SPECTROSCOPIC FACTORS AND TRANSVERSE-LONGITUDINAL ASYMMETRY FROM (e,e'p) EXPERIMENTS IN ^{16}O, ^{12}C, and ^{208}Pb

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Experimental coincidence cross section and the transverse-longitudinal asymmetry A_{TL} have been obtained in experimental Hall A of the Thomas Jefferson National Accelerator Facility (JLAB)for the quasielastic (e,e'p) reaction in ^{16}O, ^{12}C, and ^{208}Pb in constant q-ω kinematics.

The first of these experiments, E00-102 [1], performed in the fall of 2001 using a waterfall (H_20) target, measured the ^{16}O(e,e'p) reaction in quasielastic kinematics at Q^2=0.90 (GeV/c)^2 over one of the largest ranges of missing momentum ever explored with unprecedented statistical accuracy. In this work, results from proton knock-out from the $p_{1/2}$ shell of ^{16}O in the p_{miss} range [-350,350] MeV/c are shown. The measured experimental data are in agreement with a previous JLAB experiment (E89-003), performed at slightly lower Q^2. The measured cross sections and asymmetry A_{TL} have been compared with both Distorted Wave Impulse Approximation (DWIA) calculations with relativistic and non-relativistic spinors. Spectroscopic factors of 0.71 ± 0.05 ($p_{1/2}$ shell) were obtained for both models. A_{TL} measurements favor the relativistic DWIA calculation. The excellent agreement with the data is interpreted as a great success for the fully relativistic Impulse Approximation. Further, these data constitute compelling experimental evidence for the need to modify the structure of spinors that describe nucleons bound in nuclei to account for relativistic dynamical effects.

The second experiment, E06-007 [2], was performed in the spring of 2007 using three-foil C+Pb+C and C+Bi+C targets. Additional measurements on a single carbon target foil were performed allowing for the study of the nuclear structure of ^{12}C. In this work, results from the knockout of protons from the $p_{3/2}$ shell of ^{12}C and the valence states of ^{208}Pb in the p_{miss} range [-350,350] MeV/c are shown.

Carbon results are in good agreement with results from previous experiments. The

experimental cross sections and A_{TL} asymmetry have been compared with Monte Carlo simulations based on DWIA calculations with both relativistic and non-relativistic spinor structure. The spectroscopic factor obtained for the $p_{3/2}$ shells in ^{12}C is 0.85 ± 0.05 for the relativistic DWIA and 0.81 ± 0.05 for the non-relativistic DWIA. The A_{TL} measurements for the $p_{3/2}$ shell in ^{12}C are in agreement with both relativistic and non-relativistic simulations. This was expected and may be interpreted as a further successful prediction of the relativistic model, as dynamical relativistic effects are less evident in the $p_{3/2}$ shell than in the $p_{1/2}$ shell.

$^{208}Pb(e,e'p)$ data were obtained at different and more complete kinematics than in previous experiments. The A_{TL} asymmetry in ^{208}Pb was measured for the first time. The spectroscopic factors for the valence states of ^{208}Pb have been obtained from a (E_{miss}, p_{miss}) fitting procedure obtained from relativistic and non-relativistic DWIA calculations. These spectroscopic factors are in agreement with other measurements performed at Saclay and NIKHEF-K. A_{TL} measurements for the aggregate of the valence states favor in the fully relativistic DWIA predictions.

Further (e,e'p) data were measured at three different Q^2 values, looking for a possible dependence of the spectroscopic factors on Q^2. The results of this analysis for both ^{12}C and ^{208}Pb have found no signs of such a dependence for $0.8 < Q^2 < 2$ $(GeV/c)^2$ to the level of 5% statistical accuracy and with reduced systematic uncertainties. This is the first time that this has been confirmed in a heavy nucleus.

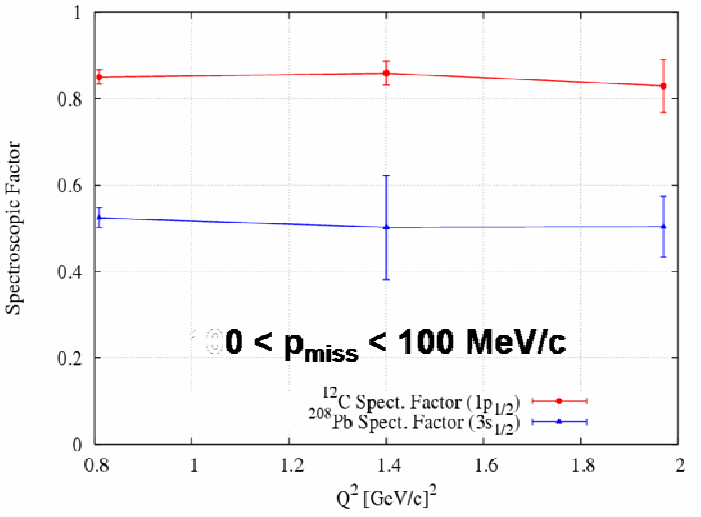

Fig. 1 - Spectroscopic Factors for the $p_{1/2}$ shell of ^{12}C and $3s_{1/2}$ of ^{208}Pb at different Q^2 values. No significant dependence of the spectroscopic factors with Q^2 has been found.

[1] http://hallaweb.jlab.org/experiment/E00-102/e00102/e00102.html
[2] http://hallaweb.jlab.org/experiment/E06-007/