – 23.40.-s – 25.85.Ec – 27.50.+e – 32.80.Fb

Nuclides in the vicinity of the doubly magic ^{78}Ni nucleus are ideal test cases for the nuclear shell model [1, 2]. Still, experimental data in this region is rather scarce because of experimental limitations. In this contribution we report the first observation of the β-decay of ^{78}Cu, only one proton and one neutron hole away from ^{78}Ni.

Heavy copper isotopes were produced at the ISOLDE-facility at CERN (Geneva, Switzerland) [3]. A Ta rod, serving as a proton-neutron-converter, was bombarded by high-energy (1.4 GeV) protons and mainly the low energy spallation neutrons hit the parallel mounted standard ISOL uraniumcarbide/graphite target to induce rather low-energy fission [4]. This method helped to suppress the omnipresent background of neutron-deficient rubidium isotopes produced abundantly in high-energy fission.

The ionization with the ISOLDE RILIS (resonance ionization laser ion source) [5, 6] allowed to separate the copper isotopes with increased selectivity to compete with the background of isobars produced in orders of magnitude higher quantities. After extraction and mass separation, the ^{78}Cu isotopes were collected and the radioactive decay was measured using a $\beta-\gamma-\gamma$-coincidence set-up.

The experiment permitted the first observation of the β-delayed γ-decay of ^{78}Cu. The $4^+ \rightarrow 2^+$ and $2^+ \rightarrow 0^+$ transitions in the daughter nucleus ^{78}Zn, known from literature [7], with energies of 890.7(3) keV and 730.4(3) keV respectively, were observed. Both γ-ray transitions are in coincidence and have equal intensities. A third γ-ray of 114.9(2) keV was also observed in the β-decay of ^{77}Cu and thus unambiguously attributed to being populated in β-delayed neutron emission to ^{77}Zn. This β-delayed neutron branch of $P_\mathrm{n} = 65(20)\%$ (deduced from the observed γ-ray intensities) is unexpectedly strong. The half-life determined from these γ-rays is $T_{1/2} = 290(103)$ ms and agrees well with the values known from literature 342(11) ms [8] and 335(6) ms [9] which were measured by detection of β-delayed neutrons. The deduced decay scheme is shown in Fig. 1.

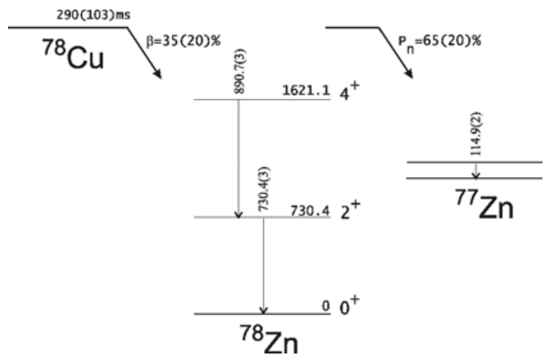

Fig. 1. Deduced decay scheme for the β-decay of ^{78}Cu.

This work was supported by the European Union (contract ERBFMGEECT980120).

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J. Äystö et al. (eds.), *Exotic Nuclei and Atomic Masses*