Radiations from Radioactive Co^{56}

C. SHARP COOK AND PAUL W. MCDANIEL
Department of Physics, Indiana University, Bloomington, Indiana
(Received August 12, 1942)

LIVINGOOD and Seaborg[1] have reported a new cobalt isotope of about 72-days half-life. This isotope emits positrons and gamma-radiation of considerably higher energy than does the previously reported 72-day cobalt activity. It has also been found to be independent of the first-known 72-day activity and has been subsequently assigned to Co^{56}, the lower energy activity being assigned to Co^{58}.

A nickel wire was bombarded by deuterons in the Indiana University cyclotron and was allowed to age for nearly two months before measurements were taken. The shorter-lived isotopes of nickel, cobalt, and copper which would appear normally from such a bombardment thus had time to decay to a point at which they would no longer be of sufficient intensity to cause trouble. The only isotopes of these three elements which would remain active after such a time would be the long-lived isotopes of cobalt (72-day, 270-day, and 5.5-year) which could not be separated chemically. According to Livingood and Seaborg's[1] isotope assignments the 270-day cobalt could not be produced by deuteron bombardment of nickel. Of the other two the probability of producing the 72-day activity is much greater than that of producing the 5.5-year activity.

Measurements were made with a high speed amplifier and scaling circuit, previously developed in this laboratory.[2] The apparatus was capable of measuring radiations of one type or coincidences between two or more types of radiations.

Over a period of two and a half months the activity was measured on a single counter with and without an aluminum absorber. The half-life obtained for the beta-rays and for the gamma-rays was identical, being 80 ± 5 days, with no apparent change to a longer half-life.

The beta-ray end point was found to be at 0.48 g/cm^2 of aluminum, which corresponds to a particle whose maximum energy is 1.2 Mev. A part of the sample was put in the cloud chamber by Mr. Franklin E. Waterfall. The activity was found to be of positive charge.

The energy of the gamma-rays was investigated by allowing the gamma-rays to eject Compton electrons from an aluminum radiator and measuring the range of these electrons. The electrons produced in the radiator pass through two counters, arranged in a coincidence circuit, and the number of coincidences is studied as a function of the thickness of aluminum placed between the two counters. The range is given by that thickness of aluminum at which the number of coincidences reaches a constant value. At this point all electrons produced in the radiator have been absorbed by the aluminum and the appropriate counter wall thickness (0.18 g/cm^2). The range of the Compton electrons from the cobalt sample was 1.34 g/cm^2, corresponding to an energy (for the highest energy

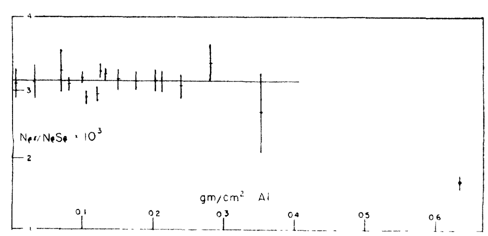

FIG. 1. Beta-gamma-coincidences as a function of the beta-ray energy. Solid circle shows $N_{\gamma\gamma}/N_\gamma S_\gamma$.

gamma-ray) of 2.9 Mev.[3] By use of the method described by Mitchell and Langer,[4] the average energy of the gamma-rays was found to be 1.74 Mev. An ordinary absorption curve in lead gave an absorption coefficient of 0.536 cm^{-1}, corresponding to an energy of 1.7 Mev.[5]

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Measurements of the number of beta-gamma-coincidences as a function of the energy of the beta-rays is shown in Fig. 1. Since the number of beta-gamma-coincidences per disintegration does not change with energy, it can be concluded that the beta-ray spectrum is simple. The average number of beta-gamma-coincidences per recorded beta-particle is 3.1×10^{-3}. Gamma-gamma-coincidences were also found, the number per recorded gamma-ray being 1.7×10^{-3}. Gamma-gamma-coincidence measurements were made over a period of about one month and were found to decay with essentially the same half-life as do the singles. The above evidence leads one to believe that positron emission leaves the resulting nucleus in an excited state from which one or more gamma-rays follow. Whether more than one gamma-ray follows the positron cannot be definitely stated at the present time. The fact that the number of recorded gamma-rays is so large in comparison to the number of recorded positive particles (a ratio of about one to three) leads one to suspect a process competing with the positron decay. Thus we are led to the conclusion that perhaps the K-capture process is also present.

The authors wish to express their thanks to Professor Allan C. G. Mitchell for his advice and interest during the progress of the work, Mr. Edward der Mateosian for help with certain parts of the chemical separation, and Dr. Hugh Hunter and other members of the cyclotron crew who helped run the cyclotron.

NOVEMBER 1 AND 15, 1942 PHYSICAL REVIEW VOLUME 62

Artificial Radioactivity of Cr^{49}

J. J. O'Connor, M. L. Pool, and J. D. Kurbatov
The Ohio State University, Columbus, Ohio
(Received July 24, 1942)

A radioactive isotope of half-life 41.9 ± 0.3 minutes has been produced by alpha-particle bombardment of titanium and by fast neutron bombardment of chromium. Evidence presented shows that the activity should be assigned to Cr^{49}. Absorption measurements indicate the presence of gamma-rays of energies 0.19 and 1.55 Mev. The end point of the positron spectrum is 1.45 Mev. The 33-minute activity in vanadium is assigned to V^{47}.

INTRODUCTION

Many radioactive isotopes have been reported in the region of chromium and vanadium. Of particular interest in the present discussion are the 600-day,[1] 16-day,[2] 33-minute,[2] and 3.7-hour[2] periods of vanadium and the 26.5-day[3] period of chromium. In Fig. 1 are shown these and other adjoining isotopes exactly as they have been reported with the exception of the 33-minute period which has been changed from V^{49} to V^{47}. The data necessitating this change will be discussed later.

The present study of this region was begun in an effort to determine the position and characteristics of a newly observed 41.9-minute positron emitter which was obtained after activation of titanium with alpha-particles. Bombardments were made with the cyclotron at The Ohio State University which furnishes approximately 20-Mev alpha-particles, 10-Mev deuterons, and 5-Mev protons. Fast neutrons were obtained from deuteron bombardment of lithium. Decay and absorption measurements were made by means of a Wulf quartz fiber electrometer connected to a Freon filled ionization chamber. The length of bombardment was always adjusted to discriminate against a long period. The substances bombarded include chemically pure TiO_2, Sc_2O_3, Cr_2O_3, and V_2O_5.

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