Test of Two-Neutron Transfer Reactions with ^{10}Be Targets at the Q3D

W. Schwerdtfeger, C. Alvarez, A. Bergmaier, G. Dollinger, T. Faestermann, R. Gernhäuser, D. Habs, T. Kröll, R. Krücken, H.J. Maier, T. Morgan, P.G. Thirolf, H.H. Wolter, and W. von Oertzen [a]

[a] Hahn-Meitner-Institute, Glienicker Str. 100, 14109 Berlin (Wannsee)

Two-neutron transfer reactions are a useful tool for nuclear structure studies around the island of inversion ($N \simeq 20-28, A \simeq 30-45$). In particular the study of the nucleus ^{32}Mg via the two-neutron transfer reaction (^{30}Mg,^{32}Mg) may yield important information on the shape coexistence in single-magic nuclei. The ground state of ^{30}Mg is spherical whilst the ground state of ^{32}Mg is deformed with $\beta \sim 0.5$. The reason is the large difference between the neutron and the proton number and the resulting $\tau\sigma$ coupling [1]. A spherical 0^+ state is predicted to exist at an excitation energy of ~ 1.55 MeV [2].

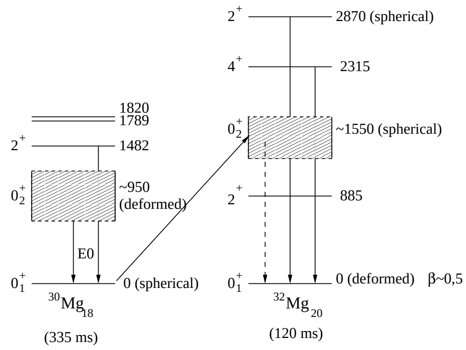

Fig. 1: Excited states and deformation of ^{30}Mg and ^{32}Mg

While transfering two neutrons from ^{30}Mg to ^{32}Mg the shape of the nucleus is conserved and the excited spherical 0^+ state is expected to be predominantly populated (see Fig. 1).

The ideal target [3] for these studies is ^{10}Be, providing a clear trigger for two-neutron transfer via the 2α particles produced in the decay of the (unbound) ^{8}Be reaction product. ^{10}Be is a very rare radioactive target material. We used enriched material (61.4% ^{10}Be oxide, rest ^{9}Be).

Also DWBA calculations using FRESCO [4] were performed. The optical-model parameters of the reaction ^{10}Be(^{26}Mg,^{28}Mg)^{8}Be will be extrapolated to estimate the cross section for the reaction ^{10}Be(^{30}Mg,^{32}Mg)^{8}Be. The cross section for the two-neutron transfer can be expected to be about one order of magnitude lower than the one of the one-neutron transfer.

The ^{10}Be(^{30}Mg,^{32}Mg)^{8}Be experiment will be performed at REX-ISOLDE with the MINIBALL γ-ray spectrometer [5]. In preparation of this one- and two-neutron transfer measurements with ^{9}Be and ^{10}Be targets using ^{16}O and ^{26}Mg beams were done at the Q3D magnet spectrograph in Garching in order to quantify the transfer cross sections. Another preparatory γ-spectroscopy experiment with a ^{26}Mg beam using MINIBALL will be done in Cologne.

First two-neutron transfer measurements with ^{10}Be targets (20 μg/cm^2) with a thin carbon backing (38 μg/cm^2) using ^{16}O and ^{26}Mg beams were performed at the Q3D in Garching. The ejectiles of the reactions ^{9}Be(^{16}O,^{17}O)^{8}Be / ^{10}Be(^{16}O,^{18}O)^{8}Be and ^{9}Be(^{26}Mg,^{27}Mg)^{8}Be / ^{10}Be(^{26}Mg,^{28}Mg)^{8}Be were detected at Q3D angles of 20° and 10°. These angles are close to the grazing angles 26.2° and 11.3° for the oxygen and magnesium-induced reactions, respectively. For the α detection a 6×4cm^2 Silicon-strip detector with 14 strips was placed inside the target chamber covering the α angles $80° \pm 20°$ and $90° \pm 20°$, respectively. The beam energy in all cases was chosen to be 2.3 MeV/u, equivalent to the beam energy presently available at REX-ISOLDE. This resulted in a beam energy of 36.8 MeV (59.8 MeV) for ^{16}O (^{26}Mg).

For comparison the one-neutron transfer was measured with a self-supporting metallic (74 μg/cm^2) and a carbon-backed (50 μg/cm^2) ^{9}Be target. For the two-neutron transfer a 20 μg/cm^2 ^{10}Be target on a C backing was used.

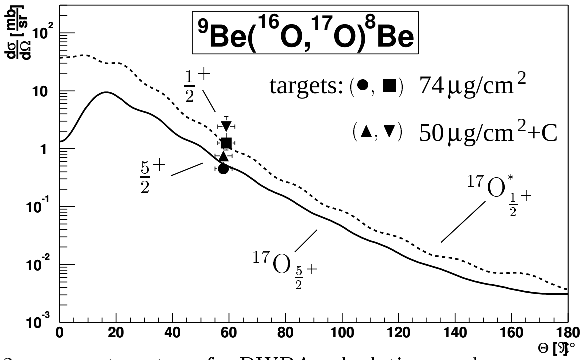

Fig. 2: one-neutron transfer DWBA calculations and measurements

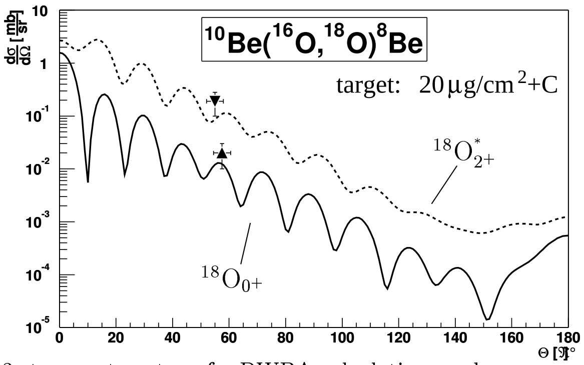

Fig. 3: two-neutron transfer DWBA calculations and measurements

First results of the one- and two-neutron transfer measurements ^{9}Be(^{16}O,^{17}O)^{8}Be and ^{10}Be(^{16}O,^{18}O)^{8}Be are shown in Fig. 2 and 3. The lines represent the DWBA calculations with parameters taken and adapted from [6,7]. The experimental data points are superimposed onto the DWBA predictions. For the one-neutron transfer with the metallic target the experimental results perfectly agree with the calculations. The cross section obtained with the backed target systematically exceeds the predictions. However there is agreement within the errors. Also the experimental results of the two-neutron transfer agree within errors with the calculation.

References

[1] T. Otsuka *et al.*, Phys. Rev. Lett. **87** (2001) 082502
[2] D. Guillemaud-Mueller *et al.*, Eur. Phys. J. **A13** (2002) 63
[3] H.J. Maier *et al.*, Annual report 2000, p. 64
[4] I.J. Thompson *et al.*, Comp. Phys. Rep. **7** (1987) 167
[5] J. Eberth *et al.*, Prog. Part. Nucl. Phys. **46** (2001) 389
[6] I. Weitzenfelder *et al.*, Nucl. Phys. **A489** (1988) 125
[7] M. Bernas *et al.*, Phys. Rev. **C19** (1979) 2246