Decay Properties of Neutron Deficient Nuclei near ^{100}Sn – First Results

T. Faestermann, M. Münch, R. Schneider, A. Stolz, K. Sümmerer [a], E. Wefers, J. Friese, H. Geissel [a], J. Gerl [a], M. Hellström [b], P. Kienle, H.-J. Körner, G. Münzenberg [a], C. Schlegel [a], K. Schmidt [a], R. Simon [a], P. G. Thirolf, H. Weick [a], and K. Zeitelhack

[a] GSI Darmstadt [b] University of Lund, Sweden

Neutron deficient nuclei near ^{100}Sn were produced by fragmentation of a $1A \cdot GeV$ ^{112}Sn beam in a beryllium target. The reaction products were separated and identified [1] in the FRS at GSI and implanted into an implantation detector which was designed to allow for a 4π spectroscopy of the emitted β^+ and beta-delayed protons with very low background and high efficiency [2]. For measuring γ-radiation the implantation detector was surrounded by a 6-fold segmented NaI detector covering 2π and a Ge clover detector in close geometry. All components worked perfectly.

The main aim of the experiment S192 at GSI was to determine the Gamow-Teller strength in the decay of ^{100}Sn and neighbouring nuclei. After about 50 hours of beam with the expected intensity we had observed just one event which could be clearly identified as ^{100}Sn. The corresponding cross section is about 1 pb, a factor of 200 smaller than anticipated, based on our own measurements in 1994 with the ^{124}Xe beam [3,4] and on the yields measured at GANIL using a ^{112}Sn beam [5].

It was obvious that it would not be possible to improve considerably the statistics on the ^{100}Sn decay properties compared to the 7 decays we had already detected in 1993 [3,4]. Therefore we concentrated our efforts on the nuclei in the neighbourhood of ^{100}Sn.

For determining the Gamow-Teller strength, we collected beta- and gamma-data of ^{98}Cd [6], where the Q-value is unknown, and ^{102}Sn, where even the halflife and the beta-decay branching are unknown. Next to ^{100}Sn these two nuclei are the best candidates to address the problem of missing Gamow-Teller strength.

Our further interest referred to Fermi beta emitters and nuclei on the path of the rp-process.

The heaviest nuclei, where one can hope to study pure Fermi beta transitions are the odd-odd N=Z nuclei up to ^{98}In. We investigated the six cases between ^{78}Y and ^{98}In and will be able to show if the heavier three have also a low lying T=1, 0^+ state decaying with an extremely fast superallowed Fermi transition as has recently been shown at GANIL [7] for the three lighter members of this series ^{78}Y to ^{86}Tc. Moreover, the study of odd-odd N=Z nuclei provide a unique laboratory for the study of pairing correlations and isospin symmetry in nuclear systems [8].

In addition we extended the region of known waiting point nuclei in the rp-process up to ^{92,93}Pd (fig. 1). The total lifetime of these waiting points exclusively determine the velocity of the flux to heavier nuclei and the produced isotopic abundances. The decay properties of these nuclei are poorly known and we will be able to determine their halflives, which are necessary input data for rp-process calculations [9].

Another important question regarding rp-process calculations is the exact location of the proton dripline. Therefore we searched for the possible proton unstable nuclei ^{77}Y and ^{81}Nb. Apart from astrophysical motivations, the p-dripline provides a crucial test of mass models.

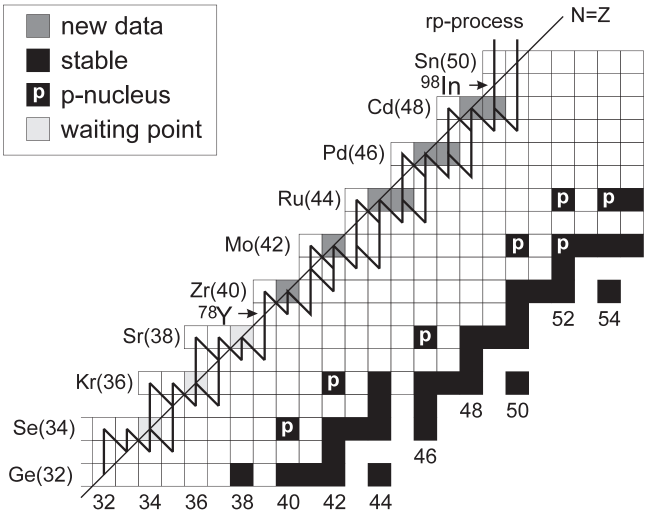

Fig. 1: Reaction flux of the rp-process. The boxes named "p" indicate nuclei, which are only produced via the rp-process. The dark grey boxes show wainting point nuclei for which we collected new decay data.

Finally we obtained much more information on fragmentation cross sections in the above discussed regions and even on such exotic processes, where the "fragment" has one or two protons more than the beam. These data will help to improve the parameters in empirical fragmentation calculations and thus to design future experiments.

While we are analyzing these data, we will consider the possibilities to improve the available intensity of a ^{124}Xe beam in order to produce - now with known cross section - enough ^{100}Sn nuclei, to measure precisely its halflife and decay energy.

References

[1] T. Faestermann *et al.*, this report p.90
[2] T. Faestermann *et al.*, this report p.91
[3] R. Schneider, Ph.D. thesis, TU München, 1996
[4] R. Schneider *et al.*, Z. Phys. **A348** (1994) 241
[5] M. Lewitowicz, Phys. Lett. **B332** (1994) 20
[6] A. Plochocki *et al.*, Z. Phys. **A342** (1992) 43
[7] C. Longour *et al.*, Phys. Rev. Lett. **81** (1998) 3337
[8] D. Rudolph *et al.*, Phys. Rev. Lett. **76** (1996) 376
[9] H. Schatz, Ph.D. thesis, Forschungszentrum Karlsruhe, 1998