Letters to the Editor

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Communications should not in general exceed 600 words in length.

On the Isotopic Constitution of Cobalt

JOHN J. MITCHELL, HARRISON S. BROWN AND ROBERT DUDLEY FOWLER
*Department of Chemistry, The Johns Hopkins University,
Baltimore, Maryland*
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THE question as to whether the cobalt isotope Co^{57} is stable or radioactive is one of considerable interest. Sampson and Bleakney[1] reported the existence of this isotope in 1936, after a mass spectrometric study of $CoCl_2$ vapor. The abundance of Co^{57} was estimated to be about 1 part in 600 of Co^{59}. Their work and the experimental fact that cobalt gives rise to two distinct water-sensitive activities upon neutron irradiation[2] were accepted as quite conclusive proof of the existence of Co^{57} as a stable or very long-lived nuclear species. The deduction that the 36-hour nickel activity[3] is due to Ni^{57} would appear to lend weight to the spectrometric measurements, as the Ni^{57} presumably decays to stable Co^{57}.

However, several rather puzzling features connected with the existence of Co^{57} seemed to warrant a reinvestigation with a mass spectrometer. Co^{57} possesses a stable neighboring isobar Fe^{57}. While this would not be unusual among the heavier nuclei, it is quite unusual among the lighter species. Only one such case exists in the region of low atomic number, namely that of radioactive K^{41}. This particular feature of Co^{57} becomes still more striking when one realizes that the two similar nuclei V^{49} and Mn^{53} are

FIG. 1. A typical mass spectrum of cobalt containing a small amount of nickel and iron impurities.

non-existent in nature. It might be well to point out, also, that the existence of Co^{57} proved to be one of but three exceptions to the interesting considerations of Dickinson and Konopinski in their empirical correlation of half-lives.[4]

The experimental evidence against the existence of Co^{57} is meager but suggestive. The 70-day Co^{58} has never been observed by slow neutron irradiation of cobalt. It has been produced only by cross bombardment of neighboring elements. The 7-year $(n-\gamma)$ product is quite definitely Co^{60}. The 11-minute $(n-\gamma)$ product is either an isomer of Co^{60} or of Co^{58}. It is to be noted that the existence of nuclear isomerism renders unnecessary the hypothesis of a stable Co^{57} in order to explain the existence of two neutron-induced activities.

We consequently analyzed cobalt with a 180° Dempster-type mass spectrometer of 15-cm radius of curvature.[5] Anhydrous $CoCl_2$ was vaporized in the ion source. The ions were formed by electron bombardment. They were then accelerated through about 2000 volts before entering the magnetic field. Both the Co^+ and the $CoCl^+$ ions were studied. Figure 1 shows a typical mass spectrum of the Co^+ ions. As the $CoCl_2$ contained an appreciable amount of nickel and a small amount of iron, peaks at 60, 58, and 56 can be seen, besides the large peak at 59 corresponding to cobalt. No trace of a peak was observed at mass number 57. Because of the steadiness of the spectrometer, we would be able to detect a peak as low as 2 percent of background. Using this figure, one can see that if Co^{57} exists it must exist to less than 1 part in 30,000 of Co^{59}. The iron impurity was low enough so that the Fe^{57} present in no way interfered with the evaluation of the above limit.

A study of the $CoCl^+$ ions showed no trace of a peak at mass 92, although there were peaks at 91, 93, 94, 95 and 96. Because of the low ion intensities, the limit with the $CoCl^+$ ions could be set at only 1 part in 2000.

From the low limit of 1 part in 30,000 set for the abundance of Co^{57}, one can see that it is quite impossible for the 11-minute cobalt activity to be due to Co^{58}. Consequently, the activity is probably isomeric with the 7-year activity ascribed to Co^{60}.

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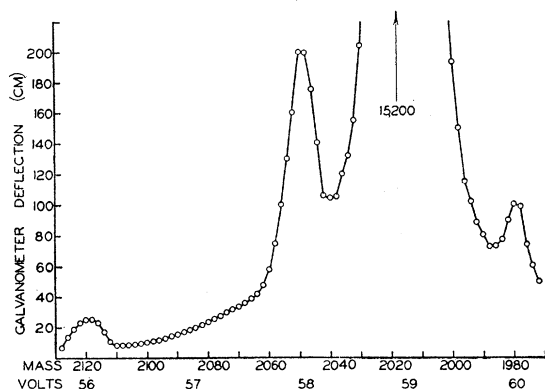
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Note on the Beta-Ray Energy of H^3

R. D. O'NEAL
University of Illinois, Urbana, Illinois
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BROWN[1] has recently published a value of 9.5 ± 2 kev for the maximum energy of the beta-rays from H^3. Although this is in disagreement with O'Neal and Goldhaber's[2] previously reported value of 15 ± 3 kev, his experimentally determined range is in essential agreement with

theirs, and the discrepancy is in the use of the range-energy relations.

Since only the result of the latter's measurements, 15 ± 3 kev, has been reported, a few details will be given here. The range was determined simply by varying the pressure of Trost mixture (argon and alcohol in the ratio 9 to 1) in a chamber containing a screen-wall Geiger counter and a previously bombarded beryllium target used as a source of H^3 electrons. This admittedly rough measurement gave as a range for the H^3 electrons 0.46 ± 0.05 mg/cm² of Trost mixture. Data[3,4] of atomic stopping powers for α-particle absorption were used to convert this range into a range in aluminum. Unfortunately, these atomic stopping powers are not particularly well known at this low energy, but by using what seemed the most likely values, a range of 0.48 ± 0.06 mg/cm² of aluminum was found.

Brown's measurements gave a range of 0.23 mg/cm² of helium for these beta-rays. Upon taking, from α-particle data,[3,4] the atomic stopping powers referred to air of 1.25 for aluminum and 0.40 for helium, it was found that this range corresponded to a range of 0.50 mg/cm² of aluminum, a value in good agreement with the above. This treatment for helium seems well justified since Alper,[5] comparing air and helium, showed experimentally, for low energy electrons, that the relative stopping powers for α-particles and for electrons are the same to within the limits of error of his experiment, about 5 percent.

The range of 0.48 mg/cm² of aluminum corresponded, according to the range-energy curve for aluminum in Rasetti's[6] *Elements of Nuclear Physics*, to an energy of 15 ± 2 kev. A plot of Schonland's[7] data for the absorption of homogeneous cathode rays in aluminum showed that this range corresponded to a maximum energy of the beta-rays of about 16 kev. However, since Schonland's data are for extrapolated ranges, one might expect this value to be somewhat high. It may, therefore, be concluded that 15 ± 3 kev is a reasonable value for the maximum energy of the beta-rays from H^3.

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Electrets Made from Dry-Mixed Components

WELLESLEY J. DODDS AND J. D. STRANATHAN
Department of Physics, University of Kansas, Lawrence, Kansas
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PERMANENT electrets are ordinarily made by mixing the wax and rosin components while in the melted state, and it is known[1] that the thoroughness of mixing affects the subsequent behavior of the electret. A method has been developed for making these electrets from dry-mixed components. The resulting electrets are strong, smooth, and physically uniform. They exhibit the usual electrical characteristics. It appears somewhat easier to duplicate these characteristics by the present method of manufacture than by the usual method.

The "Selected Flora" carnauba wax and the "WG" grade[2] rosin used in making these electrets were first pulverized with a mortar and pestle. Each component was then sifted through a series of sieves with meshes conforming to U.S.B.S. specifications. Equal portions by weight of a chosen size of each powdered component were then mixed in a mechanically driven mixer, the time of mixing being the same in all cases. The desired amount of the dry-mix was weighed out in a tinned pan and placed in an electrode-and-tank system[1] which was immersed in an oil bath. The melting and cooling times for the electret were carefully controlled, and a uniform procedure adopted for all electrets.

Proper choice of particle size is necessary to eliminate two faults which otherwise appear in the resulting electrets. If too large particles are used, stratification into two component layers occurs during melting. If too small particles are used, numerous small bubbles, probably of air, appear on the raised surface of the electret next to the movable electrode.[1] These bubbles can be removed by holding the material at a temperature slightly above its melting point for a longer time, but this procedure causes stratification for still smaller particles. Both stratification and air bubbles can be avoided by using particle sizes smaller than U.S.B.S. #30 but larger than #200.

Electrets made after the method described show the same general shape of reversal curve[1,3-5] as those made by other methods, and are closely reproducible both physically and electrically. Preliminary work indicates a slight particle-size effect on the shape of the reversal curve. The general shape of the reversal curve is given by a simple mathematical relation[5] of exponential form. The reversal times of electrets made in the present investigation were considerably shorter than many of those reported in the literature for electrets of similar composition. This is due to the grade of carnauba wax and rosin used, rather than to the method of manufacture.

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[5] W. J. Dodds, master's thesis, University of Kansas (1941).

Effect of Pressure on the Surface Charge of an Electret

GLENN E. SHEPPARD AND J. D. STRANATHAN
Department of Physics, University of Kansas, Lawrence, Kansas
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PERMANENT electrets[1,2] made of equal parts by weight of "Selected Flora" carnauba wax and "WG" grade[3] rosin have been studied under air pressures from 10 to 228 cm of Hg. The electrets were manufactured under atmospheric pressure by the method described by Good and Stranathan,[4] except that the two components were powdered and mixed dry, as suggested by Dodds and Stranathan.[5] An electric field of 11,000 volts/cm was used