# Spectroscopy of $^{196}$Au via the $(\vec{d}, \alpha)$ Reaction ◇

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The nucleus $^{196}$Au is a member of a quartet of nuclei (see Fig. 1) that might be described within the theory of extended supersymmetry [1]. The motivation for the $(\vec{d}, \alpha)$ measurement is given by the fact that the study of $^{196}$Au by one-neutron transfers like $^{197}$Au(d,t) cannot determine quantum numbers unambigously. The target nucleus has an odd proton number which results in a spin of $3/2^+$. Thus up to four transferred angular momenta can contribute to the same final state. The measured angular distributions are difficult to analyze and a spin and parity value of a level cannot be determined unambiguously in most cases.

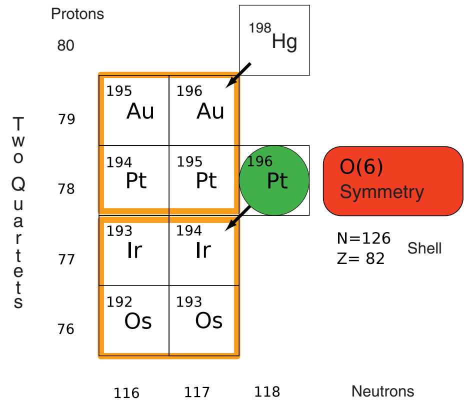


Fig. 1: The two quartets of interest for the model of supersymmetry. The $(\vec{d}, \alpha)$ reaction is symbolized by an arrow.

Much better is the situation if the target nucleus has even proton and neutron numbers. Then the target spin is 0 and the angular distributions become more easy to interpret. This is why the reaction $^{198}$Hg$(\vec{d}, \alpha)^{196}$Au is preferable, even if to some final states (with $\pi \neq (-)^J$) two different $L$-transfers can contribute. This is due to the two-nucleon pick-up. Nevertheless this measurement is difficult because the cross sections are nearly two orders of magnitude smaller than in (d,p) or (d,t). The requirement on the ion source [2] (high currents on target), the detector [3] (radiation hardness), the Q3D and accelerator (longterm stability) are high.

At eight angles between 10 and 60 degrees two separate spectra have been recorded for deuteron spin up and down. The target consisted of $40\,\mu$g/cm$^2$ mercury (96.4 %$^{198}$Hg) sulfide, evaporated on an $8\,\mu$g/cm$^2$ carbon backing. The polarized deuteron current on target was up to $2\,\mu$A, but had to be decreased because of the high vapor pressure of the mercury sulfide. A target between two layers of carbon was more stable and used for normalization of the cross sections. Figure 2 shows the spin up and spin down spectra for $^{198}$Hg$(\vec{d}, \alpha)^{196}$Au at $E_d = 18$ MeV and a laboratory angle of 40 degrees. The big effect of the polarization is visible when comparing the lines at $E_x = 166.6$ keV and $E_x = 348.6$ keV. The FWHM is 8 keV.

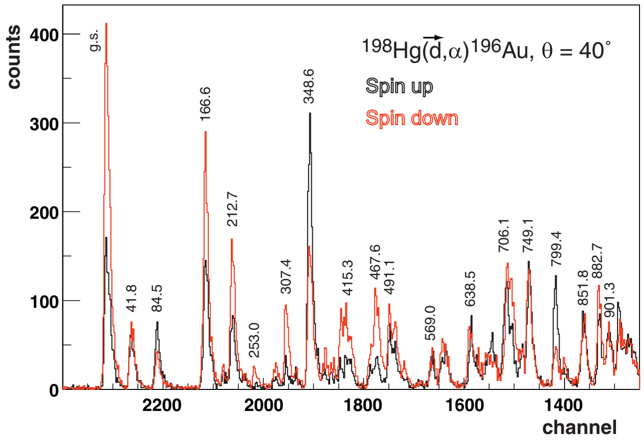


Fig. 2: Spectra of the $^{198}$Hg$(\vec{d}, \alpha)^{196}$Au reaction at $E_d = 18$ MeV. Some peaks are labeled with their excitation energy in keV.

In Fig. 3 typical angular distributions are shown. The detailed comparison with the theory is in progress.

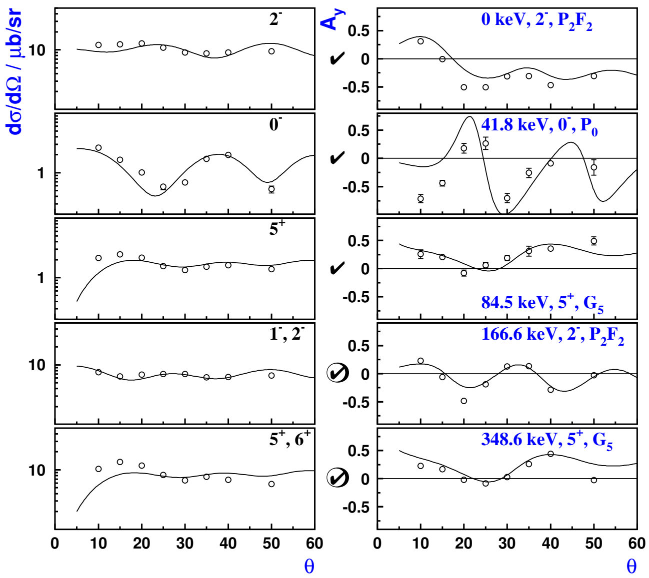


Fig. 3: Typical angular distributions of the $^{198}$Hg$(\vec{d}, \alpha)^{196}$Au reaction. Left: Absolute cross sections and $J^\pi$ values from NDS. Right: Analyzing powers and assignments from $(\vec{d}, \alpha)$. The lines are results of DWBA calculations.

## References

[1] A. Metz *et al.*, *Evidence for the Existence of Supersymmetry in Atomic Nuclei*, Phys. Rev. Lett. **83**(8), 1542 (1999).

[2] R. Hertenberger *et al.*, *A High Intensity Stern-Gerlach Polarized Hydrogen Source for the Munich MP-Tandem Laboratory Using ECR Ionisation and Charge Exchange in Cesium Vapor.* In *Spin 2000, Osaka 2000, AIP Conf. Proc. 570*, ed. K. Hatanaka, p. 825 (2000).

[3] H.-F. Wirth *et al.*, Annual report 2000, p. 71

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