Background Eradication of Nuclear Emulsions by Accelerated Fading of the Latent Image

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IN a continuation of our studies[1] on the fading of the latent image of alpha-particle tracks we have observed that conditions of temperature, humidity, and the presence of hydrogen peroxide have a pronounced effect on the rate. As shown in Fig. 1, the normal fading over a period of 20 days can be duplicated in the course of several hours by maintaining the exposed emulsion in an atmosphere saturated with water at 35°C. Storage *in freshly distilled water* does not destroy the latent image. The destruction of the latent image is further accelerated by augmenting the H_2O_2 concentration of the atmosphere in which the plates are stored. After exposure to 10^7 α-particles from RaF, the latent image is completely obliterated by keeping the emulsion *over* 3 percent hydrogen peroxide at 25°C for 4 hours. After 1–2 hour desiccation of the eradicated emulsion over $CaCl_2$, sensitivity is restored and tracks develop from new exposures with normal mean grain spacings.

This phenomenon permits the eradication of the accumulated latent images of the alpha-tracks and stars produced by traces of Ra and Th normally present as impurities in the emulsion. By continuing the exposure of the dry eradicated plate the rate of track growth can be studied accurately. Quantitative recording, without apparent fading of the track structures, can be maintained for periods exceeding 2 months. Under these conditions single α-tracks accumulate at a rate of 8–100/cm²/day, depending on emulsion purity and thickness. Low energy α-ray stars originating from decay of Rd Th in the emulsion layer generate ~0.3 multiple events/cm²/day. Near sea level, the controlled exposure indicates a daily rate of long proton and meson tracks of 0.03–0.06/cm²; and a population of 0.0005/cm² nuclear evaporations induced by cosmic radiation.

This method is applicable only to fine-grained nuclear type emulsions as Eastman NTA and Ilford Conc. With coarse-grained, light-sensitive emulsions as x-ray films and process plates the H_2O_2 vapor produces the well-known pseudophotographic effects.[2] Loading fine-grained emulsions with borax and lithium sulfate inhibits the destructive action of H_2O_2 on the latent image. Background eradication must therefore precede loading. Details of the method and a mechanism for spontaneous fading based on *in situ* H_2O_2 generation by the action of densely ionizing radiations on water in the gelatin will be reported on in the future.

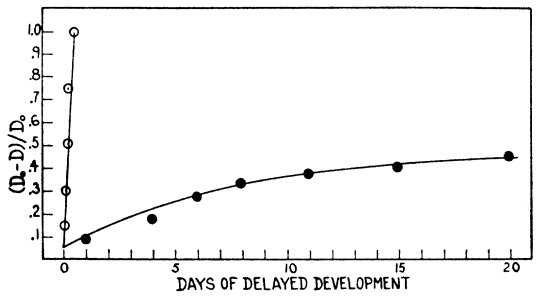

FIG. 1. Rate of latent image fading under differing storage conditions. ● ambient conditions, 25°C, low humidity; O eradication conditions, 35°C, saturation humidity.

[1] H. Yagoda and N. Kaplan, Phys. Rev. **71**, 910 (1947).
[2] H. Yagoda, Am. Mineralogist **31**, 87 (1946).

Coincidence Study of Gold^{198}*

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THE radiations from Au^{198} have been studied by many investigators.[1–5] Some experiments[2] have purported to show effects from only one gamma-ray of energy 0.4 Mev. On the other hand, considerable evidence[1] has been compiled which would indicate that more than one quantum per disintegration is emitted in the de-excitation of Hg^{198}, the residual nucleus. Results of gamma-gamma coincidence experiments have also been at variance. Norling[3] and Jurney and Keck[3] of the Indiana University group have found no gamma-gamma coincidences in the disintegration of Au^{198}. These results would support the view that only a single gamma-ray is present. Other investigations[4] have shown genuine gamma-gamma coincidences to exist.

In order to reinvestigate the radiations from Au^{198} by coincidence techniques, metallic gold was irradiated by slow neutrons in the Clinton pile. Chemical purification was carried out to remove possible impurities of calcium, iron, phosphorous, and platinum.

Using two matched G-M counters in a coincidence circuit with a resolving time of 0.10 microsecond,[5] gamma-gamma coincidences were measured in Au^{198}. The gamma-gamma coincidence rate was found to be $(0.103\pm0.007)\times10^{-3}$ gamma-gamma coincidence per gamma-ray recorded in the gamma-ray counter. This result should be particularly reliable, since, owing to the short resolving time, the background of accidental counts was virtually negligible for counting rates of 10,000 singles per minute in either counter. Cascade emission of gamma-rays in Au^{198} is thus established. For the same single counting rate and from the observed gamma-gamma coincidence rate, it is estimated that at a resolving time of one microsecond, the background of accidental coincidences would be approximately four times the number of geniune coincidences recorded in any particular period of time. This ratio emphasizes the importance of short resolving times.

The beta-gamma coincidence rate of Au^{198} was measured as 0.19×10^{-3} coincidence per beta-ray recorded in the beta-ray counter and was independent of the beta-ray energy. A delay of a few tenths of a microsecond has been reported in the emission of the 0.4-Mev gamma-ray which follows beta-emission.[6] In the course of measuring beta-gamma coincidences in the present experiment, the re-

solving time of the coincidence circuit was varied from 1.0 microsecond to 0.035±0.002 microsecond. No loss in the genuine beta-gamma coincidence rate was observed down to the shortest resolving time employed. This result must be regarded as evidence against the existence of a short-lived metastable state in Hg^{198}.

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[1] J. R. Richardson, Phys. Rev. **53**, 942 (1938); *ibid.* **55**, 609 (1939); G. J. Sizoo and C. Eijkman, Physica **6**, 332 (1939); J. L. Lawson and J. M. Cork, Phys. Rev. **58**, 580 (1940); E. H. Plesset, Phys. Rev. **62**, 181 (1942); N. Feather and J. Dainty, Proc. Camb. Phil. Soc. **40**, 57 (1944); M. L. Wiedenbeck and K. Y. Chu, Phys. Rev. **72**, 1171 (1947); P. W. Levy and E. Greuling, Phys. Rev. **73**, 83 (1948).
[2] Kai Siegbahn, Proc. Roy. Soc. **A189**, 527 (1947); J. M. Cork, Phys. Rev. **72**, 581 (1947).
[3] F. Norling, Arkiv f. Mat. Astr. O. Fys. **B(27)** 3, 9 (1941); E. T. Jurney and M. R. Keck, Bull. Am. Phys. Soc. **22**, No. 6, 6 (1947).
[4] A. F. Clark, Phys. Rev. **61**, 242 (1942); N. Feather and J. Dainty, Proc. Camb. Phil. Soc. **40**, 57 (1947); M. L. Wiedenbeck and K. Y. Chu, Phys. Rev. **72**, 1171 (1947).
[5] C. E. Mandeville and M. V. Scherb, Phys. Rev. **73**, 90 (1948).
[6] L. Madansky and M. L. Wiedenbeck, Phys. Rev. **72**, 185 (1947).

Anomalies in the Hyperfine Structure of CH_3I and ICN*

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Simmons and Gordy[1] have found that the usual formula for calculating nuclear quadrupole interaction in symmetric top molecules does not agree exactly with the experimentally observed values for the hyperfine structure of ammonia. We have found somewhat larger deviations from this theory in the hyperfine structure of methyl iodide. Certain hyperfine levels have been found to deviate from their theoretically predicted positions by the order of 1 to 3 megacycles. The disagreement with theory is most strikingly illustrated in the cases where theory predicts that because of degeneracy, certain lines in the hyperfine spectrum should fall at the same frequency. Some of these lines are separated by a few megacycles, as may be seen by examination of Fig. 1. Brackets are placed over those lines which, though predicted to fall at the same frequency, are completely resolved. For the $J=3$, $K=2$ rotational term there is, according to theory, no nuclear quadrupole coupling energy because of the vanishing of the factor $(3K^2/J(J+1)-1)$. Our observations, however, show that there is appreciable nuclear interaction for this case.

Deviations from theory in the hyperfine structure of the linear molecule ICN have also been noted. Table I gives a comparison of the nuclear quadrupole coupling of iodine determined by measurements on the different $F_1 \rightarrow F_1+1$ lines of the eighth rotational transition occurring in the region of 5.9 mm.

The nitrogen nuclear quadrupole effects, which for this transition are too small to be resolved, do not appear to

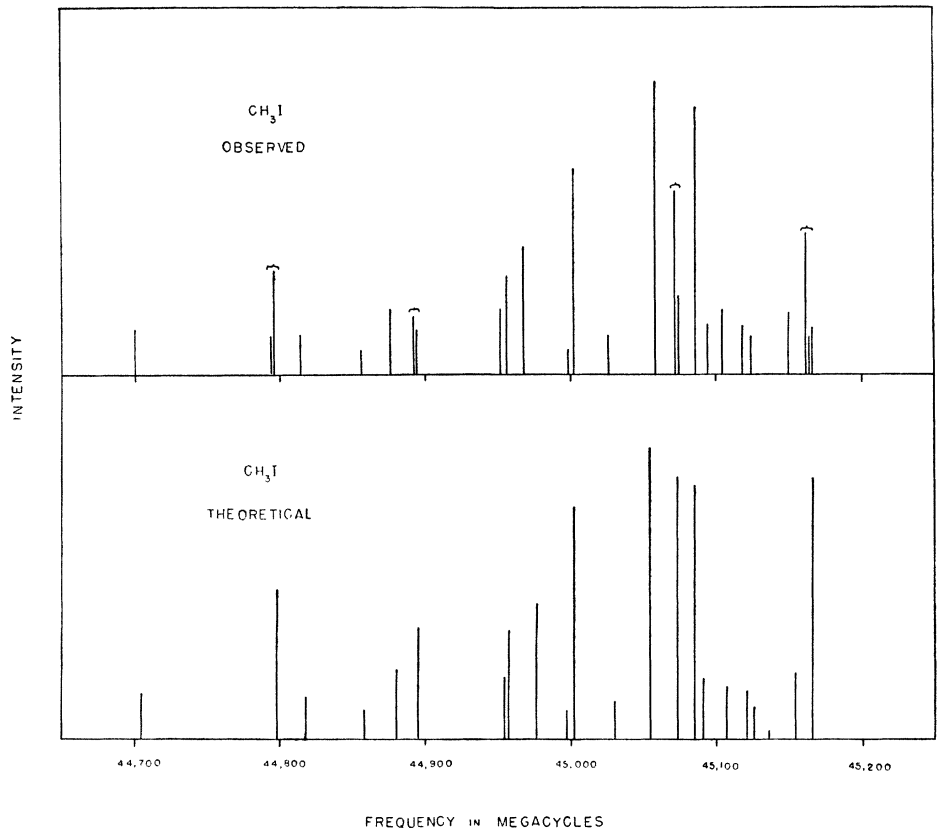

FIG. 1. Hyperfine structure of the $J=2\rightarrow3$ rotational transition of CH_3I.