It provides a way to investigate the interesting question of spin-lattice coupling. Incidentally, as the apparatus required is rather simple, the method should be useful for standardization of magnetic fields. An extension of the method in which the r-f field has a rotating component should make possible the determination of the sign of the moment.

The effect here described was sought previously by Gorter and Broer, whose experiments are described in a paper[3] which came to our attention during the course of this work. Actually, they looked for dispersion, rather than absorption, in LiCl and KF. Their negative result is perhaps to be attributed to one of the following circumstances: (a) the applied oscillating field may have been so strong, and the relaxation time so long, that thermal equilibrium was destroyed before the effect could be observed—(b) at the low temperatures required to make the change in permeability easily detectable by their procedure, the relaxation time may have been so long that thermal equilibrium was never established.

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The γ-Rays of Radium D

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FOR many years RaD was regarded as a radioactive substance which emits nuclear β-rays of very low energy and monochromatic γ-rays of quantum energy 46.7 kev. Just before the war, however, it was shown by Amaldi and Rasetti,[1] using the method of selective absorption, that the radiation is complex, the well-known 46.7 kev line being accompanied by a much weaker component of energy 43 kev. Following the publication of this result, a systematic study of the subject was started in Paris with a very strong source of RaD of about 100 mC, extracted previously by Professors Irène Joliot-Curie and F. Joliot. The following is a brief summary of the main experimental results, obtained in the Curie Laboratory and in the Laboratory of Nuclear Chemistry in the difficult conditions which prevailed from 1942–1945. The results deal with the detailed structure of the γ-radiation, the absolute intensity of the different lines, and the nature of γ-rays of quantum energy 46.7 kev.

In the region between 25 and 100 kev, the analysis made by the methods of selective absorption[2] and crystal diffraction[3] leads to the conclusion that RaD emits in this region four γ-lines (A, B, C, D) and two lines of x-rays of K-83, the corresponding energy and intensity being given in Table I.

The existence of these six different radiations is confirmed by another series of experiments in which the corresponding quantum energies are determined by measuring the true range of the photoelectrons which they project in a Wilson chamber.[4,5] This method also suggested the existence of an additional weak line at about 65 kev (x) and relatively intense radiations below 25 kev.

TABLE I. γ-rays from RaD.

γ-ray line	E (kev)	I (quanta per 100 disintegrations)	Reference
(X)	(65±5)	(<0.2)	(5)
A	46.7±0.1	2.8±0.6	(1, 2, 3, 5, 8)
B	43±1	0.2±0.1	(1, 2, 3, 5)
C	37±1	0.2±0.1	(2, 3, 5)
D	32±1	0.4±0.2	(2, 3, 5, 6)
E	23.2±0.6	1.0±0.5	(5, 6)
F	7.3±0.7	~10	(6, 7)

In order to study the region below 25 kev, experiments were made with a Wilson chamber operating at suitable low pressure.[6] It was thus found that in addition to the L spectrum of element 83, there is a new γ-ray line (E) of 23.2±0.6 kev. This line has thus almost exactly half the quantum energy of the principle line (A) and would be confused in diffraction spectrum experiments with the second-order image of the (A) line. Another very intense γ-ray line (F) of 7.3±0.7 kev has been observed in the energy region below the L levels of element 83.[6a] This radiation has been observed previously by Droste[7] who classified it as one of the components of the L spectrum of element 83. From the energy determinations in our present experiments, it seems more reasonable to regard it as a new γ-ray line.

In order to investigate the nature of the principle line (A) we have determined the intensity of the conversion electrons of this radiation by the usual methods of magnetic β-ray spectrography and obtained the value 2.9 for the internal conversion coefficient, N_e/N_r in the L_1 level.[8,2] The comparison with the theoretical calculation of Fisk[9] indicates that the 46.7 kev line is most probably a quadripole radiation. For other γ-rays there is no information available about their conversion electrons[10] to permit similar deduction about their nature to be made.

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