Comment on "Giant $M1$ Resonance in ^{90}Zr"

The recent Letter by Laszewski, Alarcon and Hoblit[1] on tagged-photon measurements of $M1$ strength in ^{90}Zr suggests that the importance of $E1$ excitations in this region of ^{90}Zr has been underestimated in analyses of proton scattering.[2–4] In reply, it should be noted first that measurements of spin-flip cross sections σS_{nn} in proton inelastic scattering are essentially completely insensitive to Coulomb-excited $E1$ and other $\Delta S=0$ excitations. In such measurements,[2,5,6] spin-excitation strength is noted not only in the 9-MeV region discussed in Ref. 1 but also well above. A detailed analysis of the ^{90}Zr σS_{nn} data by Yabe, Osterfeld, and Cha[7] reported that the strength seen up to 25 MeV is consistent with almost complete exhaustion of the integrated $M1$ strength expected without ground-state correlations.

The strength attributed to $M1$ excitations in the proton σ work is often determined by the drawing of a smooth background line connecting neighboring regions of the spectrum (cf. Fig. 1 of Ref. 2, and Fig. 2 of Crawley *et al.*[8]) It has always been clear that this procedure is subject to error. Nevertheless, the procedure does not underestimate the background due to the $E1$ part of the neighboring resonances unless the $E1$ strength contains an additional bump at the same excitation energy as the $M1$ bump. Now an important result of Ref. 1 is that the $E1$ strength in this region is very close to the extrapolated tail of the Lorentz-line fit to the giant dipole resonance. Thus there is no justification for suggesting, as done in Table I of Ref. 1, that too little $E1$ background has been subtracted, or for actually reducing the reported $M1$ cross sections by the amount of the calculated $E1$ cross section.

The background in the 9-MeV region in proton σ measurements might indeed be overestimated, but not because of the improper treatment of $E1$ Coulomb excitation. On the high-excitation-energy side of the $M1$ resonance the $E1$ resonance coexists with $E0$, $E2$, and various magnetic resonances, all of which contribute at small angles. On the low-excitation-energy side, ordinary nuclear excitations and possible instrumental background both can be important. Any background line is thus somewhat arbitrary; consideration of only one element, such as the $E1$, does not reduce this arbitrariness. Thus real $M1$ strength beneath the peak or in the tails may be eliminated, as is well known. A primary reason for the undertaking of the σS_{nn} measurements of Ref. 2 was to find this "hidden" strength. The difference between the $M1$ strengths extracted from the σ data in Refs. 2 and 3 can be explained by different instrumental background at low excitation energy and different distorted-wave impulse-approximation calculations at different energies. The results expressed tentatively in Ref. 4, which are based on data at one angle with a spectrometer that was at that time not well suited for such measurements, are difficult to interpret without much more information. The background there[4] is subtracted somewhat differently from Refs. 2 and 8, but it is *equally* uncertain; it includes an unknown percentage of the actual $E1$ cross section. It is not appropriate to single out this one contribution and subtract it again, as Ref. 1 suggests, even if this procedure yields apparently more consistent $M1$ strengths.

In sum, we believe that the difficulties posed for proton scattering by the $E1$ resonance in ^{90}Zr have been exaggerated in Ref. 1. Perhaps this problem in interpretation arose because photons are relatively much more sensitive to the $E1$ than protons are. Using the numbers stated in Ref. 1, we calculate that, of the summed cross sections for $E1$ and $M1$ excitation in the 9-MeV region in ^{90}Zr, 319-MeV protons should see about 80% as $M1$ (at 2°) while photons see only 14% as $M1$. Both probes yield useful and complementary information.

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C. Glashausser
Serin Physics Laboratory
Rutgers University
Piscataway, New Jersey 08855

A. Galonsky
National Superconducting Cyclotron Laboratory
and Department of Physics and Astronomy
Michigan State University
East Lansing, Michigan 48824

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