Q3D-Measurement of ^{232}Pa and ^{230}Pa

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In October 2007 a ten days measurement was done at the Q3D-spectrometer to explore the unknown excitation spectra of ^{232}Pa and ^{230}Pa. For this purpose the reactions ^{231}Pa($\vec{d}$,p)^{232}Pa and ^{231}Pa($\vec{d}$,t)^{230}Pa were used. The polarized deuteron beam impinged with an energy of 22 MeV onto the rare ^{231}Pa target with a thickness of 140 μg/cm^2. Due to the odd proton number of the target (Z=91), it was necessary to measure in addition the reactions ^{230}Th($\vec{d}$,p)^{231}Th and ^{234}U($\vec{d}$,t)^{233}U as references. The spectra from these reactions also serve as energy calibration, as the energies of the excited states in ^{232}Pa and ^{230}Pa are completely unknown [1,2]. All four reactions were measured with both polarizations of the beam at 9 scattering angles between 7 ° and 45 °. The analysis of the promising data set started with the (d,p) reactions. Figure 1 shows two typical spectra. Already 50 new excited energy states below 800 keV could be identified in ^{232}Pa. The analysis of the (d,t) data will follow as soon as the (d,p) data analysis is completed.

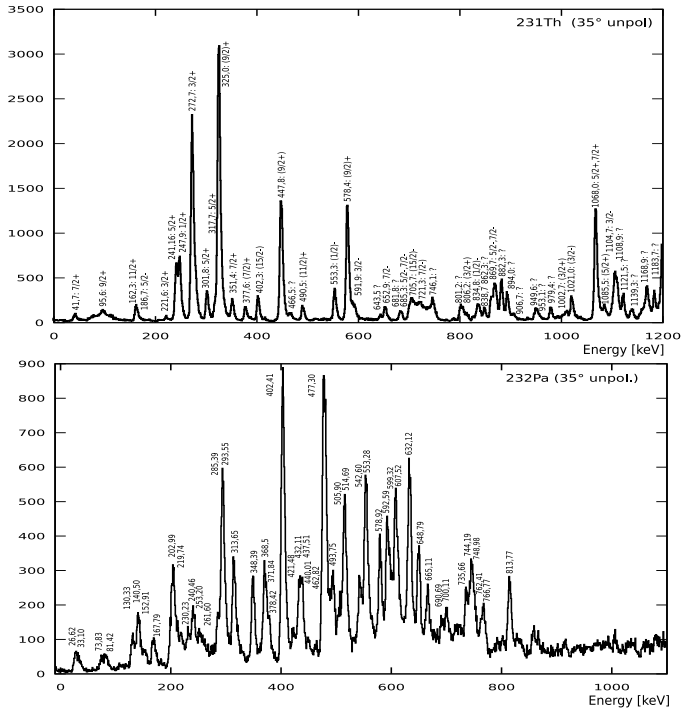

Fig. 1: Typical spectra from the reactions ^{230}Th($\vec{d}$,p)^{231}Th and ^{231}Pa($\vec{d}$,p)^{232}Pa. The ^{231}Th spectrum serves as calibration spectrum for the unknown spectrum of ^{232}Pa.

The angular distributions of the transfer cross section to specific excitation states and the corresponding analyzing power is extracted from the spectra of the different angles and polarizations. Figure 2 shows typical angular distributions. By comparison of these measured angular distributions to calculated distributions the transfered total angular momentum and orbital angular momentum can be extracted and thus a spin and parity assignment for unknown states will be performed.

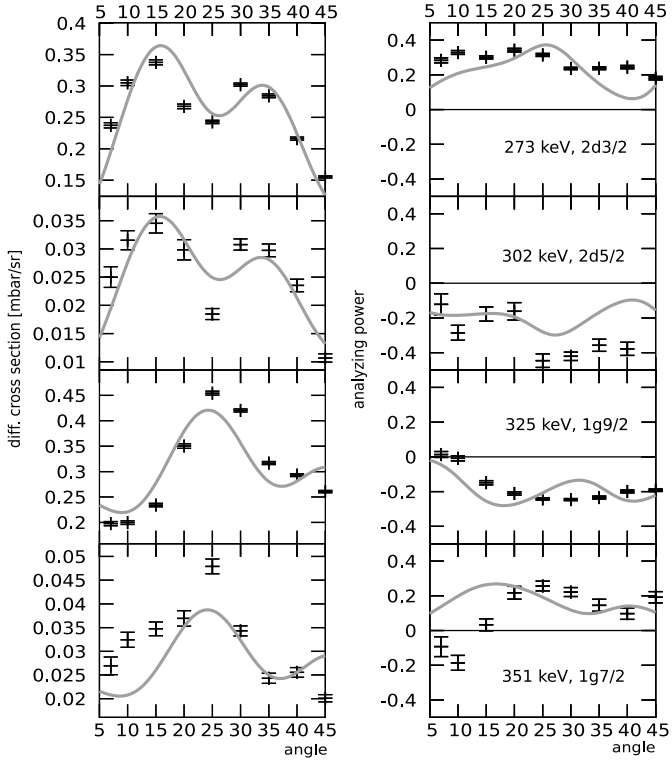

Fig. 2: angular distributions for the transfer to four well known states in ^{231}Th. The curves are the theoretical expected angular distributions for that transfer.

The curves in figure 2 show the calculated angular distributions using the optical parameters from [3]. Optimization of the parameter set, which does not describe the data sufficiently, is on going.

References

[1] Y.A. Akovali Nuclear Data Sheets for A = 230 **69** (1993) 155-208
[2] E. Browne Nuclear Data Sheets for A = 232 **107** (2006) 2579-2648
[3] C.M. Perey and F.G. Perey Atomic Data and Nuclear Data Tables **17** (1976) 1-101