STUDIES OF THE HEAVY TRANSITIONAL NUCLEI USING THE $(\vec{p},p')$ REACTIONS AT 135 MEV

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As a means of studying the nuclear structure of the heavy transitional nuclei ($180 \leq A \leq 200$), a survey of these nuclei has been initiated with the $^{192}Os(p,p')$ reaction. One of the principal motivations of this work is to acquire detailed information concerning excited 4^+ states and to compare these measurements with predictions of current nuclear models.

Data for ground-state band transitions were first analyzed using coupled-channels calculations with rotational-model form factors. Since both $d\sigma/d\Omega$ and A_y data were obtained, the analysis yielded deformation parameters with quite small uncertainties, the real central and imaginary spin-orbit being best determined. It should be noted, however, that good fits to the data are achieved only if all four (real and imaginary, central and spin-orbit) deformation parameters for both β_2 and β_4 deformations are allowed to vary independently in the search and that βR scaling does not apply. The deformation parameters are shown in Table 1 and the fits for the 2_1^+ (206 keV) and 4_1^+ (580 keV) states are shown in Figs. 1 and 2.

Data for the higher-lying second (909 keV) and third (1070 keV) 4^+ states were next analyzed. It was found that analysis of intermediate-energy proton scattering yields much less ambiguous results for L=4 direct-excitation matrix elements for these states than did earlier (α,α') measurements.[1] The reasons for this are that the (p,p') excitation is insensitive to Coulomb-excitation and reorientation matrix elements and that the direct excitation of these states is much larger relative to multiple excitations for (p,p') than for (α,α'). The results are

$$M04_1/M04_2/M04_3 \simeq -1000/-590/\pm 550 \text{ e-fm}^4$$

where

$$M04_i = \langle 4_i^+ || M(E4) || 0_1^+ \rangle .$$

These are to be contrasted with earlier results from (α,α'):

$$M04_1/M04_2/M04_3 \simeq -1000/+230/-490 \text{ e-fm}^4 .$$

Table 1. Deformation parameters for $^{192}Os(\vec{p},p')$

Potential	β_2	β_4
Real Central	0.151±0.003	-0.049±0.001
Imaginary Central	0.099±0.010	-0.037±0.004
Real $\vec{L}\cdot\vec{S}$	0.119±0.020	-0.057±0.005
Imaginary $\vec{L}\cdot\vec{S}$	0.201±0.011	-0.071±0.002

Considerable attention has been focused on interpreting our results using the interacting-boson model (IBM). Standard IBM calculations in which the boson space includes only s-and d-bosons appear to be incapable of reproducing our results for the E4 matrix

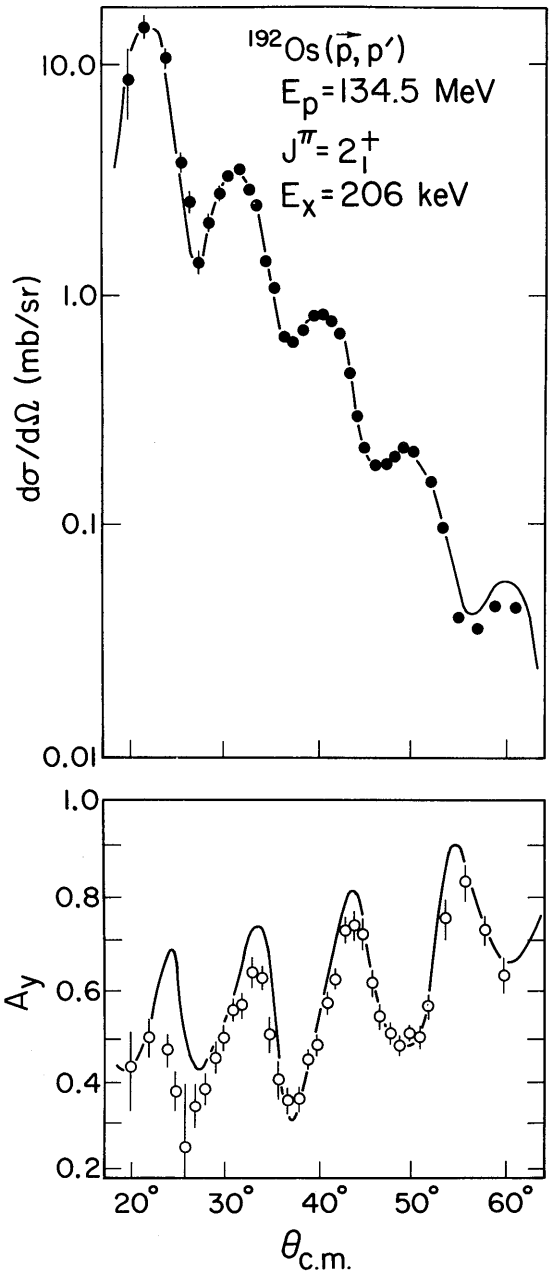

Figure 1. Data and coupled-channels fits for the cross section and analyzing power for excitation of the 2_1^+ state in ^{192}Os.

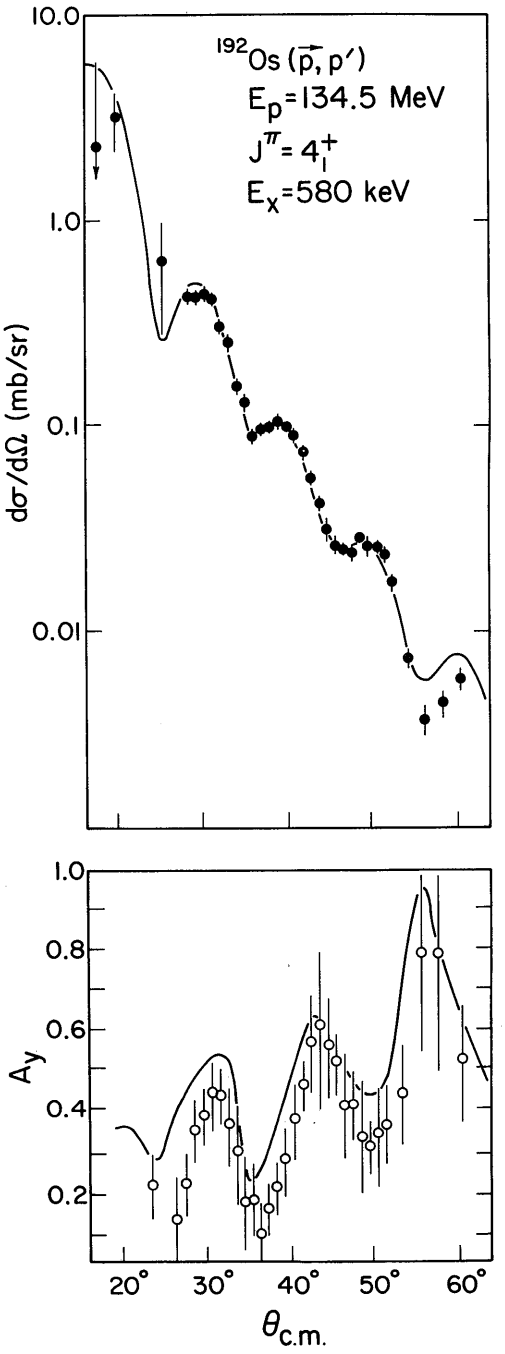

Figure 2. Data and coupled-channels fits for the cross section and analyzing power for excitation of the 4_1^+ state in ^{192}Os.

elements. Introduction of a g-boson using the methods of Van Isacker et al.,[2,3] however, allows reproduction of our results with relatively modest (10-12%) admixtures of g-boson configurations in low-lying states. Unfortunately, our single experiment yields only three data points (the three E4 matrix elements) whereas the model, even in its simplest form, contains four parameters (three effective charges, one hamiltonian parameter) to which these matrix elements are sensitive. As already mentioned, however, ^{192}Os is only the first in a survey of these nuclei; the ^{194}Pt(p,p') experiment has been approved by the PAC and will soon be performed.

1) F.T. Baker et al., Nucl. Phys. A371, 68 (1981).
2) P. Van Isacker et al., Nucl. Phys. A380, 383 (1982).
3) K. Heyde et al., Nucl. Phys. A398, 235 (1983).

^{154}Sm, ^{166}Er, ^{176}Yb, ^{182}W($\vec{p}$,p') REACTIONS AT 134 MeV

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Our study of the ^{154}Sm, ^{166}Er (p,p') reactions at 134 MeV was published[1] this past year. The cross section and asymmetry data are well described by a coupled channels analysis for scattering from a deformed optical model potential within a rigid rotor model framework. The angular distributions of cross sections were also investigated using an analytic eikonal approximation model developed by Amado and co-workers,[2] from which satisfactory descriptions were obtained as well as insight into the relative contributions of single-step and multi-step excitations.

We also found that the multipole moments of the real potential are in good agreement with measurements using other reactions but that there might be energy dependences. The hexacontatetrapole deformation parameter, β_6, was found to be positive for ^{154}Sm and negative for ^{166}Er, in agreement with the predictions by Nilsson et al.[3]

To investigate further the trend of β_6 in this mass region as well as other coupled channel effects we extended our study to ^{176}Yb and ^{182}W using the same reaction. Elastic and inelastic scattering measurements were made at the QDDM spectrometer using the 134 MeV polarized proton beam. Angular distributions of cross sections and asymmetries for ground band states having $J^{\pi}=0^+$ through 8^+ (6^+ in the case of ^{182}W) were measured at laboratory angles from 22° through 42° in 2° steps and then through 77° (^{176}Yb) or 79.5° (^{182}W) in 2.5° steps. Typical spectra are shown in Fig. 1. Peak fitting has been performed for the rotational states in both these nuclei and