

LETTERS TO THE EDITOR

MEASUREMENT OF K-SHELL PHOTOELECTRIC CROSS-SECTIONS FOR SOME CHARACTERISTIC X-RAYS

BECAUSE of the non-availability of clean and strong low energy photon sources, external conversion X-rays in various suitable targets have been produced and successfully used to measure relative K shell photoelectric cross-sections in Y for incident energies 17.781, 22.581, 23.618, 25.770, 29.208, 35.478, 41.006 and 43.949 keV in a double reflection geometry experiment as shown in Fig. 1.

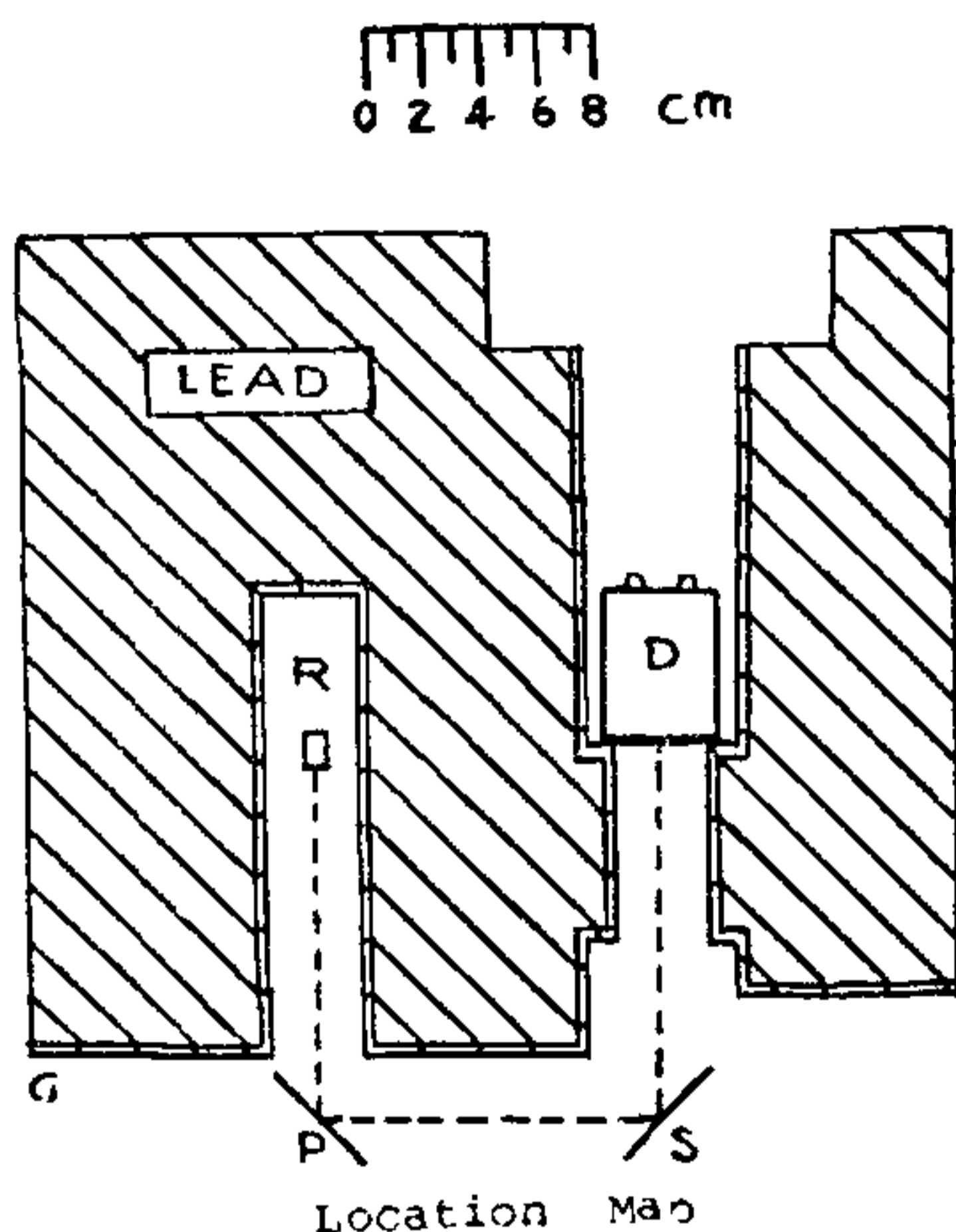


FIG. 1. Experimental arrangement for the double reflection experiment for the measurement of photoelectric cross-sections; R, Radiation source Tm^{170} ; P, Primary target; S, Secondary target; D, Detector. G, Graded absorber of Sn, Cu and Al.

A brief outline of the procedure of measurement and the results obtained are given in this communication. The details will be published elsewhere.

A Y target placed at S was irradiated, turn, with characteristic X-ray of elements, Mo, Ag, Cd, Sn, I, Ce, Sm and Gd, obtained as a result of interaction of photons from a ~ 2 Curie Tm^{170} source R with their respective targets placed at P. The intensity of the resulting K X-rays in Y was measured with a thin NaI (Tl) detector placed at D. The intensities of the K X-rays of various target elements, used as primary targets, falling on Y target were measured with a calibrated NaI (Tl) detector placed at S.

Background due to the scattering of photons was taken care of by subtracting the spectrum recorded with an equivalent aluminium target from the main spectrum in each case.

The ratio of the K shell photoelectric cross-sections for the primary energies E_1 and E_2 corresponding to primary targets P_1 and P_2 is given as

$$\frac{\sigma(E_1)}{\sigma(E_2)} = \frac{N(P_2)}{N(P_1)} \cdot \frac{N_Y(P_1)}{N_Y(P_2)} \cdot \frac{\beta(E_1)\epsilon(E_1)}{\beta(E_2)\epsilon(E_2)} \quad (1)$$

where $N(P_2)/N(P_1)$ is the ratio of the counting rates under photopeaks of primary K X-ray spectra taken with the counter placed at S for primary targets P_2 and P_1 . $N_Y(P_1)/N(P_2)$ is the ratio of the counting rates under photopeaks of spectra when Y target is irradiated with primary X-rays from targets P_1 and P_2 respectively. $\beta(E_2)/\beta(E_1)$ and $\epsilon(E_1)/\epsilon(E_2)$ are the ratios of the self-absorption corrections for Y target and effective efficiencies of the counter used for the detection of primary X-rays, at energies E_1 and E_2 respectively.

Measuring $N(P_2)/N(P_1)$ and $N_Y(P_1)/N_Y(P_2)$ from the respective spectra and calculating $\beta(E_2)/\beta(E_1)$ and $\epsilon(E_1)/\epsilon(E_2)$ as described earlier^{1,2} $\sigma(E_1)/\sigma(E_2)$ were determined and are compared with theoretical calculations of Scofield³ in Table I.

TABLE I

The present measurements of the relative K shell photoelectric cross-sections of Y are compared with the theoretical calculations of Scofield³

Primary target element	Average K X-ray energy (E_1) in keV	$\sigma(E_1^*)/\sigma(E_2)$	
		Present measurements	Theoretical calculations ³
Mo	17.781	1.000 ± 0.033	1.000
Ag	22.581	1.887 ± 0.066	1.833
Cd	23.618	2.220 ± 0.078	2.115
Sn	25.770	2.671 $+ 0.093$	2.619
I	29.208	3.822 $+ 0.134$	3.606
Ce	35.478	5.875 ± 0.235	5.789
Sm	41.006	8.630 $+ 0.345$	8.627
Gd	43.949	10.865 ± 0.436	10.476

E_1^* is taken as 17.781 keV.

The experimental results show good agreement with theory. It may be noted that the errors involved in the present measurements are less than 5% as compared to 10% in the earlier measurements made by using internal conversion X-rays^{4,5}. To the best of our knowledge, the data reported above are new and no other measurements are yet available in this energy region.

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Patiala 147 002, July 11, 1975.

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EFFECT OF SOLVENT ON POLARIZATION OF LUMINESCENCE

It is known that the polarization of luminiscence of solution changes due to several factors, viz., viscosity of the solvent¹, migration of the excited state from the originally excited molecule to a neighbouring molecule², shape and size of the fluorescent molecule³, etc. The present report deals with the effect of dielectric constant/dipole moment of the solvent as an extrinsic cause of depolarization. The polarization of fluorescein in different solvents (con. $\sim 10^{-5}$ g/cc) has been measured at room temperature ($\sim 20^\circ\text{C}$) with an Aminco Bowman spectrophotofluorometer. The solvents used are of spectral grade purity with low viscosity. The effect of scattered light and background for each solvent was checked by using pure solvent in the cuvette and setting the excitation and emission monochromators at values used in polarization measurements. The contribution of this effect to the intensity of luminiscence was found to be less than 0.5%. The results obtained for polarization are given in Table I. The data on the excitation wavelength (λ_{ex}), the emission wavelength (λ_{em}) and the relative intensity of lumi-

science in different solvents are also included in Table I.

The observed variation of polarization (Table I) cannot be accounted for as viscosity effect because in this case a 'Perrin Plot'¹ will not be linear. Also as the concentration is low the electromagnetic coupling of neighbouring molecules and its effect on decrease in polarization due to energy migration is small. In any case the concentration is the same in all the solvents and hence the variation in polarization cannot be explained only by energy migration. It is, therefore, likely that the observed variation in polarization is due to the dipole moment/dielectric constant of the solvent. The effect of these can be explained as follows: During absorption of the exciting radiation which takes place in a very short time, the equilibrium orientation of the dipole moment of the solute molecule, under the influence of dipole-dipole interaction, in the solvent cage of the surrounding solvent molecules, remains unchanged. But the solute molecules get enough time before a radiative transition takes place to reorient itself in the cage to get a new equilibrium state and this causes fluorescence depolarization. The Brownian rotation tends to destroy this equilibrium orientation and causes further depolarization. But the Brownian rotation is opposed by the dipole-dipole interaction between solvent-solute molecules which for a given solute depends on the dipole moment and the dielectric constant of the solvent. Thus this interaction tries to reduce the depolarization caused by the Brownian rotation. Therefore the polarization is expected to be higher in a solvent with higher dielectric constant/dipole moment. For acetone the dipole moment is comparable to water but the percentage polarization is lower. However as can be seen from Table I the intensity of fluorescence in this case is lower indicating some migration of energy which may cause depolarization. This additional cause of depolarization also explains the difference between the values of polarization for methanol and ethanol. Also the polarization should be minimum in non-polar solvents. To check this in the present case several non-polar solvents, viz., benzene, cyclohexane, carbon tetrachloride; carbon disulphide, etc., were tried, but fluorescein is found

TABLE I

Solvent	Dipole ⁴ moment	Dielectric ⁴ constant	Viscosity ⁴	λ_{ex} nm	λ_{em} nm	Relative intensity	% Polarization
Water	2.0-3.0	81	1.002	506	520	80	4.4
Methanol	1.65	32	0.594	512	524	81	2.0
Acetone	3.0	21	0.324	528	540	36	1.9
Ethanol	1.7.	26	1.197	514	528	62	1.2