Beta Decay of ^{56}Cu

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Beta-decay studies of proton-rich isotopes near the doubly closed-shell nucleus ^{56}Ni are of interest as (i) nuclei with a few nucleons outside a doubly-magic core are expected to represent comparatively simple configurations and thus be useful for testing nuclear shell-model predictions, and (ii) the large decay-energy window permits to experimentally access a sizeable fraction of the strength of the allowed β decay. Moreover, nuclear structure properties of proton-rich N $\sim$ Z isotopes are of astrophysical interest, e.g., concerning the EC cooling of supernovae and the astrophysical rp-process.

The β decay of ^{56}Cu was studied at the GSI On-line Mass Separator by using a 5.5 MeV/u ^{32}S beam from the UNILAC to induce ^{28}Si(^{32}S, p3n)^{56}Cu fusion-evaporation reactions. The reaction products were stopped in a catcher inside an ion source, released as singly-charged ions, accelerated to 55 kV and mass-separated in a magnetic field. The A=56 beam was implanted into a movable tape and investigated by means of a β-γ-γ detector array consisting of two composite high-resolution germanium (Ge) detectors and a plastic scintillator.

The ^{56}Cu decay to the doubly-magic nucleus ^{56}Ni has been investigated for the first time at the On-line Mass Separator in 1996 [1]. Four γ transitions have been observed, corresponding to the β-feedings of three excited ^{56}Ni states, and a half-life of (78 $\pm$ 15) ms has been determined. In the present experiment [2], due to the more efficient detection set-up and a longer measurement time, the quality of the data was considerably improved, and it was in particular possible to observe γ-γ coincidences. Six γ transitions were identified besides the four ones already known, three new states were added to the level scheme of ^{56}Ni, and the half-life ((92 $\pm$ 3) ms) was determined more accurately. By using the newly determined level scheme and halflife, β feedings and reduced Gamow-Teller (GT) transition probabilities (B(GT)) were deduced with higher accuracy. The experimental B(GT) values were confronted with predictions obtained from five shell-model calculations. Two of these theoretical predictions, one using the FPD6* [3] and the other the KB3G [4] interaction, are presented together with the experimental results in Fig. 1. The shell-model calculations include a 'quenching factor' of 0.74 [5]. It was found that the experimental GT-strength distribution over ^{56}Ni states between 3.9 and 6.6 MeV qualitatively agrees with the predictions (see [2]). We consider this to be a valuable test of shell-model calculations, including their ability to reliably predict the higher-lying GT strength. Moreover, the identification of hitherto unobserved low-spin states in ^{56}Ni is important for further improvement of data from in-beam spectroscopy as well as for further tests of nuclear models. Finally, it was shown [2] that the new experimental data do not imply a revision of the calculated stellar weak-interaction rates of A=56 nuclei [6].

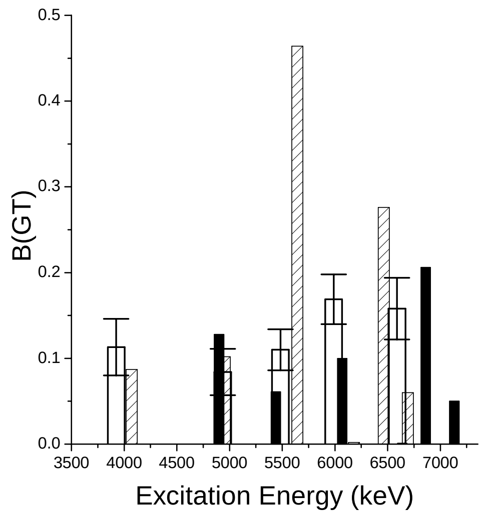

Figure 1: Experimental B(GT)values (empty bars) for the ^{56}Ni levels together with shell-model predictions obtained by using the FPD6* (dashed bars) and KB3G interactions (black bars).

[1] M. Ramdhane *et al.*, Phys. Lett. B 432 (1998) 22
[2] R. Borcea *et al.*, submitted to Nucl. Phys. A
[3] T. Otsuka *et al.*, Phys. Rev. Lett. 81 (1998) 1588
[4] A. Poves *et al.*, nucl-th/0012077, submitted to Nucl. Phys. A
[5] G. Martínez-Pinedo *et al.*, Phys. Rev C 53 (1996) 2602
[6] K. Langanke and G. Martínez-Pinedo, Nucl. Phys. A 673 (2000) 481