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[18] The expression for $v(T)$ [Eq. (2)] cannot be identical for two different sets of T_{sf} and E_{ex}. This is a weakness of this phenomenological model which, however, in view of Fig. 2, does not seem to be serious.

COMMENTS

Multipole Assignment of the 8.9-MeV Resonance in ^{208}Pb†

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High-resolution inelastic electron scattering [full width at half-maximum (FWHM) ≃ 38 keV] with 50-MeV electrons on ^{208}Pb yields a width $\Gamma = 1.3 \pm 0.2$ MeV for the 8.9-MeV resonance. This result together with the results from a reanalysis of older data with moderate energy resolution (FWHM ≃ 300 keV) shows that the previous identification of the 8.9-MeV resonance as a monopole excitation is not conclusive. The excitation of this state may as well be $E2$. The giant quadrupole resonance at 10.8 MeV seen in former measurements has been reanalyzed.

There has recently been some controversy about the existence of a giant monopole resonance in heavy nuclei. Pitthan *et al.*[1] claim to have observed a resonance of this type with 90-MeV electrons scattered inelastically from ^{197}Au and ^{208}Pb. Their excitation energies were determined to be $E_x = 9.2$ and 8.9 MeV, and the total widths found to be $\Gamma = 2.2$ and 1.8 MeV, respectively. From a comparison of the angular dependence of the cross sections at large scattering angles with distorted-wave Born-approximation (DWBA) calculations an indication of the $E0$ mode of excitation rather than an $E2$ was stated. An $E2$ assignment was definitely ruled out by these authors since the magnitude of the (e,e') cross section, on the assumption of an $E2$ excitation, would lead to a peak in the photoabsorption cross section of ^{208}Pb. Such a peak had not been observed in the (γ,n) spectrum measured by Veyssière *et al.*[2] In ^{208}Pb, e.g., the peak height of the 8.9-MeV resonance in the (γ,n) spectrum expected on the basis of the (e,e') data[1] was $\sigma_0 = 30$ mb. The (γ,n) measurements,[2] on the other hand, showed no peak with a height exceeding the statistical error of about ± 6 mb.

The foregoing argument in favor of an $E0$ assignment has been doubted by Benenson and Bertsch[3] who derived, from the data of Ref. 1, a height of the (γ,n) peak at 8.9 MeV of 3 mb, a value much smaller than 30 mb.

The purpose of this comment is to present new facts which contradict the former arguments[1] given for a 0^+ assignment of the 8.9-MeV resonance in ^{208}Pb. One is based on the total width measured in electron scattering, and the other on a discussion of the DWBA calculations for $E0$ transitions.

Obviously, the height σ_0 of the peak in the photoabsorption cross section inferred from electron scattering depends on the total width Γ of the peak in the (e,e') spectrum. The smaller the width, the higher is the (γ,n) peak for a given $B(E2)$ value. An upper limit to σ_0 is obtained if a lower limit can be set to the total width Γ measured in electron scattering. So far, no reliable lower limit exists. We have, therefore, taken advantage of the recently installed high-resolution energy-loss system at Darmstadt[4] to measure just this quantity.

A ^{208}Pb target with a thickness of 10 mg/cm^2 has been bombarded with electrons of energy $E_0 = 50$ MeV. The lower part of Fig. 1 shows a high-resolution spectrum at $\theta = 129°$. For comparison, the spectrum obtained under identical conditions in an earlier low-resolution experiment[5] is displayed in the upper part. The new spectrum exhibits a number of isolated peaks between 6.5 and 8.2 MeV from which an experimental resolution of 38 keV (full width at half-maximum) is inferred. The nature of these peaks (mostly $M1$ excitation) is discussed elswewhere.[6] Here we focus our attention to the broad bump centered about 8.9-MeV excitation energy, i.e., the resonance in question. It appears to have some fine structure, but there is no concentration of strength in any single peak of this structure, so that its gross shape is consistent with the one in Ref. 5. If radiation tail and background, given by the solid line in the high-resolution spectrum of Fig. 1, are subtracted, the width is obtained to be $\Gamma = 1.3 \pm 0.2$ MeV; the error includes the uncertainty in the height of the radiation tail and the background. This value has to be compared to the value of $\Gamma = 1.8 \pm 0.5$ MeV from Ref. 1.

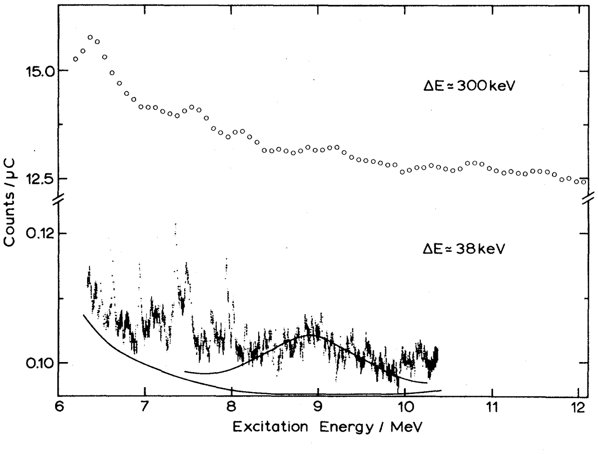

FIG. 1. Spectra of inelastically scattered electrons from ^{208}Pb. Moderate-resolution data (Ref. 5) are shown in the upper half, and high-resolution data in the lower half. The raw data are given. The solid lines indicate the background used in the analysis and the assumed line shape, respectively.

We used this value of Γ from the high-resolution data to reanalyze our low-resolution data on ^{208}Pb taken earlier. These data are based on measurements at $E_0 = 50$ and 65 MeV and $\theta = 93°$, 129°, and 165°. Part of them have been published previously[5] with the aim to present evidence of the $E2$ giant resonance in ^{208}Pb. The analysis was performed in the following way. First, radiation tail and background were subtracted from the measured spectra. The shape of the radiation tail and background was described by a polynomial in excitation energy E_x. The coefficients were chosen such that the calculations of Ginsberg and Pratt[7] for radiation during scattering and those of Barber *et al.*[8] for bremsstrahlung in the target, except for a nearly constant background, were reproduced. This shape was slightly modified by requiring that the total width of the $E1$ giant resonance, under the assumption of a Lorentzian for the line profile, was equal to the value 4.05 MeV deduced from the photonuclear data.[2] A comparison of the resulting $E1$ cross sections for the forward angles ($\theta = 93°$ and 129°) with DWBA calculations in the hydrodynamic model[9] yielded a $B(E1)$ value of 59 ± 5 fm^2 in good agreement with 63.6 ± 4.2 fm^2, deduced from the integrated photoabsorption cross section 3.48 MeV b (see Ref. 2). We consider this as a test for the reliability of the subtraction procedure.[10]

Subtracting the Lorentzian of the $E1$ giant resonance from the spectrum reveals the aforementioned $E2$ resonance, which in ^{208}Pb is split into three peaks[5] at 10.2, 10.6, and 11.2 MeV excitation energy (see upper part of Fig. 1), and the peak of interest at 8.9 MeV. In the subsequent fitting procedure the peaks of the $E2$ triplet were approximated by a single Lorentzian. The cross sections obtained from this fit were compared with DWBA calculations[11] for $E0$ and $E2$ transitions in the hydrodynamic model. The right-hand part of Fig. 2 shows this comparison. It is seen that the $E0$ and $E2$ curves are very similar, as expected. The best-fit curves for an $E2$ excitation correspond to a $B(E2)$ value of $B(E2) = 6000 \pm 1500$ fm^4 or an integrated photoabsorption cross section of 24 ± 6 MeV mb. This value is a factor

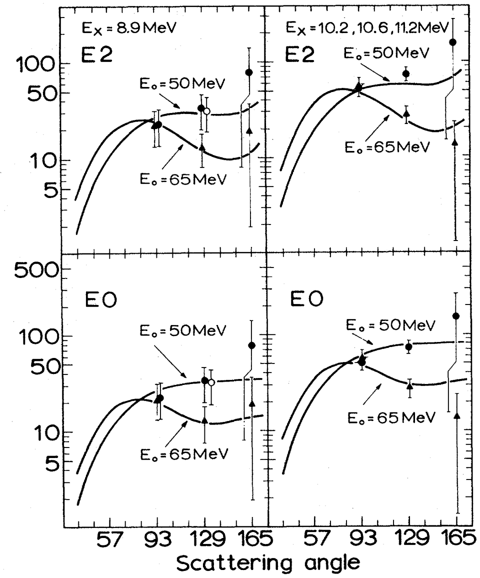

FIG. 2. Ratio of inelastic to Mott cross section as a function of scattering angle. The sum of the cross sections for the states at 10.2, 10.6, and 11.2 MeV excitation energy is given on the right-hand side; the cross section for the 8.9-MeV resonance is shown on the left-hand side. The full points show the results of the low-resolution data; the open circle is the result of the high-resolution measurement. The error bars include the uncertainties in the radiation tail and background subtraction. The full curves result from DWBA calculations described in the main text.

of about 2 larger than the result from our previous analysis[5, 12] and the one reported by Nagao and Torizuka,[13] but agrees quite well with the value $B(E2) = 6700 \pm 2500$ fm^4 obtained in Ref. 1. Our $B(E2)$ value exhausts 80% of the energy-weighted sum rule (EWSR) for isoscalar quadrupole transitions.[14]

The angular dependence of the cross section of the 8.9-MeV resonance is displayed in the left-hand half of Fig. 2. An $E0$ assignment cannot be favored over $E2$. Adjusting the height of the DWBA curves to the measured points yields a $B(E2)$ value of 3100 ± 1200 fm^4 equivalent to 35% of the EWSR. Summing up the $E2$ strengths of the triplet and the 8.9-MeV resonance yields 9100 fm^4 or 115% of the EWSR. This may be compared with 8200 fm^4 predicted by Ring and Speth.[15] The best fit of the height of the $E0$ curves to the data would result in a monopole matrix element $|M_{fi}|^2 = 4600 \pm 1800$ fm^4 or 31% of the monopole EWSR.[16] Concerning the angular dependence of an $E0$ transition we have tried to use the DUELS code with the modifications by Kassis[17] as in Ref. 1. However, the essential agreement of the plane-wave Born approximation with the DWBA at $Z = 0$ could not be achieved with these modifications. The difference was up to 50% in the scattering angle range from 50° to 160° and at energies of 65 and 250 MeV. The code used in our analysis[11] for which this difference was always less than 1% could not reproduce the large difference of the $E2$ and $E0$ angular dependences in the region of the second maximum as reported in Ref. 1. In particular, inserting the same parameters as used for the curve of Fig. 3 of Ref. 1, we do find the minimum at 105° completely washed out, as expected in a DWBA calculation.

TABLE I. Results deduced from combined low- and high-resolution (e,e') data from Fig. 2. The uncertainties in the transition strengths are comparable for the low- and high-resolution data.

J^π	E_x (MeV)	$B(EL)$ (fm^{2L})	Γ (MeV)	B_{exp}/B_{EWSR}
2^+	8.9	3100 ± 1200	1.3 ± 0.2	0.35
2^+	10.8	6000 ± 1500^a	2.7 ± 0.2	0.80
1^-	14.1	59 ± 5	4.05 ± 0.3^b	1.12^c

[a] Sum of triplet of states at 10.2, 10.6, and 11.2 MeV.
[b] Taken from the (γ,n) data of Ref. 2.
[c] Obtained from the Thomas-Reiche-Kuhn sum rule.

The multipolarities, excitation energies, transition probabilities, widths, and fractions of the energy-weighted sum rule for the resonances, determined from our analysis, are summarized in Table I. They were finally used to calculate the shape of the photoabsorption cross section. The result clearly shows that the shape of the cross section inferred from our (e,e') data is consistent with the one measured in the (γ,n) experiment.[2] In particular, the $E2$ assignment for the 8.9-MeV resonance does not lead to a clearly visible peak in the calculated photoabsorption cross section below the $E1$ giant resonance. There is hence no need to invoke a monopole state in order to reconcile electron scattering with photonuclear data. Various theoretical calculations also predict the monopole state to be at higher excitation energies.[15, 18]

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