Comment on “Medium-Modified Form Factors, Relativistic Dynamics, and the (e,e'p) Reaction”

Cohen, Van Orden, and Picklesimer have examined the effects of relativistic dynamics and medium-modified form factors on the ratio of transverse to longitudinal response functions in the (e,e'p) reaction. They find (1) that these effects are small and (2) that the observed anomalous $T/L$ ratio\(^2,3\) can be fully explained by final-state distortions. We agree with (1), but disagree with (2).

The crucial aspect of our analysis has been to use model parameters [i.e., bound-state wave function and optical potential] that yield a good fit to the momentum distribution $\rho_{1p}(p_m)$ for $1p$ knockout (see Ref. 4 for details). The data and results of our unfactorized nonrelativistic distorted-wave impulse-approximation (DWIA) calculations (Ref. 5) with the McVoy–Van Hove off-shell current operator are shown in Fig. 1 for both $1p$ knockout from $^{12}$C and $1s$ knockout form $^6$Li in the representation $R_G = (4m_e^3W_T/Q^2W_L)^{1/2}$. The bump at $Q^2 \approx 0.145$ (GeV/c)$^2$ is due to the occurrence of a minimum in $\rho_{1p}(p_m)$. The distortion effects that are somewhat larger than quoted in Refs. 2 and 3 are because of (i) an improved calculation of Coulomb distortion and (ii) the constraint of the complete $\rho_{1p}(p_m)$, are nonnegligible, but at the two largest $Q^2$ points the data show a significant deviation from the DWIA calculation. In view of the discrepancy with the calculations of Cohen, Van Orden, and Picklesimer, we stress the importance of a proper description of $\rho(p_m)$ for a meaningful interpretation of $R_G$. In this context it is noted that for $1s$ knockout where the dependence on a proper model description of $\rho(p_m)$ is reduced, the data show again a clear deviation from the impulse approximation. We note in addition that the current operator for a free (on-shell) Dirac particle has been used by Cohen, Van Orden, and Picklesimer to describe a bound proton, whereas we have used an off-shell operator that satisfies gauge invariance.

In conclusion, we claim that model calculations should first of all reproduce the shape of measured momentum distributions, before meaningful interpretations of $T/L$-separated data can be made. In addition, the dependence of model calculations on the choice of current operator needs further theoretical attention (see Refs. 6 and 7). We see therefore no reason at present to abandon the conclusion reached in Refs. 2 and 3 that $(e,e'p)$ experiments on both $^6$Li and $^{12}$C reveal a significant deviation from the impulse approximation.

FIG. 1. The quantity $R_G$ deduced from the $^{12}$C $1p$-knockout and the $^6$Li $1s$-knockout data as a function of momentum transfer squared. Solid (dashed) curve is an unfactorized DWIA calculation for $R_G$. The dotted curve is the plane-wave impulse-approximation calculation. (FSI denotes final-state interaction.)


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Received 2 February 1988
PACS numbers 25.30.Fj