Absolute Spectroscopic Factors from Single-Nucleon Knockout Reactions

P.G. Hansen[1], B.A. Brown[1], B.M. Sherrill[1], J.A. Tostevin[2]

1. National Superconducting Cyclotron Laboratory and Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan 48824
2. Department of Physics, University of Surrey, Guildford, Surrey GU2 7XH U.K

We have recently completed an analysis which strongly suggests that single-nucleon knockout reactions at intermediate and high energies can provide absolute spectroscopic factors for both neutrons and protons. This should make it possible to explore the foundations of the shell model in a systematic way. We make use of accurately known inclusive cross sections for ^{16}O and ^{12}C on a target of ^{12}C measured at 0.25–2.1 Gev/nucleon at the Bevalac to calculate average quenching factors R_s of 0.49–0.68. The values for proton knockout are essentially identical to those found in the (e,e′p) reaction, normally considered the benchmark for spectroscopic factors. We have also used accurate data taken at the GSI at 0.14–1.4 Gev/nucleon for the case of radioactive ^{8}B, for which, evidently, no electron data are available. The result, $R_s = 0.88(4)$, is much closer to the full shell model strength. This suggests that the picture of a universal quenching factor, close to one half and independent of the nuclear mass, may not be the full story.

In the general application of the knockout technique [1] at somewhat lower energies, we measured projectile residues with a high-resolution spectrograph in coincidence with γ rays, which identified individual final levels. The resulting partial cross sections, analyzed in eikonal reaction theory [2], gave spectroscopic factors, while the shape of the longitudinal momentum distribution determined the l value. The technique is not only simple, it is also extremely sensitive and has already been applied [3] to incident beams of less than one atom per second. In a first first survey of its precision in the p, sd shells [4], data were included for 25 partial cross sections. However, neither experiment nor theory were accurate enough to reveal the presence of significant re-scaling. The present work circumvents these problems by using data taken at high energies, where the eikonal theory is believed to be very accurate, and also by using nuclei such as ^{8}B, ^{12}C and ^{16}O, for which the shell-model theory is on an extremely solid basis.

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References

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