have lead to serious error in the present work where a square law relation has been shown to be invalid.

VI. CONCLUSIONS

The analysis presented in this study furnishes possible answers to several problems concerning the succession of events in a flash discharge and the probable mechanisms which are operative in exciting the various types of radiation observed.

It is quite obvious that the rate of increase of radiation intensity is primarily dependent upon the build-up of the plasma ion density. The maximum intensity of spark line emission occurs simultaneously with the occurrence of peak ion concentration, and this radiation is due to impact excitation. Arc line oscilloscope traces are broader and their maxima occurs later in time. Recombination of electrons and ions accounts for a large fraction of the arc line intensity although it amounts to only a few percent of the total radiation from the plasma. Arc lines are observed in the afterglow phase of the discharge long after the disappearance of spark lines.

The analysis shows that the intense continuum, accounting for most of the emitted radiation, is primarily due to retardation of electrons moving in orbits about ions ("free-free" transitions). The rate of decay of this bremsstrahlung radiation depends both on the rate of decrease of plasma ion density and the rate at which the mean energy of the electrons is diminishing.

During the portion of the flash period for which data is shown the electron "temperature" has not changed a great deal and the value of the recombination coefficient of electrons and ions remains essentially constant. Moreover, the small value of the coefficient obtained indicates that recombination processes contribute a relatively small amount to the continuous radiation in the visible spectral region.

It is believed that these results provide the correct explanations of delay of emission of radiation following the input of electrical power, and furnish the first semiquantitative picture of the excitation mechanisms involved in flash discharges at low gas pressures.

PHYSICAL REVIEW VOLUME 87, NUMBER 6 SEPTEMBER 15, 1952

The Decay Scheme of Ir^{192}

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(Received May 21, 1952)

Scintillation spectrometer time-correlation studies of the Ir^{192} disintegration have yielded new information about the Pt^{192} level scheme. Gamma-rays have been observed of considerably higher energy than any reported previously.

The disintegration of Ir^{192} to Pt^{192} has been studied by a number of workers and a decay scheme has recently been proposed by Cork *et al.*,[1] based on accurate measurements of the energies of internal conversion electrons in a beta-spectrometer. Evidence for the existence of an alternative decay process (by *K*-capture) to Os^{192} was also produced.

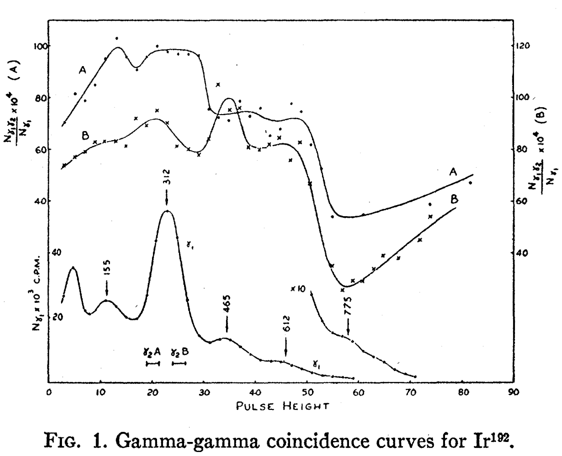

Fig. 1. Gamma-gamma coincidence curves for Ir^{192}.

In studies of the gamma-ray spectrum of Ir^{192} with a scintillation spectrometer, evidence for gamma-rays of energies higher than those previously reported (611 kev) was obtained. Two lines at approximately 775 and 870 kev have been detected with the spectrometer using a pulse-height analyzer. An oscillogram of the spectrum by a method similar to the grey wedge technique, using exponential intensity modulation of the cathode-ray tube beam, indicates further gamma-rays up to an energy of 1.2 Mev. There are really no distinctive features in the region 900 to 1200 kev but rather a continuum, which suggests the presence of several unresolved gamma-rays.

A check of the total energy involved in the Pt^{192} ground-state transition was made by placing a piece of the active material in contact with the scintillating crystal and comparing the end point of the pulse-height distribution curve with that of the distribution for the gamma-rays of Co^{60}. This gave a value of 1.58 ± 0.03 Mev in good agreement with previously ac-

[1] J. M. Cork *et al.*, Phys. Rev. **82**, 258 (1951).

cepted conclusions based on separate beta- and gamma-ray measurements.

Gamma-gamma coincidence studies, as previously proposed,[2] were carried out to obtain further information on the disintegration. The equipment consisted of two scintillation spectrometers of conventional design, the output pulses from the analyzers being passed to a British type 1036A coincidence unit. A resolving time of 0.3 microsecond was used. One analyzer was set to select pulses in a certain range of pulse heights and the spectrum was scanned by the other analyzer, both the coincidence and the single channel counting rates being measured concurrently.

In Figs. 1 and 2 are plotted the gamma-ray counting rate in channel 1, and the ratio of the coincidence counting rate to the gamma-ray counting rate for different selected ranges of pulse heights in channel 2, the ranges involved and the corresponding coincidence ratio curves being marked with letters A, B, C, D, and E.

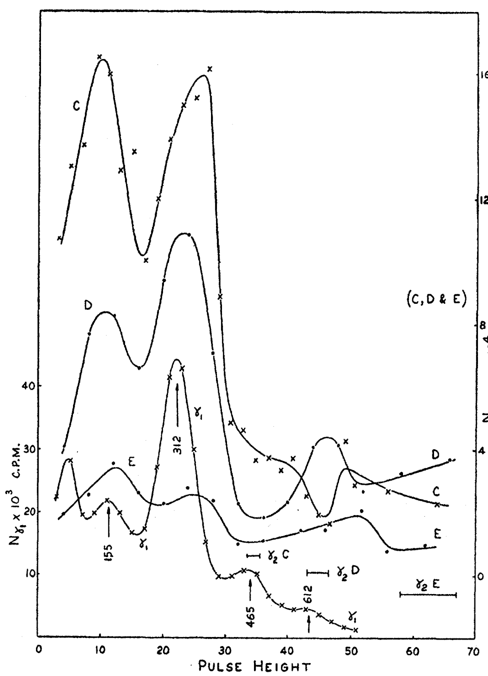

FIG. 2. Gamma-gamma coincidence curves for Ir^{192}.

In interpreting the results it must be borne in mind that, of the smaller pulses, some are due to high energy gamma-rays; this, combined with the effects of lower resolution for low energy gamma-rays, results in less distinctive features in the coincidence ratio curve for the small pulse-height region.

Examination of the curves confirms Cork's scheme, as far as it goes, but requires the addition of several higher energy gamma-rays. It should be noted that the 312-kev peak in the $N_{\gamma 1}$ curves consists of three unresolved components of energy 295, 308, and 316 kev.

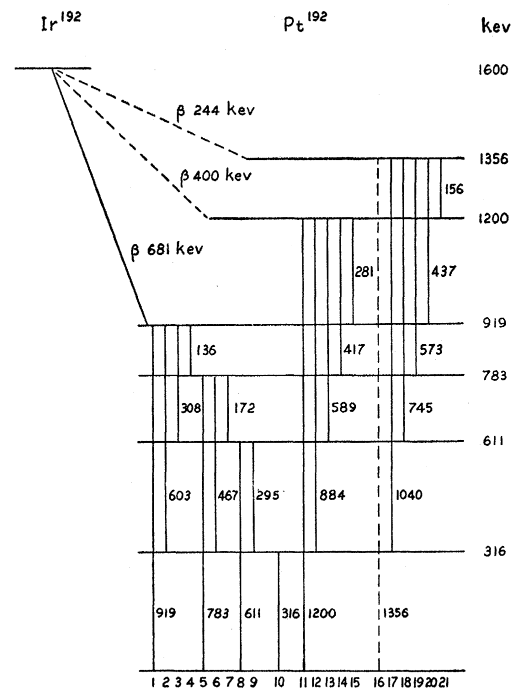

FIG. 3. Proposed level scheme for Pt^{192} following beta-emission from Ir^{192}.

Curve A requires the addition of two gamma-rays in the 700–800 kev region, e.g., lines 5 and 18 in Fig. 3. Curve B requires lines at energies approximately those of lines 5, 12, and 18, and possibly 17. Curve C can be explained by the existence of line 14 or line 20. Line 19 might also be necessary. Curve E requires lines 12 and 21.

Thus the gamma-gamma investigations require the addition of lines 5, 12, 18, 21, and possibly 17, 19, and 14 or 20 to those of Cork's scheme. Line 21 requires the addition of another energy level and one at 1356 kev is suggested. This would give an energy difference of 437 kev to the 919-kev level which could be identified with Cork's value of 438 kev for a gamma-ray. However, no evidence of a gamma-ray of energy 1356 kev has been obtained.

It might be noted that there is no direct support for the proposed level scheme from observations of the beta-spectrum itself. Most of the work done has indicated only a simple spectrum of end-point energy close to 681 kev. However, the partial beta-components of energy 400 and 244 kev are much less intense than the main component and will be difficult to detect in a conventional beta-ray spectrometer.

Our thanks are due the National Research Council of Canada for the support of this work.

[2] Pringle, Roulston, and Taylor, Rev. Sci. Instr. **21**, 216 (1950).