

LETTER TO THE EDITOR

**On the relation between the transition probabilities
for K -capture and positon-emission**

Measurements of the ratio $\varrho = P_K/P_+$ of the probabilities of K -capture and positon emission provide an interesting and accurate test of the Fermi theory of β -radioactivity, because two quantities, which cannot be determined precisely viz. the Fermi constant G and the nuclear matrix element disappear from the theoretical result for ϱ , if the following conditions are fulfilled:

a) an allowed transition must be studied, *b*) both the K -capture and the positon emission must be simple transitions (or if they are complex the complexity must be analysed in a quantitative and accurate manner, which is in general very difficult).

The first measurements that made this check possible were performed on ^{107}Cd by Bradt et al. ¹⁾, who found for this nucleus: $\varrho_{exp} = 320 \pm 30$, while according to the Fermi theory they calculated: $\varrho_{theor} = 342$, hence an excellent agreement. However, other measurements by Bradt et al. ²⁾ on ^{64}Cu and ^{61}Cu revealed a discrepancy with the theory: the ratio of ϱ_{64} (P_K/P_+ for ^{64}Cu) and ϱ_{61} (P_K/P_+ for ^{61}Cu) was measured; the result was $\Lambda_{exp} = \varrho_{64}/\varrho_{61} = 5,5 \pm 0,3$, while according to the theory $\Lambda_{theor} = 8,1$ was calculated.

In order to study this discrepancy more accurately a separate determination of ϱ_{64} and ϱ_{61} was undertaken by Bouchez and Kayas ³⁾, which gave $\varrho_{64} = 2,65 \pm 0,4$ and $\varrho_{61} = 0,55 \pm 0,06$ while the theoretical values are $\varrho_{64} = 2,4$ and $\varrho_{61} = 0,3$. From these results it seems that agreement exists between theory and experiment for ^{64}Cu , while the discrepancy is located on ^{61}Cu ; it must be remarked that the measurement of the quantity ϱ_{61} is difficult, because of the small intensity of the K -radiation.

A further study of this discrepancy was made, both theoretically and experimentally (cf. for details a paper which is soon to appear ⁴⁾). It was checked that the nuclear matrix element disappears from the theoretical result for ϱ for each of the five invariants of the Dirac theory which can be chosen for the nucleon-lepton interaction.

This is true particularly for the tensor and axial vector interaction, though it seemed from a paper from Marshak ⁵⁾ that different sums of nuclear matrix elements might occur in the formulae for K -capture and

positon emission. However, the formulae of Marshak have not the required rotational invariance because of omission of certain terms (cf. 4) and 6)). Considerations 4) for the five invariants, simplified by the use of group-theoretical methods, give the result that the sum of nuclear matrix elements can be written in a form which has only one or two terms. (This result is, by the way, valid as well for allowed as for forbidden transitions).

As a result it turned out that the discrepancy could not be explained on the theoretical side. A thorough re-examination of the experiments of Bouchez³⁾ was undertaken; it was found that two effects were of greater importance than had been thought: a) the annihilation radiation originating in the diaphragms to define the beam had been neglected, b) the ^{61}Cu which had been obtained by irradiation in the cyclotron may have been contaminated with ^{64}Cu by contact with brass.

The new determination gave: $\varrho_{61} = 0,38 \pm 0,08$ while the value of ϱ_{64} is unaffected. Hence we can conclude that the theory is also verified for ^{61}Cu , though not with the same precision as for ^{107}Cd and ^{64}Cu .

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