SHELL STRUCTURE STUDIES IN THE Pb-REGION

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The depletion of shell model strength has been the subject of many studies which were prompted by the low occupancies of several many-body predictions. In particular the 3s proton occupancy in doubly magic ^{208}Pb permits convenient access to the influence of the short-range correlations through the underlying characteristic shape of the 3s wave function. For this purpose we have developed the CERES method (Combined Evaluation of Relative spectroscopic factors and Electron Scattering), which was successfully applied to earlier low resolution proton transfer data (ref. 1,2). An increase of precision and a clarification of open spectroscopic problems were expected and obtained from our measurements at the IUCF of ($\vec{d}$,^{3}He) cross sections and analyzing powers at 80 MeV incident energy, where cross sections for all three isotones, ^{204}Hg, ^{205}Tl and ^{206}Pb, have been measured relative to that of ^{208}Pb in the same setup.

The measurements were performed with the K600 magnetic spectrometer. Targets of isotopically enriched ^{204}Hg^{34}S and ^{205}Tl, evaporated on thin carbon backings, and ^{206,208}Pb, as self-supporting foils, were used. Particle identification was established via time of flight through the spectrometer. An energy resolution of 30 – 55 keV was achieved, depending on target thickness. The 30 keV resolution was enough to separate the 39 keV ground state doublet of ^{203}Au. The ^{3}He spectra taken on the four targets at $\theta_{lab} = 8.5°$ are shown in Fig. 1 where the states containing 3s-strength have been marked by a dot. Note that the fragmentation of strength observed in ^{205}Tl and ^{206}Pb is counterbalanced by shell effects in ^{204}Hg.

In Fig. 2 we present the angular distributions of cross sections measured on ^{204}Hg in the range of 4° to 22°. The distinct patterns allow for a unique ℓj assignment and the extraction of relative spectroscopic factors by comparison to exact finite-range DWBA calculations (solid line fig. 2). A light mass contaminant was found in the ^{205}Tl($\vec{d}$,^{3}He) reaction to have caused the previous erroneous $\ell = 0$ assignment at $E_x \sim 3.9$ MeV (ref. 2). The present proton transfer data agree well with earlier data (ref. 2 – 5) in the low excitation part, and extend to significantly higher excitation energies.

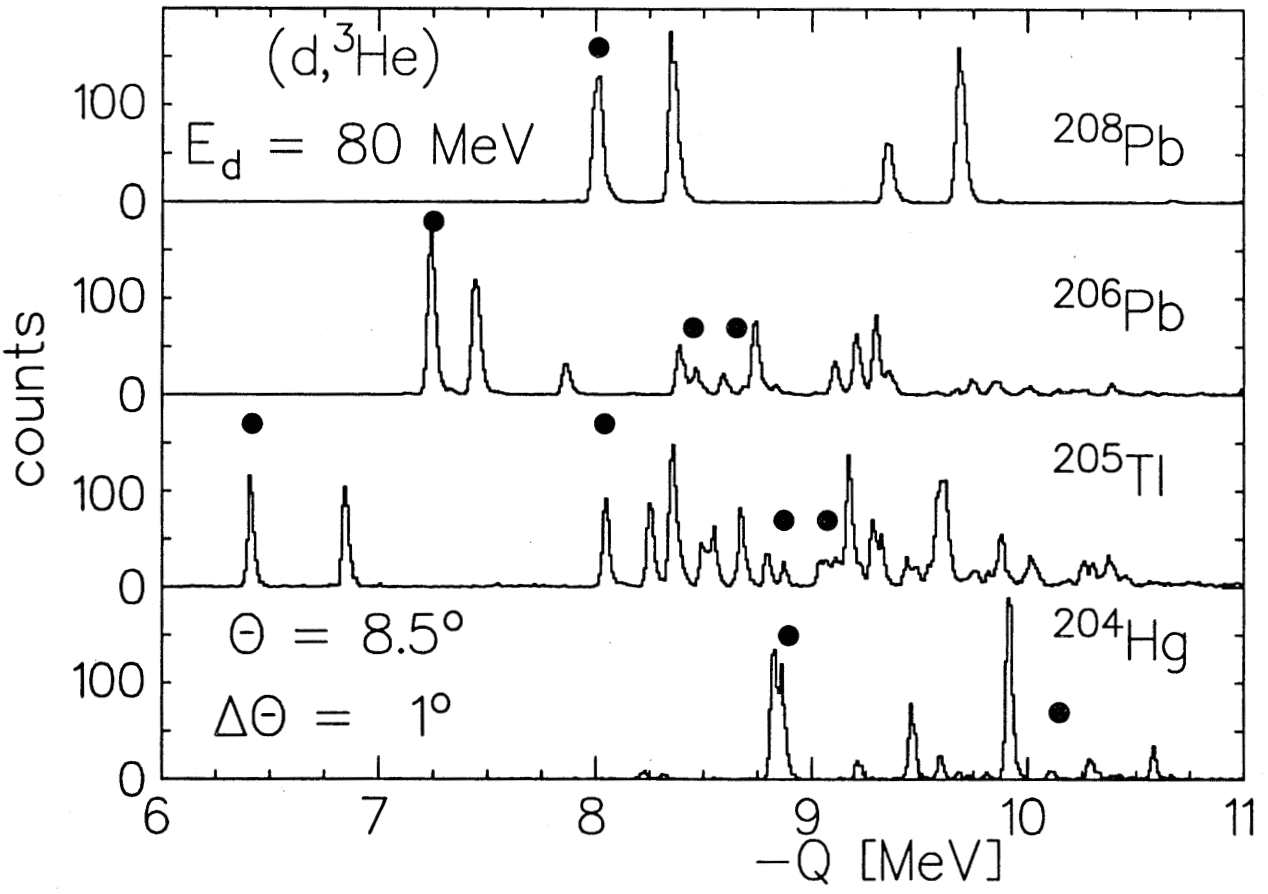

Figure 1. ^{3}He-spectra for ^{204}Hg, ^{205}Tl and ^{206,208}Pb taken at $\theta_{lab} = 8.5°$. The 3s strength is marked by full dots.

Combining all proton transfer and knockout data (refs. 2 – 6) we determined the 3s proton occupation number in ^{208}Pb as $n = 2.46(16)z$, where z is the 3s part of the charge density difference of ^{205}Tl and ^{206}Pb. Using the most recent value of $z = 0.64(6)$ (ref. 7) we obtain $n = 1.57(17)$. Note, that most of the uncertainty comes from z. With the present data we predict the 3s part of the charge density difference between ^{204}Hg and ^{206}Pb to be $z' = 0.74(10)$, which is only 16% larger than the difference z between ^{205}Tl and ^{206}Pb.

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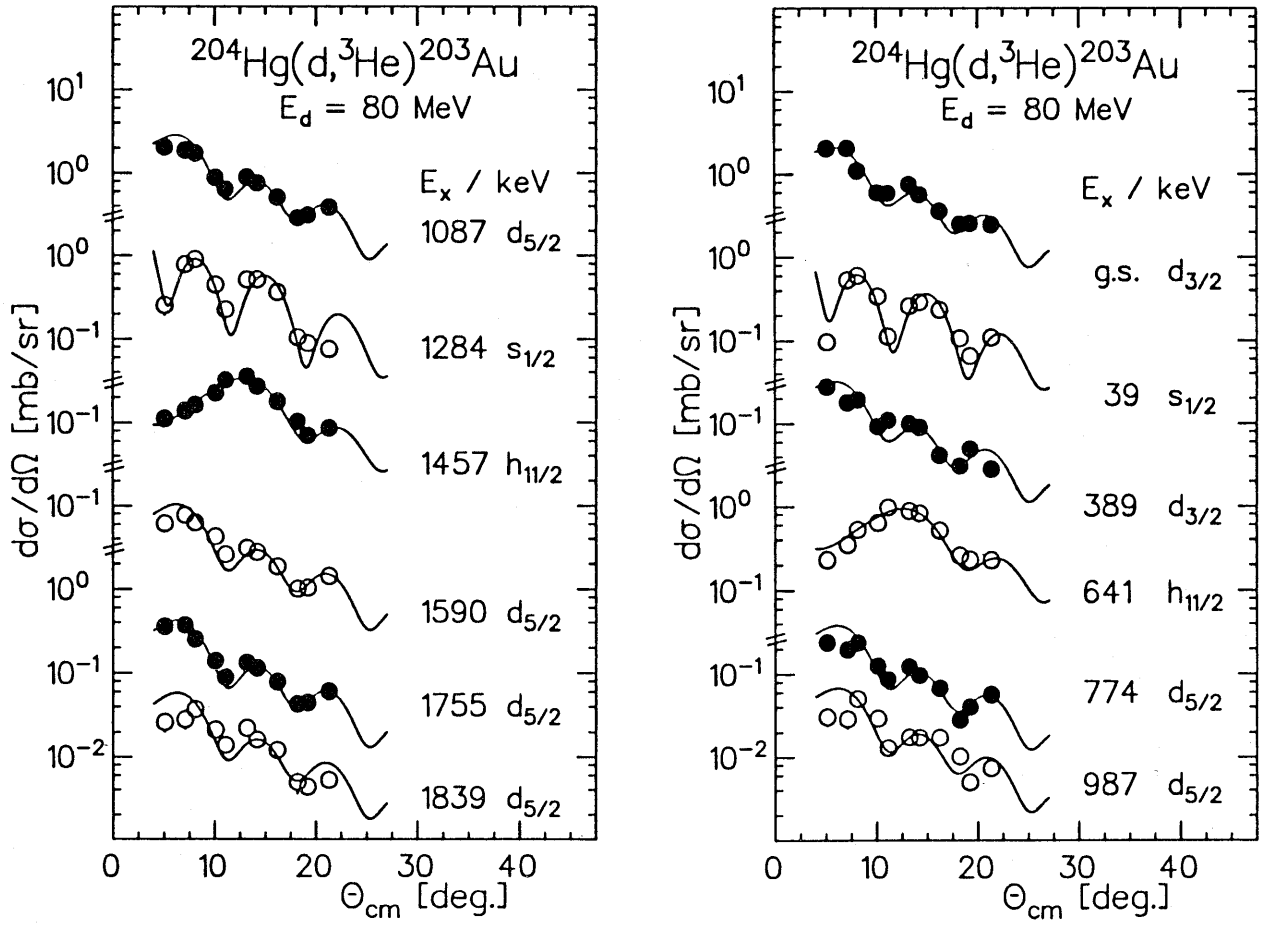

Figure 2. Differential cross sections for transitions on ^{204}Hg. The solid curves represent exact finite-range DWBA calculations.