conclusive, since the differences in spacing between successive elements are about the same as the experimental uncertainties of electron energies. Tentatively, as indicated above, the 52-kev γ-ray is assigned to the β^--transition and the 38-kev γ-ray to the electron-capture transition. This leaves unaccounted for the origin of the x-rays of americium, so if the above assignments are to be taken seriously, the conversion electrons accompanying the isomeric transition must lie among the Auger electrons. There is some evidence that this is the case.

Lead and copper absorption curves showed no hard γ-rays or K x-rays and only the 50-kev soft γ-ray. When compared with the abundance of the conversion electrons, this γ-ray appears to be about 50 percent converted.

From arguments (not all consistent) based on relative abundances of x-rays, conversion electrons, and the β^--particles, Am^{242m} appears to decay about 60 percent by β^--emission, 20 percent by L-electron capture, and 20 percent by isomeric transition. All three of the modes of decay give rise to L-series x-rays which, when properly assigned and abundances measured, should aid materially in arriving at a decay scheme and in shedding light on the nuclear processes which result in the particular x-rays of this interesting nucleus.

The β^--particle of the ground state of Am^{242} has also been measured, but the accuracy of the end point has not yet been determined with desirable accuracy. The value obtained is 580±30 kev which is consistent with the supposed 52 kev associated with the isomeric transition of Am^{242m}.

* This work was performed under the auspices of the AEC.

[1] Seaborg, James, and Morgan, *The Transuranium Elements: Research Papers* (McGraw-Hill Book Company, Inc., New York, 1949), Paper No. No. 22.1, National Nuclear Energy Series, Plutonium Project Record, Vol. 14B.

[2] W. M. Manning and L. B. Asprey, loc. cit., Paper No. 22.7.

[3] Thompson, Street, Ghiorso, and Reynolds, University of California Radiation Laboratory Report, UCRL-657 (June, 1950), to be submitted for publication.

[4] Barton, Robinson, and Perlman, to be submitted for publication.

On Sommerfeld's Surface Wave

C. J. BOUWKAMP
Philips Research Laboratories, Eindhoven, Netherlands
October 24, 1949*

NUMEROUS papers on the theory of propagation of electromagnetic waves over plane earth have appeared, following Sommerfeld's celebrated paper[1] of 1909. Though it has been realized by subsequent authors that Sommerfeld's discussion of his basic equation for the vector potential of a vertical electric dipole in the presence of the earth is not quite satisfactory, this equation itself was generally accepted. However, in 1947 Epstein[2] proposed a new solution. As I have pointed out elsewhere[3] Epstein's expression for the vector potential is incompatible with the physical situation because it is singular along the whole axis of the dipole, whereas Sommerfeld's solution is regular outside the dipole. In fact, Epstein's solution is nothing but Sommerfeld's solution minus the surface wave.

The surface-wave problem was reconsidered by Kahan and Eckart. In their first note[4] these authors accepted Epstein's solution as being the only one compatible with Sommerfeld's radiation condition,[5] though they only showed that the surface wave does not fulfill this condition. It is, of course, immaterial whether some part (e.g., the surface-wave term) of Sommerfeld's solution does or does not satisfy the radiation condition. The behavior of the complete solution is conclusive.

In a second note,[6] Eckart and Kahan come to the conclusion that Epstein's solution is incorrect, though they fail to mention that they were of a different opinion in their first note.[4] They now accept Sommerfeld's original solution and point out that Sommerfeld's evaluation of the integral along the branch cut is in error. They stress that a correct evaluation would have yielded an expression that contains the surface wave with negative sign, so that the final result would have coincided with Weyl's result,[7] the negative surface-wave term being cancelled by the positive term due to the residue of the pole of the integrand. This explanation and clarification of the controversy is not at all new but has been known since 1937 through the work of Wise[8] and Rice.[9]

In two longer papers,[10, 11] of which the last is apparently an English version of the first, Kahan and Eckart elaborate their previous discussions. In view of the foregoing arguments it will be evident that a detailed analysis of these papers is unfruitful. Let it be sufficient to mention, therefore, that the only new and interesting part of these two papers consists in an attempt to prove a uniqueness theorem on the basis of Sommerfeld's radiation condition, for real-valued wave numbers k_1 and k_2. Unfortunately, their proof breaks down, as one can demonstrate from Eq. (24) of reference 11. The left-hand member of this equation is a space integral of which the imaginary part is zero. The right-hand member is a surface integral of which the real part is zero. It is important to note that Eq. (24) is only valid in the limit $R\rightarrow\infty$. It is true that both members of Eq. (24) tend to zero as $R\rightarrow\infty$. Consequently, Ru_1 and Ru_2 tend to zero if R tends to infinity. This is the only important conclusion that can be drawn from Eq. (24). It cannot be inferred that u_1 and u_2 vanish identically, because the left-hand member, though equal to zero, consists of a sum of positive and negative terms. Whereas in many problems Sommerfeld's condition $\lim_{R\rightarrow\infty}R(\partial u/\partial R-iku)=0$ is sufficient, and $Ru\rightarrow 0$ superfluous, this does not hold in the presence of an infinite plane earth, as is apparent from Rellich's paper.[12] If the earth is infinite, Sommerfeld's conventional form of the radiation condition does not apply at all, and even Rellich's theorem[12] is not applicable to a *plane* earth.

* Revised manuscript received August 28, 1950.

[1] A. Sommerfeld, Ann. d. Physik **28**, 665 (1909).

[2] P. S. Epstein, Proc. Nat. Acad. Sci. **33**, 195 (1947).

[3] C. J. Bouwkamp, Math. Rev. **9**, 126, 637 (1948).

[4] T. Kahan and G. Eckart, Comptes Rendus **226**, 1513 (1948).

[5] See A. Sommerfeld, Vorlesungen über theoretische Physik (Wiesbaden, 1947), Vol. 6, p. 192.

[6] G. Eckart and T. Kahan, Comptes Rendus **227**, 969 (1948).

[7] H. Weyl, Ann. d. Physik **60**, 481 (1919).

[8] W. H. Wise, Bell Sys. Tech. J. **16**, 35 (1937).

[9] S. O. Rice, Bell Sys. Tech. J. **16**, 101 (1937).

[10] T. Kahan and G. Eckart, J. de phys. et rad. **10**, 165 (1949).

[11] T. Kahan and G. Eckart, Phys. Rev. **76**, 406 (1949).

[12] F. Rellich, Jahresber. d. Deutsch. Math. Ver. **53**, 57 (1943).

On the Transport of Aluminum Atoms by a Gas

MICHEL TER-POGOSSIAN, FRED T. PORTER, AND C. SHARP COOK
Physics Department, Washington University, St. Louis, Missouri*
August 28, 1950

A SYSTEM which provides for the continuous flow of radioactive gas[1] between a duraluminum bombardment chamber at the cyclotron and a 14-cm radius of curvature magnetic spectrometer[2] has been in operation in this laboratory for several months. Because of the distance between the cyclotron building and the physics laboratory where the spectrometer is located, it is necessary to circulate the gas between these two buildings through underground copper pipes. The total length of pipe between the bombardment chamber at the cyclotron and the beta-ray spectrometer is 600 feet. An experimentally measured time of 16 seconds is required for the gas to travel through this length of pipe.

One of the most interesting facts discovered to date while using this system is that an activity which can be attributed to Al^{28} can be carried through the system in appreciable quantities. The fact that the activity belongs to aluminum has been verified in a number of ways. The maximum beta-ray end-point energy (2.8 Mev according to our measurements) and the half-life (127 seconds) of this activity as measured at the magnetic spectrometer end of the system agree quite closely with previously reported[3] values for Al^{28}. The activity appears to be produced because of the duraluminum construction of the bombardment chamber and the window separating the main vacuum system of the cyclotron from this chamber. The cyclotron beam (10 Mev, 100 μamp. for