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Addendum to "Impact-Parameter Dependence of Inner-Shell Vacancy Production by Heavy-Ion Bombardment"

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The impact-parameter dependence of L-shell vacancies in the collision of 30-MeV I ions with Te atoms has been remeasured with improved accuracy.

We remeasured with improved accuracy the impact-parameter dependence of L-shell vacancy production in collisions of 30-MeV I ions with Te atoms (Fig. 1). The new measurement is in good agreement with our previously published results.[1] The formula given in Ref. 1 for the total cross section in the case of the Gauss function for $P(p)$ should be $2\pi\alpha p^2_{\max}$ instead of $2\alpha p^2_{\max}$. A detailed presentation of our recent measurements and former results of concern will be given in a forthcoming paper.

The authors would like to add the following comment to the reference list in Ref. 1: This type of experiment was proposed in 1965 by H. J. Specht.[2] More recently Q. C. Kessel *et al.*[3] and W. Brandt *et al.*,[4] among others, also suggested such coincidence experiments in studies of inelastic energetic-ion interaction.

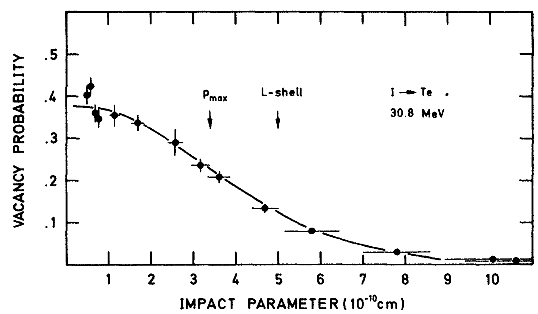

FIG. 1. Probability $P(p)$ for production of L-shell vacancies in I or Te as a function of impact-parameter p.

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L_2- and L_3-Subshell Fluorescence Yields for $Z>37$

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The relativistic calculation of radiative widths for K shell and L subshells, as reported by Scofield, are in agreement (within 0.1%) with our independent calculations. Theoretical total K-shell widths (x ray + Auger) are presented as a function of the atomic number. Using the experimental widths of $K\alpha_1$ and $K\alpha_2$ and our theoretical results, calculated L_2- and L_3-subshell fluorescence yields are presented versus atomic number.

It is the purpose of this note to present comments on two recent papers[1,2] and to report on the L_2- and L_3-subshell fluorescence yields.

Scofield[1] has recently published the radiative widths for x rays, where the relativistic interaction Hamiltonian with the relativistic Hartree-Fock-Slater model was employed. Rosner and the author have also performed similar calculations[3] with essentially the same atomic model.[4] We have included the finite nuclear size effects[5,6] which have little effect on the radiative widths. Detailed comparison of our work with that of Scofield shows an excellent agreement (better than 0.1%). The conclusion is that the theoretical radiative transition rates for the K shell and the L subshells are indeed reliable.

Figure 1 contains our calculated values of the

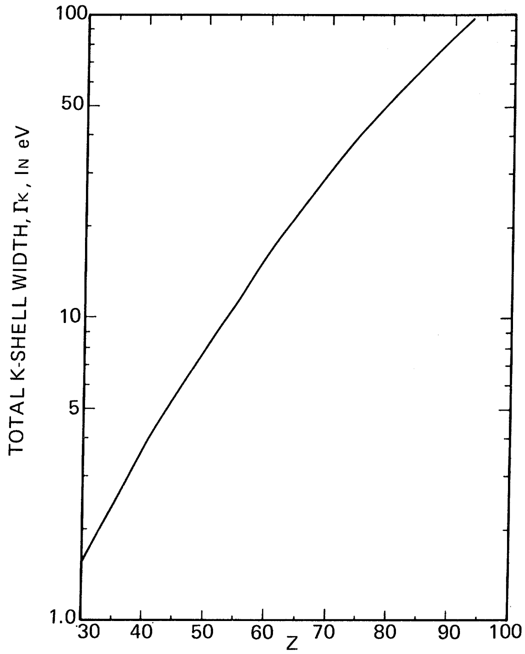

FIG. 1. Theoretical total K-shell width versus atomic number. Relativistic Hartree-Fock-Slater atomic model is used for the radiative and the nonradiative (Auger) transition rates.

total K-shell width Γ_K versus atomic number. The total K-shell width Γ_K is equal to Γ_K (x ray) + Γ_K (Auger). The relativistic Auger transition rates[7,8] were obtained with the relativistic Hartree-Fock-Slater model.[4] The calculated K-shell fluorescence yields[9] are in excellent agreement with the available experimental data.[10]

Experimental widths for $K\alpha_1$ and $K\alpha_2$, $\Gamma_{K\alpha 1}$ and $\Gamma_{K\alpha 2}$, have been reported by Nelson, John, and Saunders[2] for $Z > 50$. Gokhale[11] has published experimental widths $\Gamma_{K\alpha 1}$ and $\Gamma_{K\alpha 2}$ for $37 \leq Z \leq 50$,

$$\Gamma_{K\alpha_1} \equiv \Gamma_K\,(\text{x ray}) + \Gamma_K\,(\text{Auger}) + \Gamma_{L_3}\,(\text{x ray}) + \Gamma_{L_3}\,(\text{Auger}) \tag{1a}$$

and

$$\Gamma_{K\alpha_2} \equiv \Gamma_K\,(\text{x ray}) + \Gamma_K\,(\text{Auger}) + \Gamma_{L_2}\,(\text{x ray}) + \Gamma_{L_2}\,(\text{Auger})\ . \tag{1b}$$

The experimental and theoretical fluorescence yields for L_2 and L_3 subshells w_2 and w_3 have not been available[10] for $Z < 66$ except for an early measurement of w_3 for $Z = 55$. Recent accurate measurements have been reported by Price, Mark, and Swift[12] for $Z \geq 71$. Equations (1) can be written as

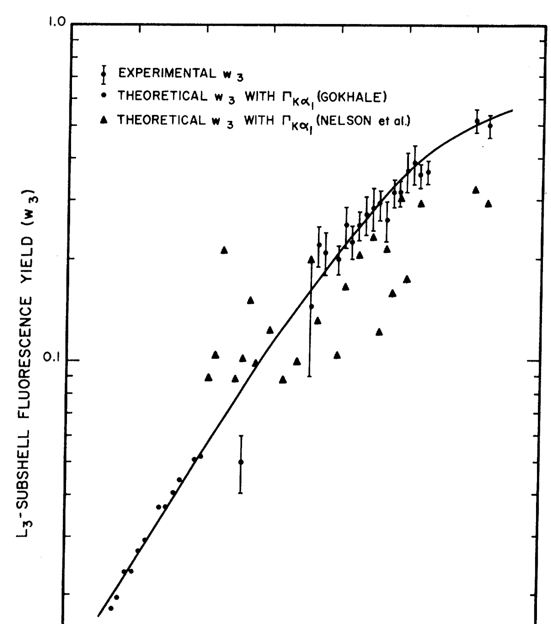

FIG. 2. Calculated L_3-subshell fluorescence yield versus atomic number. The experimental $K\alpha_1$ widths were used, as explained in the text. Experimental values of w_3 are also shown. The smooth curve represents the "best" average values of w_3.

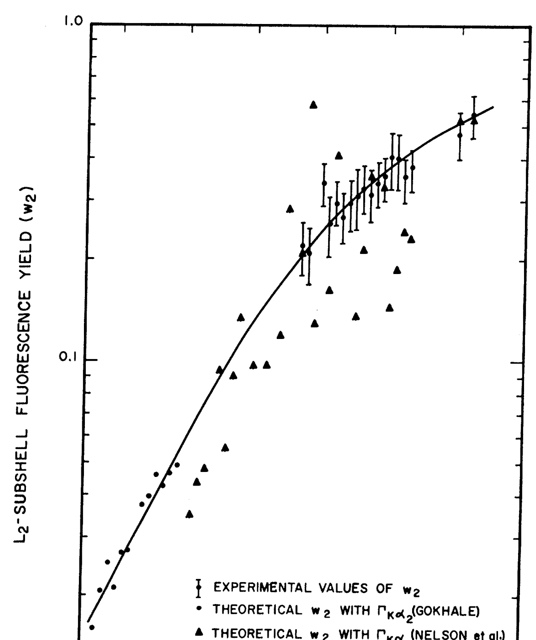

FIG. 3. Calculated L_2-subshell fluorescence yields versus atomic number. The experimental $K\alpha_2$ widths are used, as explained in the text. Experimental values of w_2 are also shown. The smooth curve represents the "best" average values of w_2.

$$w_3 = \Gamma_{L_3}(\text{x ray})/(\Gamma_{K\alpha_1} - \Gamma_K) \quad (2a)$$

and

$$w_2 = \Gamma_{L_2}(\text{x ray})/(\Gamma_{K\alpha_2} - \Gamma_K) \ . \quad (2b)$$

The values of w_2 and w_3 can, therefore, be calculated from Eqs. (2) using our theoretical results of Γ_K, Γ_{L_2}(x ray), and Γ_{L_3}(x ray), *and* the experimental values[2,11] of $\Gamma_{K\alpha_1}$ and $\Gamma_{K\alpha_2}$.

The calculated values of w_3 and w_2 are plotted versus atomic number in Figs. 2 and 3, respectively. The experimental values are also shown. The solid curves represent the realistic estimates of w_2 and w_3. The calculated values of w_2 and w_3 using Gokhale's data[11] show very little fluctuations. The quoted experimental uncertainty in $\Gamma_{K\alpha_1}$ and $\Gamma_{K\alpha_2}$ of $\approx 10\%$ in the data of Nelson *et al.*[2] results in rather large uncertainties ($\gtrsim 50\%$) for w_2 and w_3 especially for medium and large Z values. However, these values of w_2 and w_3 (within the appropriate errors) are not inconsistent with the experimental values of Price *et al.*[12] for $Z > 71$.

We thank Dr. Nelson, Dr. John, and Dr. Saunders for communicating their experimental results prior to publication.

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Comment on "Damping of a Heated Oscillating Cylinder in He II"

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In a recent paper Payne reports on experiments verifying the existence of the "heat-exchange torques" predicted by Penney and Overhauser. His results were obtained by measuring the heat-induced changes in the logarithmic decrement of a cylindrical torsion pendulum immersed in He II and seem to be in good agreement with the measurements of the torque on heated cylinders in rotating superfluid helium reported earlier by the present author. Payne claims however, that these earlier measurements are open to serious question because of a torque-producing mechanism which he calculates will be effective if the test cylinder is heated nonuniformly. In this note we show that the physical model chosen for Payne's calculation is unrealizable, and further, that the mathematics is carried through incorrectly. When properly analyzed, the mechanism he proposes yields zero net torque for all distributions of the heat input and could not, therefore, have been a complicating factor in the earlier experiments.

Recently Payne reported[1,2] on an experiment in which he observed the "heat-exchange torque" in superfluid helium which was predicted by Penney and Overhauser (PO).[3] His results were obtained by measuring the logarithmic decrement of a cylindrical torsion pendulum immersed in He II and the changes in the decrement as a function of the rate of heat input to the test cylinder. He obtained good agreement with the earlier experiments of the present author[4] in which the net torque on a heated cylinder immersed in rotating superfluid helium was measured.

In his paper Payne stated that his calculations show that nonuniform heating of the probe cylinder in this earlier experiment could have led, even in the absence of superfluid circulation, to the observation of torques as large as those reported. This criticism is serious because such torques, if present, would necessarily have been unrelated to the predictions of PO, and this would have invalidated