Letters to the Editor

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On the Isotopic Constitution of Cobalt

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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 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]

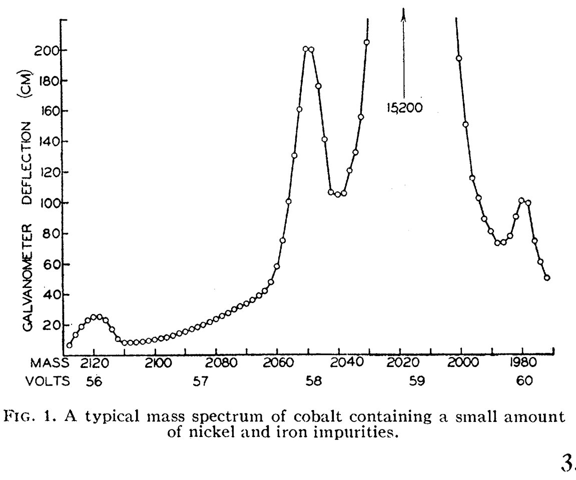

FIG. 1. A typical mass spectrum of cobalt containing a small amount of nickel and iron impurities.

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}.

We wish to thank Dr. H. A. B. Dunning whose financial support made this work possible.

[1] M. B. Sampson and W. Bleakney, Phys. Rev. **50**, 732 (1936).
[2] (a) J. R. Risser, Phys. Rev. **52**, 768 (1937); (b) J. J. Livingood and G. T. Seaborg, Phys. Rev. **53**, 847 (1938); (c) F. A. Heyn, Physica **4**, 160 (1937); (d) Livingood, Seaborg and Fairbrother, Phys. Rev. **52**, 135 (1937).
[3] J. J. Livingood and G. T. Seaborg, Phys. Rev. **53**, 765 (1938).
[4] G. R. Dickinson and E. J. Konopinski, Phys. Rev. **58**, 949 (1940).
[5] Brown, Mitchell, and Fowler, Rev. Sci. Inst. (in press).

Note on the Beta-Ray Energy of H^3

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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