

end-point measurement of Elliot and King.²⁹ The end point was obtained by simple extrapolation of the actual β^+ spectrum. In cooperation with B. J. Dropesky of this Laboratory, the fermi functions were computed for this particular isotope and energy range, and a Kurie plot of the 1941 data was made. Since the data were taken with a cloud chamber, the statistical accuracy was limited; however, a considerable portion of the spectrum resulted in a straight line with the end-point energy of 5.3 ± 0.1 Mev rather than the 4.94 Mev reported. The predicted end point from the $\text{Ca}^{40}(\text{He}^3, d)\text{Sc}^{41}$ and $\text{Ca}^{40}(d, n)\text{Sc}^{41}$ reactions is 5.60 Mev. A discrepancy is still indicated, although the revised β^+ value is increased in the direction of the predicted end points.

Preliminary results of a recent measurement of this β^+ spectrum by Class, Farmer, and Cramer at the Rice Institute³⁴ indicate the end point to be 5.65 ± 0.10 Mev in approximate agreement with the predicted end point. These results are also indicated in Fig. 13.

$\text{O}^{16}(\text{He}^3, d)\text{F}^{17}$ Reaction

Since oxygen was present as a contaminant in the targets used, it was possible to measure the Q value for the $\text{O}^{16}(\text{He}^3, d)\text{F}^{17}$ reaction. The measured Q value of -4.90 ± 0.09 Mev is in agreement with the calculated value²⁸ and has not been previously reported.²⁷

³⁴ J. G. Cramer, B. J. Farmer, and C. M. Class (to be published); and private communication.

Angular Correlation of Annihilation Radiation in Sulfur and Its Compounds*

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The angular correlation of annihilation radiation in elemental sulfur and in several sulfur compounds was found to be practically the same in all samples studied. The observed correlation is similar to that observed with chlorine salts; a similarity that, in some cases at least, may be correlated to the similarity of the ions Cl^- and S^{2-} .

THE angular correlation between the γ rays of positron annihilation has been measured in samples of sulfur in different allotropic states, in chemical com-

pounds of sulfur, and for comparison in some salts not containing this element.

The elemental sulfur was studied in the rhombic,

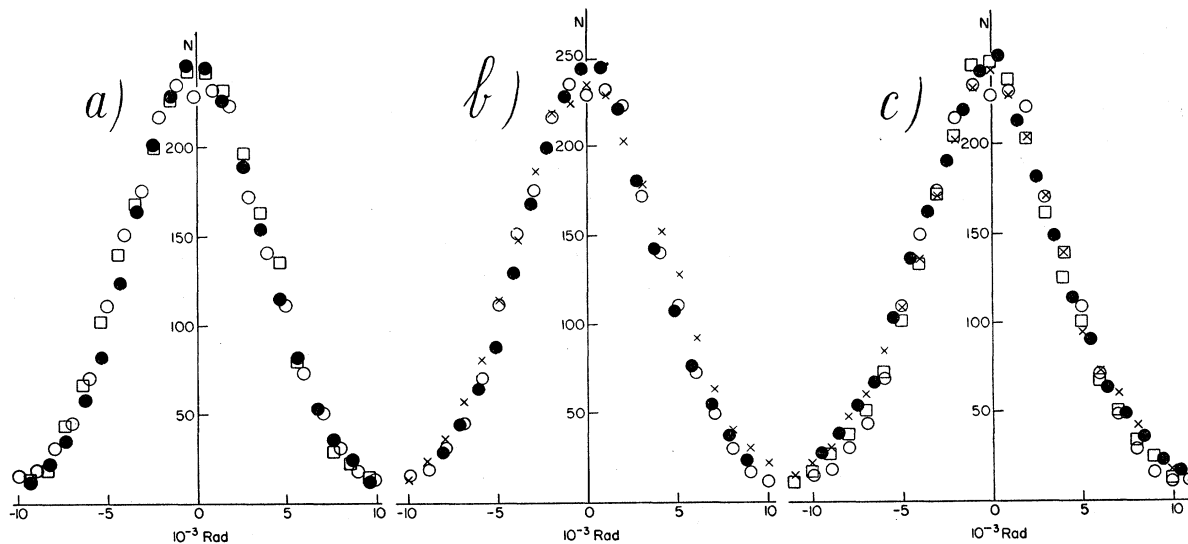


FIG. 1. The angular correlation between γ rays from position annihilation: (a) \circ S rhombic (20°C); \bullet S plastic (20°C); \square S monoclinic (105°C), (b) \circ S rhombic; \bullet Na_2S ; \times FeS , (c) \circ S rhombic; \bullet Cs_2SO_4 ; \times Li_2SO_4 ; \square Na_2SO_4 . The curves are normalized to the same area.

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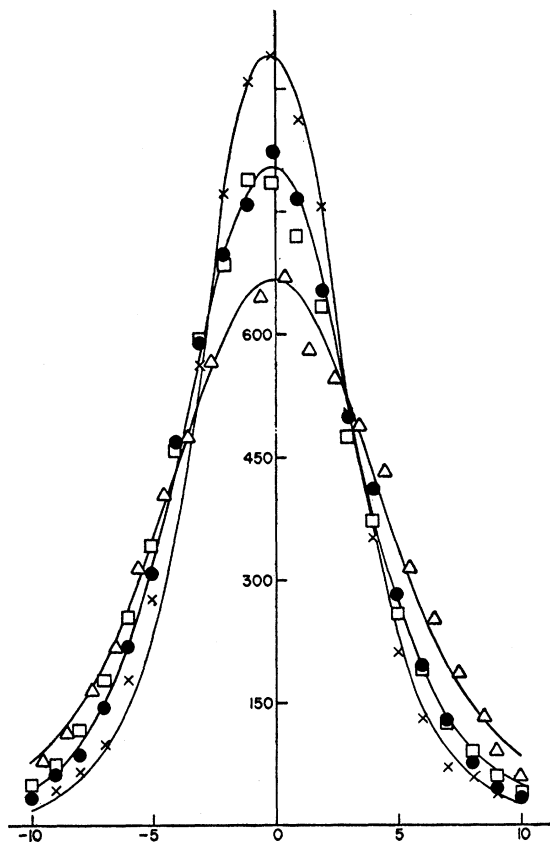


FIG. 2. The angular correlation between γ rays from positron annihilation: \times KI; \bullet NaCl; \square Na₂S; \triangle NaF. The curves are all normalized to the same area.

monoclinic, and plastic state. The samples of rhombic and plastic sulfur were at room temperature, while those of the monoclinic sulfur were at 105°C. The curves obtained are shown in Fig. 1(a) and are remarkable for their similarity.

The difference in density between rhombic and monoclinic sulfur, at the temperature of our measurements, is 5.5%. Thus our results show that the relation between density and "peakedness" observed by De Zafra and Toyner¹ does not hold in general. Most probably

¹ R. L. DeZafra and W. T. Toyner, Phys. Rev. **112**, 19 (1958).

that relation is valid when the "peakedness" reveals the formation of positronium within imperfections in the solid. In our case the interpretation of the angular distribution curves does not require positronium formation.

Bell and Graham² have observed the long positron mean life τ_2 in plastic, but not in monoclinic sulfur. Our data do not show any evident relation with the long mean life in the plastic state. Rather, one can say that the most striking feature of the data in Fig. 1(a) is the similarity of the curves obtained with different states.

The measurements were extended to sulfides [NaS and FeS, Fig. 1(b)] and sulfates [Li₂SO₄, Na₂SO₄, Cs₂SO₄, Fig. 1(c)]. Here again the differences are very small. These differences, if any, are surely much smaller than those observed when the nonmetal element is changed, as shown in Fig. 2, where Na₂S is compared with NaF, NaCl, and KI, in measurements performed with the same equipment.

As was already known,³ the width of the angular distribution of annihilation radiation in salts of different halogens decreases with increasing atomic weight. This is easily understood assuming that the positron annihilates with the external electrons of the negative ion, as is natural because of electrostatic attraction: the heavier halogen-ions give a sharper curve since they have larger ionic radius, and—according to the uncertainty principle—smaller momentum of the peripheral electrons.

The similarity between the behavior of sulfur and chlorine shown in Fig. 2 is easily understood in the case of Na₂S. In this case we are concerned with an ionic crystal in which the outside structures of the ions Cl⁻ and S²⁻ are very similar: their ionic radii are almost identical.

For the other substances investigated the interpretation is not so direct. Though it cannot be ruled out that the similarity of the angular distribution curves may be accidental, one is tempted to look for a more general explanation and to wonder whether the positron may not end its life in the same manner in all cases.

² R. E. Bell and R. L. Graham, Phys. Rev. **90**, 644 (1953).

³ G. Lang and S. DeBenedetti, Phys. Rev. **108**, 918 (1957).